

SCIENTIFIC MISTEACHINGS

SOME COMMON MISUNDERSTANDINGS OF SCIENTIFIC CONCEPTS FOUND IN TEXTBOOKS AND LECTURE NOTES FOR RESEARCH METHODS COURSES

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VALIDITY

- To be valid, a measure must be reliable. *Reliability and validity are independent of one another. A reliable measure is one that is consistent across time, subjects, and testing conditions. A valid measure is one that measures what it is intended to measure.*
- Valid = good or true. *Validity is not sufficient for truth or value. It refers only to the structure of an argument. Validity is necessary to draw conclusions about truth, but something that is high in validity may be 100% untrue.*
- Individual differences among subjects are potential confounds. *Confounding variables are those that compromise a comparison. Unless these differences are used to assign subjects to groups, they cannot confound. Nothing a single subject in an adequate sample does or is can derail a well-designed study.*
- The manner in which instructions are given, the gender of the researcher, the room, the time of day, etc. are possible confounds. *Nothing that is held constant can confound. Only those things that co-vary with treatment conditions can confound. Any variable that co-varies with treatment is a possible confound.*

CONTROL GROUPS

- Experiments always require "control groups". *Experiments require comparisons. Control, in the strict sense of the word, is not always possible. For example, we cannot test the effects of presentation mode (e.g., visual, audio) on memory using a control group. You cannot have a condition that presents the material without a mode of presentation.*

RANDOM ASSIGNMENT

- Random assignment reduces or eliminates individual differences in unmeasured variables (noise). *Random assignment is simply a method for assigning subjects to groups. It cannot change those subjects. It does not make people taller (or shorter), more (or less) intelligent, or a different gender. Random assignment reduces possible confounds by eliminating*

experimenter bias in the assignment process (the experimenter uses no criteria other than chance to assign subjects to treatment conditions).

- Random assignment controls for individual differences in unmeasured variables. *To control for something, you must either measure it or hold it constant. Ignoring it, which is what random assignment does, is not controlling it.*
- Random assignment distributes individual differences in unmeasured variables (noise) evenly among treatment groups. *Comes from the human tendency to think of randomness as meaning "spread out" evenly. Random assignment distributes noise randomly.*
- Random assignment equalizes groups. *Random, again, does not mean even. It is entirely possible to assign randomly and end up with a treatment group with only women and control with only men. It is highly improbable, but entirely possible.*
- Random assignment eliminates confounding variables. *There are many possible sources of confounding variables. Random assignment only eliminates bias in assignment, which itself is not a guarantee that the groups do not differ on an important variable by chance. It also cannot address the confounds that may exist in the method.*

STATISTICAL ANALYSIS AND INTERPRETATION

SIGNIFICANCE

- The purpose of statistical analysis is to "find significance" in data. *The term "find significance" is meaningless. It is a warped version of "statistically significant differences" and students usually have no idea what either actually means.*
- Significant differences means the differences are large or the findings are significant. *"Children in the Phonics class had significantly higher scores than children in the Traditional class" does not mean that Phonics is significantly better than Traditional teaching. In a nutshell it means that the difference between the samples' mean scores is likely to be a result of teaching method, not chance.*

EQUAL SAMPLE SIZES

- Results were not "significant" because the groups were not the same size. *Small differences do not affect the outcome of most statistical tests. However large differences in sample size are a problem because ample size affects variance. Researchers must also consider the reasons for unequal samples in experiments due to possibility of confounding variables.*

INTERACTIONS

- Interactions are the combined effect of two independent variables on a dependent variable. *Interactions are when the effect one independent variable has on the dependent measure*

differs among levels of another independent variable. This is not a combined or additive effect; interactions take on many forms, including the absence of simple effects in some conditions.

THE EFFECTS OF SAMPLE SIZE ON POWER

- *If you run more subjects, you will probably "find significance". Although sample size affects power, power is not the probability one will "find significance". It is the probability of detecting an effect that exists. If you start with an adequate sample, you cannot improve your chances by adding subjects. In addition, the "significant" results you get may be of no practical significance; they may have no predictive value.*

CAUSAL MODELING

- *Causal modeling allows the researcher to draw causal conclusions without experimental design. This is a method of analysis, not a design feature. It compares obtained data to a model of causal relationships and determines if the data are consistent with the model. This approach is more powerful than simple correlation analysis in eliminating alternative hypotheses, but no amount of statistical analysis can compensate for a lack of random assignment and/or control of possible confounding variables.*

EFFECT SIZES

- *Measures of effect size tell us the magnitude of the relationship and/or the difference we can expect to find among treatments. Some measures of effect size in some situations may be described in this way, but most cannot. Experimental controls, laboratory settings, and strong manipulations make effect sizes somewhat meaningless. One must always consider method and sample size when evaluating findings; measures of effect size do not change this fact.*