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“There are 3 kinds of people…”

How to use latent class methods
to understand subgroup differences in evaluation

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Latent Class Analysis Demonstration AEA 2015

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Roadmap

1. Introduce Latent Class Analysis (LCA)
2. Illustrate how LCA works in practice
3. Demonstrate how to conduct an LCA
4. Questions?
5. Take away messages

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“Hi! I’m Latent Class Analysis.
You can call me LCA.”



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LCA is

a statistical method…

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LCA is

a statistical method

for using multivariate data…

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LCA is

a statistical method

for using multivariate data

to empirically identify
subgroups within a population.

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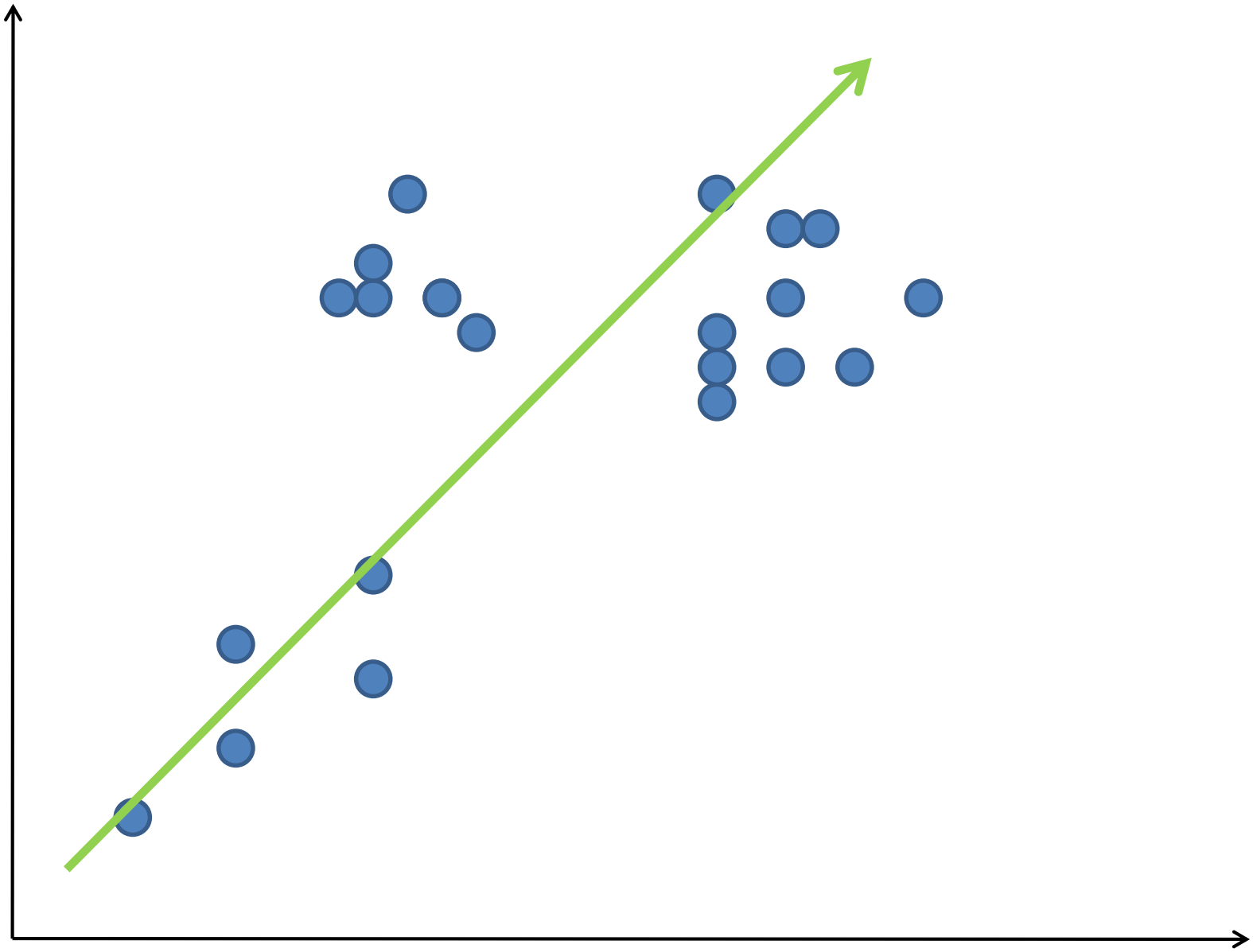
People in a subgroup

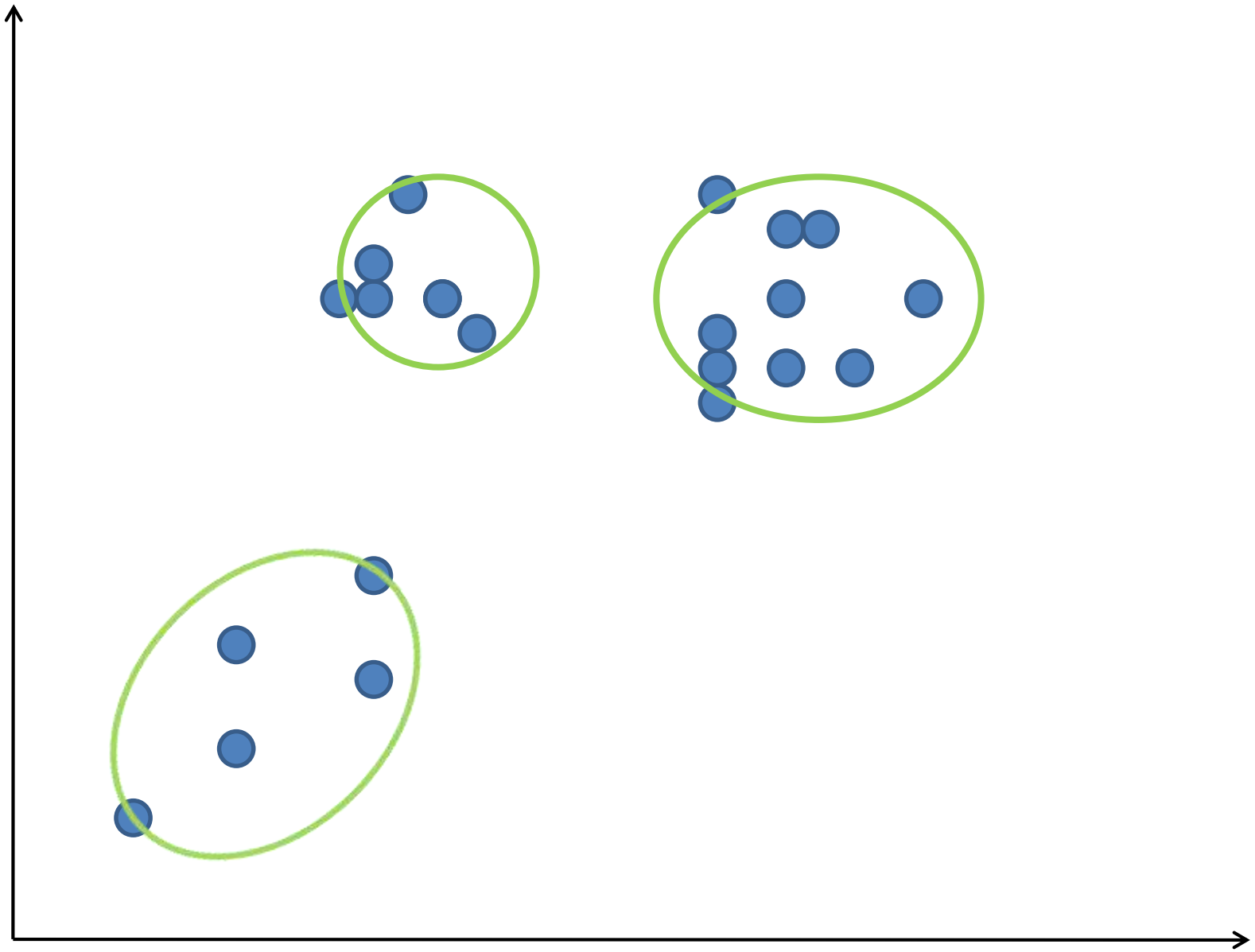
are like each other
(in terms of their responses on a set of variables)
and different from people in other groups.

