W241 Final Project Experiment Results

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1. Pilot Study

TODO

2. Getting the Data

2.1 Load the Data

Survey responses were sourced from three different environments: 1. Amazon Mechanical Turk with Masters qualification 2. Amazon Mechanical Turk without Masters qualification 3. Friends & Family (Facebook, LinkedIn, I School Slack)

Although this step is not critical for analyzing the results of the experiment, it might be interesting to know later on where a subject was recruited from. So, here we pre-process the data to explicitly identify each subject's group. We do that by matching the mTurkCOde from the Amazon Mechanical Turk (mturk) responses to the mTurkCode in the qualtrics data set.

```
mturk_masters =
  read.csv("experiment_results/mturk_W241_Final-Project_Survey_Masters-Batch_Results.csv")
mturk_regulars =
  read.csv("experiment_results/mturk_W241_Final-Project_Survey_Non-Masters-Batch_Results.csv")

# the second and third rows of the qualtrics results contain meta info
# we do not need so we remove it here
all_content =
  readLines("experiment_results/qualtrics_W241_Final-Project_Survey_Experiment_August-1-2018_14-06.csv")
all_content = all_content[-3]
all_content = all_content[-2]
qualtrics = read.csv(textConnection(all_content), header = TRUE, stringsAsFactors = FALSE)
rm(all_content)
# thank you: https://stackoverflow.com/questions/15860071/read-csv-header-on-first-line-skip-second-lin
```

2.2 Concatenate MTurk Masters & MTurk Regulars

```
# assign groups
mturk_masters['source_group'] = 1
mturk_regulars['source_group'] = 2
mturk_all = rbind(mturk_masters, mturk_regulars)

# keep these columns and drop the rest (switched to reverse where we explicitly drop the not necessary
#mturk_cols_to_keep = c('HITId', 'CreationTime', 'Expiration', 'AssignmentId', 'WorkerId', 'AssignmentS
#mturk_all = mturk_all[mturk_cols_to_keep]

# drop unnecessary columns
mturk_all = subset(mturk_all, select = -c(HITTypeId, Title, Description, Keywords,
```

```
                                          Reward, MaxAssignments, RequesterAnnotation,
                                          AssignmentDurationInSeconds, AutoApprovalDelayInSeconds,
                                          NumberOfSimilarHITs, LifetimeInSeconds, AssignmentId,
                                          AutoApprovalTime, ApprovalTime, RejectionTime,
                                          RequesterFeedback, Approve, Reject))

# rename mTurkCode column to match qualtrics
mturk_all['mTurkCode'] = mturk_all['Answer.surveycode']

# check out the combined dataset
#head(mturk_all)
table(mturk_all['source_group'])
```

```
##
##   1   2
##  42 300
```

```
dim(mturk_all)
```

```
## [1] 342  14
```

2.3 Merge MTurk and Qualtrics Datasets

```
#head(qualtrics)
responses = merge(x = qualtrics, y = mturk_all, by = "mTurkCode", all.x = TRUE)
dim(responses)
```

```
## [1] 519  42
```

```
table(responses$source_group)
```

```
##
##   1   2
##  42 298
```

```
#head(responses)
#colnames(responses)
responses$source_group[is.na(responses$source_group)] = 3
responses$source_group <- factor(responses$source_group, labels = c("Mturk Masters", "Mturk Regulars",
#hist(responses$source_group, breaks=3) # could probably make this prettier
table(responses$source_group)
```

```
##
##  Mturk Masters Mturk Regulars            F&F
##             42            298            179
```

```
rm(list = c('mturk_all', 'mturk_masters', 'mturk_regulars', 'qualtrics'))
```

3. Data Cleaning

3.1 Identifying Invalid Data Rows

Potentially invalid responses are those that:

- have `Status` = 'Spam' or 'Survey Preview'

- Duplicate `IPAddress` occurance. We'll keep the first response for the analysis (alternatively, we can exclude all of them)
- not finished (progress less than 100%). These cases need to be investigated for potential bias

3.1.1 Invalid Status

```
table(responses$Status)
```

```
##
##     IP Address           Spam Survey Preview
##            514              1              4
```

