Psych 216: Elementary Statistics
Dr. Crutcher

HW # 12

revised 03-25-13

[Note: Not all probs show descriptives - e.g. figures]

(10) What is the effect of discrepancy on change in attitudes?

SIZE OF DISCREPANCY

SMALL	MODERATE	LARGE
	3	0
1	4	2
0	6	0
0	3	4
2	5	0
3	3	0
0		
$T_1 = 6$	$T_2 = 24$	$T_3 = 6$
$n_1 = 6$	$n_2 = 6$	$n_3 = 6$
$\bar{X}_1 = 1$	$\bar{X}_2 = 4$	$\bar{X}_3 = 1$
$SS_1 = 8$	$SS_2 = 8$	$SS_3 = 14$

$N = 18$

$G = 36$

$\sum x^2 = 138$

$$SS_1 = \sum x^2 - \frac{(\sum x)^2}{n} = 14 - \frac{6^2}{6} = 8$$

$$SS_2 = \sum x^2 - \frac{(\sum x)^2}{n} = 104 - \frac{24^2}{6} = 8$$

$$SS_3 = \sum x^2 - \frac{(\sum x)^2}{n} = 20 - \frac{6^2}{6} = 14$$

Step 1 Set-up hypotheses

$H_0: \mu_1 = \mu_2 = \mu_3$ (The size of discrepancy has no effect on attitude change)

H_1: At least one pop. mean is different (The size of the discrepancy has an effect ...)

$\alpha = .05$

Step 2 Define critical region

$df_{TOTAL} = N-1 = 18-1 = 17$

$df_{Bet\,treat} = K-1 = 3-1 = 2$

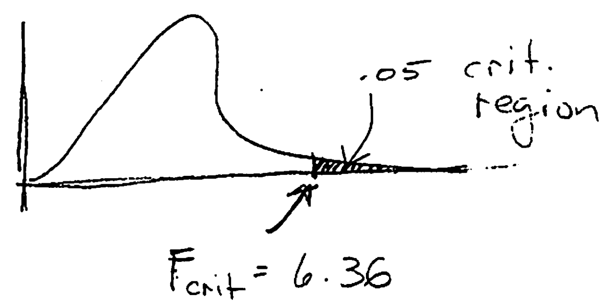
$df_{within\,treat} = N-K = 18-3 = 15$

Source	SS	df	MS	F
Bet Treat.	36	2	18	F(2,15) = 9.00
Within Treat.	30	15	2	
Total	66	17		

p<.05 ✓

$F_{crit}(2, 15) = 6.36$

$\alpha = .05$



Step 3 Collect sample data

$$F_{obt} = \frac{MS_{Bet.}}{MS_{within}} = \frac{\frac{SS_{Bet}}{df_{Bet}}}{\frac{SS_{within}}{df_{within}}}$$

$$SS_{TOTAL} = \sum x^2 - \frac{G^2}{N} = 138 - \frac{36^2}{18}$$

$$= 138 - 72$$

$$= \boxed{66}$$

$$SS_{Bet.} = \sum \frac{T^2}{n} - \frac{G^2}{N} = \left[\frac{6^2}{6} + \frac{24^2}{6} + \frac{6^2}{6}\right] - 72$$

$$= [6 + 96 + 6] - 72 = 108 - 72 = \boxed{36}$$

$$SS_{within} = SS_1 + SS_2 + SS_3 = 8 + 8 + 14 = \boxed{30}$$

$$F_{obt}(2,15) = \frac{\frac{36}{2}}{\frac{30}{15}} = \frac{18}{2} = 9.00$$

Step 4 Decision.

Reject H_0 because F_{obt} of 9.00 > F_{crit} of 6.36

Step 5 Conclusion The size of the discrepancy between original attitude and the persuasive argument significantly affects the amount of attitude change, $F(2, 15) = 9.00$, $MSE = 2.0$, $p < .01$.

Part 6) Interesting result. A small or large discrepancy between original attitude & the persuasive argument does not change attitude much ($M=1$ and $M=1$). However a moderate discrepancy produces a much larger attitude change ($M=4$).

