Item Analysis & Structural Equation Modeling
Society for Nutrition Education & Behavior Journal Club
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Survey development process

Define Construct
Define Scale
Pilot
Item Analysis
Validation
Background

- MS, Social Behavior & Community Health University at Albany, SPH
- Program evaluation & organizational assessment for nonprofits, government, foundations and corporate giving
- Expertise working on hunger and nutrition issues in low-income communities
  - Feeding America BackPack Program
  - NYC Farmers Market Nutrition Education
  - NYS WIC Supplemental Food Program
  - USDA SNAP-Ed programs
Evaluation of Supplemental Nutrition Assistance Program Education: Application of Behavioral Theory and Survey Validation

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Define Construct
The Scientific Process

INDUCTIVE

THEORY

DATA

GENERALIZATIONS

HYPOTHESIS

DEDUCTIVE
“To develop an intervention for a given community, the determinants of behavior in that particular population must be ascertained. Then the intervention must be developed based on knowledge of these determinants and on theories of behavior and behavior change.”

- Fishbein & Guinan, 1996
Constructs from Behavior Theory

- **Decisional balance** - Janis and Mann (1977); balance sheet of pros/cons determinant of behavior.

- **Self-efficacy** - Bandura (1977); confidence in one’s capacity to execute (or not execute) a behavior determinant of decision to perform (or not perform) behavior.
Defining constructs

Well-defined theoretical concepts simplify scale development and hypothesis validation

Perceived barriers to eating fruits & vegetables

- I do not know how to prepare them
- Difficult to find fruits and vegetables the whole family likes
- It takes too much time to prepare fruits and vegetables
Defined construct most useful in context of theoretical framework

- Nutrition Ed & Cooking Demos
- Perceived Benefits
- Perceived Barriers
- Self-efficacy
- F&V Consumption

Perceived Benefits

Nutrition Ed & Cooking Demos

Perceived Barriers

Self-efficacy

F&V Consumption

Defined construct most useful in context of theoretical framework.
Define Scale
Why use multi-item scales?

- **Reliability** - random error spread across items in scales
- **Precision** - multiple items and responses allow for more specific category assignment and relative comparison
- **Scope** - multiple items capture details about various aspects of a construct
Selecting items for scale

- A priori articulation of theory and constructs guides item selection
- Literature review on construct of interest
  - Make use of previously validated scales
  - Use items from existing scales to create new scale to be tested
Item Analysis
Item Analysis Statistics

- **Internal Consistency** - Cronbach’s Alpha
- **Item Difficulty** - Item mean / # response choices
- **Item Discrimination** - Correlated Item Total Correlation
Cronbach’s Alpha

● Compares variance of total scale score with the variance of the individual items

\[ \alpha = \frac{K}{K-1} \left[ 1 - \frac{\sum S_i^2}{S_T^2} \right] \]

- K = number of items
- \( S_i^2 \) = variance of item
- \( S_T^2 \) = variance of sum of the items

● Commonly use >.70 as threshold for internal consistency

● Limitations
  ○ Influenced by sample size
  ○ Does not necessarily reflect unidimensionality
Item Difficulty

- Simple statistic (mean or mean/# of response options) that is essential to scale development
- Unable to detect who is who with high proportion of “correct” responses for an item
- Little to no use when making comparisons
- More “difficult” questions also highlight intervention targets
Item Discrimination

- Degree to which a person who is truly a “high performer” responds to a particular item “correctly” (and vice versa)
- Example: Ability of someone who knows material (and will get an A on test) to answer each particular item correctly
- Correlation of the item and the total score without the item

<table>
<thead>
<tr>
<th>Item</th>
<th>Scale Mean if Item Deleted</th>
<th>Scale Variance if Item Deleted</th>
<th>Corrected Item-Total Correlation</th>
<th>Squared Multiple Correlation</th>
<th>Cronbach’s Alpha if Item Deleted</th>
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<tr>
<td>PRE_ATT_1</td>
<td>10.310</td>
<td>12.150</td>
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<td>10.996</td>
<td>9.392</td>
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Validation
Perceived Benefits

"adds variety"
"feel better"
"eat as a family"

Factor Analysis

Other stuff

Observed variables

Latent variable ("trait" or "factor")
Factor Analysis

**Exploratory**
- Inductive process
- Constructs interpreted from data
- Number of factors based on interrelationship of data
- Model fit not an issue

**Confirmatory**
- Deductive process
- Constructs selected a priori based on theory
- Number of factors predetermined
- Model fit primary goal to support theory
Preparing data for SEM

- **Sample size**
  - Min varies and depends on number of constructs
  - Generally $n >100$, but support for as few as 30
  - Large $n$ common to have poor model fit using Chi Sq. test

- **Missing data**
  - SEM will not work with missing data
  - Imputation can correct (recommend FIML)

- **Normality**
  - Flag outliers, assess skewness and kurtosis of each item
  - If appropriate, corrections can be made to data using bootstrapping
SEM Measurement Model
SEM Structural Regression Model

L1

x1 → L1
x2 → L1
x3 → L1

L2

x4 → L2
x5 → L2

L3

x7 → L3
x8 → L3
x9 → L3

Y

e1, e2, e3, e4, e5, e6, e7, e8, e9, e10, e11

x4, x5, x6, x7, x8, x9, x1, x2, x3
Fit Indices

- **Chi Square** - if not significant (p<.05), good model

- **Goodness of Fit (GFI)** - range from 0 to 1 and better fit with higher value; >.90 good fit

- **Standardized RMR** - predicted correlations - observed, lower the better (<.05) good fit

- **Comparative Fit Index (CFI)** - range from 0 to 1 and better fit closer to 1; >.95 good fit
Perceived Benefits

- "adds variety"
- "feel better"
- "eat as a family"

Interpreting results

Unexplained variance (error)

Factor loading

Predicted amount of change in observed variable with every unit change in latent construct

Perceived Benefits

Factor loading

Predicted amount of change in observed variable with every unit change in latent construct

-.44

-.51

-.50

-.58

-.70

-.71
Interpreting results

Parameter estimate adjusted for other vars in the model & error

Correlation between exogenous variables

Unexplained variance, so L1 & L2 explained 60% of variance in L3, all vars 14% of Y

* Statistically significant p>0.05
Resources

- **Behavior Change Theory**

- **Summated Scale Development & Item Analysis**

- **Factor Analysis & SEM**

Questions?

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