Improving experimental design:
Ethical implications and how the Experimental Design Assistant (EDA) can help

NIH National Institutes of Health
Office of Laboratory Animal Welfare

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National Centre
for the Replacement
Refinement & Reduction
of Animals in Research

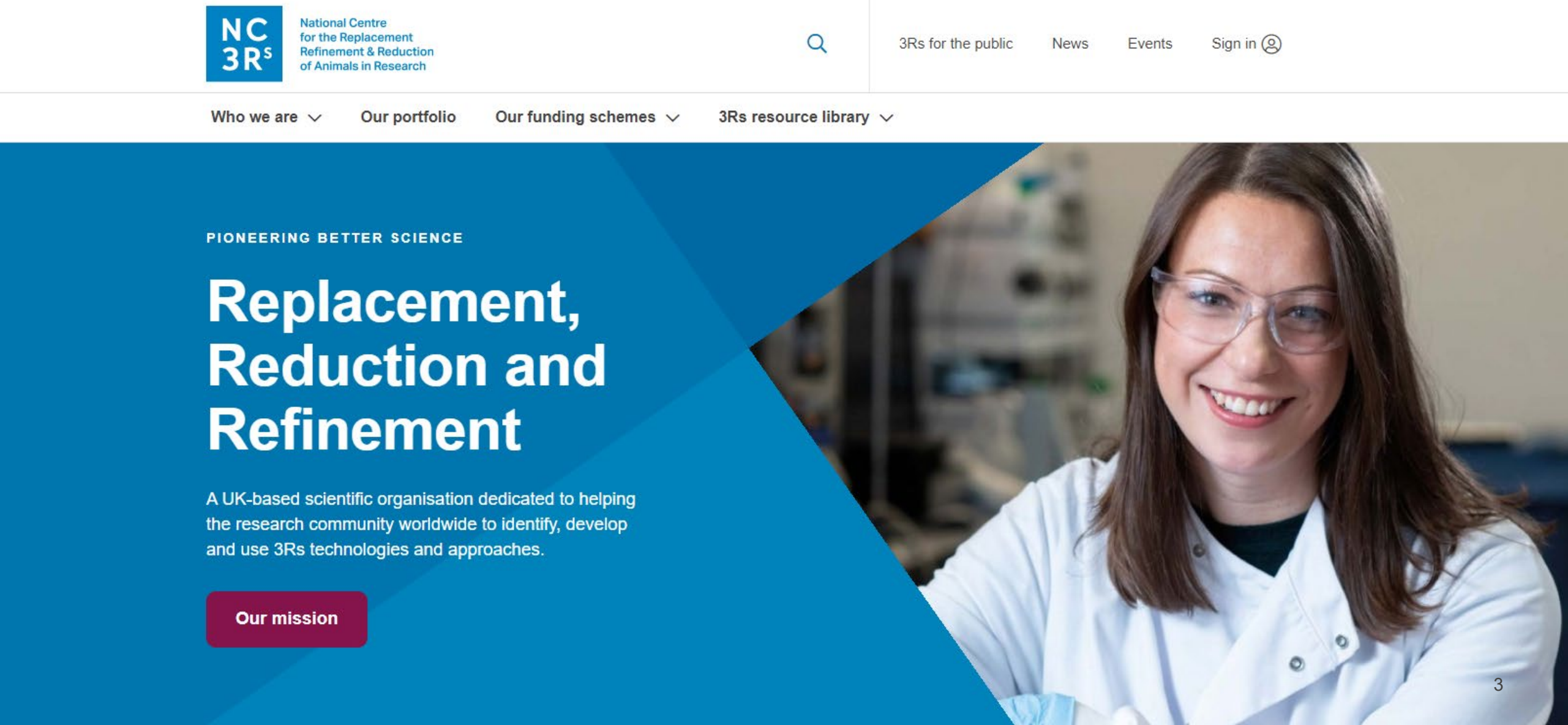
Improving experimental design: Ethical implications and how the Experimental Design Assistant (EDA) can help

Dr Esther Pearl

14 September 2023

National Institutes of Health Office of Laboratory Animal Welfare
Online Seminar

www.nc3rs.org.uk



Learning objectives

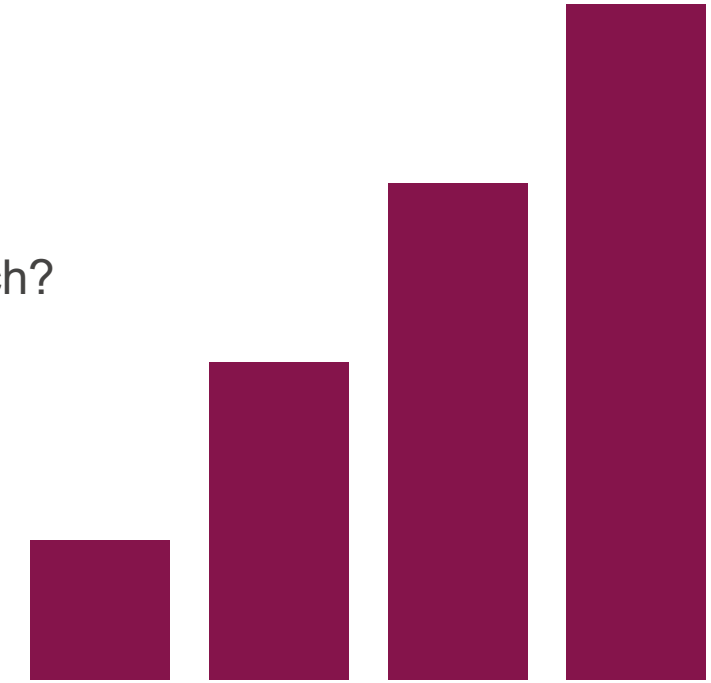
By the end of this talk you will:

- Understand why we need to improve experimental design
- Identify key ways to improve biomedical research
- Know what the Experimental Design Assistant (EDA) is and its benefits to researchers
- Understand how the EDA can be used as part of the ethical review process

Poll

Introductory poll

- Are you involved in designing experiments?
- Have you had any formal training in experimental design?
- Do you have access to statistical support?
- Do you sit on an IACUC?
- Do you conduct your own research?



Why we need to improve experimental design

Research waste

- 33 meta-studies in ecology
- 10,464 studies

THE LANCET

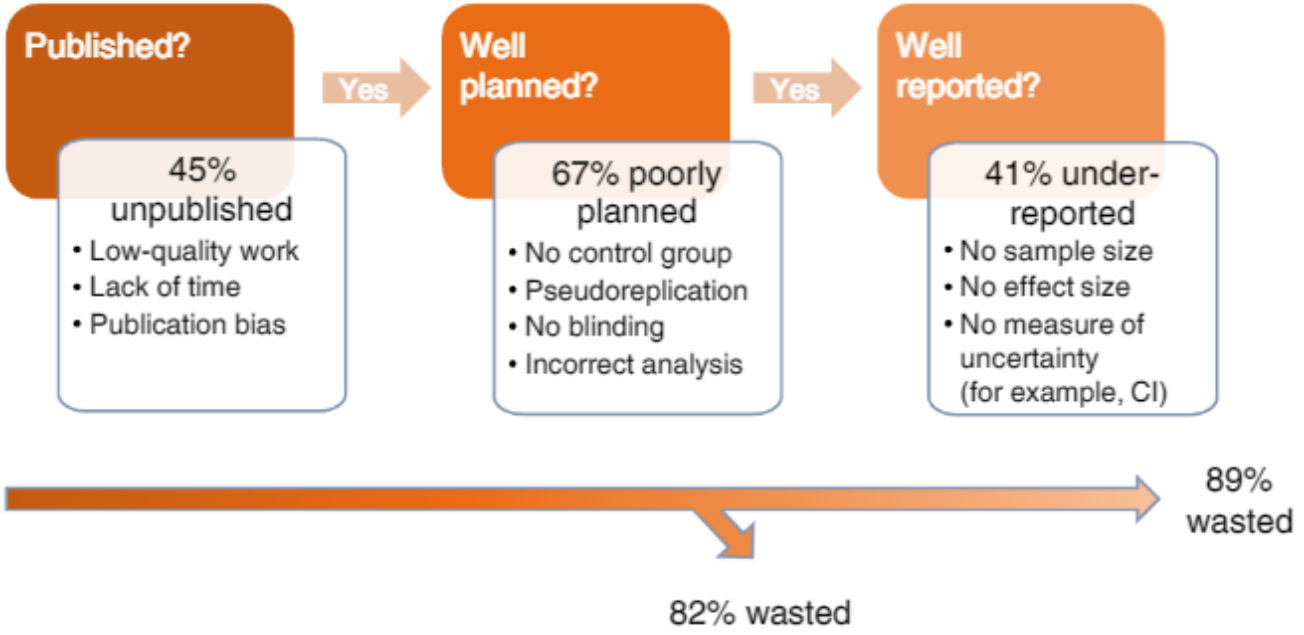
VIEWPOINT | VOLUME 374, ISSUE 9683, P86-89, JULY 04, 2009

Avoidable waste in the production and reporting of research evidence

Iain Chalmers, DSc • Prof Paul Glasziou, RACGP

Published: June 15, 2009 • DOI: https://doi.org/10.10

85% of investment in biomedical research wasted



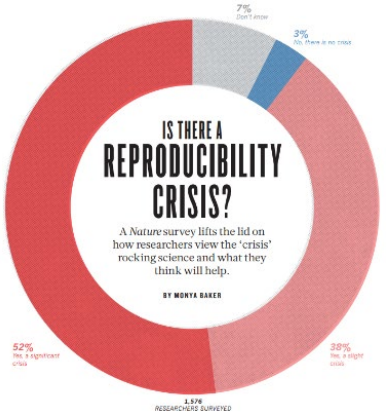
Purgar M, Klanjscek T and Culina A (2022). Quantifying research waste in ecology. *Nat Ecol Evol.* http://dx.doi.org/10.1038/s41559-022-01820-0

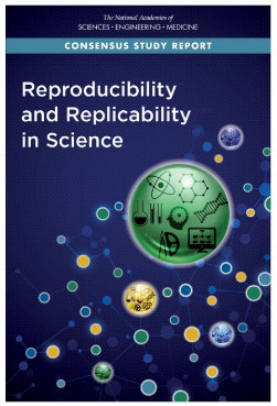
Research waste in *in vivo* studies

Ethical implications

If research is not reported in enough detail, or if findings are not reliable, benefits cannot be realised

→ **Research is unethical**





Likely benefits to science and society

- New scientific knowledge
- Improvements in human (or animal) health or safety

Likely harms to the animals involved

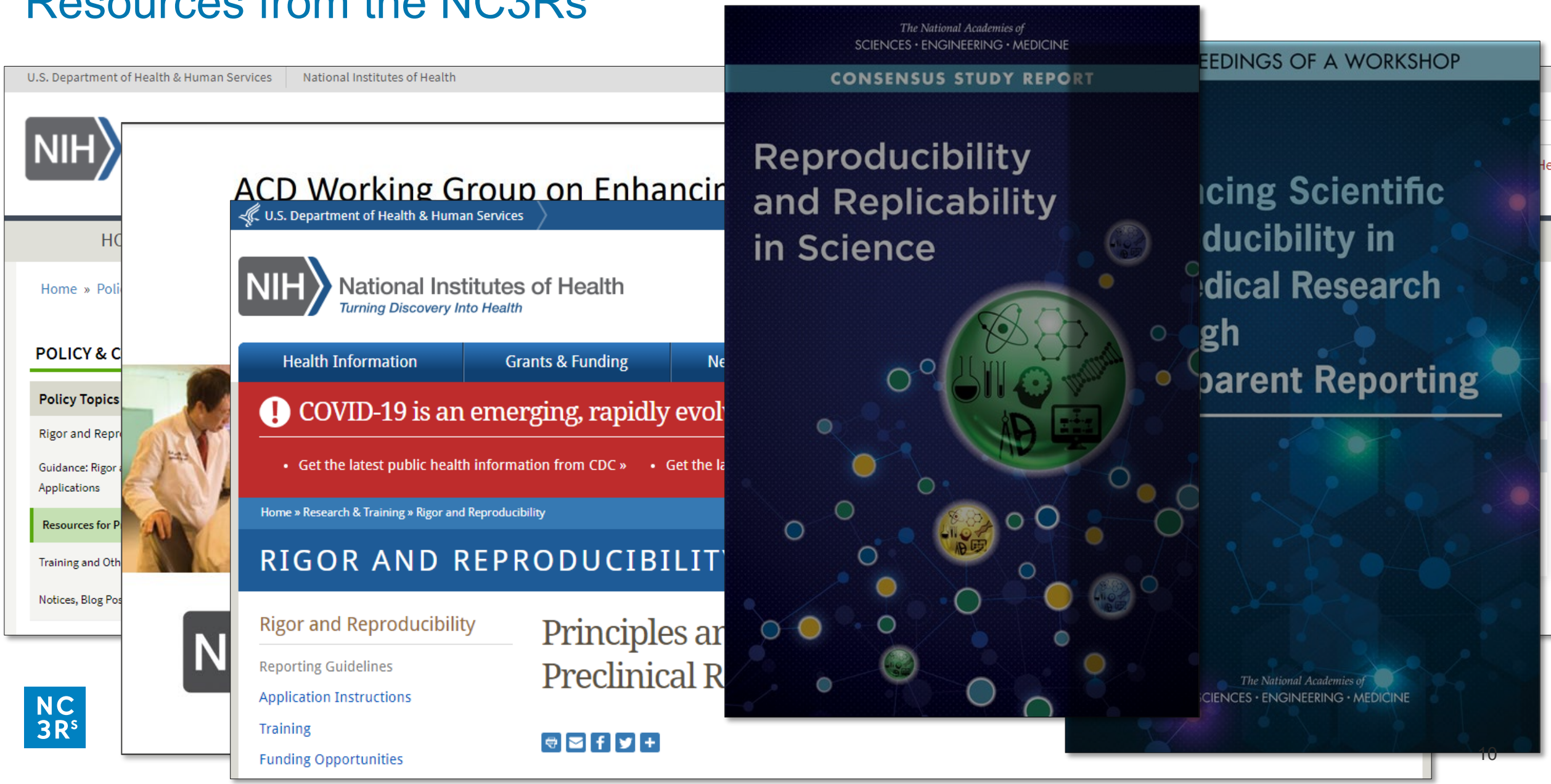
- Scientific procedures and their effects
- Contingent suffering due to housing, transport, etc.

