

## 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 LabChart 8 software was used for data collection

Data analysis Data from LabChart 8 was exported to MATLAB R2021a. Data analysis was conducted via custom code written in MATLAB R2021a, to analyze parameters such as peak inspiratory flow and tidal volumes.

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 datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

# 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)

## Life sciences study design

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

Sample size

We used a total of nine swine during the development and testing of our system, and we present data from six swine in the manuscript. For each subject, a series of respiratory challenges and conditions were tested. In this study, each breath provides a data point for the various analyses shown. A single respiratory challenge supplies a large pool of data.

Data exclusions

Data from six swine are presented in this manuscript. The data from the three swine not shown were not conducted under the same conditions as the other six swine, and therefore are not presented. The six swine presented are labeled A-F. 5 of 6 swine (A-E) are shown in Fig. 2, subject F did not have data for the apnea condition at the start of the respiratory challenge and is therefore not shown. Fig. 3 shows data from all 6 swine. Fig. 5 omits subject C and F because the pressure sensing instrumentation was nonfunctional for those two swine and the data for this parameter was not collected.

Replication

The trends shown in Fig. 4 are from 1 respiratory challenge within the animal. To ensure replication, this analysis was conducted on all data from this subject, and the reported trend replicates in a different respiratory challenge within the same animal. For other subjects, the synchronization actually overly consistent, and therefore lacked the variability in timing needed to visualize these trends. In order to replicate these results in another subject, a sweep of the synchronization/delay will generate the appropriate variability needed.

Randomization

The full set of respiratory challenges were conducted in each subject, but in a semi-random order. (Independent vs synchronous challenge order was randomized, but the challenges conducted with a severed phrenic nerve necessarily came after all of the data with an intact phrenic nerve were collected).

Blinding

Individual subjects were not grouped and instead a variety of respiratory challenges were conducted within each subject.

## 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 type="checkbox"/>	<input checked="" type="checkbox"/> Animals and other organisms
<input checked="" type="checkbox"/>	<input 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

## Animals and other organisms

Policy information about [studies involving animals; ARRIVE guidelines](#) recommended for reporting animal research

Laboratory animals

Yorkshire swine, female, 30-40kg

Wild animals

n/a

Field-collected samples

n/a

Ethics oversight

All studies were conducted according to protocol #19-05-3907 approved by the Boston Children's Hospital (BCH) Institutional Animal Care and Use Committee (IACUC) policy.

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