小组作业：中介效应与调节效应

周诗怡、田微微、薛野、范佳玲、韩传亮、黄泰诚、黄婷、李名扬、王非池

1 模型验证

```
DATA:FILE IS data.txt;
NOBSERVATIONS ARE 1430;
VARIABLE:
NAMES ARE rc1 rc2 wo1 wo2 ss1 ss2 se1-se3 ee1-ee3 dp1 dp2 pa1-pa3 G;
USEVAR = rc1 rc2 wo1 wo2 ss1 ss2 ee1-ee3 dp1 dp2 pa1-pa3 ;
MODEL:
EE by ee1-ee3;
DP by dp1 dp2;
PA by pa1-pa3;
RC by rc1 rc2;
WO by wo1 wo2;
SS by ss1 ss2;
EE on WO;
EE on RC;
DP on RC;
DP on EE;
PA on DP;
PA on EE;
PA on SS;
MODEL indirect:
DP IND EE WO;
PA IND EE WO;
PA IND EE RC;
PA IND DP RC;
PA IND DP EE;
OUTPUT: mod(10) cinterval sampstat stdyx;
```

整体拟合指标结果较好，该模型可以接受。

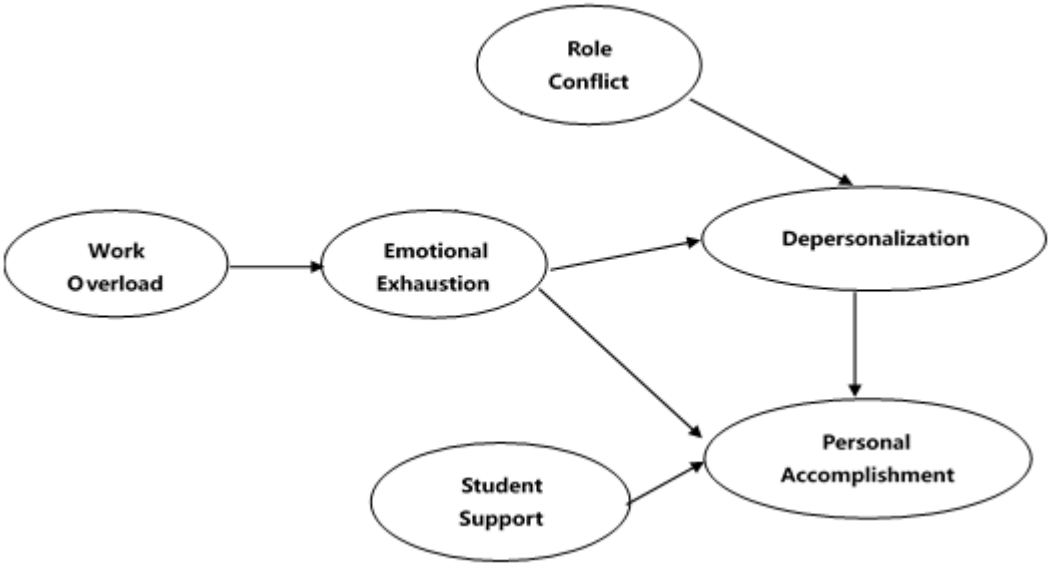
```
Chi-Square Test of Model Fit

          Value                            485.296
          Degrees of Freedom                67
          P-Value                           0.0000

RMSEA (Root Mean Square Error Of Approximation)

          Estimate                           0.066
          90 Percent C.I.                    0.061  0.072
          Probability RMSEA <= .05           0.000

CFI/TLI

          CFI                                0.962
          TLI                                0.948
```

测量模型各题载荷均在 0.4 以上，RC 与 EE 间路径不显著，删除该路径，检验模型 2 的

拟合情况，得到如下所示的整体拟合指标，将此模型作为模型 2。

```
Chi-Square Test of Model Fit

          Value                             486.138
          Degrees of Freedom                    68
          P-Value                           0.0000

RMSEA (Root Mean Square Error Of Approximation)

          Estimate                           0.066
          90 Percent C.I.                    0.060  0.071
          Probability RMSEA <= .05           0.000

CFI/TLI

          CFI                                0.962
          TLI                                0.949
```

