Multi-level Latent Class Analysis with {MplusAutomation}

$\sim \sim \sim$

A tutorial replicating the analyses presented in Henry & Muthén (2010)

• LCA with nested data • a 2-level model with school- & student- levels •

Adam Garber

2/7/2020

Note:

- The example used in this tutorial, data about teacher discipline, is different from the example presented in Henry & Muthén (2010). This data is not currently publicly available.
- All models are estimated in `Mplus` via the R package `MplusAutomation`.

References

SOURCE CITATION: Henry, K. L., & Muthén, B. (2010). Multilevel latent class analysis: An application of adolescent smoking typologies with individual and contextual predictors. Structural Equation Modeling, 17(2), 193-215.

Hallquist, M. N., & Wiley, J. F. (2018). MplusAutomation: An R Package for Facilitating Large-Scale Latent Variable Analyses in Mplus. Structural equation modeling: a multidisciplinary journal, 25(4), 621-638.

Muthén, L.K. and Muthén, B.O. (1998-2017). Mplus User's Guide. Eighth Edition. Los Angeles, CA: Muthén & Muthén

---

Prepare & explore data

loading packages…

```
library(tidyverse)
library(haven)
library(MplusAutomation)
library(rhdf5)
```

```r
library(here)
library(glue)
library(stargazer)
library(gt)
library(janitor)
library(semPlot)
library(reshape2)
library(cowplot)
```

read spss » write csv » read csv

```r
data_spss <- read_spss(here("data", "teacher_discip_strat_data.sav")) %>%
  clean_names()

# write a CSV datafile (to remove labels)
write_csv(data_spss, here("data", "teach_discip_data.csv"))
```

read the unlabeled data back into R

```r
mlca_data <- read_csv(here("data", "teach_discip_data.csv"), na = c("9999"))
```

view labeled data (create a codebook)

```r
sjPlot::view_df(data_spss)
```

prepare data for `MplusAutomation`

```r
mlca_mplus <- mlca_data %>%
  select(-id, -districtname, -schoolname) # remove columns with strings
```

shorten names to be `<` 8 characters

```r
names(mlca_mplus) <-  str_remove(names(mlca_mplus), pattern = "itive")

mlca_mplus <- mlca_mplus %>%
  rename(pop =  population,  # Bullying is a big problem in this school
         distcode = districtcode,
         schlcode = schoolcode,
         postcode = positioncode)
```

View descriptive statistics for LCA measurement indicators

```r
lca_summary <- mlca_mplus %>%
  select(53:67)

stargazer(as.data.frame(lca_summary), header = FALSE, digits=1)
```

Table 1

Statistic	N	Mean	St. Dev.	Min	Pctl(25)	Pctl(75)	Max
pun_1	5,087	1.8	0.5	1.0	2.0	2.0	4.0
pos_1	5,087	3.2	0.6	1.0	3.0	4.0	4.0
sel_1	5,087	3.1	0.6	1.0	3.0	3.0	4.0
pun_2	5,087	2.2	0.7	1.0	2.0	3.0	4.0
pos_2	5,087	3.0	0.6	1.0	3.0	3.0	4.0
sel_2	5,087	3.0	0.6	1.0	3.0	3.0	4.0
pun_3	5,087	1.9	0.6	1.0	2.0	2.0	4.0
pos_3	5,087	3.2	0.5	1.0	3.0	4.0	4.0
sel_3	5,087	3.1	0.6	1.0	3.0	3.0	4.0
pun_4	5,087	2.0	0.7	1.0	2.0	2.0	4.0
pos_4	5,087	3.0	0.7	1.0	3.0	3.0	4.0
sel_4	5,087	2.9	0.6	1.0	3.0	3.0	4.0
pun_5	5,087	1.7	0.6	1.0	1.0	2.0	4.0
pos_5	5,087	3.0	0.6	1.0	3.0	3.0	4.0
sel_5	5,087	3.1	0.6	1.0	3.0	3.0	4.0

