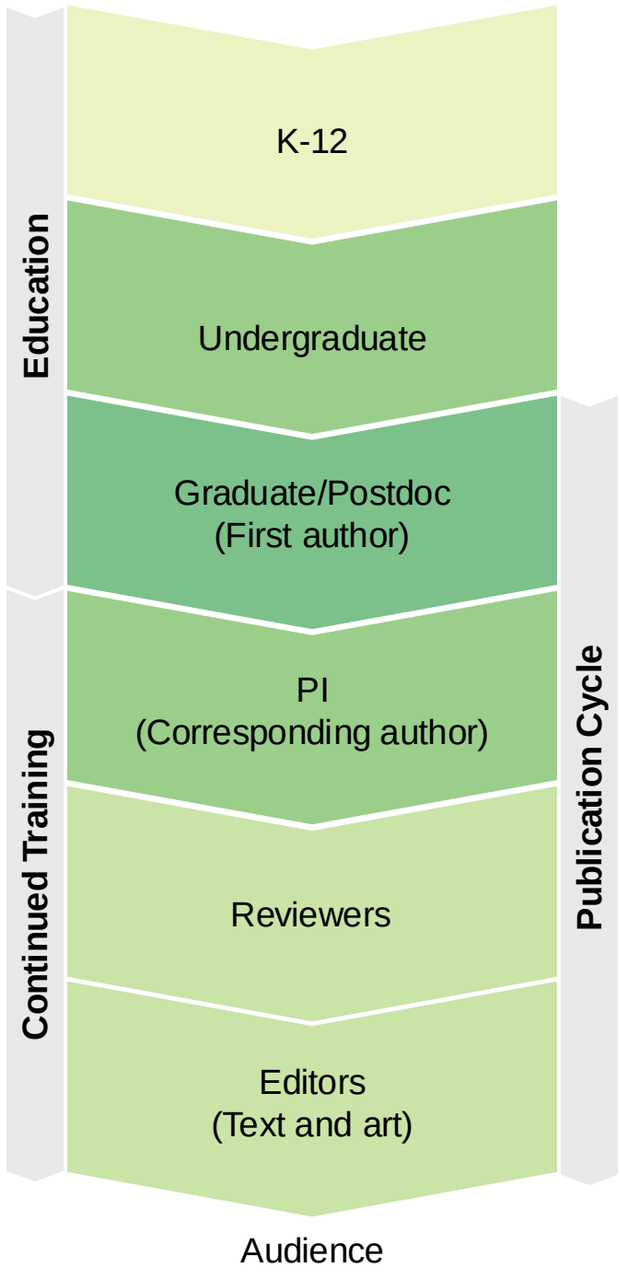
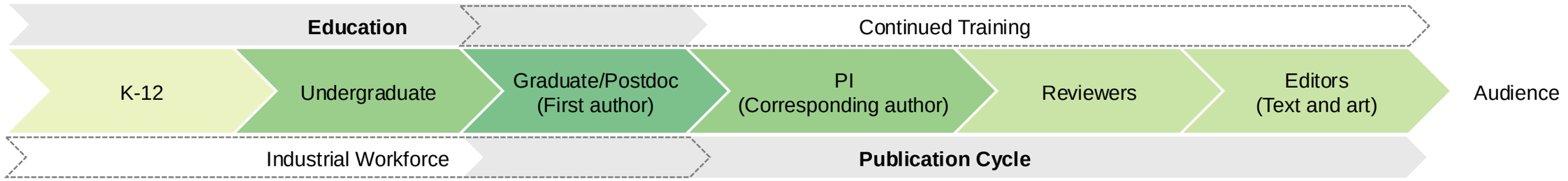

Education
K-12
Undergraduate
Graduate/Postdoc
(First author)
PI
(Corresponding author)
Reviewers
Editors
(Text and art)
Continued Training
Publication Cycle
Audience


Education
Continued Training
K-12
Undergraduate
Graduate/Postdoc
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PI
(Corresponding author)
Reviewers
Editors
(Text and art)
Audience
Industrial Workforce
Publication Cycle

