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Easy Statistical Mediation Analysis with Distinguishable Dyadic Data

Andrew F. Hayes

Ohio State University

in collaboration with Jacob J. Coultts and Tao Jiang


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MEDYAD: An Analytical Tool for Assessing Mediation in Distinguishable Dyads

Jacob J. Coultts, Andrew F. Hayes, and Tao Jiang
The Ohio State University, Department of Psychology
coultts.14@osu.edu hayes.518@osu.edu jiang.588@osu.edu



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The APIMeM

The dyad is the fundamental unit of analysis in interaction science, family, & health (Burt, 1936). Consequently, it is important for researchers to measure dyads as they seek to understand social phenomena, distribute such as love, conflict, and friendship not only say something about one specific individual, but other both persons involved.

Dyadic data analysis has grown in popularity in recent years, and continues to grow as quantitative methods develop and become more accessible for substantive researchers. Mediation analysis is a popular analytical technique in the social sciences that investigates how one variable causes another through one or more mediating variable(s) (Preacher, 2010). The Actor Partner Interdependence Model Extended to Mediation (APIMeM) applies this methodology to a dyadic framework and is an extension of the Actor Partner Interdependence Model, a model commonly used in dyadic data literature. A conceptual diagram of the APIMeM, with the corresponding regression equations, is presented below in the basic APIMeM, there are three constructs measured by six mixed variables. This results in eight indirect effects, four total effects, and four direct effects that can be estimated.

The APIMeM is typically estimated using a structural equation modeling (SEM) program, or through a series of regression equations, while the estimation procedure differs between SEM and OLS regression, the substantive conclusions reached are often if not always identical (Hayes, Montoya, & Rockwood, 2017).

[SPSS] Syntax Structure*

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  m976 = 976
```

Dyads

Interpersonal relationships and interactions are crucial in people's lives.

Dyad is the most basic unit of interpersonal relationships and interactions.

- married or dating couples
- friends
- parent and child
- patient and caregiver
- coworkers

Many social phenomena are dyadic in nature.

- Conflict
- Love
- Social support

Many theories in social and behavioral science are about dyadic interactions.

- Social exchange theory
- Interdependence theory
- Attachment theory

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Assessing Mediation in Dyadic Data Using the Actor-Partner Interdependence Model

Thomas Ledermann
University of Basel, Switzerland

Siegfried Macho
University of Fribourg, Switzerland

David A. Kenny
University of Connecticut

The assessment of mediation in dyadic data is an important issue if researchers are to test process models. Using an extended version of the actor-partner interdependence model the estimation and testing of mediation is complex, especially when dyad members are distinguishable (e.g., heterosexual couples). We show how the complexity of the model can be reduced by assuming specific dyadic patterns. Using structural equation modeling, we demonstrate how specific mediating effects and contrasts among effects can be tested by phantom models that permit point and bootstrap interval estimates. We illustrate the assessment of mediation and the strategies to simplify the model using data from heterosexual couples.

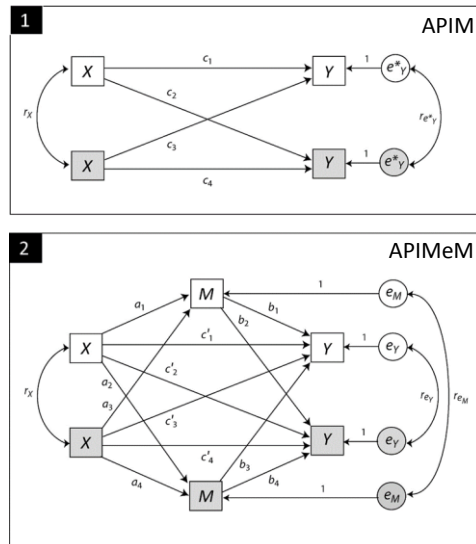
Keywords: mediation, dyadic data, APIM, phantom models, bootstrapping

Models of mediation are common and of great importance, as they can provide information about causal relationships between variables that are mediated by one or more sets of intervening variables. Mediation refers to a mechanism through which an initial (X) influences an outcome (Y) by a third variable (M), termed *mediator* or *intervening variable* (Baron & Kenny, 1986; Judd & Kenny, 1981). In this mediation model, the effect from X to M is commonly designated as a , the effect from M on Y as b , and the effect from X on Y as c' (MacKinnon, 2008). The mediating or indirect effect (IE) of X on Y equals ab and the total effect equals $ab + c'$.

