

Tdubius__bait__color__new__unbalanced.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 W    12
FRT W    15
FRT W     7
FRT W     4
IDT B     2
IDT B     1
IDT B     4
IDT W     2
IDT W     1
IST B     2
IST B     2
IST B    10
IST B     7
IST W     4
")
```

```

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

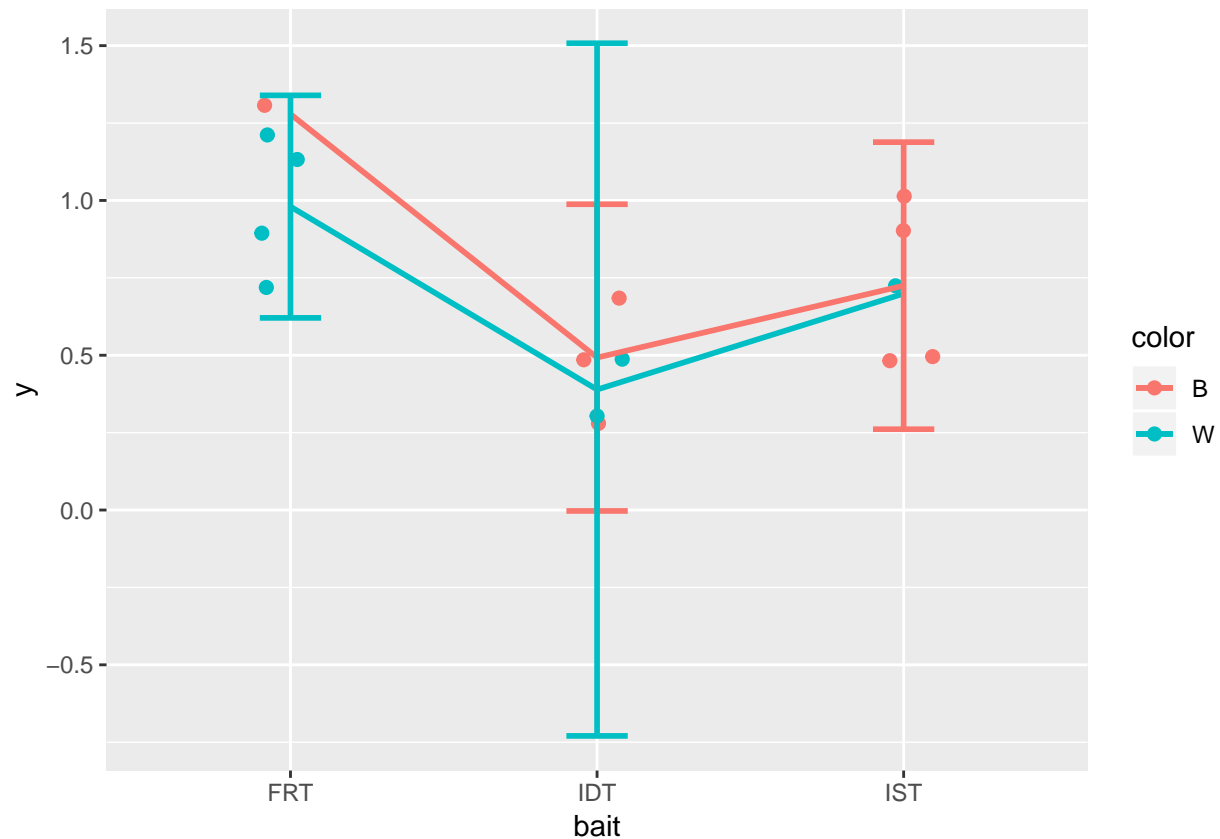
# Print data
Tdata

##      bait color Tdubius      y
## 1   FRT     B      18 1.2787536
## 2   FRT     W      12 1.1139434
## 3   FRT     W      15 1.2041200
## 4   FRT     W       7 0.9030900
## 5   FRT     W       4 0.6989700
## 6   IDT     B       2 0.4771213
## 7   IDT     B       1 0.3010300
## 8   IDT     B       4 0.6989700
## 9   IDT     W       2 0.4771213
## 10  IDT     W       1 0.3010300
## 11  IST     B       2 0.4771213
## 12  IST     B       2 0.4771213
## 13  IST     B      10 1.0413927
## 14  IST     B       7 0.9030900
## 15  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)

## Warning: Removed 2 rows containing missing values (geom_errorbar).

```



```
# 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  0.86871  0.43436   7.7748 0.01094 *
## color     1  0.05253  0.05253   0.9402 0.35756
## bait:color 2  0.03219  0.01610   0.2881 0.75632
## Residuals 9  0.50280  0.05587
```

```
## ---
```

```
## 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      0.90585  2   8.1072 0.009698 **
## color     0.05253  1   0.9402 0.357557
## bait:color 0.03219  2   0.2881 0.756323
```

