Name_____

Ψ 420
Ainsworth

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

Name_____

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			

Name_____

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? And how much percent of variance is accounted for by this comparison? (2 points)**

No it is not, because the quadratic comparison (1 -1 -1 1) is not significant. This comparison accounts for 40% of the variance based on partial eta squared.

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)**

	T1+T2/2	T3+T4/2	Case total
S_1	14	23	37
S_2	20	28.5	48.5
S_3	14	23.5	37.5
S_4	20	27	47
S_5	17	25	42
Sum	85	127	212

or

	T1+T2	T3+T4	Case Total
S_1	28	46	74
S_2	40	57	97
S_3	28	47	75
S_4	40	54	94
S_5	34	50	84
Sum	170	254	424

For the sum method on the right, $\Sigma Y^2 = 18914$

$$SS_{comp} = \frac{170^2 + 254^2}{5} - \frac{424^2}{10} = 18{,}683.2 - 17{,}977.6 = 705.600$$

$$SS_S = \frac{74^2 + 97^2 + 75^2 + 94^2 + 84^2}{2} - \frac{424^2}{10} = 18{,}201 - 17{,}977.6 = 223.400$$

$$SS_{A_{comp}xS} = 18{,}914 - 18{,}683.2 - 18{,}201 + 17{,}997.6 = 27.400$$

$$SS_{Total} = 18{,}914 - 17{,}997.6 = 916.400$$

Source	SS	df	MS	F
Acomp	705.6	1	705.6	103.007
S	223.4	4	55.85	
Acomp x S	27.4	4	6.85	
Total	916.4	9		

Fcrit(1,4) = 7.71, since 103.007 > 7.71, reject h_0.

Name_____

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

Name_____

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			

Name_____

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

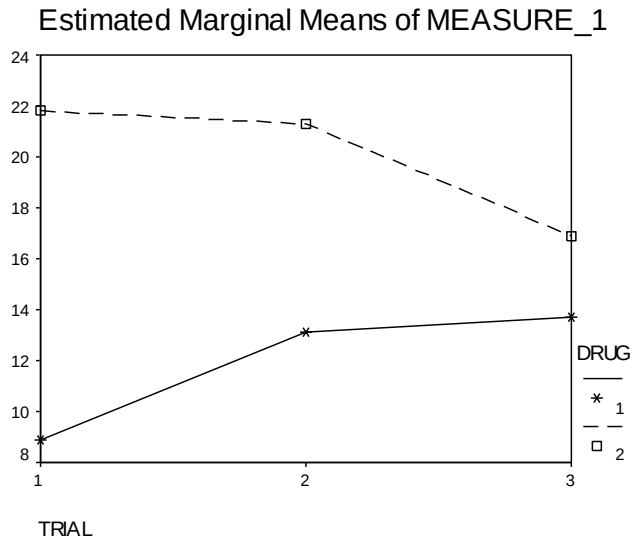
TRIAL	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
1	15.350	.931	13.244	17.456
2	17.200	.904	15.154	19.246
3	15.300	.961	13.126	17.474

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



Name_____

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)**

   Yes, because none of Mauchly's tests for sphericity are significant. The drug variable was not tested for sphericity because there are only two levels.

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
Drug	984.150	1	984.150	1152.8
Trial	46.9	2	23.450	95.211
S	155.006	9	17.233	
Drug x Trial	235.3	2	117.650	394.602
Drug x S	7.683	9	.854	
Trial x S	4.433	18	.246	
Drug x Trial x S	5.367	18	.298	
Total				

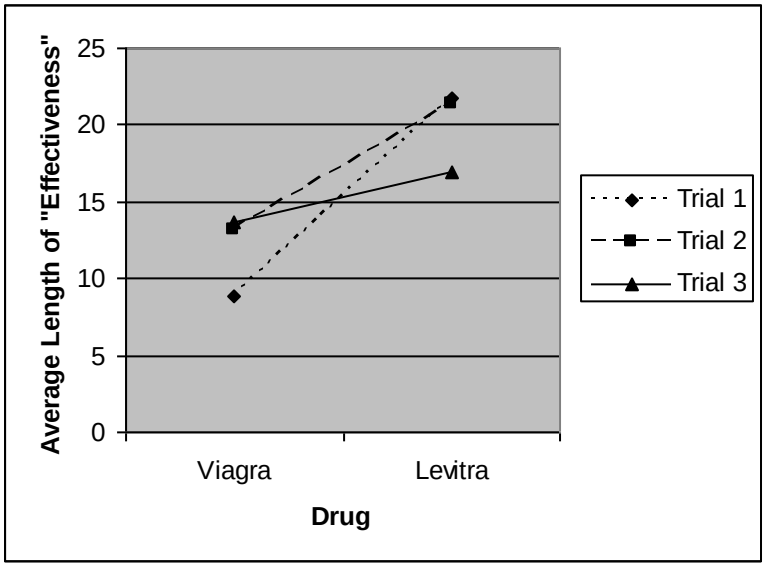
5. **Why is there a main effect for trial (where are the differences?)? When describing it include the directionality of the comparison. (4 points).**

   According to the comparisons, Trial 2 (M = 17.2) is significantly greater than Trial 1 (M = 15.35) and Trial 2 is significantly greater than Trial 3 (M = 15.3).

6. **Base on the line graph why is there a significant interaction? (2 points)**
   Any explanation that makes some sense

Name_____

Redraw the line graph so that the interaction can be shown in a different way. (3 points)



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

Interaction Contrasts

Name_____

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

Name_____

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			

Name_____

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

Name_____

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

Name_____

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

AxB and AxC are not significant, because the sphericity assumed lines for each show significance levels above .05.

