SURVEY FUTURES

SURVEY DATA COLLECTION METHODS COLLABORATION

Mode Effects in Practice

Liam Wright, Georgia D. Tomova, and Richard J. Silverwood

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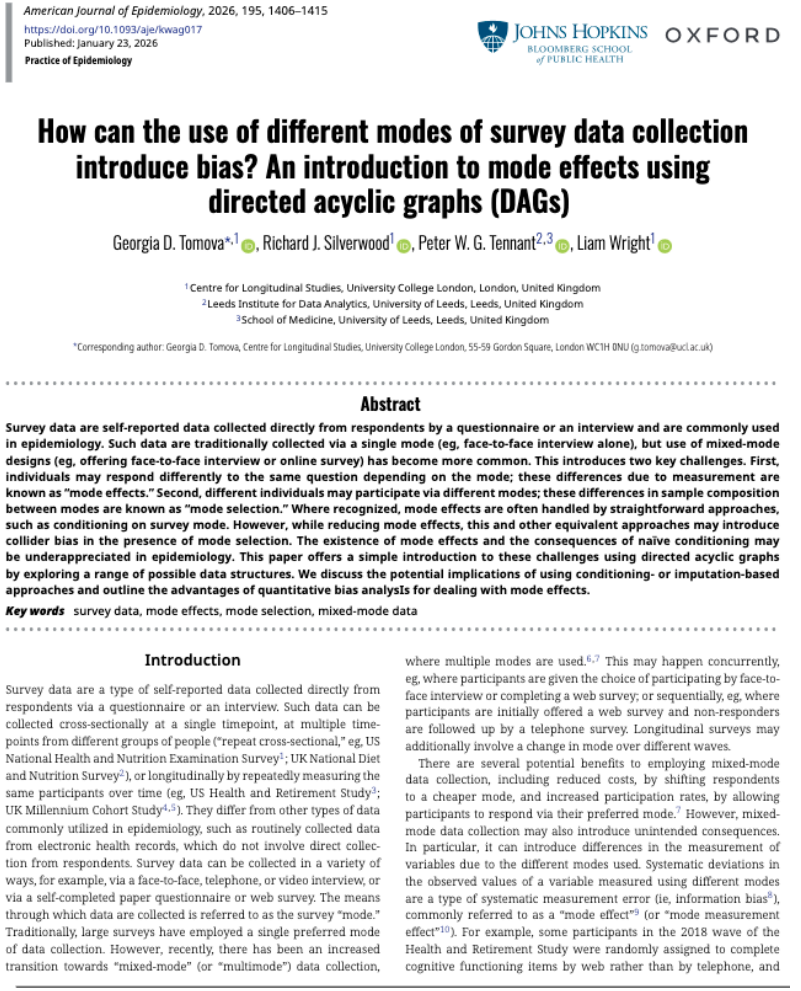
Some Necessary Concepts

- ***Mode effects*** are differences in responses between modes due to ***how*** items are being measured
- ***Mode selection*** is differences due to ***who*** is being measured
- Mixed-mode designs can bias associations between variables due to mode effects with or without mode selection.
- This bias can be represented with ***Causal Directed Acyclic Graphs (DAGs)***



American Journal of Epidemiology, 2026, 195, 1406–1415
https://doi.org/10.1093/aje/kwag017
Published: January 23, 2026
Practice of Epidemiology

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How can the use of different modes of survey data collection introduce bias? An introduction to mode effects using directed acyclic graphs (DAGs)

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Abstract

Survey data are self-reported data collected directly from respondents by a questionnaire or an interview and are commonly used in epidemiology. Such data are traditionally collected via a single mode (eg, face-to-face interview alone), but use of mixed-mode designs (eg, offering face-to-face interview or online survey) has become more common. This introduces two key challenges. First, individuals may respond differently to the same question depending on the mode; these differences due to measurement are known as "mode effects." Second, different individuals may participate via different modes; these differences in sample composition between modes are known as "mode selection." Where recognized, mode effects are often handled by straightforward approaches, such as conditioning on survey mode. However, while reducing mode effects, this and other equivalent approaches may introduce collider bias in the presence of mode selection. The existence of mode effects and the consequences of naïve conditioning may be underappreciated in epidemiology. This paper offers a simple introduction to these challenges using directed acyclic graphs by exploring a range of possible data structures. We discuss the potential implications of using conditioning- or imputation-based approaches and outline the advantages of quantitative bias analysIs for dealing with mode effects.

Key words survey data, mode effects, mode selection, mixed-mode data

Introduction

Survey data are a type of self-reported data collected directly from respondents via a questionnaire or an interview. Such data can be collected cross-sectionally at a single timepoint, at multiple time-points from different groups of people ("repeat cross-sectional," eg, US National Health and Nutrition Examination Survey[1]; UK National Diet and Nutrition Survey[2]), or longitudinally by repeatedly measuring the same participants over time (eg, US Health and Retirement Study[3]; UK Millennium Cohort Study[4,5]). They differ from other types of data commonly utilized in epidemiology, such as routinely collected data from electronic health records, which do not involve direct collection from respondents. Survey data can be collected in a variety of ways, for example, via a face-to-face, telephone, or video interview, or via a self-completed paper questionnaire or web survey. The means through which data are collected is referred to as the survey "mode." Traditionally, large surveys have employed a single preferred mode of data collection. However, recently, there has been an increased transition towards "mixed-mode" (or "multimode") data collection, where multiple modes are used.[6,7] This may happen concurrently, eg, where participants are given the choice of participating by face-to-face interview or completing a web survey; or sequentially, eg, where participants are initially offered a web survey and non-responders are followed up by a telephone survey. Longitudinal surveys may additionally involve a change in mode over different waves.

There are several potential benefits to employing mixed-mode data collection, including reduced costs, by shifting respondents to a cheaper mode, and increased participation rates, by allowing participants to respond via their preferred mode.[7] However, mixed-mode data collection may also introduce unintended consequences. In particular, it can introduce differences in the measurement of variables due to the different modes used. Systematic deviations in the observed values of a variable measured using different modes are a type of systematic measurement error (ie, information bias[8]), commonly referred to as a "mode effect"[9] (or "mode measurement effect"[10]). For example, some participants in the 2018 wave of the Health and Retirement Study were randomly assigned to complete cognitive functioning items by web rather than by telephone, and

