Earth Agency Project: Progress Report

Consulting Team A, group 3

March 14th, 2021

1. Decisions made in creating the working data frame

(a) We have combined *EarthAgency_Adults_R.csv* and *EarthAgency_Children_R.csv* into one data.frame: `AC_df`. We have done this so that we can make an Adult vs. children comparison. To combined the two data sets we have done b-d.

(b) To normalize the adult and children's `invitalscores`, we have compressed the adult's scores (which ranged from 0-5), to match the children's scores (which ranged from 0-3).

original	0	1	2	3	4	5
normalized	0	0	1	2	3	3

(c) To normalize the adult and children's `inpsychscore`, we have compressed the adult's scores (which ranged from 0-5), to match the children's scores (which ranged from 0-4).

original	0	1	2	3	4	5
normalized	0	1	2	2	3	3

(d) We have added `FirstLang` to the children's records, and assigned every child a value of 1 for `FirstLang`. We're assuming that 1=using first language, and 0=not using first language.

(e) The 87th entry in the children's record's has a `MeanSeverity` of 2.67. But 2.67 is not a possible value (given that `MeanSeverity` is an average of 4 integer scores, and should thus be a multiple of 0.25). We've changed the `MeanSeverity` for that record to 2.5.

(f) The 41st children's record has no `BIoJtscore` or `AntJtscore`. We did not use this record in the data.frame.

(g) The 45th children's record has no `Agency_Language` or `SRFactsTotal`. We did not use this record in the data.frame.

(h) We have not included the independent variable `SRTotal` in the data frame. Our understanding is that this variable is measuring comprehension of the video and was designed to test if children had payed attention to the video. For the children it was a 4 question test. Of the 91 children, 4 had a score of 2, 28 a score of 3, and 59 a score of 4. And we have not filtered out any children from the data frame based on this comprehension check.

(i) There is also a `SRTotal` variable for the adults. We did not include it in the data frame. If it is also a comprehension check, it might be useful consider filtering out some of the adults based on the results. This is a table of the results:

score	6	7	8	9	10	11	12
count	1	1	15	18	40	37	20

(j) We have renamed the `Condition` levels to `Obj` (object), `Nat` (nature, animal, vitalist), `Per` (person, psychological), for ease of understanding and consistency while we were coding.

(k) For a better model fit, we have combined the original 13 levels of `MeanSeverity` into three levels, as follows:

original	0.00	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00
combined	1	1	1	1	1	1	2	2	2	3	3	3	3

(l) For a better model fit, we have combined the original 5 levels of `BioJtscore` (the number of scenarios where the respondent used a biocentric justification), into three levels, as follows:

original	0	1	2	3	4
combined	1	1	1	2	3

(m) For a better model fit, we have combined the original 5 levels of `AntJtscore` (the number of scenarios where the respondent used an anthropocentric justification), into three levels, as follows:

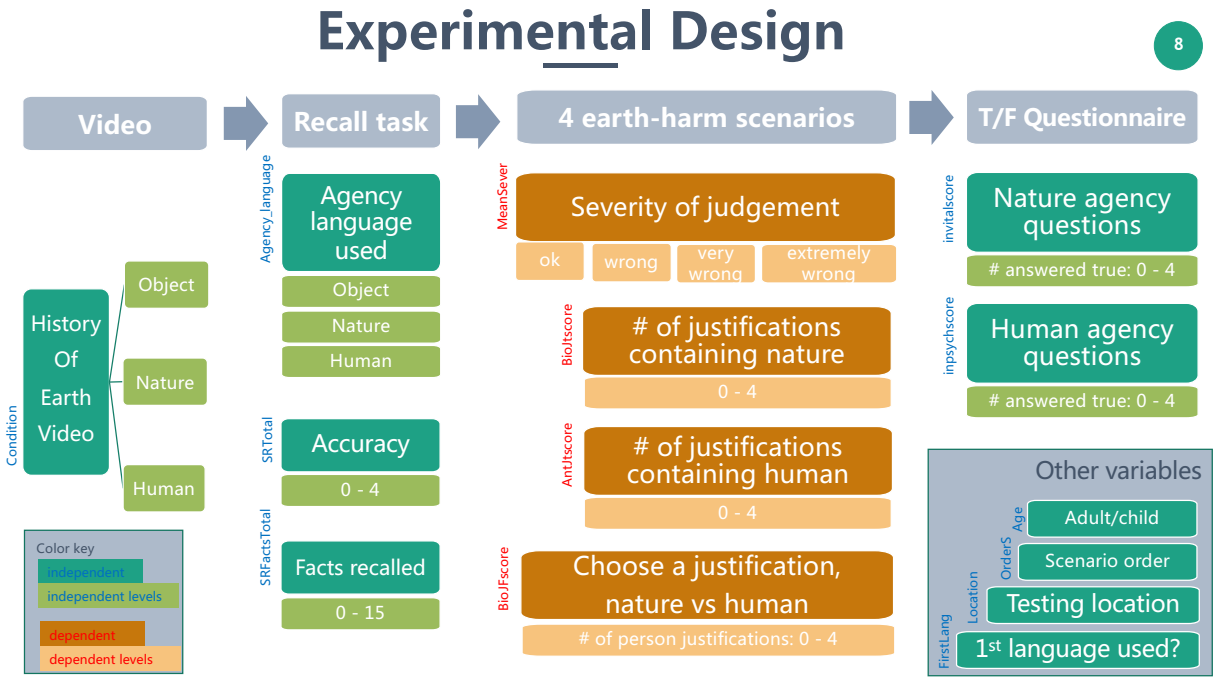
original	0	1	2	3	4
combined	1	1	1	2	3

(n) For a better model fit, we have combined the original 5 levels of `BioJFtotal` (the number of scenarios where the respondent chose biocentric when given a choice between biocentric and anthropocentric), into three levels, as follows:

original	0	1	2	3	4
combined	1	1	2	3	3

2. Experimental Design concerns

The chart below shows our understanding of the variables collected. The green are the independent variables with their levels, and the brown are the four dependent variables. As you have noted, the flow our your experiment design has intertwined the `Condition` variable with the `Agency_language`, `inpsychscore` and `invitalscore` variables. In particular, since the questionnaire was given after the participants watched the video, it's not clear that the `invitalscore` and `inpsychscore` variables are measuring the participants underlying beliefs, or the beliefs expressed in the video that they just watched. Also `Agency_language`, which is attempting to measure how the participants describe the video, overlaps with the perspective of the video watched. As such it is not clear that `Agency_language` is descriptive of the participant or of the video they just watched.



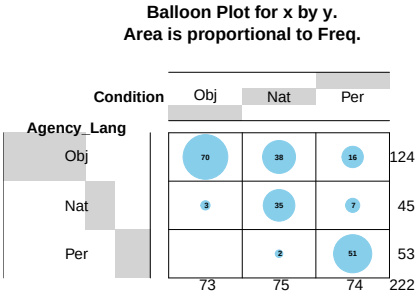
3. Correlation among independent variables

Because of our worry about the independence of the independent variables, we checked the correlations between the independent variables. The following chart (which is redundant across the diagonal), shows Pearson product-moment correlations between the numeric variables (`SRFactsTotal`, `invitalscore`, `inpsychscore`), a polychoric correlations between ordinal categorical variables (`Condition`, `Agency_Language`, `FirstLang` and `Age`), and polyserial correlations between numeric and ordinal variables. 1 or -1 is a strong correlation. 0 is no correlation.

	Condition	Agency_Language	SRFactsTotal	invitalscore	inpsychscore	FirstLang	Age
Condition	1.00	0.85	0.01	0.09	0.19	0.01	0.03
Agency_Language	0.85	1.00	0.10	0.04	0.24	0.14	0.18
SRFactsTotal	0.01	0.10	1.00	0.10	-0.24	-0.19	-0.52
invitalscore	0.09	0.04	0.10	1.00	0.43	-0.11	-0.22
inpsychscore	0.19	0.24	-0.24	0.43	1.00	0.15	0.38
FirstLang	0.01	0.14	-0.19	-0.11	0.15	1.00	0.88
Age	0.03	0.18	-0.52	-0.22	0.38	0.88	1.00