Hierarchy of Control

Most effective

Elimination

Do not use bar graphs

Substitution

Use correct bar graphs

Engineering Controls

Build warnings in software

Administrative Controls

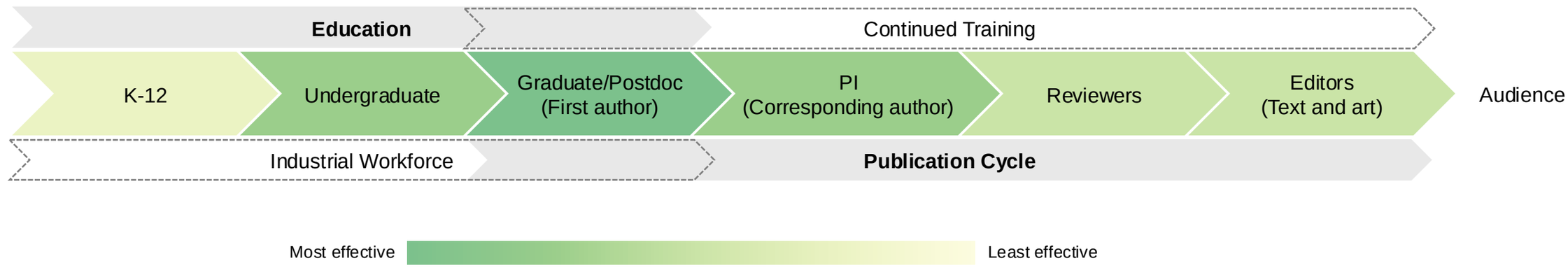
Data science awareness of personnel in publication cycle

PPE

Data science awareness of audience

Least effective

a


Education
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Audience
Industrial Workforce
Publication Cycle
Most effective
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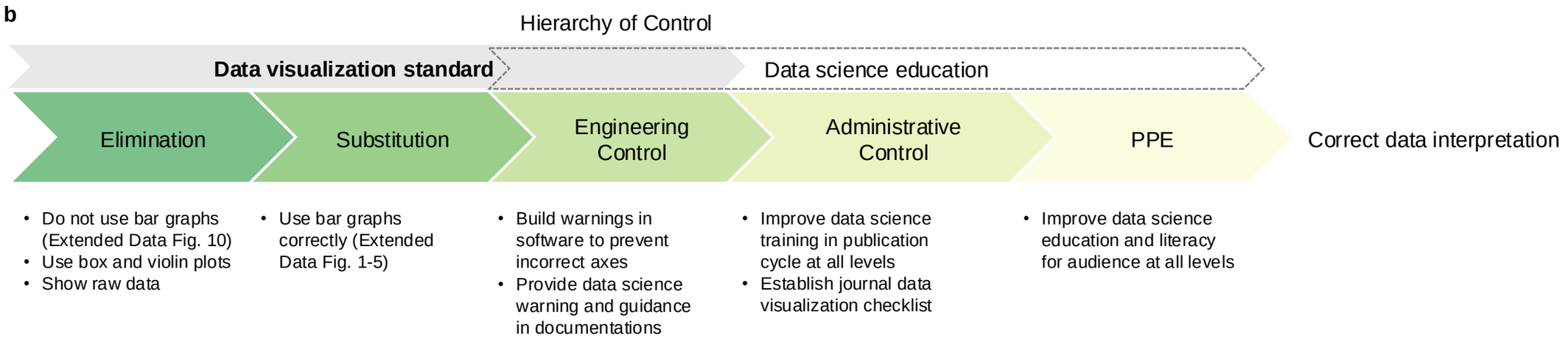
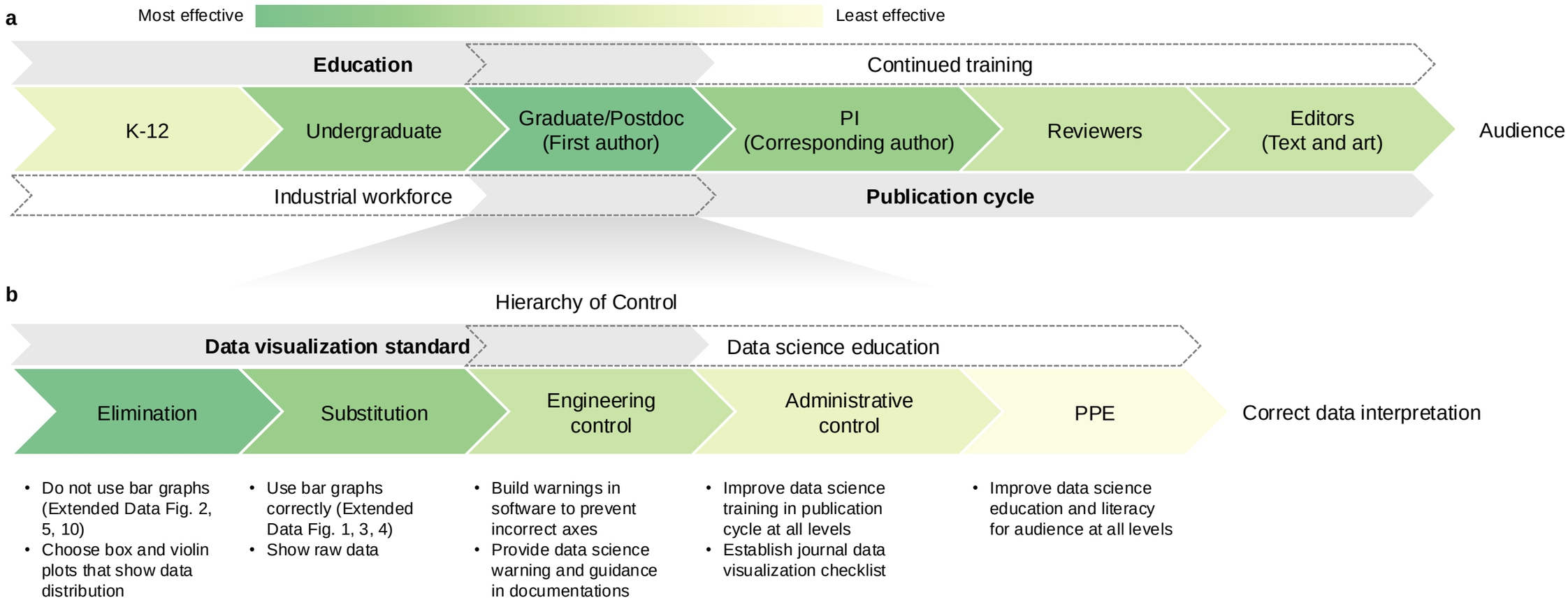
b


