Analysing longitudinal data with hierarchical linear models and identifying subgroups in prevention research

--- additional slides, shown at the workshop ---

Workshop at 6. EUSPR, Ljubliana, October 21, 2015

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Excellent courses on statistics (multilevel, longitudinal) and IRT models; examples in SAS, Mplus (some with SPSS and Stata)

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www.lesahoffman.com/index.html

Welcome to my new home page!

Home | CV | Research | Course Materials | Recent Talks and Workshops | My book is finally in print! *Longitudinal Analysis*

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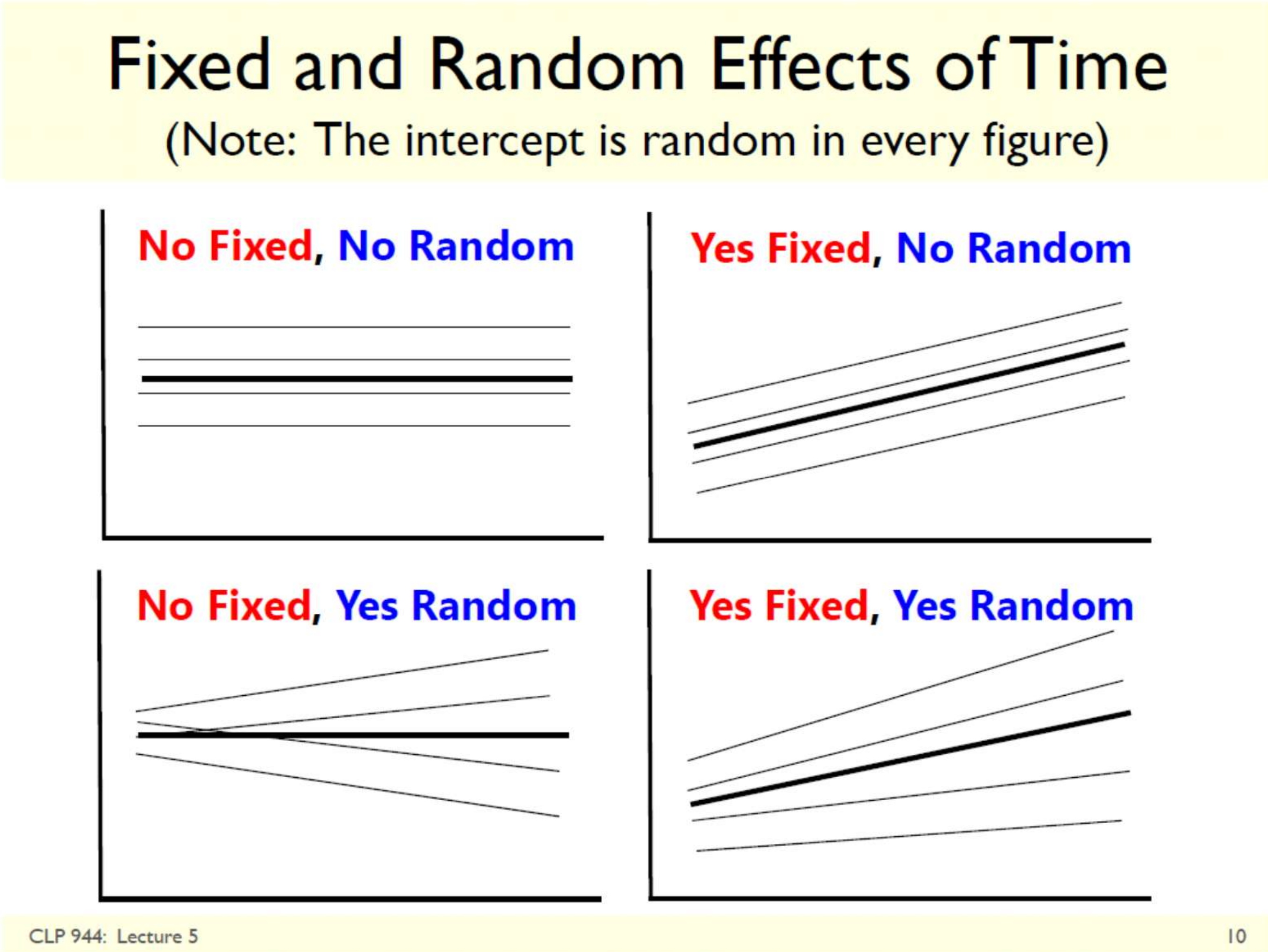
We are what we repeatedly do. Excellence, therefore, is not an act, but a habit. –Aristotle

