

Two-Way ANOVA

1 Two-Way ANOVA (2 levels for each) with No Interaction

The main goal in two-way ANOVA is to compare the mean of a certain response variable across different levels of two factor effects.

	Taught BSE	
	No	Yes
HISTORY	No	\bar{Y}_{00}
	Yes	\bar{Y}_{10}

The Model that we would like to fit is:

$$Y_i = B_0 + B_1 HIST_i + B_2 BSE_i + \epsilon_i \quad (1)$$

Where our variables for the i^{th} individual:

Y_i = Perceived benefit of mammography. And \bar{Y}_{ij} = the average perceived benefit of mammography for history i and BSE j.

$$History_i = \begin{cases} 0, & \text{No History} \\ 1, & \text{History} \end{cases}$$

$$BSE_i = \begin{cases} 0, & \text{Not Taught BSE} \\ 1, & \text{Taught BSE} \end{cases}$$

What does our model look like when Disease = 0?

What does our model look like when Disease = 1?

What does our B_0 estimate?

What does our B_1 estimate?

What does our B_2 estimate?

What is the overall F-test testing in terms of our means?

What will the individual $H_0 : B_i = 0$ test in terms of our means?

When is it appropriate to use dummy coding, contrast coding, unweighted effect coding, and weighted effect coding?

2 Two-Way ANOVA Full Model w/ Dummy Coding

Above we assumed that there was no interaction in the different effects. However as we saw in our first example that might not be a good assumption. Lets try refitting that model with an interaction term. We will be fitting the model:

$$PB_i = B_0 + B_1HIST_i + B_2BSE_i + B_3HIST_i * BSE_i \epsilon_i \quad (2)$$

Using Dummy coding what will our:

What does our B_0 estimate?

What does our B_1 estimate?

What does our B_2 estimate?

What does our B_3 estimate?

What will the individual $H_0 : B_3 = 0$ test?

Lets try this in SAS:

```
proc means;
by HIST BSE;
VAR PB;

PROC GLM DATA=MAMMO;
MODEL PB = HIST BSE HIST*BSE/SOLUTION;
OUTPUT OUT=OUT1 R=RY P=PY;

PROC PLOT DATA=OUT1;
PLOT RY*PY;
RUN;
QUIT;
```

Since our interaction term is insignificant I would refit this model as an additive model (no interaction) and interpret the means separately.

How could we use the Type I and Type III sums of squares, for testing the significance of two different research factors **A** (with four groups), **B** (with three groups) and **A** × **B**?

When would be the appropriate time to use Type I?

Type III?

3 Two-Way ANOVA Full Model w/ Effect Coding and Dummy Coding

”As we will see, designs in which two different coding systems are employed require special care to assure proper interpretation of the individual regression coefficients” (Cohen et al. pg 365) (i.e. **THIS GETS TO BE REALLY CONFUSING!!!**)

Now lets use the same model, but instead of having 0 as our control we will make -1 our control. First lets do this for just BSE, and we will leave the coding of History to be the same. BSE is now:

$$BSE_i = \begin{cases} -1, & \text{Not Taught} \\ 1, & \text{Taught} \end{cases}$$

We now have the same model.

$$PB_i = B_0 + B_1HIST_i + B_2BSE_i + B_3HIST_i * BSE_i \epsilon_i \quad (3)$$

But the interpretations have changed. So using effect coding:

What does our B_0 estimate?

What does our B_1 estimate?

What does our B_2 estimate?

What does our B_3 estimate?

Lets try this in SAS:

```
data mammo;
set TMP1.meexp2;
BSE2 = 1;
if BSE = 0 then BSE2 = -1;
run;
PROC GLM DATA=MAMMO;
MODEL PB = HIST BSE2 HIST*BSE2/SOLUTION;
OUTPUT OUT=OUT1 R=RY P=PY;
run;
quit;
```