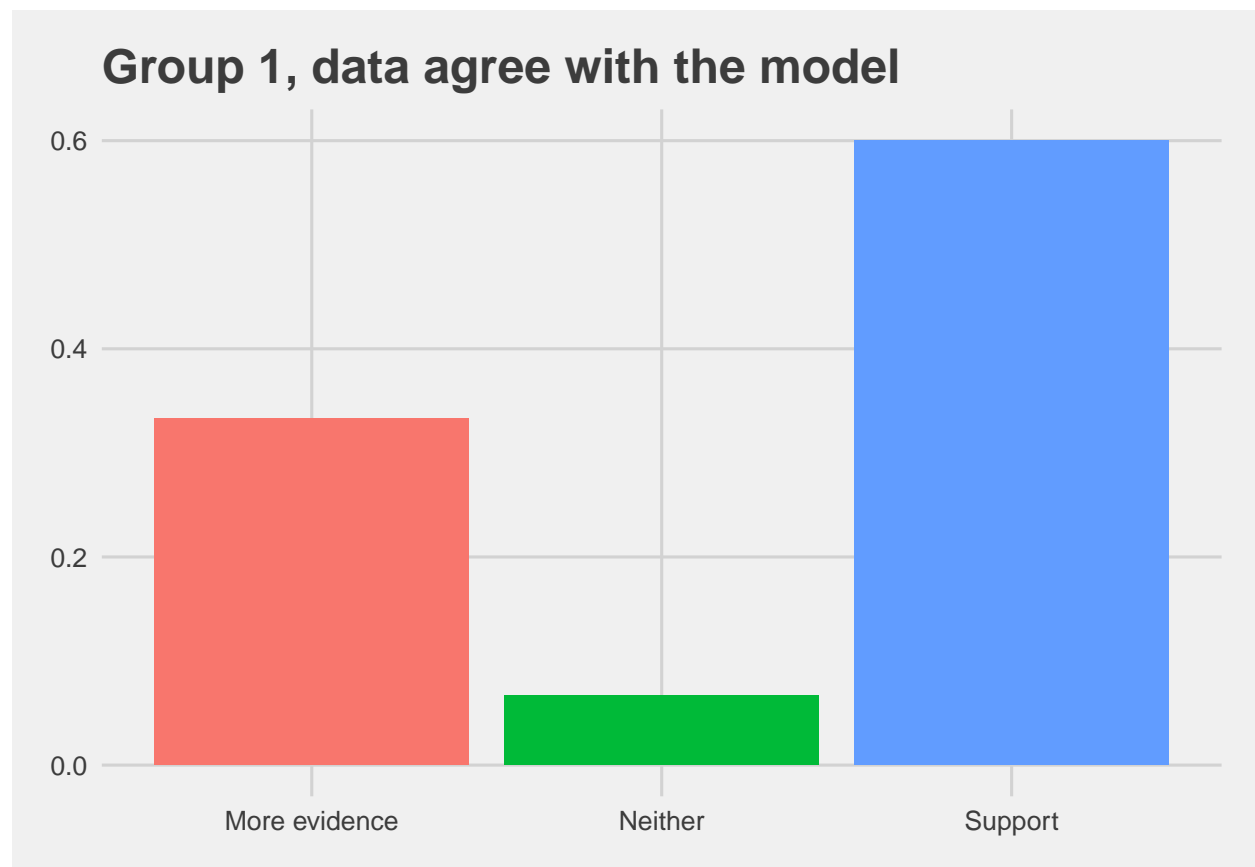# Load necessary packages

# Load file and do some preprocessing

Analysis

Page 1

```
## [1] "What do you think Group 1 should say about whether their data agree with \n     the model?"
```



```
## [1] "Which statements below support your reasoning for whether Group 1s data \n     agree with the
```

```
##                                                           t.info...cols.temp..
## Q1b_2                     The two spring constant values are not exactly the same
## Q1b_5   The two spring constant values do not agree within experimental uncertainties
## Q1b_8         The percent difference between the spring constant values is large
## Q1b_35               The average periods for the two masses are different
## Q1b_28   The size of the uncertainty (or variability between measurements) is large
## Q1b_19                                              Other (Please describe)
## Q1b_37                     The two spring constant values are similar
## Q1b_33       The two spring constant values agree within experimental uncertainties
## Q1b_34         The percent difference between the spring constant values is small
## Q1b_16                        The average periods for the two masses are similar
## Q1b_36   The size of the uncertainty (or variability between measurements) is small
```
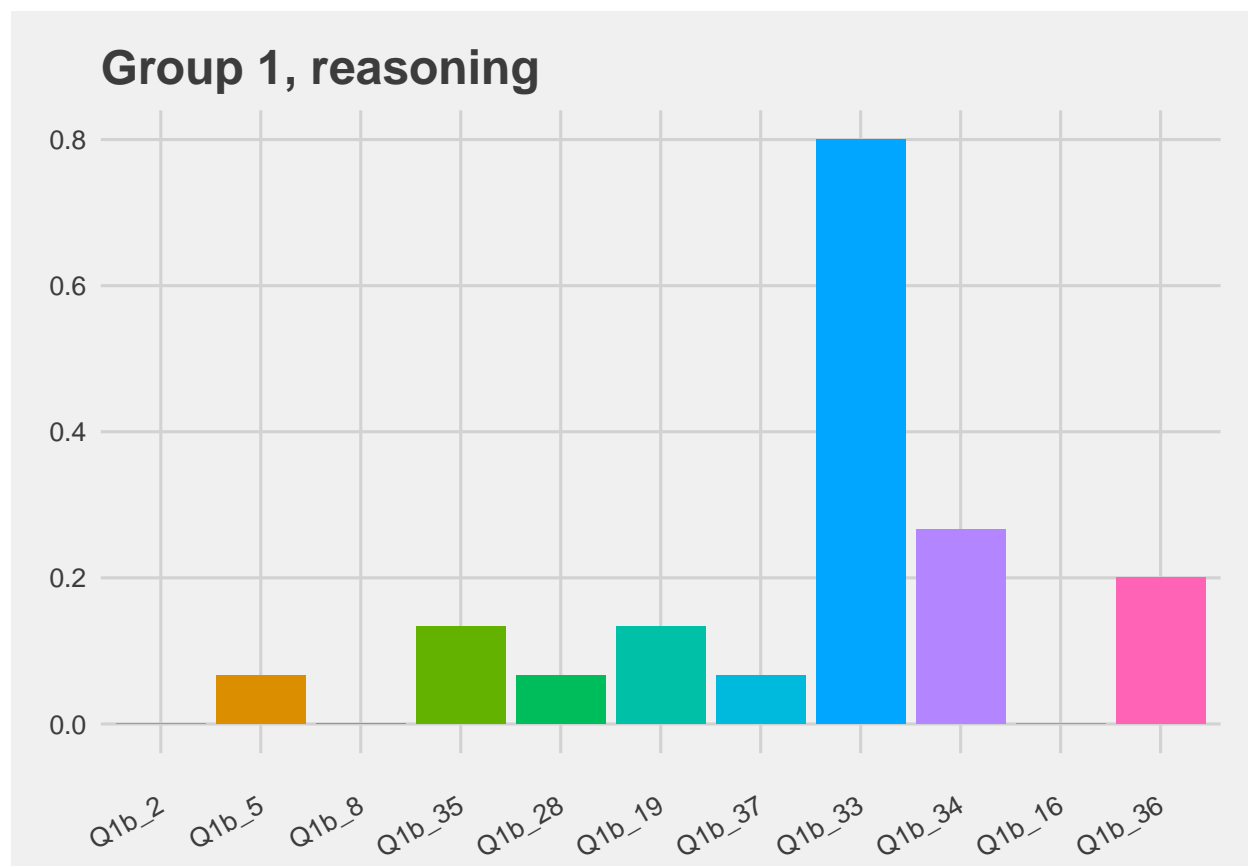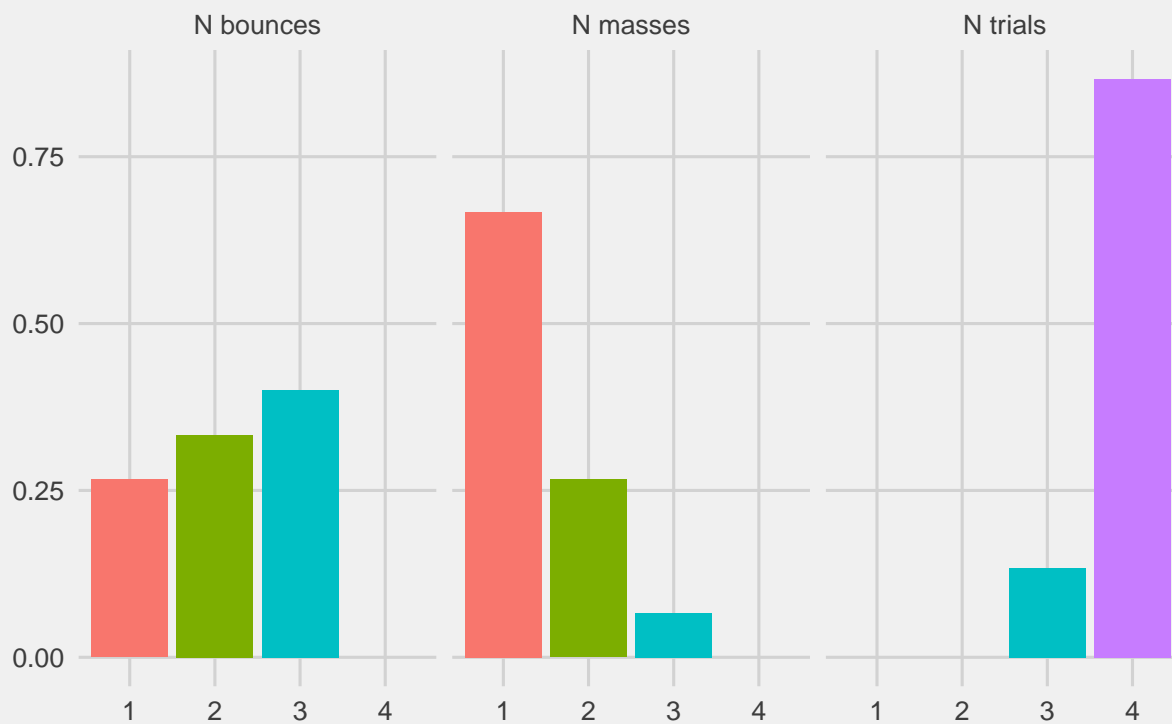
[1] "Group 1 evaluate methods"

