RESEARCH METHODS

TYPES OF RESEARCH QUESTIONS

Do people understand and remember reading material better when studying with classical music or popular music?
Experiment: you could randomly assign people to study passages while different music plays, so both treatment groups start out the same except for the background music

Do people who attend class score better on an exam than those who don't?
Correlational Study: students aren't randomly assigned to attend or not, so groups may already be inherently different in ways that affect exam scores: illness, stress, depression, socioeconomic status (have to work, can't afford textbook), irresponsibility or lack of interest (don't bother studying), had class material already
TWO MAJOR PROBLEMS IN PSYCHOLOGICAL RESEARCH

measurement problem: relation between constructs and operational definitions (e.g., of "understand" and "remember") is not as tight as in other natural sciences; reliability and validity are challenging.

noise problem: group differences in responses may be random noise (due to inherent variability among individuals, and within individuals from occasion to occasion), or may really be due to treatment effect; statistics can help decide which.

RELIABILITY

The consistency or repeatability of a measure: the degree to which a measure would give you the same result over and over, assuming the phenomenon being measured is not changing.
**VALIDITY**

**Construct Validity** (addresses measurement problem) - Do the operational definitions accurately reflect the intended constructs of interest?

**Internal Validity**: Was the experiment appropriately controlled and carried out (using random assignment and other aspects of experimental method) to ensure legitimate conclusions – such that observed changes (effect) can be attributed to the treatment or program or intervention (cause) and not some other possible (alternative) cause?

**External Validity**: Do the experiment's conclusions apply to the real world? For instance, random selection of participants means the results will represent the population accurately.

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**Goals of Science**
- Describe
- Predict
- Understand
- Control

**Scientific Method**

-world of concepts

Theory → Prediction

Prediction → Revision

Revision → Observation

Observation → Theory

(Forced by inductive thinking)

(Forced by deductive thinking)
Where do Methods & Statistics Fit?

World of concepts

“Real” world

Theory

Observation

Prediction

Revision

Verification

Methods
- Correlational
- Experimental

Statistics
- Hypothesis Testing

Steps of the Scientific Method

1. Develop a research question
2. Generate a research hypothesis
3. Form operational definitions
4. Choose a research design
5. Evaluate the ethics
6. Collect data
7. Analyze data and form conclusions
8. Report research results

These steps are used in both basic and applied research
STATISTICS

**Descriptive statistics** - what scores (e.g., on an exam) are like: mean (average), median (middle score, with half above and half below), mode (most common score); how spread out scores are: range (from lowest to highest), variance, standard deviation (typical distance from mean)

**Correlation** - how much variables go together (e.g., exam score and GPA, SAT and GPA, SAT and IQ, anxiety and depression); association between variables can be large or small, positive or negative, from -1.0 to +1.0

**Inferential statistics** - do scores in this sample generalize to the whole population?; examine using t-test, chi-square test, Analysis of Variance (ANOVA), multiple regression, etc.

NOTE: Statistics is awesome and would be a great thing to major in.
CORRELATIONAL OR "FIELD" STUDY

- examines relationship between variables; DOES NOT imply causation
- maybe variable 1 causes variable 2, or maybe it’s the other way around, or maybe something else causes both of them
- crime rate increases when people eat more ice cream

examples:
- naturalistic observation (of children's behavior for instance) - no experimental control, but very representative of reality, unlike experiments which are controlled and can be artificial
- survey research - online questionnaires, etc. - just measuring characteristics, no way to say which are causes and which are effects, or which other characteristics influence what’s being measured

EXPERIMENTAL OR "LAB" STUDY

- make groups the same (control), change one thing (manipulation), attribute difference in responses to the change you made; DOES imply causation
- random SELECTION of sample of subjects from population for generalizability (e.g., to everyone, or just to college students)
- random ASSIGNMENT of subjects to treatment groups in sample (to ensure equality of groups)

independent variable (IV): the cause; what you change or manipulate; independent of other variables, NOT "dependent on what you do"; what you put your hands on

dependent variable (DV): the effect; what you measure or observe; dependent on IV, NOT "independent of what you do"; what you put your eyes on

confound - other variable besides IV that might affect DV because you haven't controlled it
INFERENTIAL STATISTICS

observe group means or correlations in sample, then generalize to population

role of statistics: reduce all your data to one number
- locate it in known distribution of other random numbers like it
- see how probable it is that your number would occur by chance alone, and therefore how probable it is that your data would occur by chance alone

null hypothesis – the hypothesis that your treatment has no effect (i.e., observed differences in your data are due to chance)
- corresponds to that distribution of random numbers
- is your data unlikely enough to make you reject the null hypothesis, and decide that your treatment does have an effect in the population?

P-VALUE

- the result of a statistical test of a null hypothesis
- conventionally, when p-value is less than .05 (5%), null hypothesis is rejected, result is called "statistically significant", and treatment effect is considered to really be present in the population, not just apparently present in the sample

- p-value is probability of getting your data by chance if null hypothesis is true; NOT probability that null hypothesis is true (i.e., NOT probability that your data occurred by chance)
  - consider: “p-value is probability you WOULD get your data just by chance” is correct; “p-value is probability you DID get your data just by chance” is wrong!
- p-value is probability of your data given the null hypothesis, NOT probability of null hypothesis given your data - THESE ARE DIFFERENT!...
REVERSING PROBABILITIES

probability of being Italian given that you're in the mafia is very high; probability of being in the mafia given that you're Italian is about 0

probability of being Muslim given that you're a terrorist may be very high*; probability of being a terrorist given that you're a Muslim is about 0
[* though that's based on TV and media coverage; in real life there are plenty of non-Muslim terrorists (Irish, German, Russian, American, Christian, Jewish, Hindu, Buddhist, etc.)]

SO…
probability of data given the null hypothesis (p-value) may be very low; probability of the null hypothesis given the data is still unknown

EFFECT SIZE

p-values are usually misinterpreted, possibly leading to unreplicable findings (among other reasons for that), and anyway are nearly useless even at their best, according to me and many experts
- but we still gotta learn them because of (1) history and (2) inertia and (3) lack of clear alternatives (stay tuned for the bumpy future though)
- they definitely do not give an indication of how much of an effect your treatment had, which should be the main question

effect size measures - how much of a difference did your treatment make? Express this with statistics like $R^2$, $\eta^2$, $d$, $f$, $\omega^2$, etc.
- more informative than p-values, required in all research reports nowadays
ETHICS IN RESEARCH

protection of human and animal subjects, with federal funding at stake; approval of research studies is overseen by
Institutional Review Board (IRB) -humans
Institutional Animal Care and Use Committee (IACUC) - animals

principles and issues in human research:
- confidentiality
- informed consent
- deception allowed when unavoidable for procedure; seek alternatives
- debriefing
- no coercion
- special considerations in field research
- minimize risks, concern with welfare, psychological well being
- leave them like you found them