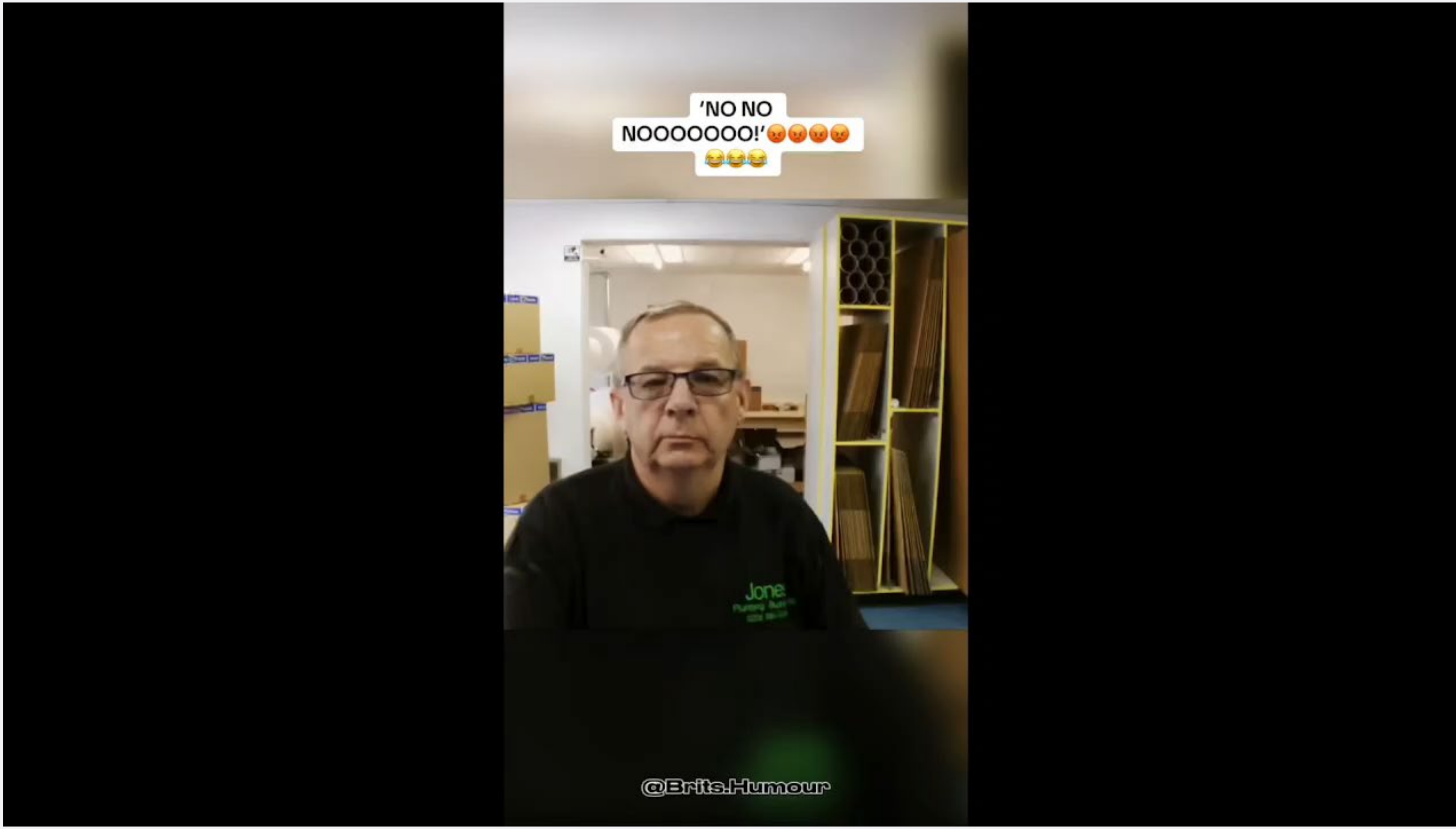
# human computer interaction

Lecture 8:
Data Analysis, Interpretation & Presentation

**Dmitrijs Dmitrenko**

# Good design vs Bad design

## bad
# design: an extreme case ☺




Thanks, Moldir, for sharing this example!

## share your observations...

...on X or per email!

Use hashtags **#HCISussex #GoodDesign #BadDesign**

**Tag me @DoubleDmi**

Your examples will be featured in lectures!

**Now back to today's lecture...**

# why bother doing data analysis properly?

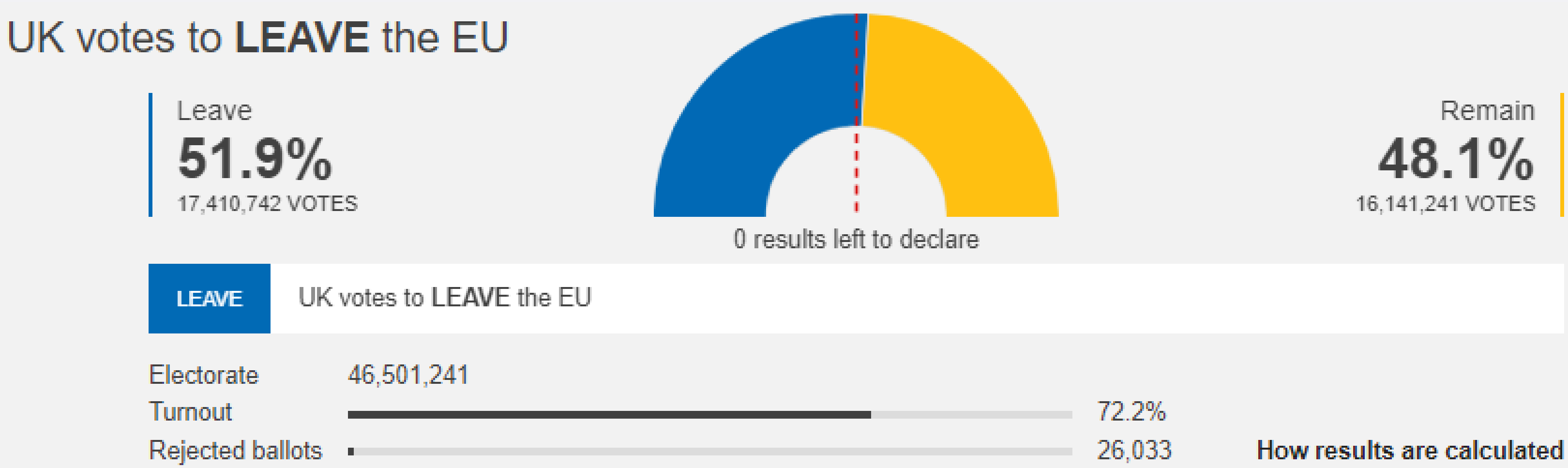
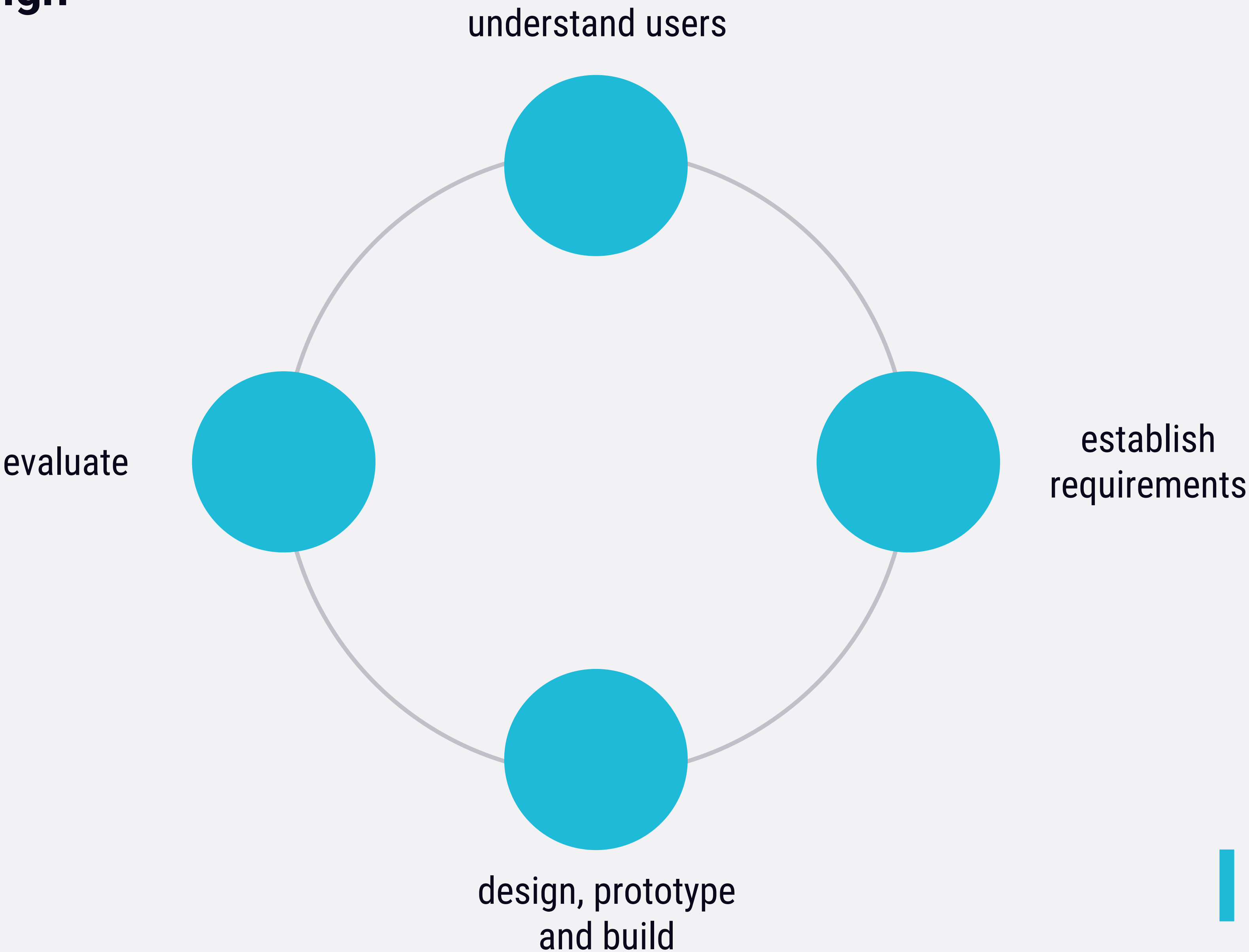



