

# Internal Validity Cards

(adapted from study.com)

## 10:1 What is Internal Validity in Research? - Definition & Examples

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The purpose of most research is to show that one variable causes changes in another variable. But what happens when other variables come into play? In this lesson, we'll explore the definition, importance and threats to internal validity.

### Internal Validity

Sean works for a large corporation, and they've hired someone to figure out if more money will mean more productivity for their workforce. In other words, they want to know if they pay Sean a higher salary, will he work more?

At first glance, the answer appears to be yes. After all, the people who get paid the most at the company tend to be the ones that come in early and stay late. They are the hardest working people in the company. So, it stands to reason that the more a person gets paid, the harder they will work, right?

Maybe, but it's actually a bit more complicated than that. Maybe those people get paid the most because they were already hard workers. Maybe they're motivated to work hard because they really like what they do and the pay is incidental. Maybe they are hyper competitive and don't want to be the first to leave the office.

How do we know what the cause of their hard work is? In research, **internal validity** is the extent to which you are able to say that no other variables except the one you're studying caused the result. For example, if we are studying the variable of pay and the result of hard work, we want to be able to say that no other reason (not personality, not motivation, not competition) causes the hard work. We want to say that pay and pay alone makes people like Sean work harder.

## Importance

You may be wondering why we should care about internal validity. If people who work the hardest get paid the most, then why not just say that's what happens and call it a day?

The purpose of most research is to study how one thing (called the independent variable) affects another (called the dependent variable). The strongest statement in research is one of causality. That is, if we can say that the independent variable causes the dependent variable, we have made the strongest statement there is in research.

But that's not possible if an experiment has low internal validity. Remember our example from above? How do we know that pay causes harder work if there are other possibilities, like competition or motivation? The answer is that we don't. That's why internal validity is so important.

The best experiments are designed to try to eliminate the possibility that anything other than the independent variable caused the changes in the dependent variable. In our experiment, we would try to eliminate all other things that might be causing the hard work by the workers. If we can do that, then we can show that higher pay causes harder work.

## Threats

But designing a study that allows you to prove causality isn't as easy as it might seem. That's because there are several common threats to internal validity. These are things that make it difficult to prove that the independent variable is causing the changes in the dependent variable.

One threat to internal validity is **selection**. This is simply the fact that the **people who are studied may not be normal**. Do the people at Sean's company who get paid the most work hard because they are paid a lot, or do they get paid a lot because they are inherently hard workers? By studying them, we might be studying just people who already work hard; we have accidentally selected people whose experience does not mirror everyone else's.

Another threat to internal validity is **maturation**. How do we know that people wouldn't **change during the study because they matured instead of because of the effect of the independent variable**? For example, imagine that we look at Sean's productivity before and after he got a raise and figure out that he is more productive after the raise.

But what if he became a harder worker because he is aging and becoming more responsible? What if he became more productive because he's had more time at his job and has learned how to do it better? We don't know if one of these is the reason or if the raise is the reason.

Likewise, if a one-time historical event happens that affects Sean's productivity, it's the threat of **history**. Maybe Sean's wife had a baby around the time he got a raise; being a dad has made him more responsible and a harder worker.

Maybe we look at how productive Sean is one week before his raise and one week after his raise. But what if the week before his raise was a bad week for him, and the week afterwards, he goes back to his normal level of productivity? To us, it looks like he's working harder, but the truth is that he was just really bad the week before. This threat is called **regression to the mean**.

And what if our measurement of productivity isn't actually the best measure? For example, maybe we measure how long a person stays at work, but Sean is able to get his work done faster. He does the same amount of work but in less time. This is a problem with our **instrumentation**.

What if we give Sean a test the first week to measure how hardworking he is? The second week, after the raise, we give him the test again. Because he took the test already, he's better at it the second time. This is called **testing effects**.

Finally, what if we measure Sean's productivity before his raise, but shortly after his raise, he quits? Because he no longer works at the company, we can't measure his post-raise productivity. This type of threat to internal validity is called **mortality, and it happens when members of the study leave the study for some reason**.

