

New Advances In Longitudinal Modeling

Bengt Muthén
UCLA
bmuthen@ucla.edu

CALDAR presentation, August 14, 2006
Research supported by a K award from NIAAA

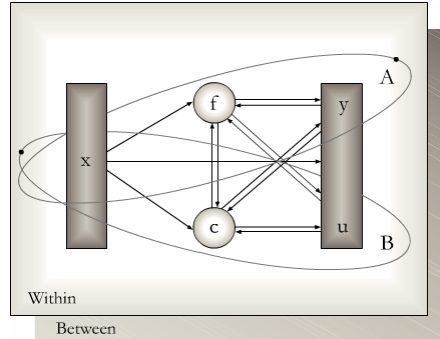
1

Overview

- Latent transition analysis
- Growth mixture analysis
- Two-part growth and growth mixture analysis
- Survival analysis

2

General Latent Variable Modeling Framework



- Observed variables
 - x background variables (no model structure)
 - y continuous and censored outcome variables
 - u categorical (dichotomous, ordinal, nominal) and count outcome variables
- Latent variables
 - f continuous variables
 - interactions among f's
 - c categorical variables
 - multiple c's

3

Latent Class Analysis

Factor Analysis (IRT)

Factor Mixture Analysis

Latent Transition Analysis

5

Further Readings On Latent Transition Analysis

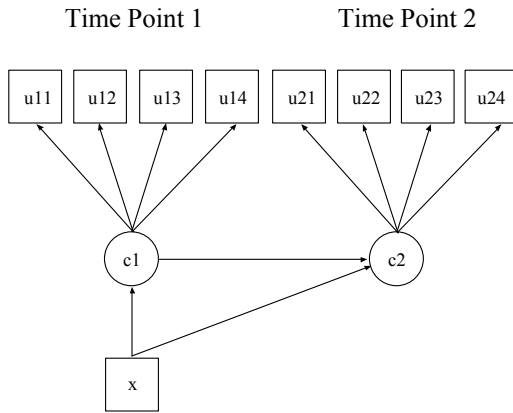
- Chung, H., Park, Y., & Lanza, S.T. (2005). Latent transition analysis with covariates: pubertal timing and substance use behaviors in adolescent females. *Statistics in Medicine*, 24, 2895 - 2910.
- Collins, L.M. & Wugalter, S.E. (1992). Latent class models for stage-sequential dynamic latent variables. *Multivariate Behavioral Research*, 27, 131-157.
- Collins, L.M., Graham, J.W., Rousculp, S.S., & Hansen, W.B. (1997). Heavy caffeine use and the beginning of the substance use onset process: An illustration of latent transition analysis. In K. Bryant, M. Windle, & S. West (Eds.), *The science of prevention: Methodological advances from alcohol and substance use research*. Washington DC: American Psychological Association. pp. 79-99.
- Reboussin, B.A., Reboussin, D.M., Liang, K.Y., & Anthony, J.C. (1998). Latent transition modeling of progression of health-risk behavior. *Multivariate Behavioral Research*, 33, 457-478.

6

Latent Transition Analysis

Transition Probabilities

		c2	
		1	2
c1	1	0.8	0.2
	2	0.4	0.6



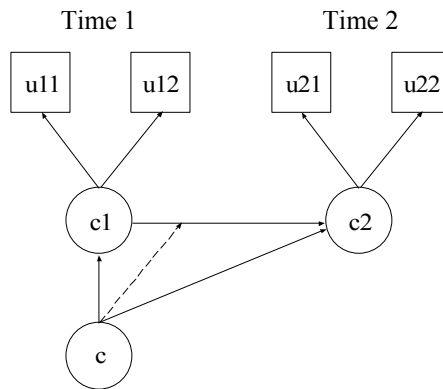
7

Mover-Stayer Latent Transition Analysis

Transition Probabilities

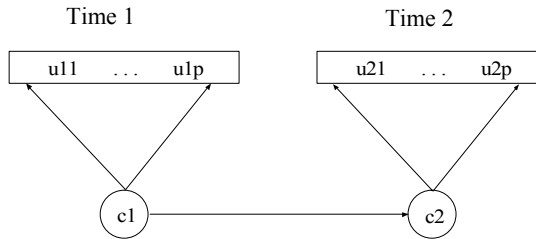
Mover Class (c=1)		c2	
		1	2
c1	1	0.6	0.4
	2	0.3	0.7