SUBGROUP = LATENT CLASS = PROFILE

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LCA can help us

understand how multiple factors combine

to produce different “types” of people

with regard to our interest.

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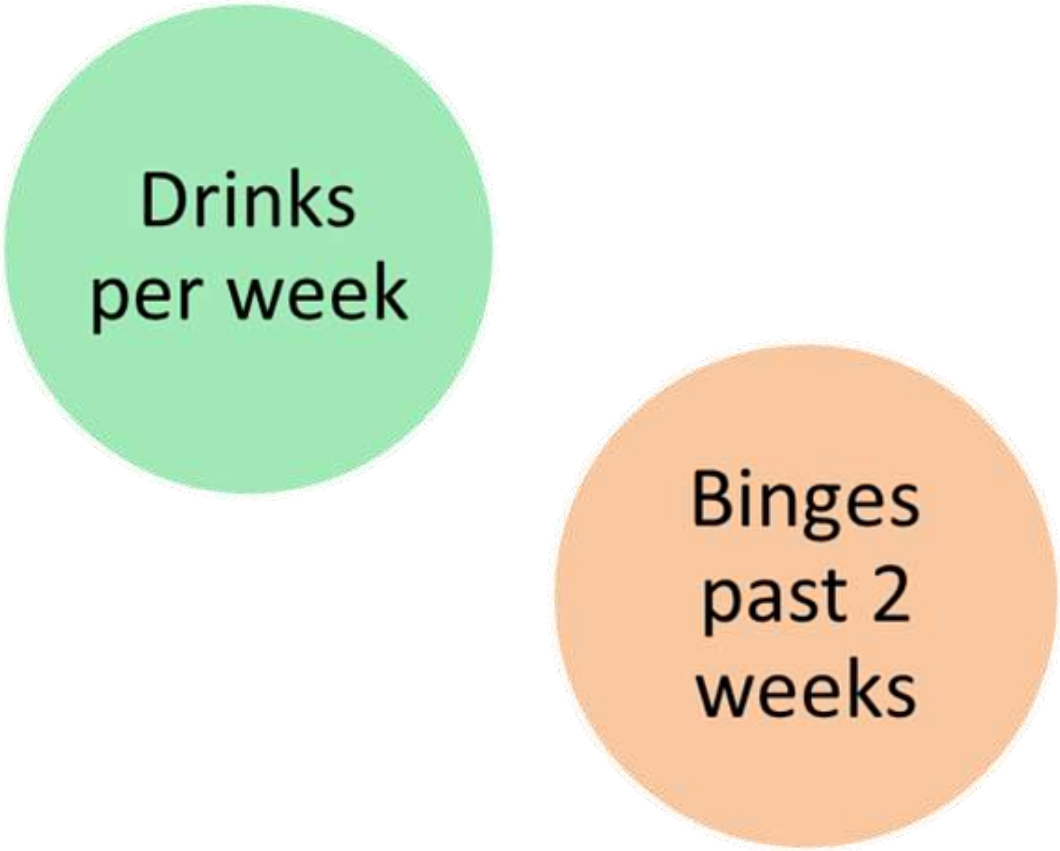
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Practice illustration: College student drinking

What's the best way to understand how a college student drinks?



