**SPLH 861 HW2: Interactions in General Linear Models (7 points total)  
Due Friday 9/19/2014 by 11:59 PM via Blackboard  
Revision Due by Friday 10/10/14 by 11:59 PM via Blackboard  
  
Please submit all requested files (word document, syntax, and output)  
using this naming convention: 861\_Firstname\_Lastname\_HW2**

**General Instructions:** This homework uses the same data as HW1, but now adds interaction terms. Your task is to answer the research questions below by estimating general linear models predicting scrabble scores using restricted maximum likelihood. I have provided the data in SPSS, SAS, and STATA formats, and you will need to create your own syntax file. Please make comments in your syntax file as to what the codes do, that way you will have it as a future reference in analyzing your own data. Please submit your syntax file and the resulting final output file (i.e., with correct results only) with this word file containing the items below. As in HW1, with respect to your predictors, use the easy opponent as the reference group, center verbal ability at 30, and center spatial ability at 10. All values should be recorded to the nearest .01 to be correct. Use a cut-off of *p* < .05 as your indicator of significance. Note that the REML −2LL, approximately LL value, and the fixed intercept estimate have been given for each model so that you can verify that you have estimated the right model—do not proceed until these match your output. Each section below requires one model lists the questions to be answered from its output (or via additional model-implied estimates). You will then complete a results section about the model by inserting the answers you found where needed and selecting the correct answer out of the list of possible choices below **[leave the bold text and brackets in please]**:

**[EST]** = corresponding fixed effect estimate (coefficient)   
**[PROGRAM]** = program you used to complete this assignment **[VALUE]** = corresponding value calculated separately  
**[A]** = simple main effect or main effect  
**[B]** = simple interaction or interaction  
**[C]** = significantly or nonsignificantly   
**[D]** = higher or lower  
**[E]** = positive or negative  
**[F]** = more positive, less positive, more negative, less negative  
**[G]** = more helpful or less helpful  
**[H]** = stronger or weaker  
**[I]** = simple two-way interaction of opponent by verbal ability, simple two-way interaction of opponent by spatial ability, simple two-way interaction of verbal by spatial ability, or three-way interaction of opponent by verbal by spatial ability

**SECTION 1**

**Section 1 is repeated from the last model in HW1:** estimate a model including just the main effects of opponent, verbal ability, and spatial ability in predicting scrabble scores.  
Check your model: −2LL = 1817.4, LL ~= −908.7, fixed intercept = 294.84

**Section 1 questions to be answered in order to complete the results section:**

1. Write out the model equation: Scrabblei =
2. What is the proportion of variance accounted for by the model?
3. What is the effect of opponent?
4. What is the effect of verbal ability?
5. What is the effect of spatial ability?
6. What is the test of the model R2?

**Section 1 results:**

General linear models were estimated using restricted maximum likelihood within **[PROGRAM]** to examine the additive and interactive effects of ability and environment in playing three games of Scrabble. To serve as a baseline, a model with main effects of opponent type (easy vs. hard), verbal ability (the Boston Naming Test, centered at 30), and spatial ability (the Block Design Test, centered at 10) was examined first, and shown in Equation 1:

**[insert model equation here]**

This main effects model achieved a model R2 = **[VALUE]**, which was significant, **[insert F or χ2 test result for model R2]**. The fixed intercept of **[EST]** was the expected three-game Scrabble total for the reference person, someone with verbal ability of 30 and spatial ability of 10 playing an easy opponent. The **[A]** of opponent type of **[EST]** indicated that persons playing hard opponents scored **[B C]** than persons playing easy opponents. The **[A]** of verbal ability of **[EST]** indicated that persons with higher verbal ability scored **[B C]** than persons with less verbal ability. Finally, the **[A]** of spatial ability of **[EST]** indicated that persons with higher spatial ability scored **[B C]** than persons with less spatial ability.

**SECTION 2**

**Section 2 is new:** estimate a model that examines the extent to which opponent moderates the effect of verbal ability and the effect of spatial ability.  
Check your model: −2LL = 1802.5, LL ~= −901.3, fixed intercept = 295.98

**Section 2 questions to be answered in order to complete the results section:**

1. Write out the model equation: Scrabblei =
2. What is the proportion of total variance accounted for by the model?
3. What is the incremental variance accounted for by the new interactions?
4. What is the test of the improvement in R2?
5. What is the effect of verbal ability for easy opponents?
6. What is the effect of verbal ability for hard opponents?
7. What is the difference in the effect of verbal ability between easy and hard opponents?
8. What is the effect of spatial ability for easy opponents?
9. What is the effect of spatial ability for hard opponents?
10. What is the difference in the effect of spatial ability between easy and hard opponents?

