How to read & understand scientific articles

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Seminar „Digital culture: Cognitive context"
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How to read & understand scientific articles

1. Finding relevant papers

2. Reading original research articles

3. Understanding the results

4. Making sense of scientific fidings

Your experience with scientific articles

- Where do you usually get your information?

- Have you read scientific research articles before? How did it go?

- What are your questions about reading scientific articles?

1. Finding relevant papers

Article types

- Original research articles Details
- Reviews Overview
- Opinions / Perspectives / ... Understanding
- „News & Views" For „non-specialists"

Search: scholar.google.com

- Start with reviews
- Go deeper: check citations, search in cited articles
- Filter: year, author

1. Finding relevant papers

Getting access

- Through an institution (university, library)

- Open access (scholar.google.com)

- Google „filetype:pdf"

- Email the (corresponding) author

- Scihub (illegal!)

1. Finding relevant papers

Journals: superstars vs. predators

- Nature, Science, Cell: headlines-making above accuracy
- Predatory journals: unprofessional website & article formatting, often poor grammar (no proof-editing of articles)
  - → [Beall's list](#) of predatory journals (not updated since 2017)

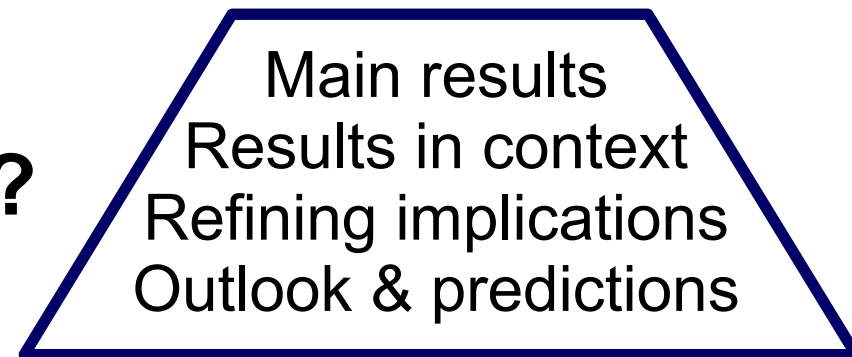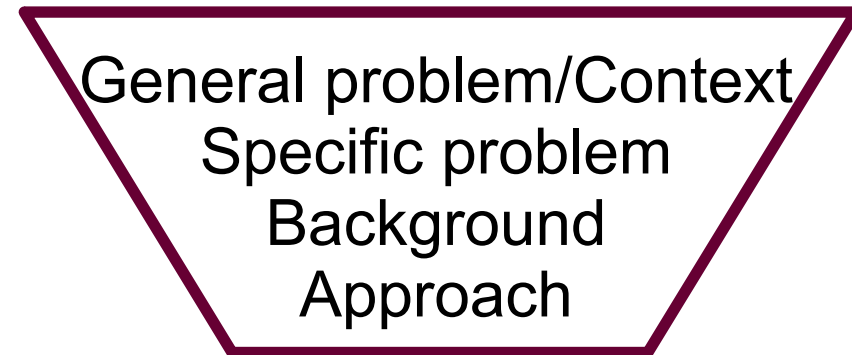# 2. Reading original research articles
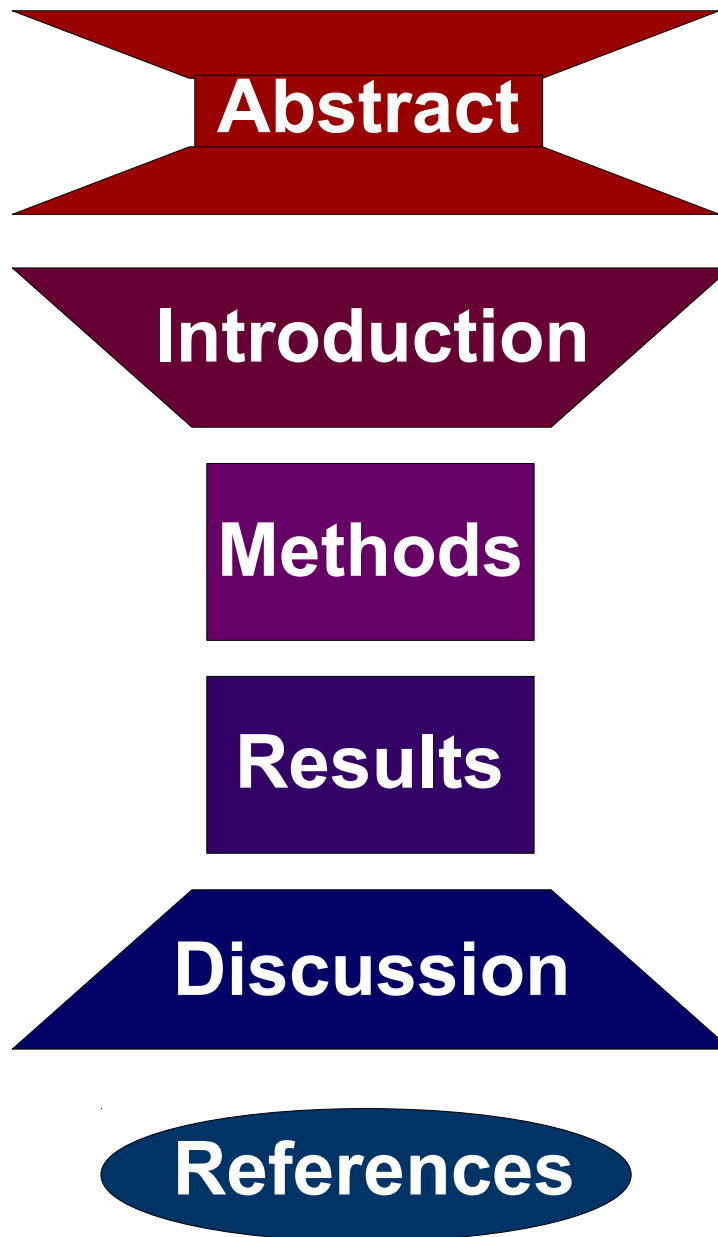
2. Reading original research articles

