Pathways of Influence of Early Intervention on Family, Parent, and Child Outcomes

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Purpose of the Session

- Describe how meta-analysis and structural equation modeling can be combined and used to test the manner in which different structural and process intervention variables are directly and indirectly related to child, parent, or family outcomes

- Illustrate how meta-analytic structural equation modeling can identify pathways of influence between intervention and outcome variables as well as variables that mediate the relationships between the interventions and the outcomes

A Brief Description and Examples of:

- Meta-Analysis
- Structural Equation Modeling

Meta-Analysis

A procedure for combining (integrating) findings from different studies investigating the same or similar intervention (independent) variables and the same or similar outcome (dependent) variables to determine the average strength of the relationships between the two sets of variables. The weighted average size of effect for the relationships provide a more precise estimate of the effect of an intervention variable on an outcome variable.

Effect Sizes

Effect sizes rather than statistical significance are used to determine the strength of the relationships between independent and dependent variables in a meta-analysis. An effect size is a way of quantifying the differences between groups or the relationship between two variables. It is common practice to use standardized effect sizes because they mean the same thing for different studies.

Dunst, C.J., & Hamby, D.W. (2012). Guide for calculating and interpreting effect sizes and confidence intervals in intellectual and developmental disabilities research studies. *Journal of Intellectual and Developmental Disability*, 37(2), 89-99.

Two Families of Effect Sizes[a]

- Contrast Effect Sizes (e.g., Cohen's *d*)

  These effect sizes are used to determine the differences between two groups on an outcome measure where the two groups had different experiences (e.g., intervention group vs. control group).

- Correlation Effect Sizes (e.g., Pearson Product Moment Correlation)

  These effect sizes are used to determine the strength of the relationship between two variables for the same group of individuals (e.g., the relationship between frequency of an intervention and amount of child progress).

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[a] R.L. Rosnow, R. Rosenthal, D.B. Rubin. (2000). Contrasts and correlations in effect-size estimation. *Psychological Science*, 446-453.

Relationship Between Cohen's *d* and Correlation Coefficient Effect Sizes

r	*d*	*r*	*d*	*r*	*d*	*r*	*d*
0.00	0.00	0.25	0.52	0.50	1.15	0.76	2.34
0.01	0.02	0.26	0.54	0.51	1.19	0.77	2.41
0.02	0.04	0.27	0.56	0.52	1.22	0.78	2.49
0.03	0.06	0.28	0.58	0.53	1.25	0.79	2.58
0.04	0.08	0.29	0.61	0.54	1.28	0.80	2.67
0.05	0.10	0.30	0.63	0.55	1.32	0.81	2.76
0.06	0.12	0.31	0.65	0.56	1.35	0.82	2.87
0.07	0.14	0.32	0.68	0.57	1.39	0.83	2.98
0.08	0.16	0.33	0.70	0.58	1.42	0.84	3.10
0.09	0.18	0.34	0.72	0.59	1.46	0.85	3.23
0.10	0.20	0.35	0.75	0.60	1.50	0.86	3.37
0.11	0.22	0.36	0.77	0.61	1.54	0.87	3.53
0.12	0.24	0.37	0.80	0.62	1.58	0.88	3.71
0.13	0.26	0.38	0.82	0.63	1.62	0.89	3.90
0.14	0.28	0.39	0.85	0.64	1.67	0.90	4.13
0.15	0.30	0.40	0.87	0.65	1.71	0.91	4.39
0.16	0.32	0.41	0.90	0.66	1.76	0.92	4.69
0.17	0.35	0.42	0.93	0.67	1.81	0.93	5.06
0.18	0.37	0.43	0.95	0.68	1.85	0.94	5.51
0.19	0.39	0.44	0.98	0.70	1.91	0.95	6.08
0.20	0.41	0.45	1.01	0.71	1.96	0.96	6.86
0.21	0.43	0.46	1.04	0.72	2.02	0.97	7.98
0.22	0.45	0.47	1.06	0.73	2.08	0.98	9.85
0.23	0.47	0.48	1.09	0.74	2.14	0.99	14.04
0.24	0.49	0.49	1.12	0.75	2.20		

Example of a Meta-Analysis Using Contrasts Effect Sizes

Meta-Analysis of the Effectiveness of Four Adult Learning Methods and Strategies[a]

Carl J. Dunst Carol M. Trivette Deborah W. Hamby

Adult Learning Methods: Accelerated learning, coaching, guided design, just-in-time training

Studies: 58 randomized controlled design studies (N=2,095 experimental and 2,213 control group participants)

Coding: Six characteristics and associated practices of the adult learning methods were coded (instructor introduction and illustration of new knowledge or practice, and learning application, evaluation, reflection, and self-assessment of mastery of the knowledge or practice) and related to the study outcomes

Outcomes: Learner knowledge, skills, attitudes, and self-efficacy beliefs

Measure of Effect Size: Weighted average Cohen's *d* effect sizes for between group post-test differences

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[a] *International Journal of Continuing Education and Lifelong Learning*, 2010, 3, 91-112.

Cohen's *d* Effect Sizes for the Different Adult Learning Method Characteristics and Practices

Characteristics/Practices	Number		Mean Effect Size	95% Confidence Interval	*Z*
	Studies	Effect Sizes			
Introduction					
Out of class activities/self instruction	9	11	.64	.52-.77	10.43**
Classroom/workshop lectures	21	31	.63	.53-.72	13.14**
Pre-class exercises	5	5	.54	.38-.71	6.44**
Illustration/Demonstration					
Role playing/simulations	14	21	.55	.42-.68	8.20**
Learner input	4	4	.53	.34-.72	5.41**
Real life example/real life + role playing	3	4	.45	.14-.76	2.85*
Practicing					
Real life application	9	13	.94	.79-1.09	12.15**
Real life application + role playing	5	7	.86	.61-1.03	6.75**
Problem solving tasks	13	19	.49	.39-.58	10.10**
Evaluation					
Assess strengths/weaknesses	7	9	.94	.65-1.22	6.49**
Review experience/make changes	16	24	.47	.38-.56	10.19**
Reflection					
Performance improvement	4	6	1.27	.89-1.65	6.56*
Journaling/behavior suggestion	5	5	.82	.52-1.12	5.33**
Group discussion about feedback	13	19	.49	.39-.58	10.10**
Mastery					
Standards-based assessment	8	11	.86	.72-.99	12.47**
Self assessment	13	19	.49	.39-.58	10.10**

* p. <01. ** p <.0001.

Example of a Meta-Analysis of Correlation Effect Sizes

Meta-Analysis of Family-Centered Help-giving Practices Research[a]

Carl J. Dunst C.M. Trivette Deborah W. Hamby

Family-Centered Practices: Relational and participatory helpgiving practices measured by 12 different family-centered practices scales

Studies: 47 studies conducted in 7 countries (N=11,187 study participants)

Outcomes: Parent satisfaction, self-efficacy beliefs, social support, child behavior functioning, parent and family well-being, and parenting competence and confidence

Measure of Effect Size: Weighted average correlation coefficients for the relationships between relational and participatory family-centered practices and the study outcomes

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[a] *Mental Retardation and Developmental Disabilities Research Reviews*, 2007, *13*, 370-378.

Effect Sizes for the Relationship Between Relational and Participatory Practices and the Outcomes Measures

	Relational Helpgiving Practices				Participatory Helpgiving Practices			
	Number		Effect Size[a]		Number		Effect Size[a]	
Outcome Measures	Sample Size	Effect Size	Mean	95% CI	Sample Size	Effect Size	Mean	95 % CI
Participant Satisfaction								
Satisfaction with Staff	601	4	.67****	.63-.72	526	5	.38****	.34-.42
Satisfaction with Program	1598	20	.63****	.62-.65	1598	8	.67****	.65-.70
Self Efficacy Beliefs								
Practitioner Control	1368	10	.62****	.59-.65	1368	11	.62****	.59-.66
Program Control	754	10	.70****	.66-.73	754	13	.67****	.64-.70
Life Events Control	675	12	.32****	.26-.38	913	19	.39****	.35-.43
Program Resources								
Parent/Child Supports	181	4	.26****	.17-.36	181	4	.37****	.28-.46
Program Helpfulness	252	2	.47****	.37-.56	252	2	.52****	.43-.61
Child Behavior								
Positive Child Behavior	345	8	.25****	.19-.31	345	5	.34****	.27-.41
Negative Child Behavior	93	8	.25****	.18-.31	93	4	.20****	.11-.30
Behavioral Competence	252	3	.24****	.14-.34	252	3	.18***	.08-.28
Well-Being								
Personal Well-Being	1543	26	.27****	.25-.30	1543	16	.26****	.22-.30
Family Well-Being	245	4	.18****	.11-.27	245	4	.29****	.23-.37
Parenting Behavior								
Confidence	331	3	.16**	.06-.27	331	4	.26****	.18-.35
Competence	236	2	.05	-.07-.18	236	3	.11*	.01-.21
Enjoyment	331	3	.15**	.05-.26	331	4	.24****	.16-.35

*p < .05. **p < .01. ***p < .001. ****p < .0001.

Structural Equation Modeling

A procedure for evaluating how a set of variables are related to one another in terms of causes and effects (i.e., pathways of influence). Structural equation modeling tests the fit of a proposed or hypothesized model to the pattern of relationships (e.g., correlations) among the variables in the model. Path diagrams are used to show how the variables in a model "go together." How well the model fits the data is assessed by fit indices which tell us whether the model is accepted or rejected.

Two of the many fit indices are:

- Comparative fit index (The closer the fit index is to 1.0, the better is the fit of the model to the data)
- Root mean square error of approximation (The closer the fit index is to zero, the better is the fit of the model to the data)

A Simple Example of Structural Equation Modeling

Parent and Community Assets as Sources of Young Children's Learning Opportunities[a]

Carl J. Dunst

Participants: 100 low income mothers and their preschool age child(ren) in five public housing neighborhoods

Intervention: Number and frequency of child and parent-child participatory learning opportunities used by the mothers

Outcomes: Child engagement and positive affect and parent confidence and enjoyment in providing her child(ren) informal everyday family and community learning opportunities

Predictions: Parents who successfully engaged their children in the learning activities would have positive outcomes on both the children and parents where the relationship between the participatory learning opportunities and parent outcomes was mediated by child benefits