Contemporary definitions of the 3Rs

	Standard	Contemporary
Replacement	Methods which avoid the use of animals (or species 'protected' under law) in areas where they otherwise would have been used	Accelerating the development and use of models and tools, based on the latest science and technologies, to address important scientific questions without the use of animals (i.e. *in vitro* or *in silico*)
Reduction	Methods which minimise the number of animals used per experiment (or maximise the information gained from a given number of animals)	Appropriately designed and analysed animal experiments that are robust and reproducible, and truly add to the knowledge base
Refinement	Improvements to scientific procedures and husbandry which minimise pain, suffering, distress or lasting harm and/or improve animal welfare	Advancing research animal welfare by exploiting the latest *in vivo* technologies and by improving understanding of the impact of welfare on scientific outcomes

NC 3Rs

Resources from the NC3Rs



Reproducibility and reliability of biomedical research: improving research practice

Symposium report, October 2015

The Academy of Medical Sciences · BBSRC bioscience for the future · MRC Medical Research Council · wellcome trust

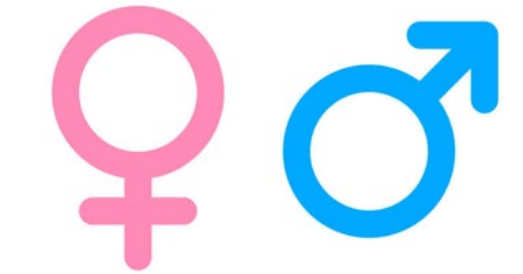
Key ways to improve biomedical research

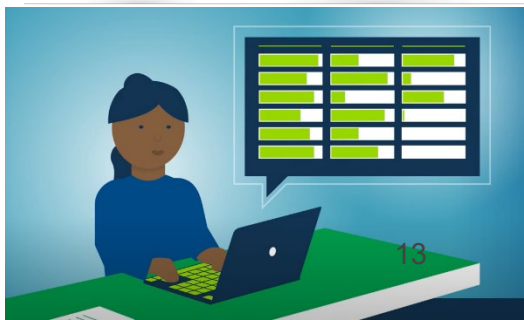
Key aspects of good experimental design

If experiments are not rigorously designed the results are unlikely to be reliable.

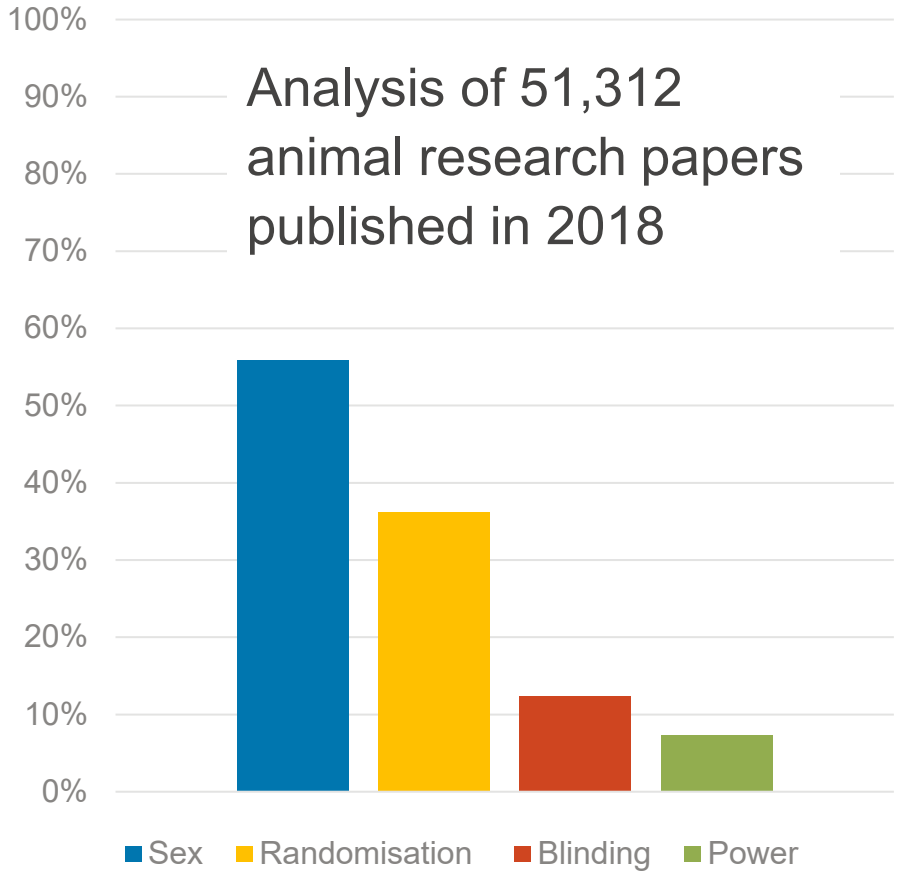
Aspects of good experimental design you can look out for:

- Randomisation
- Masking (blinding)
- Using both sexes
- Appropriate sample size
- Pre-planned statistical analysis method

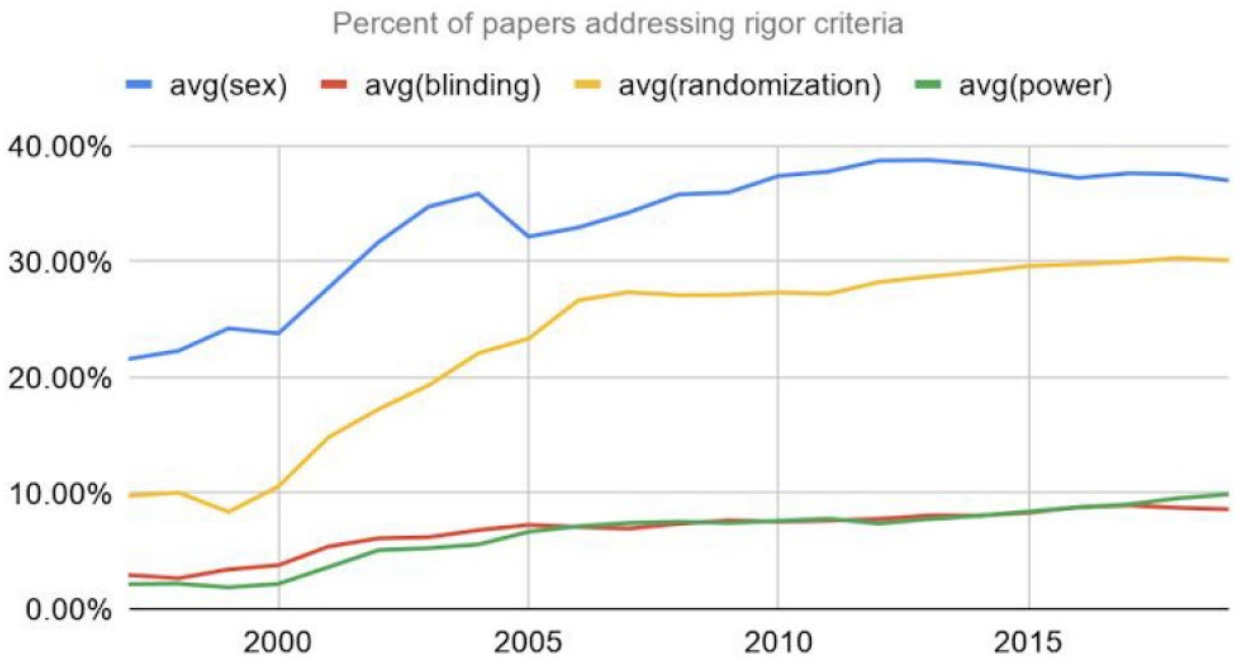




Reporting of rigour criteria in animal research publications



1.6M Biomedical research papers (clinical + preclinical)

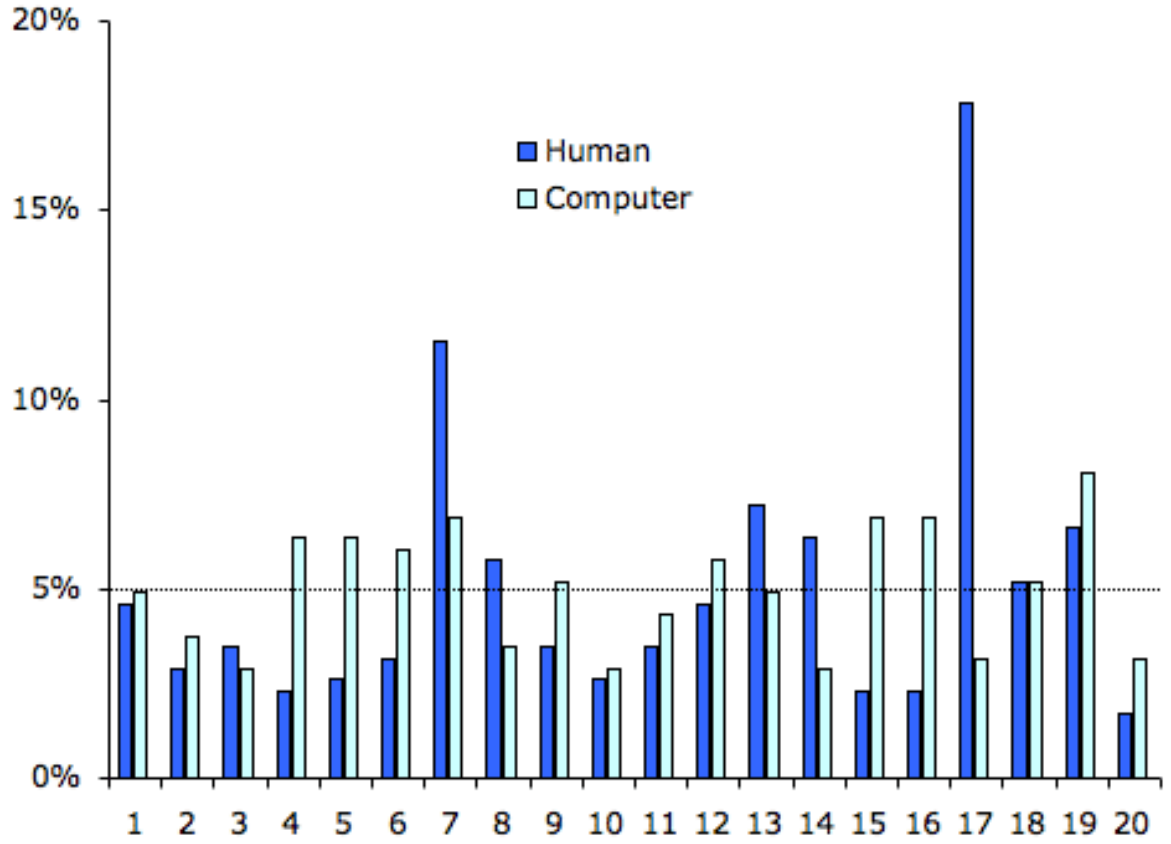


Menke J et al (2020). *iScience*. https://doi.org/10.1016/j.isci.2020.101698

Randomisation

How the randomisation sequence is generated is important – haphazard is not random. Random sequences can be generated by computers, dice or flipping coins.

Pick a number between 1 and 10



http://scienceblogs.com/cognitivedaily/2007/02/05/is-17-the-most-random-number/

Randomisation

How the randomisation sequence is generated is important – haphazard is not random. Random sequences can be generated by computers, dice or flipping coins.

Random allocation to interventions

Randomisation is crucial for two reasons:

1. Minimise selection bias

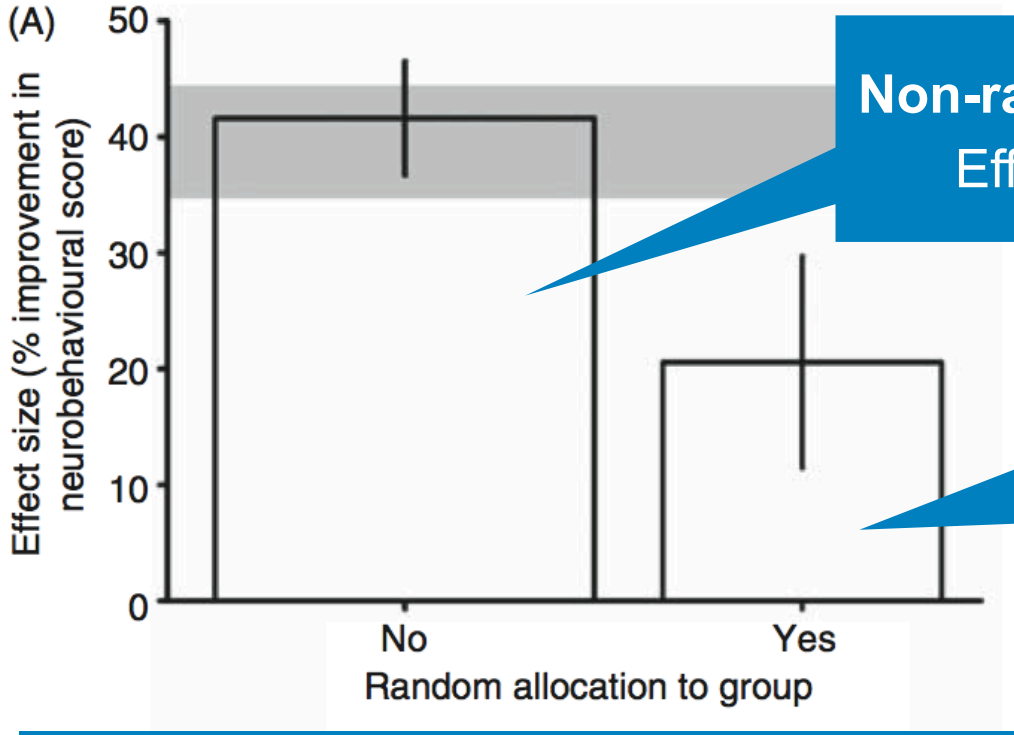
e.g. haphazard selection may result in slowest mice allocated to the same group

2. Key assumption of the statistical analysis

Different groups should be drawn from the same background population using random sampling

Randomisation

- Animal models of multiple sclerosis
- Comparison of randomised and non-randomised studies



Non-randomised studies
Effect size = **42%**

Randomised studies
Effect size = **21%**

Studies not randomised **overestimate** treatment efficacy

Vesterinen H M et al 2010. *Mult Scler*. https://doi.org/10.1177/1352458510379612

Masking

Being unaware of group assignment (e.g. not knowing which intervention any animal has received, how they are grouped or which group data came from).

