PSYC30013 – Research Methods for Human Inquiry

Lecture 1 – Week 1

<u>Structure of psychological research</u>

1. Rationale
2. Research question
3. Research design
4. Inferential analysis
5. Evaluation and integration

These 5 points are coherent and inter-related, and a change/elaboration of one feature affects the preceding and subsequent stages.

Form of research questions

- " ? "
- Constructs (and construct measures)
- Population(s)
  *Population (theoretical area being investigated) – size **N***
  *Sample (set of individuals selected from the population N) – size **n***
- Relationships
  Associations
  - e.g. Correlation / contingency table

  Predictions
  - e.g. Regression

  Group differences
  - e.g. t-test, ANOVA, linear contrast

<u>Population</u>: A population is the complete set of all persons for whom the research question or research hypothesis is relevant. It is defined in terms of either (i) a particular psychological construct (e.g., depression) or some defined condition (e.g., people with epilepsy), which identifies a homogeneous grouping, or (ii) the general population (when theory and the research question/hypothesis are not restricted to a homogeneous group). A research population can be theoretically infinite in size, or it may be finite.

<u>Sample</u>: A sample is a finite set of people of size n who are selected from a relevant population to investigate the research question, and on whom we take measurements in order to undertake the research.

Constructs, measurements, and scores

- Psychological constructs (unobservable attribute, i.e. behaviour, cognition, affect)
- "Labels" of hypothetical causes and effects
- Construct measures – valid and reliable method of measurement for a construct e.g. questionnaires, aptitude tests, reaction time, etc. – any method of measurement will generate a **score**.

Construct scores

- Score on **construct measures**, e.g. sum of (total) scores on questionnaire items, or number of milliseconds on reaction time. Note that many, but not all, construct measures are arbitrary.
- Used to explain differences in behaviour, cognition, or affect, and reflects variability – e.g. degree / amount (i.e. height, weight) rather than kind / type (i.e. sex, religion).

What's the difference between a construct and a score?

Constructs are hypothetical attributes whereas a score is an observed measurement of a construct.

Different kinds of construct scores

- A score can include a response, coding value, or a count.
- Raw scores are indicated as X_i or Y_i (where the subscript refers to the i^{th} person)
- Raw scores are numerical values of variable obtained directly from the original method of measurement used in the research = **observed score**, e.g. reaction time (milliseconds), age (years), galvanic skin response (ohms).

The standard deviation is a numerical value used to indicate how widely individuals in a group vary. If individual observations vary greatly from the group mean, the standard deviation is big; and vice versa.

- *Transforming raw scores*

Deviation score: $x_i = X_i - M_x$

Where x_i is the deviation score, X_i is the original raw score, and M_x is the mean value.

The observed score and the raw score in sample data mean exactly the same thing: They are the actual untransformed values recorded for each person when measuring a construct.

Any deviation score that is positive in value implies that the original raw score is above the sample mean. In contrast, any deviation score that is negative in value corresponds to a raw score than is less than the sample mean. Deviation scores always have a mean of zero when the sample mean was used to create them.

- *Standardised score*
  Numerical value obtained by transforming a raw score into a new value that has (i) a predefined mean value, and (ii) a predefined scale (metric) e.g. raw scores on IQ tests

- *Z score*
  special standardised score, mean = 0, each numerical unit of Z score equals to 1 S.D. of raw scores – Z scores indicate the number of S.D. the raw score is from the mean.

Deviation scores and Z scores

Deviation scores have a mean of zero, but their standard deviation will equal whatever the standard deviation of the sample raw scores (i.e., creating deviation scores does not change the average amount of variability in the scores themselves). Z scores, on the other hand, can be thought of as standardized deviation scores, because Z scores also have a mean of zero but they additionally have a standard deviation equal to one. This is because Z scores are calculated as deviation scores that have each been divided by the standard deviation.

Deviation scores tell us whether a value is above or below the mean, but they do not tell us how far any value is from the mean. Z scores, in comparison, tell us (i) whether a person's value is above or below the mean and (ii) how far that person's score is from the mean (because Z scores are measured in standard deviation units). Both deviation scores and Z scores can be regarded as ways of applying a transformation to raw scores.