Brief Biosketch: I received my Ph.D. in Psychology at the University of Kansas in 2003, and completed a post-doctoral fellowship at The Pennsylvania State University before joining the Department of Psychology at the University of Nebraska-Lincoln as an Assistant Professor in 2006 (and as Associate Professor in 2011). Most recently, as of August 2014 I am now the Scientific Director of the Research Design and Analysis (RDA) Unit of the Lifespan Institute and Associate Professor of

Combination of fixed and random effects of time



From: Lesa Hoffman: Course CLP 944 (available at: http://www.lesahoffman.com/CLP944/index.html)

Influence of coding of time

Table 5.5 Results for model 5 for different scalings of measurement occasion

Model	M5a: first occasion = 0	M5b: last occasion = 0	M5c: occasions centered
Fixed part	Coeff. (s.e.)	Coeff. (s.e.)	
Intercept	2.56 (.10)	3.07 (.09)	2.82 (.09)
Occasion	0.10 (.006)	0.10 (.006)	0.10 (.006)
Job status	–0.13 (.02)	–0.13 (.02)	–0.13 (.02)
GPA highschl	0.09 (.03)	0.09 (.03)	0.09 (.03)
Gender	0.12 (.03)	0.12 (.03)	0.12 (.03)
Random part			
σ_e^2	0.042 (.002)	0.042 (.002)	0.042 (.002)
σ_{u0}^2	0.038 (.006)	0.109 (.014)	0.050 (.006)
σ_{u1}^2	0.004 (.001)	0.004 (.001)	0.004 (.001)
σ_{u01}	–0.002 (.002)	0.017 (.003)	0.007 (.001)
r_{u01}	–.21	.82	.51
Deviance	170.1	170.1	170.1
AIC	188.1	188.1	188.1
BIC	233.9	233.9	233.9

From: Hox, Joop (2010): Multilevel analysis: Techniques and Applications. 2nd ed.

Principle of Empirical Bayes estimation

are close to the overall average. The statistical method used is called *empirical Bayes estimation*. Because of this shrinkage effect, empirical Bayes estimators are biased. However, they are usually more precise, a property that is often more useful than being unbiased (see Kendall, 1959).

The equation to form the empirical Bayes estimate of the intercepts is given by:

$$\hat{\beta}_{0j}^{\text{EB}} = \lambda_j \hat{\beta}_{0j}^{\text{OLS}} + (1 - \lambda_j)\gamma_{00}, \tag{2.14}$$

where λ_j is the reliability of the OLS estimate β_{0j}^{OLS} as an estimate of β_{0j}, which is given by the equation $\lambda_j = \sigma_{u_0}^2 / \left(\sigma_{u_0}^2 + \sigma_e^2 / n_j\right)$ (Raudenbush & Bryk, 2002), and γ_{00} is the overall intercept. The reliability λ_j is close to 1.0 when the group sizes are large and/or the variability of the intercepts across groups is large. In these cases, the overall estimate γ_{00} is not a good indicator of each group's intercept. If the group sizes are small and there is little variation across groups, the reliability λ_j is close to 0.0, and more

From: Hox, Joop (2010): Multilevel analysis: Techniques and Applications. 2nd ed., chap. 2