Masking can be implemented at different steps in an experiment

During allocation and intervention

Steps where the animals are assigned to experimental groups and steps when they receive the experimental intervention(s).

During conduct of the experiment

Housing and welfare management of the animals during the experiment.

When assessing the outcome

Steps where an outcome is measured, or a sample processed in preparation for a measurement.

When assessing results

Data processing and statistical analysis.

Reducing bias

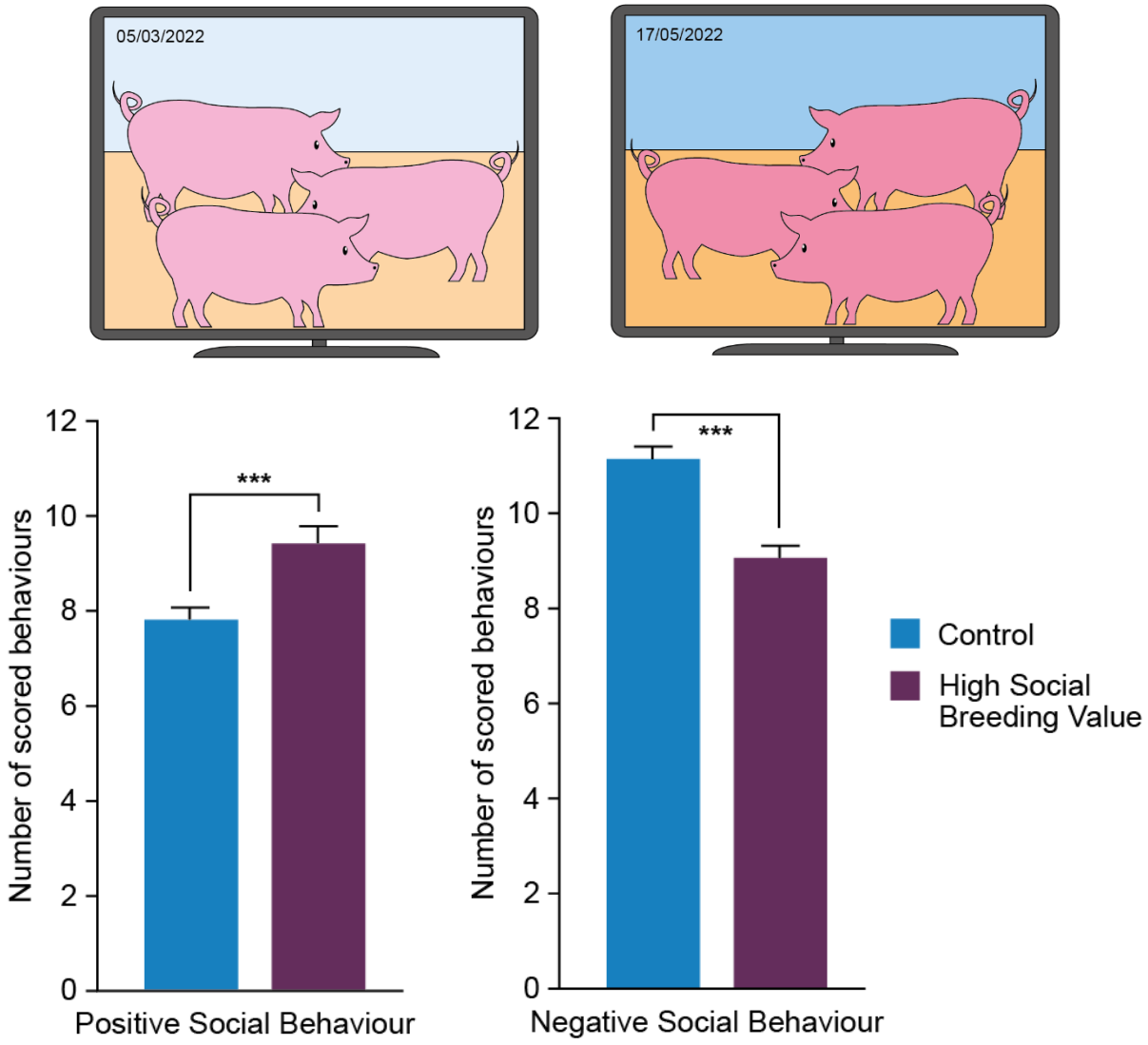
157 veterinary medicine students

Trained to identify positive and negative social interactions in pigs

5-minute video clips

Control pigs, and ‘High Social Breeding Value’ pigs

Masking



Tuyttens et al (2014). *Ani Behav*. doi: 10.1016/j.anbehav.2014.02.007

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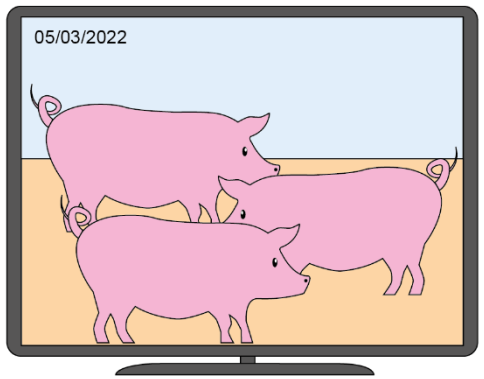
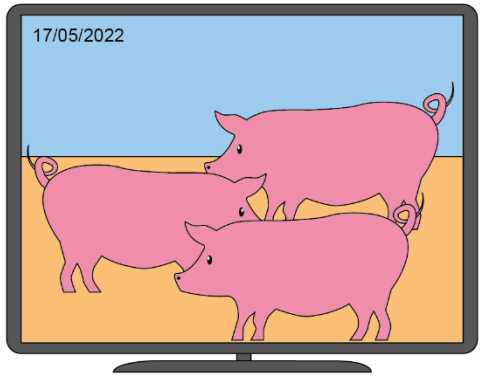
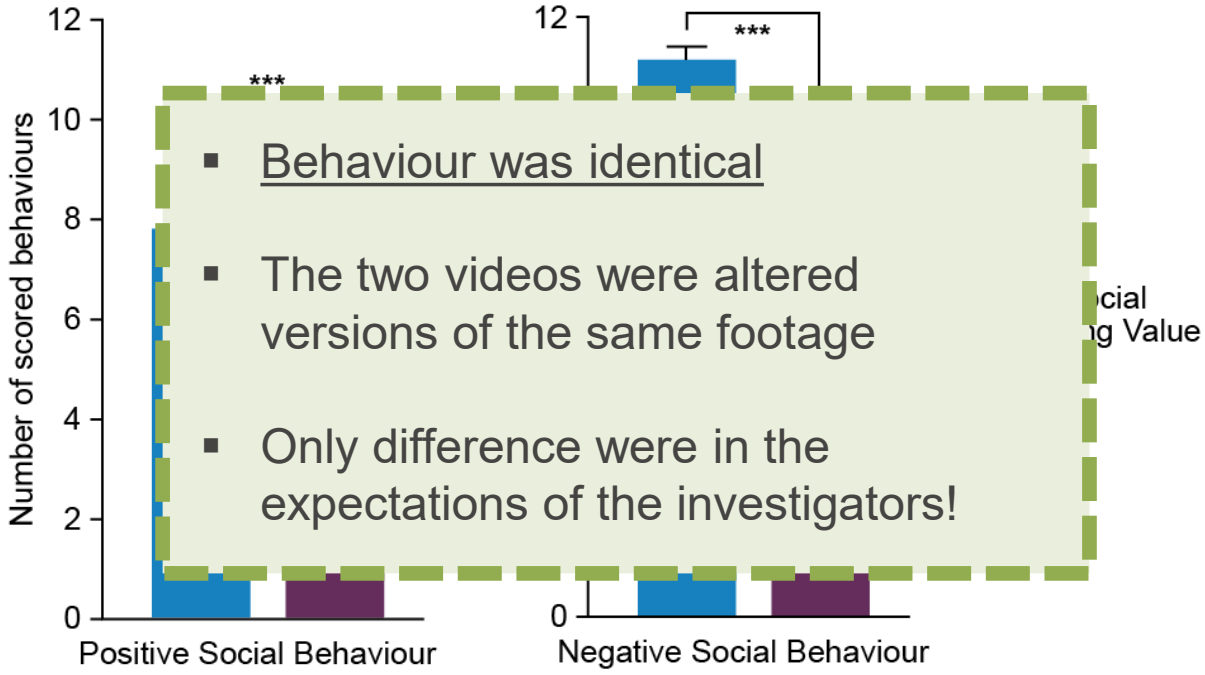






- Behaviour was identical
- The two videos were altered versions of the same footage
- Only difference were in the expectations of the investigators!

Tuyttens et al (2014). *Ani Behav*. doi: 10.1016/j.anbehav.2014.02.007

GUIDANCE

Using masking/blinding in in vivo experiments

On this page

Why use masking in an animal experiment?

Masking (also known as blinding) is a methodological process where an animal's allocation to a specific experimental group is concealed from the people running the study, caring for the animals or analysing the data.

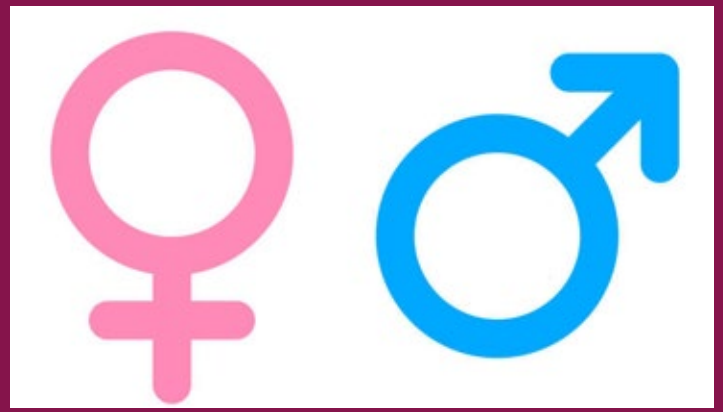
Read the full article in PLOS Biology

A qualitative study of the barriers to using blinding in in vivo experiments and suggestions for improvement

https://nc3rs.org.uk/3rs-resources/using-maskingblinding-vivo-experiments

Karp NA et al (2022). *PLOS Biol.* https://doi.org/10.1371/journal.pbio.3001873

Using both sexes



Most research is conducted on male subjects.

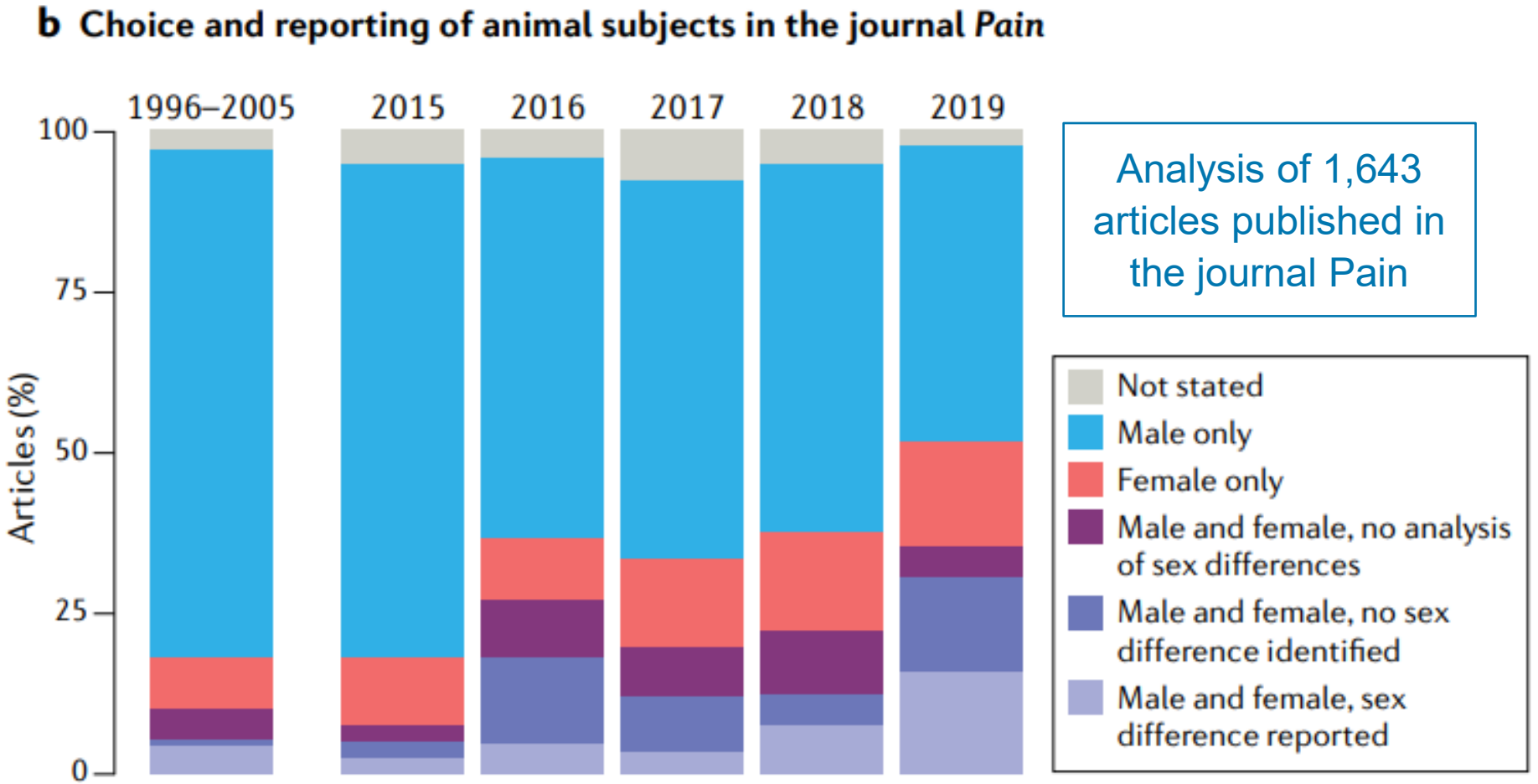
We cannot assume that findings in males translate to females.

Why it is important to use both sexes in preclinical research

- Issue recognised for clinical trials, which now include women in the research pipeline
- But limited change in preclinical research, despite role in informing clinical trials
- **Example of Thalidomide – teratogenic effects could have been predicted with in vitro testing of female human tissue**
- Funders actively pushing the inclusion of sex as a biological variable (e.g. NIH)

.