Make table grouped by school (`schlcode`)

```r
# how many school clusters are there?
# length(unique(mlca_mplus$schlcode)) # 130 schools

school_summary <- mlca_mplus %>%
  group_by(schlcode) %>%
  summarize(
      mean_lvl = mean(level, na.rm = TRUE),
    mean_pun_1 = mean(pun_1, na.rm = TRUE),
    mean_pos_1 = mean(pos_1, na.rm = TRUE),
    mean_sel_1 = mean(sel_1, na.rm = TRUE),
    sample_n = n())

school_summary[1:10,] %>%
  gt()
```

schlcode	mean_lvl	mean_pun_1	mean_pos_1	mean_sel_1	sample_n
10	1	1.704545	3.545455	3.477273	44
11	1	1.482759	3.482759	3.413793	29
14	1	1.451613	3.483871	3.548387	31
16	2	1.794872	3.102564	3.000000	39
17	2	1.797101	3.260870	3.043478	69
18	3	1.871795	2.948718	2.833333	78
20	1	1.435897	3.615385	3.615385	39
21	1	1.659574	3.617021	3.319149	47
23	2	1.838710	3.096774	3.032258	31
24	3	1.825000	2.825000	2.375000	40

Note: In order to reduce estimation time for this example 7 indicators were chosen and dichotomized. For the same reason the 4-class solution was used in all MLCA models for purposes of demonstration.

convert indicators to be dichotomous

```
mlca_mplus <- mlca_mplus %>%
  mutate(
    pos_1b = case_when(
    pos_1 <  3 ~ 0,        # disagree ~ responses 1 & 2
    pos_1 >= 3 ~ 1)) %>%   # agree ~ responses 3 & 4
  mutate(
    pos_3b = case_when(
    pos_3 <  3 ~ 0,
    pos_3 >= 3 ~ 1)) %>%
  mutate(
    pos_2b = case_when(
    pos_2 <  3 ~ 0,
    pos_2 >= 3 ~ 1)) %>%
  mutate(
    pos_4b = case_when(
    pos_4 <  3 ~ 0,
    pos_4 >= 3 ~ 1)) %>%
  mutate(
    sel_5b = case_when(
    sel_5 <  3 ~ 0,
    sel_5 >= 3 ~ 1)) %>%
  mutate(
    sel_2b = case_when(
    sel_2 <  3 ~ 0,
    sel_2 >= 3 ~ 1)) %>%
  mutate(
    sel_1b = case_when(
    sel_1 <  3 ~ 0,
    sel_1 >= 3 ~ 1))


table(mlca_mplus$sel_1)
```

```
##
##    1    2    3    4
##   81  659 3190 1157
```

```
table(mlca_mplus$sel_1b)
```

```
##
##    0    1
##  740 4347
```

---

model 00: LCA enumeration (fixed effect model)

```
lca_k1_6  <- lapply(1:6, function(k) {
  lca_enum  <- mplusObject(

    TITLE = glue("C{k}_mlca_enum_demo"),

    VARIABLE =
  glue(
    "categorical = pos_1b-sel_1b;
     usevar = pos_1b-sel_1b;

     classes = c({k});"),

  ANALYSIS =
   "estimator = mlr;
    type = mixture;
    starts = 500 100;",

  MODEL = "",
  OUTPUT = "",

  PLOT =
    "type = plot3;
    series = pos_1b-sel_1b(*);",

  usevariables = colnames(mlca_mplus),
  rdata = mlca_mplus)

lca_enum_fit <- mplusModeler(lca_enum,
                            dataout=glue(here("enum_mplus", "c_{k}_mlca_enum.dat")),
                            modelout=glue(here("enum_mplus", "c_{k}_mlca_enum.inp")) ,
                            check=TRUE, run = TRUE, hashfilename = FALSE)
})
```

