13 A | 3. Pair-wise Post-hoc t tests

In exercise 12A5, the introversion means and standard deviations for students seated in three classroom locations (**n = 80 per group**) were as follows:

	Front	Middle	Back
M	28.7	34.3	37.2
SD	11.2	12.0	13.5

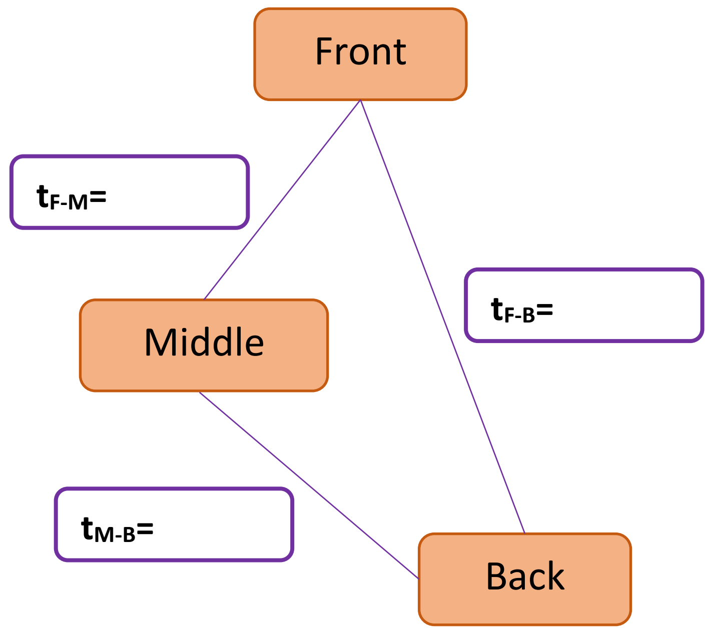
a) Use formula 13.4 to calculate a t value for each pair of means.

Formula 12.5B

$$MS_{WithGrp} = \frac{\sum_{i=1}^{k} s_i^2}{k}$$

Formula 13.4

$$t_{pair} = \frac{\bar{x}_i - \bar{x}_j}{\sqrt{\frac{2MS_w}{n}}}$$



b) Which of these t values exceed the critical t based on df_w, with alpha = .05? (table A.2)

Formula 12.4

$$df_{WithGrp} = n_T - k$$

t_{CV} (______) = ____________

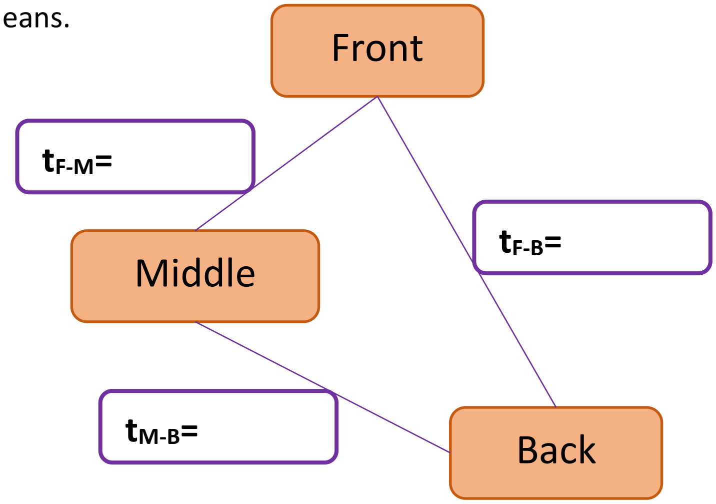
13	A	4.Effect on Pair-wise Post-hoc t tests – 2x SD

Assume the **standard deviations** from exercise 3 were **doubled**.

a) Recalculate the t value for each pair of means.

Formula 12.5B

$$MS_{WithGrp} = \frac{\sum_{i=1}^{k} s_i^2}{k}$$



Formula 13.4

$$t_{pair} = \frac{\bar{x}_i - \bar{x}_j}{\sqrt{\frac{2MS_w}{n}}}$$

b) Which of these t values NOW exceed the critical t?

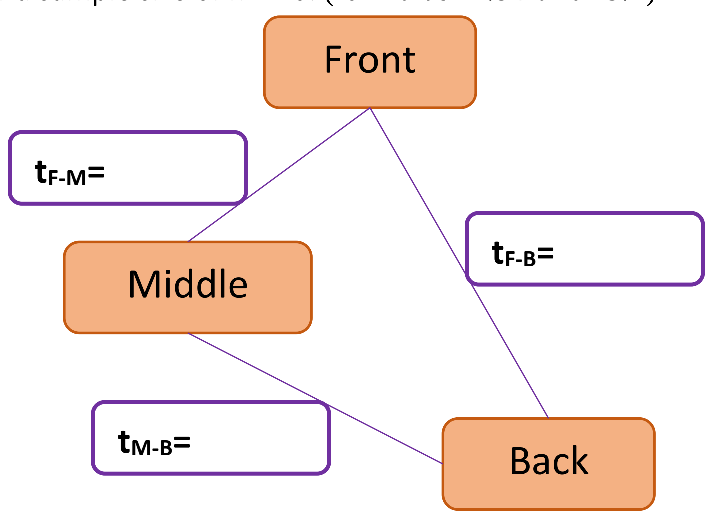
c) What is the effect on the t value of **doubling the standard deviations**?

