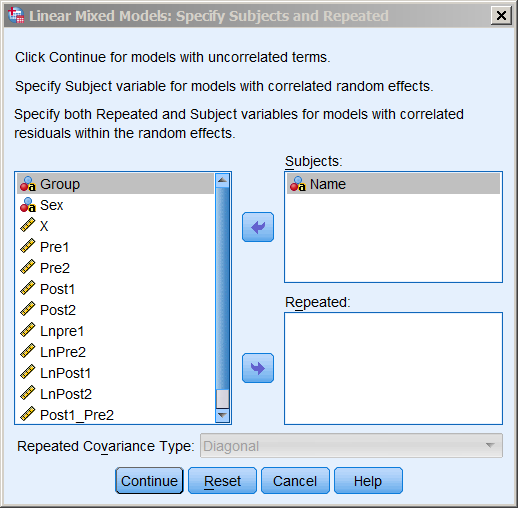
**SPSS Controlled-Trial Mixed Models**

When you have pre and post measurements of a dependent variable in a treatment and control group, you have a classic controlled trial. You can analyze such data by converting the repeated measurements into a single change score for each subject, as shown in my controlled-trial spreadsheet. You are effectively keeping the data in "wide" format. Although there is no repeated measurement on subjects, you still use a mixed model to estimate the SD representing individual responses. You can also put the data into "long" format, in which each repeated measurement is a separate datum or "observation". This is the usual approach when you have lots of repeated measurements. We'll do both here, with the same data, and we'll compare what we get with the analyses in the controlled-trial spreadsheet.

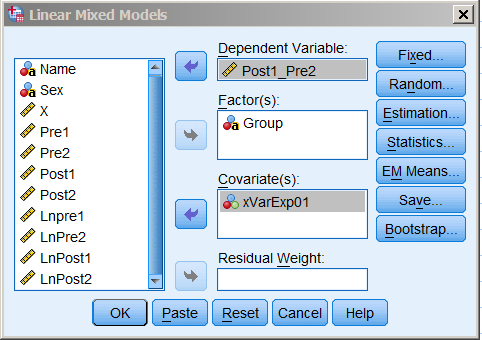
Links to the different analyses:  
[Analyzing Change Scores, Data in Wide Format](#changescoresdatawide)  
[Analyzing Change Scores, Data in Wide Format, Plus a Covariate](#changescorespluscovariate)  
[Analysis with Data in Long Format](#datalong)  
A[nalysis with Data in Long Format and More Than One Repeated Measurement](#datalongmorethanonerep)  
[Adjusting for Baseline with Data in Long Format](#adjustbaseinedatalong)  
[Estimating the Modifying Effects of Sex with the /TEST Statement](#effectsofsex)  
[Summary table](#summary)

**Analyzing Change Scores, Data in Wide Format**

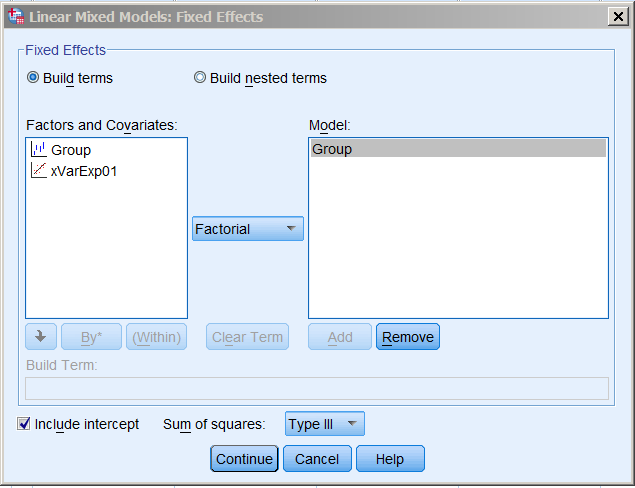
1. Import the Excel file "controlled trial data wide.xlsx". Inspect the data, and note the dummy variable xVarExp01. Then choose **Analyze/Mixed Models/Linear**. Make Name the **Subjects:**



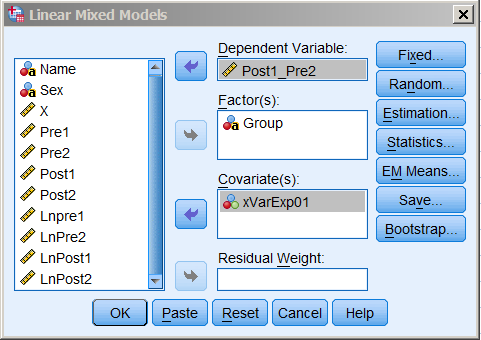
1. Choose this dependent variable, factor and covariate. We won't include X yet. Then click **Fixed**:



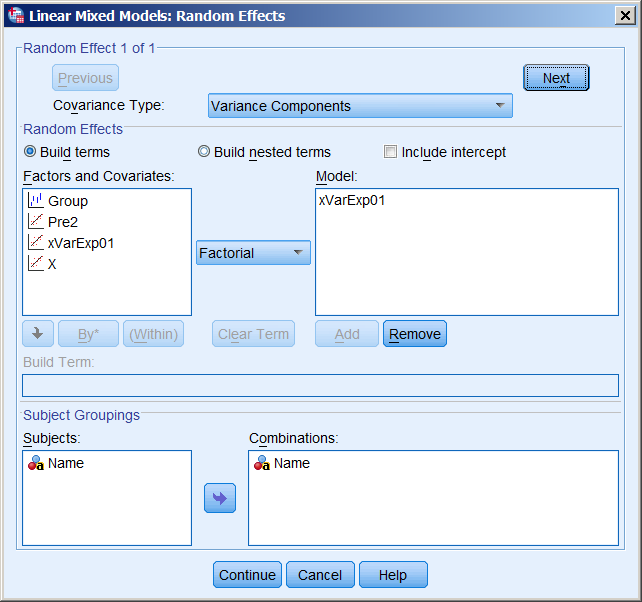
1. Now choose Group and **Add**. The choices in the **Factorial** button don't make any difference, and it doesn't matter whether you include the intercept. **Continue**.



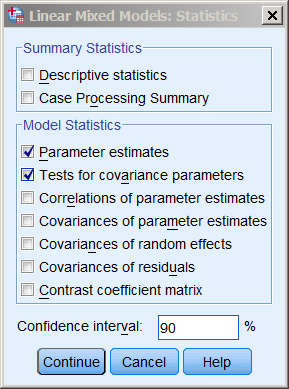
1. Click **Random**:



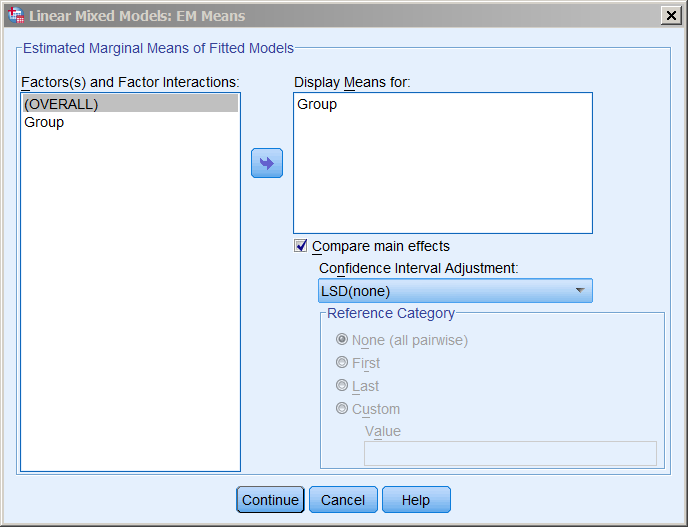
1. Put xVarExp01 into the Model and Name into Combinations. Keep the default Variance Components and do NOT tick Include intercept. This makes Name\*xVarExp01 a random effect. What we're doing here is adding a randomly chosen number to the change score for each athlete in the experimental group. That makes each number an individual response for each athlete in that group. The variance of those numbers is the statistic summarizing the individual responses. Click **Continue**:



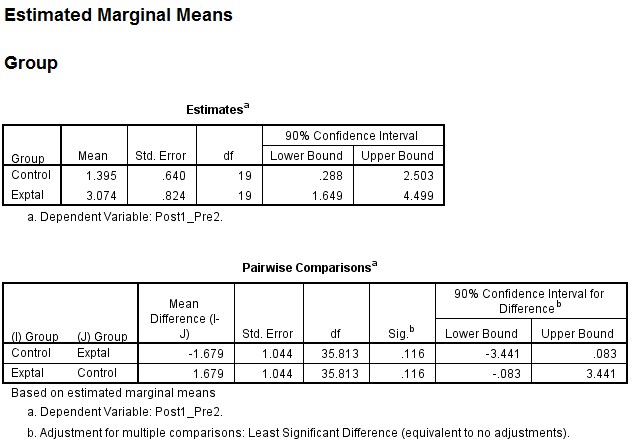
1. Click **Statistics** and select the following:



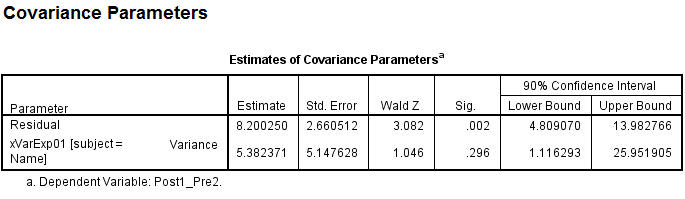
1. Click **Continue**, then **EM Means** and set this up, then **Continue**:



1. Then **OK**. Let's take the output in order of interest.
2. First, the treatment effect comes from the Estimated Marginal Means. The mean change scores are in the first panel, and the comparison of the means is in the second:



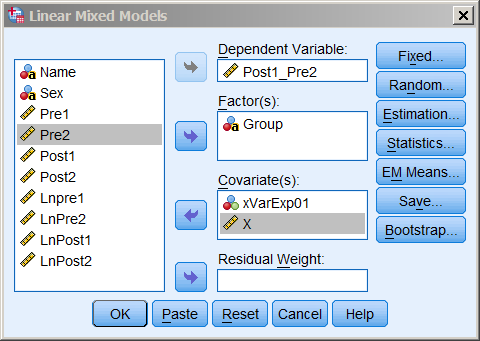
1. Check these against the spreadsheet "xParallelGroupsTrial to compare SPSS.xlsx". I have highlighted all relevant cells in pale green. Remember we are dealing with a log-transformed dependent! The un-back-transformed means are underneath each block of change scores. You will have to look lower down where the analysis is done before back transformation to find the difference in the changes and the confidence limits. You have to do the back-transformation to convert the above to an exact percent effect, 1.7% (Cell AB129: check the formula therein.)
2. Now the random effects:



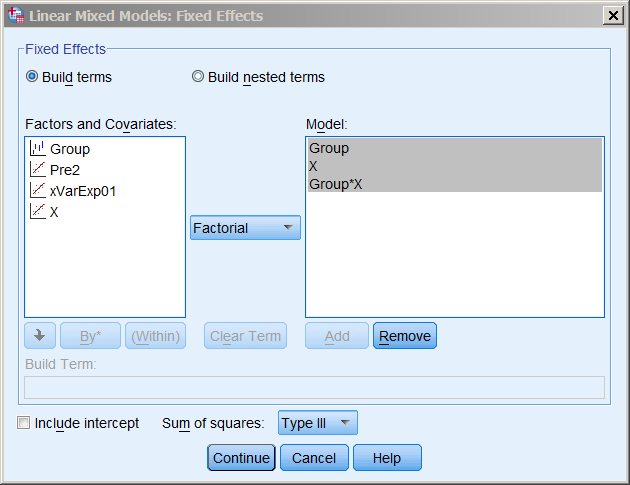
1. The individual responses are the square root of 5.38, which comes to 2.3. Fine, but the square roots of the confidence limits aren't the same as in the spreadsheet. The problem here is that SPSS will not allow negative variance, so it calculates confidence limits incorrectly, as if the variance had a chi-squared distribution rather than a normal distribution (the correct option). The chi-squared distribution is right for the Residual, but again it doesn't immediately agree with what's in the spreadsheet. The reason: SPSS is showing effectively the standard deviation of the change scores in the control group, but I have converted it to a typical error in the spreadsheet by dividing it by √2.
2. So how do you get correct confidence limits for the individual responses? Fortunately SPSS provides a standard error (the stats package R doesn't yet, March 2016). You just multiply the standard error by a z score appropriate for 90% confidence limits, 1.65, to get the confidence limits in ± form. Do it before you take the square root. Now the lower confidence limit is negative, so you have to change the sign before you take the square root, then make the answer negative. See the spreadsheet.

**Analyzing Change Scores, Data in Wide Format, Plus a Covariate**

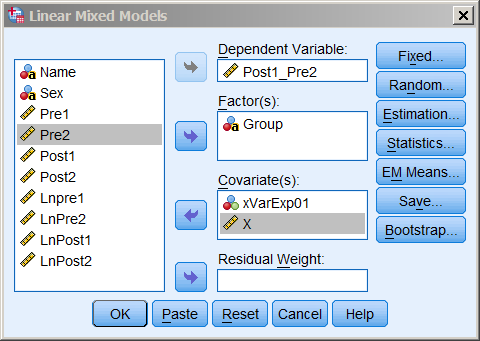
1. Choose **Analyze/Mixed Models/Linear** again. Keep the Specify subjects window as before (choose Name for the Subjects), **Continue**, add X to the covariates, then click **Fixed**:



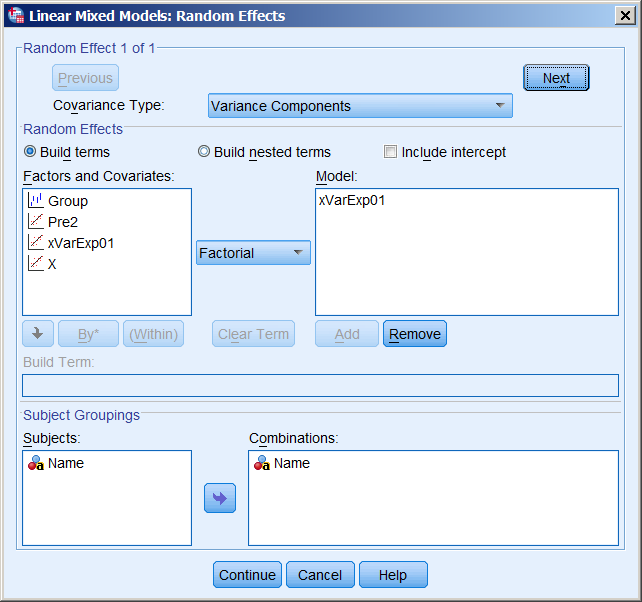
1. Select Group and X, keep the default Factorial, and **Add**. By the way, you don't have to have X itself in the model. Without it, you get a slope for X for each group, which represents the modifying effect of X on the change score in each group. With it, you still get two slopes, but one is associated with X, and the other is the difference between the slopes. It's hard to explain! Try it both ways and you will see what I mean. The intercept doesn't matter. **Continue**.



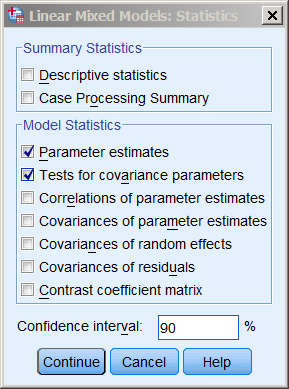
1. The rest is the same as before. Click **Random**:



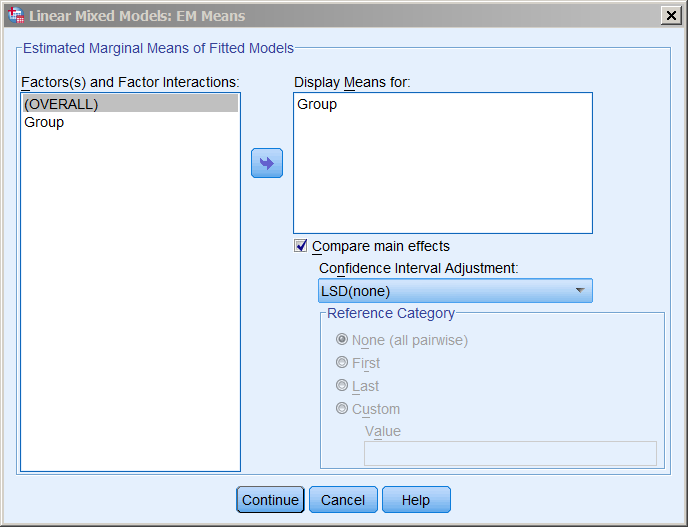
1. Keep the following. Click **Continue**:



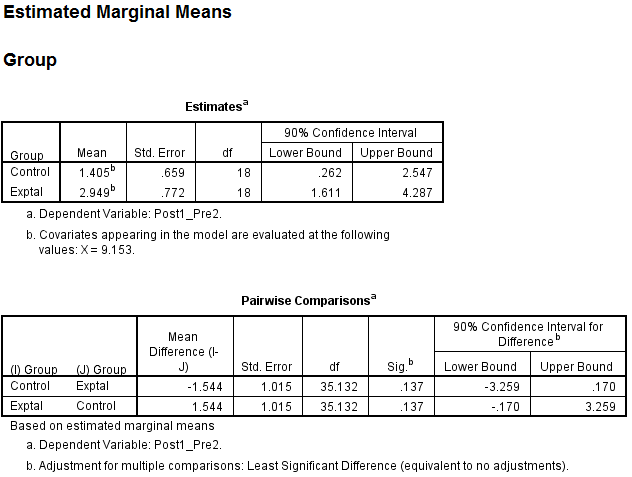
1. Click **Statistics** and keep the following, then **Continue**:



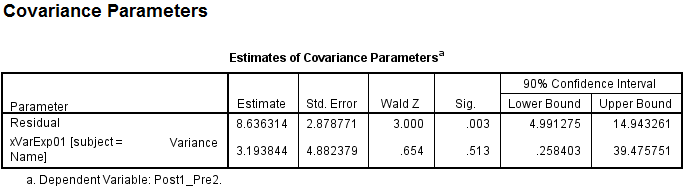
1. Click **Continue**, then **EM Means**, keep the following, then **Continue**:



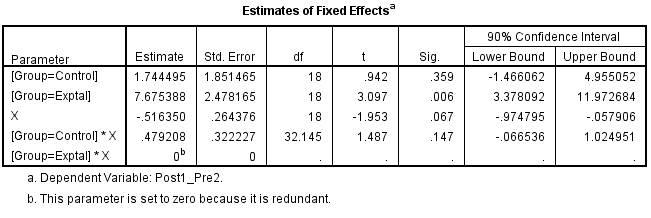
1. Then **OK**. Let's take the output in order of interest.
2. As before, the treatment effect comes from the Estimated Marginal Means. The mean change scores are in the first panel, and the comparison of the means is in the second:



