

Tdubius__bait__color__new.R

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```
# Tdubius_bait_color_new.R
# Two-way ANOVA for T. dubius counts (Reeve et al. 2009)

# Load necessary libraries
library(car)

## Loading required package: carData
library(ggplot2)

## Warning: package 'ggplot2' was built under R version 3.5.1
library(emmeans)
library(multcomp)

## Loading required package: mvtnorm
## Loading required package: survival
## Loading required package: TH.data
## Loading required package: MASS
##
## Attaching package: 'TH.data'
## The following object is masked from 'package:MASS':
##
##      geyser
library(phia)

# Read in data set
Tdata <- read.table(header=T,colClasses=c("factor","factor","numeric"),text="
bait color Tdubius
FRT B    18
FRT B    12
FRT B    22
FRT B     6
FRT W    12
FRT W    15
FRT W     7
FRT W     4
IDT B     0
IDT B     2
IDT B     1
IDT B     4
IDT W     2
IDT W     1
IDT W     2
IDT W     0
IST B     2
```

```

IST B      2
IST B     10
IST B      7
IST W      1
IST W      4
IST W     14
IST W      4
")

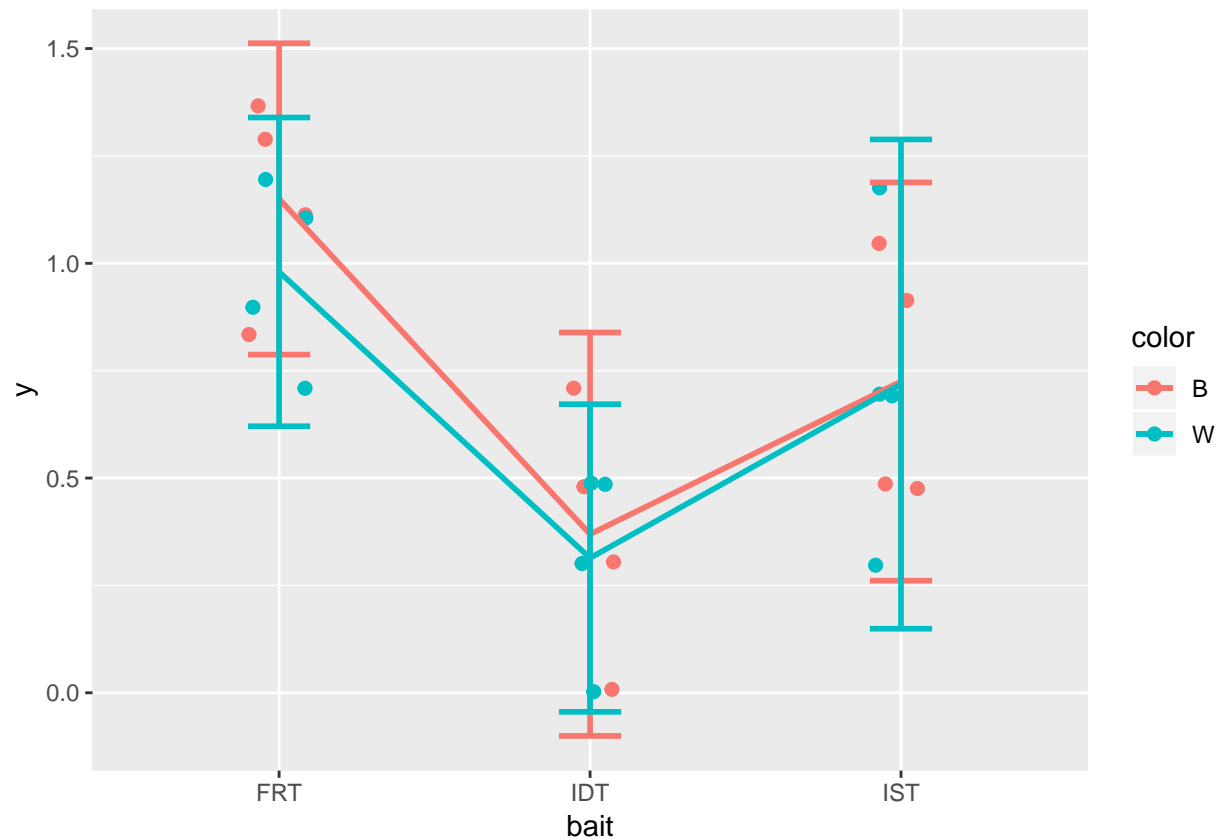
# Apply transformations here
Tdata <- transform(Tdata,y=log10(Tdubius+1))

