Another example of testing a research hypothesis by comparing a full nested model -- and a bit more…

Something that you are all familiar with is the selection of students for a graduate psychology program. The program involved had routinely requested four pieces of information from applicants: gre quant score, gre verbal score, Miller's Analogy Test scores, and a rating (5-point scale) from the applicants major undergraduate advisor. One member of the selection committee has the hypothesis that the last two of these (MAT and Rating) were unnecessary, that the two GRE scores provided equivalent information, and they alone (the reduced model) would predict graduate student grades as well as all four of the variables (the full model). Here we go...

SPSS Code:

```
data list free / gpa greq grev mat averate.
  regression variables = gpa greq grev mat averate
            /statistics r coef anova cha
            /dependent = gpa /enter grev greq /enter mat averate.
```

SPSS Output:

```
Equation Number 1    Dependent Variable..   GPA
 Variable(s) Entered on Step Number 1..  GREV 2..  GREQ

Multiple R           .69874
R Square             .48824          R Square Change    .48824
Adjusted R Square    .45033          F Change         12.87959
Standard Error       .44472          Signif F Change    .0001
```

You will notice that the R-square Change for the first model requested is the same as the R-square for that model.

```
Analysis of Variance
                     DF      Sum of Squares      Mean Square
Regression            2             5.09463          2.54731
Residual             27             5.34004           .19778

F =      12.87959       Signif F =  .0001


------------------ Variables in the Equation ------------------
Variable              B         SE B       Beta         T  Sig T
GREV           .002757     .001119    .381620     2.464  .0204
GREQ           .005307     .001885    .435990     2.815  .0090
(Constant)   -1.274540     .963890               -1.322  .1972
```

So far so good. The reduced model "works," accounting for nearly 50% of the variance in the graduate school GPA! Also, BOTH of the variables in this reduced model are contributing to the model (though the raw score regression weights for both are quite small, because of the scale difference between GREs (mean = 500, std = 100) and GPA.

Now, we will test the research hypothesis by adding the other elements of the full model, to see if the R-square improves significantly. If it does, then the committee member's research hypothesis is not supported.

SPSS Output:

```
Variable(s) Entered on Step Number   3..  MAT 4..  AVERATE

  Multiple R           .80177
  R Square             .64283          R Square Change    .15459
  Adjusted R Square    .58568          F Change          5.41030
  Standard Error       .38611          Signif F Change    .0112

  Analysis of Variance
                     DF      Sum of Squares      Mean Square
  Regression          4             6.70773          1.67693
  Residual           25             3.72693           .14908

  F =      11.24876       Signif F =  .0000
```

```
------------------ Variables in the Equation ------------------
Variable              B        SE B       Beta          T  Sig T
GREV            .001538     .001042    .212965      1.476  .1524
GREQ            .003993     .001792    .328059      2.229  .0351
MAT             .020996     .009520    .323681      2.205  .0368
AVERATE         .141783     .112770    .198180      1.257  .2203
(Constant)    -1.742873     .939926                -1.854  .0755
```

Contrary to the committee member's research hypothesis, the addition of the MAT and the Rating did significantly improve the R-square (from .488 to .643, with a significant F Change).

However, you should note that not all four predictors are contributing to the full model. Specifically, both GREV and the Rating have non-significant regression weights in this model. This suggests that the full model is not necessary. What we know about the interpretation of multiple regression weights (that they reflect the contribution of that variable in that particular model) tells us that we can remove EITHER (BUT NOT BOTH) of these non-contributors without lowering the R-square significantly from .643.

Which should we choose? From a statistical perspective, the Rating is less likely to contribute to the full model than is GREV (compare the significance levels of the t-test). Also, from the committee member's perspective, the one to toss would be the Rating. So, the committee member decided to examine the model including only GREV. GREQ, and MAT.

SPSS Code:

```
regression variables = gpa greq grev mat averate
             /statistics r coef anova cha
             /dependent = gpa /enter grev greq mat averate / remove averate.
```

The full model results were the same as shown just above (deleted here to save paper). Below is the result from removing the Rating.

```
Equation Number 1    Dependent Variable..   GPA

  Block Number  2.  Method:  Remove      AVERATE

  Multiple R           .78756
  R Square             .62025          R Square Change   -.02258
  Adjusted R Square    .57643          F Change          1.58075
  Standard Error       .39039          Signif F Change    .2203

  Analysis of Variance
                      DF      Sum of Squares      Mean Square
  Regression           3             6.47208          2.15736
  Residual            26             3.96259           .15241
  F =      14.15524       Signif F =  .0000

  ------------------ Variables in the Equation ------------------
  Variable              B        SE B       Beta          T  Sig T
  GREV            .004630     .001051    .345674      4.405  .0014
  MAT             .026136     .008694    .402919      3.006  .0058
  GREQ            .004893     .001661    .401987      2.946  .0067
  (Constant)    -2.143359     .894128                -2.397  .0240
```

These results indicate that there is no significant loss in predictive power when the Rating is dropped from the regression model. In addition, notice that all three of the predictors are contributing significantly to the model. So, one way of describing these results is that the committee member was "half right", having correctly identified the Rating as unnecessary, but also incorrectly wanting to toss the MAT, which was contributing.