

A researcher wants to compare 8 groups using a one-way anova analysis.

<b>A1</b>	<b>A2</b>	<b>A3</b>	<b>A4</b>	<b>A5</b>	<b>A6</b>	<b>A7</b>	<b>A8</b>

- How many pairwise comparisons are *possible* with 8 groups?
  
- What is the *maximum* number of orthogonal comparisons that can be conducted?

We have discussed several multiple comparison procedures: Bonferroni, Brown & Forsythe, Dunnett, Dunnett's T3, Games-Howell, Scheffe, Sidak, and Tukey's HSD. Which multiple comparison procedures can be used with unequal sample sizes?

Explain how each of the following is related to power.

1. Number of groups.
  
2. Sample size.

Describe the variance or sphericity assumption(s) made by each of the following statistical procedures.

1. one-way anova where the between factor has 3 levels
  
2. welch's anova where the between factor has 3 levels
  
3. one-way repeated measures anova where the within factor has 3 levels
  
4. two-way repeated measures anova with one between factor (A has 2 levels) and one within factor (B has 3 levels)

**Choose from the following statistical procedures for this page.**

- A. one-way between subjects anova
- B. two-way between subjects anova
- C. trend analysis
- D. one-way analysis of covariance
- E. one-way repeated measures anova
- F. two-way anova with one between subjects factor and one within subjects factor
- G. two-way anova with both factors within subjects

**A researcher observed 30 freshmen during the first 12 months of college. Do time of semester (beginning, middle, end) and type of semester (spring, summer, fall) predict the average number of alcohol-based drinks consumed by the freshmen?**

1. The independent variable(s) are:
2. The dependent variable is:
3. The covariate variable is:
4. The appropriate statistical procedure is:

**Does current college classification (freshman, sophomore, junior, senior) predict the number of classes taken for the current semester?**

5. The independent variable(s) are:
6. The dependent variable is:
7. The covariate variable is:
8. The appropriate statistical procedure is:

**Do people who have consumed alcohol in the last six months (alcohol = yes) differ in years of age compared to those who have not consumed alcohol in the last six months (alcohol = no)?**

9. The independent variable(s) are:
10. The dependent variable is:
11. The covariate variable is:
12. The appropriate statistical procedure is:

**Do physical health status (poor, good, excellent) and gender (female, male) predict depression scores?**

13. The independent variable(s) are:
14. The dependent variable is:
15. The covariate variable is:
16. The appropriate statistical procedure is:

**Does the place of residence (on-campus, off-campus) predict study time per week when the number of hours carried in the semester is controlled?**

17. The independent variable(s) are:
18. The dependent variable is:
19. The covariate variable is:
20. The appropriate statistical procedure is:

A researcher conducted a controlled experiment on alcohol consumption. Seventy-five college students were randomly assigned to consume one of five alcohol conditions (no drinks, 1 drink, 2 drinks, 3 drinks, 4 drinks). Then, the college students consumed the alcohol one hour prior to playing a driving simulation game on the computer. The researcher recorded the number of crashes per student. The descriptive statistics are reported below.

Report

#Drinks	Mean	Std. Deviation	Variance	N
.00	3.0667	1.57963	2.495	15
1.00	4.6000	.82808	.686	15
2.00	5.8000	1.20712	1.457	15
3.00	7.3333	1.71825	2.952	15
4.00	7.4667	2.47463	6.124	15
Total	5.6533	2.32782	5.419	75

The researcher wants to control the familywise alpha to .05 for the linear and quadratic tests of trend using the *Bonferroni* procedure, what alpha level should be used for each test?

The researcher wants to control the familywise alpha to .05 for the linear and quadratic tests of trend using the *Dunn-Sidak* procedure, what alpha level should be used for each test?

Conduct the *linear and quadratic* tests of trend by hand while controlling the familywise alpha to .05 using the *Bonferroni* procedure. Each test of trend that you conduct must be interpreted (i.e., write one sentence per test of trend—using APA style). You do not, however, have to write a complete results section.

**Scenario 1.** A researcher wanted to know whether the first-year GPA of female college athletes was similar. Basketball, golf, softball, and volleyball players were compared. The SPSS output for the overall test is attached. Conduct the necessary pairwise comparisons by hand. Write a results section that interprets the SPSS output and your pairwise comparison results. Use a familywise alpha of .05.

**Scenario 2. Can the likelihood of purchasing a product within the next week (1 = very unlikely, 10 = very likely) be predicted by the type of product (Compact Disc, Book, Clothing) and the age group (teens, young adults, adults)?** Write a results section that interprets the SPSS output. The descriptive statistics table has been completed for you. Use a familywise alpha of .05.