1. Check these against the spreadsheet. You will have to copy the mean of X in Cell AA36 into Cell AA35, to make the spreadsheet show effects adjusted to the mean of X. The same cells highlighted in pale green are still relevant. The un-back-transformed means are underneath each block of change scores. You will have to look lower down where the analysis is done before back transformation to find the difference in the changes and the confidence limits. The back-transform value is 1.6%.
2. Now the random effects:



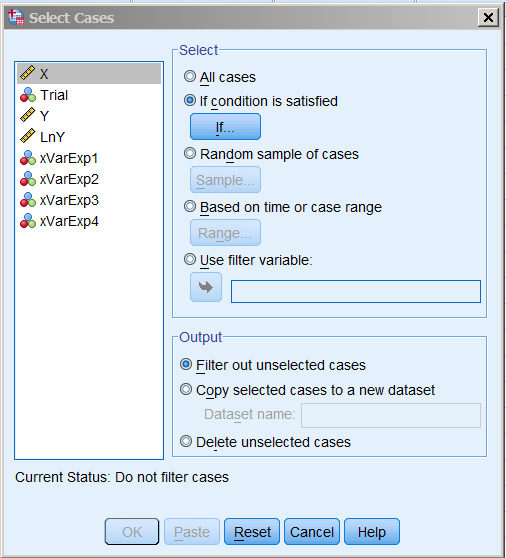
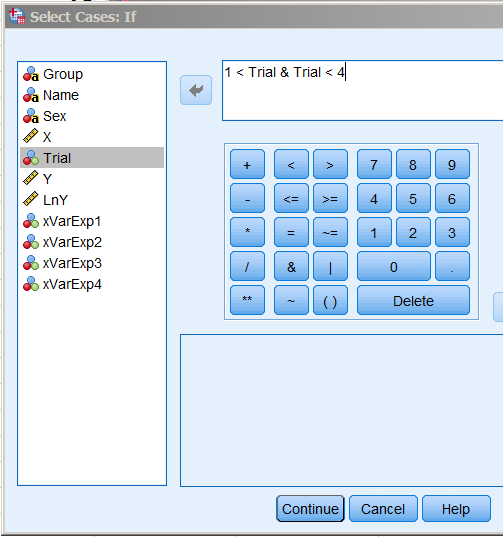
1. The individual responses are the square root of 3.19, which comes to 1.8: smaller than before, because the covariate X is accounting for some individual responses. As before, the square roots of the confidence limits aren't the same as in the spreadsheet. To get the correct confidence limits, as before you use that standard error with a z score appropriate for 90% confidence limits, 1.65. Do it before you take the square root. Now the lower confidence limit is negative, so you have to change the sign before you take the square root, then make the answer negative.
2. Finally the modifying effect of the covariate X… The spreadsheet does this too, but to see the slopes and the difference between the slopes you have to put something in Cell AA38. If you put 1 into that cell you will get the difference in slopes as an effect. The value for the difference in slopes is in Cell AB245, -0.48. This matches the value of [Group=Control]\*X here, except that the sign is changed, because SPSS has effectively made the Exptal group as the reference (a value of 0):



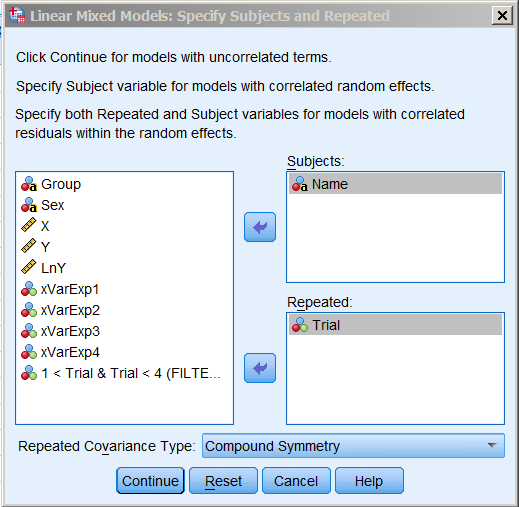
1. Read the comment in Cell Z38 of the spreadsheet to see how to evaluate the magnitude of the net modifying effect of X: you have to insert 2x the SD for X, which is 2x3.31 = 6.62. So the estimate and its confidence limits here would have to be multiplied by 6.62.

**Analysis with Data in Long Format**

1. The data are the same as above, a control and experimental group each with two pre-intervention and two post-intervention trials. Import the Excel file "controlled trial data long.xlsx". Inspect the data. The dependent variable is called Y and the trials have values 1 to 4. I have added four dummy variables with values of 1 for each of the four trials in the experimental group. We won't use all these.
2. To compare this approach with the change-scores approach, we have to limit the analyses to Trials 2 and 3. On the main menu, click Data/Select Cases…, then select **If condition is satisfied** and click **If…** Then create the condition shown (1 < Trial & Trial < 4), and click **Continue** and then **OK**.

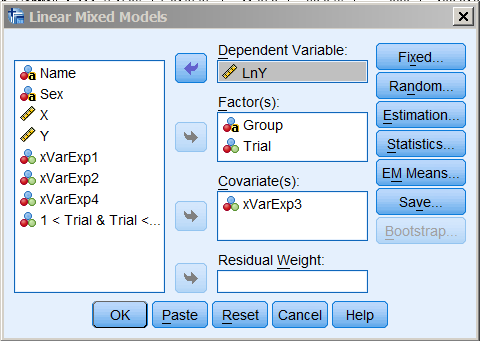
 

You can check the data window to see which cases have been crossed out.

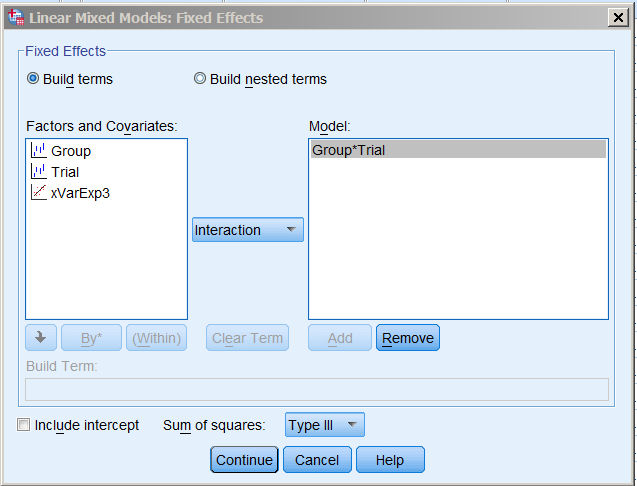
1. Choose **Analyze/Mixed Models/Linear**. Choose Name for Subjects, Trial for Repeated, and select **Compound Symmetry** for the Repeated Covariance Type:  
   

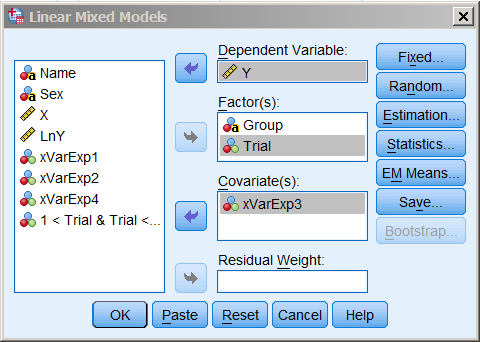
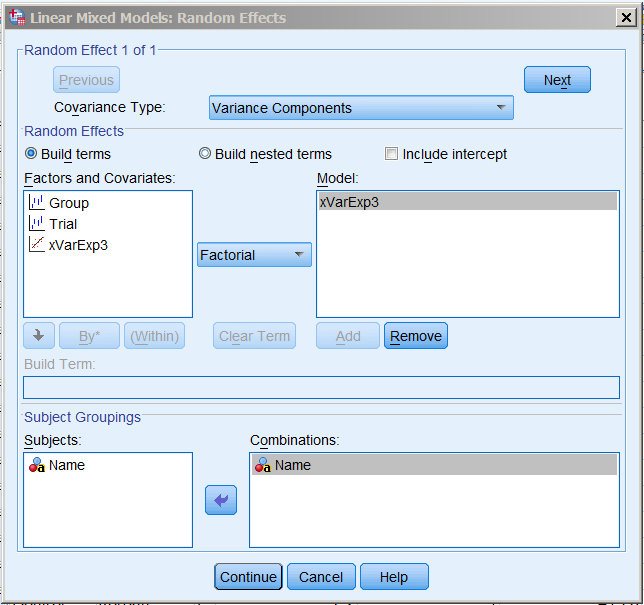
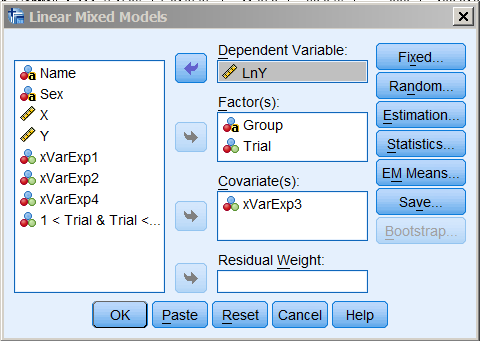
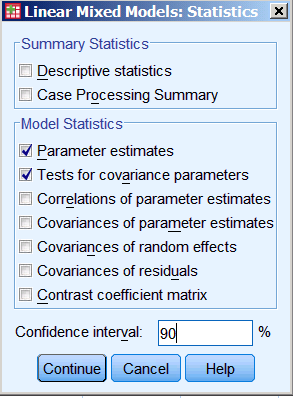
This random-effects structure estimates a mean value for each subject and the same residual error for every trial. This is an alternative approach to making Name a random effect in the Random window. I've included it here only to show you that it's possible and to show the different terminology it produces in the output.

