Physical Pragmatics (Experiment 2a)

Preprocessing

Preprocess both partitions of participant data (a second experiment was needed to round out the pre-registered sample size).

```
# Read in the first partition of the participant data.
data_0 = read_csv(file.path(data_0_path, "raw_data.csv"))

# Update old formatting and remove irrelevant columns.
data_1 = data_0 %>%
  rename(condition=CostCondition, object=Object, side=Counterbalancing,
         costlier=HighCost, possible=Difficulty, response=DoorChoice,
         unique_id=UserID) %>%
  select(unique_id, condition, object, side, costlier, possible, response)
data_1$side[which(data_1$side=="0")] = "right"
data_1$side[which(data_1$side=="1")] = "left"
data_1$costlier[which(data_1$costlier=="BaseDoor")] = "unmodified"
data_1$costlier[which(data_1$costlier=="TargetDoor")] = "modified"
data_1$possible[which(data_1$possible=="Yes")] = 1
data_1$possible[which(data_1$possible=="No")] = 0
data_1$response[which(data_1$response=="ClearDoor")] = 1
data_1$response[which(data_1$response=="ModifiedDoor")] = 0

# Remove missing entries.
data_2 = data_1 %>%
  filter(condition!="") %>%
  na.omit()

# Add participant numbers to make it easier to distinguish participants across
# the disjoint datasets.
data_3 = data_2 %>%
  rownames_to_column() %>%
  mutate(rowname=as.integer(as.integer(rowname)-1),
         possible=as.integer(possible),
         response=as.integer(response)) %>%
  rename(participant=rowname) %>%
  select(-unique_id) %>%
  mutate(age=NA)

# Write the preprocessed data for the first partition.
write_csv(data_3, file.path(data_0_path, "data.csv"))
```

```
# Read in the preprocessed data for the first partition.
data_3 = read_csv(file.path(data_0_path, "data.csv"))
```

```r
# Read in the second partition of the participant data.
data_4 = read_csv(file.path(data_1_path, "raw_data.csv")) %>%
  mutate(target=as.integer(substr(target, 2, 2)))

# Read in the participant age information.
data_5 = read_csv(file.path(data_1_path, "subject_information.csv")) %>%
  select(workerid, age) %>%
  mutate(age=as.numeric(gsub("\"", "", age)))

# Combine the trial and exclusion columns.
data_6 = data_4 %>%
  gather(trial_type, num, trial_num, exclusion_num) %>%
  na.omit() %>%
  mutate(trial=gsub("num", "", paste(trial_type, num, sep=""))) %>%
  select(-trial_type, -num) %>%
  arrange(workerid) %>%
  left_join(data_5)

# Import the setup information to know which side the low-cost door was on.
setup_0 = read_tsv(file.path(data_1_path, "trial_information.tsv")) %>%
  select(workerid, Answer.setup)

# Remove the quotes, backslashes, and braces.
setup_1 = setup_0 %>%
  mutate(Answer.setup=gsub("\\", "", Answer.setup, fixed=TRUE)) %>%
  mutate(Answer.setup=gsub("\"", "", Answer.setup, fixed=TRUE)) %>%
  mutate(Answer.setup=gsub("{", "", Answer.setup, fixed=TRUE)) %>%
  mutate(Answer.setup=gsub("}", "", Answer.setup, fixed=TRUE))

# Extract the side information.
setup_2 = setup_1 %>%
  separate(Answer.setup, into=c(NA, "side", NA, NA), sep=",") %>%
  mutate(side=gsub("side:", "", side))

# Append the side information.
data_7 = data_6 %>%
  spread(trial, target) %>%
  rename(costlier=exclusion_1, possible=exclusion_2, response=trial_1) %>%
  left_join(setup_2) %>%
  rename(participant=workerid) %>%
  mutate(participant=participant+nrow(data_3))

# Rename the factors for readability.
data_7$costlier[which(data_7$costlier==0)] = "unmodified"
data_7$costlier[which(data_7$costlier==1)] = "modified"
data_7$costlier[which(data_7$costlier==2)] = "equal"

# Write the preprocessed data for the second partition.
write_csv(data_7, file.path(data_1_path, "data.csv"))

# Combine the two data partitions.
data_8 = data_3 %>%
  rbind(data_7)
```

