PSY308d.DA2

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At a recent school board meeting, concerns were raised about alcohol, cigarette, and marijuana use among local high school students. After a heated discussion, two extreme views about alcohol and drugs emerged: a strict view and a lenient view. Advocates of the strict view called for a no tolerance policy because they believe that use of one substance will lead to use of other substances. For example, in their view, students who drink are also more likely to smoke cigarettes and use marijuana. Advocates of the lenient view disagreed and don't believe that the use of alcohol is related to the use of cigarettes or marijuana (or that the use of cigarettes is related to the use of marijuana).

So, the board designed a survey and asked high school seniors whether they had ever used alcohol, cigarettes, or marijuana.

The board has tasked you to examine the research questions below. They are interested in publishing what you find so they ask that you write up the results and discussion section to look at a sample of the report.

Research Questions to Investigate: *RQ1:* Investigation of three relationships proposed: (a) Is there a relationship between alcohol use and cigarette use? (b) Is there a relationship between alcohol use and marijuana use? (c) Is there a relationship between cigarette use and marijuana use?

RQ2: Is there statistical support for the strict view (students who drink are also more likely to smoke cigarettes and use marijuana) and/or the lenient view (use of alcohol is NOT related to the use of cigarettes or marijuana + use of cigarettes is NOT related to the use of marijuana)?

RQ3: Which model best explains the results? (This can be strict view, lenient view, or a view in between the two)?

Please report all relevant statistics per APA format and write for a professional audience.

```
#Load in your data
AMCtable <- array(data = c(911, 44, 538, 456, 3, 2, 43, 279),
                  dim = c(2,2,2),
                  dimnames = list("cigarette" = c("yes","no"),
                                  "marijuana" = c("yes","no"),
                                  "alcohol" = c("yes","no")))

dat <- as.data.frame(as.table(AMCtable))
dat
```

```
##   cigarette marijuana alcohol Freq
## 1       yes       yes     yes  911
## 2        no       yes     yes   44
## 3       yes        no     yes  538
## 4        no        no     yes  456
## 5       yes       yes      no    3
## 6        no       yes      no    2
## 7       yes        no      no   43
## 8        no        no      no  279
```

Load libraries

```
library(pacman)
p_load(vcd, vcdExtra, MASS, jmv)
```

Transform data

```
# in order to run jmv analyses, must change contingency table to case form
dat.case <- vcdExtra::expand.dft(dat)
dim(dat)
```

```
## [1] 8 4
```

```
class(dat)
```

```
## [1] "data.frame"
```

```
dim(dat.case)
```

```
## [1] 2276    3
```

```
class(dat.case)
```

```
## [1] "data.frame"
```

Frequency analysis Assumptions

```
# 2x2x2 table
# independence of observations assumption met
# adequate expected cell counts assumption met
desc <- jmv::descriptives(data = dat.case,
                     vars = c('cigarette', 'marijuana', 'alcohol'),
                     freq = TRUE)
desc
```

```
##
##  DESCRIPTIVES
##
##  Descriptives
##  ------------------------------------------------
##                cigarette    marijuana    alcohol
##  ------------------------------------------------
##    N                2276         2276       2276
##    Missing             0            0          0
##    Mean
##    Median
##    Minimum
##    Maximum
##  ------------------------------------------------
##
##
##  FREQUENCIES
##
##  Frequencies of cigarette
##  ------------------------------------------------------
##    Levels    Counts    % of Total    Cumulative %
##  ------------------------------------------------------
##    no           781          34.3            34.3
##    yes         1495          65.7           100.0
##  ------------------------------------------------------
##
##
##  Frequencies of marijuana
##  ------------------------------------------------------
```

```
##    Levels    Counts    % of Total    Cumulative %
##  ---------------------------------------------------
##    no          1316          57.8            57.8
##    yes          960          42.2           100.0
##  ---------------------------------------------------
##
##
##  Frequencies of alcohol
##  ---------------------------------------------------
##    Levels    Counts    % of Total    Cumulative %
##  ---------------------------------------------------
##    no           327          14.4            14.4
##    yes         1949          85.6           100.0
##  ---------------------------------------------------
```

