Study 1 Analysis: Women's Voices

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Introduction

This study investigates the social evaluative implications of sensory adaptation to women's voices.

Stimuli. Test stimuli were audio recordings of 20 young adult women reciting the sentence "Hi, I'm a student at UCLA". Samples were recorded digitally (M-Audio Microtrack recorder, 16-bit amplitude resolution, 44.1 kHz sampling rate) using an AKG E535 condenser microphone placed approximately 15cm from the mouth. Stimuli varied naturally in duration, fundamental frequency (f_o), and voice quality.

Adapting stimuli. Adaptors included both masculinized and feminized exemplars that would be gender-atypical and gender-typical, respectively, relative to test stimuli. Adaptors were generated from recordings of 5 young adult women producing the same sentence as test stimuli. These recordings were manipulated to be more masculine or more feminine using the VT-Change script in Praat (Boersma & Weenink, 2021). We altered f_o, a well-established sexually dimorphic aspect of voice, using PSOLA (Pitch Synchronous Overlap Add) resynthesis. For masculinized versions, f_o values were lowered to 70% of baseline. For feminized versions, f_o was increased to 140% of baseline.

Procedure. We recruited U.S. residents from Prolific. After providing consent, participants were randomly assigned to either the gender-typical (feminized) or gender-atypical (masculinized) adaptation condition. On each trial, participants fist heard an adapting voice followed by a test voice which they judged for attractiveness and femininity (1 = *Not at all* to 9 = *Extremely*). We also collected perceptions of likability, friendliness, and typicality for future exploratory analyses not reported here. To maintain attention, participants completed a secondary task rating whether the pitch of each adaptor was higher, lower, or identical to the previous adaptor. In total, participants completed 20 trials in pseudo-randomized order, with each adaptor presented four times.

Hypotheses. Variability in vocal tract length and laryngeal cavity size create large differences in fundamental frequency for male and female voices (Hillenbrand et al., 1995). Perceivers evaluate men and women with regard to these differences, rating men as more attractive when their voices have low fundamental frequency but women as more attractive when their voices have high fundamental frequency (Puts, 2005; Puts, Barndt, Welling, Dawood, & Burriss, 2011). Therefore, we predicted that adaptation to masculinized voices would produce contrastive aftereffects, making neutral female test voices sound more gender-typical and therefore more attractive. Conversely, adaptation to feminized voices should make neutral female test voices sound less gender-typical and therefore less attractive.

Analysis

Load Data

```
data <- read.csv("study1_data.csv", header = TRUE)
```

Factor

```r
# participant ID
data$ID <- factor(data$ID)

# condition
data$condition <- as.factor(data$condition)

# participant sex
data$Sex <- as.factor(data$Sex)
```

Filter
There were only 3 participants who did not identify as male or female. Because we were interested in investigating the interaction between condition and participant sex, we filtered out participants who did not identify as male or female since the power for detecting an effect with a sample size of 3 is too low.

```r
nrow(data)/20
```

```
## [1] 182
```

```r
data <- data %>%
    filter(Sex == "1" | Sex == "2")
nrow(data)/20
```

```
## [1] 179
```

Check Data Quality
Group by participant ID and filter out participants with a response range of 1 on any of the dependent variables.

```r
# sample size before filtering
nrow(data)/20
```

```
## [1] 179
```

```r
# attraction
data <- data %>%
    group_by(ID) %>%
    filter((max(attraction) - min(attraction) > 1))

# femininity
data <- data %>%
    group_by(ID) %>%
    filter((max(femininity) - min(femininity) > 1))

# likability
data <- data %>%
    group_by(ID) %>%
    filter((max(likability) - min(likability) > 1))

# friends
data <- data %>%
    group_by(ID) %>%
```

```
    filter((max(friends) - min(friends) > 1))

# typicality
data <- data %>%
    group_by(ID) %>%
    filter((max(typicality) - min(typicality) > 1))

# sample size after filtering
nrow(data)/20
```

```
## [1] 153
```

The original sample size was 182. After filtering participants whose responses did not meet our requirements, the final sample size is 153.