Read models & plot LCA $(K = 4)$

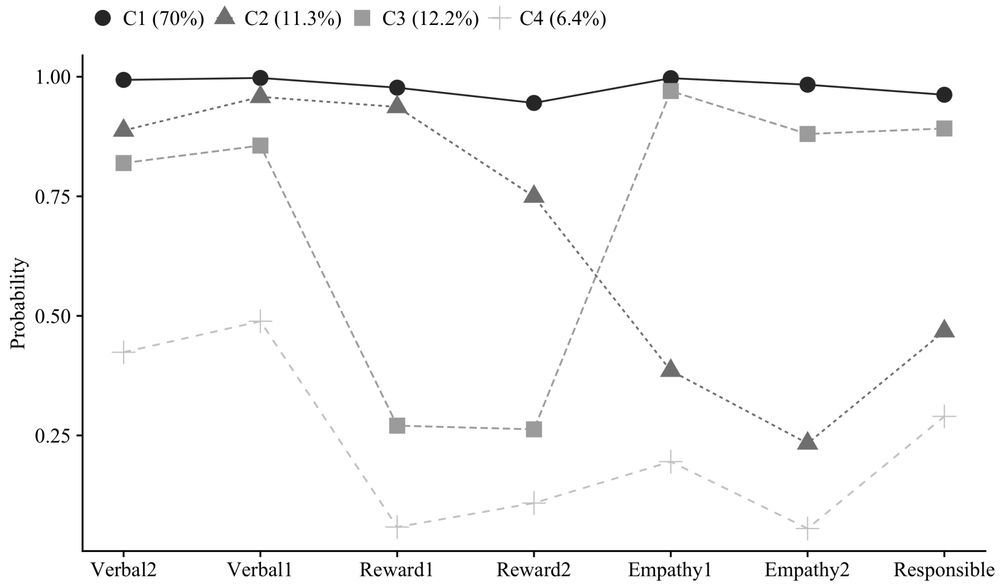
```
output_enum <- readModels(here("enum_mplus"), quiet = TRUE)


enum_summary <- LatexSummaryTable(output_enum,
                keepCols=c("Title",
                           "LL",
                           "BIC",
                           "aBIC"),
                                   sortBy = "Title")

enum_summary %>%
  gt()
```

Title	LL	BIC	aBIC
C1_mlca_enum_demo	-13867.62	27794.98	27772.73
C2_mlca_enum_demo	-11348.33	22824.67	22777.01
C3_mlca_enum_demo	-10971.08	22138.45	22065.36
C4_mlca_enum_demo	-10671.22	21607.00	21508.50
C5_mlca_enum_demo	-10628.89	21590.62	21466.69
C6_mlca_enum_demo	-10600.19	21601.50	21452.15

plot 4-class LCA probability plot

```r
# extract posterior probabilities
pp1 <- as.data.frame(output_enum[["c_4_mlca_enum.out"]]
                                [["gh5"]]
                                [["means_and_variances_data"]]
                                [["estimated_probs"]]
                                [["values"]]
                                [seq(2, 14, 2),]) #seq("from","to","by")

# extract model estimated class sizes
c_size <- as.data.frame(output_enum[["c_4_mlca_enum.out"]]
                                   [["class_counts"]]
                                   [["modelEstimated"]]
                                   [["proportion"]])

colnames(c_size) <- paste0("cs")
c_size <- c_size %>% mutate(cs = round(cs*100, 1))

colnames(pp1) <- paste0("C", 1:4, glue(" ({c_size[1:4,]}%)"))
pp1 <- cbind(Var = paste0("U", 1:7), pp1)


# choose the order of indicators & label
pp1$Var <- factor(pp1$Var,
                  levels = c("U1","U2","U3","U4","U5", "U6", "U7"),
                  labels = c("Verbal2", "Verbal1", "Reward1", "Reward2",
                             "Empathy1","Empathy2", "Responsible"))

pd_long <- melt(pp1, id.vars = "Var")

# plot data
ggplot(pd_long, aes(as.integer(Var), value, shape = variable,
                    colour = variable, lty = variable)) +
  geom_point(size = 4) + geom_line() +
  scale_x_continuous("", breaks = 1:7, labels = pp1$Var) +
  scale_y_continuous("Probability") +
  scale_colour_grey() +
  theme_cowplot() +
  theme(text=element_text(family="Times New Roman", size=12),
        legend.key.width = unit(.5, "line"),
        legend.text = element_text(family="Times New Roman", size=12),
        legend.title = element_blank(),
        legend.position = "top")
```

```
ggsave(here("figures","C4_LCA_MLCA.png"), dpi=300, height=5, width=8, units="in")
```



---

model00: Compute intra-class correlations (type = basic; w/ analysis = TWOLEVEL;)

```
# Note: In this example the ICC's are zero because items are dichotomous

  mlca_00  <- mplusObject(

    TITLE = "model00_basic__ICC_mlca",

    VARIABLE =
    "usevar = pos_1b-sel_1b;

     cluster = schlcode;
     within = pos_1b-sel_1b;",

  ANALYSIS =
   "estimator = mlr;
    type = basic twolevel; ! ask for ICC curves
    processors = 10;",

  MODEL = "",

  OUTPUT = "sampstat;",

  PLOT = "",
  usevariables = colnames(mlca_mplus),
  rdata = mlca_mplus)

mlca_00_fit <- mplusModeler(mlca_00,
                            dataout=here("mlca_mplus", "model00_basic.dat"),
                            modelout=here("mlca_mplus", "model00_basic.inp"),
                            check=TRUE, run = TRUE, hashfilename = FALSE)
```

