What's Coming in PROCESS v3.0

www.processmacro.org

This document provides a sampling of some of the new features available in PROCESS version 3.

A streamlined syntax

- In version 3, **vars=** is no longer used. You do not need to tell which variables are being used in the model prior to assigning them roles. So, for example,

```
process vars=pmi import reaction cond/x=cond/m=import pmi/
   y=reaction/model=4.
```

becomes the more streamlined

```
process x=cond/m=import pmi/y=reaction/model=4.
```

- Whereas in version 2, covariates were listed in **vars=** but not assigned a role anywhere in the model. In version 3, covariates are specified following **cov=**. So, for example,

```
process vars=pmi import reaction cond age sex/x=cond
   /m=import pmi/y=reaction/model=4.
```

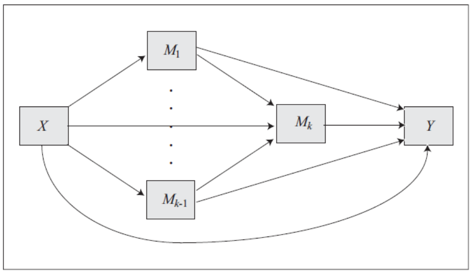
becomes

```
process x=cond/m=import pmi/y=reaction/cov=age sex/model=4.
```

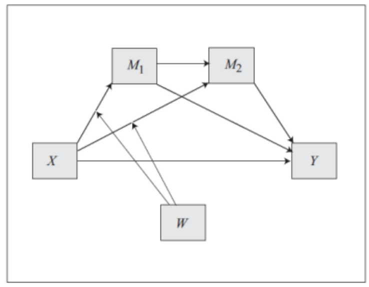
New preprogrammed models

- PROCESS version 2 was built around a model numbering system. This is the only way of telling PROCESS v2 what you are trying to do.
- Version 3 retains the model numbering system. The number of models has been reduced by eliminating all models with more than two moderators.
- Version 3 has 13 new numbered models that combine moderation with serial mediation, and that combine parallel and serial mediation. Examples:

Model 80

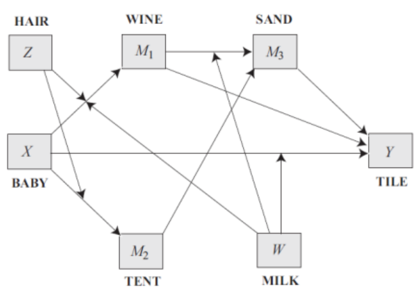


Model 84



Customizing and creating models

In version 3, preprogrammed model numbers are shortcuts for populating four matrices that define a model. You can directly program these matrices in version 3 to create your own models. No model number is needed. For example, the model below does not have a corresponding model number:



In version 3, the command below estimates this model:

```
process y=tile/m=wine tent sand/x=baby/w=milk/z=hair/
bmatrix=1,1,0,0,1,1,1,1,0,1/wmatrix=1,0,0,0,1,0,1,0,0,0/
zmatrix=1,1,0,0,0,0,0,0,0,0.
```

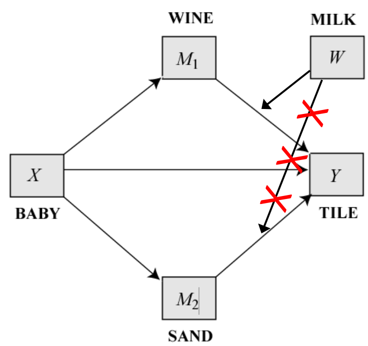
Modifying numbered models

- In version 2, numbered models are fixed. If you don't like something about the model, too bad. Choose another model, or abandon PROCESS. Version 3 allows you to edit numbered models to tailor them to your specific wants.

For example, this is model 14:

But what if you don't want W to moderate the path from M_2 to Y. In version 2, tough luck.