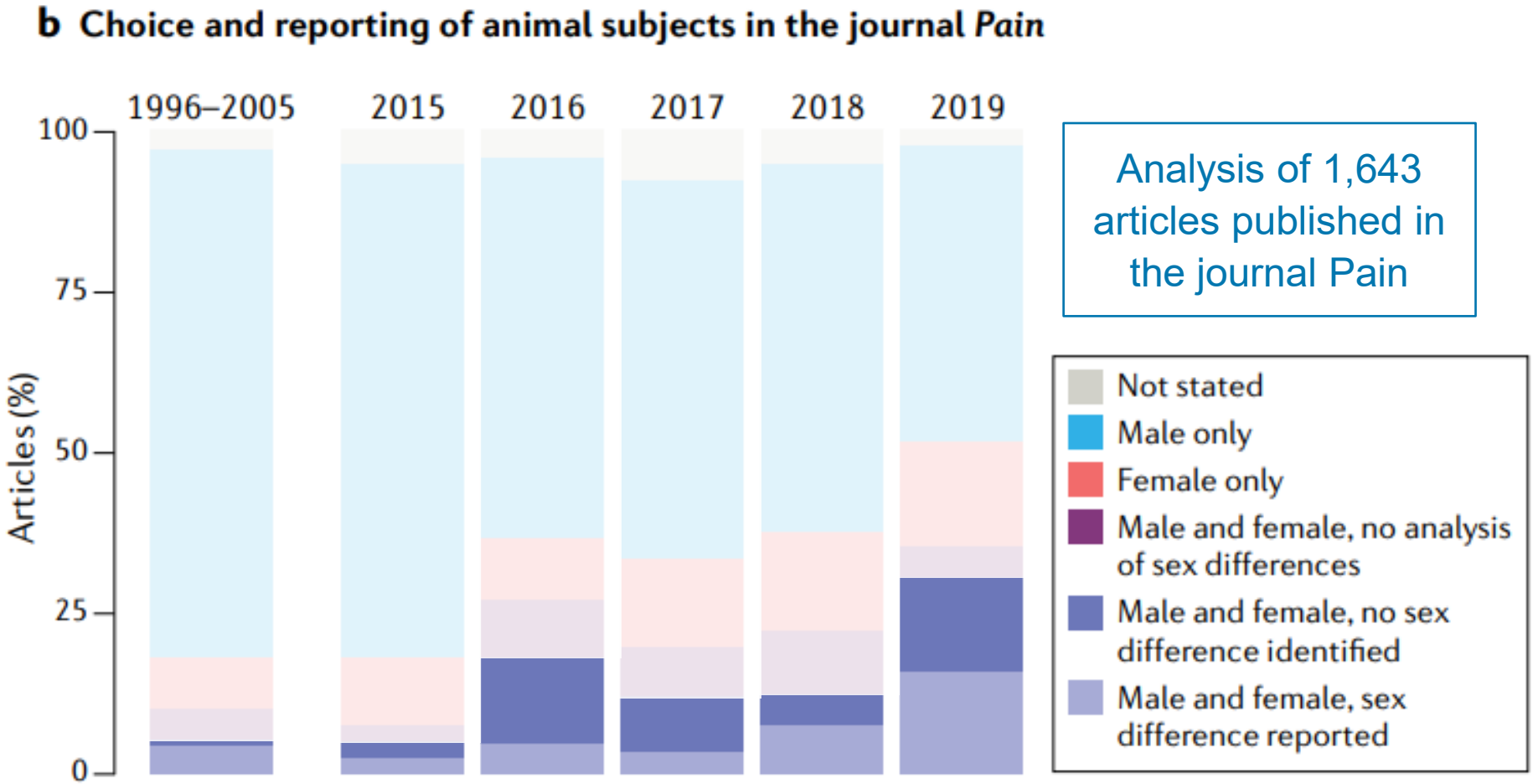
Sex bias in animal experiments



Analysis of 1,643 articles published in the journal Pain

Mogil JS (2020). *Nat Rev Neurosci.* https://doi.org/10.1038/s41583-020-0310-6

Sex bias in animal experiments



Analysis of 1,643 articles published in the journal Pain

Mogil JS (2020). *Nat Rev Neurosci.* https://doi.org/10.1038/s41583-020-0310-6

Using both male and female animals

https://eda.nc3rs.org.uk/experimental-design-animal-characteristics

In most cases researchers should include both sexes in their protocol

It should be clear from the protocol what researchers are trying to do

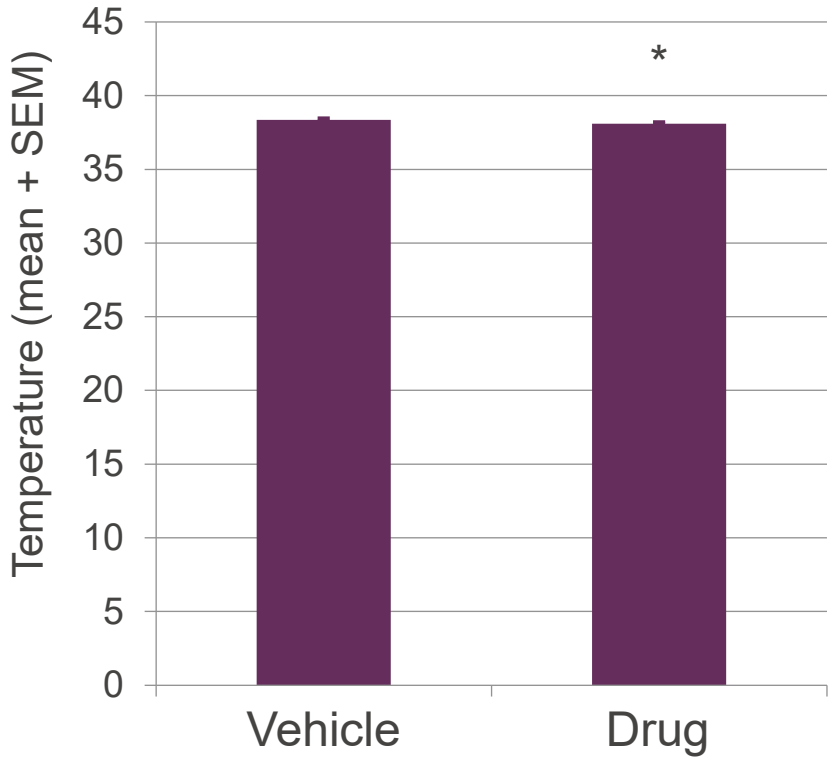
- Are they including both sexes to ensure results are generalisable?
- Are they directly comparing the sexes? Do they have adequate numbers to make this comparison? Will they need to include more animals?
- If the researcher is not directly comparing the sexes they may not need to increase animal numbers
- Suggest the researcher consults a statistician

Sample size

Using an appropriate sample size is essential to the reliability of results.

The number of animals in an experiment must be justified

If data will be compared with a statistical test (e.g. tests that give a p-value or F statistic) the sample size should be determined with a power calculation.



Sample size

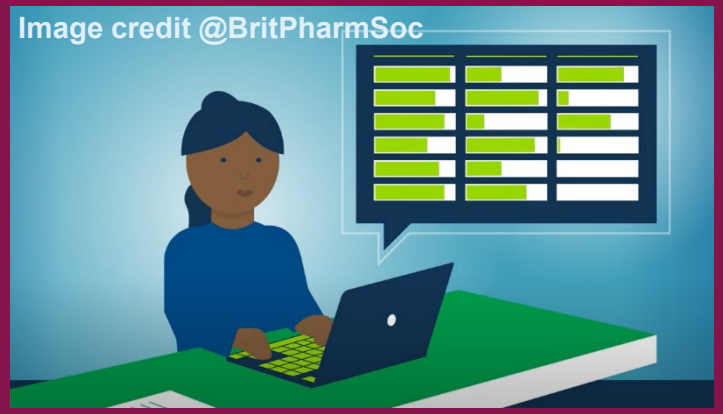
Using an appropriate sample size is essential to the reliability of results.

The number of animals in an experiment must be justified

If data will not be compared with statistical tests it is still important to justify the number of animals needed for the study.

For example, if the study aims to establish if a new surgical technique works in mice the number of animals needed depends on how many animals the researcher needs to ascertain if the technique would work and be practical for the future applications (e.g. a further study).

Analysis plan



It is important that a statistical analysis plan is made before the study starts

Analysis plans are an integral part of experimental design.

- Promote careful consideration of variables and outcome measures
- Identify appropriate analysis path (inferential vs descriptive statistics)
- Helps prevent p-hacking
- Identify statistical support needs

The EDA: benefits for researchers and IACUCs

Experimental Design Assistant (EDA)

Online tool for researchers to design *in vivo* experiments

Free to use

Secure

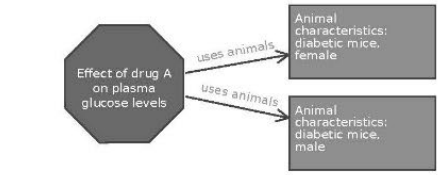
Focuses on internal validity

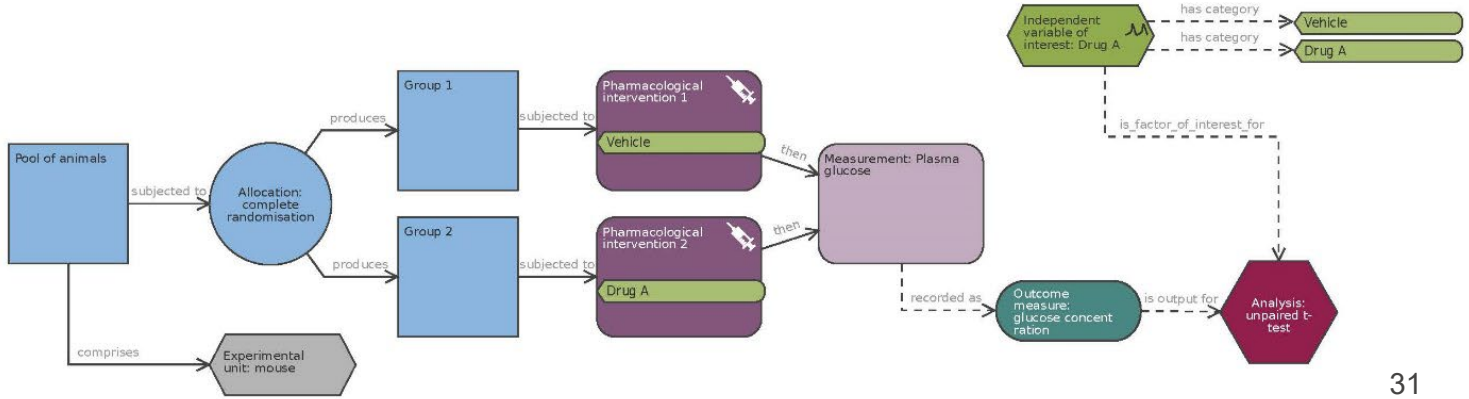
Developed by *in vivo* researchers and statisticians

[eda.nc3rs.org.uk](eda.nc3rs.org.uk)

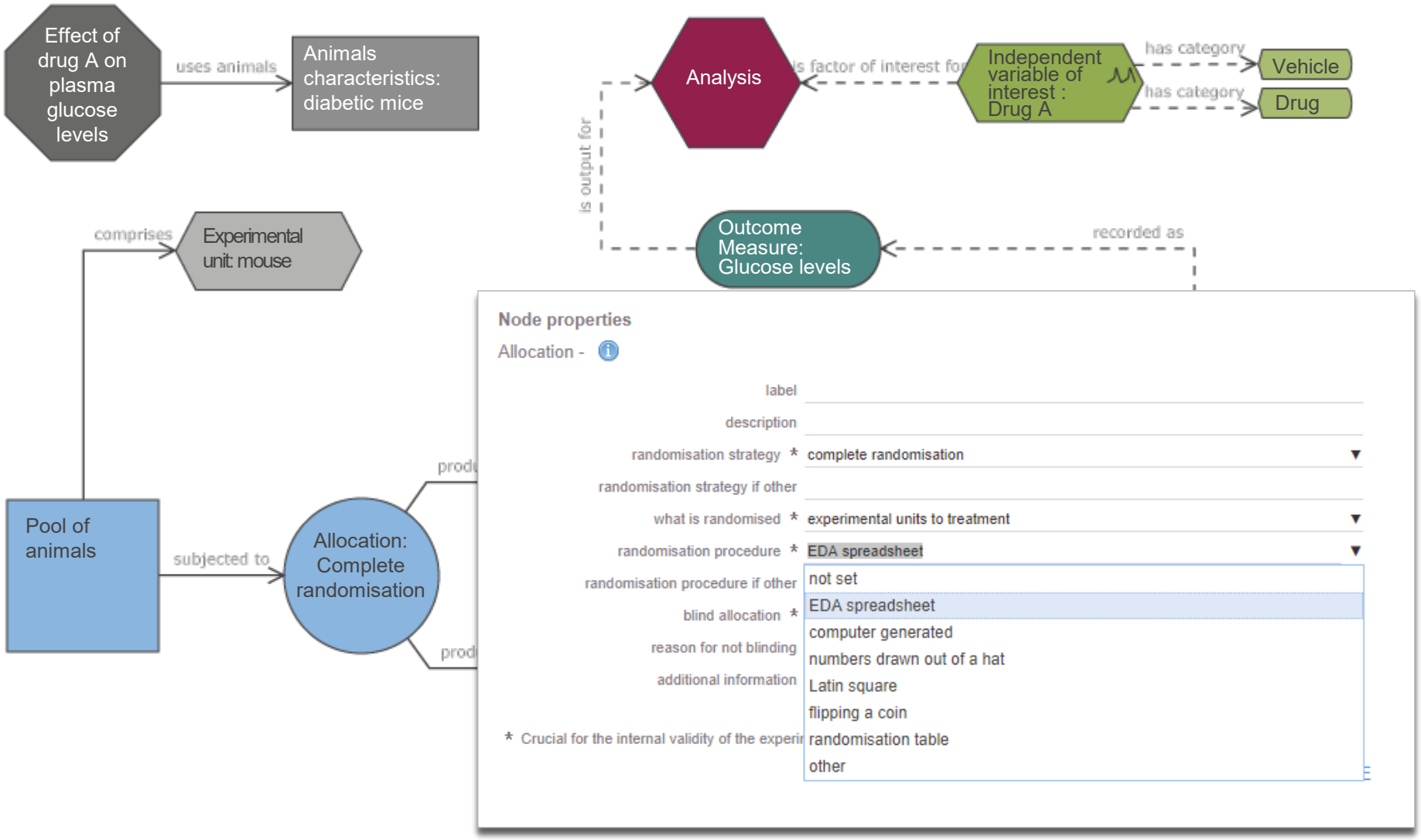
Features of the EDA

- Advice to improve the experimental plan
- Recommendations for the statistical analysis
- Power calculation
- Randomisation and masking
- Improve transparency
- Teach experimental design





The EDA diagram



The diagram does not include any nuisance variables | NC3Rs EDA - Google Chrome

https://eda.nc3rs.org.uk/RT0011

The diagram does not include any nuisance variables

In the EDA, nuisance variable nodes are used to indicate *other sources of variability* or *con*
influence the outcome, such as blocking factors or covariates.