Table 1

*Descriptive Statistics for Amount Spent per Product*

Descriptive Statistics

	AGEGROUP	Mean	Std. Deviation	N
CDS	Teens	9.0392	3.73610	51
	Young Adults	11.5231	2.58062	65
	Adults	6.3548	2.15327	31
	Total	9.5714	3.55582	147
BOOKS	Teens	6.1569	2.61054	51
	Young Adults	5.9385	2.58528	65
	Adults	8.3548	2.37414	31
	Total	6.5238	2.70801	147
CLOTHING	Teens	12.9608	4.10347	51
	Young Adults	7.0769	2.99639	65
	Adults	7.0968	3.21823	31
	Total	9.1224	4.43970	147

## Scenario 1.

### Oneway

#### Descriptives

GPA

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
basketball	20	2.4116	.56638	.12665	2.1466	2.6767	1.38	3.59
softball	20	2.7395	.46849	.10476	2.5203	2.9588	1.98	3.56
volleyball	20	3.1252	.46417	.10379	2.9080	3.3424	1.89	3.90
golf	20	3.4204	.52108	.11652	3.1765	3.6643	2.07	4.36
Total	80	2.9242	.62830	.07025	2.7844	3.0640	1.38	4.36

#### ANOVA

GPA

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	11.669	3	3.890	15.145	.000
Within Groups	19.518	76	.257		
Total	31.186	79			

## Scenario 2.

### General Linear Model

#### Within-Subjects Factors

Measure: MEASURE\_1

PRODUCT	Dependent Variable
1	CDS
2	BOOKS
3	CLOTHING

#### Between-Subjects Factors

	Value Label	N
AGEGROUP .00	Teens	51
1.00	Young Adults	65
2.00	Adults	31

#### Descriptive Statistics

	AGEGROUP	Mean	Std. Deviation	N
CDS	Teens	9.0392	3.73610	51
	Young Adults	11.5231	2.58062	65
	Adults	6.3548	2.15327	31
	Total	9.5714	3.55582	147
BOOKS	Teens	6.1569	2.61054	51
	Young Adults	5.9385	2.58528	65
	Adults	8.3548	2.37414	31
	Total	6.5238	2.70801	147
CLOTHING	Teens	12.9608	4.10347	51
	Young Adults	7.0769	2.99639	65
	Adults	7.0968	3.21823	31
	Total	9.1224	4.43970	147

**Tests of Within-Subjects Effects**

Measure: MEASURE\_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
PRODUCT	Sphericity Assumed	428.988	2	214.494	24.616	.000
	Greenhouse-Geisser	428.988	1.915	224.073	24.616	.000
	Huynh-Feldt	428.988	1.967	218.132	24.616	.000
	Lower-bound	428.988	1.000	428.988	24.616	.000
PRODUCT * AGEGROUP	Sphericity Assumed	1589.288	4	397.322	45.598	.000
	Greenhouse-Geisser	1589.288	3.829	415.065	45.598	.000
	Huynh-Feldt	1589.288	3.933	404.060	45.598	.000
	Lower-bound	1589.288	2.000	794.644	45.598	.000
Error(PRODUCT)	Sphericity Assumed	2509.497	288	8.714		
	Greenhouse-Geisser	2509.497	275.689	9.103		
	Huynh-Feldt	2509.497	283.197	8.861		
	Lower-bound	2509.497	144.000	17.427		

**Tests of Between-Subjects Effects**

Measure: MEASURE\_1

Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	27511.630	1	27511.630	2792.706	.000
AGEGROUP	277.099	2	138.549	14.064	.000
Error	1418.579	144	9.851		

**Oneway**

**Descriptives**

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
CDS	Teens	51	9.0392	3.73610	.52316	7.9884	10.0900	2.00	19.00
	Young Adults	65	11.5231	2.58062	.32009	10.8836	12.1625	6.00	18.00
	Adults	31	6.3548	2.15327	.38674	5.5650	7.1447	2.00	11.00
	Total	147	9.5714	3.55582	.29328	8.9918	10.1510	2.00	19.00
BOOKS	Teens	51	6.1569	2.61054	.36555	5.4226	6.8911	1.00	13.00
	Young Adults	65	5.9385	2.58528	.32066	5.2979	6.5791	2.00	15.00
	Adults	31	8.3548	2.37414	.42641	7.4840	9.2257	4.00	13.00
	Total	147	6.5238	2.70801	.22335	6.0824	6.9652	1.00	15.00
CLOTHING	Teens	51	12.9608	4.10347	.57460	11.8067	14.1149	6.00	22.00
	Young Adults	65	7.0769	2.99639	.37166	6.3345	7.8194	1.00	14.00
	Adults	31	7.0968	3.21823	.57801	5.9163	8.2772	2.00	16.00
	Total	147	9.1224	4.43970	.36618	8.3988	9.8461	1.00	22.00

