PSYC 7720 Lab

Lab 10 Activity

Andrew Graves, Department of Psychology, University of Virginia

Directions:

A. Download the angle_noise_data.csv. This is a two-factor within subjects design with two levels of the noise factor and three levels of the angle factor. In the data, abs represents the condition where noise is absent and pres represents where noise is present. The 0, 4, and 8 denote the three different angle conditions. The measurements in each cell are aggregated reaction times.
B. Answer the following questions and save the code you used in an R script.
C. You have until the end of lab to complete.

```
library(tidyverse)
library(ez)
library(emmeans)
options(contrasts = c("contr.sum","contr.poly"))
theme_set(theme_classic())
```

Questions:

1. Convert the angle_noise_data from wide format to long format. Name the first column *id*, the second column *noise*, the third column *angle*, the fourth column *rt*, and the dataframe *long_data*. Print the head and the dimensions of the long data.

```
long_data <- read.csv("angle_noise_data.csv") %>%
  rownames_to_column(var = "id") %>%
  pivot_longer(-id,
               names_to = "ws", values_to = "rt") %>%
  separate(ws, into = c("noise", "angle"), sep = -1,
           remove = TRUE) %>%
  mutate_if(is_character, factor) %>%
  mutate(angle = factor(angle, ordered = TRUE))
head(long_data)
```

```
## # A tibble: 6 x 4
##   id    noise angle    rt
##   <fct> <fct> <ord> <int>
## 1 1     abs   0       420
## 2 1     abs   4       420
## 3 1     abs   8       480
## 4 1     pres  0       480
## 5 1     pres  4       600
## 6 1     pres  8       780
```

```
dim(long_data)
```

```
## [1] 60  4
```

2. Ensure that the within-subjects conditions are appropriately implemented as qualitative and/or quantitative factors. Print the appropriate structure of *long_data* using str().

```r
str(long_data)
```

```
## Classes 'tbl_df', 'tbl' and 'data.frame':    60 obs. of  4 variables:
##  $ id   : Factor w/ 10 levels "1","10","2","3",..: 1 1 1 1 1 1 3 3 3 3 ...
##  $ noise: Factor w/ 2 levels "abs","pres": 1 1 1 2 2 2 1 1 1 2 ...
##  $ angle: Ord.factor w/ 3 levels "0"<"4"<"8": 1 2 3 1 2 3 1 2 3 1 ...
##  $ rt   : int  420 420 480 480 600 780 420 480 480 360 ...
```

3. Run and interpret the results of the two-way factorial RM ANOVA using aov.

```r
aov_mod <- aov(rt ~ noise * angle + Error(id/(noise * angle)), data = long_data)
summary(aov_mod)
```

```
##
## Error: id
##           Df Sum Sq Mean Sq F value Pr(>F)
## Residuals  9 292140   32460
##
## Error: id:noise
##           Df Sum Sq Mean Sq F value   Pr(>F)
## noise      1 285660  285660   33.77 0.000256 ***
## Residuals  9  76140    8460
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Error: id:angle
##           Df Sum Sq Mean Sq F value   Pr(>F)
## angle      2 289920  144960   40.72 2.09e-07 ***
## Residuals 18  64080    3560
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Error: id:noise:angle
##             Df Sum Sq Mean Sq F value   Pr(>F)
## noise:angle  2 105120   52560   45.31 9.42e-08 ***
## Residuals   18  20880    1160
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

4. Run and interpret the results of the two-way factorial RM ANOVA using ezANOVA.