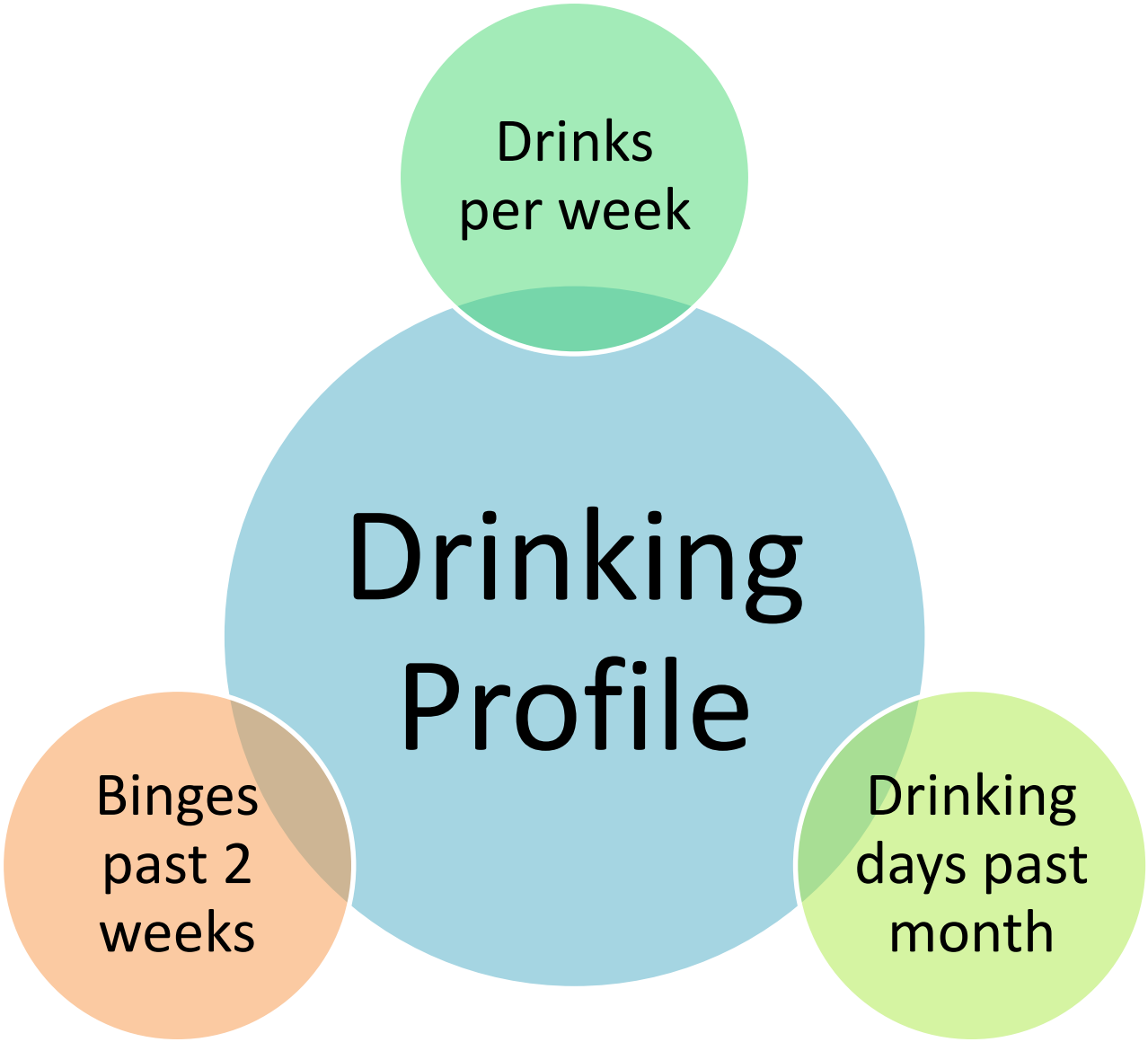
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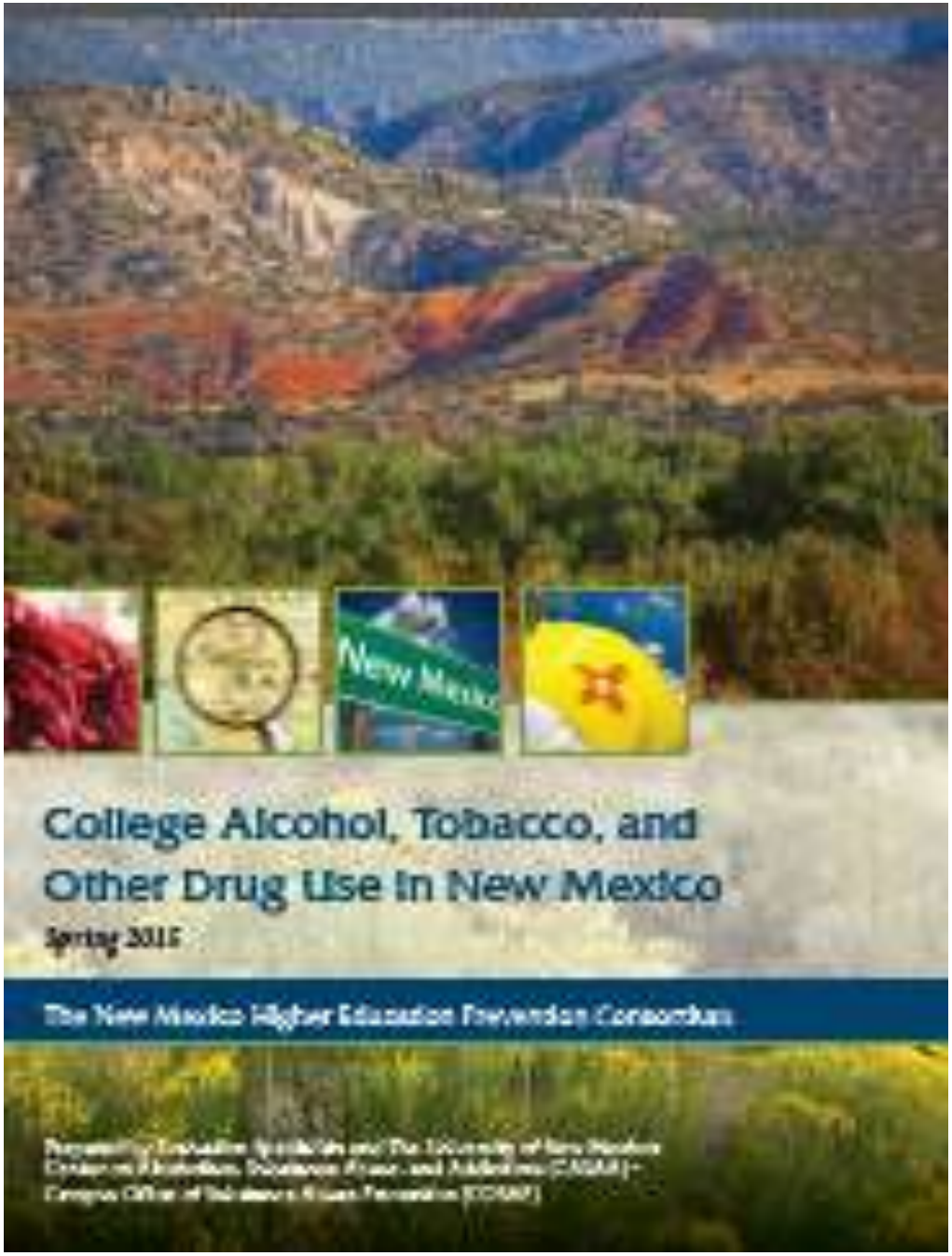


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College Alcohol, Tobacco, and
Other Drug Use in New Mexico
Spring 2015
The New Mexico Higher Education Prevention Consortium

College student drinking LCA

- 6 New Mexico colleges
- Survey of student drinking behavior (2015)
- 2702 participants
- 18 to 40 years old
- Men and women analyzed separately

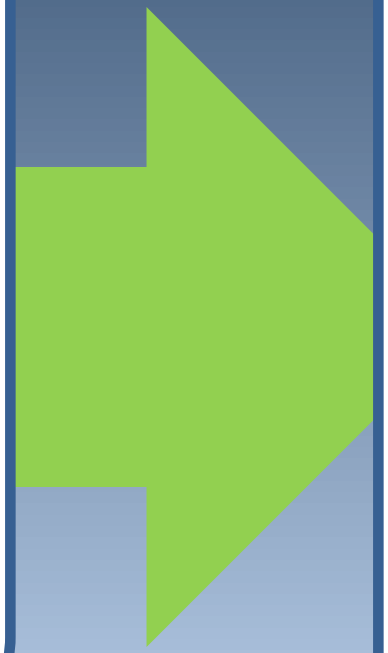
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College Women's Drinking Profiles