```r
# Exclude participants who said the unmodified door was more difficult to walk
# through.
data_9 = data_8 %>%
  filter(costlier!="unmodified")

# Chop off the extra participant in the low-cost condition.
data_10 = data_9 %>%
  filter(participant!=161)
```

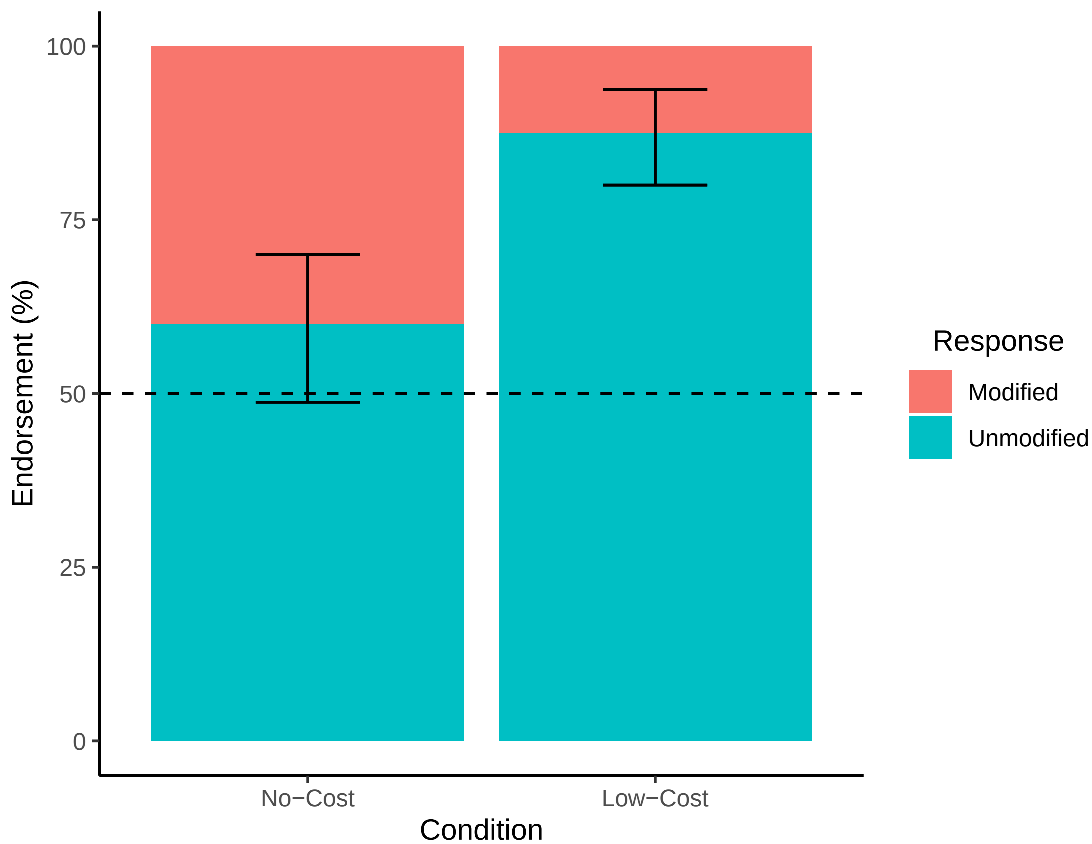
Compute Door Endorsement

a priori Labels

First, we'll compute the participant endorsement (N=160, M=34.85 years, SD=8.38 years) for the unmodified door (i.e., that the modified door should be avoided) using our *a priori* labels of door difficulty.

```r
# Compute the (percent) participant endorsement of each door in each condition.
data_11 = data_10 %>%
  do(left_join(., summarize(group_by(., condition),
                            unmodified=sum(response==1),
                            modified=sum(response==0),
                            total=n()))) %>%
  mutate(unmodified=unmodified/total*100,
         modified=modified/total*100)

# Set up the bootstrap functions.
compute_mean = function(data, indices) {
  return(mean(data[indices]))
}

compute_bootstrap = function(data) {
  simulations = boot(data=data,
                     statistic=compute_mean,
                     R=10000)

  return(boot.ci(simulations, type="perc")$perc)
}