```r
 ez_mod <- ezANOVA(data = long_data,
                  dv = rt,
                  within = .(angle, noise),
                  wid = id,
                  return_aov = TRUE,
                  detailed = TRUE
       )
ez_mod
```

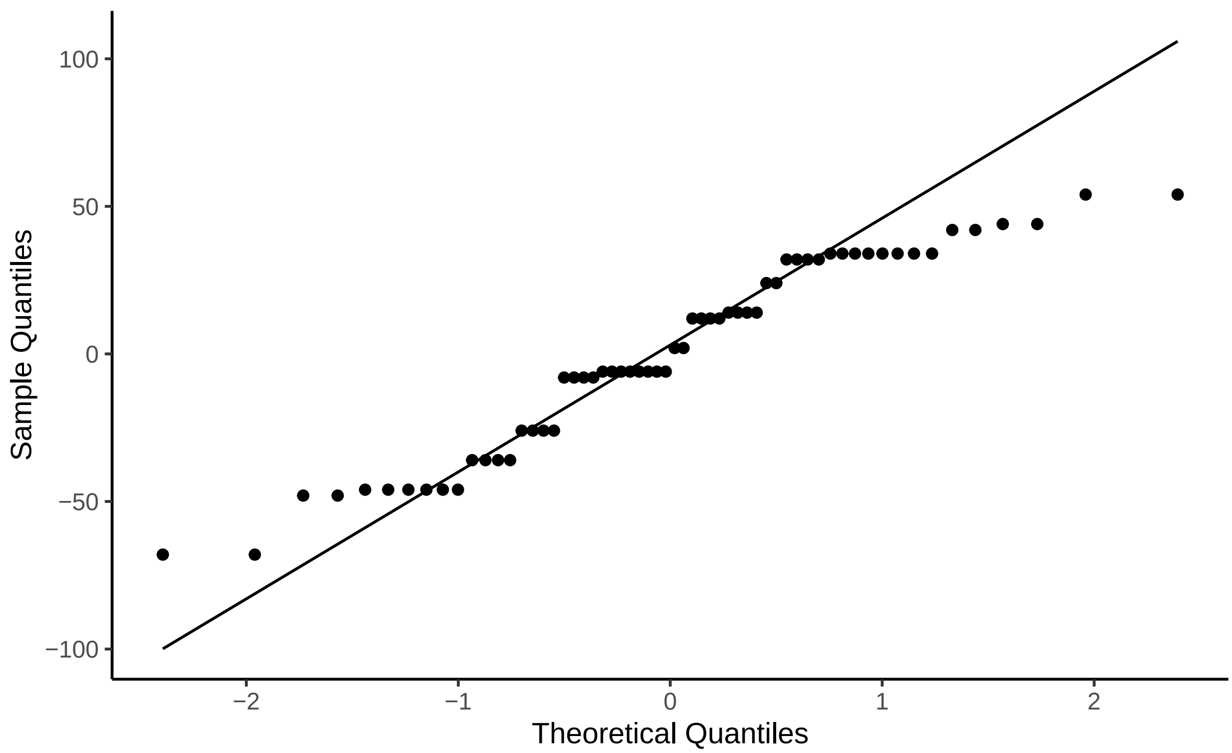
```
## $ANOVA
##        Effect DFn DFd      SSn    SSd         F            p p<.05       ges
## 1 (Intercept)   1   9 19425660 292140 598.44917 1.526600e-09     * 0.9771999
```

```
## 2       angle   2  18   289920  64080  40.71910 2.086763e-07     * 0.3901179
## 3       noise   1   9   285660  76140  33.76596 2.559737e-04     * 0.3866017
## 4 angle:noise   2  18   105120  20880  45.31034 9.424093e-08     * 0.1882656
##
## $`Mauchly's Test for Sphericity`
##        Effect         W         p p<.05
## 2       angle 0.9601060 0.8497219
## 4 angle:noise 0.8937772 0.6381418
##
## $`Sphericity Corrections`
##        Effect       GGe        p[GG] p[GG]<.05      HFe        p[HF] p[HF]<.05
## 2       angle 0.9616365 3.401705e-07         * 1.217564 2.086763e-07         *
## 4 angle:noise 0.9039771 3.453931e-07         * 1.117870 9.424093e-08         *
##
## $aov
##
## Call:
## aov(formula = formula(aov_formula), data = data)
##
## Grand Mean: 569
##
## Stratum 1: id
##
## Terms:
##                 Residuals
## Sum of Squares     292140
## Deg. of Freedom         9
##
## Residual standard error: 180.1666
##
## Stratum 2: id:angle
##
## Terms:
##                  angle Residuals
## Sum of Squares  289920     64080
## Deg. of Freedom      2        18
##
## Residual standard error: 59.66574
## Estimated effects are balanced
##
## Stratum 3: id:noise
##
## Terms:
##                  noise Residuals
## Sum of Squares  285660     76140
## Deg. of Freedom      1         9
##
## Residual standard error: 91.97826
## Estimated effects are balanced
##
## Stratum 4: id:angle:noise
##
## Terms:
##                 angle:noise Residuals
```

```
## Sum of Squares       105120     20880
## Deg. of Freedom           2        18
##
## Residual standard error: 34.05877
## Estimated effects are balanced
```

