

## 10.2: Interpreting main effects and interactions

The interpretation of main effects and interactions can get tricky. Consider the concept of a main effect. This is the idea that a particular IV has a consistent effect. For example, drinking 5 cups of coffee makes you more awake compared to not drinking 5 cups of coffee. The main effect of drinking 5 cups of coffee vs not drinking coffee will generally be true across the levels of other IVs in our life. For example, let's say you conducted an experiment testing whether the effect of drinking 5 cups of coffee vs not, changes depending on whether you are in your house or in a car. Perhaps the situation matters? No, probably not so much. You will probably still be more awake in your house, or your car, after having 5 cups of coffee, compared to if you hadn't.

The coffee example is a reasonably good example of a consistent main effect. Another silly kind of example might be the main effect of shoes on your height. For example, if your IV was wearing shoes or not, and your DV was height, then we could expect to find a main effect of wearing shoes on your measurement of height. When you wear shoes, you will become taller compared to when you don't wear shoes. Wearing shoes adds to your total height. In fact, it's hard to imagine how the effect of wearing shoes on your total height would ever interact with other kinds of variables. You will be always be that extra bit taller wearing shoes. Indeed, if there was another manipulation that could cause an interaction that would truly be strange. For example, imagine if the effect of being inside a bodega or outside a bodega interacted with the effect of wearing shoes on your height. That could mean that shoes make you taller when you are outside a bodega, but when you step inside, your shoes make you shorter...but, obviously this is just totally ridiculous. That's correct, it is often ridiculous to expect that one IV will have an influence on the effect of another, especially when there is no good reason.

The summary here is that it is convenient to think of main effects as a consistent influence of one manipulation. However, when an interaction is observed, this messes up the consistency of the main effect. That is the very definition of an interaction. It means that some main effect is not behaving consistently across different situations. Indeed, whenever we find an interaction, sometimes we can question whether or not there really is a general consistent effect of some manipulation, or instead whether that effect only happens in specific situations.

For this reason, you will often see that researchers report their findings this way:

"We found a main effect of X, BUT, this main effect was qualified by an interaction between X and Y".

Notice the big BUT. Why is it there? The sentence points out that before they talk about the main effect, they need to first talk about the interaction, which is making the main effect behave inconsistently. In other words, the interpretation of the main effect depends on the interaction, the two things have to be thought of together to make sense of them.

Here are two examples to help you make sense of these issues:

### A consistent main effect and an interaction

```
library(ggplot2)
p7<- data.frame(IV1 = c("A","A","B","B"),
                 IV2 = c("1","2","1","2"),
                 means = c(2,12,5,9))
ggplot(p7, aes(x=IV1, y=means, group=IV2, color=IV2))+
  geom_point()+
  geom_line()+
  theme_classic()+
  theme(legend.position = "top")
```

run

restart

restart & run all

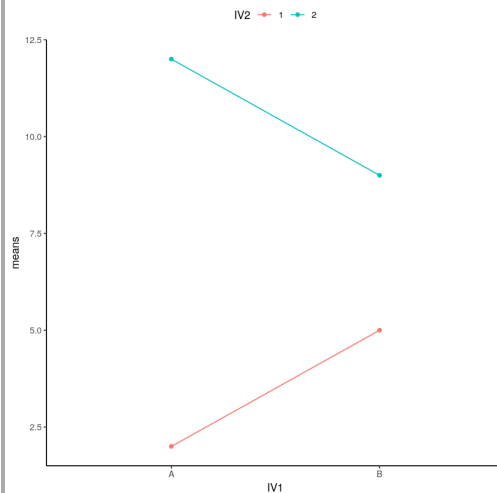


Figure \(\PageIndex{1}\): Example means showing a generally consistent main effect along with an interaction.

There is a main effect of IV2: the level 1 means (red points and bar) are both lower than the level 2 means (aqua points and bar). There is also an interaction. The size of the difference between the red and aqua points in the A condition (left) is bigger than the size of the difference in the B condition.

How would we interpret this? We could say there WAS a main effect of IV2, BUT it was qualified by an IV1 x IV2 interaction.

What's the qualification? The size of the IV2 effect changed as a function of the levels of IV1. It was big for level A, and small for level B of IV1.

What does the qualification mean for the main effect? Well, first it means the main effect can be changed by the other IV. That's important to know. Does it also mean that the main effect is not a real main effect because there was an interaction? Not really, there is a generally consistent effect of IV2. The green points are above the red points in all cases. Whatever IV2 is doing, it seems to work in at least a couple situations, even if the other IV also causes some change to the influence.

## An inconsistent main effect and an interaction

```
library(ggplot2)
p7<- data.frame(IV1 = c("A","A","B","B"),
                 IV2 = c("1","2","1","2"),
                 means = c(5,10,5,5))
ggplot(p7, aes(x=IV1, y=means, group=IV2, color=IV2))+
  geom_point()+
  geom_line()+
  theme_classic()+
  theme(legend.position = "top")
```

run

restart

restart & run all

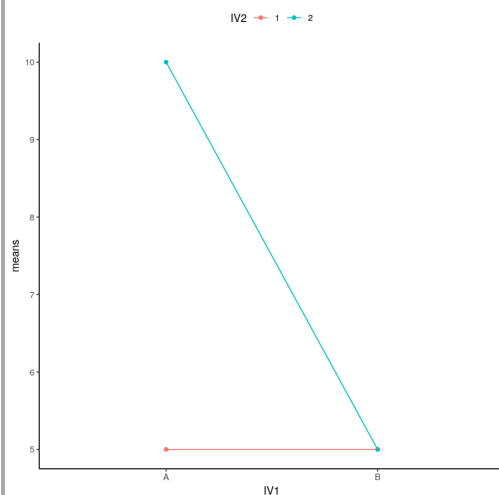


Figure 10.2: Example data showing how an interaction exists, and a main effect does not, even though the means for the main effect may show a difference.

This figure shows another 2x2 design. You should see an interaction here straight away. The difference between the aqua and red points in condition A (left two dots) is huge, and there is 0 difference between them in condition B. Is there an interaction? Yes!

Are there any main effects here? With data like this, sometimes an ANOVA will suggest that you do have significant main effects. For example, what is the mean difference between level 1 and 2 of IV2? That is the average of the green points (  $(10+5)/2 = 15/2 = 7.5$  ) compared to the average of the red points (5). There will be a difference of 2.5 for the main effect (7.5 vs. 5).

Starting to see the issue here? From the perspective of the main effect (which collapses over everything and ignores the interaction), there is an overall effect of 2.5. In other words, level 2 adds 2.5 in general compared to level 1. However, we can see from the graph that IV2 does not do anything in general. It does not add 2.5s everywhere. It adds 5 in condition A, and nothing in condition B. It only does one thing in one condition.

What is happening here is that a “main effect” is produced by the process of averaging over a clear interaction.

How would we interpret this? We might have to say there was a main effect of IV2, BUT we would definitely say it was qualified by an IV1 x IV2 interaction.

What’s the qualification? The size of the IV2 effect completely changes as a function of the levels of IV1. It was big for level A, and nonexistent for level B of IV1.

What does the qualification mean for the main effect? In this case, we might doubt whether there is a main effect of IV2 at all. It could turn out that IV2 does not have a general influence over the DV all of the time, it may only do something in very specific circumstances, in combination with the presence of other factors.

This page titled 10.2: Interpreting main effects and interactions is shared under a CC BY-SA 4.0 license and was authored, remixed, and/or curated by Matthew J. C. Crump via source content that was edited to the style and standards of the LibreTexts platform.