Group 1, data collection methods

Equipment used | Variables controlled | Variables measured
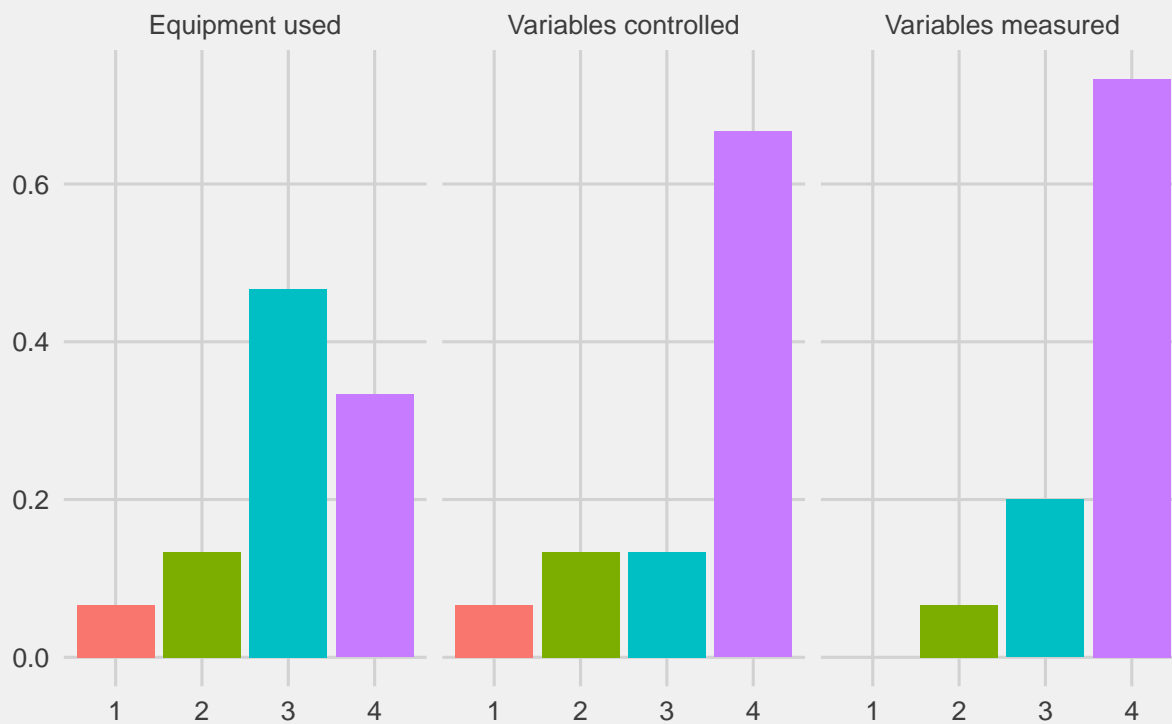
Group 1, amount of data

Group 1, analysis and outcomes

Analysis

Explanations

Similar k values

Uncertainty in data and k
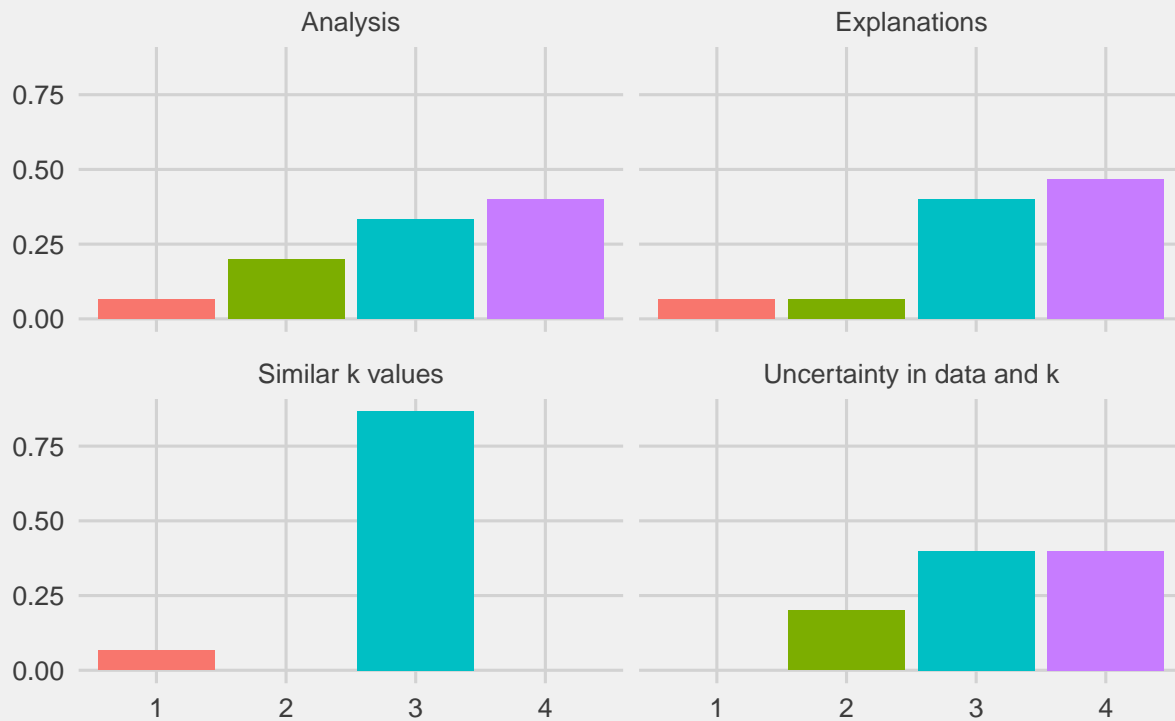
[1] "How effective do you think Group 1s method was for testing whether the \n   data obey the mo[...]

Group 1, method effectiveness
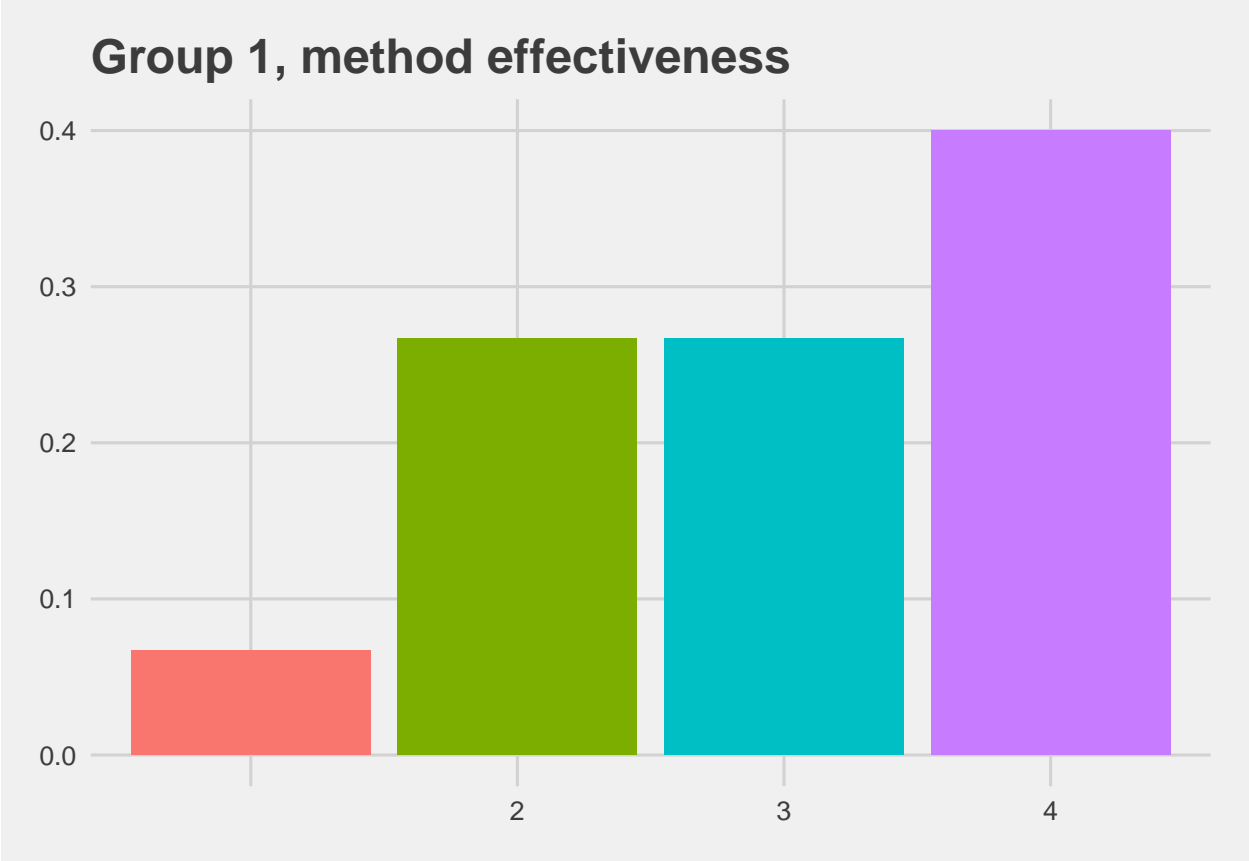
## [1] "What feature was most important to you in evaluating the effectiveness of \n   Group 1s metho