Reading strategy

- Read Abstract & decide whether this article is relevant to you
- Read Introduction & try to understand the context of the study
- Look up cited literature if needed for better understanding
- Read Discussion to get an overview of the results & their implications
- Look at the figures & tables and try to understand the data
- Read the corresponding parts of Results
- Look up details in Methods if needed
- Read again Discussion to evaluate whether data support the conlcusions
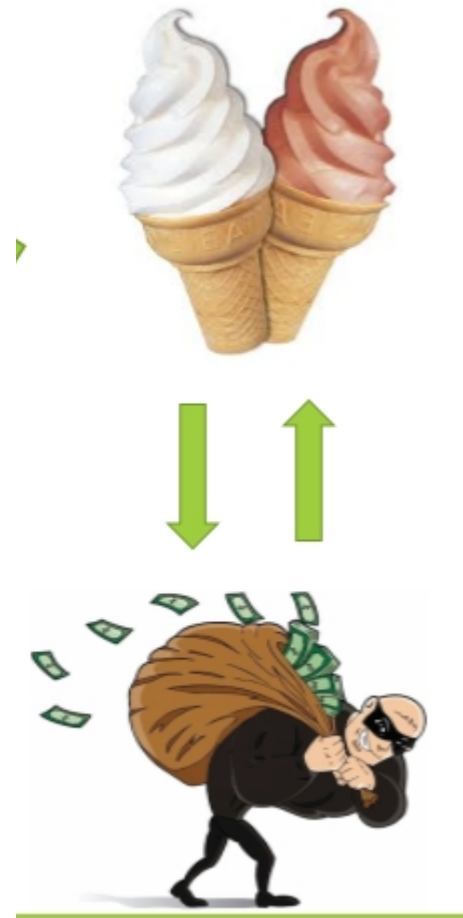
3. Understanding the results

The scientific method

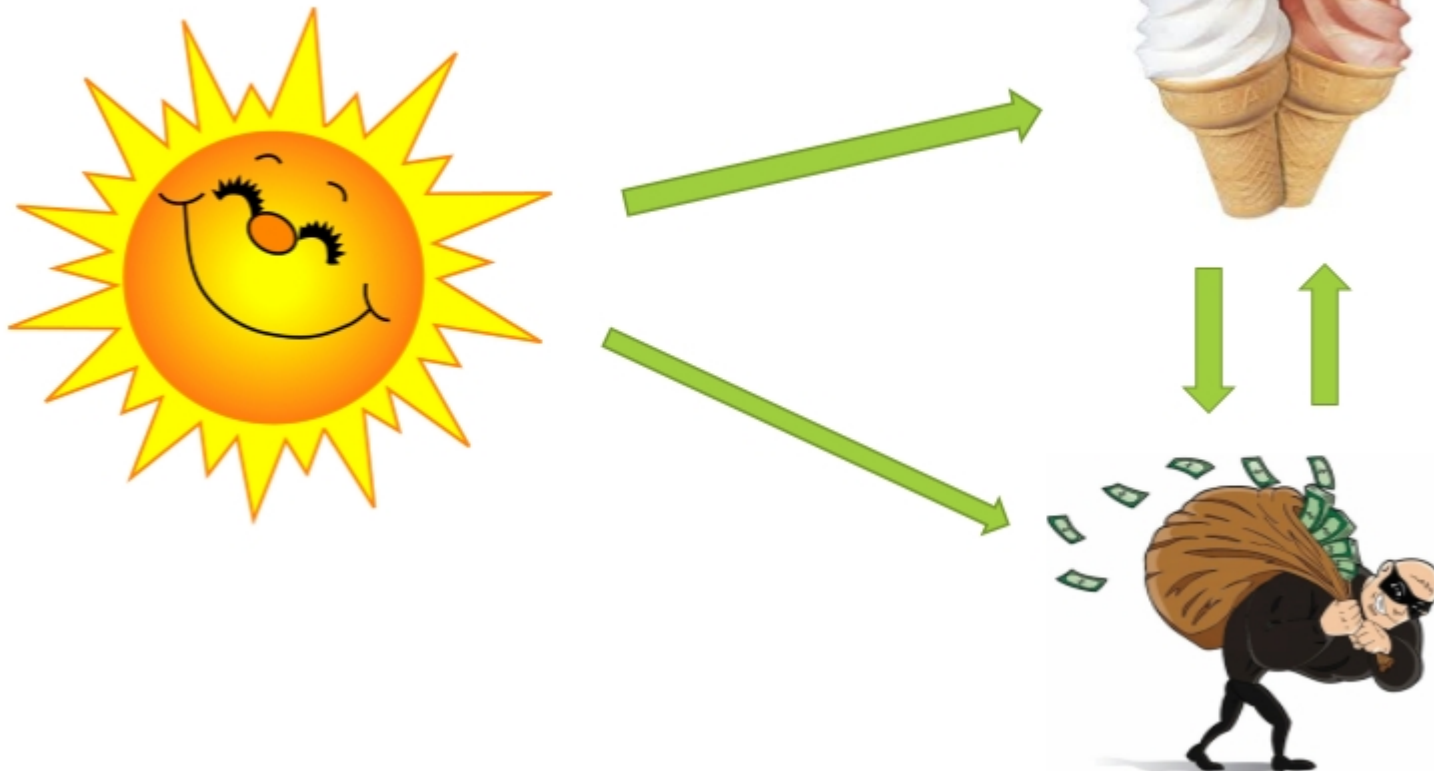- Process of rejecting hypotheses on the basis of experiments
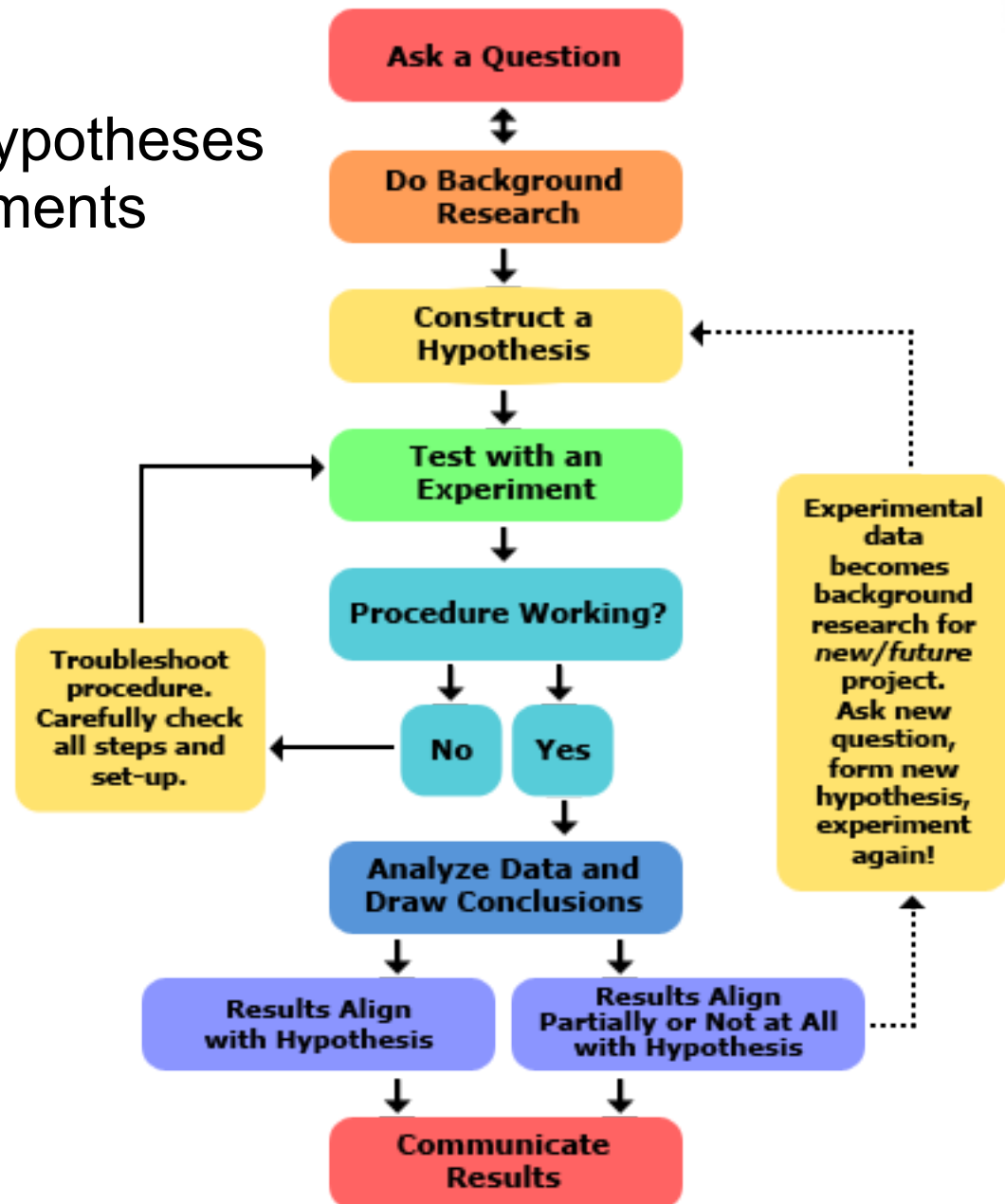
3. Understanding the results

