

Multilevel Confirmatory Factor Analysis of the SOCIS

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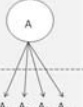





Introduction

- SOCIS study used a nested or two-level design
- Multiple informants within a county (level-1) were used to generate an aggregate county-level (level-2) score
- Recent advances in SEM
 - ◆ Multilevel confirmatory factor analysis (MCFA)
 - ◆ Allows for testing measurement models with nested data structures

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Multilevel Study Design

Level	Counties			
	A	B	C	D
County	A	B	C	D
Individual	 A ₁ A ₂ A ₃ A ₄	 B ₁ B ₂ B ₃ B ₄	 C ₁ C ₂ C ₃ C ₄	 D ₁ D ₂ D ₃ D ₄

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Study Purpose

- Using multilevel CFA (MCFA), test the factorial validity of the SOCIS implementation factors
- For each factor:
 - ◆ Unidimensionality
 - ◆ Significance of item loadings
 - ◆ Sufficient county-level variance for analyzing structural relationships

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CFA Limitations

- Traditional CFA does not recognize the multilevel data structure
 - ◆ Operates on the *total* covariance matrix, combines both within- and between-counties variance into a single variance
 - ◆ Implicit assumption that the two types of covariance have the same factor structure (e.g., dimensionality, loadings) at each level
 - ◆ Produces *atomistic fallacy*, incorrectly assumes that the relationship between variables observed at the individual level holds for group-level versions of the variables

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Why Multilevel CFA?

- Variation in the data can come from two qualitatively different sources
 - ◆ Between-counties: differences between counties
 - ◆ Within-counties: differences between individuals within a county, i.e., measurement error

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Multilevel Confirmatory Factor Analysis

- Separate variances for within- and between-levels
- Tests the underlying measurement model/factor structure *at each level*
- Provides assessment of whether sufficient between-county variation for multilevel regression analysis

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Schematic Diagram for MCFA

Multi-Level CFA of Outreach and Access to Care

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Research Questions

For each implementation factor:

1. At the county-level, do the items fit a one-factor or unidimensional factor structure (i.e. factorial validity, number of factors and item loadings)?
2. Is there sufficient variability between counties to warrant further investigation of structural relationships?

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Analysis Plan: Unidimensional Factor Structure

- For each factor:
 - ◆ Fit a one-factor MCFA at each level
 - ◆ Assess goodness-of-fit of the one-factor model using multiple fit indices
 - ◆ Test the significance of the item loadings at each level

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Analysis Plan: Sufficient Variability Between Counties?

- For each implementation factor, calculate the intraclass correlation (ICC)
 - Proportion of systematic, between-county, variance relative to the total variance
 - $ICC = \text{Between } \sigma^2 / \text{Total } \sigma^2$
 - $\text{Total } \sigma^2 = (\text{Between } \sigma^2 + \text{Within } \sigma^2)$
 - Ranges from 0 to 1.0
 - When ICCs are small, multilevel models may be difficult or impossible to estimate
 - No firm guidelines : most published multilevel CFAs have reported ICCs > .10

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Analysis Plan: Sufficient Variability Between Counties?

- For each implementation factor:
 - ◆ Test the significance ($p < .10$) of the county-level variance
 - ◆ If county-level variance is not different from zero, or the ICC < .08,
 - ◆ then insufficient variance to proceed to meaningful analysis of structural relationships

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Results: Unidimensionality

Factor	Fit Indices		
	CFI	TLI	RMSEA
1. Family Choice and Voice	.985	.976	.048
2. Individualized, Comprehensive and Culturally Competent Treatment	.959	.952	.047
3. Outreach and Access to Care	.996	.992	.038
4. Transformational Leadership	.991	.988	.051
5. Theory of Change	.986	.980	.038
6. Implementation Plan	.998	.998	.027
7. Local Population of Concern	1.000	1.001	.000
8. Interagency and Cross-Sector Collaboration	.959	.952	.046
9. Values and Principles	.999	.998	.015
10. Comprehensive Financing Plan	.958	.942	.056
11. Skilled Provider Network	1.000	1.001	.000
12. Performance Measurement System	.996	.994	.018
13. Provider Accountability	.999	.999	.008
14. Performance Measurement System	.992	.983	.045