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

$$F = \frac{12[0(10.083)+1(7.083)-1(11.917)]^2 \Big/ 0^2+1^2+(-1)^2}{13.413} = \frac{140.205}{13.413} = 10.453$$

Fcrit(1,6) = 5.99, since 10.453 > 5.99, reject h_0 for the comparison.

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

$F_T = (4.34^2/2) = 9.417$, since 10.453 > 9.417, you would still reject after a Tukey adjustment

Name_____

11. Without any computations, would the A2 vs. A3 comparison be significant after a Scheffe adjustment. How do you know? (1 point)

Without any computations I would say that it would not be significant under a Scheffe adjustment because Scheffe makes the Fcrit value larger than that for Tukey. Since, the Fobtained is pretty close to the Tukey value, the Fscheffe value would probably be larger than the obtained value.

12. On the next page is beginnings of the setup for the regression approach to a problem similar to the one above. You job is to complete the columns required to code the S/A error, no computations. (12 points)

Name_____

					A		B	C	AB		AC		BC	ABC		S/A					
				Y	Alin	Aquad	B	C	Alin*B	Aquad*B	Alin*C	Aquad*C	B*C	Alin*B*C	Aquad*B*C	A1Sc1	A1sc2	A2Sc1	A2Sc2	A3Sc1	A3Sc2
a_1	b_1	c_1	S_1	5	1	1	1	1	1	1	1	1	1	1	1	2	0	0	0	0	0
			S_2	9	1	1	1	1	1	1	1	1	1	1	1	-1	1	0	0	0	0
			S_3	3	1	1	1	1	1	1	1	1	1	1	1	-1	-1	0	0	0	0
a_2			S_4	1	0	-2	1	1	0	-2	0	-2	1	0	-2	0	0	2	0	0	0
			S_5	3	0	-2	1	1	0	-2	0	-2	1	0	-2	0	0	-1	1	0	0
			S_6	4	0	-2	1	1	0	-2	0	-2	1	0	-2	0	0	-1	-1	0	0
a_3			S_7	6	-1	1	1	1	-1	1	-1	1	1	-1	1	0	0	0	0	2	0
			S_8	5	-1	1	1	1	-1	1	-1	1	1	-1	1	0	0	0	0	-1	1
			S_9	5	-1	1	1	1	-1	1	-1	1	1	-1	1	0	0	0	0	-1	-1
a_1	b_1	c_2	S_1	9	1	1	1	-1	1	1	-1	-1	-1	-1	-1	2	0	0	0	0	0
			S_2	12	1	1	1	-1	1	1	-1	-1	-1	-1	-1	-1	1	0	0	0	0
			S_3	7	1	1	1	-1	1	1	-1	-1	-1	-1	-1	-1	-1	0	0	0	0
a_2			S_4	5	0	-2	1	-1	0	-2	0	2	-1	0	2	0	0	2	0	0	0
			S_5	6	0	-2	1	-1	0	-2	0	2	-1	0	2	0	0	-1	1	0	0
			S_6	8	0	-2	1	-1	0	-2	0	2	-1	0	2	0	0	-1	-1	0	0
a_3			S_7	11	-1	1	1	-1	-1	1	1	-1	-1	1	-1	0	0	0	0	2	0
			S_8	8	-1	1	1	-1	-1	1	1	-1	-1	1	-1	0	0	0	0	-1	1
			S_9	9	-1	1	1	-1	-1	1	1	-1	-1	1	-1	0	0	0	0	-1	-1
a_1	b_2	c_1	S_1	11	1	1	-1	1	-1	-1	1	1	-1	-1	-1	2	0	0	0	0	0
			S_2	14	1	1	-1	1	-1	-1	1	1	-1	-1	-1	-1	1	0	0	0	0
			S_3	9	1	1	-1	1	-1	-1	1	1	-1	-1	-1	-1	-1	0	0	0	0
a_2			S_4	7	0	-2	-1	1	0	2	0	-2	-1	0	2	0	0	2	0	0	0
			S_5	8	0	-2	-1	1	0	2	0	-2	-1	0	2	0	0	-1	1	0	0
			S_6	10	0	-2	-1	1	0	2	0	-2	-1	0	2	0	0	-1	-1	0	0
a_3			S_7	13	-1	1	-1	1	1	-1	-1	1	-1	1	-1	0	0	0	0	2	0
			S_8	11	-1	1	-1	1	1	-1	-1	1	-1	1	-1	0	0	0	0	-1	1
			S_9	12	-1	1	-1	1	1	-1	-1	1	-1	1	-1	0	0	0	0	-1	-1
a_1	b_2	c_2	S_1	14	1	1	-1	-1	-1	-1	-1	-1	1	1	1	2	0	0	0	0	0
			S_2	16	1	1	-1	-1	-1	-1	-1	-1	1	1	1	-1	1	0	0	0	0
			S_3	12	1	1	-1	-1	-1	-1	-1	-1	1	1	1	-1	-1	0	0	0	0
a_2			S_4	10	0	-2	-1	-1	0	2	0	2	1	0	-2	0	0	2	0	0	0
			S_5	10	0	-2	-1	-1	0	2	0	2	1	0	-2	0	0	-1	1	0	0
			S_6	13	0	-2	-1	-1	0	2	0	2	1	0	-2	0	0	-1	-1	0	0
a_3			S_7	15	-1	1	-1	-1	1	-1	1	-1	1	-1	1	0	0	0	0	2	0
			S_8	12	-1	1	-1	-1	1	-1	1	-1	1	-1	1	0	0	0	0	-1	1
			S_9	12	-1	1	-1	-1	1	-1	1	-1	1	-1	1	0	0	0	0	-1	-1