

# PS: Independent and Dependent t-test for TAs

Pablo E. Gutiérrez-Fonseca

2023-08-11

## R practice.

Install packages.

```
library(car)
```

```
## Loading required package: carData
```

```
library(ggplot2)
```

```
library(dplyr)
```

```
##
```

```
## Attaching package: 'dplyr'
```

```
## The following object is masked from 'package:car':
```

```
##
```

```
##      recode
```

```
## The following objects are masked from 'package:stats':
```

```
##
```

```
##      filter, lag
```

```
## The following objects are masked from 'package:base':
```

```
##
```

```
##      intersect, setdiff, setequal, union
```

Load the Bird Migration data into R.

```
##   Birds   Species Gender Treatment value
## 1      1 Hylocichla      M Pre_weight  46
## 2      2 Hylocichla      M Pre_weight  44
## 3      3 Hylocichla      M Pre_weight  48
## 4      4 Hylocichla      M Pre_weight  42
## 5      5 Hylocichla      M Pre_weight  51
## 6      6 Hylocichla      M Pre_weight  51
```

Make a subgroup of Weight before migration (Pre\_weight).

```
df_bird_Pre_weight <- df_bird_all %>%
  filter(Treatment == 'Pre_weight')

summary(df_bird_Pre_weight)
```

```
##      Birds      Species      Gender      Treatment
## Min.   : 1.00   Length:28   Length:28   Length:28
## 1st Qu.: 7.75   Class :character Class :character Class :character
## Median :14.50   Mode  :character Mode  :character Mode  :character
## Mean   :14.50
## 3rd Qu.:21.25
## Max.   :28.00
##      value
## Min.   :41.00
## 1st Qu.:46.75
## Median :49.00
## Mean   :48.68
## 3rd Qu.:52.00
## Max.   :55.00
```

## Part I.

### 2. Analyze data distribution. Is your pre-weight data normally distributed?

```
shapiro.test(df_bird_Pre_weight$value)
```

```
##  
## Shapiro-Wilk normality test  
##  
## data: df_bird_Pre_weight$value  
## W = 0.95557, p-value = 0.2725
```

### 3. Test to see if you meet the assumption of equal variance for this test. Based on the results of this test for unequal variance, which test should you use?

```
# Perform Levene's test  
result <- leveneTest(value~Gender, data=df_bird_Pre_weight)
```

```
## Warning in leveneTest.default(y = y, group = group, ...): group coerced to  
## factor.
```

```
print(result)
```

```
## Levene's Test for Homogeneity of Variance (center = median)  
##      Df F value Pr(>F)  
## group 1  0.0061 0.9381  
##      26
```

```
p_value <- result$Pr[1]  
# Significance level  
alpha <- 0.05  
  
# Interpret the result  
if (p_value < alpha) {  
  cat("Reject null hypothesis: Variances are significantly different.\n")  
} else {  
  cat("Fail to reject null hypothesis: Variances are not significantly different.\n")  
}
```

```
## Fail to reject null hypothesis: Variances are not significantly different.
```

### 4. Run this analysis. What is the test statistic (obtained) value for the test you selected?

Use alternative to determine your hypothesis. Default= "two.sided".