Stayer Class (c=2)		c2	
		1	2
c1	1	0.90	0.10
	2	0.05	0.95



8

Latent Transition Analysis

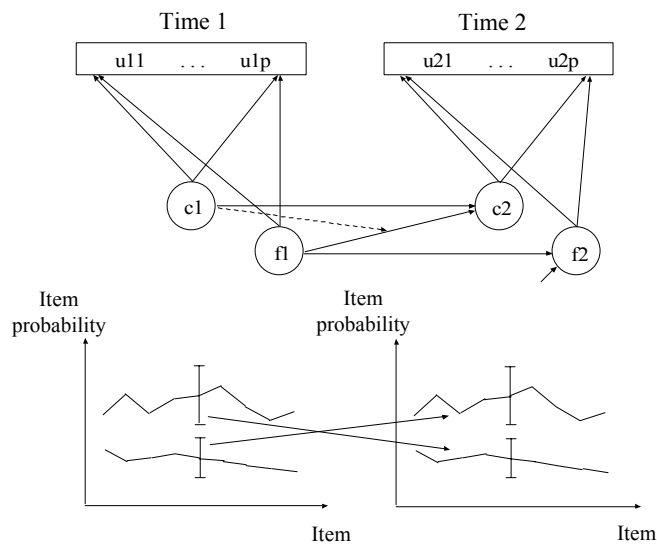


Transition Probabilities

		c_2	
		1	2
c_1	1	0.6	0.4
	2	0.3	0.7

9

Factor Mixture Latent Transition Analysis Muthen (2006)



10

**Factor Mixture Latent Transition Analysis:
Aggressive-Disruptive Behavior In The Classroom**

- 1,137 first-grade students in Baltimore public schools
- 9 items: Stubborn, Break rules, Break things, Yells at others, Takes others property, Fights, Lies, Teases classmates, Talks back to adults
- Skewed, 6-category items; dichotomized (almost never vs other)
- Two time points: Fall and Spring of Grade 1
- For each time point, a 2-class, 1-factor FMA was found best fitting

11

**Factor Mixture Latent Transition Analysis:
Aggressive-Disruptive Behavior In The Classroom
(Continued)**

Model	Loglikelihood	# parameters	BIC
Conventional LTA	-8,649	21	17,445
FMA LTA factors related across time	-8,012	40	16,306

12

Factor Mixture Latent Transition Analysis: Aggressive-Disruptive Behavior In The Classroom (Continued)

Estimated Latent Transition Probabilities, Fall to Spring

Conventional LTA

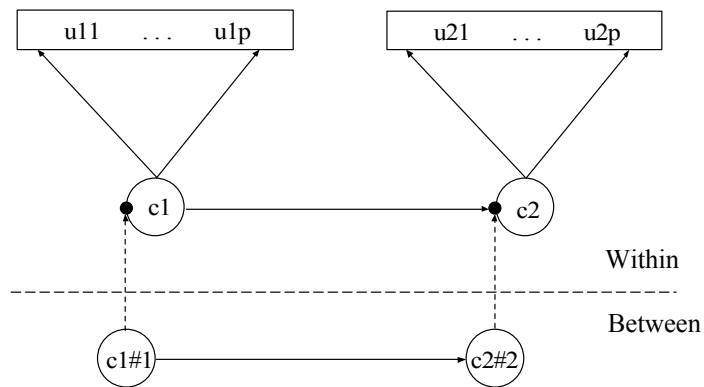
	Low	High
Low	0.93	0.07
High	0.17	0.83

FMA-LTA

	Low	High
Low	0.94	0.06
High	0.41	0.59

13

Two-Level Latent Transition Analysis Asparouhov & Muthen (2006)