Image source: [BBC News]
Also worth checking: [What does the data of the Brexit referendum really say?]

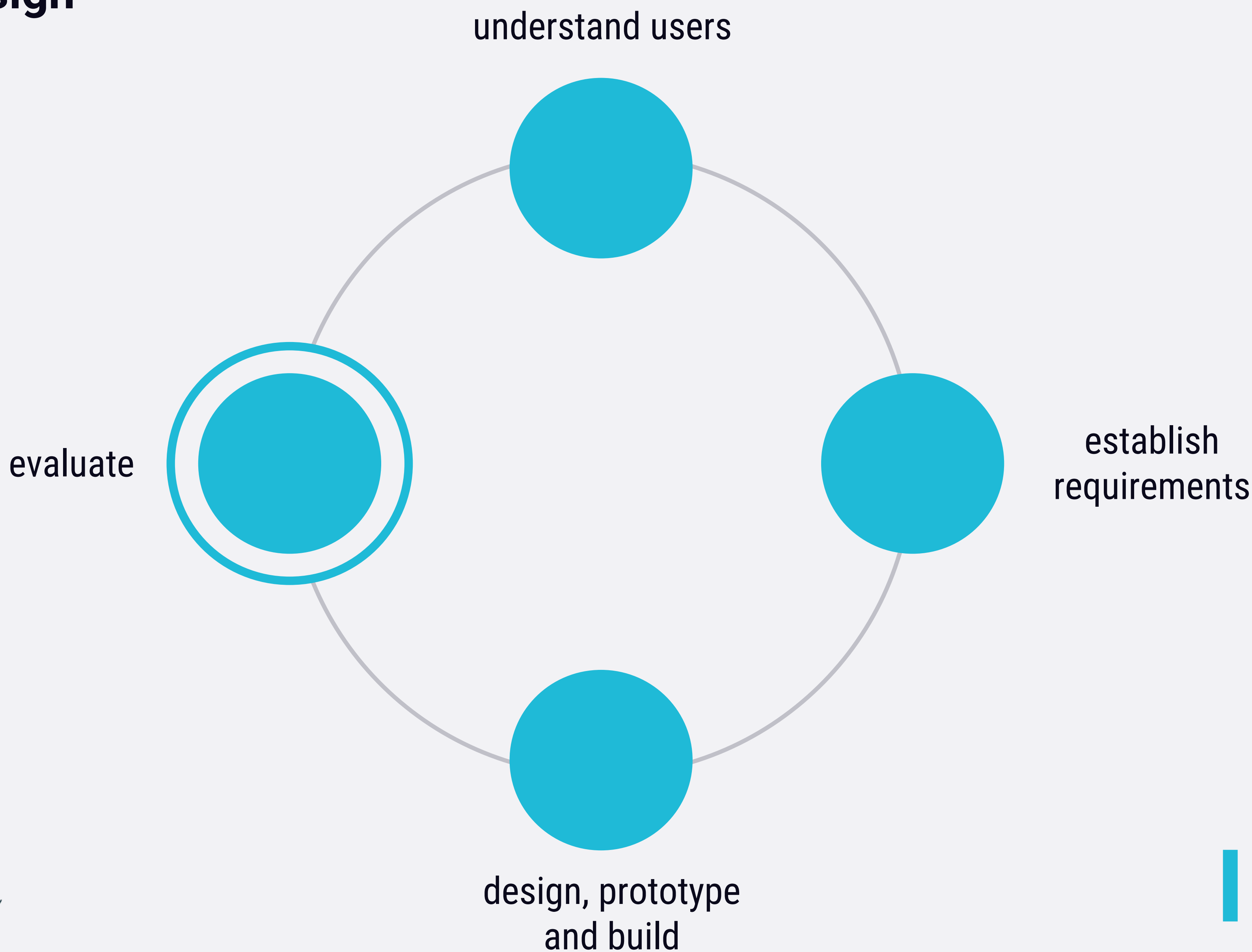
## this week:

## data analysis, interpretation & presentation

# user-centred design



# user-centred design



# aims

- discuss the difference between **qualitative and quantitative** data and **analysis**
- enable you to **analyse data** gathered from:
  - user testing
  - questionnaires
  - interviews
  - observation studies
- **identify** common **pitfalls** in data analysis, interpretation, and presentation
- enable you to **interpret and present your findings** in appropriate ways

## things to consider
## when interpreting data

- **validity:** does the method measure what it is intended to measure?
- **ecological validity:** does the environment of the evaluation distort the results?
- **biases:** are there biases that distort the results?
- **scope:** how generalisable are the results?

# quantitative & qualitative

| | quantitative | qualitative |
|---|---|---|
| data | usually expressed as numbers | typically descriptive, difficult to measure sensibly as numbers |
| analysis | numerical methods to ascertain size, magnitude, amount | expresses the nature of elements and is represented as themes, patterns, stories |

# your data

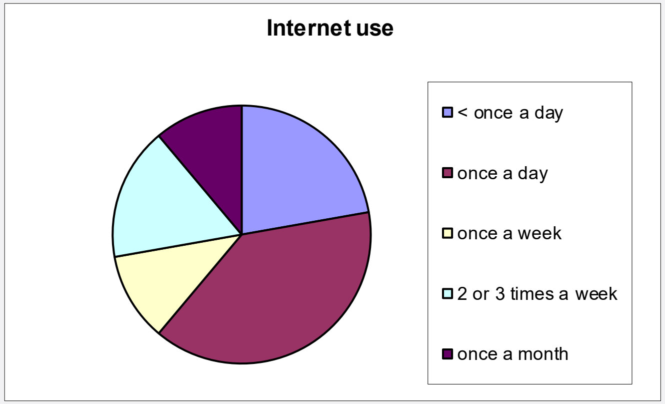
- methods
  - interviews/focus groups
  - questionnaires
  - testing/observation studies
- data
  - qualitative
  - quantitative
  - both

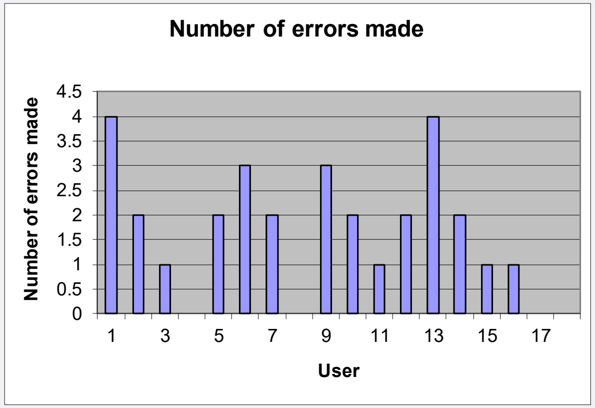
# simple quantitative variables


Source: https://www.youtube.com/c/ResearchByDesign

# simple quantitative analysis

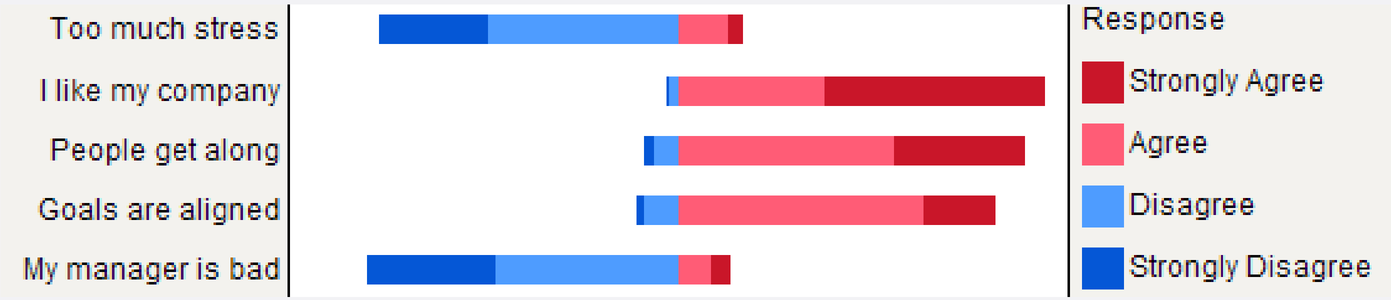
- averages (e.g. mean values)
- percentages
- graphical representations give overview of data