alternative = c("two.sided", "less", "greater"),

```

# Perform t-test
t_test_result <- t.test(value~Gender, alternative = "two.sided",
                        var.equal=TRUE, data=df_bird_Pre_weight)
print(t_test_result)

##
## Two Sample t-test
##
## data:  value by Gender
## t = -0.78654, df = 26, p-value = 0.4387
## alternative hypothesis: true difference in means between group F and group M is not equal to 0
## 95 percent confidence interval:
##  -4.387692  1.959120
## sample estimates:
## mean in group F mean in group M
##      48.07143      49.28571

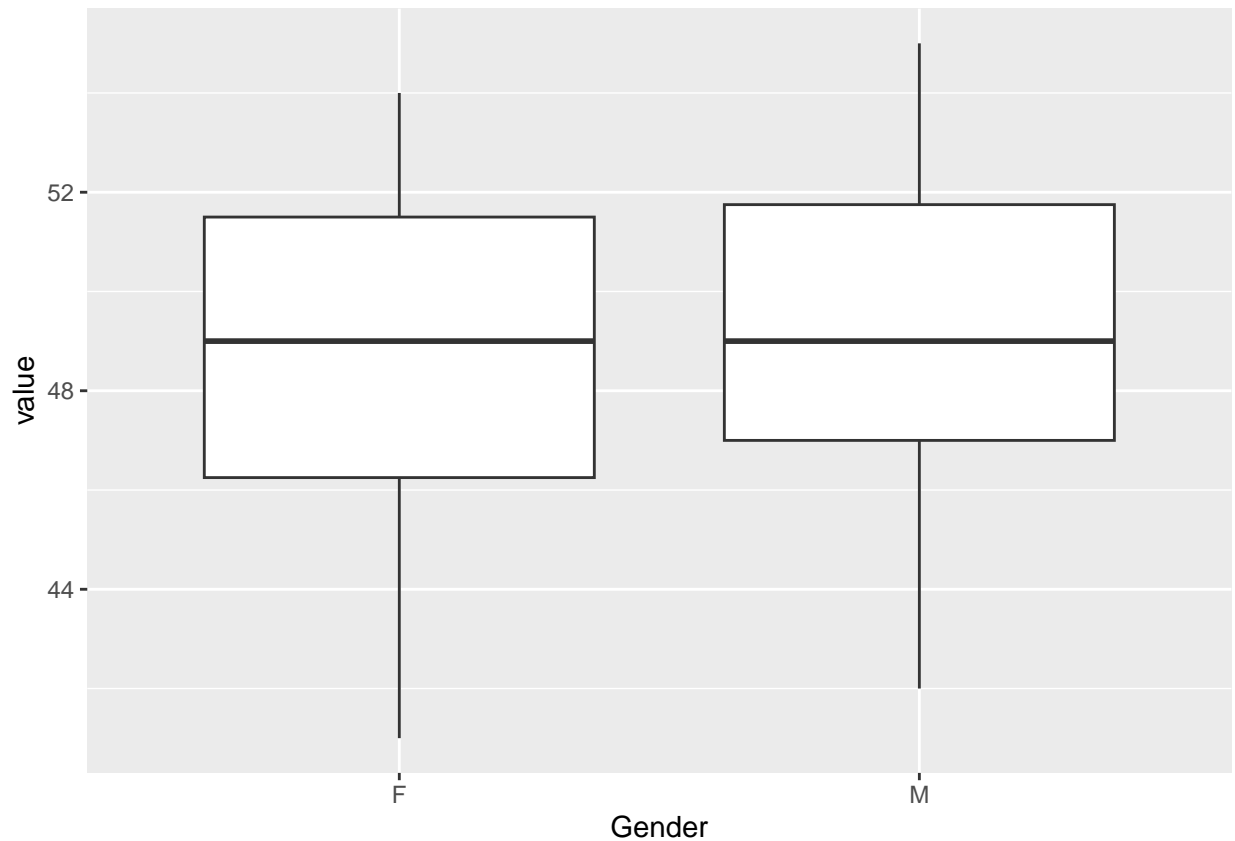
```

We hypothesized that there is a difference in the pre-weights of male and female songbirds. However, an independent two-tailed pooled t-test indicated that there was not a significant difference between genders ( $t(26) = -0.78654$ ,  $p = 0.4387$ ). It is possible that low power limited the ability of this test to detect significant differences.

```

# Create a boxplot plot using ggplot2
ggplot(df_bird_Pre_weight, aes(x = Gender, y = value)) +
  geom_boxplot()

```



## Part II.

Analyze data distribution. Is your pre-weight data normally distributed?

```
shapiro.test(df_bird_Pre_weight$value)
```

```
##  
##  Shapiro-Wilk normality test  
##  
## data:  df_bird_Pre_weight$value  
## W = 0.95557, p-value = 0.2725
```

Test to see if you meet the assumption of equal variance for this test. Based on the results of this test for unequal variance, which test should you use?

```
# Perform Levene's test
result <- leveneTest(value~Species, data=df_bird_Pre_weight)
```

```
## Warning in leveneTest.default(y = y, group = group, ...): group coerced to
## factor.
```

```
print(result)
```

```
## Levene's Test for Homogeneity of Variance (center = median)
##      Df F value Pr(>F)
## group 1  1.2128 0.2809
##      26
```

```
p_value <- result$Pr[1]
# Significance level
alpha <- 0.05

# Interpret the result
if (p_value < alpha) {
  cat("Reject null hypothesis: Variances are significantly different.\n")
} else {
  cat("Fail to reject null hypothesis: Variances are not significantly different.\n")
}
```

```
## Fail to reject null hypothesis: Variances are not significantly different.
```

## 8. Run this analysis. What is the test statistic (obtained) value for the test you selected?

Use alternative to determine your hypothesis. Default= "two.sided".

