Introduction

Structural equation modeling (SEM) is a statistical tool that can be used to test and examine causal relationships. In SEM, manifest variables are measurable variables assumed to be representative of a larger concept called a latent construct. For example, “language” could be considered a latent construct made up of measurable variables including standardized language assessments, language sample measures (e.g., mean length of utterance), parent report of vocabulary, etc.

SEM has been used frequently in education research, especially research on reading, (e.g., Bieron & Farkas, 2004; Compton, 2000; Kershaw & Schatschneider, 2012; Lervåg & Hulme, 2009). However, less research in child language research has used SEM (e.g., Stright, Friel-Patti, Flipsen, & Roger, 2002). Applying SEM could be worthwhile because there are several benefits to the approach: for example, theory testing and information on potential causal relationships. However, unlike educational research, child language research seems to have not have the necessary prerequisites to use SEM (in particular, sample size). There are also constraints based on the types of measures employed in child language research. Despite the difficulties, SEM offers researchers a powerful tool that has been used successfully in related fields and can be used more extensively in child language research.

Another aspect to consider is goodness of fit. When interpreting a model using SEM, there are several statistical values to check goodness-of-fit and path coefficients. Goodness-of-fit refers to how well a model represents the underlying patterns in the data. Path coefficients estimates are analogous to beta weights in regression equations. To determine if the model had good fit various goodness-of-fit statistics were examined. The most commonly used goodness-of-fit statistic is SEM is χ² (Cohen, 1988). It is important to bear in mind that a non-significant χ² means that there is good fit to the data. It is advisable to use more than one goodness-of-fit statistic as different statistics provide information about different aspects of the model, such as the error in the model using Root Mean Square Error of Approximation (RMSEA; Steiger & Lind, 1990). After determining whether a model has good fit, path estimates can be examined. When examining path estimates, a researcher is looking for a small standard error and a significant t-value (>=1.96). Path estimates can be obtained for paths between manifest variables and latent constructs (e.g., grammar subtests to “Grammar” construct) and between two latent variables (e.g., “Grammar” to “Vocabulary”).

In this example, the latent construct “Grammar” is used to predict performance on a single task Word-Sound Deletion, based on the theory that developmental pragmatics and grammatical awareness are related. The correlations between Grammatical Understanding and Word-Sound Deletion were r = .358 (Table 1). This example provides more information about how “Grammar” might impact on Word-Sound Deletion performance, because measurement error associated with the subtests Grammatical Understanding, and Sentence Imagination allowing for a better estimate of the relationship between “Grammar” and Word-Sound Deletion.

Goodness of fit: The model is saturated (It is perfect). Saturated models occur when there are zero degrees of freedom. Zero degrees of freedom occur when the number of paths estimated is equal to the number of parameter estimates.

Example 2: Latent construct predicting a manifest variable

Example 3: Mediation model

Discussion

Structural equation modeling (SEM) can be a useful statistical tool for researchers in child language when used appropriately.

Benefits:

- SEM allows for the examination of constructs that cannot be directly measured. The measures that are used to build a construct can be examined to determine how well they map onto a latent construct.
- Causal and associative relationships can be explored more effectively than when using regression or correlation.

Pitfalls:

- There is a need for multiple measures using a variety of methods of collection. It is often considered prudent to have at least three measures/methods to build a latent construct. For example, a behavioral, physiological, and parent report could be used as three manifest variables that map onto the latent construct “Stuttering.”
- To effectively model a relationship there needs to be a large sample size (e.g., N = 100).

In order to use tools like SEM, the field needs to develop more collaborative large-scale databases.

Selected References


Acknowledgements

This study was supported by a Preparation of Leadership Personnel grant (H235D080019; P1. Schweke) US Department of Education.

Acknowledgement is given to original grant #N01-DC-1-2107 and supplement #R35 PD002746-09B1 from the National Institute on Deafness and Other Communication Disorders, a division of the National Institutes of Health. The authors also acknowledge support given by the Vanderbilt Kennedy Center.

The content is solely the responsibility of the authors and does not necessarily represent the views of Vanderbilt University.

Poster available at: https://medschool.vanderbilt.edu/developmental-disabilities/

Using Structural Equation Modeling in Child Language Research

Hope S. Lancaster  •  Stephen Camarata

Vanderbilt University School of Medicine

Methodology

Random sample of 150 TD children from EpilSli database (Tomblin, 2010)

Table 1

<table>
<thead>
<tr>
<th></th>
<th>1. GU</th>
<th>2. GC</th>
<th>3. BI</th>
<th>4. OV</th>
<th>5. PV</th>
<th>6. WSD</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>.545</td>
<td>.526</td>
<td>.535</td>
<td>.421</td>
<td>.358</td>
<td>.365</td>
</tr>
</tbody>
</table>

LISREL (2012) was used to test all models. All path estimates were determined using the General Least Square (GLS). Error was estimated by the standard procedure (i.e., ph was set to 1 for exogenous variables and for endogenous variables one lambda path was fixed.

Fit was estimated by examining χ², RMSEA, PNFI, and CFI. Path estimates were examined for models with appropriate goodness-of-fit.