Received: October 1, 2025. **Accepted:** January 17, 2026

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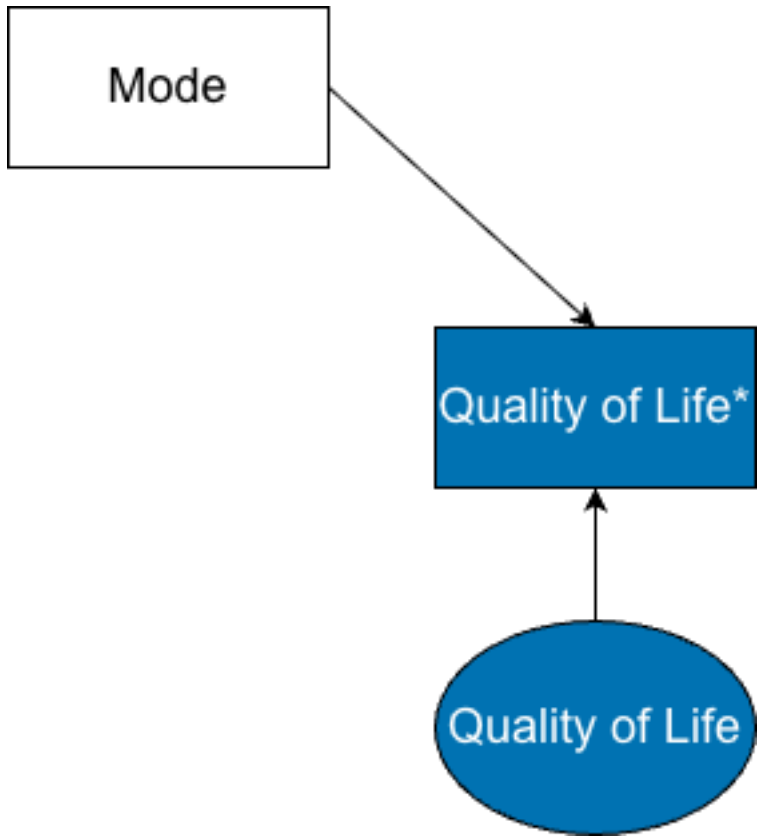
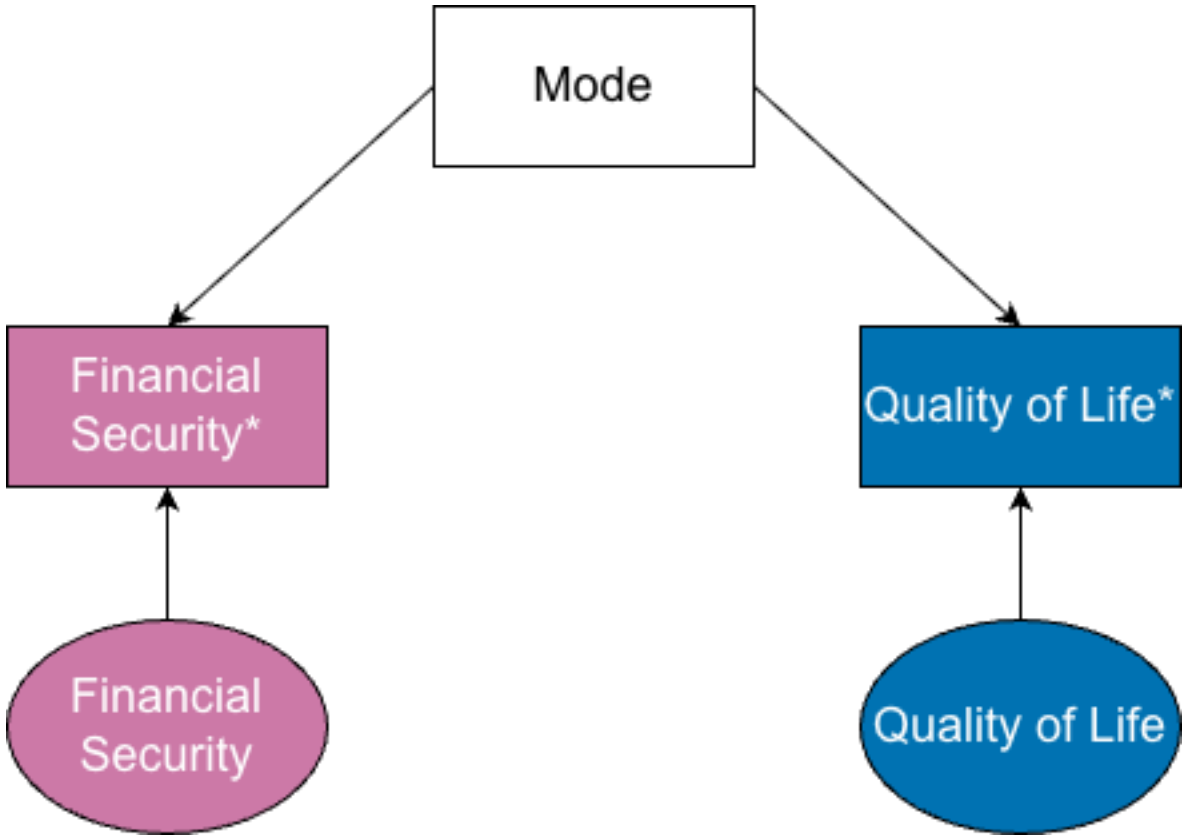
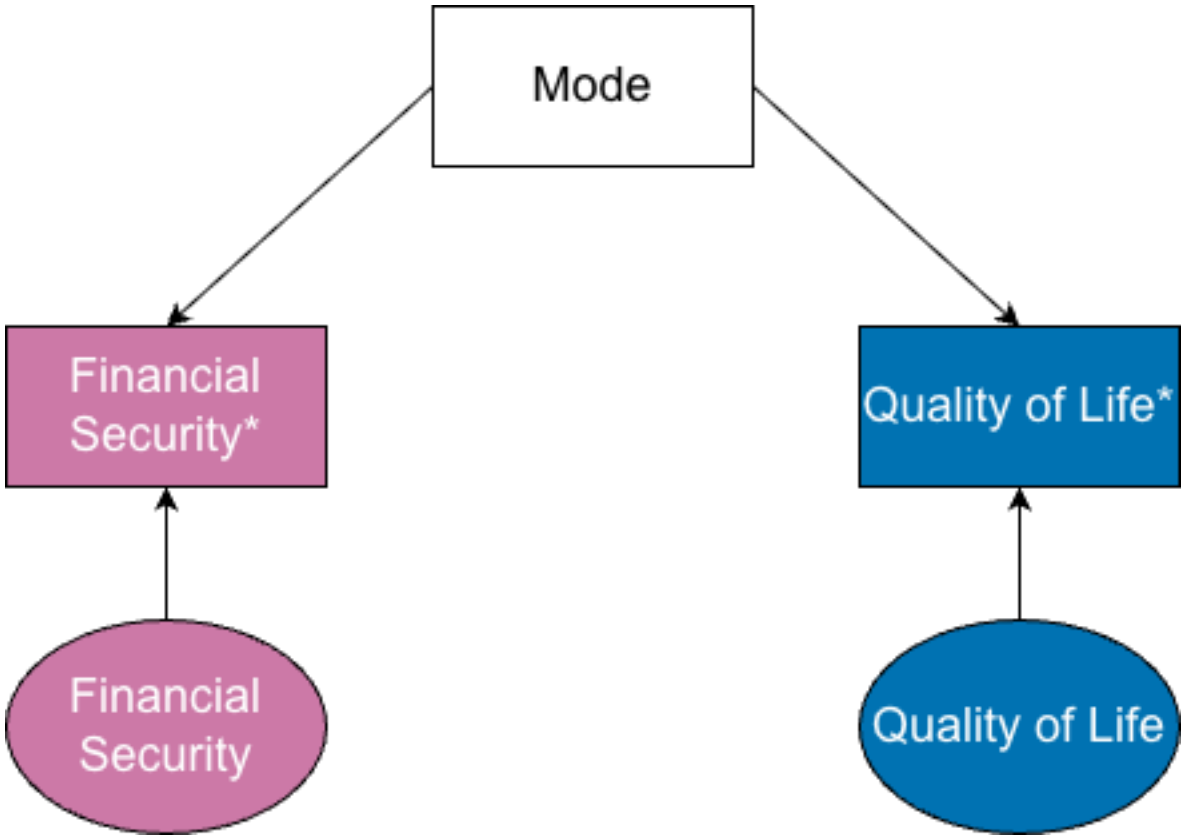
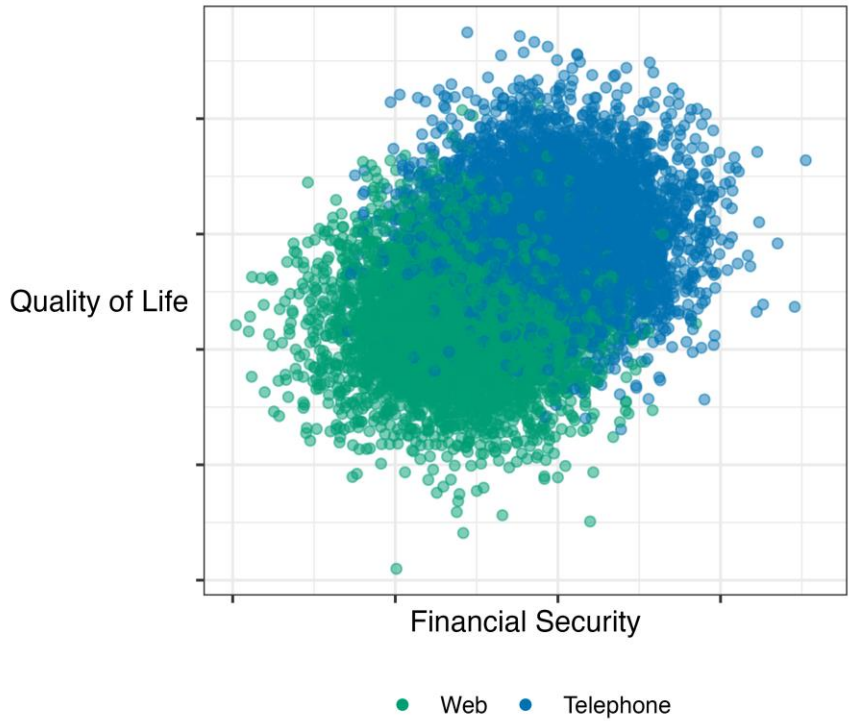
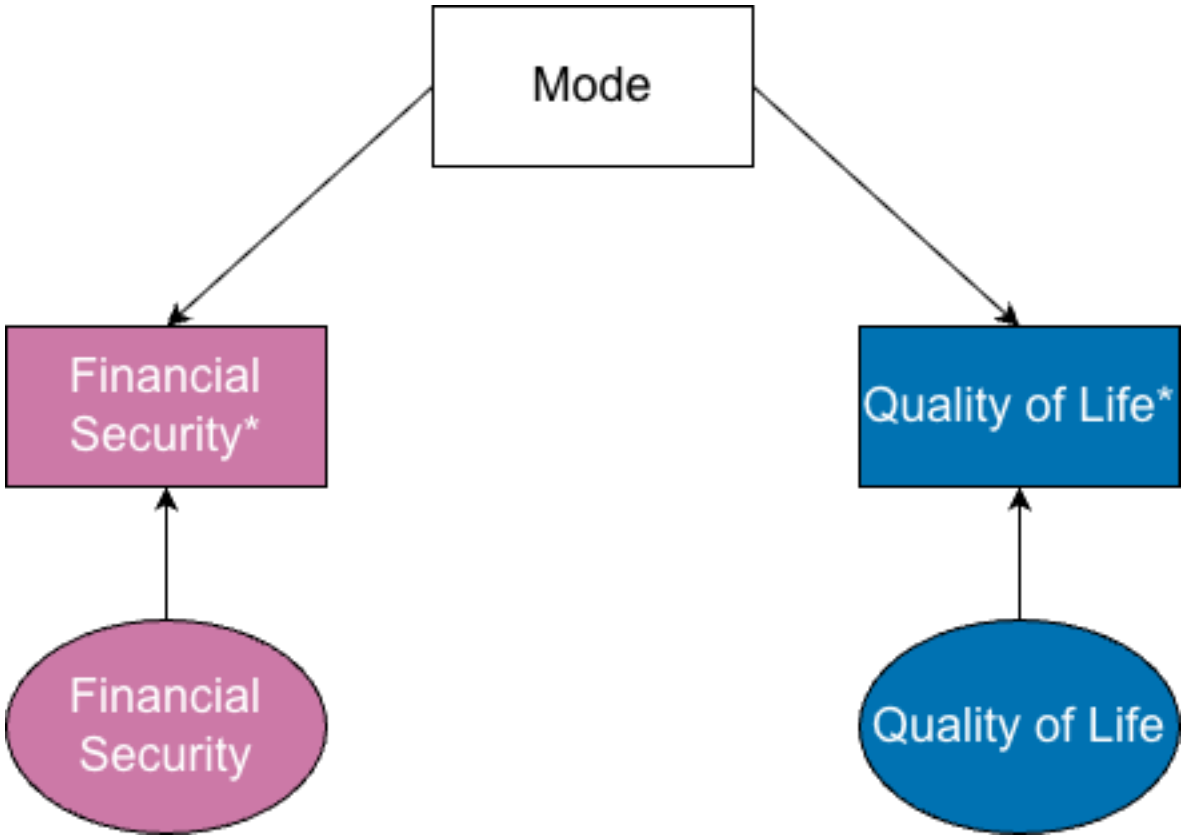
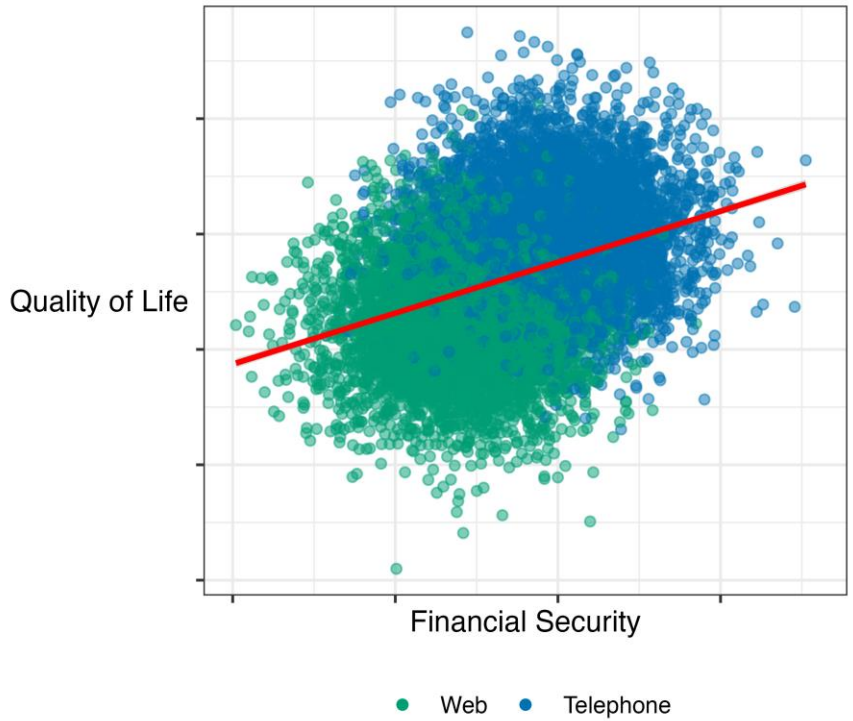