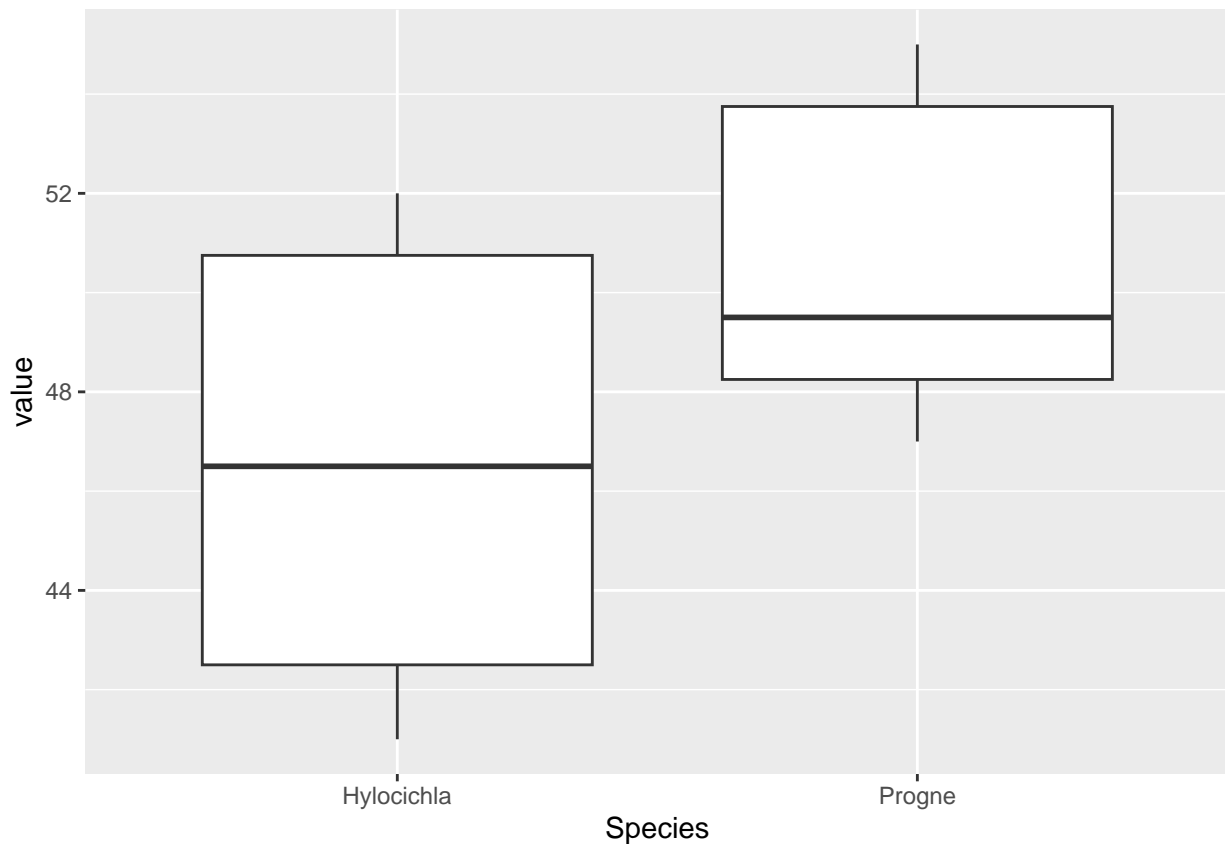
alternative = c("two.sided", "less", "greater"),

```
# Perform t-test
t_test_result <- t.test(value~Species, alternative = "two.sided",
                        var.equal=TRUE, data=df_bird_Pre_weight)
print(t_test_result)
```

```
##
## Two Sample t-test
##
## data: value by Species
## t = -2.891, df = 26, p-value = 0.007655
## alternative hypothesis: true difference in means between group Hylocichla and group Progne is not equal to 0
## 95 percent confidence interval:
## -6.721783 -1.135360
## sample estimates:
## mean in group Hylocichla mean in group Progne
## 46.71429 50.64286
```