Over the last decade, researchers have begun to examine mediating mechanisms in dyadic data. The most commonly used model for this purpose is the actor-partner interdependence

Correspondence should be addressed to Thomas Ledermann, Department of Psychology, University of Basel, CH-4055 Basel, Switzerland. E-mail: thomas.ledermann@unibas.ch

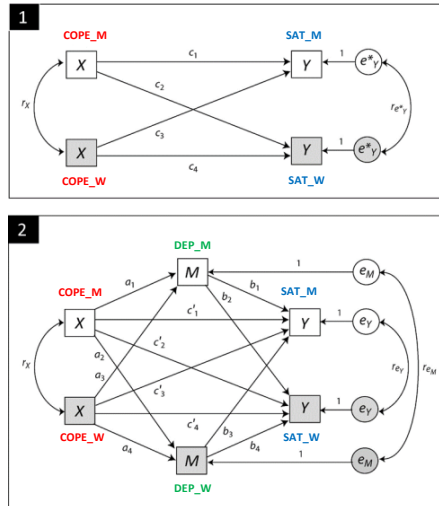
595



Ledermann et al (2011) discuss these model for distinguishable and indistinguishable dyad members. Here, I focus only on distinguishable dyad members.

Example

- Data from the 500 Family Study (Pls: Barbara Schneider and Linda Waite)
- A study of husbands and wives
 - 319 heterosexual couples
- Coping (X)** - Feeling of cannot cope with everything (higher = more inability to cope)
 - COPE_M – Man (Husband)
 - COPE_W – Woman (Wife)
- Depression (M)** - CES-D
 - DEP_M – Man (Husband)
 - DEP_W – Woman (Wife)
- Marital Satisfaction (Y)** - (15 items of the ENRICH marital inventory)
 - SAT_M – Man (Husband)
 - SAT_W – Woman (Wife)



I reserve judgment on whether this is substantively interesting. It is the example used in Ledermann et al. (2011). I ignore worries about causal inference from correlational data. That's another talk. This kind of design and analysis is commonplace.

The data

A data file to be used in a dyadic data analysis must be in the proper form, depending on the type of analysis being conducted. For this analysis, the data are in “dyad structure” form. Each row is a dyad. Columns are variables measured on one or both dyad members.

FAMID_1	COPE_W	DEP_W	SAT_W	COPE_M	DEP_M	SAT_M
1001	2	7	39	1	5	41
1002	0	3	36	2	4	39
1003	2	2	46	1	4	49
1004	3	27	31	2	7	34
1005	4	31	37	2	11	35
1006	3	7	27	2	13	38
1008	3	10	34	2	5	39
1009	1	2	45	0	1	49
1010	2	10	42	1	3	35
1011	1	14	43	2	7	38
1012	1	9	50	1	12	48
1014	2	9	39	1	2	40
1016	2	0	38	0	3	47
1017	2	6	37	1	5	31
1018	2	2	36	1	14	33
1020	1	3	44	1	5	36

Typical analytical approach →

SEM is most typically used, though there is lots of variation in implementation

An Mplus program to do the analysis:

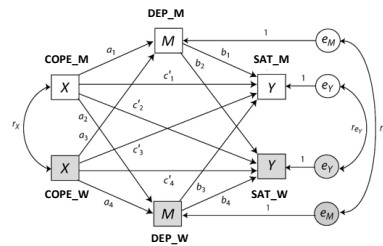
```
ANALYSIS:
  !BOOTSTRAP = 5000;
MODEL:
  DEP_M ON COPE_M COPE_W;
  DEP_W ON COPE_M COPE_W;
  SAT_M ON DEP_M DEP_W COPE_M COPE_W;
  SAT_W ON DEP_M DEP_W COPE_M COPE_W;
  COPE_M WITH COPE_W;
  DEP_M WITH DEP_W;
  SAT_M WITH SAT_W;
MODEL INDIRECT:
  SAT_M IND COPE_M;
  SAT_W IND COPE_M;
  SAT_W IND COPE_W;
  SAT_M IND COPE_W;
OUTPUT:
  !CINTERVAL(BOOTSTRAP);
```

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Psychology Press

Assessing Mediation in Dyadic Data Using the Actor-Partner Interdependence Model

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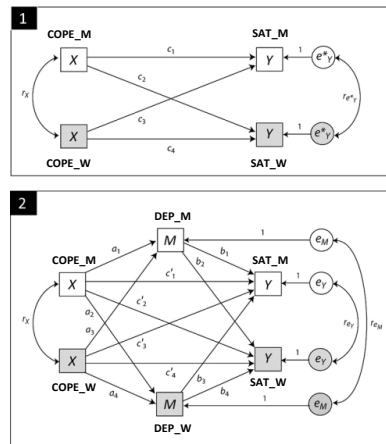
This would be executed **twice**, once without bootstrapping to get model paths and standard errors and once with to get bootstrap confidence intervals for indirect effects.

