



BUILDING BLOCKS OF SCIENTIFIC PSYCHOLOGY:

STUDENTS' UNDERSTANDING OF PROBABILISTIC TRENDS AND CORRELATION-VERSUS-CAUSATION

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BACKGROUND:

Humans display a variety of cognitive biases that inhibit rational thought¹. For example, people search for confirmatory rather than disconfirmatory evidence, are swayed by vivid testimonials, over-project their opinions onto others, and combine probabilities incoherently^{2,3}. Two related deficits occur in the design and interpretation of scientific research on human behavior⁴: Understanding the distinction between causal and non-causal associations (and evidence required for each), and understanding the probabilistic nature of associations between variables (i.e., probabilistic reasoning). Training in psychological science, particularly in research methods classes, often centers on addressing these deficits in rational thinking. To determine the magnitude of these deficits, we designed a study to investigate the inferences that people draw from causal and non-causal research scenarios.

SCENARIOS:

VIDEO GAMES AND AGGRESSION:

All participants read:
Several teachers are interested in whether video games are associated with aggression in their students...

Participants receiving experimental version read:

They randomly assign 100 middle school boys to one of two groups. The first group, the control group, is not allowed to play any video games for a week. The second group, the experimental group, is asked to play video games for two hours every day for a week. The teachers ask the lunchroom and playground attendants, who are unaware which group each boy belongs to, to record how often each boy engages in aggressive behaviors, such as hitting, kicking, yelling, pushing, etc.

Participants receiving non-experimental version read:

They distribute a survey to a group of 100 middle school boys. On the survey, the boys report how many hours a day they spend playing video games. Then, the teachers collect reports from the lunch room and playground attendants on how often each of the boys engages in aggressive behaviors, such as hitting, kicking, yelling, pushing, etc.

All participants read:
The teachers find a positive association between the number of hours the boys spend playing video games and the attendants' reports of the boys' aggressiveness. What is an appropriate inference to draw from these findings? Check all that apply.

PORNOGRAPHY CONSUMPTION AND MARITAL SATISFACTION:

All participants read:
Relationship scientists are interested in the relationship between pornography exposure and how satisfied people are with their romantic relationships...

Participants receiving experimental version read:

They collect a sample of 300 married people, and randomly assign them to one of two groups. The first group, the control group, is not allowed to consume any pornography (via video, pictures, or magazines) for a month. The second group, the experimental group, is asked to come into the lab for two hours each week for a month to consume pornography. At the end of the month, all participants complete a marital adjustment inventory designed to assess how satisfied they are with their current romantic relationship (extremely dissatisfied to extremely satisfied).

Participants receiving non-experimental version read:

They collect data from an anonymous sample of married people. First, the people report many hours per week they consume pornography in the form of video, pictures, and magazines. Then, the people complete a marital adjustment inventory designed to assess how satisfied they are with their current romantic relationship (extremely dissatisfied to extremely satisfied).

All participants read:
The researchers find a negative association between the number of hours people spend consuming pornography and how satisfied they are with their marriage. Which of the following is an appropriate inference for the researchers to make on the basis of these data? Check all that apply.

EXERCISE AND BODY DISSATISFACTION:

All participants read:
Researchers are interested in the relationship between exercise and body image in adolescents...

Participants receiving experimental version read:

They went into several high schools in their area and assigned 500 students to one of two conditions via a coin toss. Students in the first condition were restricted from exercising for a month. Students in the second condition were assigned to exercise five hours per week for a month. After the month was complete, all students were asked how satisfied they were with their bodies.

Participants receiving non-experimental version read:

They went into several high schools in their area and administered surveys to 500 students. The students reported how many hours per week they engaged in physical activity and how satisfied they were with their bodies.

All participants read:
The researchers found that the number of hours adolescents exercised was negatively associated with how satisfied adolescents were with their bodies. Which of the following is an appropriate inference for the researchers to make? Check all that apply.

RESULTS:

Experimental	
Ideal	Actual
100%	62%
0%	12%
100%	85%
0%	8%
0%	22%

Playing video games leads to an increase in aggression.
Aggression leads to an increase in time spent playing video games.
Boys who spend more time playing video games tend to be more aggressive compared to boys who spend less time playing video games.
Any boy who spends a lot of time playing video games will also be aggressive.
If we found a boy who spends a lot of time playing video games but is not aggressive, it would invalidate the teachers' results.