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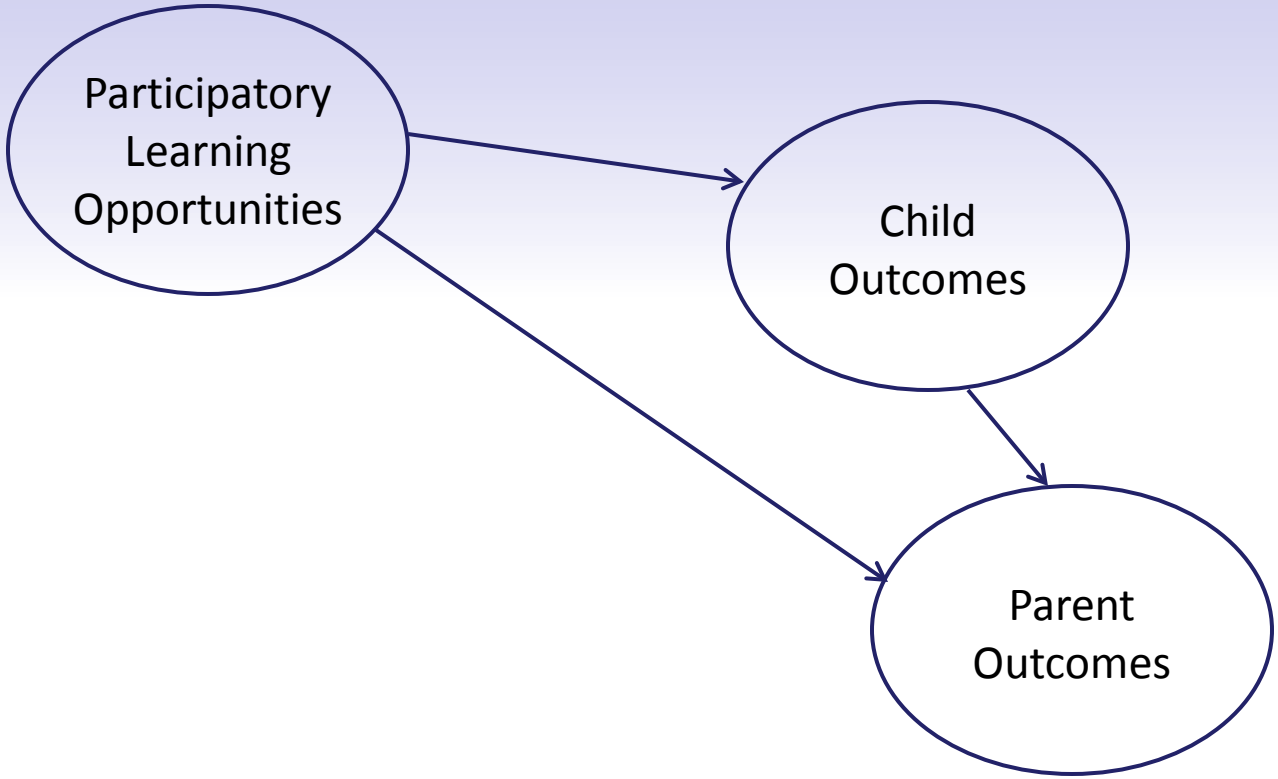
[a] *Winterberry Press Monograph Series*. 2008. Asheville, NC: Winterberry Press.

Path Diagram for the Relationships Among the Measures in the Model



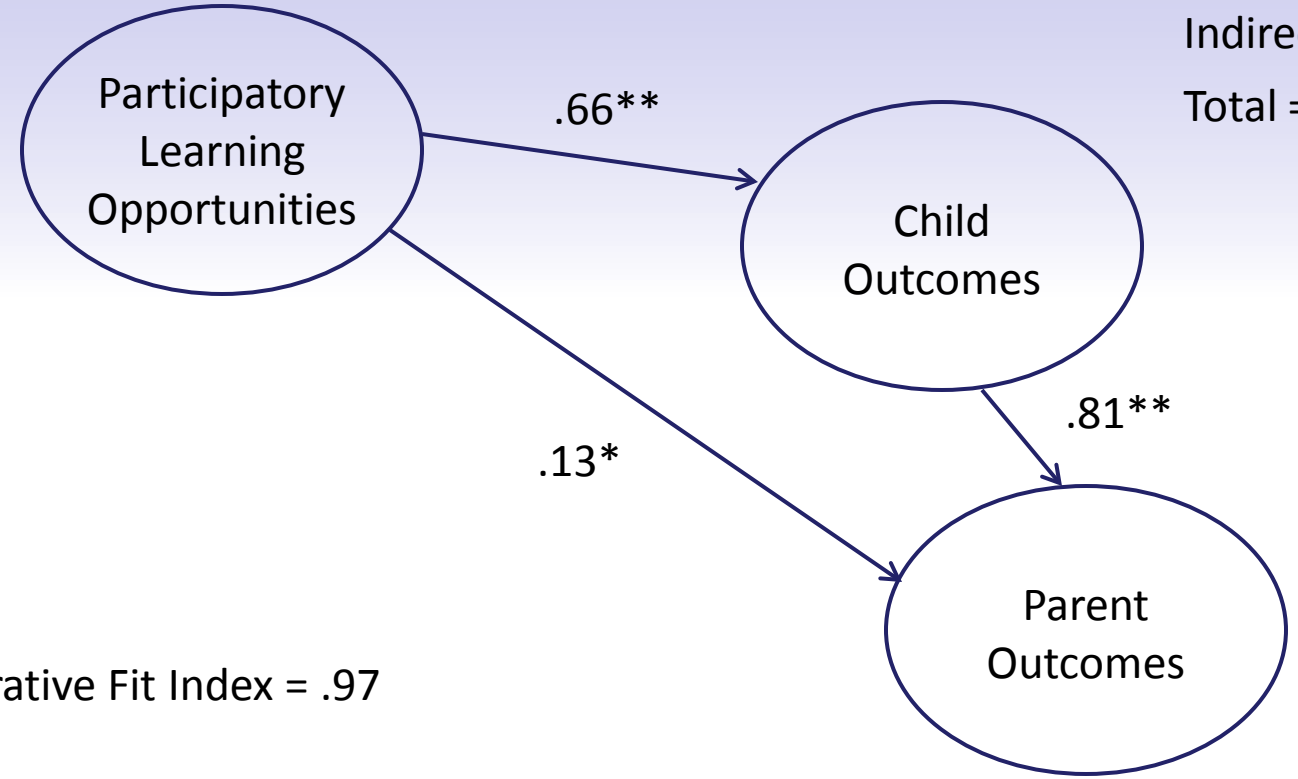
Structural Equation Modeling Results

Effects Decomposition

Direct =.13

Indirect = .53

Total =.66



Comparative Fit Index = .97

* $p < .06$. ** $p < .0001$.

A More Complex Example of Structural Equation Modeling

Modeling the Effects of Early Intervention Variables on Parent and Family Well-Being[a]

Carl J. Dunst Deborah W. Hamby Jeffri Brookfield

Participants: 250 parents and their young children with disabilities or developmental delays involved in 59 different early childhood intervention programs in the same State.

Intervention: Effects of structural (e.g., length of program involvement) and process (family-centered practices) early intervention variables on parent and family well-being mediated by self-efficacy beliefs.

Hypothesis: (1) Family-centered practices would be indirectly related to parent well-being mediated by self-efficacy beliefs. (2) Program-related self-efficacy beliefs would be indirectly related to parent well-being mediated by personal belief appraisals. (3) Hours of parent contact would be indirectly related to program control appraisals mediated by family-centered practices.

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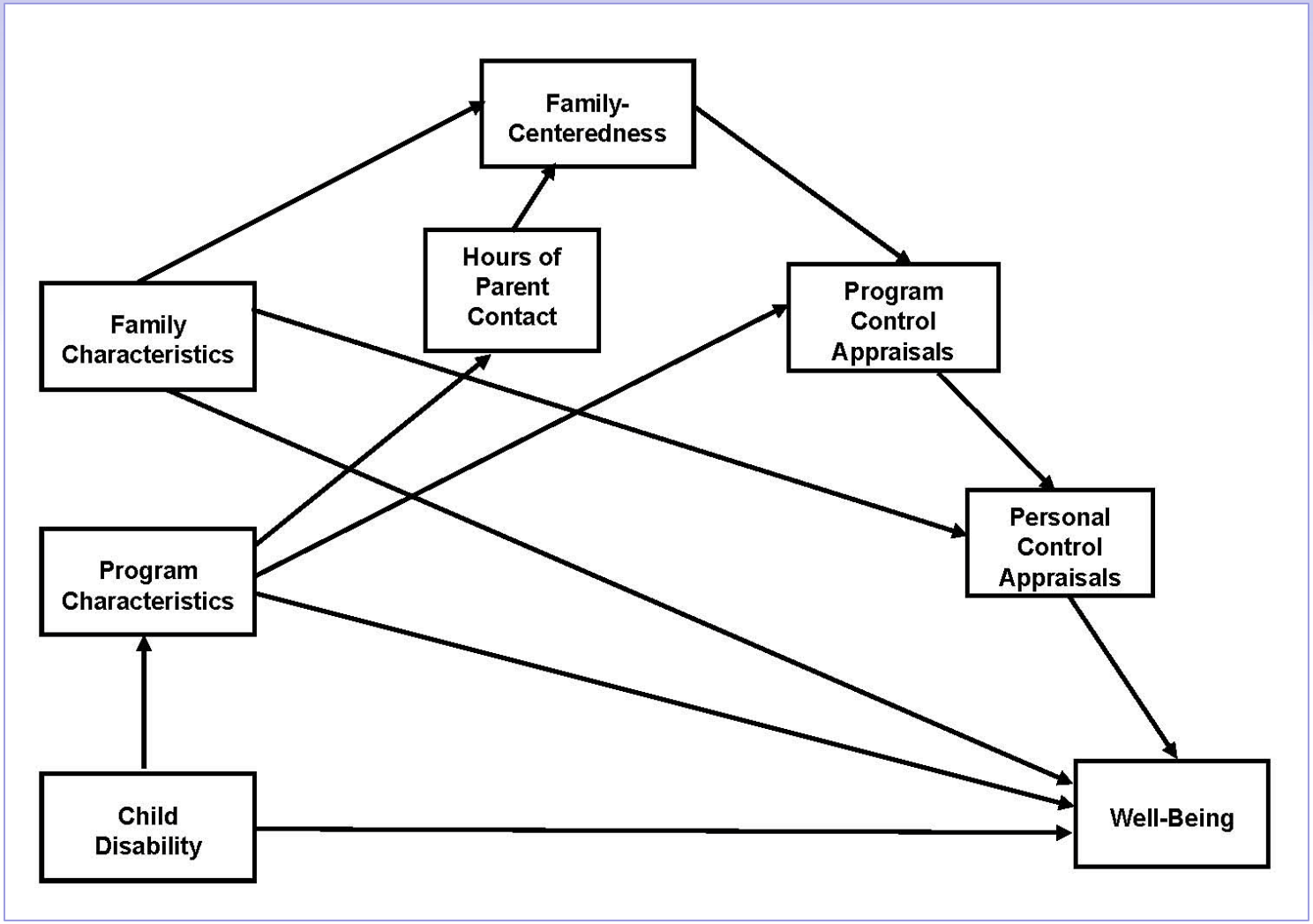
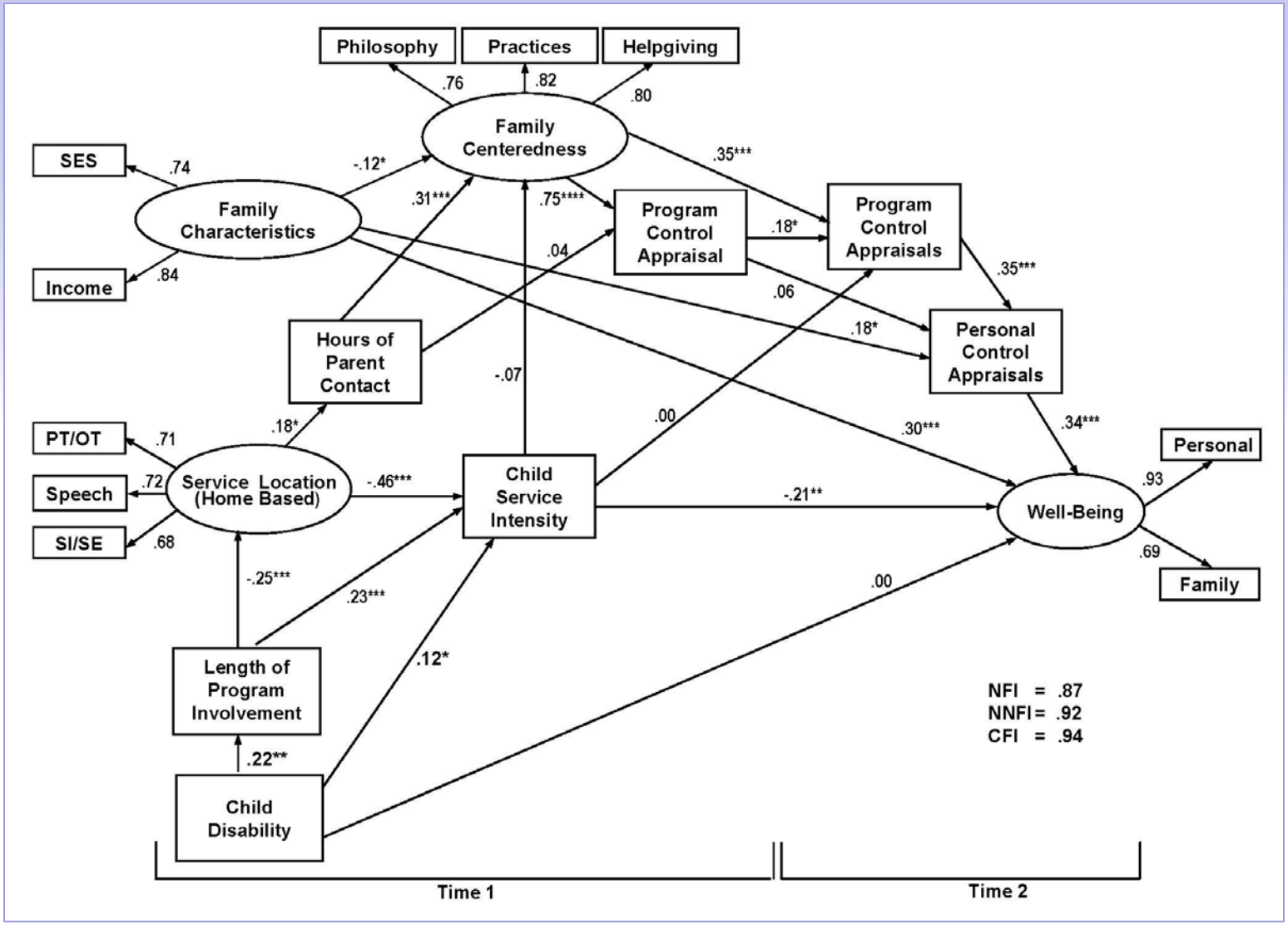
[a]*Journal of Applied Quantitative Methods*, 2007, 2(3), 268-288.

