12.9: Specific Comparisons (Correlated Observations)

Learning Objectives

- Compute t for a comparison for repeated-measures data

In the "Weapons and Aggression" case study, subjects were asked to read words presented on a computer screen as quickly as they could. Some of the words were aggressive words such as injure or shatter. Others were control words such as relocate or consider. These two types of words were preceded by words that were either the names of weapons, such as shotgun or grenade, or non-weapon words, such as rabbit or fish. For each subject, the mean reading time across words was computed for these four conditions. The four conditions are labeled as shown in Table $12.9.1$. Table $12.9.2$ shows the data from five subjects.

Table 12.9.1: Description of Conditions

Variable	Description
aw	The time in milliseconds (msec) to name an aggressive word following a weapon word prime.
an	The time in milliseconds (msec) to name an aggressive word following a non-weapon word prime.
cw	The time in milliseconds (msec) to name a control word following a weapon word prime.
cn	The time in milliseconds (msec) to name a control word following a non-weapon word prime.

Table 12.9.2: Data from Five Subjects

Subject	aw	an	cw	cn
1	447	440	432	452
2	427	437	469	451
3	417	418	445	434
4	348	371	353	344
5	471	443	462	463

One question was whether reading times would be shorter when the preceding word was a weapon word (aw and cw conditions) than when it was a non-weapon word (an and cn conditions). In other words,

Is

$$L_1 = (an + cn) - (aw + cw) \tag{12.9.1}$$

greater than 0?

This is tested for significance by computing L_1 for each subject and then testing whether the mean value of L_1 is significantly different from 0. Table $12.9.3$ shows L_1 for the first five subjects. L_1 for Subject 1 was computed by:

$$L1 = (440 + 452) - (447 + 432) = 892 - 879 = 13 \tag{12.9.2}$$

Table 12.9.3: L_1 for Five Subjects

Subject	aw	an	cw	cn	L_1
1	447	440	432	452	13
2	427	437	469	451	-8
3	417	418	445	434	-10

4	348	371	353	344	14
5	471	443	462	463	-27

Once L_1 is computed for each subject, the significance test described in the section "Testing a Single Mean" can be used. First we compute the mean and the standard error of the mean for L_1. There were 32 subjects in the experiment. Computing L_1 for the 32 subjects, we find that the mean and standard error of the mean are 5.875 and 4.2646, respectively. We then compute

$$t = \frac{M-\mu}{S_M} \tag{12.9.3}$$

where M is the sample mean, μ is the hypothesized value of the population mean (0 in this case), and s_M is the estimated standard error of the mean. The calculations show that $t = 1.378$. Since there were 32 subjects, the degrees of freedom is $32 - 1 = 31$. The t distribution calculator shows that the two-tailed probability is 0.178.

A more interesting question is whether the priming effect (the difference between words preceded by a non-weapon word and words preceded by a weapon word) is different for aggressive words than it is for non-aggressive words. That is, do weapon words prime aggressive words more than they prime non-aggressive words? The priming of aggressive words is $(an - aw)$. The priming of non-aggressive words is $(cn - cw)$. The comparison is the difference:

$$L_2 = (an - aw) - (cn - cw) \tag{12.9.4}$$

Table $12.9.4$ shows L_2 for five of the 32 subjects.

Table 12.9.4: L_2 for Five Subjects

Subject	aw	an	cw	cn	L_2
1	447	440	432	452	-27
2	427	437	469	451	28
3	417	418	445	434	12
4	348	371	353	344	32
5	471	443	462	463	-29

The mean and standard error of the mean for all 32 subjects are 8.4375 and 3.9128, respectively. Therefore, $t = 2.156$ and $p = 0.039$.

Multiple Comparisons

Issues associated with doing multiple comparisons are the same for related observations as they are for multiple comparisons among independent groups.

Orthogonal Comparisons

The most straightforward way to assess the degree of dependence between two comparisons is to correlate them directly. For the weapons and aggression data, the comparisons L_1 and L_2 are correlated 0.24. Of course, this is a sample correlation and only estimates what the correlation would be if L_1 and L_2 were correlated in the population. Although mathematically possible, orthogonal comparisons with correlated observations are very rare.