

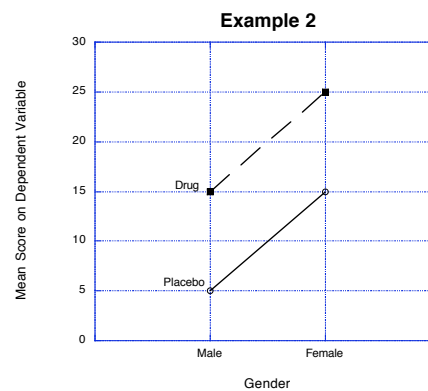
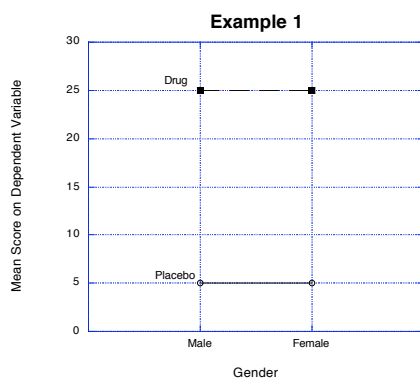
Name \_\_\_\_\_

## Two-Way ANOVA Lab: Interactions

Perhaps the most complicated situation that you face in interpreting a two-way ANOVA is the presence of an interaction. This brief lab is intended to give you additional experience in determining the source of an interaction and describing /interpreting the interaction. We'll begin by looking at results in which the interaction is not significant.

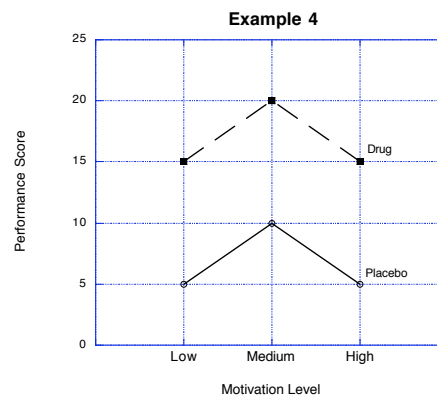
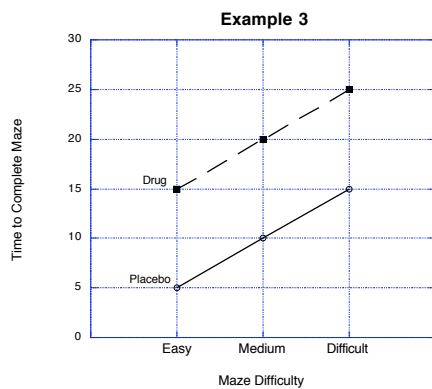
### 1. Interaction Absent

As you've already seen, one way of envisioning the lack of an interaction is that the lines within a graph of your result will be parallel (or roughly parallel, given a sufficiently large error term). When an interaction is absent, you may think of the effects of one factor as being roughly the same regardless of the levels of the other factor. Imagine that you're testing the effectiveness of a drug on men and women (two levels of your independent variable of gender, which is actually a non-manipulated variable). Suppose that both men and women show the same level of improvement after taking the drug (relative to a placebo). In that case, there would be no interaction. Both graphs below are consistent with this possibility. In Example 1, males and females don't differ in their scores on the DV when given a placebo, and both show a 20-point increase when given the drug. In Example 2, females produce higher scores than males when given the placebo, however both males and females show the same 10-point increase when given the drug. Although both examples illustrate a situation in which no interaction is present and there is a likely effect of drug, they differ in that Example 1 is consistent with no main effect of gender, but Example 2 is consistent with a main effect of gender.



When the interaction is not significant, you would focus your attention on the two main effects. In Example 1, you could talk about the improvement due to drug, relative to the placebo, without mentioning gender at all (because there were no gender differences). In Example 2, you may also be talking about a main effect for gender, without mentioning the drug at all. You would also talk about the main effect for drug, without mentioning gender at all (because the effects of the drug were equivalent for males and females). In other words, when the interaction is not significant, your results can be discussed in terms of each independent variable separately.