## Lesson Summary

An experiment that is high in **internal validity** is able to prove that the independent variable caused the dependent variable and no other variable did. It is important in order to show causality between variables. There are several threats to internal validity, though, including selection, maturation, history, regression to the mean, instrumentation, testing and mortality.

## 10:2 Extraneous & Confounding Variables: Differences & Examples

What happens when something other than your independent variable is influencing the outcome of your study? In this lesson, we'll look at two types of variables that can affect an experiment: extraneous and confounding variables.

### Internal Validity

Josh is in love. He's been with his girlfriend a while now and wants to propose. But he doesn't know how he should do it. Should he propose in a crowd? When they're alone? At the place where they went for their first date? After he whisks her off to Paris or the Bahamas?

Josh is a psychologist and does research for a living, so he decides to do a study on marriage proposals and figure out which one women like best. That's how he'll decide how to propose. He gathers a bunch of women, shows them videos of marriage proposals, and then measures their reactions: whether they cry or if their heart races or if they just watch it and go, 'Eh.'

In research, **internal validity** is when a researcher can say that only the independent variable caused changes in the dependent variable. For example, in Josh's study, the videos are the independent variables and the women's reactions are the dependent variables. If Josh changes which videos he shows the women, he sees different reactions. If his internal validity is high, he can say that the difference in videos caused the changes in the reactions.

If most women who watch video A say, 'Aw, how sweet!' and most women watching video B say, 'Well, that's an epic fail,' then Josh wants to know for sure that it's actually the video that's causing the reactions, not something else. Let's look closer at variables that might affect the dependent variable besides the independent variable: extraneous and confounding.

### Extraneous Variables

Okay. So, let's imagine that Josh has set up his experiment. Each subject is brought into a little room and is shown two of six different videos. Josh measures their reaction to each video and then their reaction overall.

Josh expects that he will see the women react more positively to the videos they believe are most romantic. Not only that but he believes that if he shows a woman two proposals that most women believe are really romantic, then she'll have a higher reaction level overall than someone who is shown only one really romantic video and one that's, well, sort of romantic. But what happens if the women who are shown two really romantic proposal videos are put in a room that's much warmer than the other women? Or what if they are given a red rose before going into the room but the other women aren't?

Both of these are examples of **extraneous variables**, or **variables present in the experiment that aren't being studied**. If all of the women who are shown the two most romantic proposals are tall and all the other women are short, will that make a difference? What about the examples we gave above of room temperature or the rose? How will those affect the outcomes of the study?

The problem with extraneous variables is that **they might affect the dependent variable but they might not. There's no way to tell until after the experiment is done**. Extraneous variables are usually grouped into three categories:

1. **Physical or Situational Variables:** These occur when the physical situation of subjects changes for certain groups, like the fact that women shown the most romantic proposals are in a warmer room.
2. **Personal Variables:** These are when one group has personality or other traits that members of the other group don't. For example, what if the women shown the most romantic video clips are also more romantic in nature than the other women?
3. **Researcher Variables:** These are when the researcher, himself, does something different for the various groups of the experiment. For example, what if Josh was really nice to the women who saw the two romantic videos and he was very gruff with the other groups?

Notice that **extraneous variables are only important if they are present for one group and not the other**. If all of your subjects are exposed to the same extraneous variable (like if Josh was nice to all the subjects), then it won't change your dependent variable and it's not considered an extraneous variable.

## Confounding Variables

So, extraneous variables affect your dependent variable in some way, and what you really want is for the independent variable to be the only one affecting your dependent variable. But what if you have an extraneous variable that is related to your independent variable, which in turn affects your dependent variable?

For example, what if Josh gives the women who are watching the most romantic proposals a rose before they go in to watch the proposals? Maybe that makes the women feel more romantic even before watching the videos, and so they are more likely to have a romantic reaction. Being given the rose is related to which videos that the women watch; if a subject is given a rose, then she will also be shown the romantic videos.

A **confounding variable** is an extraneous variable that is related to your independent variable and might affect your dependent variable. In an ideal study, there will be no confounding variables.