Hierarchy of Control
Data visualization standard
Data science education
Elimination
Substitution
Engineering
Control
Administrative
Control
PPE
Correct data interpretation
• Do not use bar graphs (Extended Data Fig. 10)
• Use box and violin plots
• Show raw data
• Use bar graphs correctly (Extended Data Fig. 1-5)
• Build warnings in software to prevent incorrect axes
• Provide data science warning and guidance in documentations
• Improve data science training in publication cycle at all levels
• Establish journal data visualization checklist
• Improve data science education and literacy for audience at all levels


a
Most effective
Least effective
Education
Continued training
K-12
Undergraduate
Graduate/Postdoc
(First author)
PI
(Corresponding author)
Reviewers
Editors
(Text and art)
Audience
Industrial workforce
Publication cycle
b
Hierarchy of Control
Data visualization standard
Data science education
Elimination
Substitution
Engineering control
Administrative control
PPE
Correct data interpretation
• Do not use bar graphs (Extended Data Fig. 2, 5, 10)
• Choose box and violin plots that show data distribution
• Use bar graphs correctly (Extended Data Fig. 1, 3, 4)
• Show raw data
• Build warnings in software to prevent incorrect axes
• Provide data science warning and guidance in documentations
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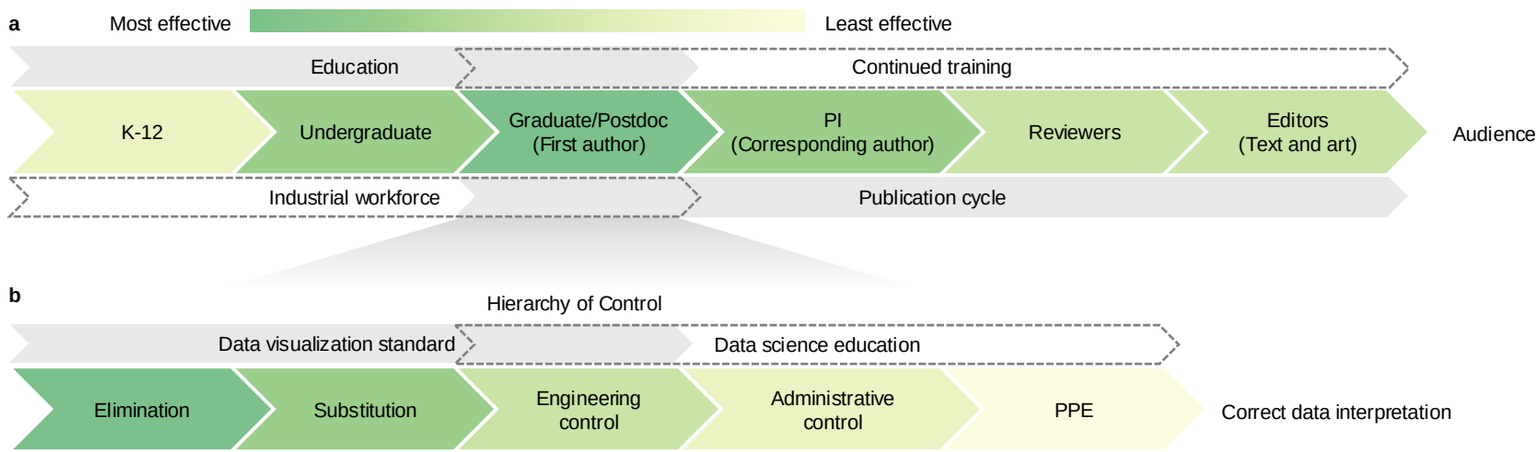