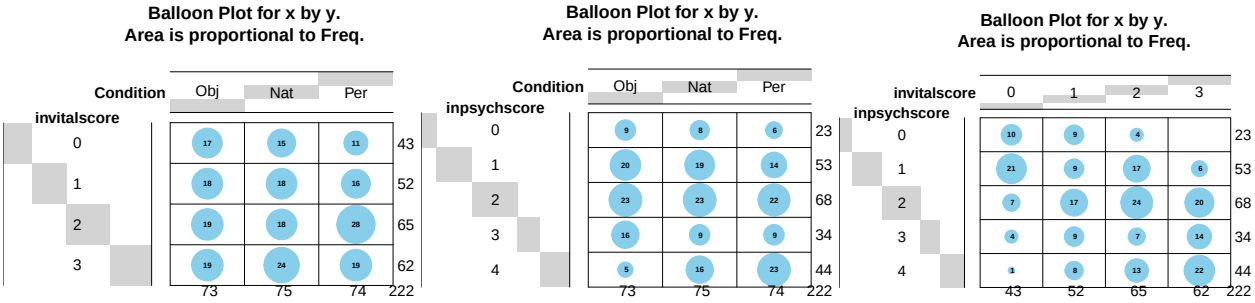
3a. Correlation between `Condition` and `Agency_language`

`Condition` and `Agency_language` had the strongest correlation and the p-value of the Pearson's chi-square test was effectively zero ($p = 7.3{*}10^{-36}$). Because of this, and because of our concerns about the experimental design, we have not included `Agency_language` in the model fits below. If we have time, we will explore using PCA (principal component analysis) to combine these two independent variables.



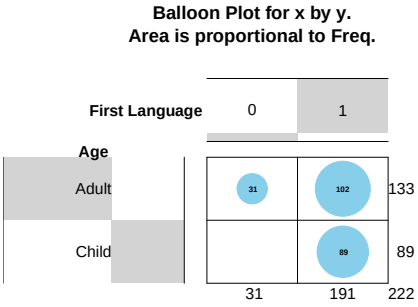
3b. Correlation between `Condition`, `invitalscore`, and `inpsychscore`

A Chi-square test shows that there is not a significant correlation between `Condition` and `invitalscore` (p=0.54), and there is a slightly significant correlation between `Condition` and `inpsychscore` (p=0.04). But the correlation between `invitalscore` and `inpsychscore` is highly significant ($p = 5.0 * 10^{-4}$). We have included both of these variables in the model fit below, and (if time permits) we are going to explore using PCA (principal component analysis) to combine these two independent variables (`invitalscore` and `inpsychsocre`).



3c. Correlation between `FirstLang` and `Age`

Because we are assuming that the 89 children in the study are all using their first language, there is a strong correlation between `FirstLang` and `Age` ($p = 2.4 * 10^{-6}$). But, for contextual reasons, we have left both of these variables in the models below. And when we ran the model without `FirstLang` it did not imporove the model fit.



5. Modeling

5a. Mean Severity Ordinal model with combined levels

```
original levels

   0 0.25  0.5 0.75    1 1.25  1.5 1.75    2 2.25  2.5 2.75    3
   1    2    6   18   17   21   22   24   29   23   24   16   19

combined levels

 1  2  3
65 75 82

polr(formula = comMeanSever ~ Condition + SRFactsTotal + invitalscore +
    inpsychscore + FirstLang + Age, data = AC_df)

              Value Std. Error t value p value
ConditionNat  0.286      0.321   0.891   0.373
ConditionPer  0.248      0.318   0.778   0.437
SRFactsTotal  0.058      0.047   1.239   0.215
invitalscore -0.016      0.144  -0.111   0.912
inpsychscore  0.019      0.131   0.148   0.882
FirstLang1   -0.787      0.395  -1.994   0.046
AgeChild      2.049      0.362   5.659   0.000
1|2          -0.430      0.519  -0.828   0.408
2|3           1.266      0.526   2.408   0.016

              1  2  3
1            42 14  9
2            31 13 31
3            17 10 55
prop.correct 65 17 67

Misclassification error is: 0.5045045
```

5b. Biocentric Justification score, Ordinal model with combined levels

```
original levels

 0  1  2  3  4
19 57 61 62 23

combined levels

  1   2   3
137  62  23

polr(formula = comBioJtscore ~ Condition + SRFactsTotal + invitalscore +
    inpsychscore + FirstLang + Age, data = AC_df)

              Value Std. Error t value p value
ConditionNat -0.059      0.356  -0.166   0.868
ConditionPer  0.196      0.358   0.548   0.584
SRFactsTotal  0.163      0.055   2.978   0.003
invitalscore -0.010      0.159  -0.066   0.947
inpsychscore -0.011      0.147  -0.073   0.942
FirstLang1   -0.474      0.473  -1.002   0.316
AgeChild      2.144      0.418   5.123   0.000
1|2           1.816      0.627   2.899   0.004
2|3           3.736      0.673   5.548   0.000

               1  2 3
1            128  9 0
2             44 17 1
3              9 14 0
prop.correct  93 27 0

Misclassification error is: 0.3468468
```