3.1.2 Duplicate IP Addresses

```
# record duplicate IP Addresses and first timestamp
responses %>%
  group_by(IPAddress) %>%
  arrange(StartDate) %>%
  summarize(ip_count = n(),
            StartDate = first(StartDate)) %>%
  filter(ip_count > 1) -> duplicate_ips

# merge duplicate IP Addresses based on first time stamp
responses <- merge(x = responses, y = duplicate_ips,
               by = c("IPAddress", "StartDate"), all.x = TRUE)
# merge all duplicate IP Addresses
responses <- merge(x = responses, y = duplicate_ips[,c("IPAddress", "ip_count")],
               by = "IPAddress", all.x = TRUE)

responses$duplicate_ip <- 0
responses[!is.na(responses$ip_count.y),]$duplicate_ip <- 1
responses$duplicate_ip_xfirst <- 0
responses[!is.na(responses$ip_count.x),]$duplicate_ip_xfirst <- 1
responses$ip_count.x <- NULL
colnames(responses)[colnames(responses)=="ip_count.y"] <- "ip_count"
responses[is.na(responses$ip_count),]$ip_count <- 1
rm(duplicate_ips)
```

```
table(responses$duplicate_ip, responses$duplicate_ip_xfirst)
```

```
##
##       0   1
##   0 430   0
##   1  60  29
```

```
table(responses$ip_count)
```

```
##
##   1   2   3   4   5  16
## 430  38   9  16  10  16
```

3.1.3 Unfinished Surveys

We have 70 responses that were not finished. We'll create a separate flag variable to determine if they are a cause for attrition concern:

```
## ========================================================================

##
## Summary of survey's progress:

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   53.00  100.00  100.00   94.24  100.00  100.00

## ========================================================================

##
## Number of responses that are not finished:

## [1] 70

## ========================================================================

##
## Primary outcome distribution for unfinished responses:

## < table of extent 0 >

## ========================================================================

##
## Source of  unfinished responses:

##
##  Mturk Masters Mturk Regulars            F&F
##              0              0             70

## ========================================================================

##
## Treatment assignment for unfinished responses:

##
##    Introduction:1Star Introduction:4.5Stars  Introduction:Control
##                    17                    28                    25
```

3.1.4 Putting It All Together

```
responses$valid <- "Valid"
responses[responses$Status %in% c("Spam", "Survey Preview"), ]$valid <- "Preview/Spam"
responses[responses$duplicate_ip_xfirst==1,]$valid <- "Duplicate"
responses[responses$Progress < 100,]$valid <- "Not Finished"
table(responses$valid)
```

```
##
##    Duplicate Not Finished Preview/Spam        Valid
##           23           70            3          423

## ========================================================================

##
## Source of valid responses:

##
##  Mturk Masters Mturk Regulars            F&F
##             39            291             93

##
## Source of invalid responses:
```

```
##
##  Mturk Masters Mturk Regulars            F&F
##              3              7             86
```

```
## ========================================================================
```

```
##
## Treatment assignment for valid responses:
```

```
##
##    Introduction:1Star Introduction:4.5Stars  Introduction:Control
##                   135                   141                   147
```

```
##
## Treatment assignment for invalid responses:
```

```
##
##    Introduction:1Star Introduction:4.5Stars  Introduction:Control
##                    27                    38                    31
```

```
table(responses[responses$valid == "Valid",]$FL_2_DO,
      responses[responses$valid == "Valid",]$source_group)
```

```
##
##                         Mturk Masters Mturk Regulars F&F
##   Introduction:1Star               10             90  35
##   Introduction:4.5Stars            12            101  28
##   Introduction:Control             17            100  30
```

3.2 Are Valid Responses Actually Valid?

```
short_story_word_count = 990
duration_secs_minimum = 30
correct_answers_minimum = 1
```

This experiment relies entirely on the assumption that the subjects read the short story. To ensure this, we added several validation checks to the survey.

First, a timer to track how long each participant spends on the short story page itself. The short story is 990 words, so any subject with less than 30, a reading speed of 0.55 will be dropped. Given that the adult average reading speed is about 200 wpm), we believe that this is more than justified.

Second, the survey contains three reading comprehension questions to test the reader's understanding of the story. These questions are designed to be extremely basic and high-level. In fact, the questions were made easier after the pilot as those were deemed to be too difficult. If the subject read the story, then they should be able to answer these questions. Since no one is perfect, we are electing to keep all subjects that answered at least 1 answer correctly. We drop the rest.