Mode
Quality of Life*
Quality of Life

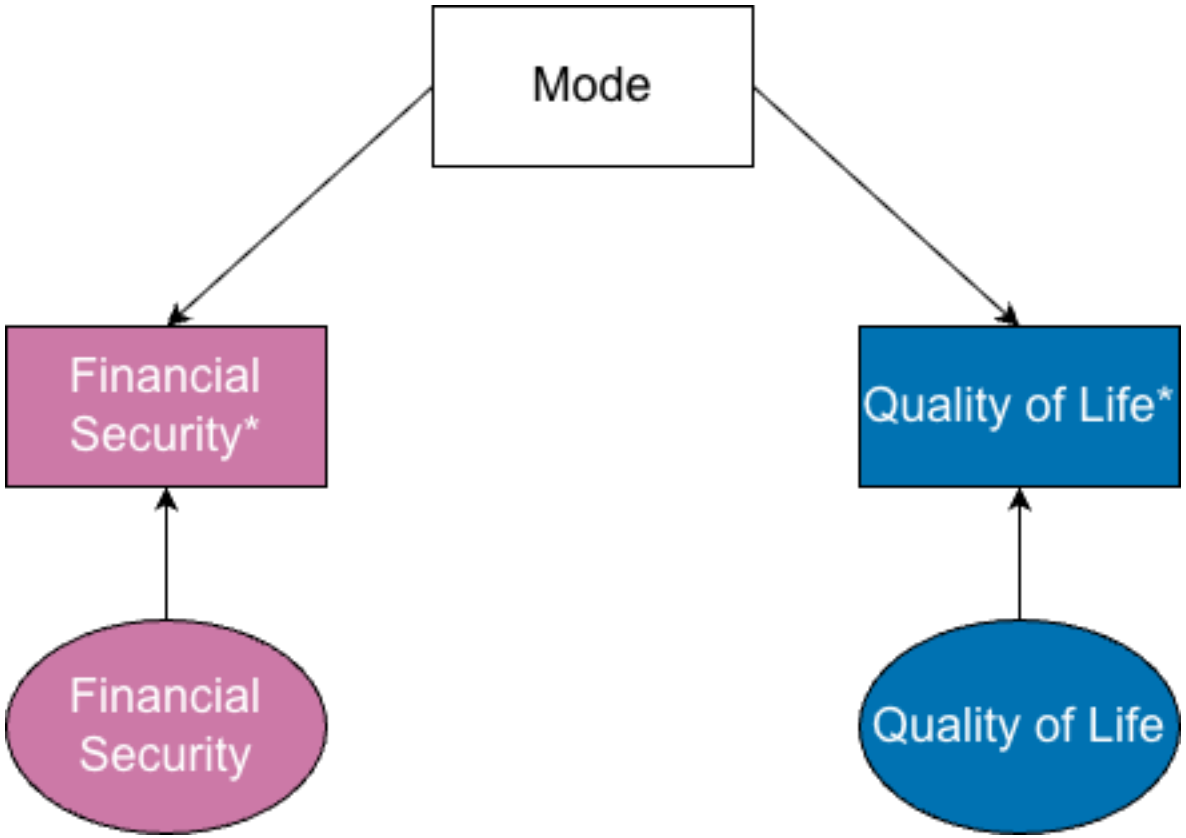

Mode
Financial Security*
Quality of Life*
Financial Security
Quality of Life

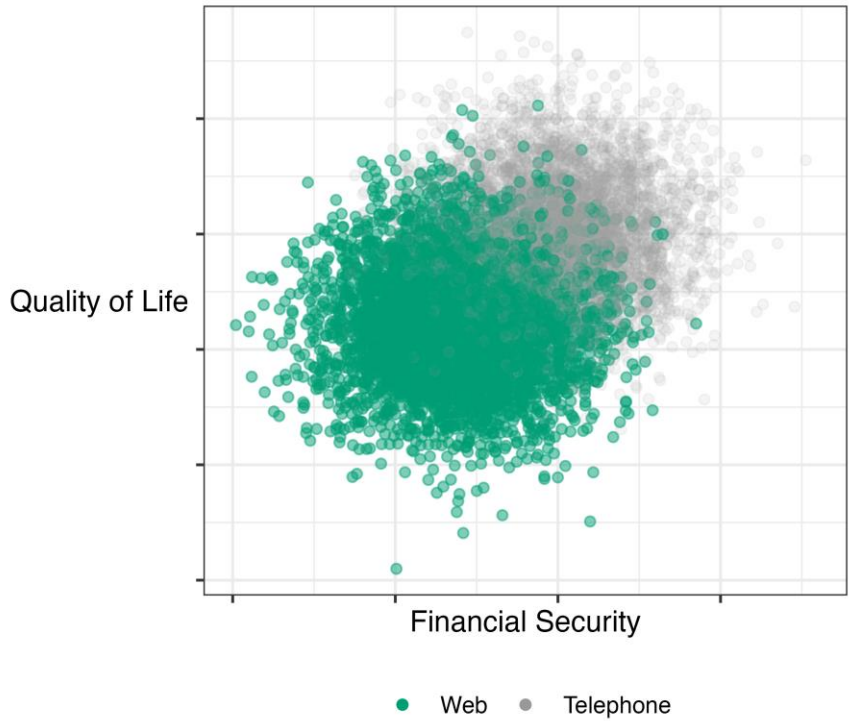

Mode
Financial Security*
Quality of Life*
Financial Security
Quality of Life

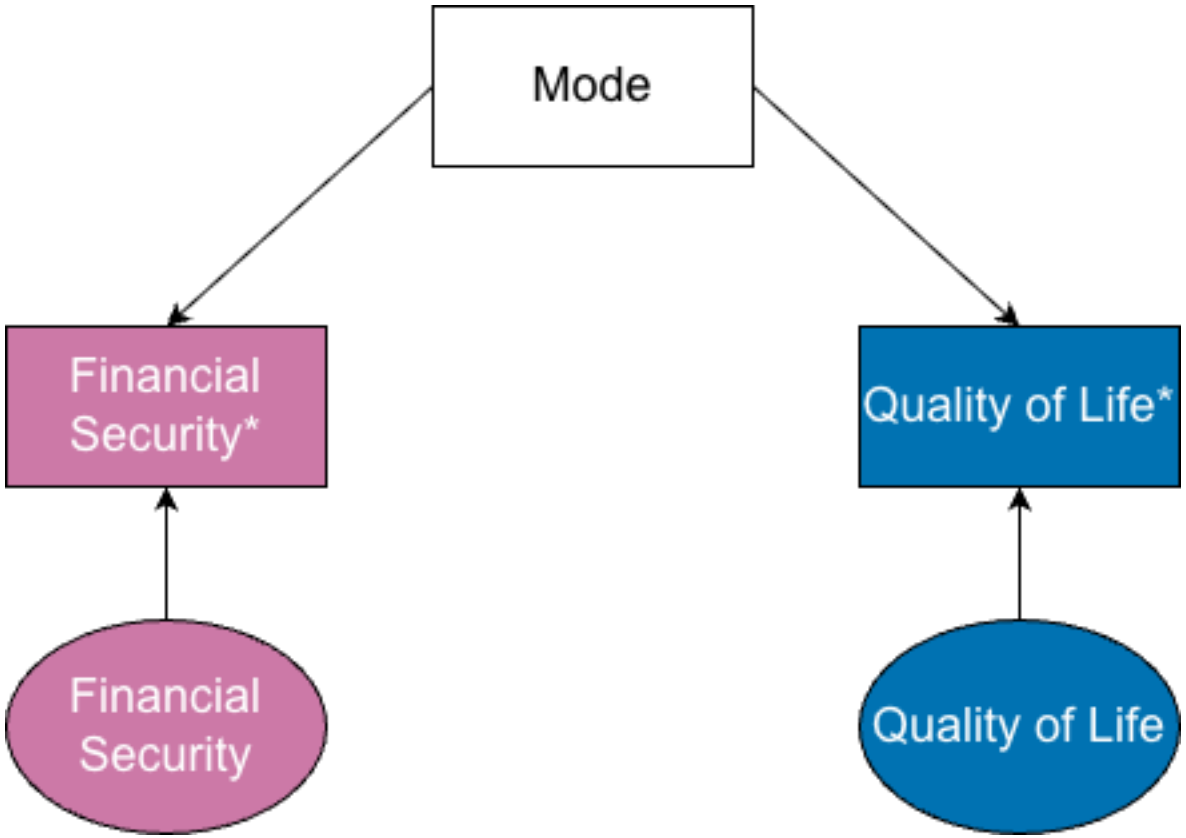

Quality of Life
Financial Security
Web
Telephone

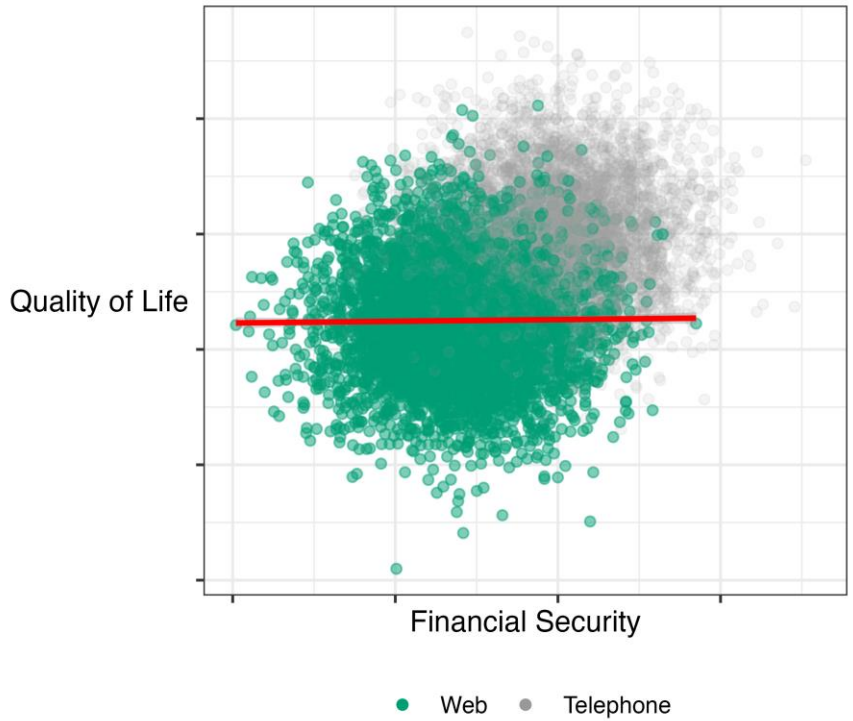

Mode
Financial Security*
Quality of Life*
Financial Security
Quality of Life

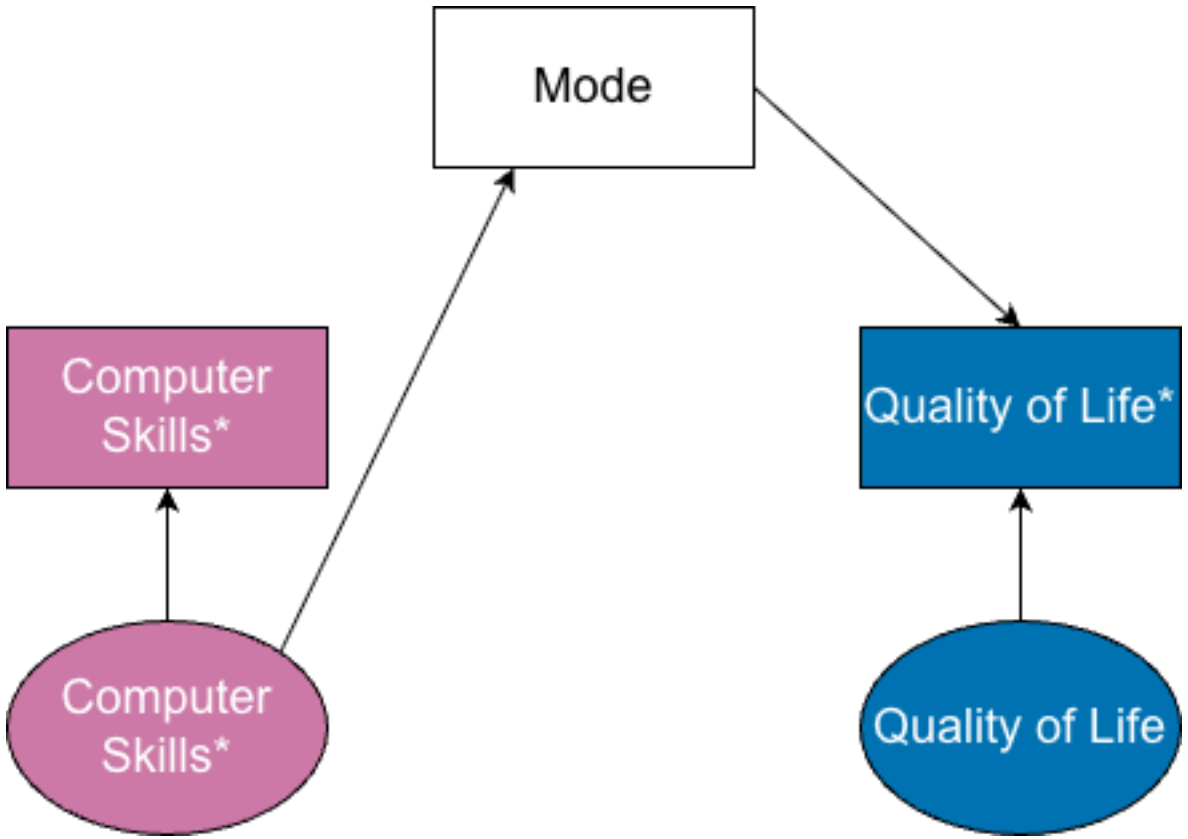

Quality of Life
Financial Security
Web
Telephone

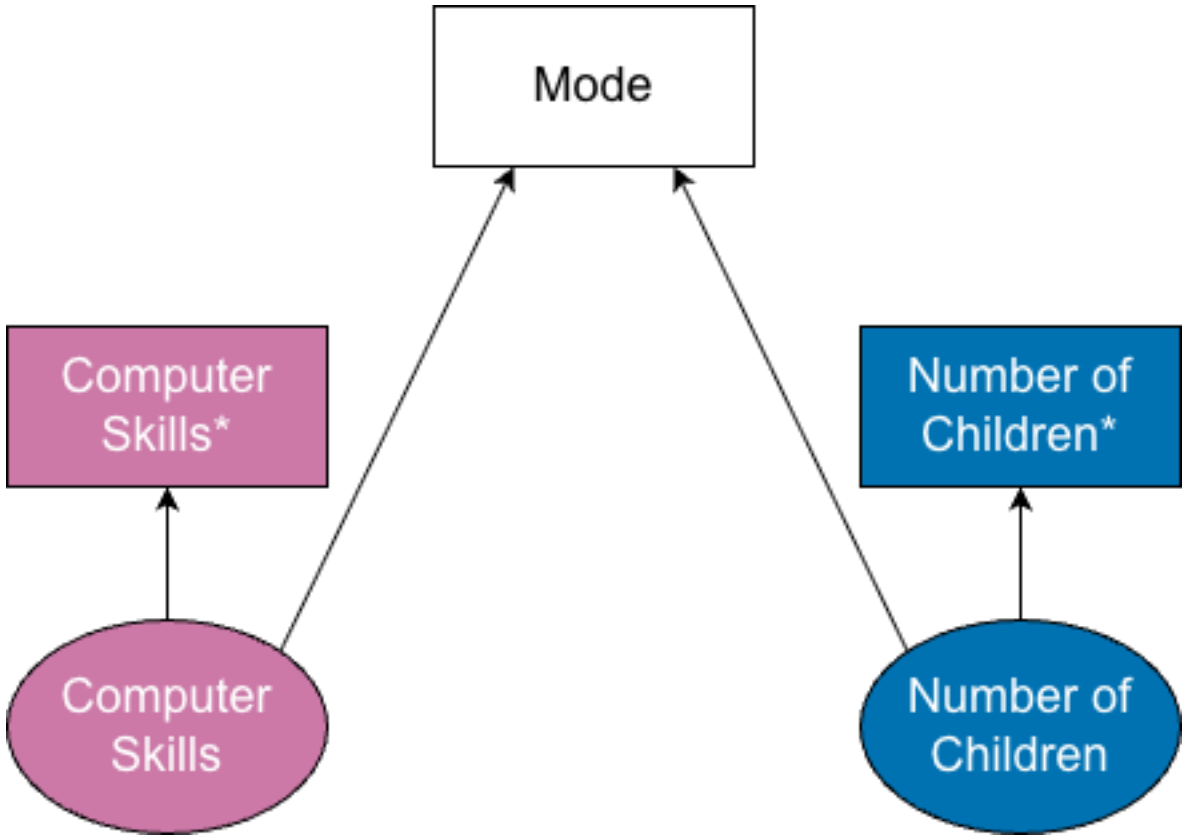

Mode
Financial Security*
Quality of Life*
Financial Security
Quality of Life

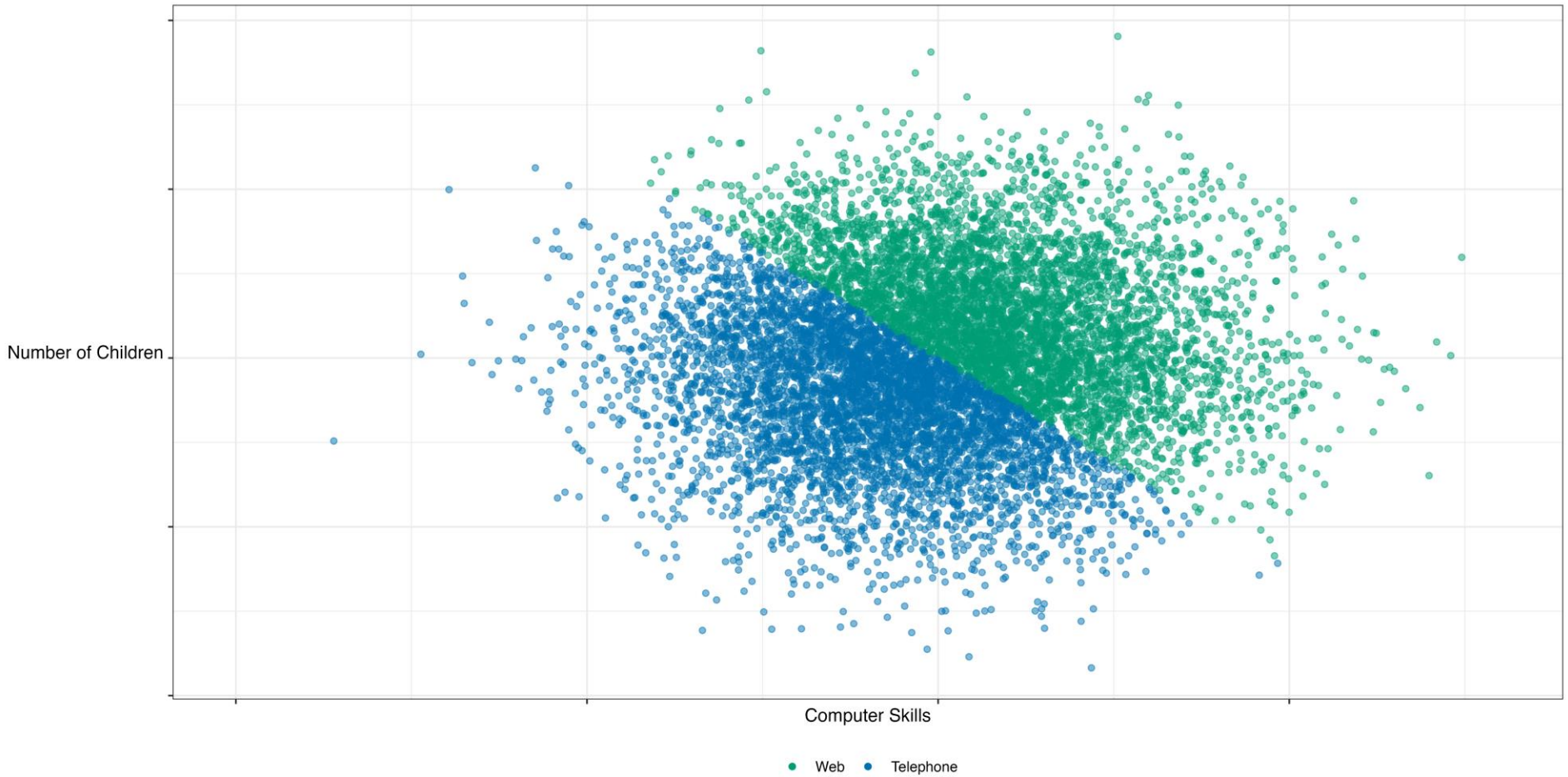

Quality of Life
Financial Security
Web
Telephone

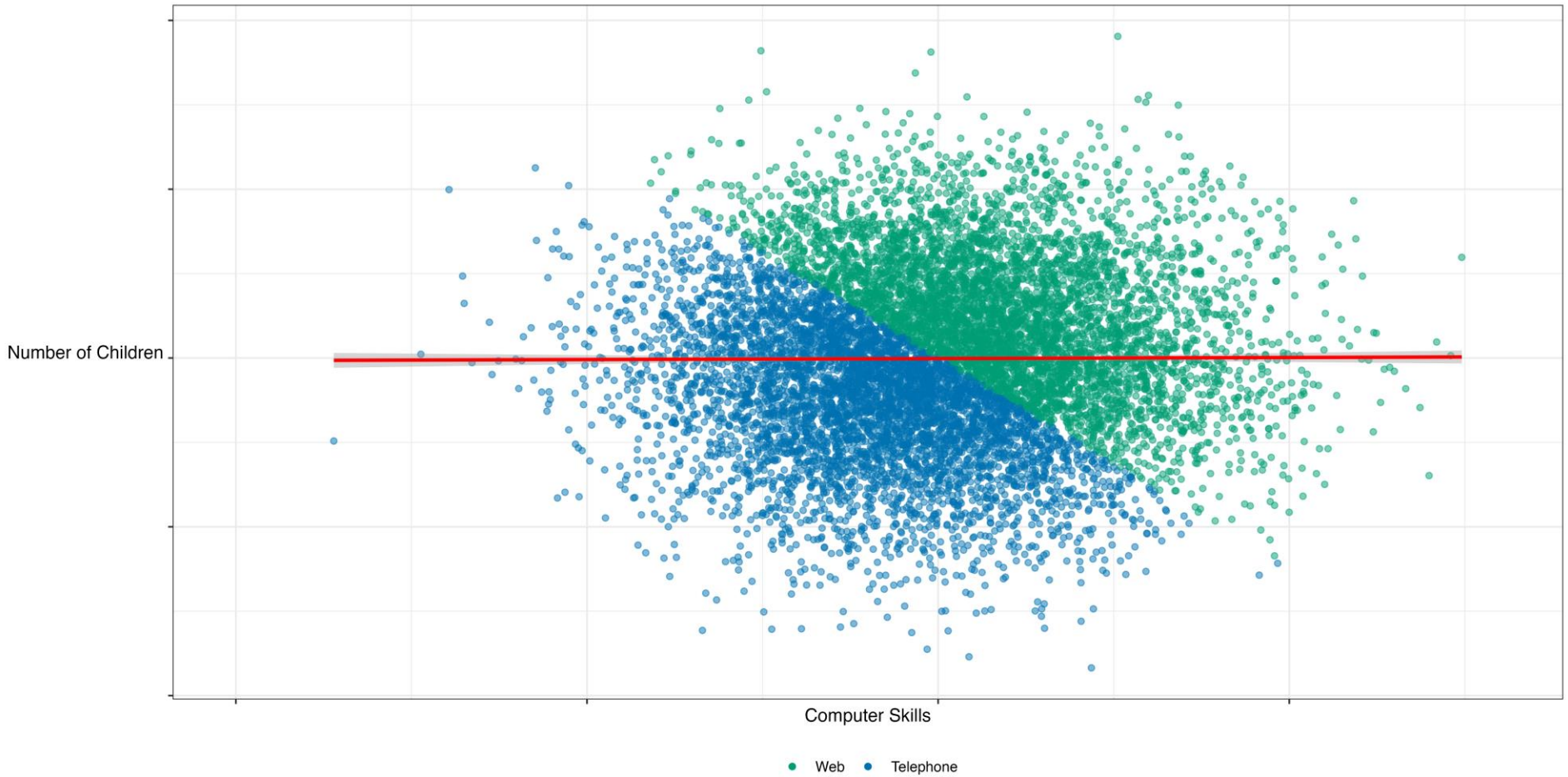

Mode
Financial Security*
Quality of Life*
Financial Security
Quality of Life

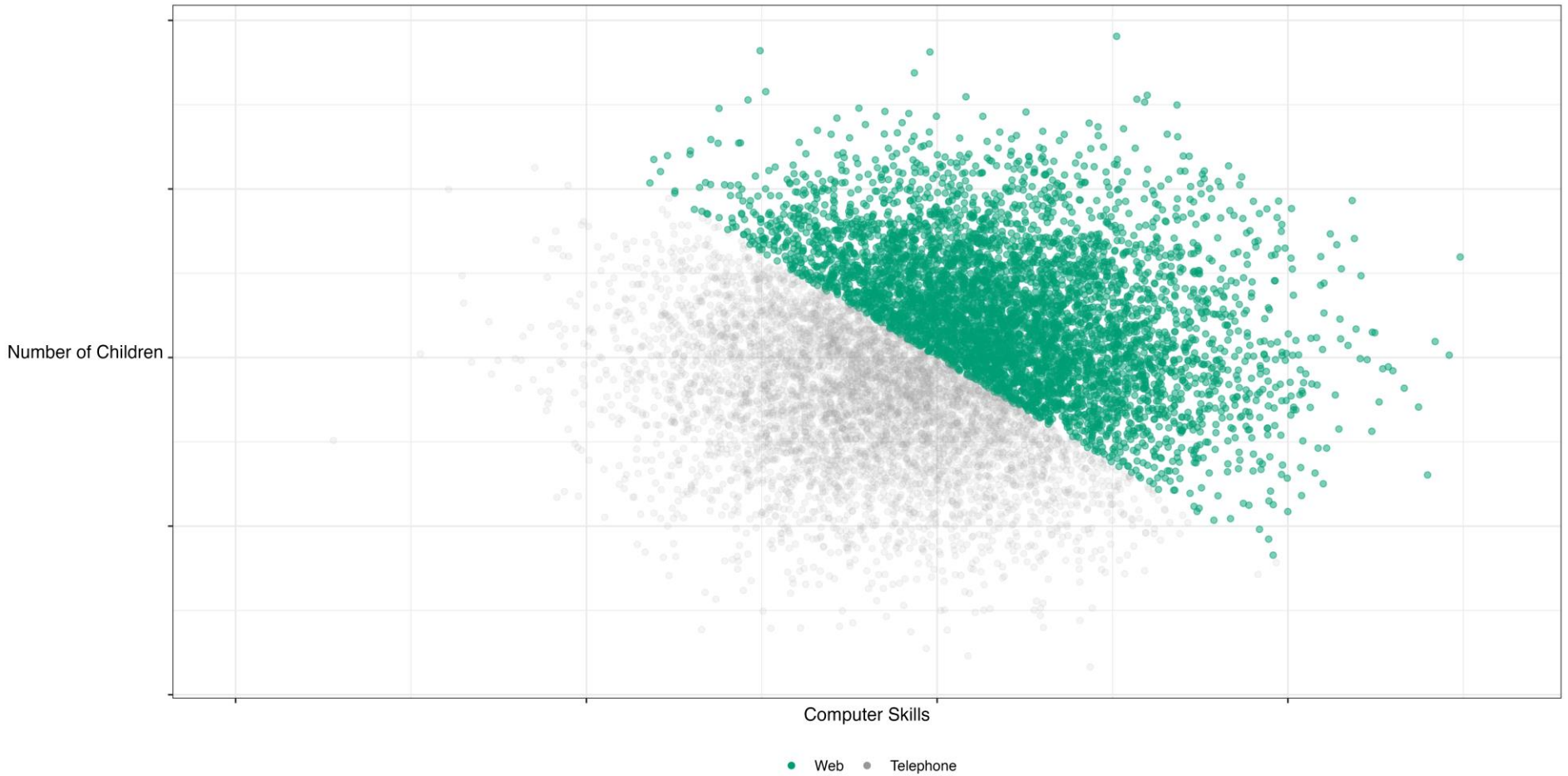