Correlation vs. Causation
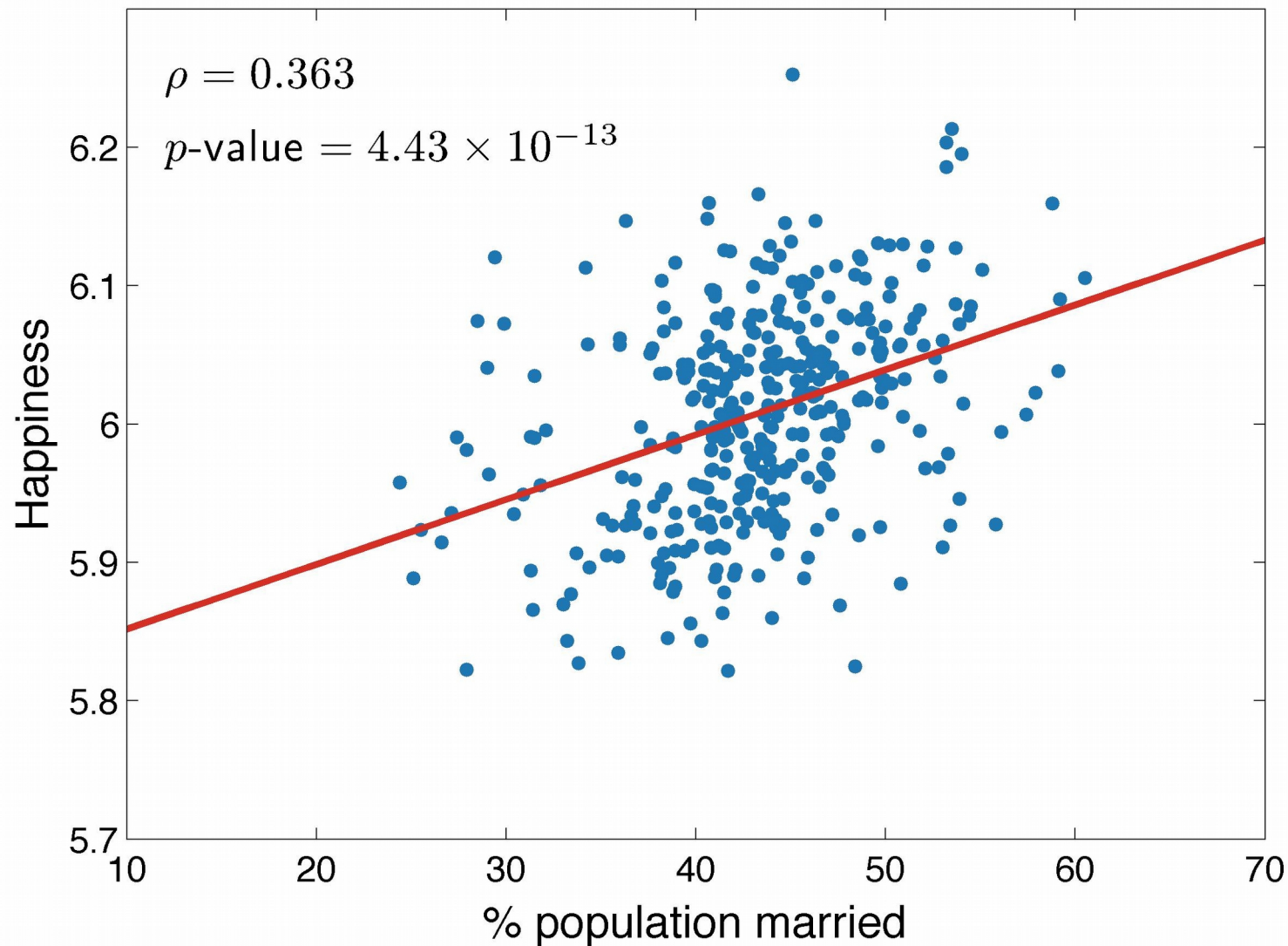
3. Understanding the results

Correlation vs. Causation

3. Understanding the results

Correlation vs. Causation

$$\rho = 0.363$$

$$p\text{-value} = 4.43 \times 10^{-13}$$

Plot: x-axis "% population married" (10 to 70), y-axis "Happiness" (5.7 to 6.2)