Finally, we will be dropping any subject that failed to answer all questions in the survey.

```
valid_responses = subset(responses, valid == "Valid")
```

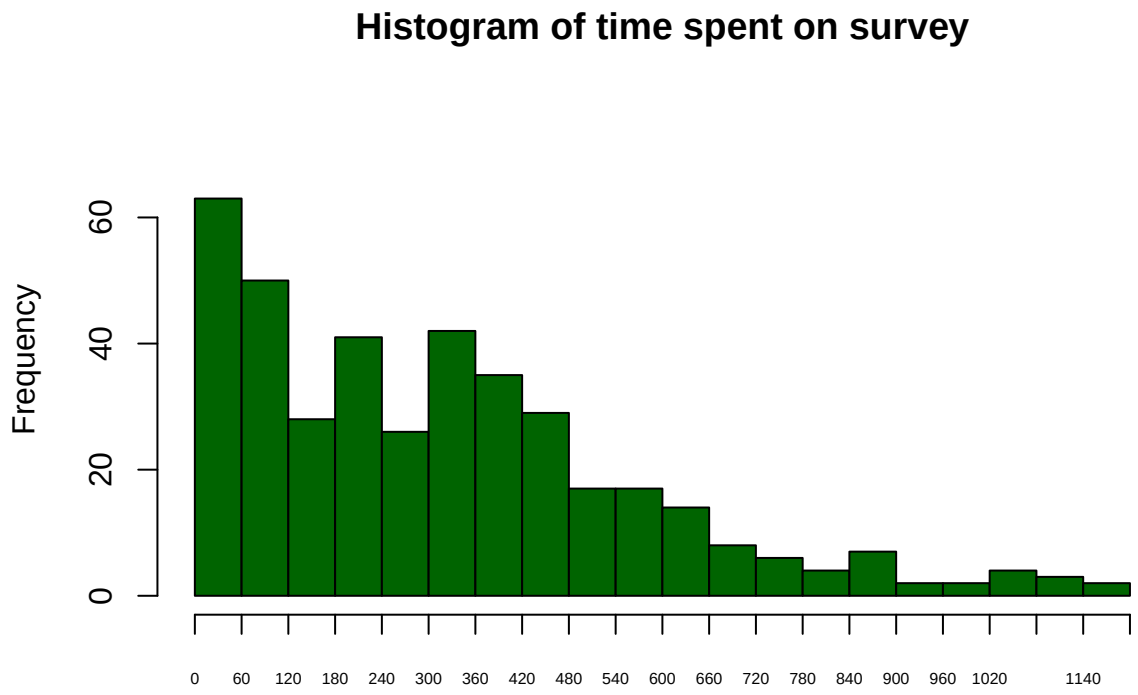
```
summary(valid_responses$Duration..in.seconds.)
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##     9.0   104.5   305.0   744.5   494.0 78097.0
```

```
sum(valid_responses$Duration..in.seconds. < 1200)
```

```
## [1] 400
```

```
hist(valid_responses[valid_responses$Duration..in.seconds. < 1200,]$Duration..in.seconds.,
     col = "darkgreen",
     breaks = seq(0,1200,60),
     ylim = c(0, 75),
     xaxt = 'n',
     xlab = "Time spent on the whole survey",
     main = "Histogram of time spent on survey")
axis(side = 1, at = seq(0,1200,60), labels = seq(0,1200,60), cex.axis = 0.5)
```