**Section 2 results:**

Next, to examine the extent to which environment moderates the effects of ability, two-way interactions of opponent by verbal ability and opponent by spatial ability were added to the model, as shown in Equation 2:

**[insert equation here]**

The addition of these two interactions resulted in a total model R2 = **[VALUE]**. The increase in R2 = **[VALUE]** was a significant improvement over the main effects model, **[insert F or χ2 test result for increment to model R2]**.

First, the **[B]** of opponent by verbal ability of **[EST]** revealed that the effect of verbal ability was **[C F]** when playing hard opponents as opposed to easy opponents. More specifically, the effect of verbal ability for easy opponents of **[EST]** was **[C E]**, and the effect of verbal ability for hard opponents of **[EST]** was **[C E]**. Second, the **[B]** of opponent by spatial ability of **[EST]** revealed that the effect of spatial ability was **[C F]** when playing hard opponents as opposed to easy opponents. More specifically, the effect of spatial ability for easy opponents of **[EST]** was **[C E]**, and the effect of spatial ability for hard opponents of **[EST]** was **[C E]**.

**SECTION 3**

**Section 3 is new:** estimate a model that examines how opponent moderates the extent to which the effect of verbal ability depends on spatial ability.  
Check your model: −2LL = 1225.0, LL ~= −612.5, fixed intercept = 299.30

**Section 3 questions to be answered in order to complete the results section:**

1. Write out the model equation: Scrabblei =
2. What is the proportion of total variance accounted for by the model?
3. What is the incremental variance accounted for by the new interactions?
4. What is the test of the improvement in R2?
5. What is the effect of verbal by spatial ability for easy opponents?
6. What is the effect of verbal by spatial ability for hard opponents?
7. What is the difference in the interaction of verbal by spatial ability between easy and hard opponents?
8. What is the effect of verbal ability for spatial=8 and easy opponents?
9. What is the effect of verbal ability for spatial=12 and easy opponents?
10. What is the effect of verbal ability for spatial=8 and hard opponents?
11. What is the effect of verbal ability for spatial=12 and hard opponents?

**Create Figure 1:**

Predict a total of 8 expected scrabbled scores for the following combinations of predictor values: easy or hard opponent, verbal ability = 25 or 35, spatial ability = 8 or 12. Use verbal ability as the x-axis (scaled from 25 to 35) and predicted scrabble score as the y-axis (scaled from 0 to 400).

**Section 3 Results:**

The final model examined how opponent moderated the extent to which the effect of verbal ability depends on spatial ability. Accordingly, a two-way interaction of verbal by spatial ability as well as a three-way interaction of opponent by verbal by spatial ability were added to the model, as shown in Equation 3:

**[insert equation here]**

The addition of these two interactions resulted in total model R2 = **[VALUE]**. The increase in R2 = **[VALUE]** was a significant improvement over the main effects model, **[insert F or χ2 test result for increment to model R2]**.

The three-way interaction of opponent by verbal by spatial ability of **[EST]** revealed that the **[B]** of verbal by spatial ability was **[C F]** when playing hard opponents as opposed to easy opponents. More specifically, the **[B]** of verbal by spatial ability for easy opponents of **[EST]** was **[C E]**, and the **[B]** of verbal by spatial ability for hard opponents of **[EST]** was **[C E]**.

**[Insert Figure 1 here]**

Simple effects of verbal ability were estimated to illustrate the three-way interaction, as shown in Figure 1, in which verbal ability is the x-axis, and separate effects are plotted for persons of low (8) or high (12) spatial ability playing easy or hard opponents. For persons playing easy opponents, the effect of verbal ability when spatial ability=8 of **[EST]** was **[C E]**, whereas the effect of verbal ability when spatial ability=12 of **[EST]** was **[C E]**. This indicates that when playing an easy opponent, verbal ability is **[C G]** when paired with greater spatial ability. In contrast, for persons playing hard opponents, the effect of verbal ability when spatial ability=8 of **[EST]** was **[C E]**, whereas the effect of verbal ability when spatial ability=12 of **[EST]** was **[C E]**. Accordingly, when playing a hard opponent, verbal ability is **[C G]** when paired with greater spatial ability. In total, moderation of the effect of verbal ability by spatial ability was **[C H]** when playing hard opponents as opposed to easy opponents, as indicated by the **[I]**.