Modeling change: A gentle introduction to cross-lagged and latent growth curve approach: course materials

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Latent growth (curve) modeling primer

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LGCM: when & what is it good for?

- WHEN?
  - You have three (3) or more data collection points („waves")
  - Measurements do not need to be evenly spaced
  - Reasonably large panel sample (at each wave; unless FIML)
  - Shape of growth is of interest in itself

- WHY?
  - A state-of-the-art robust and (more) powerful statistical technique
  - Gives insight into intra-individual change
  - Enables multigroup testing (comparing growth in two or more groups)
  - Unlike multi-level regression modeling, LGCM accommodates latent variables
  - LGCM is highly flexible approach

Essential elements:

- **Intercept (*fixed effects*):** M = average latent mean at baseline; var. = individual variations

- **Slope (*random effects*):** M = average latent growth; var. = individual variations in growth
  - Positive & negative growth
  - Various specifications possible and often needed
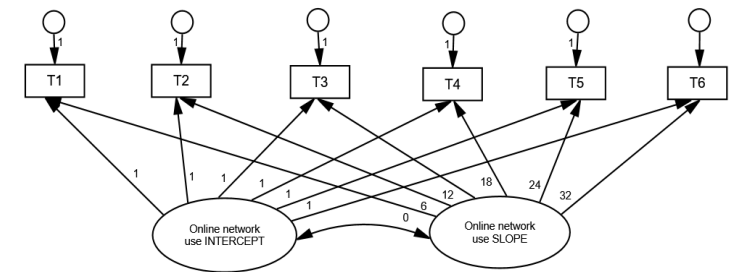
# Unconditional & conditional models / multi-domain models

- Unconditional LGC model = no baseline correlates/predictors

- Conditional models: time-invariant vs. *time-varying predictors/correlates*

- Multidomain or multivariate models = two or more LGC models are specified and associated („parallel growth")

- LGC model can be used to predict a construct measured at the last wave or afterwards (not ideal)

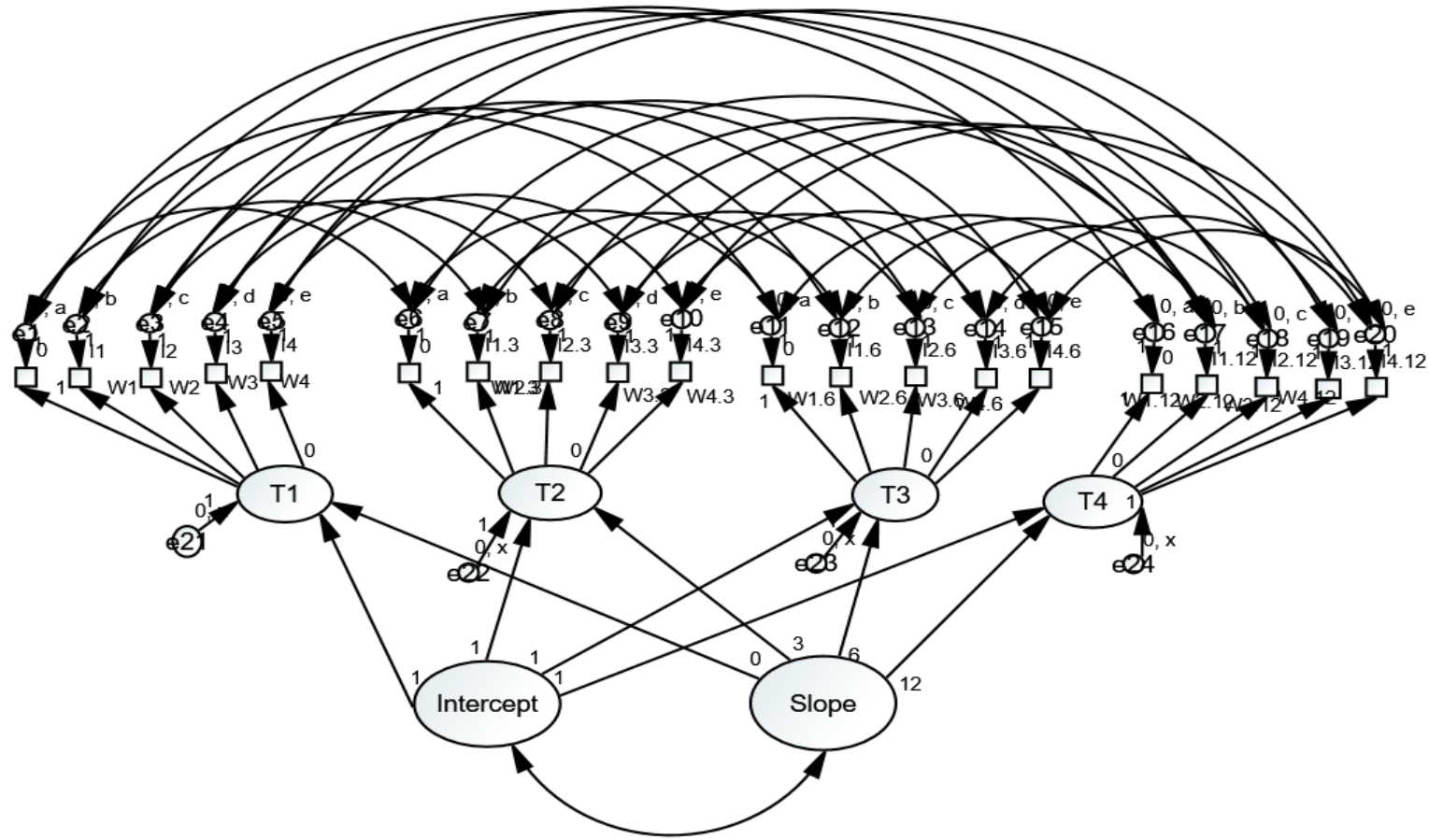# Linear latent growth curve specification
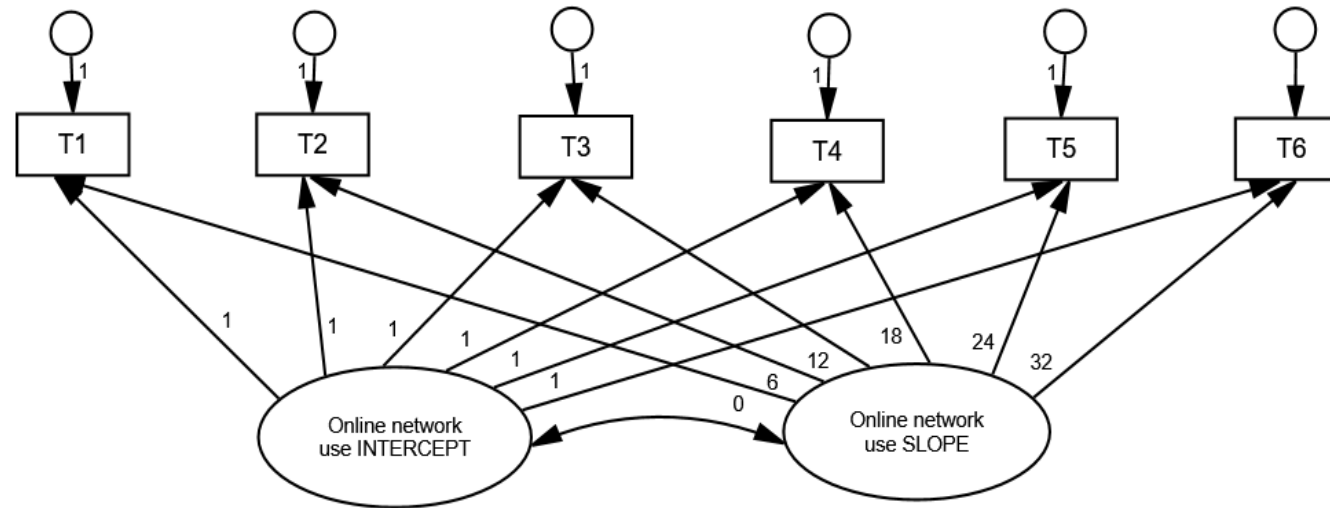
SPECIFICATION IS ALL ABOUT CODING TIME (SPECIFYING SLOPE PATHS)