1. Select the Dependent Variable (LnY), Factors (Group, Trial), and Covariates (xvarExp3). We'll leave X out of the model to start with:

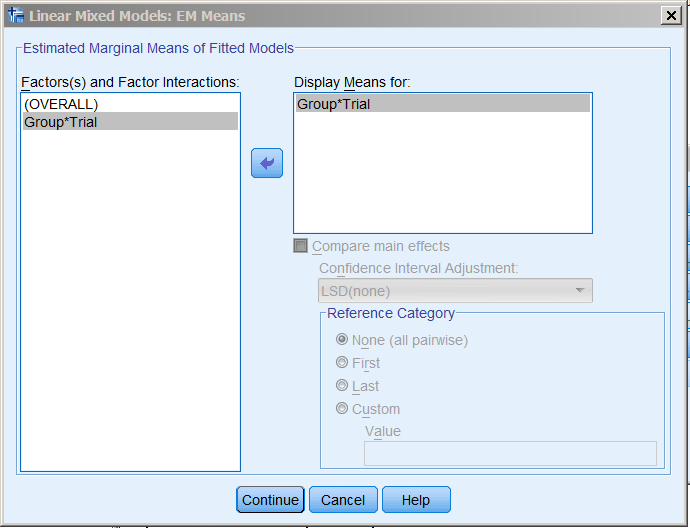


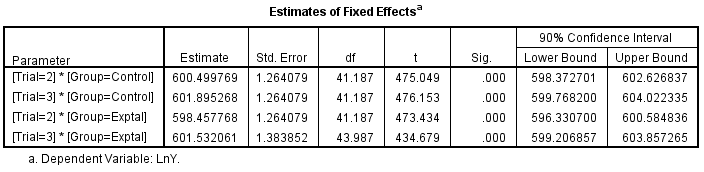
1. Click **Fixed**... Select Group and Trial, choose Interaction (not Factorial), click **Add**. The Intercept doesn't matter. Then **Continue**:



1. Click **Random**…   
     
   Keep the default **Variance Components**. In the Factors and Covariates window, select xvarExp3, then click **Add**. **Factorial** doesn't matter. In the Subject Groupings, select Athlete and put into Combinations. Once again this makes a random effect for Name\*xVarExp3, to estimate individual responses. Don't include the intercept. Click **Continue**.  
     
   
2. Click **Statistics**…  
     
      
     
   and under Model Statistics tick Parameter estimates and Tests for covariance parameters. And, of course, a 90% confidence interval. **Continue**.
3. Click **EM Means**…

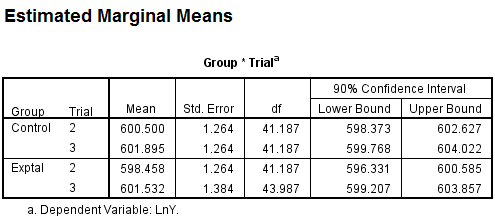
Click **EM Means** and select Group\*Trial. Then **Continue**.



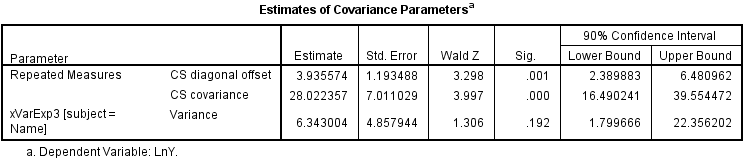
1. Finally, click **OK**.
2. The Estimates of the Fixed Effects are the coefficients of the fixed effects in the linear model:

If we had kept the Intercept in the fixed-effects model, these would look quite different, but it doesn't matter.

1. The Estimated Marginal Means are the same as the coefficients. These wouldn't change if we included an intercept in the fixed-effects model:



1. At this stage we don't have the thing we want most, the difference (Exptal – Control) in the changes (Trial 3 – Trial 2). We'll come back to that shortly.
2. Meantime the Covariance Parameters…

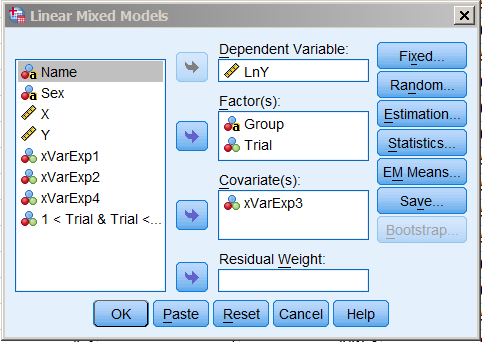


xVarExp3 [Subject = Name] is the individual responses in the experimental group on the first post-test. You will see it's a bit different from the value we got with the analysis of change scores (5.38). The CS diagonal offset (3.94) is the residual error, which at first glance is quite different from the residual in the previous analysis (8.20). In fact it is about half the previous value, which is right, because the residual in the previous analysis represents the overall SD of change scores, which are √2 times the typical error. These estimates here are variances, which makes the variance of the change scores twice the variance for the typical error. Only it's not quite twice!

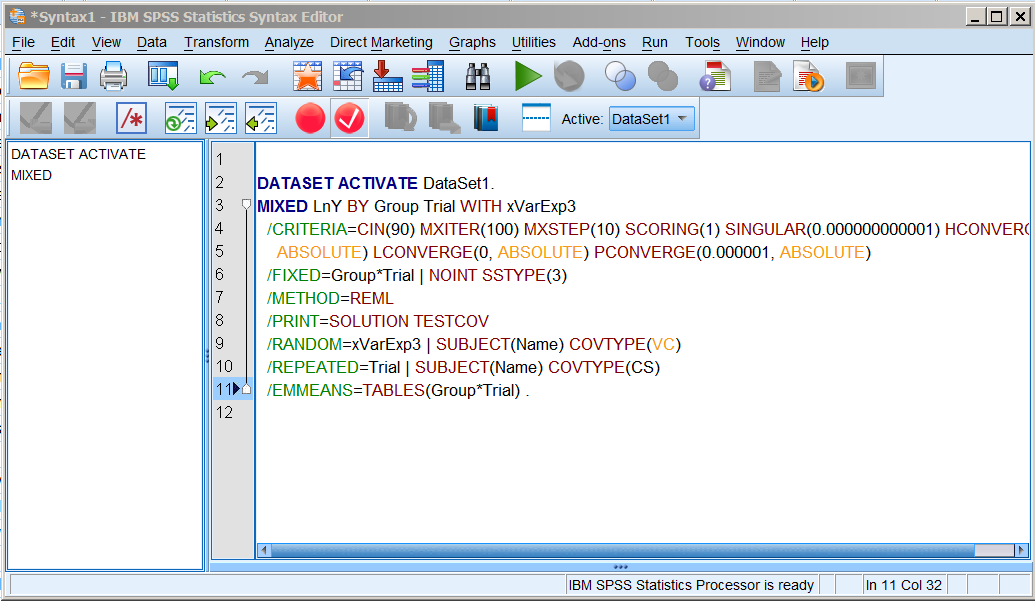
The estimates differ slightly, because the mixed model here is also trying to estimate a random effect for subjects; that is, an individual mean value for each subject. With the analysis of change scores, the differences between subjects disappear. The optimization of the fit of the data to the model therefore has to contend with something extra here, so it converges on a slightly different answer. The values for each subject are summarized as a variance with the CS covariance estimate, 28.0. The square root is 5.3, which is the approximate difference between subjects expressed as a coefficient of variation (%).

As before, to get proper confidence limits for the individual responses and the subject variance (but not the residual error), you use the standard error with a z score appropriate for 90% confidence limits, 1.65. Do it before you take the square root. If the lower confidence limit is negative, you have to change the sign before you take the square root, then make the answer negative. And you have to back-transform everything to get exact percent values.

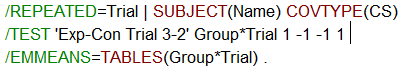
1. Now let's estimate the mean effect of the treatment. To do so, we have to access and modify the script that SPSS uses to run its analyses. Bring up the analysis again via **Analyze/Mixed Models/Linear…**, click **Continue**, and in this window, click **Paste**:



1. This window will open:

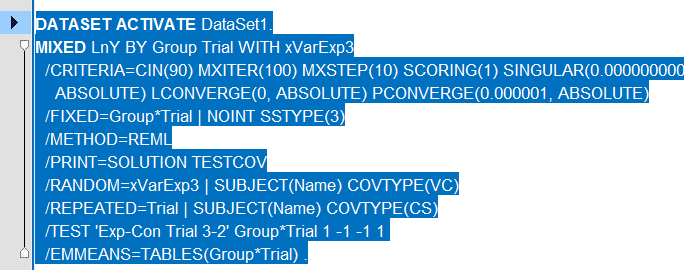
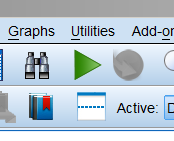


Click at the end of the /REPEATED line, then type /TEST 'Exp-Con Trial 3-2' Group\*Trial 1 -1 -1 1   
as shown here:

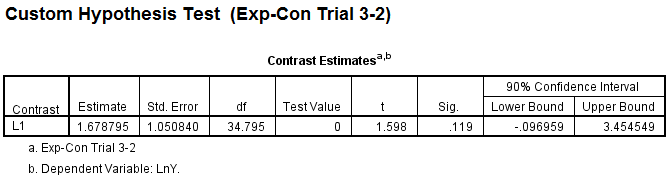


You will have to get used to this kind of obscure code! Group\*Trial implies that four means are estimated, the means for:  
Group=Control, Trial =2  
Group=Control, Trial = 3  
Group=Exptal, Trial =2  
Group=Exptal, Trial = 3.  
These are evaluated in the alphabetical order shown, the first level of Group first, with its two trials, then the second level of Group, with its two trials. The numbers 1 -1 -1 1 combine these means to get the net effect that we want.