Compare Multi-level parametric & non-parametric models described in Henry & Muthen (2010)

---

model01: parametric random effects model (4-class)

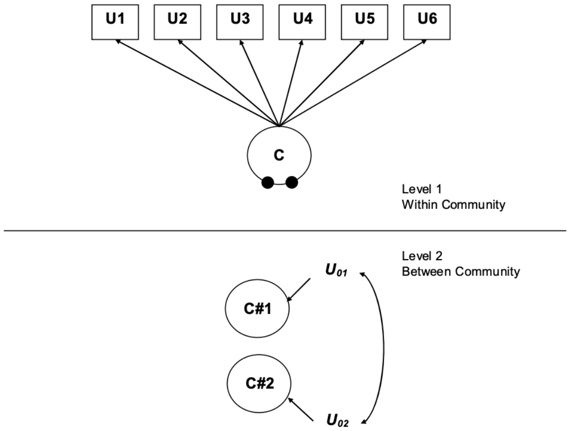


Figure 1. Picture adapted from, Henry & Muthen 2010

```
# warning, run-time is very slow

  mlca_01  <- mplusObject(

    TITLE = "model01_parametric_mlca",

    VARIABLE =
    "usevar = pos_1b-sel_1b;
     categorical = pos_1b-sel_1b;
     classes = c(4);

     cluster = schlcode;      ! level 2 units are schools
     within = pos_1b-sel_1b;",

  ANALYSIS =
   "estimator = mlr;
    type = mixture twolevel;
    integration=montecarlo(1000);
    starts = 100 50;
    processors = 10;",

  MODEL =
    "%WITHIN%
     %OVERALL%

     %BETWEEN%
     %OVERALL%
     C#1;
     C#2;
     C#3;
     C#1 WITH C#2;
     C#3 WITH C#1 C#2; ",

  OUTPUT = "TECH8;",

  PLOT =
    "type = plot3;
    series = pos_1b-sel_1b(*);",

  usevariables = colnames(mlca_mplus),
  rdata = mlca_mplus)

mlca_01_fit <- mplusModeler(mlca_01,
                            dataout=here("mlca_mplus", "model01_parametric.dat"),
                            modelout=here("mlca_mplus", "model01_parametric.inp"),
                            check=TRUE, run = FALSE, hashfilename = FALSE)
```

model02: parametric model with 2nd level factor

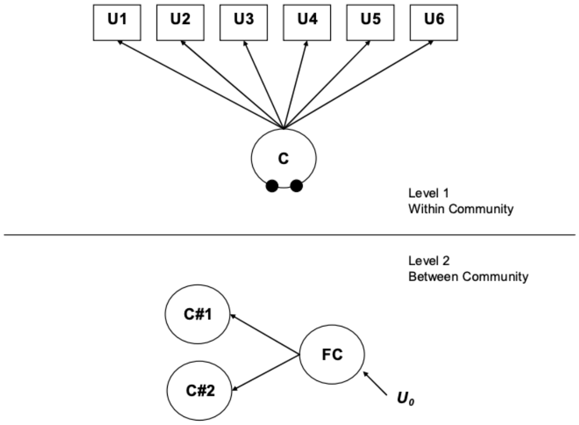


Figure 2. Picture adapted from, Henry & Muthen 2010

```
  mlca_02  <- mplusObject(

    TITLE = "model02_parametric_mlca",

    VARIABLE =
    "usevar = pos_1b-sel_1b;
     categorical = pos_1b-sel_1b;
     classes = c(4);

     cluster = schlcode;      ! level 2 units are schools
     within = pos_1b-sel_1b;",

  ANALYSIS =
   "estimator = mlr;
    type = mixture twolevel;
    starts = 20 10;
    processors = 10;",

  MODEL =
    "%WITHIN%
     %OVERALL%

     %BETWEEN%
     %OVERALL%
     FC by C#1 C#2 C#3;",

  OUTPUT = "TECH8;",

  PLOT =
    "type = plot3;
    series = pos_1b-sel_1b(*);",

  usevariables = colnames(mlca_mplus),
  rdata = mlca_mplus)

mlca_02_fit <- mplusModeler(mlca_02,
                            dataout=here("mlca_mplus", "model02_parametric.dat"),
                            modelout=here("mlca_mplus", "model02_parametric.inp"),
                            check=TRUE, run = FALSE, hashfilename = FALSE)
```