- Do not use bar graphs (Extended Data Fig. 2, 5, 10)
- Choose box and violin plots that show data distribution

- Use bar graphs correctly (Extended Data Fig. 1, 3, 4)
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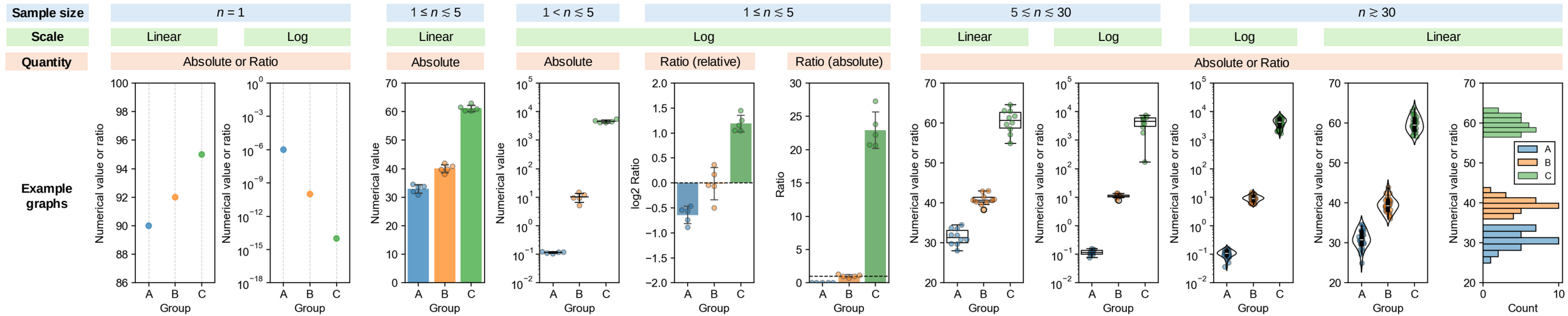
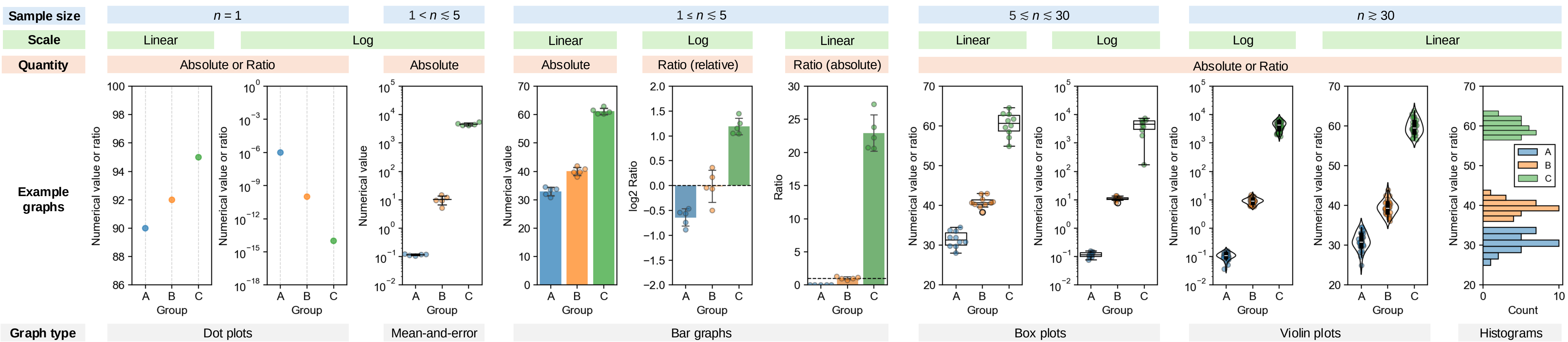
a



b

Graph type	Sample size	Axis scale		Difference		
		Linear	Log	Absolute difference	Fold difference	Relative difference
Point plot	$n = 1$	✓	✓	✓		
Bar plot	$1 \leq n \lesssim 5$	✓			✓	✓
Mean-and-error plot	$1 < n \lesssim 5$	✓	✓	✓		
Box plot	$5 \lesssim n \lesssim 30$	✓	✓	✓		
Violin plot	$n \gtrsim 30$	✓	✓	✓		
Histogram	$n \gtrsim 30$	✓		✓		


