CHAPTER 11

FILL-IN-THE-BLANK ITEMS

Introduction

The *t* test in Chapter 10 was used to compare the results from (1) _________________ samples in order to see whether they were drawn from (2) _________________ populations. One important technique to compare the results from two or more groups is the (3) _________________ _____ _________________. Two reasons not to apply the *t* test to results from more than two groups are that the computations would be (4) _________________ and the more tests you do on the same data, the greater the likelihood of committing a Type (5) _________________ error, rejecting a (6) _________________ null hypothesis.

Between-Subjects ANOVA

Like the *t* test, one-way ANOVA has two versions: a (7) _________________ ANOVA, which parallels the independent *t,* and a (8) _________________ _________________ ANOVA, which parallels the dependent *t.* The *t* score is a measure of the distance between a group mean and a (9) _________________ mean, or another group (10) _________________ in standard (11) _________________ terms. One of the reasons that variance can be used to determine whether more than two groups differ is the property of (12) _________________. According to the property of additivity, the variance of the sum of independent scores is equal to the (13) _________________ of the variances of the scores. Because variance is additive, we can divide the total variability in a set of scores into its (14) _________________ _________________.

Visualization of ANOVA concepts

The two components of variability in which we're interested are based on within-groups variability and (15) _________________ variability, and the (16) _______________ ________________ for these components are ($X_g - \overline{X}_g$) and ($\overline{X}_g - \overline{X}_{tot}$), respectively. $\overline{X}_{tot}$ is often called the (17) _________________ _________________. To analyze the variances, we are interested in comparing the (18) _________________ variability to the within-groups variability. If the between-groups variability is (19) _________________ relative to within-groups variability, we will probably conclude that the treatments had an effect.

Everyday ANOVA.

The static on your cellular phone or the distracting noise at a party is analogous to (20) _________________ variability; the message or signal you're trying to detect is analogous to (21) _________________ variability.

Three sources of variability in some data are discussed: (22) _________________ variability, between-groups variability, and (23) _________________ variability. The variability within groups is caused by experimental error and (24) _________________ _________________. The variability between groups comes from experimental error, individual differences, and the (25) _________________. The ANOVA test is the ratio of the variability (26) _________________ groups to the variability (27) _________________ groups. If there is no treatment effect, the *F* ratio will be near (28) _________________, whereas a treatment effect will make the statistic relatively (29) _________________.

Measuring variability: The sum of squares

The (30) _________________ sum of squares is the sum of the squared deviation of each score from the total mean. The sum of squares (31) _________________ groups is the sum of the squared deviations of each group score from a group mean, with the deviations summed across groups. The sum of squares (32) _________________ groups is based on the deviation between each group mean and the total mean.

Computing the sums of squares

Although computation of the sums of squares can be tedious, the "trick" is to first compute the sum of the (33) _________________ in each group, the sum of the (34) _________________ _________________ in each group, the (35) _________________ sum of scores, the total sum of squared scores, the number of subjects per group, and the (36) _________________ number of subjects. The symbols are ΣX_g, (37) _________________, ΣX, (38) _________________, N_g, and N, respectively.

Remember that variance is additive. In one-way between-subjects ANOVA, once SS_{tot} and one of its components (either SS_b or SS_w) have been computed, the other component can be found by (39) _________________, although the value should be computed as a check on the accuracy of your calculations.

The analysis of variance summary table

The ANOVA summary table provides a place for the sums of squares; the (40) _________________ for each of the sums of squares; the (41) _________________ squares, which are computed by dividing each *SS* by its *df;* and the (42) _________________ _________________. F is computed by dividing the MS_b by (43) _________________. df_b is equal to $K - 1$, where K is the number of (44) _________________. df_w = (45) _________________. If the computed F ratio is larger than the critical F ratio from Table (46) _________________, the null hypothesis is (47) _________________. Instead of being symmetrical like the t distributions, the F distributions are (48) _________________ skewed with a peak around (49) _________________. (50) _________________ tests are tests that follow a significant F ratio.