Time can be specified to test a particular hypothesis!
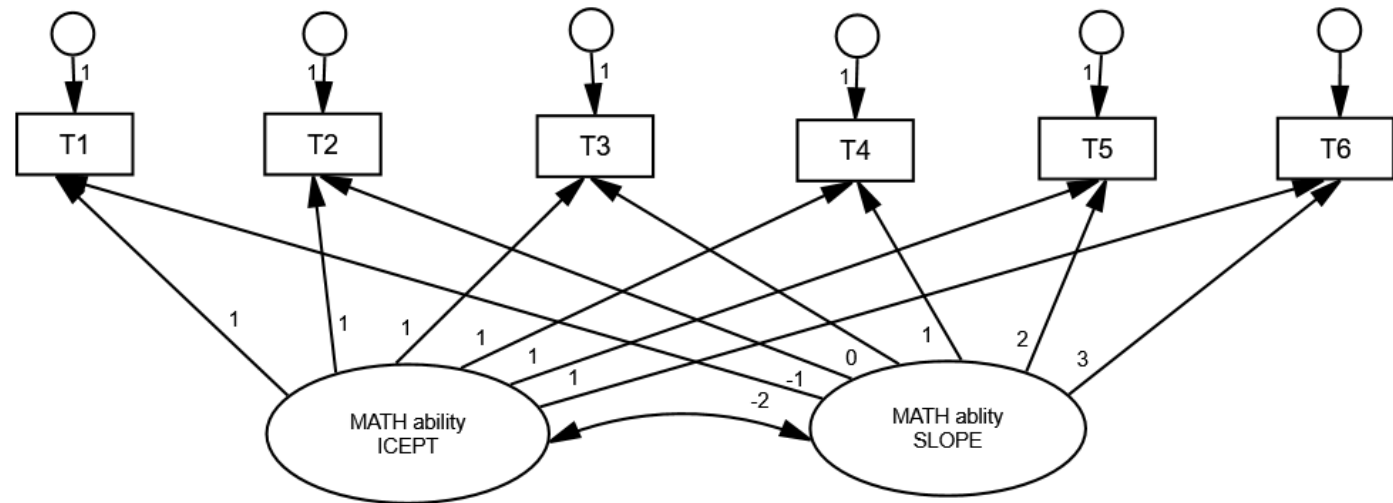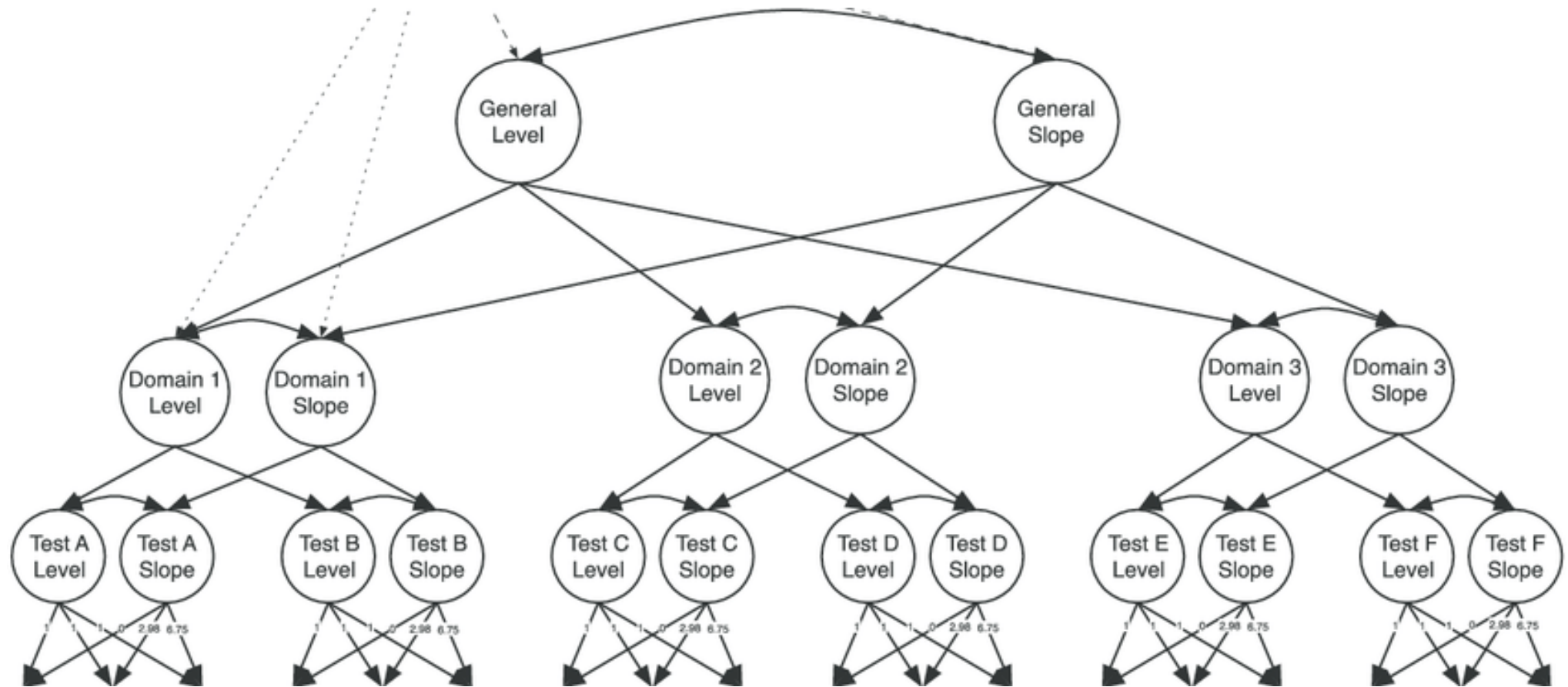