Path Diagram for the Relationships Among the Measures in the Model



Structural Equation Modeling Results



Meta-Analytic Structural Equation Modeling

Meta-analytic structural equation modeling is a procedure for combining data (e.g., correlations) from multiple studies (meta-analysis) and using the combined data set to evaluate the fit of a model to the patterns of relationships among the variables in the model by structural equation modeling. Recent advances in data analysis procedures make meta-analytic structural equation modeling potentially useful for evaluating the effects of different kinds of intervention practices on outcomes of interest. Dr. Mike Cheung at the National University of Singapore has developed software[a] to prepare and analyze data to perform a MASEM.

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[a] Cheung, M.W.L. (2009). TSSEM: A LISREL syntax generator for two-stage structural equation modeling (Version 1.11) [Computer software manual]. Singapore: Author. Available at http://courses.nus.edu.sg/coursepsycwlm/internet/tssem.zip.

Two-Stage Structural Equation Modeling[a]

Stage 1. Test the homogeneity of a pooled correlation matrix and produce a weighted pooled correlation matrix. This involves two steps:

1A. Testing the homogeneity of a pooled matrix

1B. Producing a weighted correlation matrix if the pooled matrix is homogeneous

Stage 2. Testing the fit of a hypothesized model to the patterns of relationships among the variables in the pooled matrix using SEM. Two types of statistics are used to evaluate fit:

2A. Testing the fit of a model to the patterns of correlations among the variables in the model

2B. Estimate the strength of the relationships between the variables in a model

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[a] Cheung, M.W., & Chan, W. (2005). Meta-analytic structural equation modeling: A two-stage approach. *Psychological Methods*, 10(1), 40-64.

Stage 1A: Pooling Correlation Matrices

	Study 1	+	Study 2	+	Study 3	=	Pooled
Variable 1	1.0		1.0		1.0		1.0
Variable 2	.62 1.0		.49 1.0		.55 1.0		.55 1.0
Variable 3	.33 .51 1.0	+	- -	+	.42 .49 1.0	=	.37 .50 1.0
Variable 4	.41 .32 .38 1.0		.45 .23 -1.0		.33 .30 .36 1.0		.40 .28 .34 1.0

- The pooled correlation matrix is first evaluated to determine if the correlations among the measures in different studies are homogeneous
- The procedure is analogous to a confirmatory factor analysis (CFA)
- The CFA is evaluated by the same fit indices (e.g., RMSEA, CFI) used to test the fit of a model to the data in an SEM

Stage 1B: Produce a Weighted Pooled Correlation Matrix

A weighted pooled correlation matrix adjusts the size of the correlations between variables by giving more weight to studies with larger sample sizes.

- If the correlations for large N studies are smaller than those for small N studies, the pooled correlation will be ***smaller*** than the weighted average correlation
- If the correlations for large N studies are larger than those for small N studies, the pooled correlation will be ***larger*** than the weighted average correlation

Stage 2A: Testing Model Fit

Model fit is a procedure used to assess “how well” the hypothesized model fits the hypothesized relationships between the variables in a pooled correlation matrix. This is equivalent to performing an SEM on the pooled correlation matrix. Different fit indices are available for weighted test. Two of the recommended fit indices for two-stage meta-analytic structural equation modeling are:

- Comparative fit index
- Root mean square error of approximation

Stage 2B: Sizes of Effects in the Structural Equation Model

This step produces the effect sizes (parameter estimates) for each of the paths in a model. You can use either standardized or nonstandardized path coefficients as the sizes of effect. Standardized effect sizes can range between -1 and +1. We prefer standardized coefficients for several reasons:

- Measures of the same construct are generally not scaled the same in the different primary studies
- All effect sizes can be interpreted in the same manner

A Simple Example of a Meta-Analytic Structural Equation Modeling Analysis

Influences of Family-Centered Help-Giving on Parenting Confidence, Competence and Enjoyment

Studies: Eight studies that all included measures of family-centered practices, parent self-efficacy beliefs, and parenting confidence, competence and enjoyment.

Sample: N = 934 participants.

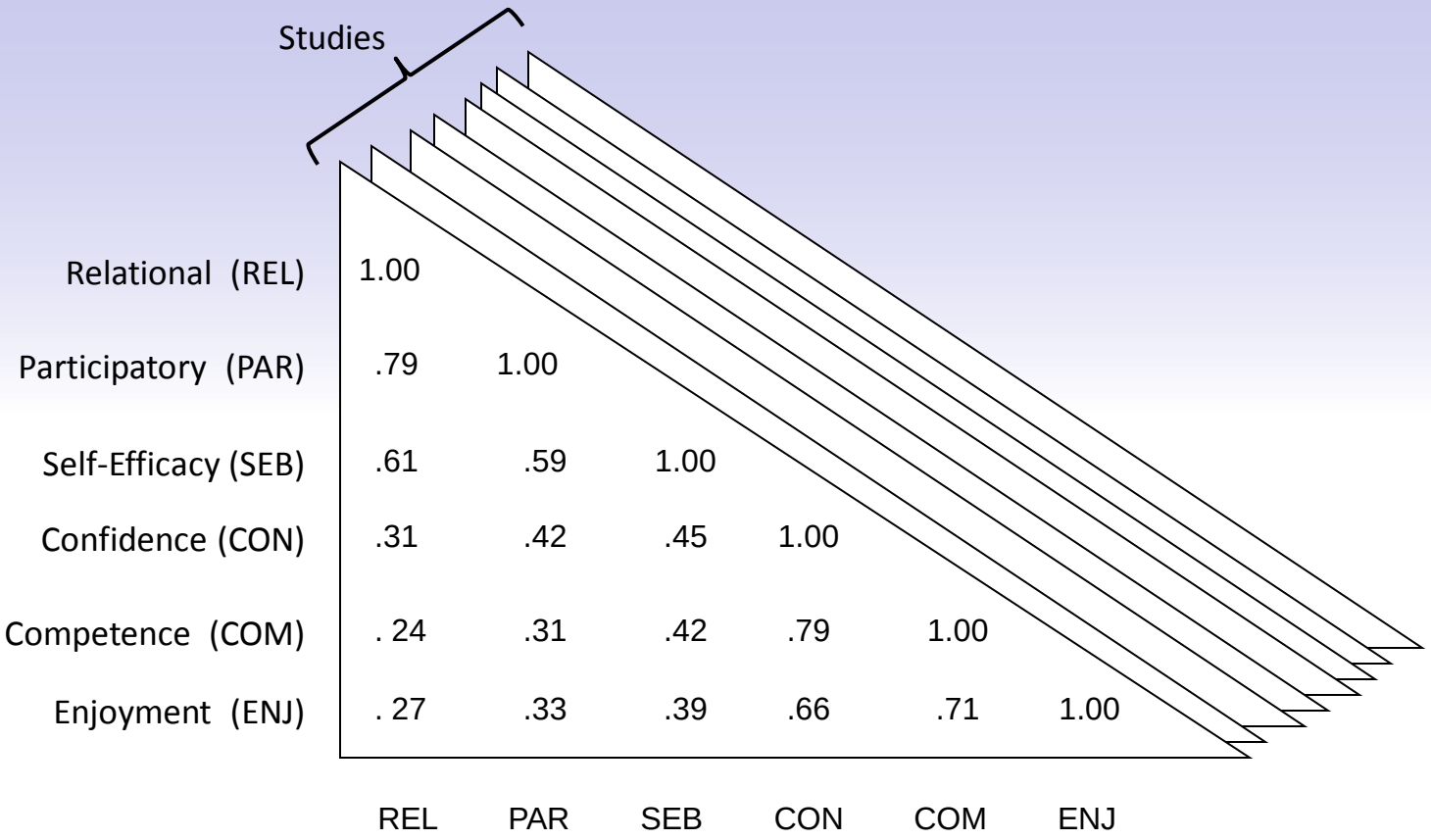
Family-Centered Practices Measures: Family-Centered Practices Scale, Enabling Practices Scale

Self-Efficacy Beliefs: Control appraisals of the ability to obtain the information and guidance, and supports and resources, from early intervention program staff