model03: non-parametric model

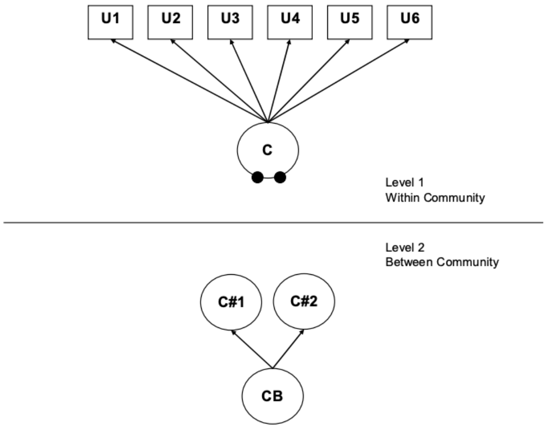


Figure 3. Picture adapted from, Henry & Muthen 2010

```
mlca_03  <- mplusObject(

  TITLE = "model03_non_parametric_mlca",

  VARIABLE =
  "usevar = pos_1b-sel_1b;
   categorical = pos_1b-sel_1b;
   classes = CB(3) c(4);

   cluster = schlcode;      ! level 2 units are schools
   within = pos_1b-sel_1b;
   between = CB;",

ANALYSIS =
 "estimator = mlr;
  type = mixture twolevel;
  starts = 20 10;
  processors = 10;",

MODEL =
  "%WITHIN%
   %OVERALL%

   %BETWEEN%
   %OVERALL%
   C on CB;

   MODEL C:
   %WITHIN%
   %C#1%
   [pos_1b$1-sel_1b$1];
```

```
     %C#2%
     [pos_1b$1-sel_1b$1];
     %C#3%
     [pos_1b$1-sel_1b$1];
     %C#4%
     [pos_1b$1-sel_1b$1]; ",

  OUTPUT = "TECH8;",

  PLOT =
    "type = plot3;
    series = pos_1b-sel_1b(*);",

  usevariables = colnames(mlca_mplus),
  rdata = mlca_mplus)

mlca_03_fit <- mplusModeler(mlca_03,
                            dataout=here("mlca_mplus", "model03_non_parametric.dat"),
                            modelout=here("mlca_mplus", "model03_non_parametric.inp"),
                            check=TRUE, run = FALSE, hashfilename = FALSE)
```

model04: parametric model with 2nd level factor on random latent class indicators

