

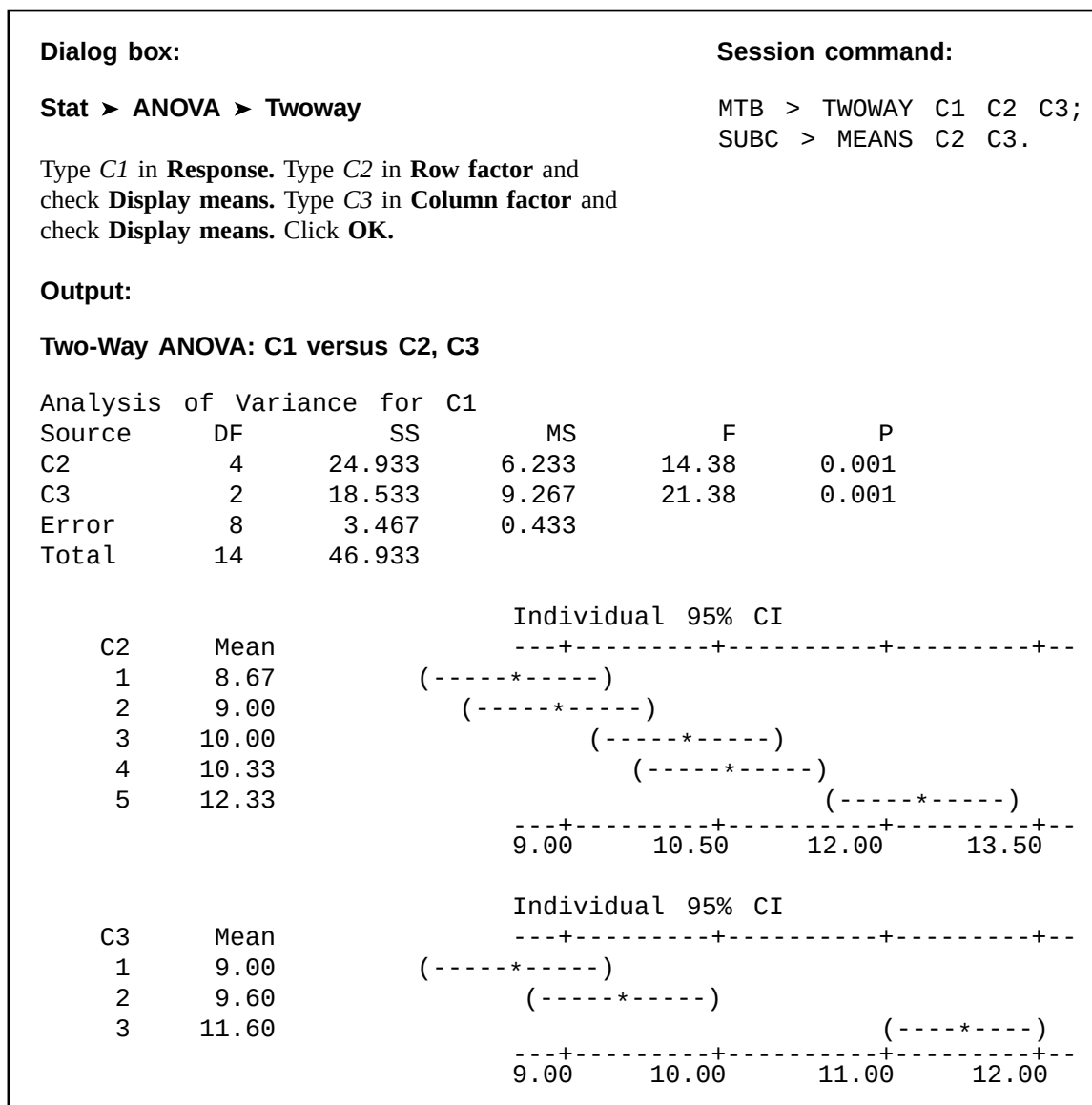


FIGURE 8.3.2 MINITAB dialog box and output for two-way analysis of variance, Example 8.3.1.

EXERCISES

For Exercise 8.3.1 to 8.3.5 perform the ten-step hypothesis testing procedure for analysis of variance.