VARIABLES

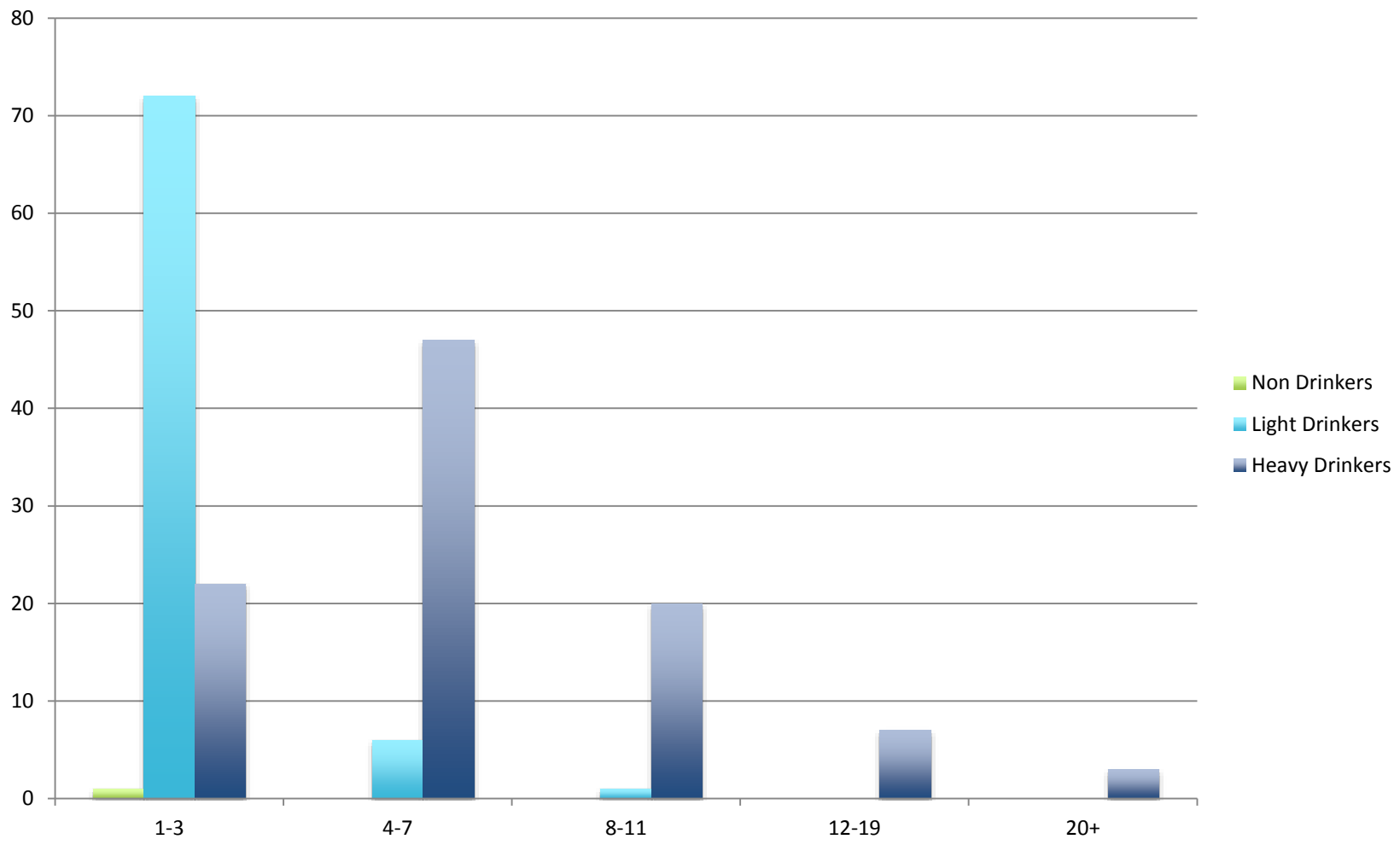
- Drinks per week
- Binges past 2 weeks
- Drinking days past month



PROFILES

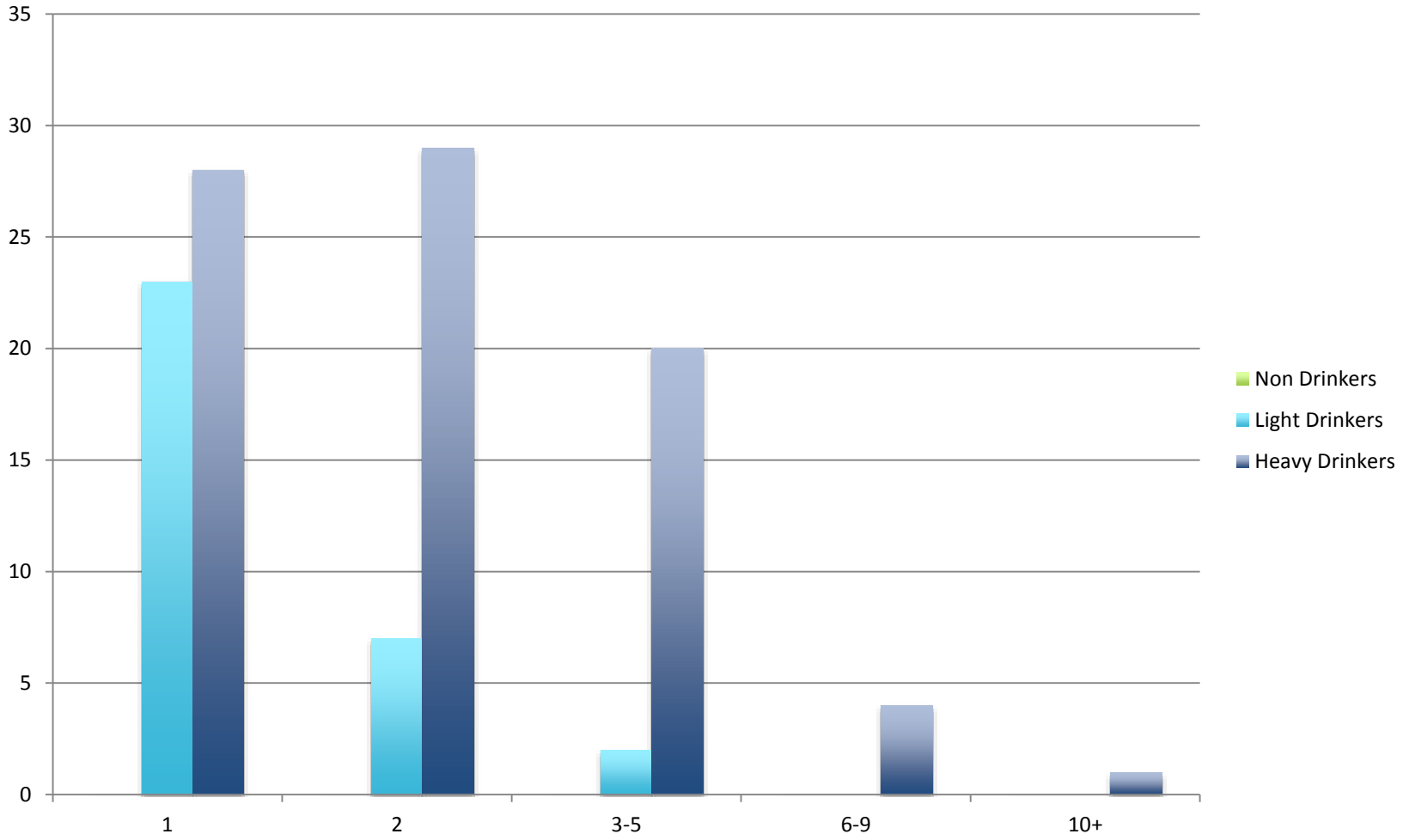
- Nondrinkers
- Light Drinkers
- Heavy Drinkers

