**Comparing Groups with the t-test and F Test Statistics

Follow-up of Data Collection Comparing
Pseudo-random Reaction Time Data
and Fixed Interval Reaction Time Data
by Ray L. Winstead**

****

**After determining the mean, variance, and standard deviation of the Pseudo-random data and also the mean, variance, and standard deviation of the Fixed Interval data for the class on the “Reaction Time Experiments with Biopac” data sheet, then continue with the following statistical tests to compare the two groups.**

**The index of Standard Deviation gives a measure of the spread of the values WITHIN a group around the mean of that group, i.e., the standard deviation is a measure of variation. (The best one word definition of “variation” is “differences.”) If the index is small, it will mean that the observation values, in general, are close to the mean, however if the index is large, it will mean, in general, that the observation values are spread farther out from the mean. The Standard Deviation is just the average difference between individual observation measurements and the mean of that group. The average of the squared differences is also a legitimate index of variation, since as the index goes up this also means that the spread of the values around the mean is greater. The average of the squared differences is usually called the "Variance." The standard deviation is the square root of the variance.**

**After the collection of data in the first part of this lab to compare reaction time based on pseudo-random stimuli and reaction time based on fixed-interval stimuli, you have already assessed the variation WITHIN each group of measurements by calculating each group’s Standard Deviation and its Variance. In this lab you will also compare the variability BETWEEN the two groups of pseudo-random stimuli data and fixed-interval stimuli data.**

**Using the information from the two samples, you will now be able to more formally compare the difference observed between the two groups. Certainly the means and variances that you have calculated from the two groups will vary some, however the question really is whether or not the observed differences in the means and variances between the two groups are due to chance sampling within that particular characteristic or, in fact, indicate a real difference between the two larger groups from which the smaller samples were drawn. Observed differences could exist between the two smaller samples even if the true means of the two larger populations are the same. We want to specifically test whether or not the mean of the Pseudo-random data is greater than the mean of the Fixed Interval data. The standard statistical test called the "t-test" will allow us to draw conclusions about a possible, real difference between the means of the two larger populations (the two groups being compared) based on the means of the two small samples, i.e., the function of the t-test is to compare the means of two groups. Larger sample sizes, i.e., more subjects, would certainly give us more accurate results about the characteristics. In this particular case when the data from one group come from exactly the same subjects as in the second group being compared, we need to use a “Paired Comparison t-test” to compare the means, rather than the standard t test when the subjects in the two groups being compared would be different from each other. In order to calculate the paired comparison t-test statistic, we need first to complete the following table of differences based on the student means from Table 11.3 in your lab manual:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Subject** | **Pseudo-random data:Student Means(PR - Segment 2)** | **Fixed Interval data:Student Means(FI - Segment 4)** | **DifferencePR - FI** |
| **1** |  |  |  |
| **2** |  |  |  |
| **3** |  |  |  |
| **4** |  |  |  |
| **5** |  |  |  |
| **6** |  |  |  |

**Next calculate the mean, variance, and standard deviation of the DIFFERENCES in the table above using the same procedure you used on the “Reaction Time Experiments with Biopac” data sheet (“Measurement” in the table below refers to “Difference” from the table above in this case):**

**Next calculate the standard error (SE) of the differences by taking the standard deviation of the differences from step 8 above and dividing it by the square root of 6 (just n, NOT n-1 = 5 as you did use in step 8 above), i.e. divide the standard deviation of the differences (step 8 above) by 2.449. (If you have only five lab tables/entries divide by 2.236.) (The standard error is a specialized standard deviation of an estimate, e.g. a mean, rather than just a standard deviation of original measurements.)**

**Standard Error = SE = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**The Paired Comparison t-test statistic is equal to the mean of differences (step 3 in the table above) divided by the Standard Error (SE above).**

**Calculate the Paired Comparison t-test statistic for your data:**

**\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**If the value of the calculated Paired Comparison t-test statistic above is greater than 2.015, then our conclusion is that there is probably a real, "significant" difference between the means of the two larger groups from which the samples came, and specifically in this case that the Pseudo-random stimuli have longer reaction times than the Fixed Interval stimuli. Be aware that such a small sample size will definitely influence the final results, such that the results may not be clear, e.g., if the conclusion is that the difference is “not significant” (the t-test statistic being less than 2.015), this may simply be a reflection of a small sample size, rather than indicating actually no difference in the populations.**

**The t test determines whether or not there is a difference between the means of the two groups. The variance, however, is an index of variability WITHIN a group and this variability may be equal to or not equal to the variability within another group, regardless of whether or not their means are the same. To test whether or not the variability WITHIN the Pseudo-random group is specifically greater than the variability WITHIN the Fixed Interval group, compare the calculated variances of each group using the standard F test below. The function of the F test is to compare the variances of two groups. Use the results from step 7 in I. and II. on the original “Reaction Time Experiments with Biopac” data sheet.**

**Pseudo-random variance**

**F = ----------------------------------------**

 **Fixed Interval variance**

**Calculate the F test statistic comparing the variances found in the two groups:**

**If the value of the calculated F test statistic above is greater than 5.05, then our conclusion is that there is a real, significant difference between the variability found WITHIN each group with respect to the chosen characteristic, and, specifically, the Pseudo-random group variability is greater than the variability within the Fixed Interval group. If the calculated value is less than 5.05, then the observed difference in the variances is probably due to chance sampling and there is probably no real difference between the two groups with respect to the variability around their respective means. Again, sample size will greatly influence our results. If the conclusion is that the difference in the variance is “not significant” (the F test statistic being less than 5.05), this may simply be a reflection of a small sample size, rather than indicating actually no difference in the populations (groups).**

****