

AP Statistics - Experimental Design and Random Assignment - Lesson

Common Core AP STAT 3.4, AP STAT 3.5, AP STAT 3.6, HSS-IC.B.3, HSS-IC.B.5 · maths-pdf.fr/en/

An experiment imposes treatments on experimental units and measures a response; an observational study only observes. Good experiments use comparison, random assignment, control of other variables, and replication, and may use placebos and blinding. Random assignment supports cause-and-effect conclusions, while random selection supports generalizing to a population.

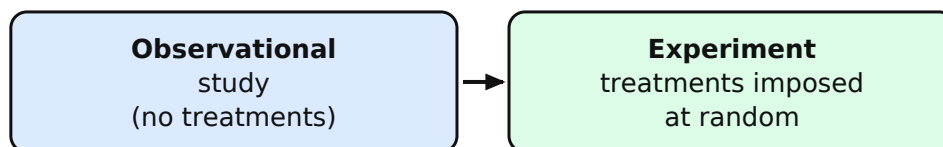
AP Statistics · Common Core State Standards: **AP STAT 3.4, AP STAT 3.5, AP STAT 3.6, HSS-IC.B.3, HSS-IC.B.5**

Key facts

- Experiments impose treatments; observational studies do not and cannot prove causation.
- Confounding occurs when the effects of two variables on the response cannot be separated.
- Good design: comparison, random assignment, control, replication; use blinding and placebos when needed.
- Designs: completely randomized, randomized block, matched pairs.
- Random assignment allows cause-and-effect; random selection allows generalization.

What is the difference between an observational study and an experiment?

In an **observational study**, researchers observe individuals and measure variables without influencing them. In an **experiment**, researchers impose **treatments** on **experimental units** and measure the response. Only well-designed experiments can support cause-and-effect conclusions.



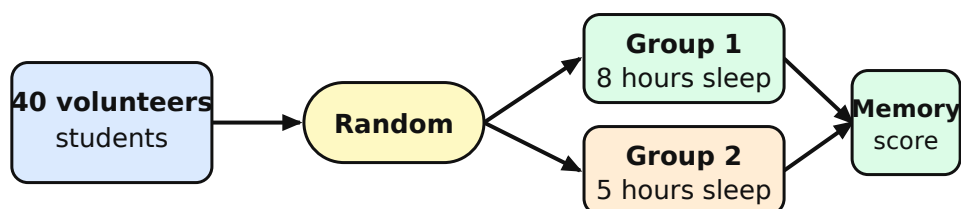
Only an experiment can show cause and effect.

Key terms

The **explanatory variable** is the factor that is manipulated, and its values are the **treatments**. The **response variable** is what is measured. A **confounding variable** is associated with the explanatory variable and also affects the response, so its effect cannot be separated.

What makes a good experiment?

1. **Comparison:** use at least two treatments, often including a control group (no treatment or a placebo).
2. **Random assignment:** use chance to assign units to treatments, so the groups are alike on average.
3. **Control:** keep other variables the same for all groups.
4. **Replication:** use enough units to see the effect despite random variation.

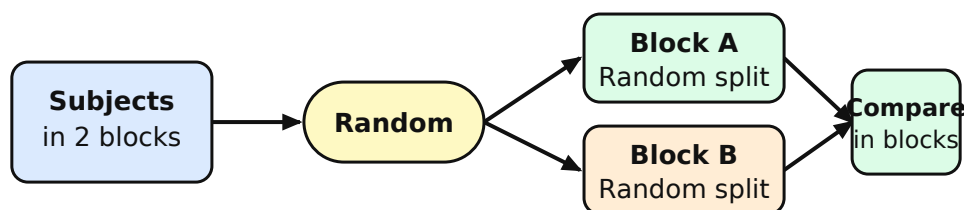


Completely randomized design: random assignment to two treatments, then compare the response.

A **placebo** is an inactive treatment. In a **double-blind** experiment, neither the subjects nor the people measuring the response know who got which treatment.

What are the common experimental designs?

In a **completely randomized design**, all units are randomly assigned to treatments. In a **randomized block design**, units are first grouped into **blocks** of similar units (for example by age), and random assignment is done within each block. In a **matched pairs design**, each subject receives both treatments in random order, or two similar subjects are paired and one gets each treatment.



Randomized block design: randomize within blocks of similar subjects.

What can you conclude?

If the difference in responses is too large to be explained by chance variation in the random assignment, the result is **statistically significant**. Random assignment lets you conclude cause and effect; random selection lets you generalize to the population.

	Random assignment	No random assignment
Random selection	Generalize and cause	Generalize only
No random selection	Cause for the sample	Neither

Scope of inference: selection controls generalizing; assignment controls causation.

Questions about experimental design and random assignment

Why is random assignment important?

It creates treatment groups that are similar on every variable, measured or not, on average. Then a large difference in responses is unlikely to be caused by anything except the treatment.

What is a confounding variable?

A confounding variable is related to both the explanatory variable and the response so that you cannot tell which one caused the change. In an observational study, confounding is a major reason not to claim causation.

What is the difference between blocking and stratifying?

Both group similar units. Blocking is used in experiments before random assignment to treatments; stratifying is used in sampling before randomly selecting individuals.

When should I use a matched pairs design?

Use it when subjects can serve as their own control, such as measuring each runner's time in both shoe types in random order, or when subjects can be paired by a strong related variable.

What does statistically significant mean?

It means the observed difference between treatment groups is larger than would be expected from random assignment alone, so it is unlikely to be due to chance.