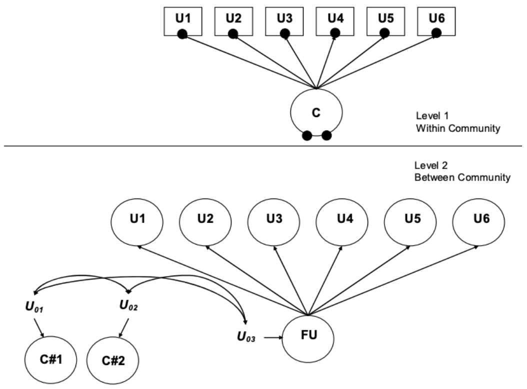


Figure 4. Picture adapted from, Henry & Muthen 2010

```
  mlca_04  <- mplusObject(

    TITLE = "model04_parametric_mlca",

    VARIABLE =
    "usevar = pos_1b-sel_1b;
     categorical = pos_1b-sel_1b;
     classes = c(4);

     cluster = schlcode; ",
  ANALYSIS =
   "estimator = mlr;
    type = mixture twolevel;
    starts = 20 10;
    processors = 10;",

  MODEL =
    "%WITHIN%
     %OVERALL%

     %BETWEEN%
     %OVERALL%
     FU by pos_1b-sel_1b;
     [FU@0];
     FU WITH C#1 C#2 C#3;
     C#1;
     C#2;
     C#3;
     C#1 WITH C#2;
     C#3 WITH C#1 C#2;

     %C#1%
     [pos_1b$1-sel_1b$1];
     %C#2%
     [pos_1b$1-sel_1b$1];
     %C#3%
     [pos_1b$1-sel_1b$1];
     %C#4%
     [pos_1b$1-sel_1b$1]; ",

  OUTPUT = "TECH8;",

  PLOT =
    "type = plot3;
    series = pos_1b-sel_1b(*);",

  usevariables = colnames(mlca_mplus),
  rdata = mlca_mplus)

mlca_04_fit <- mplusModeler(mlca_04,
                            dataout=here("mlca_mplus", "model04_parametric.dat"),
                            modelout=here("mlca_mplus", "model04_parametric.inp"),
                            check=TRUE, run = F, hashfilename = FALSE)
```

model05: parametric model with 2nd level factor on random latent class intercepts & 2nd level factor on random latent class indicators

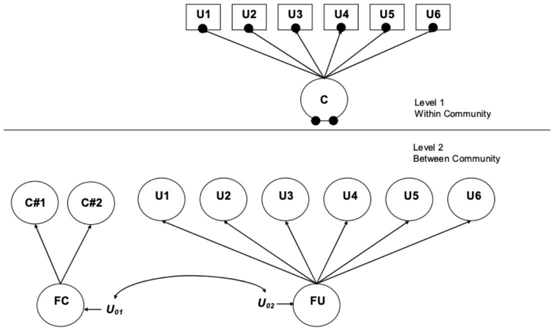


Figure 5. Picture adapted from, Henry & Muthen 2010

```
mlca_05  <- mplusObject(

  TITLE = "model05_parametric_mlca",

  VARIABLE =
  "usevar = pos_1b-sel_1b;
   categorical = pos_1b-sel_1b;
   classes = c(4);

   cluster = schlcode; ",

ANALYSIS =
 "estimator = mlr;
  type = mixture twolevel;
  starts = 20 10;
  processors = 10;",

MODEL =
  "%WITHIN%
   %OVERALL%

   %BETWEEN%
   %OVERALL%
   FU by pos_1b-sel_1b;
   [FU@0];
   FC BY C#1 C#2 C#3;
   FC WITH FU;

   %C#1%
   [pos_1b$1-sel_1b$1];
   %C#2%
   [pos_1b$1-sel_1b$1];
   %C#3%
```

```
     [pos_1b$1-sel_1b$1];
     %C#4%
     [pos_1b$1-sel_1b$1]; ",

  OUTPUT = "TECH8;",

  PLOT =
    "type = plot3;
    series = pos_1b-sel_1b(*);",

  usevariables = colnames(mlca_mplus),
  rdata = mlca_mplus)

mlca_05_fit <- mplusModeler(mlca_05,
                            dataout=here("mlca_mplus", "model05_parametric.dat"),
                            modelout=here("mlca_mplus", "model05_parametric.inp"),
                            check=TRUE, run = F, hashfilename = FALSE)
```