Demographics
After filtering participants, calculate the demographics of the final sample.

Sex

```
table(data$Sex)/20  # 1 = male, 2 = female, 3 = other
```

```
##
##  1  2  3
## 81 72  0
```

The majority of the sample is male (52.94%), followed by female (47.06%).

Race

```
table(data$Race)/20  # 1 = Asian, 2 = Black, 3 = Latino, 4 = White, 5 = Biracial/Other
```

```
##
##  1  2  3  4  5
## 24 15 13 96  5
```

The majority of the sample is White (62.75%).

Age

```
stat.desc(data$Age)
```

```
##       nbr.val      nbr.null        nbr.na           min           max
##  3060.0000000     0.0000000     0.0000000    18.0000000    66.0000000
##         range           sum        median          mean       SE.mean
##    48.0000000 95900.0000000    30.0000000    31.3398693     0.1930486
##  CI.mean.0.95           var       std.dev      coef.var
##     0.3785182   114.0394037    10.6789233     0.3407456
```

The average age is 31.34 years old, with a range from 18 - 66.

Multilevel Analyses

The following analyses are done in a step-wise fashion.

Attraction

Main Effect: Attraction by Condition (Atypical/Typical)

```
# reference group = atypical condition
data$condition <- relevel(data$condition, ref = "atypical")

# multilevel model
model.1 <- lmer(attraction ~ condition + (1 | ID) + (1 | trial), data = data,
    na.action = "na.exclude", control = lmerControl(optimizer = "optimx",
        calc.derivs = FALSE, optCtrl = list(method = "nlminb")))
```

```
## Loading required namespace: optimx
```

```
summary(model.1)
```

```
## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: attraction ~ condition + (1 | ID) + (1 | trial)
##    Data: data
## Control:
## lmerControl(optimizer = "optimx", calc.derivs = FALSE, optCtrl = list(method = "nlminb"))
##
## REML criterion at convergence: 11988.6
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -3.6689 -0.5874  0.0478  0.6831  2.9483
##
## Random effects:
##  Groups   Name        Variance Std.Dev.
##  ID       (Intercept) 1.0308   1.0153
##  trial    (Intercept) 0.1487   0.3856
##  Residual             2.5999   1.6124
## Number of obs: 3060, groups:  ID, 153; trial, 20
##
## Fixed effects:
##                  Estimate Std. Error       df t value            Pr(>|t|)
## (Intercept)        6.0130     0.1500  99.0022  40.077 <0.0000000000000002 ***
## conditiontypical  -0.3636     0.1742 150.9987  -2.087              0.0385 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr)
## condtntypcl -0.577
```

```r
# confidence interval
ci.1 <- confint(model.1, method = "Wald", level = 0.95)
ci.1
```

```
##                         2.5 %      97.5 %
## .sig01                     NA          NA
## .sig02                     NA          NA
## .sigma                     NA          NA
## (Intercept)        5.7189225  6.30705153
## conditiontypical -0.7050844 -0.02220539
```

```r
# group means
attraction_condition <- data %>%
    group_by(condition) %>%
    summarise(mean = mean(attraction), sd = sd(attraction), n = n(), se = sd(attraction)/sqrt(n()))
attraction_condition
```

```
## # A tibble: 2 x 5
##   condition  mean    sd     n     se
##   <fct>     <dbl> <dbl> <int>  <dbl>
## 1 atypical   6.01  1.96  1540 0.0499
## 2 typical    5.65  1.92  1520 0.0492
```

Test voices were rated as more attractive after adaptation to masculinized voices (M = 6.01, SD = 1.96) relative to feminized voices (M = 5.65, SD = 1.92), $t(150)$ = -2.09, p = .039.

