One-Way Between-Subjects ANOVA Demo

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One-way Between-Subjects ANOVA | Research Context Prompt

A developmental psychologist is looking for a Grad student who can help them with their research project looking into adolescent self-esteem and its relationship with parenting style. There were three parenting styles: (1) `authoritative` (high expectations with support), (2) `authoritarian` (high expectations with little support), and (3) `permissive` (low expectations with support).

Data on 90 teenagers self-esteem levels and the parenting style they experienced (30 per style) has been collected. The research question of interest is: Does parenting style differences impact teenage self-esteem?

One-way Between-Subjects ANOVA | Data

```
library(psych)
library(tidyverse)
library(jmv)
library(ggpubr)
library(apaTables)
library(rstatix)

dat_A <- read.csv("One-way ANOVA.A.csv")
dim(dat_A)
```

```
## [1] 90  3
```

```
head(dat_A)
```

```
##    Teenager Style Self_esteem
## 1         1     1       34.88
## 2         2     1       38.73
## 3         3     1       35.34
## 4         4     1       34.53
## 5         5     1       39.22
## 6         6     1       37.65
```

One-way Between-Subjects ANOVA | Descriptive Stats

```
# Descriptive Stats
describe(dat_A[,2:3])
```

```
##                vars  n  mean   sd median trimmed  mad   min  max range  skew
## Style            1 90  2.00 0.82   2.00    2.00 1.48  1.00  3.0  2.00  0.00
## Self_esteem      2 90 34.46 2.50  34.79   34.48 2.31 28.58 39.8 11.22 -0.11
##              kurtosis   se
## Style           -1.53 0.09
## Self_esteem     -0.37 0.26
```

One-way Between-Subjects ANOVA | Grouped Descriptive Stats

```
dat_A$Style<-factor(dat_A$Style,
                labels = c("Authoritative","Authoritarian","Permissive"))

# Descriptive Stats
describeBy(dat_A$Self_esteem,
          dat_A$Style,
          mat=TRUE)
```

```
##      item        group1 vars  n     mean       sd median  trimmed      mad   min
## X11     1 Authoritative    1 30 36.26967 1.911749 35.690 36.20000 1.905141 32.39
## X12     2 Authoritarian    1 30 32.14300 1.986734 32.060 32.08917 2.142357 28.58
## X13     3    Permissive    1 30 34.96133 1.531965 34.945 34.91042 1.341753 32.02
##      max range      skew   kurtosis        se
## X11 39.80  7.41 0.2585508 -0.9602706 0.3490359
## X12 36.68  8.10 0.3020997 -0.6486497 0.3627263
## X13 38.67  6.65 0.2448705 -0.1540893 0.2796972
```

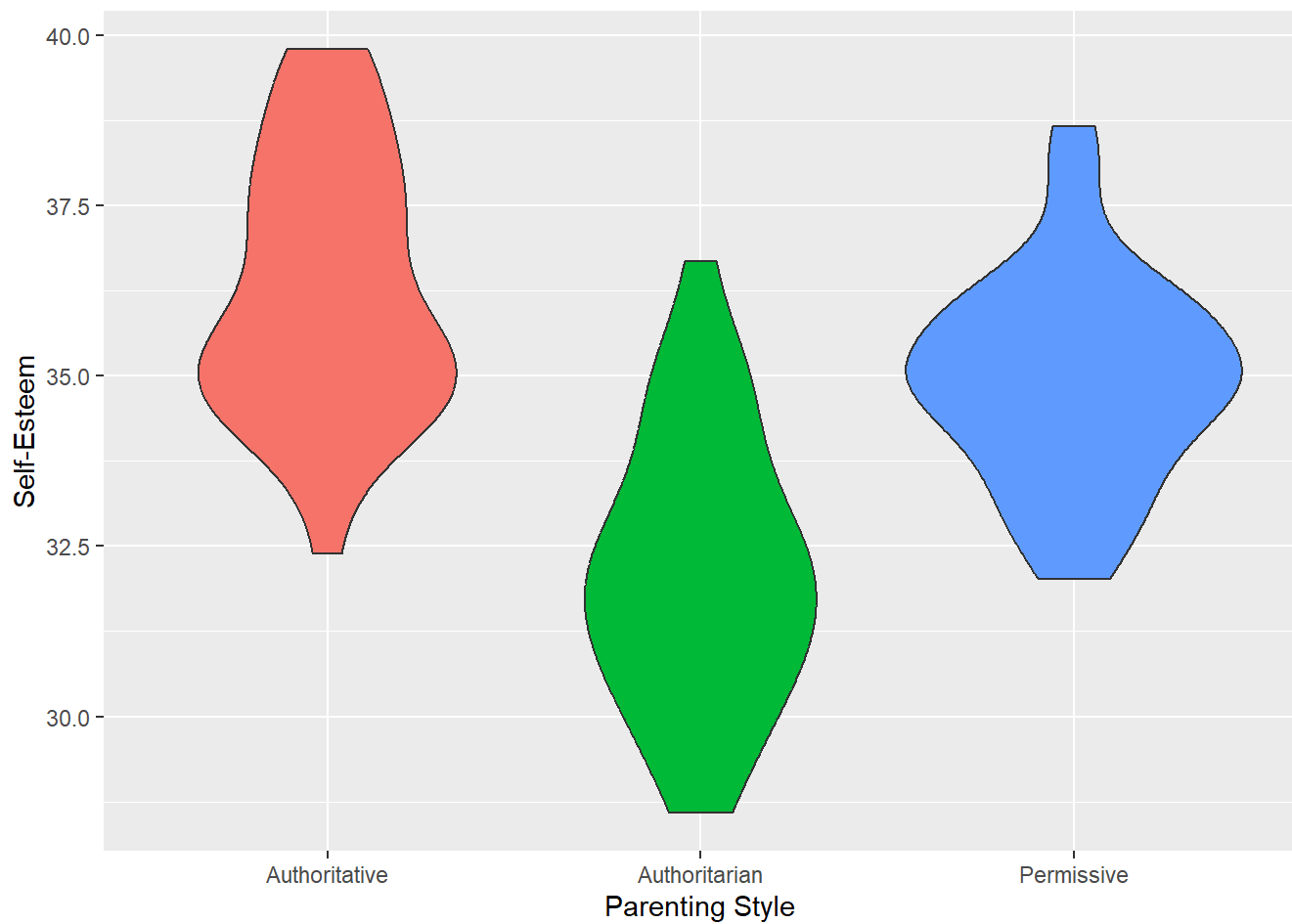# One-way Between-Subjects ANOVA | Univariate Visualizations