理论模型如下所示：



2 中介效应检验

根据路径分析结果、间接效应显著性检验结果与路径图，发现：

EE 在 WO 与 DP 间关系中起中介作用，即工作超负荷通过情感枯竭影响自我感丧失；

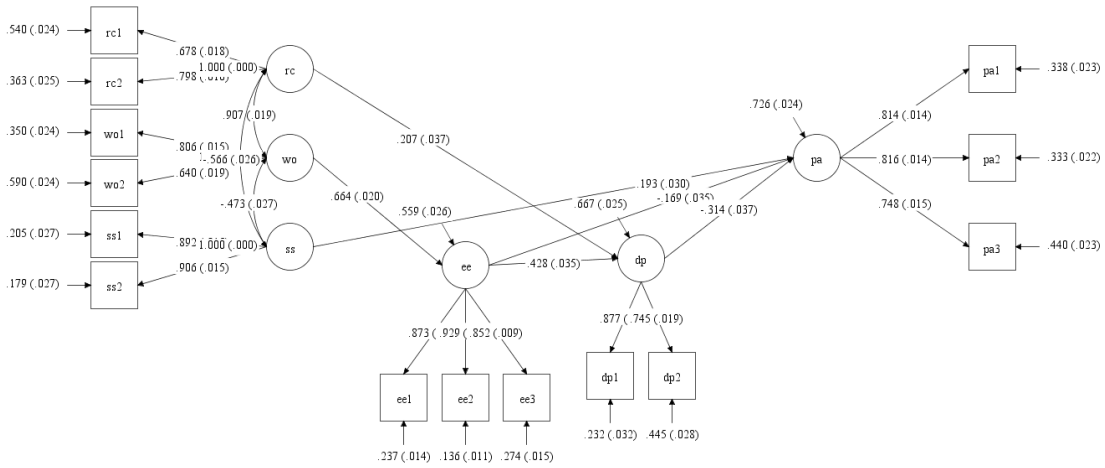
EE 在 WO 与 PA 间关系中起中介作用，即工作超负荷通过情感枯竭影响个人成就感；

DP 在 RC 与 PA 间关系中起部分中介作用，即角色冲突通过自我感丧失影响个人成就感，且还有其他中介变量；

DP 在 EE 与 PA 间关系中起中介作用，即情感枯竭通过自我感丧失影响个人成就感。

		Estimate	S.E.	Est./S.E.	Two-Tailed P-Value
EE	BY				
EE1		0.873	0.008	110.895	0.000
EE2		0.929	0.006	150.720	0.000
EE3		0.852	0.009	96.000	0.000
DP	BY				
DP1		0.877	0.018	47.385	0.000
DP2		0.745	0.019	39.199	0.000
PA	BY				
PA1		0.814	0.014	58.683	0.000
PA2		0.816	0.014	60.189	0.000
PA3		0.748	0.015	49.725	0.000
RC	BY				
RC1		0.678	0.018	37.856	0.000
RC2		0.798	0.016	50.612	0.000
WO	BY				
WO1		0.806	0.015	53.982	0.000
WO2		0.640	0.019	33.636	0.000
SS	BY				
SS1		0.892	0.015	58.856	0.000
SS2		0.906	0.015	59.842	0.000
EE	ON				
WO		0.664	0.020	33.728	0.000
DP	ON				
RC		0.207	0.037	5.519	0.000
EE		0.428	0.035	12.396	0.000
PA	ON				
DP		-0.314	0.037	-8.565	0.000
EE		-0.169	0.035	-4.776	0.000
SS		0.193	0.030	6.456	0.000

	Estimate	S.E.	Est./S.E.	Two-Tailed P-Value
Effects from WO to DP				
Sum of indirect	0.285	0.025	11.483	0.000
Specific indirect				
DP				
EE				
WO	0.285	0.025	11.483	0.000
Effects from WO to PA				
Sum of indirect	-0.112	0.024	-4.721	0.000
Specific indirect				
PA				
EE				
WO	-0.112	0.024	-4.721	0.000
Effects from RC to PA				
Sum of indirect	-0.065	0.014	-4.680	0.000
Specific indirect				
PA				
DP				
RC	-0.065	0.014	-4.680	0.000
Effects from EE to PA				
Sum of indirect	-0.135	0.020	-6.794	0.000
Specific indirect				
PA				
DP				
EE	-0.135	0.020	-6.794	0.000