Making it easier: MEDYAD

Pronounced **Meh'**-die-add or Meh-**die'**-add

- An observed variable path analysis tool for SPSS and SAS.
- Can estimate the APIM and APIMeM and variations.
- **Only a single line of code conducts the analysis**, regardless of how complex the model.
- **Generates the same results you get when using an SEM program.**
- Estimates path coefficients using OLS regression.
- Inference about indirect effects through percentile bootstrap confidence intervals.
- Conducts contrasts of indirect effects.
- Many other features.
- Freely available.

MEDYAD code



In SPSS:

MEDYAD Y=SAT_M SAT_W/M=DEP_M DEP_W/X=COPE_M COPE_W.

In SAS:

%MEDYAD (DATA=COUPLES,Y=SAT_M SAT_W,M=DEP_M DEP_W,X=COPE_M COPE_W) ;

That's it!

MEDYAD output

Model Variables:

X1 : COPE_M
X2 : COPE_W
Y1 : SAT_M
Y2 : SAT_W

Paired Mediators:

M1 : DEP_M
M2 : DEP_W

N: 319

Seed: 5000

***** DESCRIPTIVES FOR MODEL VARIABLES *****

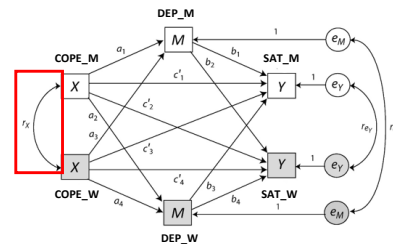
Descriptive Statistics of Model Variables

	Mean	SD	Min	Max
COPE_M	1.5611	.8982	.0000	4.0000
COPE_W	1.7962	.9107	.0000	4.0000
DEP_M	8.3504	7.0800	.0000	41.0000
DEP_W	7.8063	6.8506	.0000	43.0000
SAT_M	37.6270	6.7247	17.0000	50.0000
SAT_W	37.3605	7.1624	15.0000	50.0000

Correlation Matrix of Antecedents and Consequents

	COPE_M	COPE_W	DEP_M	DEP_W	SAT_M	SAT_W
COPE_M	1.0000	.1095	.4684	.0590	-.3068	-.1899
COPE_W	.1095	1.0000	.0980	.4558	-.1881	-.2857
DEP_M	.4684	.0980	1.0000	.0454	-.4454	-.3188
DEP_W	.0590	.4558	.0454	1.0000	-.2250	-.3723
SAT_M	-.3068	-.1881	-.4454	-.2250	1.0000	.5612
SAT_W	-.1899	-.2857	-.3188	-.3723	.5612	1.0000

Simple correlations between couples' inability to cope, depression, and marital satisfaction.



MEDYAD output

(first stage effects)

Actor and partner effects of inability to cope on depression.