Main Effect: Attraction by Participant Sex (Male/Female)

```r
# reference group = female participants
data$Sex <- relevel(data$Sex, ref = "2")

# multilevel model
model.2 <- lmer(attraction ~ Sex + (1 | ID) + (1 | trial), data = data,
    na.action = "na.exclude", control = lmerControl(optimizer = "optimx",
        calc.derivs = FALSE, optCtrl = list(method = "nlminb")))
summary(model.2)
```

```
## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: attraction ~ Sex + (1 | ID) + (1 | trial)
##    Data: data
## Control:
## lmerControl(optimizer = "optimx", calc.derivs = FALSE, optCtrl = list(method = "nlminb"))
##
## REML criterion at convergence: 11992.9
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -3.6570 -0.5918  0.0495  0.6852  2.9422
##
## Random effects:
##  Groups   Name        Variance Std.Dev.
```

```
##  ID       (Intercept) 1.0637   1.0314
##  trial    (Intercept) 0.1487   0.3856
##  Residual             2.5999   1.6124
## Number of obs: 3060, groups:  ID, 153; trial, 20
##
## Fixed effects:
##              Estimate Std. Error        df t value            Pr(>|t|)
## (Intercept)   5.85625    0.15497 106.15891  37.791 <0.0000000000000002 ***
## Sex1         -0.04514    0.17696 151.00554  -0.255               0.799
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##      (Intr)
## Sex1 -0.605
```

```
# confidence interval
ci.2 <- confint(model.2, method = "Wald", level = 0.95)
ci.2
```

```
##                 2.5 %    97.5 %
## .sig01             NA        NA
## .sig02             NA        NA
## .sigma             NA        NA
## (Intercept)  5.552524 6.1599759
## Sex1        -0.391983 0.3017052
```

```
# group means
attraction_Sex <- data %>%
    group_by(Sex) %>%
    summarise(mean = mean(attraction), sd = sd(attraction), n = n(), se = sd(attraction)/sqrt(n()))
attraction_Sex
```

```
## # A tibble: 2 x 5
##   Sex    mean    sd     n     se
##   <fct> <dbl> <dbl> <int>  <dbl>
## 1 2      5.86  1.93  1440 0.0508
## 2 1      5.81  1.96  1620 0.0488
```

There is no difference in attraction ratings between male participants (M = 5.81, SD = 1.96) and female participants (M = 5.86, SD = 1.93), $t(151)$ = -0.26, p = .799.

Interaction: Attraction by Condition (Atypical/Typical) and Participant Sex (Male/Female)

```
# multilevel model
model.3 <- lmer(attraction ~ condition * Sex + (1|ID) + (1|trial), data=data, na.action = 'na.exclude',
summary(model.3)
```

```
## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: attraction ~ condition * Sex + (1 | ID) + (1 | trial)
##    Data: data
```

```
## Control:
## lmerControl(optimizer = "optimx", calc.derivs = FALSE, optCtrl = list(method = "nlminb"))
##
## REML criterion at convergence: 11989.5
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -3.6742 -0.5863  0.0520  0.6865  2.9558
##
## Random effects:
##  Groups   Name        Variance Std.Dev.
##  ID       (Intercept) 1.0385   1.0191
##  trial    (Intercept) 0.1487   0.3856
##  Residual             2.5999   1.6124
## Number of obs: 3060, groups:  ID, 153; trial, 20
##
## Fixed effects:
##                       Estimate Std. Error       df t value            Pr(>|t|)
## (Intercept)             5.9408     0.1954 146.4071  30.401 <0.0000000000000002
## conditiontypical       -0.1790     0.2552 149.0004  -0.702               0.484
## Sex1                    0.1425     0.2464 149.0004   0.579               0.564
## conditiontypical:Sex1  -0.3460     0.3506 149.0004  -0.987               0.325
##
## (Intercept)           ***
## conditiontypical
## Sex1
## conditiontypical:Sex1
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr) cndtnt Sex1
## condtntypcl -0.617
## Sex1        -0.639  0.489
## cndtntyp:S1  0.449 -0.728 -0.703
```

```
#confidence interval
ci.3 <- confint(model.3,method="Wald", level=0.95)
ci.3
```

```
##                            2.5 %    97.5 %
## .sig01                        NA        NA
## .sig02                        NA        NA
## .sigma                        NA        NA
## (Intercept)            5.5577892 6.3237898
## conditiontypical      -0.6791701 0.3211206
## Sex1                  -0.3403843 0.6254720
## conditiontypical:Sex1 -1.0330815 0.3411310
```

```
# group means
attraction_total <- data %>% group_by(condition, Sex) %>%
  summarise(mean = mean(attraction),
            sd = sd(attraction),
```

```
            n = n(),
            se = sd(attraction)/sqrt(n()))
```