Drinks per week (average)



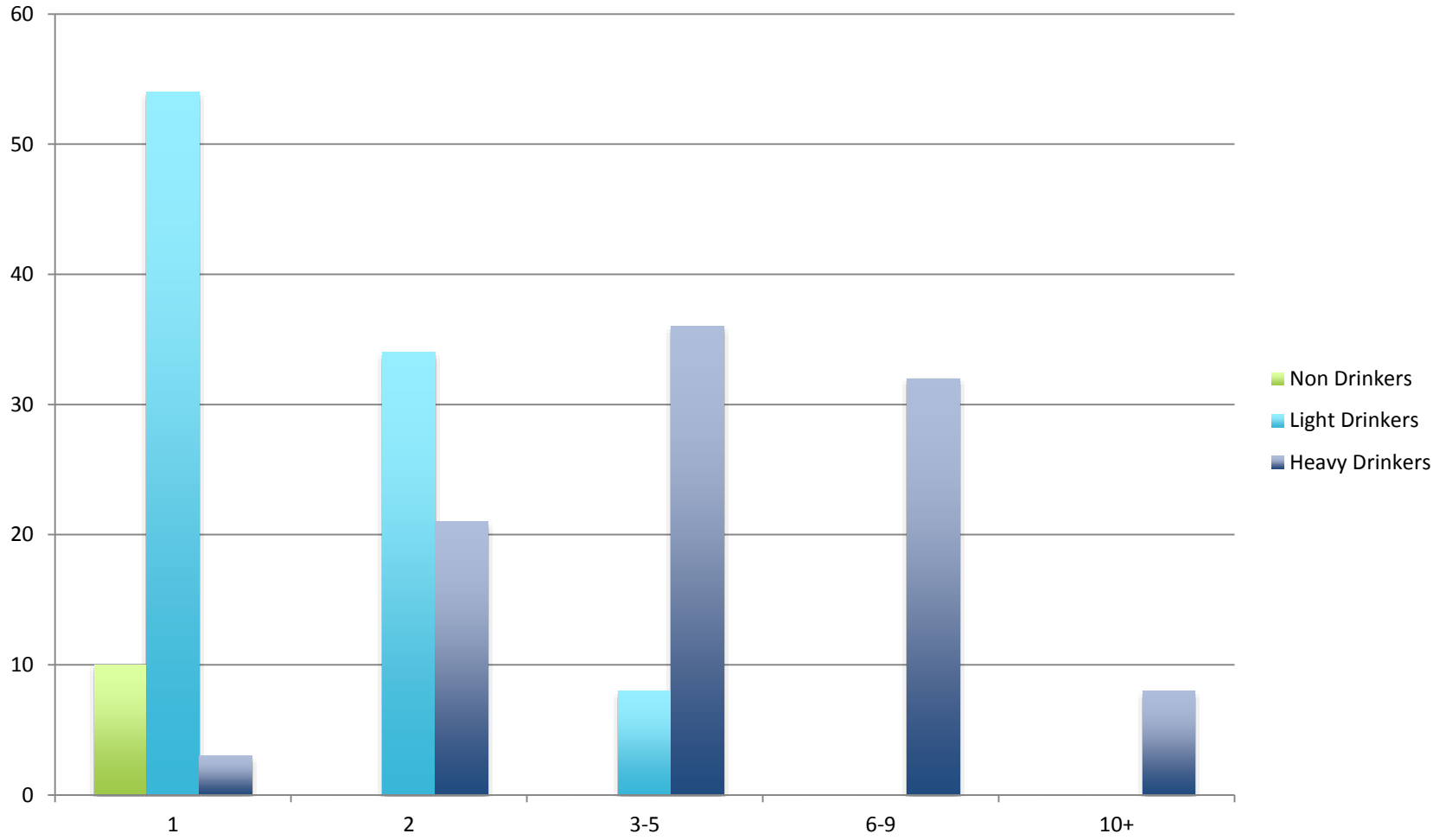
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Binges past 2 weeks



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Drinking days in past month



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How do you do it?

Steps in an LCA

1. Start with your concept
2. Explore and prepare data
3. Export data to Mplus
4. Run LCAs for 2 to 6 (or so) classes
5. Compare fit indices for all models…
6. …and select best fitting one
7. Describe the subgroups produced
8. Test groups' associations with "outcome" variables

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LCA software

Mplus

- Powerful
- Great resources for learning and using

BUT

- Expensive
- Steep learning curve

Other mixture modeling software

- Latent Gold
- SAS (needs “PROC LCA” module)