5c. Anthropocentric Justification score, Ordinal model with combined levels

```
original levels

 0  1  2  3  4
 9 36 76 61 40

combined levels

  1   2   3
121  61  40

polr(formula = comAntJtscore ~ Condition + SRFactsTotal + invitalscore +
    inpsychscore + FirstLang + Age, data = AC_df)

              Value Std. Error t value p value
ConditionNat -0.278      0.328  -0.848   0.396
ConditionPer -0.527      0.334  -1.576   0.115
SRFactsTotal  0.055      0.050   1.105   0.269
invitalscore  0.089      0.151   0.589   0.556
inpsychscore  0.195      0.139   1.403   0.161
FirstLang1    0.353      0.461   0.767   0.443
AgeChild      1.301      0.354   3.680   0.000
1|2           1.566      0.598   2.621   0.009
2|3           3.065      0.624   4.908   0.000

               1  2  3
1            104 15  2
2             45  9  7
3             21 11  8
prop.correct  86 15 20

Misclassification error is: 0.454955
```

5d. Biocentric choice score, Ordinal model with combined levels

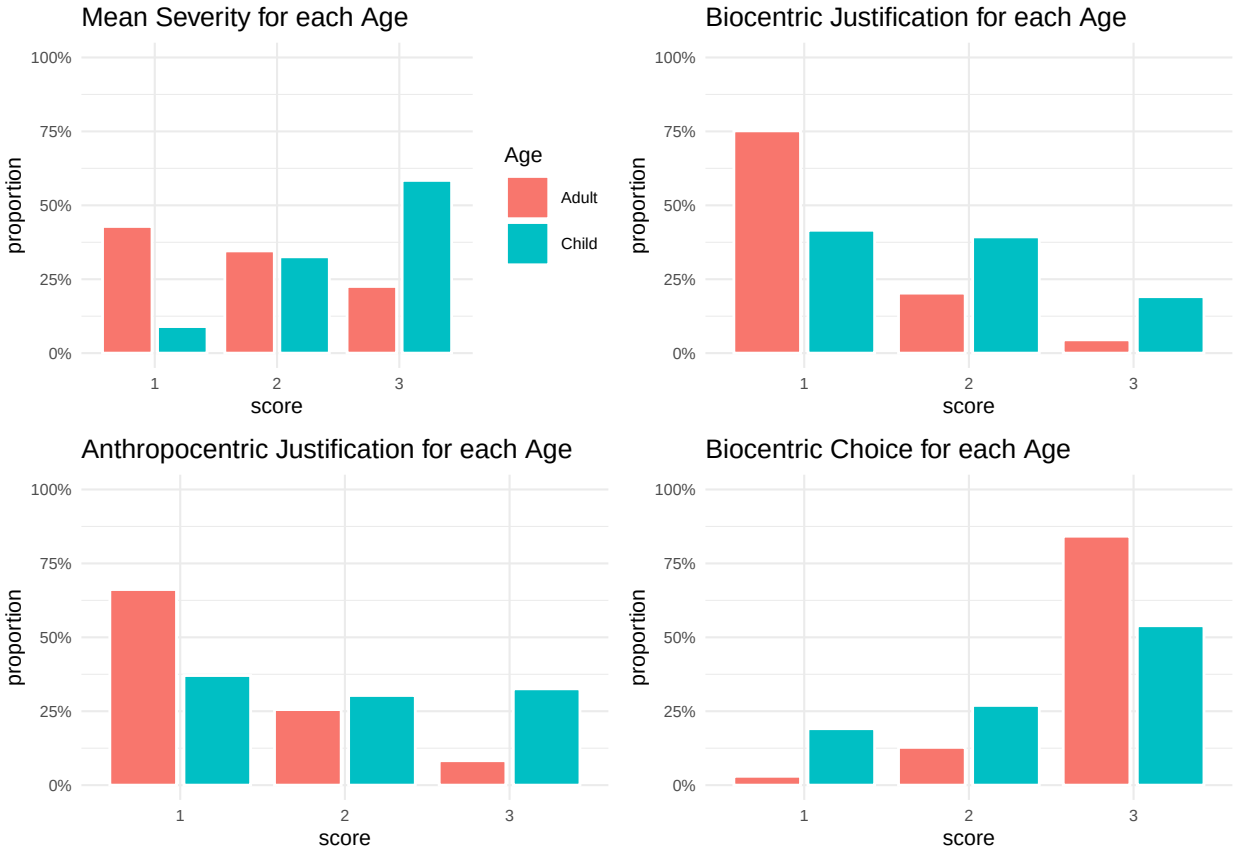
```
original levels

  0   1   2   3   4
  5  16  41  60 100

combined levels

  1   2   3
 21  41 160

polr(formula = comBioJFtotal ~ Condition + SRFactsTotal + invitalscore +
    inpsychscore + FirstLang + Age, data = AC_df)

              Value Std. Error t value p value
ConditionNat  0.041      0.400   0.102   0.919
ConditionPer -0.279      0.404  -0.691   0.490
SRFactsTotal  0.195      0.065   3.012   0.003
invitalscore  0.377      0.185   2.041   0.041
inpsychscore -0.394      0.174  -2.258   0.024
FirstLang1    0.967      0.518   1.868   0.062
AgeChild     -1.030      0.433  -2.378   0.017
1|2          -1.696      0.654  -2.592   0.010
2|3          -0.153      0.631  -0.243   0.808

              1 2   3
1             3 5  13
2             0 3  38
3             1 2 157
prop.correct 14 7  98

Misclassification error is: 0.2657658
```

