

# HLM Brownbag

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12/14/2017

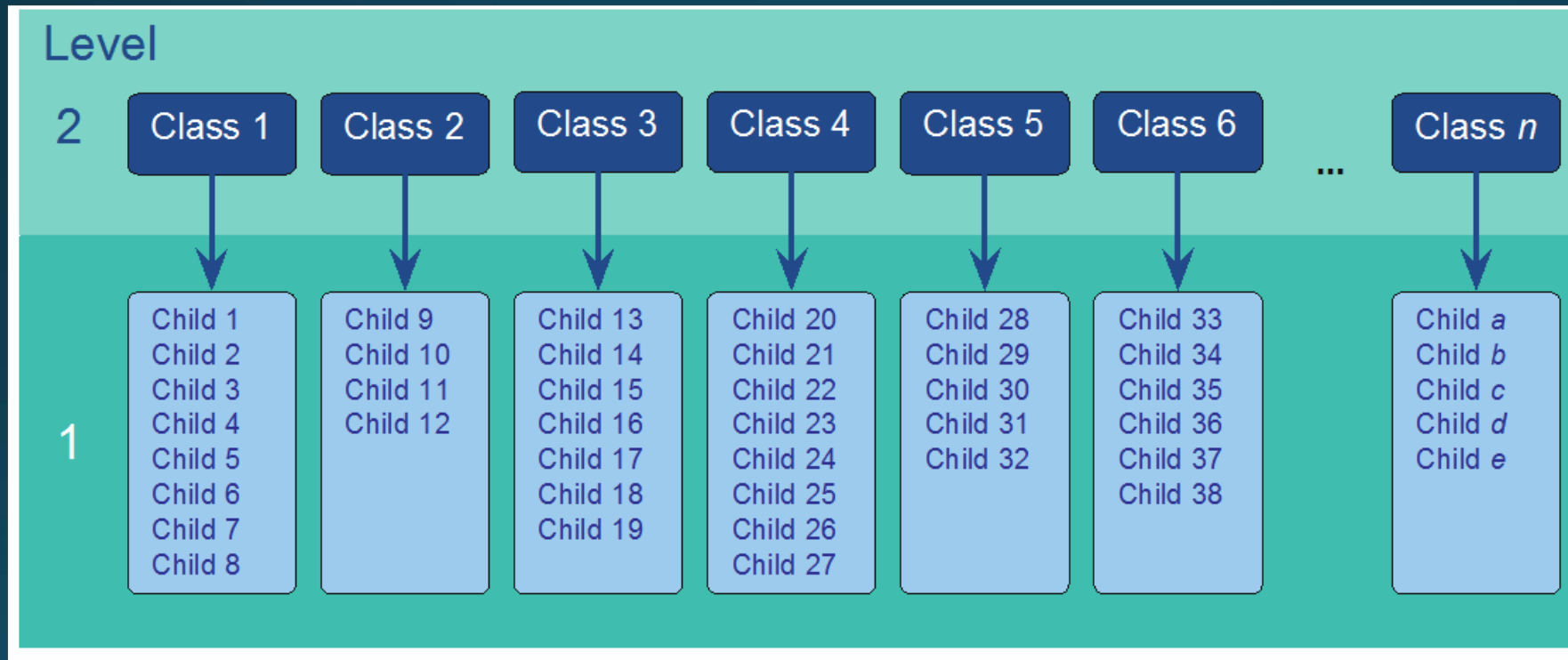
# Multi-level Analyses

- Many times in behavioral sciences, students are nested in other “levels” (not the same levels in an independent variable).
  - Think of birds in one nest, another nest, then another nest.
  - Nesting can occur in many ways
- There are now multiple sources of variance
  - That due to the students
  - That due to the teacher
  - That due to the school...etc.
- We call this Hierarchical data

