

5.1: Within-Subjects Design

The designs we have covered so far in the book are all between-subjects designs, meaning each participant is assigned into one condition and being tested under one condition only. When we compare whether the treatments yield different outcomes, we are compare between participants or subjects from different treatment conditions, thus the name between-subjects design. In this chapter, we will look at a different type of design, where each participants will be assigned into multiple treatments. It is called within-subjects design.

Within-Subjects Design

In a **within-subjects design**, each participant is tested under all conditions. Consider an experiment on the effect of a defendant's physical attractiveness on judgments of his guilt. Again, in a between-subjects experiment, one group of participants would be shown an attractive defendant and asked to judge his guilt, and another group of participants would be shown an unattractive defendant and asked to judge his guilt. In a within-subjects experiment, however, the same group of participants would judge the guilt of both an attractive and an unattractive defendant.

The primary advantage of this approach is that it provides maximum control of extraneous participant variables. Participants in all conditions have the same mean IQ, same socioeconomic status, same number of siblings, and so on—because they are the very same people. Within-subjects design also makes it possible to use statistical procedures that remove the effect of these extraneous participant variables on the dependent variable and therefore make the data less “noisy” and the effect of the independent variable easier to detect. We will look more closely at this idea later shortly. However, not all experiments can use a within-subjects design nor would it be desirable to do so.

Carryover Effects and Counterbalancing

Remember in the first chapter, we talked about different common threats that can jeopardize the internal validity of our research designs. There are certain threats that are associated with within-subject design. The primary one in within-subjects designs is order effects. An **order effect** occurs when participants' responses in the various conditions are affected by the order of conditions to which they were exposed. One type of order effect is a carryover effect. A **carryover effect** is an effect of being tested in one condition on participants' behavior in later conditions. For example, participants may perform a task better in later conditions because they have had a chance to practice it. Or it could be the opposite where participants may perform a task worse in later conditions because they become tired or bored. Being tested in one condition can also change how participants perceive stimuli or interpret their task in later conditions. This type of effect is called a **context effect (or contrast effect)**. For example, an average-looking defendant might be judged more harshly when participants have just judged an attractive defendant than when they have just judged an unattractive defendant. Within-subjects experiments also make it easier for participants to guess the hypothesis. For example, a participant who is asked to judge the guilt of an attractive defendant and then is asked to judge the guilt of an unattractive defendant is likely to guess that the hypothesis is that defendant attractiveness affects judgments of guilt. This knowledge could lead the participant to judge the unattractive defendant more harshly because he thinks this is what he is expected to do. Or it could make participants judge the two defendants similarly in an effort to be “fair.”

Carryover effects can be interesting in their own right. (Does the attractiveness of one person depend on the attractiveness of other people that we have seen recently?) But when they are not the focus of the research, carryover effects can be problematic. Imagine, for example, that participants judge the guilt of an attractive defendant and then judge the guilt of an unattractive defendant. If they judge the unattractive defendant more harshly, this might be because of his unattractiveness. But it could be instead that they judge him more harshly because they are becoming bored or tired. In other words, the order of the conditions is a confounding variable. The attractive condition is always the first condition and the unattractive condition the second. Thus any difference between the conditions in terms of the dependent variable could be caused by the order of the conditions and not the independent variable itself.

There is a solution to the problem of order effects that can be used in many situations. It is **counterbalancing**, which means testing different participants in different orders. Using counterbalancing, the researcher(s) can have an equal or similar number of participants complete each possible order of conditions. For example, half of the participants would be tested in the attractive defendant condition followed by the unattractive defendant condition, and others half would be tested in the unattractive condition followed by the attractive condition. With three conditions (A, B, C), there would be six different orders (ABC, ACB, BAC, BCA, CAB, and CBA), so some participants would be tested in each of the six orders. With four conditions, there would be 24 different orders; with five conditions there would be 120 possible orders. With counterbalancing, participants are assigned to orders

randomly, using the techniques we have already discussed. Here, instead of randomly assigning to conditions, they are randomly assigned to different orders of conditions.

There are two ways to think about what counterbalancing accomplishes. One is that it controls the order of conditions so that it is no longer a confounding variable. Instead of the attractive condition always being first and the unattractive condition always being second, the attractive condition comes first for some participants and second for others. Likewise, the unattractive condition comes first for some participants and second for others. Thus any overall difference in the dependent variable between the two conditions cannot have been caused by the order of conditions. A second way to think about what counterbalancing accomplishes is that if there are carryover effects, it makes it possible to detect them. One can analyze the data separately for each order to see whether it had an effect.

Between-Subjects or Within-Subjects?

Now you have seen both between-subjects designs and within-subjects designs. Which one should we use? Almost every experiment can be conducted using either a between-subjects design or a within-subjects design. This possibility means that researchers must choose between the two approaches based on their relative merits for the particular situation.

Between-subjects designs have the advantage of being conceptually simpler and requiring less testing time per participant. They also avoid carryover effects without the need for counterbalancing. Within-subjects designs have the advantage of controlling extraneous participant variables, which generally reduces noise in the data and makes it easier to detect any effect of the independent variable upon the dependent variable. Within-subjects designs also require fewer participants than between-subjects designs to detect an effect of the same size.

A good rule of thumb, then, is that if it is possible to conduct a within-subjects experiment (with proper counterbalancing) in the time that is available per participant—and you have no serious concerns about carryover effects—this design is probably the best option. If a within-subjects design would be difficult or impossible to carry out, then you should consider a between-subjects design instead. For example, if you were testing participants in a doctor's waiting room or shoppers in line at a grocery store, you might not have enough time to test each participant in all conditions and therefore would opt for a between-subjects design. Or imagine you were trying to reduce people's level of prejudice by having them interact with someone of another race. A within-subjects design with counterbalancing would require testing some participants in the treatment condition first and then in a control condition. But if the treatment works and reduces people's level of prejudice, then they would no longer be suitable for testing in the control condition. This difficulty is true for many designs that involve a treatment meant to produce long-term change in participants' behavior (e.g., studies testing the effectiveness of new teaching/advising/counseling techniques). Clearly, a between-subjects design would be necessary here.

Remember also that using one type of design does not preclude using the other type in a different study. There is no reason that a researcher could not use both a between-subjects design and a within-subjects design to answer the same research question. In fact, professional researchers often take exactly this type of mixed methods approach.

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