Group 1, feature of method
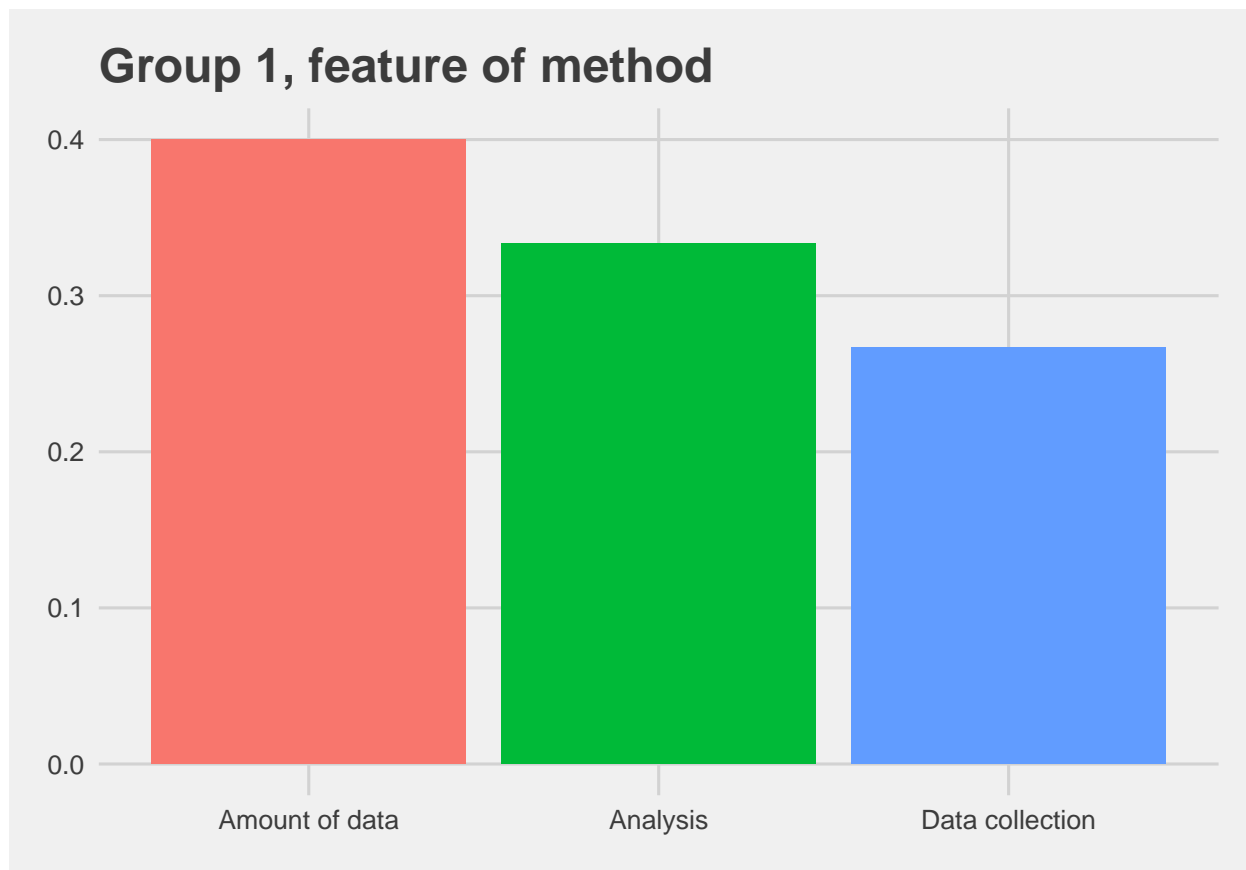


```
## [1] "What do you think Group 1 should do next?"
```

```
##                                                                   t.info...cols.temp..
## Q134_1                                                     Test or control other variables
## Q134_2   Reduce uncertainty (e.g., more trials for the same masses, more bounces per trial, etc.)
## Q134_10                                                             Account for human error
## Q134_3                                            Repeat the experiment with more and different masses
## Q134_9                                                   Repeat the experiment with better equipment
## Q134_4        Use a different analysis (e.g., graph the results, incorporate systematic effects)
## Q134_6                                                 Compare their k-values to the expected value
## Q134_8                                                 Design a new experiment to test the results
## Q134_5                                                           Check their work and write it up
## Q134_7                                                                                Other
```
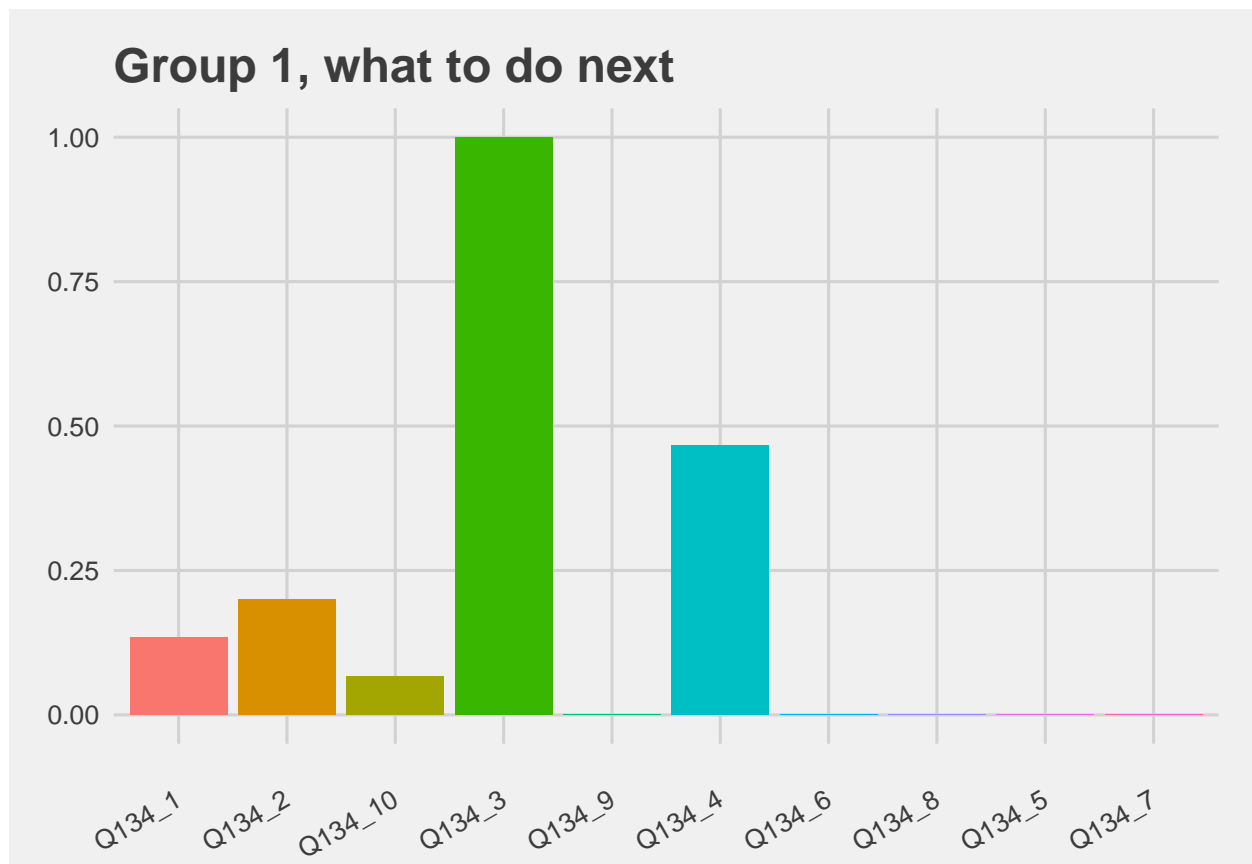
Group 1, what to do next

