

## Reporting Summary

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### 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

The online tasks were created using PsychoPy3 (v2020.1.2) and were uploaded to the task hosting site Pavlovia for distribution to participants. Pavlovia used the javascript package PsychoJS to display tasks in the web browser. Each task used the latest version of Pavlovia and PsychoJS available at the time of data collection. The code for the data collection task and survey are now available at <https://gitlab.pavlovia.org/mooddrift>.

#### Data analysis

Data were analysed using custom Python 3 (version 3.8.8) software depending on several Python packages, including the Pymer4 package (version 0.7.3). This software, as well as the means to create a Python environment that automatically installs it on a user's machine, has been made available at <https://github.com/djangraw/MoodDrift>. As stated on that site, the dependencies and their versions are: python=3.8.8 numpy=1.19.2 pandas=1.1.5 pytest=6.2.2 joblib=1.0.1 rpy2=3.4.3 matplotlib=3.3.4 seaborn=0.11.1 scikit-learn=0.24.1 numexpr=2.7.3 patsy=0.5.1 statsmodels=0.12.2 openpyxl=3.0.7 pymer4=0.7.3 r-psych=2.1.3 xlrd=2.0.1 r-mumin=1.43.17.

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 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

All data used in the manuscript have been made publicly available. Online Participants' data can be found on the Open Science Framework at <https://osf.io/km69z>. Mobile App Participants' data can be found on Dryad at <https://doi.org/10.5061/dryad.prr4xgkxk>.

## 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://nature.com/documents/nr-reporting-summary-flat.pdf)

## Behavioural & social sciences study design

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

### Study description

The study consists primarily of quantitative cross-sectional data about the subjective mood of participants and how patterns in these mood ratings relate to their depression risk as assessed by clinical questionnaires. Some cohorts of participants completed slightly modified versions of the task to assess these patterns' sensitivity to changes in the task. These cohorts always consisted of naive participants to reduce expectation effects, and they were, in general, recruited in series rather than randomized to a condition on the same day. Some participants, however, were asked to return multiple times to assess the stability of their mood rating behaviour.

### Research sample

There are four distinct research samples in this study. 1) Original cohort of Online Adult Participants recruited using Amazon Mechanical Turk. Participants were required to be adults living in the United States who had completed over 5,000 jobs for other requesters with a 97% satisfactory completion rate. 914 participants completed the task online. Some data files did not save properly due to technical difficulties or the participant closing the task window before being asked to do so. 44 participants whose task or survey data did not save were excluded. Of the 870 remaining Mechanical Turk participants, 390 were female (44.8%). Participants had a mean age of 37.6 years (range: 19-74).

2) Online adolescent participants recruited in person at the National Institute of Mental Health. Adolescent participants recruited in person at the National Institute of Mental Health were also invited to participate by completing a similar task on their computer at home. These participants completed a different set of questionnaires, developed for adolescents, about their mental health. Every participant received the same scripted instructions and provided informed consent to a protocol approved by the NIH Institutional Review Board. 129 adolescents completed the task. 10 adolescents who had not completed all three questionnaires were excluded from the results as were 3 participants declined to allow their data to be shared openly. Of the remaining 116 adolescent participants, 77 were female (66.4%). They had a mean age of 16.3 years (range: 12 - 19). 56 participants (48.2%) had been diagnosed with MDD by a clinician at the NIH, and 4 were determined to have sub-clinical MDD (3.4%). Participants had a mean depression score of MFQ = 6.5 ( $\pm$  5.5 SD) and a mean anxiety score of SCARED = 2.2 ( $\pm$  3.0 SD).

3) Mobile App Participants: Gambling behaviour and mood rating data were collected from a mobile app called "The Great Brain Experiment", described in Rutledge et al., 2014. The Research Ethics Committee of University College London approved the study. When participants opened the app for the first time, they gave informed consent by reading a screen of information about the research and clicking "I Agree." They then rated their life satisfaction as an integer between 0 (not at all) and 10 (completely). Any time they used the app after this, participants could then choose between several games, including one called "What makes me happy?" that was used in this research. We used a subset of 26,896 people, largely from the US and UK in our analyses. The median life satisfaction of the included subjects, which will be used as a proxy for depression risk in this cohort, was 7/10. Age for this cohort was provided in bands. These are the bands and number of individuals in each band in the subset of data used in our analysis: 18-24 (6,500), 25-29 (4,522), 30-39 (7,190), 40-49 (4,829), 50-59 (2,403), 60-69 (1,158), and 70+ (294). 13,168 were female (49.0%).

4) Follow-Up Cohort: a cohort of online adult participants recruited identically to Sample #1 to answer specific preregistered hypotheses about boredom, mind-wandering, and freely chosen activities. 1143 participants completed the task online in this cohort. 93 participants were excluded because their task or survey data was incomplete or did not save, because they completed the task more than once despite instructions to the contrary, or because they failed to answer one or more "catch" questions correctly on the survey. Of the 1050 remaining participants, 463 were female (44.1%). Participants had a mean age of 39.3 years (range: 20-80).

We recruited the adult (MTurk) and an adolescent sample so as to ensure that we cover both age ranges and can therefore draw inferences about any developmental differences. The adult (MTurk) sample was collected online and should be considered a convenience rather than a nationally representative sample. The adolescent sample was collected so as to be enriched for mental health difficulties, MDD in particular. This enrichment allows us also to draw inferences about the relationship between depression and passage of time dysphoria in that age range. Finally, the Mobile App Participant sample should also be considered a convenience rather than a nationally representative sample.