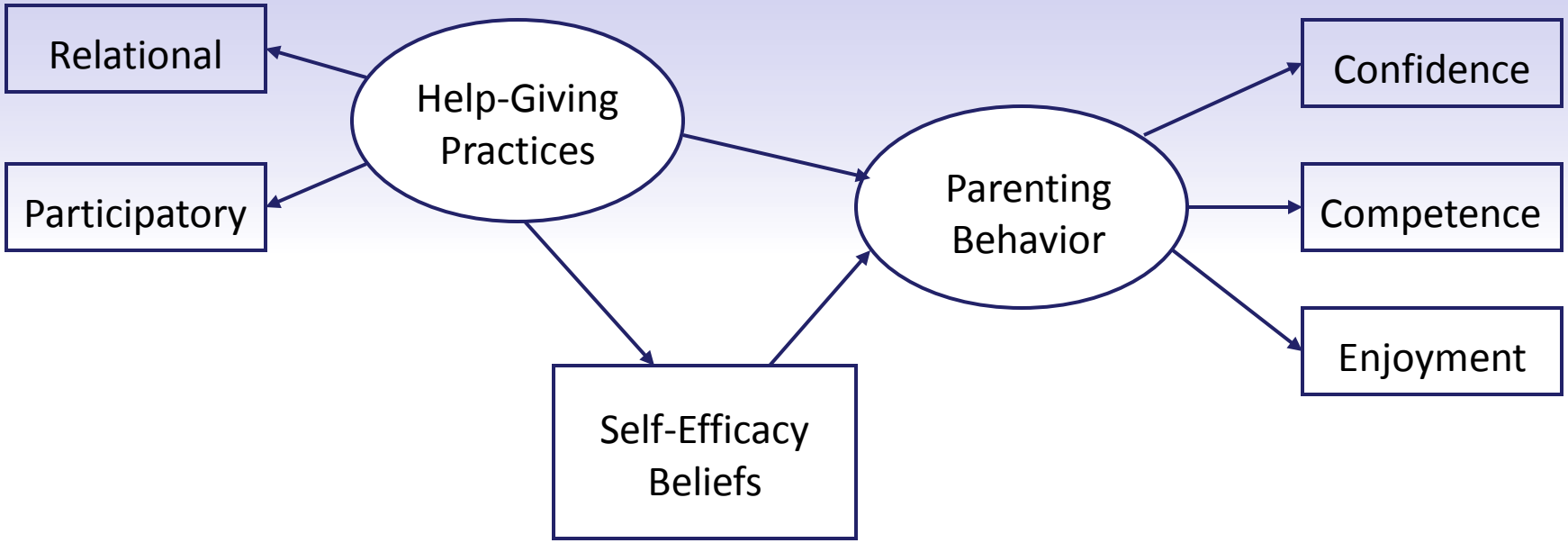
Parenting Capabilities: Everyday Parenting Scale (confidence, competence, enjoyment)

Hypothesis: Family-centered practices would be indirectly related to parenting confidence, competence and enjoyment mediated by self-efficacy beliefs

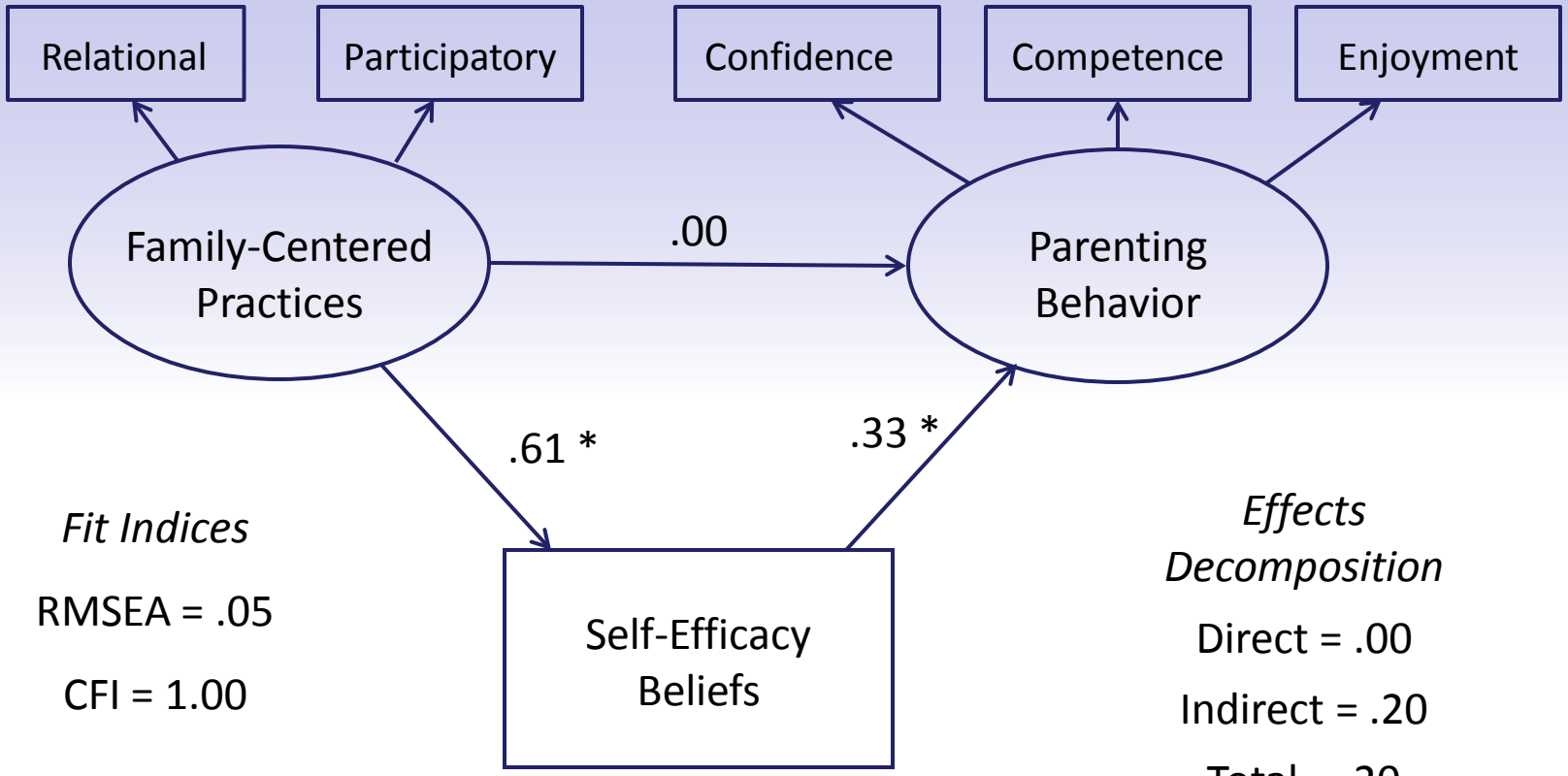
Stacked Correlation Matrices



Model for Testing the Direct and Indirect Effects of Family-Centered Practices or Parenting Behavior



Meta-Analytic Structural Equation Modeling Results



Fit Indices

RMSEA = .05

CFI = 1.00

Effects Decomposition

Direct = .00

Indirect = .20

Total = .20

* $p < .0001$.

Multi-Variable Complex Model Examples

- Meta-analytic structural equation modeling of the influences of family-centered care on parent and child psychological health. *International Journal of Pediatrics,* 2009, 1, 1-9. Article ID 576840
- Influences of family-systems intervention practices on parent-child interactions and child development. *Topics in Early Childhood Special Education,* 2010, 30, 3-19.
- Influences of child nursery rhyme knowledge on phonological awareness and later reading abilities (in preparation).
- Meta-analytic structural equation modeling of family capacity-building early intervention practices on parent, parent-child, and child outcomes (study in progress).

Meta-Analytic Structural Equation Modeling of the Influences of Family-Centered Care on Parent and Child Psychological Health[a]

Carl J. Dunst Carol M. Trivette

Studies: 15 investigations of family-centered care that included measures of family-centered practices, self-efficacy beliefs, parent psychological health, and child psychological health.

Sample: N= 2948 parents and their young children with disabilities or medical conditions involved in different early intervention, health care, and hospital programs.

Family-Centered Care Measures: Help-Giving Practices Scale, Family-Centered Practices Scale, and Enabling Practices Scale

Hypothesis: Based on contentions in the family-centered care literature, family-centered practices were expected to directly affect parent psychological health and parent health in turn affect child psychological health. Based on our own research, the relationships between family-centered care and parent and child health were expected to be mediated by self-efficacy beliefs.

