

The Chi Square Twist: A Pseudo-Longitudinal Protocol for Gaining Temporal Insight from Quantitative Studies

Author(s): Dr. David M Robertson

ORCID iD

Author Affiliations: GrassFire Industries LLC, The National Leaderology Assn.

© 2025 Dr. David M Robertson. Published by the *GrassFire Industries LLC*. This article is Open Access under the Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License (CC BY-NC-ND 4.0). This license allows copying and redistribution in any medium or format for non-commercial purposes, provided no modifications are made, appropriate credit is given, and a link to the license is included. For more details, visit <http://creativecommons.org/licenses/by-nc-nd/4.0>. Please note that this license does not cover any third-party material included in the article with permission. For commercial use, please request permission from Dr. David M Robertson via GrassFire Industries, LLC.

Revised: 2025 May

Originally Published: 2022 March - All Rights Reserved

Abstract: Quantitative research is widely valued for its precision, objectivity, and generalizability. However, one of its longstanding limitations is its inability to capture the temporal evolution of variables without resorting to full longitudinal designs, which are often resource-intensive and logistically prohibitive. This article introduces the "Chi Square Twist," a pragmatic and replicable protocol that enables researchers to gain pseudo-longitudinal insight from cross-sectional quantitative studies. By stratifying participants based on time since intervention and analyzing outcomes using chi-square testing, this method simulates temporal comparison, offering meaningful inferences regarding duration-based effects. Originally designed to evaluate leadership development outcomes in credit union employees, the Chi Square Twist is broadly applicable across domains such as education, healthcare, and organizational behavior. This paper outlines the theoretical rationale, methodological structure, implementation protocol, and limitations of the Chi Square Twist, proposing it as an accessible solution for researchers seeking insight into time-sensitive phenomena.

Keywords: pseudo-longitudinal analysis, cross-sectional design, chi-square methodology, leadership development evaluation, temporal stratification, applied research methods, organizational behavior, practitioner-focused analytics, categorical data analysis, survey-based research, methodological innovation, leadership outcomes, employee perception studies, strategic research design, quantitative insight modeling.

Introduction

Quantitative studies excel in capturing structured, measurable relationships between variables. They are prized for their clarity, replicability, and statistical rigor. Yet, their inability to incorporate time without transitioning into full longitudinal or time-series methodologies is a persistent criticism. While robust, these approaches are frequently inaccessible to researchers due to constraints such as cost, duration, data attrition, or institutional barriers.

Temporal insight is crucial in contexts where the effect of an intervention is expected to evolve over time. Whether assessing the sustained impact of professional training, the lasting effect of a public health campaign, or the decaying influence of a policy change, the temporal dimension is often essential to valid interpretation. However, traditional cross-sectional quantitative studies capture a single snapshot in time, offering little information about the trajectory of effects. This creates a gap between methodological capacity and research needs.

The Chi Square Twist is a methodological innovation designed to bridge this gap. It offers researchers a structured, low-cost, and easily implemented method for extracting longitudinal-like insight from cross-sectional data. By stratifying respondents into time-based cohorts post-intervention and using chi-square analysis to detect significant differences in categorical or ordinal outcomes, the method offers a temporal lens without requiring the resource-intensive nature of true longitudinal research.

Literature Review

Cross-sectional quantitative studies remain the most widely used research design in social sciences and leadership research due to their simplicity, cost-effectiveness, and suitability for large-scale data collection (Cummings, 2018). However, these designs are fundamentally limited in tracking variable changes over time or establishing causal relationships, as cross-sectional data lacks the temporal sequencing required to determine directionality (Maier et al., 2023). Traditional longitudinal studies provide this insight, along with increased statistical power (Yee & Niemeier, 1996). Still, they also have drawbacks: increased costs, participant attrition, extended timelines, and a higher risk of confounding variables influencing results across collection waves (Farrington, 1991; Morrow, 2010).

For example, time is critical in leadership development and organizational behavior research (Day, 2014; Vullingsh & Dóci, 2020). Leadership programs often produce effects that manifest gradually, decay over time, or shift focus (Castillo & Trinh, 2018; Getha-Taylor et al., 2015). Yet, few accessible methodologies exist to examine these dynamics outside of full longitudinal tracking. Researchers have called for more pragmatic methods to account for temporal nuance without sacrificing feasibility (Jarvis, Gulati, McCrerrick, & Simpson, 2013). Unfortunately, few attempts have been made to answer the call.

