Basics of Experimentation

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Why study experimental design?

- Answer interesting questions
- Evaluate research critically
  - Many confounds present in published work
- When ever you hear “X causes Y”, your brain should immediately try to think of alternative factors that could explain the association
Don’t have access to cognitive and emotional processes. Need to infer from:
- RT
- Accuracy
- Brain activation (fMRI)
- Self-report
Experimental manipulation vs correlational study

- **Correlational**
  - looks at relationship between existing variables
  - Is amount of youtube viewing related to grades?
  - Other explanations?

- **Experimental Manipulation**
  - Independent vs dependent variables
  - If I manipulate X (amount of youtube viewing) will that affect Y (grades)?

- What is benefit of manipulation?
  - Try to establish cause and effect
Design Types

- Repeated-Measures
  - Measure each person at 2 different times, or on two different conditions.
  - For each person contrast performance
    - Hold in mind 2 items or 7; see what brain areas display differential activation within each person
    - Much greater power
      - Need to counterbalance order

- Between groups
  - Each group gets different treatment
    - One group holds in mind 2 items; other group holds in mind 7; see what brain areas display differential activation between the groups
    - Much random variance within each group that decreases power to detect differences between the groups

***Go with repeated-measures when possible!!!
Internal validity

- Can you rule out confounding variables?
  - Random assignment to groups
    - Equates groups (e.g., gender, age, IQ)
  - Conditions
    - Must be equivalent except for key variable that you are manipulating
    - Working memory example: 7 vs 2 items only differ in how much it taxes memory capacity? Might also cause use of different strategy.
- Are you actually testing what you want to test?
  - Grades reflect aptitude or motivation?
Internal validity

- Repeated Testing
  - Exposure to a test can alter performance; compare IQ test scores before and after a ‘brain–training’ program
    - Control group
    - Alternate forms of IQ test
    - Separate testing sessions in time (e.g., weeks or months in between)

In short, how well can you establish a cause and effect relationship?
External validity

- Do my results tell us something about the population at large, i.e., do they generalize?
- If I only test 15-year old males, can I confidently claim that all people will perform similarly?

- Need a representative sample
  - Gender; Age; SES; Ethnicity
Key concepts

- Random Assignment
  - To equate groups before treatment/intervention (hold constant random individual variation)

- Identify and eliminate confounds
  - Want to limit any alternative explanations

- Representative Sample
  - To extend claims beyond your study sample
1 independent variable and 1 dependant
- Effect of drug vs placebo on depressive symptoms

Factorial
- More than 1 IV
  - Look at gender in addition to drug vs placebo
  - main effects and interaction analyses

**********Do not attempt more than 2 IVs!!!
Conflict Detection and the Anterior Cingulate
Botvinic et al., 1999, Nature

- ACC registers activation of conflicting responses and signals the need for greater top-down cognitive control.

Greater conflict, because not prepared

less conflict, because prepared
ACC activation is greater on incompatible trials following compatible

- Evidence for conflict detection?

- These trials also likely involve greater effort
- Involve more attention to action
- Decreased likelihood of reinforcement

Many confounds!!!
Example 1

Emotion and Attention

- Rowe et al. 2007, PNAS
- Is the scope of spatial attention influenced by mood?
  - Manipulate mood with pics
  - Examine amount of flanker interference as a function of mood
Example 1

- What Kind of Design?
  - Repeated–measures
  - Single independent factor (mood)
  - Single dependent factor (RT interference)

- Considerations
  - Order of mood manipulation must be counterbalanced
  - Do pics effectively induce different moods?
Example 2

- Perceptual inference in the sensory cortex
  - Is the brain actively predicting what it will see next?
    - Summerfield et al., 2006 Nature Neuroscience
  - Hypothesis: brain activation occurs primarily when sensory info does not match expectations (brain’s model of the world)
Example 2

- Repeating and alternating faces
  - Repetitions occur frequently or infrequently

- When repetitions are frequent, the brain should expect to see the same face
  - Therefore neural response should be smaller in this block
Considerations

- Key events of interest are independent of task
  - Ensures effect is purely sensory and not based on more complex things like stimulus–response associations.
  - Some evidence that sensory prediction occurs implicitly
    - However, they could have probed subjects’ awareness of the probability of face repetition.
Example 3

- Executive function: unified construct or separable mechanisms?
  - Miyake et al., 2000, Cognitive Psychology
  - Is performance on EF tasks correlated?
What kind of design?
- Look at Accuracy

Considerations
- Sample size
  - Even though it’s a RM design, need large sample size to find effects with correlation (due to large sampling error)
- Tasks are complex
  - Likely measure multiple cognitive processes; may not be pure measure of the key EFs
- Tasks are rather boring
  - Influence of waning motivation
  - Do they capture same cognitive processes that would be engaged in everyday situations?
Long-term Memory

- Are there sex differences in the neural basis of memory for emotional events?
  - Present subjects with emotional and neutral pics (IAPS)
  - Subjects rate emotional experience to each pic in the scanner
  - Surprise recognition memory task 3 weeks later
    - Remember pic vs familiarity
Example 4

- Amygdala activation that correlates with memory is more robust in the left hemisphere for women and the right hemisphere for men.
Considerations

- Design?
- Superior performance in women could be due to use of a different strategy
- How long will images be presented?
- Want to examine implicit or explicit memory? (could find different effects)
- Balance valence and arousal
  - Are you looking at the effect of a specific valence (e.g., negative) or emotional arousal more generally?
- What pics to use? IAPS standardized database with ratings
Example 5

- Language learning
  - How do infants segment continuous word stream into meaningful units?
  - Saffron et al., 1996, Science

- Transitional probability
  - Likelihood of 2 sounds following one another is higher within a word than between words
  - E.g., Take “tasty sandwich”
    - Tas-ty is more likely than ty-sand
Example 5

- Present infants with continuous speech stream of non-sense words
  - Vary the transitional probability (likelihood that two sounds will follow each other)
  - Then present infants with speech sounds from the learning phase, or the same sounds but in a different order
    - Infants choose to listen longer to novel combinations (controlled by looking time at a light)
That’s all there is to design!!