



## Structural equation models for latent variables

In a study designed to determine the predictors of drinking and driving behavior among 18- to 24-year-old males, the model shown in the path diagram in Figure 1 was proposed.

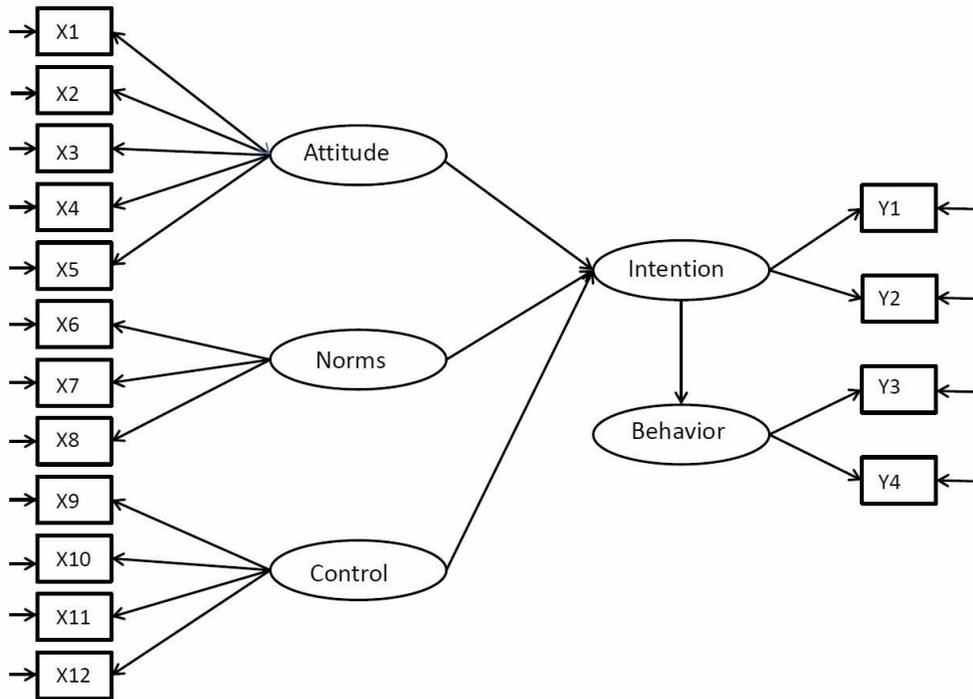
The latent variables shown in the figure are as follows:

- **Attitude** attitude toward drinking and driving
- **Norms** social norms pertaining to drinking and driving
- **Control** perceived control over drinking and driving
- **Intention** intention to drink and drive
- **Behavior** drinking and driving behavior

Attitude is measured by five indicators  $X_2 - X_5$ , Norms is measured by three indicators  $X_6 - X_8$ , Control is measured by four indicators  $X_9 - X_{12}$ , Intention is measured by two indicators  $Y_1 - Y_2$ , and behavior is measured by two indicators  $Y_3 - Y_4$ . Fictitious data based on the theory of planned behavior (Ajzen, 1991) is given in file **drinkdata.lsf** in the **SIMPLIS Examples** folder.

This example illustrates a possible strategy of analysis. Begin by testing the measurement model for Attitude, see file **drink11a.spl**.

```
Drinking and Driving
Testing Measurement Model for Attitude
Raw Data from File drinkdata.lsf
Latent Variables Attitude
Relationships
X1-X5 = Attitude
Path Diagram
End of Problem
```



**Figure 1: Conceptual Path Diagram for Attitudes to Drinking and Driving**

Note that although the data file **drinkdata.lsf** contains many variables, LISREL automatically selects the subset of variables used in the model.

To test the measurement model for Attitude and Norms simultaneously, add Norms in the list of Latent Variables and add the line, see file **drink12a.spl**.

X6-X8 = Norms

To test the measurement model for Attitude, Norms, and Control simultaneously, add Control in the list of Latent Variables and add the line, see file **drink13a.spl**.

X9-X12= Control

Finally, to test the measurement model for all latent variables simultaneously, add Intention and Behavior in the list of Latent Variables and add the two lines, see file **drink14a.spl**.

Y1-Y2 = Intention

Y3-Y4 = Behavior

If any of these analysis shows a large modification index for an indicator, the measurement model must be reconsidered and modified. For example, suppose there is a large modification index for the path from Attitude to X8. This might mean that X8 is not entirely an indicator of Norms but to some extent also a measure of Attitude. If this idea makes sense then the model should be modified by letting X8 be a composite measure of both Norms and Attitude.

One can now test the full model in Figure 1 by adding the two lines (see file **drink15a.spl**)

Intention = Attitude - Control Behavior = Intention

defining the structural relationships among the latent variables. The full SIMPLIS command file is now

Drinking and Driving  
 Testing the Full Model  
 Raw Data from File drinkdata.lsf  
 Latent Variables Attitude Norms Control Intention Behavior  
 Relationships  
 Y1-Y2 = Intention  
 Y3-Y4 = Behavior  
 X1-X5 X8 = Attitude  
 X6-X8 = Norms  
 X9-X12= Control  
 Intention = Attitude - Control  
 Behavior = Intention  
 Path Diagram  
 End of Problem

According to Browne & Cudeck (1993) one can use the following fit measures, see file **drink15a.out**:

Root Mean Square Error of Approximation (RMSEA)	0.0282	
90 Percent Confidence Interval for RMSEA	(0.0196	);
	0.0363)	
P-Value for Test of Close Fit (RMSEA < 0.05)	1.00	

to conclude that the model fits at least approximately.