T3 = participants are 10 years old
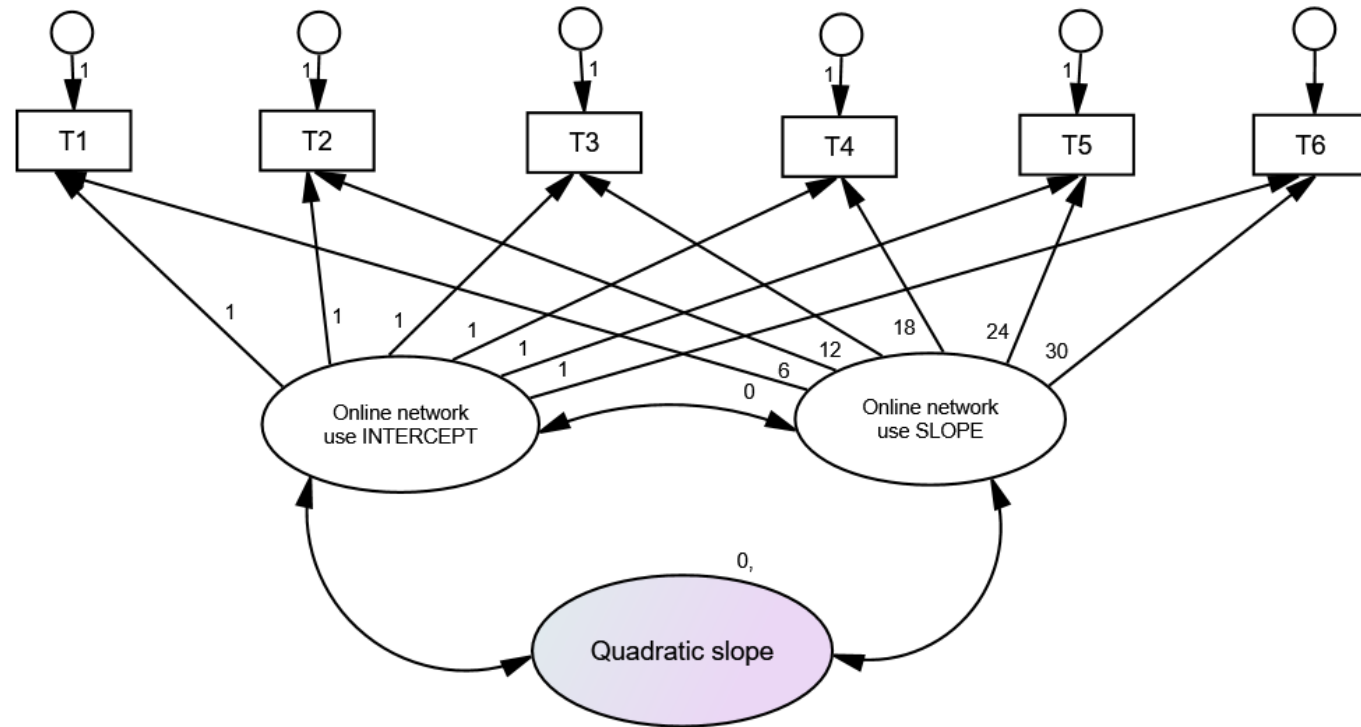
Going totally latent: *Curve-of-factors models*

...and *factor-of-curves models*

Quadratic specification (cubic…)

Piecewise curve specification (finding the „knot")