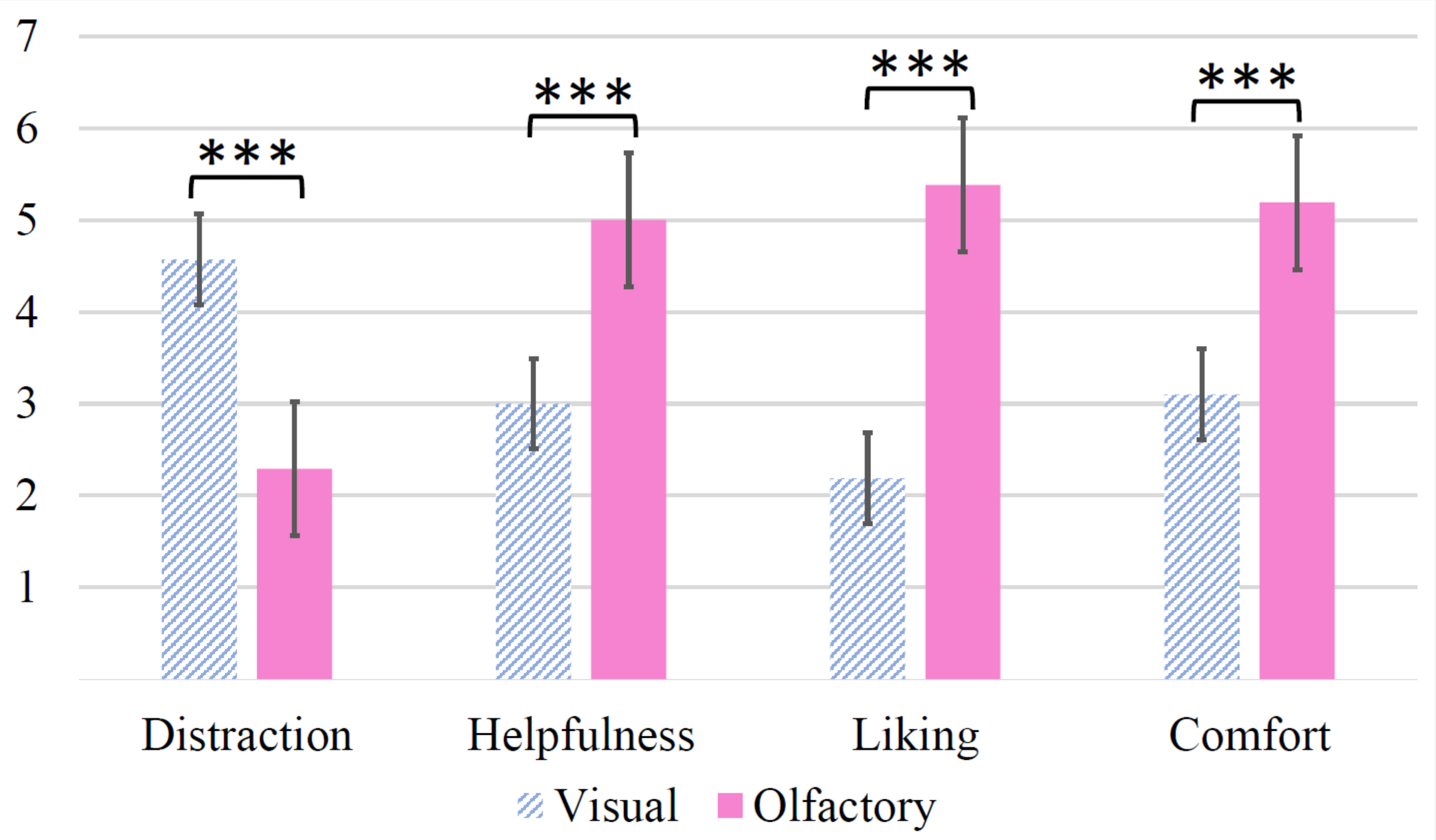



# Likert scales


- often used in questionnaires – they give **ordinal data**
- analysing individual responses:
  - can be presented using **bar charts**
  - can be analysed using **statistical tests**
- can look at all responses together if they use exactly the same scale



# Likert scales




Dmitrenko et al. (2018), „I smell trouble: using multiple scents to convey driving-relevant information“

# bar charts

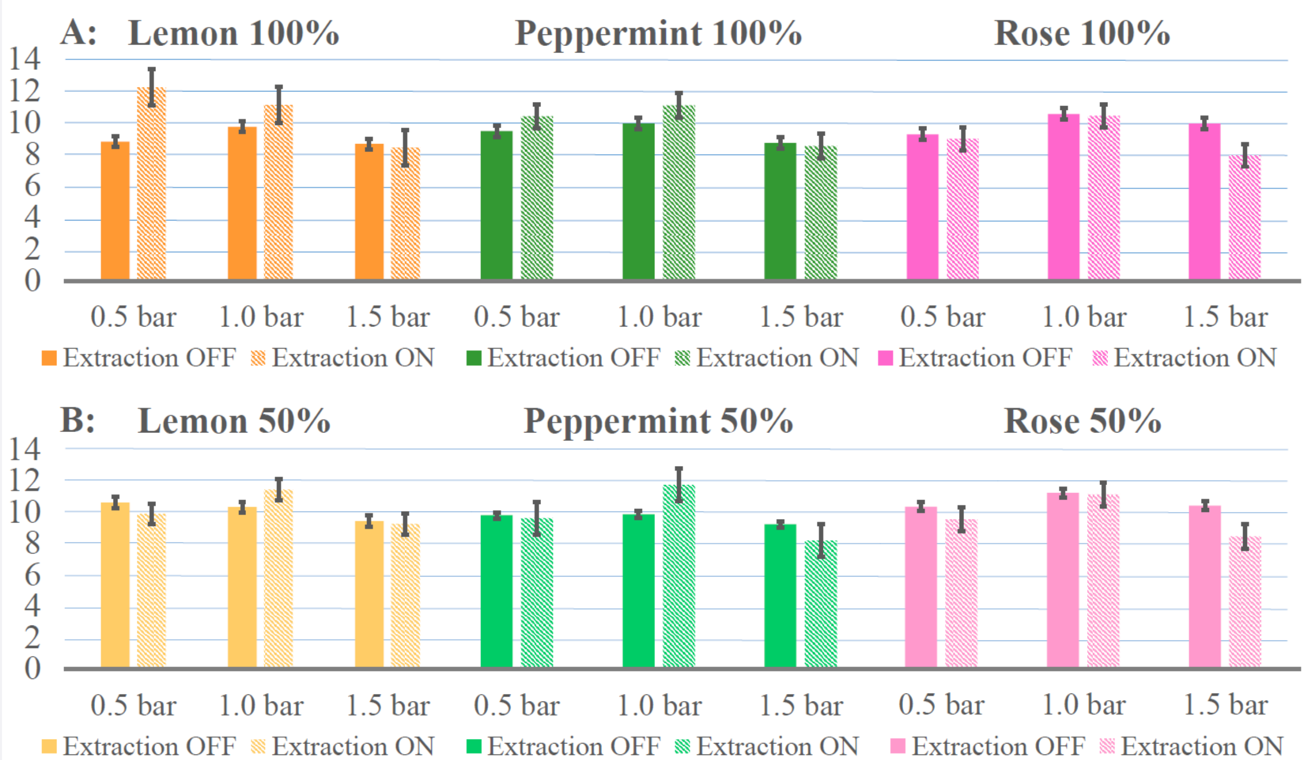



**Figure 7. Mean Scent Detection times in seconds under the air pressure conditions of 0.5, 1.0, and 1.5 bars, for A: 100% pure essential oils of lemon, peppermint, and rose, and for B: 50% dilutions of lemon, peppermint, and rose essential oils with water. Error bars, ± s.e.m.**

Dmitrenko et al. (2017), „OSpace: Towards a Systematic Exploration of Olfactory Interaction Spaces“

# bar charts

Unless you are analysing percentages, it's generally recommended to use bar charts (e.g. to plot mean values)