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Start with your concept

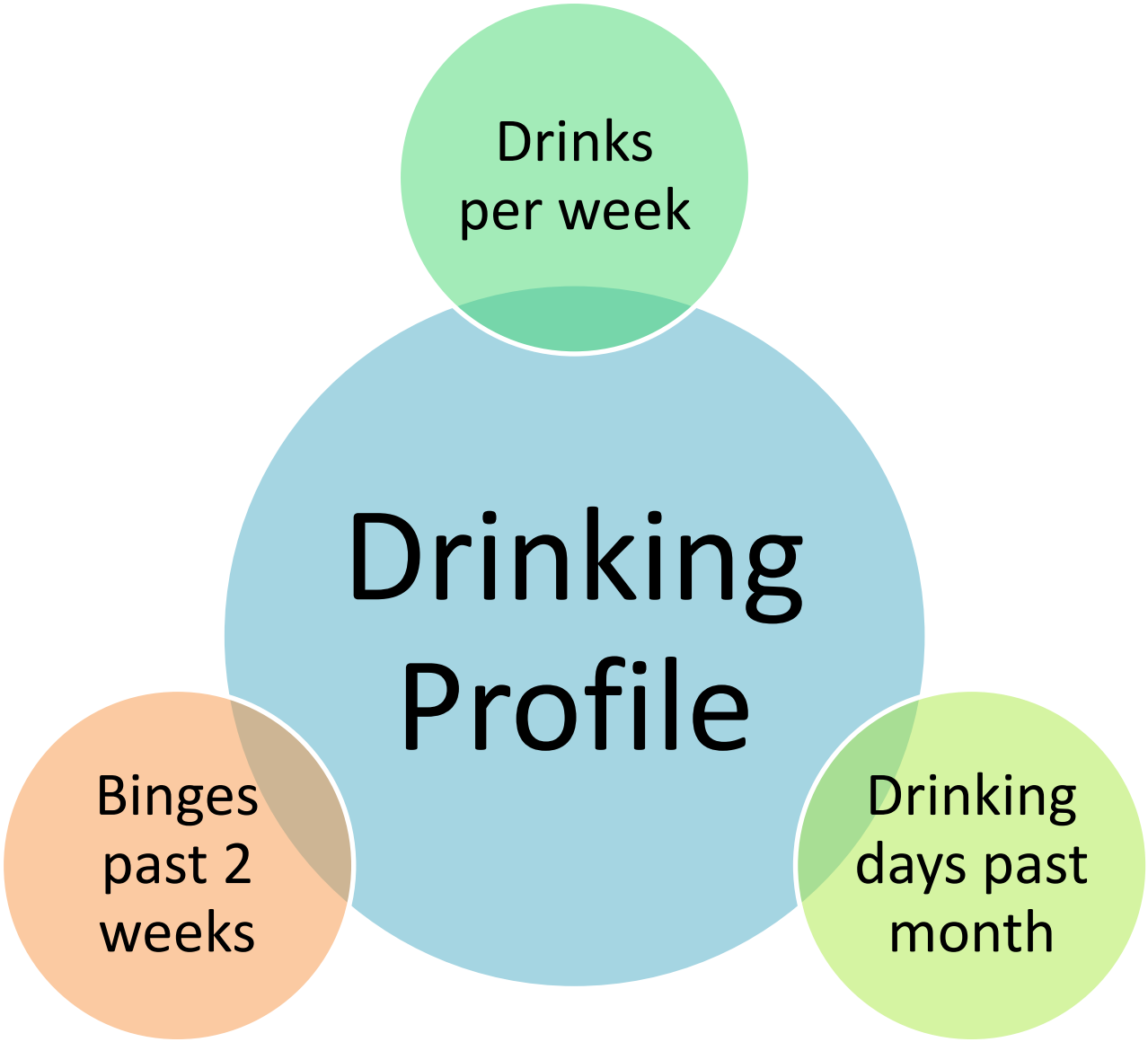
Variables in an LCA should be

- Conceptually related…
- …and thus also correlated (check!)
- Do you expect interesting patterns?

Enough, but not too many

- Three minimum to be interesting
- Six probably maximum
- Can you understand what variable patterns mean?

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Explore and prepare data

- Use SPSS
- Correlations
- Frequencies
  - “bald spots” in distributions?
  - Categories more meaningful than means?
- Missing data patterns to recode?
- Other recoding needed?
- Descriptives to check data export

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SPSS Syntax

```
FREQUENCIES VARIABLES
q8_self_drinks_week
q10_num_binges
q11b_alcohol_30d.

CORRELATIONS
  /VARIABLES=q8_self_drinks_week
q10_num_binges q11b_alcohol_30d
  /PRINT=TWOTAIL NOSIG
  /STATISTICS DESCRIPTIVES
  /MISSING=LISTWISE.
```

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Ugly SPSS Output

Correlations[a]

		q8_self_drinks_week 8. Average number of drinks you consume in a week?	q10_num_binges 10. Think back over the past 2 weeks. How many times have you had five or more drinks at a sitting?	q11b_alcohol_30d 11b. During the past 30 days on how many days did you have: alcohol
q8_self_drinks_week 8. Average number of drinks you consume in a week?	Pearson Correlation	1	.632**	.602**
	Sig. (2-tailed)		.000	.000
q10_num_binges 10. Think back over the past 2 weeks. How many times have you had five or more drinks at a sitting?	Pearson Correlation	.632**	1	.652**
	Sig. (2-tailed)	.000		.000
q11b_alcohol_30d 11b. During the past 30 days on how many days did you have: alcohol	Pearson Correlation	.602**	.652**	1
	Sig. (2-tailed)	.000	.000	

**. Correlation is significant at the 0.01 level (2-tailed).
a. Listwise N=2610

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q8_self_drinks_week 8. Average number of drinks you consume in a week?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	1403	51.9	53.2	53.2
	1	316	11.7	12.0	65.2
	2	200	7.4	7.6	72.8
	3	156	5.8	5.9	78.7
	4	91	3.4	3.5	82.2
	5	108	4.0	4.1	86.3
	6	48	1.8	1.8	88.1
	7	35	1.3	1.3	89.4
	8	40	1.5	1.5	90.9
	9	11	.4	.4	91.4
	10	86	3.2	3.3	94.6
	11	3	.1	.1	94.7
	12	33	1.2	1.3	96.0
	13	3	.1	.1	96.1
	14	6	.2	.2	96.3
	15	21	.8	.8	97.1
	16	5	.2	.2	97.3
	18	7	.3	.3	97.6
	20	24	.9	.9	98.5
	71	1	.0	.0	99.9
	73	1	.0	.0	100.0
	99	1	.0	.0	100.0
	Total	2636	97.6	100.0	
Missing	System	66	2.4		
Total		2702	100.0		



More SPSS Syntax

```
********************    RECODING    ****************************.
*** LCA requires tighter distributions with no sparse spots, so you usually need to recode.

*** recode q8_self_drinks_week into 6 categories.
RECODE q8_self_drinks_week
   (0=0) (1=1) (2=1) (3=1) (4=2) (5=2) (6=2) (7=2)
   (8=3) (9=3) (10=3) (11=3) (12=4) (13=4) (14=4) (15=4) (16=4) (17=4) (18=4) (19=4) (20 thru HI=5)
INTO drnk_wk6.
VARIABLE LABELS drnk_wk6 'drinks per week, self, 6 categories'.
VALUE LABELS drnk_wk6
   0 '0 drinks' 1 '1-3 drinks' 2 '4-7 drinks' 3 '8-11 drinks' 4 '12-19 drinks' 5 '20 or more drinks'.
FREQUENCIES VARIABLES q8_self_drinks_week drnk_wk6.
```

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Export data to Mplus

- Recode all missing values to same
- Specify which variables to export
- Always (always!) export ID variable
- Save SPSS **.sav** file as an Mplus **.dat** file

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Even More SPSS Syntax

```
**********************
 make Mplus data file
**********************.

*** SET MISSING DATA FOR ALL VARIABLES TO SYSMIS.
MISSING VALUES
  drnk_wk6  q10_num_binges  alc30day  q24_gender  surveyid  DUI  poorperf
  (-99).
EXECUTE.
RECODE
   drnk_wk6  q10_num_binges  alc30day  q24_gender  surveyid  DUI  poorperf
   (SYSMIS=-99).
EXECUTE.

*** SAVE MPLUS FILE.
SAVE TRANSLATE outfile= 'C:\Users\Tatiana\Desktop\NM Colleges 2015\NM LCA
data w-outcomes.dat'
    /type=tab/map/repla
    /keep=
     drnk_wk6  q10_num_binges  alc30day  q24_gender  surveyid  DUI  poorperf.
```

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Did data read in correctly?

```
TITLE:  Check NM college data export.inp
DATA:
  FILE IS
    "NM Colleges 2015\
              NM LCA data w-outcomes.dat";
VARIABLE:
     NAMES ARE
          drnk_wk6 binge2wk alc30day
          gender surveyid weight school
          DUI poorperf;
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
     USEVARIABLES ARE
          drnk_wk6 binge2wk alc30day
          gender surveyid weight school
          DUI poorperf;
     MISSING ARE ALL (-99);
ANALYSIS:
    TYPE = BASIC;
```

Mplus (.dat) file name

Variable names in order from SPSS file – 8 characters only!

