Overall Mark for summaries on Moodle is misleading

- Moodle shows an "Overall Mark" for your paper summaries, which is the average of the two summaries you will submit

- The second unsubmitted summary gets assigned the default mark of 0% so your overall mark is
(first mark + 0%) / 2 = first mark / 2

- Once your second summary is marked the overall mark will be correct, and this will go into Portico

- Results are unconfirmed and provisional and are subject to change by the Board of Examiners and UCL Education Committee

Counterfactual reasoning to establish causality

- Statistics gives us correlations, which are not the same as causation
- Causation can be shown by re-winding time and changing one thing
  - Hypothesis: not studying causes poor grades
  - Wind back time, start studying, do grades improve?
- Good experiments approximate re-winding time in order to show causality

A Good Experiment

- **Reminder**: Experiments manipulate the topic under study

  - Different from observational study

- Provides sufficient data to support or refute the hypothesis – i.e. experiment is <u>valid</u>

A Good Experiment

- Only tests one variable
  - If more than one variable, which one affected result?
- Is unbiased – researcher does not let their opinions influence the experiment
- Is repeated – not a 'one-off'
- Attempts to remove all external factors which may influence experiment
  - e.g. lab environment, time of day, equipment, etc.
  - Really difficult to achieve with human subjects
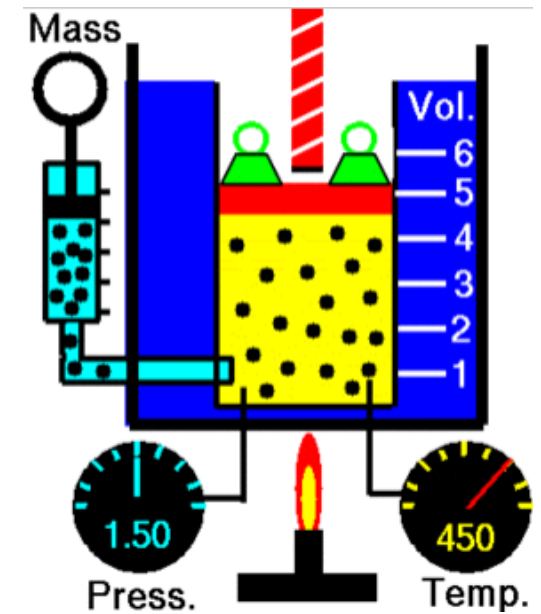
Variables

- Something in an experiment which can vary, or be deliberately changed by the experimenter

  - e.g. temperature of gas, height a ball dropped from, length of password in characters

- Sometimes researcher not aware of all variables influencing an experiment

  - e.g. Trying to measure affect of keyboard design on typing speed, but perhaps temperature of room influences participants' typing speed.

Types of Variables

- Independent variable (sometimes called factor)
  - Manipulated by the researcher – e.g. password length
  - Experiment must only change one variable
- Dependent variable
  - Hypothesized to change if independent variable changes
    - Effect is observed and measured - data collected
  - State how dependent variable measured and units
- Controlled variable
  - Variable not allowed to change

Independent & Dependent Variables

- Charles's Law – simply put
  - As temperature increases – volume of gas expands
  - As temperate decreases – volume of gas decreases
- Design the experiment
  - What could be the independent variable?
  - What could be the dependent variable?
  - What could be a controlled variable?

Control Group

- Some studies have a control group
  - Different from a controlled variable
- What happens if independent variable is not changed?
  - Not all experiments have control groups
  - Common in drug trials – use of placebos
- Could you have a control group with an information security experiment?

Within Subjects/Paired Design

- Each participant has one treatment and two measurements
  - One sample group of participants
    - e.g. time to complete a task before and after training
- Advantages
  - Few subjects – can be quicker
  - Removes risk of introducing confounding variables
- Disadvantages
  - Participants may drop out
    - Need to remove them from data set
  - Participants may suffer from fatigue and practice effects

Between Subjects/Independent Design

- Two or more groups of participants have same treatment and measured once
  - e.g. measure of privacy concern between old and young
    - Look for statistically significant difference between means of groups
- Advantages
  - Less risk of participants dropping out
  - Participants unlikely to suffer fatigue and practice effects
- Disadvantages
  - Higher risk of introducing confounding variables
  - More participants needed – takes more time

Sampling Bias

- Statistical term
- Important in surveys and user trials
- Sample population not representative of total population
  - Members of total population less likely to be included in sample
 - Non-random sample - all individuals not equally likely to be selected