Having no nuisance variable implies that only the independent variable(s) of interest (e.g. th
influence the outcome measure. Thus it is rarely appropriate as the result of an experiment
by many variables. Identifying these nuisance variables and accounting for them increases
experiment to detect changes induced by the variable(s) of interest.

The type of things to consider may include cages or rooms, if the animals are not all housed
of the intervention or measurement, or the person doing it if animals are not all processed th
experimenters with different levels of skills. The list could be endless but the important thing
relevant to a particular experiment, based on common sense and past experimental results,
to identify new sources of variability.

These should be indicated on the EDA diagram using nuisance variable nodes; then the us
best to account for each of the nuisance variables identified. Depending on the type of nuis
objective of the experiment, there are different options to account for the variability; the vari

- standardised - for example record all measurements on the same piece of equipmen
- randomised across - for example the effect of the location of the cage in the room co
  randomly allocating each cage to the housing rack
- blocked - for example the day of the experiment can be used as a blocking factor in t
  analysis
- nested within another variable - for example individual neurons can be nested within
  'mouse' when multiple neurons are recorded for each mouse
- used as a covariate - for example baseline locomotor activity could be included as a
- if none of these things are done, then the variable is deemed uncontrolled.

Indicate the blinding status during assessment of the outcome | NC3Rs EDA - Google Chrome

https://eda.nc3rs.org.uk/RT0093

Indicate the blinding status during assessment of the outcome

Information crucial to the internal validity of the experiment is missing. In the properties of this node, in the field 'blind measurement' please indicate whether the experimenter will be aware of the group allocation when assessing the results. Note that this only concerns the measurement stage; blinding before, during and after the intervention, and during the data analysis should be indicated in the properties of the allocation and analysis nodes, respectively. Choose from the dropdown menu to indicate how the investigator will be blinded to the group allocation or whether they will be aware of the group allocation during the measurement.

Blinding is especially important when it comes to assessment, particularly if there is a subjective element in assessing the outcome of the treatments, for example when assessing behavioural changes or reading histological slides. The person taking care of the animals and the person assessing the outcome should not know which intervention each of the animals received (i.e. the group allocation) and which animals are grouped together. Randomising the order of examination can help with this. For further information about blinding, click here.

Options in the dropdown menu

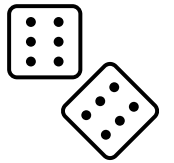
Investigator aware of the group allocation (not blinded) – the investigator taking the measurement knows what treatment each animal has received, or what animals are grouped together. Sometimes the person assessing the outcome cannot be blinded to the group allocation, for example if there are obvious phenotypic differences between groups of genetically modified animals; this could be mitigated by, for example, taping the behaviours and sending them to a third party, who has no vested interest in the experiment and does not know whether the transgenic should improve or worsen the outcome. Such an approach would at least counter the directional expectation.

Key features for rigorous research

Randomisation sequence

EDA generates sequences for:

- Complete randomisation
- Block randomisation
- Randomisation within factors

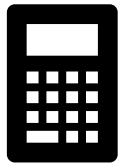


Workflow for blinding (masking)

Randomisation sequence directly sent to the person helping with blinding so that the researcher remains unaware of the group allocation

Sample size calculators

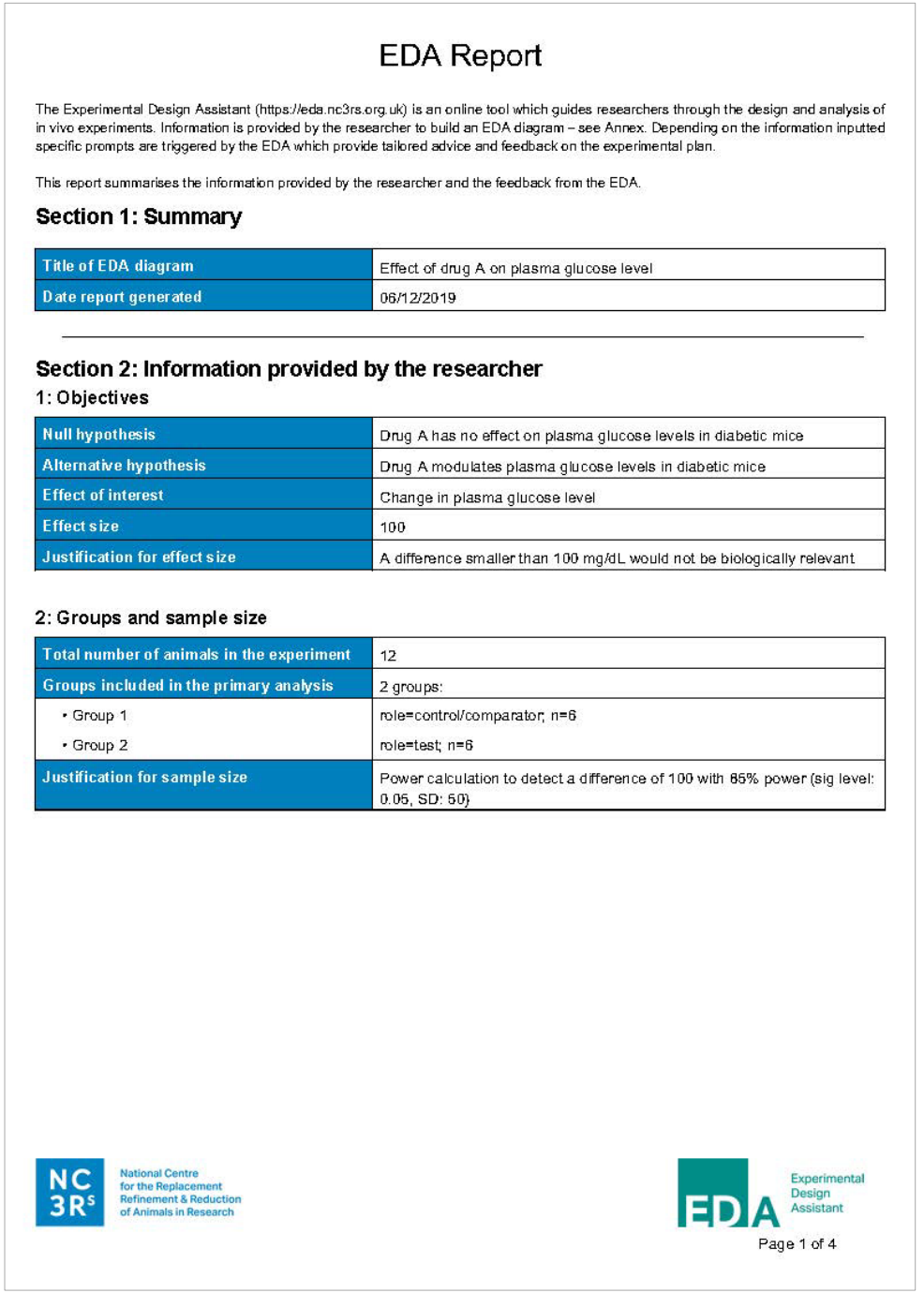
- For unpaired t-tests, paired t-tests
- Full guidance to identify parameters for the calculation
- Decision tree to select the correct calculator



EDA Report

Key experimental information:

- Objectives and hypotheses
- Animal numbers and justification for sample size



EDA Report

The Experimental Design Assistant (https://eda.nc3rs.org.uk) is an online tool which guides researchers through the design and analysis of in vivo experiments. Information is provided by the researcher to build an EDA diagram – see Annex. Depending on the information inputted specific prompts are triggered by the EDA which provide tailored advice and feedback on the experimental plan.

This report summarises the information provided by the researcher and the feedback from the EDA.

Section 1: Summary

Title of EDA diagram	Effect of drug A on plasma glucose level
Date report generated	06/12/2019

Section 2: Information provided by the researcher

1: Objectives

Null hypothesis	Drug A has no effect on plasma glucose levels in diabetic mice
Alternative hypothesis	Drug A modulates plasma glucose levels in diabetic mice
Effect of interest	Change in plasma glucose level
Effect size	100
Justification for effect size	A difference smaller than 100 mg/dL would not be biologically relevant

2: Groups and sample size

Total number of animals in the experiment	12
Groups included in the primary analysis	2 groups:
• Group 1	role=control/comparator; n=6
• Group 2	role=test; n=6
Justification for sample size	Power calculation to detect a difference of 100 with 85% power (sig level: 0.05, SD: 50)

NC 3Rs National Centre for the Replacement Refinement & Reduction of Animals in Research

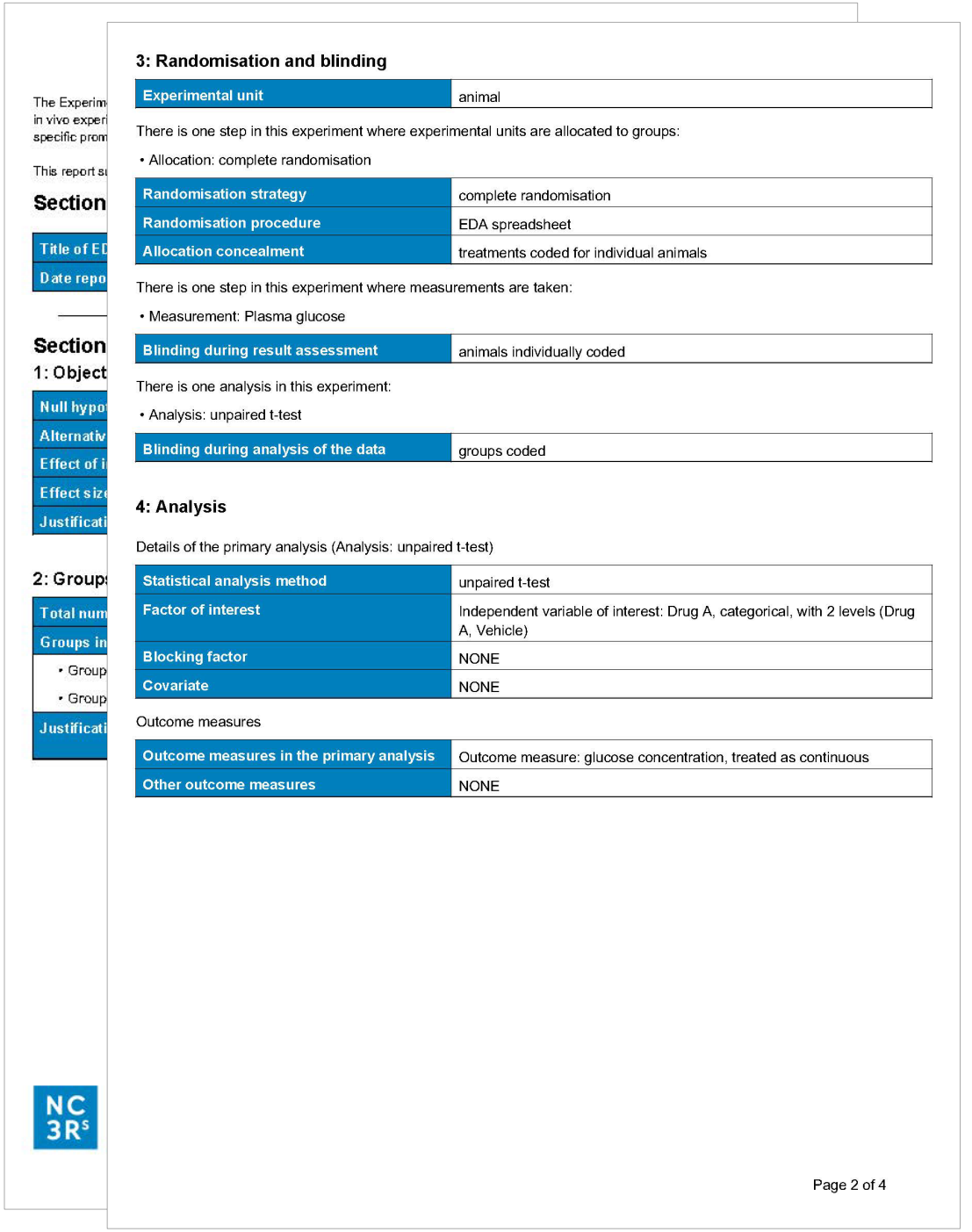
EDA Experimental Design Assistant

Page 1 of 4

EDA Report

Key experimental information:

- Steps taken to minimise the effect of bias
- Primary and secondary outcome measures
- Planned statistical analysis



3: Randomisation and blinding

Experimental unit	animal

There is one step in this experiment where experimental units are allocated to groups:

• Allocation: complete randomisation

Randomisation strategy	complete randomisation
Randomisation procedure	EDA spreadsheet
Allocation concealment	treatments coded for individual animals

There is one step in this experiment where measurements are taken:

• Measurement: Plasma glucose

Blinding during result assessment	animals individually coded

There is one analysis in this experiment:

• Analysis: unpaired t-test

Blinding during analysis of the data	groups coded

4: Analysis

Details of the primary analysis (Analysis: unpaired t-test)

Statistical analysis method	unpaired t-test
Factor of interest	Independent variable of interest: Drug A, categorical, with 2 levels (Drug A, Vehicle)
Blocking factor	NONE
Covariate	NONE