1. Highlight the code, as shown, then click the big green triangle in the menu bar:

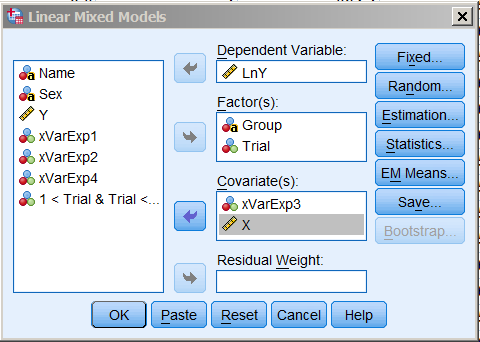
   
  


1. The output is the same as before, but we now have this extra bit, which is what we want:

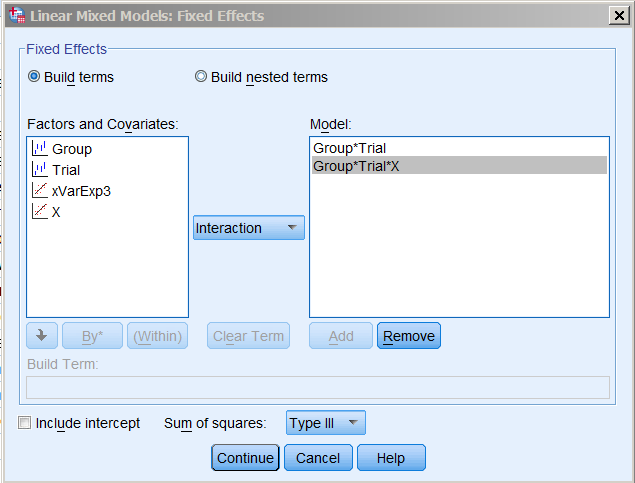


The value is the same as for the analysis of change scores. The estimate and its confidence limits have to be back-transformed to get the exact percent effect.

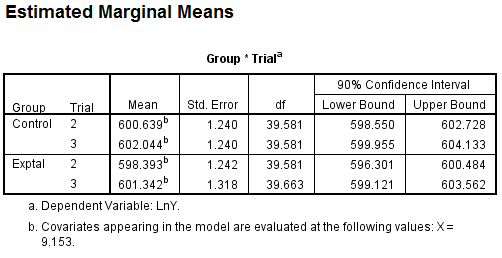
1. Now let's include the covariate X. Choose **Analyze/Mixed Models/Linear**. The previous model should still be installed. Click **Continue**, and add X to the Covariate(s) window:



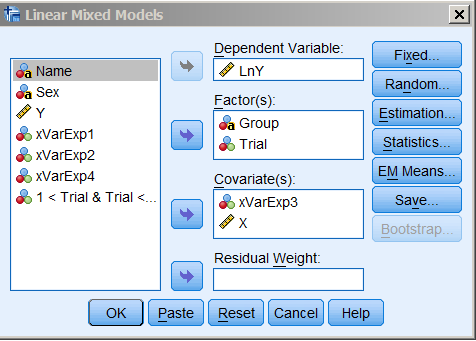
1. Click **Fixed** and add Group\*Trial\*X to the model, then **Continue**:



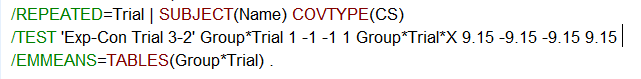
1. Click **OK** in the next window.
2. The estimated marginal means are now adjusted to the overall mean value for X, 9.153, as stated here:



1. The differences between these means give us the effect of the treatment adjusted to the mean of X, but to get the difference we want, we need another /TEST statement, as follows.
2. Choose **Analyze/Mixed Models/Linear** yet again, click **Continue**, then click **Paste** in this window:

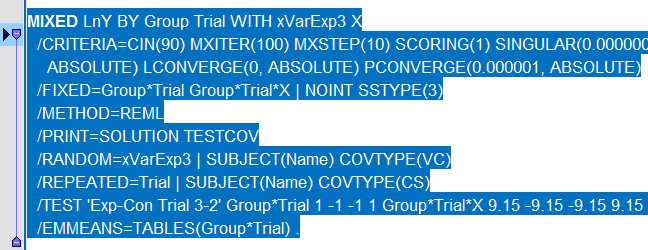
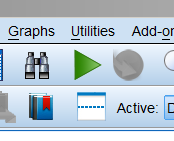


1. Find the Syntax window, copy /TEST 'Exp-Con Trial 3-2' Group\*Trial 1 -1 -1 1 from the previous code, paste it into the new code, then add Group\*Trial\*X 9.15 -9.15 -9.15 9.15 to the end of that line:

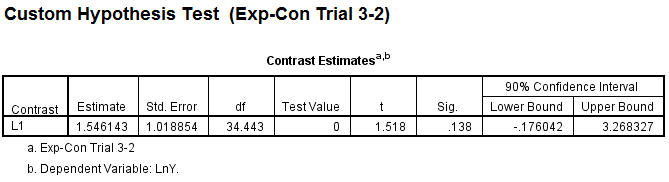


This extra bit of code means that we are taking into account the contribution of the covariate in the model at the mean value of X. If we didn't have this term, we would end up evaluating the effect of the treatment for X=0, which would mean no baseline training. My controlled-trial spreadsheet makes it clearer what's going on. I don't know how anyone understands this sort of thing without the graphical interpretation I show there.

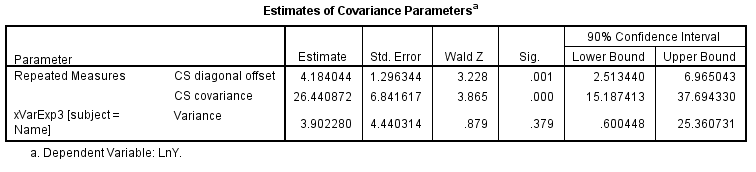
1. Highlight the code and click the green triangle:

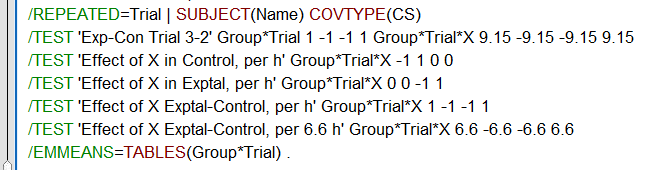
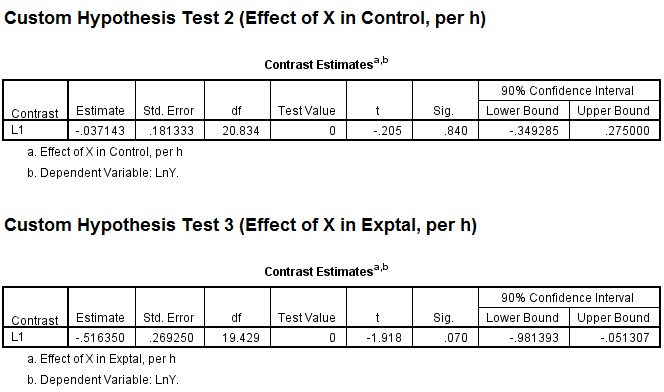
1. This part of the output now has the net effect of the treatment, properly adjusted to the mean of X:



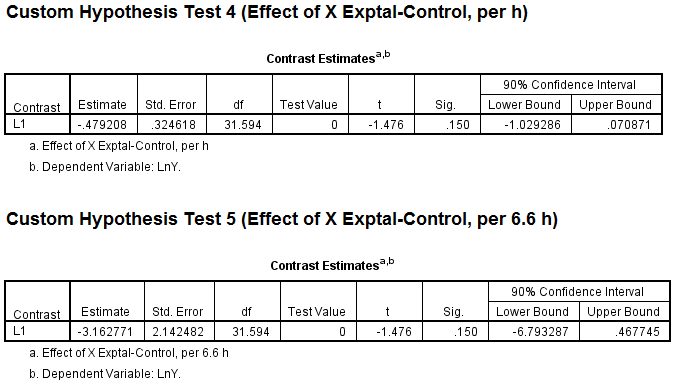
1. And the covariance parameters provide the individual responses and typical error, as variances:



As before, the individual responses are smaller than in the model without X, because X is obviously accounting for some individual responses. The value here isn't exactly the same as in the analysis of change scores with X included, for reasons already explained about the different kinds of analysis.

