

ANOVA Problems

1

9. A company researcher examines the sales performance of $n = 5$ new employees at the real estate firm. To see if there is a significant trend toward improvement, the number of homes sold is recorded each month for the first 3 months of employment. The data are as follows:

Person	Month 1	Month 2	Month 3
A	1	3	4
B	4	6	8
C	3	3	5
D	2	4	7
E	0	4	6

- Compute the mean number each month of sales that were made in each month.
- Is there a significant change in sales performance with more experience? Test at the .05 level of significance.

2

2. A psychologist would like to examine how the rate of presentation affects people's ability to memorize a list of words. A list of 20 words is prepared. For one group of subjects the list is presented at the rate of one word every $1/2$ second. The next group gets one word every second. The third group has one word every 2 seconds, and the fourth group has one word every 3 seconds. After the list is presented, the psychologist asks each person to recall the entire list. The dependent variable is the number of errors in recall. The data from this experiment are as follows:

$\frac{1}{2}$ Second	1 Second	2 Seconds	3 Seconds	
4	0	3	0	G = 32 $\Sigma X^2 = 104$
6	2	1	2	
2	2	2	1	
4	0	2	1	
$T = 16$	$T = 4$	$T = 8$	$T = 4$	
$SS = 8$	$SS = 4$	$SS = 2$	$SS = 2$	

- a. Can the psychologist conclude that the rate of presentation has a significant effect on memory? Test at the .05 level.
- b. Use Tukey's HSD test to determine which rates of presentation are statistically different and which are not.

3

11. A psychologist is asked by a dog food manufacturer to determine if animals will show a preference among three new food mixes recently developed. The psychologist takes a sample of $n = 6$ dogs. They are deprived of food overnight and presented simultaneously with three bowls of the mixes on the next morning. After 10 minutes, the bowls are removed, and the amount of food (in ounces) consumed is determined for each type of mix. The data are as follows:

	Mix		
	1	2	3
3	2	1	
0	5	1	
2	7	3	
1	6	5	
1	2	3	
3	0	3	

Is there evidence for a significant preference? level of significance.

4

5. A developmental psychologist is examining problem-solving ability for grade school children. Random samples of 5-year-old, 6-year-old, and 7-year-old children are obtained with $n = 3$ in each sample. Each child is given a standardized problem-solving task, and the psychologist records the number of errors. These data are as follows:

5-Year-Olds	6-Year-Olds	7-Year-Olds	
5	6	0	$G = 30$
4	4	1	$\Sigma X^2 = 138$
6	2	2	
$T = 15$	$T = 12$	$T = 3$	
$SS = 2$	$SS = 8$	$SS = 2$	

a. Use these data to test whether there are any significant differences among the three age groups. Use $\alpha = .05$.

b. Use Tukey's different.

5

12. In a paired-associate learning task, subjects are required to learn pairs of words. The first word in each pair is called the stimulus word, and the second is the response word. On each trial, the experimenter presents the stimulus word and asks the subject to recall the correct response. If the subject fails, the correct response word is given, and the experimenter continues through the list. The dependent variable is the number of times the experimenter must go through the entire list before the subject can recall all response words perfectly. This task often is used to demonstrate the effectiveness of mental imagery as an aid to memory. In a typical experiment, subjects in one group are instructed to form a mental image combining the two words in each pair. A second group

is instructed to form a sentence that uses both of the words. A third group receives no special instructions. The data from this experiment are as follows:

No Instructions			Images			Sentences		
6	7	5	3	6	5	5	8	6
5	8	10	5	3	4	4	5	8
8	9	10	4	5	3	5	10	9
4	8	8	3	8	3	6	7	6
5	10	7	5	4	6	8	8	6

Do the data indicate significant differences among the instruction groups? Test with alpha set at .05.

6

6. It has been suggested that pupil size increases during emotional arousal. A researcher, therefore, would like to see if the increase in pupil size is a function of the type of arousal (pleasant versus aversive). A random sample of five subjects is selected for the study. Each subject views all three stimuli: neutral, pleasant, and aversive photographs. The neutral photograph portrays a plain brick building. The pleasant photograph consists of a young man and woman sharing a large ice cream cone. Finally, the aversive stimulus is a graphic photograph of an automobile accident. Upon viewing each stimulus, the pupil size is measured (in millimeters) with sophisticated equipment. The data are as follows. Perform an ANOVA and make a conclusion about the findings.