Quality of Life
Financial Security
Web
Telephone

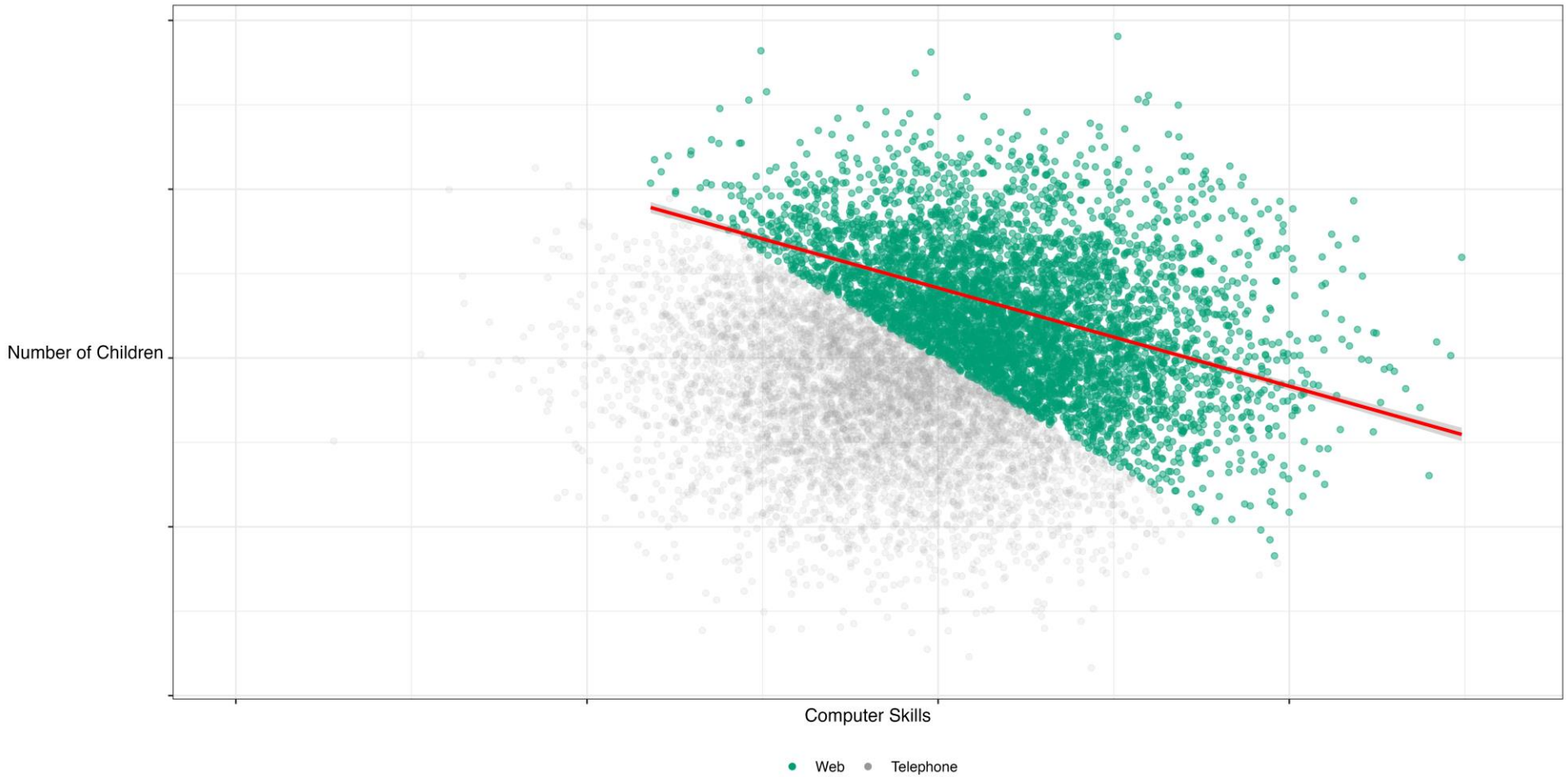

Mode
Computer Skills*
Quality of Life*
Computer Skills*
Quality of Life


Mode
Computer Skills*
Number of Children*
Computer Skills
Number of Children

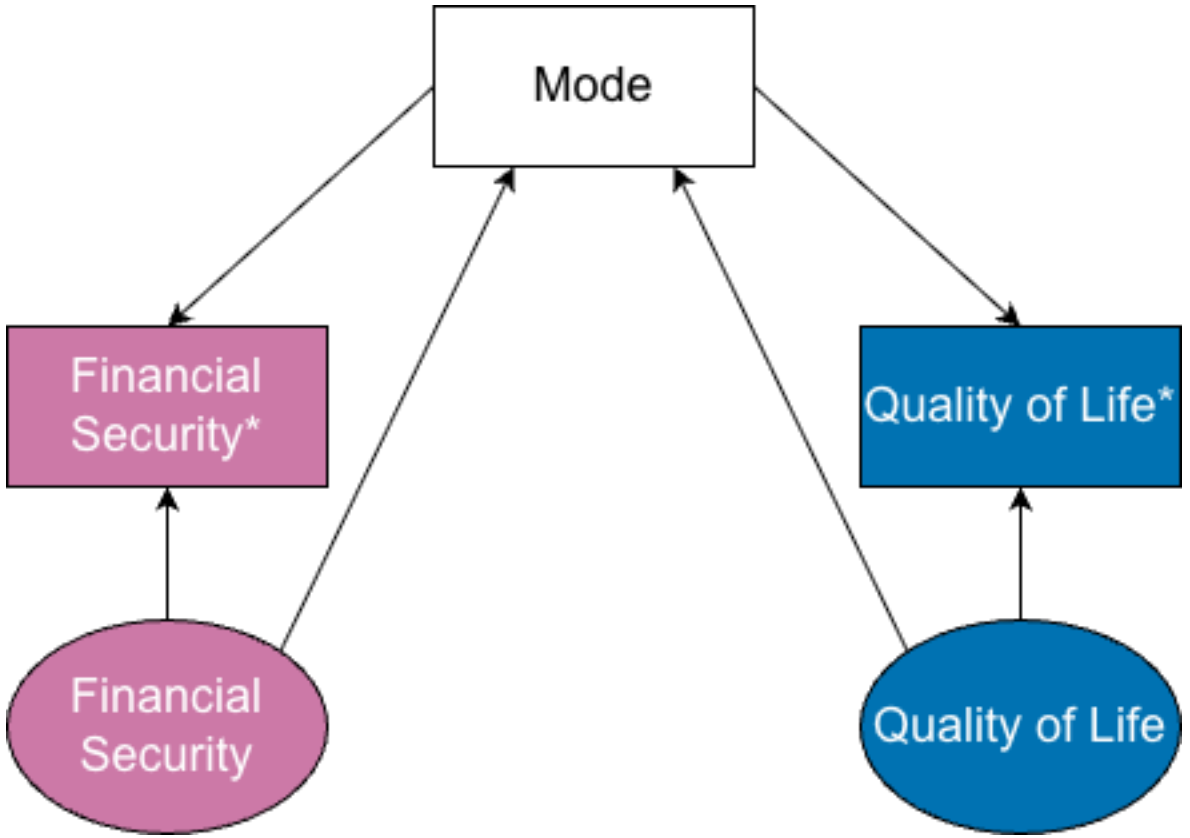

Number of Children
Computer Skills
Web
Telephone


Number of Children
Computer Skills
Web
Telephone


Number of Children
Computer Skills
Web
Telephone

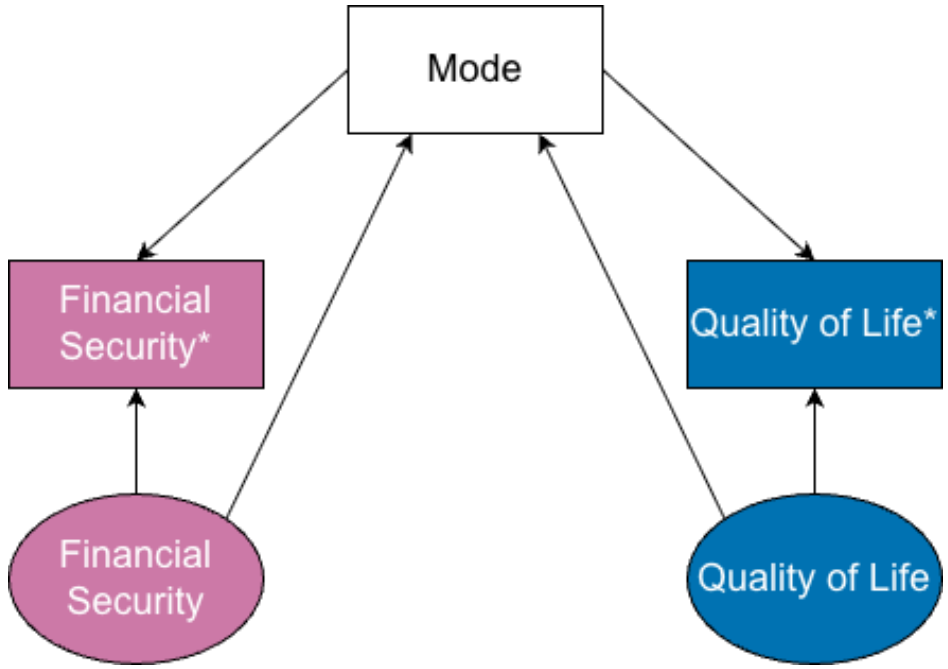

Number of Children
Computer Skills
Web
Telephone

Damned if you do, damned if you don't



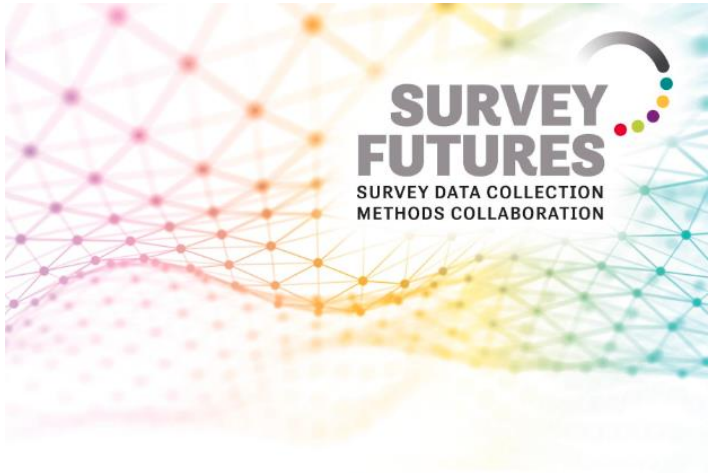
Theory and Practice

- Mixed-mode data have been used and will continue to be used.
- The indicator method may not resolve bias and could increase it.
- But (relative) size of bias depends on:
  - Strength of mode effects
  - The mode split
  - Strength of mode selection
  - Association absent survey design