Page 2

```
## [1] "What do you think Group 2 should say about whether their data agree with \n      the model?"
```
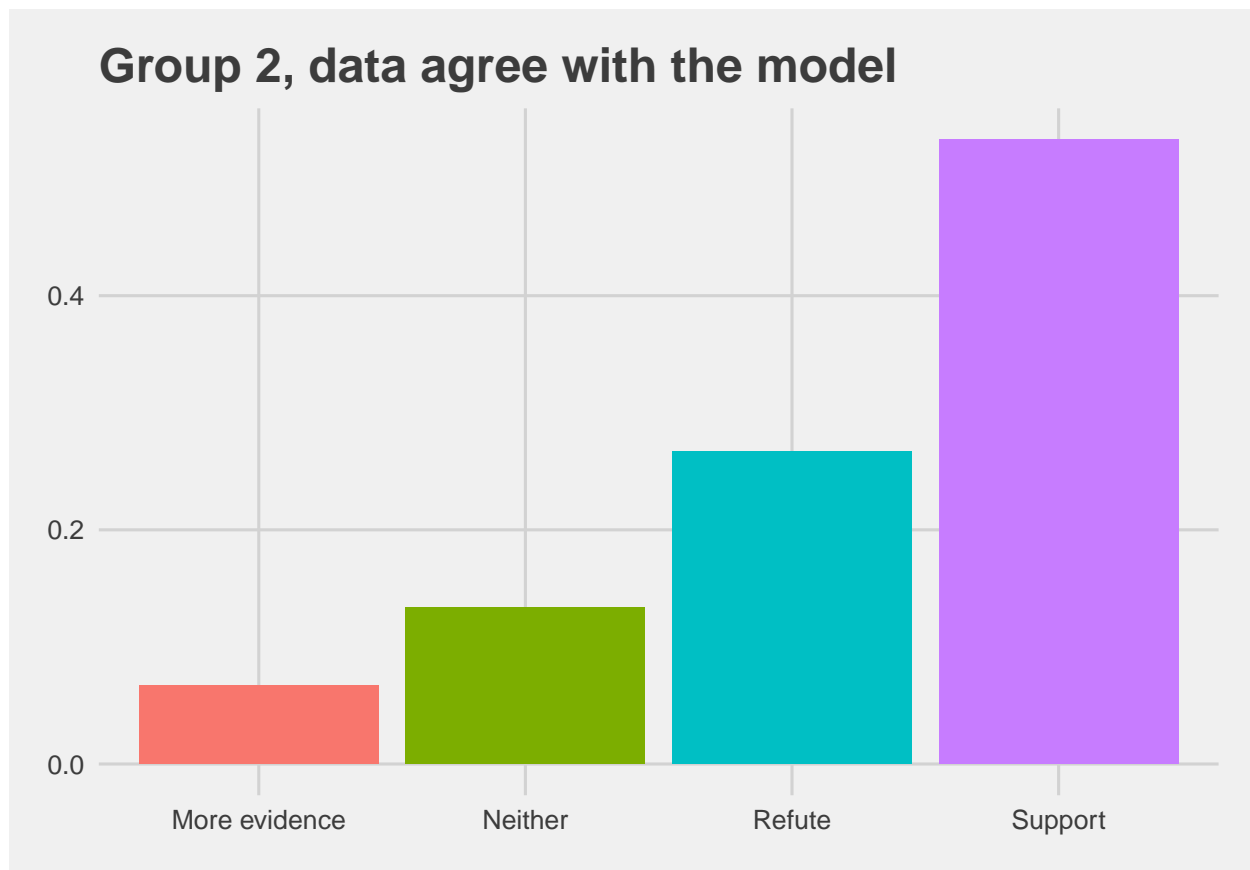
Group 2, data agree with the model


```
## [1] "Which statements below support your reasoning for whether Group 2s data \n          agree with the 
```

```
##                                                                 t.info...cols.temp..
## Q2b_8                                               The points are close to the line
## Q2b_11             The points are close to the line compared to the uncertainties
## Q2b_21                    There are equal numbers of points above and below the line
## Q2b_2                    The points are randomly scattered above and below the line
## Q2b_9                                                       There are very few outliers
## Q2b_36                              The uncertainty in the points is small
## Q2b_6      Many of the points cross the line (when considering their uncertainties)
## Q2b_1                                               The data are approximately linear
## Q2b_38                                                 Other (Please describe)
## Q2b_39                                               The points are far from the line
## Q2b_40          The points are far from the line compared to the uncertainties
## Q2b_41              There are not equal numbers of points above and below the line
## Q2b_42 There is a pattern in how the points are scattered above and below the line
## Q2b_43                                                       There are too many outliers
## Q2b_44                               The uncertainty in the points is large
## Q2b_45        Too few points cross the line (when considering their uncertainties)
## Q2b_46                                               The data are curved (not linear)
```
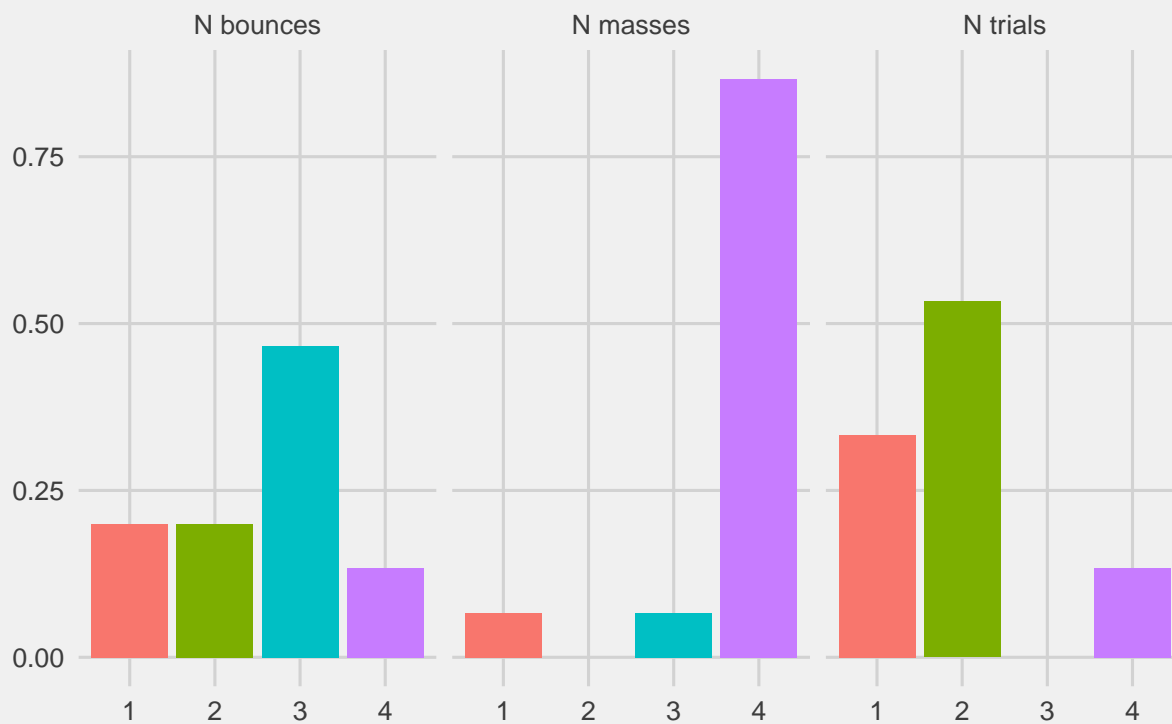
Group 2, reasoning
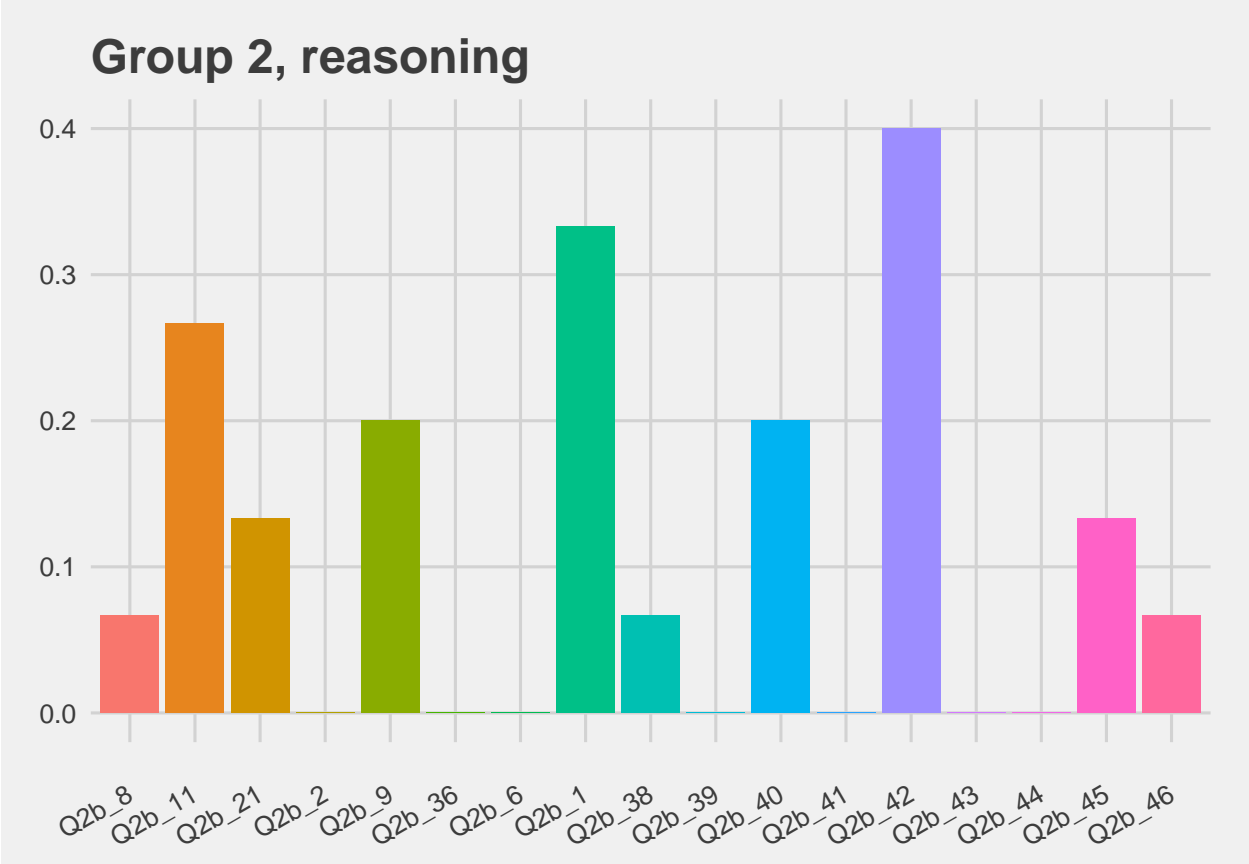
[1] "Group 2 evaluate methods"

Group 2, data collection methods

Group 2, amount of data

N bounces   N masses   N trials
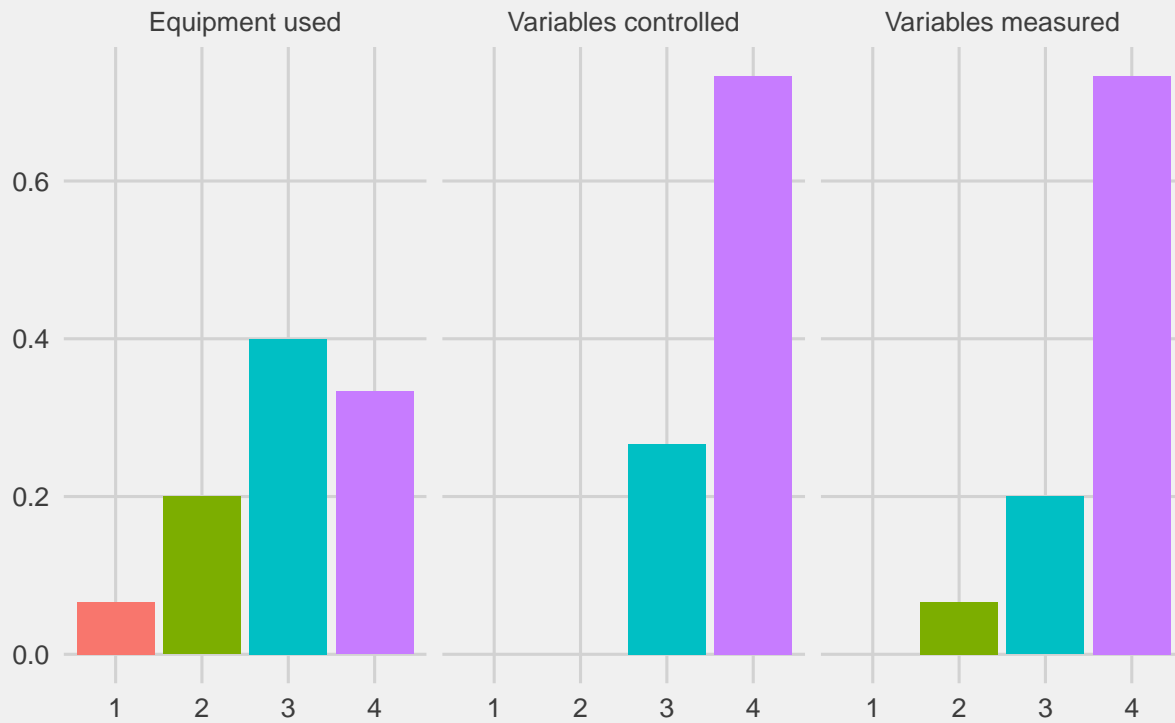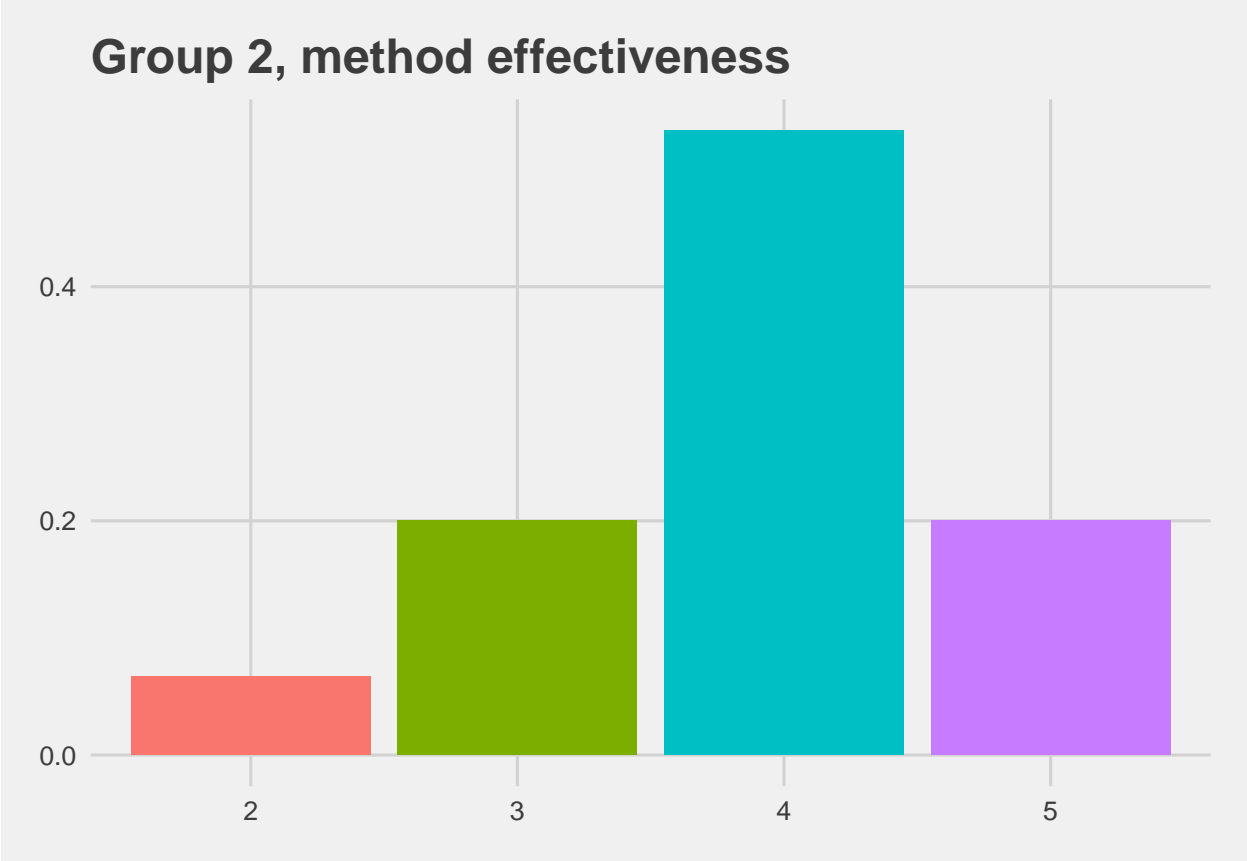
Group 2, analysis and outcomes
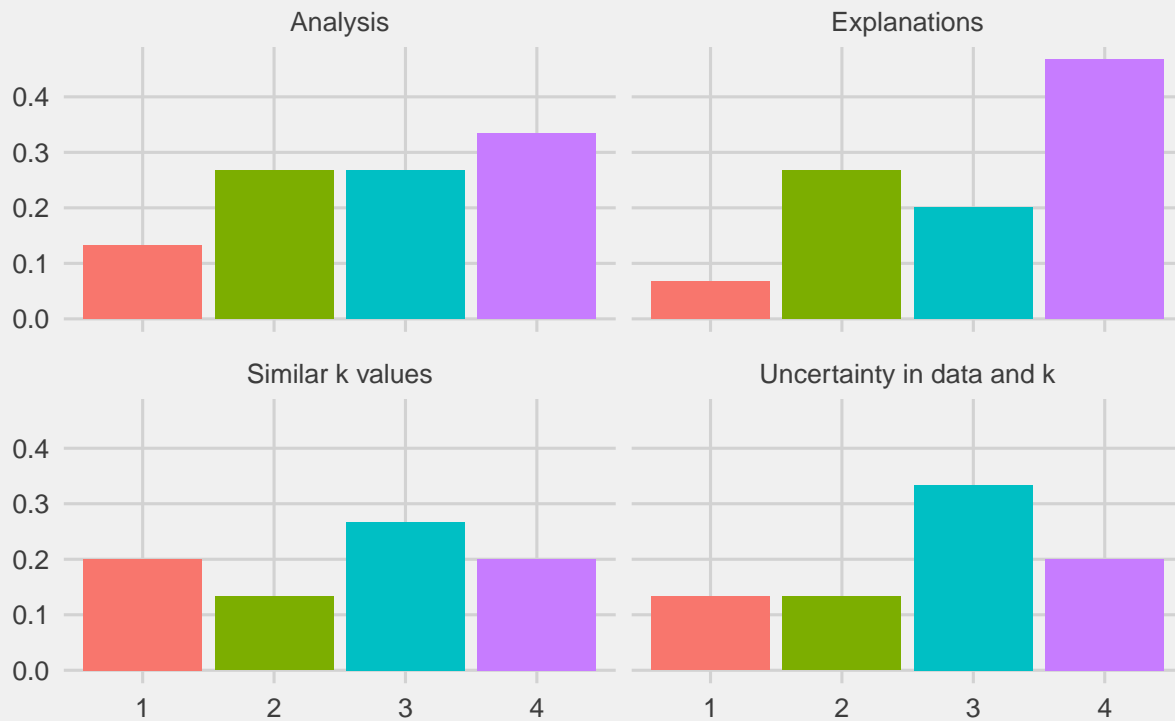
[1] "How effective do you think Group 2s method was for testing whether the data \n   obey the mod

