Module 2

Statistics Review

- More often than not, we are interested in simply *describing* test data, or
- Seeing what the test is *associated* with (e.g., job performance, turnover rates)
- As a result, it allows us to:
  - Interpret test scores (Constructs)
  - Evaluate test quality (Usefulnes)
- Hence, inferential statistics not as prominent in psychological measurement

Ultimately….

- We are interested in getting a best guess of someone's "true score" is on a test….
- How do we do that?
- Inferential statistics?
- Confidence intervals!
- And then determining what meaningful constructs it may be associated with!

Individual Differences

- **Inter-individual differences - People**
  - A single construct across individuals [*Prediction*]
- **Intra-individual differences** - **Time**
  - A single construct across time [*Maturation*]
- **Intra-individual differences** - **Constructs**
  - Different constructs within the same individual [*Classification*]

Completely Describing a Distribution of Data

- Central Tendency (Mean, Mode, Median)
- Dispersion (Range, IQR, Variance, Std Dev)
- Shape
  - Statistics (Skew, Kurtosis)
  - Graphs (Histogram, Scattergram)
- For individual scores we can look at Standard Scores (Z, T, Percentiles)
  - What makes for a good norm group?

Moments of the Distribution

- **Mean** – 1st moment $$\overline{X} = \frac{\sum X}{N}$$
- **Variance** – 2nd moment $$S^2 = \frac{\sum (X - \overline{X})^2}{N}$$
- **Skew** – 3rd moment $$Skew = \frac{\sum (X - \overline{X})^3 / N}{S^3}$$
- **Kurtosis** – 4th moment $$Kurtosis = \frac{\sum (X - \overline{X})^4 / N}{S^4} - 3$$

Comparing Test Data with Some Criterion of Interest

- ALWAYS create a scatter plot first! Why?
  - Gives direction and estimates strength, but more importantly it…
    - Tells you the nature (shape) of the relationship
    - If any outliers exist
    - Possible subgroups
    - Possible restriction of range
    - Estimates scedasticity

Correlation Coefficients

- Theoretical Correlation Formula

$$r_{xy} = \frac{\sum (X - \overline{X})(Y - \overline{Y})}{\sqrt{[\sum (X - \overline{X})^2][\sum (Y - \overline{Y})^2]}}$$

- Z-Score Correlation Formula

$$r_{xy} = \frac{\sum ZxZy}{N}$$

Correlation Coefficient

- The correlation coefficient is simply a standardized covariance between X and Y
  - You can standardize it by dividing by the two variances or standardize it ahead of time by using Z scores and use the second (simpler) formula

Pearson Product Moment Correlation Coefficient

- Probably the most used (and important) statistic in measurement.
- Why, because it is used in….
  - Reliability Estimates/Standard Error of Measurement
  - Validity Estimates
  - Item Analysis
  - Meta-Analysis
  - Factor Analysis
  - Utility Analysis
  - And much much more …

Factors Affecting the PPM r_{xy}

- Sample size – Stability
- Marginal distributions – Must be similar
- Linearity – Must be at least an asymptote
- Subpopulation – e.g., men versus women
- Homogeneity of Variance – Scedasticity
- Restriction of Range in X or Y
- Unreliability of X or Y

Corrections

- For unreliability $r_{est} = \frac{r_{xy}}{\sqrt{r_{xx} \bullet r_{yy}}}$

- For restriction of range

$$r_{est} = \frac{r_{xy}\left(\frac{s_{est}}{s_x}\right)}{\sqrt{1 - r_{xy}^{\ 2} + r_{xy}^{\ 2}\left(\frac{s_{est}}{s_x}\right)^2}}$$

Correcting for Unreliability in the Criterion Variable

$$r_{T_X T_Y} = \frac{r_{xy}}{\sqrt{r_{xx}}\sqrt{r_{yy}}}$$

$$r_{XT_Y} = \frac{r_{xy}}{\sqrt{r_{yy}}} = \frac{.35}{\sqrt{.74}} = .41$$

Correcting for Restriction of Range in the Criterion Variable

- If GRE and Grad GPA
  - r_{xy} =.10, S_y=.5 and S_{est}=1.5

$$r_{est} = \frac{.10\left(\frac{1.5}{.5}\right)}{\sqrt{1-.01+.01^2\left(\frac{1.5}{.5}\right)^2}} = .289$$

SEM and SEE Example

- Std Error of Measurement: $SEM = S_x \sqrt{1 - r_{yy}}$
- Std. Error of Estimate: $SEE = S_x \sqrt{1 - r^2{}_{yy}}$
- EXAMPLE: Sx = 10, r_{yy}=.71

$$SEM = 10\sqrt{1 - .71} = 10(.5385) = 5.4$$

- **95% CI = X±1.96 (5.4) = X ±10.58**

$$SEE = 10\sqrt{1 - .50} = 10(.7071) = 7.1$$

- **95% CI = X±1.96 (7.1) = X ±13.92**

Alternate Measures of Assoc.

- True Dichotomy
  - Phi
  - Point Biserial
- Underlying Continuum
  - Tetrachoric
  - Biserial

- Spearmans Rho
- Kendall’s Tau
- Eta Coefficient

In Summary

- Inferential statistics less important than descriptive statistics for psychological measurement.
- Correlation coefficients ubiquitous in psychological measurement because of their numerous applications.
- Variety of correlation coefficients are available.
- May need to be "corrected."