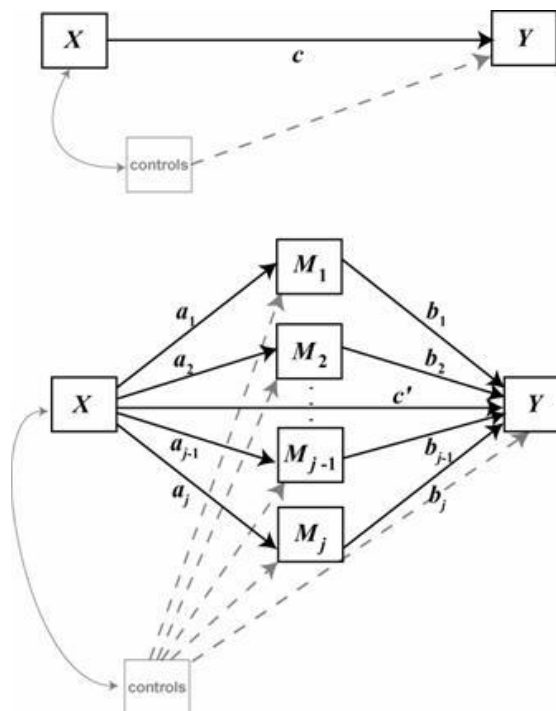


# INDIRECT

```
INDIRECT Y = yvar/X = xvar/M = mvlist [covlist]
      [/C = {cov} (0**)]
      [/BOOT = {z} (1000**)]
      [/CONF = {ci} (95**)]
      [/NORMAL = {t} (0**)]
      [/CONTRAST = {n} (0**)]
      [/PERCENT = {p} (0**)]
      [/BC = {b} (1**)]
      [/BCA = {d} (0**)]
      [/CONVERGE = (.000001**)]
      [/ITERATE = (10000)] .
```

Subcommands in brackets are optional

\*\* Default if subcommand is omitted



## Overview

INDIRECT estimates the total, direct, and single-step indirect effects (specific and total) of causal variable `xvar` on outcome variable `yvar` through a proposed mediator variable or list of mediator variables `mvlist`, controlling for one or more variables listed in `covlist`. It calculates the Sobel test for the total and specific indirect effect(s) as well as percentile-based, bias-corrected, and bias-corrected and accelerated bootstrap confidence intervals for the indirect effects. When more than one variable is listed in `mvlist`, it also calculates normal theory (aka “Sobel tests”) and bootstrap tests of the difference between the indirect effects. For details on the methods, see Preacher, K. J., & Hayes, A. F. (2008). Asymptotic and resampling methods for estimating and comparing indirect effects. *Behavior Research Methods*, 40, 879-891. Estimates of all paths are calculated using OLS regression.

## Instructions for Use

The `INDIRECT.sps` file should be opened as a syntax file in SPSS. Once it has been opened, execute the entire file exactly as is. Do not modify the code at all. Once the program is executed, the `INDIRECT` program window can be closed. You then have access to the `INDIRECT` command until you quit SPSS. See below for some example commands. The `INDIRECT.sps` file must be loaded and reexecuted each time to open SPSS. To install `INDIRECT` permanently in SPSS, install the custom dialog version (see below).

## Examples

```
INDIRECT Y = know/X = educ/M = attn elab/CONTRAST = 1/NORMAL = 1/BOOT = 5000.
```

- Estimates the total and direct effects of `educ` on `know`, as well as the total and specific indirect effects of `educ` on `know` through `attn` and `elab`
- Produces the Sobel test for the total and specific indirect effects
- Conducts a contrast between the two specific indirect effects
- Generates 95% bias-corrected and accelerated bootstrap confidence intervals for the indirect effects using 5000 bootstrap samples.

```
INDIRECT Y = know/X = educ/M = attn elab sex age/C = 2/CONTRAST = 1  
/CONF = 99/PERCENT = 1/BOOT = 1000.
```

- Estimates the total and direct effects of `educ` on `know`, as well as the indirect effect of `educ` on `know` through `attn` and `elab`, while controlling for `sex` and `age`
- Conducts a contrast between the two specific indirect effects
- Generates 99% percentile and bias-corrected and accelerated bootstrap confidence intervals for the indirect effects using 1000 bootstrap samples.