6. For `Age`, is there a significant difference in the dependent variables `MeanSeverity`, `BioJscore`, `AntJtscore`, and `BioJFtotal`?

Yes, there is a significant difference.

6a. Visualization

You can see the difference in the plots of the dependent variables colored by `Age`. Note: none of the other predictor variables are included in this visualization.



6b. ANOVA test

We did an ANOVA test using our ordinal models and found that when Age was included in the model there was significant difference from the model that excluded Age. Which means that knowing the age of the participant (adult vs. child) makes a difference to the modeling, and thus there is a significant difference between the dependent variable scores for adults and children. The p-values for these differences are `MeanSeverity` ($p = 4.8 * 10^{-09}$), `BioJscore` ($p = 5.3 * 10^{-08}$), `AntJtscore` ($p = 1.8 * 10^{-04}$), and `BioJFtotal` ($p = 0.015$).

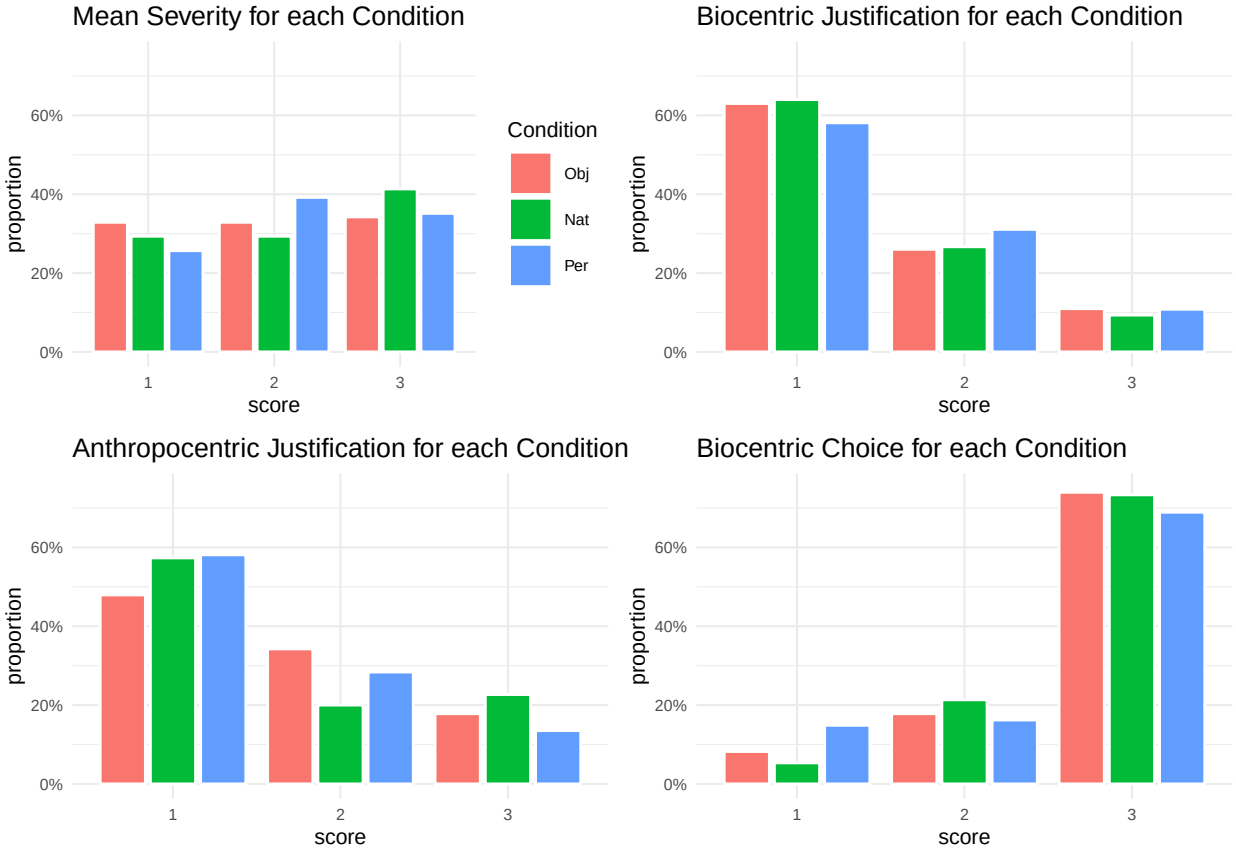
```
Likelihood ratio tests of ordinal regression models

Response: comMeanSever
                                                                      Model
1       Condition + SRFactsTotal + invitalscore + inpsychscore + FirstLang
2 Condition + SRFactsTotal + invitalscore + inpsychscore + FirstLang + Age
  Resid. df Resid. Dev   Test    Df LR stat.      Pr(Chi)
1       214   472.3211
2       213   438.0412 1 vs 2     1  34.2799 4.772864e-09

Likelihood ratio tests of ordinal regression models

Response: comBioJtscore
                                                                      Model
1       Condition + SRFactsTotal + invitalscore + inpsychscore + FirstLang