- 8.3.1.** The objective of a study by Brooks et al. (A-11) was to evaluate the efficacy of using a virtual kitchen for vocational training of people with learning disabilities. Twenty-four students participated

The SAS System**Analysis of Variance Procedure**

Dependent Variable: DAYS

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	6	43.46666667	7.244444444	16.72	0.0004
Error	8	3.46666667	0.433333333		
Corrected Total	14	46.93333333			
	R-Square	C.V.	Root MSE		DAYS Mean
	0.926136	6.539211	0.65828059		10.06666667
Source	DF	Anova SS	Mean Square	F Value	Pr > F
GROUP	2	18.53333333	9.26666667	21.38	0.0006
AGE	4	24.93333333	6.23333333	14.38	0.0010

FIGURE 8.3.3 Partial SAS® output for analysis of Example 8.3.1.

in the study. Each participant performed four food preparation tasks and they were scored on the quality of the preparation. Then each participant received regular vocational training in food preparation (real training), virtual training using a TV and computer screen of a typical kitchen, workbook training with specialized reading materials, and no training (to serve as a control). After each of these trainings, the subjects were tested on food preparation. Improvement scores for each of the four training methods are shown in the following table.

Subject No.	Real Training	Virtual Training	Workbook Training	No Training
1	2	10	2	-4
2	4	3	2	1
3	4	13	0	1
4	6	11	2	1
5	5	13	5	1
6	2	0	1	4
7	10	17	2	6
8	5	5	2	2
9	10	4	5	2
10	3	6	9	3
11	11	9	8	7
12	10	9	6	10
13	5	8	4	1

(Continued)

Subject No.	Real Training	Virtual Training	Workbook Training	No Training
14	8	11	1	1
15	4	8	5	2
16	11	8	10	2
17	6	11	1	3
18	2	5	1	2
19	3	1	0	-3
20	7	5	0	-6
21	7	10	4	4
22	8	7	-2	8
23	4	9	3	0
24	9	6	3	5

Source: Data provided courtesy of B. M. Brooks, Ph.D.

After eliminating subject effects, can we conclude that the improvement scores differ among methods of training? Let $\alpha = .05$.

- 8.3.2.** McConville et al. (A-12) report the effects of chewing one piece of nicotine gum (containing 2 mg nicotine) on tic frequency in patients whose Tourette's disorder was inadequately controlled by haloperidol. The following are the tic frequencies under four conditions:

Patient	Number of Tics During 30-Minute Period			
	Baseline	Gum Chewing	After End of Chewing	
			0-30 Minutes	30-60 Minutes
1	249	108	93	59
2	1095	593	600	861
3	83	27	32	61
4	569	363	342	312
5	368	141	167	180
6	326	134	144	158
7	324	126	312	260
8	95	41	63	71
9	413	365	282	321
10	332	293	525	455

Source: Data provided courtesy of Brian J. McConville, M. Harold Fogelson, Andrew B. Norman, William M. Klykylo, Pat Z. Manderscheid, Karen W. Parker, and Paul R. Sanberg. "Nicotine Potentiation of Haloperidol in Reducing Tic Frequency in Tourette's Disorder," *American Journal of Psychiatry*, 148 (1991), 793-794. Copyright © 1991, American Psychiatric Association.

After eliminating patient effects, can we conclude that the mean number of tics differs among the four conditions? Let $\alpha = .01$.

- 8.3.3.** A remotivation team in a psychiatric hospital conducted an experiment to compare five methods for remotivating patients. Patients were grouped according to level of initial motivation. Patients in each

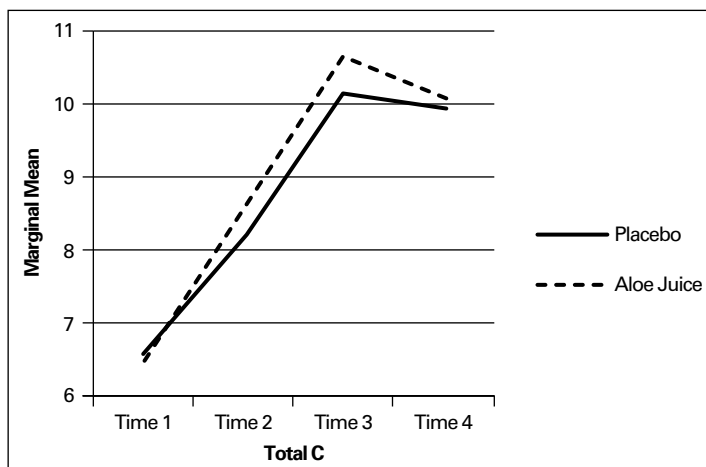


FIGURE 8.4.5 Excel plot of marginal means against total oral health score for the data of Example 8.4.2.