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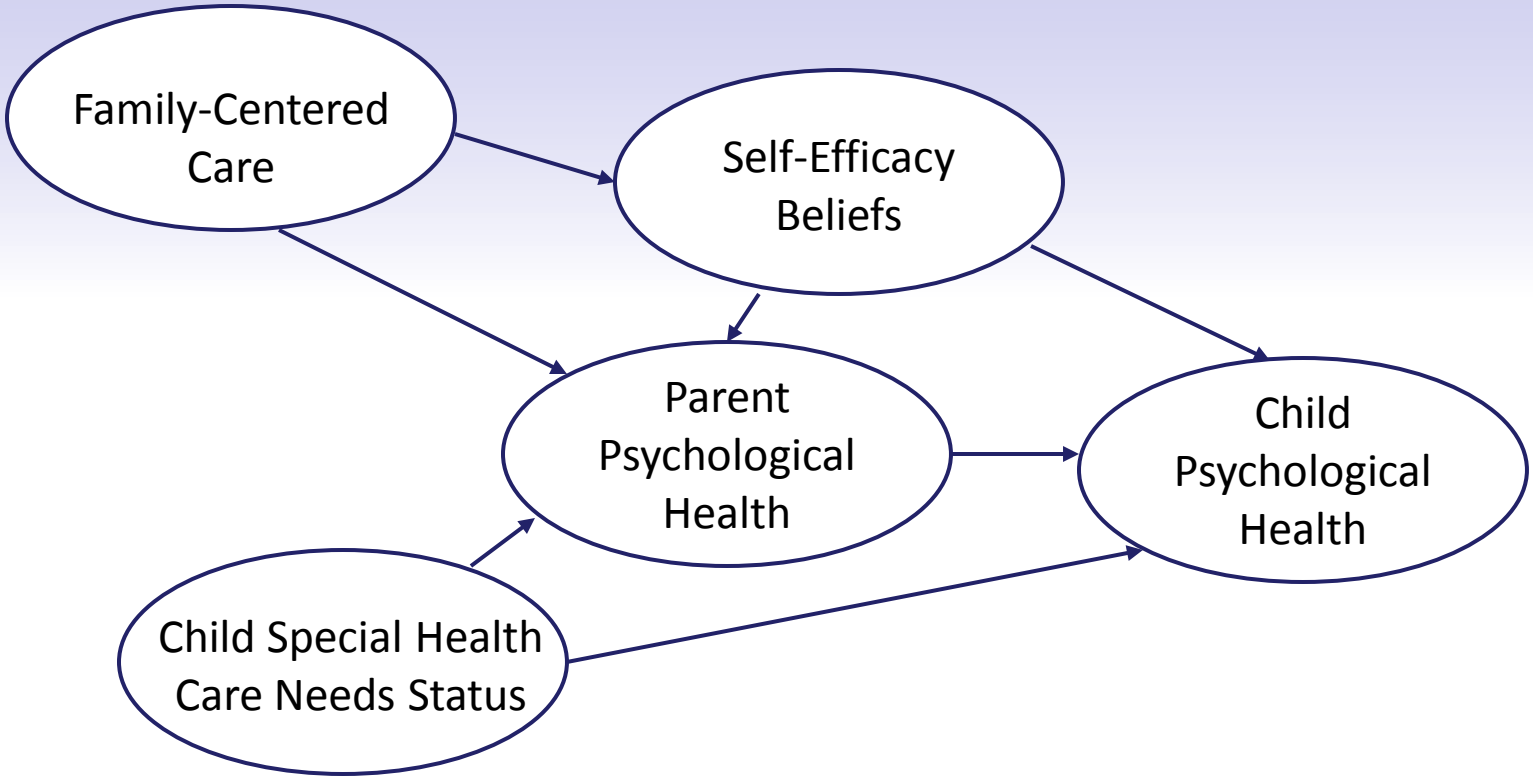
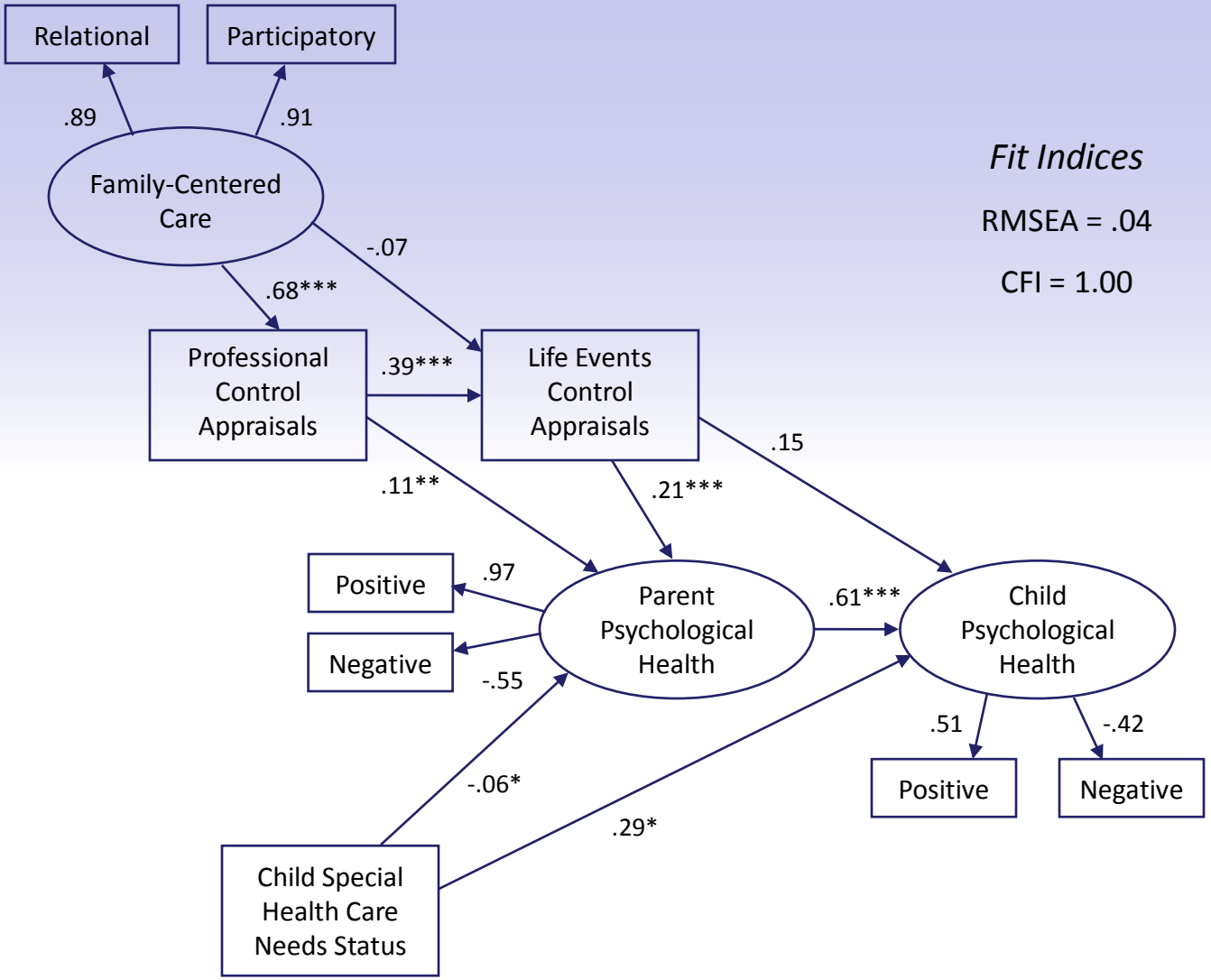
[a] *International Journal of Pediatrics*, 2009, 1, 1-9. Article ID 576840

Structural Equation Model for Evaluating the Effects of Family-Centered Care, Self-Efficacy Beliefs, and Child Special Health Care Needs on Parent and Child Psychological Health



Meta-Analytic Structural Equation Modeling Results



. *$p < .01$, **$p < .001$, ***$p < .0001$.

Influences of Family-Systems Intervention Practices on Parent-Child Interactions and Child Development[a]

Carol M. Trivette Carl J. Dunst Deborah W. Hamby

Studies: Eight studies that included measures allowing us to trace the effects of capacity-building help-giving practices and family-systems intervention practices on parent-child interactions and child development

Sample: 910 preschoolers and their parents involved in different kinds of help-giving programs

Predictions: The influences of help-giving and family-systems intervention practices on parent-child interactions and child development would be indirect and mediated by self-efficacy beliefs and parent well-being

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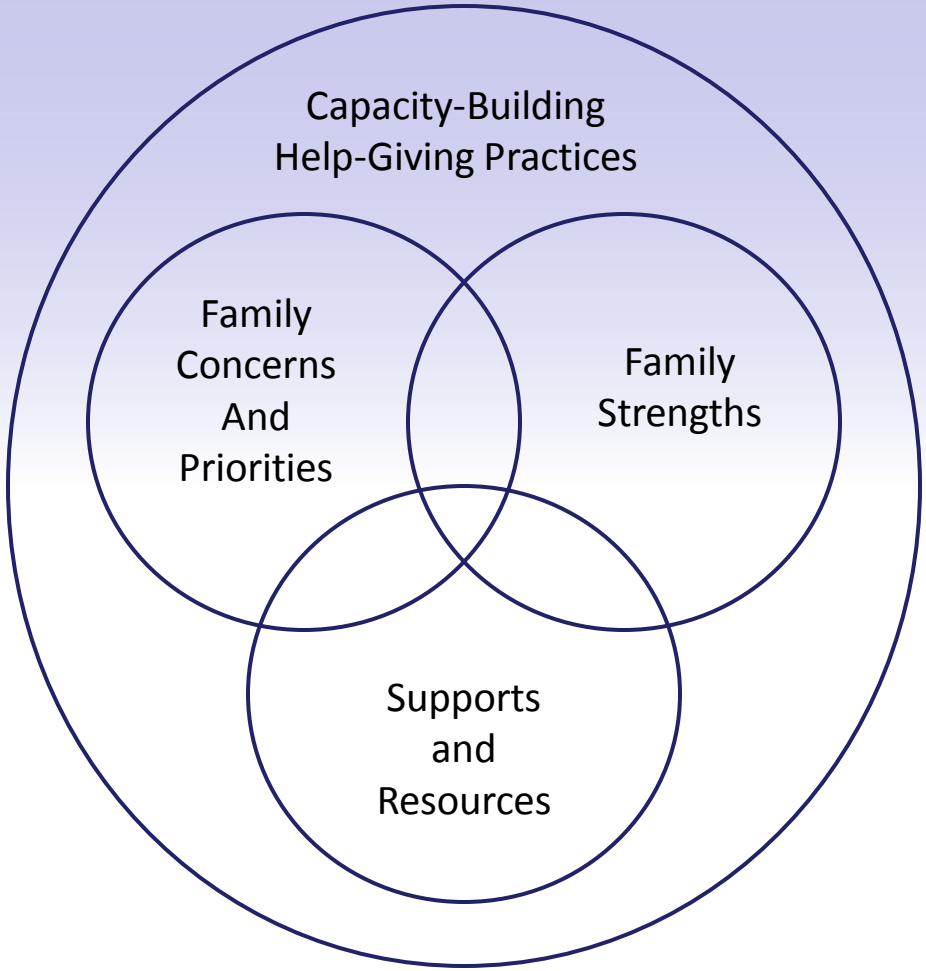
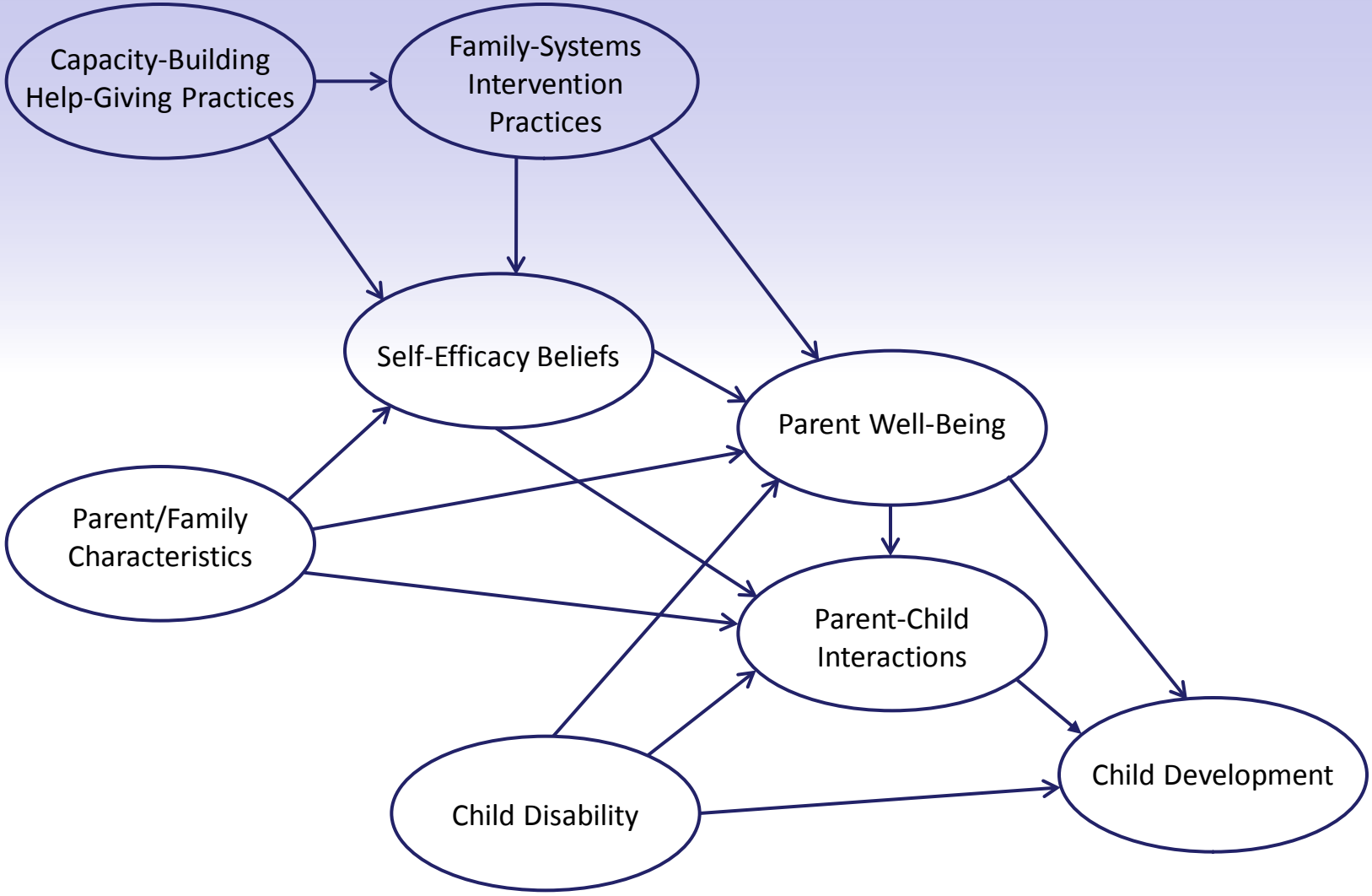
[a] *Topics in Early Childhood Special Education*, 2010, 30, 3-19.