0, 0, 0, 6, 12, 18
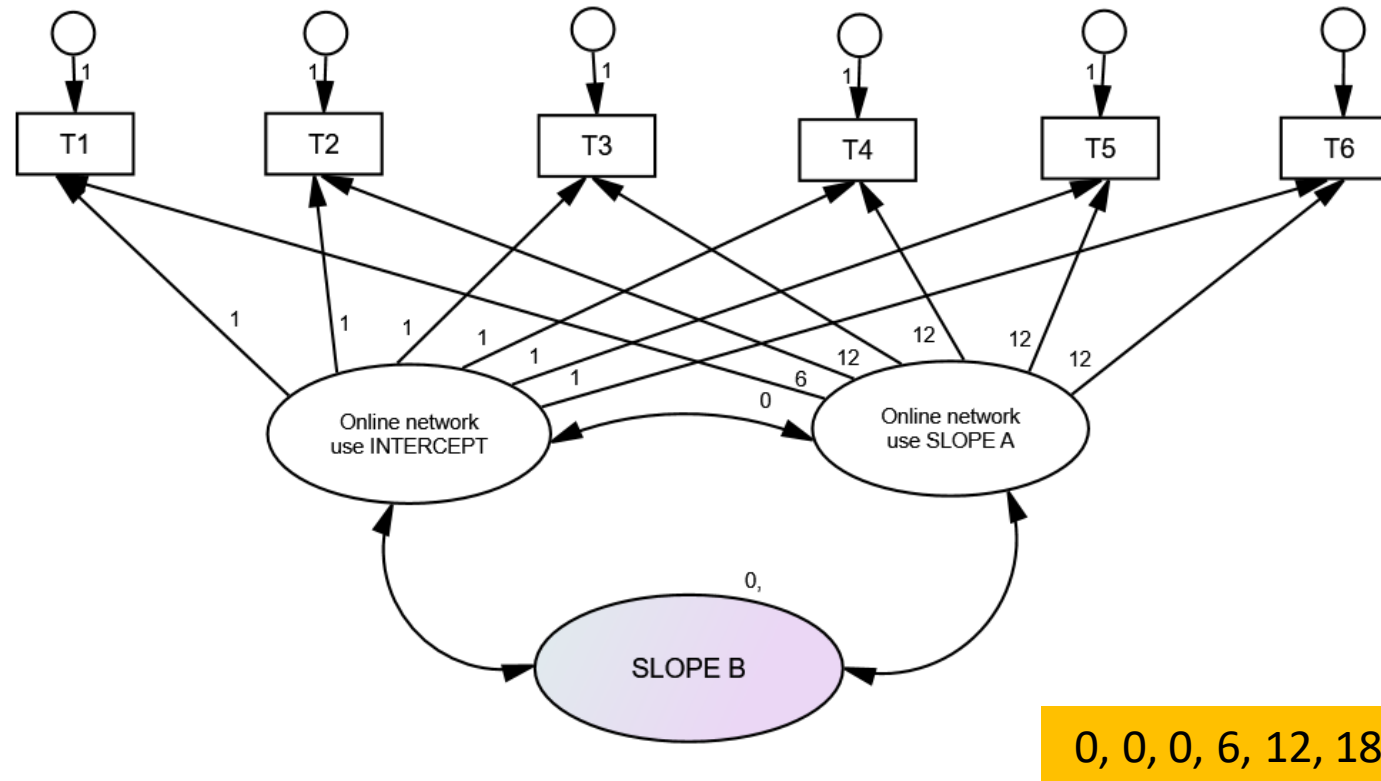
Unspecified (or cumulative) growth curve
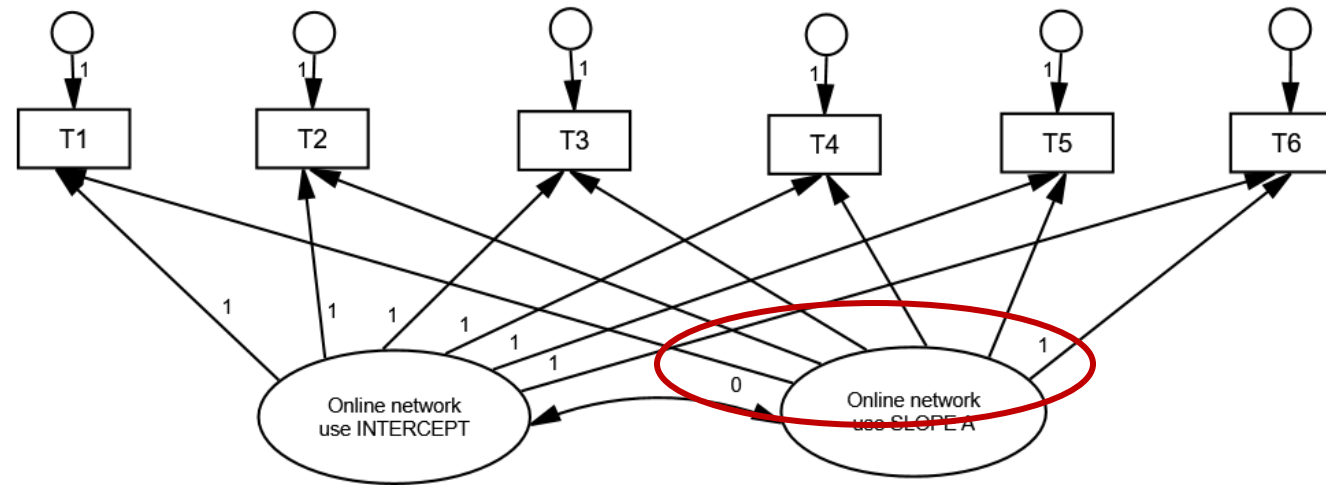
Possible additional specification element:

With no time invariance testing, items' residuals (error variances) can be fixed to equality*