Outcome:
DEP_M

Model Summary

	R	R-sq	MSE	F	df1	df2	p
	.4708	.2216	39.2641	44.9883	2.0000	316.0000	.0000

Model

	coeff	se	t	p	LLCI	ULCI
constant	1.9890	.9450	2.1049	.0361	.1298	3.8482
COPE_M	3.6514	.3936	9.2776	.0000	2.8770	4.4257
COPE_W	.3680	.3882	.9481	.3438	-.3957	1.1317

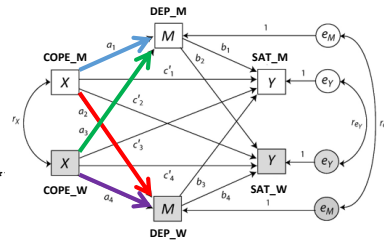
Outcome:
DEP_W

Model Summary

	R	R-sq	MSE	F	df1	df2	p
	.4559	.2078	37.4125	41.4536	2.0000	316.0000	.0000

Model

	coeff	se	t	p	LLCI	ULCI
constant	1.5515	.9224	1.6820	.0936	-.2633	3.3664
COPE_M	.0704	.3842	.1832	.8548	-.6855	.8262
COPE_W	3.4210	.3789	9.0287	.0000	2.6755	4.1665



MEDYAD output

(second stage effects)

Actor and partner effects of depression on marital satisfaction

Outcome:
SAT_M

Model Summary

	R	R-sq	MSE	F	df1	df2	p
	.5036	.2537	34.1812	26.6793	4.0000	314.0000	.0000

Model

	coeff	se	t	p	LLCI	ULCI
constant	44.0674	.8918	49.4147	.0000	42.3128	45.8221
COPE_M	-.8419	.4142	-2.0324	.0430	-1.6569	-.0269
COPE_W	-.4370	.4067	-1.0746	.2834	-1.2372	.3632
DEP_M	-.3600	.0525	-6.8592	.0000	-.4633	-.2568
DEP_W	-.1710	.0538	-3.1800	.0016	-.2768	-.0652

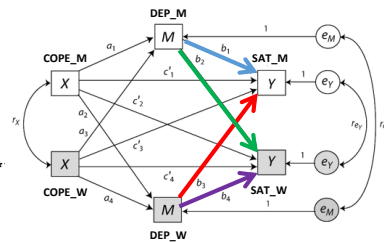
Outcome:
SAT_W

Model Summary

	R	R-sq	MSE	F	df1	df2	p
	.4914	.2415	39.4073	24.9931	4.0000	314.0000	.0000

Model

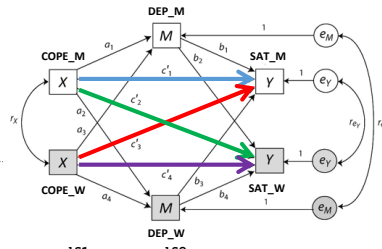
	coeff	se	t	p	LLCI	ULCI
constant	44.2061	.9575	46.1664	.0000	42.3221	46.0901
COPE_M	-.2214	.4448	-.4977	.6191	-1.0965	.6538
COPE_W	-.9128	.4367	-2.0903	.0374	-1.7720	-.0536
DEP_M	-.2839	.0564	-5.0373	.0000	-.3948	-.1730
DEP_W	-.3190	.0577	-5.5245	.0000	-.4326	-.2054



MEDYAD output

(direct effects)

Actor and partner direct effects of inability to cope on marital satisfaction



Outcome:

SAT_M

Model Summary

	R	R-sq	MSE	F	df1	df2	P
	.5036	.2537	34.1812	26.6793	4.0000	314.0000	.0000

Model

	coeff	se	t	p	LLCI	ULCI
constant	44.0674	.8918	49.4147	.0000	42.3128	45.8221
COPE_M	-.8419	.4142	-2.0324	.0430	-1.6569	-.0269
COPE_W	-.4370	.4067	-1.0746	.2834	-1.2372	.3632
DEP_M	-.3600	.0525	-6.8592	.0000	-.4633	-.2568
DEP_W	-.1710	.0538	-3.1800	.0016	-.2768	-.0652

Outcome:

SAT_W

Model Summary

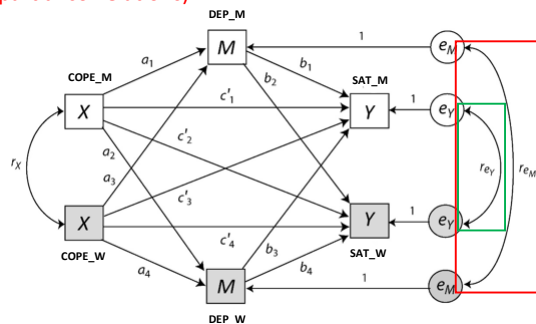
	R	R-sq	MSE	F	df1	df2	P
	.4914	.2415	39.4073	24.9931	4.0000	314.0000	.0000

Model

	coeff	se	t	p	LLCI	ULCI
constant	44.2061	.9575	46.1664	.0000	42.3221	46.0901
COPE_M	-.2214	.4448	-.4977	.6191	-1.0965	.6538
COPE_W	-.9128	.4367	-2.0903	.0374	-1.7720	-.0536
DEP_M	-.2839	.0564	-5.0373	.0000	-.3948	-.1730
DEP_W	-.3190	.0577	-5.5245	.0000	-.4326	-.2054

MEDYAD output

(residual, i.e, partial correlations)



***** RESIDUAL CORRELATION MATRIX *****

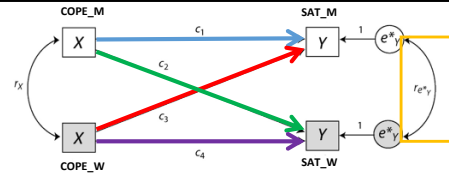
	DEP_M	DEP_W	SAT_M	SAT_W
DEP_M	1.0000	-.0045	.0000	.0000
DEP_W	-.0045	1.0000	.0000	.0000
SAT_M	.0000	.0000	1.0000	.4482
SAT_W	.0000	.0000	.4482	1.0000

Correlation between spouses' depression controlling for inability to cope, and correlation between spouses' marital satisfaction controlling for inability to cope and depression.

