

Psy 420 – Midterm 2
Part 2 (Version A) – In lab (50 points total)

A researcher wants to know if memory is improved by repetition (Duh!). So he shows a group of five participants a list of 30 words at for different time points. At each time point the participants are given a free recall task. The number of words recalled at each trial is recorded below for each participant.

	Time 1	Time 2	Time 3	Time 4
S ₁	10	18	20	26
S ₂	16	24	26	31
S ₃	10	18	19	28
S ₄	16	24	24	30
S ₅	13	21	21	29

Memory over time study

Within-Subjects Factors

Measure: MEASURE_1

TIME	Dependent Variable
1	TIME1
2	TIME2
3	TIME3
4	TIME4

Descriptive Statistics

	Mean	Std. Deviation	N
TIME1	13.0000	3.00000	5
TIME2	21.0000	3.00000	5
TIME3	22.0000	2.91548	5
TIME4	28.8000	1.92354	5

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
TIME	Sphericity Assumed	628.400	3	209.467	276.220	.000	.986
	Greenhouse-Geisser	628.400	1.704	368.875	276.220	.000	.986
	Huynh-Feldt	628.400	2.838	221.407	276.220	.000	.986
	Lower-bound	628.400	1.000	628.400	276.220	.000	.986
Error(TIME)	Sphericity Assumed	9.100	12	.758			
	Greenhouse-Geisser	9.100	6.814	1.335			
	Huynh-Feldt	9.100	11.353	.802			
	Lower-bound	9.100	4.000	2.275			

Tests of Within-Subjects Contrasts

Measure: MEASURE_1

Source	TIME	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
TIME	Linear	585.640	1	585.640	525.238	.000	.992
	Quadratic	1.800	1	1.800	2.667	.178	.400
	Cubic	40.960	1	40.960	84.454	.001	.955
Error(TIME)	Linear	4.460	4	1.115			
	Quadratic	2.700	4	.675			
	Cubic	1.940	4	.485			

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	8988.800	1	8988.800	321.891	.000	.988
Error	111.700	4	27.925			

- 1. Based on the output is (Time1 and Time 4) vs. (Time 2 and Time 3) a significant comparison? How do you know (it's right in front of you so think about it)? And how much percent of variance is accounted for by this comparison? No calculations involved. (2 points)**

- 2. Perform a comparison of (Time 1 and Time 2) vs. (Time 3 and Time 4) by hand and test it for significance. Show all work. (6 points)**

The pharmaceutical companies are trying to figure out which is the best medication to treat erectile dysfunction (ED), Viagra (Drug 1) and Levitra (Drug 2). An independent company conducts clinical trials to test the treatments using three trials per treatment with 10 participants. Scores indicate the number of hours that the “treatment” lasted.

	Viagra			Levitra		
	T1	T2	T3	T1	T2	T3
S ₁	11	14	15	23	22	19
S ₂	7	11	12	19	18	14
S ₃	6	11	11	19	19	14
S ₄	6	10	11	20	19	14
S ₅	8	13	13	21	21	16
S ₆	7	11	10	20	20	16
S ₇	16	20	21	28	28	23
S ₈	7	12	13	22	21	16
S ₉	9	14	14	22	22	18
S ₁₀	12	15	17	24	23	19

Output for Drug by Trial Study

Within-Subjects Factors

Measure: MEASURE_1

DRUG	TRIAL	Dependent Variable
1	1	VT1
	2	VT2
	3	VT3
2	1	LT1
	2	LT2
	3	LT3

Mauchly's Test of Sphericity^b

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon ^a		
					Greenhouse-Geisser	Huynh-Feldt	Lower-bound
DRUG	1.000	.000	0	.	1.000	1.000	1.000
TRIAL	.546	4.840	2	.089	.688	.771	.500
DRUG * TRIAL	.428	6.785	2	.034	.636	.694	.500

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

b.

Design: Intercept

Within Subjects Design: DRUG+TRIAL+DRUG*TRIAL

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
DRUG	Sphericity Assumed	984.150	1	984.150	1152.800	.000	.992
	Greenhouse-Geisser	984.150	1.000	984.150	1152.800	.000	.992
	Huynh-Feldt	984.150	1.000	984.150	1152.800	.000	.992
	Lower-bound	984.150	1.000	984.150	1152.800	.000	.992
Error(DRUG)	Sphericity Assumed	7.683	9	.854			
	Greenhouse-Geisser	7.683	9.000	.854			
	Huynh-Feldt	7.683	9.000	.854			
	Lower-bound	7.683	9.000	.854			
TRIAL	Sphericity Assumed	46.900	2	23.450	95.211	.000	.914
	Greenhouse-Geisser	46.900	1.376	34.094	95.211	.000	.914
	Huynh-Feldt	46.900	1.542	30.417	95.211	.000	.914
	Lower-bound	46.900	1.000	46.900	95.211	.000	.914
Error(TRIAL)	Sphericity Assumed	4.433	18	.246			
	Greenhouse-Geisser	4.433	12.381	.358			
	Huynh-Feldt	4.433	13.877	.319			
	Lower-bound	4.433	9.000	.493			
DRUG * TRIAL	Sphericity Assumed	235.300	2	117.650	394.602	.000	.978
	Greenhouse-Geisser	235.300	1.272	184.919	394.602	.000	.978
	Huynh-Feldt	235.300	1.388	169.546	394.602	.000	.978
	Lower-bound	235.300	1.000	235.300	394.602	.000	.978
Error(DRUG*TRIAL)	Sphericity Assumed	5.367	18	.298			
	Greenhouse-Geisser	5.367	11.452	.469			
	Huynh-Feldt	5.367	12.490	.430			
	Lower-bound	5.367	9.000	.596			

