Comparing Alternatives to the Three-Form Planned Missing Data Design

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Outline

- Planned missing data designs
  - 3 forms design
- Complete data vs. planned missing
  - Real data example
- Random missing vs. planned missing
  - Simulation study

Planned missing data designs

- Missing data does not have to be a problem!
- Two types of planned missing data designs:
  - Time-based planned missing data designs
    - Control participant entry into the study (e.g., cohort sequential design)
  - Participant based planned missing data designs
    - Randomly assign participants to receive only a subset of items

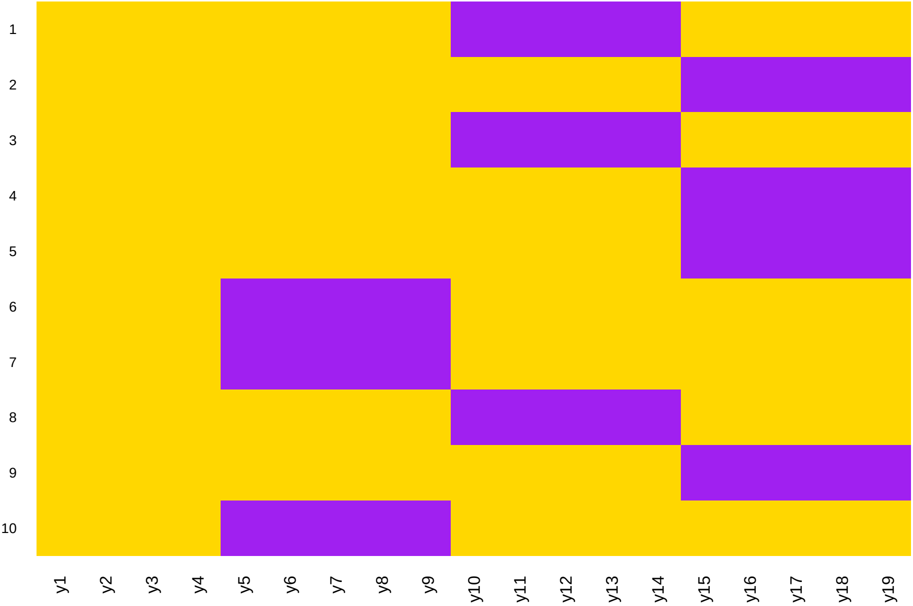
Three-form planned missing design

- Item based planned missing design
- Items are divided into 4 “sets”
    - Set X: items administered to all participants
    - Sets A, B, and C: Items administered to 2/3 of participants
        - Participants are randomly assigned to receive 2 of the 3 sets (e.g. AC)

Three-form planned missing design

Form	X	A	B	C
1	1	1	1	0
2	1	1	0	1
3	1	0	1	1

Three-form planned missing design



Three-form planned missing design

- Advantages
  - More items per participant!
  - Or. . . less fatigue per participant!
  - Less unplanned missing data (Harel, Stratton, & Aseltine, 2011)
  - Reduced practice effects (Jorgensen, et al., 2014)
- Disadvantages
  - Less power than a complete data design
    - Latent variable models alleviate this
  - Requires a “large” sample size
    - 100+ participants (Jia, et al., 2014)

Alternative designs

- Complete data design
  - Assign all participants to receive all items
- Random planned missing
  - Assign each participant to receive a random subset of all items.

Complete data design

- Greater power and less unplanned missing than complete data designs (Harel et al., 2015)

Complete data design

- Greater power and less unplanned missing than complete data designs (Harel et al., 2015)
- Increased fatigue for participants

Complete data design

- Greater power and less unplanned missing than complete data designs (Harel et al., 2015)
- Increased fatigue for participants
- How do parameter estimates compare between complete data and planned missing designs?

Complete data design: Example

- Survey of 892 real-estate agents
- Survey had a total of 163 items including demographics and various work based constructs
- Pariticipants randomly assigned to complete all items ($n = 131$) or complete a subset ($n = 872$)
  - Subset of items were 110 total items based on a 3-forms design
  - Planned missing had ~33% missing

Complete data design: Example

- Compare factor model with two constructs
  - Construct 1 - Work Engagement: 9 items
  - Construct 2 - Turnover Intentions: 4 items
- Engagement assessed at the start of the study, turnover intentions assessed at the end of the study
- Items for constructs were split across the X, A, B, and C sets

Complete data design: Example

- Use multiple group CFA to compare:
    - Factor structure
    - Factor loadings
    - Item intercepts
    - Item residual variances
    - Latent means variance and covariances

Complete data design: Results

- Established configural, and weak invariance
  $\chi^2(11) = 8.57, p = .661, \Delta CFI = .000$
- Established strong invariance?
  $\chi^2(11) = 53.78, p < .001, \Delta CFI = .007$
  - Driven by two intercepts in engagement. Small differences in intercepts ($d < .3$)
- Established strict invariance? $\chi^2(13) = 30.22, p = .004, \Delta CFI = .003$
  - Driven by one variance in turnover intentions.
  - No systematic differences in residual variances

Complete data design: Results

- Difference in latent means $\chi^2(2) = 97.77, p < .001$
  - No significant difference in turnover intention means
  - Mean of engagement is lower in the complete data group ($d = 1.10, p < .001$)
- No difference in latent variances $\chi^2(2) = 1.87, p = .394$
- Difference in latent covariance $\chi^2(1) = 3.99, p = .046$
  - $r = -.37$ for missing data and $r = -.56$ for complete data

Complete data design: Discussion

- No major differences in parameters between planned missing and complete data designs
- No evidence of fatigue from participants in parameters
  - Survey may be too short ($\sim$15 minutes) to observe fatigue effects
  - Almost no unplanned missing (unplanned missing $<$1% in both conditions)
  - Survey was (relatively) “high stakes” with strong motivation to respond
  - Small n with complete data

Random planned missing

- Easily implemented in survey software (e.g. Qualtics)
- Can include all variables, or a subset of variables
  - e.g., collect complete data on demographics and planned missing on other variables
- Increased patterns of missing data compared to 3 forms design

Random planned missing: Simulation

- Simulation study comparing 3 forms design with random planned missing data
- CFA model: 4 latent variables, 6 indicators each
    - 24 total items
    - Factor loadings between .5 and .7 within each factor
    - Latent correlations between .2 and .4

Random planned missing: Simulation

- 2 missing data conditions
    - 3 forms missing data have 6 items in each set
        - Distributed across each factor
        - 25% missing data
    - Random planned missing: 25% missing for each participant
- 4 sample sizes (100, 200, 400, 700)
- All missing data handled with FIML

Random planned missing: Simulation

- Convergence 100% in all conditions
- Random planned missing replications too 2-3 times longer to fit
- No differences in parameter estimates, standard errors, or bias across 3-forms or random missing data designs
  - No differences in power for parameters

Random planned missing: Discussion

- 3-forms planned missing and random planned missing perform similarly in the simulation study
- Random planned missing designs may be easier to program in survey software
- Random planned missing designs may be harder to fit due to larger numbers of missing patterns
    - Potential issues with coverage when not all items in a survey are used in a model
- 3-forms designs may work better in longitudinal designs
    - Especially with practice effects

Conclusion

- Complete data, 3-form planned missing, and random planned missing designs perform similarly
  - With cross-sectional latent variable models
- The choice of design depends on survey length, anticipated modeling strategy, and ease of implementation

Thank you!

- Questions?
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