One-way Between-Subjects ANOVA | Boxplot

```
ggplot(data = dat_A,
       mapping = aes(y = Self_esteem, x =Style)) +
  geom_boxplot() +
    labs(y = "Parenting Style")
```
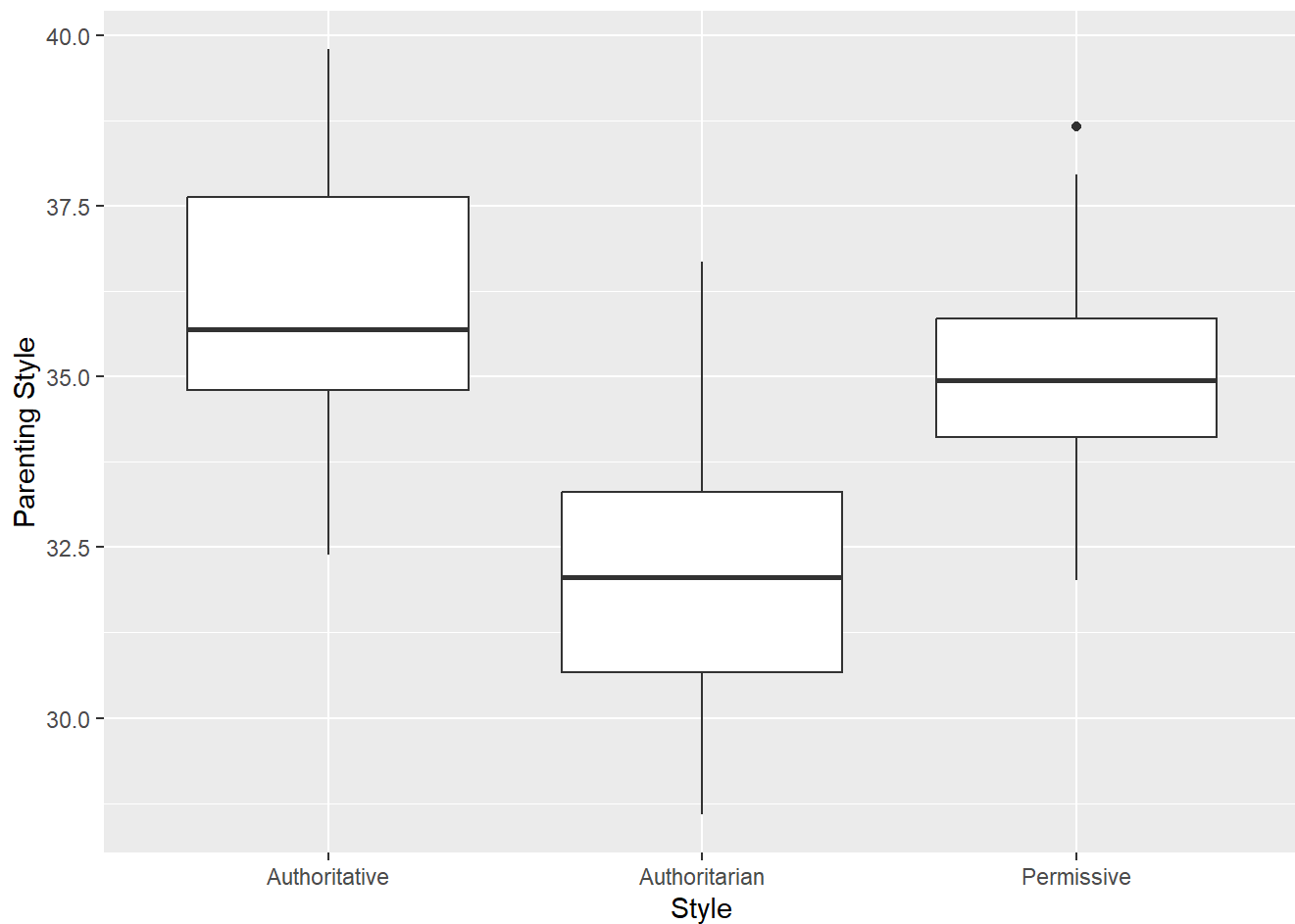
One-way Between-Subjects ANOVA | Violin Plot

```
ggplot(data = dat_A,
       aes(x = Style, y = Self_esteem,
           fill = Style))+
  geom_violin(show.legend=FALSE)+
  ylab("Self-Esteem")+
  xlab("Parenting Style")
```

```
ggplot(data = dat_A,
       aes(x = Style, y = Self_esteem,
           fill = Style))+
  geom_violin(show.legend=FALSE)+
  ylab("Self-Esteem")+
  xlab("Parenting Style")+
  scale_fill_manual(values=c("#D55e00","#56B4E9","#009E73"))
```
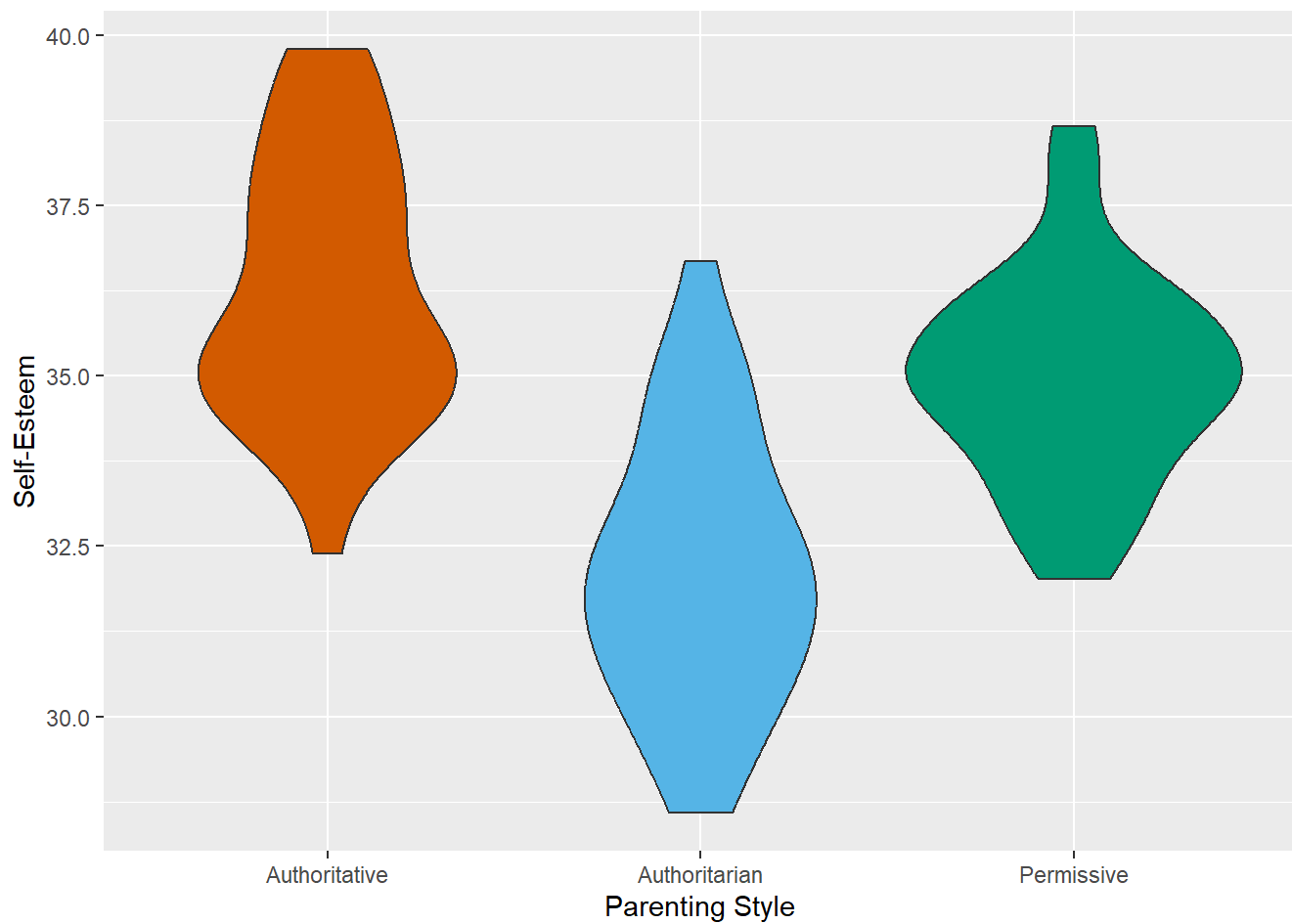
One-way Between-Subjects ANOVA | Omnibus Assumption Checks Code

```
# Omnibus Assumption Checking
ANOVA(data = dat_A,
      dep = 'Self_esteem',
      factors = c('Style'),
      homo = TRUE,
      norm = TRUE,
      qq = TRUE)
```

```
##
##   ANOVA
##
##   ANOVA - Self_esteem
##   ─────────────────────────────────────────────────────────────────
##                    Sum of Squares    df    Mean Square     F            p
##   ─────────────────────────────────────────────────────────────────
##     Style               266.8412      2     133.420583    40.23213    < .0000001
##     