# Compute the bootstrapped 95% CIs for participant endorsement of the
# unmodified door for both conditions.
set.seed(seed)
ci = data.frame()
bootstrap_data = compute_bootstrap(filter(data_11, condition=="none")$response)
ci = rbind(ci, data.frame(lower_ci=bootstrap_data[4]*100,
                          upper_ci=bootstrap_data[5]*100,
                          condition="none"))

bootstrap_data = compute_bootstrap(filter(data_11, condition=="low")$response)
ci = rbind(ci, data.frame(lower_ci=bootstrap_data[4]*100,
                          upper_ci=bootstrap_data[5]*100,
                          condition="low"))
```

```r
# Compute the percentage participant endorsement for each door per condition.
data_12 = data_11 %>%
  gather(response, endorsement, unmodified, modified) %>%
  group_by(condition, endorsement, response) %>%
  summarize(total=n()) %>%
  left_join(ci) %>%
  select(-total)

# Plot the data (using our labels of door difficulty).
plot_0 = data_12 %>%
  ggplot(aes(x=condition, y=endorsement, fill=response)) +
  geom_histogram(stat="identity") +
  geom_errorbar(aes(ymin=lower_ci, ymax=upper_ci), width=0.3) +
  geom_hline(yintercept=50, linetype="dashed", color="black") +
  theme_classic() +
  theme(aspect.ratio=1.0,
        legend.title=element_text(hjust=0.5)) +
  scale_x_discrete(name="Condition",
                   limits=c("none", "low"),
                   labels=c("No-Cost", "Low-Cost")) +
  ylab("Endorsement (%)") +
  scale_fill_discrete(name="Response",
                      limits=c("modified", "unmodified"),
                      labels=c("Modified", "Unmodified"))
plot_0
```



```r
# Compute a mixed-effects logistic regression with objects as random
# intercepts.
mem_0 = glmer(response~condition+(1|object), data=data_11, family="binomial")
summary(mem_0)
```

```
## Generalized linear mixed model fit by maximum likelihood (Laplace
##   Approximation) [glmerMod]
##  Family: binomial  ( logit )
## Formula: response ~ condition + (1 | object)
##    Data: data_11
##
##      AIC      BIC   logLik deviance df.resid
##    167.8    177.1    -80.9    161.8      157
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -3.5617 -0.7917  0.2808  0.5756  1.2631
##
## Random effects:
##  Groups Name        Variance Std.Dev.
##  object (Intercept) 0.5838   0.7641
## Number of obs: 160, groups:  object, 8
##
## Fixed effects:
##               Estimate Std. Error z value Pr(>|z|)
## (Intercept)     2.1544     0.4565   4.719 2.37e-06 ***
## conditionnone  -1.6949     0.4332  -3.913 9.12e-05 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr)
## conditionnn -0.665
```

```r
# Compute a binomial test for each condition.
# NOTE: Computing a two-sided binomial test for "conservativeness".
data_13 = filter(data_11, condition=="none")
binom.test(x=sum(data_13$response), n=length(data_13$response), p=0.5,
           alternative="two.sided")
```

```
##
##  Exact binomial test
##
## data:  sum(data_13$response) and length(data_13$response)
## number of successes = 48, number of trials = 80, p-value = 0.09291
## alternative hypothesis: true probability of success is not equal to 0.5
## 95 percent confidence interval:
##  0.4843769 0.7079906
## sample estimates:
## probability of success
##                    0.6
```

```r
data_14 = filter(data_11, condition=="low")
binom.test(x=sum(data_14$response), n=length(data_14$response), p=0.5,
           alternative="two.sided")
```

```
##
##  Exact binomial test
##
## data:  sum(data_14$response) and length(data_14$response)
## number of successes = 70, number of trials = 80, p-value = 3.161e-12
## alternative hypothesis: true probability of success is not equal to 0.5
## 95 percent confidence interval:
##  0.7821109 0.9383979
## sample estimates:
## probability of success
##                  0.875
```