RQ1: Tests of Independence (a) Is there a relationship between alcohol use and cigarette use? YES

```
jmv::contTables(dat = dat.case,
                rows = 'alcohol',
                cols = 'cigarette',
                exp = TRUE,
                phiCra = TRUE)
```

```
##
##  CONTINGENCY TABLES
##
##  Contingency Tables
##  ---------------------------------------------
##    alcohol                no     yes     Total
##  ---------------------------------------------
##    no          Observed    281      46      327
##                Expected    112     215
##
##    yes         Observed    500    1449     1949
##                Expected    669    1280
##
##    Total       Observed    781    1495     2276
##                Expected    781    1495
##  ---------------------------------------------
##
##
##  <U+03C7>² Tests
##  ------------------------------
##           Value    df    p
##  ------------------------------
##    <U+03C7>²      451     1    < .001
##    N      2276
##  ------------------------------
##
##
##  Nominal
##  ---------------------------
##                       Value
##  ---------------------------
##    Phi-coefficient    0.445
```

```
##    Cramer's V         0.445
##  ----------------------------
```

(b) Is there a relationship between alcohol use and marijuana use? YES

```
jmv::contTables(dat = dat.case,
                rows = 'alcohol',
                cols = 'marijuana',
                exp = TRUE,
                phiCra = TRUE)
```

```
##
##  CONTINGENCY TABLES
##
##  Contingency Tables
##  ---------------------------------------------
##    alcohol                no      yes    Total
##  ---------------------------------------------
##    no         Observed     322       5      327
##               Expected     189    138
##
##    yes        Observed     994    955     1949
##               Expected    1127    822
##
##    Total      Observed    1316    960     2276
##               Expected    1316    960
##  ---------------------------------------------
##
##
##  <U+03C7>² Tests
##  ------------------------------
##          Value    df    p
##  ------------------------------
##    <U+03C7>²      259     1    < .001
##    N      2276
##  ------------------------------
##
##
##  Nominal
##  ----------------------------
##                       Value
##  ----------------------------
##    Phi-coefficient    0.337
##    Cramer's V         0.337
##  ----------------------------
```

(c) Is there a relationship between cigarette use and marijuana use? YES

```
jmv::contTables(dat = dat.case,
                rows = 'cigarette',
                cols = 'marijuana',
                exp = TRUE,
                phiCra = TRUE)
```

```
##
##  CONTINGENCY TABLES
```

```
##
##  Contingency Tables
##  ---------------------------------------------------
##    cigarette                no      yes    Total
##  ---------------------------------------------------
##    no           Observed     735     46      781
##                 Expected     452    329
##
##    yes          Observed     581    914     1495
##                 Expected     864    631
##
##    Total        Observed    1316    960     2276
##                 Expected    1316    960
##  ---------------------------------------------------
##
##
##  <U+03C7>² Tests
##  -------------------------------
##          Value    df    p
##  -------------------------------
##    <U+03C7>²      642     1    < .001
##    N      2276
##  -------------------------------
##
##
##  Nominal
##  ---------------------------
##                       Value
##  ---------------------------
##    Phi-coefficient    0.531
##    Cramer's V         0.531
##  ---------------------------
```

RQ2: Is there statistical support for the strict view (loglinear model of three-way relationship is a good fit) and/or the lenient view (loglinear model of all two way relationships not a good fit)?

Model1: null model - H0: all variables are orthogonal - NO

```
# Null hypothesis means that expected frequencies satisfy our model of expected values
# Alternative Hypothesis means that difference between expected and observed frequencies is significant

# Observed = mytable
mytable<- xtabs(dat$Freq ~ dat$cigarette + dat$marijuana + dat$alcohol) # table of observed values
mytable
```

```
## , , dat$alcohol = yes
##
##              dat$marijuana
## dat$cigarette yes  no
##           yes 911 538
##           no   44 456
##
## , , dat$alcohol = no
##
##              dat$marijuana
## dat$cigarette yes  no
```

```
##           yes   3  43
##           no    2 279
```

```
# Expected = loglm
model1 <- loglm(~dat$cigarette + dat$marijuana + dat$alcohol, mytable)
summary(model1)
```

```
## Formula:
## ~dat$cigarette + dat$marijuana + dat$alcohol
## attr(,"variables")
## list(dat$cigarette, dat$marijuana, dat$alcohol)
## attr(,"factors")
##               dat$cigarette dat$marijuana dat$alcohol
## dat$cigarette             1             0           0
## dat$marijuana             0             1           0
## dat$alcohol               0             0           1
## attr(,"term.labels")
## [1] "dat$cigarette" "dat$marijuana" "dat$alcohol"
## attr(,"order")
## [1] 1 1 1
## attr(,"intercept")
## [1] 1
## attr(,"response")
## [1] 0
## attr(,".Environment")
## <environment: R_GlobalEnv>
##
## Statistics:
##                       X^2 df P(> X^2)
## Likelihood Ratio 1286.020  4        0
## Pearson          1411.386  4        0
```