Residuals           288.5155     87       3.316270
##   ─────────────────────────────────────────────────────────────────
##
##
##   ASSUMPTION CHECKS
##
##   Homogeneity of Variances Test (Levene's)
##   ──────────────────────────────────────────
##     F            df1    df2    p
##   ──────────────────────────────────────────
##     1.782551       2     87     0.1742966
##   ──────────────────────────────────────────
##
##
##   Normality Test (Shapiro-Wilk)
##   ─────────────────────────────────
##     Statistic     p
##   ─────────────────────────────────
##     0.9846491     0.3708903
##   ─────────────────────────────────
```
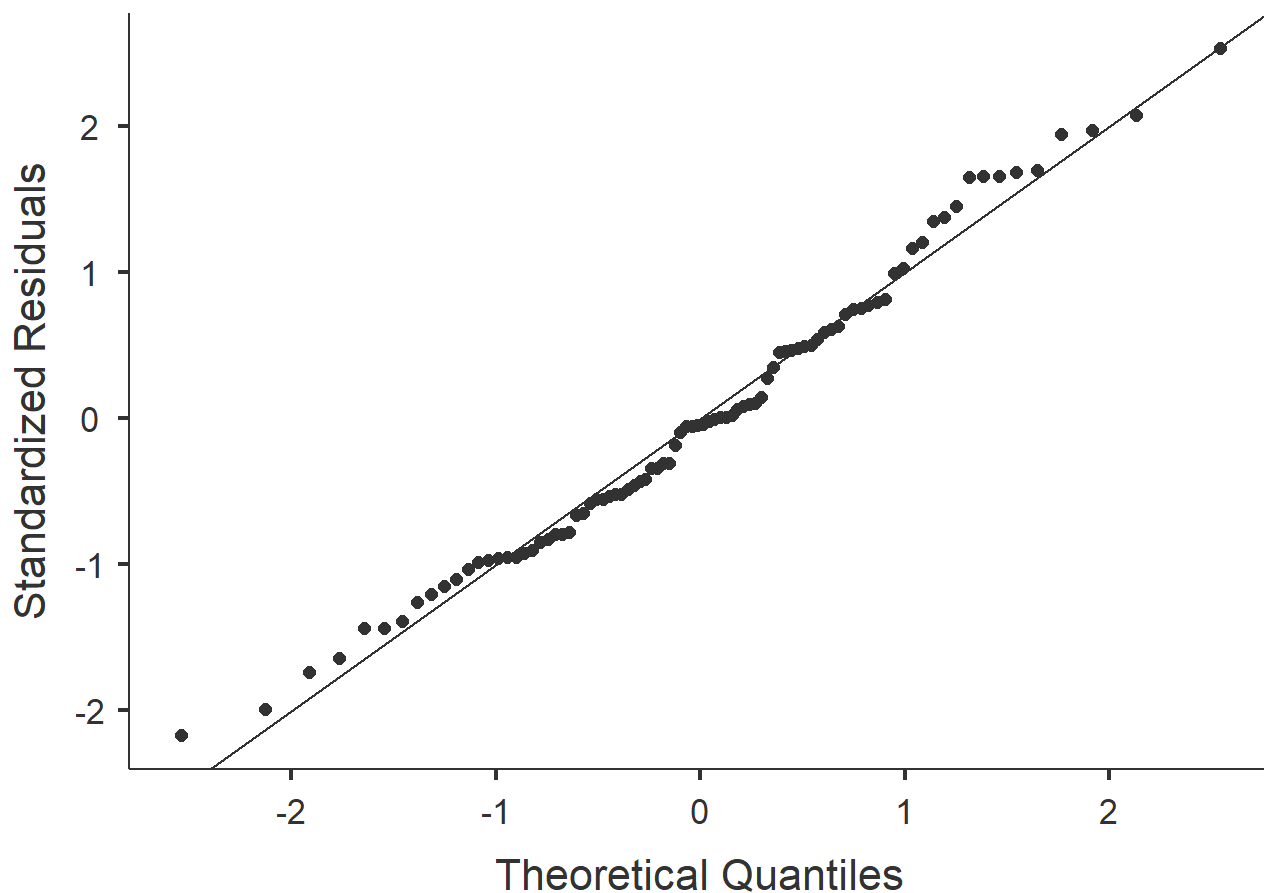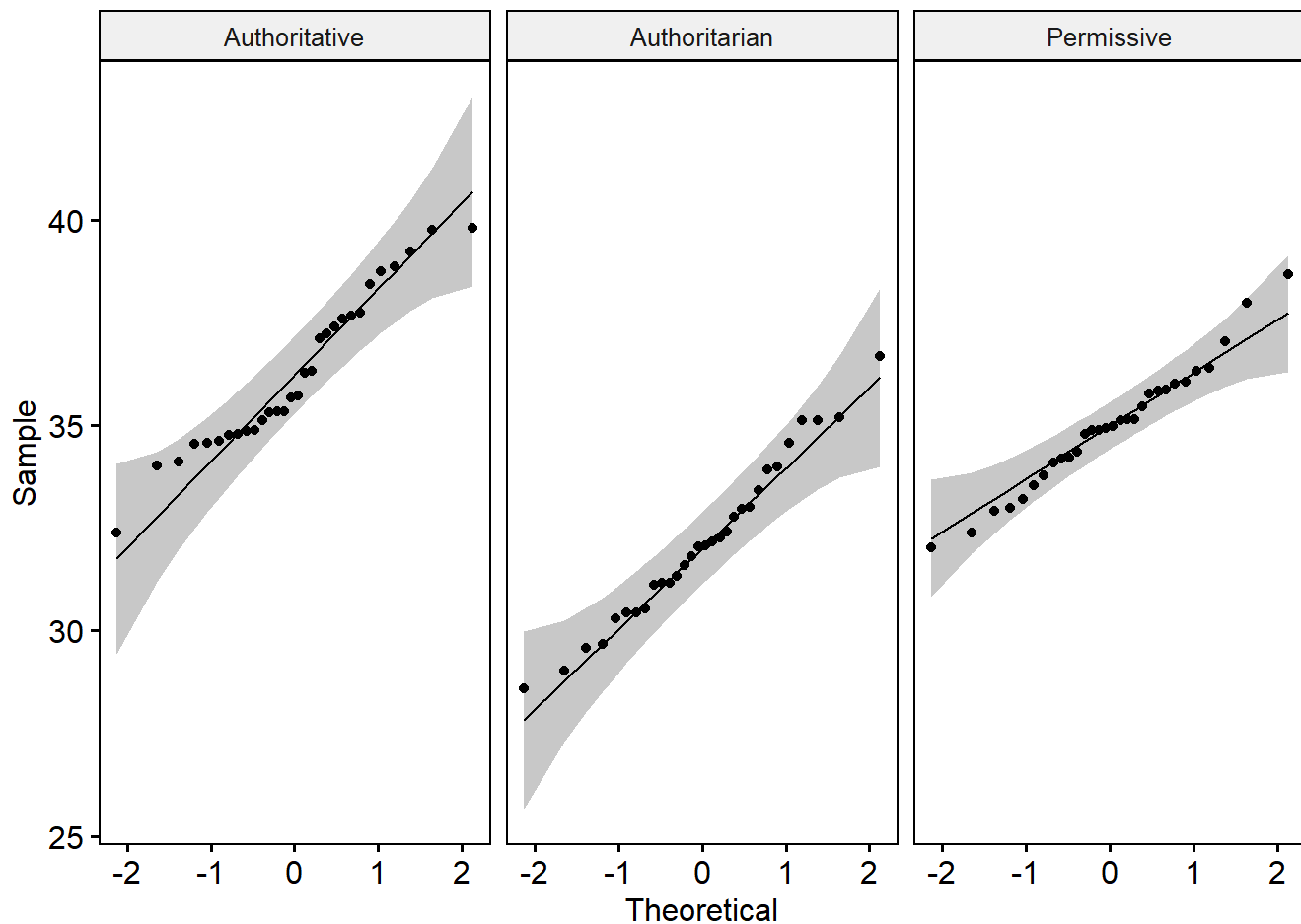
One-way Between-Subjects ANOVA | Group Level Assumption Checks

```
dat_A %>%
  group_by(Style) %>%
  shapiro_test(Self_esteem)
```

```
## # A tibble: 3 × 4
##   Style          variable      statistic     p
##   <fct>          <chr>             <dbl> <dbl>
## 1 Authoritative  Self_esteem       0.949 0.157
## 2 Authoritarian  Self_esteem       0.980 0.828
## 3 Permissive     Self_esteem       0.982 0.870
```

One-way Between-Subjects ANOVA | Group Level Assumption Checks

```
ggqqplot(dat_A,
         'Self_esteem',
         facet.by = "Style")
```