3. Understanding the results

Correlation coefficient ρ (R)

- Measure of the linear correlation between two variables

3. Understanding the results

Correlation coefficient ρ (R)

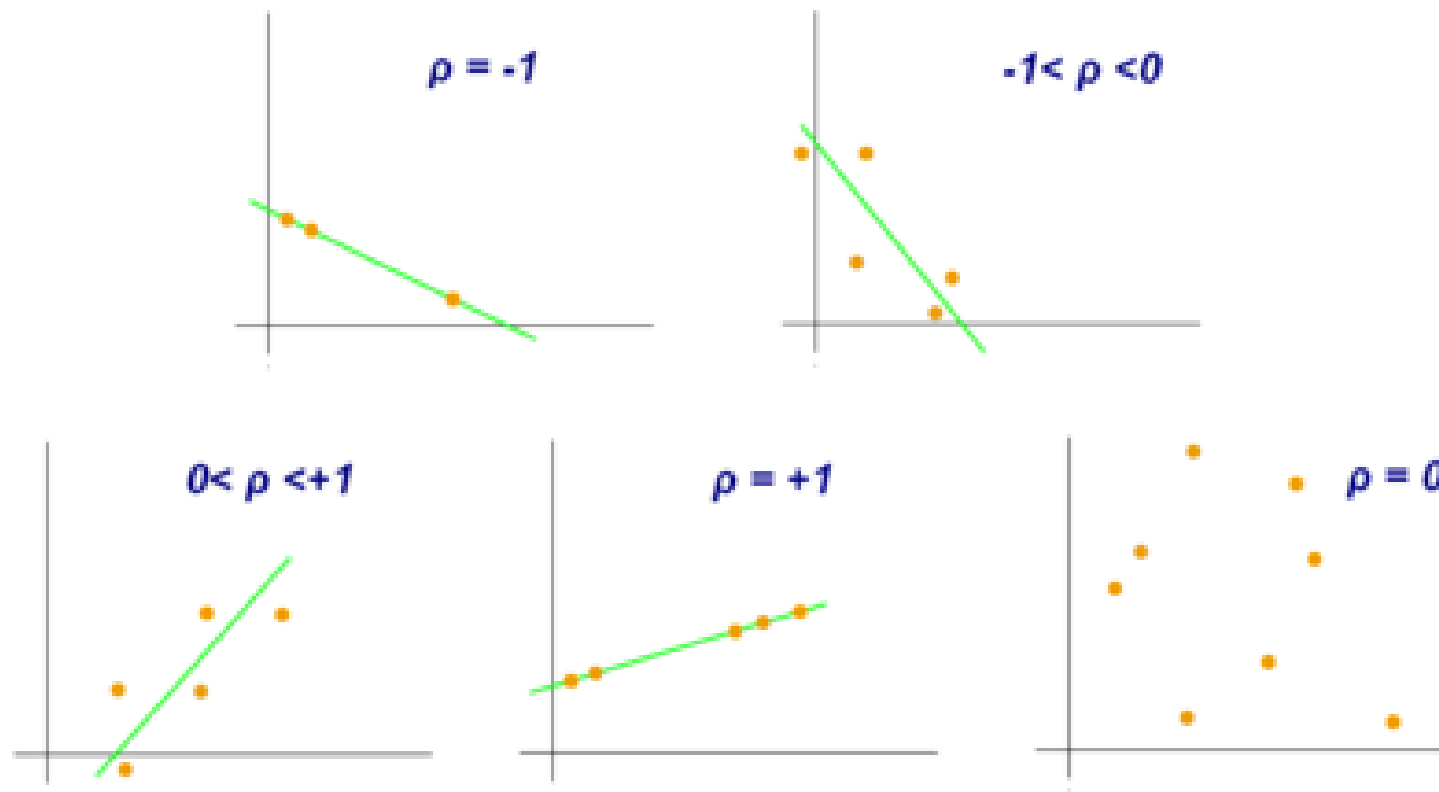• Measure of the <u>linear</u> correlation between two variables
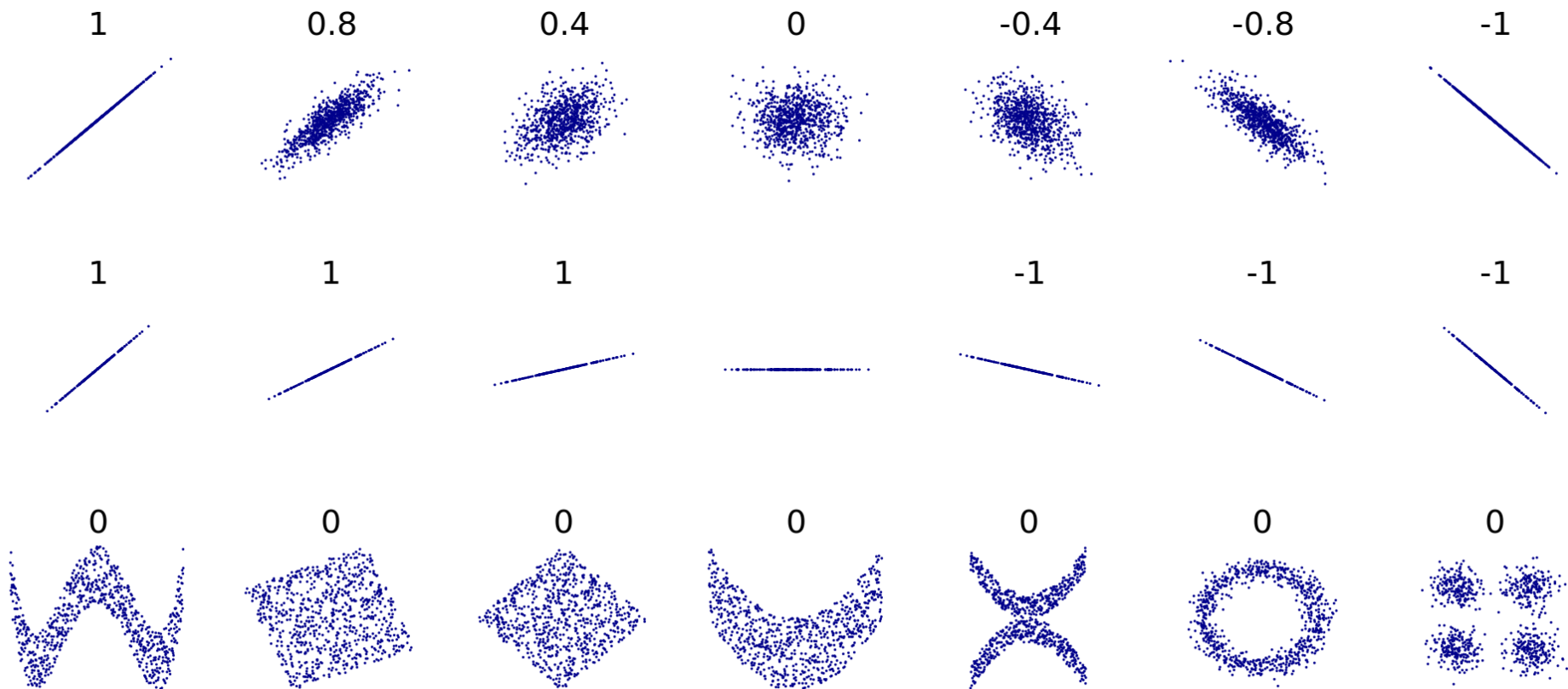
3. Understanding the results