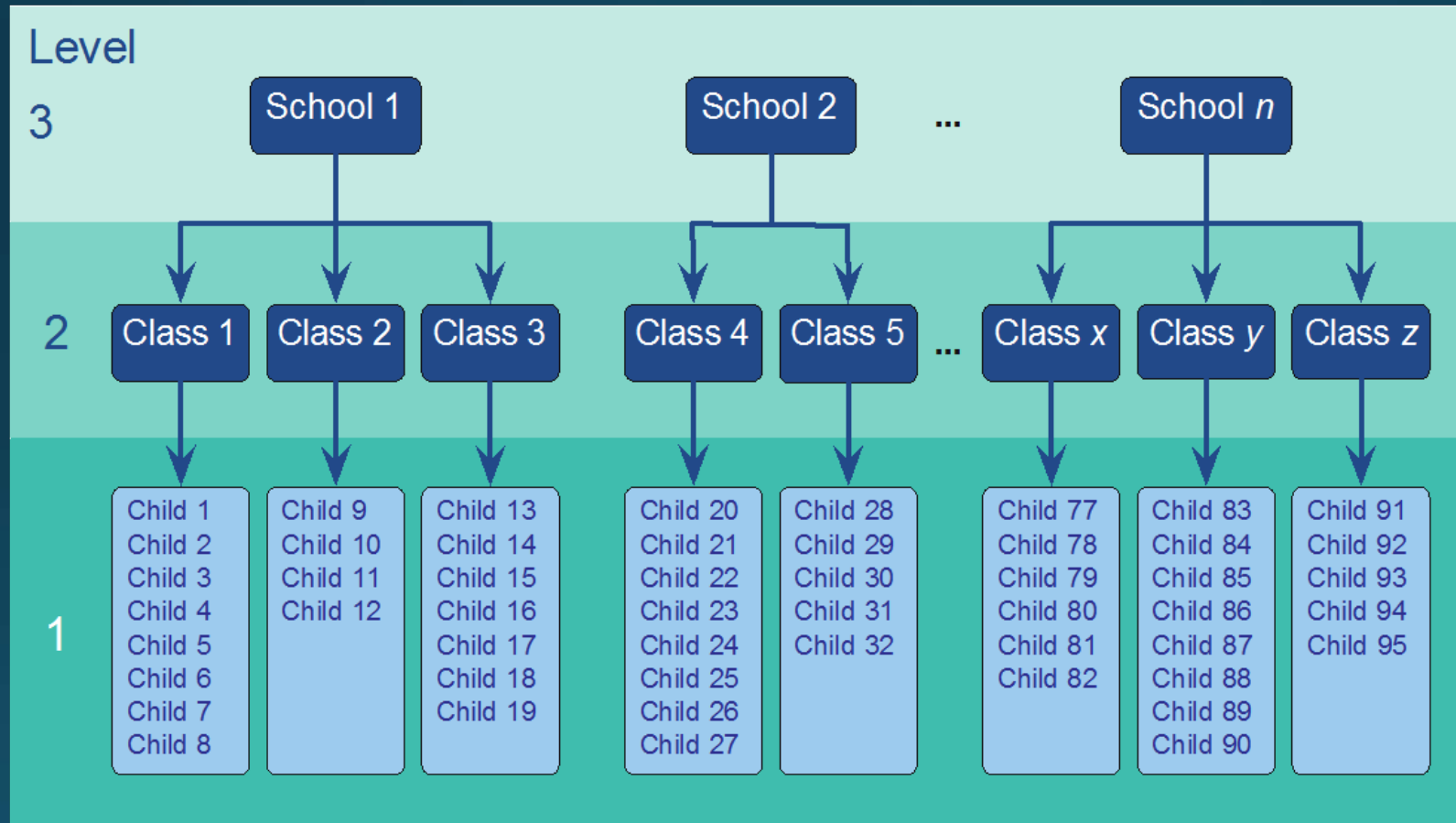
# Hierarchical Data

- Data structures are often hierarchical
- Examples:
  - Children nested within classrooms (two levels)
  - Schools nested within districts (two levels)
  - Children nested within classrooms nested within teachers (3 levels)

# Hierarchical Data: Two levels



# Hierarchical Data: Three levels



# Intraclass Correlation (ICC)

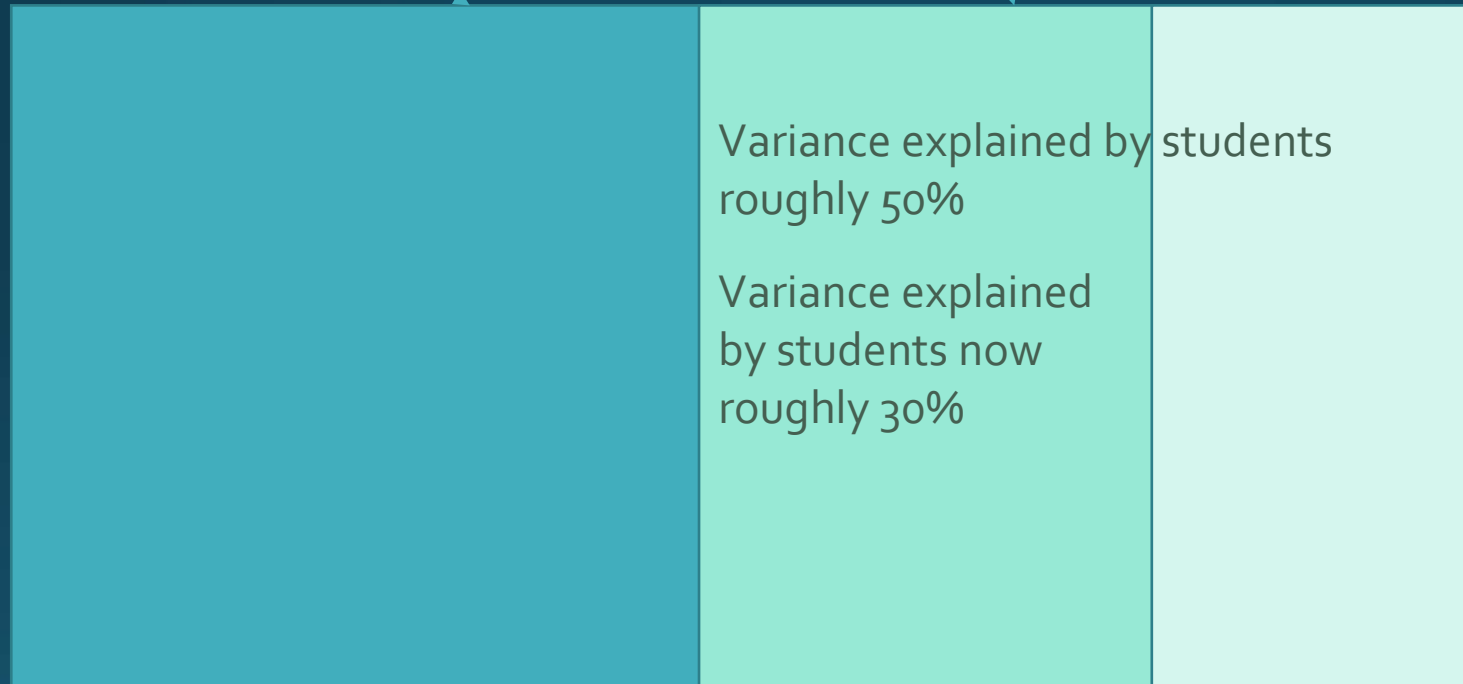
- Data from the same “nest” will typically be more similar than data from different “nest”
  - E.g. Children in the same class will perform more similarly to each other than children from different classes
  - Lack of independence
  - Creates problems in ANOVA/Regression
- The ICC measures this variability
  - E.g. the variability between classrooms
- Tells us amount of variance explained at each level
  - General rule is less than .1 (or 10%) of variance should be explained at higher levels
  - If it is higher than that, then the differences are in the teachers and not the students