2 Condition + SRFactsTotal + invitalscore + inpsychscore + FirstLang + Age
  Resid. df Resid. Dev   Test    Df LR stat.      Pr(Chi)
1       214   386.1977
2       213   356.5992 1 vs 2     1 29.59845 5.314746e-08

Likelihood ratio tests of ordinal regression models

Response: comAntJtscore
                                                                      Model
1       Condition + SRFactsTotal + invitalscore + inpsychscore + FirstLang
2 Condition + SRFactsTotal + invitalscore + inpsychscore + FirstLang + Age
  Resid. df Resid. Dev   Test    Df LR stat.      Pr(Chi)
1       214   423.6080
2       213   409.5921 1 vs 2     1 14.01596 0.0001812655

Likelihood ratio tests of ordinal regression models

Response: comBioJFtotal
                                                                      Model
1       Condition + SRFactsTotal + invitalscore + inpsychscore + FirstLang
2 Condition + SRFactsTotal + invitalscore + inpsychscore + FirstLang + Age
  Resid. df Resid. Dev   Test    Df LR stat.    Pr(Chi)
1       214   299.7488
2       213   293.8512 1 vs 2     1 5.897596 0.01516157
```

7. For `Condition`, is there a significant difference in the dependent variables `MeanSeverity`, `BioJscore`, `AntJtscore`, and `BioJFtotal`?

We did not find any evidence to conclude that `Condition` had an effect on any of the four dependent variables.

7a. Visualization

Looking at the distribution of Condition for each of the scores (for `MeanSeverity`, `BioJscore`, `AntJtscore`, and `BioJFtotal`) there is no clear visual pattern. Though, these plots do not include any of the other predictor variables.



