

Science Education Collection

# Within-subjects Repeated-measures Design

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## Overview

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A within-subjects, or repeated-measures, design is an experimental design where all the participants receive every level of the treatment, *i.e.*, every independent variable. For example, in a candy taste test, the researcher would want every participant to taste and rate each type of candy.

This video demonstrates a within-subjects experiment (*i.e.*, one where there is an independent variable with several variations or levels) that examines how different motivational messages (*e.g.*, hard work, self-affirmation, outcomes, and positive affect) influence willingness to exert physical effort. As a within-subjects design, the participant will read each of the four types of motivational messages and then lift weights to measure physical effort. By providing an overview of how a researcher conducts a repeated-measures experiment, this video allows viewers to see how to address order effects through counterbalancing, which involves a systematic approach to making sure all possible orders of the conditions occur in the study.

Psychological studies often use higher sample sizes than studies in other sciences. A large number of participants helps to ensure that the population under study is better represented and the margin of error accompanied by studying human behavior is sufficiently addressed. In this video, we demonstrate this experiment using just one participant. However, as represented in the results, we used a total of 72 participants to reach the experiment's conclusions.

## Procedure

### 1. Define key variables.

1. Create an operational definition (*i.e.*, a clear description of exactly what a researcher means by a concept) of a motivational message.
  1. For the purposes of this experiment, a motivational message is any combination of image and phrase designed to energize a person's behavior, manipulated here by viewing a series of images accompanied by empowering quotes focusing on one of 4 areas: hard work, self-affirmation, outcomes/success, and general positive feelings/emotions (**Figures 1 - 4**).



Figure 1: The image shown with hard work motivational message.

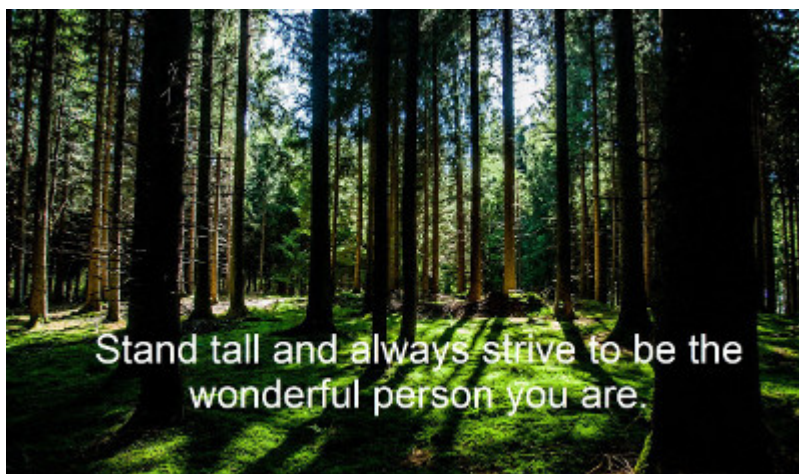


Figure 2: The image shown with self-affirmation motivational message.



Figure 3: The image shown with outcomes/success motivational message.

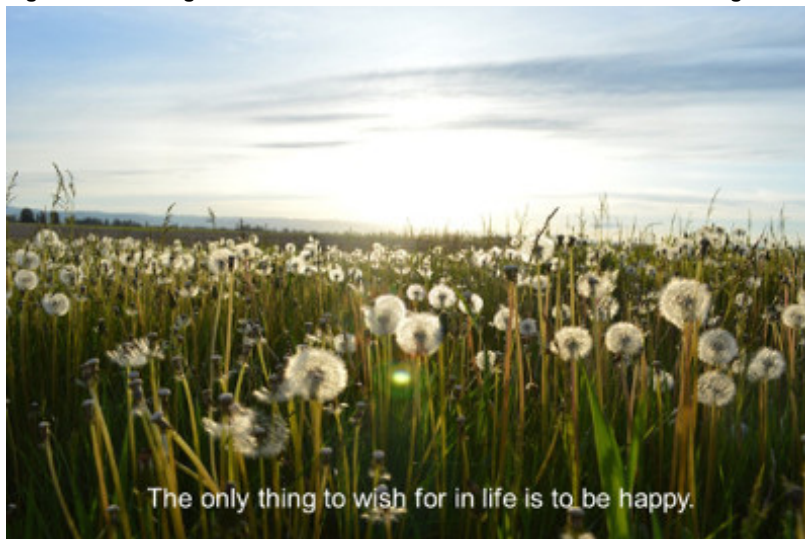


Figure 4: The image shown with general positive feelings and emotions motivational message.

2. Create an operational definition (*i.e.*, a clear description of exactly what a researcher means by a concept) of effort.
  1. For purposes of this experiment, effort is defined as the participant's willingness to exert physical strength on a weight-lifting task.