EXERCISES

For Exercises 8.4.1 to 8.4.3 perform the ten-step hypothesis testing procedure. Let $\alpha = .05$.

- 8.4.1.** One of the purposes of a study by Liu et al. (A-17) was to determine the effects of MRZ 2/579 on neurological deficit in Sprague-Dawley rats. In this study, 10 rats were measured at four time periods following occlusion of the middle carotid artery and subsequent treatment with the uncompetitive *N*-methyl-D-aspartate antagonist MRZ 2/579, which previous studies had suggested provides neuro-protective activity. The outcome variable was a neurological function variable measured on a scale of 0–12. A higher number indicates a higher degree of neurological impairment.

Rat	60 Minutes	24 Hours	48 Hours	72 Hours
1	11	9	8	4
2	11	7	5	3
3	11	10	8	6
4	11	4	3	2
5	11	10	9	9
6	11	6	5	5
7	11	6	6	6
8	11	7	6	5
9	11	7	5	5
10	11	9	7	7

Source: Data provided courtesy of Ludmila Belayev, M.D.

- 8.4.2.** Starch et al. (A-18) wanted to show the effectiveness of a central four-quadrant sleeve and screw in anterior cruciate ligament reconstruction. The researchers performed a series of reconstructions on eight cadaveric knees. The following table shows the loads (in newtons) required to achieve different graft laxities (mm) for seven specimens (data not available for one specimen) using five different load weights. Graft laxity is the separation (in mm) of the femur and the tibia at the points of graft fixation.

Is there sufficient evidence to conclude that different loads are required to produce different levels of graft laxity? Let $\alpha = .05$.

Specimen	Graft Laxity (mm)				
	1	2	3	4	5
1	297.1	297.1	297.1	297.1	297.1
2	264.4	304.6	336.4	358.2	379.3
3	188.8	188.8	188.8	188.8	188.8
4	159.3	194.7	211.4	222.4	228.1
5	228.2	282.1	282.1	334.8	334.8
6	100.3	105.0	106.3	107.7	108.7
7	116.9	140.6	182.4	209.7	215.4

Source: David W. Starch, Jerry W. Alexander, Philip C. Noble, Suraj Reddy, and David M. Lintner, "Multistranded Hamstring Tendon Graft Fixation with a Central Four-Quadrant or a Standard Tibial Interference Screw for Anterior Cruciate Ligament Reconstruction," *American Journal of Sports Medicine*, 31 (2003), 338–344.

- 8.4.3.** Holben et al. (A-19) designed a study to evaluate selenium intake in young women in the years of puberty. The researchers studied a cohort of 16 women for three consecutive summers. One of the outcome variables was the selenium intake per day. The researchers examined dietary journals of the subjects over the course of 2 weeks and then computed the average daily selenium intake. The following table shows the average daily selenium intake values (in $\mu\text{g}/\text{d}$) for the 16 women in years 1, 2, and 3 of the study.

Subject	Year 1	Year 2	Year 3	Subject	Year 1	Year 2	Year 3
1	112.51	121.28	94.99	9	95.05	93.89	73.26
2	106.20	121.14	145.69	10	112.65	100.47	145.69
3	102.00	121.14	130.37	11	103.74	121.14	123.97
4	103.74	90.21	135.91	12	103.74	121.14	135.91
5	103.17	121.14	145.69	13	112.67	104.66	136.87
6	112.65	98.11	145.69	14	106.20	121.14	126.42
7	106.20	121.14	136.43	15	103.74	121.14	136.43
8	83.57	102.87	144.35	16	106.20	100.47	135.91

Source: Data provided courtesy of David H. Holben, Ph.D. and John P. Holcomb, Ph.D.

- 8.4.4.** Linke et al. (A-20) studied seven male mongrel dogs. They induced diabetes by injecting the animals with alloxan monohydrate. The researchers measured the arterial glucose (mg/dl), arterial lactate (mmol/L), arterial free fatty acid concentration, and arterial β -hydroxybutyric acid concentration prior to the alloxan injection, and again in weeks 1, 2, 3, and 4 post-injection. What is the response variable(s)? Comment on carryover effect and position effect as they may or may not be of concern in this study. Construct an ANOVA table for this study in which you identify the sources of variability and specify the degrees of freedom for each.
- 8.4.5.** Werther et al. (A-21) examined the vascular endothelial growth factor (VEGF) concentration in blood from colon cancer patients. Research suggests that inhibiting VEGF may disrupt tumor growth. The researchers measured VEGF concentration (ng/L) for 10 subjects and found an upward trend in VEGF concentrations during the clotting time measured at baseline, and hours 1 and 2. What is the response variable? What is the treatment variable? Construct an ANOVA table for this study in which you identify the sources of variability and specify the degrees of freedom for each.