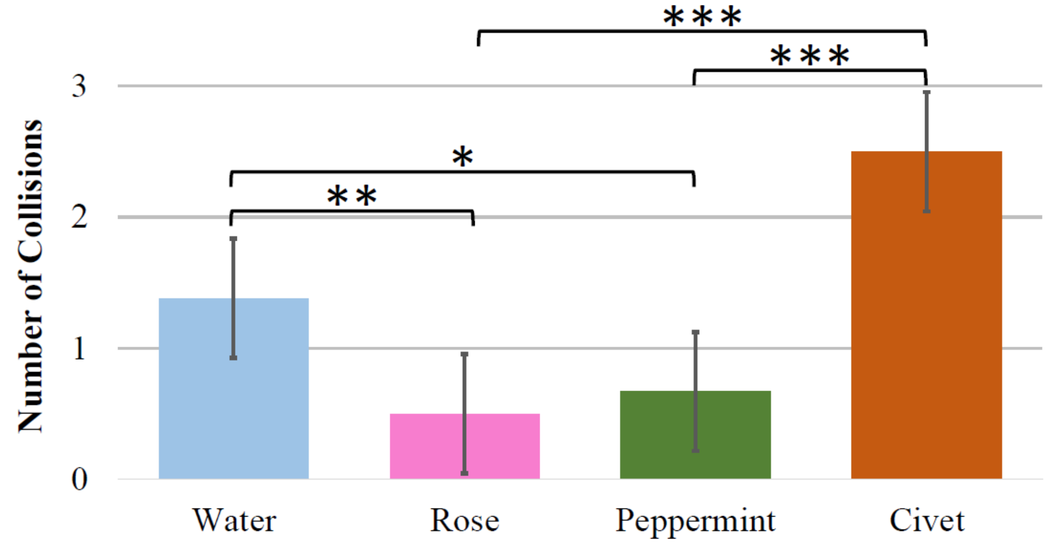


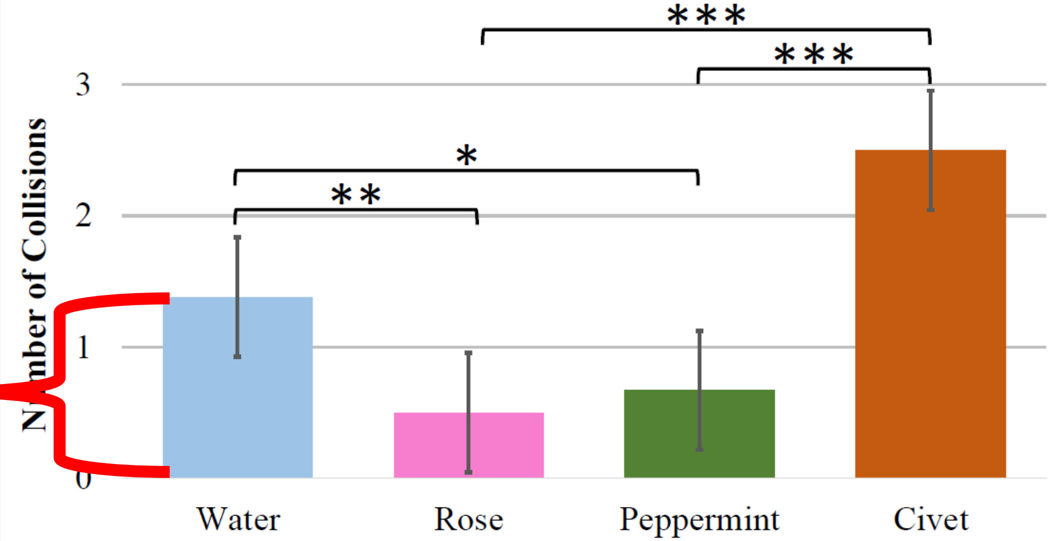

**Figure 8: The mean number of collisions in the water (clean air, control), rose, peppermint, and civet conditions. Error bars, ± s.e.m., $*p < .05$; $**p < .01$; $***p < .001$.**

Dmitrenko et al. (2020), „CARoma Therapy: Pleasant Scents Promote Safer Driving, Better Mood, and Improved Well-Being in Angry Drivers "

# bar charts

Unless you are analysing percentages, it's generally recommended to use bar charts (e.g. to plot mean values)

Mean value

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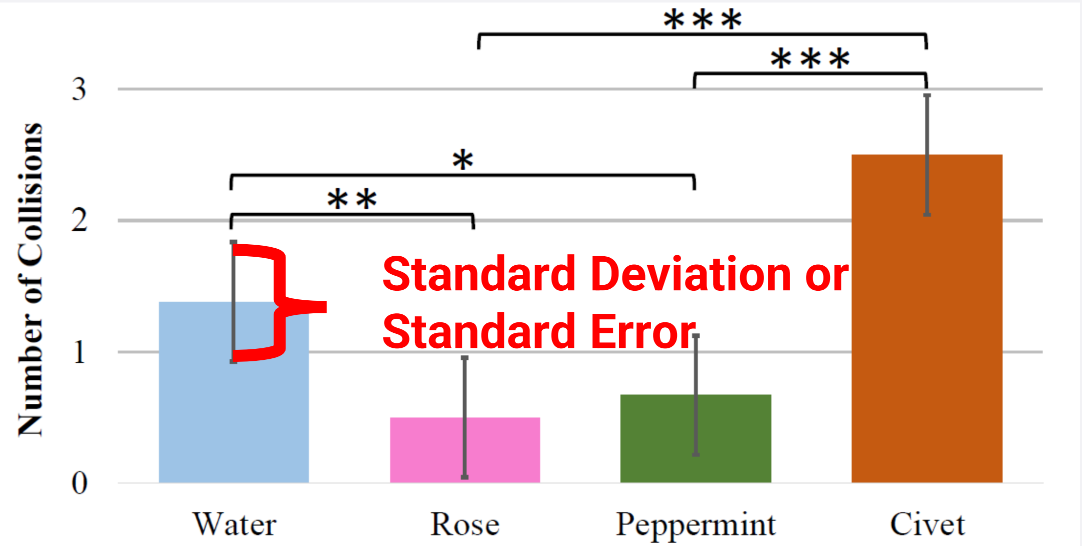


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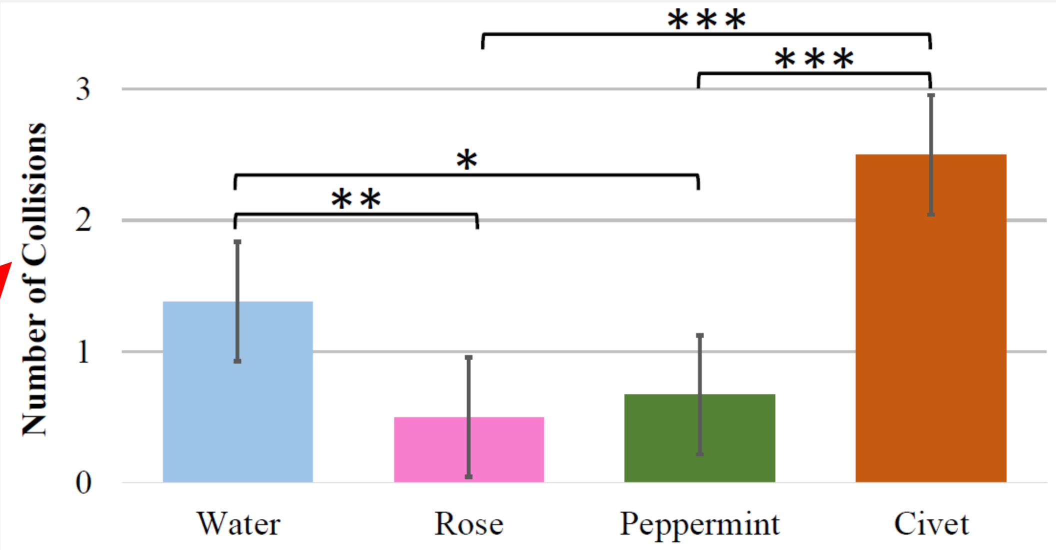
# bar charts

Unless you are analysing percentages, it's generally recommended to use bar charts (e.g. to plot mean values)

State the units of your measurements

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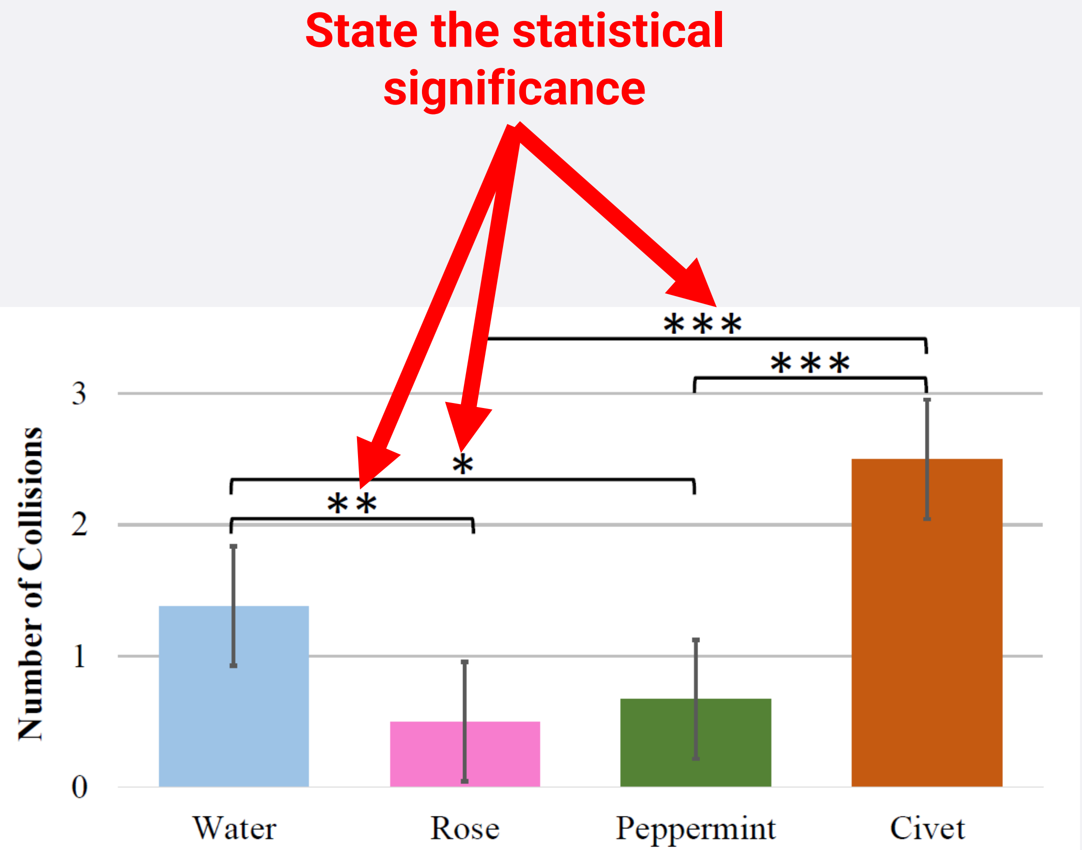