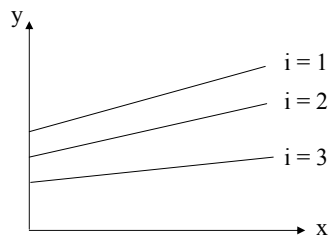


14

Multilevel Growth Mixture Modeling

15

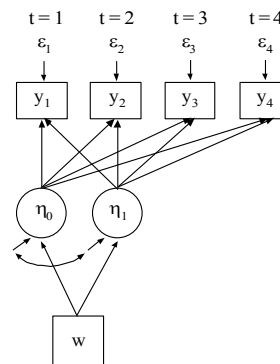
Individual Development Over Time



$$(1) \quad y_{it} = \eta_{0i} + \eta_{1i} x_t + \varepsilon_{it}$$

$$(2a) \quad \eta_{0i} = \alpha_0 + \gamma_0 w_i + \zeta_{0i}$$

$$(2b) \quad \eta_{1i} = \alpha_1 + \gamma_1 w_i + \zeta_{1i}$$



16

Mixtures And Latent Trajectory Classes

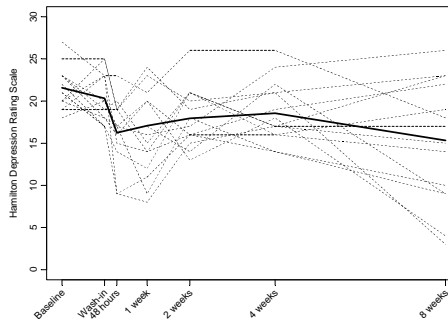
Modeling motivated by substantive theories of:

- Multiple Disease Processes: Prostate cancer (Pearson et al.)
- Multiple Pathways of Development: Adolescent-limited versus life-course persistent antisocial behavior (Moffitt), crime curves (Nagin), alcohol development (Zucker, Schulenberg)
- Subtypes: Subtypes of alcoholism (Cloninger, Zucker)

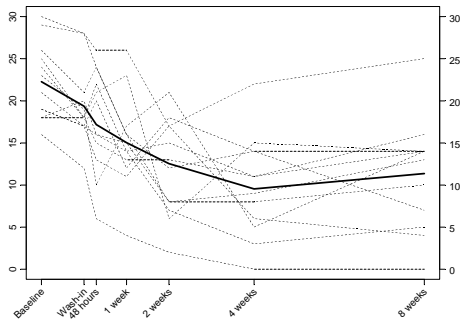
17

A Clinical Trial Of Depression Medication: Two-Class Growth Mixture Modeling

Placebo Non-Responders, 55%

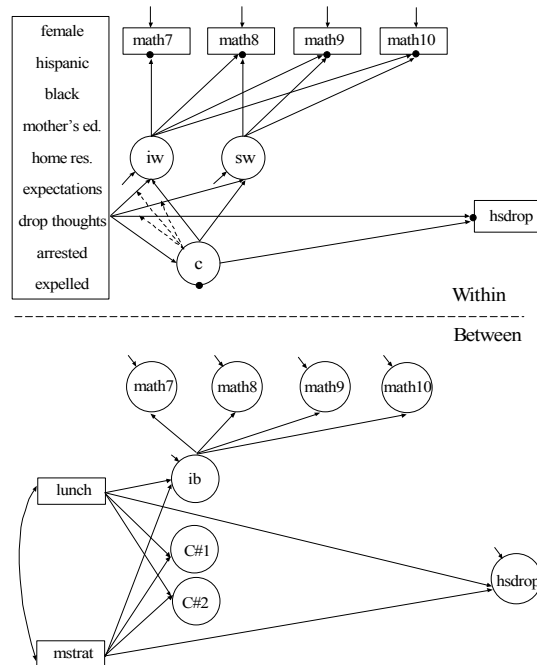
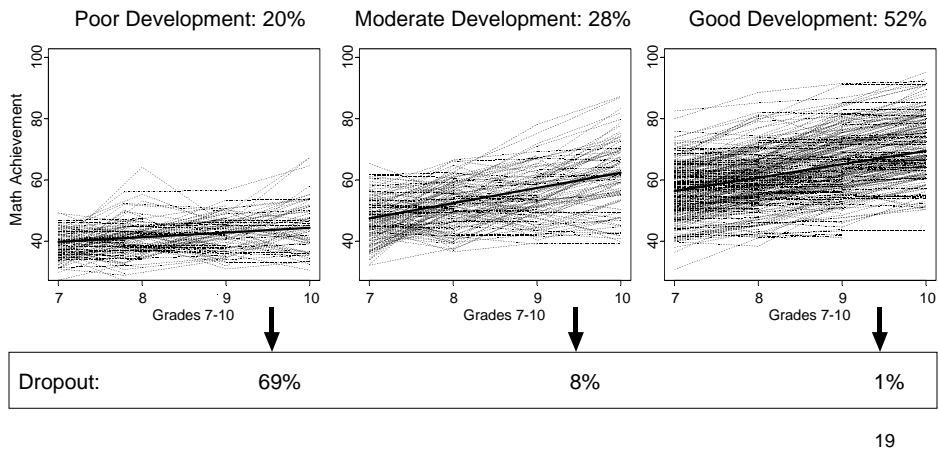


