**Two-Way Independent Samples Trend Analysis[[1]](#footnote-1)©**

Imagine that we are continuing our earlier work (from the handout "One-Way Independent Samples ANOVA with SAS") evaluating the effectiveness of the drug Athenopram HBr. This time we have data from three different groups. The groups differ with respect to the psychiatric condition for which the drug is being employed. We wish to determine whether the dose-response curve is the same across all three groups.

Download and run the file Trend2.sas from my [SAS programs page](http://core.ecu.edu/psyc/wuenschk/SAS/SAS-Programs.htm). The contrived data (created with SAS' normal random number generator) are within the program. We have 100 scores (20 at each of the five doses) in each diagnostic group. Our design is Diagnosis x Dose, 3 x 5. Diagnosis is a qualitative variable, Dose is quantitative. Our dependent variable, as before, is a measure of the patients' psychological illness after two months of pharmacotherapy.

In the data step I compute the powers of the Dose variable necessary to conduct the analysis as a polynomial regression. If I had used a input statement of "INPUT DOSE DIAGNOS $ ILLNESS," I would have required 300 data lines, one for each participant, from "0 A 83" to "40 C 120. I only needed 30 data lines (two per cell) with the do loop I employed.

PROC MEANS and PROC PLOT are used to create a plot of the dose-response curve for each diagnostic group, with the plotting symbols being the letter representing diagnostic group. You should edit your output file in Word to connect the plotted means with line segments. Look at that plot. The plots for group A is clearly quadratic, while that for group B and C are largely linear, with some quadratic thrown in.

The first invocation of PROC GLM is used to conduct a standard 3 x 5 factorial ANOVA. Note that all three effects are significant. The interaction here is not only significant, but also large in magnitude, with an *η2* of .14. Clearly we need to investigate this interaction.

The second invocation of PROC GLM obtains trend components for the Dose variable and for the interaction between Dose and Diagnosis. Look at the output. Sum the *SS* for the four trends for the main effect of Dose. You should get the *SSDose* from the previous analysis. The trends for the main effect of Dose are an orthogonal partitioning of the *SS* for the main effect of Dose. Sum the SS for the trend components of the interaction between Dose and Diagnosis. You should get the *SSDose x Diagnosis* from the previous analysis. The trends for the interaction are an orthogonal partitioning of the *SS* for the interaction. We see that the effect of Dose differs significantly across the diagnostic groups with respect to its linear, quadratic, and cubic trends. Given these results, we should look at the linear, quadratic, and cubic trends in the simple effects (the effect of dose in each of the diagnostic groups).

The third invocation of PROC GLM is used to conduct a trend analysis for each diagnostic group. Do notice that I excluded the quartic trend from the models, given that our earlier analysis indicated that it was both trivial and not significant. We see that in Group A, there is a strong (*η2* = .15) and significant quadratic trend, and a weak (*η2* = .03) but significant cubic trend. The cubic component is so small that we should not be surprised if we can see no sign of it when we look at a plot of the means or a plot of the predicted values from the cubic regression model. PROC GLM also gives us the intercept and slopes for the cubic regression equation. You should ignore the p values that accompany these -- they are for Type III sums of squares. With Type III sums of squares, any overlap between predictors is not counted any predictor's sum of squares. Our predictors are powers of the dose variable, which, of course, are highly correlated with one another, making Type III sums of squares not appropriate.

In Group B, the linear trend is large (*η2* = .18) and significant, and the quadratic trend is small (*η2* = .03) yet significant. In Group C, the linear effect is very strong (*η2* = .31) and significant, and the quadratic effect small (*η2* = ..03) yet significant.

I used PROC REG to obtain the regression coefficients and a plot of regression line for a quadratic model for each diagnostic group. Inspecting these plots should give you a better understanding of the quadratic functions, especially if you 'connect the dots.’

Finally, I used Gplot to make an interaction plot with smoothed lines. Proc Plot makes pretty clunky plots. Use Gplot or [Excel](http://core.ecu.edu/psyc/wuenschk/StatHelp/Excel-InteractionPlot.docx) to produce better looking plots.

# Results

# <Table of Means and Standard Deviations>

Cell means and standard deviations are shown in Table 1. A factorial trend analysis (Dose x Diagnosis) was conducted to determine the effects of dose of Athenopram in each diagnostic group of patients at the [Psychiatric Institute for Abused Cuddly Toys](http://www.parapluesch.de/) (Psychiatrie für misshandelte Kuscheltiere). As shown in Table 2, the interaction between dose of drug and diagnostic group was both statistically significant and large in magnitude. The diagnostic groups differed significantly with respect to the linear, quadratic, and cubic components of dose of Athenopram. The simple effects of dose of Athenopram were tested within each diagnostic group. Among patients diagnosed with illness A, there was a significant quadratic trend, *F*(1, 96) = 17.97, *p* < .001, *η2* = .15, and a significant cubic trend, *F*(1, 96) = 4.10, *p* = .046, *η2* = .03. As shown in Figure 1, remission of symptoms of patients with this diagnosis was greatly reduced by the 10 mg dose, but the effectiveness of the Athenopram decreased with increases in dose beyond 10 mg. Among patients with condition B, the linear effect of dose was large and significant, *F*(1, 96) = 23.09, *p* < .001, *η2* = .18, and the quadratic effect was small but significant, *F*(1, 96) = 4.08, *p* = .046, *η2* = .03. In this group the 10 mg treatment aggravated the patients' illness, but larger doses were effective in reducing symptoms, with effectiveness a linear function of dosage. Among patients with diagnosis C, there was a very strong and significant linear effect of dosage *F*(1, 96) = 44.59, *p* < .001, *η2* = .31, and a small but significant quadratic trend, *F*(1, 96) = 4.29, *p* =.041, *η2* = .03. For these patients, every increase in dosage was accompanied by a decrease in symptoms.

# Table 2: Trend Analysis

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Effect | *df* | F | *p* | *η2* |
| Diagnosis | 2 | 3.50 | .031 | .02 |
| Dose | 4 | 11.60 | < .001 | .12 |
| Linear | 1 | 40.59 | < .001 | .10 |
| Quadratic | 1 | 5.53 | .019 | .02 |
| Cubic | 1 | 0.26 | .612 | .00 |
| Quartic | 1 | 0.00 | .958 | .00 |
| Interaction | 8 | 6.67 | < .001 | .14 |
| Linear | 2 | 13.27 | < .001 | .07 |
| Quadratic | 2 | 10.05 | < .001 | .05 |
| Cubic | 2 | 3.12 | .046 | .02 |
| Quartic | 2 | 0.23 | .79 | .00 |
| Error | 285 |  |  |  |



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