Mediation Analysis, Multicategorical X, Process Hayes

This example is straight out of the second edition of Hayes. Subjects were women who had read an account of a female attorney who lost a promotion to a less qualified man. In one group (Protest = 0) subjects were told that the attorney did not protest the decision. In a second group (Protest = 1, individual protest) they were told that the attorney protested, complaining that the decision was not fair to her. In the third group (Protest = 2, collective protest) they were told that the attorney protested, complaining that the decision was not fair to women. Each subject rated how appropriate she though the attorney's response (variable respappr, the mediator) and how much she liked the attorney (variable liking, the outcome variable).

Unlike Hayes, I standardized the continuous variables. This will not affect any of the tests of significance. The code I used to conduct the analysis is:

%***process*** (**data**=protest2,y=Zliking,x=protest,m=Zrespappr,mcx=**1**,total=**1**,model=**4**,seed=**28513**);

"mcx=1" indicates that there are more than two groups and that the grouping variable should be dummy coded with the group with the smallest numeric code (0, no protest) being the reference group. Here is the annotated output:

The SAS System

********** PROCESS v3.1 for SAS **********

Model and Variables

Model:	4
Y:	ZLIKING
X:	PROTEST
M:	ZRESPAPPR

Sample size: 129

Custom seed: 28513

Coding of categorical X variable for analysis:

PROTEST	X1	X2
0	**0**	0
1	**1**	0
2	**0**	1

X1 contrasts the individual protest group with the no protest group. X2 contrasts the collective protest group with the no protest group.

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OUTCOME VARIABLE:
ZRESPAPPR

Model Summary

R	R-sq	MSE	F	df1	df2	p
0.5106	0.2607	0.7510	22.2190	2.0000	126.0000	0.0000

Model

	coeff	se	t	p	LLCI	ULCI
constant	-0.7285	0.1353	-5.3828	0.0000	-0.9964	-0.4607
X1	0.9355	0.1892	4.9456	0.0000	0.5612	1.3099
X2	1.1945	0.1871	6.3842	0.0000	0.8242	1.5647

Mean response appropriateness was .94 standard deviations higher in the individual protest group than in the no protest group and 1.19 standard deviations higher in the collective protest group than in the no protest group. Both of these differences are statistically significant. There is suppressor relationship between X1 and X2 (notice the beta that exceeds 1).

The test of the total effect here is identical to a one way ANOVA predicting response appropriateness from group membership:

ANOVA

RESPAPPR: appropriateness of response

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	60.653	2	30.327	22.219	.000
Within Groups	171.977	126	1.365		
Total	232.631	128			

RESPAPPR: appropriateness of response

Ryan-Einot-Gabriel-Welsch Range

PROTEST: experimental condition	N	Subset for alpha = 0.05	
		1	2
no protest	41	3.8841	
individual	43		5.1453
collective	45		5.4944
Sig.		1.000	.168

Means for groups in homogeneous subsets are displayed.

OUTCOME VARIABLE:
ZLIKING

Model Summary

R	R-sq	MSE	F	df1	df2	p
0.5031	0.2531	0.7648	14.1225	3.0000	125.0000	0.0000

Model

	coeff	se	t	p	LLCI	ULCI
constant	0.0744	0.1515	0.4909	0.6244	-0.2254	0.3741
X1	-0.0035	0.2086	-0.0169	0.9865	-0.4164	0.4093
X2	-0.2098	0.2172	-0.9658	0.3360	-0.6397	0.2201
ZRESPAPPR	0.5290	0.0899	5.8844	0.0000	0.3511	0.7069

Response appropriateness is strongly and significantly associated with liking. The coefficient here is a beta weight. The groups' partial effects are small, negative, and not significant.

Note that the test of the total effect here is absolutely equivalent to an analysis of covariance comparing the groups on liking while holding constant response appropriateness.

Tests of Between-Subjects Effects

Dependent Variable: LIKING: liking of the attorney

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	35.703[a]	3	11.901	14.123	.000
Intercept	91.761	1	91.761	108.891	.000
respappr	29.179	1	29.179	34.627	.000
protest	1.228	2	.614	.729	.485
Error	105.336	125	.843		
Total	4239.741	129			
Corrected Total	141.039	128			

a. R Squared = .253 (Adjusted R Squared = .235)

PROTEST: experimental condition LSMEANS

Dependent Variable: LIKING: liking of the attorney

PROTEST: experimental condition	Mean	Std. Error	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
no protest	5.715[a]	.159	5.400	6.029
individual	5.711[a]	.141	5.431	5.991
collective	5.495[a]	.144	5.210	5.779

a. Covariates appearing in the model are evaluated at the following values:
RESPAPPR: appropriateness of response = 4.8663.