3 跨组检验

选取 EE 通过 DP 对 PA 产生影响这一中介效应对男生组和女生组的跨组相等假设进行

检验。

3.1 model0:男女两组分别检验

男性组整体拟合情况如下：

```
Chi-Square Test of Model Fit

          Value                            233.783
          Degrees of Freedom                68
          P-Value                          0.0000

RMSEA (Root Mean Square Error Of Approximation)

          Estimate                           0.061
          90 Percent C.I.                    0.053  0.070
          Probability RMSEA <= .05           0.015

CFI/TLI

          CFI                                0.966
          TLI                                0.954
```

女性组整体拟合情况如下：

```
Chi-Square Test of Model Fit

          Value                            339.872
          Degrees of Freedom                68
          P-Value                          0.0000

RMSEA (Root Mean Square Error Of Approximation)

          Estimate                           0.072
          90 Percent C.I.                    0.064  0.079
          Probability RMSEA <= .05           0.000

CFI/TLI

          CFI                                0.955
          TLI                                0.940
```

从整体拟合情况来看，男女两组在本模型下拟合尚可，可进行后续检验。

3.2 model 1: configural invariance (baseline)

```
DATA:FILE IS data.txt;
NOBSERVATIONS ARE 1430;
VARIABLE:
NAMES ARE rc1 rc2 wo1 wo2 ss1 ss2 se1-se3 ee1-ee3 dp1 dp2 pa1-pa3 g;
USEVAR = rc1 rc2 wo1 wo2 ss1 ss2 ee1-ee3 dp1 dp2 pa1-pa3;
GROUPING IS g (1=male 2=female);
MODEL:
RC by rc1 rc2;
WO by wo1 wo2;
SS by ss1 ss2;
EE by ee1-ee3;
DP by dp1 dp2;
PA by pa1-pa3;
EE on WO;
DP on RC;
DP on EE;
```

PA on DP;
PA on EE;
PA on SS;
MODEL indirect:
PA IND DP EE;
MODEL female:
RC by rc2;
WO by wo2;
SS by ss2;
EE by ee2 ee3;
DP by dp2;
PA by pa2 pa3;
[RC@0];
[WO@0];
[SS@0];
[EE@0];
[DP@0];
[PA@0];
[rc1-rc2];
[wo1-wo2];
[ss1-ss2];
[ee1-ee3];
[dp1-dp2];
[pa1-pa3];
OUTPUT: cinterval sampstat stdyx;

得到模型 1 整体拟合指标如图所示，建立基线。

```
Chi-Square Test of Model Fit

          Value                             573.655
          Degrees of Freedom                    136
          P-Value                            0.0000

Chi-Square Contributions From Each Group

          MALE                              233.783
          FEMALE                            339.872

RMSEA (Root Mean Square Error Of Approximation)

          Estimate                            0.067
          90 Percent C.I.                     0.061  0.073
          Probability RMSEA <= .05            0.000

CFI/TLI

          CFI                                 0.960
          TLI                                 0.946
```

3.2 model 2: weak invariance

限定载荷相等，计算模型 2。

DATA:FILE IS data.txt;
NOBSERVATIONS ARE 1430;

```
VARIABLE:
NAMES ARE rc1 rc2 wo1 wo2 ss1 ss2 se1-se3 ee1-ee3 dp1 dp2 pa1-pa3 g;
USEVAR = rc1 rc2 wo1 wo2 ss1 ss2 ee1-ee3 dp1 dp2 pa1-pa3;
GROUPING IS g (1=male 2=female);
MODEL:
RC by rc1 rc2;
WO by wo1 wo2;
SS by ss1 ss2;
EE by ee1-ee3;
DP by dp1 dp2;
PA by pa1-pa3;
EE on WO;
DP on RC;
DP on EE;
PA on DP;
PA on EE;
PA on SS;
MODEL indirect:
PA IND DP EE;
MODEL female:
[RC@0];
[WO@0];
[SS@0];
[EE@0];
[DP@0];
[PA@0];
[rc1-rc2];
[wo1-wo2];
[ss1-ss2];
[ee1-ee3];
[dp1-dp2];
[pa1-pa3];
OUTPUT: cinterval sampstat stdyx;
```