1. Finally, let's evaluate the effect of the covariate X in each group, and the net effect (Exptal – Control). Bring up the Syntax window, copy and paste the last lot of code, then copy and paste in these terms as shown:  
    /TEST 'Effect of X in Control, per h' Group\*Trial\*X -1 1 0 0  
    /TEST 'Effect of X in Exptal, per h' Group\*Trial\*X 0 0 -1 1  
    /TEST 'Effect of X Exptal-Control, per h' Group\*Trial\*X 1 -1 -1 1  
    /TEST 'Effect of X Exptal-Control, per 6.6 h' Group\*Trial\*X 6.6 -6.6 -6.6 6.6  
     
   
2. Highlight all the code for the analysis and run it. Here's the effect of X in each group:

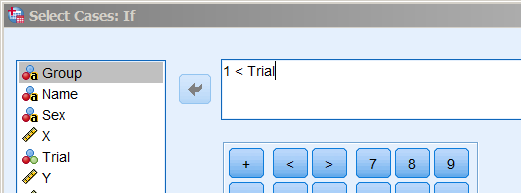
And here's the net effect for 1 h of X and for 6.6 h of X, which is, of course the effect of 2 SD of X:



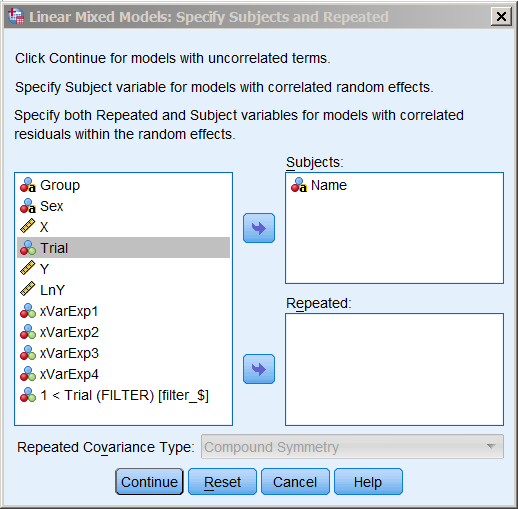
Compare all these with the effects in the controlled-trial spreadsheet.

**Analysis with Data in Long Format and More Than One Repeated Measurement**

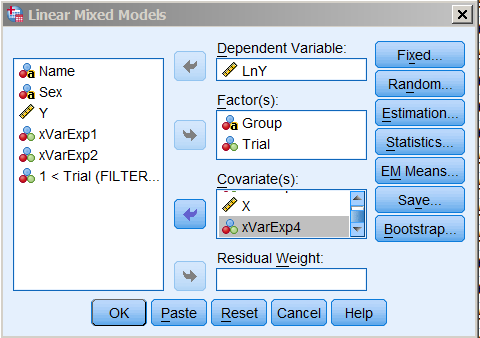
1. Let's add an extra trial, the second post test, Trial 4. Add it in by going to Data/Select Cases…, click on **If…**, and make is simply 1< Trial:

  
  
Click **Continue** and **OK**. Check the data window to make sure only Trial 1 is crossed out.

1. As usual, choose **Analyze/Mixed Models/Linear**. Choose Name for **Subjects**, but this time let's get the basic random-effects model a different way. Remove Trial from the Repeated window, and **Continue**:

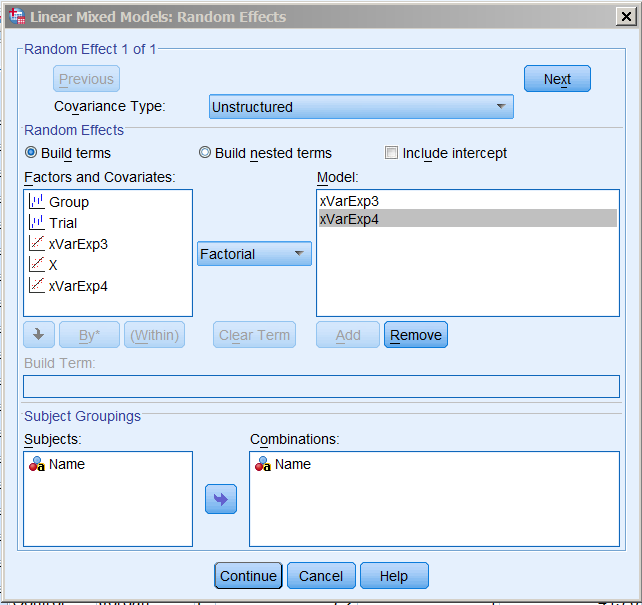


1. Add xVarExp4 to the Covariate(s) window:



We're preparing to analyze individual responses on the second post test.

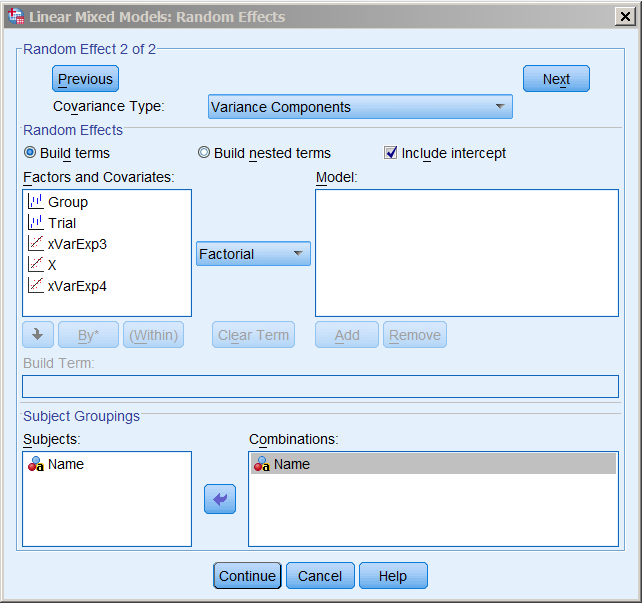
1. The Fixed effects are the same as before, but you have to change the Random effects by adding xVarExp4, as shown, and select **Unstructured** for the covariance type:



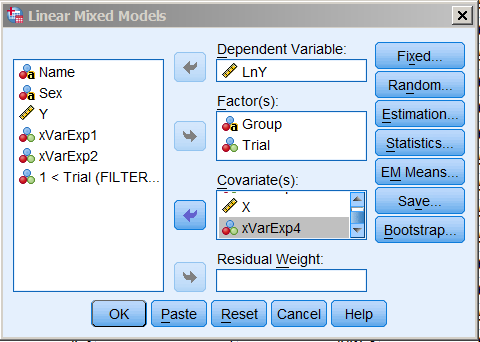
Choosing Unstructured allows for the individual responses in the first and second post test to be correlated, which is what you would expect: if someone responds well in the first post test, they will probably still be responding well to some extent in the second post test.

1. But wait, there's more...

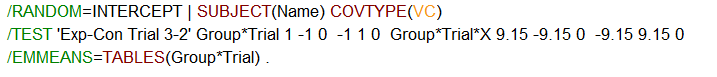
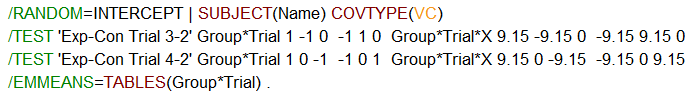
We got rid of the compound-symmetry repeated-measures structure. so we have to do something about repeated measurement here. In some ways it's more natural here, because we simply specify the subjects (Name) as a random effect. Do it by clicking **Next** rather than **Continue**, whereupon you will get another random-effect window. Put Name into Combinations, and this time tick Include intercept, then **Continue**:



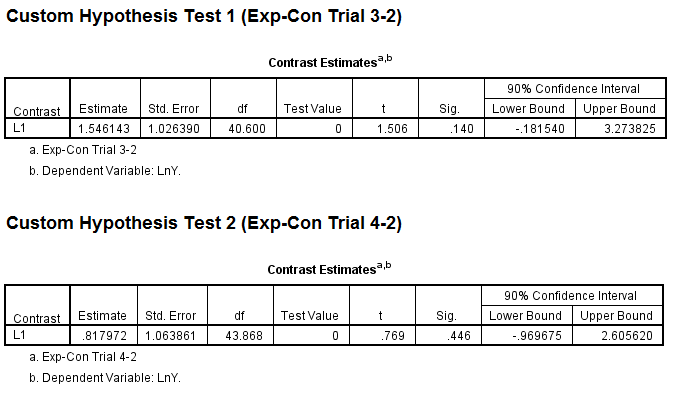
1. Instead of **OK**, let's click **Paste** and work out the new /TEST code to take into account the extra trial:



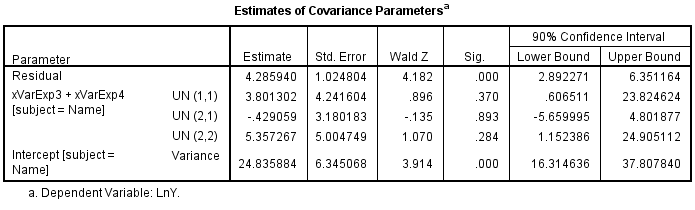
1. Find the Syntax window, copy this line  
    /TEST 'Exp-Con Trial 3-2' Group\*Trial 1 -1 -1 1 Group\*Trial\*X 9.15 -9.15 -9.15 9.15  
   from the previous code into the latest code, and add some zeros so that it really does estimate the net effect for Trial 3-2. You can put extra spaces between the sets of three so you don't get lost:

  
Now add another line to estimate the net effect for Trial 4-2:  
Highlight the complete block of code and click the green triangle to run it.

1. Here are the two net effects:

  
The treatment effect was evidently wearing off in the second post test.

1. And here are the random effects:

  
The individual responses (as a variance) in the first post test and second post test are given by UN(1,1) and UN(2,2). According to these data, the individual responses were tending to be a bit bigger in the second post test. UN(2,1) is the covariance, which I would have expected to be positive, rather than negative (because bigger responders in the first post test should be bigger responders in the second post test). Still, it has a considerable standard error, which allows for the possibility of a true positive covariance. And anyway, you don't do anything with this term.