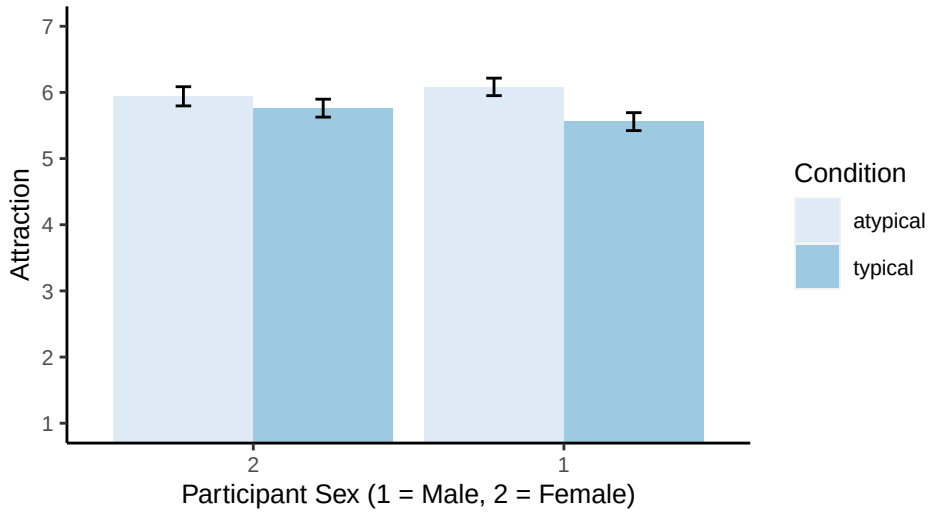
```
## `summarise()` has grouped output by 'condition'. You can override using the `.groups` argument.
```

```
attraction_total
```

```
## # A tibble: 4 x 6
## # Groups:   condition [2]
##   condition Sex    mean    sd     n     se
##   <fct>     <fct> <dbl> <dbl> <int>  <dbl>
## 1 atypical  2      5.94  2.03   760 0.0738
## 2 atypical  1      6.08  1.88   780 0.0674
## 3 typical   2      5.76  1.80   680 0.0691
## 4 typical   1      5.56  2.00   840 0.0691
```

```
#plot with 95% CI
attraction_plot <- data %>%
  group_by(condition, Sex) %>%
  phe_mean(x = attraction, type = "full", confidence = 0.95) %>%
  ggplot(aes(x=Sex, y=value, fill=condition)) +
  geom_bar(stat = "identity", position = "dodge", width = .90) +
  geom_errorbar(aes(ymin = lowercl, ymax = uppercl), position = position_dodge(.90), width = 0.1) +
  scale_y_continuous(limits=c(1,7), breaks=seq(1,7,by=1), oob = rescale_none) +
  scale_fill_brewer(palette = 1) +
  theme(panel.grid.major = element_blank(), panel.grid.minor = element_blank(),
        panel.background = element_blank(), axis.line = element_line(colour = "black"),
        text = element_text(size = 10)) + # apply custom minimal theme
  labs(title = "", x="Participant Sex (1 = Male, 2 = Female)", y="Attraction", fill="Condition")

attraction_plot
```



The interaction between condition and participant sex is not significant, $t(149) = -0.99$, $p = .325$.

