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A Question of Time: Cross-sectional Versus Longitudinal Study Designs

Sarah Lindstrom Johnson, PhD*

Case Study

You are seeing a 12-year-old boy who has attention-deficit/hyperactivity disorder (ADHD). Like so many of his peers, he loves video games and spends many hours a day playing. You know that gamers spend an average of 8 hours each week playing. Besides the lost opportunity to exercise, you begin to wonder about the effect of video games on behavior. Are children who play video games more likely to have ADHD? Embedded in your question are two possible lines of inquiry: 1) Does video game playing cause ADHD? and 2) Are children who have ADHD more likely to play video games? Each question suggests a slightly different study design (Table).

Definitions

In cross-sectional study designs, data collection occurs at one point in time. In longitudinal study designs, subjects are followed over time, with data collection occurring at predetermined intervals or at set events (eg, graduation from high school). The most powerful longitudinal study designs also are called prospective study designs because they follow subjects forward over time. Longitudinal designs allow for a determination of the timing of events and, therefore, can discern something about the order of effects.

Use of Study Designs

Cross-sectional study designs allow for the examination of associations

between variables. They also can establish the prevalence of a problem. A cross-sectional design allows for the determination that children who have ADHD are more likely to report playing video games. However, it would not be possible to determine that they play more video games because they have ADHD or that their video-game playing led to ADHD. These questions imply causality, for which a longitudinal study design is needed.

Causality necessitates a time order. To determine that video game playing causes ADHD, it is necessary to determine that the video game playing happened before the ADHD. Longitudinal study designs with data collection points occurring over time permit this determination. Longitudinal study designs have three different variants. A longitudinal design that has repeated measures on the same individuals is called a panel study and typically is used to determine causality at the individual level. A specific type of panel study is the cohort study, in which a group of individuals determined by a specific event (eg, a certain birth year) are followed over time. Another type of longitudinal design, called a repeated cross-sectional study, attempts to make causal inferences at the population level by surveying a random sample of the population at different points in time.

Limitations

A difficulty faced by both longitudinal study designs and cross-sectional research designs is determining

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Table. **Summary of Designs**

Study Design	Definition	Strengths	Weaknesses
Cross-Sectional	Single data collection point	<ul style="list-style-type: none"> • Quick • Inexpensive • Establishes prevalence • Suggests future research directions 	<ul style="list-style-type: none"> • Difficult to determine causality • Possible spurious associations
Longitudinal Prospective Retrospective	Multiple data collection points occur over time	<ul style="list-style-type: none"> • Can determine causality • Can monitor trends • Less concerned with spuriousness 	<ul style="list-style-type: none"> • Time-consuming • Expensive

whether an association is true (real) or false (spurious). An association can be spurious if a third variable is related to both the independent (video game playing) and dependent variable (ADHD). The association then would be a result of confounding and would be noncausal. For example, confounding would occur if television viewing was related to both video game playing and ADHD. In this case, it would be impossible to determine whether video game playing was causing ADHD or whether television viewing was causing ADHD and video game playing simply was related to television viewing (Figure).

Cross-sectional designs do offer some benefits. They usually are quick and relatively inexpensive to conduct. By definition, longitudinal studies take time to conduct. In ad-

dition, longitudinal studies must be concerned with subject fatigue and attrition. Ensuring that a representative sample stays representative involves a major investment of both time and money on the part of the researcher. Due to this investment, cross-sectional study designs serve an important role in research because they suggest areas in which longitudinal studies could be beneficial.

There are methods to bypass some of the limitations of each study design. In a cross-sectional study design, it is possible to ask participants about their previous behavior. This questioning is most beneficial when the information asked to be recalled can be remembered accurately. Longitudinal designs also can use information about previous behavior. Such studies are called retrospective study designs and many times involve the use of data already collected (eg, medical records). Another possibility for longitudinal studies is the use of secondary data sets, meaning that the researchers use longitudinal data that were collected for another purpose to answer their question. A potential drawback to this method is that the variables needed to address possible spurious associations may not be available.

Conclusion

The research question dictates the appropriate study design. If you are interested in knowing if children who have ADHD are more likely to play video games (ADHD and video game playing are associated), a cross-sectional design would answer your question most efficiently. However, if you are interested in knowing if playing video games cause ADHD, a longitudinal study design is necessary. Of note, published cross-sectional studies suggest an association between video games and ADHD but caution that longitudinal research is needed to establish causality.

Suggested Reading

- Chan PA, Rabinowitz T. A cross-sectional analysis of video games and attention-deficit hyperactivity disorder symptoms in adolescents. *Ann Gen Psych*. 2006;5: 16–26
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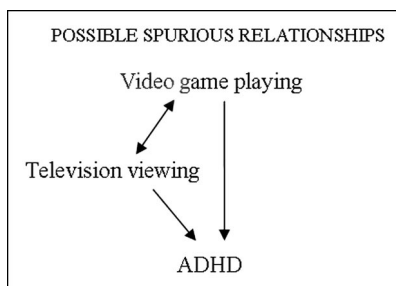


Figure. Possible spurious relationships.

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