Post Hoc Comparisons

There are many post hoc tests available that avoid the problem of inflation of Type I error by (51) _________________ the critical value needed to reject H_0. Because a posteriori or post hoc tests follow a significant F ratio, they are also called (52) _________________ tests. On the other hand, (53) _________________ _________________ tests are tests designed to look at specific hypotheses before the experiment is performed. When the experimenter cannot predict the patterning of

(54) _________________ before the research is performed, post hoc tests are appropriate.

The Fisher LSD

As presented in the text, the LSD test does not require equal (55) _________________ _________________. Also, the LSD test is a (56) _________________ test, which means that we are more likely to be able to reject the null hypothesis with it than with many other post hoc tests available. The LSD test is sometimes called a (57) _________________ *t* test because it follows a significant (58) _________________ _________________. The significant *F* ratio tells us that there is at least one (59) _________________ comparison, thus protecting the error rate. With the test, the difference between two sample means is significant if it is greater than (60) _________________, which is found with the following formula: (61) _________________. As before, (62) _________________ is the level of significance, and the value of *t* is obtained from Table (63) _________________. The results of the Fisher LSD are best summarized in a

(64) _________________ _________________ ___________________.

The Tukey HSD

Although the Tukey HSD test can be used for more complex comparisons, we used it for making all (65) _________________ comparisons when the sample sizes are (66) _________________. Like the Fisher LSD, the difference between two sample means is significant if it is greater than (67) _________________, which is found with the following formula: (68) _________________. The value of *q* comes from the distribution of the (69) _________________ _________________ _________________, whose critical values are found in Table (70) _________________. HSD stands for (71) _________________ _________________ __________________.

Repeated Measures ANOVA

Repeated measures ANOVA is appropriate in situations in which the (72) _________________ participants are measured on more than (73) _________________ occasions. In repeated measures ANOVA, each participant serves as his or her own (74) _________________. By using a person as his or her own control, we are able to extract some of the (75) _________________ from our scores.

There are two sources of variability that contribute to SS_w: experimental (76) _________________ and variability in (77) _________________. Thus, $SS_w = SS_{subj}$ + (78) _________________. SS_{error} is used as the (79) _________________ in computing the F ratio in one-way repeated measures ANOVA. Because the property of additivity applies, $SS_{tot} = SS_b + SS_{subj}$ + (80) _________________. As compared to one-way between-subjects ANOVA, the additional step in one-way repeated measures ANOVA is the computation of (81) _________________ sum of squares.

The summary table for one-way repeated measures ANOVA is similar to that for one-way between-subjects ANOVA except that SS_{tot} is divided into (82) _________________ ____________________ instead of two. For subjects, degrees of freedom are found by subtracting one from the number of (83) _________________. Degrees of freedom for error are the product of df_b and (84) _________________ or $(K - 1)(S - 1)$.

Normally, an F ratio is not computed for (85) _________________. In one-way repeated measures ANOVA, F is found by dividing MS_b by (86) _________________.

Troubleshooting Your Computations

Two obvious signs of trouble when computing the sums of squares are a (87) _________________ sign for *SS* and failure of SS_b and SS_w to sum to (88) _________________. The most common error in filling in the summary table is determining incorrectly the (89) _________________ for each *SS*. Remember that $df_{tot} = df_b + df_w =$ (90) _________________ for between-subjects ANOVA, and $df_{tot} = df_b + df_{subj} + df_{error} =$ (91) _________________ for repeated measures ANOVA.

The most common computational error made in calculating either LSD or HSD is to use *N* instead of (92) _________________ in the expression under the radical sign. Another error that is sometimes made is to use a value from the (93) _________________ table rather than the critical (94) _________________ in the formula for LSD or instead of the (95) _________________ value in the HSD formula. Also, be sure to subtract to obtain (96) _________________ differences or to use the (97) _________________ values or your differences in the significance tests. Remember, if your computed value is equal to or (98) _________________ than the critical value, then you reject the null hypothesis for that test.