Variables to use in analysis

Missing values

To get descriptives

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Mplus Descriptives Output

```
RESULTS FOR BASIC ANALYSIS

     ESTIMATED SAMPLE STATISTICS

Means
   DRNK_WK6      BINGE2WK     ALC30DAY     GENDER       SURVEYID
   _________     _________    _________    _________    _________
     0.869         0.587        1.220        0.553      24760.609

Means
   WEIGHT      SCHOOL       DUI        POORPERF
   _______     _________    ________   _________
   24.283        3.610      0.192        0.134
```

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Now we're ready for an LCA!

Specify

- Which variables to use in model
- Whether any are categorical

Start

- With a 2-class model
- Then 3, 4, and so on (up to 5 or 6)

Compare fit of different models

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Mplus Input for LCA



`USEVARIABLES ARE` `  drnk_wk6 binge2wk alc30day;`	**LCA indicator variables**
`CLASSES = c (2);`	**Start with 2 classes, then run more**
`CATEGORICAL = drnk_wk6 binge2wk alc30day;`	**All 3 variables are categorical**
`SUBPOPULATION = gender EQ 1;`	**Use women only (n = 1493)**

`ANALYSIS:`
`  TYPE = mixture;`
`  STARTS = 10000 200;`
	LCA is a ”mixture model”
	“Start” values get the software started estimating the model

`MODEL:`	
`OUTPUT: tech11;`	**Test to help determine best-fitting model (Likelihood Ratio Test)**

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LCA requires troubleshooting…

…at nearly every step.
It doesn't mean you're doing it wrong!

Mplus "Did my model run right?" Output

```
INPUT READING TERMINATED NORMALLY

NM 2015, women, 2 class;

SUMMARY OF ANALYSIS
Number of groups                                 1
Number of observations                        1493

Final stage loglikelihood values at local maxima, seeds, and
initial stage start numbers:

          -4313.681  791132           6388
          -4313.681  791132           6507
          -4313.681  435506           988
          -4313.681  919857           4378
          -4313.681  572684           5754
          -4313.681  646335           9627
```

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Mplus "Did my model run right?" Output

```
INPUT READING TERMINATED NORMALLY

NM 2015, women, 2 class;

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          -4313.681  919857           4378
          -4313.681  572684           5754
          -4313.681  646335           9627
```

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Mplus Model Fit Output

```
FINAL CLASS COUNTS AND PROPORTIONS FOR THE LATENT
CLASSES
BASED ON THEIR MOST LIKELY LATENT CLASS MEMBERSHIP

Class Counts and Proportions
   Latent
   Classes
     1              773         0.51758
     2              720         0.48242

CLASSIFICATION QUALITY
 Entropy                         0.913

Average Latent Class Probabilities for Most Likely
Latent Class Membership (Row) by Latent Class (Column)

           1        2

    1   0.974    0.026
    2   0.017    0.983
```

2-class model

Class 1 count & proportion

Class 2 count & proportion

Over 0.80 is acceptable fit

Classification quality

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MORE Mplus Model Fit Output

```
THE MODEL ESTIMATION TERMINATED NORMALLY

MODEL FIT INFORMATION

Information Criteria

          Akaike (AIC)                       8689.362
          Bayesian (BIC)                     8853.926
          Sample-Size Adjusted BIC           8755.448
            (n* = (n + 2) / 24)


LO-MENDELL-RUBIN ADJUSTED LRT TEST
    Value                                    1675.845
    P-Value                                     0.0189
```

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Mplus Input for LCA with 3 classes

```
USEVARIABLES ARE
   drnk_wk6 binge2wk alc30day;

CLASSES = c (3);

CATEGORICAL = drnk_wk6 binge2wk alc30day;

SUBPOPULATION = gender EQ 1;

ANALYSIS:
   TYPE = mixture;
   STARTS = 10000 200;

MODEL:

OUTPUT: tech11;
```

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Assessing Model Fit

Model	BIC_{ssa}	AIC	Entropy	Class Sizes	Classification Quality	LMR
2-class	8755	8689	.91	773, 720	.97, .98	$p < .05$
3-class	8410	8310	.86	272, 749, 472	.93, .95, .92	ns
4-class	8418	8284	.84	341, 645, 292, 215	.87, .99, .81, .90	ns

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A R T

and



Model Fit Guidelines

BIC_{ssa}	AIC	Entropy	Classification Quality	LMR
Should decrease substantially from previous model Lowest often best fit	Should decrease substantially from previous model Lowest often best fit	Ranges from 0 to 1 Higher is better Over .80 is acceptable fit	Ranges from 0 to 1 Higher is better Should be over .80 for all classes	First model where LMR becomes non-significant is best fit

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So how do I choose?

Model	BIC_{ssa}	AIC	Entropy	Class Sizes	Classification Quality	LMR
2-class	8755	8689	.91	773, 720	.97, .98	$p < .05$
3-class	**8410**	**8310**	**.86**	**272, 749, 472**	**.93, .95, .92**	**ns**
4-class	8418	8284	.84	341, 645, 292, 215	.87, .99, .81, .90	ns

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MODEL RESULTS	Estimate	S.E.	Est./S.E.	Two-Tailed P-Value
Latent Class 1				
Thresholds				
DRNK_WK6$1	-5.356	1.173	-4.564	0.000
DRNK_WK6$2	-1.244	0.077	-16.188	0.000
DRNK_WK6$3	0.828	0.249	3.329	0.001

RESULTS IN PROBABILITY SCALE				
Latent Class 1				
DRNK_WK6				
Category 1	0.005	0.005	0.856	0.392
Category 2	0.219	0.014	15.334	0.000
Category 3	0.472	0.046	10.321	0.000
Category 4	0.203	0.032	6.398	0.000
Category 5	0.068	0.014	4.771	0.000
Category 6	0.033	0.015	2.283	0.022
BINGE2WK				
Category 1	0.178	0.048	3.713	0.000
Category 2	0.282	0.044	6.380	0.000
Category 3	0.287	0.027	10.690	0.000
Category 4	0.198	0.072	2.766	0.006
Category 5	0.041	0.009	4.699	0.000
Category 6	0.014	0.007	1.983	0.047
ALC30DAY				
Category 1	0.000	0.000	0.000	1.000
Category 2	0.027	0.017	1.608	0.108
Category 3	0.213	0.046	4.679	0.000
Category 4	0.356	0.042	8.414	0.000
Category 5	0.320	0.025	12.723	0.000
Category 6	0.084	0.018	4.710	0.000

MODEL RESULTS	Estimate	S.E.	Est./S.E.	Two-Tailed P-Value
Latent Class 1				
Thresholds				
DRNK_WK6$1	-5.356	1.173	-4.564	0.000
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RESULTS IN PROBABILITY SCALE				
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Category 1	0.005	0.005	0.856	0.392
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ALC30DAY				
Category 1	0.000	0.000	0.000	1.000
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Category 4	0.356	0.042	8.414	0.000
Category 5	0.320	0.025	12.723	0.000
Category 6	0.084	0.018	4.710	0.000

