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DATAWorks 2024: Statistical Advantages of Validated Surveys over Custom Surveys

Jonathan L Bell, Project Leader

Adam M. Miller

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INSTITUTE FOR DEFENSE ANALYSES
730 East Glebe Road
Alexandria, Virginia 22305



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For more information:

Dr. Jonathan L Bell, Project Leader
jlbell@ida.org • 703-578-2777

Dr. V. Bram Lillard, Director, Operational Evaluation Division
vlillard@ida.org • (703) 845-2230

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Executive Summary

Surveys play an important role in quantifying user opinion during test and evaluation (T&E). Current best practice is to use surveys that have been tested, or “validated,” to ensure that they produce reliable and accurate results. However, unvalidated (“custom”) surveys are still widely used in T&E, requiring testers to determine how to select sample sizes for – and interpret data from – T&E events that rely on surveys of unknown quality. In this presentation, I characterize the statistical properties of validated and custom survey responses using data from recent T&E events and demonstrate how these properties affect test design, analysis, and interpretation.

Using validated surveys during T&E reduces the number of subjects required to estimate parameters or detect differences between populations. By reviewing survey responses from recent T&E events, I show that responses to validated survey items are significantly less skewed and marginally less variable than responses to custom survey items. Incorporating these statistical properties into standard sample size calculations reveals that T&E events using validated surveys require fewer subjects to obtain the same confidence interval widths or to achieve the same level of

statistical power as compared to T&E events using custom surveys.

Validated surveys undergo testing to ensure that they do not contain design flaws that introduce unintended changes to the data. Custom surveys, in contrast, do not undergo validation testing and therefore their design properties are unknown. To evaluate the impact of poor survey design on the statistical properties of survey responses, I simulated the process of transforming a sample of user opinions into Likert survey responses. The simulation demonstrated that poorly designed surveys can warp sample data in ways that obscure the characteristics of the source population. Such surveys can result in confidence intervals that fail to capture population means and statistical inferences that falsely characterize population differences. Thus, they increase the risk of drawing false conclusions.

The results of this analysis suggest four key takeaways for survey use going forward:

1. Use validated surveys when available.
2. Follow best practices for custom survey design.
3. Increase sample sizes when using custom surveys.

4. Be skeptical of confidence intervals or statistical inferences derived from custom survey data.

Adam M Miller

Institute for Defense Analyses

Problem Statement

Surveys play an important role in test and evaluation (T&E) by quantifying user opinions. However, poorly designed surveys can misrepresent opinions in ways that are difficult to recover statistically. Nevertheless, unvalidated (custom) surveys are still widely used in T&E, raising questions about how to size tests for—and interpret data from—surveys with unknown design properties.

What is a validated survey?

Validated surveys have been tested to ensure that they produce reliable and accurate results. Validated surveys have questions and response categories that are clearly understood by their target population.

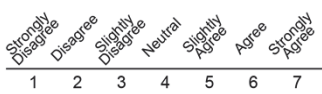
Example Validated survey items (UMUX)

1. This system's capabilities meet my requirements.
2. This system is easy to use.

Example custom survey items

1. Please rate the acceptability of hand-eye coordination while wearing this system (completing a simple task with your hands while looking through this system).
2. The process by which I had to load my unit's tactical radios using the [Notional Software] on this system supported my units tactical mission.

Likert response categories (7 point)

