

## 3.4: Factorial ANOVA - Simple Effects

### Simple Effects

When researchers find an interaction it suggests that the main effects may be a bit misleading. Still using Gilliland's study (1980) mentioned on the last page, think of the example of a crossover interaction where introverts were found to perform better on a test of verbal test performance than extraverts when they had not ingested any caffeine, but extraverts were found to perform better than introverts when they had ingested 4 mg of caffeine per kilogram of body weight. To examine the main effect of caffeine consumption, the researchers would have averaged across introversion and extraversion and simply looked at whether overall those who ingested caffeine had better or worse verbal memory test performance. Because the positive effect of caffeine on extraverts would be wiped out by the negative effects of caffeine on the introverts, no main effect of caffeine consumption would have been found. Similarly, to examine the main effect of personality, the researchers would have averaged across the levels of the caffeine variable to look at the effects of personality (introversion vs. extraversion) independent of caffeine. In this case, the positive effects extraversion in the caffeine condition would be wiped out by the negative effects of extraversion in the no caffeine condition. Does the absence of any main effects mean that there is no effect of caffeine and no effect of personality? No of course not.

The presence of the interaction indicates that the story is more complicated, that the effects of caffeine on verbal test performance depend on personality. This is where simple effects come into play. **Simple effects** are a way of breaking down the interaction to figure out precisely what is going on. An interaction simply informs us that the effects of at least one independent variable depend on the level of another independent variable. Whenever an interaction is detected, researchers need to conduct additional analyses to determine where that interaction is coming from. Of course one may be able to visualize and interpret the interaction on a graph but a simple effects analysis provides researchers with a more sophisticated means of breaking down the interaction. Specifically, a simple effects analysis allows researchers to determine the effects of each independent variable at each level of the other independent variable. So while the researchers would average across the two levels of the personality variable to examine the effects of caffeine on verbal test performance in a main effects analysis, for a simple effects analysis the researchers would examine the effects of caffeine in introverts and then examine the effects of caffeine in extraverts. As we saw previously, the researchers also examined the effects of personality in the no caffeine condition and found that in this condition introverts performed better than extraverts. Finally, they examined the effects of personality in the caffeine condition and found that extraverts performed better than introverts in this condition. For a  $2 \times 2$  design like this, there will be two main effects the researchers can explore and four simple effects.

As described previously, Brown and colleagues found an interaction between type of words (health related or not health related) and hypochondriasis (high or low) on word recall. To break down this interaction using simple effects analyses they examined the effect of hypochondriasis at each level of word type. Specifically, they examined the effect of hypochondriasis on recall of health-related words and then they subsequently examined the effect of hypochondriasis on recall of non-health related words. They found that people high in hypochondriasis were able to recall more health-related words than people low in hypochondriasis. In contrast, there was no effect of hypochondriasis on the recall of non-health related words.

Once again examining simple effects provides a means of breaking down the interaction and therefore it is only necessary to conduct these analyses when an interaction is present. When there is no interaction then the main effects will tell the complete and accurate story. To summarize, rather than averaging across the levels of the other independent variable, as is done in a main effects analysis, simple effects analyses are used to examine the effects of each independent variable at each level of the other independent variable(s). So a researcher using a  $2 \times 2$  design with four conditions would need to look at 2 main effects and 4 simple effects. A researcher using a  $2 \times 3$  design with six conditions would need to look at 2 main effects and 5 simple effects, while a researcher using a  $3 \times 3$  design with nine conditions would need to look at 2 main effects and 6 simple effects. As you can see, while the number of main effects depends simply on the number of independent variables included (one main effect can be explored for each independent variable), the number of simple effects analyses depends on the number of levels of the independent variables (because a separate analysis of each independent variable is conducted at each level of the other independent variable).

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