(for the post hoc test see the next page)

(10) (cont.)

$$HSD = q\sqrt{\frac{MS_{within}}{n}} \qquad HSD = 4.84\sqrt{\frac{2}{6}}$$

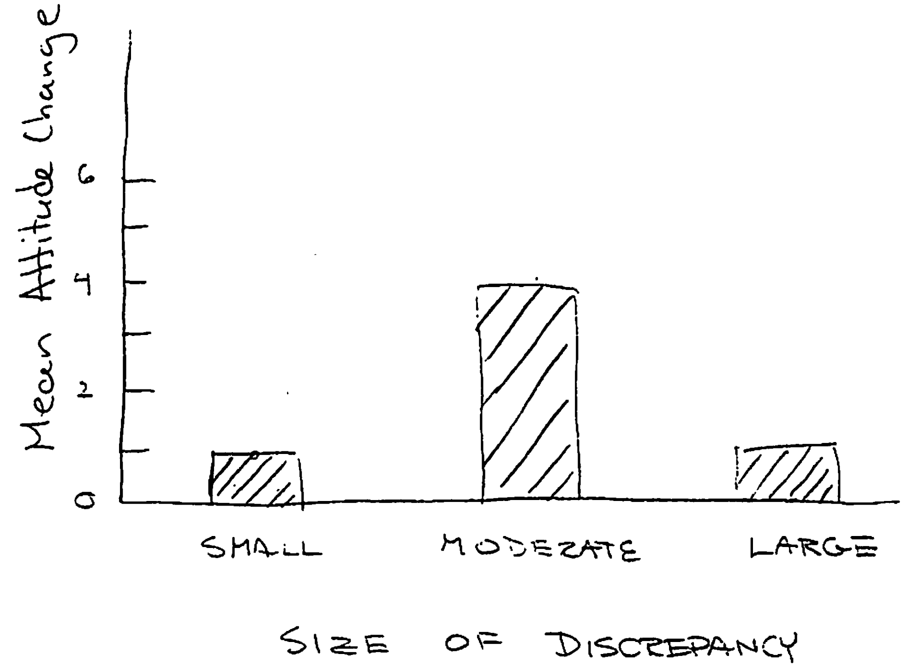
$$= 4.84\sqrt{.3333} \approx (4.84)(.5773)$$

$$\approx 2.79$$

1) small discrepancy (M=1) vs. moderate discrep. (M=4) ✓
2) small " " (M = 1) vs. large " " (M = 1) n.s.
3) moderate " " (M = 4) vs. large " " (M = 1) ✓

Conclusion. Given the overall significant effect of discrepancy on attitude change, post hoc tests using an HSD test were performed. Moderate discrepancy produced significantly more attitude change on average (M = 4 points) than either a small discrepancy (M = 1) or a large discrepancy (M = 1). There was no significant attitude change for the small discrepancy (M=1) vs. large discrepancy conditions (M=1).

10 cont.



16 Testing the effect of music on the growth of plants

24 plants
$n = 6$ in each group

Source	SS	df	MS	
Bet Treatments	30	3	10	$F(3,20) = \frac{10}{2} = 5.00$
Within Treat.	40	20	2	
Total	70	23		

if 24 plants $df_{TOTAL} = N-1 = 24-1 = 23$

6 plants in each group (treatment) $df_{within} = N-K = 24-4 = 20$

i.e. $df_{Bet} = K-1 = 4-1 = 3$

$$\frac{SS_{Bet}}{df_{Bet}} = MS_B$$

$$\frac{SS_B}{3} = 10 \qquad \therefore \; SS_B = 30$$

(19)

Treatment 1	Treatment 2
1	5
2	4
2	3
4	2
1	6
$T_1 = 10$	$T_2 = 20$
$n_1 = 5$	$n_2 = 5$
$\bar{x}_1 = 2$	$\bar{x}_2 = 4$
$SS_1 = 6$	$SS_2 = 10$

$\Sigma x^2 = 116$
$N = 10$
$G = 30$

$$SS_1 = \Sigma x^2 - \frac{(\Sigma x)^2}{n} = 26 - \frac{10^2}{5} = 26 - 20 = \boxed{6}$$

$$SS_2 = \Sigma x^2 - \frac{(\Sigma x)^2}{n} = 90 - \frac{20^2}{5} = 90 - 80 = \boxed{10}$$

a) ANOVA

Step 1: $H_0: \mu_1 = \mu_2$ (No diff bet treatment pop means)

$H_1: \mu_1 \neq \mu_2$ (There is a diff...)