# Print data
Tdata

##      bait color  Tdubius      y
## 1   FRT     B      18 1.2787536
## 2   FRT     B      12 1.1139434
## 3   FRT     B      22 1.3617278
## 4   FRT     B       6 0.8450980
## 5   FRT     W      12 1.1139434
## 6   FRT     W      15 1.2041200
## 7   FRT     W       7 0.9030900
## 8   FRT     W       4 0.6989700
## 9   IDT     B       0 0.0000000
## 10  IDT     B       2 0.4771213
## 11  IDT     B       1 0.3010300
## 12  IDT     B       4 0.6989700
## 13  IDT     W       2 0.4771213
## 14  IDT     W       1 0.3010300
## 15  IDT     W       2 0.4771213
## 16  IDT     W       0 0.0000000
## 17  IST     B       2 0.4771213
## 18  IST     B       2 0.4771213
## 19  IST     B      10 1.0413927
## 20  IST     B       7 0.9030900
## 21  IST     W       1 0.3010300
## 22  IST     W       4 0.6989700
## 23  IST     W      14 1.1760913
## 24  IST     W       4 0.6989700

# Graphics using ggplot2
ggplot(Tdata,aes(bait,y,group=color,color=color))+
geom_jitter(size=2,position=position_jitter(width=0.1))+
stat_summary(fun.y="mean",geom="line",size=1)+
stat_summary(fun.data="mean_cl_normal",geom="errorbar",width=0.2,size=1)

```



```
# MODEL WITH INTERACTION - USE THIS OUTPUT IF INTERACTION SIGNIFICANT
aovout <- aov(y~bait+color+bait:color,data=Tdata)
```

```
# ANOVA using Type I SS
anova(aovout)
```

```
## Analysis of Variance Table
```

```
##
```

```
## Response: y
```

```
##          Df Sum Sq Mean Sq F value    Pr(>F)
## bait       2  2.09509   1.04754   13.8522 0.0002279 ***
## color      1  0.03564   0.03564    0.4713 0.5011190
## bait:color  2  0.02828   0.01414    0.1870 0.8310728
## Residuals 18  1.36121   0.07562
```

```
## ---
```

```
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
# ANOVA using Type II SS
```

```
Anova(aovout)
```

```
## Anova Table (Type II tests)
```

```
##
```

```
## Response: y
```

```
##          Sum Sq Df F value    Pr(>F)
## bait       2.09509  2  13.8522 0.0002279 ***
## color      0.03564  1   0.4713 0.5011190
## bait:color 0.02828  2   0.1870 0.8310728
```

```
## Residuals 1.36121 18
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

# Calculate least squares means
emmeans(aovout,~bait:color)

##  bait color      emmean      SE df  lower.CL  upper.CL
##  FRT  B      1.1498807 0.1374979 18  0.86100834 1.4387531
##  IDT  B      0.3692803 0.1374979 18  0.08040795 0.6581527
##  IST  B      0.7246813 0.1374979 18  0.43580893 1.0135537
##  FRT  W      0.9800308 0.1374979 18  0.69115846 1.2689032
##  IDT  W      0.3138181 0.1374979 18  0.02494576 0.6026905
##  IST  W      0.7187653 0.1374979 18  0.42989295 1.0076377
##
## Confidence level used: 0.95

# Tests for simple effects
testInteractions(aovout,fixed="color",across="bait",adjustment="none")

## F Test:
## P-value adjustment method: none
##      bait1      bait2 Df Sum of Sq      F  Pr(>F)
## B      0.42520 -0.35540  2   1.22192 8.0791 0.003133 **
## W      0.26127 -0.40495  2   0.90144 5.9601 0.010322 *
## Residuals                18   1.36121
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

# MODEL WITHOUT INTERACTION - USE THIS OUTPUT IF INTERACTION NS
aovout_noint <- aov(y~bait+color,data=Tdata) # Model without interaction

# Type I SS
anova(aovout_noint)

## Analysis of Variance Table
##
## Response: y
##      Df Sum Sq Mean Sq F value    Pr(>F)
## bait      2 2.09509  1.04754 15.0782 0.0001016 ***
## color      1 0.03564  0.03564  0.5131 0.4820990
## Residuals 20 1.38948  0.06947
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

# Type II SS
Anova(aovout_noint)

## Anova Table (Type II tests)
##
## Response: y
##      Sum Sq Df F value    Pr(>F)
## bait      2.09509  2 15.0782 0.0001016 ***
## color      0.03564  1  0.5131 0.4820990
## Residuals 1.38948 20
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```

# Calculate least squares means
emmeans(aovout_noint,~bait)

## bait      emmean      SE df lower.CL upper.CL
## FRT  1.0649558 0.09318946 20 0.8705660 1.2593456
## IDT  0.3415492 0.09318946 20 0.1471594 0.5359390
## IST  0.7217233 0.09318946 20 0.5273335 0.9161131
##
## Results are averaged over the levels of: color
## Confidence level used: 0.95

emmeans(aovout_noint,~color)