	Drinking subgroups			All women in sample (n = 1493)
Drinking class indicator variables	Nondrinkers (n = 749, 50%)	Light (n = 472, 31%)	**Heavy (n = 272, 18%)**	
Drinks per week				
None (0 drinks)	1.00	.21	.01	.54
1-3 drinks	.00	.72	.22	.28
4-7 drinks	.00	.06	.47	.12
8-11 drinks	.00	.01	.20	.04
12-19 drinks	.00	.00	.07	.01
20 or more drinks	.00	.00	.03	.01
Binges (5+ drinks) past 2 weeks				
None (0 binge drinking episodes)	1.00	.66	.18	.73
1 binge drinking episode	.00	.23	.28	.14
2 binge drinking episodes	.00	.07	.29	.08
3-5 binge drinking episodes	.00	.02	.20	.04
6-9 binge drinking episodes	.00	.00	.04	.01
10 or more binge drinking episodes	.00	.00	.01	.00
Drinking days out of past 30				
None (0 days)	.90	.04	.00	.44
1-2 days	.10	.54	.03	.23
3-5 days	.00	.34	.21	.15
6-9 days	.00	.08	.36	.10
10-19 days	.00	.00	.32	.06
20 or more days	.00	.00	.08	.02

	Drinking subgroups			All women in sample (n = 1493)
Drinking class indicator variables	Nondrinkers (n = 749, 50%)	Light (n = 472, 31%)	Heavy (n = 272, 18%)	
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8-11 drinks	.00	.01	.20	.04
12-19 drinks	.00	.00	.07	.01
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1 binge drinking episode	.00	.23	.28	.14
2 binge drinking episodes	.00	.07	.29	.08
3-5 binge drinking episodes	.00	.02	.20	.04
6-9 binge drinking episodes	.00	.00	.04	.01
10 or more binge drinking episodes	.00	.00	.01	.00
Drinking days out of past 30				
None (0 days)	.90	.04	.00	.44
1-2 days	.10	.54	.03	.23
3-5 days	.00	.34	.21	.15
6-9 days	.00	.08	.36	.10
10-19 days	.00	.00	.32	.06
20 or more days	.00	.00	.08	.02

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Drinks per week				
None (0 drinks)	1.00	.21	.01	.54
1-3 drinks	.00	.72	.22	.28
4-7 drinks	.00	.06	.47	.12
8-11 drinks	.00	.01	.20	.04
12-19 drinks	.00	.00	.07	.01
20 or more drinks	.00	.00	.03	.01
Binges (5+ drinks) past 2 weeks				
None (0 binge drinking episodes)	1.00	.66	.18	.73
1 binge drinking episode	.00	.23	.28	.14
2 binge drinking episodes	.00	.07	.29	.08
3-5 binge drinking episodes	.00	.02	.20	.04
6-9 binge drinking episodes	.00	.00	.04	.01
10 or more binge drinking episodes	.00	.00	.01	.00
Drinking days out of past 30				
None (0 days)	.90	.04	.00	.44
1-2 days	.10	.54	.03	.23
3-5 days	.00	.34	.21	.15
6-9 days	.00	.08	.36	.10
10-19 days	.00	.00	.32	.06
20 or more days	.00	.00	.08	.02

	Drinking subgroups			All women in sample (n = 1493)
Drinking class indicator variables	Abstainers (n = 749, 50%)	**Light (n = 472, 31%)**	Heavy (n = 272, 18%)	
Drinks per week				
None (0 drinks)	1.00	.21	.01	.54
1-3 drinks	.00	.72	.22	.28
4-7 drinks	.00	.06	.47	.12
8-11 drinks	.00	.01	.20	.04
12-19 drinks	.00	.00	.07	.01
20 or more drinks	.00	.00	.03	.01
Binges (5+ drinks) past 2 weeks				
None (0 binge drinking episodes)	1.00	.66	.18	.73
1 binge drinking episode	.00	.23	.28	.14
2 binge drinking episodes	.00	.07	.29	.08
3-5 binge drinking episodes	.00	.02	.20	.04
6-9 binge drinking episodes	.00	.00	.04	.01
10 or more binge drinking episodes	.00	.00	.01	.00
Drinking days out of past 30				
None (0 days)	.90	.04	.00	.44
1-2 days	.10	.54	.03	.23
3-5 days	.00	.34	.21	.15
6-9 days	.00	.08	.36	.10
10-19 days	.00	.00	.32	.06
20 or more days	.00	.00	.08	.02

Mplus Input: Class "outcome" differences

```
USEVARIABLES ARE
   drnk_wk6 binge2wk alc30day;

CLASSES = c (3);

CATEGORICAL = drnk_wk6 binge2wk alc30day;

SUBPOPULATION = gender EQ 1;

AUXILIARY = DUI(e) poorperf (e);

ANALYSIS:
   TYPE = mixture;
   STARTS = 10000 200;

MODEL:

OUTPUT: tech11;
```

All code same as before…

…but here we add a test to see if our 3 drinking groups have different reported rates of

1. **Driving Under the Influence**
2. **Poor performance on a test or project**

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Mplus Output: Class differences



```
EQUALITY TESTS OF MEANS ACROSS CLASSES USING POSTERIOR PROBABILITY-BASED MULTIPLE
IMPUTATIONS WITH 2 DEGREE(S) OF FREEDOM FOR THE OVERALL TEST AND 1 DEGREE OF
FREEDOM FOR THE PAIRWISE TESTS

DUI
                           Mean       S.E.
  Class 1                 0.431      0.030
  Class 2                 0.223      0.020
  Class 3                 0.042      0.008

                       Chi-Square    P-Value
  Overall test          154.595      0.000
  Class 1 vs. 2          30.329      0.000
  Class 1 vs. 3         154.187      0.000
  Class 2 vs. 3          68.667      0.000

POORPERF
                           Mean       S.E.
  Class 1                 0.354      0.030
  Class 2                 0.156      0.018
  Class 3                 0.051      0.009

                       Chi-Square    P-Value
  Overall test          75.182       0.000
  Class 1 vs. 2         29.902       0.000
  Class 1 vs. 3         94.943       0.000
  Class 2 vs. 3         27.221       0.000
```

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Negative drinking consequences (Probability of answering “yes”)	**Drinking subgroups**			All women in sample (n = 1493)
	Nondrinkers	Light	Heavy	
Drove under the influence of alcohol	.04	.22	.43	.17
Performed poorly on a test or important project	.05	.16	.35	.13

Take away messages!

1. Look at multiple factors simultaneously
2. Understand PATTERNS…
3. …and associated consequences
4. Tailor interventions to subgroups

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QUESTIONS?

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YOU
can add subgroup analysis to your program design and evaluation work

and Evaluation Specialists can help you!

Thank you!



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