---

model06: non-parametric model with level-2 factor on latent class indicators

---

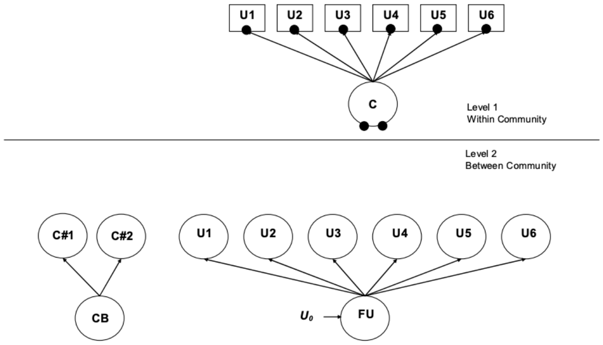


Figure 6. Picture adapted from, Henry & Muthen 2010

```
  mlca_06  <- mplusObject(

    TITLE = "model06_non_parametric_mlca",

    VARIABLE =
    "usevar = pos_1b-sel_1b;
     categorical = pos_1b-sel_1b;
     classes = CB(2) c(4);

     cluster = schlcode;      ! level 2 units are schools
     between = CB;",

  ANALYSIS =
   "estimator = mlr;
    type = mixture twolevel;
    starts = 20 10;
    processors = 10;",

  MODEL =
    "%WITHIN%
     %OVERALL%

     %BETWEEN%
     %OVERALL%
     FU BY pos_1b-sel_1b;
     [FU@0];
     C on CB;

     MODEL CB:
     %BETWEEN%
     %CB#1%
     [FU@0];
     %CB#2%
     [FU];

     MODEL C:
     %BETWEEN%
     %C#1%
     [pos_1b$1-sel_1b$1];
     %C#2%
     [pos_1b$1-sel_1b$1];
     %C#3%
     [pos_1b$1-sel_1b$1];
     %C#4%
     [pos_1b$1-sel_1b$1]; ",

  OUTPUT = "TECH8;",

  PLOT =
    "type = plot3;
    series = pos_1b-sel_1b(*);",

  usevariables = colnames(mlca_mplus),
  rdata = mlca_mplus)

mlca_06_fit <- mplusModeler(mlca_06,
                            dataout=here("mlca_mplus", "model06_non_parametric.dat"),
                            modelout=here("mlca_mplus", "model06_non_parametric.inp"),
                            check=TRUE, run = FALSE, hashfilename = FALSE)
```

---

model07: parametric model with 2nd level factor on random latent class intercepts & 2nd level factor on random latent class indicators

Auxiliaries: one individual-level covariate & two school-level covariates

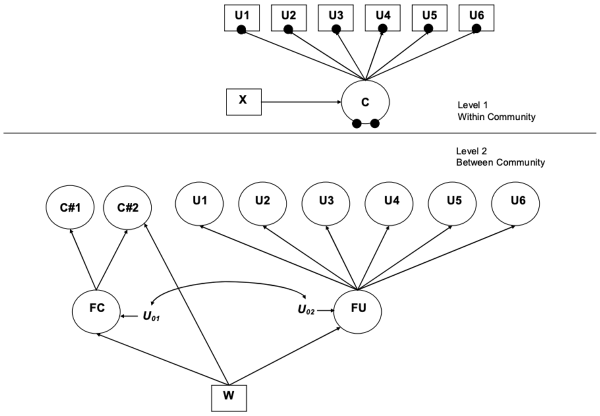


Figure 7. Picture adapted from, Henry & Muthen 2010

school-level covariates

```
# table(mlca_mplus$level)    # 2836 elementary school students
# table(mlca_mplus$d_middle) # 1174 middle school students
# table(mlca_mplus$d_high)   # 1084 high-school students
```

```
  mlca_07  <- mplusObject(

    TITLE = "model07_parametric_mlca",

    VARIABLE =
    "usevar = pos_1b-sel_1b d_middle d_high d_female;
     categorical = pos_1b-sel_1b;
     classes = c(4);

     cluster = schlcode;
     between = d_middle d_high;
      within = d_female;
    ",

  ANALYSIS =
   "estimator = mlr;
    algorithm = integration;
    type = mixture twolevel;
    starts = 20 10;
    processors = 10;",

  MODEL =
    "%WITHIN%
     %OVERALL%
     C#1-C#3 on d_female;

     %BETWEEN%
     %OVERALL%
     FU BY pos_1b@1;
     FU BY pos_3b (F_pos_3b);
     FU BY pos_2b (F_pos_2b);
     FU BY pos_4b (F_pos_4b);
     FU BY sel_5b (F_sel_5b);
     FU BY sel_2b (F_sel_2b);
     FU BY sel_1b (F_sel_1b);

     [FU@0];
     FC BY C#1 (FC_C1);
     FC BY C#2 (FC_C2);
     FC BY C#3 (FC_C3);
     FU WITH FC;

     C#2 ON d_middle (C2_mid);
     C#2 ON d_high   (C2_hs);

     FC ON d_middle (FC_mid);
     FC ON d_high   (FC_hs);
     FU ON d_middle (FU_mid);
     FU ON d_high   (FU_hs);

     %C#1%
     [pos_1b$1-sel_1b$1];
     %C#2%
     [pos_1b$1-sel_1b$1];
     %C#3%
     [pos_1b$1-sel_1b$1];
     %C#4%
     [pos_1b$1-sel_1b$1]; ",

  MODELCONSTRAINT =
    "NEW(MID_EV MID_pos3 MID_pos2 MID_pos4 MID_sel5 MID_sel2 MID_sel1
     HS_EV HS_pos3 HS_pos2 HS_pos4 HS_sel5 HS_sel2 HS_sel1
     C2_MIDSC C2_HIGHS);

       MID_EV = FU_mid;
     MID_pos3 = FU_mid*F_pos_3b;
     MID_pos2 = FU_mid*F_pos_2b;
     MID_pos4 = FU_mid*F_pos_4b;
     MID_sel5 = FU_mid*F_sel_5b;
     MID_sel2 = FU_mid*F_sel_2b;
     MID_sel1 = FU_mid*F_sel_1b;

       HS_EV = FU_hs;
     HS_pos3 = FU_hs*F_pos_3b;
     HS_pos2 = FU_hs*F_pos_2b;
     HS_pos4 = FU_hs*F_pos_4b;
     HS_sel5 = FU_hs*F_sel_5b;
     HS_sel2 = FU_hs*F_sel_2b;
     HS_sel1 = FU_hs*F_sel_1b;

     C2_MIDSC = (FC_mid*FC_C2)+C2_mid;
     C2_HIGHS = (FC_hs*FC_C2)+C2_hs;",

  OUTPUT = "TECH8;",
  PLOT =
    "type = plot3;
    series = pos_1b-sel_1b(*);",

  usevariables = colnames(mlca_mplus),
  rdata = mlca_mplus)

mlca_07_fit <- mplusModeler(mlca_07,
                            dataout=here("mlca_mplus", "model07_parametric.dat"),
                            modelout=here("mlca_mplus", "model07_parametric.inp"),
                            check=TRUE, run = F, hashfilename = FALSE)
```