One-way Between-Subjects ANOVA | Rechecking Homogen. of Variance using `rstatix`

```
dat_A %>%
  levene_test(Self_esteem ~ as.factor(Style), center = mean)
```

```
## # A tibble: 1 × 4
##     df1   df2 statistic     p
##   <int> <int>     <dbl> <dbl>
## 1     2    87      1.78 0.174
```
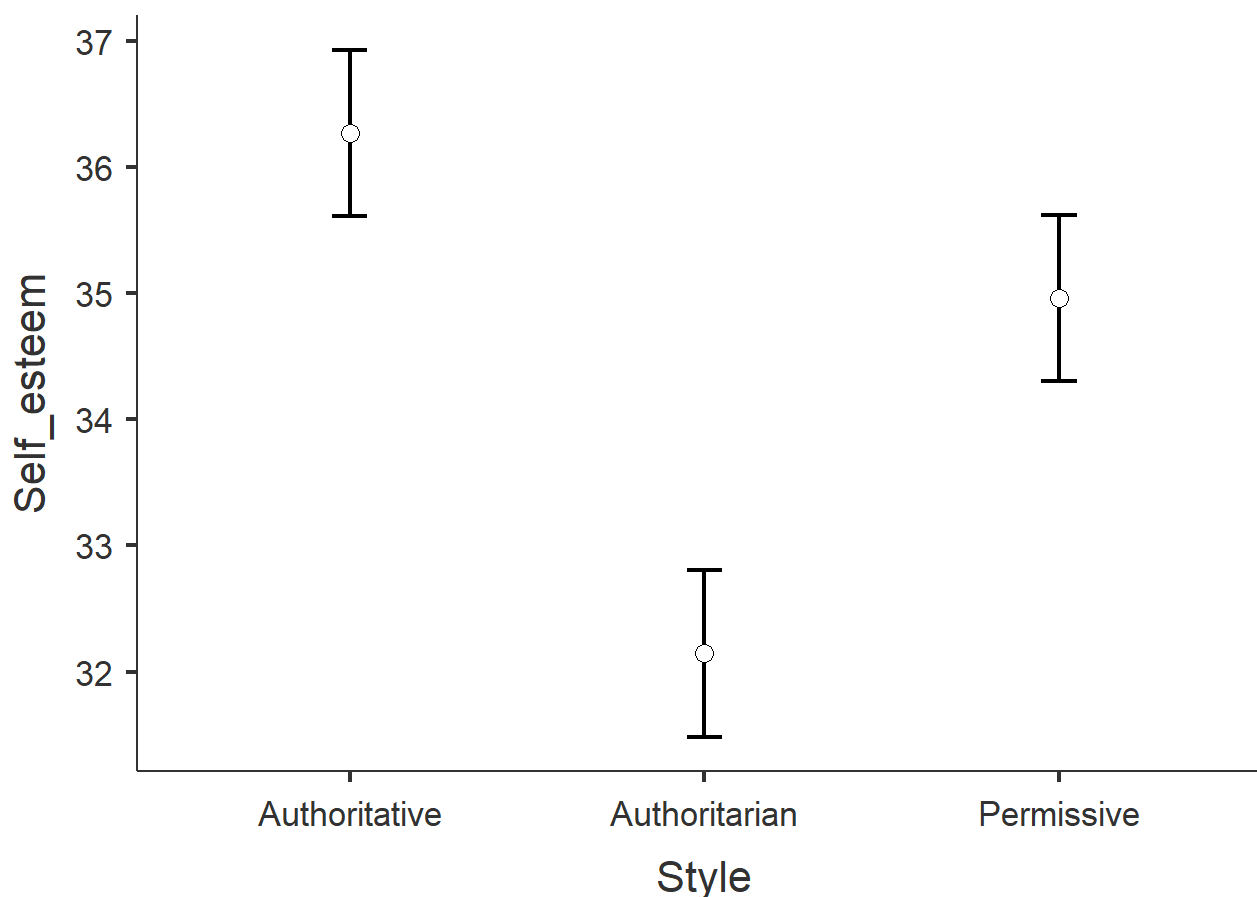
One-way Between-Subjects ANOVA | Conducting the ANOVA Code

```
options(digits = 3)
ANOVA(data = dat_A,
      dep = 'Self_esteem',
      factors = c('Style'),
      effectSize = 'eta',
      postHoc = 'Style',
      postHocCorr = 'bonf',
      postHocES = 'd',
      postHocEsCi = TRUE,
      emMeans = list(
       list('Style')),
      emmPlots = TRUE,
      emmTables = TRUE)
```

```
##
## ANOVA
##
## ANOVA - Self_esteem
## ─────────────────────────────────────────────────────────────────────
##                   Sum of Squares    df    Mean Square    F      p        η²
## ─────────────────────────────────────────────────────────────────────
##    Style                    267     2        133.42    40.2    < .001    0.480
##    Residuals                289    87          3.32
## ─────────────────────────────────────────────────────────────────────
##
##
## POST HOC TESTS
##
## Post Hoc Comparisons - Style
## ─────────────────────────────────────────────────────────────────────
## ───────────────────────────────────────────────
## Style                    Style         Mean Difference    SE       df      t       p-bonf
erroni    Cohen's d    Lower      Upper