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Dmitrenko et al. (2020), „CARoma Therapy: Pleasant Scents Promote Safer Driving, Better Mood, and Improved Well-Being in Angry Drivers "

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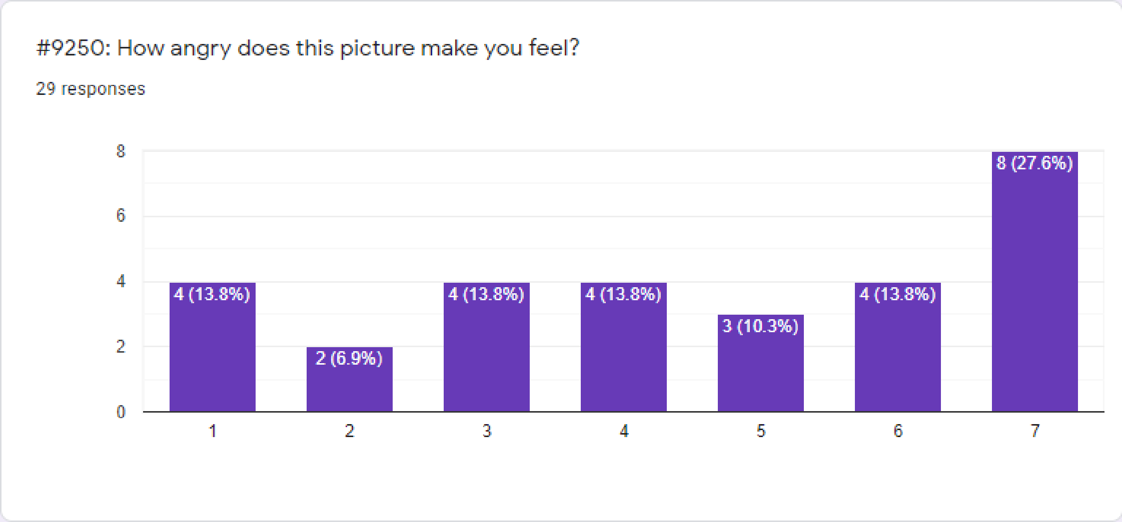
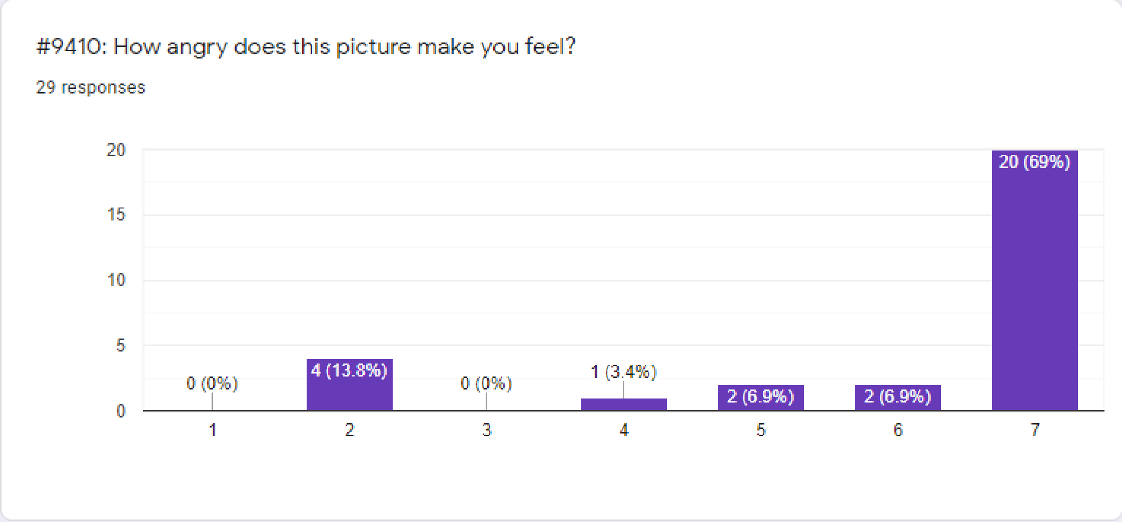
# Do not just copy the outputs of a Google Form!




Dmitrenko et al. (2020), „CARoma Therapy: Pleasant Scents Promote Safer Driving, Better Mood, and Improved Well-Being in Angry Drivers "

# pie charts

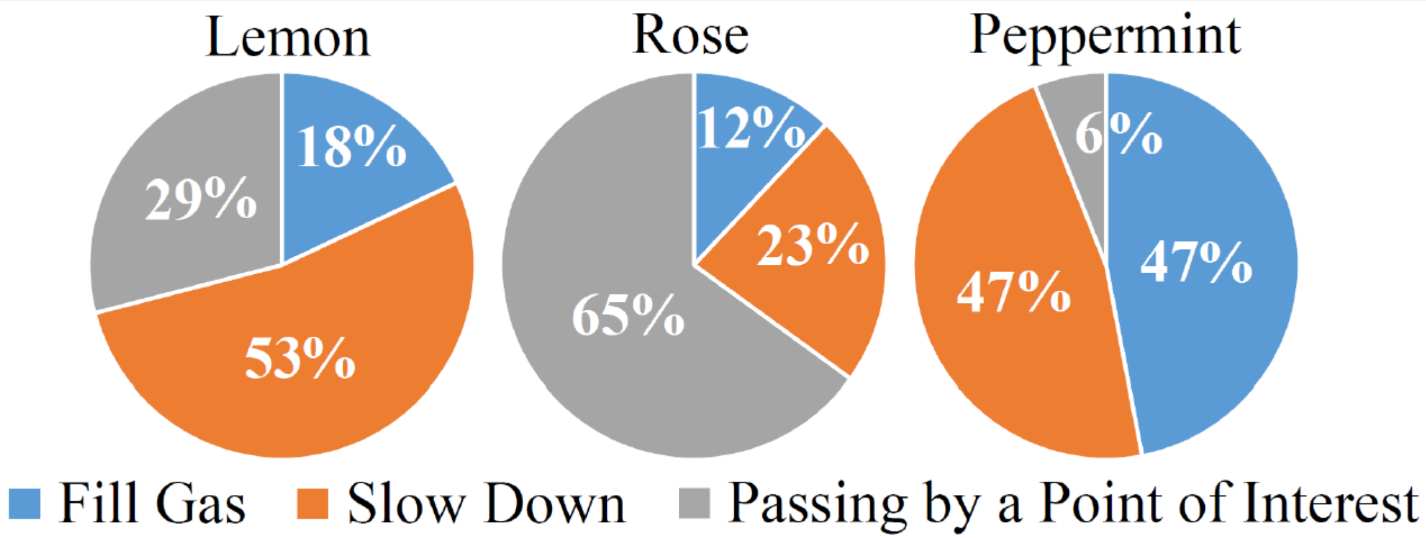
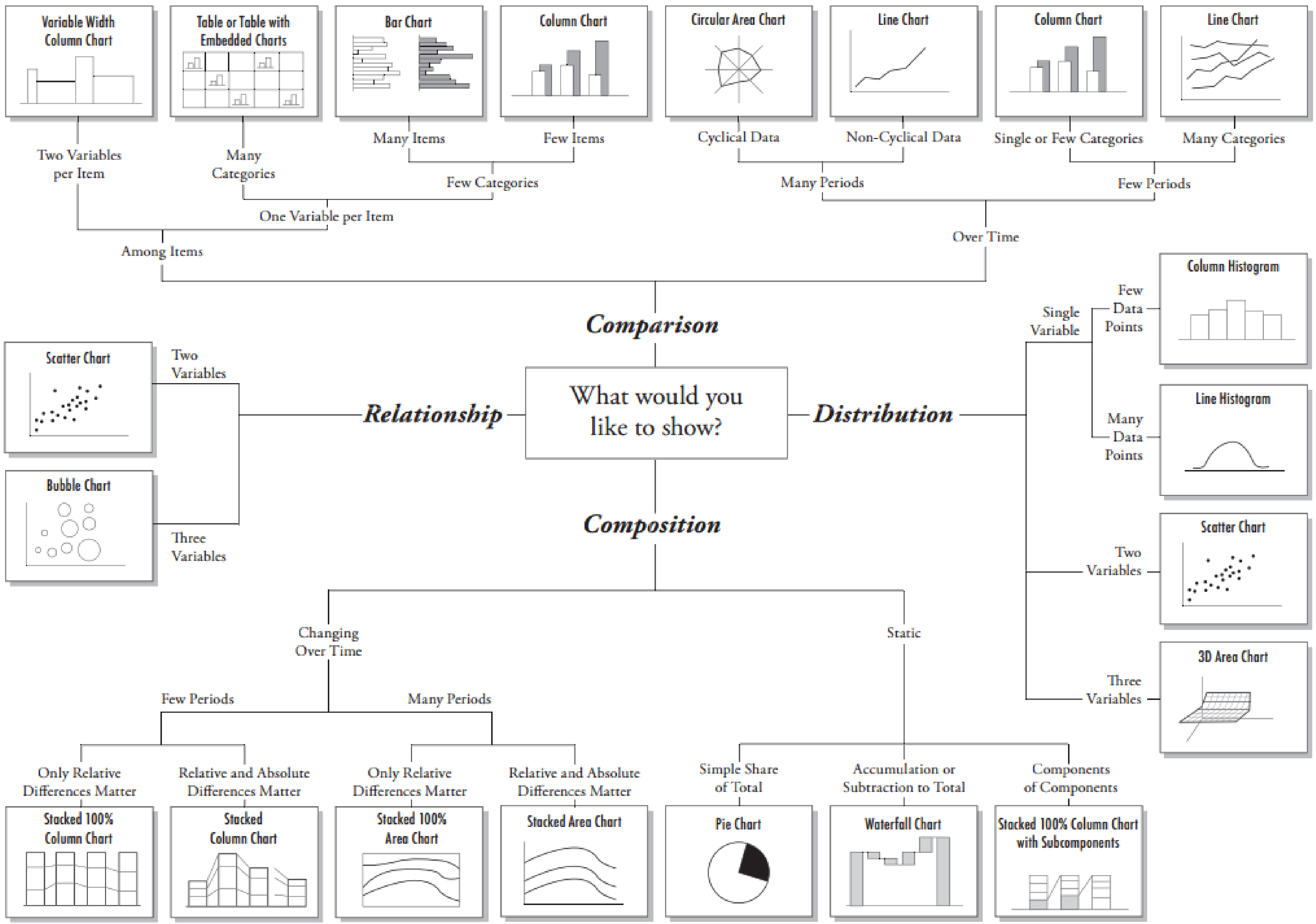