We hypothesized that there is a difference in the pre-weights of Hylocichla and Progne species. An independent two-tailed pooled t-test indicates that Hylocichla does have significantly lower pre-weights than Progne individuals ( $t(26) = -2.891043$ ,  $p = 0.007655$ ). This difference is also meaningful (Cohen's D effect size = 0.96) This indicates that any analyses of weight changes during migration may want to consider which species is examined based on their inherent difference in size.

```
# Create a boxplot plot using ggplot2
ggplot(df_bird_Pre_weight, aes(x = Species, y = value)) +
  geom_boxplot()
```



## Part III.

12. Analyze data distribution. Is your pre-weight data normally distributed?

```
shapiro.test(df_bird_all$value)
```

```
##  
## Shapiro-Wilk normality test  
##  
## data: df_bird_all$value  
## W = 0.97528, p-value = 0.3028
```

Test to see if you meet the assumption of equal variance for this test. Based on the results of this test for unequal variance, which test should you use?

```
# Perform Levene's test  
result_paired_t_test <- leveneTest(value~Treatment, data=df_bird_all)
```

```
## Warning in leveneTest.default(y = y, group = group, ...): group coerced to  
## factor.
```

```
print(result_paired_t_test)
```

```
## Levene's Test for Homogeneity of Variance (center = median)  
##      Df F value Pr(>F)  
## group 1  0.0035 0.9529  
##      54
```

```
p_value <- result_paired_t_test$Pr[1]  
# Significance level  
alpha <- 0.05  
  
# Interpret the result  
if (p_value < alpha) {  
  cat("Reject null hypothesis: Variances are significantly different.\n")  
} else {  
  cat("Fail to reject null hypothesis: Variances are not significantly different.\n")  
}
```

```
## Fail to reject null hypothesis: Variances are not significantly different.
```

Perform and Print the paired t-test result.

```
t_paired_result <- t.test(value ~ Treatment, paired = TRUE,  
                           data = df_bird_all)  
print(t_paired_result)
```

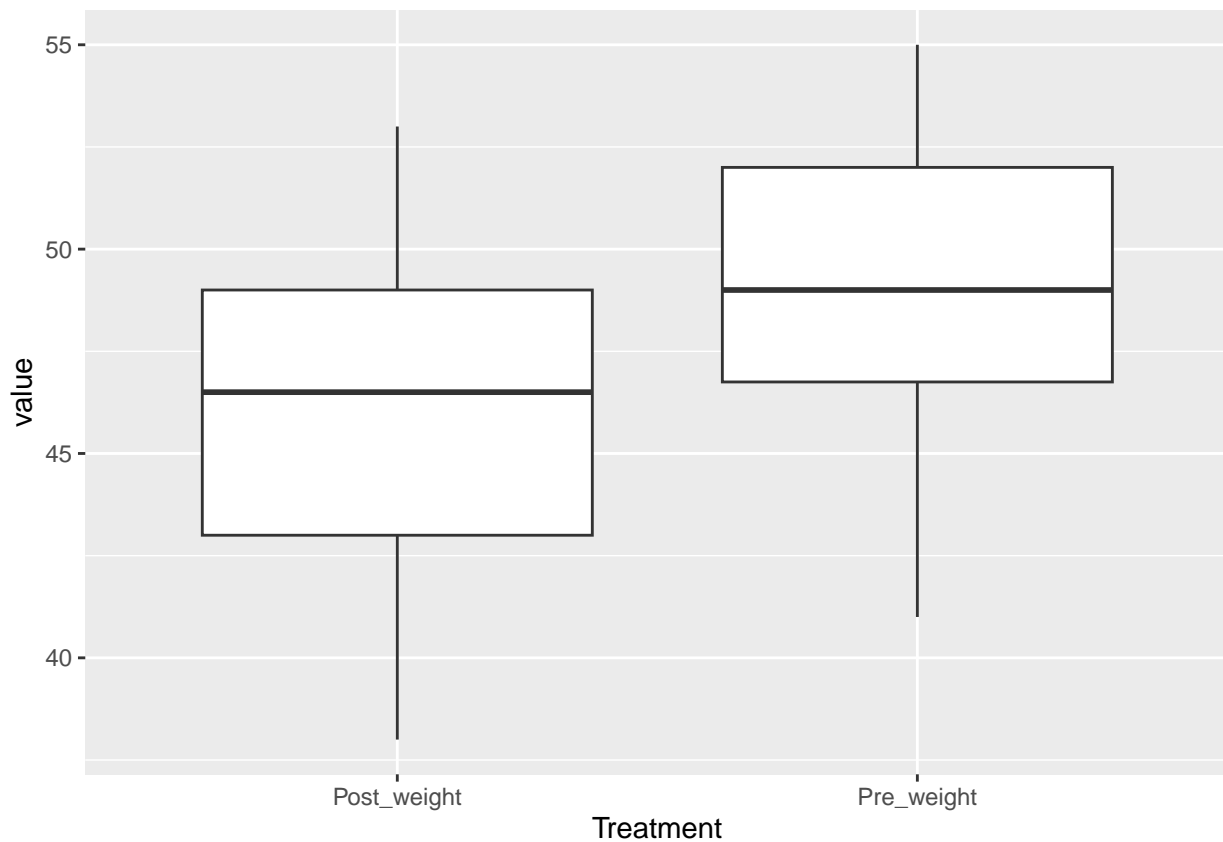
```
##  
## Paired t-test  
##  
## data: value by Treatment
```



```
## t = -3.4184, df = 27, p-value = 0.002013
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -4.400616 -1.099384
## sample estimates:
## mean of the differences
##                -2.75
```