Correlation vs. Causation
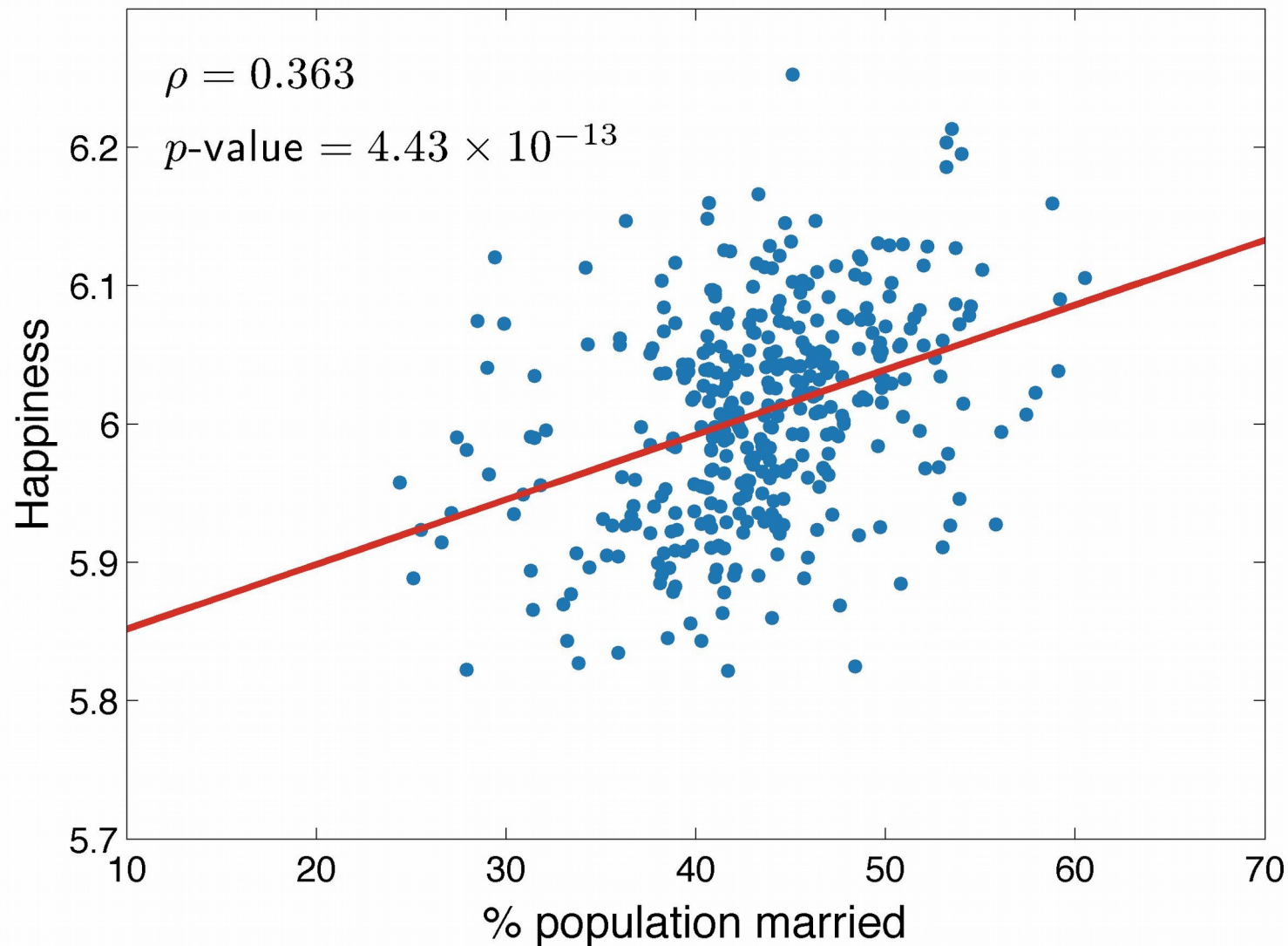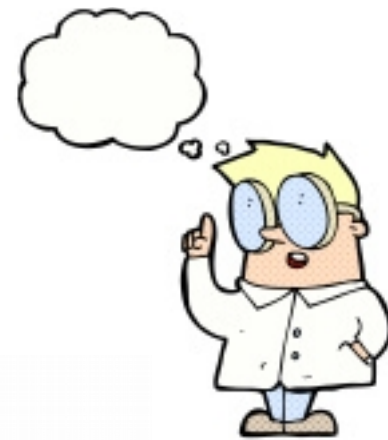
3. Understanding the results

P-value (probability value, significance)

- Used to determine result significance in a statistical test

- Probability of finding the observed (or more extreme) result when the null hypothesis is true