Good Fit
 •CFI > .95,
 •TLI > .95,
 •RMSEA < .08

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Results: Item Loadings

Factor	Number of Items	Item Loadings			
		Within		Between	
		Mean	Range	Mean	Range
1. Family Choice and Voice	5	.67	-.50-.80	.77	.51-1.00
2. Individualized, Comprehensive and Culturally Competent Treatment	8	.63	-.33-.82	.69	.28-.98
3. Outreach and Access to Care	3	.76	-.69-.85	.94	.85-1.00
4. Transformational Leadership	5	.86	-.83-.89	.96	.91-.99
5. Theory of Change	5	.69	-.48-.82	.76	.52-.98
6. Implementation Plan	5	.92	-.87-.96	.92	.80-.99
7. Local Population of Concern	3	.82	-.58-.99	.99	.96-1.00
8. Interagency and Cross-Sector Collaboration	8	.61	-.30-.78	.68	.26-.98
9. Values and Principles	5	.73	-.39-.89	.88	.50-1.00
10. Comprehensive Financing Plan	6	.60	-.37-.88	.68	.42-1.00
11. Skilled Provider Network	4	.59	-.35-.81	.48	.17-.89
12. Performance Measurement System	5	.65	-.38-.84	.64	.16-.88
13. Provider Accountability	4	.63	-.43-.82	.82	.67-.98
14. Performance Measurement System	4	.79	-.71-.84	.80	.72-.91

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Results: Factorial Validity

- Unidimensionality
 - ◆ All one-factor models had acceptable fit as assessed by multiple goodness-of-fit indices
 - ◆ All factor loadings were significant,
 - Within: mean loading = .70, range .30-.99
 - Between: mean loading = .77, range .16-1.00

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Results: Variances

Factor	Within Variance	Between Variance	ICC
1. Family Choice and Voice	0.520*	0.101*	.163
2. Individualized, Comprehensive and Culturally Competent Treatment	0.437*	0.030	.064
3. Outreach and Access to Care	0.881*	0.106*	.107
4. Transformational Leadership	0.610*	0.087*	.124
5. Theory of Change	0.403*	0.022	.052
6. Implementation Plan	1.775*	0.089	.048
7. Local Population of Concern	0.185*	0.021*	.102
8. Interagency and Cross-Sector Collaboration	0.094*	0.010*	.096
9. Values and Principles	0.078*	0.005	.060
10. Comprehensive Financing Plan	0.249*	0.033*	.117
11. Skilled Provider Network	0.146*	0.004	.027
12. Performance Measurement System	0.724*	0.021	.028
13. Provider Accountability	0.041*	0.004*	.089
14. Performance Measurement System	0.740*	0.024	.031

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Results

- Seven factors met between-county variance criteria
 - ◆ ICCs of .08 or greater
 - ◆ Between-county variance with p -values < .10

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Discussion

1. Because of the small average cluster size (number of respondents within county, $n = 4$), low power in testing if the remaining 7 factors had significant variance at the county level
 - ◆ Based on Spearman-Brown formula, approx. 20 informants per community would provide factor reliabilities of .70 or higher
 - ◆ Future research with a larger sample should resolve this question

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Discussion

2. Factorial validity of the measurement model
 - ❖ All items loaded significantly on their factors
 - ❖ All factors fit a one-factor model, both at the individual- and county-level

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Discussion

3. Boundary conditions exist for examining structural relationships
 - ❖ Among the 14 factors, seven had sufficient variability among the county-level scores to warrant analyzing structural relationships
 - ❖ Next steps: Using multilevel regression, examine county (popu. size, poverty) and individual characteristics (sector, knowledge) that are associated with higher scores on the seven factors