Femininity

Main Effect: Femininity by Condition

```
# multilevel model
model.4 <- lmer(femininity ~ condition + (1 | ID) + (1 | trial), data = data,
    na.action = "na.exclude", control = lmerControl(optimizer = "optimx",
        calc.derivs = FALSE, optCtrl = list(method = "nlminb")))
summary(model.4)
```

```
## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: femininity ~ condition + (1 | ID) + (1 | trial)
##    Data: data
## Control:
## lmerControl(optimizer = "optimx", calc.derivs = FALSE, optCtrl = list(method = "nlminb"))
##
## REML criterion at convergence: 11978.3
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -3.7384 -0.6263  0.0773  0.6935  2.4891
##
## Random effects:
##  Groups   Name        Variance Std.Dev.
##  ID       (Intercept) 0.8790   0.9375
##  trial    (Intercept) 0.2252   0.4745
##  Residual             2.6032   1.6134
## Number of obs: 3060, groups:  ID, 153; trial, 20
##
## Fixed effects:
##                   Estimate Std. Error       df t value             Pr(>|t|)
## (Intercept)         6.2981     0.1561  67.0358  40.348 < 0.0000000000000002 ***
## conditiontypical   -0.4941     0.1624 150.9995  -3.042              0.00277 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr)
## condtntypcl -0.517
```

```
# confidence interval
ci.4 <- confint(model.4, method = "Wald", level = 0.95)
ci.4
```

```
##                       2.5 %     97.5 %
## .sig01                   NA         NA
## .sig02                   NA         NA
## .sigma                   NA         NA
## (Intercept)       5.992118  6.6039860
## conditiontypical -0.812465 -0.1757441
```

```r
# group means
femininity_condition <- data %>%
    group_by(condition) %>%
    summarise(mean = mean(femininity), sd = sd(femininity), n = n(), se = sd(femininity)/sqrt(n()))
femininity_condition
```

```
## # A tibble: 2 x 5
##   condition  mean    sd     n     se
##   <fct>     <dbl> <dbl> <int>  <dbl>
## 1 atypical   6.30  1.91  1540 0.0486
## 2 typical    5.80  1.93  1520 0.0496
```

Test voices were rated as more feminine after adaptation to masculinized voices (M = 6.30, SD = 1.91) relative to feminized voices (M = 5.80, SD = 1.93), $t(150)$ = -3.04, p = .003.

Main Effect: Femininity by Participant Sex

```r
# reference group = female
data$Sex <- relevel(data$Sex, ref = "2")

# multilevel model
model.5 <- lmer(femininity ~ Sex + (1 | ID) + (1 | trial), data = data,
    na.action = "na.exclude", control = lmerControl(optimizer = "optimx",
        calc.derivs = FALSE, optCtrl = list(method = "nlminb")))
summary(model.5)
```

```
## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: femininity ~ Sex + (1 | ID) + (1 | trial)
##    Data: data
## Control:
## lmerControl(optimizer = "optimx", calc.derivs = FALSE, optCtrl = list(method = "nlminb"))
##
## REML criterion at convergence: 11987.1
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -3.7261 -0.6256  0.0743  0.6913  2.4753
##
## Random effects:
##  Groups   Name        Variance Std.Dev.
##  ID       (Intercept) 0.9393   0.9692
##  trial    (Intercept) 0.2252   0.4745
##  Residual             2.6032   1.6134
## Number of obs: 3060, groups:  ID, 153; trial, 20
##
## Fixed effects:
##             Estimate Std. Error       df t value            Pr(>|t|)
## (Intercept)   6.0111     0.1616  74.2788  37.199 <0.0000000000000002 ***
## Sex1          0.0784     0.1675 150.9999   0.468                0.64
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
```

```
## Correlation of Fixed Effects:
##      (Intr)
## Sex1 -0.549
```

```
# confidence interval
ci.5 <- confint(model.5, method = "Wald", level = 0.95)
ci.5
```

```
##                   2.5 %    97.5 %
## .sig01               NA        NA
## .sig02               NA        NA
## .sigma               NA        NA
## (Intercept)  5.6943943 6.3278279
## Sex1        -0.2498985 0.4066887
```

```
# group means
femininity_Sex <- data %>%
    group_by(Sex) %>%
    summarise(mean = mean(femininity), sd = sd(femininity), n = n(), se = sd(femininity)/sqrt(n()))
femininity_Sex
```

```
## # A tibble: 2 x 5
##   Sex    mean    sd     n     se
##   <fct> <dbl> <dbl> <int>  <dbl>
## 1 2      6.01  1.96  1440 0.0516
## 2 1      6.09  1.91  1620 0.0475
```