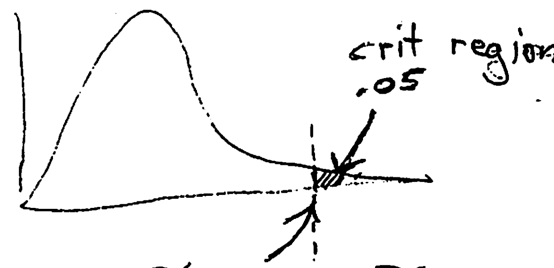
$\alpha = .05$

Step 2 Define crit region

$df_{TOTAL} = N-1 = 10-1 = 9$

$df_{Bet} = K-1 = 2-1 = 1$

$df_{within} = N-K = 10-2 = 8$



$F_{crit}(1, 8) = 5.32$ $\alpha = .05$

Source	SS	df	MS	F	p<.05
Bet treat.	10	1	10	F(1,8) = 5.00	n.s.
Within treat.	16	8	2		
Total	26	9			

Step 3 Obtain sample data & compute statistic

$$F_{obt} = \frac{MS_{Bet}}{MS_{within}} = \frac{SS_B/df_B}{SS_{within}/df_{within}}$$

$$SS_{TOTAL} = \Sigma X^2 - \frac{G^2}{N} = 116 - \frac{30^2}{10}$$

$$= 116 - 90 = \boxed{26}$$

$$SS_{Bet.} = \Sigma \frac{T^2}{n} - \frac{G^2}{N} = \left[\frac{10^2}{5} + \frac{20^2}{5}\right] - 90$$

$$= [20 + 80] - 90 = \boxed{10}$$

$$SS_{within} = SS_1 + SS_2 = 6 + 10 = \boxed{16}$$

$$F_{obt}(2,10) = \frac{10}{2} = 5.00$$

* No need to report MSE when F not signif.

Step 4 Retain H_0 (F_{obt} of $5.00 < F_{crit}$ of 5.32). No signif diff between treatment pop means, $F(1,8) = 5.00$, $p > .05$.

19 b) t-test

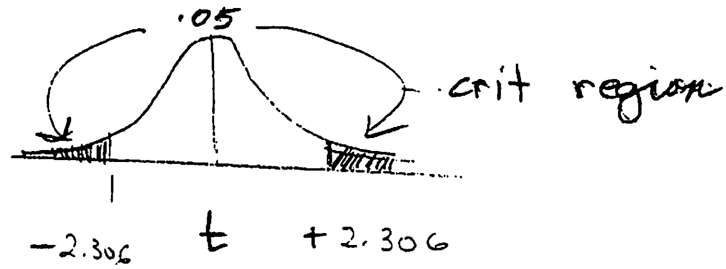
Step 1 Same as for ANOVA

Step 2 Crit region $\quad df = df_1 + df_2 = 4 + 4 = 8$

$t > +2.306$

or

$t < -2.306$



Step 3

$$t_{obt} = \frac{(\bar{X}_1 - \bar{X}_2) - (\mu_1 - \mu_2)}{s_{\bar{X}_1 - \bar{X}_2}}$$

$$= \frac{2-4}{.894427191}$$

$$= -2.236067978$$

$$s_{\bar{X}_1-\bar{X}_2} = \sqrt{\frac{s_p^2}{n_1} + \frac{s_p^2}{n_2}}$$

$$s_p^2 = \frac{SS_1 + SS_2}{df_1 + df_2}$$

$$= \frac{6+10}{4+4} = \frac{16}{8} = 2$$

$$s_{\bar{X}_1-\bar{X}_2} = \sqrt{\frac{2}{5} + \frac{2}{5}}$$

$$= \sqrt{4/5}$$

$$= .8944$$

Step 4 Retain Ho. b/c t obt of -2.236 does not fall in critical region. Conclusion: No signif diff bet pop treatment means, $t(8) = -2.236,\ p > .05$.

$$F \stackrel{?}{=} t^2$$

$$5.00 \stackrel{?}{=} (-2.236067978)^2$$

$$5.00 = 5.00 \checkmark$$

(21) Language skills for single children versus twins, versus triplets

Language Skill

Single Child	Twin	Triplet
8	4	4
7	6	4
10	7	7
6	4	2
9	9	3
$T_1 = 40$	$T_2 = 30$	$T_3 = 20$
$n_1 = 5$	$n_3 = 5$	$n_3 = 5$
$\bar{X}_1 = 8$	$\bar{X}_2 = 6$	$\bar{X}_3 = 4$
$SS_1 = 10$	$SS_2 = 18$	$SS_3 = 14$