13	A	5.Effect on Pair-wise Post-hoc t tests – ¼ sample size

a) Recalculate the t values from exercise 3 for a sample size of n = 20. (formulas 12.5B and 13.4)

Formula 12.5B

$$MS_{WithGrp} = \frac{\sum_{i=1}^{k} s_i^2}{k}$$



Formula 13.4

$$t_{pair} = \frac{\bar{x}_i - \bar{x}_j}{\sqrt{\frac{2MS_w}{n}}}$$

b) What is the effect on the t value of **dividing the sample size by 4?**

13	B	3.Fisher's LSD & Tuekey's HSD corrections & Conf Intervals

In exercise 12A7, the following means and standard deviations were given as the hypothetical results of an experiment involving the effects of four different drugs (**n = 8 subjects per group**):

	Marijuana	Amphetamine	Valium	Alcohol
M	7	8	5	4
SD	3.25	3.95	3.16	2.07

a) Calculate Fisher's LSD (alpha = .05), whether or not it is permissible. (see page 3 for the MS_w)

Formula 12.4
$$df_{WithGrp} = n_T - k$$

Formula 13.7
$$LSD = t_{CV}\sqrt{\frac{2MS_w}{n}}$$

t_{CV} (_____) = ___________

Fisher'S LSD =

b) Calculate Tukey's HSD (alpha = .05).

q_{CV} (_____ , _____) = ___________

Formula 13.8
$$HSD = q_{CV}\sqrt{\frac{MS_w}{n}}$$

Tukey's HSD =

c) Use HSD to construct **95% Cis** for each pair of drug conditions.

Marijuana vs. Amphetamine = _________ , _________

Marijuana vs. Valium = _________ , _________

Marijuana vs. Alcohol = _________ , _________

Amphetamine vs. Valium = _________ , _________

Amphetamine vs. Alcohol = _________ , _________

Valium vs. Alcohol = _________ , _________

13	B	4.LSD & HSD – effect of doubling sample size

Recalculate Fisher's LSD and Tukey's HSD for the data in exercise 3, assuming that the number of **subjects per group was 16**. (formula 12.4, tables A.2 & A.11, formulas 13.7 & 13.8)

Formula 12.4
$$df_{WithGrp} = n_T - k$$

Formula 13.7
$$LSD = t_{CV}\sqrt{\frac{2MS_W}{n}}$$

t_{CV} (______) = ____________

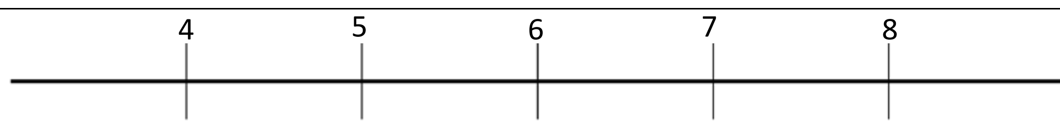
Formula 13.8
$$HSD = q_{CV}\sqrt{\frac{MS_W}{n}}$$

q_{CV} (______ , ______) = ____________

Fisher's LSD =

Tukey's HSD =

a) What effect does **increasing the number of subjects** have on the size of LSD and HSD?



b) What conclusions can you draw from the LSD test?

c) Does the conclusion from Tukey's HSD differ?

d) Which test is recommended in the four-group case and why?

13	B	8. HSD with FIVE groups & modified LSD

In exercise 12B1, an experiment involving five different antidepressants yielded the following means and standard deviations:

	1	2	3	4	5
M	23	30	34	29	26
SD	6.5	7.2	7	5.8	6

a) Assuming that none of the original subjects were lost (i.e. n = 15), calculate Tukey's HSD for this experiment.