Sample size
n = 1
1 < n ≲ 5
1 ≤ n ≲ 5
5 ≲ n ≲ 30
n ≳ 30
Scale
Linear
Log
Linear
Log
Linear
Linear
Log
Log
Linear
Quantity
Absolute or Ratio
Absolute
Absolute
Ratio (relative)
Ratio (absolute)
Absolute or Ratio
Example graphs
Numerical value or ratio
Numerical value
log2 Ratio
Ratio
Group
Count
A
B
C
Graph type
Dot plots
Mean-and-error
Bar graphs
Box plots
Violin plots
Histograms

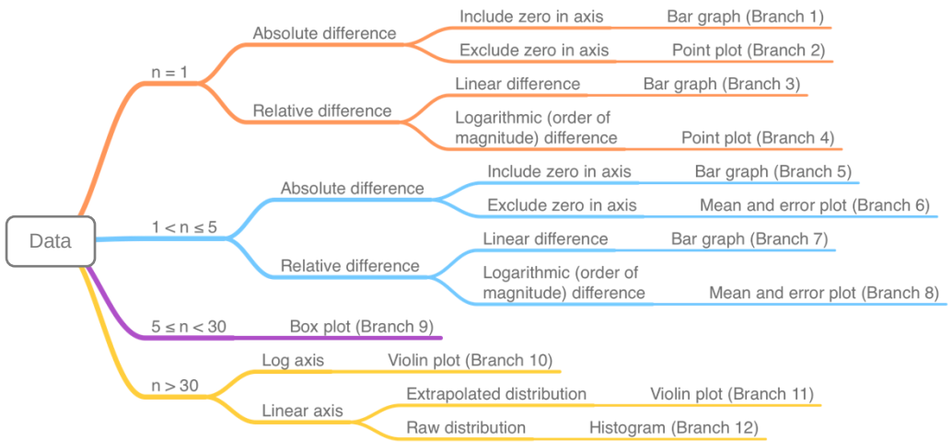
Graph type	Sample size per group	Axis scale		Change		
		Linear	Log	Absolute change	Fold change	Relative change
Point plot	$n = 1$	✓	✓	✓		
Bar plot	$1 \leq n \lesssim 5$	✓			✓	✓
Mean-and-error plot	$1 < n \lesssim 5$	✓	✓	✓		
Box plot	$5 \lesssim n \lesssim 30$	✓	✓	✓		
Violin plot	$n \gtrsim 30$	✓	✓	✓		
Histogram	$n \gtrsim 30$	✓		✓		

Graph type	Sample size per group	Axis scale		Change		
		Linear	Log	Absolute change	Fold change	Relative change
Point plot	$n = 1$	✓	✓	✓		
Lollipop plot	$n = 1$	✓			✓	✓
Bar plot	$1 \leq n \lesssim 5$	✓			✓	✓
Mean-and-error plot	$1 < n \lesssim 5$	✓	✓	✓		
Box plot	$5 \lesssim n \lesssim 30$	✓	✓	✓		
Violin plot	$n \gtrsim 30$	✓	✓	✓		
Histogram	$n \gtrsim 30$	✓		✓		