```
# Check the residuals for normality
resid <- proj(ez_mod$aov)[[3]][, "Residuals"]

resid %>%
  tibble() %>%
  ggplot(aes(sample = `.`)) +
  geom_qq() +
  stat_qq_line() +
  labs(x = "Theoretical Quantiles",
       y = "Sample Quantiles")
```

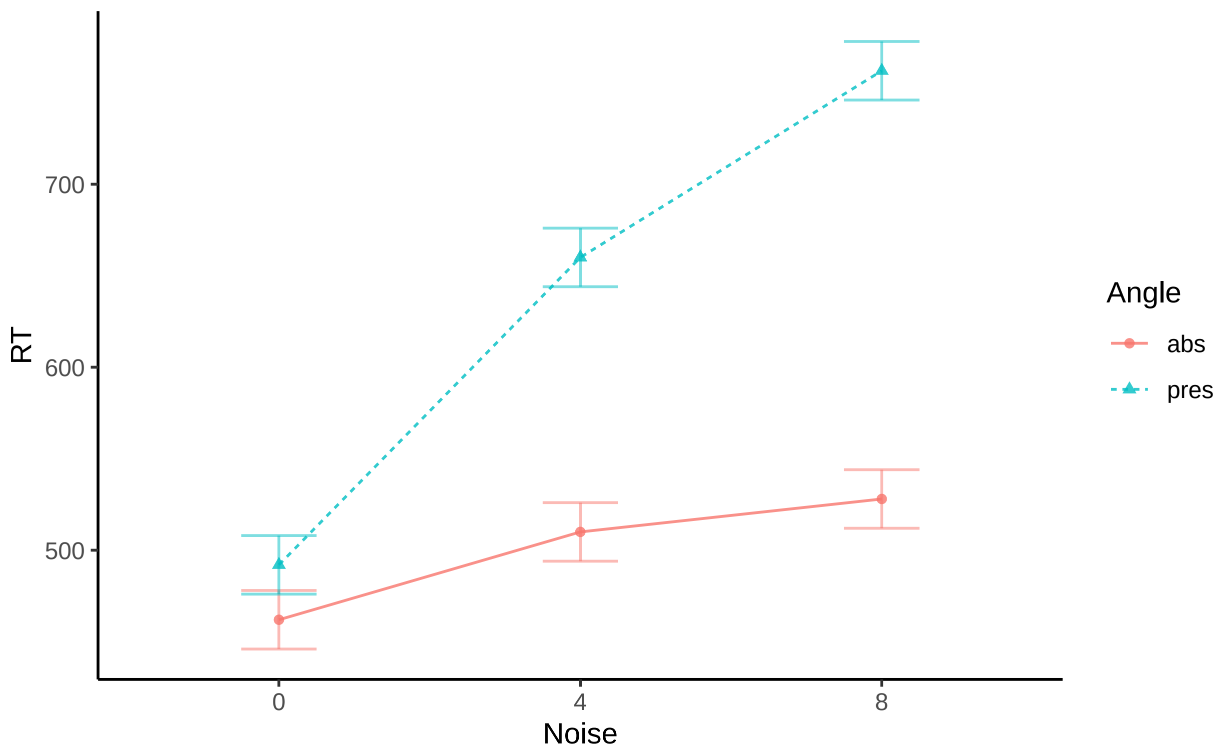



```
# Interaction is significant... here we are
# testing the effect of noise within each
# level of angle. You could also test the
# effect of noise at each angle as a
# follow-up for this interaction.
follow_up <- contrast(
  emmeans(ez_mod$aov, ~ noise|angle),
          method = "trt.vs.ctrl",
          adjust = "bonferroni"
  )
follow_up
```

```
## angle = 0:
```

```
##   contrast   estimate   SE   df t.ratio p.value
##   pres - abs       30 26.8 14.1 1.119   0.2818
##
## angle = 4:
##   contrast   estimate   SE   df t.ratio p.value
##   pres - abs      150 26.8 14.1 5.595   0.0001
##
## angle = 8:
##   contrast   estimate   SE   df t.ratio p.value
##   pres - abs      234 26.8 14.1 8.729   <.0001
```

```r
ez_plot <- ezPlot(
  data = long_data,
  dv = rt,
  wid = id,
  within = .(angle, noise),
  x = angle,
  split = noise,
  x_lab = "Noise",
  split_lab = "Angle",
  y_lab = "RT"
  )
ez_plot
```



- There was a significant two-way interaction between *noise* and *angle* on *rt*. Following up this interaction, it seems that the contrasts between the two noise conditions is not significant when *angle* is 0, but is significant when *angle* is 4 and 8. Another way to interpet this interaction is that there is a stronger positive linear trend when *noise* is present relative to when it is absent.