## 2. Conduct the study.

1. Meet the student/participant at the lab.
2. Provide participants with informed consent, a brief description of the research (influences on physical behavior), a sense of the procedure, an indication of potential risks/benefits, the right of withdrawal at any time, and a manner to get help if they experience discomfort.
3. Determine the order of conditions through counterbalance.
  1. It is important to address order effects. If conditions were always in the same order, the later conditions would likely perform worse because participants would be tired.
  2. Counterbalanced conditions involve a systematic approach in which the researcher insures that every order occurs during the study. Each condition occurs the same number of times in each of the spots in the order.
  3. Each participant receives only one order.
  4. Determine all possible orders of the four conditions (**Figure 5**).

HSOP	SHOP	OHSP	PHSO
HSPO	SHPO	OHPS	PHOS
HOSP	SOHP	OSHP	PSHO
HOPS	SOPH	OSPH	PSOH
HPSO	SPHO	OPHS	POHS
HPOS	SPOH	OPSH	POSH

H = Hard Work; S = Self-Affirmation;  
O = Outcomes; P = Positive Emotion

**Figure 5: Possible orders for the four conditions.**

5. Put each of the 24 possible orders on a slip of paper and place all slips in a bowl.
6. Researcher selects one slip and proceeds to run the experiment in that order. This action randomly selects one of the counterbalanced orders. The researcher should not replace the order in the bowl so that every order gets done once before repeating any one order a second time.
4. Run the conditions. (NOTE: the researcher will run all 4 conditions using these exact same steps. The only difference will be the image the participant views. The same participant will be shown doing all 4 conditions.)
  1. Show the participant a page-sized printout of the image/quote while the participant sits at a table.
  2. Tell the participant: "Please read this over and take 1 min to reflect on what it means to you."
  3. After a minute say: "Please stand and take this 10 lb dumbbell in your dominant hand. Complete as many curls as you'd like to in the next 30 s." Demonstrate the curl motion to the participant. Count aloud as you complete each one.
  4. Note the participant's number of curls on a data sheet (**Figure 6**).

Participant	Order	Hard Work	Self-Affirmation	Outcomes / Success	Positive Feelings
1	SOHP	10	6	5	3
2					
3					
4					
5					

**Figure 6: An example for recording participants' data by condition.**

## 3. Debrief the participant.

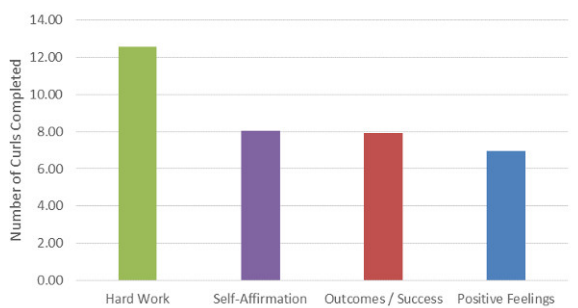
1. Tell the participant the nature of the study.
  1. "Thank you for participating. In this study, I was trying to determine if different types of motivational messages would increase the amount of physical effort participants were willing to exert. There were four types of messages: one emphasizing hard work, one emphasizing what a good person you are, one emphasizing successful outcomes, and one that was generally positive. We hypothesized that the message emphasizing hard work would result in exerting more physical effort."
2. Explain explicitly why deception was necessary for the experiment.
  1. "We could not tell you about our hypotheses ahead of time because we wanted you to act as naturally as possible."

## Results

The procedure was repeated three times in 24 counterbalanced orders, so data were collected from 72 total participants. A large number of participants is necessary to ensure that the results are reliable. If this research were conducted using just a few participants, it is likely that the results would have been much different and not reflective of the greater population.

To determine if there were differences between the motivational messages on physical effort, we performed a repeated-measures analysis of variance (ANOVA). The results indicated that participants who read the hard work motivational message exerted more physical effort by doing more curls of the 10 lb weight in 30 s (**Figure 7**).

This repeated-measures within-subject experiment shows how researchers use a study design to compare participants' experiences in one context to their own experiences in another context. In other words, the study allowed researchers to compare participants to themselves.



**Figure 7: Average number of times participants lifted the weight by motivational message type.**

## Applications and Summary

Repeated-measures within-subjects designs are particularly common in functional magnetic resonance imaging (fMRI) research. Participants lie in an fMRI machine and experience several conditions to see how the brain reacts to different experiences.

For example, one fMRI study wanted to determine which areas of the brain correlate with feelings of long-term and intense romantic love.<sup>1</sup> To test this, participants saw each of the following images: a highly familiar acquaintance, a close long-term friend, a low-familiar person, and their long-term romantic partner. Analyses indicated that the long-term romantic partner activated areas of the brain (e.g., the ventral tegmental area and dorsal striatum) associated with the dopamine reward system, as well as areas (e.g., globus pallidus and substantia nigra) associated with emotional attachments.

## References

1. Acevedo, B. P., Aron, A., Fisher, H. E., & Brown, L. L. Neural correlates of long-term intense romantic love. *Social Cognitive And Affective Neuroscience*. **8** (2), 145-159. doi:10.1093/scan/nsq092 (2012).