Family-Systems Intervention Model[a]

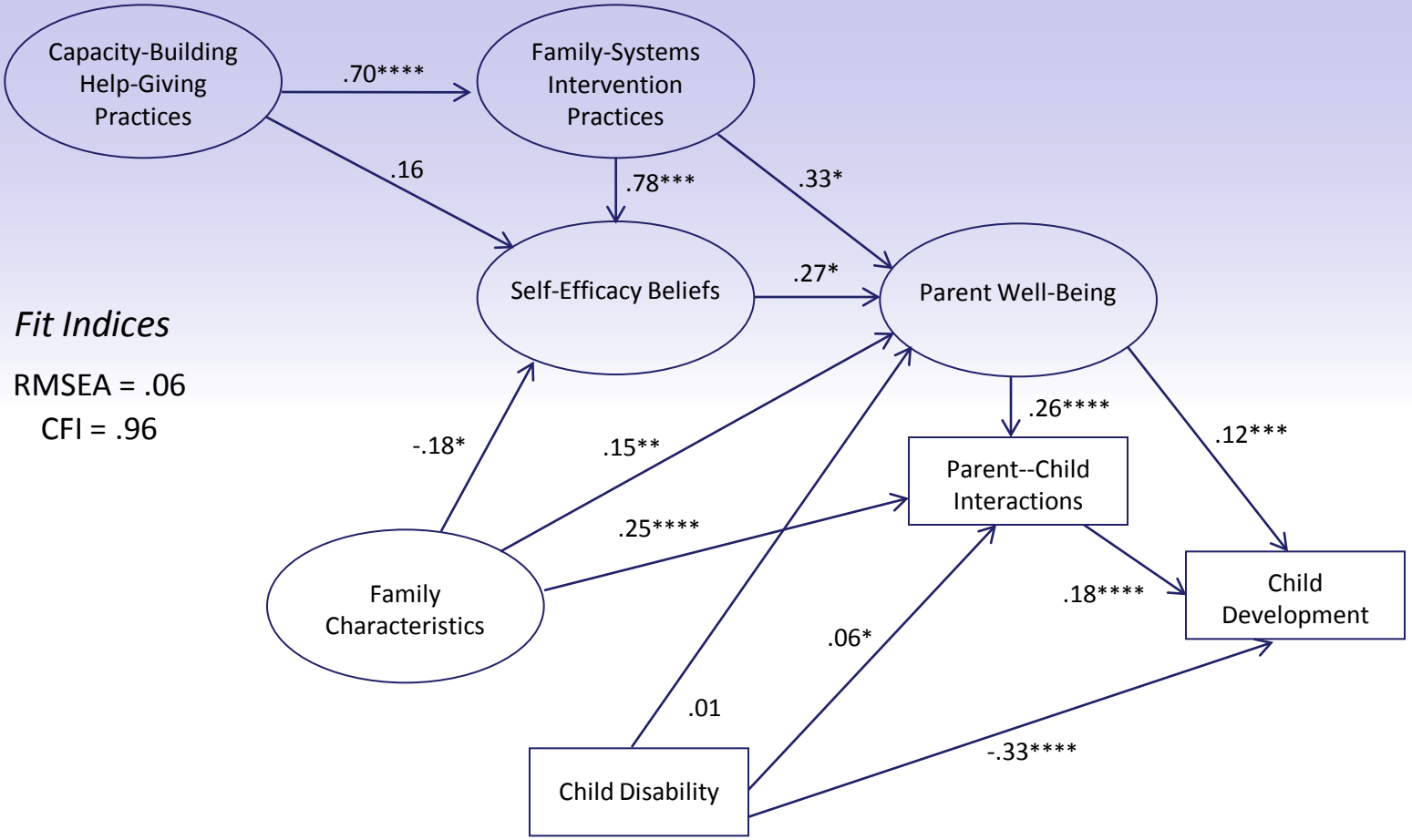


[a] Dunst, C.J., & Trivette, C.M., (2009). Capacity-building family-systems intervention practices. *Journal of Family Social Work*, 12, 119-143.

Model for Assessing the Direct and Indirect Effects of Different Predictor Variables on Parent-Child Interactions and Child Development



Meta-Analytic Structural Equation Modeling Results



* p < .05. **p < .01. *** p < .001. **** p < .0001.

Influences of Child Nursery Rhyme Knowledge on Phonological Awareness and Later Reading Abilities[a]

Carl J. Dunst

Studies: 15 studies (identified so far) that have assessed preschoolers nursery rhyme knowledge or awareness and its relationship to phonological awareness and later reading abilities

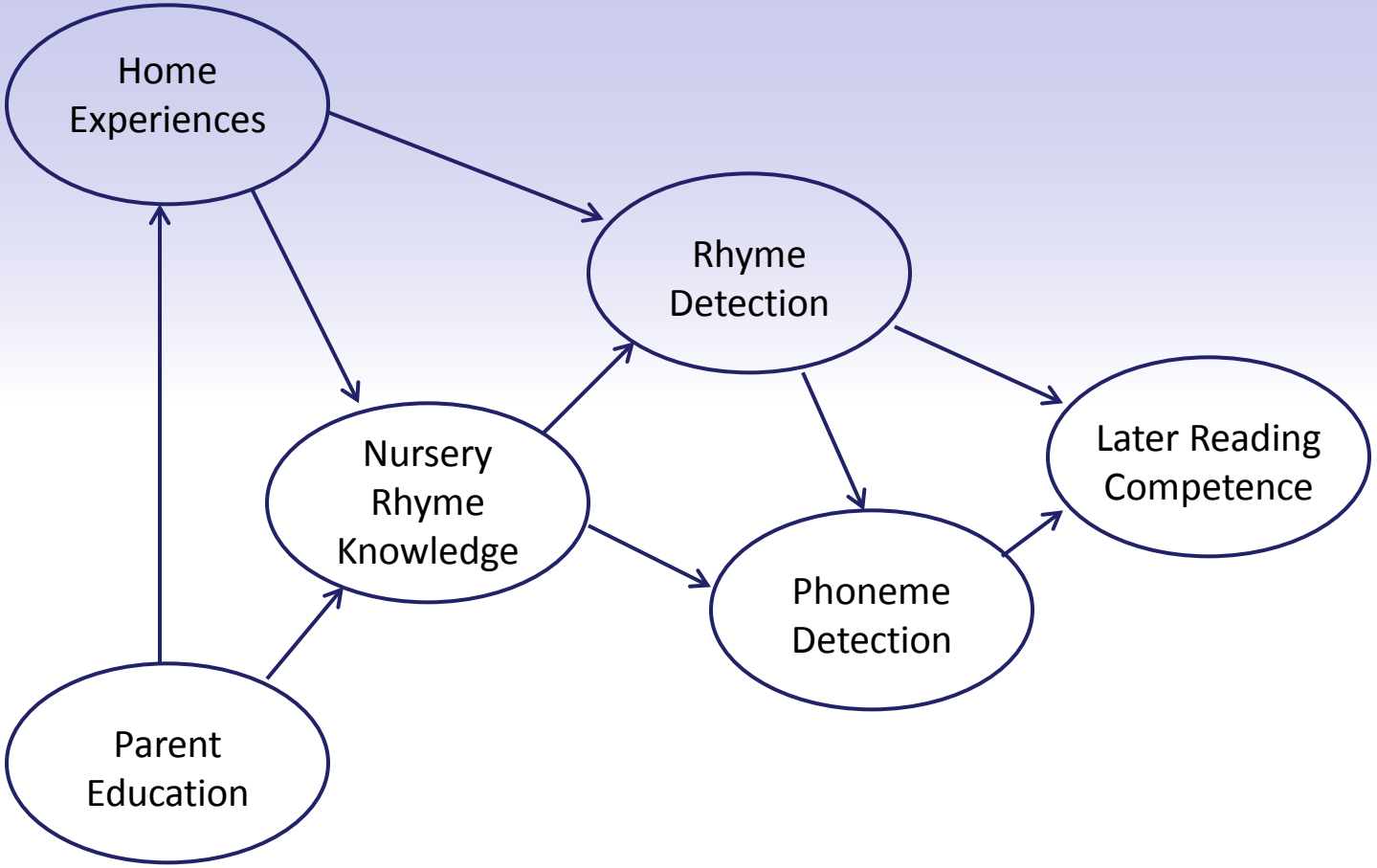
Sample: 350 (so far)

Measures: Home experiences, child nursery rhyme knowledge, child phonological awareness (rhyme detection, phoneme detection), parent education, child IQ, and child reading, vocabulary, expressive language, and receptive language (among other measures)

Hypotheses: Parent mediated home literacy experiences would be related to children's nursery rhyme knowledge where nursery rhyme knowledge would be indirectly reading to emergent reading mediated by phonological awareness

[a] In preparation.

Model for Evaluating the Determinants and Consequences of Nursery Rhyme Knowledge[a]



[a] Based on research conducted by Peter Bryant, Lynette Bradley, and colleagues at the University of Oxford.