- Null hypothesis: no effect / no relationship between variables

3. Understanding the results

Correlation vs. Causation

Flow Chart for Selecting Commonly Used Statistical Tests

Parametric Assumptions:
1. Independent, unbiased samples
2. Data normally distributed
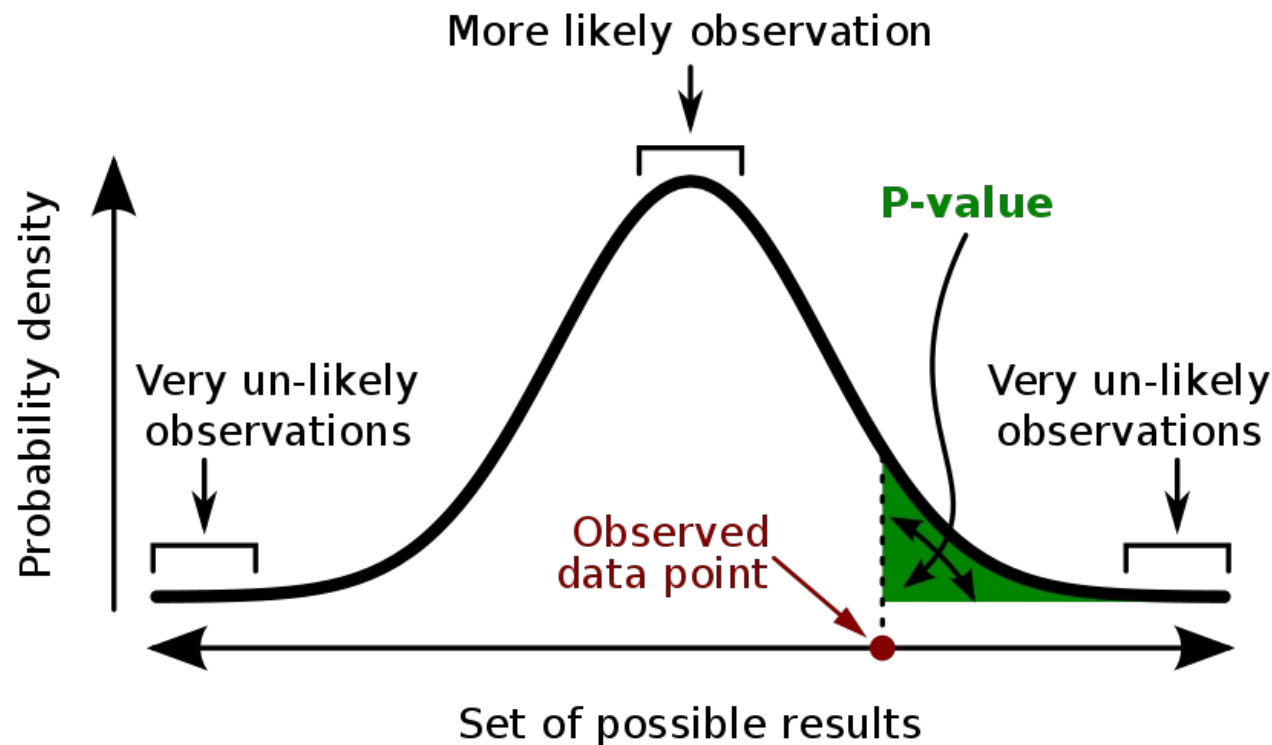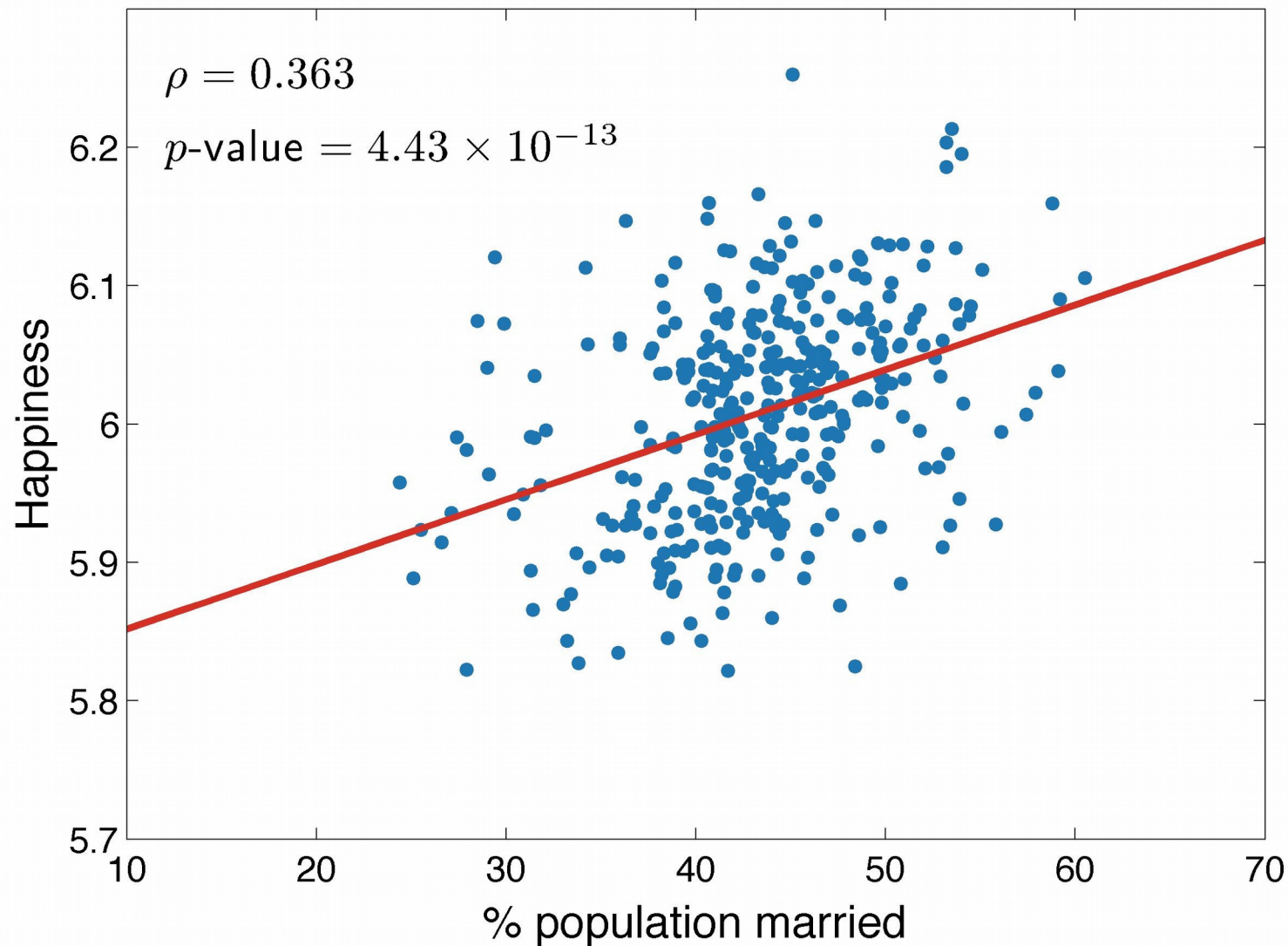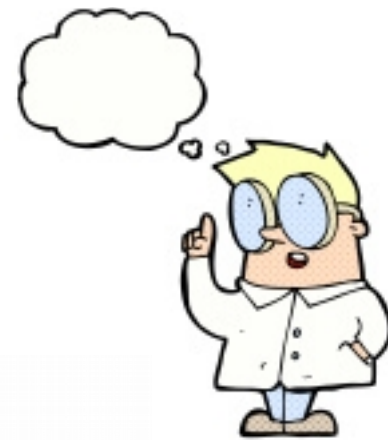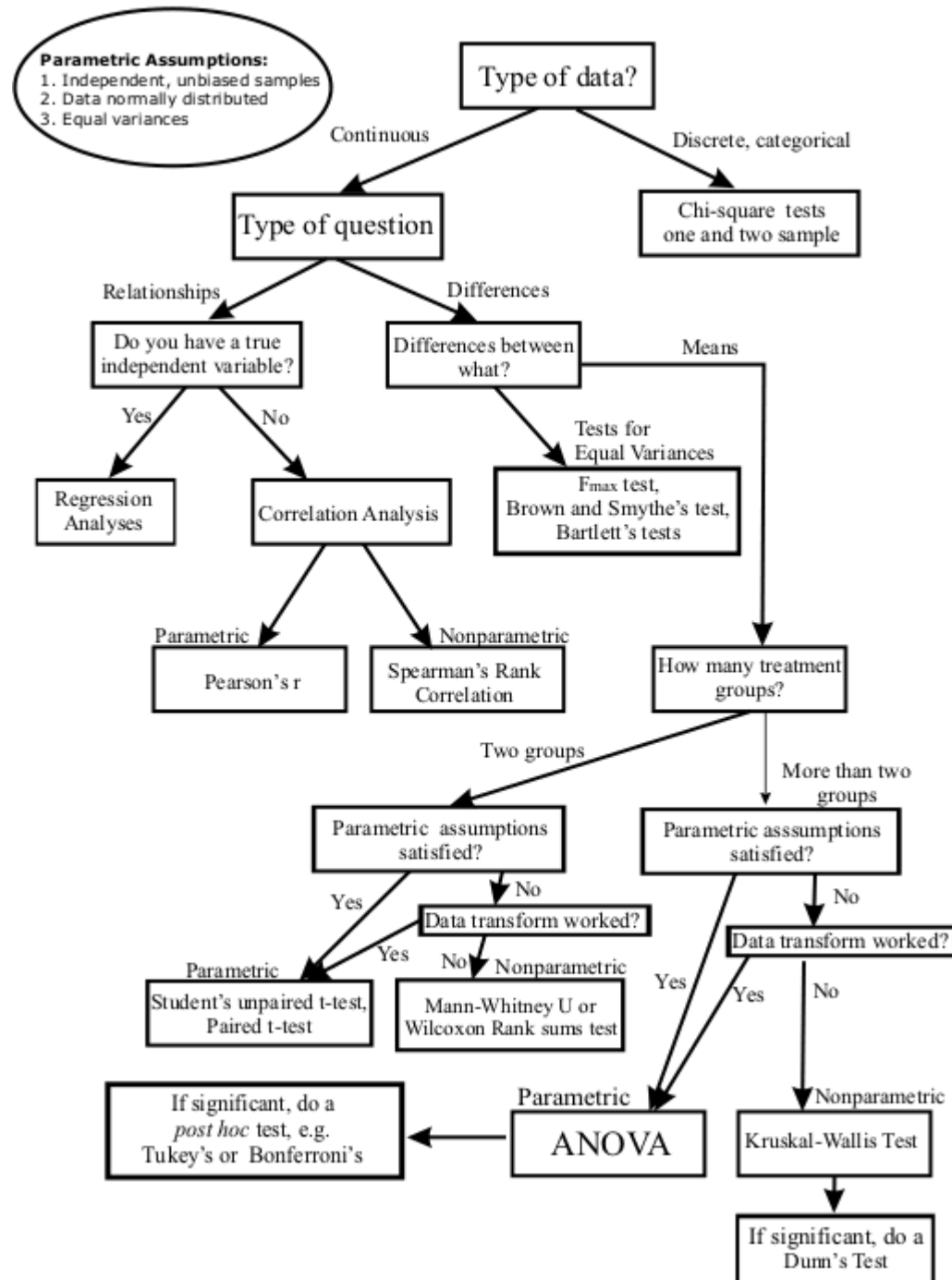3. Equal variances