Percent Compared to Glutamate	–LY294002 vs + LY294002	Troglitazone Dose (μ M)
97.11	Positive	1.3
114.26	Positive	1.3
120.26	Positive	1.3
92.39	Positive	1.3
26.95	Negative	4.5
53.23	Negative	4.5
59.57	Negative	4.5
53.23	Negative	4.5
28.51	Positive	4.5
30.65	Positive	4.5
44.37	Positive	4.5
36.23	Positive	4.5
–8.83	Negative	13.5
25.14	Negative	13.5
20.16	Negative	13.5
34.65	Negative	13.5
–35.80	Positive	13.5
–7.93	Positive	13.5
–19.08	Positive	13.5
5.36	Positive	13.5

Source: Data provided courtesy of Shigeo Uryu.

- 8.5.2.** Researchers at a trauma center wished to develop a program to help brain-damaged trauma victims regain an acceptable level of independence. An experiment involving 72 subjects with the same degree of brain damage was conducted. The objective was to compare different combinations of psychiatric treatment and physical therapy. Each subject was assigned to one of 24 different combinations of four types of psychiatric treatment and six physical therapy programs. There were three subjects in each combination. The response variable is the number of months elapsing between initiation of therapy and time at which the patient was able to function independently. The results were as follows:

Physical Therapy Program	Psychiatric Treatment			
	<i>A</i>	<i>B</i>	<i>C</i>	<i>D</i>
I	11.0	9.4	12.5	13.2
	9.6	9.6	11.5	13.2
	10.8	9.6	10.5	13.5
II	10.5	10.8	10.5	15.0
	11.5	10.5	11.8	14.6
	12.0	10.5	11.5	14.0
III	12.0	11.5	11.8	12.8
	11.5	11.5	11.8	13.7
	11.8	12.3	12.3	13.1

(Continued)

Physical Therapy Program	Psychiatric Treatment			
	A	B	C	D
IV	11.5	9.4	13.7	14.0
	11.8	9.1	13.5	15.0
	10.5	10.8	12.5	14.0
V	11.0	11.2	14.4	13.0
	11.2	11.8	14.2	14.2
	10.0	10.2	13.5	13.7
VI	11.2	10.8	11.5	11.8
	10.8	11.5	10.2	12.8
	11.8	10.2	11.5	12.0

Can one conclude on the basis of these data that the different psychiatric treatment programs have different effects? Can one conclude that the physical therapy programs differ in effectiveness? Can one conclude that there is interaction between psychiatric treatment programs and physical therapy programs? Let $\alpha = .05$ for each test.

Exercises 8.5.3 and 8.5.4 are optional since they have unequal cell sizes. It is recommended that the data for these be analyzed using SAS[®] or some other software package that will accept unequal cell sizes.

- 8.5.3.** Main et al. (A-24) state, “Primary headache is a very common condition and one that nurses encounter in many different care settings. Yet, there is a lack of evidence as to whether advice given to sufferers is effective and what improvements may be expected in the conditions.” The researchers assessed frequency of headaches at the beginning and end of the study for 19 subjects in an intervention group (treatment 1) and 25 subjects in a control group (treatment 2). Subjects in the intervention group received health education from a nurse, while the control group did not receive education. In the 6 months between pre- and post-evaluation, the subjects kept a headache diary. The following table gives as the response variable the difference (pre – post) in frequency of headaches over the 6 months for two factors: (1) treatment with two levels (intervention and control), and (2) migraine status with two levels (migraine sufferer and nonmigraine sufferer).

Change in Frequency of Headaches	Migraine Sufferer (1 = No, 2 = Yes)	Treatment	Change in Frequency of Headaches	Migraine Sufferer (1 = No, 2 = Yes)	Treatment
–2	1	1	–3	2	2
2	2	1	–6	2	2
33	1	1	11	1	2
–6	2	1	64	1	2
6	2	1	65	1	2
98	1	1	14	1	2
2	2	1	8	1	2
6	2	1	6	2	2

(Continued)