```r
# Compute the bootstrapped 95% CIs for the participant endorsement of whether
# it would be possible to walk through the modified door for each condition.
set.seed(seed)
bootstrap_data = compute_bootstrap(filter(data_11, condition=="none")$possible)
lower_ci = bootstrap_data[4]*100
upper_ci = bootstrap_data[5]*100
possible = sum(filter(data_11, condition=="none")$possible)
not_possible = length(filter(data_11, condition=="none")$possible) - possible
possible_endorsement = possible / (possible+not_possible) * 100
print(c(possible_endorsement, lower_ci, upper_ci))
```

```
## [1] 83.75 75.00 91.25
```

```r
bootstrap_data = compute_bootstrap(filter(data_11, condition=="low")$possible)
lower_ci = bootstrap_data[4]*100
upper_ci = bootstrap_data[5]*100
possible = sum(filter(data_11, condition=="low")$possible)
not_possible = length(filter(data_11, condition=="low")$possible) - possible
possible_endorsement = possible / (possible+not_possible) * 100
print(c(possible_endorsement, lower_ci, upper_ci))
```

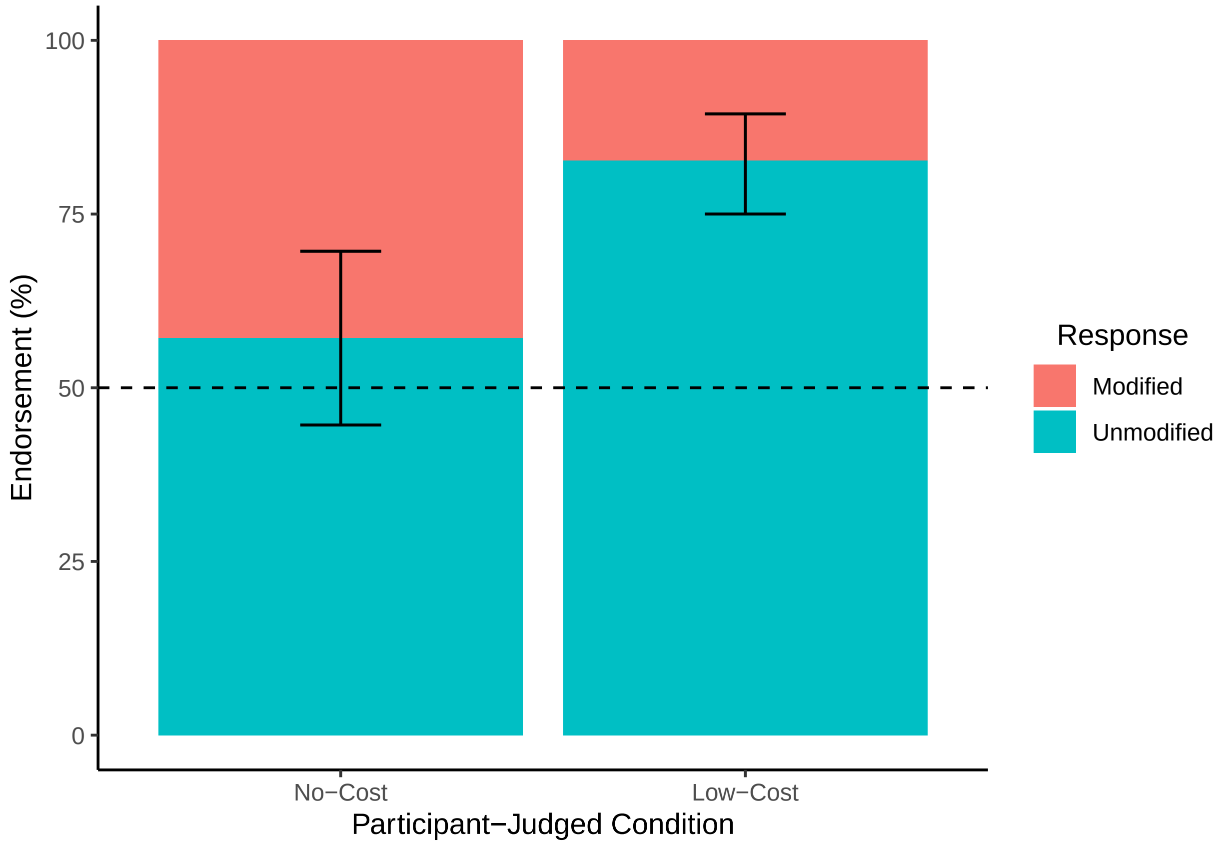
```
## [1] 87.50 80.00 93.75
```

Participant Labels

Now, we'll compute the participant endorsement (N=160, M=34.85 years, SD=8.38 years) for the unmodified door (i.e., that the modified door should be avoided) using their labels of door difficulty.