## color      emmean      SE df lower.CL upper.CL
## B      0.7479474 0.07608888 20 0.5892288 0.9066661
## W      0.6708714 0.07608888 20 0.5121528 0.8295900
##
## Results are averaged over the levels of: bait
## Confidence level used: 0.95

# All pairwise comparisons - Tukey method
compout <- glht(aovout_noint,linfct=mcp(bait="Tukey"))
summary(compout)

##
## Simultaneous Tests for General Linear Hypotheses
##
## Multiple Comparisons of Means: Tukey Contrasts
##
##
## Fit: aov(formula = y ~ bait + color, data = Tdata)
##
## Linear Hypotheses:
##              Estimate Std. Error t value Pr(>|t|)
## IDT - FRT == 0  -0.7234      0.1318  -5.489  <0.001 ***
## IST - FRT == 0  -0.3432      0.1318  -2.604   0.0429 *
## IST - IDT == 0   0.3802      0.1318   2.885   0.0238 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## (Adjusted p values reported -- single-step method)

confint(compout)

##
## Simultaneous Confidence Intervals
##
## Multiple Comparisons of Means: Tukey Contrasts
##
##
## Fit: aov(formula = y ~ bait + color, data = Tdata)
##
## Quantile = 2.5313
## 95% family-wise confidence level
##
##
## Linear Hypotheses:

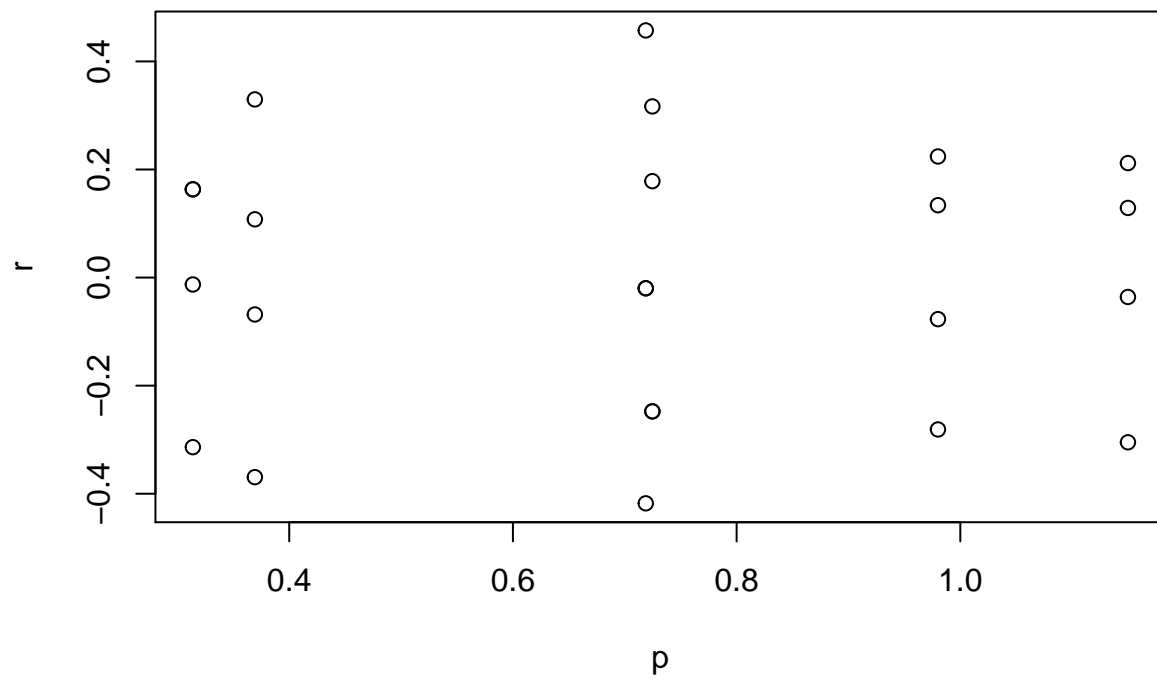
```

```
##           Estimate lwr      upr
## IDT - FRT == 0 -0.723407 -1.057008 -0.389806
## IST - FRT == 0 -0.343232 -0.676833 -0.009632
## IST - IDT == 0  0.380174  0.046573  0.713775
```

```
cld(compout)
```

```
## FRT IDT IST
## "c" "a" "b"
```

```
# Diagnostic plots to check ANOVA assumptions
p <- predict(aovout)
r <- resid(aovout)
plot(p,r)
```



```
qqnorm(r)
```

Normal Q-Q Plot