**ANOVA**

		Sum of Squares	df	Mean Square	F	Sig.
CDS	Between Groups	582.766	2	291.383	33.216	.000
	Within Groups	1263.234	144	8.772		
	Total	1846.000	146			
BOOKS	Between Groups	133.071	2	66.535	10.219	.000
	Within Groups	937.596	144	6.511		
	Total	1070.667	146			
CLOTHING	Between Groups	1150.549	2	575.275	47.960	.000
	Within Groups	1727.247	144	11.995		
	Total	2877.796	146			

**Robust Tests of Equality of Means**

		Statistic <sup>a</sup>	df1	df2	Sig.
CDS	Welch	52.785	2	82.380	.000
BOOKS	Welch	11.237	2	80.224	.000
CLOTHING	Welch	40.023	2	75.943	.000

a. Asymptotically F distributed.

# Post Hoc Tests

## Multiple Comparisons

Games-Howell

Dependent Variable	(I) AGEGROUP	(J) AGEGROUP	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
CDS	Teens	Young Adults	-2.4839*	.61331	.000	-3.9468	-1.0209
		Adults	2.6844*	.65059	.000	1.1307	4.2381
	Young Adults	Teens	2.4839*	.61331	.000	1.0209	3.9468
		Adults	5.1682*	.50202	.000	3.9661	6.3704
	Adults	Teens	-2.6844*	.65059	.000	-4.2381	-1.1307
		Young Adults	-5.1682*	.50202	.000	-6.3704	-3.9661
BOOKS	Teens	Young Adults	.2184	.48626	.895	-.9373	1.3741
		Adults	-2.1980*	.56165	.001	-3.5436	-.8523
	Young Adults	Teens	-.2184	.48626	.895	-1.3741	.9373
		Adults	-2.4164*	.53353	.000	-3.6966	-1.1362
	Adults	Teens	2.1980*	.56165	.001	.8523	3.5436
		Young Adults	2.4164*	.53353	.000	1.1362	3.6966
CLOTHING	Teens	Young Adults	5.8839*	.68432	.000	4.2526	7.5151
		Adults	5.8640*	.81502	.000	3.9151	7.8129
	Young Adults	Teens	-5.8839*	.68432	.000	-7.5151	-4.2526
		Adults	-.0199	.68719	1.000	-1.6747	1.6350
	Adults	Teens	-5.8640*	.81502	.000	-7.8129	-3.9151
		Young Adults	.0199	.68719	1.000	-1.6350	1.6747

\*. The mean difference is significant at the .05 level.

## General Linear Model

### Within-Subjects Factors

Measure: MEASURE\_1

PRODUCT	Dependent Variable
1	CDS
2	BOOKS
3	CLOTHING

## AGEGROUP = Teens

### Descriptive Statistics<sup>a</sup>

	Mean	Std. Deviation	N
CDS	9.0392	3.73610	51
BOOKS	6.1569	2.61054	51
CLOTHING	12.9608	4.10347	51

a. AGEGROUP = Teens

### Tests of Within-Subjects Effects<sup>a</sup>

Measure: MEASURE\_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
PRODUCT	Sphericity Assumed	1189.660	2	594.830	50.710	.000
	Greenhouse-Geisser	1189.660	1.883	631.750	50.710	.000
	Huynh-Feldt	1189.660	1.954	608.713	50.710	.000
	Lower-bound	1189.660	1.000	1189.660	50.710	.000
Error(PRODUCT)	Sphericity Assumed	1173.007	100	11.730		
	Greenhouse-Geisser	1173.007	94.156	12.458		
	Huynh-Feldt	1173.007	97.719	12.004		
	Lower-bound	1173.007	50.000	23.460		

a. AGEGROUP = Teens

## AGEGROUP = Young Adults

Descriptive Statistics<sup>a</sup>

	Mean	Std. Deviation	N
CDS	11.5231	2.58062	65
BOOKS	5.9385	2.58528	65
CLOTHING	7.0769	2.99639	65