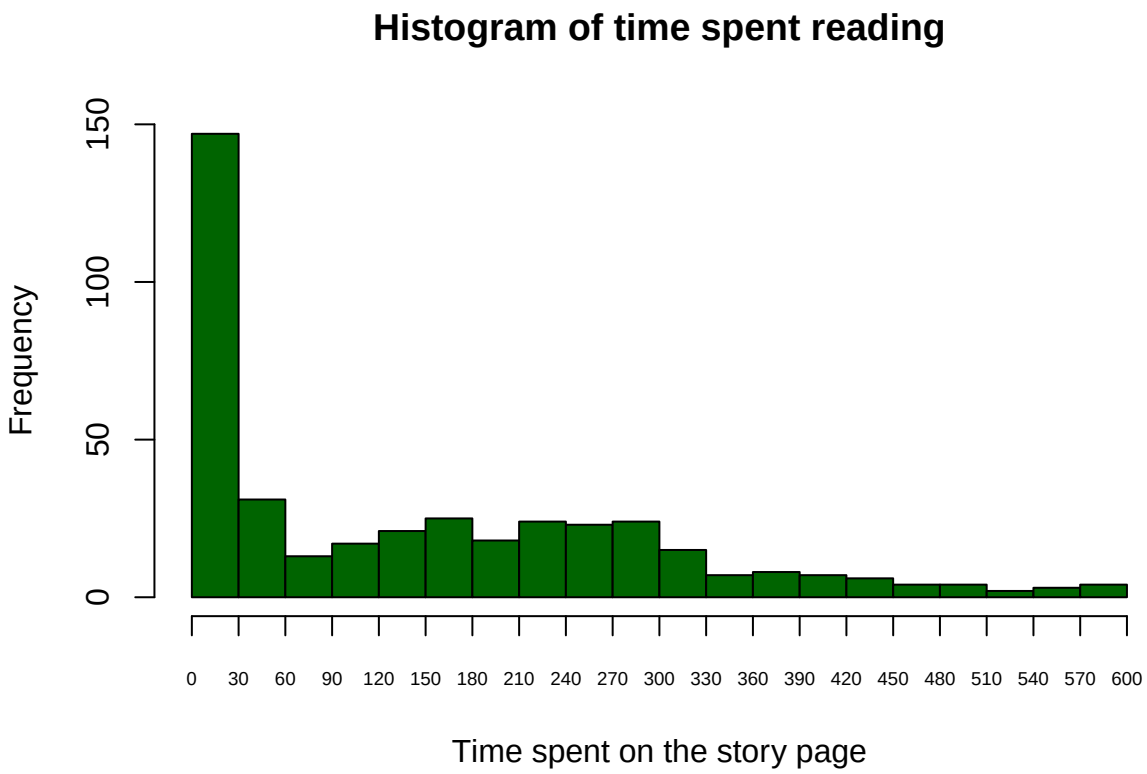

```
summary(valid_responses$Q2_Page.Submit)
```

```
##     Min.  1st Qu.   Median     Mean  3rd Qu.     Max.
##    1.511    9.493  126.567  204.099  265.954 7691.925
```

```
sum(valid_responses$Q2_Page.Submit < 600)
```

```
## [1] 403
```

```
hist(valid_responses[valid_responses$Q2_Page.Submit < 600,]$Q2_Page.Submit,
     col = "darkgreen",
     breaks = seq(0,600,30),
     ylim = c(0, 150),
     xaxt = 'n',
     xlab = "Time spent on the story page",
     main = "Histogram of time spent reading")
axis(side = 1, at = seq(0,600,30), labels = seq(0,600,30), cex.axis = 0.6)
```




```
# reading time check
#valid_responses = subset(valid_responses, Q2_Page.Submit >= duration_secs_minimum)
valid_responses[valid_responses$Q2_Page.Submit < duration_secs_minimum,]$valid <- "Undertime"
table(valid_responses$valid)
```

```
##
## Undertime     Valid
##       147       276
```

```
table(valid_responses$valid, valid_responses$FL_2_DO)
```

```
##
##             Introduction:1Star Introduction:4.5Stars Introduction:Control
##   Undertime                 45                    53                   49
##   Valid                     90                    88                   98
```

```
table(valid_responses$valid, valid_responses$source_group)
```

```
##
##             Mturk Masters Mturk Regulars F&F
##   Undertime             5            128  14
##   Valid                34            163  79
```

```
# reading questions check
Q12_correct_ans = 'Beautiful'
Q14_correct_ans = 'Rome'
Q16_correct_ans = 'Gaius was killed'
valid_responses['Q12_correct'] = ifelse(valid_responses$Q12 == Q12_correct_ans, 1, 0)
```

```