Syntax examples for SPSS Mixed Model

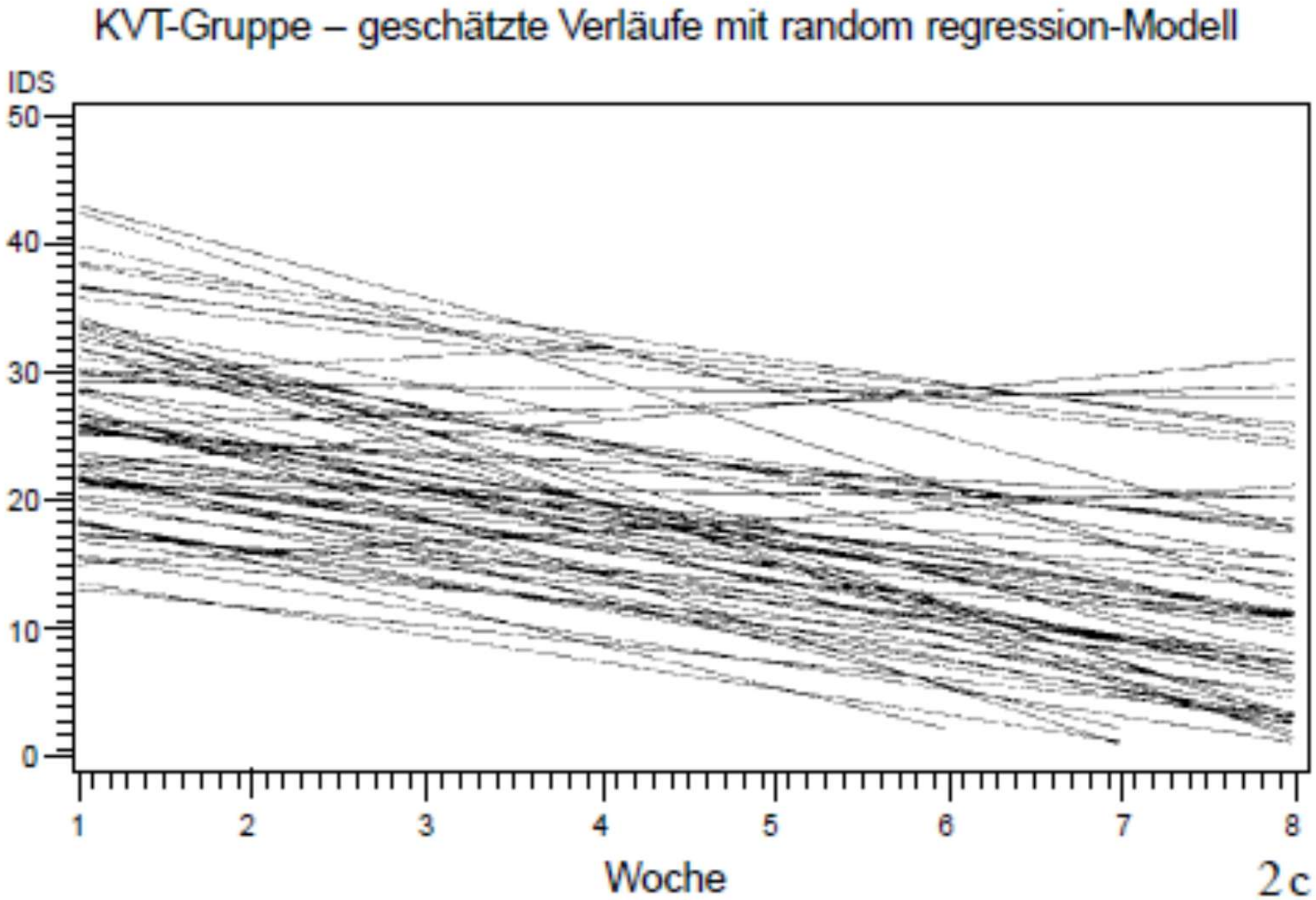
Table 1. Example of SPSS and SAS syntax

SPSS Mixed	GET FILE = 'C:/hsb12.sav' . MIXED mathach BY sector WITH meanses cses /METHOD = REML /PRINT = SOLUTION TESTCOV /FIXED = meanses sector cses meanses*cses sector*cses | SSTYPE(3) /RANDOM = INTERCEPT cses | SUBJECT(school) COVTYPE(UN).
SAS Proc Mixed	PROC MIXED DATA = hlmc.hsb12 COVTEST NOCLPRINT ; CLASS school sector ; MODEL mathach = meanses sector cses meanses*cses sector*cses / SOLUTION ; RANDOM INTERCEPT cses / SUB=school ; RUN;

1.	GET FILE = 'C:/hsb12.sav' .	Opens a data file.
2.	MIXED mathach BY sector WITH meanses cses	The procedure (MIXED), the outcome variable (mathach), and factor (BY) and/or covariates (WITH) are specified on the first line. Note: the SPSS approach applies traditional ANOVA terminology in that categorical predictors are referenced as 'Factor' and listed after the BY term; where continuous predictors are referred to as 'Covariate' and are listed after the WITH term.

From: John Painter: Designing Multilevel Models using SPSS 11.5 Mixed Model

Therapy study (Hautzinger/de Jong)
(estimated regression lines with RRM)



Aus: Keller, F. (2003): Analyse von Längsschnittdaten: Auswertungsmöglichkeiten mit hierarchischen linearen Modellen. *Zeitschrift für Klinische Psychologie und Psychotherapie, 32,* 51-61

Syntax examples for SAS: model the dependency within-person

The structure of the within-person error covariance matrix is specified using a REPEATED statement. To fit the model in (11a) under the assumption that Σ is compound symmetric we write:

```
proc mixed noclprint covtest noitprint;
 class id wave;
 model y = time/s notest;
 repeated wave/type=cs subject=id r;
```