We hypothesized that songbirds lose body mass during migration (quantified as a comparison of pre-and post-weights). A dependent one-tailed t-test indicated this was true as there was a significant loss of body mass for songbirds during migration ( $t(27) = -3.4184$ ,  $p = 0.002013$ ). This difference is also moderately meaningful (Cohen's D effect size = 0.678).

```
# Create a boxplot plot using ggplot2
ggplot(df_bird_all, aes(x = Treatment, y = value)) +
  geom_boxplot()
```



## Part IV.

From the data.frame make two groups (females and males)

```
df_bird_female <- df_bird_all %>%  
  filter(Gender == 'F')
```

```
df_bird_male <- df_bird_all %>%  
  filter(Gender == 'M')
```

Assumptions for Females

```
shapiro.test(df_bird_female$value)
```

```
##  
## Shapiro-Wilk normality test  
##  
## data: df_bird_female$value  
## W = 0.95617, p-value = 0.282
```

```
leveneTest(value~Treatment, data=df_bird_female)
```

```
## Warning in leveneTest.default(y = y, group = group, ...): group coerced to  
## factor.
```

```
## Levene's Test for Homogeneity of Variance (center = median)  
##      Df F value Pr(>F)  
## group 1  0.0053 0.9424  
##      26
```

Perform and Print the paired t-test result

```
t_paired_female <- t.test(value ~ Treatment, paired = TRUE,  
  alternative='less',  
  data = df_bird_female)  
print(t_paired_female)
```

```
##  
## Paired t-test  
##  
## data: value by Treatment  
## t = -1.9868, df = 13, p-value = 0.03422  
## alternative hypothesis: true difference in means is less than 0  
## 95 percent confidence interval:  
##      -Inf -0.1164104  
## sample estimates:  
## mean of the differences  
##      -1.071429
```

## Assumptions for Males

```
shapiro.test(df_bird_male$value)
```

```
##  
## Shapiro-Wilk normality test  
##  
## data: df_bird_male$value  
## W = 0.97278, p-value = 0.6567
```

```
leveneTest(value~Treatment, data=df_bird_male)
```

```
## Warning in leveneTest.default(y = y, group = group, ...): group coerced to  
## factor.
```

```
## Levene's Test for Homogeneity of Variance (center = median)  
##      Df F value Pr(>F)  
## group 1    0.334 0.5683  
##      26
```

## Perform and Print the paired t-test result

```
t_paired_male <- t.test(value ~ Treatment, paired = TRUE,  
                        alternative= 'less',  
                        data = df_bird_male)  
print(t_paired_male)
```

```
##  
## Paired t-test  
##  
## data: value by Treatment  
## t = -3.1601, df = 13, p-value = 0.003762  
## alternative hypothesis: true difference in means is less than 0  
## 95 percent confidence interval:  
##      -Inf -1.946804  
## sample estimates:  
## mean of the differences  
##      -4.428571
```

We wanted to see if males and females lose body mass during migration (measured as change in body weight). Two separate one-tailed, dependent t-tests indicate that both males ( $t(13) = -3.16013$ ,  $p = 0.003762$ ) and females ( $t(13) = -1.9868$ ,  $p=0.03422$ ) lose body weight during migration, although this loss is more significant in males. This difference, while highly meaningful for males, was not meaningful for females (Cohen's D effect size = 1.02 and 0.25 respectively for males and females). This indicates that while both genders lose weight, females may spend more time foraging along the route to maintain their weight for breeding.