Non-experimental	
Ideal	Actual
0%	54%
0%	12%
100%	87%
0%	8%
0%	22%

Experimental	
Ideal	Actual
100%	45%
0%	26%
100%	78%
0%	8%
0%	20%

Consuming pornography leads to a decrease in marital satisfaction.
Marital dissatisfaction leads to an increase in pornography consumption.
People who spend more time consuming pornography tend to be less satisfied with their marriage compared to people who spend less time consuming pornography.
Any person who spends a lot of time consuming pornography will also be dissatisfied with their marriage.
If we found a person who spends a lot of time consuming pornography but is satisfied with their marriage, it would invalidate the scientists' results.

Non-experimental	
Ideal	Actual
0%	44%
0%	45%
100%	71%
0%	14%
0%	18%

Experimental	
Ideal	Actual
100%	28%
0%	35%
100%	49%
0%	7%
0%	24%

Exercising leads adolescents to feel more dissatisfied with their bodies.
Feeling dissatisfied with their bodies leads adolescents to exercise.
Adolescents who exercise more tend to be less satisfied with their bodies compared to adolescents who do not exercise.
Any adolescent who does not exercise will also be satisfied with their body.
If we found an adolescent who does exercise but is satisfied with their body, it would invalidate the researchers' results.

Non-experimental	
Ideal	Actual
0%	16%
0%	45%
100%	46%
0%	4%
0%	23%

DISCUSSION:

VIDEO GAMES AND AGGRESSION:

- Participants who read the experimental scenario, in which video game playing was manipulated, would have been correct to infer that playing video games leads to an increase in aggression. In actuality, only 62% did, and we question why it wasn't 100%. Perhaps some people conflate causality with determination.
- Participants who received the non-experimental scenario should not have inferred that playing video games leads to an increase in aggression. In fact, 54% of them did, a percentage that was not significantly different from the percentage inferring causality after the experimental scenario.
- The fact that only 12% of participants who received the non-experimental scenario inferred that aggression leads to video game playing betrays a bias in our participants' intuitions - they seem to assume that video games can lead to aggression, but not vice versa.
- Participants also demonstrated limited probabilistic reasoning in that over one in five inferred that an exception to the trend (in both conditions), would invalidate the researchers' results.

PORNOGRAPHY CONSUMPTION AND MARITAL SATISFACTION:

- Participants who received the experimental scenario, in which pornography consumption was manipulated, should have inferred that consuming pornography leads to a decrease in marital satisfaction. In actuality, only 45% did, and again, we question why it wasn't 100%.
- Participants who received the non-experimental scenario should not have inferred that pornography leads to a decrease in marital satisfaction, nor that marital dissatisfaction leads to an increase in pornography consumption. In fact, each of these mistaken inferences was made by almost half of participants, and additional analyses suggested that participants were just as likely to infer one or the other as they were to infer both. This suggests that participants see the relationship between pornography consumption and marital satisfaction as being able to go in either direction.
- It is in this scenario that the highest proportion of participants failed to recognize that the trend may not be true in all cases. Over 1 in 8 (14%) mistakenly inferred that any one person who consumes pornography will also be dissatisfied.

EXERCISE AND BODY DISSATISFACTION:

- This scenario was designed to test participants' ability to reason about findings that oppose preconceived notions. A common assumption is that exercise leads to body satisfaction, so instead we presented exercise as leading to body dissatisfaction.
- Participants who received the experimental scenario, in which exercise was manipulated, should have inferred that exercising leads adolescents to feel more body dissatisfaction. In reality, only 28% did. Participants seemed unwilling to accept experimental evidence that challenges their preconceived notions about which variable causes which. Furthermore, 35% inferred that body dissatisfaction leads adolescents to exercise - despite that exercise was presented as the independent variable.
- Participants in the non-experimental scenario should not have inferred that exercise leads to dissatisfaction, and only 16% did. Yet, 45% of participants in this scenario mistakenly inferred that feeling dissatisfied leads adolescents to exercise, again betraying their reliance on assumptions about which variables causes which.

GENERAL DISCUSSION:

In general, participants consistently conflated experimental and non-experimental inferences. Specifically, participants frequently inferred cause-and-effect relationships from correlational data. A large percentage of these participants were also likely to select the causal direction that fit people's intuitions. Even when people read an experimental scenario, some of them selected the incorrect causal direction, suggesting that they cling to their prior beliefs about the topic. Finally, approximately 1 in 5 participants did not demonstrate probabilistic reasoning - that is, they failed to recognize that one exception to the trend does not invalidate an association. Given that our sample was comprised primarily of lower-level college students, our findings imply that reasoning about probabilistic trends requires explicit, structured, and repeated practice. We aim to determine whether advanced undergraduates perform any better, and we aim to determine how people in the general community, who hear research claims in the media on a daily basis, fare in the accuracy of their inferences.

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