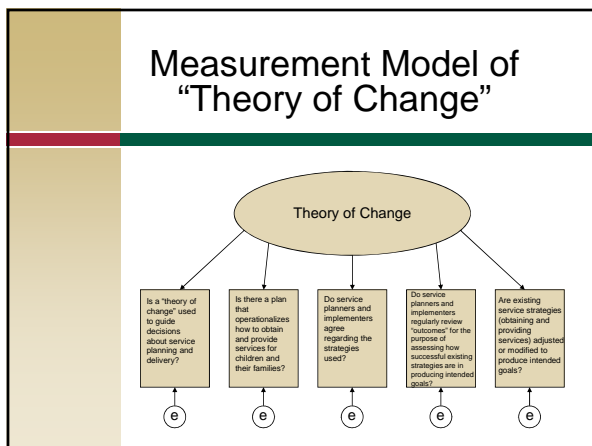
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Study Purpose: Use Multilevel Modeling to Examine SOCIS Data

- Approach: Structural Equation Modeling (SEM)
 - Combines factor analysis with path analysis
 - Reduce measurement error by having multiple indicators per latent variable
 - Model complex relationships among many variables/constructs
- Two-step process
 1. Establish the measurement model
 2. Analyze structural relationships (among the implementation factors and their associations with contextual variables (popu. size, poverty))
- Study purpose: Extend the standard CFA (reported by Kutash earlier) with a series of multilevel CFAs (MCFA)

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Developing the Measurement Model

- In-house experts selected indicators of each factor
 - Reviewed and revised by Director and Study PIs
- Expert panel review
 - Reviewed and revised based on expert panel scores and comments
- Cognitive interviewing
 - Revised
- Pilot testing the Qs.
 - Revised
- Final review by family members
 - Final revision

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Table 1: Pilot Interview Cronbach's Alphas for the Implementation Factors (N = 38)

Factor	Cronbach's α	Number of Items
Transformational Leadership	.837	5
Theory of Change	.840	5
Implementation Plan	.727	5
Family Choice & Voice	.769	5
Local Population of Concern	.620	3
Interagency Collaboration	.876	5
Individualized Care, & Cultural Competency	.866	6
Values & Principles	.605	5
Financing	.862	5
Outreach Pathways	.777	3
Skilled Provider Network	.692	5
Performance Measurement	.778	5
Provider Accountability	.700	4
Management & Governance	.819	4
General System Performance	.817	6
Total	.769	71

Study Design

- Randomly sample US counties using disproportionate stratified probability sampling
- Multilevel survey of implementation factors
- Within each county, sample multiple informants from different children's service sectors and family organizations

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Sampling Frame and Projected Sample Cell Sizes for U. S. Counties Stratified by Population Size and Poverty

Population Size	Participants Per County	< Median Poverty		> Median Poverty		Total
1,000,000+	15	17	[9]	17	[9]	34 [18]
500,000-999,999	13	46	[15]	24	[14]	70 [29]
250,000-499,999	12	101	[19]	26	[19]	127 [38]
100,000-249,999	8	195	[26]	85	[26]	280 [52]
50,000-99,999	5	224	[14]	153	[15]	377 [29]
25,000-49,999	5	308	[15]	216	[15]	524 [30]
<25,000	5	696	[14]	1004	[15]	1670 [29]
Total	1959	1547	[112]	1535	[113]	3082 [225]

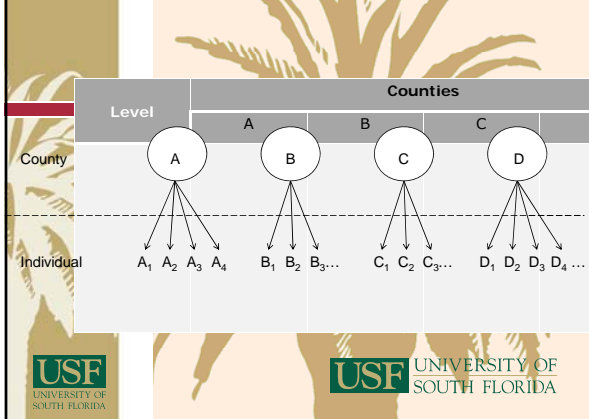
Note: "Median Poverty" equals 14.15% of individuals living in the county are living below the poverty level. Numbers in square brackets represent the number of counties to be sampled.

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SOCIS Multi-level Design



Multi-Level CFA of Outreach and Access to Care