**Figure 8: Percentage of subjects having mapped the corresponding scent on one of the three driving-related messages.**



Dmitrenko et al. (2017), „What Did I Sniff? Mapping Scents Onto Driving-Related Messages“

# Chart Suggestions—A Thought-Starter




www.ExtremePresentation.com

# tables

| | Condition Mean (SD) | | | |
|---|---|---|---|---|
| | *Water/Clean Air* | *Rose* | *Peppermint* | *Civet* |
| Lane Deviation (m) | .44 (.11) | .52 (.26) | .71 (.50) | .73 (.33) |
| Steering Angle (rad) | .09 (.01) | .10 (.03) | .09 (.02) | .11 (.03) |
| Average Speed (mph) | 46.68 (6.95) | 42.95 (7.41) | 44.63 (6.71) | 48.83 (7.47) |

**Table 3: Mean scores and standard deviations of the objective driving performance and behaviour data.**

# How to analyse quantitative data?

## dependent and independent variables
## (recap)

An **independent** variable, sometimes called an experimental or predictor variable, is a variable that is being manipulated in an experiment to observe the effect on a **dependent** variable, sometimes called an outcome variable.



Source: https://statistics.laerd.com/statistical-guides/types-of-variable.php

# dependent and independent variables
**(recap)**

Imagine that a tutor asks **100 students** to complete a maths test. The tutor wants to know **why some students perform better than others**. Whilst the tutor does not know the answer to this, she thinks that it might be because of two reasons: **(1) some students spend more time revising** for their test; and **(2) some students are naturally more intelligent than others**. As such, the tutor decides to investigate the effect of revision time and intelligence on the test performance of the 100 students. The dependent and independent variables for the study are:

> **Dependent** Variable: **Test Mark** (measured from 0 to 100)
> **Independent** Variables: **Revision time** (measured in hours), **Intelligence** (measured using IQ score)

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Source: https://statistics.laerd.com/statistical-guides/types-of-variable.php

# how many participants do I need?
## power analysis

- Allows us to **determine the sample size** required to detect an effect of a given size with a given degree of confidence.
- Determine the probability of **detecting an effect** of a given size with a given level of confidence, under sample size constraints.
- **If the probability is** unacceptably **low**, it would be wise to **alter or abandon the experiment**.



Source: https://statistics.laerd.com/statistical-guides/types-of-variable.php

## how many participants do I need?
## power analysis

- Consider using the **G*Power** tool to conduct power analysis
- It is often used for this purpose and regularly maintained

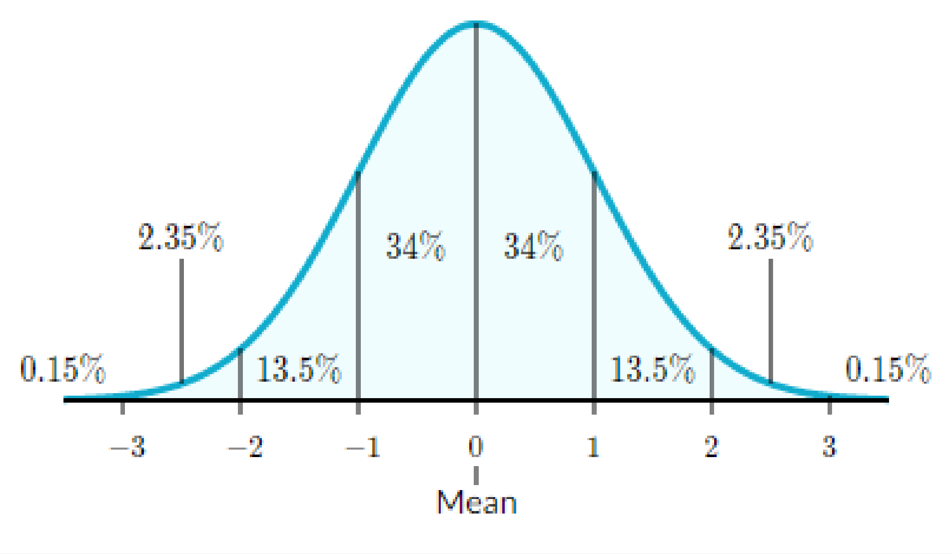
Source: G*Power

## distribution of the data

Features of the **normal distribution**:

- symmetric bell shape
- mean and median are equal; both located at the centre of the distribution
- ≈68% of the data falls within 1 SDs of M
- ≈95% of the data falls within 2 SDs of M
- ≈99.7% of the data falls within 3 SDs of M

M – mean value
SD – standard deviation




Source: Khan Academy

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# test of normality

- Check if your data is normally distributed.
- Use the **Shapiro-Wilk Test**.
- A test of normality is important because normal data is an underlying assumption in **parametric testing**.
- If data is not normally distributed, you should conduct a **non-parametric test.**

Source: Laerd Statistics

## Let's test you understanding!

- **Q1:** Imagine that your team has developed a new customer registration system to be used by call centre staff. You are trying to figure out whether experienced office workers complete the task of registering a new customer faster. What would be your dependent and independent variables?
- **Q2:** What approach/tool can help you figure out how many participants your study would require to achieve credible results?
- **Q3:** For an arbitrary study, how can you find out whether you need to analyse your data using a parametric or non-parametric (statistical) test?