- In version 3, just reprogram the W matrix to eliminate the undesired moderation specification.




```
process y=tile/m=wine sand/x=baby/w=milk/model=14
   /wmatrix=0,0,0,0,1,0.
```

Multicategorical independent variables and moderators

- PROCESS v2 has limited features for dealing with multicategorical variables. Patchwork modifications were added in updates over the years only for models 1 and 4.
- In version 3, X (causal antecedent) and moderators W and Z can be multicategorical with up to nine categories in **any** model PROCESS can estimate, using the **mcx**, **mcw**, and/or **mcz** options. Four coding systems are preprogrammed (indicator, sequential, Helmert, effect).
- If you don't like the preprogrammed coding systems, you can program your own system with the **xcatcode**, **wcatcode**, and **zcatcode** options. For example:

	X1	X2	X3
Group 1	-0.5	-0.5	0
Group 2	-0.5	0.5	0
Group 3	0.5	0	-0.5
Group 4	0.5	0	0.5

```
process y=tile/m=wine/x=baby/mcx=5/xcatcode=-0.5,-0.5,0,-0.5,
   0.5,0,0.5,0,-0.5,0.5,0,0.5.
```

Example v3 output. Model 8 with a multicategorical *X*

```
process x=protest/m=respappr/y=liking/w=sexism/model=8/mcx=1/plot=1.
```

```
Model  : 8
    Y  : liking
    X  : protest
    M  : respappr
    W  : sexism

Sample
Size:  129

Coding of categorical X variable for analysis:
 protest      X1      X2
    .000    .000    .000
   1.000   1.000    .000
   2.000    .000   1.000

**************************************************************************
OUTCOME VARIABLE:
 respappr

Model Summary
          R       R-sq        MSE          F        df1        df2          p
      .5618      .3156     1.2945    11.3424     5.0000   123.0000      .0000

Model
              coeff         se          t          p       LLCI       ULCI
constant     6.5667     1.2023     5.4616      .0000     4.1868     8.9467
X1          -3.7751     1.7118    -2.2054      .0293    -7.1636     -.3867
X2          -2.1044     1.6082    -1.3085      .1931    -5.2878     1.0790
sexism       -.5290      .2345    -2.2559      .0258     -.9932     -.0648
Int_1         .9778      .3284     2.9771      .0035      .3277     1.6279
Int_2         .7339      .3144     2.3347      .0212      .1117     1.3562

Product terms key:
 Int_1    :        X1       x        sexism
 Int_2    :        X2       x        sexism

Test(s) of highest order unconditional interaction(s):
       R2-chng          F        df1        df2          p
X*W      .0537     4.8233     2.0000   123.0000      .0096
```

Example v3 output. Model 8 with a multicategorical *X*

```
    Focal predict: protest  (X)
          Mod var: sexism   (W)

Conditional effects of the focal predictor at values of the moderator(s):

Moderator value(s):
sexism     4.3332

       Effect         se          t          p       LLCI       ULCI
X1      .4619      .3682     1.2546      .2120     -.2669     1.1906
X2     1.0758      .3346     3.2150      .0017      .4135     1.7382

Test of equality of conditional means
          F        df1        df2          p
     5.2501     2.0000   123.0000      .0065

Estimated conditional means being compared:
    protest   respappr
      .0000     4.2744
     1.0000     4.7363
     2.0000     5.3503
----------
Moderator value(s):
sexism     5.1170

       Effect         se          t          p       LLCI       ULCI
X1     1.2282      .2503     4.9069      .0000      .7328     1.7237
X2     1.6510      .2464     6.6994      .0000     1.1632     2.1389

Test of equality of conditional means
          F        df1        df2          p
    23.8997     2.0000   123.0000      .0000

Estimated conditional means being compared:
    protest   respappr
      .0000     3.8598
     1.0000     5.0880
     2.0000     5.5109
----------
```

Example v3 output. Model 8 with a multicategorical *X*

```
Moderator value(s):
sexism     5.9007

       Effect         se          t          p       LLCI       ULCI
X1     1.9946      .3497     5.7035      .0000     1.3024     2.6868
X2     2.2263      .3618     6.1531      .0000     1.5101     2.9424

Test of equality of conditional means
          F        df1        df2          p
    22.8045     2.0000   123.0000      .0000

Estimated conditional means being compared:
    protest   respappr
      .0000     3.4452
     1.0000     5.4398
     2.0000     5.6715

Data for visualizing the conditional effect of the focal predictor:
Paste text below into a SPSS syntax window and execute to produce plot.

DATA LIST FREE/
   protest    sexism     respappr   .
BEGIN DATA.
      .0000     4.3332     4.2744
     1.0000     4.3332     4.7363
     2.0000     4.3332     5.3503
      .0000     5.1170     3.8598
     1.0000     5.1170     5.0880
     2.0000     5.1170     5.5109
      .0000     5.9007     3.4452
     1.0000     5.9007     5.4398
     2.0000     5.9007     5.6715
END DATA.
GRAPH/SCATTERPLOT=
 sexism   WITH     respappr BY       protest  .
```