Non-experimental designs using time as a grouping variable, such as retrospective self-report surveys or cohort-based evaluations, have been explored. However, these approaches are often loosely structured and lack a standardized protocol (Cuttler, 2020). Complicating the matter is the general idea that research is incremental and no single study can answer all aspects of a research question (Thompson & Panacek, 2007). However, gaining longitudinal insight is highly valuable, as it helps researchers identify emerging trends, anticipate outcome trajectories, and formulate more targeted questions for future investigation (Kelloway & Francis, 2012; Lewis, 2015; Scribbr, 2023). The Chi Square Twist aims to formalize this strategy and bridge the divide, using well-established statistical techniques to uncover patterns related to the timing of interventions and provide a replicable method for pseudo-longitudinal analysis.

Conceptual Framework

The Chi Square Twist is rooted in the tension between static measurement and dynamic phenomena. It addresses the epistemic limitation of fixed-time assessment by introducing stratification based on *elapsed time since intervention*. Though the data is collected at one point in time, respondents are grouped into pseudo-temporal categories. These cohorts serve as proxies for a temporal sequence, allowing the researcher to examine how an intervention's effects manifest, sustain, or decline.

The statistical backbone of the method is the chi-square test of independence. This non-parametric test is ideal for categorical outcome measures and is robust to violations of normality. It enables the researcher to test for significant associations between group (time since intervention) and outcome (e.g., perceived benefit, behavioral change, satisfaction). While it does not permit causal inference, it does support contingency-based interpretations, especially when aligned with theory or triangulated with qualitative data.

Protocol Design and Implementation

The Chi Square Twist consists of five key components:

1. Define the Intervention and Time Categories

The intervention under study (e.g., leadership development, training, policy change) must be clearly defined. Participants are then categorized into meaningful temporal cohorts, such as:

- No exposure to the intervention (control)
- Recent exposure (e.g., within the last 12 months)
- Distant exposure (e.g., more than 12 months ago)

2. Design the Inclusion and Exclusion Criteria

Participants must be screened to ensure valid placement within the time categories. New participants (e.g., new hires) or those exposed to only partial or non-professional versions of the intervention may be excluded to improve internal validity.

3. Select or Design Measurement Instruments

Use validated survey tools with strong psychometric properties. The method works best with categorical or ordinal data that can be logically stratified by time category. Likert-based instruments are ideal if data is analyzed in an ordinal format.

4. Administer the Survey Cross-Sectionally

The survey is distributed at a single time point. However, it includes categorical questions to identify time since intervention. Data is then grouped accordingly.

5. Analyze Using Chi-Square Tests

A chi-square test of independence is conducted between time category (independent variable) and outcome variable(s) (dependent). Significance (typically set at $\alpha = 0.05$) indicates that the variable of interest may be contingent on the time elapsed since the intervention.

Use Case Example: Leadership Development

In a study of Kansas credit union employees, the Chi Square Twist was applied to evaluate the impact of professional leadership development on employee engagement, perceived productivity, and advancement opportunities. Participants were grouped into three categories: those who had never received leadership development, those who had received it within the past two years, and those whose training occurred more than two years ago. Using validated survey instruments and a chi-square analysis, the study revealed statistically significant differences in perceived advancement opportunities, suggesting that the benefit of training may attenuate or shift over time.

Advantages of the Chi Square Twist

- Requires only a single round of data collection
- Reduces cost and participant attrition
- Allows for insight into time-based dynamics without full longitudinal commitment
- Easy to implement with standard survey tools
- Applicable across disciplines and sectors

Limitations

- Inference is correlational, not causal
- Assumes group equivalence at baseline, which cannot be verified
- Vulnerable to recall bias if timing is self-reported
- Not appropriate for continuous outcome variables without binning
- Requires careful construction of time categories to avoid arbitrary distinctions

It is also important to clarify that while the Chi Square Twist provides valuable longitudinal insight, it does not constitute a longitudinal study in the traditional sense. As originally stated in the foundational research, *"This study attempted to address and overcome the time limitation issues of cross-sectional research... While these tactics and results are considered reliable and provide the necessary insight for this study, future researchers' improvements, innovations, and understandings of the approach may modify or limit the current results or understanding. Furthermore, while such insights are valuable and supportive, longitudinal insight must not be confused with longitudinal studies. Instead, such insights merely illuminate potentials for a better understanding and further exploration."*

Why This Approach Is Novel

The Chi Square Twist introduces a structured methodology to address a widely recognized limitation in quantitative research—the lack of temporal insight in cross-sectional designs. While the chi-square test of independence is not new, its use within a temporally stratified framework represents a novel application. This protocol intentionally segments participants by time since intervention and uses categorical outcome data to simulate longitudinal insight, providing a practical means of examining how perceptions, behaviors, or effects may evolve over time.