## If your data is normally distributed:

## independent-samples t-test

- The independent-samples t-test (or independent t-test, for short) **compares the means between two unrelated groups on the same continuous, dependent variable.**
- For example, this way you could understand whether **first year graduate salaries** differed based on **gender** (i.e., your dependent variable would be "first year graduate salaries" and your independent variable would be "gender", with two groups: "male" and "female").
- Check the guide here

Check the following pages for more detail:

- [Dependent T-Test]
- [One-Sample T-Test]

# t-test example

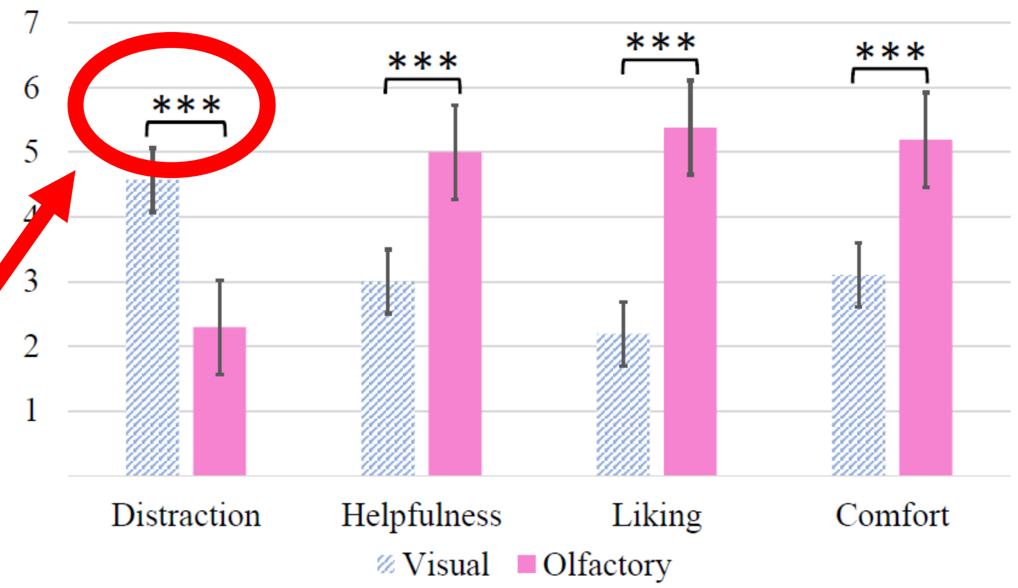


**Figure 4.9:** Mean ratings of distraction, helpfulness, liking, and comfort of the visual and olfactory modalities (1= "Not at all", 7= "Very much"). Error bars, ± s.e.m., $***p < .001$

*A dependent t-test for paired samples demonstrated that the olfactory modality had been reported significantly less distracting than the visual modality (t(20)= 5.510, P<.001).*



Dmitrenko et al. (2018), „I smell trouble: using multiple scents to convey driving-relevant information“

# one-way ANOVA

- **ANOVA = Analysis of Variance.**
- Used to determine whether there are any statistically significant **differences between** the means of **two or more independent groups**.
- For example, you could use a one-way ANOVA to understand whether **exam performance** differed based on **test anxiety** levels amongst students, dividing students into three independent groups (e.g**. (1) low, (2) medium, and (3) high-stressed** students).



Source: Laerd Statistics

# other types of ANOVA tests

Check the following pages for more detail:

- Two-way ANOVA
- ANOVA with Repeated Measures

Source: Laerd Statistics

# one-way repeated-measures ANOVA example

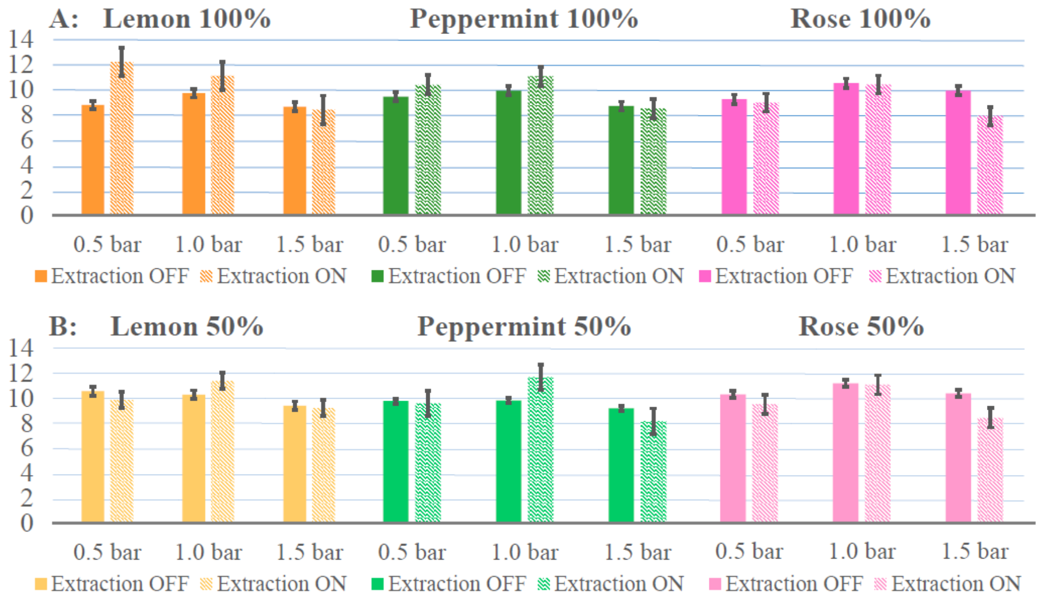


**Figure 8.7:** Mean Scent Detection times in seconds under the air pressure conditions of 0.5, 1.0, and 1.5 bars, for A: 100% pure essential oils of lemon, peppermint, and rose, and for B: 50% dilutions of lemon, peppermint, and rose essential oils with water. Error bars, ± s.e.m.

*A series of one-way repeated-measures ANOVA tests was performed to analyse the effect of the* ***scent type*** *(independent variable)* ***on*** *each of the dependent variables:* ***scent detection and lingering times****. No statistically significant differences were found.*



Dmitrenko et al. (2017), „OSpace: Towards a Systematic Exploration of Olfactory Interaction Spaces“

## Let’s test you understanding!

- **Q1:** Imagine that your team has developed an “Explore your campus” app. You want to find out whether Psychology students score more points in this app (per week) than English Literature students. Knowing that your data is normally distributed, which statistical test would you use to analyse it?
- **Q2:** Imagine that your team has developed a new racing game. You want to figure out whether the player’s average driving speed depends on the number of crashes they have experienced in the previous level. You split your players into four groups: those who crashed (1) only once, (2) 2-5 times, (3) 6-9 times, (4) 10 or more times. Knowing that your data is normally distributed, which statistical test would you use to analyse it?

**If your data is <u>not</u> normally distributed:**

# non-parametric tests

Use one of the following non-parametric tests (you might want to **check the related work or ask an expert to** figure out which one fits your data best):

- Friedman test
- Kruskal-Wallis H test
- Chi-Square test

Source: Laerd Statistics

# Kruskal-Wallis H test example

| | Condition Mean (SD) | | | |
|---|---|---|---|---|
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| Average Speed (mph) | 46.68 (6.95) | 42.95 (7.41) | 44.63 (6.71) | 48.83 (7.47) |

**Table 13.3:** Mean scores of the objective driving performance and behaviour data.

*We compared the means of the four conditions using the non-parametric Kruskal-Wallis H test. The test showed no significant differences (see Table 13.3) for lane deviation, steering angle, and average speed.*



Dmitrenko et al. (2020), „CARoma Therapy: Pleasant Scents Promote Safer Driving, Better Mood, and Improved Well-Being in Angry Drivers "

## quantitative analysis:
## tools and resources

- You might find it useful to use **SPSS** software for calculating values like the mean and the standard deviation, e.g. as described here:

https://ezspss.com/how-to-calculate-mean-and-standard-deviation-in-spss/

- **Laerd Statistics** is a good resource for guidance on stats:

https://statistics.laerd.com/statistical-guides/measures-of-spread-standard-deviation.php

- **SPSS** is available for **free to Sussex students**:

http://www.sussex.ac.uk/its/help/guide?id=23

# How to analyse qualitative data?

# simple qualitative variables


Source: https://youtu.be/69qP8kFJp_k

# simple qualitative analysis

- **recurring patterns** or themes
  - emergent from data, dependent on observation framework if used
- **categorising** data
  - categorization scheme may be emergent or pre-specified
- looking for **critical incidents**
  - helps to focus on key events

# simple qualitative analysis

Scents were also perceived as helpful in performing the task of driving and in monitoring the autonomous system. 20/25 participants had mentioned the scents as helpful in perceiving the change between the reliability levels and as supportive in capturing the visual information displayed in the center console. For example, *P14* said: *"The scents helped, especially when there was no eye contact with the display."*



Wintersberger and Dmitrenko et al. (2019), „S(C)ENTINEL - Monitoring Automated Vehicles with Olfactory Reliability Displays"