```
## Residuals 0.50280 9
## ---
## 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      1.2787536 0.2363619  9 0.74406588 1.8134413
##  IDT  B      0.4923738 0.1364636  9 0.18367165 0.8010759
##  IST  B      0.7246813 0.1181809  9 0.45733743 0.9920252
##  FRT  W      0.9800308 0.1181809  9 0.71268697 1.2473747
##  IDT  W      0.3890756 0.1671331  9 0.01099431 0.7671569
##  IST  W      0.6989700 0.2363619  9 0.16428228 1.2336577
##
## 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      0.55407 -0.23231  2   0.46635 4.1737 0.05218 .
## W      0.28106 -0.30989  2   0.47170 4.2216 0.05091 .
## Residuals                9   0.50280
## ---
## 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 0.86871 0.43436  8.9307 0.004965 **
## color      1 0.05253 0.05253  1.0800 0.321001
## Residuals 11 0.53500 0.04864
## ---
## 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      0.90585  2  9.3125 0.004301 **
## color      0.05253  1  1.0800 0.321001
## Residuals 0.53500 11
## ---
## 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  1.0808652 0.10625686 11 0.8469954 1.3147350
## IDT  0.4373579 0.09950336 11 0.2183525 0.6563633
## IST  0.6784492 0.10625686 11 0.4445794 0.9123190
##
## 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      0.8007071 0.08381654 11 0.6162282 0.9851861
## W      0.6637411 0.09046112 11 0.4646375 0.8628447
##
## 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  -0.6435      0.1491  -4.316 0.00343 **
## IST - FRT == 0  -0.4024      0.1603  -2.510 0.06883 .
## IST - IDT == 0   0.2411      0.1419   1.698 0.24842
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## (Adjusted p values reported -- single-step method)
```

```
confint(compout)
```

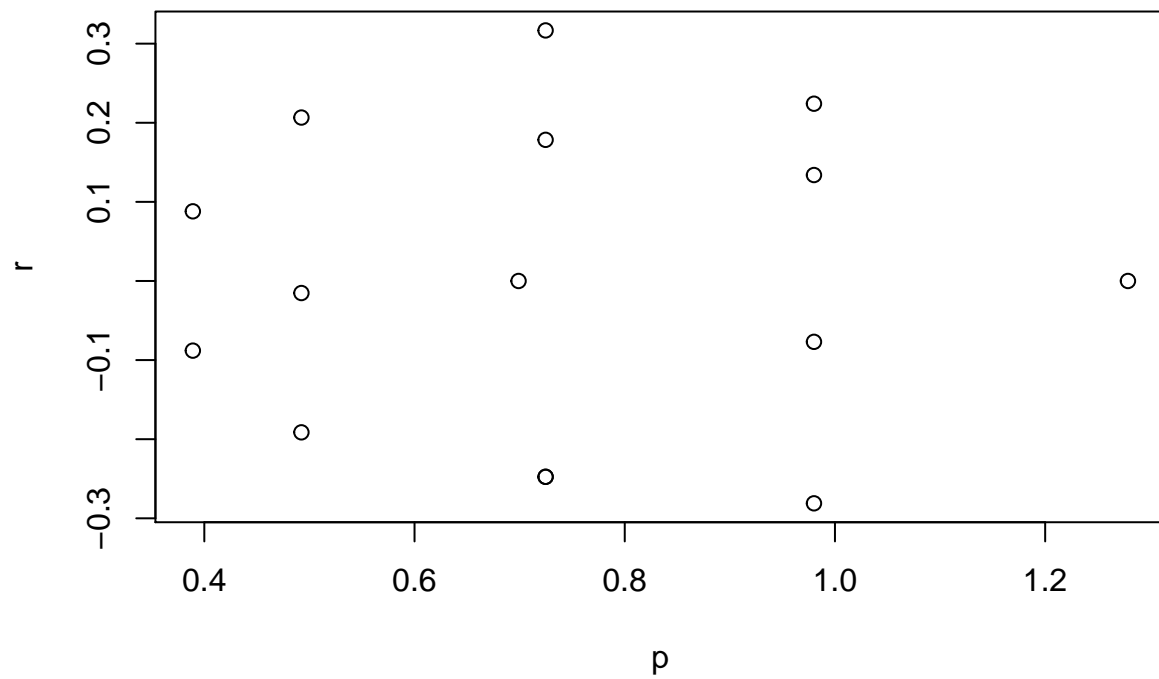
```
##
## Simultaneous Confidence Intervals
##
## Multiple Comparisons of Means: Tukey Contrasts
##
##
## Fit: aov(formula = y ~ bait + color, data = Tdata)
##
## Quantile = 2.6976
## 95% family-wise confidence level
##
##
## Linear Hypotheses:
```

```
##           Estimate lwr    upr
## IDT - FRT == 0 -0.6435 -1.0457 -0.2413
## IST - FRT == 0 -0.4024 -0.8349  0.0301
## IST - IDT == 0  0.2411 -0.1418  0.6240
```

```
cld(compout)
```

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

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



```
qqnorm(r)
```

Normal Q-Q Plot