Sampling Bias

- Examples
  - People at a local painting club used to determine views concerning funding of the arts in the UK – (qualitative)
  - Average male height in UK determined by measuring people in local basketball team – (quantitative)
- Aim to minimise bias
  - Papers likely to be criticised if there is obvious sampling bias
- Undermines ability to generalise to total population
- Also impacts between subjects/independent experiment design
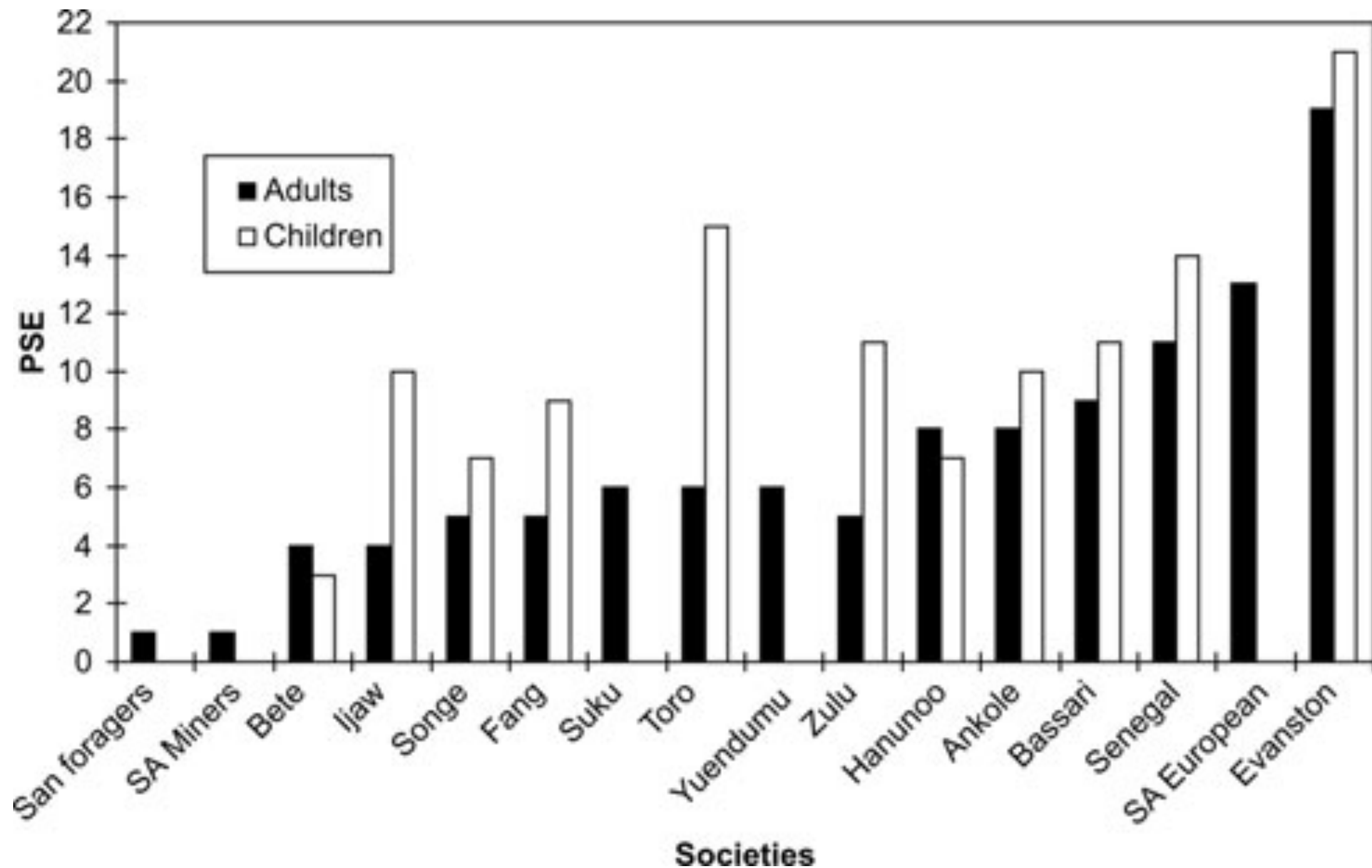
WEIRD