Placebo Responders, 45%



18

Growth Mixture Modeling: LSAY Math Achievement Trajectory Classes And The Prediction Of High School Dropout

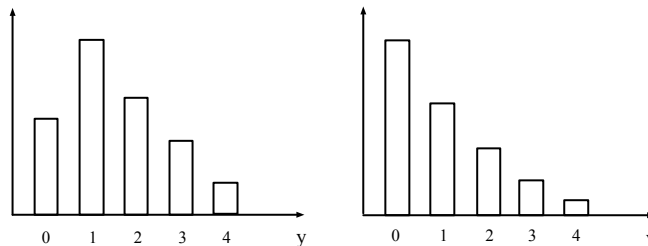


Further Readings On General Growth Mixture Modeling

- Muthén, B. (2004). Latent variable analysis: Growth mixture modeling and related techniques for longitudinal data. In D. Kaplan (ed.), Handbook of quantitative methodology for the social sciences (pp. 345-368). Newbury Park, CA: Sage Publications. (#100)
- Muthén, B. & Shedden, K. (1999). Finite mixture modeling with mixture outcomes using the EM algorithm. Biometrics, 55, 463-469. (#78)
- Muthén, B., Brown, C.H., Masyn, K., Jo, B., Khoo, S.T., Yang, C.C., Wang, C.P., Kellam, S., Carlin, J. & Liao, J. (2002). General growth mixture modeling for randomized preventive interventions. Biostatistics, 3, 459-475. (#87)
- Muthén, B., Khoo, S.T., Francis, D. & Kim Boscardin, C. (2002). Analysis of reading skills development from Kindergarten through first grade: An application of growth mixture modeling to sequential processes. In S.R. Reise & N. Duan (eds), Multilevel modeling: Methodological advances, issues, and applications (pp. 71 – 89). Mahaw, NJ: Lawrence Erlbaum Associates. (#77)

21

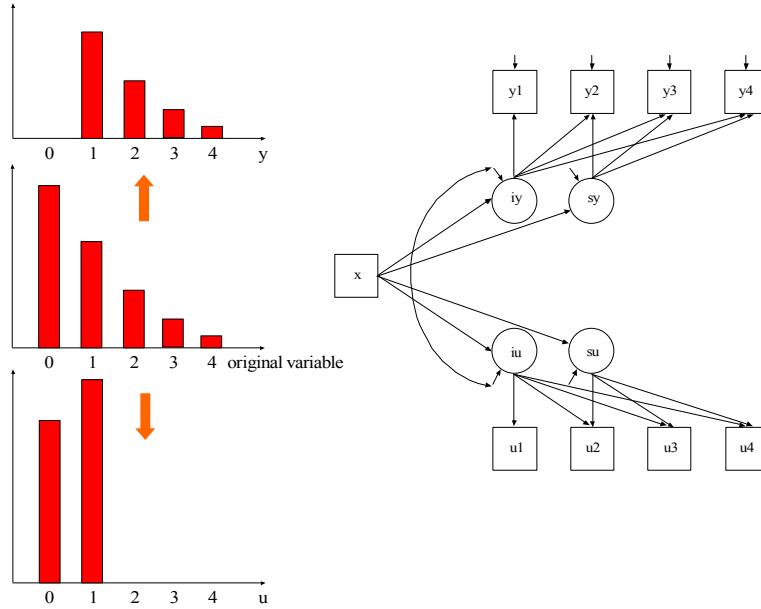
Modeling With A Preponderance Of Zeros



- Outcomes: non-normal continuous – count – categorical
- Censored-normal modeling
- Two-part (semicontinuous modeling): Duan et al. (1983), Olsen & Schafer (2001)
- Mixture models, e.g. zero-inflated (mixture) Poisson (Roeder et al., 1999), censored-inflated, mover-stayer latent transition models, growth mixture models
- Onset (survival) followed by growth: Albert & Shih (2003)

