

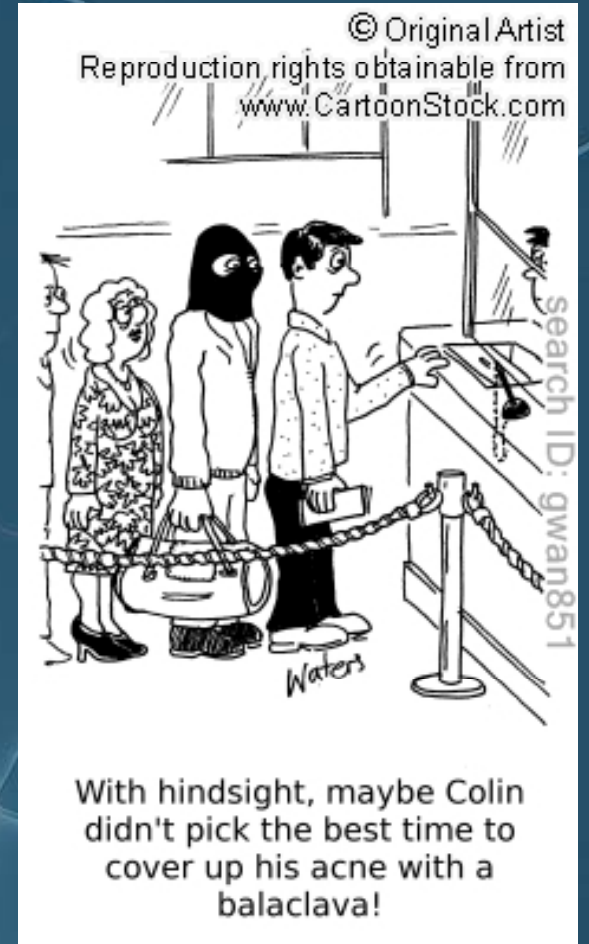
A Priori & Post-Hoc Tests

Statistics



Hindsight is 20-20

- Although your data may suggest a new relationship, and thus new analyses...
- Theory should guide research and thus comparisons should be decided on before you conduct your experiment.





Planned & A Priori Comparisons

- Based on literature review
 - Theoretical
- Planned comparisons
 - *A test that is conducted when there are multiple groups of scores, but specific comparisons have been specified prior to data collection.*
 - A Priori Comparisons



Planned & A Priori Comparisons

- If you have planned comparisons...
 - Just run t tests
 - Subjective Decision about p value
 - $p = .05$?
 - $p = .01$?
 - Bonferroni Correction?



Post-Hoc: Tukey HSD

- Tukey Honestly Significant Difference
 - *Determines differences between means in terms of standard error*
 - 'Honest' because we adjust for making multiple comparisons
 - The HSD is compared to a critical value
 - Overview
 1. Calculate differences between a pair of means
 2. Divide this difference by the standard error

* Basically this is a variant of a *t* test *



Tukey HSD

$$HSD = \frac{(M_1 - M_2)}{S_M}$$

$$t = \frac{(M_1 - M_2)}{S_{Difference}}$$

- For Tukey HSD, standard error is calculated differently depending on whether your sample sizes are equal.



Tukey HSD

- Equal Sample Sizes

$$s_M = \sqrt{\frac{MS_{Within}}{N}}$$

N = Sample size
within each group

- Unequal Sample Sizes

$$s_M = \sqrt{\frac{MS_{Within}}{N'}}$$

$$N' = \frac{N_{Groups}}{\sum \left(\frac{1}{N} \right)}$$



Tukey HSD

- Determine Critical Value from Table
- Make a Decision
- Let's do an example...



Tukey HSD: Example

- We will use the data from our One-Way ANOVA example:
 - Decision: Foreign graduate students in different programs place different importance on financial factors, on average.
 - Where are our differences?



Tukey HSD: Example

Importance Scores					
Arts & Sciences	4	5	4	3	4
Education	4	3	4	4	
Law	3	3	2	3	
Business	4	4	4	3	

SOURCE	SS	df	MS	F
Between	3.866	3	1.289	3.94
Within	4.256	13	0.327	
Total	8.122	16		



Tukey HSD: Example

- Standard Error: Unequal Sample Sizes

$$N' = \frac{N_{Groups}}{\sum \left(\frac{1}{N} \right)}$$

$$s_M = \sqrt{\frac{MS_{Within}}{N'}}$$

$$N' = \frac{4}{\frac{1}{5} + \frac{1}{4} + \frac{1}{4} + \frac{1}{4}} = \frac{4}{.95} = 4.211$$

$$s_M = \sqrt{\frac{.327}{4.211}} = .279$$



Tukey HSD: Example

- Arts & Sciences ($M=4.00$) vs. Education ($M=3.75$)

$$HSD = \frac{(M_1 - M_2)}{s_M} = \frac{(4 - 3.75)}{.279} = .896$$

- Arts & Sciences ($M=4.00$) vs. Business ($M=3.75$)

$$HSD = \frac{(M_1 - M_2)}{s_M} = \frac{(4 - 3.75)}{.279} = .896$$

- Arts & Sciences ($M=4.00$) vs. Law ($M=2.75$)

$$HSD = \frac{(M_1 - M_2)}{s_M} = \frac{(4 - 2.75)}{.279} = 4.480$$



Tukey HSD: Example

- Critical Value

$p = .05$, 4 groups

$df_{\text{within}} = 13$

- A&S—Ed.

$q = .896$

- A&S—Bus.

$q = .896$

- A&S—Law

$q = 4.480$

TABLE 10-13. EXCERPT FROM THE q TABLE

Like the F table, we use the q table to determine critical values for a given p level, based on the number of means being compared and the within groups degrees of freedom. Note that critical values are in regular type for 0.05 and **boldface for 0.01**.

WITHIN-GROUPS DEGREES OF FREEDOM	k = NUMBER OF TREATMENTS (LEVELS)			
	...	3	4	5 ...
· · · 12		3.77 5.05	4.20 5.50	4.51 5.84
13		3.73 4.96	4.15 5.40	4.45 5.73
14		3.70 4.89	4.11 5.32	4.41 5.63
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Tukey HSD: Example

- Make a Decision
 - Foreign graduate students in Arts & Sciences place more importance on financial factors than students in Law but they do not differ from students in either Education or Business.