得到如下所示的整体拟合结果：

```
Chi-Square Test of Model Fit

          Value                             587.257
          Degrees of Freedom                    144
          P-Value                           0.0000

Chi-Square Contributions From Each Group

          MALE                              241.792
          FEMALE                            345.464

RMSEA (Root Mean Square Error Of Approximation)

          Estimate                            0.066
          90 Percent C.I.                     0.060  0.071
          Probability RMSEA <= .05            0.000

CFI/TLI

          CFI                                 0.959
          TLI                                 0.949
```

相比于模型 1，$\Delta\chi2(8)= 13.602$，$p>0.05$，表明卡方值变化不显著，弱等价性成立。

3.3 中介效应等价性检验

由于弱等价性成立，则进一步进行中介效应等价检验，限定中介效应中的 a、b、c’在男性组和女性组中相等。

```
DATA:FILE IS data.txt;
NOBSERVATIONS ARE 1430;
VARIABLE:
NAMES ARE rc1 rc2 wo1 wo2 ss1 ss2 se1-se3 ee1-ee3 dp1 dp2 pa1-pa3 g;
USEVAR = rc1 rc2 wo1 wo2 ss1 ss2 ee1-ee3 dp1 dp2 pa1-pa3;
GROUPING IS g (1=male 2=female);
MODEL:
RC by rc1 rc2;
WO by wo1 wo2;
SS by ss1 ss2;
EE by ee1-ee3;
DP by dp1 dp2;
PA by pa1-pa3;
EE on WO;
DP on RC;
DP on EE(a);
PA on DP(b);
PA on EE(c);
PA on SS;
MODEL indirect:
PA IND DP EE;
MODEL female:
EE on WO;
DP on RC;
DP on EE(a);
PA on DP(b);
```

PA on EE(c);
PA on SS;
[RC@0];
[WO@0];
[SS@0];
[EE@0];
[DP@0];
[PA@0];
[rc1-rc2];
[wo1-wo2];
[ss1-ss2];
[ee1-ee3];
[dp1-dp2];
[pa1-pa3];
OUTPUT: cinterval sampstat stdyx;

得到如下所示的整体拟合指标：

```
Chi-Square Test of Model Fit

          Value                             588.763
          Degrees of Freedom                    147
          P-Value                           0.0000

Chi-Square Contributions From Each Group

          MALE                              242.675
          FEMALE                            346.088

RMSEA (Root Mean Square Error Of Approximation)

          Estimate                            0.065
          90 Percent C.I.                     0.059  0.070
          Probability RMSEA <= .05            0.000

CFI/TLI

          CFI                                 0.960
          TLI                                 0.950
```

相比于模型 2，$\Delta\chi2(3)= 1.506$，$p>0.05$，表明卡方值变化不显著，中介效应在男性组和女性组里跨组相等。

4 交互作用检验

4.1 乘积指标方法

研究假设为：教师 self esteem（潜变量）与 student support（潜变量）之间可能存在交互作用，即对不同自尊水平的教师而言，学生支持对其个人成就感的影响程度不同。

首先对数据进行中心化，得出潜变量载荷大小并配对乘积项，使用乘积指标方法计算交互作用。

DATA:FILE IS burnout.dat;
VARIABLE:
NAMES ARE g rc1 rc2 wo1 wo2 ss1 ss2 se1-se3 ee1-ee3 dp1 dp2 pa1-pa3;
USEVAR = rc1 rc2 wo1 wo2 ss1 ss2 se1-se3 ee1-ee3 dp1 dp2 pa1-pa3 mm1 mm2;
DEFINE:

```
mm1 = se2*ss2;
mm2 = se3*ss1;
ANALYSIS:
MODEL = nomeanstructure;
INFORMATION = expected;
MODEL:
EE by ee1-ee3;
DP by dp1 dp2;
PA by pa1-pa3;
RC by rc1 rc2;
WO by wo1 wo2;
SS by ss1 ss2;
SE by se1-se3;
SSSE by mm1 mm2;
EE on WO;
DP on RC;
DP on EE;
PA on DP;
PA on EE;
PA on SS SE;
PA on SSSE;
MODEL indirect:
DP IND EE WO;
PA IND EE WO;
PA IND DP RC;
PA IND DP EE;
OUTPUT: standardized;
```