Tests of Within-Subjects Contrasts

Measure: MEASURE_1

Source	DRUG	TRIAL	SS	df	MS	F	Sig.	Partial Eta Squared
TRIAL		Trial 1 vs. Trial 2	68.450	1	68.450	101.826	.000	.919
		Trial 2 vs. Trial 3	72.200	1	72.200	112.034	.000	.926
Error(TRIAL)		Trial 1 vs. Trial 2	6.050	9	.672			
		Trial 2 vs. Trial 3	5.800	9	.644			

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	5088.050	1	5088.050	295.425	.000	.970
Error	155.006	9	17.223			

Estimated Marginal Means

1. DRUG

Measure: MEASURE_1

DRUG	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
1	11.900	.985	9.671	14.129
2	20.000	.883	18.002	21.998

2. TRIAL

Measure: MEASURE_1

TRIAL	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
1	15.350	.931	13.244	17.456
2	17.200	.904	15.154	19.246
3	15.300	.961	13.126	17.474

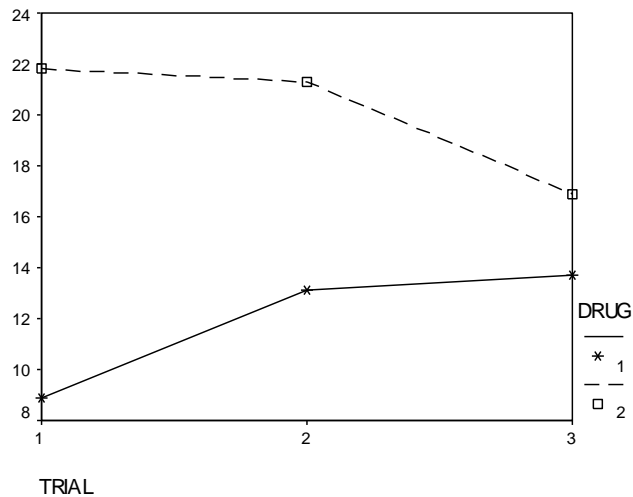
3. DRUG * TRIAL

Measure: MEASURE_1

DRUG	TRIAL	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
1	1	8.900	1.016	6.602	11.198
	2	13.100	.924	11.009	15.191
	3	13.700	1.044	11.338	16.062
2	1	21.800	.867	19.839	23.761
	2	21.300	.895	19.275	23.325
	3	16.900	.912	14.836	18.964

Profile Plots

Estimated Marginal Means of MEASURE_1



3. Did we meet the sphericity assumption for all variables? How do you know? Why isn't sphericity test for the Drug variable? (2 points)

4. Create an ANOVA summary table that looks a little more like we're used to. Include all sources of variance. (3 points)

Source	SS	DF	MS	F
Total				

5. Why is there a main effect for trial (where are the differences?)? When describing it include the directionality of the comparison. (4 points).

6. Base on the line graph why is there a significant interaction (in words)? (2 points)

7. Based on the significant effects what other follow-up analysis(es) would you perform (in words)? (1 point)

An experimenter is doing a study where variable A is a between groups variable and variables B and C are within subjects variables. Results are shown below.

		b ₁		b ₂	
		c ₁	c ₂	c ₁	c ₂
a ₁	S ₁	5	9	11	14
	S ₂	9	12	14	16
	S ₃	3	7	9	12
a ₂	S ₄	1	5	7	10
	S ₅	3	6	8	10
	S ₆	4	8	10	13
a ₃	S ₇	8	13	15	17
	S ₈	7	10	13	14
	S ₉	7	11	14	14