**Group 2, method effectiveness**

[1] "What feature was most important to you in evaluating the effectiveness of \n   Group 2s metho

Group 2, feature of method


```
## [1] "What do you think Group 2 should do next?"
```
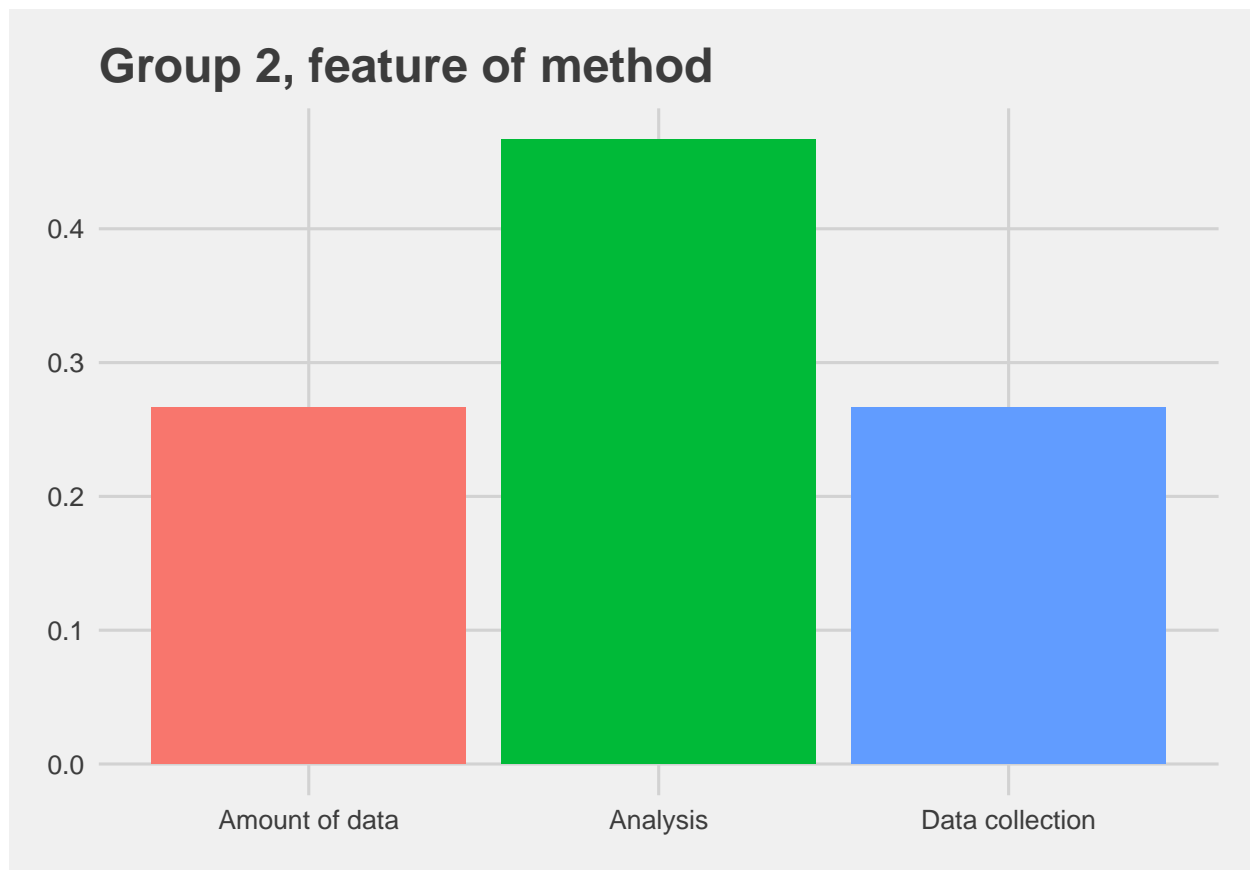
```
##                                                                    t.info...cols.temp..
## Q2e_6                                                       Test or control other variables
## Q2e_4                                               Repeat the experiment with better equipment
## Q2e_12    Change the analysis (e.g., use a different fit line, incorporate systematic effects)
## Q2e_14                                              Compare their k-value to the expected value
## Q2e_15                                              Design a new experiment to test the results
## Q2e_16 Reduce uncertainty (e.g., more trials for the same masses, more bounces per trial, etc.)
## Q2e_17                                                        Check their work and write it up
## Q2e_34                                        Repeat the experiment with more and different masses
## Q2e_11                                                                Other (Please describe)
```
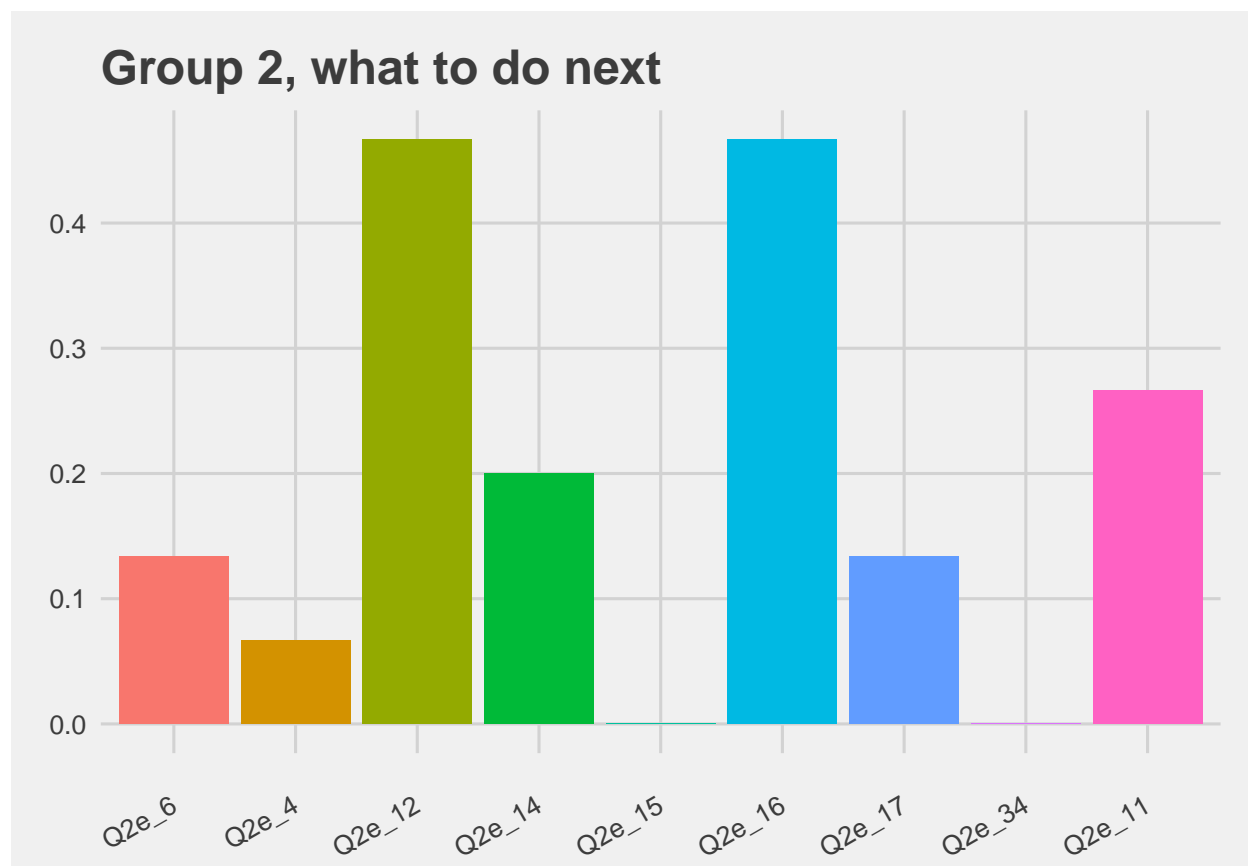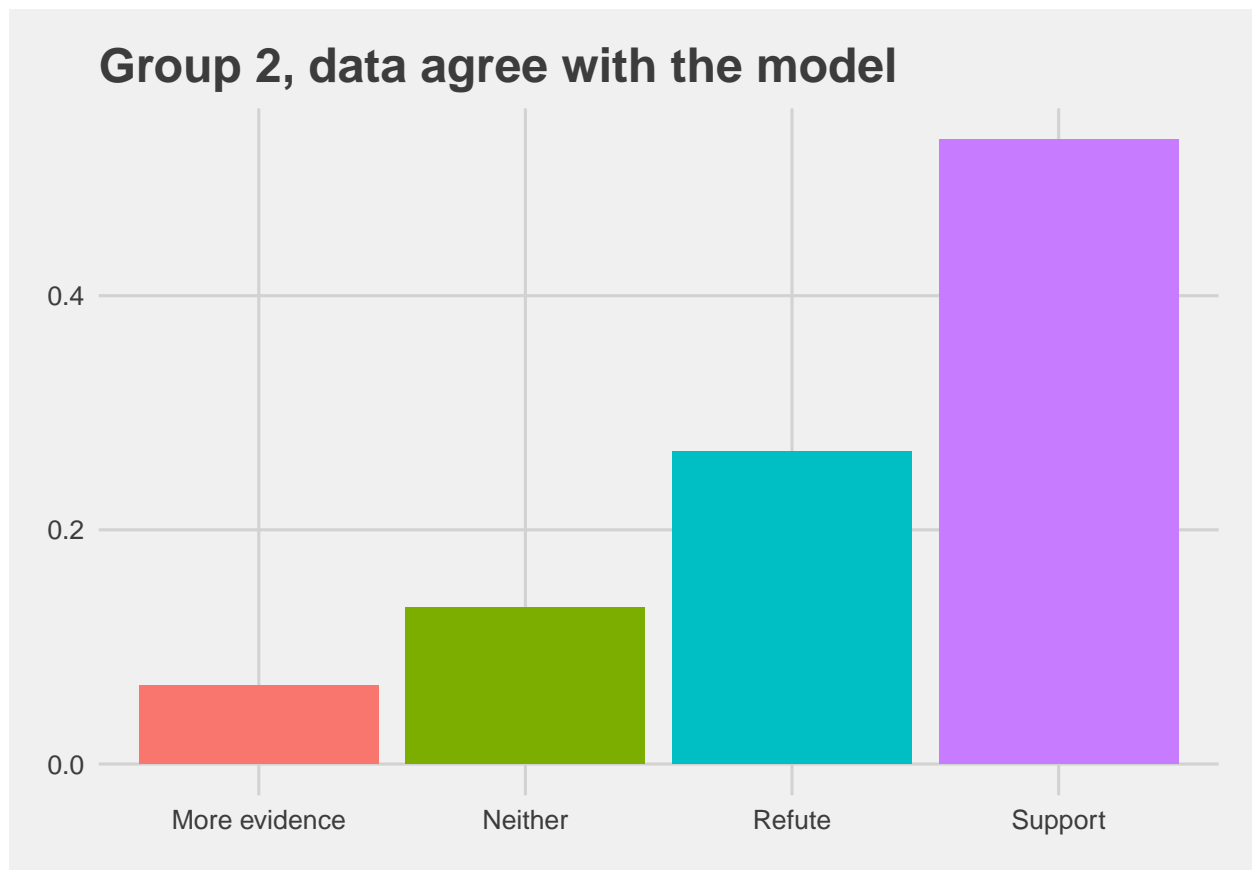
Group 2, what to do next