$\Sigma x^2 \;\; 622$

$G = 90$

$N = 15$

$$SS_3 = \Sigma x^2 - \frac{(\Sigma x)^2}{n} = 94 - \frac{20^2}{5} = 94 - 80 = 14$$

$$SS_1 = \Sigma x^2 - \frac{(\Sigma x)^2}{n} = 330 - \frac{40^2}{5} = 330 - 320 = 10$$

$$SS_2 = \Sigma x^2 - \frac{(\Sigma x)^2}{n} = 198 - \frac{(30)^2}{5} = 198 - 180 = 18$$

Step 1 Hypotheses

$H_0: \mu_1 = \mu_2 = \mu_3$ (No difference in lang skill for single children, twins, & triplets)

H_1: At least one pop treatment mean is different

$\alpha = .05$.

Step 2 Crit region

$df_{TOTAL} = N - 1 = 15 - 1 = 14$

$df_{Bet} = K - 1 = 3 - 1 = 2$

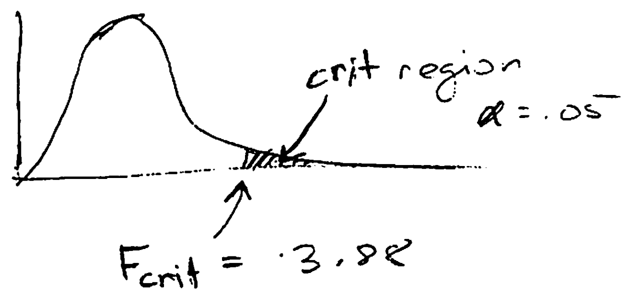
$df_{within} = N - K = 15 - 3 = 12$

$F_{crit}(2, 12) = 3.88$

Source	SS	df	MS	F
Bet treat	40	2	20	$F(2,12) = 5.714$
Within Treat.	42	12	3.5	
Total	82	14		

$p < .05$

✓



Step 3 Obtain sample statistic

$$F(2,12) = \frac{MS_{Bet.tr.}}{MS_{within}}$$

$$SS_{TOTAL} = \Sigma X^2 - \frac{G^2}{N}$$

$$= 622 - \frac{90^2}{15} = 622 - 540 = \boxed{82}$$

$$SS_{Bet.} = \Sigma \frac{T^2}{n} - \frac{G^2}{N} = \left[\frac{40^2}{5} + \frac{30^2}{5} + \frac{20^2}{5}\right] - 540$$

$$= [320 + 180 + 80] - 540 = 580 - 540 = \boxed{40}$$

$$SS_{within} = SS_1 + SS_2 + SS_3 = 10 + 18 + 14 = \boxed{42}$$

$$F(2,12) = \frac{SS_{Bet}/df_{Bet.}}{SS_{within}/df_{within}} = \frac{40/2}{42/12} = \frac{20}{3.5} = \boxed{5.714}$$

$\boxed{\text{Step 4}}$ Reject Ho F_{obt} of 5.714 exceeds F_{crit} of 3.88

$\boxed{\text{Step 5}}$ Conclusion: There is an overall signif difference in language skills amongst single children, twins, & triplets, $F(2, 12) = 5.714$, $MSE = 3.5$, $p < .05$

Post hoc using Tukey's HSD $\alpha = .05$

$$HSD = q\sqrt{\frac{MS_{within}}{n}} = q\sqrt{\frac{3.5}{5}} = 3.77\sqrt{.7} = (3.77)(.837)$$
$$\approx 3.16 \text{ or } 3.2$$

1. single child lang skills (M = 8) vs. twins (M = 6) n.s.
2. " " " " (M = 8) vs. triplets (M = 4) ✓
3. twins lang skills (M = 6) vs. triplets (M = 4) n.s.

Using an HSD post hoc procedure (HSD = 3.2, $p < .05$), a series of post hoc comparisons were performed. These showed that the language skills of single children (M = 8) were significantly better than those of triplets (M = 4). However, there was no significant difference between the language skills of single children and twins, nor between the language skills of twins and triplets.

(22) Correlation of Personality Type (Alpha Beta, Gamma) and health.