Mode Effects in Practice: A Systematic Review

- Many mode effect experiments have been conducted to estimate mode effects (i.e., item means and proportions)
- Georgia systematically reviewed 90 of these from general population samples.



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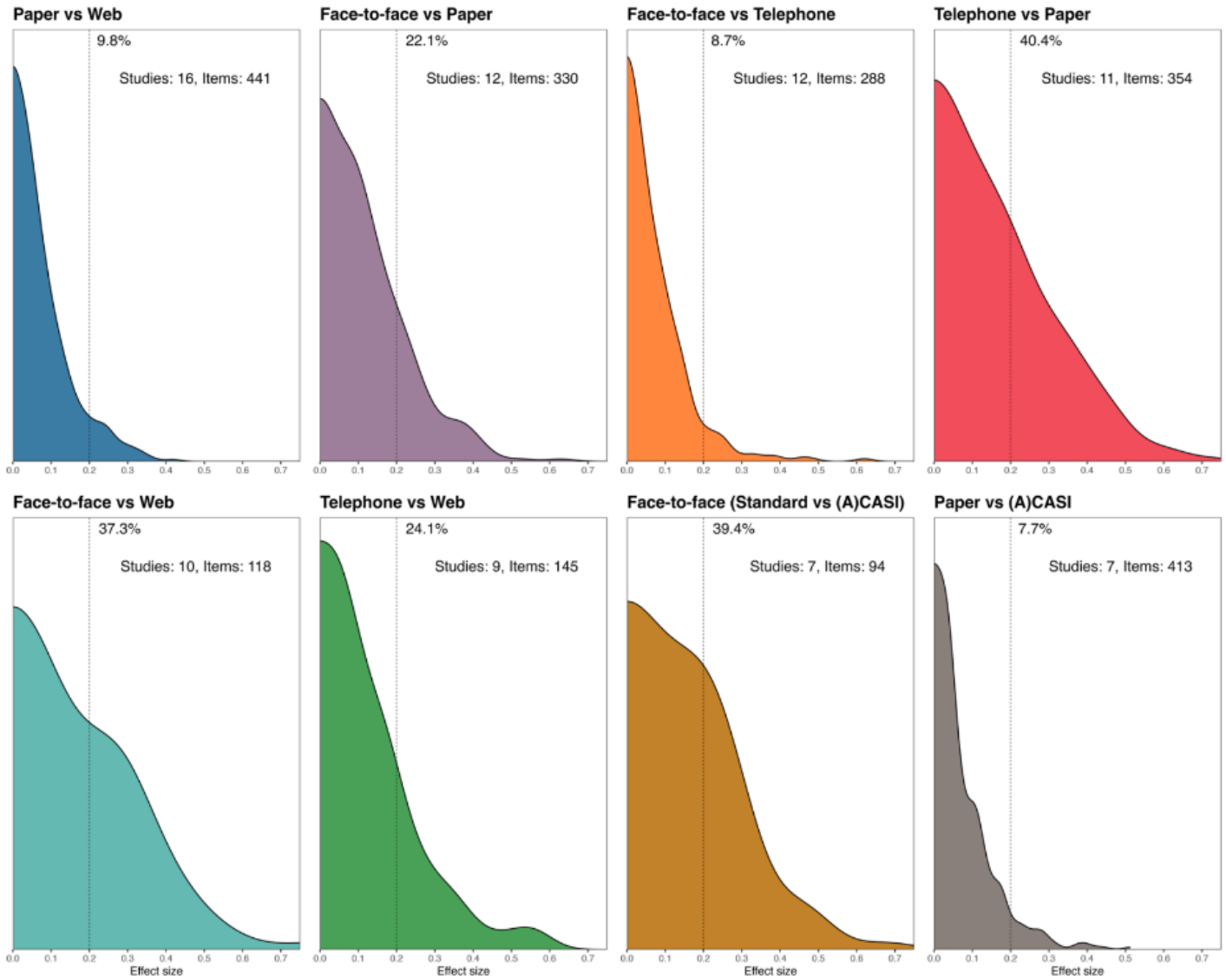
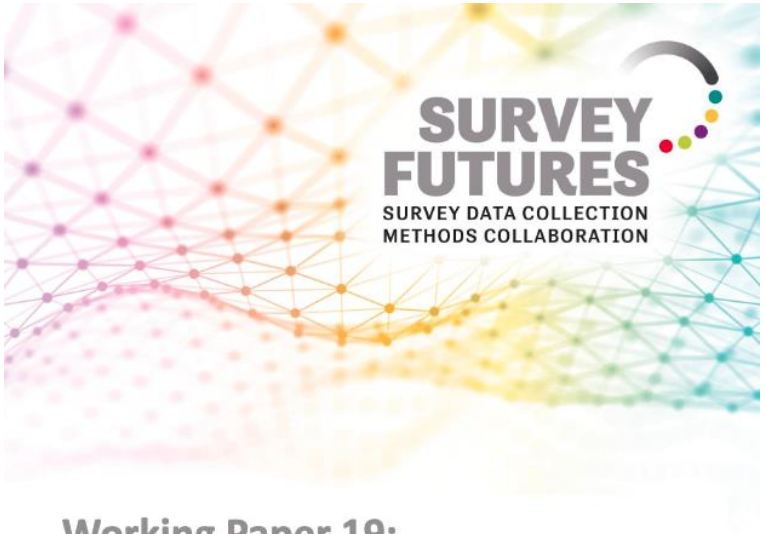

Paper vs Web
9.8%
Studies: 16, Items: 441
Face-to-face vs Paper
22.1%
Studies: 12, Items: 330
Face-to-face vs Telephone
8.7%
Studies: 12, Items: 288
Telephone vs Paper
40.4%
Studies: 11, Items: 354
Face-to-face vs Web
37.3%
Studies: 10, Items: 118
Telephone vs Web
24.1%
Studies: 9, Items: 145
Face-to-face (Standard vs (A)CASI)
39.4%
Studies: 7, Items: 94
Paper vs (A)CASI
7.7%
Studies: 7, Items: 413
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7
Effect size

Mode Effects in Practice: A Systematic Review

Mode Characteristic	Recommendation / Finding
(Physical) Interviewer Presence	Most likely to introduce mode effects for sensitive items. Consider self-completion.
Written (vs. Aural) Question Delivery	Expect mode effects to occur and explain in technical documentation
Computer Assistance	Evidence not consistent enough to give clear recommendation
Self- or Interviewer-Completion	Highest risk of mode effects when transitioning between these
Paper vs. Electronic Self-Completion Transcription	Low risk of mode effects
Interviewer Collection (vs. Mere Presence)	Consider using self-complete consistently

Mode Effects in Practice: Simulations

- We now have DAGs to represent bias from mixed mode and empirical evidence on size of mode effects
- We can use this to simulate data and observe the conditions in which mode effects matter in practice.



Working Paper 19:

When, and how much, might effect estimates be biased when analysing mixed-mode survey data? The roles of mode effects, mode selection, and mode split.

