Neuendorf
Post Hoc Tests–A Primer

(So many to choose from. . .)

Post hoc tests ("after the fact" tests) allow assessments of comparisons among IV groups, after the overall ANOVA-type test of a given effect (main effect or interaction) has been executed.

1. Cumulative Type I Error (α)
   Acknowledges that Type I error can accumulate across tests within a single analysis plan.

   PC (per comparison) error–traditional α, assumes tests are independent
   vs.
   FW (familywise) error:

$$\alpha_{FW} = 1 - (1 - \alpha)^C$$

   where C = # of orthogonal comparisons
   (the calculation for nonorthogonal comparisons is more complex)

2. Planned contrasts vs. Post hocs

   Planned contrasts:
   - A priori
   - Asks "Is this particular difference significant?"
   - Part of the design
   - α_{FW} is typically ignored; α is used, sometimes with a Bonferroni adjustment
   - Maximum #? Keppel says there is no agreement on this. . . ~df_A. . . theory

   Post hocs:
   - A posteriori (actually another name for post hocs. . .)
   - Asks "Which differences are significant?"
   - Not part of the design–often unexpected findings
   - α_{FW} controlled via special evaluation procedures
   - Maximum #? See p. 167 Keppel for a simple formula.

3. Post hoc "Types"

A. *Unrestricted comparisons* after screening via "omnibus F"
If F is significant, then may proceed
Criticized by many, because it doesn't really control α_{FW}
The other types at least try–Keppel calls them "alpha-adjusted techniques"

Example stat procedure–**Fisher's LSD** (as described above–
omnibus F followed by unrestricted comparisons)

B. *All comparisons*, pairwise and complex

Example stat procedure–**Scheffe's test**

Uses regular F, with "special" critical value:

$F_S = (k - 1)F_{crit}$
where k = # of group means

C. *Total set of pairwise comparisons*
Possible # = (a)(a-1)/2

Example stat procedure–**Tukey test** (one of Tukey's many contributions)

Finds the minimum pairwise difference between means that must be exceeded to be significant with the Tukey test:

$$\bar{d}_T = q_T \sqrt{\frac{MS_{S/A}}{n}}$$

where q_T = an entry in the table of the studentized range statistic
$MS_{S/A}$ = the error term for the overall ANOVA
n = the sample size for each group

Example stat procedures–see also the **Newman-Keuls procedure** and the similar **Duncan procedure** as described by Winer (1971)

D. *Comparing one group to all others*
e.g., Control group vs. several experimental groups

Example stat procedure–**Dunnett test**

Calculates the control-experimental mean differences and compares them against a critical mean difference ($\bar{d}_D$) that must be exceeded to be significant:

$$\bar{d}_D = q_D\sqrt{\frac{2(MS_{S/A})}{n}}$$

where q_D = an entry in the Dunnett table (see Keppel)
$MS_{S/A}$ = the error term for the overall ANOVA
n = the sample size for each group

4. An all-purpose test? An easy way out? The **Bonferroni technique:**

$\alpha_{BON} = \alpha_{FW}$ / # of tests

Hair et al. apply this to k-groups as a post hoc.
Keppel applies this to multiple planned contrasts.

OR, Garson's online version:

$\alpha_{BON} = 1 - (1 - \alpha 1)(1 - \alpha 2)(1 - \alpha 3) \ldots (1 - \alpha n)$

where α1 to αn are the set levels of alpha for a series of tests. For example, a series of 4 tests at alpha = .01 would use a Bonferroni corrected alpha criterion of $1 - .99^4 = .039$. (This is equivalent to the FW (familywise) error formula on p. 1.)

<u>Graphical representations for selected contrasts and post hoc families</u>:

Assume this 4-group IV:	Married	Separated/ Divorced	Widowed	Never Been Married
	1	2	3	4

2. Planned contrast (e.g.)

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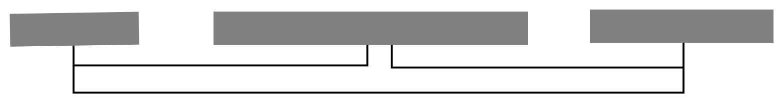
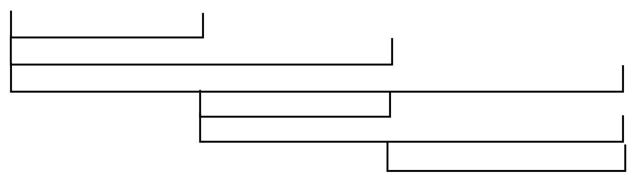
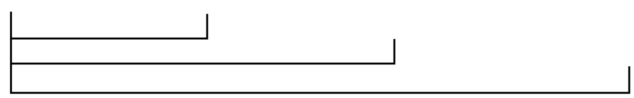


3. C. Total set of pairwise comparisons



3. D. Comparing one group to all others (e.g.)



3. A. & B. –too complex to draw here

<u>References</u>

Keppel, G. (1991). *Design and analysis: A researcher's handbook* (3rd ed.). Englewood Cliffs, NJ: Prentice Hall.

Winer, B. J. (1971). *Statistical principles in experimental design* (2nd ed.). New York: McGraw-Hill Book Company.

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