Let's look at another example of a confounding variable; let's say that whenever Josh is stressed out, he gets muscle cramps. He thinks that stress causes his muscle cramps. In this example, stress is the independent variable, and the muscle cramps are the dependent variable. But wait a minute; when he's stressed, he also drinks lots of caffeine and he exercises more to try to combat the stress. His muscle cramps could be caused by caffeine or over-exercising. Those are both confounding variables: they are related to his stress levels and might affect his muscle cramps.

## Lesson Summary

**Internal validity** is the extent to which a researcher can say that only the independent variable affected the dependent variable. There are two types of variables that can lower internal validity: **extraneous variables**, which are any factors that are in the experiment but not being studied, and **confounding variables**, which are related to the independent variable and affect the dependent variable.

## 10:3 Physical Variables that Affect Internal Validity

How might a researcher accidentally mess up the results of his or her study? In this lesson, we'll look at one type of extraneous variable that can change experimental results - physical or situational variables.

## Internal Validity

Sarah is a psychologist, and she wants to know whether tall people are better at math problems than short people. She decides to run an experiment where she gives tall people math problems and compares their results to the performance of short people given the same math test. If the tall people do better than the short people, then she believes she'll have proven that tall people are better than short people at math.

But what if the tall people that she chooses have taken a lot of math classes and the short people have only taken one or two? What if the tall people are older and therefore better at math than the short people?

In research, **internal validity** is an important concept. Internal validity is the extent to which a researcher can say that only the independent variable is causing changes in the dependent variable. In Sarah's case, the independent variable is height, and the dependent variable is math skill. If Sarah has a high internal validity, then she can say that height (and only height) is the cause of higher math skill.

## Extraneous Variables

But what if Sarah can't quite say that? Remember that we said that perhaps the taller subjects are actually older and are therefore better at math because their brains have developed more. Or maybe they've taken more math classes than the short people. Both of these are examples of **extraneous variables**, or factors other than the independent variable that might cause changes in the dependent variable.

Extraneous variables are dangerous things because they mean that the researcher isn't able to fully prove his or her case. For example, even if the tall people in Sarah's study do better on her math problems, is she able to say that it's because they are better at math? Or is it because they are older and have had more math classes?

The goal of research is to show that one thing causes another. If there are many extraneous variables in the study, then the researcher is not sure what is causing the changes in the dependent variable. Internal validity is low, and the study is not as good as it could be.

Of course, there are ways to eliminate the impact of extraneous variables. For example, Sarah could make sure that all of the study participants are the same age and that they've all taken the same number of math

courses. This will help her control or eliminate the impact of those extraneous variables.

## Physical Variables

There are many types of extraneous variables. One type that's easy to control are **physical variables**, sometimes called **situational variables**, which are extraneous variables that have to do with the physical space or situation of the experiment. Let's look at an example. What if, in Sarah's study, the tall people were given the math problems in a comfortable room? The room was quiet, at a comfortable temperature and had good lights to see by.

But what if Sarah gave the short people the math problems in a room that had loud construction going on right outside of it, was freezing cold and had very dim lights that made it hard to see? The differences in the situations while taking the math test could impact the results. The tall people, who are in a comfortable room, might do better because they are tall or because they have a better situation for taking the test. The short people might be distracted by the noise or cold temperature, and they might have trouble reading the problems on the test because of the lights.

As we mentioned, the best studies control for extraneous variables, and situational variables are relatively easy to control for. What should Sarah do? She should give the math problems to all of the subjects under the same conditions. If tall people are in a comfortable room, then short people should be, too. If tall people are given the test in the afternoon, she shouldn't give it to the short people in the morning.

There are many, many situational extraneous variables, but as long as all the subjects are in the same situation, the variables are controlled for. If Sarah gives the math problems to the short people in a room that has loud construction noises, she should do the same for the tall people. That way, even if the noise affects the subjects' performance, the effect will occur in both groups.