Type of data?

- Continuous → **Type of question**
- Discrete, categorical → **Chi-square tests one and two sample**

Type of question

- Relationships → **Do you have a true independent variable?**
  - Yes → **Regression Analyses**
  - No → **Correlation Analysis**
    - Parametric → **Pearson's r**
    - Nonparametric → **Spearman's Rank Correlation**
- Differences → **Differences between what?**
  - Tests for Equal Variances → **Fmax test, Brown and Smythe's test, Bartlett's tests**
  - Means → **How many treatment groups?**
    - Two groups → **Parametric assumptions satisfied?**
      - Yes → Parametric → **Student's unpaired t-test, Paired t-test**
      - No → **Data transform worked?**
        - Yes → Parametric → **Student's unpaired t-test, Paired t-test**
        - No → Nonparametric → **Mann-Whitney U or Wilcoxon Rank sums test**
    - More than two groups → **Parametric asssumptions satisfied?**
      - Yes → Parametric → **ANOVA**
      - No → **Data transform worked?**
        - Yes → Parametric → **ANOVA**
        - No → Nonparametric → **Kruskal-Wallis Test**

ANOVA → **If significant, do a *post hoc* test, e.g. Tukey's or Bonferroni's**

Kruskal-Wallis Test → **If significant, do a Dunn's Test**

3. Understanding the results

## Correlation vs. Causation

3. Understanding the results

Proving causation

- Randomized experiment: experimental group & control group differing only in the one variable that is being tested
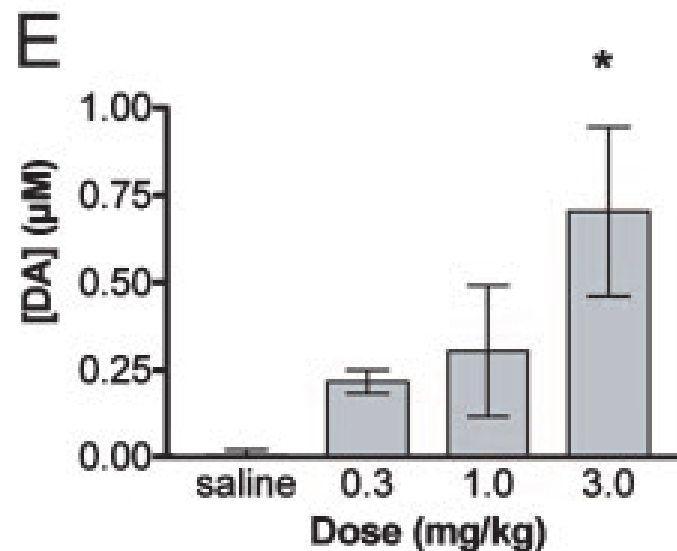
  Example:
- Hypothesis: marriage causes happiness
- Experiment: <u>randomly</u> assign people to the groups „don't marry" (control) and „get married" (experimental), measure the level of their happiness after some time, and compare them in a statistical test