Now, let's consider a more complex two-factor design. Imagine that you run rats in one of three types of maze (Easy, Medium, Difficult). Some rats are given a placebo injection (saline) and others are given an injection of a drug that is thought to inhibit "cognitive" but not motor abilities. Suppose that the results turned out as seen below (Example 3). How would you interpret the results?



Suppose that you were studying the effects of a drug on performance. Consistent with the Yerkes-Dodson "Law," performance is best when motivation is medium. How would you interpret the results seen in Example 4?

Now let's consider an example using SPSS.

Pierroutsakos and DeLoache (2003) were interested in the development of pictorial competence in children. They use the term pictorial competence to “encompass the many factors that are involved in perceiving, interpreting, understanding, and using pictures (DeLoache, Pierroutsakos, & Uttal, 2003, p. 115).” These researchers observe infants as they explore pictures of familiar objects. Unlike adults, infants are not content to look at the pictures, but will typically attempt to manipulate the pictured object.

In the data depicted below, 9-month-old infants were shown photographs and line drawings of familiar objects. The photographs and line drawings were either in black-and-white or in color. The dependent variable is the number of manual behaviors the infant exhibits toward the picture. Complete the following source table, which depicts results consistent with those of Pierroutsakos and DeLoache, and then analyze the results as completely as you can. Make an effort to interpret the results, as you would in a Discussion section.

**Descriptive Statistics**

Dependent Variable: Manual Behav

Pict Type	Color	Mean	Std. Deviation	N
Drawing	B&W	.9000	.56765	10
	Color	2.7000	.94868	10
	Total	1.8000	1.19649	20
Photo	B&W	3.0000	.81650	10
	Color	5.0000	.81650	10
	Total	4.0000	1.29777	20
Total	B&W	1.9500	1.27630	20
	Color	3.8500	1.46089	20
	Total	2.9000	1.66102	40

**Tests of Between-Subjects Effects**

Dependent Variable: Manual Behav

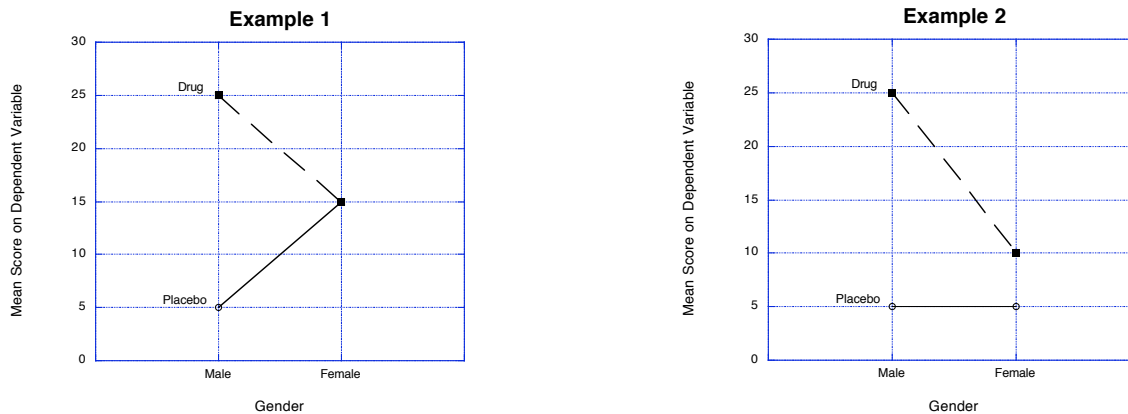
Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power <sup>b</sup>
Corrected Model					.000	.786	132.417	1.000
Intercept					.000	.936	526.539	1.000
PictType				75.75	.000	.678	75.757	1.000
Color			36.100	56.50	.000	.611	56.504	1.000
PictType * Color			.100		.695	.004	.157	.067
Error								
Total								
Corrected Total								

a. R Squared = .786 (Adjusted R Squared = .768)