What distinguishes this approach from isolated instances of time-based grouping is its formalization into a replicable process. Rather than relying on ad hoc cohort comparisons or retrospective estimations, the Chi Square Twist offers clear parameters for data collection, participant classification, and statistical analysis. It transforms a workaround into a defined method—one that is accessible, low-cost, and immediately usable by researchers facing logistical, financial, or ethical barriers to longitudinal study design.

The novelty of the Chi Square Twist lies not in the statistical technique itself, but in how it reframes the temporal problem space in quantitative research. It does not claim to replace true longitudinal methods, but instead provides a practical and academically sound alternative for researchers seeking meaningful insights into time-sensitive phenomena without the demands of extended study durations. In doing so, it contributes to the advancement of applied research methodology in fields such as leadership development, education, healthcare, and organizational behavior.

Future Research and Applications

The Chi Square Twist opens new doors for applied and academic researchers alike. Future studies could enhance their power by integrating qualitative follow-up, incorporating covariate controls, or triangulating with archival data. Its application could be expanded to fields as diverse as education, healthcare, nonprofit programming, and civic engagement. There is also potential to build computational tools or plug-ins that assist with automated stratification and chi-square computation, increasing scalability.

Conclusion

The Chi Square Twist offers a meaningful contribution to the researcher's toolbox, especially for those seeking cost-effective methods to explore the evolving impact of interventions. Transforming traditional categorical comparison into a temporally-informed protocol provides pseudo-longitudinal insight where none previously existed. As the demand for rapid, flexible, and insight-rich methods grows, the Chi Square Twist stands as a bridge between rigor and practicality in contemporary research design.

Resources:

Day, D. V. (2014). *Time and leadership*. In *Time and Work*, Volume 2 (pp. 30-52). Routledge.

Castillo, E. A., & Trinh, M. P. (2018). *In search of missing time: A review of the study of time in leadership research*. *The Leadership Quarterly*, 29(1), 165-178.

Cummings, C. L. (2018). *Cross-sectional design*. *The SAGE Encyclopedia of Communication Research Methods*. Thousand Oaks: SAGE Publications Inc.

Cuttler, C. (2020). *Overview of non-experimental research*. In *Research Methods in Psychology* (3rd ed.). Washington State University. Retrieved from <https://opentext.wsu.edu/carriecuttler/chapter/overview-of-non-experimental-research/>

Farrington, D. P. (1991). *Longitudinal research strategies: Advantages, problems, and prospects*. *Journal of the American Academy of Child & Adolescent Psychiatry*, 30(3), 369-374.

- Getha-Taylor, H., Fowles, J., Silvia, C., & Merritt, C. C. (2015). *Considering the effects of time on leadership development: A local government training evaluation*. *Public Personnel Management*, 44(3), 295-316.
- Jarvis, C., Gulati, A., McCririck, V., & Simpson, P. (2013). *Leadership matters: Tensions in evaluating leadership development*. *Advances in Developing Human Resources*, 15(1), 27–45.
<https://doi.org/10.1177/1523422312467138>
- Kelloway, E. K., & Francis, L. (2012). *Longitudinal research and data analysis*. In *Research methods in occupational health psychology* (pp. 374-394). Routledge.
- Lewis, J. (2015). *Methodological developments in qualitative longitudinal research*. *BMC Medical Research Methodology*, 15, Article 73. <https://pmc.ncbi.nlm.nih.gov/articles/PMC4406119/>
- Maier, C., Thatcher, J. B., Grover, V., & Dwivedi, Y. K. (2023). *Cross-sectional research: A critical perspective, use cases, and recommendations for IS research*. *International Journal of Information Management*, 70, 102625.
- Morrow, B. (2010). *An overview of cohort study designs and their advantages and disadvantages*. *International Journal of Therapy and Rehabilitation*, 17(10), 518-523.
- Scribbr. (2023, June 22). *Longitudinal study | Definition, approaches & examples*.
<https://www.scribbr.com/methodology/longitudinal-study/>
- Thompson, C. B., & Panacek, E. A. (2007). *Research study designs: Non-experimental*. *Air medical journal*, 26(1), 18-22.
- Vullingsh, J. T., & Dóci, E. (2020). *A temporal approach to studying organizational leadership*. In *Handbook on the temporal dynamics of organizational behavior* (pp. 251-273). Edward Elgar Publishing.
- Yee, J. L., & Niemeier, D. (1996). *Advantages and disadvantages: Longitudinal vs. repeated cross-section surveys*.