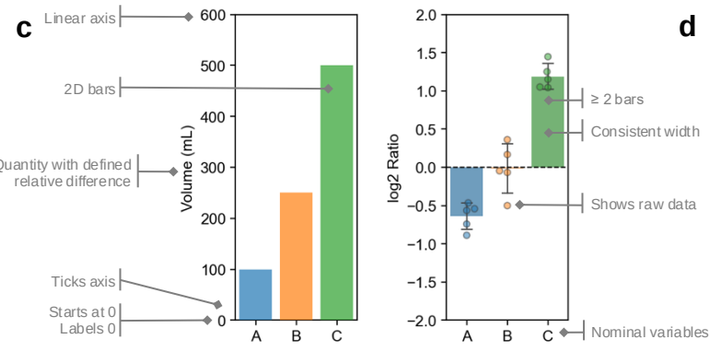
a

Graph type	Sample size per group	Axis scale		Difference		
		Linear	Log	Absolute difference	Fold difference	Relative difference
Point plot	$n = 1$	✓	✓	✓		
Bar graph	$1 \lesssim n \lesssim 5$	✓			✓	✓
Mean-and-error plot	$1 < n \lesssim 5$	✓	✓	✓		
Box plot	$5 \lesssim n \lesssim 30$	✓	✓	✓		
Violin plot	$n \gtrsim 30$	✓	✓	✓		
Histogram	$n \gtrsim 30$	✓		✓		