- Progressive transformations
  Raw score (X_i) to deviation scores (x_i) , subtract mean (M_x) from raw score:

$$x_i = X_i - M_x$$

Deviation scores to Z scores (Z_i) , divide deviation score by sample standard deviation (s):

$$Z_i = \frac{X_i - M_x}{s} = \frac{x_i}{s}$$

Z scores to another standardised score, re-scale Z score by the desired mean (μ) and SD value (σ):

$$e.g. IQ_i = 100\ (\mu) + \ (Z_i\ \times 15\ (\sigma))$$

Parameters and Statistics

- In research, construct scores from a single sample is used rather than the complete population, because the population might be infinite, unfeasible and unnecessary.
- *(Population) Parameter*
  A single numerical value that specifies a particular summary characteristic of a population that is almost is always unknown in practice (except conventional scores like IQ)

- *(Sample) Statistic*
  A single numerical value for a particular summary characteristic calculated on scores from one sample. It is typically used as an estimate of a corresponding unknown population parameter value.
- Inferences from a parameter value include **associations, predictions, or differences**.

Distributions of individual scores

- Distribution in psychological research are used in four different but related concepts:
    - Observed **sample distributions** of construct scores;
    - Unobserved, but hypothesised, **population distribution**;
    - Sampling distributions of **sample statistics**; and
    - Theoretical probability distributions defined by **population parameters**.

Sample distribution: The complete set of n observed scores from measuring a construct in one particular sample. The main characteristics of a sample distribution of scores are summarised by ***sample statistics***.

"Summary characteristic" = a sample statistic. E.g., sample mean, or standard deviation, or correlation, etc

Population distribution: The complete set of N values on a construct measure for the entire population. The main characteristics of a population distribution are summarised by ***population parameter*** values. Typically in psychology, we assume that individual variability in a construct is quantitative, and therefore people differ in degree (i.e. on "how much" of the construct they would exhibit). Population distributions in most psychological research are virtually never observed or measured.

μ refers to a population mean; and $\bar{x}$, to a sample mean. σ refers to the standard deviation of a population; and *s*, to the standard deviation of a sample.

A distribution of sample scores can be displayed graphically using a **histogram** or a **boxplot**. A histogram emphasises the relative frequency of small groupings of scores by the height of the bins used to construct it. It can also indicate symmetry in the frequency of scores around a central point (i.e., bell-shaped look) or skewness in which scores are asymmetrically thinned out to the left (negative skewness) or to the right (positive skewness).

A box plot clearly indicates the 25^{th} and 75^{th} percentile values of the distribution of scores by the top and bottom of the box. It also indicates the median value in the distribution by the line within the box. An equal distance above and below this middle line in the box indicates symmetric distributions (unequal distance indicates skewness in the middle 50% of scores). The two whiskers attached to either end of the box can indicate the spread of scores from the lower and upper quartile to approximately the 1% and 99% percentiles respectively. If they are also of equal length, then this again indicates symmetry in the shape of the distribution.

Statistics – Summing, Squaring, and Averaging
Mean = average raw score of sample
Variance = average variability in scores of sample – square of standard deviation

The **summing** procedure enables us to get a total value over all people who are in the sample (i.e., the total "amount" of what is being measured), from which some kind of summary characteristic of the scores can be derived.

The **squaring** procedure is a way to identify the amount of variability in scores (rather than the total amount per se). Dividing the amount obtained from either or both summing and squaring enables some kind of an average summary characteristic (by virtues of having summed up all scores over everyone in the sample).

Averaging enables a summary characteristic value (e.g., a sample statistic like the mean, the variance, the standard deviation, etc) to be obtained that does not depend on the number of people in the sample. That is, a mean of 10 will be obtained from a summed total of individual scores equal to 50 (when n = 5) or a summed total of scores equal to 500 (when n = 50). The average score (i.e., 10 is the same in each instance), whereas the summed total score differs because of the size of each sample. Averaging removes this kind of influence from sample size.