1. OMG, there's even more…

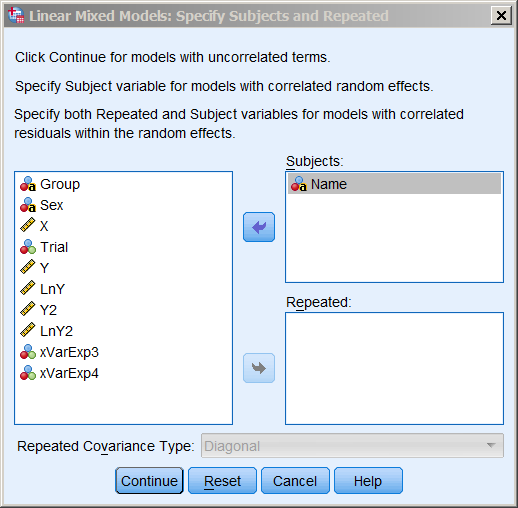
**Adjusting for Baseline with Data in Long Format**

1. The baseline or pre-test value of the dependent variable can be an important modifier of a treatment effect (e.g., subjects with high initial values have less headroom for improvement). It's easy to include the pre-test as a modifier of change scores, but when modeling in long format, it's a bit trickier

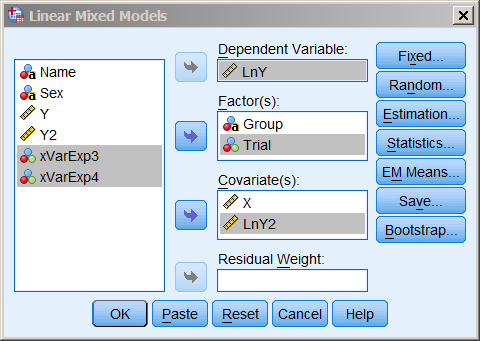
When using the pre test as a covariate, it simply doesn't make sense to include the pre test as a repeated measurement, because you'd be predicting that measurement with itself! Instead, you have to delete all the observations for that trial, but copy it alongside all the other trials like any other subject characteristic. It's as if you start the repeated measurements with the first post test. In the analysis, you include baseline as a modifying covariate, which means you are effectively analyzing change scores.

I have modified the dataset we have been using as an example. I've made Trial 2 the baseline, to make it easy to develop the /TEST codes from the previous programs, and I have dropped Trial 1 from the dataset altogether, for simplicity.

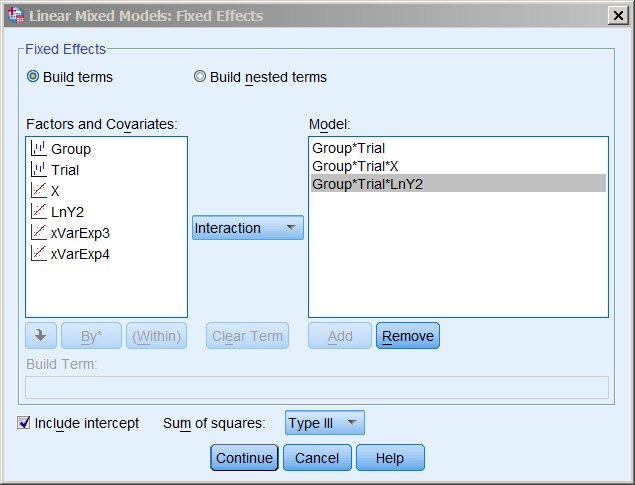
1. Import the file "controlled trial data long baseline covariate.xlsx", and view the data to see that there are now only two trials, Trial 3 and 4, and that Trial 2 has been copied into each trial as the new variables Y2 and LnY2. And there are now only two dummy variables, xVarExp3 and xVarExp4.
2. Choose **Analyze/Mixed Models/Linear** yet again and start the same model again, **Continue**:



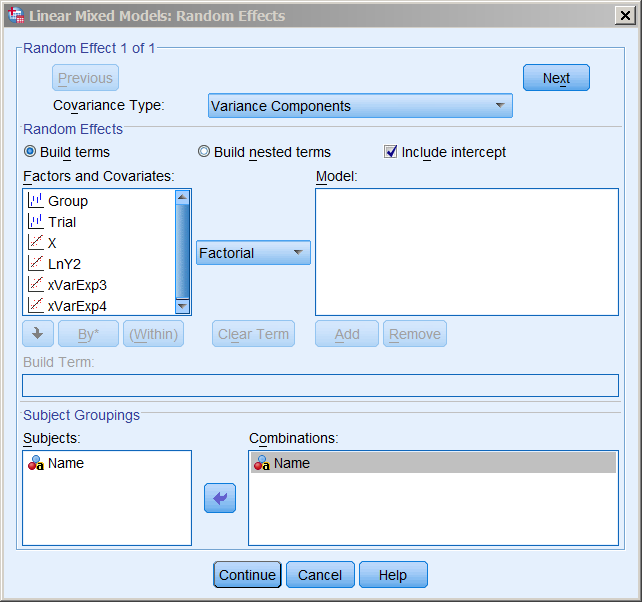
1. Choose LnY as the dependent, Group and Trial as factors, and X, LnY2, xVarExp3 and xVarExp4 as covariates:



1. Click **Fixed** and put Group\*Trial, Group\*Trial\*X and Group\*Trial\*LnY2 into the model:

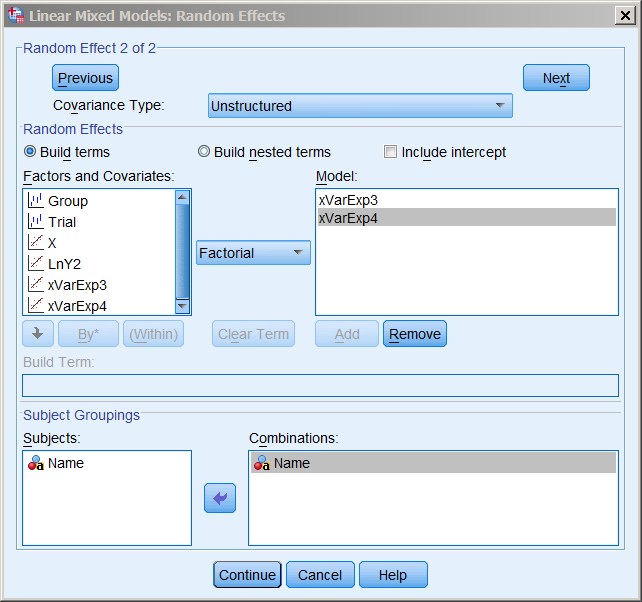


1. Continue, then Random and set this up, which makes Name (the subjects) a random effect:



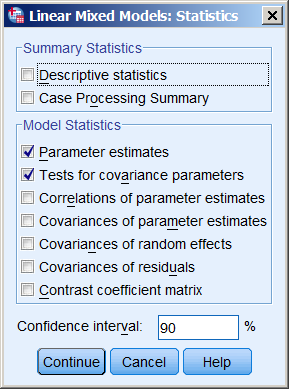
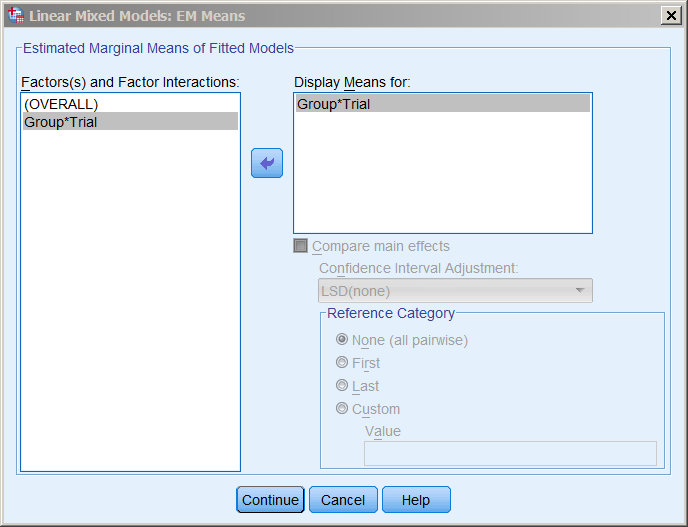
Make sure you tick Include intercept!

1. Click **Next** and set this up, which specifies individual responses in the two post tests by making Name\*xVarExp3 and Name\*xVarExp4 random effects:

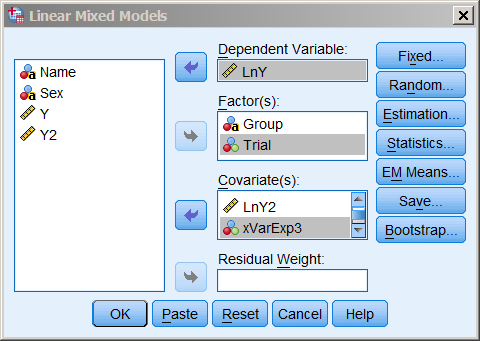


Make sure you have chosen **Unstructured**, to allow the individual responses to be correlated.

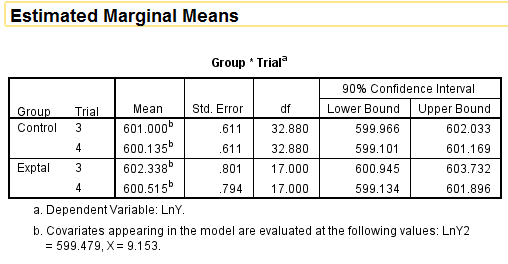
1. Choose the usual options in the Statistics and EM Means windows…

1. **Continue** to get back to this window:

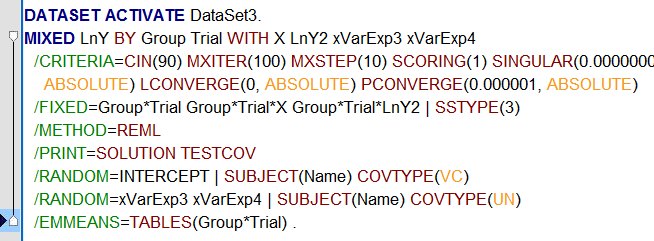


1. Click OK, then find the Estimated Marginal Means panel and get the mean value for LnY2 (599.479) from the footnote:

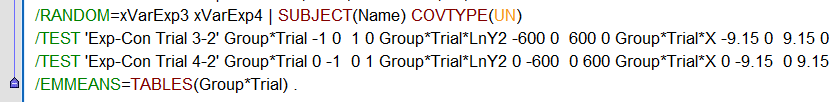


(Or you could get it via Analyze/Descriptive Statistics, but this is quicker.)