## Covariates

The direct, indirect, and total effects of `xvar` on `yvar` can be calculated with or without including a set of covariates which are partialled out of `yvar` and any and all variables in the `mlist` list. The covariates should be listed after the list of mediators in the `/M =` subcommand, and then the number of covariates in `covlist` should be used as the argument for `cov` in the `/C =` subcommand. For example, if four variables are provided in `covlist`, then specify `/C = 4`. In the output, what is listed as the total effect of the independent variable is actually corrected for the effect of the covariates. To get an uncorrected total effect, remove the covariates from the model and rerun the macro.

The output will include a section labeled “Partial Effect of Control Variables on DV.” These are the partial regression weights for the covariates in the model of the outcome variable. `INDIRECT` does not provide the coefficients for the covariates in the model(s) of the mediator(s), although the covariates are in those models as well.

## Normal Theory Tests and Contrasts

By setting `t` to 1 in the `/NORMAL` subcommand, the macro conducts Sobel tests for the total and specific indirect effects, defined as the effect divided by its standard error. A *p*-value is derived using the standard normal distribution. If covariates are listed, the Sobel tests are not conducted or printed.

Specifying `n` equal to 1 in the `/CONTRAST` subcommand produces pairwise contrasts between all specific indirect effects by calculating the difference, dividing it by its standard error, and deriving a *p*-value from the standard normal distribution. When there are only two mediator variables in the model, the contrast between specific indirect effects is listed in the output as `C1`. With *k* mediators, the  $0.5k(k - 1)$  possible pairwise contrasts are listed as `C1`, `C2`, `C3`, and so forth, and a key for interpreting which code corresponds to which contrast is provided at the bottom of the output.

The standard errors for indirect effects and contrasts produced with the `/NORMAL` subcommand do *not* assume zero correlation between the errors in estimation of the proposed mediators.

Although the Sobel test is widely used in many fields, experts in mediation analysis discourage its use in favor of methods that respect the nonnormality of the sampling distribution of the indirect effect. See Preacher and Hayes (2008) or Hayes (2009) for a discussion.

## Bootstrapping

As discussed in Preacher and Hayes (2008), Hayes (2009, 2018) and Hayes and Scharkow (2013), bootstrap confidence intervals are preferred over the Sobel test because of the unrealistic assumption the Sobel tests makes about the shape of the sampling distribution of the indirect effect. By default, the macro generates 95% bias-corrected bootstrap confidence intervals for all indirect effects and contrasts of indirect effects using  $z = 1000$  bootstrap samples. The number of bootstrap samples can be changed by setting `z` in the `/BOOT` subcommand to the desired number. The level of confidence for confidence intervals can be changed by setting `ci` to the desired number (such as 90, 99, and so forth) in the `/CONF` subcommand. Percentile or bias-corrected confidence intervals can be requested by setting `p` and/or `b` to 1 in the `/PERCENT` and/or `/BC` subcommands, respectively. To turn off the printing of a particular form of bootstrap confidence interval, set its argument to 0 in the corresponding subcommand.

An example of the bootstrapping section of the output can be found below. In this output, “Data” is the indirect effect calculated in the original sample, “Boot” is the mean of the indirect effect estimates calculated across all bootstrap samples, bias is the difference between “Data” and “Boot,” and “SE” is the standard deviation of the bootstrap estimates of the indirect effect. This standard deviation could be used as a bootstrap-derived estimate of the standard error of the indirect effect. Below this section of the output is the “Lower” and “Upper” endpoints of the bootstrap confidence interval for the indirect effect.

Indirect Effects of IV on DV through Proposed Mediators (ab paths)

	Data	Boot	Bias	SE
TOTAL	-.0350	-.0373	-.0024	.1461
satis	.1907	.1870	-.0037	.1057
happy	-.2256	-.2243	.0013	.1060

Bias Corrected and Accelerated Confidence Intervals

	Lower	Upper
TOTAL	-.3235	.2456

satis	.0118	.4248
happy	-.5014	-.0662

Because bootstrapping is based on random resampling of the data, bootstrap confidence intervals will differ slightly each time the macro is run as a result of the random sampling process. The more bootstrap samples that are requested, the less this variation between runs. To replicate a bootstrap sample of the same data, execute a SET SEED command prior to running the macro. For example, the command `SET SEED 3423` will seed the random number generator with a start value of 3423. For details, see the SPSS Command Syntax Reference manual, which is available as a PDF under the SPSS “Help” menu.