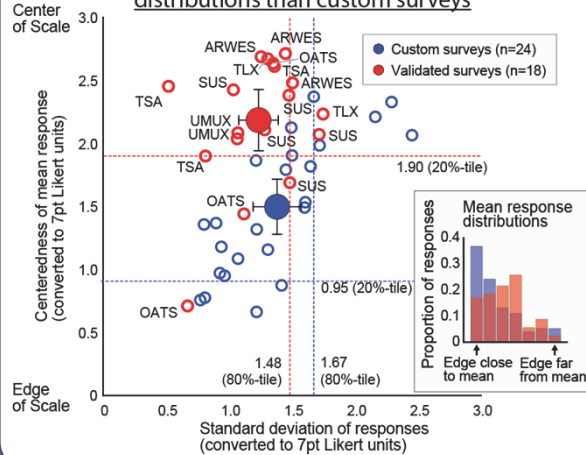


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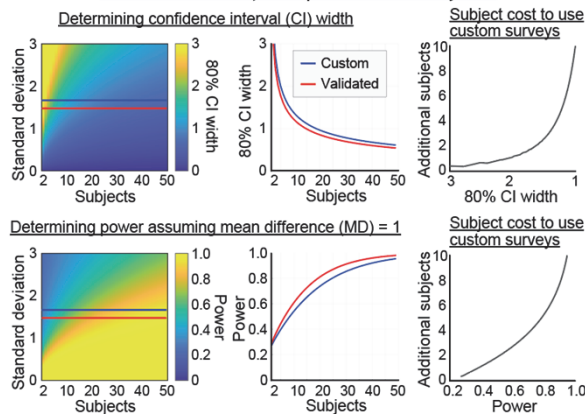
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Statistical Advantages of Validated Surveys over Custom Surveys

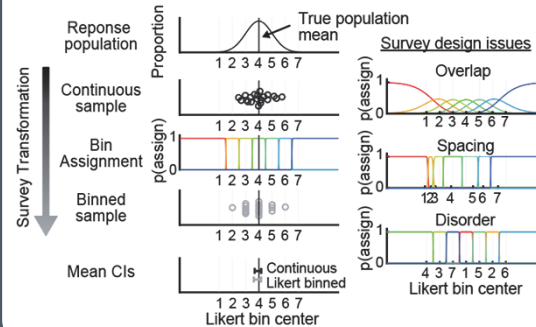
Validated surveys have less skewed response distributions than custom surveys



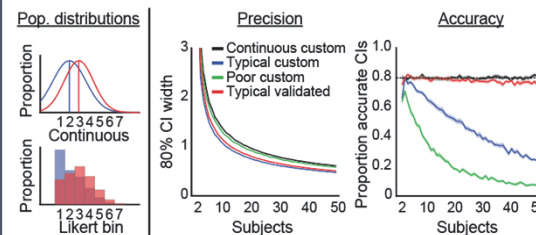
Validated surveys require fewer subjects



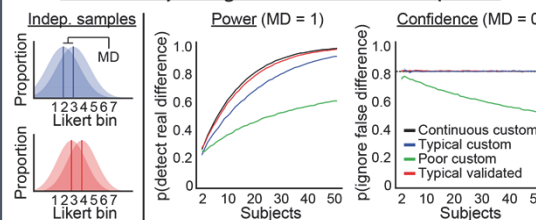
IDA simulated the survey process to determine the consequences of poor survey design



Poor survey design invalidates confidence intervals



Poor survey design reduces statistical power



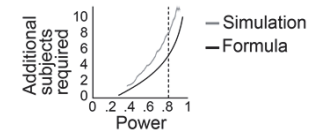
Conclusions

Main findings

Data from validated surveys items have less skewed distributions and low variability compared to custom survey items. This results in more accurate confidence intervals and increased power from statistical tests.

Takeaways

- Use validated surveys when possible.
- Follow best practices when designing custom surveys.
- Custom surveys require additional subjects (~8 per group to achieve 80% power, assuming MD = 1 and historical means and variance).



- Parameter estimates may be inaccurate when computed from custom survey data.
- Statistical inferences may be inaccurate when computed from custom survey data.
- Poor survey design cannot be overcome with bootstrapping or nonparametric statistical techniques (not shown).
- Consider focus groups or interviews when statistical analysis is not needed.

Methods

- All survey data were collected during Land Warfare system tests conducted between 2021 and 2023.
- Validated surveys were restricted to the Validated Scales Repository (testscience.org).
- Poorly designed custom survey items were simulated by combining moderate overlap, spacing, and disorder design issues.

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