There was no significant difference in femininity ratings between male participants ($M = 6.09$, $SD = 1.91$) and female participants ($M = 6.01$, $SD = 1.96$), $t(150) = 0.47$, $p = .64$.

Interaction: Femininity by Condition and Participant Sex

```
# multilevel model
model.6 <- lmer(femininity ~ condition * Sex + (1|ID) + (1|trial), data=data, na.action = 'na.exclude',
summary(model.6)
```

```
## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: femininity ~ condition * Sex + (1 | ID) + (1 | trial)
##    Data: data
## Control:
## lmerControl(optimizer = "optimx", calc.derivs = FALSE, optCtrl = list(method = "nlminb"))
##
## REML criterion at convergence: 11980
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -3.7453 -0.6279  0.0734  0.6912  2.4912
##
## Random effects:
##  Groups   Name        Variance Std.Dev.
##  ID       (Intercept) 0.8889   0.9428
```

```
##  trial    (Intercept) 0.2252   0.4745
##  Residual             2.6032   1.6134
## Number of obs: 3060, groups:  ID, 153; trial, 20
##
## Fixed effects:
##                       Estimate Std. Error       df t value            Pr(>|t|)
## (Intercept)             6.2158     0.1951 115.5703  31.854 <0.0000000000000002
## conditiontypical       -0.4334     0.2383 149.0000  -1.819               0.071
## Sex1                    0.1624     0.2301 149.0000   0.706               0.481
## conditiontypical:Sex1  -0.1233     0.3274 149.0000  -0.377               0.707
##
## (Intercept)           ***
## conditiontypical      .
## Sex1
## conditiontypical:Sex1
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr) cndtnt Sex1
## condtntypcl -0.577
## Sex1        -0.597  0.489
## cndtntyp:S1  0.420 -0.728 -0.703
```

```
#confidence interval
ci.6 <- confint(model.6,method="Wald", level=0.95)
ci.6
```

```
##                              2.5 %     97.5 %
## .sig01                          NA         NA
## .sig02                          NA         NA
## .sigma                          NA         NA
## (Intercept)            5.8333343 6.59824460
## conditiontypical      -0.9005148 0.03364174
## Sex1                  -0.2885837 0.61341502
## conditiontypical:Sex1 -0.7650183 0.51833826
```

```
# group means
femininity_total <- data %>% group_by(condition, Sex) %>%
  summarise(mean = mean(femininity),
            sd = sd(femininity),
            n = n(),
            se = sd(femininity)/sqrt(n()))
```

```
## `summarise()` has grouped output by 'condition'. You can override using the `.groups` argument.
```