Sampling strategy	<p>Cohorts 1-3 are convenience samples. No sample-size calculations were performed a priori. Sample sizes for each batch of the Online Adult Participants was ad hoc. All together, nearly 1,000 participants were recruited on MTurk and in person, which was sufficient to demonstrate the mood drift over time effect repeatedly both within cohorts and within individuals. The Online Adolescent data and a subset of the Online Adult Participants were asked to complete the task multiple times on different days or different weeks, all other data was collected cross-sectionally. The adolescent online participants were recruited from an ongoing study characterizing adolescent depression.</p> <p>The Follow-Up Cohort sample sizes were selected using power calculations described in detail in the preregistration. For the scale validation experiments, a sample size of 150 in each group with an alpha of 0.01 gives 99.02 power to detect a medium effect (<math>d = 0.5</math>) and 83.04% power to detect an intermediate effect (<math>d = 0.3</math>) assuming the effect truly is null at a population level. Power for linear multiple regression tests were calculated in G*Power. In the boredom and MW cohorts, samples of 150 participants were selected to provide 80% power to detect a 7.99% increase in variance explained with the inclusion of a single parameter (<math>\alpha = 0.01</math>, 20 total predictors) and a 95% power to detect a 12.18% change in variance explained. In analyses using a pair of cohorts, 300 participants gives 80% power to detect a 3.93% increase in variance explained and a 95% power to detect a 6.01% increase in variance explained. An Activities cohort of 450 participants was chosen to provide 80% power to detect a difference between the Activities and MTurk cohorts of Cohen's <math>d = 0.2</math>, and it also provides 80% power to detect a decrease in mood in the Activities cohort of Cohen's <math>d = 0.15</math>.</p>
Data collection	All data were collected online. Data from Mobile App Participants was collected through a mobile app, all other data was collected online through a web browser. No members of the study team were present when participants were completed forms or tasks. Researchers were not blinded to experimental condition or study hypotheses.
Timing	<p>Data for the original online adult sample was collected in batches from September 27th, 2019 to June 19th, 2020.</p> <p>Data from the online adolescent sample was collected from April 6th, 2020 to June 5th, 2020.</p> <p>Data from the mobile app participants was collected from January 4th, 2013 to December 9th 2015.</p> <p>Data from the follow-up cohorts (Activities, Mind-wandering, and Boredom) were collected from December 9, 2021 to January 8, 2022.</p>
Data exclusions	Data from the original cohort of Online Adult Participants were excluded if data was missing or incomplete or they failed to answer catch questions correctly, which impacted 44 participants. In the Online Adolescent Participants, 10 adolescents who had not completed all three questionnaires were excluded from the results as were 3 participants who declined to allow their data to be shared openly. In linear mixed effects models on the Mobile App Participants, we excluded participants whose average response times were more than 1.5 times the interquartile range below the first quartile or above the third quartile. In the 5000 exploratory participants, 217 had long average response times and 15 had short average reaction times for a total of 232 participants excluded. In the 21,896 confirmatory participants 981 had long average response times and 38 had short average reaction times for a total of 1019 participants excluded. In the Follow-Up Cohort participants, 93 participants whose data was missing or incomplete or who failed to answer catch questions correctly were excluded.
Non-participation	There were 230 adolescents enrolled in the NIMH depression characterization study who were offered to complete tasks for this study as Online Adolescent Participants. 129 agreed to complete tasks for this study, a participation rate of 56.1%. 82 (70.6%) individuals completed the task a week later and 4 (3.4%) completed the task a third time the following week. Due to the low participation rate in the third visit, only the first two were used. There were two longitudinal samples in the Adult Online cohort. One subset was asked to return 1 day later (Daily-Rest). Of the 66 individuals who completed both the task and the survey on the first day, 53 (80.3%) completed the task and survey on the second day. One subset was asked to return weekly for three weeks (Weekly-Rest). 196 individuals completed the task and survey the first week. 163 (83.2%) of these completed the task and survey the second week and 158 (80.6%) completed the task and survey the third week. 149 (76.0%) individuals completed the task and survey on all three waves.
Randomization	Participants in the Expectation cohorts (a subset of the original Online Adult Participants) were randomised to the Expectation-7mRest or Expectation-12mRest cohort at the time of participation. Participants in the Follow-Up Cohort were randomised to one of 5 groups (BoredomBeforeAndAfter, BoredomAfterOnly, MwBeforeAndAfter, MwAfterOnly, or Activities) at the time of participation. There was no random allocation of participants between conditions in the other cohorts because they were collected in series to answer an evolving set of questions about mood drift over time.

## 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
<input checked="" type="checkbox"/>	<input type="checkbox"/> Antibodies
<input checked="" type="checkbox"/>	<input type="checkbox"/> Eukaryotic cell lines
<input checked="" type="checkbox"/>	<input type="checkbox"/> Palaeontology and archaeology
<input checked="" type="checkbox"/>	<input type="checkbox"/> Animals and other organisms
<input type="checkbox"/>	<input checked="" type="checkbox"/> Human research participants
<input checked="" type="checkbox"/>	<input type="checkbox"/> Clinical data
<input checked="" type="checkbox"/>	<input type="checkbox"/> Dual use research of concern

### 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

## Human research participants

Policy information about [studies involving human research participants](#)

Population characteristics

See above

Recruitment

See above

Ethics oversight

Because we did not obtain information by direct intervention or interaction with the Adult Online participants and did not obtain any personally identifiable private information, our MTurk studies were classified as not human subjects research and were determined to be exempt from IRB review by the NIH Office of Human Subjects Research Protections (OHSRP). The consent process and task/survey specifics were approved by the OHSRP.

Adolescent participants recruited in person at the National Institute of Mental Health provided informed consent to a protocol approved by the NIH Institutional Review Board.

Gambling behaviour and mood rating data were collected from the Mobile App Participants in a mobile app called "The Great Brain Experiment", described in (Rutledge, 2014). The Research Ethics Committee of University College London approved the original study.

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