Meta-Analytic Structural Equation Modeling of Family Capacity-Building Early Intervention Practices on Parent–Child, and Child Outcomes

Carl J. Dunst Melinda Raab Deborah W. Hamby Carol N. Trivette

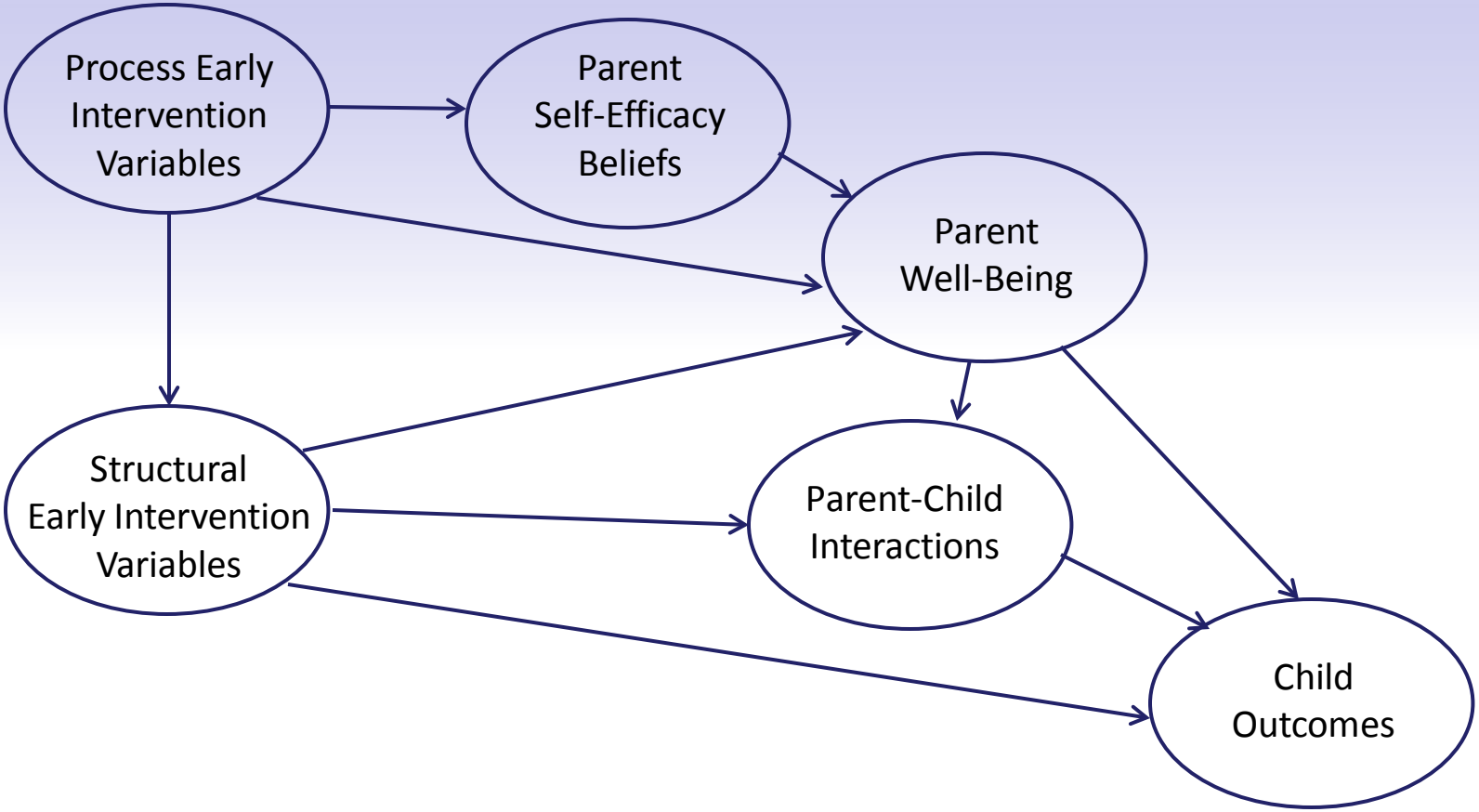
Studies: More than 75 studies of parents and their infants and toddlers with disabilities or developmental delays.

Sample: The final sample size for the MASEM is expected to include more than 10,000 parents and children.

Hypotheses: (1) Early intervention provided in a family-centered manner will have more positive effects on parent outcomes. (2) Family-centered practices will be indirectly related to parent well-being and parent-child outcomes mediated by self-efficacy beliefs. (3) Parenting self-efficacy beliefs will be directly related to parent-child interactions and indirectly related to child outcomes mediated by parent well-being.

[a]Institute for Education Sciences Development Grant (study in progress).

Model for Evaluating the Influences of Process and Structural Early Intervention of Parent, Parent-Child, and Child Outcomes



Variables Included in the Model and Analyses

- Parent/Family Background Variables
- Child Background Variables
- Early Intervention Structural Variables
- Early Intervention Process Variables
- Parent Self-Efficacy Beliefs
- Parent Stress and Well-Being
- Parent-Child Interactions
- Child Behavioral Outcomes
- Child Developmental Outcomes

Parent, Family, and Child Variables

Parent Variables

- Parent age, parent education level

Family Variables

- Family socioeconomic status, family income

Child Variables

- Child disability, child severity of delay

Early Intervention Variables

Structural Variables

- Child age at the start of intervention, length of intervention
- Type of child services (special instruction/education, speech and language pathology, occupational therapy, physical therapy)
- Hours of intervention, frequency of intervention, intensity of services
- Length of parent involvement, frequency of contact with early intervention staff

Process Variables

- Family-centered practices, working alliance, relational help giving practices, participatory help giving practices

Parent-Related Measures

Self-Efficacy Beliefs

- Program-related parent control appraisals, parenting self-efficacy beliefs, general life events belief appraisals

Parent Well-Being

- Parent stress, parent psychological health, parent positive and negative affect

Parenting Interactional Styles

- Parent sensitivity, parent responsiveness, parent directiveness

Child Outcome Variables

Child Behavioral Measures

- Cognitive style, social-emotional behavior, positive affect, negative affect, interactional style, social responsiveness

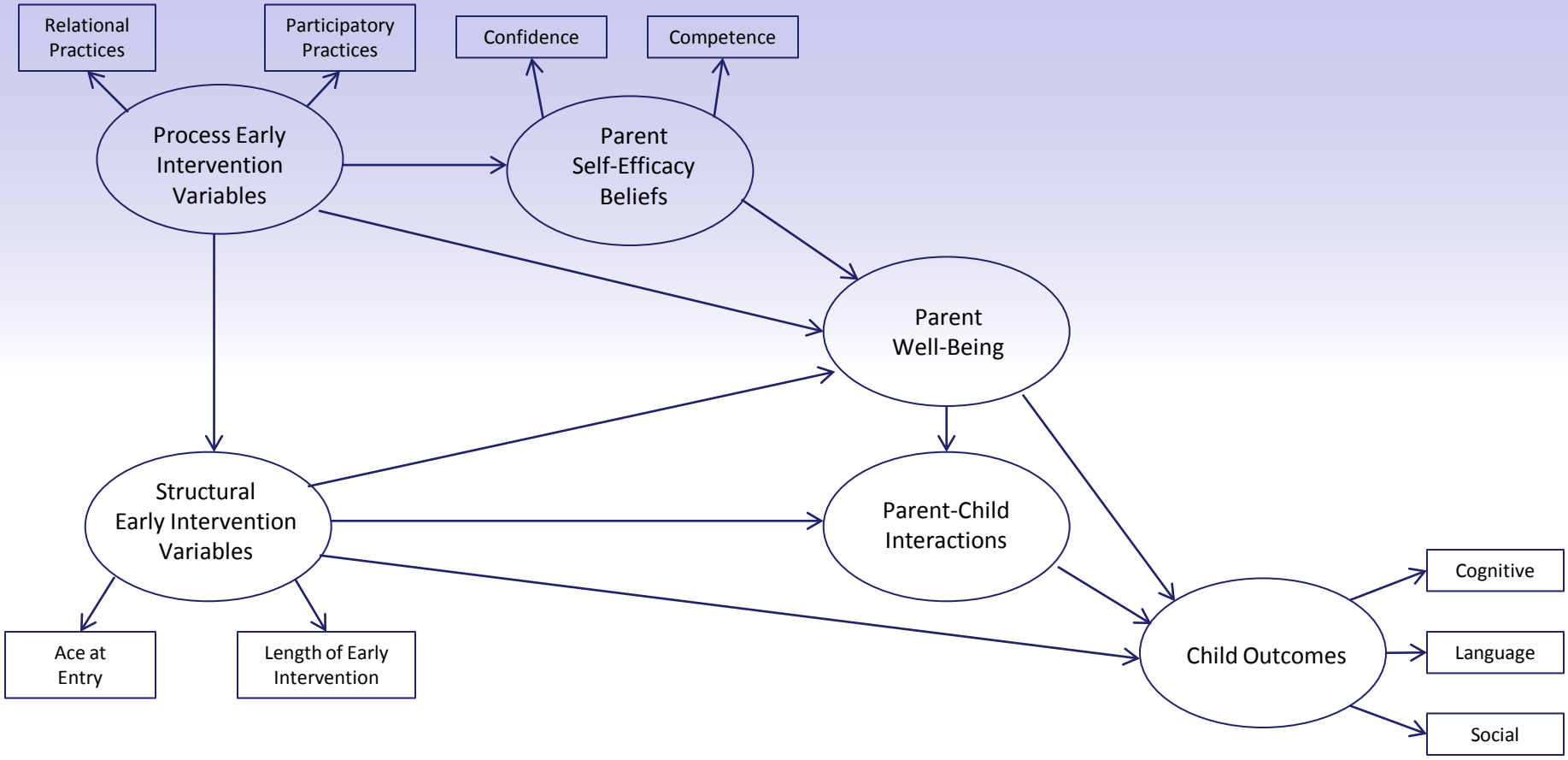
Child Developmental Measures

- Cognitive, language, social, motor, and adaptive functioning

Major Types of Planned Analyses

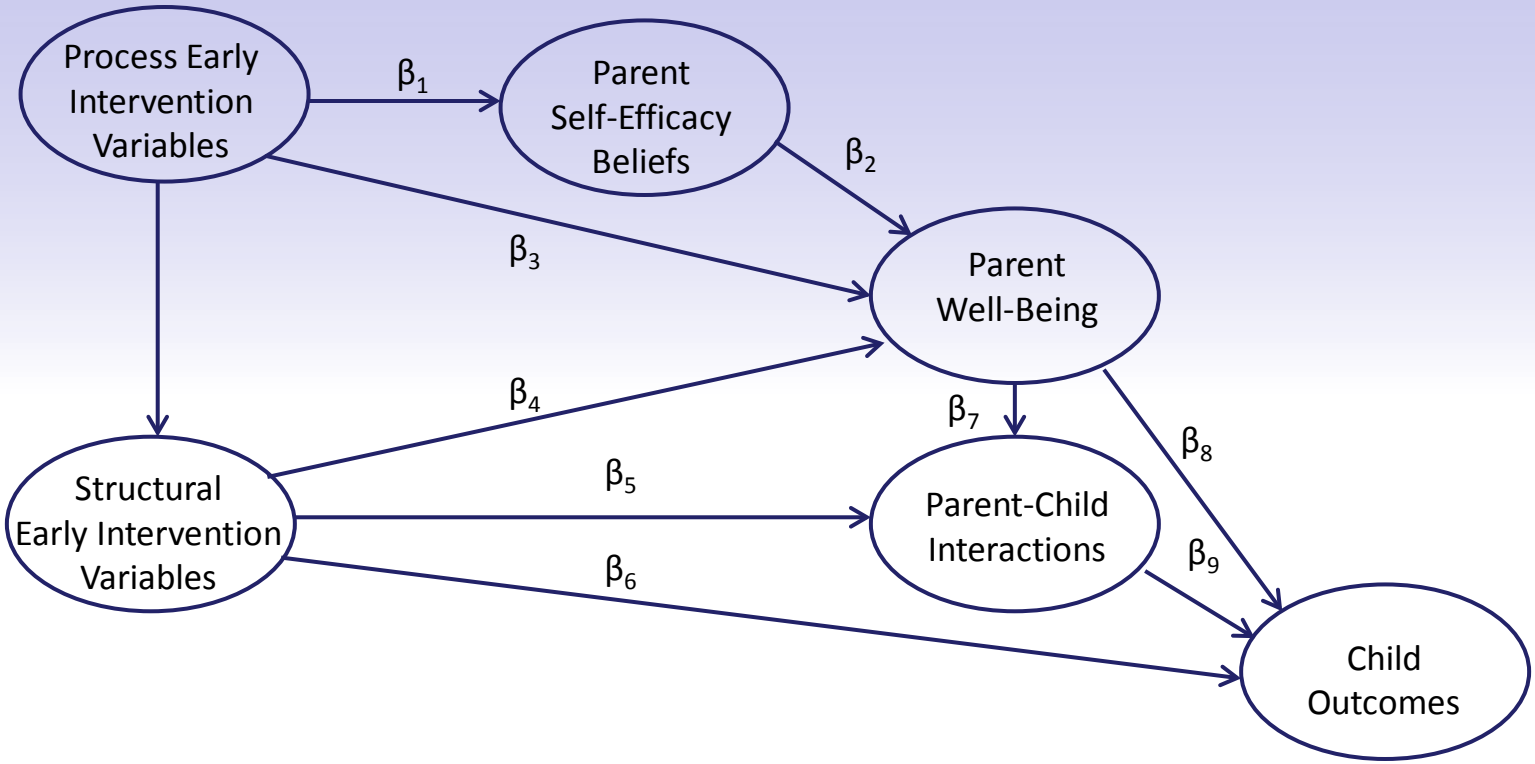
- Direct effects of the process and structural early intervention variables on the parent measures (self-efficacy beliefs, well-being, parent-child interaction)
- Indirect effects of the process early intervention measures on the parent measures mediated by the structural early intervention measures
- The mediated relationships among variables in the SEM model to identify pathways of influence
- The moderating effects of parent, family, and child background variables on the relationships between the other variables in the model