## ─────────────────────────────────────────────────────────────────────
## ───────────────────────────────────────────────
##    Authoritative    -    Authoritarian         4.13      0.470    87.0    8.78    < .001
2.266      1.650      2.882
##                     -    Permissive            1.31      0.470    87.0    2.78
0.020         0.718    0.194      1.243
##    Authoritarian    -    Permissive           -2.82      0.470    87.0    -5.99   < .001
-1.548     -2.111    -0.984
## ─────────────────────────────────────────────────────────────────────
## ───────────────────────────────────────────────
##    Note. Comparisons are based on estimated marginal means
##
##
## ESTIMATED MARGINAL MEANS
##
## STYLE
##
## Estimated Marginal Means - Style
## ─────────────────────────────────────────────────
##    Style            Mean    SE       Lower     Upper
## ─────────────────────────────────────────────────
##    Authoritative    36.3    0.332    35.6      36.9
##    Authoritarian    32.1    0.332    31.5      32.8
##    Permissive       35.0    0.332    34.3      35.6
## ─────────────────────────────────────────────────
```
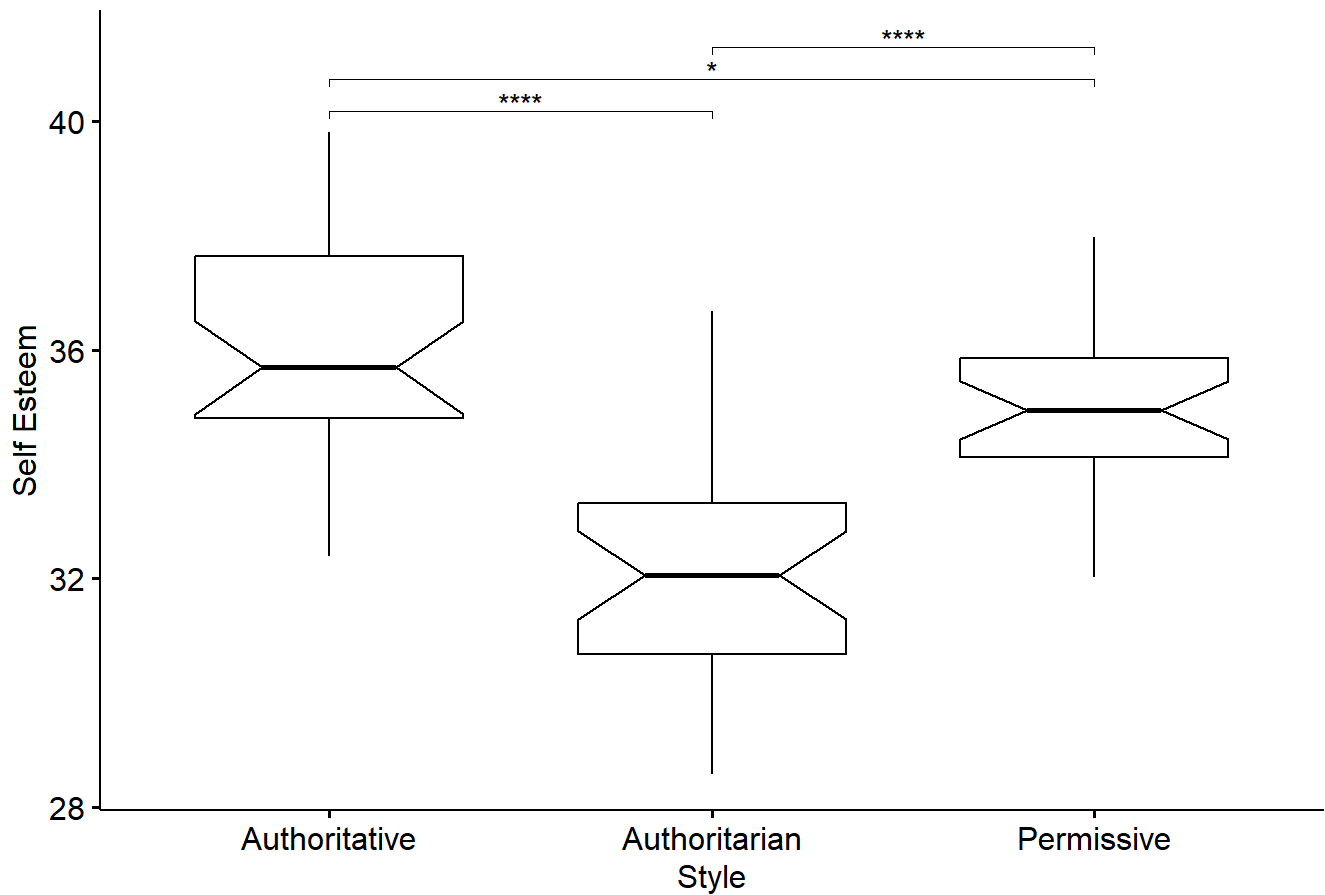
One-way Between-Subjects ANOVA | Professional ANOVA Visualization Code

```
# Pairwise Post-Hoc Tests (Bonferroni Correction)
pwc <- dat_A %>%
  pairwise_t_test(Self_esteem ~ Style, p.adjust.method = "bonferroni") %>%
  add_xy_position(x = "Style")
```

One-way Between-Subjects ANOVA | Professional ANOVA Visualization Code

```
# Visualization: box plots with p-values
ggboxplot(dat_A,
          x = "Style",
          y = "Self_esteem",
          notch = TRUE,
          outlier.shape = NA) +
  stat_pvalue_manual(pwc,
                     hide.ns = TRUE,
                     tip.length = .01) +
  labs(caption = get_pwc_label(pwc),
       y = "Self Esteem")
```

pwc: **T test**; p.adjust: **Bonferroni**

One-way Between-Subjects ANOVA | Saving the ANOVA Model

```
aovm<-ANOVA(data = dat_A,
            dep = 'Self_esteem',
            factors = c('Style'),
            effectSize = 'eta',
            postHoc = 'Style',
            postHocCorr = 'bonf',
            postHocES = 'd',
            postHocEsCi = TRUE,
            emMeans = list(
              list('Style')),
            emmPlots = TRUE,
            emmTables = TRUE)$model
```

One-way Between-Subjects ANOVA | APA Style ANOVA Tables

```
apa.aov.table(aovm,