Page 3

```
## [1] "What do you think Group 2 should say about whether their data agree with \n      the model?"
```

Group 2, data agree with the model

```
## [1] "Which statements below support your reasoning for whether Group 2s data \n      agree with the
```

```
##                                                              t.info...cols.temp..
## Q145_8                                             The points are close to the line
## Q145_11            The points are close to the line compared to the uncertainties
## Q145_21                 There are equal numbers of points above and below the line
## Q145_2                 The points are randomly scattered above and below the line
## Q145_9                                                    There are very few outliers
## Q145_36                                       The uncertainty in the points is small
## Q145_6    Many of the points cross the line (when considering their uncertainties)
## Q145_1                                             The data are approximately linear
## Q145_38                                                       Other (Please describe)
## Q145_39                                              The points are far from the line
## Q145_40            The points are far from the line compared to the uncertainties
## Q145_41             There are not equal numbers of points above and below the line
## Q145_42 There is a pattern in how the points are scattered above and below the line
## Q145_43                                                    There are too many outliers
## Q145_44                                       The uncertainty in the points is large
## Q145_45       Too few points cross the line (when considering their uncertainties)
## Q145_46                                              The data are curved (not linear)
```
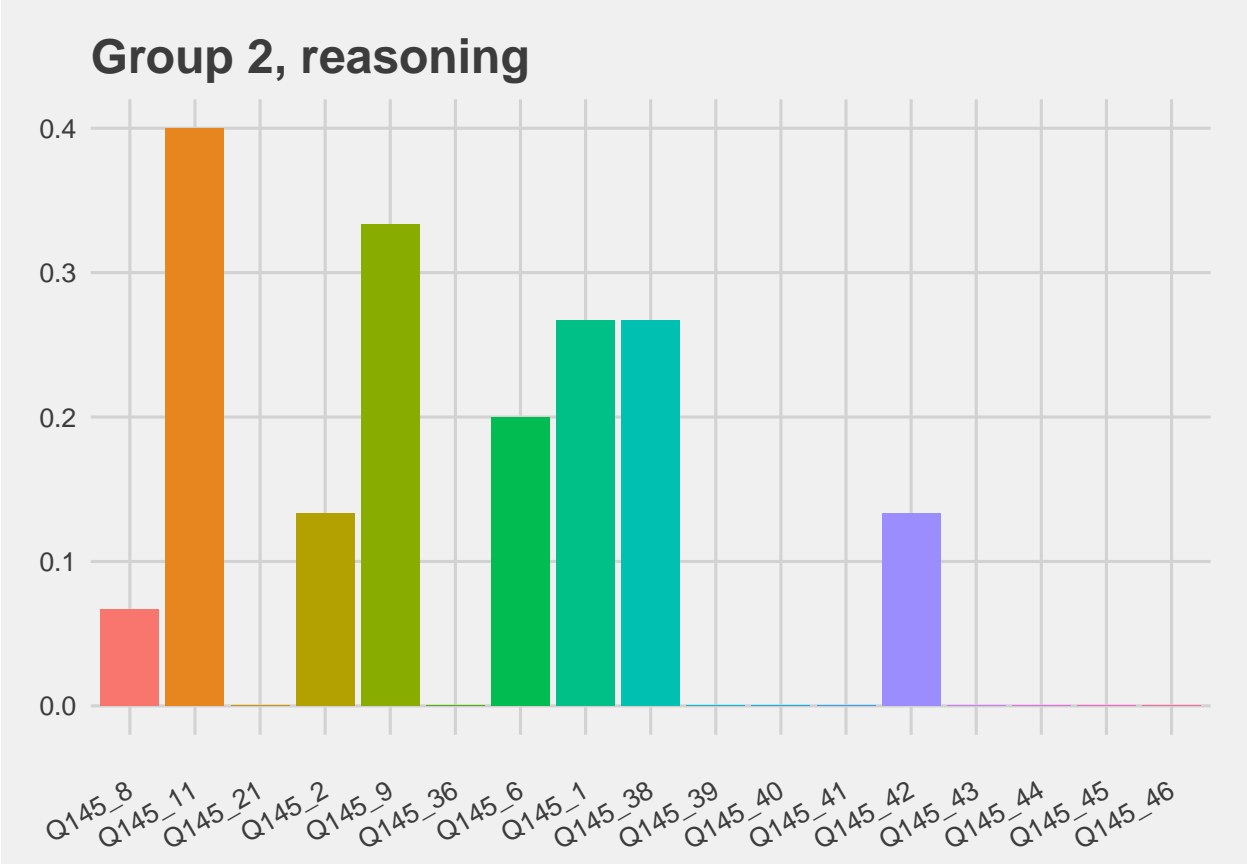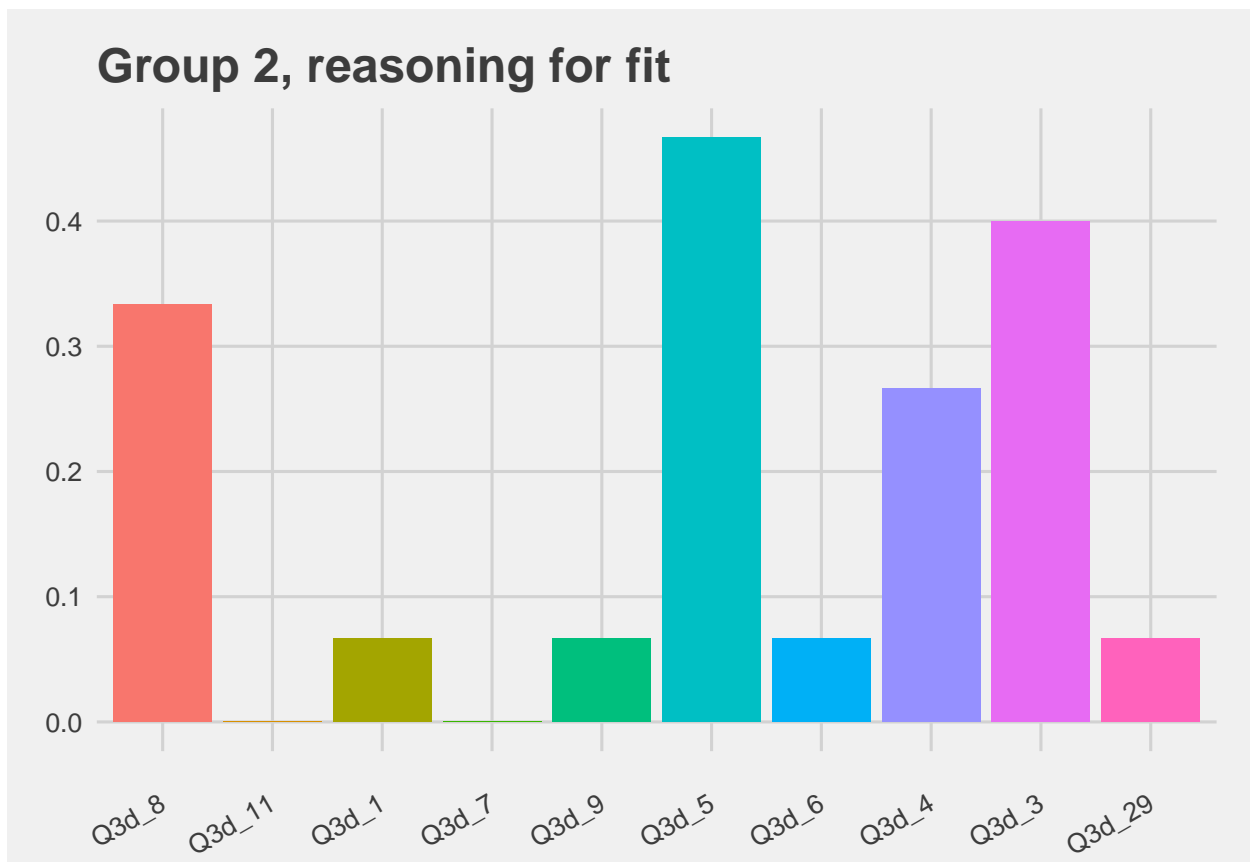
Group 2, reasoning

[1] "Which fit do you think Group 2 should use?"