Example v3 output. Model 8 with a multicategorical *X*

```
**************************************************************************
OUTCOME VARIABLE:
 liking

Model Summary
          R       R-sq        MSE          F        df1        df2          p
      .5355      .2868      .8245     8.1767     6.0000   122.0000      .0000

Model
              coeff         se          t          p       LLCI       ULCI
constant     5.2977     1.0696     4.9529      .0000     3.1803     7.4151
X1          -2.7441     1.3929    -1.9701      .0511    -5.5016      .0133
X2          -2.7189     1.2924    -2.1038      .0375    -5.2774     -.1605
respappr      .3668      .0720     5.0969      .0000      .2243      .5092
sexism       -.2785      .1910    -1.4581      .1474     -.6565      .0996
Int_1         .5426      .2714     1.9992      .0478      .0053     1.0799
Int_2         .5086      .2564     1.9839      .0495      .0011     1.0162

Product terms key:
 Int_1    :        X1       x        sexism
 Int_2    :        X2       x        sexism

Test(s) of highest order unconditional interaction(s):
       R2-chng          F        df1        df2          p
X*W      .0298     2.5479     2.0000   122.0000      .0824
----------
    Focal predict: protest  (X)
          Mod var: sexism   (W)

Conditional effects of the focal predictor at values of the moderator(s):
(These are also the relative conditional direct effects of X on Y)

Moderator value(s):
sexism     4.3332

       Effect         se          t          p       LLCI       ULCI
X1     -.3930      .2957    -1.3289      .1864     -.9783      .1924
X2     -.5149      .2781    -1.8519      .0665    -1.0654      .0355

Test of equality of conditional means
          F        df1        df2          p
      .2950     2.0000   122.0000      .7451
```

Example v3 output. Model 8 with a multicategorical *X*

```
Estimated conditional means being compared:
    protest     liking
      .0000     5.6577
     1.0000     5.6900
     2.0000     5.5414
----------
Moderator value(s):
sexism     5.9007

       Effect         se          t          p       LLCI       ULCI
X1      .4576      .3138     1.4580      .1474     -.1637     1.0789
X2      .2824      .3302      .8551      .3942     -.3713      .9361

Test of equality of conditional means
          F        df1        df2          p
     1.0699     2.0000   122.0000      .3462

Estimated conditional means being compared:
    protest     liking
      .0000     5.4394
     1.0000     5.8970
     2.0000     5.7218

Data for visualizing the conditional effect of the focal predictor:
Paste text below into a SPSS syntax window and execute to produce plot.

DATA LIST FREE/
   protest    sexism     liking     .
BEGIN DATA.
      .0000     4.3332     5.8759
     1.0000     4.3332     5.4830
     2.0000     4.3332     5.3610
      .0000     5.1170     5.6577
     1.0000     5.1170     5.6900
     2.0000     5.1170     5.5414
      .0000     5.9007     5.4394
     1.0000     5.9007     5.8970
     2.0000     5.9007     5.7218
END DATA.
GRAPH/SCATTERPLOT=
 sexism   WITH     liking   BY       protest  .
```