```r
# Compute the (percent) participant endorsement of each door in each condition.
data_15 = data_10 %>%
  do(left_join(., summarize(group_by(., costlier),
                            unmodified=sum(response==1),
                            modified=sum(response==0),
                            total=n()))) %>%
```

```r
  mutate(unmodified=unmodified/total*100,
         modified=modified/total*100)

# Compute the bootstrapped 95% CI for participant endorsement of the
# unmodified door with participant labels of costliness.
set.seed(seed)
ci = data.frame()
bootstrap_data = compute_bootstrap(filter(data_15,
                                          costlier=="equal")$response)
ci = rbind(ci, data.frame(lower_ci=bootstrap_data[4]*100,
                          upper_ci=bootstrap_data[5]*100,
                          condition="equal"))

bootstrap_data = compute_bootstrap(filter(data_15,
                                          costlier=="modified")$response)
ci = rbind(ci, data.frame(lower_ci=bootstrap_data[4]*100,
                          upper_ci=bootstrap_data[5]*100,
                          condition="modified"))

# Compute the percentage participant endorsement for each door per condition.
data_16 = data_15 %>%
  gather(response, endorsement, unmodified, modified) %>%
  group_by(costlier, endorsement, response) %>%
  summarize(total=n()) %>%
  ungroup() %>%
  rename(condition=costlier) %>%
  select(-total) %>%
  left_join(ci)

# Plot the data (using participant labels of door difficulty).
plot_1 = data_16 %>%
  ggplot(aes(x=condition, y=endorsement, fill=response)) +
  geom_histogram(stat="identity") +
  geom_errorbar(aes(ymin=lower_ci, ymax=upper_ci), width=0.2) +
  geom_hline(yintercept=50, linetype="dashed", color="black") +
  theme_classic() +
  theme(legend.title=element_text(hjust=0.5)) +
  scale_x_discrete(name="Participant-Judged Condition",
                   limits=c("equal", "modified"),
                   labels=c("No-Cost", "Low-Cost")) +
  ylab("Endorsement (%)") +
  scale_fill_discrete(name="Response",
                      limits=c("modified", "unmodified"),
                      labels=c("Modified", "Unmodified"))
plot_1
```




```r
# Compute a mixed-effects logistic regression with objects as random
# intercepts.
mem_1 = glmer(response~costlier+(1|object), data=data_15, family="binomial")
summary(mem_1)
```

```
## Generalized linear mixed model fit by maximum likelihood (Laplace
##   Approximation) [glmerMod]
##  Family: binomial  ( logit )
## Formula: response ~ costlier + (1 | object)
##    Data: data_15
##
##      AIC      BIC   logLik deviance df.resid
##    172.4    181.6    -83.2    166.4      157
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -3.3578 -0.7470  0.3444  0.6042  1.3387
##
## Random effects:
##  Groups Name        Variance Std.Dev.
##  object (Intercept) 0.5538   0.7442
## Number of obs: 160, groups:  object, 8
##
## Fixed effects:
##                   Estimate Std. Error z value Pr(>|z|)
```

```
## (Intercept)        0.3101     0.3911   0.793  0.42796
## costliermodified   1.4330     0.4055   3.534  0.00041 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr)
## costlirmdfd -0.521
```

```
# Compute a binomial test for each condition.
# NOTE: Computing a two-sided binomial test for "conservativeness".
data_17 = filter(data_15, costlier=="equal")
binom.test(x=sum(data_17$response), n=length(data_17$response), p=0.5,
           alternative="two.sided")
```

```
##
##  Exact binomial test
##
## data:  sum(data_17$response) and length(data_17$response)
## number of successes = 32, number of trials = 56, p-value = 0.3497
## alternative hypothesis: true probability of success is not equal to 0.5
## 95 percent confidence interval:
##  0.4321590 0.7028791
## sample estimates:
## probability of success
##              0.5714286
```

```
data_18 = filter(data_15, costlier=="modified")
binom.test(x=sum(data_18$response), n=length(data_18$response), p=0.5,
           alternative="two.sided")
```

```
##
##  Exact binomial test
##
## data:  sum(data_18$response) and length(data_18$response)
## number of successes = 86, number of trials = 104, p-value = 8.22e-12
## alternative hypothesis: true probability of success is not equal to 0.5
## 95 percent confidence interval:
##  0.7403265 0.8940758
## sample estimates:
## probability of success
##              0.8269231
```