7b. ANOVA test

The ANOVA test for our models did not show any significant difference when we included/excluded the `Condition` variable. The p-values for these differences are `MeanSeverity` ($p = 0.62$), `BioJscore` ($p = 0.75$), `AntJtscore` ($p = 0.28$), and `BioJFtotal` ($p = 0.68$).

```
Likelihood ratio tests of ordinal regression models

Response: comMeanSever
                                                                        Model
1             SRFactsTotal + invitalscore + inpsychscore + FirstLang + Age
2 Condition + SRFactsTotal + invitalscore + inpsychscore + FirstLang + Age
  Resid. df Resid. Dev   Test    Df  LR stat.  Pr(Chi)
1       215   438.9851
2       213   438.0412 1 vs 2     2 0.9439182 0.623779

Likelihood ratio tests of ordinal regression models

Response: comBioJtscore
                                                                        Model
1             SRFactsTotal + invitalscore + inpsychscore + FirstLang + Age
2 Condition + SRFactsTotal + invitalscore + inpsychscore + FirstLang + Age
  Resid. df Resid. Dev   Test    Df  LR stat.   Pr(Chi)
1       215   357.1722
2       213   356.5992 1 vs 2     2 0.5730063 0.7508847

Likelihood ratio tests of ordinal regression models

Response: comAntJtscore
                                                                        Model
1             SRFactsTotal + invitalscore + inpsychscore + FirstLang + Age
2 Condition + SRFactsTotal + invitalscore + inpsychscore + FirstLang + Age
  Resid. df Resid. Dev   Test    Df LR stat.   Pr(Chi)
1       215   412.1081
2       213   409.5921 1 vs 2     2 2.516047 0.2842152

Likelihood ratio tests of ordinal regression models

Response: comBioJFtotal
                                                                        Model
1             SRFactsTotal + invitalscore + inpsychscore + FirstLang + Age
2 Condition + SRFactsTotal + invitalscore + inpsychscore + FirstLang + Age
  Resid. df Resid. Dev   Test    Df  LR stat.   Pr(Chi)
1       215   294.6179
2       213   293.8512 1 vs 2     2 0.7667055 0.6815724
```

7c. Confidence intervals of the model coefficients

We also looked at the 95% confidence intervals for the model coefficients. For each dependent variable, the `Condition` coefficient's confidence interval included zero. A coefficient of zero would mean that the predictor variable had no effect on the model. So a confidence interval that includes zero, means that we can not conclude that the predictor variable has an effect on the dependent variable.

```
polr(formula = comMeanSever ~ Condition + SRFactsTotal + invitalscore +
    inpsychscore + FirstLang + Age, data = AC_df)

                   2.5 %      97.5 %
ConditionNat -0.34201110  0.91727883
ConditionPer -0.37558060  0.87431887
SRFactsTotal -0.03311747  0.14996192
invitalscore -0.29854242  0.26668405
inpsychscore -0.23928611  0.27706224
FirstLang1   -1.56725670 -0.01501482
AgeChild      1.35027947  2.77260471

polr(formula = comBioJtscore ~ Condition + SRFactsTotal + invitalscore +
    inpsychscore + FirstLang + Age, data = AC_df)

                   2.5 %    97.5 %
ConditionNat -0.75954490 0.6408489
ConditionPer -0.50572133 0.9018800
SRFactsTotal  0.05756338 0.2734021
invitalscore -0.32178274 0.3052878
inpsychscore -0.30018546 0.2767641
FirstLang1   -1.38404530 0.4861793
AgeChild      1.34542910 2.9910121

polr(formula = comAntJtscore ~ Condition + SRFactsTotal + invitalscore +
    inpsychscore + FirstLang + Age, data = AC_df)

                   2.5 %    97.5 %
ConditionNat -0.92493184 0.3634734
ConditionPer -1.18960442 0.1244914
SRFactsTotal -0.04232262 0.1536525
invitalscore -0.20620987 0.3885849
inpsychscore -0.07716574 0.4688358
FirstLang1   -0.51733629 1.3076648
AgeChild      0.61579560 2.0052806

polr(formula = comBioJFtotal ~ Condition + SRFactsTotal + invitalscore +
    inpsychscore + FirstLang + Age, data = AC_df)

                   2.5 %      97.5 %
ConditionNat -0.74824484  0.82869064
ConditionPer -1.07880038  0.51334422
SRFactsTotal  0.07137494  0.32623007
invitalscore  0.01651931  0.74351854
inpsychscore -0.74170361 -0.05486527
FirstLang1   -0.06797407  1.98055981
AgeChild     -1.90400372 -0.19635358
```