- Experiments typically performed on:
  - Western
  - Educated
  - Industrialized
  - Rich
  - Democratic countries
- Around 12% of the population
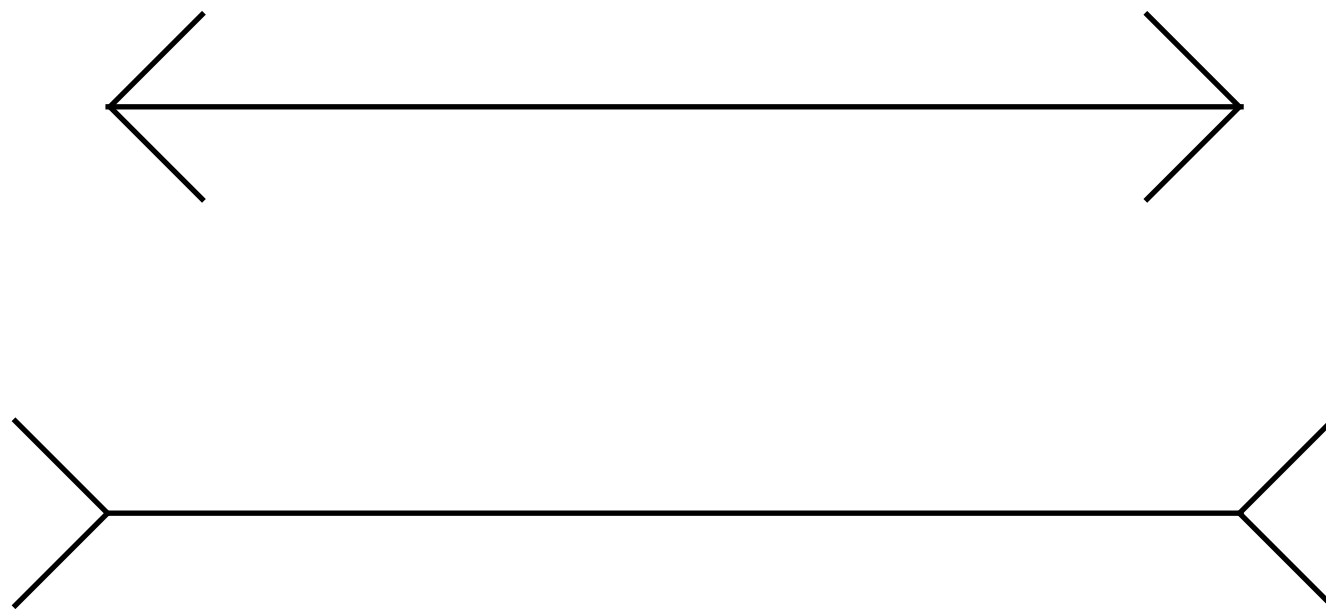
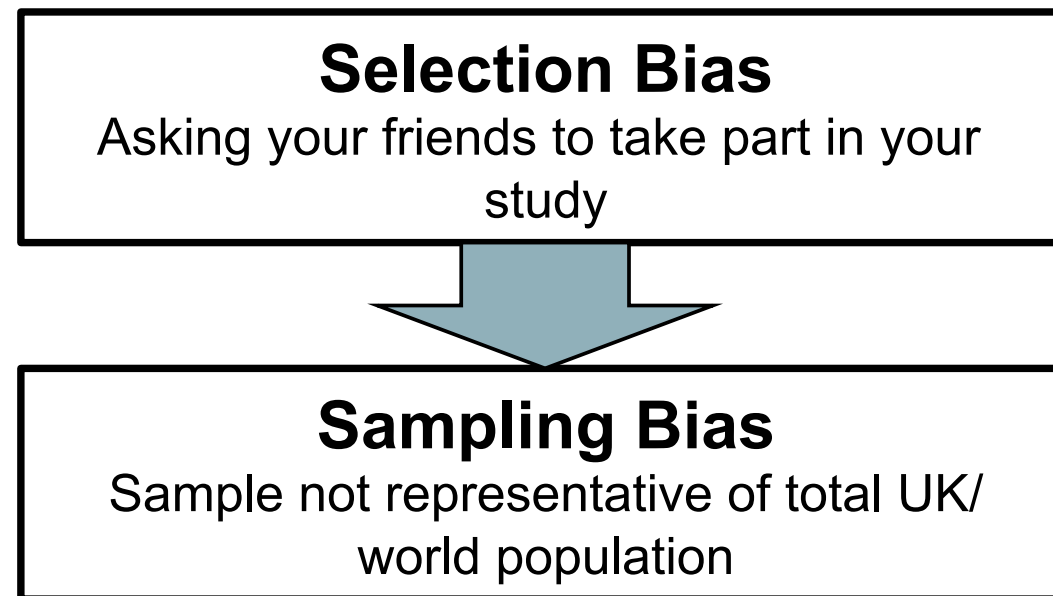# The weirdest people in the world?
Henrich et al. (2010)

Selection Bias

- Selection bias leads to sampling bias
  - Terms often used interchangeably (incorrectly)
  - Sampling bias is a sub-type of selection bias
- Other types of selection bias:
  - Terminate trial when result achieved
  - Discounting drop outs