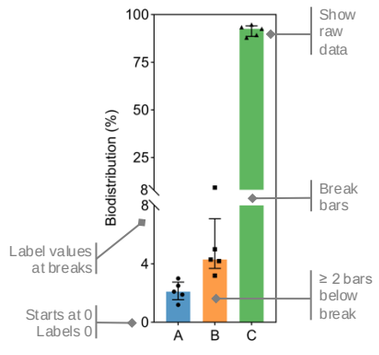
b



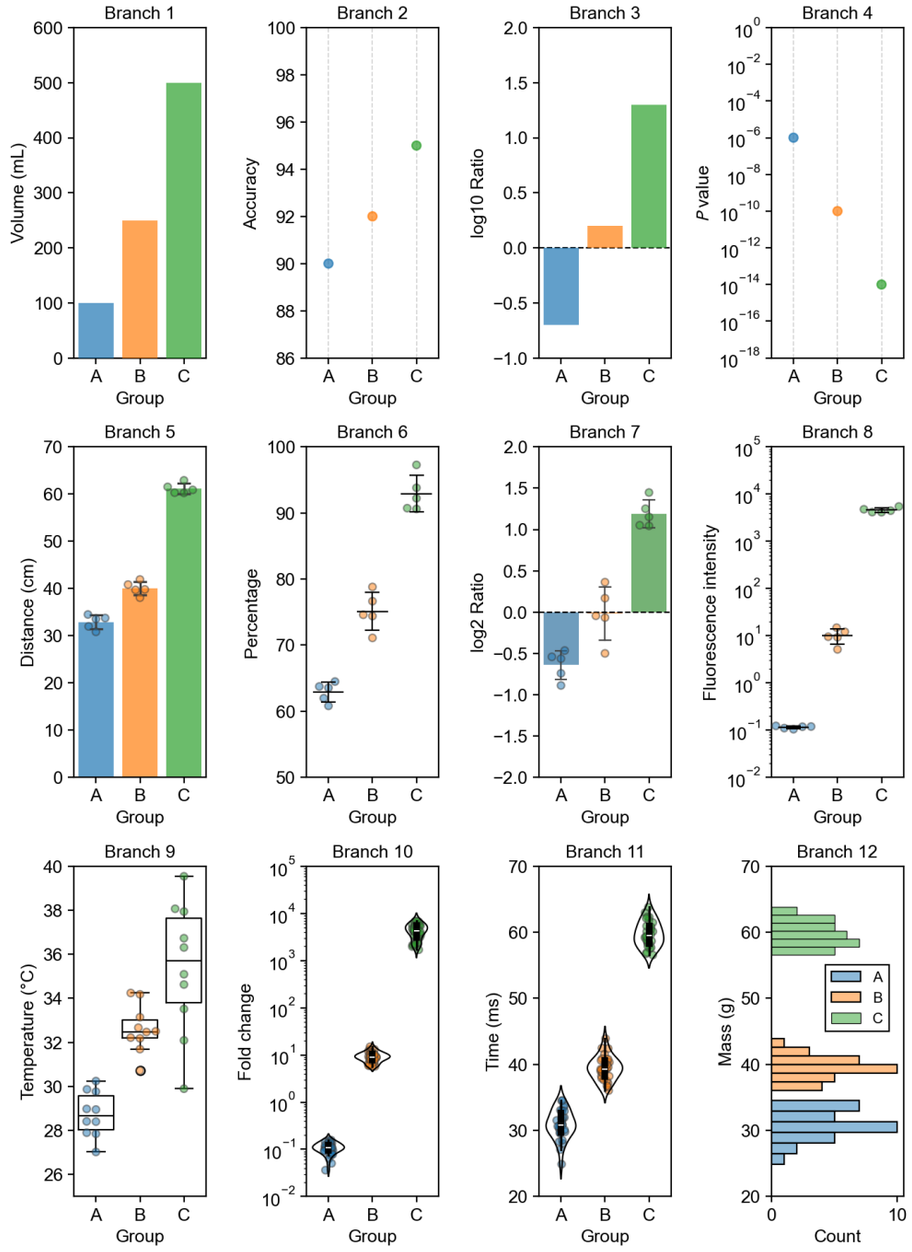
c

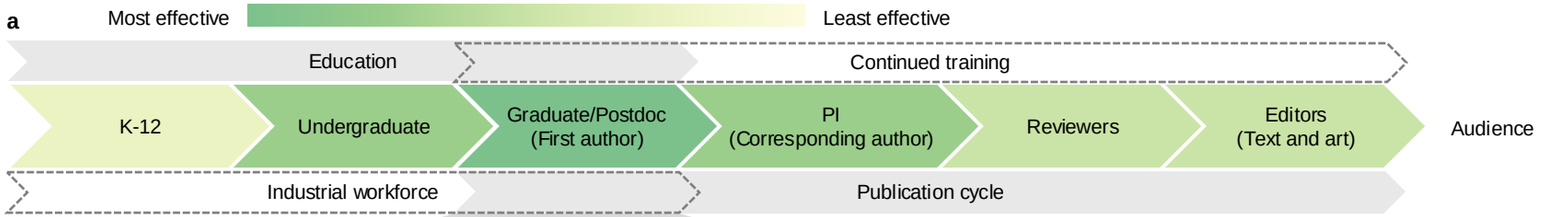


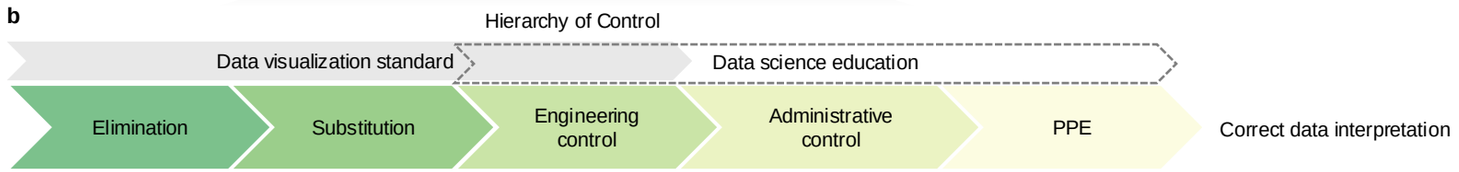
d



e







- Do not use bar graphs (Fig. 2d, Extended Data Fig. 2, 5, 10)
- Choose box and violin plots that show data distribution