Outcome measures

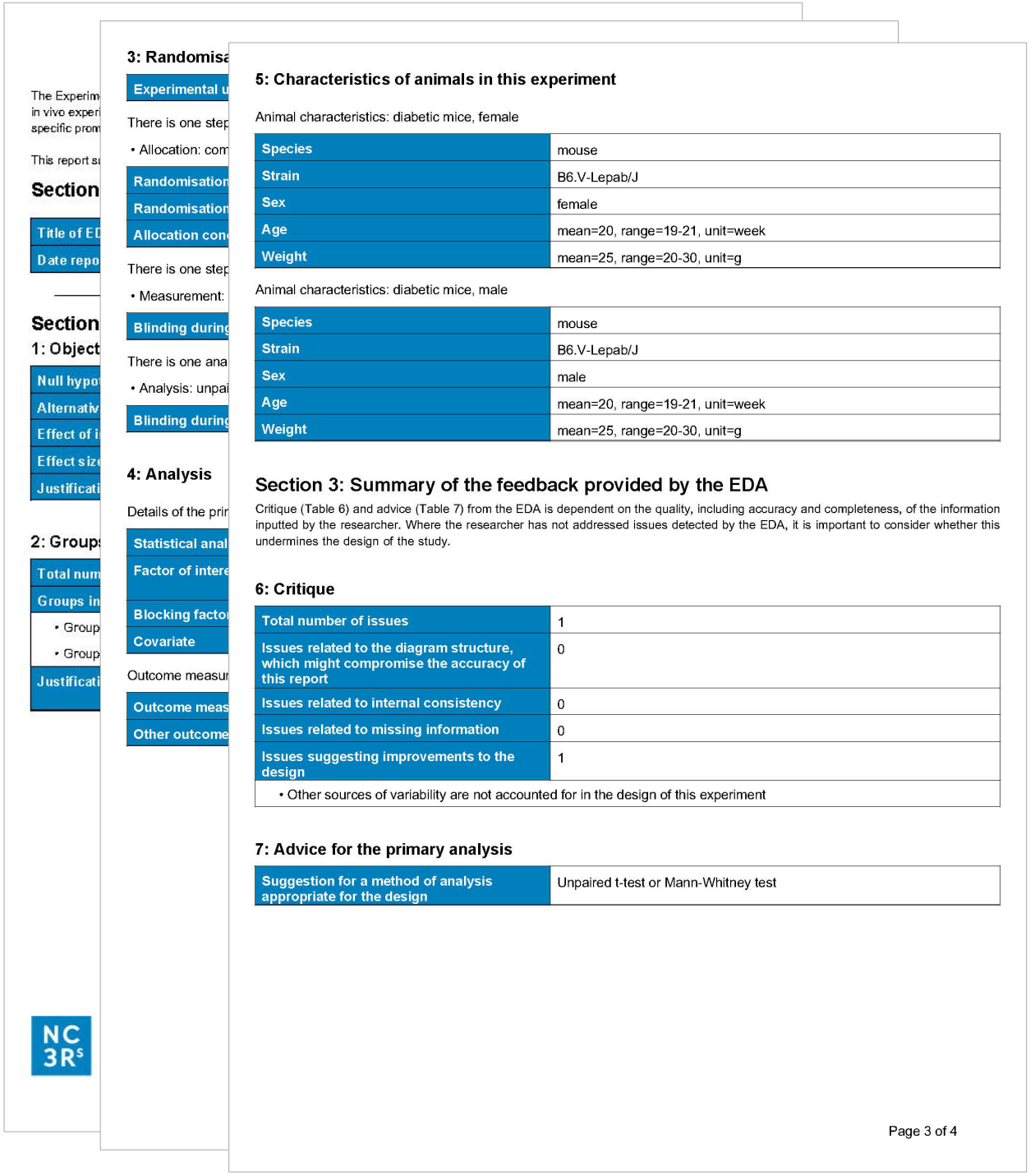
Outcome measures in the primary analysis	Outcome measure: glucose concentration, treated as continuous
Other outcome measures	NONE

Page 2 of 4

EDA Report

Key experimental information:

- Characteristics of the animals in the study



5: Characteristics of animals in this experiment

Animal characteristics: diabetic mice, female

Species	mouse
Strain	B6.V-Lepab/J
Sex	female
Age	mean=20, range=19-21, unit=week
Weight	mean=25, range=20-30, unit=g

Animal characteristics: diabetic mice, male

Species	mouse
Strain	B6.V-Lepab/J
Sex	male
Age	mean=20, range=19-21, unit=week
Weight	mean=25, range=20-30, unit=g

Section 3: Summary of the feedback provided by the EDA

Critique (Table 6) and advice (Table 7) from the EDA is dependent on the quality, including accuracy and completeness, of the information inputted by the researcher. Where the researcher has not addressed issues detected by the EDA, it is important to consider whether this undermines the design of the study.

6: Critique

Total number of issues	1
Issues related to the diagram structure, which might compromise the accuracy of this report	0
Issues related to internal consistency	0
Issues related to missing information	0
Issues suggesting improvements to the design	1

- Other sources of variability are not accounted for in the design of this experiment

7: Advice for the primary analysis

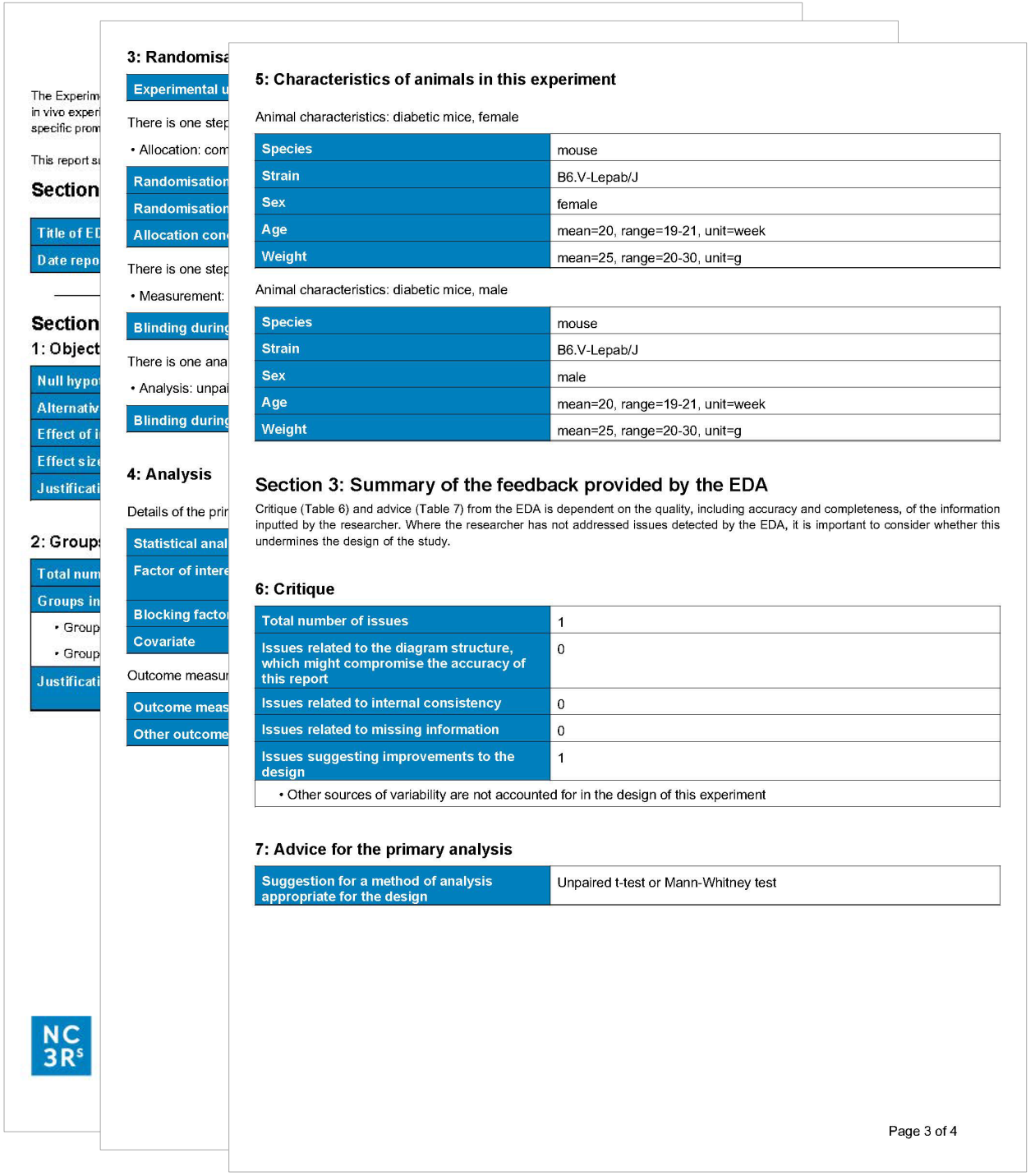
Suggestion for a method of analysis appropriate for the design	Unpaired t-test or Mann-Whitney test

Page 3 of 4

EDA Report

Information about feedback:

- Summary of the EDA feedback that has not been addressed
- Statistical analysis method recommended by the EDA



5: Characteristics of animals in this experiment

Animal characteristics: diabetic mice, female

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Sex	female
Age	mean=20, range=19-21, unit=week
Weight	mean=25, range=20-30, unit=g

Animal characteristics: diabetic mice, male

Species	mouse
Strain	B6.V-Lepab/J
Sex	male
Age	mean=20, range=19-21, unit=week
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• Other sources of variability are not accounted for in the design of this experiment	

7: Advice for the primary analysis

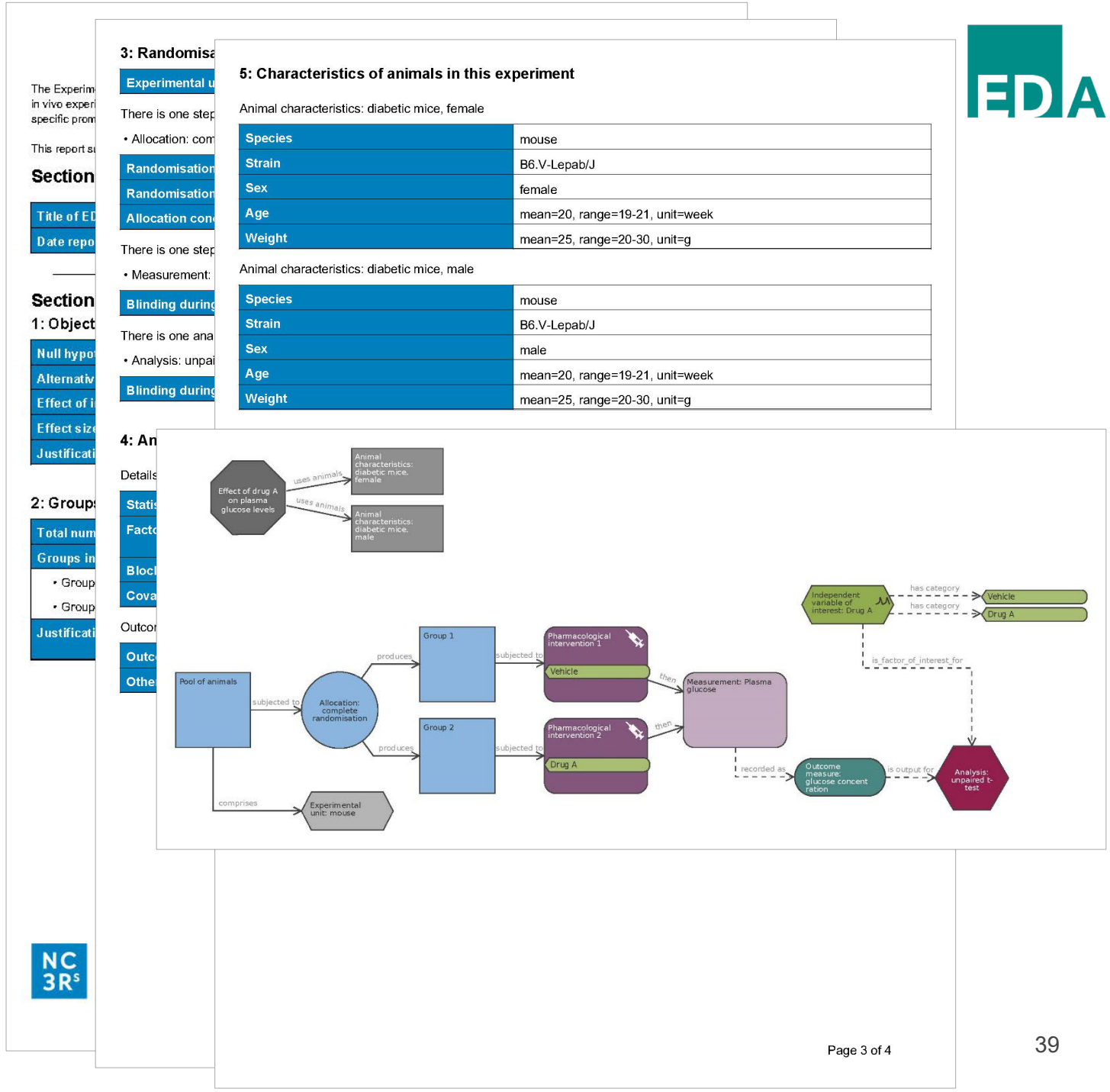
Suggestion for a method of analysis appropriate for the design	Unpaired t-test or Mann-Whitney test

Page 3 of 4

EDA Report

EDA diagram provides a visual overview to easily see:

- How many groups are being compared
- What variables have been included
- If any variability is being taken into account as a blocking factors or covariates



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Species	mouse
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Sex	male
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Page 3 of 4

Read-only EDA diagram

eda.nc3rs.org.uk/eda/modelPublicExport/index/D465A36951173BAE0BE404B82F5A7E41

Experimental Design Assistant

Title of Experiment	Example 1: Effect of drug A on plasma glucose level
Date report generated	22/03/2023