Selection and Sampling Bias

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┌─────────────────────────────────────────┐
│           Selection Bias                 │
│  Asking your friends to take part in your│
│                 study                    │
└─────────────────────────────────────────┘
                    ↓
┌─────────────────────────────────────────┐
│           Sampling Bias                  │
│  Sample not representative of total UK/  │
│           world population               │
└─────────────────────────────────────────┘
```

- In Method section of paper

  - Provide description of selection process and any limitations

  - Provided description of sample collected and any limitations

Structured Sampling

- May want to deliberately manage sampling
- Deliberately select participants based on criteria
- Example:
  - Focus groups to discuss television viewing habits
  - Objective of selection process is to get a good coverage of ages and regions in the UK

Quantitative Research

- Historical roots in *positivism*
  - Goal is to find laws that explain the real world
  - Identify causal links between things
  - Knowledge is only obtained through experience and observation
  - Facts are separated from values
  - Science is based on **quantitative data** obtained through rigorous processes

Quantitative Research

- Types of variables
  - Categorical variables
    - Binary (e.g. yes/no)
    - Nominal (e.g. males, females)
    - Ordinal (e.g. strongly/somewhat agree/disagree)
  - Continuous variables
    - Interval (e.g. temperature in degrees Fahrenheit)
    - Ratio (e.g. natural zero point e.g. degrees Kelvin)

Quantitative Research

- Measurement error
  - Discrepancy between real value of a variable and measurement obtained
  - Instruments can be calibrated to reduce measurement error
  - Self-reported measures can also have measurement error because participants may have a reason to lie

Quantitative Research

- Validity
  - Whether an instrument measures what it is supposed to measure
    - e.g. Can we use password length to measure password complexity?
- Content validity
  - Whether the questions in a questionnaire cover the full range of a construct
- Reliability
  - Whether a measure produces the same results under the same conditions

Quantitative Research

- Correlational Research
  - Observe what happens in the world without interfering
  - Measure two or more variables at one point in time
    - e.g. Measure complexity of passwords used by employees in one organisation and which ones write them down
  - Minimises researcher bias
  - Contributes to external validity (ecological validity)
  - Note: Correlation does not imply causality!

Questionnaires

- "Feel the pulse" of a specific population about a topic
- Collect small amount of data from large sample
- Aim to get sample representative of population
- Advantages
  - Efficient
  - Statistical significance
  - Simplicity
  - Transparency
  - Credible results
- Disadvantages
  - Require high technical proficiency to design
  - Only measure attitudes, not behaviour
    - e.g. self-selection bias of more private individuals!

Experimental Research

- Manipulate one variable to see effect on another variable (remember independent/dependent variables)
  - e.g. create passwords with different complexities and assign them to different participants. Take note of which ones resort to writing them down
- Cause and effect (David Hume)
  - Events must occur close together in time
  - Cause must precede the effect
  - Effect never occurs without the cause
- Confounding variables may cause both events :
  - Cause never occurs without the effect

Experiments

- Between-groups design
  - Manipulate the independent variable with different participants
  - Each group of participants is tested under different experimental conditions
  - Differences between people (e.g. IQ) can lead to unsystematic variation in results

Experiments

- Within-subjects design
    - Manipulate the independent variable with same participants
    - Every participants goes through all the experimental conditions
    - Can introduce learning and boredom/fatigue effects

Laboratory experiments

- Advantages:
  - Control over environment
  - Replicable
  - Allows the determination of cause and effect
  - Statistical significance
  - Capture behaviour, not just attitudes

- Disadvantages
  - Artificiality
  - Researcher bias
  - Demand bias (participants guess what the experiment is about)

Qualitative Research

- Associated with *constructivism*
  - Reality is a social construction
  - Capture multiple perspectives of same phenomenon
  - Context in which data was collected is very important
  - Relationship between researcher and object/subject of research is taken into account

Qualitative Research

- Qualitative data has no variables per se
  - But, you can generate some:
    - e.g. Counting instances of a code / theme
    - e.g. Correlation between code and age group

Interviews

- Conducted with less people than questionnaires
- Can be structured, semi-structured, or unstructured
- Advantages
  - Flexible
  - Rich interactions
  - Generate secondary level data such as body language or tone of voice
- Disadvantages:
  - Standardisation is hard
  - Less reliability
  - Researcher bias
  - Time consuming
  - Only measure attitudes

Focus groups

- Group interviews between 4–12 participants
- Group can be homogeneous or heterogeneous
- Advantages
  - Participants interact with each other
  - Efficient
  - Extreme views are kept in check by the group
  - Enjoyable to participants
- Disadvantages
  - Difficult to manage
  - Dominating personalities
  - Small sample sizes make it difficult to generalise results
  - Group dynamic bias

Diary methods

- Participants record their own experiences
- Capture data in natural contexts
- Substitute for observation
- Advantages
  - Report of experience close in time to actual experience
  - Data generated by participant
- Disadvantages
  - Require lots of training and briefing of participants
  - Time consuming for participants
  - Participants may want to please researcher (bias)