整体拟合情况如下表所示：

```
Chi-Square Test of Model Fit

          Value                             787.043
          Degrees of Freedom                    134
          P-Value                           0.0000

RMSEA (Root Mean Square Error Of Approximation)

          Estimate                           0.058
          90 Percent C.I.                    0.054  0.062
          Probability RMSEA <= .05           0.000

CFI/TLI

          CFI                                0.955
          TLI                                0.942
```

查看标准化结果，发现 SS 和 SE 与 PA 的主效应显著，但 INT 与 PA 的交互作用不显著，即对不同自尊水平的教师而言，学生支持对其个人成就感的影响程度没有差异。

PA	ON				
	DP	-0.272	0.035	-7.705	0.000
	EE	-0.089	0.036	-2.494	0.013
	SS	0.181	0.029	6.270	0.000
	SE	0.260	0.030	8.572	0.000
	SSSE	0.031	0.030	1.034	0.301

4.2 潜调节结构方程法

研究假设为：教师 self esteem（潜变量）与 student support（潜变量）之间可能存在交互作用，即对不同自尊水平的教师而言，学生支持对其个人成就感的影响程度不同。

首先对数据进行中心化，再使用 LMS 计算交互作用。

```
DATA:FILE IS burnout.dat;
VARIABLE:
NAMES ARE g rc1 rc2 wo1 wo2 ss1 ss2 se1-se3 ee1-ee3 dp1 dp2 pa1-pa3;
USEVAR = rc1 rc2 wo1 wo2 ss1 ss2 se1-se3 ee1-ee3 dp1 dp2 pa1-pa3;
ANALYSIS:
TYPE = RANDOM;
ALGORITHM = INTEGRATION;
MODEL:
EE by ee1-ee3;
DP by dp1 dp2;
PA by pa1-pa3;
RC by rc1 rc2;
WO by wo1 wo2;
SS by ss1 ss2;
SE by se1-se3;
INT | SS XWITH SE;
EE on WO;
DP on RC;
DP on EE;
PA on DP;
PA on EE;
PA ON SS SE INT;
```

拟合情况如下图所示：

```
MODEL FIT INFORMATION

Number of Free Parameters                       65

Loglikelihood

          H0 Value                       -27748.599
          H0 Scaling Correction Factor        1.2384
            for MLR

Information Criteria

          Akaike (AIC)                    55627.197
          Bayesian (BIC)                  55969.450
          Sample-Size Adjusted BIC        55762.967
            (n* = (n + 2) / 24)
```

由于 LMS 没有标准化结果，直接看模型检验情况。结果发现 SS 和 SE 与 PA 的主效应显著，但 INT 与 PA 的交互作用不显著，即对不同自尊水平的教师而言，学生支持对其个人成就感的影响程度没有差异。

MODEL RESULTS

		Estimate	S.E.	Est./S.E.	Two-Tailed P-Value
EE	ON				
WO		0.841	0.038	22.204	0.000
DP	ON				
RC		0.285	0.064	4.476	0.000
EE		0.350	0.040	8.754	0.000
PA	ON				
DP		-0.209	0.036	-5.771	0.000
EE		-0.058	0.026	-2.185	0.029
SS		0.120	0.023	5.332	0.000
SE		0.553	0.089	6.208	0.000
INT		0.012	0.069	0.181	0.856

5 问题

（1）模型修正时，是否需要单独将测量模型拿出来先行计算？

（2）在理论模型中未画出直接效应的中介是否需要检验？Mplus 可以按照侯老师中介效应检验流程先计算 c 的结果再按流程计算 ab 及 c’吗？

（3）多组比较应当如何做？是否应当先限定整体模型，在满足弱等价性条件后再进行中介效应的跨组比较？

（4）调节效应是应当在完整模型中检验还是应单独拿出来做？