Group 2, which fit
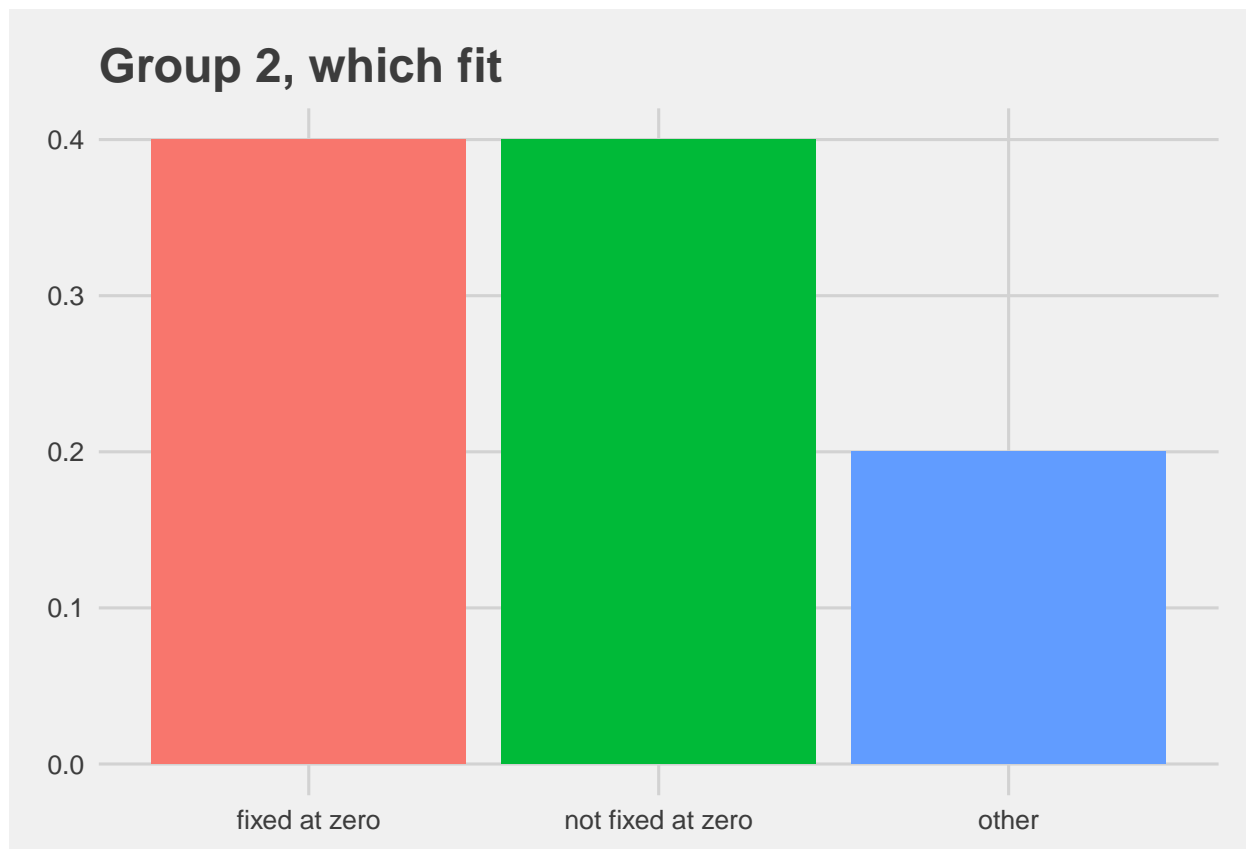

```
## [1] "Others: Either fix the intercept at zero or change the model., both, \n      I think the results
```

```
## [1] "Which items below best reflect your reasoning?"
```

```
##                                                                    t.info...cols.temp..
## Q3d_8                                                                   The fit is better
## Q3d_11                              The uncertainty in the spring constant value is smaller
## Q3d_1                                    There may have been mistakes in the data collection
## Q3d_7                                            There may have been random uncertainty
## Q3d_9                                                 There may have been human error
## Q3d_5            There may have been an invalid assumption (or something was ignored)
## Q3d_6                                    The intercept is irrelevant in the investigation
## Q3d_4                                    The ideal model doesn't really apply in the real world
## Q3d_3  The model says the intercept should be zero (and they can't just add a parameter)
## Q3d_29                                                                                Other
```