valid_responses['Q14_correct'] = ifelse(valid_responses$Q14 == Q14_correct_ans, 1, 0)
valid_responses['Q16_correct'] = ifelse(valid_responses$Q12 == Q16_correct_ans, 1, 0)
valid_responses['correct_answers'] = valid_responses$Q12_correct +
  valid_responses$Q14_correct + valid_responses$Q16_correct
table(valid_responses$correct_answers)
```

```
##
##   0   1   2
##  63 121 239
```

```
valid_responses[valid_responses$correct_answers < correct_answers_minimum,]$valid <- "Very incorrect"
table(valid_responses$valid)
```

```
##
##      Undertime          Valid Very incorrect
##             95            265             63
```

```
sum(valid_responses$Q4 == -99)
```

```
## [1] 8
```

```
valid_responses[valid_responses$Q4 == -99,]$valid <- "Missing outcome"
table(valid_responses$valid)
```

```
##
## Missing outcome       Undertime           Valid  Very incorrect
##               8              95             265              55
```

```
table(valid_responses$Q25)
```

```
##
##     -99  No Yes
##   4   5 292 122
```

```
valid_responses$issues <- "No issues"
#valid_responses[valid_responses$Q25 == 'Yes',]$issues <- "Know the story"
valid_responses[valid_responses$Q5 == '-99',]$issues <- "Missing text review"
valid_responses[valid_responses$Q25 == '-99',]$issues <- "Missing answer"
valid_responses[valid_responses$Q12 == '-99',]$issues <- "Missing answer"
valid_responses[valid_responses$Q14 == '-99',]$issues <- "Missing answer"
valid_responses[valid_responses$Q16 == '-99',]$issues <- "Missing answer"
table(valid_responses$issues)
```

```
##
##      Missing answer Missing text review           No issues
##                  16                  22                 385
```

```
table(valid_responses$valid, valid_responses$issues)
```

