Experimental Design

2 C's 2R's   CRRC

(Control, Randomization,

Replication, Compare)

Blocking

Blinding

Confounding

Observational Studies vs. Experiments

2C's 2R's CRRC

Control - At least two groups to be compared

Randomization - Use impersonal chance to assign subjects to treatments

Repetition - Experiments must be done multiple times to confirm results

Compare - Make a statement that you will be comparing results to determine how control and experimental groups are different

Blocking

The arranging of experimental units in groups (blocks) that are similar to one another. For example, an experiment is designed to test a new drug on patients. There are two levels of the treatment, *drug*, and *placebo*, administered to *male* and *female* patients in a double blind trial. The sex of the patient is a *blocking* factor accounting for treatment variability between *males* and *females*. This reduces sources of variability and thus leads to greater precision.

Blinding

a test or experiment in which information about the test that might lead to bias in the results is concealed from the tester, the subject, or both until after the test. Bias may be intentional or unconscious. If both tester and subject are "blinded", the trial is a **double-blind trial**. Blind testing is used wherever items are to be compared without influences from testers' preferences or expectations, for example in clinical trials to evaluate the effectiveness of medicinal drugs and procedures without placebo effect, observer bias, or conscious deception; and comparative testing of commercial products to objectively assess user preferences without being influenced by branding and other properties not being tested.

Confounding

A confounding variable is an extraneous variable (i.e., a variable that is not a focus of the study) that is statistically related to (or correlated with) the independent variable. This means that as the independent variable changes, the confounding variable changes along with it. The result is that subjects in one condition are different in some unintended way from subjects in the other condition. This is bad because the point of an experiment is to create a situation in which the only difference between conditions is a difference in the independent variable. This is what allows us to conclude that the manipulation is the cause of differences in the dependent variable. But if there is some other variable that is changes along with the independent variable, then this confounding variable could be the cause of any difference.

Confounded Testing

Now imagine a less than ideal version of this experiment, with some other variables that differ systematically across conditions. These are confounding variables (all highlighted). Now if there is a difference in the concentration levels of subjects in the quiet and noisy conditions, it could be caused by the independent variable … but it could also be caused by any of the confounding variables. If subjects in the quiet condition have greater concentration levels, is it because it was quiet, because the temperature was not too hot, or because they were tested in the morning? There is no way to tell. Obviously, this is less than ideal.

Variables	Quiet Condition	Noisy Condition
Noise Level (IV)	Low	High
IQ (EV)	Average	Average
Room Temperature (EV)	68 Degrees	68 Degrees
Sex of Subjects (EV)	60% F	60% F
Task Difficulty (EV)	Moderate	Moderate
Time of Day (EV)	Morning	Afternoon
Etc. (EV)	Same as Noisy Cond.	Same as Quiet Cond.
Etc. (EV)	Same as Noisy Cond.	Same as Quiet Cond.

Ideal Testing

Imagine a randomized experiment concerning the effect of noise on concentration. There are 50 subjects in the quiet condition and 50 in the noisy condition. The ideal version of this experiment is represented by the table below. The independent variable is labeled “IV” and extraneous variables are labeled “EV.” Note that the only variable that differs systematically across the two conditions is the independent variable itself (which is highlighted in the table). There is little noise in the quiet condition and lots of noise in the noisy condition. The rest of the variables—IQ, room temperature, etc.—are the same across the two conditions. They have been controlled. So if there is a difference in the concentration levels of subjects in the quiet and noisy conditions, it must be caused by the independent variable.

Variables	Quiet Condition	Noisy Condition
Noise Level (IV)	Low	High
IQ (EV)	Average	Average
Room Temperature (EV)	68 Degrees	68 Degrees
Sex of Subjects (EV)	60% F	60% F
Task Difficulty (EV)	Moderate	Moderate
Time of Day (EV)	All Different Times bet. 9 – 5	All Different Times bet. 9 – 5
Etc. (EV)	Same as Noisy Cond.	Same as Quiet Cond.
Etc. (EV)	Same as Noisy Cond.	Same as Quiet Cond.

Observational Studies

<u>Observational Study</u>: watching and knowing what to look for/looking for patterns

*Observes individuals and measures variables of interest but does ***<u>NOT</u>*** attempt to influence the responses.

**The purpose of an observational study is to describe some group or set.

For example: Comparing last year's grades to this year's grades on the same test

Teacher observations

"Observe but don't disturb"

<u>Benefits of Observational Study</u>

Ethics   Long-term effects

<u>Pitfalls of Observational Study</u>

Confounding Variables (variables we can't control/don't notice)   No control group

Experiments

<u>Experiment</u>: Deliberately imposes some ***<u>treatment</u>*** on individuals in order to observe their responses. The purpose of an experiment is to study whether the treatment <u>CAUSES</u> a change in the response.

*You can see cause and effect.
*The experimenter has control in an experiment.
*groups are similar, individuals don't have to be (only one systematic difference)

<u>Benefits of experiments:</u>

gives good evidence   has a control

<u>Some disadvantages of experiments:</u>

evidence is "on average", doesn't say much about an individual

ethics   long-term is hard

Sample Questions:

1998 Q. 3

1999 Q. 3

2000 Q. 5

2001 Q. 4

2002 Q. 2

2002 - Pt B Q. 3

2003 Q. 4