*The assumption about the stationarity of residuals; helps with estimation (Little, 2013)
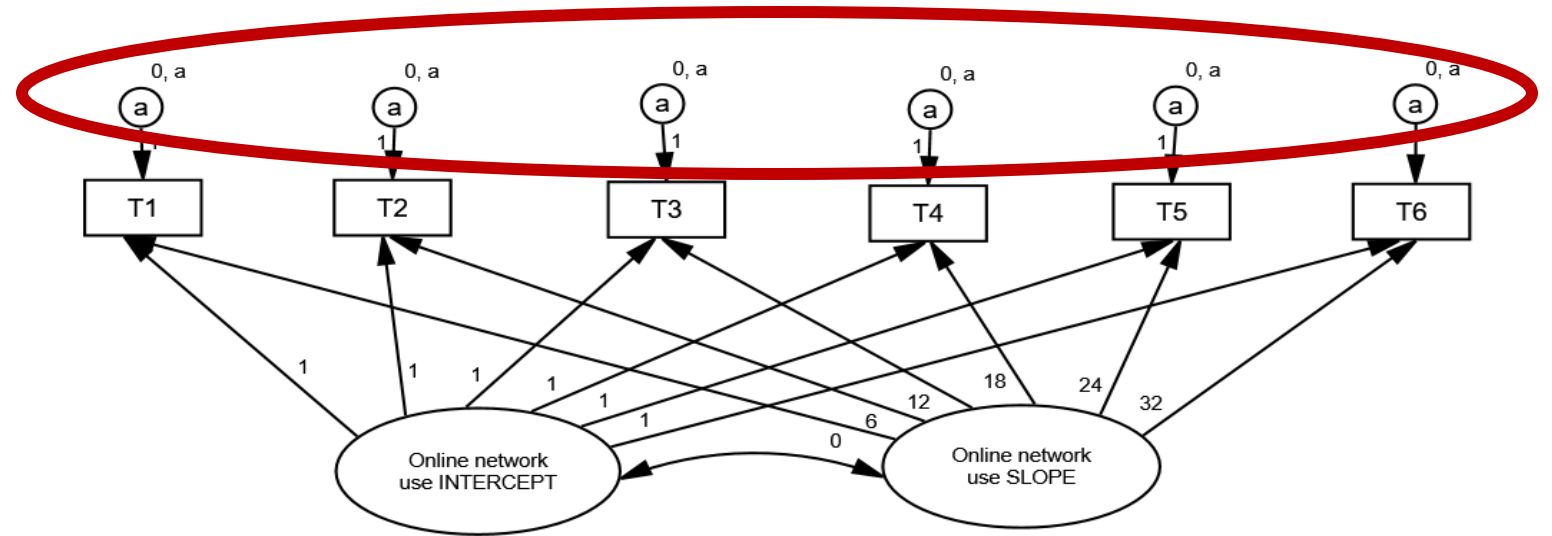
All „real life" examples are from publications related to the **PROBIOPS research project** funded by the *Croatian Science Foudation*

For details see:
http://probiops.ffzg.hr/papers-published/

Piecewise growth curve specification example
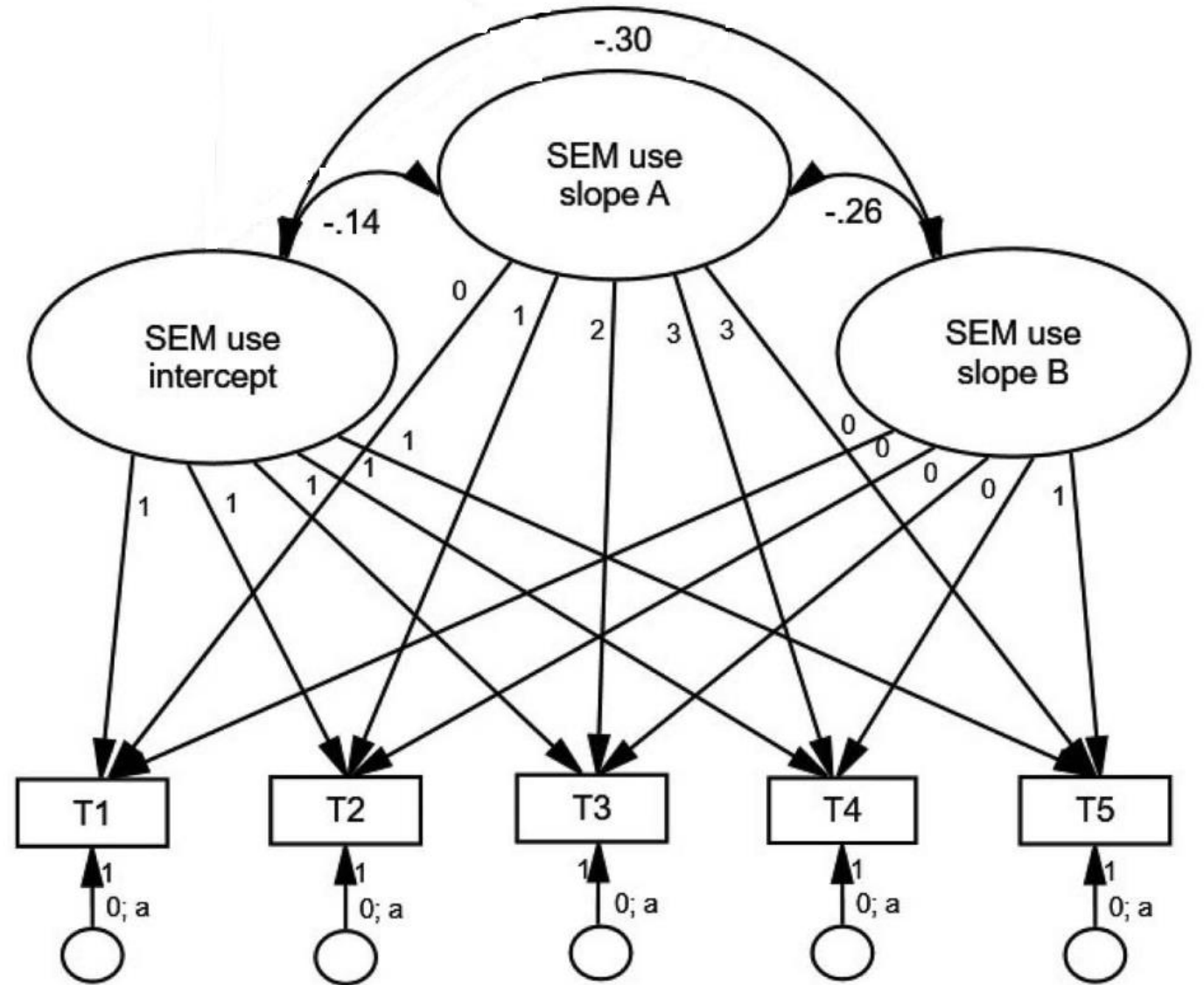
Fig. 2