## Lesson Summary

**Internal validity** is the extent to which a researcher can say that only the independent variable causes the changes in the dependent variable of a study. This can be made more complicated by the presence of **extraneous variables**, which are factors other than the independent



variable that can impact the dependent variable. One type of extraneous variable is **physical** or **situational variables**, which involve the situation of the experiment. **Situational variables can be controlled for by having all subjects experience the same situation during the experiment.**

## 10:4 Researcher Variables that Affect Internal Validity

Scientists want only the independent variable to affect the outcome of their studies, but sometimes it is the things they do themselves that change the outcome. We'll look at three common researcher-related variables: researcher bias, selection bias, and researcher personality in this lesson.

### Internal Validity

Joan is an educational psychologist. She's doing research on what teaching technique works best for college students. She has three different techniques, which she calls A, B, and C. She also has three different college professors teaching an introductory psychology class. Each professor will try out a different technique, and at the end of the semester, the students who do best on the final will tell Joan which technique is the most effective one.

Sounds pretty simple and straightforward, right? Joan has an independent variable (teaching technique), and she believes it will affect her dependent variable (student performance on the final). But what if one of the professors has students who study more often than the students in the other professors' classes? What if one of the professors ends up sick and unable to teach the second half of the semester?

**Internal validity** is the extent to which a researcher can say that only their independent variable caused changes in the dependent variable. Other variables that might influence the dependent variable (like students' study time or professor illness) are called **extraneous variables**. The goal of any study is to have high internal validity by having no extraneous variables. Of course, in the real world this is not always possible, but there are some things that researchers can do to control or eliminate the effects of certain extraneous variables. Let's look at extraneous variables that have to do with the researcher and how to control them.

## **Researcher Bias**

Joan believes that teaching technique A is better than teaching techniques B and C. She thinks that the students in the class with the professor using technique A will do better on the final exam and prove her theory that technique A is better than the others. Joan's belief that technique A is best is a hypothesis, but it can also be a source of researcher bias.

In researcher bias, the researcher's beliefs influence the outcome of an experiment. For example, what if Joan grades the final exams for the technique A class in an easier light than those in the other classes? In this case, Joan is influencing the results; the students in the class exposed to technique A might have learned the material better or they might just have scored better because of Joan's grading.

The thing about researcher bias is that it is often unknown even to the researcher. Maybe Joan doesn't realize that she's grading the technique A class finals easier. She's looking for evidence to support her hypothesis, and she sees it and goes with it, not realizing that she's displaying bias. Or maybe Joan grades the finals for technique A last and by that time she's tired and goes through them quickly, not noticing as many errors as in the ones she graded earlier. Again, this could be a cause of bias.

There is always bias; if there wasn't, we would never have hypotheses! But to control for the impact of bias on the results, Joan could have someone else (or two other people) score the finals and not tell them which finals are from which group. That would help keep her bias from impacting the results.

## **Subject Selection**

A specific type of researcher bias that pops up sometimes is selection bias. In this case, the bias appears at the beginning of the experiment, when selecting and assigning subjects to conditions. For example, let's say that one of the three professors is a really good, really experienced professor. Students who are psychology majors sign up for his section of the introductory class, while the non-psych majors are left with the other two less experienced professors.

When assigning techniques, Joan has the experienced professor do technique A and assigns the other two professors to techniques B and C.

The problem is that the professor is more experienced, and he has psychology majors who are more interested, adept, and highly motivated to do well in the class than the students in the other sections.

So how does Joan know if the students in that class did better because they were exposed to technique A or because they would have done better anyway? The answer is that she doesn't know. Selection bias is influencing her results and making it difficult to know what is actually causing that class's success. To control for selection bias, Joan should randomly assign the techniques to the professors. She could, for example, draw names from a hat to assign this professor to that technique.

## Researcher Personality

One final researcher-based extraneous variable is researcher personality. Let's say for a moment that the professor assigned to technique A is very dynamic and energetic. He's friendly and approachable, so his students feel comfortable seeking him out and asking questions.