Subject	Stimulus		
	Neutral	Pleasant	Aversive
A	4	8	3
B	3	6	3
C	2	5	2
D	3	3	6
E	3	8	1

7

1. A social psychologist would like to examine the relationship between personal appearance and authority. A special questionnaire is prepared which requires very careful attention to instructions in order to fill it in correctly. Three random samples of college students are obtained. For the first group the psychologist dresses very casually (blue jeans and T-shirt) when the questionnaire is administered. For the second sample, the psychologist wears a suit, and for the third sample the psychologist wears a very "scientific" laboratory coat. The psychologist records the number of errors made by each individual while completing the questionnaire. These data are as follows:

Blue Jeans	Suit	Lab Coat	
5	3	1	
2	3	0	$G = 30$
2	0	1	$\Sigma X^2 = 86$
4	2	2	
2	2	1	
$T = 15$	$T = 10$	$T = 5$	
$SS = 8$	$SS = 6$	$SS = 2$	

Should the psychologist conclude that appearance had influence on the amount of attention people paid to the instructions? Test at the .05 level of significance.

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7. It has been demonstrated that when subjects must memorize a list of words serially (in the order of presentation) the words at the beginning and end of the list are remembered better than the words in the middle. This observation has been called the *serial-position effect*. The following data represent the number of errors made in recall of the first eight, second eight, and last eight words in the list:

Person	Serial Position		
	First	Middle	Last
A	1	5	0
B	3	7	2
C	5	6	1
D	3	2	1

- Compute the mean number of errors for each position and draw a graph of the data.
- Is there evidence for a significant effect of serial position? Test at the .05 level of significance. Based on the ANOVA, explain the results of the study.

9

10. When a stimulus is presented continuously and it does not vary in intensity, the individual will eventually perceive the stimulus as less intense or not perceive it at all. This phenomenon is known as sensory adaptation. Years ago Zigler (1932) studied adaptation for skin (cutaneous) sensation by placing a small weight on part of the body and measuring how much time lapsed until subjects reported they felt nothing at all. Zigler compared cutaneous adaptation on the back of the hand, forearm, forehead, and cheek. Suppose a researcher does a similar study, comparing adaptation on the back of the hand, the lower back, the middle of the palm, and the chin just below the lower lip. A SOD-milligram weight is gently placed on the region, and the latency (in seconds) for a report that it is no longer felt is recorded for each subject. A sample of $n = 9$ subjects is used, and each subject is tested for adaptation in each of the four regions. The data are as follows:

Subject	Area of Stimulation			
	Back of Hand	Lower Back	Middle of Palm	Chin Below Lower Lip
1	6.5	4.6	10.2	12.1
2	5.8	3.5	9.7	11.8
3	6.0	4.2	9.9	11.5
4	6.7	4.7	8.1	10.7
5	5.2	3.6	7.9	9.9
6	4.3	3.5	9.0	11.3
7	7.4	4.8	10.8	12.6
8	5.4	3.1	9.3	11.0
9	6.6	4.0	11.7	13.9

Is there a significant effect of area of stimulation on the of adaptation? Set the alpha level to .01.

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3. A psychologist would like to show that background noise can interfere with a student's concentration and therefore cause poorer performance on complex mental tasks. A sample of 12 students is obtained, and the psychologist randomly assigns these students to three separate groups. Each group is given a standard problem-solving task. One group works on this task under quiet conditions, one group works with soft background music, and the third group works with a loud radio tuned to a popular rock station. For each student the psychologist measures the number of errors on the task. The results from this experiment are summarized as follows:

Quiet	Soft Music	Loud Music	
$n = 4$	$n = 4$	$n = 4$	
$T = 4$	$T = 6$	$T = 14$	$\Sigma X^2 = 71$
$SS = 2$	$SS = 4$	$SS = 3$	

Can the psychologist conclude that the background noise had an effect on performance? Test at the .05 level of significance.

11

4. A psychologist administers an art appreciation questionnaire to a group of five science students and a group of five English majors. The average score for the science students was $\bar{X} = 6$ with $SS = 200$, and the average score was $\bar{X} = 8$ with $SS = 120$ for the English majors

a. Use an analysis of variance to determine whether or not these two populations differ significantly in art appreciation. Use $\alpha = .05$.

b. Use a t test to compare the two groups. You should find that: $F = t^2$.

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