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June 2026

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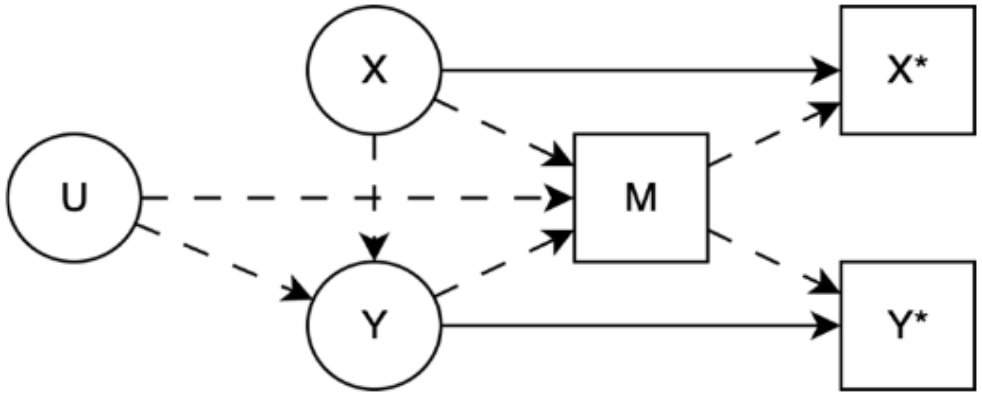


Strength of focal relationship (SD)

$X \rightarrow Y$
0.0
0.2
0.5

Mode split (%)

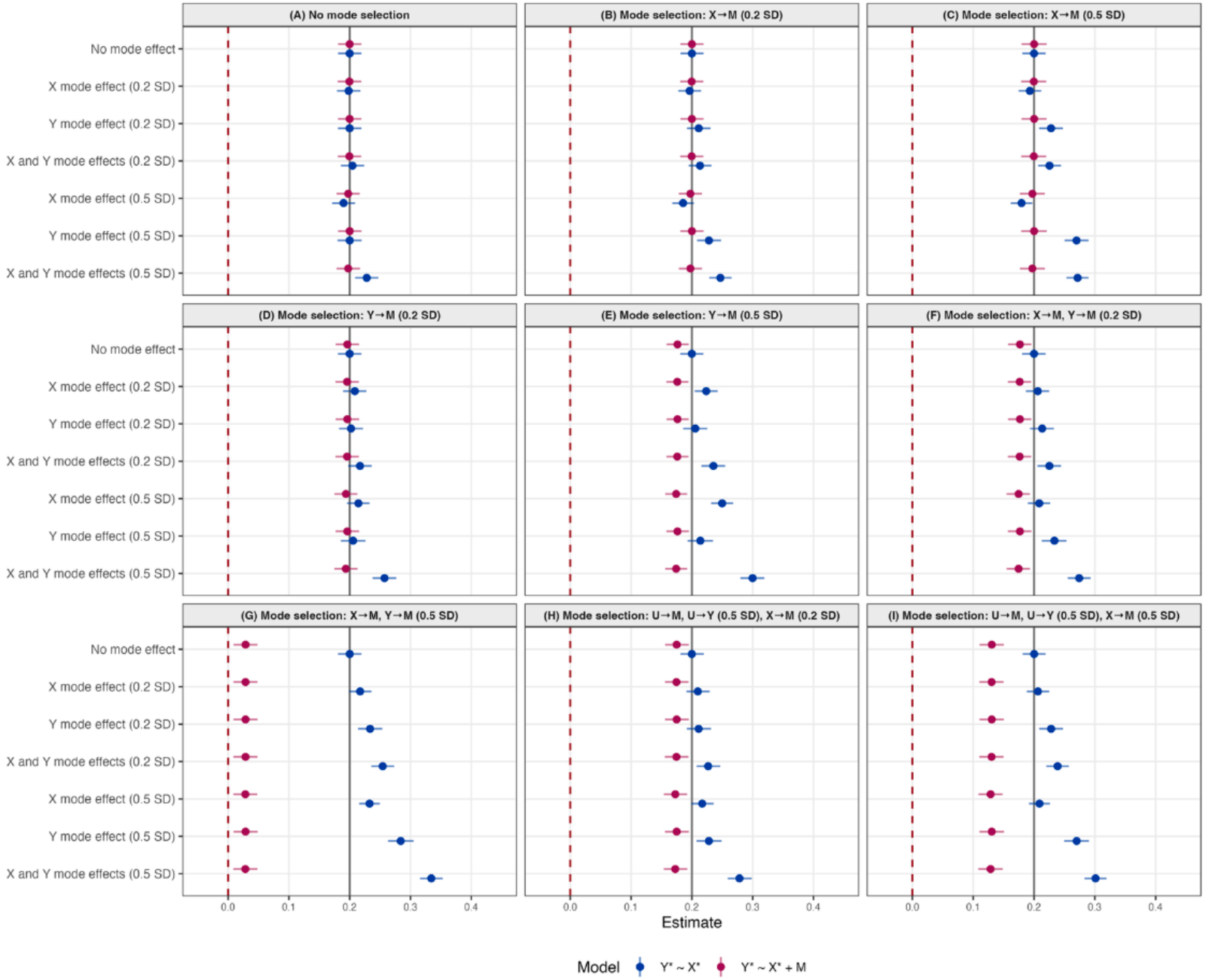
Mode 0	Mode 1
50	50
20	80

Mode selection (SD)

$X \rightarrow M$	$Y \rightarrow M$	$U \rightarrow M$	$U \rightarrow Y$
0	0	0	0
0.2	0	0	0
0	0.2	0	0
0.2	0.2	0	0
0.2	0	0.5	0.5
0.5	0	0	0
0	0.5	0	0
0.5	0.5	0	0
0.5	0	0.5	0.5

Mode effects (SD)

$M \rightarrow X^*$	$M \rightarrow Y^*$
0	0
0.2	0
0	0.2
0.2	0.2
0.5	0
0	0.5
0.5	0.5


(A) No mode selection
(B) Mode selection: X→M (0.2 SD)
(C) Mode selection: X→M (0.5 SD)
(D) Mode selection: Y→M (0.2 SD)
(E) Mode selection: Y→M (0.5 SD)
(F) Mode selection: X→M, Y→M (0.2 SD)
(G) Mode selection: X→M, Y→M (0.5 SD)
(H) Mode selection: U→M, U→Y (0.5 SD), X→M (0.2 SD)
(I) Mode selection: U→M, U→Y (0.5 SD), X→M (0.5 SD)
No mode effect
X mode effect (0.2 SD)
Y mode effect (0.2 SD)
X and Y mode effects (0.2 SD)
X mode effect (0.5 SD)
Y mode effect (0.5 SD)
X and Y mode effects (0.5 SD)
0.0
0.1
0.2
0.3
0.4
Estimate
Model
Y* ~ X*
Y* ~ X* + M

Mode Effects in Practice: Quantitative Bias Analysis

- The indicator method not resolved bias from mixing modes.
- Other methods are required.
- Ongoing work: a tutorial on three QBA methods for handling / examining bias from mode effects

ID	Mode	CASP-6	Degree
1	TEL	4	0
2	WEB	5	1
3	TEL	5	1
4	WEB	7	0
5	TEL	3	0
6	WEB	6	0
…	…	…	…

Mode Effects in Practice: Quantitative Bias Analysis

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- Other methods are required.
- Ongoing work: a tutorial on three QBA methods for handling / examining bias from mode effects

ID	Mode	CASP-6	Degree	Sim
1	TEL	4	0	
2	WEB	5	1	
3	TEL	5	1	
4	WEB	7	0	
5	TEL	3	0	
6	WEB	6	0	
…	…	…	…	…

Mode Effects in Practice: Quantitative Bias Analysis

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- Ongoing work: a tutorial on three QBA methods for handling / examining bias from mode effects

ID	Mode	CASP-6	Degree	Sim
1	TEL	4	0	
2	WEB	5	1	**5**
3	TEL	5	1	
4	WEB	7	0	**7**
5	TEL	3	0	
6	WEB	6	0	**6**
…	…	…	…	**…**

Mode Effects in Practice: Quantitative Bias Analysis

- The indicator method not resolved bias from mixing modes.
- Other methods are required.
- Ongoing work: a tutorial on three QBA methods for handling / examining bias from mode effects

ID	Mode	CASP-6	Degree	Sim
1	TEL	4	0	*3*
2	WEB	5	1	**5**
3	TEL	5	1	*4*
4	WEB	7	0	**7**
5	TEL	3	0	*2*
6	WEB	6	0	**6**
…	…	…	…	…

Mode Effects in Practice: Quantitative Bias Analysis

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- Other methods are required.
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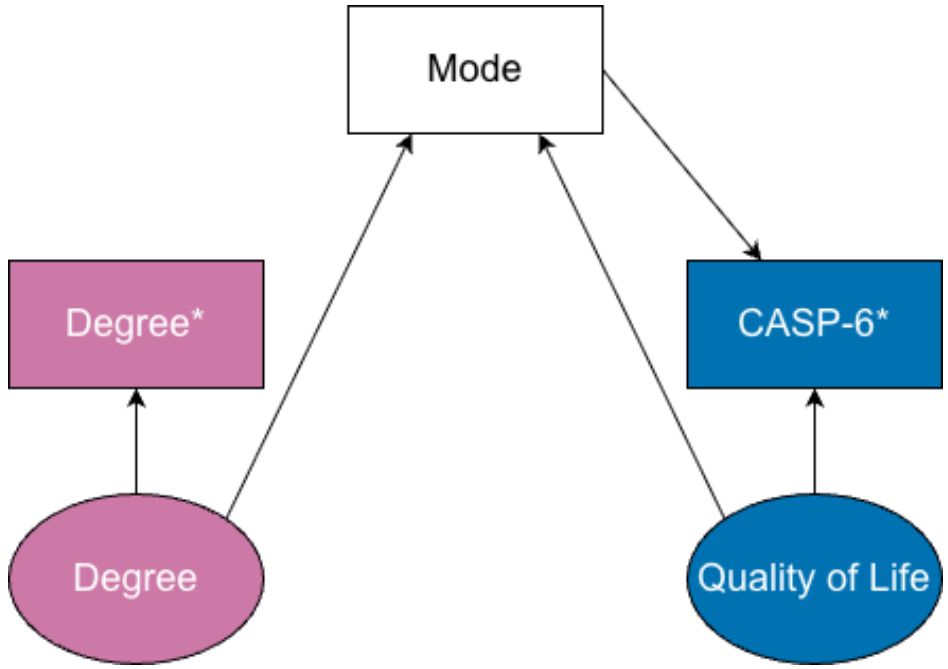

