EXPERIMENTAL DESIGN

…PLEASE!

EXPERIMENTAL RESEARCH

Experimental research is an attempt by the researcher to maintain control over all factors that may affect the result of an experiment. In doing this, the researcher attempts to determine or predict what may occur.

OVERVIEW OF EXPERIMENTAL RESEARCH

Traditional type of research

- Laboratory Experiments
- Field Experiments
- Natural Experiments

Purpose is to investigate cause-and-effect relationships among variables

- Experimental groups vs. control groups
- Each group of participants receives a different treatment
- Always involves manipulation of the independent variable

Answers the question "What will be?"

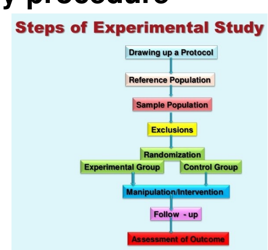
EXPERIMENTAL DESIGN

Experimental design is a blueprint of the procedure that enables the researcher to test his hypothesis by reaching valid conclusions about relationships between independent and dependent variables.

SYSTEMATIC PROCEDURES

More than any other type of research, experimental research should follow a definite, orderly procedure

Specific steps



STEPS IN EXPERIMENTAL RESEARCH

1. State the research problem
2. Determine if experimental methods apply
3. Specify the independent variable(s)
4. Specify the dependent variable(s)
5. State the tentative hypotheses
6. Determine measures to be used
7. Pause to consider potential success
8. Identify intervening (extraneous) variables
9. Formal statement of research hypotheses
10. Design the experiment
11. Final estimate of potential success
12. Conduct the study as planned
13. Analyze the collected data
14. Prepare a research report

RESEARCH ESSENTIALS

- Manipulation of an independent variable
- All variables except the dependent variable are held constant (control)
- Manipulation of the dependent variable by the independent variable is observed (observation)

EXPERIMENTAL CONTROL

Experimental control attempts to predict events that will occur in the experimental setting by neutralizing the effects of other factors

CONTROL METHODS

- Physical control
- Selective control
- Statistical control

PHYSICAL CONTROL

- Gives all subjects equal exposure to the independent variable
- Controls non-experimental variables that effect the dependent variable

SELECTIVE CONTROL

Indirectly manipulate by selecting in or out variables that cannot be controlled

STATISTICAL CONTROL

Variables not conducive to physical or selective manipulation may be controlled by statistical techniques

INTERNAL VALIDITY

Did the experimental treatment make the difference in this specific instance rather than extraneous variables?

INTERNAL VALIDITY FACTORS

1. History
2. Maturation
3. Pre-testing
4. Measuring instruments
5. Statistical regression
6. Differential selection
7. Experimental mortality
8. Interaction of factors

HISTORY

The events occurring between the first and second measurements in addition to the experimental variable which might affect the measurement

MATURATION

The process of maturing which takes place in the individual during the duration of the experiment which is not a result of specific events but of simply growing older, growing tired or similar changes

PRE-TESTING

The effect created on the second measurement by having a measurement before the experiment

MEASURING INSTRUMENTS

Changes in instruments, calibration of instruments, observers or scorers may cause changes in the measurements

STATISTICAL REGRESSION

Where groups are chosen because of extreme scores of measurements, those scores tend to move toward the mean with repeated measurements even without an experimental variable

DIFFERENTIAL SELECTION

Different individuals or groups have different previous knowledge or ability which would affect the final measurement if not taken into account

EXPERIMENTAL MORTALITY

The loss of subjects from comparison groups could greatly affect the comparisons because of unique characteristics of those subjects. Groups to be compared need to be the same as before the experiment

INTERACTION OF FACTORS

Combinations of many of these factors may interact especially in multiple group comparisons to produce erroneous measurements

EXTERNAL VALIDITY

To what populations, settings, treatment variables and measurement variables can this observed effect be generalized?

EXTERNAL VALIDITY FACTORS

1. Pre-testing
2. Differential selection
3. Experimental procedures
4. Multiple treatment interference

PRE-TESTING

Individuals who were pre-tested might be less or more sensitive to the experimental variable or might have learned from the pre-test making them unrepresentative of the population who had not been pre-tested

DIFFERENTIAL SELECTION

The selection of the subjects determines how the findings may be generalized. Subjects selected from a small group or one with particular characteristics would limit generalizability

EXPERIMENTAL PROCEDURES

The experimental procedures and arrangements have a certain amount of effect on the subjects in the experimental settings

MULTIPLE TREATMENT INTERFERENCE

If the subjects are exposed to more than one treatment, then the findings could only be generalized to individuals exposed to the same treatments in the same order of presentation

TOOLS TO CONTROL VALIDITY JEOPARDIZING FACTORS

- **Pre-test**
- **Control group**
- **Randomization**
- **Additional groups**

TYPES OF DESIGNS

The basic structure of a research study . . . particularly relevant to experimental research

Types of designs (Campbell & Stanley, 1963)