Key Experimental Design Features

Section 1: Information provided by the researcher

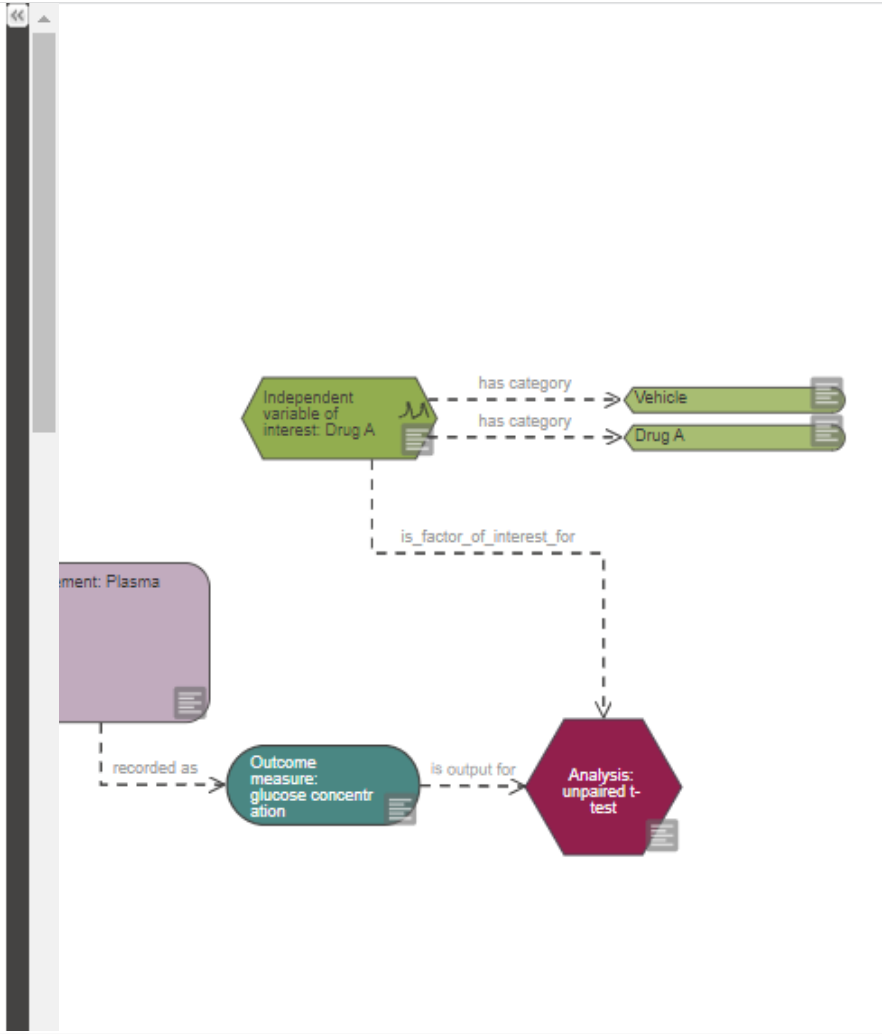
1: Objectives

Null hypothesis	Drug A has no effect on plasma glucose levels in diabetic mice
Alternative hypothesis	Drug A modulates plasma glucose levels in diabetic mice
Effect of interest	Change in plasma glucose level
Effect size	100
Justification for effect size	A difference smaller than 100 mg/dL would not be biologically relevant

2: Groups and sample size

Total number of animals in the experiment	12
Groups included in the primary analysis	2 groups:
• Group 1 • Group 2	role=control/comparator; n=6 role=test; n=6
Justification for sample size	Power calculation to detect a difference of 100 with 85% power (sig level: 0.05, SD: 50)

3: Randomisation and blinding



Legend

Click on this icon on the diagram for more information about a specific step in the experiment.

What each shape represents

Experiment

- Experiment
- Animal characteristics
- Experimental unit

Practical steps

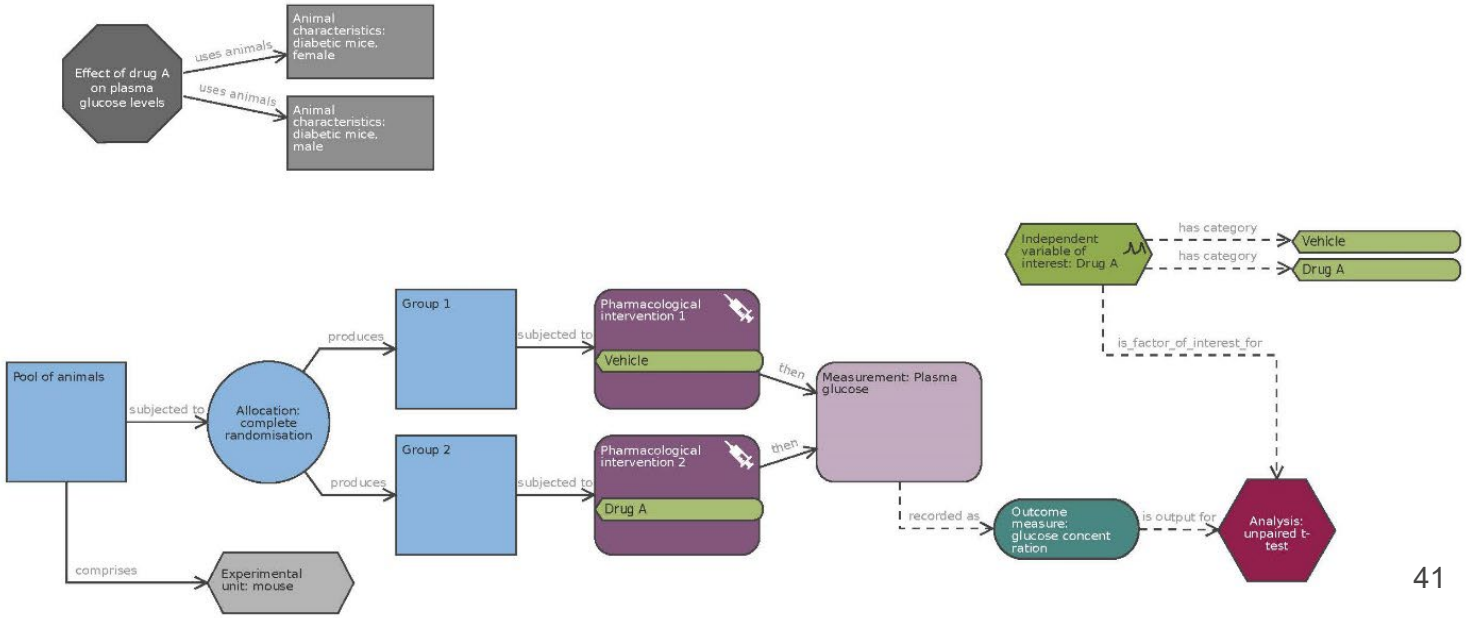
- Group
- Allocation
- Pharmacological intervention
- Surgical intervention
- Pathogen infection
- Other intervention
- Euthanasia
- Measurement
- Repeated measurement

Analysis

This figure was generated with the Experimental Design Assistant (EDA, **eda.nc3rs.org.uk**, RRID: SCR_017019, **doi.org/10.1371/journal.pbio.2003779**), software to help researchers design in vivo experiments. EDA diagrams are machine-readable, the EDA analyses them to provide researchers with tailored advice and feedback to improve the design of their experiments.

The EDA: Benefits for researchers

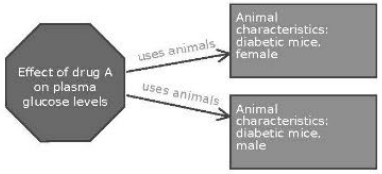
- Bespoke advice on experimental plans, leading to better experimental design
- Analysis recommendations for the appropriate statistical analysis method
- Help determining the appropriate sample size
- Support for randomisation and masking

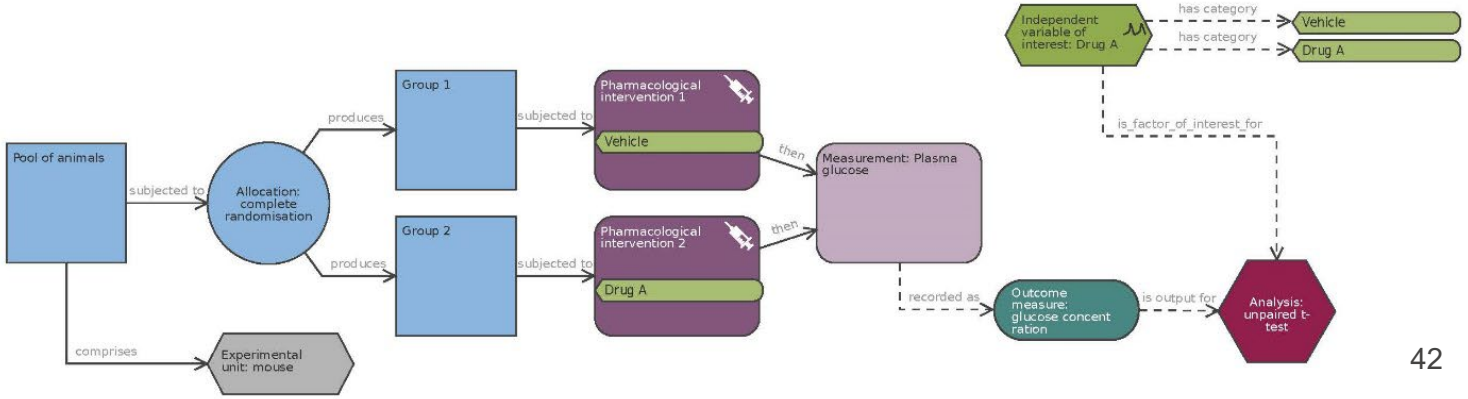


The EDA: Benefits for IACUCs

You could request an EDA report, or read-only diagram, as part of an IACUC application.

- The report and read-only diagram highlight missing information.
- The EDA identifies issues with experimental design.
- You can refer researchers to the EDA application and supporting website for experimental design guidance.





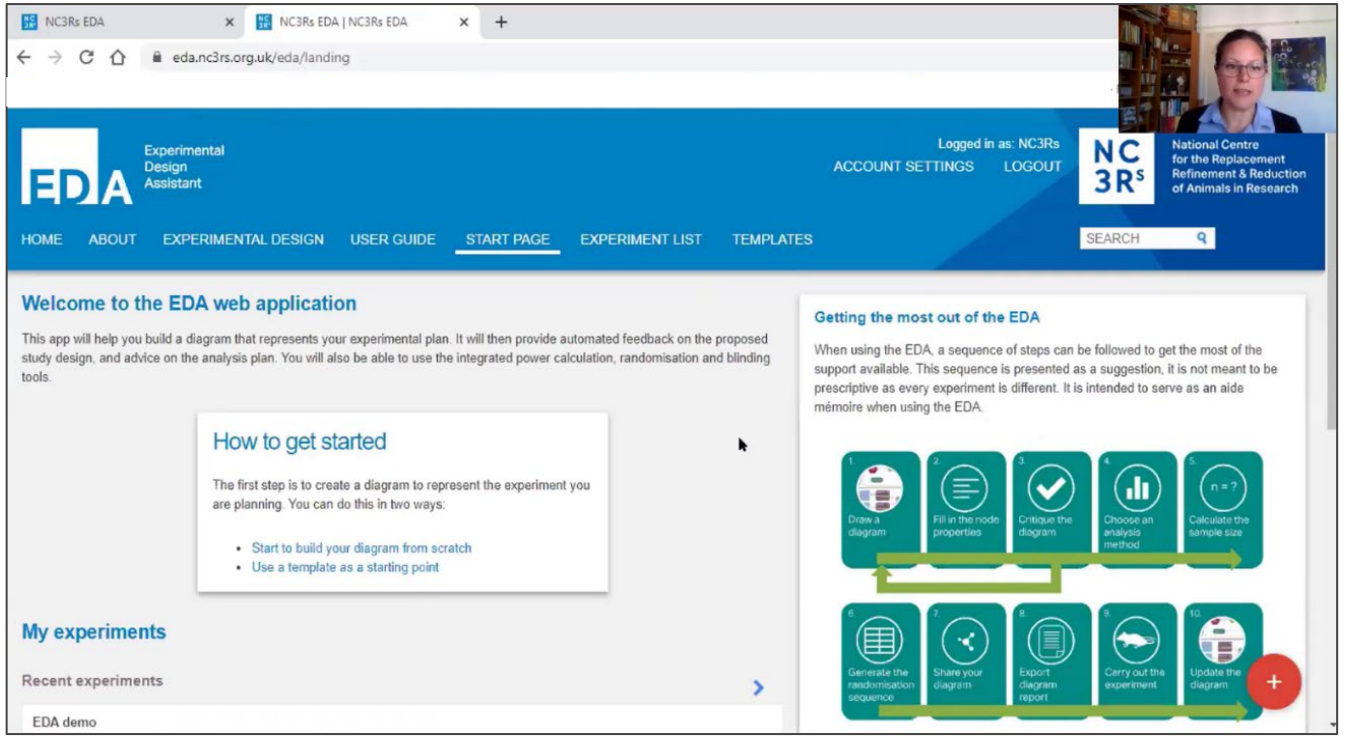
Live: inside the EDA

EDA demonstration

www.nc3rs.org.uk/EDAdemos

Regular live demonstrations

- Building an experiment diagram
- Getting feedback
- Generating a randomisation sequence
- Generating a pdf report
- Generating the read-only diagram
- Finding the built-in help



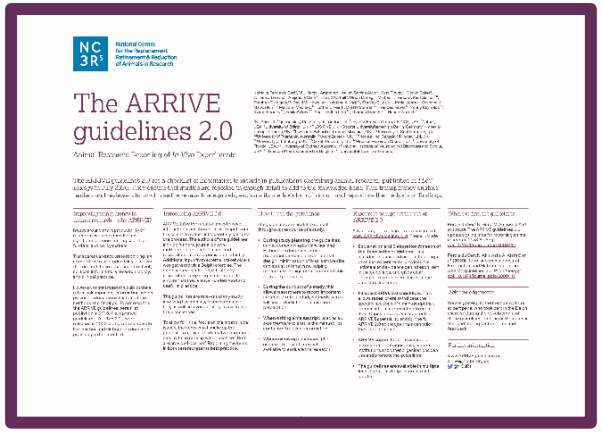
https://eda.nc3rs.org.uk/overview-demonstration

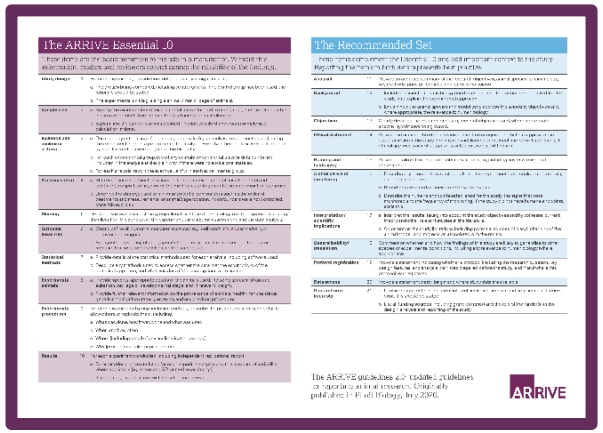
ARRIVE guidelines

Guidelines to improve the reporting of animal research – maximising information published and minimising unnecessary studies.