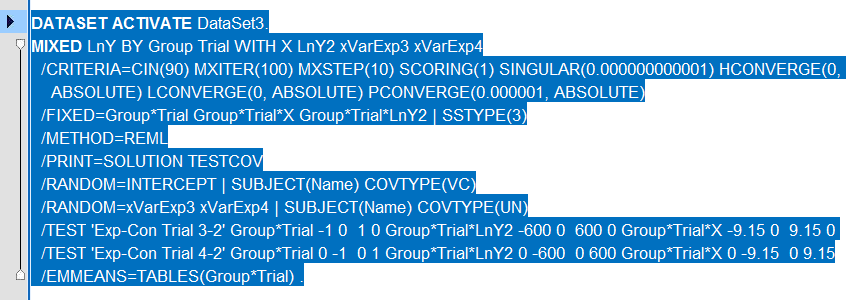
1. Now activate **Analyze/Mixed Models/Linear** yet again to start the same model again, click **Continue**, then click **Paste** to generate this code in the Syntax window…



1. Copy and modify a previous /TEST line to create these lines:  
    /TEST 'Exp-Con Trial 3-2' Group\*Trial -1 0 1 0 Group\*Trial\*LnY2 -600 0 600 0 Group\*Trial\*X -9.15 0 9.15 0   
    /TEST 'Exp-Con Trial 4-2' Group\*Trial 0 -1 0 1 Group\*Trial\*LnY2 0 -600 0 600 Group\*Trial\*X 0 -9.15 0 9.15  
   (or just copy them from here), and interpolate them into the code before the last command:

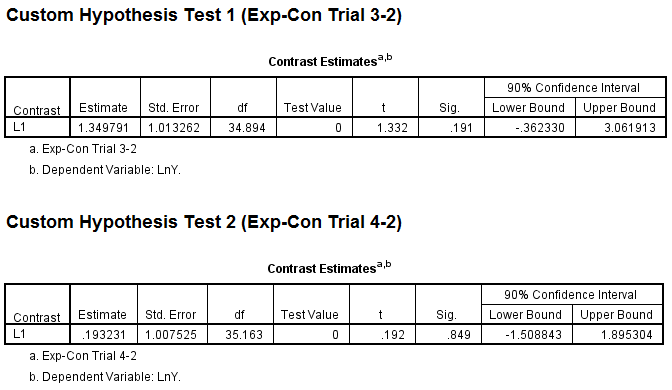


1. Now select it:



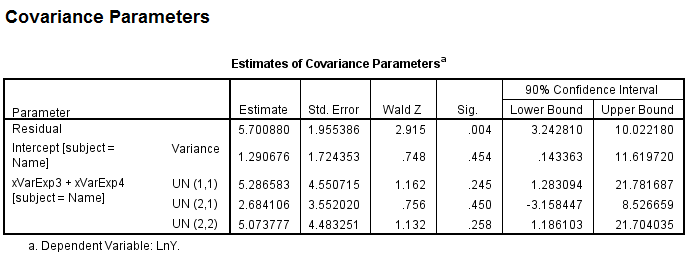
and run it with the green triangle.

1. Here's the output that matters, the two new estimates:

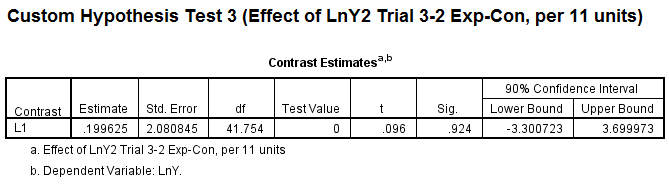


The effects look about right!

And the random effects:



1. Check back to the values for the previous model, without the baseline. The individual responses in the first post test, UN(1,1), have actually increased a bit: 5.3 vs 3.8. I suspect that the baseline is not having any modifying effect on the effect! How else to decide? By estimating the modifying effect directly, of course! We'll need to evaluate it for 2 SD of the baseline. You can find the SD in Cell V105 of the controlled-trial spreadsheet. It's 5.5, so let's evaluate 11 units, which is the approximate percent difference between subjects with a typically high vs typically low baseline value of the dependent variable.
2. Go back to the Script window and interpolate this statement before the last line of code:  
    /TEST 'Effect of LnY2 Trial 3-2 Exp-Con, per 11 units' Group\*Trial\*LnY2 -11 0 11 0  
   then highlight and run the whole block of code.
3. Uh huh, only 0.2%:



We haven't considered smallest important effects yet, but if we use standardization, and the baseline SD is ~5.5%, then the smallest important change is 0.2\*5.5 = 1.1%, so 0.2% is trivial. The standard error is 2.1%, so the confidence interval is awfully wide, which makes this effect awfully unclear, but in this sample the effect is trivial, and that's why it didn't reduce the individual responses.

**Estimating the Modifying Effects of Sex with the /TEST Statement**

1. When you have two or more distinct subgroups of subjects, such as females and males, in a controlled trial, you should investigate the effects of the treatment in each subgroup, the difference between the subgroups, and possibly the effect averaged over the two subgroups (which is equivalent to the effect with equal numbers of females and males and without sex in the model). You do it with /TEST statements. As an example, let's return to the first use of /TEST with data in long format.
2. We used /TEST 'Exp-Con Trial 3-2' Group\*Trial 1 -1 -1 1 to estimate the change in the exptal group minus the change in the control group. To take Sex into account, we have to make Sex a factor, then make Sex\*Group\*Trial the fixed effect. We are estimating eight means, four each for the females and the males. So we need eight coefficients in the /TEST statement. The first four will be for the females, and the second four will be for the males. Here, then, are the statements you need, hopefully self-evident:

Effect in females: /TEST 'F Exp-Con Trial 3-2' Sex\*Group\*Trial 1 -1 -1 1 0 0 0 0  
Effect in males: /TEST 'M Exp-Con Trial 3-2' Sex\*Group\*Trial 0 0 0 0 1 -1 -1 1

Effect in females - males: /TEST 'F-M Exp-Con Trial 3-2' Sex\*Group\*Trial 1 -1 -1 1 -1 1 1 -1  
Effect in (females+males)/2: /TEST '(F+M)/2 Exp-Con Trial 3-2' Sex\*Group\*Trial .5 -.5 -.5 .5 .5 -.5 -.5 .5  
 or /TEST '(F+M)/2 Exp-Con Trial 3-2' Sex\*Group\*Trial 1 -1 -1 1 1 -1 -1 1 divisor=2

If you have other predictors in the model, and you are concerned about the modifying effect of sex on those predictors, interact Sex with those predictors and write similar doubled-up sets of coefficients for those terms in the /TEST statement. Consider carefully whether you want females and males compared at overall mean value of a predictors, or at the mean values of the females and males. If you do separate analyses of the females and males (highly advisable!), you would usually evaluate effects at their respective means, and you would compare the females and males with the "Combine/compare effects" spreadsheet.

1. And finally…

|  |  |  |
| --- | --- | --- |
| **Summary of the various methods for analyzing reliability, controlled trials and other repeated measures.** Anything other than my spreadsheets has the disadvantage that you have to do lots of processing to deal with log transformation and magnitude-based inferences. SPSS also has the disadvantage of not producing negative variance for estimates and confidence limits of random effects. | | |
| Method | Advantages | Disadvantages |
| **Reliability Analyses** | | |
| Sportscience consecutive pairwise spreadsheet | Best for performance or fitness tests.  Logs and graphs all done for you. | No good for clustering (multiple sources of variability). |
| Sportscience one- and two-way spreadsheets | Good for simple block of repeated measurements, if discard familiarization trial(s).  Logs and graphs all done for you. | No good for clustering (multiple sources of variability).  Can’t handle missing data in 2-way analyses. |
| SPSS Scale/Reliability | Good for simple block of repeated measurements, if discard familiarization trial(s). | No good for clustering (multiple sources of variability).  Can’t handle missing data in 2-way analyses. |
| Mixed modeling | Best for clustering (multiple sources of variability).  Add covariates for studies of monitoring. | Can't create random-effect model for consecutive pairwise analysis (usual autoregressive models don't work). |
| **Controlled-trial Analyses** | | |
| Spreadsheet for analysis of change scores | Good for only a few trials.  Logs, graphs and MBIs all done for you.  Modifying effect of covariates is easy to understand from the graphs.  Modifying effect of baseline is easy.  Mediator analysis with change scores for a covariate is easy. | Only one covariate at a time.  Only two groups at a time.  Only one trial effect at a time (but can combine trials using "within-subject modeling"). |
| Mixed modeling of change scores,  data in wide format | Best for only a few trials.  Simple fixed and random effects.  Modifying effect of baseline is easy. | Only one trial effect at a time (but can combine trials using "within-subject modeling"). |
| Mixed modeling,  data in long format | Classic mixed model with random effect for subjects–especially with lots of repeated measurements and clustering.  Several trial effects and >2 groups can be estimated in one analysis. | Fixed effects are a bit complex with the group\*covariate interactions. |
| Mixed modeling,  data in long format, adjusting for baseline | As above. | Have to modify the long-format data to turn the baseline trial into a subject characteristic.  Less intuitive specification of model and estimates. |