- Pre-experimental
- True experimental
- Quasi-experimental

PRE-EXPERIMENTAL DESIGNS

- Weak experimental designs in terms of control
- No random sampling
- Threats to internal and external validity are significant problems
- Many definite weaknesses

Example: One-group pretest/posttest

TRUE EXPERIMENTAL DESIGNS

- Best type of research design because of their ability to control threats to internal validity
- Utilizes random selection of participants and random assignment to groups

Example: Pretest/posttest control group design

QUASI-EXPERIMENTAL DESIGNS

- These designs lack either random selection of participants or random assignment to groups
- They lack some of the control of true experimental designs, but are generally considered to be fine

Example: Nonequivalent group design

EXPERIMENTAL DESIGNS

Pre-Experimental

Quasi-Experimental

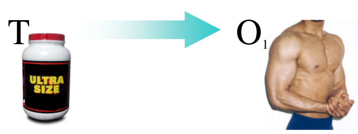
True-Experimental

Question:

"Does protein supplementation increase muscle hypertrophy?"

PRE-EXPERIMENTAL DESIGNS

One Shot Study

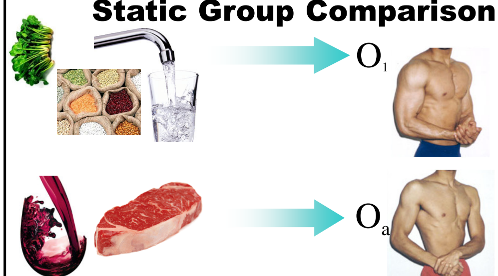


PRE-EXPERIMENTAL DESIGNS

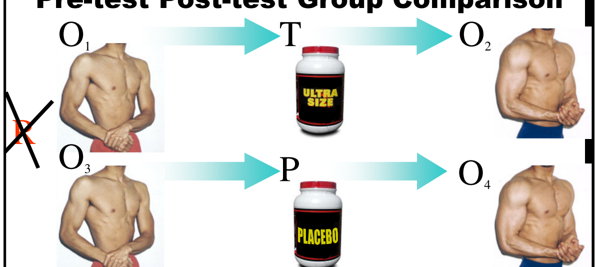
One Group Pre-test Post-test

PRE-EXPERIMENTAL DESIGNS
Static Group Comparison

PRE-EXPERIMENTAL DESIGNS
Static Group Comparison



QUASI-EXPERIMENTAL DESIGNS
Pre-test Post-test Group Comparison

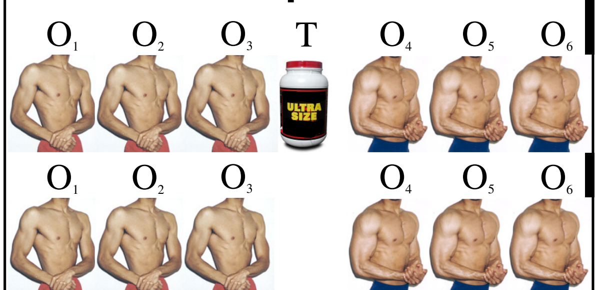


QUASI-EXPERIMENTAL DESIGNS

Time series (ABA design)

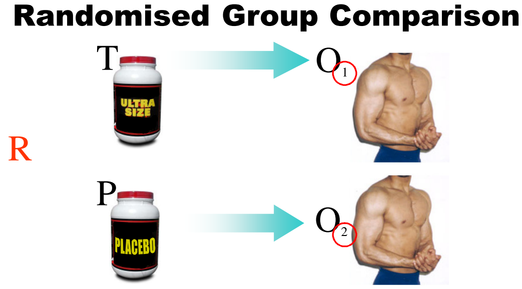
QUASI-EXPERIMENTAL DESIGNS

Control Group Time series



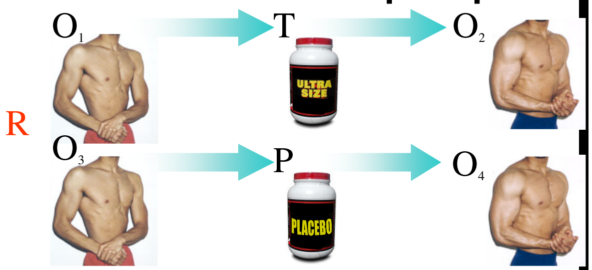
TRUE-EXPERIMENTAL DESIGNS

Randomised Group Comparison

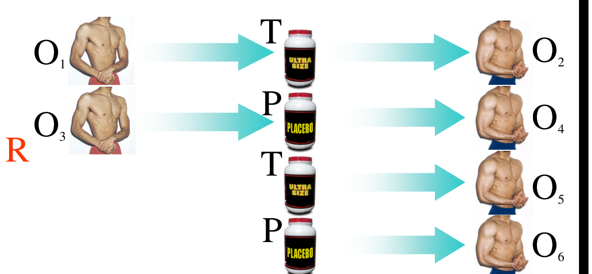


TRUE-EXPERIMENTAL DESIGNS

Pre Post Randomised Group Comparison



TRUE-EXPERIMENTAL DESIGNS



Solomon Four-Group Design

COMMON SOURCES OF ERROR

Many possible sources of error can cause the results of a research study to be incorrectly interpreted.