Notice that I have added a second CLASS variable (WAVE) to indicate the time structured nature of the data within person and I have used WAVE on the REPEATED statement. WAVE differs from TIME in that WAVE is treated as a series of dummies, whereas TIME is treated as a continuous variable to yield the growth model. The variable specified on the REPEATED statement must be categorical (although it need not be equal interval). The TYPE=option is crucial, for it specifies the form of the within-person variance-covariance matrix. In addition to the compound symmetry specification (CS) shown here, other possibilities include UN (for unstructured) and AR(1) for autoregressive with a lag of one. The SUBJECT=ID tells SAS that there are to be separate blocks of this matrix, one for each subject. The R option asks SAS to print the R matrix.

From: Singer, J.D. (1998). Using SAS Proc Mixed to fit Multilevel Models…. *J Educ Behav Statistics, 24,* 323-355

Syntax examples for SAS: a (cross-sectional) model with 3 levels

The ideas presented in this paper can be easily extended to three-level (and higher-level models). In the case of "school-effects" analyses, the user must specify multiple RANDOM statements, with appropriate nesting specifications given in the SUB= option. For example, if you have data on students within teachers within schools, you could fit an unconditional means model with the syntax:

```
proc mixed noclprint covtest;
 class teacher school;
 model mathach = /solution;
 random intercept/sub=school;
 random intercept/sub=teacher(school);
```

From: Singer, J.D. (1998). Using SAS Proc Mixed to fit Multilevel Models…. *J Educ Behav Statistics, 24,* 323-355

Syntax examples for SAS: a (longitudinal) model with three levels

```
title "Model 7.1";
proc mixed data = veneer noclprint covtest;
   class patient tooth;
   model gcf = time base_gcf cda age time*base_gcf
               time*cda time*age / solution outpred = resids;
   random intercept time / subject = patient type = un solution
               v = 1 vcorr = 1;
   random intercept / subject = tooth(patient) solution;
run;
```

From: West/Welch/Galecki (2007)….., dentristy example

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