Formula 12.4

$$df_{WithGrp} = n_T - k$$

Formula 12.5B

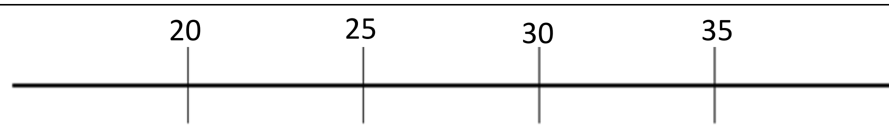
$$MS_{WithGrp} = \frac{\sum_{i=1}^{k} s_i^2}{k}$$

Formula 13.8

$$HSD = q_{CV}\sqrt{\frac{MS_w}{n}}$$

q_{CV} (_____ , _____) = ___________

Tukey's HSD =



b) Which pairs of means differ significantly?

e) Calculate the modified LSD. (pages 424-425)

Formula 12.4

$$df_{BetGrp} = k - 1$$
$$df_{WithGrp} = n_T - k$$

$$mod\ LSD = q_{CV}\sqrt{\frac{MS_w}{n}}$$

q_{CV} (_____ , _____) = ___________

Modified Fisher's LSD =

Would using this test change your answer to part b?

13	C	1. LSD & Tukey post-hoc tests	Code: R notebook	*(exclude 1b)*

a) Redo the one-way ANOVA requested in Exercise #1 of the previous chapter selecting both LSD and Tukey as Post Hoc tests.

For postquiz heart rate, which pairs of experimental conditions differ significantly from each other, according to each test.

Fisher's LSD *(adjust = "none")*	**Tukey's HSD** *(adjust = "tukey")*

Can you justify using the results of the LSD test?

c) Perform a contrast to compare the "impossible" condition with the other three for postquiz heart rate

Contrast: t(_____) = _________, p = _______

How does the significance of this contrast compare to the one-way ANOVA? Explain.

Looking at the means for the four conditions, design a contrast that you think would capture a large portion of the between-group variance.

13	C	2.post-hoc all tests vs. planned comparisons	Code: R notebook

a) Redo the one-way ANOVA requested in Exercise #2 of the previous chapter just for the **mathquiz** variable, TWICE: once with **Tukey** and once with **Bonferroni** as post hoc tests in each case.

b)
Why is it problematic to use HSD with major as the factor in this dataset?

Given the results of the post hoc tests, does the Tukey or Bonferroni test seem to have greater power when testing all possible pairs of means?

Tukey's HSD *(adjust = "tukey")*	**Bonferroni** *(adjust = "bon")*

c) Redo the one-way ANOVA requested in Exercise 2 of the previous chapter just for the **statquiz** variable, and request a **contrast** that compares the **average** of the biology and sociology majors to the average of the other three majors.

Contrast: t(___) = _________, p = _______

Would this contrast be significant if it had been planned?

- ☐ *Yes*
- ☐ *No*

Would this contrast be significant according to Scheffé's test? (formula 13.16)

$F = t^2$

F =

Formula 13.16 (1-way)
$F_s = (k-1)F_{cv}(k-1, n_T - k)$

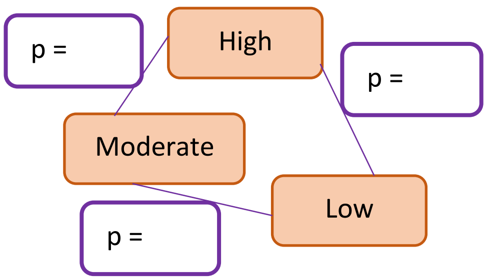
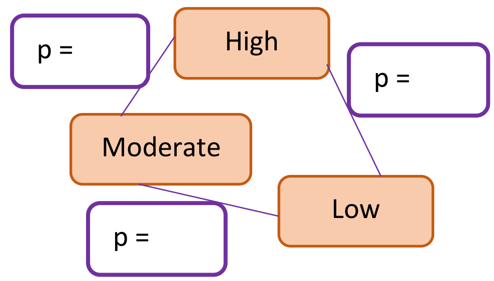
$F_{Scheffe}$ =

- ☐ *Yes*
- ☐ *No*

13 C 4. post-hoc all tests & contrasts **Code: R notebook**

a) Perform a one-way ANOVA on the **pre-quiz anxiety** measurement (anx_pre) using **the grouping variable** (phob_group) you created in Exercise 5 of the previous chapter (based on phobia ratings). Select both LSD and Bonferroni as your post hoc tests.

Which pairs differ significantly for each test?

Fisher's LSD *(adjust = "none")*	**Bonferroni** *(adjust = "bon")*
	

b) Perform a **contrast** that compares students who had reported **low or moderate** phobia with those reporting **high** phobia.

Calculate the **effect size** for this contrast. *(hint: use formula 13.9 to find the harmonic mean of the 3 sample sizes (n_H = 31.80165) & then use formula 8.5 to find the effect size)*

Contrast: t(_____) = _________, p = _______

Formula 13.9

$$n_H = k \frac{1}{\sum_{i=1}^{k} 1/n_i}$$

Formula 8.5

$$g = t\sqrt{\frac{2}{n}}$$

g =

Is it small, medium, or large? *(Cohen's guide lines are on page 242)*

- ☐ *Strong*
- ☐ *Medium*
- ☐ *Weak*