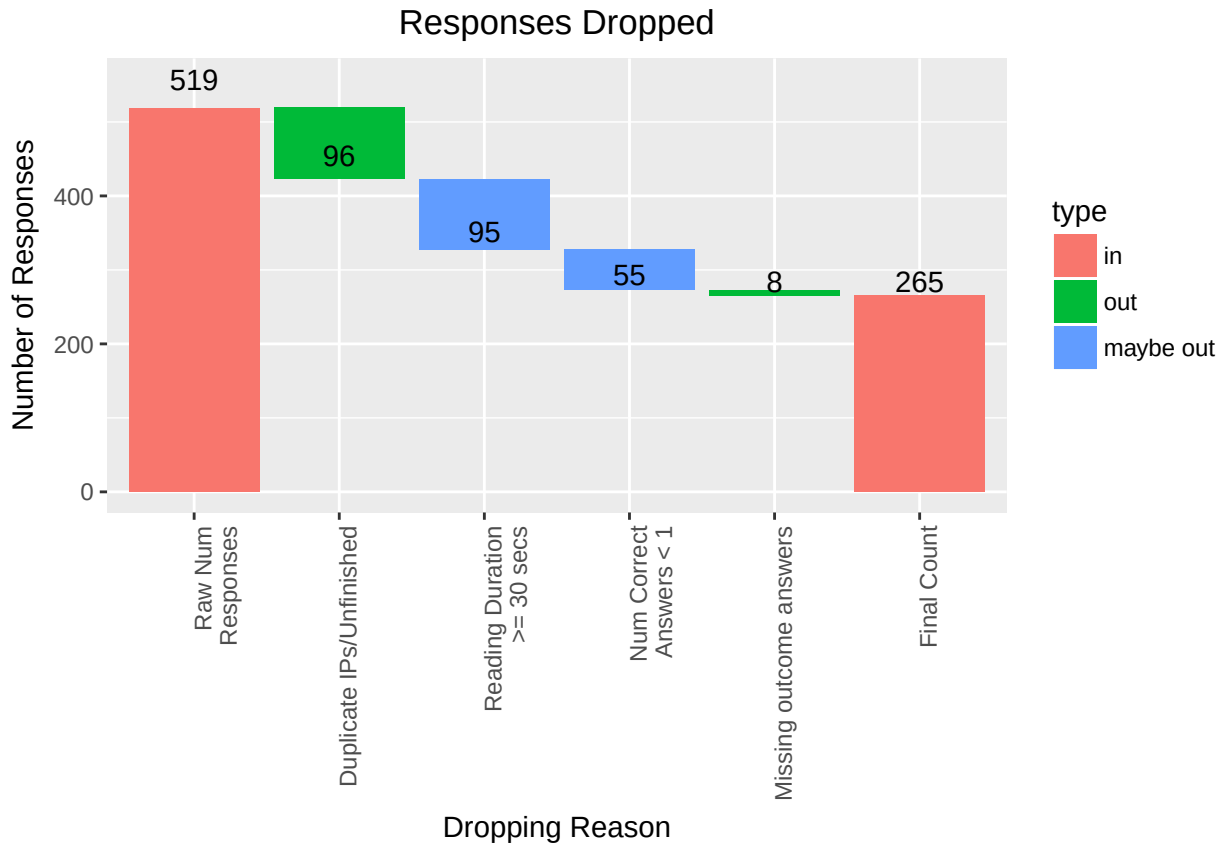
```
##
##                   Missing answer Missing text review No issues
##   Missing outcome              8                   0         0
##   Undertime                    1                   8        86
##   Valid                        1                   8       256
##   Very incorrect               6                   6        43
```

```
nrows_raw <- nrow(responses)
excl_dups_unfinished <- nrow(valid_responses)
```

```
excl_dur_undertime <- excl_dups_unfinished - sum(valid_responses$valid == 'Undertime')
excl_incorrect_answ <- excl_dur_undertime - sum(valid_responses$valid == 'Very incorrect')
excl_missing_outcome <- excl_incorrect_answ - sum(valid_responses$valid == 'Missing outcome')
nrows_final <- sum(valid_responses$valid == 'Valid')
```

```
labels = c('Raw Num\nResponses',
           'Duplicate IPs/Unfinished',
           sprintf('Reading Duration\n>= %s secs', duration_secs_minimum),
           sprintf('Num Correct\nAnswers < %s', correct_answers_minimum),
           'Missing outcome answers',
           'Final Count')

desc = factor(labels, levels=labels)
type = c('in', 'out', 'maybe out', 'maybe out', 'out', 'in')
type = factor(type, levels = c("in", "out", "maybe out"))

start = c(0, nrows_raw,
          excl_dups_unfinished,
          excl_dur_undertime,
          excl_incorrect_answ,
          excl_missing_outcome)
end = c(nrows_raw,
        excl_dups_unfinished,
        excl_dur_undertime,
        excl_incorrect_answ,
        nrows_final, 0)
amount = c(nrows_raw,
           -excl_dups_unfinished,
           -excl_dur_undertime,
           -excl_incorrect_answ,
           -excl_missing_outcome,
           -nrows_final)
id = seq_along(amount)
waterfall_data = data.frame(id, desc, type, start, end, amount)

label_names <- c(nrows_raw,
                 nrows_raw - excl_dups_unfinished,
                 excl_dups_unfinished - excl_dur_undertime,
                 excl_dur_undertime - excl_incorrect_answ,
                 excl_incorrect_answ - excl_missing_outcome,
                 nrows_final)

adj <- 1.075
label_pos <- c(nrows_raw * adj,
               excl_dups_unfinished * adj,
               excl_dur_undertime * adj,
               excl_incorrect_answ * adj,
               excl_missing_outcome * adj,
               nrows_final * adj)

waterfall_plot =
  ggplot(waterfall_data, aes(desc, fill = type,
                             xmin = id - 0.45, xmax = id + 0.45, ymin = end, ymax = start,
                             label = label_names)) +
```

```
  geom_rect()
waterfall_plot +
  ggtitle("Responses Dropped") +
  theme(plot.title = element_text(hjust = 0.5),
        axis.text.x = element_text(angle = 90, hjust = 1)) +
  labs(y="Number of Responses", x="Dropping Reason") +
  geom_text(aes(y = label_pos, label = label_names))
```