A B C study

Within-Subjects Factors

Measure: MEASURE_1

B	C	Dependent Variable
1	1	B1C1
	2	B1C2
2	1	B2C1
	2	B2C2

Between-Subjects Factors

		N
A	1.00	3
	2.00	3
	3.00	3

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
B	Sphericity Assumed	240.250	1	240.250	961.000	.000	.994
	Greenhouse-Geisser	240.250	1.000	240.250	961.000	.000	.994
	Huynh-Feldt	240.250	1.000	240.250	961.000	.000	.994
	Lower-bound	240.250	1.000	240.250	961.000	.000	.994
B * A	Sphericity Assumed	.000	2	.000	.000	1.000	.000
	Greenhouse-Geisser	.000	2.000	.000	.000	1.000	.000
	Huynh-Feldt	.000	2.000	.000	.000	1.000	.000
	Lower-bound	.000	2.000	.000	.000	1.000	.000
Error(B)	Sphericity Assumed	1.500	6	.250			
	Greenhouse-Geisser	1.500	6.000	.250			
	Huynh-Feldt	1.500	6.000	.250			
	Lower-bound	1.500	6.000	.250			
C	Sphericity Assumed	78.028	1	78.028	165.235	.000	.965
	Greenhouse-Geisser	78.028	1.000	78.028	165.235	.000	.965
	Huynh-Feldt	78.028	1.000	78.028	165.235	.000	.965
	Lower-bound	78.028	1.000	78.028	165.235	.000	.965
C * A	Sphericity Assumed	.889	2	.444	.941	.441	.239
	Greenhouse-Geisser	.889	2.000	.444	.941	.441	.239
	Huynh-Feldt	.889	2.000	.444	.941	.441	.239
	Lower-bound	.889	2.000	.444	.941	.441	.239
Error(C)	Sphericity Assumed	2.833	6	.472			
	Greenhouse-Geisser	2.833	6.000	.472			
	Huynh-Feldt	2.833	6.000	.472			
	Lower-bound	2.833	6.000	.472			
B * C	Sphericity Assumed	6.250	1	6.250	75.000	.000	.926
	Greenhouse-Geisser	6.250	1.000	6.250	75.000	.000	.926
	Huynh-Feldt	6.250	1.000	6.250	75.000	.000	.926
	Lower-bound	6.250	1.000	6.250	75.000	.000	.926
B * C * A	Sphericity Assumed	2.000	2	1.000	12.000	.008	.800
	Greenhouse-Geisser	2.000	2.000	1.000	12.000	.008	.800
	Huynh-Feldt	2.000	2.000	1.000	12.000	.008	.800
	Lower-bound	2.000	2.000	1.000	12.000	.008	.800
Error(B*C)	Sphericity Assumed	.500	6	.083			
	Greenhouse-Geisser	.500	6.000	.083			
	Huynh-Feldt	.500	6.000	.083			
	Lower-bound	.500	6.000	.083			

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	3383.361	1	3383.361	252.176	.000	.977
A	142.889	2	71.444	5.325	.047	.640
Error	80.500	6	13.417			

Estimated Marginal Means

1. A

Measure: MEASURE_1

A	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
1.00	10.083	1.057	7.496	12.671
2.00	7.083	1.057	4.496	9.671
3.00	11.917	1.057	9.329	14.504

2. B

Measure: MEASURE_1

B	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
1	7.111	.641	5.543	8.679
2	12.278	.591	10.833	13.723

3. C

Measure: MEASURE_1

C	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
1	8.222	.626	6.690	9.754
2	11.167	.616	9.659	12.674

4. A * B

Measure: MEASURE_1

A	B	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
1.00	1	7.500	1.110	4.785	10.215
	2	12.667	1.023	10.164	15.170
2.00	1	4.500	1.110	1.785	7.215
	2	9.667	1.023	7.164	12.170
3.00	1	9.333	1.110	6.618	12.049
	2	14.500	1.023	11.997	17.003

5. A * C

Measure: MEASURE_1

A	C	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
1.00	1	8.500	1.084	5.847	11.153
	2	11.667	1.067	9.055	14.278
2.00	1	5.500	1.084	2.847	8.153
	2	8.667	1.067	6.055	11.278
3.00	1	10.667	1.084	8.013	13.320
	2	13.167	1.067	10.555	15.778

6. B * C

Measure: MEASURE_1

B	C	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
1	1	5.222	.667	3.591	6.853
	2	9.000	.638	7.438	10.562
2	1	11.222	.598	9.758	12.686
	2	13.333	.609	11.844	14.822

7. A * B * C

Measure: MEASURE_1

A	B	C	Mean	Std. Error	95% Confidence Interval	
					Lower Bound	Upper Bound
1.00	1	1	5.667	1.155	2.841	8.492
		2	9.333	1.106	6.628	12.038
	2	1	11.333	1.036	8.797	13.869
		2	14.000	1.054	11.421	16.579
2.00	1	1	2.667	1.155	-.159	5.492
		2	6.333	1.106	3.628	9.038
	2	1	8.333	1.036	5.797	10.869
		2	11.000	1.054	8.421	13.579
3.00	1	1	7.333	1.155	4.508	10.159
		2	11.333	1.106	8.628	14.038
	2	1	14.000	1.036	11.464	16.536
		2	15.000	1.054	12.421	17.579

8. What effects are NOT significant? How do you know? (2 points)

9. Compare A2 to A3 and test for significance. Show your work. (6 points)

10. Is the A2 vs. A3 comparison significant after a Tukey adjustment? Show your work. (3 points)

11. Based on the Tukey test you just performed (without any further computations), would the A2 vs. A3 comparison be significant after a Scheffe adjustment. How do you know? (1 point)

12. Graph the A x C interaction. (3 points)