Group 2, reasoning for fit

```
## [1] "What do you think Group 2 should do next?"

##                                                                t.info...cols.temp..
## Q147_6                                                    Test or control other variables
## Q147_4                                                 Repeat the experiment with better equipment
## Q147_12    Change the analysis (e.g., use a different fit line, incorporate systematic effects)
## Q147_14                                                  Compare their k-value to the expected value
## Q147_15                                                  Design a new experiment to test the results
## Q147_16 Reduce uncertainty (e.g., more trials for the same masses, more bounces per trial, etc.)
## Q147_17                                                       Check their work and write it up
## Q147_34                                             Repeat the experiment with more and different masses
## Q147_11                                                            Other (Please describe)
```
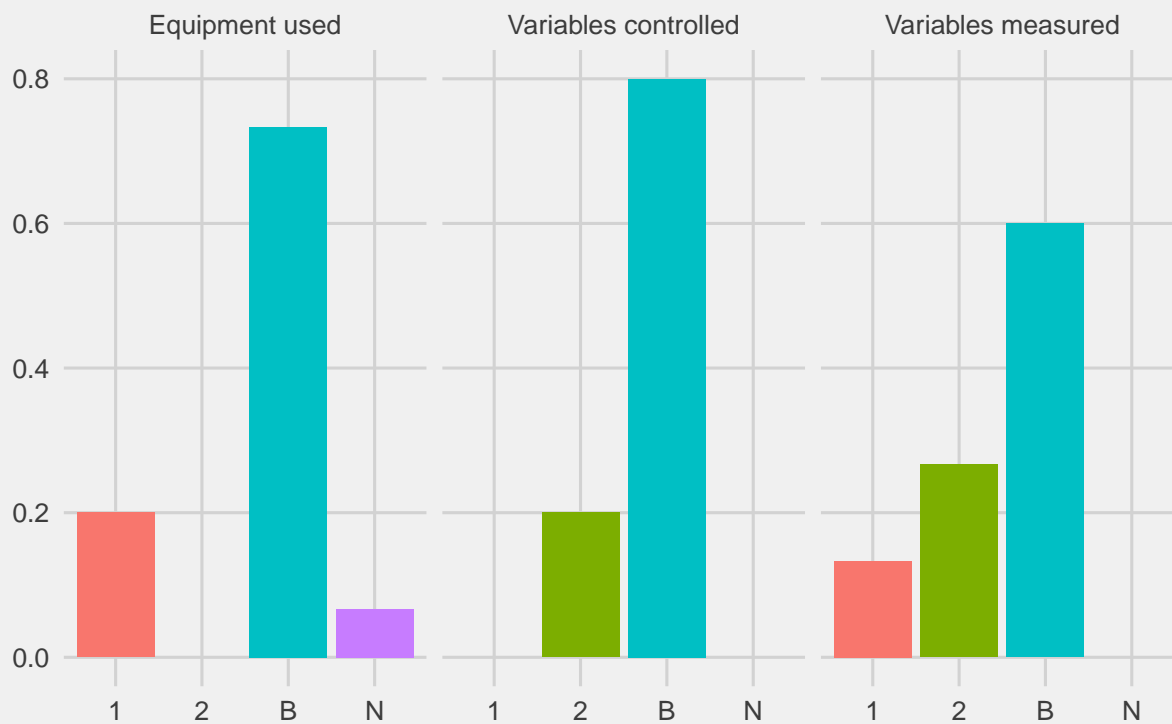
Group 2, what to do next
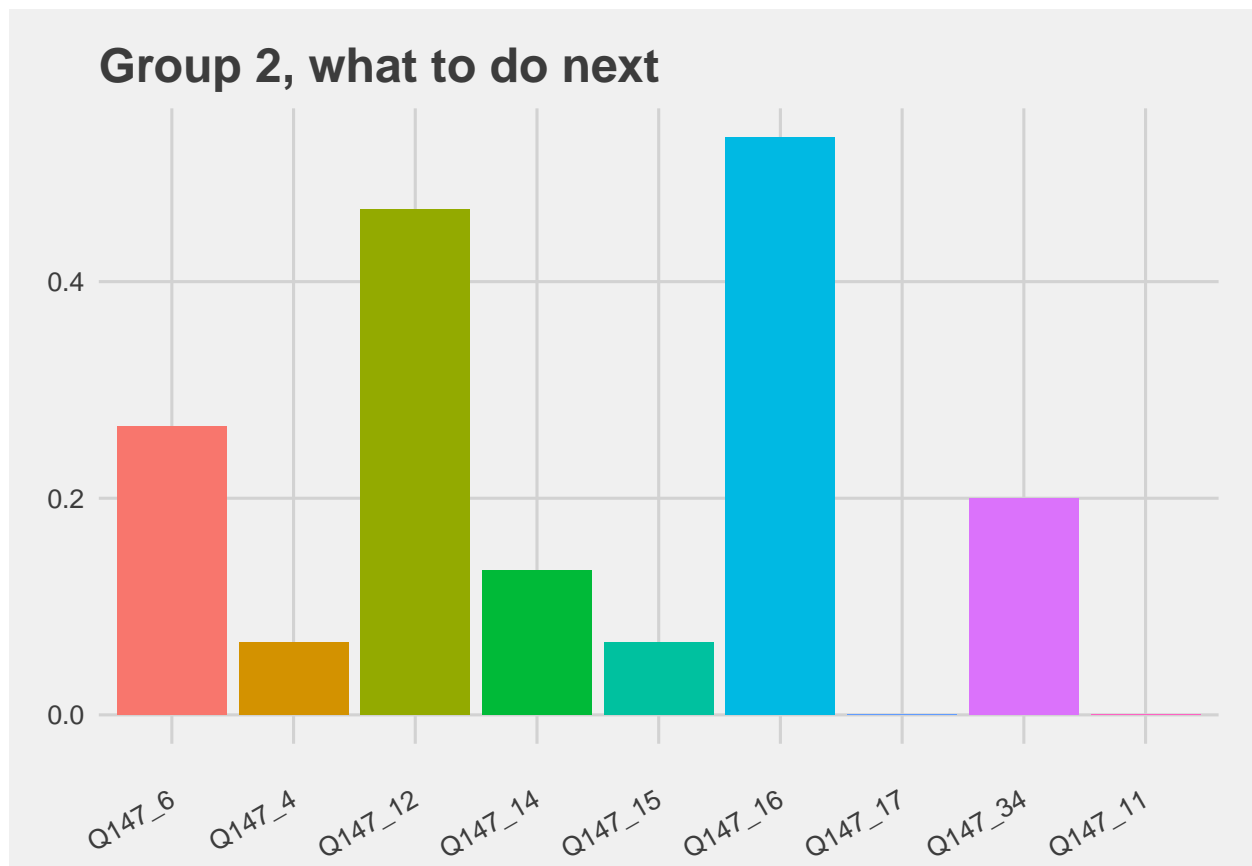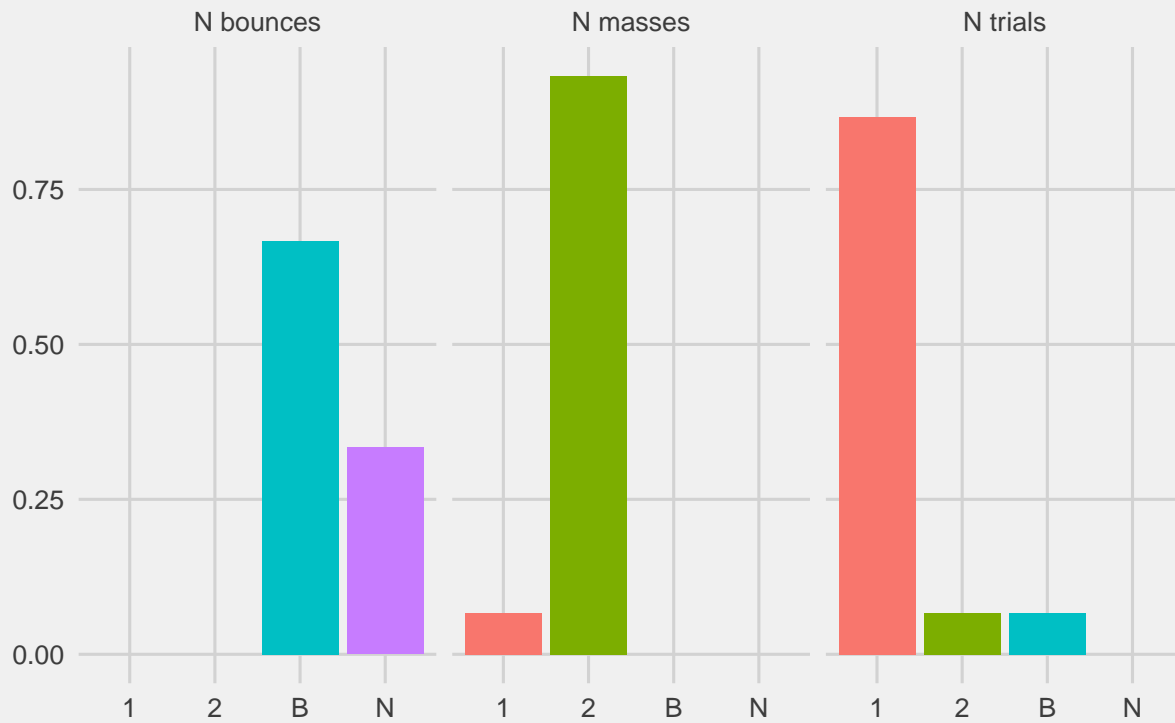
Page 4

```
## [1] "Which group do you think did a better job of testing the model?"
```
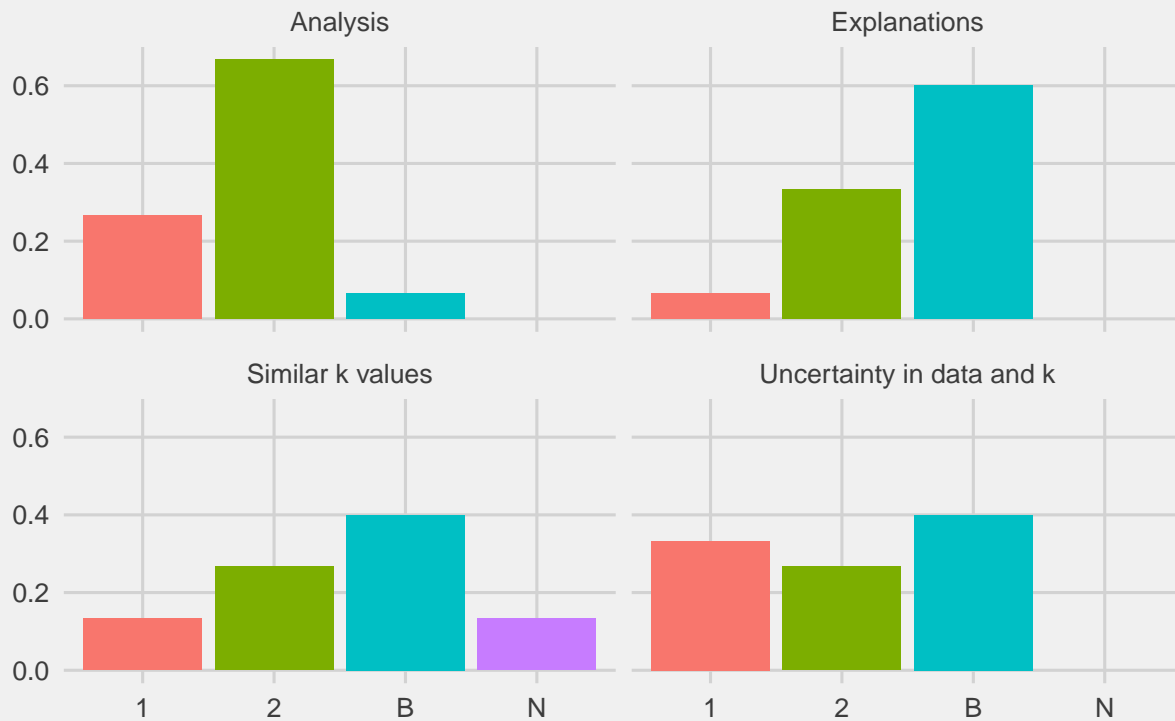
Which group did a better job?
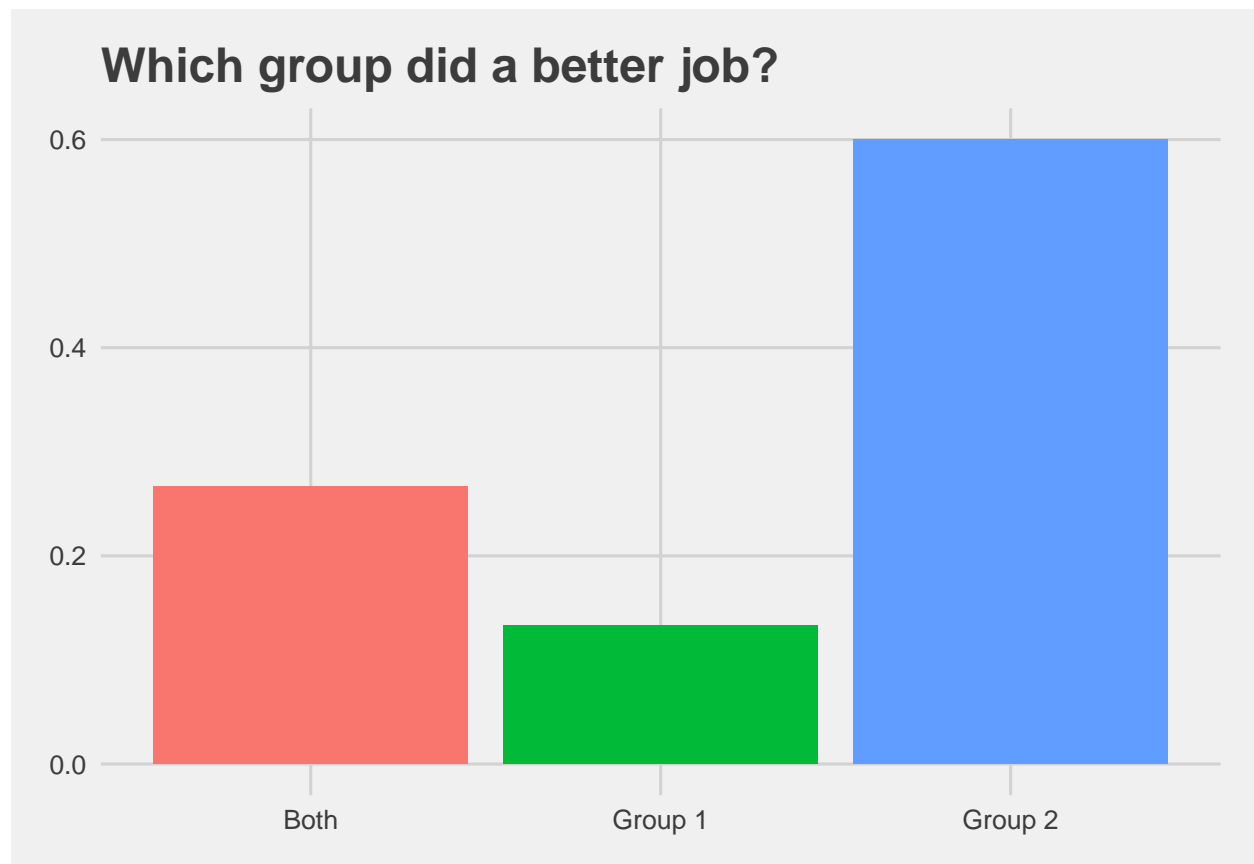
```
## [1] "Compare methods"
```

Compare data collection methods

Equipment used   Variables controlled   Variables measured

Compare amount of data

Compare analysis and outcomes

[1] "What feature was most important to you for comparing the two groups?"

Feature for comparing methods