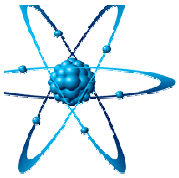


A Strong Hypothesis

"If _____[I do this] _____, then _____[this]_____ will happen."

Sound familiar? It should. This approach to making a statement about what you "think" will happen is the basis of most science fair projects and much scientific exploration.

Step by Step

You can see from the basic outline of the Scientific Method below that writing your hypothesis comes early in the process:

1. Ask a Question
2. Do Background Research
3. **Construct a Hypothesis**
4. Test Your Hypothesis by Doing an Experiment
5. Analyze Your Data and Draw a Conclusion
6. Communicate Your Results

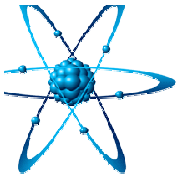
Following the scientific method, we come up with a question that we want to answer, we do some initial research, and then **before** we set out to answer the question by performing an experiment and observing what happens, we first clearly identify what we "think" will happen.

We make an "educated guess."

We write a hypothesis.

We set out to prove or disprove the hypothesis.

What you "think" will happen, of course, should be based on your preliminary research and your understanding of the science and scientific principles involved in your proposed experiment or study. In other words, ***you don't simply "guess."*** You're not taking a shot in the dark. You're not pulling your statement out of thin air. Instead, you make ***an "educated guess"*** based on what you already know and what you have already learned from your research.



If you keep in mind the format of a well-constructed hypothesis, you should find that writing your hypothesis is not difficult to do. You'll also find that in order to write a solid hypothesis, you need to understand what your variables are for your project. It's all connected!

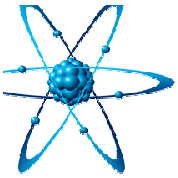
If I never water my plant, it will dry out and die.

That seems like an obvious statement, right? The above hypothesis is too simplistic for most upper el- Jr. High science projects. However, as you work on deciding what question you will explore, you should be looking for something for which the answer is not already obvious or already known (to you). When you write your hypothesis, it should be based on your "educated guess" not on known data. Similarly, the hypothesis should be written ***before*** you begin your experimental procedures—not after the fact.

Hypotheses Tips

From the staff at Sciencebuddies.com.

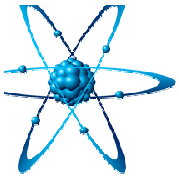
- ***The question comes first.*** Before you make a hypothesis, you have to clearly identify the question you are interested in studying.
- ***A hypothesis is a statement, not a question.*** Your hypothesis is not the scientific question in your project. The hypothesis is an educated, testable prediction about what will happen.
- ***Make it clear.*** A good hypothesis is written in clear and simple language. Reading your hypothesis should tell a teacher or judge exactly what you thought was going to happen when you started your project.
- ***Keep the variables in mind.*** A good hypothesis defines the variables in easy-to-measure terms, like who the participants are, what changes during the testing, and what the effect of the changes will be. (For more information about identifying variables, see: Variables in Your Science Fair Project at Sciencebuddies.com.)
- ***Make sure your hypothesis is "testable."*** To prove or disprove your hypothesis, you need to be able to do an experiment and take measurements or make observations to see how two things (your variables) are related. You should also be able to repeat your experiment over and over again, if necessary.



To create a "testable" hypothesis make sure you have done all of these things:

- Thought about what experiments you will need to carry out to do the test.
- Identified the variables in the project.
- Included the independent and dependent variables in the hypothesis statement. (This helps ensure that your statement is *specific* enough.

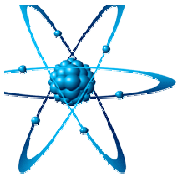
- ***Do your research.*** You may find many studies similar to yours have already been conducted. What you learn from available research and data can help you shape your project and hypothesis.
- ***Don't bite off more than you can chew!*** Answering some scientific questions can involve more than one experiment, each with its own hypothesis. **Make sure your hypothesis is a specific statement relating to a single experiment.**



Putting it in Action – Hypothesis

To help demonstrate the above principles and techniques for developing and writing solid, specific, and testable hypotheses, Sandra and Kristin, (Sciencebuddies) offer the following ***good*** and ***bad*** examples.

Good Hypothesis	Poor Hypothesis
When there is less oxygen in the water, rainbow trout suffer more lice.	***Our universe is surrounded by another, larger universe, with which we can have absolutely no contact.***
Kristin says: "This hypothesis is good because it is testable, simple, written as a statement, and establishes the participants (*trout*), variables (*oxygen in water, and numbers of lice*), and predicts effect (*as oxygen levels go down, the numbers of lice go up*)."	Kristin says: "This statement may or may not be true, but it is not a scientific hypothesis. By its very nature, **it is not testable**. There are no observations that a scientist can make to tell whether or not the hypothesis is correct. This statement is speculation, not a hypothesis."
Aphid-infected plants that are exposed to ladybugs will have fewer aphids after a week than aphid-infected plants which are left untreated.	***Ladybugs are a good natural pesticide for treating aphid infected plants.***
Sandra says: "This hypothesis gives a clear indication of what is to be tested (*the ability of ladybugs to curb an aphid infestation*), is a manageable size for a single experiment, mentions the independent variable (*ladybugs*) and the dependent variable (*number of aphids*), and predicts the effect (*exposure to ladybugs reduces the number of aphids*)."	Sandra says: "This statement is not 'bite size.' Whether or not something is a 'good natural pesticide' is too vague for a science fair project. There is no clear indication of what will be measured to evaluate the prediction."



Hypotheses in History

Throughout history, scientists have posed hypotheses and then set out to prove or disprove them. Staff Scientist Dave reminds that scientific experiments become a dialogue between and among scientists and that hypotheses are rarely (if ever) "eternal." In other words, ***even a hypothesis that is proven true may be displaced by the next set of research on a similar topic,*** whether that research appears a month or a hundred years later.

A look at the work of Sir Isaac Newton and Albert Einstein, more than 100 years apart, shows good hypothesis-writing in action.

As Dave explains, "A hypothesis is a possible explanation for something that is observed in nature. For example, it is a common observation that objects that are thrown into the air fall toward the earth. Sir Isaac Newton (1643-1727) put forth a hypothesis to explain this observation, which might be stated as 'objects with mass attract each other through a gravitational field.'"

Newton's hypothesis demonstrates the techniques for writing a good hypothesis: It is testable. It is simple. It is universal. It allows for predictions that will occur in new circumstances. It builds upon previously accumulated knowledge (e.g., Newton's work explained the observed orbits of the planets).

"As it turns out, despite its incredible explanatory power, Newton's hypothesis was wrong," says Dave. "Albert Einstein (1879-1955) provided a hypothesis that is closer to the truth, which can be stated as 'objects with mass cause space to bend.' This hypothesis discards the idea of a gravitational field and introduces the concept of space as *bendable*. Like Newton's hypothesis, the one offered by Einstein has all of the characteristics of a good hypothesis."

"Like all scientific ideas and explanations," says Dave, "hypotheses are all partial and temporary, lasting just until a better one comes along."

That's good news for scientists of all ages. There are always questions to answer and educated guesses to make!

Hypothesis Checklist

What Makes a Good Hypothesis?	For a Good Hypothesis, You Should Answer "Yes" to Every Question
Is the hypothesis based on information contained in the Research Paper?	Yes / No
Does the hypothesis include the independent and dependent variables?	Yes / No
Have you worded the hypothesis so that it can be tested in the experiment?	Yes / No
If you are doing an engineering or programming project, have you established your design criteria?	Yes / No