Mode Effects in Practice: Quantitative Bias Analysis

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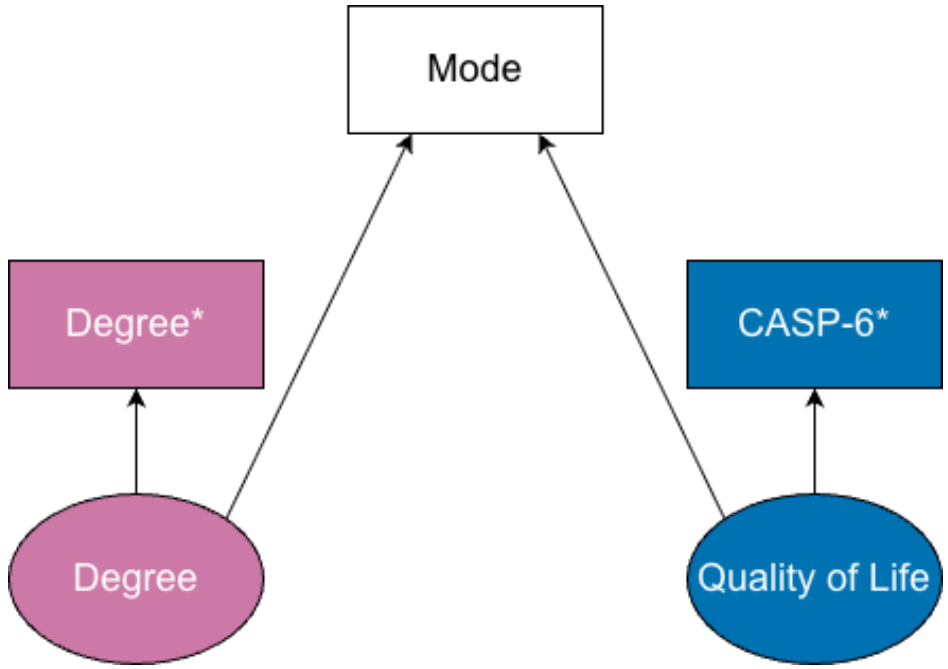
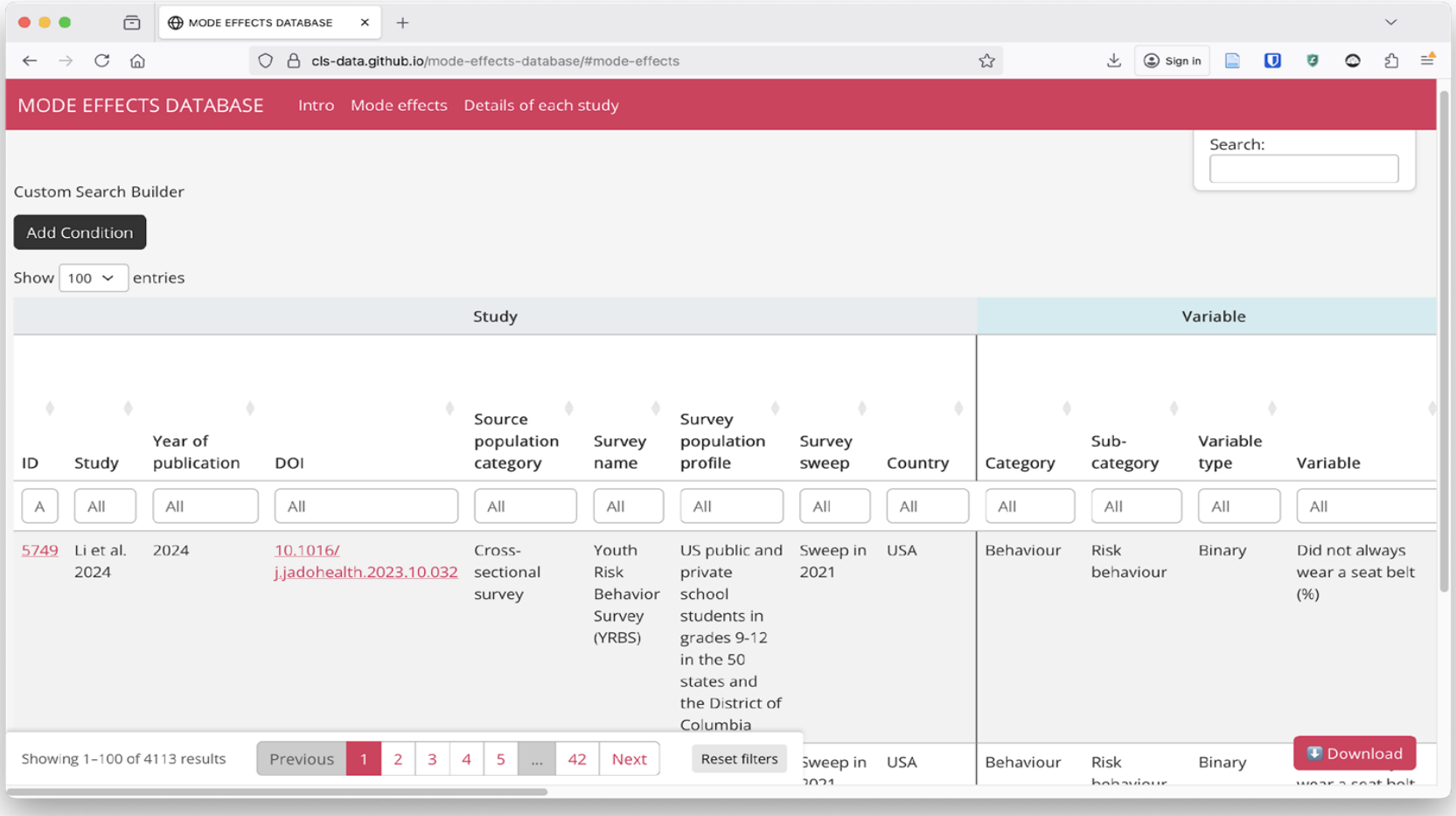
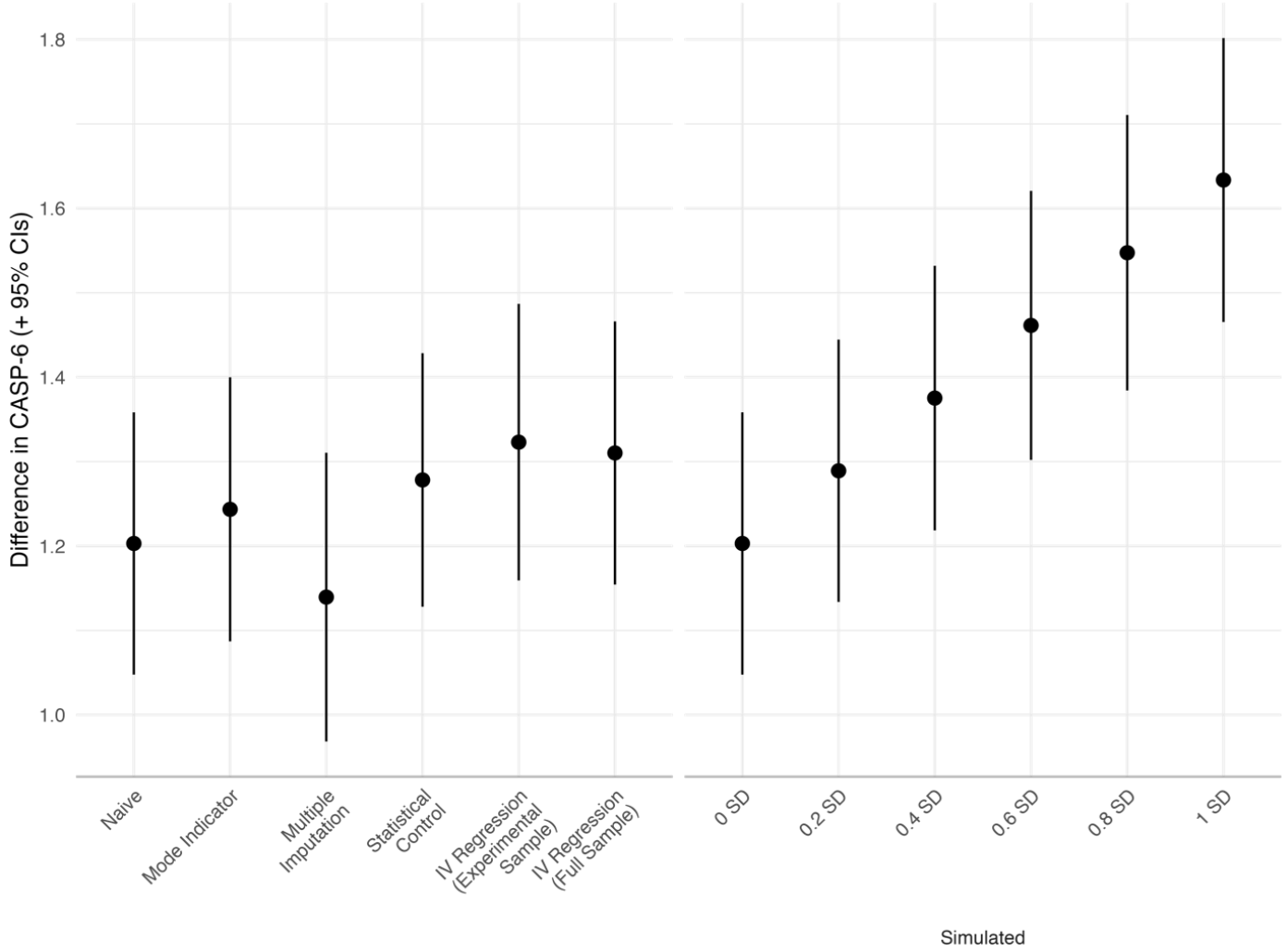


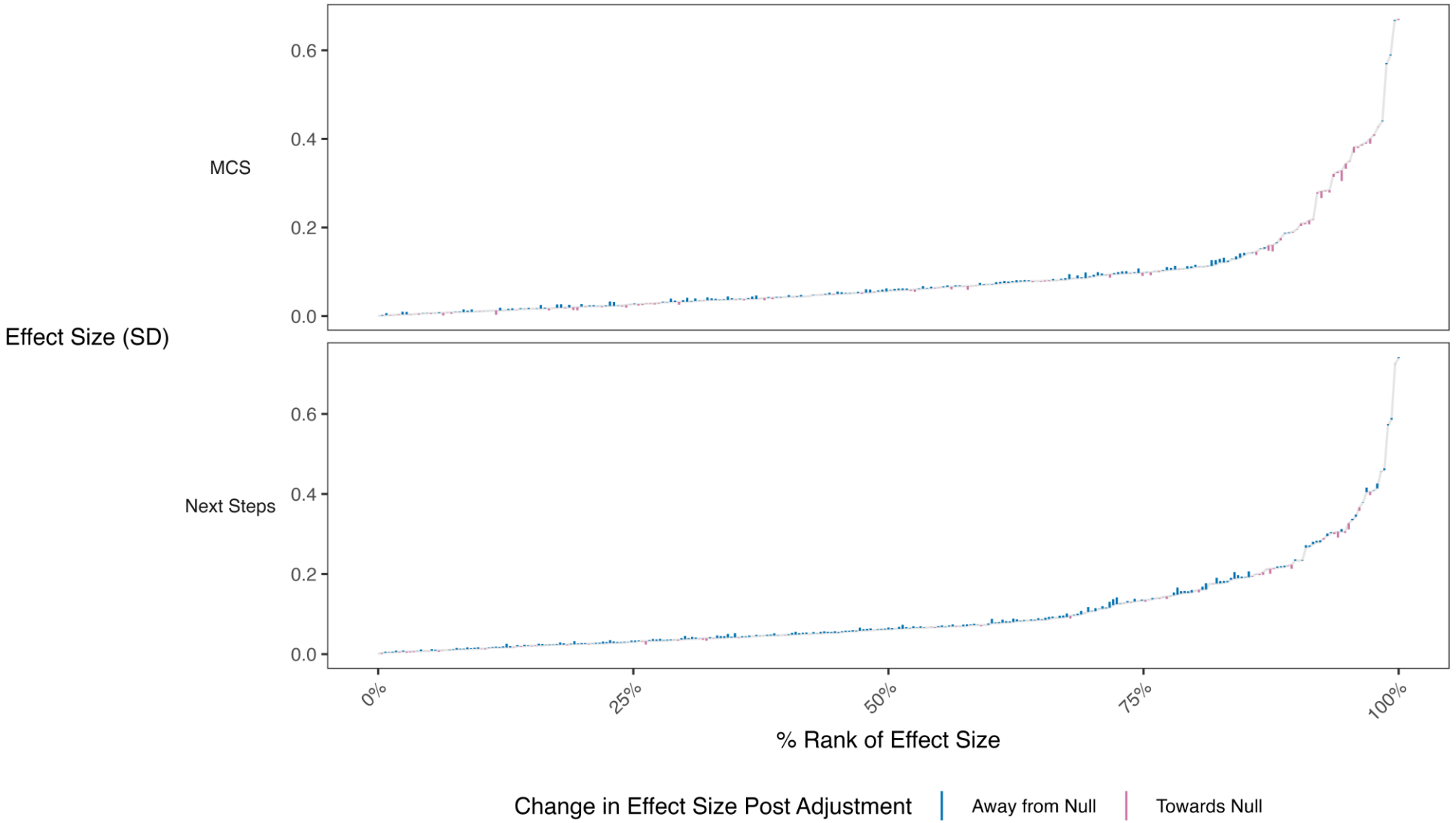
Mode Effects in Practice: Quantitative Bias Analysis



https://cls-data.github.io/mode-effects-database/

Mode Effects in Practice: Quantitative Bias Analysis




MCS
Next Steps
Effect Size (SD)
0.6
0.4
0.2
0.0
0%
25%
50%
75%
100%
% Rank of Effect Size
Change in Effect Size Post Adjustment
Away from Null
Towards Null

Recommendations

1. Try to reduce mode effects *a priori* if you can.
2. Do not give blanket advice for data users to use the indicator method.
3. Recommend that data users consider relevant causal structures for their particular research question .
    - Point them to tools and theory on how to reason about this.
4. Consider QBA methods to handle / examine mode effects *post hoc*.
5. Epistemic hygiene: Don’t assume a mixed-mode design can’t explain a specific association. Don’t assume it can either.

SURVEY FUTURES

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