On the other hand, the professors for techniques B and C are not very energetic. They give boring lectures and speak in quiet, monotone voices. They aren't very approachable, and students aren't enthusiastic about approaching them with questions. In this case, Joan can't know if the differences in the scores on the final are due to the teaching technique or to the personalities of the professors.

To control for researcher personality, Joan would ideally find three professors with similar personalities to try out the different techniques. Another option would be to have more than three professors using the technique. For example, if she had 10 professors using each technique (30 professors in total), then the personality of one or two of the professors would not have as profound an impact on the results.

## Lesson Summary

**Internal validity** is the extent to which a researcher can say that only the independent variable caused changes in the dependent variable.

**Extraneous variables**, or variables other than the independent variable that influence the dependent variable, lower internal validity. There are three major types of researcher-based extraneous variables: researcher bias, selection bias, and researcher personality.

## 10:5 Participant Variables that Affect Internal Validity

### Internal Validity

Ollie is doing a study on the effects of light on factory workers. Specifically, he wants to know if brighter lights will result in more productive work. He goes to a factory that makes computer parts and asks for volunteers for a study. After he gets his volunteers, he puts them into a room of their own and asks them to make computer parts as usual. Each week, he totals up the number of computer parts they make. Also each week, he adjusts the level of light they have in the room. If what he is thinking is right, then the weeks where the lights are brightest will produce the most computer parts.

**Internal validity** is the extent to which a study proves that only the independent variable is causing the changes in the dependent variable. In Ollie's case, he wants to prove that the light level (the independent variable) is causing changes in the productivity of the workers (the dependent variable). But wait. What if the brighter lights make the room warmer? Because they feel hotter, the subjects might not do as much work. This is an example of an **extraneous variable**, or a factor besides the independent variable that affects the dependent variable. There are several types of extraneous factors. Let's look at a few that involve the participants.

### Self-Selection Bias

Remember that Ollie asked for volunteers from among the workers at the factory. Psychological studies are done on volunteers, which poses a threat to internal validity known as **self-selection bias**. Think about this: what types of workers at the factory are most likely to volunteer for Ollie's study? Probably workers who are enthusiastic. They are most likely the same types of people who will volunteer to take on additional

responsibility. They might be better at their jobs than non-volunteers, who just don't care one way or another.

Because they are enthusiastic go-getters, the subjects themselves might be the type of people who are always trying to improve and be more productive. As a result, Ollie won't know whether the results are because

of his manipulation of the lights or because the self-selected subjects are the type of people who are regularly trying to be more productive.

## Demand Characteristics

Another participant-influenced extraneous variable is known as **demand characteristics**, or the **Hawthorne effect**. This happens when subjects figure out what the researcher is studying and change their behavior accordingly. For example, what if the workers in Ollie's study notice that the only thing changing from week to week is the level of light in the room where they're working? They might suspect that Ollie is studying the effect of light on productivity.

But what if they want the lights to be at a certain level? They might work to be more productive the week that the lights are at the level they prefer. In that way, they are changing the outcome with their behavior, and Ollie won't ever know if it's because of the Hawthorne effect or because the levels of light influence productivity.

## Good-Subject Bias

Everyone wants to be liked, which is why the **good-subject** and **social desirability** biases come into play. They are essentially the same thing: when good-subjects respond to an experimenter in order to be liked or seen as a good-subject. For example, what if the factory workers want Ollie's approval? They don't want him to be disappointed or dislike them, so they try to do their best, most productive work. But are they being more productive because they want Ollie to like them or because the light levels are changing from week to week?

The good-subject bias is most common in experiments that involve asking questions. The subjects will try to answer in a way that will please the researcher. Even if Ollie just says something like 'Good job' at the end of the week that could influence the next week's work.

## Lesson Summary

**Internal validity** is the extent to which an experimenter can prove that only the independent variable causes changes in the dependent variable. **Extraneous variables**, or factors other than the independent variable that can influence the dependent variable, can lower internal validity. Three major types of participant-based extraneous variables are **self-**

**selection bias, demand characteristics**, which is also known as the **Hawthorne effect**, and **good-subject** and **social desirability** biases.