Conditional latent growth curve model of male adolescents' pornography use over two years
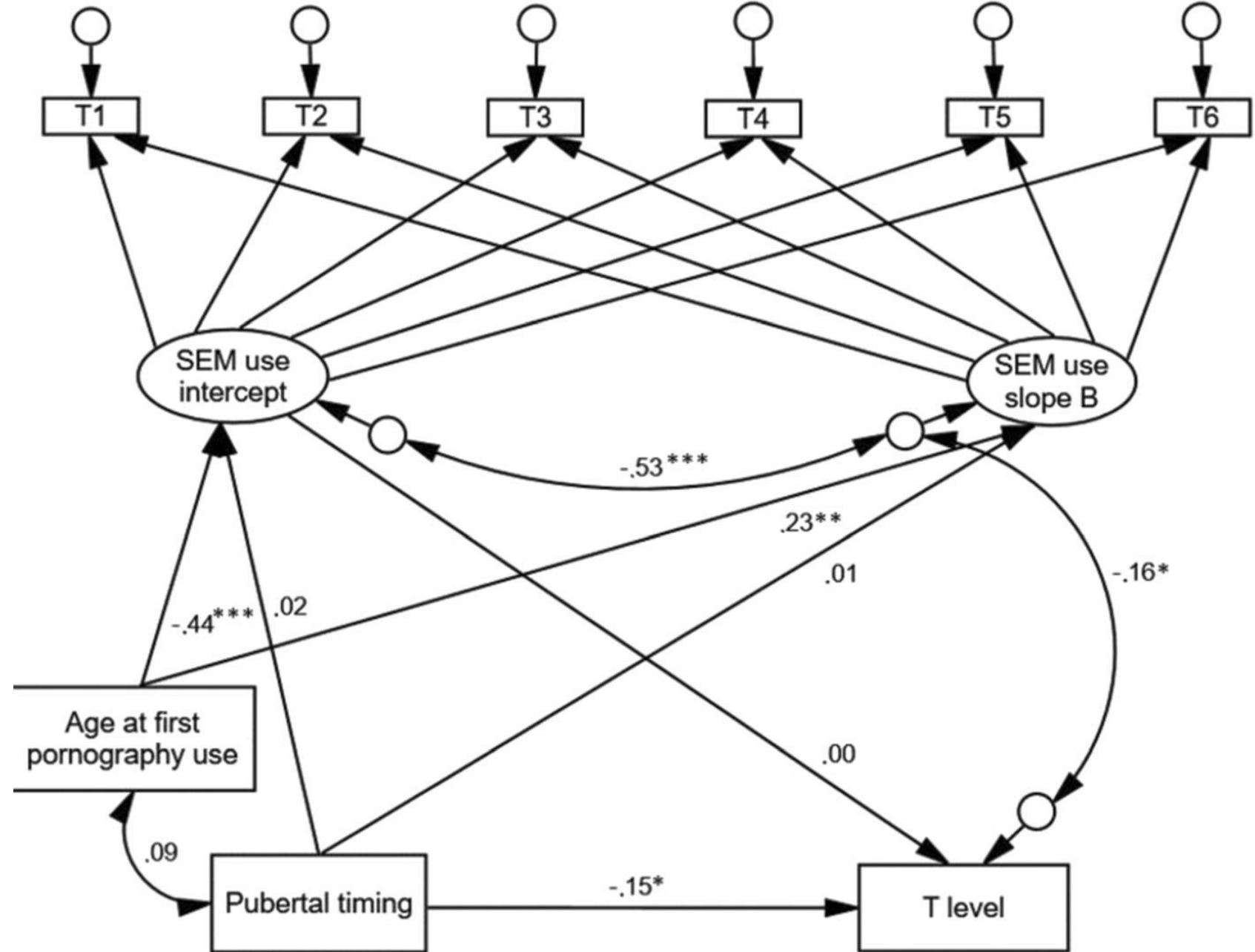
*p < .05; **p < .01; *** p < .001

Figure 1.

Associations between male adolescents' baseline frequency of and subsequent change in pornography use, and self-reported problematic pornography use at the end of the period under observation (n = 337).

Standardized path coefficients are presented; model fit: $\chi2(54)$ = 133.93, TLI = .935, TLI = .947, RMSEA = .066 (90% CI = .052-.081). * $p < .01$, ** $p < .001$