# Very Simple Example

All variance on outcome

Variance explained by students

Variance explained by classrooms



# For practical applications

- Data can be hierarchical and this hierarchical structure can be important
  - Most education analyses simply ignore the hierarchy
- HLM is more conservative
- Like all statistics, there is disagreement on how and when to use HLM.
  - For example, some say you need 50 observations (teachers) at the second level before you use HLM.



# Examples of HLM in Educational Research

- Nye, B., Konstantopoulos, S., & Hedges, L. V. (2004). How large are teacher effects?. *Educational Evaluation and Policy Analysis*, 26(3), 237-257.
- Connor, C. M., Spencer, M., Day, S. L., Giuliani, S., Ingebrand, S. W., McLean, L., & Morrison, F. J. (2014). Capturing the complexity: Content, type, and amount of instruction and quality of the classroom learning environment synergistically predict third graders' vocabulary and reading comprehension outcomes. *Journal of Educational Psychology*, 106(3), 762.
- Connor, C. M., Morrison, F. J., & Petrella, J. N. (2004). Effective Reading Comprehension Instruction: Examining Child x Instruction Interactions. *Journal of Educational Psychology*, 96(4), 682.

# More Examples...

- JONES
- Simmons, D. C., Fogarty, M., Oslund, E.L., et al. (2014). Integrating content knowledge-building and student-regulated comprehension practices in secondary English language arts classes. *Journal of Research on Educational Effectiveness*, 7, 309-330. DOI: 10.1080/19345747.2013.836766
- Elleman, A. M., Olinghouse, N. G., Gilbert, J. K., Spencer, J. L., & Compton, D. L. (2017). Developing content knowledge in struggling readers: Differential effects of strategy instruction for younger and older elementary students. *The Elementary School Journal*, 118(2).

# Books for HLM

- Klein, K. J., & Kozlowski, S. W. (2000). *Multilevel theory, research, and methods in organizations: Foundations, extensions, and new directions*. Jossey-Bass.
- Raudenbush, S. W., & Bryk, A. S. (2002). *Hierarchical linear models: Applications and data analysis methods (Vol. 1)*. Sage.



# Software & Resources for HLM

- HLM: <http://www.ssicentral.com/hlm/>
- STATA (BUGS & GLLAMM): <https://www.stata.com/>
- R (JAGS): <https://www.rstudio.com/>
- Mplus: <http://www.statmodel.com/>
- SPSS - A primer for analyzing nested data: [https://ies.ed.gov/ncee/edlabs/regions/northeast/pdf/REL\\_2015046](https://ies.ed.gov/ncee/edlabs/regions/northeast/pdf/REL_2015046).
- SAS: [https://www.sas.com/en\\_us/home.html](https://www.sas.com/en_us/home.html)
- University of Texas, Comparison of Outputs: [https://stat.utexas.edu/images/SSC/Site/hlm\\_comparison-1.pdf](https://stat.utexas.edu/images/SSC/Site/hlm_comparison-1.pdf)
- University of Indiana, Estimating Multilevel Models using Stata, SAS, SPSS, & R: <http://www.indiana.edu/~statmath/stat/all/hlm/hlm.pdf>
- Free course on HLM: <http://www.cmm.bris.ac.uk/lemma/>