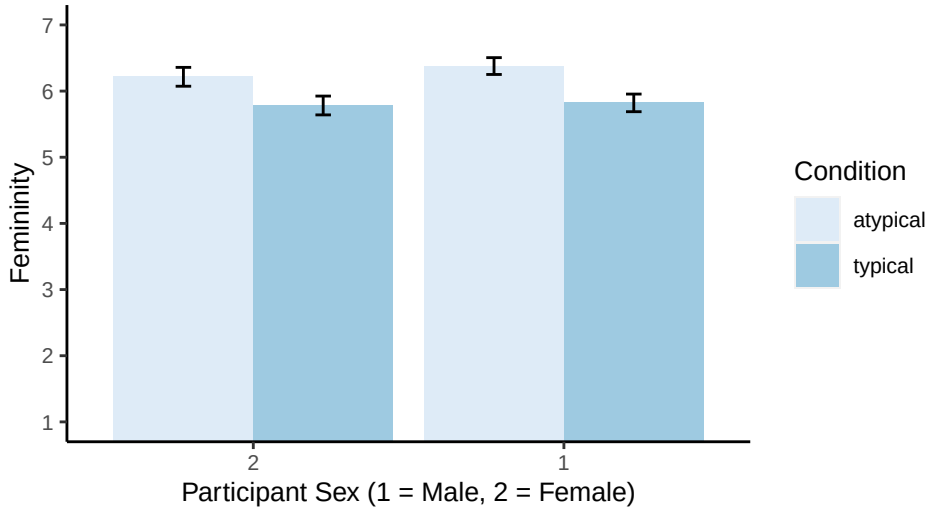
```
femininity_total
```

```
## # A tibble: 4 x 6
## # Groups:   condition [2]
##   condition Sex    mean    sd     n     se
##   <fct>     <fct> <dbl> <dbl> <int>  <dbl>
```

```
## 1 atypical  2      6.22  2.00   760 0.0725
## 2 atypical  1      6.38  1.81   780 0.0649
## 3 typical   2      5.78  1.89   680 0.0725
## 4 typical   1      5.82  1.97   840 0.0679
```

```r
#plot with 95% CI
femininity_plot <- data %>%
  group_by(condition, Sex) %>%
  phe_mean(x = femininity, type = "full", confidence = 0.95) %>%
  ggplot(aes(x=Sex, y=value, fill=condition)) +
  geom_bar(stat = "identity", position = "dodge", width = .90) +
  geom_errorbar(aes(ymin = lowercl, ymax = uppercl), position = position_dodge(.90), width = 0.1) +
  scale_y_continuous(limits=c(1,7), breaks=seq(1,7,by=1), oob = rescale_none) +
  scale_fill_brewer(palette = 1) +
  theme(panel.grid.major = element_blank(), panel.grid.minor = element_blank(),
        panel.background = element_blank(), axis.line = element_line(colour = "black"),
        text = element_text(size = 10)) + # apply custom minimal theme
  labs(title = "", x="Participant Sex (1 = Male, 2 = Female)", y="Femininity", fill="Condition")

femininity_plot
```



The interaction between condition and participant sex is not significant, $t(149) = -0.38$, $p = .707$.

Mediation

Relationship Between Perceived Femininity and Attraction

```r
# multilevel model
model.7 <- lmer(attraction ~ femininity + (1 | ID) + (1 | trial), data = data,
    na.action = "na.exclude", control = lmerControl(optimizer = "optimx",
        calc.derivs = FALSE, optCtrl = list(method = "nlminb")))
summary(model.7)
```

```
## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: attraction ~ femininity + (1 | ID) + (1 | trial)
##    Data: data
## Control:
## lmerControl(optimizer = "optimx", calc.derivs = FALSE, optCtrl = list(method = "nlminb"))
##
## REML criterion at convergence: 10212.5
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -4.8767 -0.5341  0.0533  0.5951  4.2626
##
## Random effects:
##  Groups   Name        Variance Std.Dev.
##  ID       (Intercept) 0.34003  0.5831
##  trial    (Intercept) 0.03787  0.1946
##  Residual             1.49343  1.2221
## Number of obs: 3060, groups:  ID, 153; trial, 20
##
## Fixed effects:
##               Estimate Std. Error         df t value            Pr(>|t|)
## (Intercept)    1.78325    0.10602  310.44169   16.82 <0.0000000000000002 ***
## femininity     0.66898    0.01346 2966.99418   49.71 <0.0000000000000002 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##            (Intr)
## femininity -0.768
```

```
# confidence interval
ci.7 <- confint(model.7, method = "Wald", level = 0.95)
ci.7
```

```
##                 2.5 %    97.5 %
## .sig01             NA        NA
## .sig02             NA        NA
## .sigma             NA        NA
## (Intercept) 1.5754598 1.9910431
## femininity  0.6426053 0.6953625
```