Additional sources of error that are specific threats to the validity of a study like the points mentioned earlier

Selected examples:

- Hawthorne Effect
- Placebo Effect
- John Henry Effect
- Rating Effect
- Experimenter Bias Effect

DONALD T. CAMPBELL AND JULIAN C. STANLEY

TABLE 1

SOURCES OF INVALIDITY FOR DESIGNS 1 THROUGH 6

	Internal								External			
	History	Maturation	Testing	Instrumentation	Regression	Selection	Mortality	Interaction of Selection and Maturation, etc.	Interaction of Testing and X	Interaction of Selection and X	Reactive Arrangements	Multiple-X Interference
Pre-Experimental Designs:												
1. One-Shot Case Study X O	–	–				–	–			–		
2. One-Group Pretest-Posttest Design O X O	–	–	–	–	?	+	+	–	–	–	?	
3. Static-Group Comparison X O O	+	?	+	+	+	–	–	–		–		
True Experimental Designs:												
4. Pretest-Posttest Control Group Design R O X O R O O	+	+	+	+	+	+	+	+	–	?	?	
5. Solomon Four-Group Design R O X O R O O R X O R O	+	+	+	+	+	+	+	+	+	?	?	
6. Posttest-Only Control Group Design R X O R O	+	+	+	+	+	+	+	+	+	?	?	

Note: In the tables, a minus indicates a definite weakness, a plus indicates that the factor is controlled, a question mark indicates a possible source of concern, and a blank indicates that the factor is not relevant.

It is with extreme reluctance that these summary tables are presented because they are apt to be "too helpful," and to be depended upon in place of the more complex and qualified presentation in the text. No + or – indicator should be respected unless the reader comprehends why it is placed there. In particular, it is against the spirit of this presentation to create uncomprehended fears of, or confidence in, specific designs.

SOURCES OF INVALIDITY FOR QUASI-EXPERIMENTAL DESIGNS 7 THROUGH 12

	Internal								External			
	History	Maturation	Testing	Instrumentation	Regression	Selection	Mortality	Interaction of Selection and Maturation, etc.	Interaction of Testing and X	Interaction of Selection and X	Reactive Arrangements	Multiple-X Interference
Quasi-Experimental Designs:												
7. Time Series O O O OXO O O O	–	+	+	?	+	+	+	+	–	?	?	
8. Equivalent Time Samples Design X_1O X_0O X_1O X_0O, etc.	+	+	+	+	+	+	+	+	–	?	–	–
9. Equivalent Materials Samples Design M_aX_1O M_bX_0O M_cX_1O M_dX_0O, etc.	+	+	+	+	+	+	+	+	–	?	?	–
10. Nonequivalent Control Group Design O X O O O	+	+	+	+	?	+	+	–	–	?	?	
11. Counterbalanced Designs X_1O X_2O X_3O X_4O X_2O X_4O X_1O X_3O X_3O X_1O X_4O X_2O X_4O X_3O X_2O X_1O	+	+	+	+	+	+	+	?	?	?	?	–
12. Separate-Sample Pretest-Posttest Design R O (X) R X O	–	–	+	?	+	+	–	–	+	+	+	
12a. R O (X) R X O R O (X) R X O	+	–	+	?	+	+	–	+	+	+	+	
12b. R O_1 (X) R O_2 (X) R X O_3	–	+	+	?	+	+	–	?	+	+	+	
12c. R O_1 X O_2 R X O_3	–	–	+	?	+	+	+	–	+	+	+	

SAMPLE SIZE

250 *Describing the Data*

TABLE 12.7 Rounded Sample Sizes (Total N) Required to Detect Various Effects (r) at .05 Two-tailed

	Small	Effect sizes (r)	Med			lg	
Power	.10	.20	.30	.40	.50	.60	.70
.15	85	25	10	10	10	10	10
.20	125	35	15	10	10	10	10
.30	200	55	25	15	10	10	10
.40	300	75	35	20	15	10	10
.50	400	100	40	25	15	10	10
.60	500	125	55	30	20	15	10
.70	600	155	65	40	25	15	10
.80	800	195	85	45	30	20	15
.90	1000	260	115	60	40	25	15

Source: Reproduced from *Statistical Power Analysis for the Behavioral Sciences* (2nd ed.), by J. Cohen, 1988, Lawrence Erlbaum Associates, Inc., pp. 92–93. Used by permission of Jacob Cohen and Lawrence Erlbaum Associates, Inc.

DISCUSS…

Presentations of the
Pre-Proposal, part 1
This is formative evaluation, so provide your classmates with much feedback!