

Chapter 2—Mills 2007

Truth

- Correspondence between an idea created in our mind with a referent fact obtained from sensory experience

Obtaining Reliable Facts

- Replication and randomization
 - Subsamples vs replicates (pseudoreplication)
 - Sample size implications
 - Random vs Systematic
- Controls
- Accuracy, error, and variation
 - Process vs sampling variation

Linking facts leads to understanding

- Use of the Scientific Method
 - Induction
 - Description
 - Retroduction
 - Hypothesis generation
 - Hypothetico-Deduction
 - True use of the scientific method
 - Strong Inference
 - Multiple alternative hypotheses

Linking facts leads to understanding

- P values, power, biologically important differences
 - Statistical significance: $P \leq 0.05$?
 - Type I vs Type II error
 - Statistical Power
 - Based on alpha, effect size, variance, sample size
 - Beta = 0.80?

Linking facts leads to understanding

- Model selection: Information-Theoretic Methods
 - Principle of Parsimony (Occam's Razor)—simplest models are the best
 - Akaike's Information Criterion (AIC)-one method currently used to find the best model
 - $AIC = -2\ln[L(\theta) \mid \text{data}] + 2k$
 - $L(\theta)$ = log-likelihood of model
 - K = number of variables in the model
 - Helps avoid overfitting and underfitting models

Linking facts leads to understanding

- Bayesian Statistics
 - Uses prior and posterior probabilities
 - Can use BIC – Bayesian Information Criterion – to determine best model

Ethics

- We use statistics to keep us honest
- Assumption of ethical behavior when conducting science and managing populations