Table of model fit

```
output_mlca <- readModels(here("mlca_out"), quiet = TRUE)

mlca_summary <- LatexSummaryTable(output_mlca,
                keepCols=c("Title",
                           "Parameters",
                           "LL",
                           "BIC",
                           "aBIC"),
                                   sortBy = "Title")

mlca_summary %>%
  gt()
```

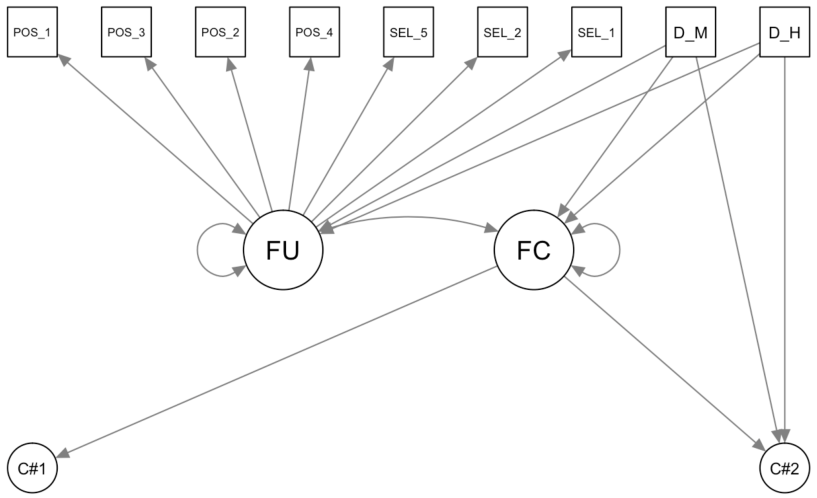
Title	Parameters	LL	BIC	aBIC
model01_parametric_mlca	37	-9928.028	20171.83	20054.26
model02_parametric_mlca	34	-10025.484	20341.14	20233.10
model03_non_parametric_mlca	39	-10018.788	20370.42	20246.49
model05_parametric_mlca	42	-9832.084	20022.62	19889.15
model06_non_parametric_mlca	43	-9847.624	20062.23	19925.59
model07_parametric_mlca	51	-9768.308	19971.87	19809.81

---

create a path diagram of the final model

```
# Read in the model to R
final_model <- readModels(here("mlca_out", "model07_par_covs.out"), quiet = TRUE)

# Plot model:
semPaths(final_model,
         intercepts=FALSE,
         fixedStyle = c(1))
```

Between


POS_1
POS_3
POS_2
POS_4
SEL_5
SEL_2
SEL_1
D_M
D_H
FU
FC
C#1
C#2