MEDYAD output

(APIM: total effects)

Actor and partner total effects of inability to cope on marital satisfaction.



***** TOTAL EFFECT (S) MODEL (S) *****

Outcome:

SAT_M

Model Summary

	R	R-sq	MSE	F	df1	df2	p
	.3439	.1183	40.1267	21.1902	2.0000	316.0000	.0000

Model

	coeff	se	t	p	LLCI	ULCI
constant	43.0860	.9553	45.1031	.0000	41.2065	44.9656
COPE_M	-2.1685	.3979	-5.4503	.0000	-2.9513	-1.3857
COPE_W	-1.1545	.3924	-2.9421	.0035	-1.9265	-.3824

Outcome:

SAT_W

Model Summary

	R	R-sq	MSE	F	df1	df2	p
	.3272	.1071	46.0971	18.9476	2.0000	316.0000	.0000

Model

	coeff	se	t	p	LLCI	ULCI
constant	43.1466	1.0239	42.1401	.0000	41.1321	45.1611
COPE_M	-1.2804	.4264	-3.0025	.0029	-2.1194	-.4414
COPE_W	-2.1084	.4206	-5.0131	.0000	-2.9359	-1.2809

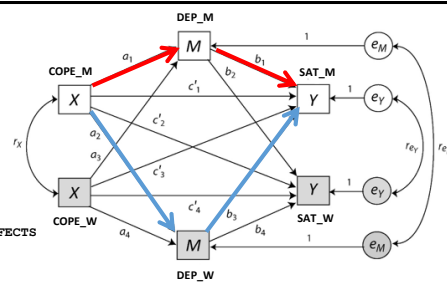
Correlation of residuals in total effect models:

.5202

MEDYAD output

(indirect effects)

Indirect effects of the husband's inability to cope on his own marital satisfaction, one through his own depression, the other through his spouse's.



***** TOTAL, DIRECT, AND INDIRECT EFFECTS *****

TOTAL, DIRECT, AND INDIRECT EFFECTS OF

COPE_M

Total effect(s) on

	effect	se	t	p	LLCI	ULCI
SAT_M	-2.1685	.3979	-5.4503	.0000	-2.9513	-1.3857
SAT_W	-1.2804	.4264	-3.0025	.0029	-2.1194	-.4414

Direct effect(s) on

	effect	se	t	p	LLCI	ULCI
SAT_M	-.8419	.4142	-2.0324	.0430	-1.6569	-.0269
SAT_W	-.2214	.4448	-.4977	.6191	-1.0965	.6538

Indirect Effect(s):

	effect	BootSE	BootLLCI	BootULCI
Ind1	-1.3146	.2484	-1.8400	-.8544
Ind2	-.0120	.0649	-.1348	.1304
Ind3	-1.0366	.2391	-1.5087	-.5715
Ind4	-.0224	.1171	-.2456	.2227

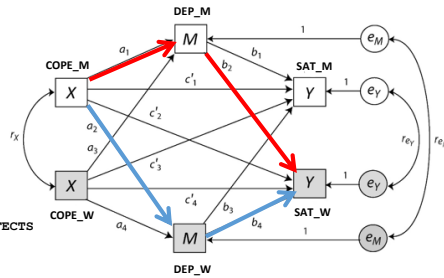
95% bootstrap confidence intervals
(percentile method)

Indirect Effect Key:

Ind1	:	COPE_M	-->	DEP_M	-->	SAT_M
Ind2	:	COPE_M	-->	DEP_W	-->	SAT_M
Ind3	:	COPE_M	-->	DEP_M	-->	SAT_W
Ind4	:	COPE_M	-->	DEP_W	-->	SAT_W

MEDYAD output (indirect effects)

Indirect effects of the husband's inability to cope on his spouse's marital satisfaction, one through his own depression, the other through hers.