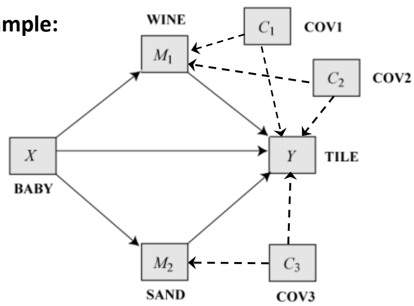
Example v3 output. Model 8 with a multicategorical *X*

```
****************** DIRECT AND INDIRECT EFFECTS OF X ON Y *****************

Relative conditional direct effect(s) of X on Y:
       sexism     Effect         se          t          p       LLCI       ULCI
X1     4.3332     -.3930      .2957    -1.3289      .1864     -.9783      .1924
X1     5.1170      .0323      .2184      .1479      .8826     -.4001      .4648
X1     5.9007      .4576      .3138     1.4580      .1474     -.1637     1.0789
X2     4.3332     -.5149      .2781    -1.8519      .0665    -1.0654      .0355
X2     5.1170     -.1163      .2298     -.5061      .6137     -.5712      .3386
X2     5.9007      .2824      .3302      .8551      .3942     -.3713      .9361

Relative conditional indirect effects of X on Y:

INDIRECT EFFECT:
 protest     ->    respappr    ->    liking

       sexism     Effect     BootSE   BootLLCI   BootULCI
X1     4.3332      .1694      .1494     -.1267      .4714
X1     5.1170      .4505      .1288      .2198      .7228
X1     5.9007      .7316      .2042      .3558     1.1536

      Index of moderated mediation:
            Index     BootSE   BootLLCI   BootULCI
sexism      .3586      .1585      .0719      .6920
---
       sexism     Effect     BootSE   BootLLCI   BootULCI
X2     4.3332      .3946      .1433      .1435      .6994
X2     5.1170      .6056      .1488      .3325      .9137
X2     5.9007      .8165      .2236      .4108     1.2840

      Index of moderated mediation:
            Index     BootSE   BootLLCI   BootULCI
sexism      .2692      .1462      .0008      .5715

********************** ANALYSIS NOTES AND ERRORS ************************

Level of confidence for all confidence intervals in output:
  95.0000

Number of bootstrap samples for percentile bootstrap confidence intervals:
  10000
```

Covariates

- Version 2 offers little flexibility in how covariates are assigned to equations. All covariates go in models of *Y* and mediator(s) *M*, or just *M*, or just *Y*. You can't split covariates up and assign them to different equations.
- With a new **cmatrix** option in version 3, covariates can now be assigned to different equations in whatever configuration you desire, rather than being forced to all be in the models of *M*s, *Y*, or both. The **covmy** option still works.

For example:




```
process y=tile/m=wine sand/x=baby/cov=cov1 cov2 cov3/model=4/
   cmatrix=1,1,0,0,0,1,1,1,1.
```

Enhanced options/output for models with interactions

- The plot option now works for all models that include a moderation component anywhere in the system of equations. And PROCESS automatically probes all interactions, regardless of whether they exist in the model.
- An option for telling PROCESS to probe interactions only if statistically significant according to some specified α-level.
- When probing interactions, the default is to condition continuous moderators on the 16^{th}, 50^{th}, and 84^{th} percentiles of the moderator distribution. Use of the mean, a standard deviation below, and a standard deviation above the mean is still possible with a new **moments** option.
- The **wmodval** and **zmodval** options now allow you to list more than one value for conditioning effects (e.g., **wmodval = 3.5, 5, 6.5** to estimate a conditional effect when moderator *W* equals 3.5, 5, and 6.5)
- An implementation of a "slope difference" test in moderation-only models with more than one moderator (models 2 and 3).

Bootstrapping

- Bootstrap confidence intervals are generated automatically for indirect effects and the index of moderated mediation. The default is 5,000 bootstrap samples, percentile method only. Bias-corrected confidence intervals are not available in v3.
- The bootstrapping algorithm has been enhanced to detect singularities more reliably and replace bootstrap samples when this happens. A new **maxboot** option makes sure that PROCESS doesn't get stuck and never returns to you.
- Bootstrap inference is now available for all regression coefficients defining a model, not just for indirect effects.

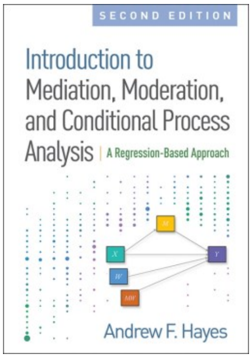
How do I get PROCESS v3?

(1) Wait. PROCESS v3 will be released toward the end of 2017 at the same time as the 2nd edition of

Introduction to Mediation, Moderation, and Conditional Process Analysis: A Regression-Based Approach

www.guilford.com/p/hayes3

Version 3 is documented in Appendices A and B



(2) If you can't wait until the end of the year, take a class from Andrew Hayes in October 2017.

Conditional Process Analysis
Two day course: 27-28 October 2017, Philadelphia, offered through Statistical Horizons
www.statisticalhorizons.com

This course will be taught using PROCESS v3. Students in this class will get an early release of version 3.