Identify Treatment and Control Groups

There are three distinct groups in this experiment:

1. Control
2. Treatment - Low Rating
3. Treatment - High Rating

```
valid_responses['experiment_group'] =
  ifelse(valid_responses$FL_2_DO == 'Introduction:Control', 1,
         ifelse(valid_responses$FL_2_DO == 'Introduction:1Star', 2,
                ifelse(valid_responses$FL_2_DO == 'Introduction:4.5Stars', 3, -1)))
valid_responses['treated'] = ifelse(valid_responses$experiment_group == 2, 1,
                                    ifelse(valid_responses$experiment_group == 3, 1, 0))
valid_responses['treatment_rating'] = ifelse(valid_responses$experiment_group == 2, 2,
                                       ifelse(valid_responses$experiment_group == 3, 5, NA))
valid_responses['experiment_group_chr'] =
  ifelse(valid_responses$FL_2_DO == 'Introduction:Control', "Control",
```

```
        ifelse(valid_responses$FL_2_DO == 'Introduction:1Star', "Treat: Low",
               ifelse(valid_responses$FL_2_DO == 'Introduction:4.5Stars', "Treat: High", "NA")))
```

```
table(valid_responses$experiment_group, valid_responses$experiment_group_chr)
```

```
##
##     Control Treat: High Treat: Low
##   1     147           0          0
##   2       0           0        135
##   3       0         141          0
```

```
summary(valid_responses$Q4)
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## -99.000   3.000   4.000   2.135   5.000   6.000
```

```
summary(valid_responses[valid_responses$valid == "Valid",]$Q4)
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   1.000   3.000   4.000   4.125   5.000   6.000
```

```
valid_responses %>%
  filter(valid != "Missing outcome") %>%
  group_by(valid, FL_2_DO) %>%
  summarize(responseCount = n(),
            avgRating = round(mean(Q4),1))
```

```
## # A tibble: 9 x 4
## # Groups:   valid [?]
##   valid          FL_2_DO                responseCount avgRating
##   <chr>          <chr>                          <int>     <dbl>
## 1 Undertime      Introduction:1Star                33       4.5
## 2 Undertime      Introduction:4.5Stars             33       4.4
## 3 Undertime      Introduction:Control              29       3.8
## 4 Valid          Introduction:1Star                86       3.7
## 5 Valid          Introduction:4.5Stars             84       4.3
## 6 Valid          Introduction:Control              95       4.4
## 7 Very incorrect Introduction:1Star                12       2.9
## 8 Very incorrect Introduction:4.5Stars             22       3.7
## 9 Very incorrect Introduction:Control              21       4
```

Calculate ATE

```
calc_exp_group_avg_rating = function(data, group) {
  avg_rating = mean(subset(data, experiment_group == group)$Q4)
  return(avg_rating)
}
get_nrow_of_group = function(data, group) {
  rows = nrow(subset(data, experiment_group == group))
  return(rows)
}
get_pct_subjects_of_group = function(data, group) {
  count = get_nrow_of_group(data, group)
  pct = round(count / nrow(data) * 100, 2)
  return(pct)
```

```
}
control_avg_rating = calc_exp_group_avg_rating(valid_responses[valid_responses$valid == "Valid",], 1)
treatment_low_avg_rating = calc_exp_group_avg_rating(valid_responses[valid_responses$valid == "Valid",]
treatment_high_avg_rating = calc_exp_group_avg_rating(valid_responses[valid_responses$valid == "Valid",
# todo: is this actually how you calculate ATE?
ate_high = treatment_high_avg_rating - control_avg_rating
ate_low = treatment_low_avg_rating - control_avg_rating
groups = c(
  'Control',
  'Treatment - Low Rating',
  'Treatment - High Rating')
counts = c(
  get_nrow_of_group(valid_responses[valid_responses$valid == "Valid",], 1),
  get_nrow_of_group(valid_responses[valid_responses$valid == "Valid",], 2),
  get_nrow_of_group(valid_responses[valid_responses$valid == "Valid",], 3))
pcts = c(
  get_pct_subjects_of_group(valid_responses[valid_responses$valid == "Valid",], 1),
  get_pct_subjects_of_group(valid_responses[valid_responses$valid == "Valid",], 2),
  get_pct_subjects_of_group(valid_responses[valid_responses$valid == "Valid",], 3))
avg_ratings = c(
  round(control_avg_rating,2),
  round(treatment_low_avg_rating,2),
  round(treatment_high_avg_rating,2))
ates = c(
  0,
  round(ate_low,2),
  round(ate_high,2))
treated_ratings = c('na', '2/6 Stars', '5/6 Stars')
outcome_table = data.frame(groups, counts, pcts, treated_ratings, avg_ratings, ates)
kable(outcome_table, col.names =
        c('Group', '# of Subjects', '% of Total Subjects', 'Treated Rating', 'AVG Rating', 'ATE'))
```

Group	# of Subjects	% of Total Subjects	Treated Rating	AVG Rating	ATE
Control	95	35.85	na	4.38	0.00
Treatment - Low Rating	86	32.45	2/6 Stars	3.71	-0.67
Treatment - High Rating	84	31.70	5/6 Stars	4.26	-0.12