b. Computed using alpha = .05

## 2. Interaction Present

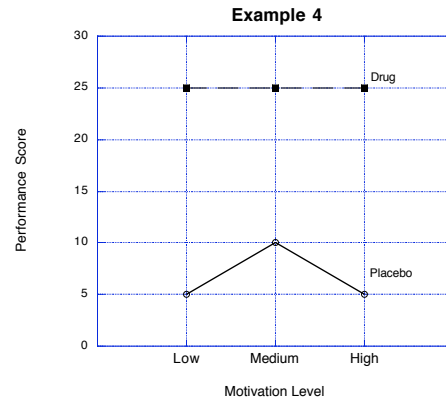
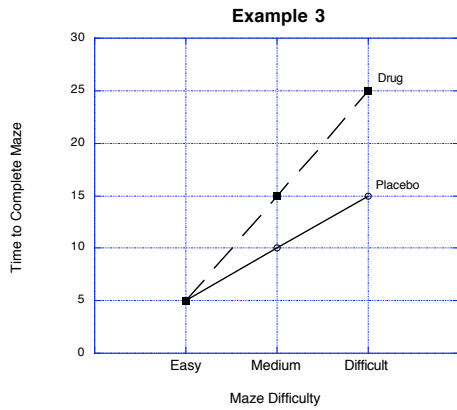
When an interaction is present, the lines in a graph of the means will not be parallel. Another way of describing the interaction is to say that the effects of one factor are not the same at all levels of the other factor. As you'll soon see, you could also say, "the *simple effects* are different," because a simple effect looks at the effects of one factor at each level of the other factor. Let's return to the Drug x Gender study that we looked at earlier. Below are two graphs of results of the study that would be consistent with an interaction.



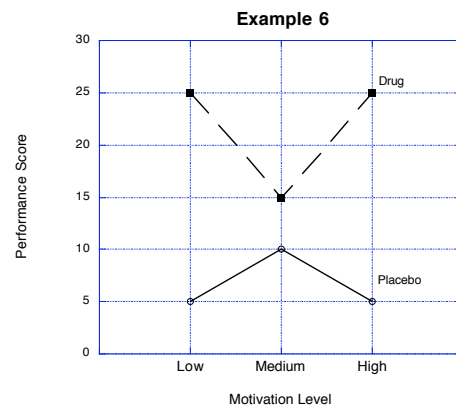
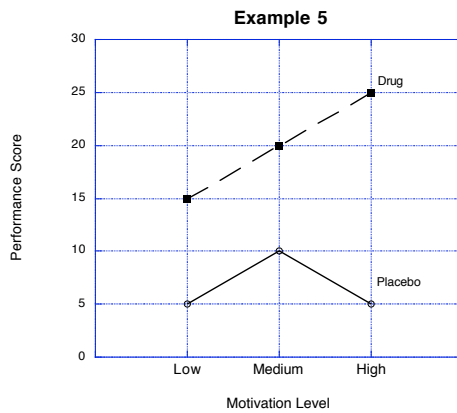
When we look at the effects of the drug on males and females separately, we're looking at the simple effects of the drug. In Example 1, for instance, there would be one simple effect of drug for males (with the drug leading to higher scores than the placebo), but there is a different simple effect for the drug on females (scores the same for the drug and placebo). Although the picture itself differs, you'll note that the simple effects of the drug still differ for males and females. In this case, for males the drug leads to higher scores than the placebo (a 20-point difference), which is also true for the females, but the change is greatly attenuated (only a 5-point difference).

In describing an interaction, you'll want to say "but," "however," "on the other hand," or some similar comparison. That is, in Example 1, you'd want to interpret the results as: "For males, the drug resulted in a higher score than the placebo, *however* for females the score for drug and placebo were not different." In Example 2, you'd want to interpret the results as: "For males, the drug resulted in a higher score than the placebo, *however* for females, although the drug resulted in higher scores than the placebo, that difference was much less than found for the males." It may, in fact, be easier to describe the interaction in Example 2 as: "For the placebo conditions, males and females did not differ, *however*, for the drug condition, males received higher scores than females." Note that we're still looking at simple effects, but we're looking at different simple effects.

