# nature research

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# **Reporting Summary**

Nature Research 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 Research policies, see our <u>Editorial Policies</u> and the <u>Editorial Policy Checklist</u>.

#### Statistics

For	all st	atistical analyses, confirm that the following items are present in the figure legend, table legend, main text, or Methods section.
n/a	Cor	firmed
	$\boxtimes$	The exact sample size ( $n$ ) for each experimental group/condition, given as a discrete number and unit of measurement
	$\square$	A statement on whether measurements were taken from distinct samples or whether the same sample was measured repeatedly
	$\boxtimes$	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.
	$\square$	A description of all covariates tested
	$\square$	A description of any assumptions or corrections, such as tests of normality and adjustment for multiple comparisons
	$\boxtimes$	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)
	$\boxtimes$	For null hypothesis testing, the test statistic (e.g. <i>F</i> , <i>t</i> , <i>r</i> ) with confidence intervals, effect sizes, degrees of freedom and <i>P</i> value noted <i>Give P values as exact values whenever suitable</i> .
$\boxtimes$		For Bayesian analysis, information on the choice of priors and Markov chain Monte Carlo settings
$\times$		For hierarchical and complex designs, identification of the appropriate level for tests and full reporting of outcomes
	$\square$	Estimates of effect sizes (e.g. Cohen's d, Pearson's r), indicating how they were calculated
		Our web collection on <u>statistics for biologists</u> contains articles on many of the points above.

## Software and code

Policy information	about <u>availability of computer code</u>
Data collection	JPK SPM software (BioAFM, Bruker, v. 6.1) was used for acquisition and analysis of AFM measurements, Microsoft office powerpoint v16.16.20 was used to make schematics and diagrams.
	• AFM software (specific to the experimental setup, e.g., SPM 6.0 JPK BioAFM, Bruker, https://www.jpk.com)
Data analysis	AFM data analysis was performed using JPK SPM software (v. 6.1). OriginPro 8 SRO software, Graphpad (Prism, v8.1.2) and IBM® SPSS® statistics version (IBM, V23) were used for graphical and statistical analyses.
	Annotated MATLAB R2019a or higher (Mathworks, https://www.mathworks.com) code for the analysis of force curves will be deposited on GitHub prior to publication.

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 <u>data availability statement</u>. 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

The unrestricted full MATLAB code used to analyse AFM F-D-curves will be deposited on GitHUB with accession codes prior to publication.

## Field-specific reporting

K Life sciences

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.

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 method was used to pre-determine sample size.			
Data exclusions	Force curves acquired by atomic force microscopy that did not meet the QC requirements described in Figure 4 were excluded from analyses in Figs. 5d (violin plots). No other data were excluded from other analyses.			
Replication	All replication experiments were successful. AFM measurements were taken from at least N=2 separate hydrogels synthesised from different batches on different days, and F-D-curve maps were sampled randomly across at least 3 different areas of the hydrogel surface.			
Randomization	Samples were prepared, treated, processed and analyzed in a random order.			
Blinding	The investigators were not blinded during this experiment, as the same investigators who set up the experiments carried out the analysis, which was incompatible with complete blinding.			

## 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
$\boxtimes$	Antibodies
$\boxtimes$	Eukaryotic cell lines
$\boxtimes$	Palaeontology and a

Palaeontology and archaeology

Human research participants

Clinical data

Dual use research of concern

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n/a	Involved in the study
$\boxtimes$	ChIP-seq
$\square$	Flow cytometry

MRI-based neuroimaging