Alphas		Betas		Gammas	
43	44	41	52	36	29
41	56	40	57	38	36
49	42	36	48	45	42
52	53	51	55	25	40
41	21	52	39	41	36

$N = 30$

$G = 1281$

$\sum x^2 = 56955$

$T_1 = 442$ $SS_1 = 865.6$
$n_1 = 10$
$\bar{x}_1 = 44.2$

$T_2 = 471$
$n_2 = 10$ $\bar{X}_2 = 47.1$
$SS_2 = 500.9$

$T_3 = 368$ $\bar{X}_3 = 36.8$
$n_1 = 10$
$SS_3 = 325.6$

$$SS_1 = \sum x^2 - \frac{(\sum x)^2}{n} = 20402 - \frac{442}{10}$$
$$= 20402 - 19536.4$$
$$= \boxed{865.6}$$

$$SS_2 = \sum x^2 = \frac{(\sum x)^2}{n} = 22685 - \frac{(471)^2}{10} = 22685 - 22184.1$$
$$= 500.9$$

$$SS_3 = \sum x^2 - \frac{\sum x)^2}{n} = 13868 - \frac{368^2}{10} = 13868 - 13542.4$$
$$= 1325.6$$

$\boxed{\text{Step 1}}$ Hypotheses

$H_0: \mu_1 = \mu_2 = \mu_3$ (No correlation between personality type and health scores)

H_1 at least one pop group's health scores are different from one of the others)

$\alpha = .05$

Step 2 Define critical values

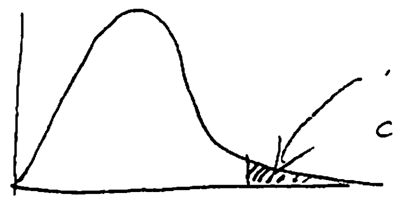
$df_{TOTAL} = N-1 = 30-1 = 29$

$df_{Bet.} = K-1 = 3-1 = 2$

$df_{within} = N-K = 30-3 = 27$

Source	SS	df	MS	F	$p<.05$
Bet. Treat.	564.2	2	282.1	$F(2,27) = 4.50$	✓
Within Treat.	1692.1	27	62.67		
Total Treat.	2256.3	29			

$F_{crit}(2,27) = 3.35$



.05 crit. region

$F_{crit} = 3.35$

Step 3 Sample statistic

$$F_{obt}(2,27) = \frac{MS_{Bet.}}{MS_{within}}$$

$$MS_{Bet} = \frac{SS_{Bet}}{df_{Bet}}$$

$$MS_{within} = \frac{SS_{within}}{df_{within}}$$

$$SS_{TOTAL} = \Sigma X^2 - \frac{G^2}{N} = 56955 - \frac{1281^2}{30}$$
$$= 56955 - 54698.7$$
$$= 2256.3$$

$$SS_{Bet.\,Treat.} = \Sigma\frac{T^2}{n} - \frac{G^2}{N} = \left[\frac{442^2}{10} + \frac{471^2}{10} + \frac{368^2}{10}\right] - 54698.7$$
$$= [19536.4 + 22184.1 + 13542.4] - 54698.7$$
$$= 55262.9 - 54698.7$$
$$= 564.2$$

$$\boxed{F(2,27) = 4.50}$$

$$SS_{within} = SS_1 + SS_2 + SS_3 = 865.6 + 500.9 + 325.6$$
$$= 1692.1$$

Step 4: Reject H_0 because F_{obt} of 4.50 is $> F_{crit}$ of 3.35

Step 5: Conclusion: Health scores were overall significantly different for the 3 personality groups, $F(2, 27) = 4.50$, $MSE = 62.67$, $p < .05$

Post hoc tests $HSD = q\sqrt{\frac{MS_{within}}{n}} = 3.53\sqrt{\frac{62.67}{10}} = 3.53\sqrt{6.267}$

$= (3.53)(2.50) = \boxed{8.8}$

1. Alpha health ($M = 44.2$) vs. Beta's health ($M = 47.1$) n.s.
2. " " ($M = 44.2$) vs. Gamma's health ($M = 36.8$) n.s.
3. Beta's health ($M = 47.1$) vs. Gamma's health ($M = 36.8$) ✓

Given the overall effect of personality type on health, post hoc tests using an HSD procedure ($HSD = 8.8$, $p < .05$) were conducted. These comparisons showed a significant difference in health only between the Betas ($M = 47.1$) and the Gammas ($M = 36.8$). Neither of the other two comparisons showed a significant difference.