********** TOTAL EFFECT MODEL **********

OUTCOME VARIABLE:
ZLIKING

Model Summary

R	R-sq	MSE	F	df1	df2	p
0.2151	0.0463	0.9689	3.0552	2.0000	126.0000	0.0506

The test of the total effect is not of much importance. This test is absolutely equivalent to a one-way ANOVA comparing the groups on liking:

ANOVA

LIKING: liking of the attorney

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	6.523	2	3.262	3.055	.051
Within Groups	134.515	126	1.068		
Total	141.039	128			

Model

	coeff	se	t	p	LLCI	ULCI
constant	-0.3110	0.1537	-2.0234	0.0452	-0.6153	-0.0068
X1	0.4914	0.2149	2.2870	0.0239	0.0662	0.9166
X2	0.4221	0.2125	1.9863	0.0492	0.0016	0.8427

Both X contrasts have significant total effects on liking.

********** TOTAL, DIRECT, AND INDIRECT EFFECTS OF X ON Y **********

Relative total effects of X on Y:

	Effect	se	t	p	LLCI	ULCI
X1	0.4914	0.2149	2.2870	0.0239	0.0662	0.9166
X2	0.4221	0.2125	1.9863	0.0492	0.0016	0.8427

Omnibus test of total effect of X on Y:

R2-chng	F	df1	df2	p
0.0463	3.0552	2.0000	126.0000	0.0506

Relative direct effects of X on Y

	Effect	se	t	p	LLCI	ULCI
X1	-0.0035	0.2086	-0.0169	0.9865	-0.4164	0.4093
X2	-0.2098	0.2172	-0.9658	0.3360	-0.6397	0.2201

Omnibus test of direct effect of X on Y:

R2-chng	F	df1	df2	p
0.0087	0.7286	2.0000	125.0000	0.4846

Neither X contrast has a significant direct effect.

Relative indirect effects of X on Y

PROTEST -> ZRESPAPP -> ZLIKING

	Effect	BootSE	BootLLCI	BootULCI
X1	0.4949	0.1459	0.2441	0.8137
X2	0.6319	0.1600	0.3506	0.9730

The indirect effects for both X1 and X2 are significant. Each of these is the product of (the beta weight for predicting the mediator from X) times (the beta weight for predicting liking from the mediator).

- X1: .9355(.529) = .4949
- X2: 1.1945(.529) = .6319

One can code the categorical variable in ways other than reference group versus each other group. See pages 562 to 565 in Hayes. mcx=3 will compare each group (starting with the first) with the subsequent (coded with a higher number) groups combined. This is known as Helmert coding. For the data here the two contrasts will be:

- X1: No protest versus yes protest (groups 2 and 3 combined)
- X2: Individual protest versus collective protest

%***process*** (**data**=protest2,y=Zliking,x=protest,m=Zrespappr,mcx=**3**,total=**1**,model=**4**,seed=**28513**);

Coding of categorical X variable for analysis:

PROTEST	X1	X2
0	-0.666667	0
1	0.3333333	-0.5
2	0.3333333	0.5

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OUTCOME VARIABLE:
ZRESPAPPR

Model Summary

R	R-sq	MSE	F	df1	df2	p
0.5106	0.2607	0.7510	22.2190	2.0000	126.0000	0.0000

Model

	coeff	se	t	p	LLCI	ULCI
constant	-0.0185	0.0764	-0.2425	0.8088	-0.1696	0.1326
X1	1.0650	0.1639	6.4988	0.0000	0.7407	1.3893
X2	0.2589	0.1848	1.4012	0.1636	-0.1068	0.6247

Mean response appropriateness is significantly higher in the two protesting groups than in the non-protesting group. The difference between the two protesting groups falls short of significance.

********** TOTAL EFFECT MODEL **********

OUTCOME VARIABLE:
ZLIKING

Model Summary

R	R-sq	MSE	F	df1	df2	p
0.2151	0.0463	0.9689	3.0552	2.0000	126.0000	0.0506

Model

	coeff	se	t	p	LLCI	ULCI
constant	-0.0065	0.0867	-0.0755	0.9400	-0.1782	0.1651
X1	0.4567	0.1861	2.4538	0.0155	0.0884	0.8251
X2	-0.0693	0.2099	-0.3300	0.7419	-0.4847	0.3461

Mirror the effects on the response appropriateness variable.

Relative direct effects of X on Y

	Effect	se	t	p	LLCI	ULCI
X1	-0.1067	0.1911	-0.5581	0.5778	-0.4848	0.2715
X2	-0.2063	0.1879	-1.0974	0.2746	-0.5782	0.1657

Omnibus test of direct effect of X on Y:

R2-chng	F	df1	df2	p
0.0087	0.7286	2.0000	125.0000	0.4846

Relative indirect effects of X on Y

PROTEST -> ZRESPAPP -> ZLIKING

	Effect	BootSE	BootLLCI	BootULCI
X1	0.5634	0.1465	0.3070	0.8803
X2	0.1370	0.0892	-0.0239	0.3215

The indirect effect is significant for protest versus non-protest, but not quite for individual protest versus collective protest.

- Hayes, A. F. (2018). ***Introduction to mediation, moderation, and conditional process analysis (2nd ed.)***. New York, NY: Guilford. ISBN: 9781462534654. This book is available as an e-book at Joyner Library**.**
- Wuensch's Stats Lessons

Karl L. Wuensch, May, 2019