# simple qualitative analysis: plotting data

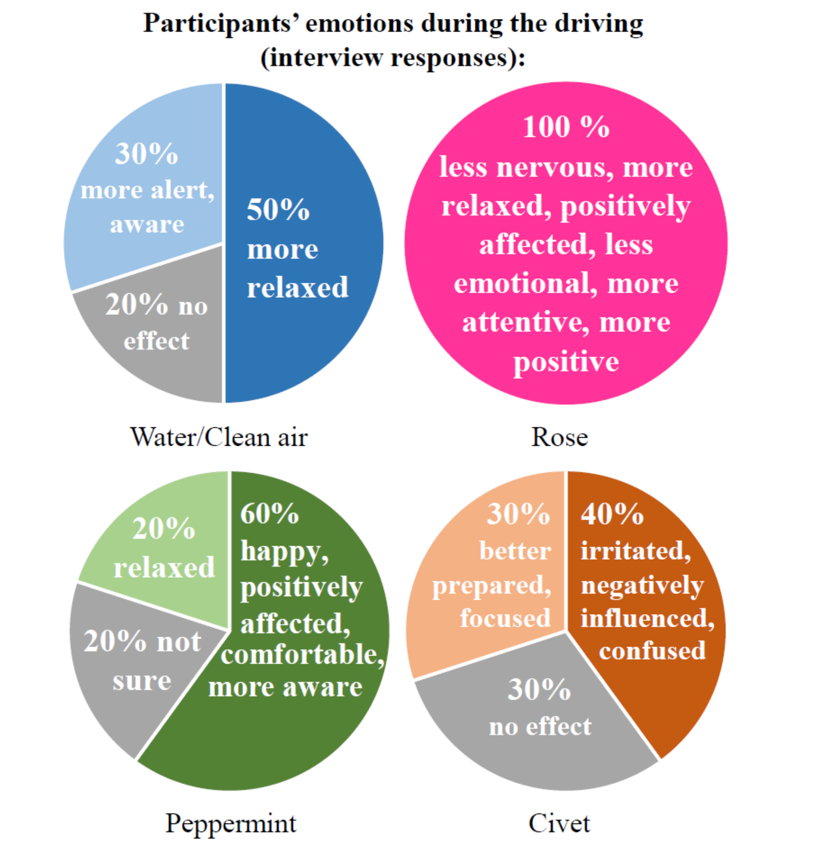



**Figure 10: Percentage of participants having experienced each emotion in the process of driving.**

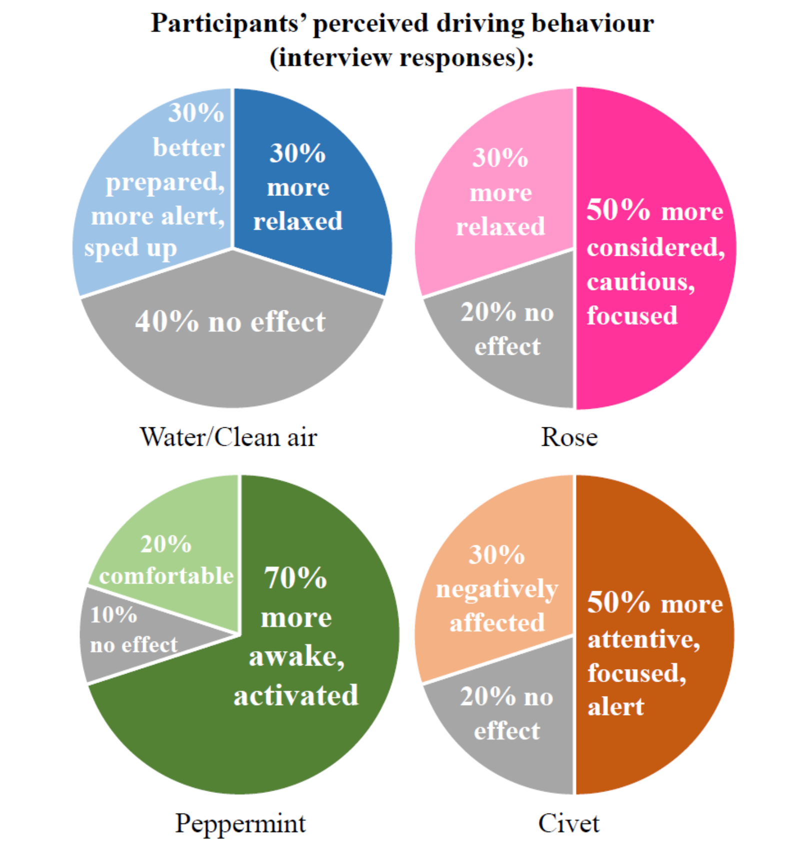



**Figure 11: Percentage of participants having experienced each driving behaviour change.**

Dmitrenko et al. (2020), „CARoma Therapy: Pleasant Scents Promote Safer Driving, Better Mood, and Improved Well-Being in Angry Drivers "

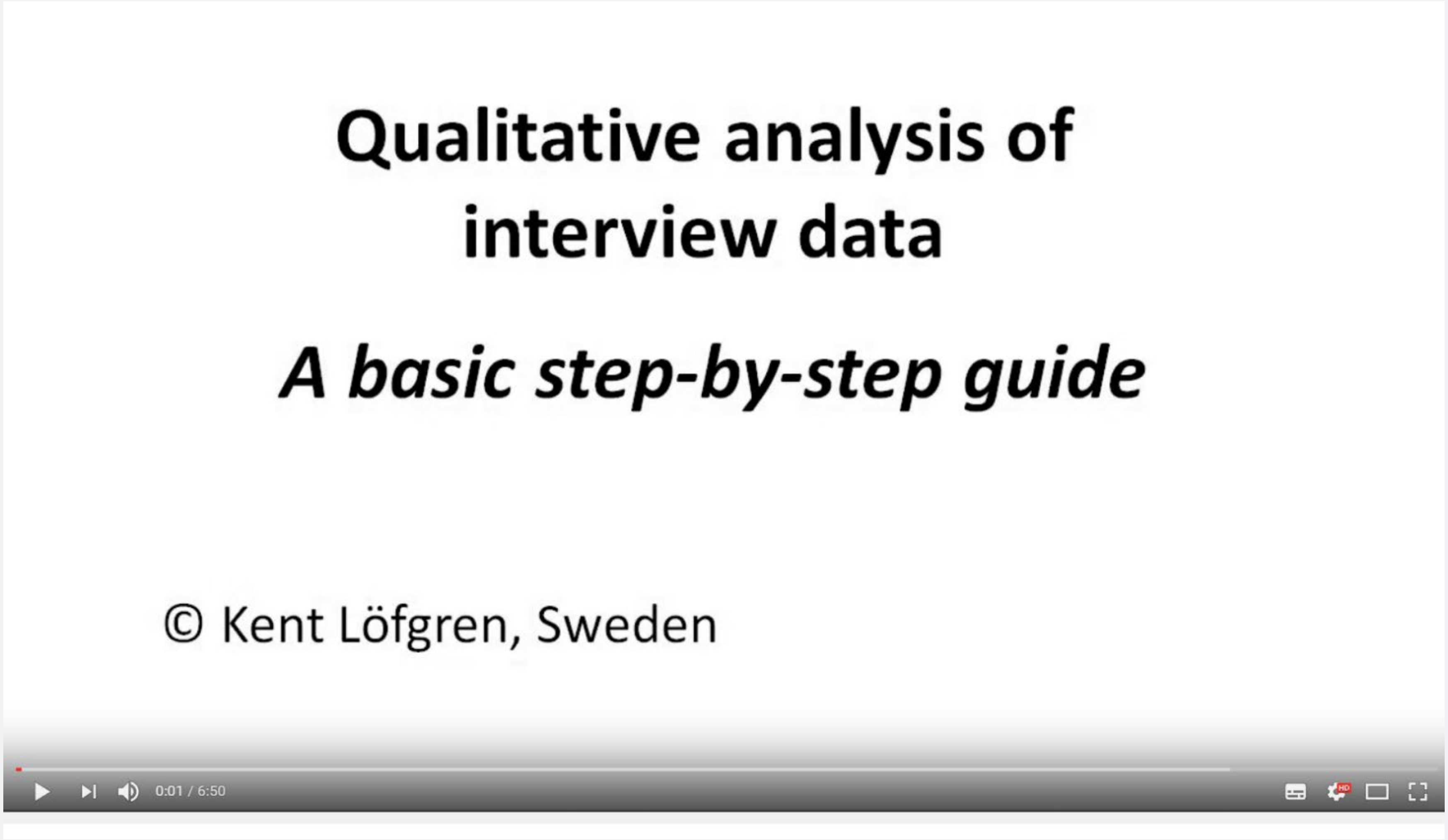
# simple qualitative analysis in field studies

- simple **counts** might be appropriate for summarising e.g. **features mentioned positively** by most users, problems highlighted by most users
- **categorising comments** and events **under** themes or **type of interaction** – e.g. 'use of visualisations'
- categories can be provided by theory, or can emerge out of data
  - grounded theory
  - activity theory

useful but complex frameworks for understanding and categorising data

# simple qualitative analysis in field studies: data presentation

- aim is to show **how the products are being** appropriated and **integrated into their surroundings**
- typical presentation forms include: vignettes, excerpts, critical incidents, patterns, and narratives
- aiming to **capture and reflect usage** rather than ‘prove’ something




https://www.youtube.com/watch?v=DRL4PF2u9XA

# quantitative vs qualitative analysis:
# the conclusion


Source: https://youtu.be/69qP8kFJp_k

## presenting
## the findings

- only make **claims that your data can support**
- presentation of the findings should **not overstate the evidence**
- the best way to present your findings **depends on the audience, the purpose, and the data gathering** and analysis undertaken
- **graphical representations** (as discussed above) may be appropriate for presentation

## Reminders

- Drop-in Sessions
- Office Hour

**Please check the "Module Contacts" page on Canvas for details!**

# reading

- Read the “**Evaluation Studies: From Controlled to Natural Settings**” and “**Evaluation: Inspections, Analytics, and Models**” chapters of the Interaction Design book.