a. AGEGROUP = Young Adults

Tests of Within-Subjects Effects<sup>a</sup>

Measure: MEASURE\_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
PRODUCT	Sphericity Assumed	1132.133	2	566.067	78.033	.000
	Greenhouse-Geisser	1132.133	1.946	581.696	78.033	.000
	Huynh-Feldt	1132.133	2.000	566.067	78.033	.000
	Lower-bound	1132.133	1.000	1132.133	78.033	.000
Error(PRODUCT)	Sphericity Assumed	928.533	128	7.254		
	Greenhouse-Geisser	928.533	124.561	7.454		
	Huynh-Feldt	928.533	128.000	7.254		
	Lower-bound	928.533	64.000	14.508		

a. AGEGROUP = Young Adults

## AGEGROUP = Adults

Descriptive Statistics<sup>a</sup>

	Mean	Std. Deviation	N
CDS	6.3548	2.15327	31
BOOKS	8.3548	2.37414	31
CLOTHING	7.0968	3.21823	31

a. AGEGROUP = Adults

Tests of Within-Subjects Effects<sup>a</sup>

Measure: MEASURE\_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
PRODUCT	Sphericity Assumed	63.376	2	31.688	4.661	.013
	Greenhouse-Geisser	63.376	1.705	37.175	4.661	.018
	Huynh-Feldt	63.376	1.797	35.266	4.661	.016
	Lower-bound	63.376	1.000	63.376	4.661	.039
Error(PRODUCT)	Sphericity Assumed	407.957	60	6.799		
	Greenhouse-Geisser	407.957	51.144	7.977		
	Huynh-Feldt	407.957	53.913	7.567		
	Lower-bound	407.957	30.000	13.599		

a. AGEGROUP = Adults

## T-Test

### AGEGROUP = Teens

Paired Samples Statistics<sup>a</sup>

	Mean	N	Std. Deviation	Std. Error Mean
Pair 1 CDS	9.0392	51	3.73610	.52316
BOOKS	6.1569	51	2.61054	.36555
Pair 2 CDS	9.0392	51	3.73610	.52316
CLOTHING	12.9608	51	4.10347	.57460
Pair 3 BOOKS	6.1569	51	2.61054	.36555
CLOTHING	12.9608	51	4.10347	.57460

a. AGEGROUP = Teens

**Paired Samples Test<sup>a</sup>**

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	CDS - BOOKS	2.8824	4.44813	.62286	1.6313	4.1334	4.628	50	.000
Pair 2	CDS - CLOTHING	-3.9216	5.40682	.75711	-5.4423	-2.4009	-5.180	50	.000
Pair 3	BOOKS - CLOTHING	-6.8039	4.62177	.64718	-8.1038	-5.5040	-10.513	50	.000

a. AGEGROUP = Teens

**AGEGROUP = Young Adults**

**Paired Samples Statistics<sup>a</sup>**

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	CDS	11.5231	65	2.58062	.32009
	BOOKS	5.9385	65	2.58528	.32066
Pair 2	CDS	11.5231	65	2.58062	.32009
	CLOTHING	7.0769	65	2.99639	.37166
Pair 3	BOOKS	5.9385	65	2.58528	.32066
	CLOTHING	7.0769	65	2.99639	.37166

a. AGEGROUP = Young Adults

**Paired Samples Test<sup>a</sup>**

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	CDS - BOOKS	5.5846	3.48161	.43184	4.7219	6.4473	12.932	64	.000
Pair 2	CDS - CLOTHING	4.4462	3.92520	.48686	3.4735	5.4188	9.132	64	.000
Pair 3	BOOKS - CLOTHING	-1.1385	3.99952	.49608	-2.1295	-.1474	-2.295	64	.025

a. AGEGROUP = Young Adults

**AGEGROUP = Adults**

**Paired Samples Statistics<sup>a</sup>**

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	CDS	6.3548	31	2.15327	.38674
	BOOKS	8.3548	31	2.37414	.42641
Pair 2	CDS	6.3548	31	2.15327	.38674
	CLOTHING	7.0968	31	3.21823	.57801
Pair 3	BOOKS	8.3548	31	2.37414	.42641
	CLOTHING	7.0968	31	3.21823	.57801

a. AGEGROUP = Adults

**Paired Samples Test<sup>a</sup>**

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	CDS - BOOKS	-2.0000	3.48329	.62562	-3.2777	-.7223	-3.197	30	.003
Pair 2	CDS - CLOTHING	-.7419	4.36629	.78421	-2.3435	.8596	-.946	30	.352
Pair 3	BOOKS - CLOTHING	1.2581	3.09804	.55642	.1217	2.3944	2.261	30	.031

a. AGEGROUP = Adults