the following reason. The data shown in part b of Table D-1 have been constrained in a way that does not occur in a between-subjects design in that each row has been forced to add to the same thing, and this additional constraint causes us to lose degrees of freedom. If you hold column totals and row totals constant in a 3×4 table, you will find that you only can fiddle around with 6 of the 12 scores. That is, once you determine 6 of the scores, the other 6 are predetermined.

In any case, to arrive at a confidence interval, we note that each of the three means in Figure 13-4 must come from a sampling distribution of sample means whose variance is estimated (based on dfI degrees of freedom) to be

$$\text{est } \sigma^2_M = \frac{\text{est } \sigma^2}{n} = \frac{\text{MSI}}{n}$$

This implies the formula for confidence intervals represented as Equation 13.1.

PROBLEMS

1. A social psychologist is interested in the amount of stage fright people have as a function of the number of people in the audience. Four subjects are each asked to imagine that they will have to recite a poem in front of 1, 5, or 15 people. They are asked to rate how frightened they would be on a scale from 0 (not frightened at all) to 7 (scared to death). The data are as follows:

	Audience Size		
Subject	1	5	15
1	3	6	5
2	1	5	6
3	3	6	7
4	1	3	5

   a. Plot the means for the three conditions along with their 95% confidence intervals.
   b. Does the audience size have a significant effect on amount of stage fright?

2. A clinical psychologist has developed a new type of training to relieve anxiety in overanxious patients. To test the treatment, she performs two experiments. In the first experiment the 10 patients simply rate their anxiety [on a scale from 0 (not anxious at all) to 7 (extremely anxious)] each day for five days. She then begins the new treatment (the second experiment), and the patients again rate their anxiety for five days running. The data are as follows:

Experiment 1 (no treatment)

Patient	Day 1	Day 2	Day 3	Day 4	Day 5
1	6	7	7	6	7
2	7	6	6	5	7
3	5	6	7	6	7
4	5	6	7	6	6
5	5	5	5	5	5
6	6	5	4	7	6
7	5	6	6	7	6
8	6	7	5	6	5
9	6	6	7	5	4
10	7	6	7	6	6

Experiment 2 (treatment)

Patient	Day 1	Day 2	Day 3	Day 4	Day 5
1	6	7	6	6	4
2	7	7	6	4	2
3	6	7	6	3	4
4	7	6	7	6	5
5	6	6	5	4	3
6	7	6	5	4	3
7	6	7	7	6	5
8	5	3	2	6	4
9	6	7	3	1	1
10	3	4	5	2	3

a. For each experiment plot the mean anxiety rating over days with the 95% confidence intervals.
b. Perform an analysis of variance on each of the two sets of data.
c. Would you conclude that the treatment was effective?

3. A new technique is invented in an attempt to eliminate mosquitoes. The technique involves releasing sterile male mosquitoes who will mate with females but produce no offspring. For a test of the technique, five different

national forests are divided into three sections each. In the first section nothing is done. In the second section DDT is sprayed. In the third section the new technique is used. The sections are then examined for presence of mosquitoes. The data (mosquitoes per square yard) are as follows:

Forest	No Treatment	DDT	New Technique
1	614	512	123
2	320	300	250
3	502	500	313
4	750	600	430

a. Plot the means for the three techniques along with 95% confidence intervals.
b. Are there significant differences among the three techniques?

4. A drug is invented to prevent forgetting. The drug is administered to five subjects, who are then presented with a 30-word list: Of the 30 words, 10 are countries, 10 are sports, and 10 are foods. Immediately following the list, the subjects are asked to remember as many countries as possible from the list. After 24 hours, subjects are asked to remember sports; and after a week, subjects are asked to remember foods. The data (number of words recalled) are as follows:

Subject	Immediate	24 hours	1 week
1	6	7	3
2	4	3	5
3	7	7	8
4	3	2	0
5	5	4	6

a. Plot the three means along with their 95% confidence intervals.
b. Perform an analysis of variance on the data.
c. Would you conclude that the drug works? Name at least two things wrong with this experiment.

5. A physician has a hypothesis that the probability of catching cold varies with season of the year. She keeps track of five patients in terms of how many colds they have during winter, spring, summer, and fall. She keeps records for three years. Thus, for each patient she has a record of the number of colds caught in each of the four seasons for three years. The data are as follows:

Number of Colds

Patient	Winter			Spring			Summer			Fall		
Bill	3	1	2	1	0	1	3	3	2	0	0	0
Sam	1	1	2	0	1	1	3	4	3	1	1	2
Fred	1	1	1	0	3	0	2	1	2	1	0	0
Ralph	3	4	3	2	2	1	5	2	2	1	2	3
Irving	2	2	3	1	2	1	2	1	0	1	0	1

(*Note:* in each cell, three numbers represent the number of colds for that patient in that season for the three separate years.)

a. Compute a mean for each cell.
b. Plot the mean number of colds for the four seasons along with 95% confidence intervals.
c. Perform a complete analysis of variance on the data. Is there indeed an effect of season? Additionally, determine whether there is an effect of patient and season by patient interaction.