3. Understanding the results
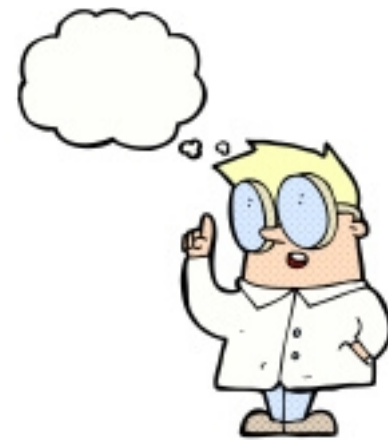
Example: Dopamine changes caused by cocaine infusion
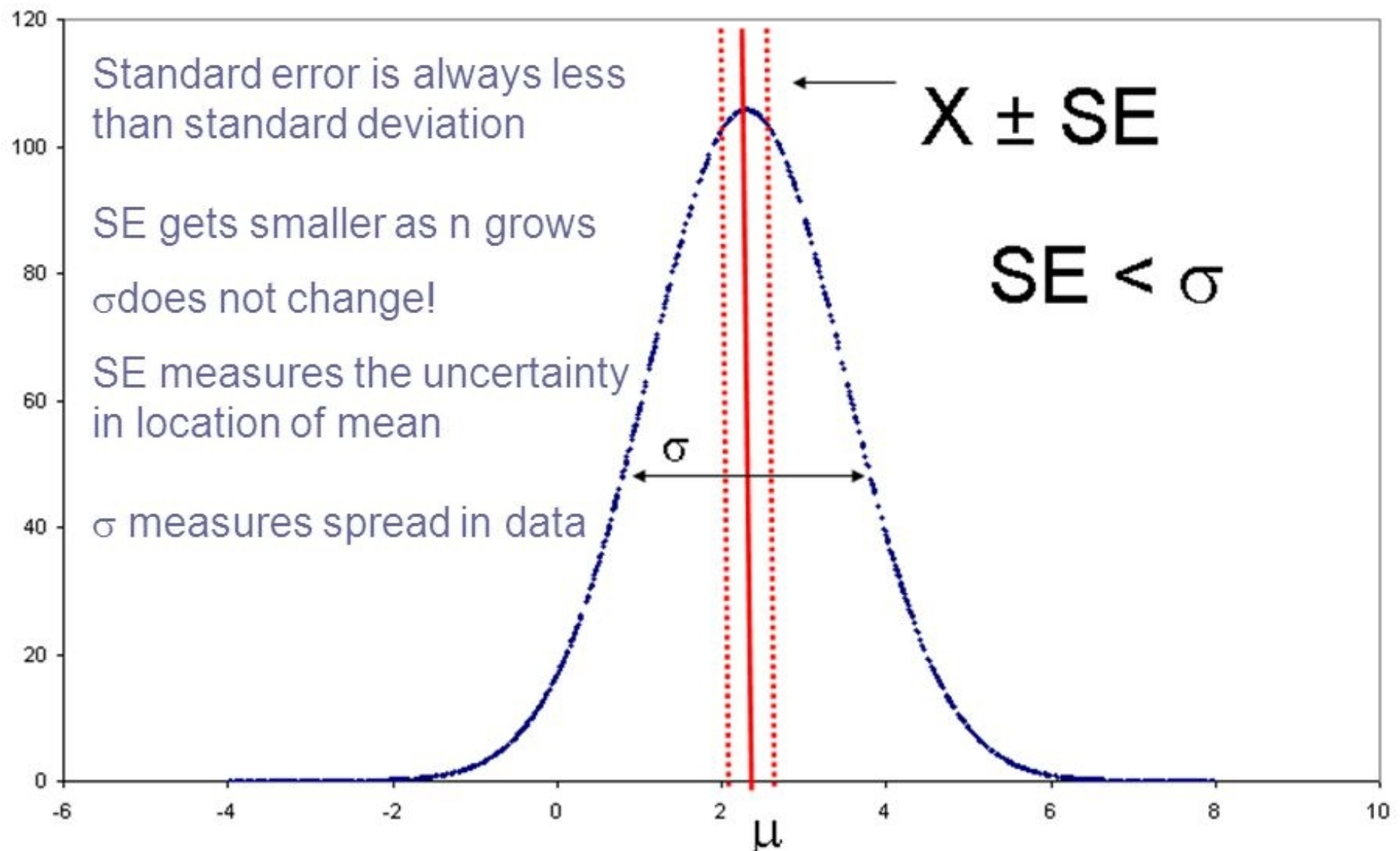

Saline: control group
Only the highest dose (3.0 mg/kg) causes a significant effect (P<0.05)
Error bars (in this case): standard error of the mean (SEM)

3. Understanding the results

Standard deviation (σ) vs. Standard error of the mean (SEM)

Standard error is always less than standard deviation

SE gets smaller as n grows

σ does not change!

SE measures the uncertainty in location of mean

σ measures spread in data

$X \pm SE$

$SE < \sigma$

4. Making sense of scientific findings

- Scientific method can't confirm, only reject
- Opposing results
- Older vs. recent articles
- Talking to scientists
- Reading peer reviews

4. Making sense of scientific <u>writing</u>

What scientists say	What they mean
Various sources	I forgot the name & author of that one paper.
A definite trend is evident	These data are practically meaningless.
While it has not been possible to provide definite answers to these questions	An unsuccessful experiment, but I still hope to get it published.
Three of the samples were chosen for detailed study	The results of the others didn't make any sense.
Typical results are shown	This is the prettiest graph.
It is believed that	I think.
It is generally believed that	A couple of other people think so, too.
Correct within an order of magnitude	Wrong.
A statistically oriented projection of the significance of these findings	A wild guess.
Complex phenomenon	I don't understand.
Has long evaded the understanding of scientists	I don't understand why I don't understand.
It is hoped that this study will stimulate further investigations in this field	I quit.

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Thank you for your attention!