***** TOTAL, DIRECT, AND INDIRECT EFFECTS

TOTAL, DIRECT, AND INDIRECT EFFECTS OF
COPE_M

Total effect(s) on

	effect	se	t	p	LLCI	ULCI
SAT_M	-2.1685	.3979	-5.4503	.0000	-2.9513	-1.3857
SAT_W	-1.2804	.4264	-3.0025	.0029	-2.1194	-.4414

Direct effect(s) on

	effect	se	t	p	LLCI	ULCI
SAT_M	-.8419	.4142	-2.0324	.0430	-1.6569	-.0269
SAT_W	-.2214	.4448	-.4977	.6191	-1.0965	.6538

Indirect Effect(s):

	effect	BootSE	BootLLCI	BootULCI
Ind1	-1.3146	.2484	-1.8400	-.8544
Ind2	-.0120	.0649	-.1348	.1304
Ind3	-1.0366	.2391	-1.5087	-.5715
Ind4	-.0224	.1171	-.2456	.2227

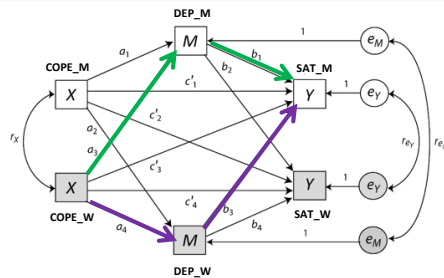
95% bootstrap confidence intervals
(percentile method)

Indirect Effect Key:

Ind1	:	COPE_M	-->	DEP_M	-->	SAT_M
Ind2	:	COPE_M	-->	DEP_W	-->	SAT_M
Ind3	:	COPE_M	-->	DEP_M	-->	SAT_W
Ind4	:	COPE_M	-->	DEP_W	-->	SAT_W

MEDYAD output (indirect effects)

Indirect effects of the wife's inability to cope on her husband's marital satisfaction, one through her own depression, the other through his.



TOTAL, DIRECT AND INDIRECT EFFECTS OF
COPE_W

	effect	se	t	p	LLCI	ULCI
SAT_M	-1.1545	.3924	-2.9421	.0035	-1.9265	-.3824
SAT_W	-2.1084	.4206	-5.0131	.0000	-2.9359	-1.2809

Direct effect(s) on

	effect	se	t	p	LLCI	ULCI
SAT_M	-.4370	.4067	-1.0746	.2834	-1.2372	.3632
SAT_W	-.9128	.4367	-2.0903	.0374	-1.7720	-.0536

Indirect Effect(s):

	effect	BootSE	BootLLCI	BootULCI
Ind5	-.1325	.1597	-.4426	.1713
Ind6	-.5850	.1972	-.9776	-.2050
Ind7	-.1045	.1313	-.3873	.1275
Ind8	-1.0911	.2345	-1.5687	-.6415

95% bootstrap confidence intervals
(percentile method)

Indirect Effect Key:

Ind5	:	COPE_W	-->	DEP_M	-->	SAT_M
Ind6	:	COPE_W	-->	DEP_W	-->	SAT_M
Ind7	:	COPE_W	-->	DEP_M	-->	SAT_W
Ind8	:	COPE_W	-->	DEP_W	-->	SAT_W

MEDYAD output (indirect effects)

Indirect effects of the wife's inability to cope on her own marital satisfaction, one through her own depression, the other through his.