Direct Effects of Early Intervention on the Parent and Parent-Child Outcomes



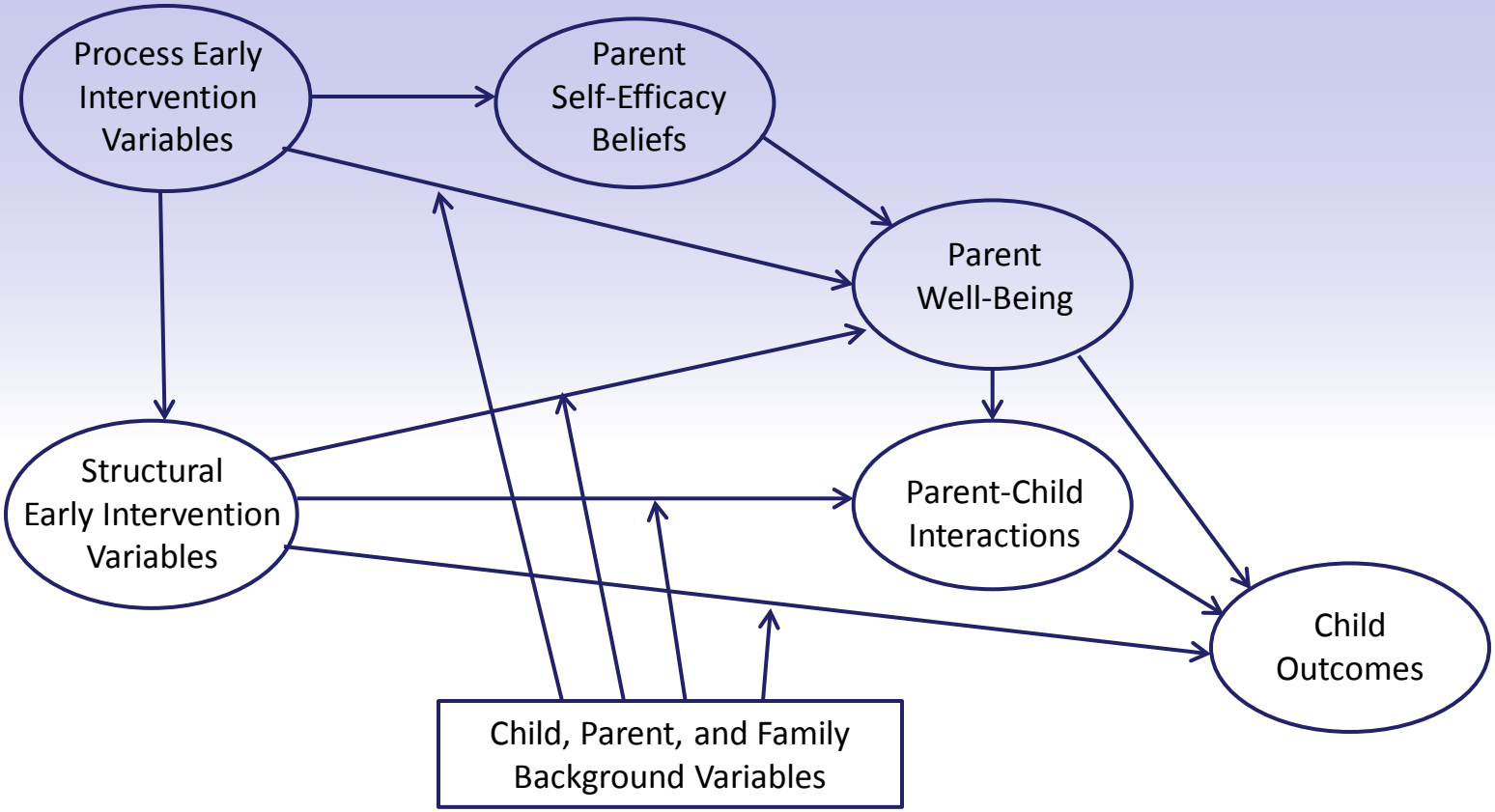
- Early intervention can be assessed as either or both measured and latent variables
- Any of the other constructs in the model can also be assessed as either measured or latent variables including the child behavioral and developmental outcomes

Indirect Effects of Early Intervention on the Study Outcomes



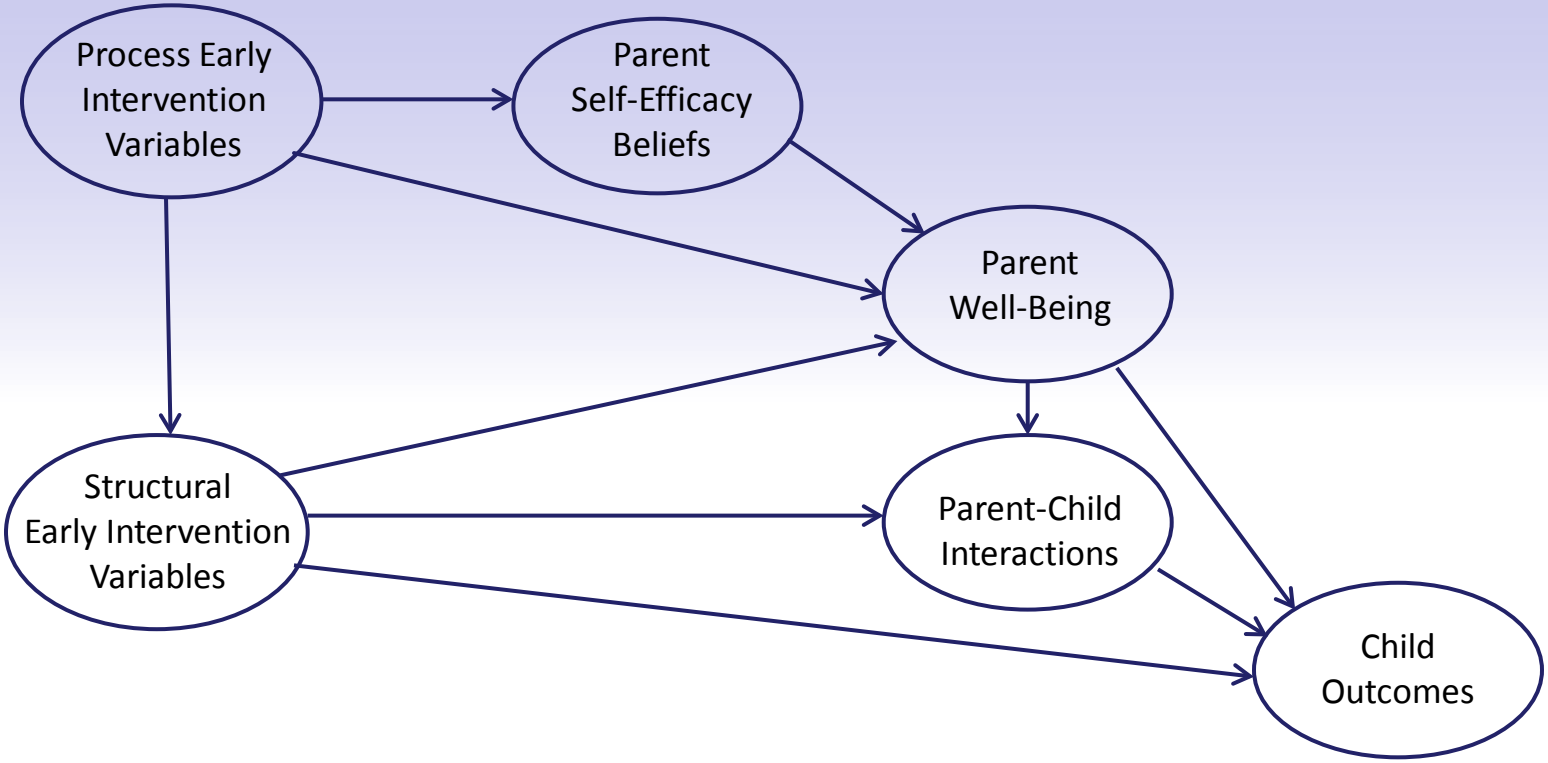
- Indirect or mediated effects are estimated from the products of two or more direct effects
- The indirect effect of process early intervention variables on parent well-being, for example, are determined from the product of $\beta_1 \times \beta_2$.

Moderators of the Relationships Between Early Intervention and the Study Outcomes



- Moderator analyses "test us" if the relationships between any two variables in the model are different at different levels of moderator variables (e.g., low SES vs. high SES)
- These types of analyses can help identify the conditions under which process and structural early intervention variables have similar or different consequences

Pathways of Influence of Early Intervention on the Parent, Parent-Child, and Child Outcome Measures



- Effects decomposition is used to identify the pathways of influence of the different early intervention variables on child outcomes.
- This data analysis strategy allows one to determine the direct, indirect, and total effect of any one variable in the model on any other variable in the model.

Conclusions

- Meta-analytic structural equation modeling is useful for evaluating the direct and indirect effects of different kinds of intervention practices on outcomes of interest
- One could include any number measured and latent intervention variables in a MASEM model and evaluate their effects on outcomes mediated by other variables (e.g., self-efficacy beliefs)
- There are many different kinds of early childhood intervention studies that can be examined to determine the pathways of influence of different kinds of intervention practices on child, parent-child, and child outcomes