Exercise06

Ken Suzuki

2023-12-10

Conditions & Background:

This exercise will use the dataset 'disgusting_scale.csv', available on eClass. The main outcome variables are **scores on the Disgust Scale Revised**. This scale contains three factors:

1. **The 'Core Disgust', a mechanism which elevates awareness about disease.**
2. **The 'Animal Reminder', a mechanism which elevates awareness to human animalistic nature.**
3. **The 'ContaminationBased Disgust', which contains items related to dangers of contamination. There is also a 'General Disgust Score' across all items.**

Use a = .05 for both questions.

Tasks

```
d <- read.csv("~/Desktop/P4330/P4330 R code/Exercise06/Multiplicity Control/disgust_scale.csv") #disgus
names(d)
```

Conduct a general linear model to explore the effects of age (Age) and education (Educ) on the general disgust score (Mean_general_ds). Note: use the categorical version of education (Educ) for this question.

```
## [1] "Age"                 "Gender"              "Education"
## [4] "Educ"                "Political"           "Mean_Animal_reminder"
## [7] "Mean_Contamination"  "Mean_core"           "Mean_general_ds"
```

```
head(d)
```

```
##   Age Gender Education      Educ Political Mean_Animal_reminder
## 1  38   male        13        HS    center                3.000
## 2  55   male        15 Coll_Univ     right                2.625
## 3  62   male        15 Coll_Univ     right                1.750
## 4  67   male        14        HS    center                2.250
## 5  28   male        15 Coll_Univ    center                1.250
## 6  23 female        15 Coll_Univ    center                3.125
##   Mean_Contamination Mean_core Mean_general_ds
```

```
## 1               3.25  2.727273        2.913043
## 2               1.25  2.363636        2.260870
## 3               3.25  3.000000        2.608696
## 4               3.50  2.636364        2.652174
## 5               0.50  1.272727        1.130435
## 6               3.00  3.090909        3.086957
```

```
library(emmeans)

m <- lm(Mean_general_ds ~ Educ + Age, data = d)
summary(m)
```

```
##
## Call:
## lm(formula = Mean_general_ds ~ Educ + Age, data = d)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -2.13086 -0.37647  0.03326  0.41392  2.81955
##
## Coefficients:
##                Estimate Std. Error t value Pr(>|t|)
## (Intercept)    2.508394   0.050678  49.496  < 2e-16 ***
## EducGrad_Prof -0.122873   0.046758  -2.628  0.00869 **
## EducHS        -0.002431   0.034740  -0.070  0.94423
## EducLess_HS   -0.028084   0.103875  -0.270  0.78692
## Age           -0.003685   0.001271  -2.899  0.00381 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.5804 on 1409 degrees of freedom
##   (184 observations deleted due to missingness)
## Multiple R-squared:  0.01408,    Adjusted R-squared:  0.01128
## F-statistic: 5.031 on 4 and 1409 DF,  p-value: 0.0005008
```

```
mns <- emmeans(m, "Educ")
pairs(mns, adjust="none")
```

Conduct all pairwise comparisons for education using each of the following methods: a) No multiplicity control; b) Bonferroni familywise error control; c) Benjamini- Hochberg false discovery rate control. Summarize which effects are statistically significant with each method.

```
##  contrast              estimate     SE   df t.ratio p.value
##  Coll_Univ - Grad_Prof  0.12287 0.0468 1409   2.628  0.0087
##  Coll_Univ - HS         0.00243 0.0347 1409   0.070  0.9442
##  Coll_Univ - Less_HS    0.02808 0.1039 1409   0.270  0.7869
##  Grad_Prof - HS        -0.12044 0.0479 1409  -2.513  0.0121
##  Grad_Prof - Less_HS   -0.09479 0.1087 1409  -0.872  0.3833
##  HS - Less_HS           0.02565 0.1041 1409   0.247  0.8053
```

Bonferroni

```
pairs(mns, adjust="bonferroni")
```

```
##  contrast              estimate     SE   df t.ratio p.value
##  Coll_Univ - Grad_Prof  0.12287 0.0468 1409   2.628  0.0521
##  Coll_Univ - HS         0.00243 0.0347 1409   0.070  1.0000
##  Coll_Univ - Less_HS    0.02808 0.1039 1409   0.270  1.0000
##  Grad_Prof - HS        -0.12044 0.0479 1409  -2.513  0.0724
##  Grad_Prof - Less_HS   -0.09479 0.1087 1409  -0.872  1.0000
##  HS - Less_HS           0.02565 0.1041 1409   0.247  1.0000
##
## P value adjustment: bonferroni method for 6 tests
```

f

```
pairs(mns, adjust="fdr")
```

```
##  contrast              estimate     SE   df t.ratio p.value
##  Coll_Univ - Grad_Prof  0.12287 0.0468 1409   2.628  0.0362
##  Coll_Univ - HS         0.00243 0.0347 1409   0.070  0.9442
##  Coll_Univ - Less_HS    0.02808 0.1039 1409   0.270  0.9442
##  Grad_Prof - HS        -0.12044 0.0479 1409  -2.513  0.0362
##  Grad_Prof - Less_HS   -0.09479 0.1087 1409  -0.872  0.7666
##  HS - Less_HS           0.02565 0.1041 1409   0.247  0.9442
##
## P value adjustment: fdr method for 6 tests
```

Conduct a general linear model to explore the effects age (Age), gender (Gender), and education (Education) on each of the factors of the Disgust Scale (Mean_Animal_reminder, Mean_core, Mean_Contamination). Note: use the continuous version of education (Education) for this question.

```
# Build each model

m2 <- lm(Mean_Animal_reminder ~ Age + Gender + Education,
         data = d)
summary(m2)
```