6. Consider Chapter 5, problems 3, 4, 5, and 8. Reevaluate these problems using analysis of variance rather than a sign test.

7. Consider Chapter 10, problem 6. Redo this problem using an analysis of variance rather than a *t*-test.

8. Consider the data from problem 5 in this chapter. For each patient graph the mean number of colds for the four seasons along with the 95% confidence interval.

9. An experimenter is interested in how long it takes to learn various types of verbal material. He chooses lists of three types of verbal material: English words, Russian words, and nonsense syllables. Each of the four subjects gets all three types of lists, and the number of trials taken to learn each type of list is measured for each subject. The following data are obtained:

Type of List

Subject	English	Russian	Nonsense
1	4	9	8
2	5	5	8
3	7	8	9
4	8	10	15

a. What is the between sum of squares?
b. What are SS (subjects), SS (conditions), and SS (interaction)?

c. Arrange these in an ANOVA table.
d. Is there a significant effect of condition?
e. Suppose that you got rid of subject variance in the above. That is, you carried out the following procedure:
   Subject 1: Add three points to each of the scores.
   Subject 2: Add six points to each of the scores.
   Subject 3: Leave the scores alone.
   Subject 4: Subtract nine points from each of the scores.
f. What would be the SS (subjects), SS (conditions), and SS (interaction) for this new set of data?
g. Make an ANOVA table for these data. Is there a significant effect of condition?

10. Joe Smith is interested in whether the typing rates of his two secretaries, Ralph and Shirley, differ for three kinds of to-be-typed material; letters, memos, and book chapters. Hence he gets a sample of typing for each of the three kinds of material from each secretary. The data are as follows (cell entries are typing rates in words per minute):

	Memos	Letters	Chapters
Ralph	60	75	50
Shirley	30	40	30

a. Can Joe conclude that different types of material are typed at different rates?
b. Suppose within-person variance (σ^2) is known to be 25. Can you conclude that there is a difference between Ralph and Shirley in terms of typing rate?

11. A sociologist is studying suicide rates in various U.S. cities. *Out of all cities*, she randomly selects Seattle and Boston (just as a psychologist might randomly select two subjects). For each city she determines the number of suicides for each season of the year (winter, spring, summer, fall) for the two years 1976 and 1977. The data are as follows:

Number of Suicides by Season

	Winter	Spring	Summer	Fall	
Seattle	18, 16 $T_{11} = 34$	4, 4 $T_{21} = 8$	5, 7 $T_{31} = 12$	10, 14 $T_{41} = 24$	$T_{R1} = 78$
Boston	10, 8 $T_{12} = 18$	7, 7 $T_{22} = 14$	5, 9 $T_{32} = 14$	11, 11 $T_{42} = 22$	$T_{R2} = 68$
	$T_{C1} = 52$	$T_{C2} = 22$	$T_{C3} = 26$	$T_{C4} = 46$	$T = 146$

a. Test whether season of the year affects number of suicides in U.S. cities. Additionally, test whether there are differences among U.S. cities in terms

of suicide rates and whether there is an interaction between cities and seasons.

b. Suppose the sociologist decides that she'll be satisfied if her conclusions extend *only* to Seattle and Boston. Test whether there is an effect of season, whether Boston and Seattle differ from one another, and whether there is an interaction between season and city.

12. An experiment is done to test the effects of alcohol consumption on reaction time. The experiment involves three conditions. A subject in condition 1 is given a shot of water; a subject in condition 2 is given a shot of beer; and a subject in condition 3 is given a shot of gin. Reaction times (in tenths of a second) are then measured. Three subjects partake twice in each of the three conditions. The data are as follows:

	Water	Beer	Gin	
Subject 1	1 2	2 1	3 4	$T_{R1} = 13$
Subject 2	2 2	1 3	4 4	$T_{R2} = 16$
Subject 3	10 12	10 14	14 15	$T_{R3} = 75$
	$T_{C1} = 29$	$T_{C2} = 31$	$T_{C3} = 44$	$T = 104$

a. Are there significant effects of alcohol condition, subject, and subject-by-condition interaction? Arrange things in an ANOVA table.

b. Do subjects 1 and 2 differ from one another?