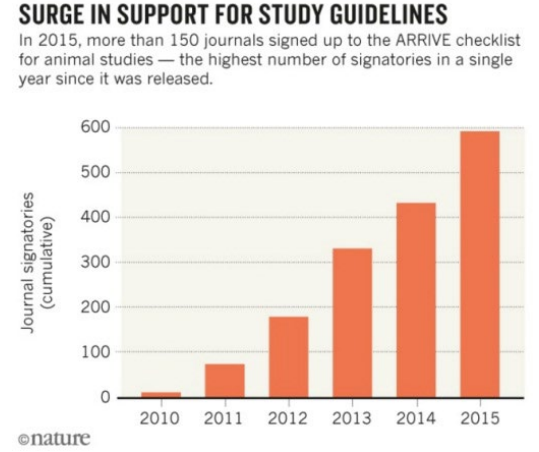
Original guidelines published in 2010.
Revised in 2020: ARRIVE 2.0.
Supporting resources on the website:

www.ARRIVEguidelines.org





Checklist containing key information necessary to describe a study comprehensively and transparently. Can be used as a framework for planning research studies.



Endorsed internationally by over 1,000 journals, major research funders, universities, learned societies and scientific organisations.

ESSENTIAL 10

2. Sample size

2a Specify the exact number of experimental units allocated to each group, and the total number in each experiment. Also indicate the total number of animals used.

2b Explain how the sample size was decided. Provide details of any a priori sample size calculation, if done.

Explanation | Examples

For any type of experiment, it is crucial to explain how the sample size was determined. For hypothesis-testing experiments, where inferential statistics are used to estimate the size of the effect and to determine the weight of evidence against the null hypothesis, the sample size needs to be justified to ensure experiments are of an optimal size to test the research question [1,2] (see **item 13 – Objectives**). Sample sizes that are too small (i.e. underpowered studies) produce inconclusive results, whereas sample sizes that are too large (i.e. overpowered studies) raise ethical issues over unnecessary use of animals and may produce trivial findings that are statistically significant but not biologically relevant [3]. Low power has three effects: first, within the experiment, real effects are more likely to be missed; second, where an effect is an over-estimation of the true effect size [4]; and finally, when low power is combined with publication bias the false positive rate in the published literature [5]. Consequently, low powered studies contribute to the research and risk wasting animals used in inconclusive research [6].

Study design can influence the statistical power of an experiment and the power calculation used needs to design implemented. Statistical programs to help perform *a priori* sample size calculations exist for a designs and statistical analyses, both freeware (web based applets and functions in R) and commercial the appropriate calculator or algorithm to use depends on the type of outcome measures and independent number of groups. Consultation with a statistician is recommended, especially when the experimental unusual.

Where the experiment tests the effect of an intervention on the mean of a continuous outcome measure calculated *a priori*, based on a mathematical relationship between the predefined, biologically relevant effect size,

www.arriveguidelines.org


PLOS BIOLOGY

COMMUNITY PAGE

Reporting animal research: Explanation and elaboration for the ARRIVE guidelines 2.0

Nathalie Percie du Sert[1]*, Amrita Ahluwalia[2,3], Sabina Alam[4], Marc T. Avey[5], Monya Baker[6], William J. Browne[7], Alejandra Clark[8], Innes C. Cuthill[9], Ulrich Dirnagl[10], Michael Emerson[11], Paul Garner[12], Stephen T. Holgate[13], David W. Howells[14], Viki Hurst[1], Natasha A. Karp[15], Stanley E. Lazic[16], Katie Lidster[1], Catriona J. MacCallum[17], Malcolm Macleod[18], Esther J. Pearl[1], Ole H. Petersen[19], Frances Rawle[20], Penny Reynolds[21], Kieron Rooney[22], Emily S. Sena[18], Shai D. Silberberg[23], Thomas Steckler[24], Hanno Würbel[25]

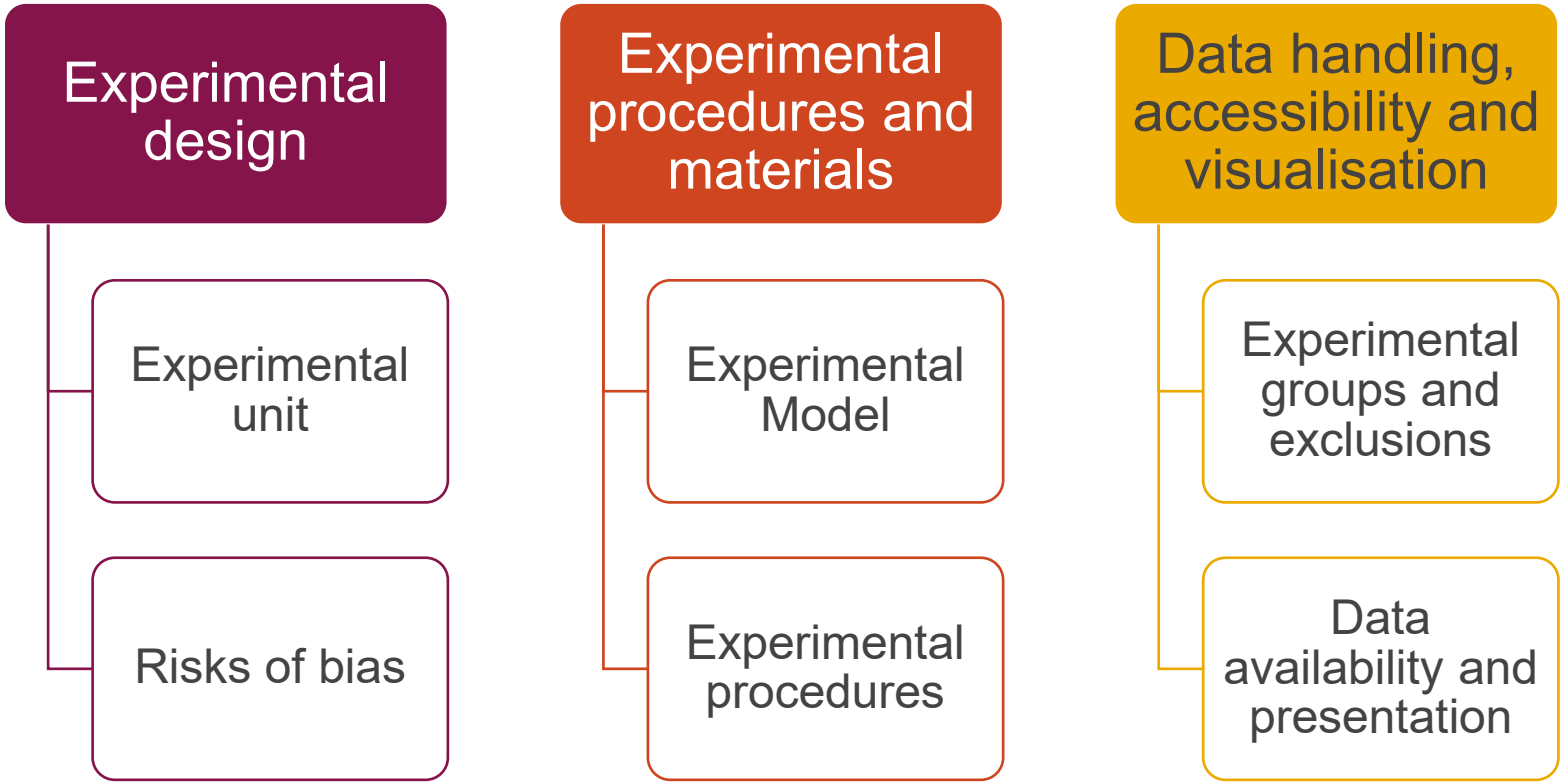
The RIVER recommendations

Reporting *In Vitro* Experiments Responsibly

Six recommendations to increase the methodological rigour and reliability of *in vitro* studies

Developed by an international working group including:

- Funders
- Journal editors / publishers
- Methodologists & statisticians
- *In vitro* researchers in industry, academia & government



The RIVER working group (2023). *MetaArxiv*. doi: 10.31222/osf.io/x6aut

MetaArXiv Preprints

Experimental design resource links

Resource	link
Experimental Design Assistant	https://eda.nc3rs.org.uk/
Experimental Design Assistant demonstrations	Register for a live demonstration - https://nc3rs.org.uk/EDAdemos Recorded demonstration - https://eda.nc3rs.org.uk/index.php/overview-demonstration
ARRIVE guidelines	https://arriveguidelines.org/
RIVER recommendations	https://doi.org/10.31222/osf.io/x6aut
Webinar: Best practices in experimental design	https://vimeo.com/442640803/09faa99012
MRC/NC3Rs Webinar: Using both sexes in animal research	https://nc3rs.org.uk/3rs-resources/mrc-nc3rs-webinar-using-both-sexes-animal-experiments
NC3Rs experimental design and reporting resources	https://nc3rs.org.uk/3rs-resources/search?topic[]=497
NC3Rs resources for masking	https://www.nc3rs.org.uk/3rs-resources/using-maskingblinding-vivo-experiments
British Pharmacological Society animation – blinding	https://www.youtube.com/watch?v=hbU5kHC9yH0
British Pharmacological Society animation – experimental unit	https://www.youtube.com/watch?v=WQSWJLDcy5M
British Pharmacological Society eLearning resources	https://www.bps.ac.uk/education-engagement/research-animals/blinding-elearning-resource

National Centre
for the Replacement
Refinement & Reduction
of Animals in Research

Thank you!

For more information

esther.pearl@nc3rs.org.uk

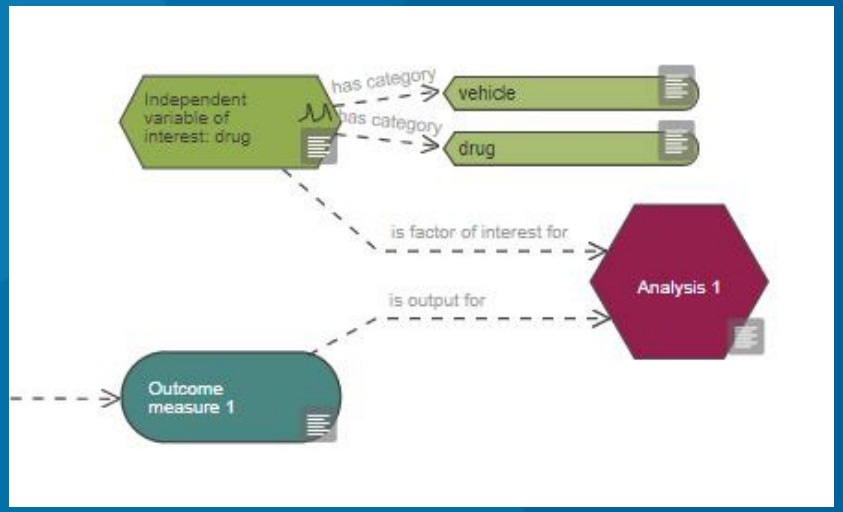
www.nc3rs.org.uk

@NC3Rs

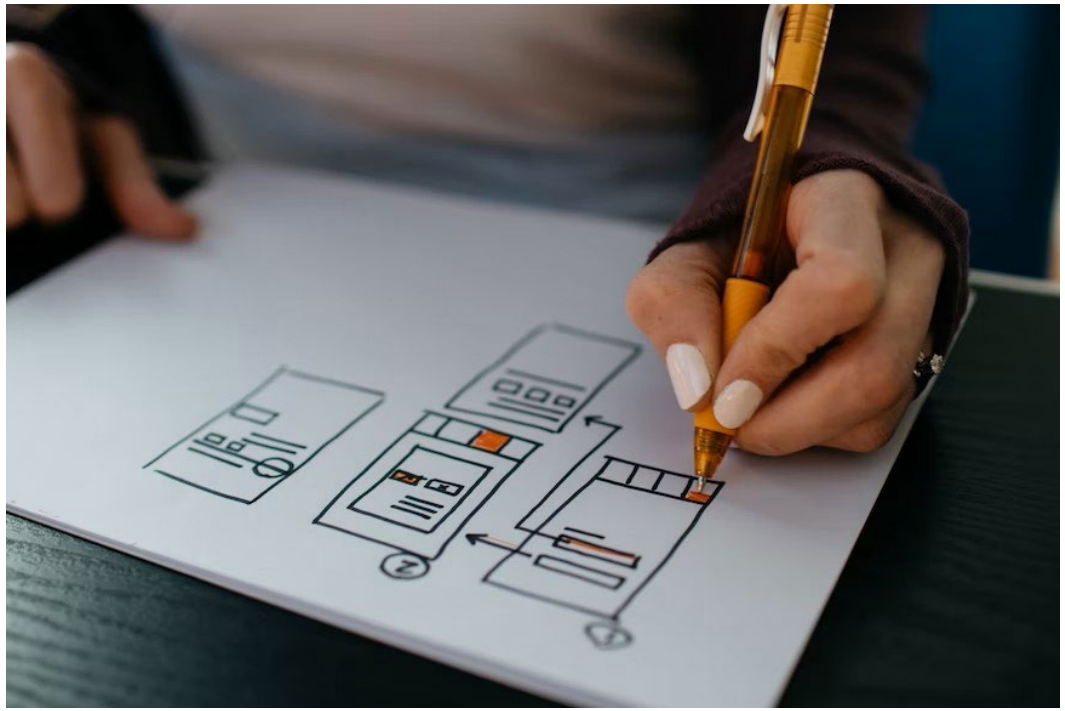
@DrEJPearl

Keep in touch

Our monthly newsletter provides the latest updates from the NC3Rs, including funding calls and events www.nc3rs.org.uk/register



In case you missed it!



OLAW Online Seminar: March 9, 2023
Foundations for Evaluating Study Design and Statistical Approaches for the IACUC

Recording and materials at:
https://olaw.nih.gov/education/educational-resources/webinar-2023-03-09.htm

OLAW Online Seminar: June 15, 2023
The ARRIVE 2.0 Essential 10:
Guidance for NIH-sponsored Research

Recording and materials at:
https://olaw.nih.gov/education/educational-resources/webinar-2023-06-15.htm

Next Webinar: Winter 2023
Topic TBD

NIH National Institutes of Health
Office of Laboratory Animal Welfare