Fig. 1 Structural associations in the multi-domain latent growth model of adolescent women's pornography use, depression and anxiety and self-esteem (n = 775). Model fit: chi-sq(151)= 428.24, TLI= 0.953, CFI= 0.959, RMSEA= 0.049 (0.043–0.054); *p < 0.01, **p < 0.001; standardized path coefficients are presented
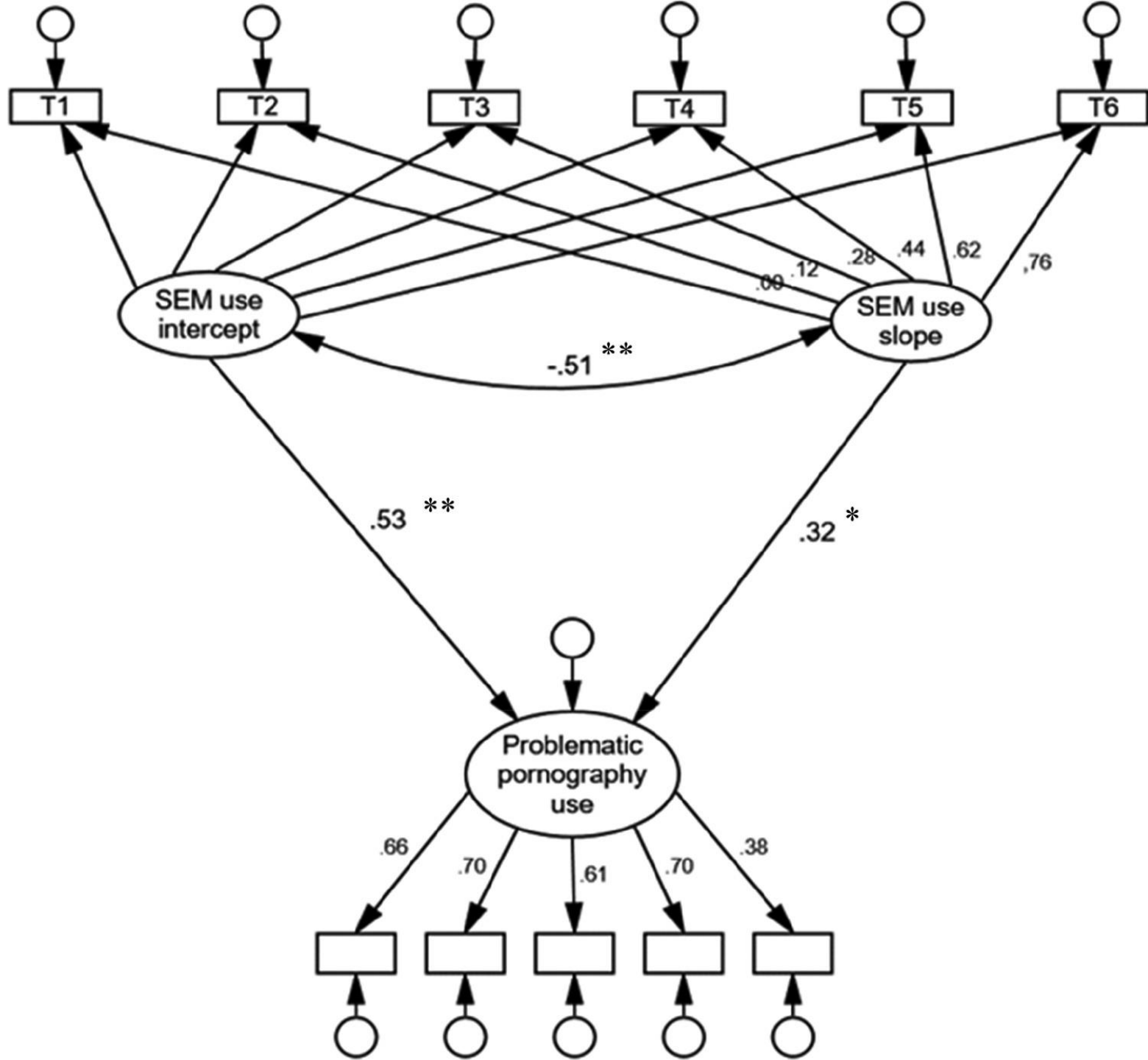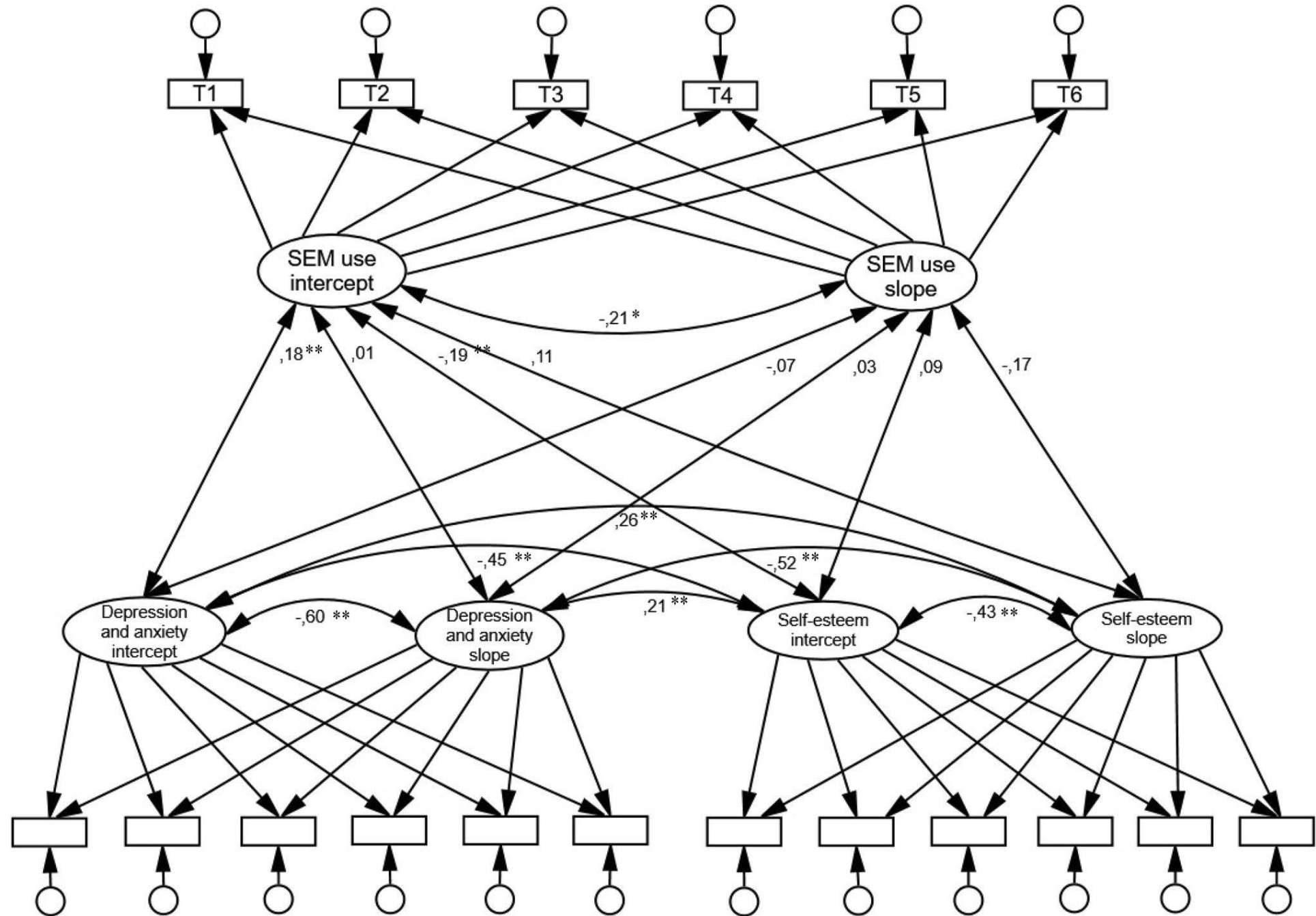
Stepwise approach is *de rigeur!*