As we did earlier, let's first consider a slightly more complex design (the rats in different mazes example). Suppose that the results turned out as seen below (Example 3). How would you interpret the results?



Now, consider Examples 4, 5, and 6 (for the motivation and drug study described earlier). How would you interpret these results?



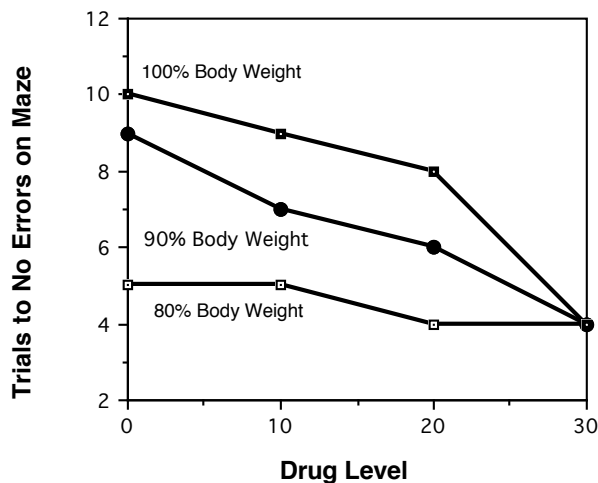
Now, let's consider some examples of results that will help you to become comfortable with interpretation of interactions.

The following is a summary of an experiment in problem solving:

The task involved a “lights and switches” apparatus (each light connected to several switches and each switch connected to several lights). The participant’s task was to figure out which switches had to be activated in order to have just the second light on the panel “on.” Two independent variables were involved in the experiment. One was the number of switches available to the participant (5, 7, or 9 switches); the other was the amount of money participants were told they could win by solving the problem very quickly (\$1, \$5, \$20). There were 10 participants in each of the cells and each participant was randomly assigned to one of the nine cells formed by the factorial combination of these two independent variables. Each participant’s time-to-solve the problem was measured in minutes. The numbers given here refer to the mean solution times for the nine cells. Assuming that all numerical differences are statistically significant, describe the results of the experiment to me in terms of main effects and the interaction. What df would be found in the source table for the components of variance (Switches, Reward, Switches x Reward, Within {or Error}, and Total)? How would you describe the outcome in words?

Amount of Money	Number of Switches		
	Five	Seven	Nine
\$1	14	17	20
\$5	10	17	24
\$20	8	17	26

An experimenter was interested in the effects of a memory-enhancing drug on the maze-completion behavior of rats. She gave 4 levels of the drug (0, 10, 20, 30) to 3 groups of rats that were food deprived to different levels of weight (80%, 90%, and 100% of free-feeding weight). She used a total of 120 rats, with an equal number in each condition. A graph of the data is seen below. The dependent variable is the number of trials it took for the rat to traverse the maze without making any errors.



Tell me what effects you would expect to find should you do an ANOVA on these data. Tell me the degrees of freedom you would use for the critical *F* you would use to test each of the effects. How would you interpret these results?

Suppose that you have a theory that self-esteem has an impact on a person's ability to solve problems. You randomly sample a large group of students and give them a test to measure self-esteem and are able to assign 40 participants to the Low Self-Esteem group, 40 participants to the Moderate Self-Esteem group, and 40 participants to the High Self-Esteem group. Suppose that you also believe that the difficulty of the problem will have an impact on problem-solving ability, so you assign a quarter of the participants in each of the 3 self-esteem groups to one of four different levels of problem complexity (Easy, Moderately Easy, Moderately Difficult, and Difficult).

