<u>Question A</u>

1. The assumption of independence of errors would be violated. For example, if we measure some aspect of hearing in a person's left ear, it likely that the measurement will be similar for the person's right ear. Thus, if we measured *both* ears, and used ears as our unit of analysis (rather than person), the errors in our analysis would be correlated (i.e., non-independent) within persons.

2. The assumption homogeneity of errors may be violated, since proportion data typically have smaller errors at more extreme values (e.g., .05, .95), whereas they produce larger errors for mid-range values (e.g., .40, .50, .60).

For both EAR and HANDED, let –1 = "left" and 1 = "right"; let "E×H" = EAR*HAND.

3. A: $P3000_i = \beta_0 + \beta_1 EAR_i + \beta_2 HANDED_i + \beta_3 E{\times}H_i + e_i$
   C: $P3000_i = \beta_0 + \beta_2 HANDED_i + \beta_3 E{\times}H_i + e_i$

4. A: $P3000_i = \beta_0 + \beta_1 EAR_i + \beta_2 HANDED_i + \beta_3 E{\times}H_i + e_i$
   C: $P3000_i = \beta_0 + \beta_1 EAR_i + \beta_2 HANDED_i + e_i$

5.
   a. This over-sampling of right-hand people will cause redundancy among our predictor variables (i.e., tolerances > 1), because of the unequal *n* between left- and right-handed people. Assuming we use mutually orthogonal (i.e., uncorrelated) contrast codes, the only source of redundancy will be unequal *n*s between cells of our design.

   b. Doing this will increase the statistical power of the HANDED comparison (and its interaction with EAR), because there will be less measurement error for left-handed people, now that we have sampled more of them. When we are comparing just two groups, we can maximize our power by having equal *n*s between our two categories (all else being equal).

6. A: $P3000_i = \beta_0 + \beta_1 EAR_i + \beta_2 HANDED_i + \beta_3 E{\times}H_i + \beta_4 P500_i + e_i$
   C: $P3000_i = \beta_0 + \beta_1 EAR_i + \beta_2 HANDED_i + \beta_4 P500_i + e_i$

7. A: $P3000_i = \beta_0 + \beta_1 EAR_i + \beta_2 HANDED_i + \beta_3 E{\times}H_i + \beta_4 P500_i + e_i$
   C: $P3000_i = \beta_0 + \beta_4 P500_i + e_i$

8. Codes: "P500×EAR" = P500*EAR
   "P500×HAND" = P500*HANDED
   "P500×E×H" = P500*EAR*HANDED

   A: $P3000_i = \beta_0 + \beta_1 EAR_i + \beta_2 HANDED_i + \beta_3 E{\times}H_i + \beta_4 P500_i + \beta_5 P500{\times}EAR_i + \beta_6 P500{\times}HAND_i + \beta_7 P500{\times}E{\times}H_i + e_i$
   C: $P3000_i = \beta_0 + \beta_1 EAR_i + \beta_2 HANDED_i + \beta_3 E{\times}H_i + \beta_4 P500_i + e_i$

<u>Question B</u>

1. From the "JS" interaction in "model 1," we know the judges are biased with respect to skaters' nationality:

   PRE = .279, F^* = 7.73, pa – pc = 1, n – pa = 20.

   b_{JS} = 0.07 is ½ the difference of the American judges' differences in the ratings of the American vs. Russian skater and the Russian judges' differences in the ratings of the American vs. Russian skater.

2. Codes: "Russian judges rating American skater" = –1
   "Russian judges rating Russian skater" = 1
   other two categories = 0

   $$SSR = (\Sigma_k \lambda_k y\text{-bar}_k)^2 / (\Sigma_k \lambda_k^2 / n_k) = [5.45(-1) + 5.60(1)]^2 / [(1/6) + (1/6)] = 0.0675$$

   $$PRE = SSR / SSR + SSE_{MODEL1} = 0.0675 / 0.0675 + 0.31167 = .178$$

   $$F^* = [PRE / (pa - pc)] / [(1 - PRE) / (n - pa)] = .178 / (.822 / 20) = 4.33$$

   $$F^*_{\text{critical for } df = 1, 20} = 4.35$$

   Russian judges tended to favor the Russian skater over the American skater, but not significantly so.

3.
   a. b_{JS} = 0.072 is ½ the difference between (a) the Russian judges' rating difference between the Russian and the American skater and (b) the American judges' rating difference between the Russian and the American skater, *adjusted for* (or taking into account) the *years of experience* the judges have.

   b. b_{EXP} = –0.016: For every year of experience a judge has, their rating goes down by 0.016 of a point on average, *controlling for* (differences in) the judges' nationalities, the skaters' nationalities, and their interaction.

4. Yes, there is evidence that experience moderates the nationality bias, because the three-way interaction is statistically reliable:

   PRE = .354, F^* = 8.78, pa – pc = 1, n – pa = 16.

   b_{EXPJS} = 0.04 is ½ the change in nationality bias for every extra year of a judge's experience. In other words, nationality bias is increasing with more experience.

5.

a. $b_{JS} = -0.169$ is ½ the nationality bias when a judge has zero years of experience, controlling for all other predictors in the model.

b. $b_{EXP} = -0.0081$: For every extra year of experience, ratings decrease by .008 points for the "average" judge and skater (across nationalities), and controlling for all other predictors in the model.