             table.number=1,
             conf.level=.95,
             type = 3)
```

```
##
##
## Table 1
##
## ANOVA results using Self_esteem as the dependent variable
##
##
##     Predictor         SS df        MS        F    p partial_eta2
##  (Intercept) 106861.84  1 106861.84 32223.51 .000
##        Style    266.84  2    133.42    40.23 .000          .48
##        Error    288.52 87      3.32
##  CI_95_partial_eta2
##
##          [.32, .59]
##
##
## Note: Values in square brackets indicate the bounds of the 95% confidence interval for partia
l eta-squared
```

```
apa.1way.table(Style,
               Self_esteem,
               dat_A,
               table.number=2,
               show.conf.interval = TRUE)
```

```
##
##
## Table 2
##
## Descriptive statistics for Self_esteem as a function of Style.
##
##         Style     M       M_95%_CI   SD
##  Authoritative 36.27 [35.56, 36.98] 1.91
##  Authoritarian 32.14 [31.40, 32.88] 1.99
##     Permissive 34.96 [34.39, 35.53] 1.53
##
## Note. M and SD represent mean and standard deviation, respectively.
## LL and UL indicate the lower and upper limits of the 95% confidence interval
## for the mean, respectively.
## The confidence interval is a plausible range of population means that could
## have caused a sample mean (Cumming, 2014).
```