1. The 'Core Disgust' - a mechanism which elevates awareness about disease.

```
##
## Call:
## lm(formula = Mean_Animal_reminder ~ Age + Gender + Education,
##     data = d)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
```

```
## -2.48996 -0.46131  0.07016  0.51004  1.96809
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)  3.292062   0.119346  27.584  < 2e-16 ***
## Age         -0.005238   0.001518  -3.451 0.000574 ***
## Gendermale  -0.381840   0.037248 -10.251  < 2e-16 ***
## Education   -0.035712   0.008255  -4.326 1.63e-05 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.6951 on 1410 degrees of freedom
##   (184 observations deleted due to missingness)
## Multiple R-squared:  0.09569,    Adjusted R-squared:  0.09377
## F-statistic: 49.73 on 3 and 1410 DF,  p-value: < 2.2e-16
```

```r
# Build each model
m3 <- lm(Mean_Contamination ~ Age + Gender + Education,
         data = d)
summary(m3)
```

2. The 'Animal Reminder'- a mechanism which elevates awareness to human animalistic nature.

```
##
## Call:
## lm(formula = Mean_Contamination ~ Age + Gender + Education, data = d)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -2.4024 -0.5463  0.0017  0.5260 10.9865
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)  2.314028   0.148590  15.573  < 2e-16 ***
## Age          0.007905   0.001890   4.183 3.05e-05 ***
## Gendermale  -0.428499   0.046375  -9.240  < 2e-16 ***
## Education   -0.019180   0.010278  -1.866   0.0622 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.8655 on 1410 degrees of freedom
##   (184 observations deleted due to missingness)
## Multiple R-squared:  0.06447,    Adjusted R-squared:  0.06247
## F-statistic: 32.39 on 3 and 1410 DF,  p-value: < 2.2e-16
```

```r
# Build each model
m4 <- lm(Mean_core ~ Age + Gender + Education,
```

```
   data = d)
summary(m4)
```

3. The 'ContaminationBased Disgust'- which contains items related to dangers of contamination. There is also a 'General Disgust Score' across all items.

```
##
## Call:
## lm(formula = Mean_core ~ Age + Gender + Education, data = d)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -2.09411 -0.36709  0.02362  0.41472  2.92583
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)  2.979395   0.100247  29.721   <2e-16 ***
## Age         -0.003128   0.001275  -2.454   0.0143 *
## Gendermale  -0.452125   0.031287 -14.451   <2e-16 ***
## Education   -0.017519   0.006934  -2.527   0.0116 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.5839 on 1410 degrees of freedom
##   (184 observations deleted due to missingness)
## Multiple R-squared:  0.1403, Adjusted R-squared:  0.1385
## F-statistic: 76.71 on 3 and 1410 DF,  p-value: < 2.2e-16
```

```
pvals<-c(summary(m2)$coefficients[2:4,4],
         summary(m3)$coefficients[2:4,4],
         summary(m4)$coefficients[2:4,4])
pvals
```

Treat the full collection of hypotheses as a single family (i.e., each of the three predictors across each of the three outcome variables - 9 total hypothesis tests).

```
##          Age   Gendermale    Education          Age   Gendermale    Education
## 5.742973e-04 7.829720e-24 1.625427e-05 3.048290e-05 8.809209e-20 6.222600e-02
##          Age   Gendermale    Education
## 1.425345e-02 3.046831e-44 1.162621e-02
```

```
names(pvals) <- c("age_ar", "gender_ar", "educ_ar",
                  "age_con", "gender_con", "educ_con",
                  "age_cor", "gender_cor", "educ_cor")
```

Assess the statistical significance of each hypothesis using each of the following methods:

```
p.adjust(pvals, method = "none")
```

a) No multiplicity control;

```
##       age_ar    gender_ar      educ_ar      age_con   gender_con     educ_con
## 5.742973e-04 7.829720e-24 1.625427e-05 3.048290e-05 8.809209e-20 6.222600e-02
##      age_cor   gender_cor     educ_cor
## 1.425345e-02 3.046831e-44 1.162621e-02
```

```
p.adjust(pvals, method = "bonferroni")
```

b) Bonferroni familywise error control;

```
##       age_ar    gender_ar      educ_ar      age_con   gender_con     educ_con
## 5.168675e-03 7.046748e-23 1.462884e-04 2.743461e-04 7.928288e-19 5.600340e-01
##      age_cor   gender_cor     educ_cor
## 1.282811e-01 2.742148e-43 1.046359e-01
```

```
p.adjust(pvals, method = "holm")
```

c) Holm familywise error control;

```
##       age_ar    gender_ar      educ_ar      age_con   gender_con     educ_con
## 2.297189e-03 6.263776e-23 9.752561e-05 1.524145e-04 6.166446e-19 6.222600e-02
##      age_cor   gender_cor     educ_cor
## 3.487863e-02 2.742148e-43 3.487863e-02
```

```
p.adjust(pvals, method = "fdr")
```

d) BenjaminiHochberg false discovery rate control. Summarize which effects are statistically significant with each method.

```
##       age_ar    gender_ar      educ_ar      age_con   gender_con     educ_con
## 8.614459e-04 3.523374e-23 3.657210e-05 5.486922e-05 2.642763e-19 6.222600e-02
##      age_cor   gender_cor     educ_cor
## 1.603514e-02 2.742148e-43 1.494799e-02
```