Multilevel Mediation - The Effect of Condition on Attractiveness Mediated by Perceived Femininity

```
# detach lmerTest package (will not run otherwise)
detach("package:lmerTest", unload = TRUE)

# mediator model
med.fit <- lmer(femininity ~ condition + (1 | ID), data = data)
```

```r
# outcome model
out.fit <- lmer(attraction ~ condition + femininity + (1 | ID), data = data)

# function to calculate indirect effect (ACME) and direct effect
# (ADE)
med.out <- mediate(med.fit, out.fit, treat = "condition", mediator = "femininity",
    sims = 1000)
```

```
## Warning in mediate(med.fit, out.fit, treat = "condition", mediator =
## "femininity", : treatment and control values do not match factor levels; using
## atypical and typical as control and treatment, respectively
```

```r
summary(med.fit)
```

```
## Linear mixed model fit by REML ['lmerMod']
## Formula: femininity ~ condition + (1 | ID)
##    Data: data
##
## REML criterion at convergence: 12169.1
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -3.5603 -0.6228  0.0930  0.6976  2.7205
##
## Random effects:
##  Groups   Name        Variance Std.Dev.
##  ID       (Intercept) 0.8677   0.9315
##  Residual             2.8284   1.6818
## Number of obs: 3060, groups:  ID, 153
##
## Fixed effects:
##                   Estimate Std. Error t value
## (Intercept)        6.2981     0.1145  55.014
## conditiontypical  -0.4941     0.1624  -3.042
##
## Correlation of Fixed Effects:
##             (Intr)
## condtntypcl -0.705
```

```r
summary(out.fit)
```

```
## Linear mixed model fit by REML ['lmerMod']
## Formula: attraction ~ condition + femininity + (1 | ID)
##    Data: data
##
## REML criterion at convergence: 10257.7
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -4.6631 -0.5343  0.0809  0.6065  4.2258
##
## Random effects:
```

```
##  Groups   Name        Variance Std.Dev.
##  ID       (Intercept) 0.3397   0.5829
##  Residual             1.5314   1.2375
## Number of obs: 3060, groups:  ID, 153
##
## Fixed effects:
##                   Estimate Std. Error t value
## (Intercept)       1.78743    0.11101  16.102
## conditiontypical -0.03213    0.10453  -0.307
## femininity        0.67093    0.01320  50.809
##
## Correlation of Fixed Effects:
##             (Intr) cndtnt
## condtntypcl -0.513
## femininity  -0.749  0.062
```

```
summary(med.out)
```

```
##
## Causal Mediation Analysis
##
## Quasi-Bayesian Confidence Intervals
##
## Mediator Groups: ID
##
## Outcome Groups: ID
##
## Output Based on Overall Averages Across Groups
##
##                Estimate 95% CI Lower 95% CI Upper             p-value
## ACME            -0.3332      -0.5387        -0.13 <0.0000000000000002 ***
## ADE             -0.0297      -0.2223         0.17                0.76
## Total Effect    -0.3629      -0.6599        -0.07                0.02 *
## Prop. Mediated   0.9153       0.4837         2.27                0.02 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Sample Size Used: 3060
##
##
## Simulations: 1000
```

The effect of condition on attraction ratings was fully mediated via perceived femininity. The indirect effect is -.33 (ACME), which is significant insofar as the confidence interval does not contain zero [-0.55, -0.12].