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- Show raw data

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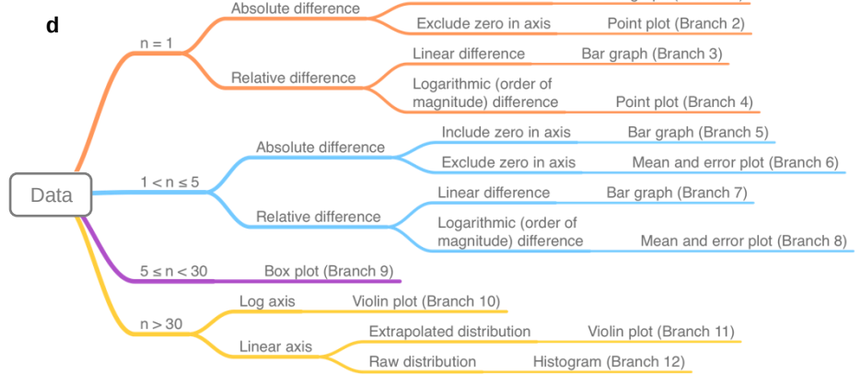
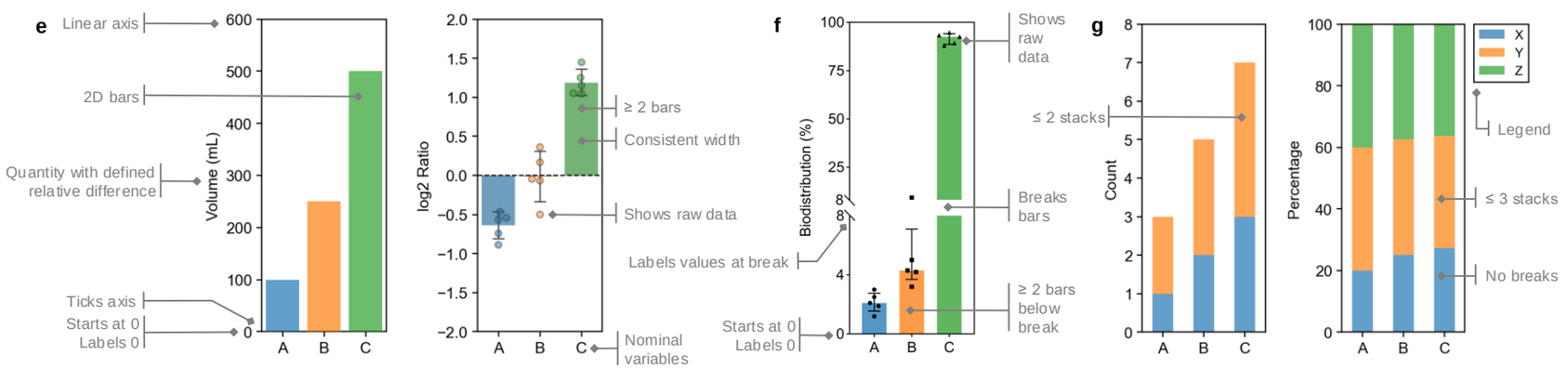
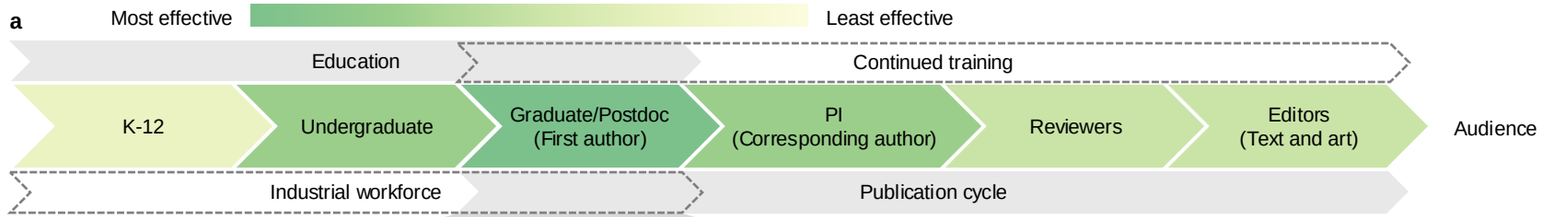
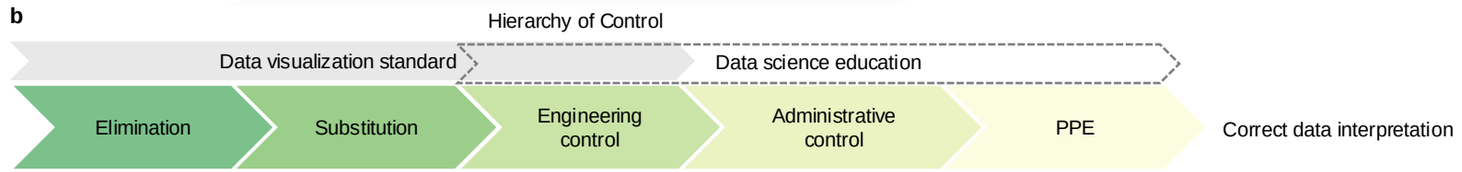
c

Graph type	Sample size per group	Axis scale		Change		
		Linear	Log	Absolute change	Fold change	Relative change
Point plot	$n = 1$	✓	✓	✓		
Lollipop plot	$n = 1$	✓			✓	✓
Bar plot	$1 \leq n \lesssim 5$	✓			✓	✓
Mean-and-error plot	$1 < n \lesssim 5$	✓	✓	✓		
Box plot	$5 \lesssim n \lesssim 30$	✓	✓	✓		
Violin plot	$n \gtrsim 30$	✓	✓	✓		
Histogram	$n \gtrsim 30$	✓		✓		









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c

Graph type	Sample size per group	Axis scale		Change		
		Linear	Log	Absolute change	Fold change	Relative change
Point plot	$n = 1$	✓	✓	✓		
Lollipop plot	$n = 1$	✓			✓	✓
Bar plot	$1 \leq n \lesssim 5$	✓			✓	✓
Mean-and-error plot	$1 < n \lesssim 5$	✓	✓	✓		
Box plot	$5 \lesssim n \lesssim 30$	✓	✓	✓		
Violin plot	$n \gtrsim 30$	✓	✓	✓		
Histogram	$n \gtrsim 30$	✓		✓