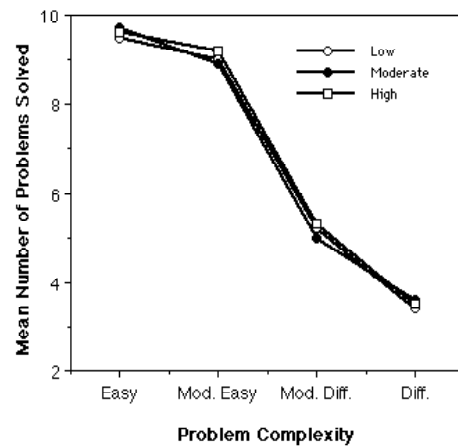
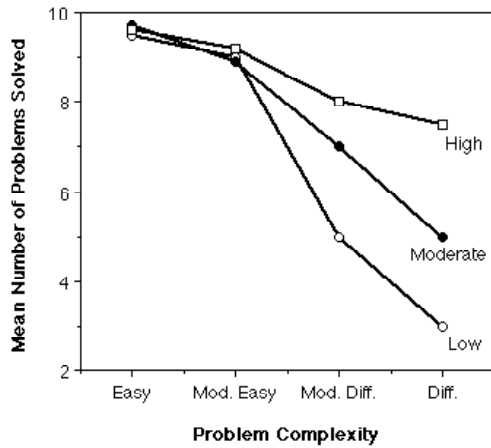
How would you describe this design?

How many participants are present in the study?

What df would you find in the source table analyzing the data?

Can you spot any limitations on your interpretation of the results of this study (i.e., any problems with your IVs)?

If your results came out as illustrated below, what would you expect to find in terms of the main effects and interactions and how would you interpret the results? (The left and right graphs illustrate the outcomes of two different experiments.)



Hmmm. There's an article with the intriguing title, "Why people fail to recognize their own incompetence" by Dunning, Johnson, Ehrlinger, and Kruger (2003). According to Confucius, "real knowledge is to know the extent of one's ignorance." Dunning, et al. (2003) asked students who were leaving an exam to judge how well they'd done on the exam. It turned out that students who performed the worst on the exam actually overestimated their performance and students who did the best on the exam were fairly accurate in their self-assessment (with a slight underestimation among the students with the best performance).

In one study, Kruger and Dunning (1999) gave additional information to some students, and that information had an impact on their judgments. Let's imagine a set of results that are consistent with their report. The dependent variable is the percent overestimation of a person's performance on an exam. So a score of zero is an accurate judgment. A positive score indicates overestimation and a negative score is an underestimation of one's performance. The students were divided into four groups based on their actual performance (Bottom Quartile, Second Quartile, Third Quartile, and Top Quartile). In addition, half of the students in each quartile were given a mini-lecture about the material after completing the exam (Add Info), but before making their judgments. The other half of each quartile was not given any additional information (No Info). Complete the source table below and interpret the results of this study as completely as you can.

**Descriptive Statistics**

Dependent Variable: Estimate

Quartile	Additional Info	Mean	Std. Deviation	N
Bottom	Add Info	12.3000	3.16403	10
	No Info	30.4000	4.29987	10
	Total	21.3500	9.98565	20
Second	Add Info	9.3000	1.41814	10
	No Info	20.9000	2.07900	10
	Total	15.1000	6.19762	20
Third	Add Info	4.0000	1.15470	10
	No Info	3.7000	1.33749	10
	Total	3.8500	1.22582	20
Top	Add Info	-.3000	.82327	10
	No Info	-1.3000	.94868	10
	Total	-.8000	1.00525	20
Total	Add Info	6.3250	5.22512	40
	No Info	13.4250	13.18874	40
	Total	9.8750	10.58824	80

**Tests of Between-Subjects Effects**

Dependent Variable: Estimate

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power <sup>b</sup>
Corrected Model					.000	.960	1720.260	1.000
Intercept					.000	.956	1578.668	1.000
Quartile	6184.650				.000	.946	1251.531	1.000
AddInfo	1008.200				.000	.739	204.020	1.000
Quartile * AddInfo	1308.100				.000	.786	264.708	1.000
Error	355.800							
Total								
Corrected Total	8856.750							

a. R Squared = .960 (Adjusted R Squared = .956)

b. Computed using alpha = .05