TOTAL, DIRECT AND INDIRECT EFFECTS OF COPE_W

	effect	se	t	p	LLCI	ULCI
SAT_M	-1.1545	.3924	-2.9421	.0035	-1.9265	-.3824
SAT_W	-2.1084	.4206	-5.0131	.0000	-2.9359	-1.2809

Direct effect(s) on

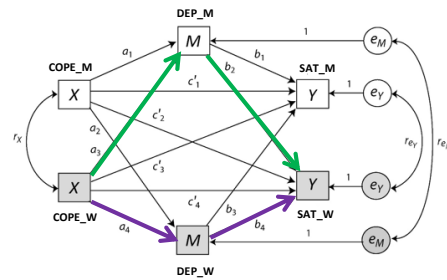
	effect	se	t	p	LLCI	ULCI
SAT_M	-.4370	.4067	-1.0746	.2834	-1.2372	.3632
SAT_W	-.9128	.4367	-2.0903	.0374	-1.7720	-.0536

Indirect Effect(s):

	effect	BootSE	BootLLCI	BootULCI
Ind5	-.1325	.1597	-.4426	.1713
Ind6	-.5850	.1972	-.9776	-.2050
Ind7	-.1045	.1313	-.3873	.1275
Ind8	-.10911	.2345	-1.5687	-.6415

Indirect Effect Key:

Ind5	:	COPE_W	-->	DEP_M	-->	SAT_M
Ind6	:	COPE_W	-->	DEP_W	-->	SAT_M
Ind7	:	COPE_W	-->	DEP_M	-->	SAT_W
Ind8	:	COPE_W	-->	DEP_W	-->	SAT_W



95% bootstrap confidence intervals
(percentile method)

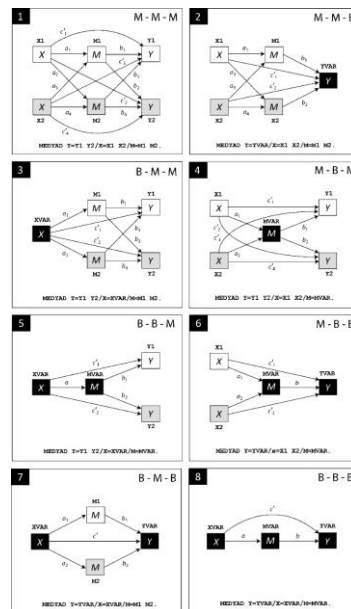
Some other single-mediator models

In the APIMeM, X , M , and Y are all mixed variables. Variation exists both within and between-dyads.

A between-dyad variable exhibits no variation within-dyad. All variation is between dyads.

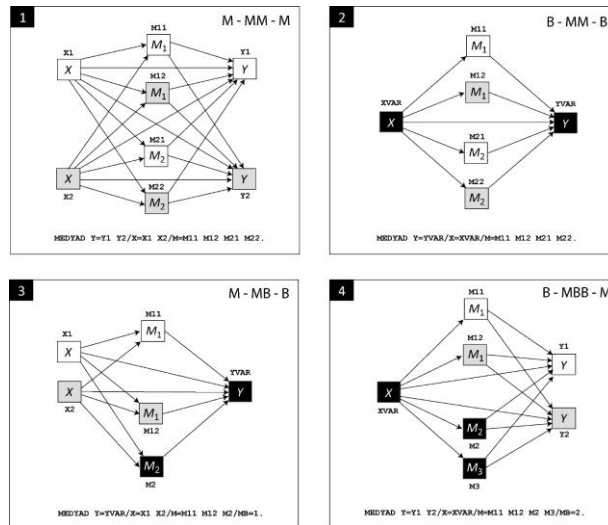
Combining X , M , and Y , with the mixed/between distinction generates eight possible models, diagrammed to the right, with a between-dyad variable represented with a black box and mixed variables represented with pairs of white and gray boxes.

MEDYAD can estimate all of these.
Only a single line of code is required.



More than one mediator

MEDYAD allows up to 12 mediators (up to 6 mixed variables, 12 between-dyad variables, or combinations of mixed and between). Some examples are below. **MEDYAD can estimate these and many, many, many others. Still, only a single line of code is required.**



Some benefits of MEDYAD

- Very easy to learn and use
- SAS and SPSS are readily accessible to most (working at universities)
- Faster than SEM programs (with respect to estimation time and set up)
- The same conclusions as SEM programs will provide
- Tiny changes in syntax to estimate different models

..but relative to SEM:

- Observed variable models only
- Requires continuous Y and M
- No sophisticated procedures for dealing with missing data
- OLS is the only option available for estimation.
- Not possible to impose constraints (e.g., fixing $X \rightarrow M$ to be the same for each member of the dyad).
- No ability to configure mediators in serial form.
- No measures of “fit” like in SEM. Not necessarily a limitation really, as focus is on estimation of effects, not overall model quality. All models MEDYAD estimates are “saturated” so fit is perfect by SEM standards.

How can I get it?

As of May 2019, MEDYAD is currently going through beta testing. But you can get a beta version now by filling out a form to download the files and documentation.

www.afhayes.com or www.jjcoutts.com

and hunt for a few seconds for MACROS or MEDYAD