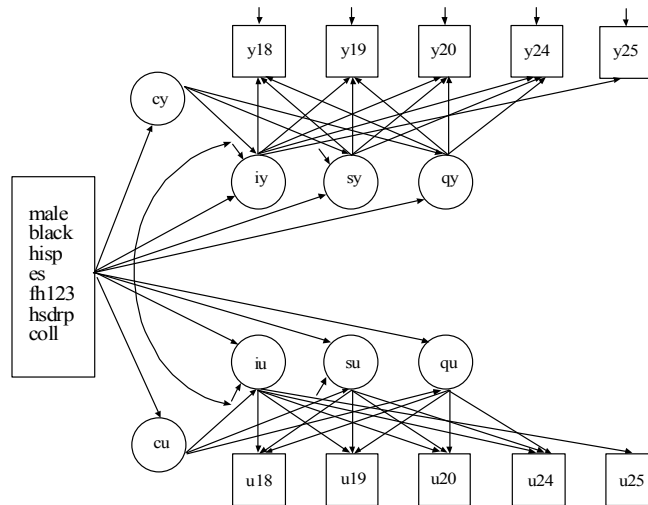
22

Two-Part (Semicontinuous) Growth Modeling



23

Two-Part Growth Mixture Modeling



24

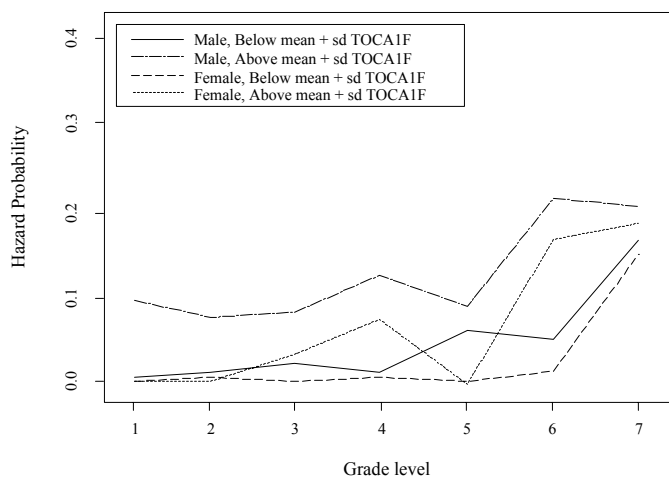
Survival Analysis

- Discrete-time survival analysis
- Continuous-time survival analysis

Fully integrated into a general latent variable framework

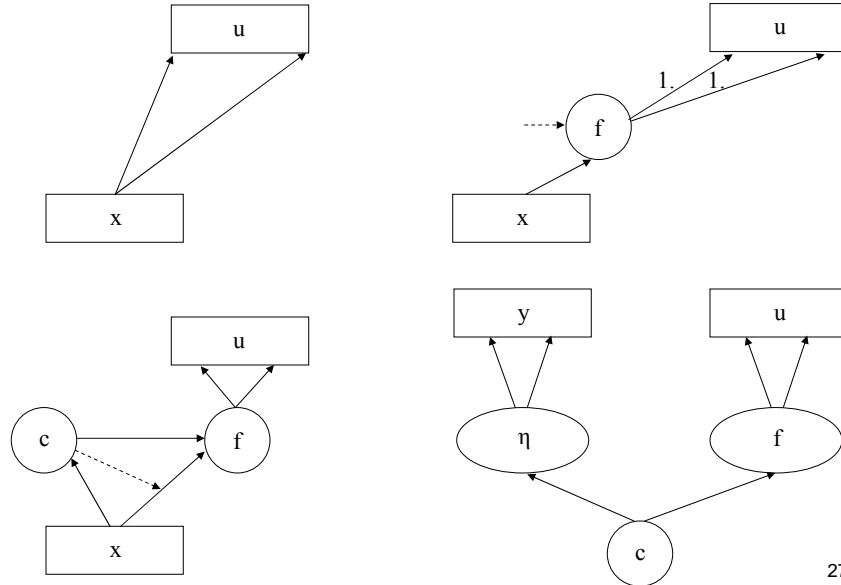
25

Hazard Sample Estimates



26

Discrete-Time Survival Models



Mplus Website

Visit www.statmodel.com to check out

- Mplus version 4.1
- Version 4.1 User's Guide
- Recent papers
- Mplus Discussion
- Web videos of courses
- Short course announcements
 - October 19-20 at Johns Hopkins:
www.jhsph.edu/prevention/Conferences/Muthen2006
 - October 23-24 at University of Montreal
<http://www.statmodel.com/index.shtml>

28