- STEP 1: Testing unconditional (linear latent growth) model fit
- STEP 2: Comparing latent and non-latent growth curves (at least linear and unspecified or *cumulative growth* curves); standard chi-sq difference test
- STEP 3: Testing conditional model fit
- STEP 4: Interpreting structural paths

- In the case of multi-domain models, STEP 1 is to be repeated for every domain

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- *Curve-of-factors & factor-of-curve models first need to be checked for invariance across time*

Interpreting LGCM findings
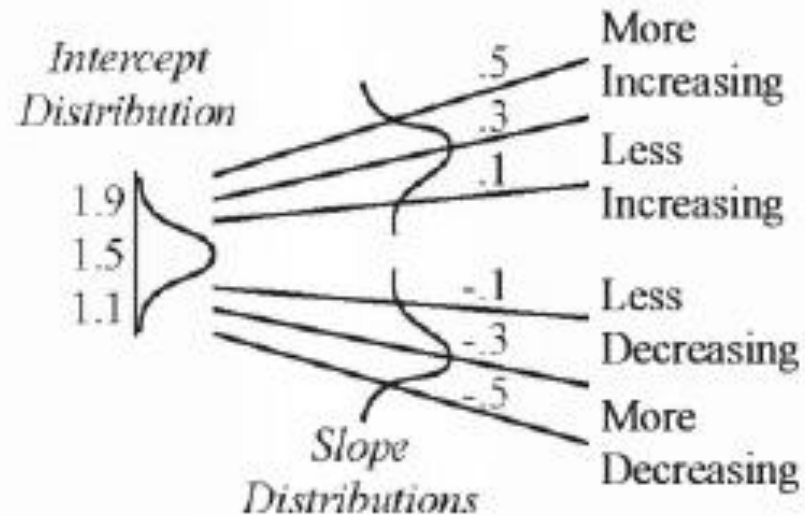
FIGURE 8.5. Interpreting a negative cor-relation in growth models. With a negative *r*, high scores go with low scores. With a positive slope, .1 is lower than .5, but, with a negative slope, −.5 is lower than −.1. (Little, 2013)

Interpreting associations:

Negative association between ICEPT and SLOPE indicate that those with higher initial values were characterized by lower growth. THIS IS COMMON.

How to report the use of LGCM and its results?

Table 3

Mean values of and individual variation in initial levels and latent change in key constructs.

	Adolescent women (n = 589)		Adolescent men (n = 286)	
	M (S.E.)	σ^2 (S.E.)	M (S.E.)	σ^2 (S.E.)
SEM realism intercept	2.38 (.06)**	.71 (.09)**	2.62 (.06)**	.76 (.09)**
SEM realism slope	-.33 (.06)**	.27 (.09)*	-.44 (.07)**	.55 (.11)**
SEM use intercept	1.83 (.07)**	1.65 (.16)**	5.17 (.13)**	3.84 (.40)**
SEM use slope	.66 (.08)**	1.21 (.24)**	.36 (.12)*	1.81 (.37)**

Notes. Statistically significant mean intercept values indicate that the initial levels in SEM realism and SEM use were significantly different from zero, while significant mean slope values indicate significant mean change, positive or negative, over time. Significant variances in intercept and slope factors denote significant individual variation in initial levels and latent trajectories of the two constructs, respectively.

*p < .01, **p < .001.

	Adolescent women ($n = 775$)	Adolescent men ($n = 514$)
Pornography use		
Mean intercept	1.72 (SE=0.05)**	4.87 (SE=0.09)**
Variance in individual intercepts	1.36 (SE=0.09)**	3.54 (SE=0.27)**
Mean slope	0.22 (SE=0.05)**	0.08 (SE=0.00)
Variance in individual slopes	0.93 (SE=0.13)**	0.01 (SE=0.00)**
Depression/anxiety		
Mean intercept	9.51 (SE=0.12)**	7.79 (SE=0.13)**
Variance in individual intercepts	8.09 (SE=0.60)**	4.94 (SE=0.49)**
Mean slope	−1.12 (SE=0.12)**	−0.63 (SE=0.13)**
Variance in individual slopes	4.27 (SE=0.62)**	1.59 (SE=0.49)*
Self-esteem		
Mean intercept	15.27 (SE=0.10)**	16.48 (SE=0.11)**
Variance in individual intercepts	6.52 (SE=0.43)**	4.62 (SE=0.37)**
Mean slope	0.60 (SE=0.10)**	0.01 (SE=0.01)
Variance in individual slopes	2.35 (SE=0.38)**	0.00 (SE=0.00)**
$\chi^2(df)$	413.18 (147)	236.52 (155)
TLI/CFI	0.954/0.960	0.975/0.977
RMSEA (90% CI)	0.048 (0.043–0.054)	0.032 (0.024–0.040)

Table 3 Unconditional multi-domain latent growth model estimates and fit by gender

SE standard errors

*$p < 0.01$, **$p < 0.001$