### ***Multiple Independent Variables***

In some cases the user might like to estimate a model that includes multiple independent variables each linked to the same set of mediators. The macro can be used to estimate the coefficients in such a model, although it provides no information that can be used to test a combined indirect effect involving all independent variables. Covariates are mathematically treated exactly like independent variables in the estimation, with paths to all mediators and the outcome, so if the desired model has  $k$  independent variables, the macro can be run  $k$  times, each time listing one variable as the independent variable and the remaining  $k - 1$  independent variables as covariates. Each run of the macro will generate the desired indirect effect for the variable currently listed as the independent variable (`xvar`).

### ***Multicategorical Independent Variables***

Hayes and Preacher (2014) discuss the estimation of direct and indirect effects of a multicategorical independent variable with more than levels using `MEDIATE` and `PROCESS`. `INDIRECT` is also capable of such an analysis using a procedure comparable to the one described for `PROCESS` in that paper. See Hayes and Preacher (2014) for details.

### ***Binary Dependent Variable***

`INDIRECT` can estimate models with either a continuous or a binary outcome, and the macro will automatically detect whether or not the outcome is binary and estimate accordingly. If the macro detects only two distinct values on the outcome variable, the direct and total effects as well as the path(s) from the proposed mediator(s) to the outcome are estimated using logistic regression, otherwise OLS is used. Normal theory tests (a.k.a. Sobel tests) are not conducted when the outcome is binary, but bootstrap confidence intervals are generated for specific and total indirect effects, estimated in the usual way as the product of the path from the independent variable to the dependent variable and the path from the proposed mediator to the outcome. Normal theory tests of indirect effects are not provided with binary outcomes. Note that with binary outcomes the indirect and total effects are scaled differently, and so the total effect will not typically be equal to the sum of the direct and indirect effects. Thus,  $c - c'$  cannot be used as a substitute for the total indirect effect, nor can one use this difference in a metric of effect size such as the proportion of the effect that is mediated.

Logistic regression coefficients are estimated using a Newton-Raphson iteration algorithm. The number of iterations and convergence criterion can be set using the `/ITERATE` and `/CONVERGE` options in the command syntax.

## INDIRECT Custom Dialog Box

If you use INDIRECT frequently, you might find it convenient to install a version of the INDIRECT macro into your SPSS menus. To do so, download the indirect.spd (UI Dialog Builder) file from <http://www.afhayes.com/> and install from within SPSS under the Utilities menu. If you have administrative access to your machine, this should install a new option under your SPSS “Analyze→Regression” menu. If you do not have administrative access, you will have to contact your local information technology specialist for assistance in setting up administrative access to your computer.

## Notes

- The variables in `mvlist` must be quantitative variables and are assumed to have at least interval-level measurement properties. `xvar`, `dvar`, and variables in `covlist` can be dichotomous or quantitative with interval-level properties. **INDIRECT should not be used with a dichotomous mediator.**
- A case will be deleted from the analysis if missing on any of the variables in the model.
- Do not use STRING formatted variables in any of your models. Doing so will produce errors. All variables should be NUMERIC format.
- The macro is limited to the estimation of 10 specific indirect effects. If the user includes more than 10 mediators in the variable list, an error will result.
- INDIRECT can be used for estimating the indirect effect in model with only a single mediator.
- All path coefficients in the output are unstandardized.
- If bootstrap confidence intervals are desired, the minimum number recognized is 1,000. Any value less than 1000 will be treated as zero. The number of bootstrap samples conducted will be rounded down to the nearest 1,000 specified.

## References

- Hayes, A. F. (2018). *Introduction to mediation, moderation, and conditional process analysis: A regression-based approach*. New York: The Guilford Press.
- Hayes, A. F., & Preacher, K. J. (2014). Statistical mediation analysis with a multicategorical independent variable. *British Journal of Mathematical and Statistical Psychology*, 67, 451–470.
- Hayes, A. F. & Scharkow, M. (2013). The relative trustworthiness of tests of indirect effects in statistical mediation analysis: Does method really matter? *Psychological Science*, 24, 1918-1927.
- Hayes, A. F. (2009). Beyond Baron and Kenny: Statistical mediation analysis in the new millennium. *Communication Monographs*, 76, 408-420.

Preacher, K. J., & Hayes, A. F. (2008). Asymptotic and resampling strategies for assessing and comparing indirect effects in multiple mediator models. *Behavior Research Methods*, 40, 879-891.