Model

```
model = lm(Q4 ~ experiment_group_chr,
           data = valid_responses[valid_responses$valid == "Valid",])
summary(model)
```

```
##
## Call:
## lm(formula = Q4 ~ experiment_group_chr, data = valid_responses[valid_responses$valid ==
##     "Valid", ])
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -3.2619 -0.7093  0.2907  0.7381  2.2907
```

```
##
## Coefficients:
##                                 Estimate Std. Error t value Pr(>|t|)
## (Intercept)                       4.3789     0.1042  42.018  < 2e-16 ***
## experiment_group_chrTreat: High  -0.1170     0.1521  -0.769    0.442
## experiment_group_chrTreat: Low   -0.6696     0.1512  -4.429 1.39e-05 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1.016 on 262 degrees of freedom
## Multiple R-squared:  0.07703,    Adjusted R-squared:  0.06999
## F-statistic: 10.93 on 2 and 262 DF,  p-value: 2.751e-05
```

```
coefci(model)
```

```
##                                     2.5 %     97.5 %
## (Intercept)                     4.1737403  4.5841545
## experiment_group_chrTreat: High -0.4165995  0.1825143
## experiment_group_chrTreat: Low  -0.9673475 -0.3719426
```

```
model = lm(Q4 ~ experiment_group_chr,
           data = valid_responses[valid_responses$valid != "Missing outcome",])
summary(model)
```

```
##
## Call:
## lm(formula = Q4 ~ experiment_group_chr, data = valid_responses[valid_responses$valid !=
##     "Missing outcome", ])
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -3.2014 -0.8321 -0.2000  0.7986  2.1679
##
## Coefficients:
##                                 Estimate Std. Error t value Pr(>|t|)
## (Intercept)                     4.200000   0.092202  45.552  < 2e-16 ***
## experiment_group_chrTreat: High  0.001439   0.131793   0.011  0.99129
## experiment_group_chrTreat: Low  -0.367939   0.133832  -2.749  0.00624 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1.11 on 412 degrees of freedom
## Multiple R-squared:  0.02343,    Adjusted R-squared:  0.01869
## F-statistic: 4.942 on 2 and 412 DF,  p-value: 0.007571
```

```
coefci(model)
```

```
##                                     2.5 %     97.5 %
## (Intercept)                     4.0187545  4.3812455
## experiment_group_chrTreat: High -0.2576323  0.2605100
## experiment_group_chrTreat: Low  -0.6310179 -0.1048599
```

```
valid_responses$undertime <- ifelse(valid_responses$valid == "Undertime", 1, 0)
valid_responses$incorrect <- ifelse(valid_responses$valid == "Very incorrect", 1, 0)
```

```
model = lm(Q4 ~ experiment_group_chr + undertime + incorrect,
           data = valid_responses[valid_responses$valid != "Missing outcome",])
```

```r
summary(model)
```

```
##
## Call:
## lm(formula = Q4 ~ experiment_group_chr + undertime + incorrect,
##     data = valid_responses[valid_responses$valid != "Missing outcome",
##         ])
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -3.3698 -0.8515  0.1485  0.7463  2.2776
##
## Coefficients:
##                                  Estimate Std. Error t value Pr(>|t|)
## (Intercept)                      4.253724   0.098899  43.011  < 2e-16 ***
## experiment_group_chrTreat: High  0.004239   0.130159   0.033  0.97404
## experiment_group_chrTreat: Low  -0.402244   0.132407  -3.038  0.00253 **
## undertime                        0.116109   0.131130   0.885  0.37643
## incorrect                       -0.531294   0.162830  -3.263  0.00120 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1.095 on 410 degrees of freedom
## Multiple R-squared:  0.05399,    Adjusted R-squared:  0.04476
## F-statistic:  5.85 on 4 and 410 DF,  p-value: 0.0001381
```

```r
coefci(model)
```

```
##                                      2.5 %     97.5 %
## (Intercept)                      4.0593120  4.4481364
## experiment_group_chrTreat: High -0.2516234  0.2601012
## experiment_group_chrTreat: Low  -0.6625253 -0.1419624
## undertime                       -0.1416626  0.3738808
## incorrect                       -0.8513802 -0.2112074
```