Model 2: H0: *Each two-way* relationship in pairs are best model fit - NO

```
model2a<- loglm(~dat$alcohol*dat$cigarette + dat$alcohol*dat$marijuana, mytable)
summary(model2a)
```

```
## Formula:
## ~dat$alcohol * dat$cigarette + dat$alcohol * dat$marijuana
## attr(,"variables")
## list(dat$alcohol, dat$cigarette, dat$marijuana)
## attr(,"factors")
##               dat$alcohol dat$cigarette dat$marijuana
## dat$alcohol             1             0             0
## dat$cigarette           0             1             0
## dat$marijuana           0             0             1
##               dat$alcohol:dat$cigarette dat$alcohol:dat$marijuana
## dat$alcohol                           1                         1
## dat$cigarette                         1                         0
## dat$marijuana                         0                         1
## attr(,"term.labels")
## [1] "dat$alcohol"               "dat$cigarette"
## [3] "dat$marijuana"             "dat$alcohol:dat$cigarette"
## [5] "dat$alcohol:dat$marijuana"
## attr(,"order")
## [1] 1 1 1 2 2
```

```
## attr(,"intercept")
## [1] 1
## attr(,"response")
## [1] 0
## attr(,".Environment")
## <environment: R_GlobalEnv>
##
## Statistics:
##                       X^2 df P(> X^2)
## Likelihood Ratio 497.3693  2        0
## Pearson          443.7611  2        0
```

```
model2b<- loglm(~dat$alcohol*dat$cigarette + dat$cigarette*dat$marijuana, mytable) # - lowest chi-squar
summary(model2b)
```

```
## Formula:
## ~dat$alcohol * dat$cigarette + dat$cigarette * dat$marijuana
## attr(,"variables")
## list(dat$alcohol, dat$cigarette, dat$marijuana)
## attr(,"factors")
##               dat$alcohol dat$cigarette dat$marijuana
## dat$alcohol             1             0             0
## dat$cigarette           0             1             0
## dat$marijuana           0             0             1
##               dat$alcohol:dat$cigarette dat$cigarette:dat$marijuana
## dat$alcohol                           1                           0
## dat$cigarette                         1                           1
## dat$marijuana                         0                           1
## attr(,"term.labels")
## [1] "dat$alcohol"                 "dat$cigarette"
## [3] "dat$marijuana"               "dat$alcohol:dat$cigarette"
## [5] "dat$cigarette:dat$marijuana"
## attr(,"order")
## [1] 1 1 1 2 2
## attr(,"intercept")
## [1] 1
## attr(,"response")
## [1] 0
## attr(,".Environment")
## <environment: R_GlobalEnv>
##
## Statistics:
##                       X^2 df P(> X^2)
## Likelihood Ratio 92.01836  2        0
## Pearson          80.81482  2        0
```

```
model2c<- loglm(~dat$alcohol*dat$marijuana + dat$cigarette*dat$marijuana, mytable)
summary(model2c)
```

```
## Formula:
## ~dat$alcohol * dat$marijuana + dat$cigarette * dat$marijuana
## attr(,"variables")
## list(dat$alcohol, dat$marijuana, dat$cigarette)
## attr(,"factors")
##               dat$alcohol dat$marijuana dat$cigarette
```

```
## dat$alcohol             1             0             0
## dat$marijuana           0             1             0
## dat$cigarette           0             0             1
##               dat$alcohol:dat$marijuana dat$marijuana:dat$cigarette
## dat$alcohol                           1                           0
## dat$marijuana                         1                           1
## dat$cigarette                         0                           1
## attr(,"term.labels")
## [1] "dat$alcohol"                 "dat$marijuana"
## [3] "dat$cigarette"               "dat$alcohol:dat$marijuana"
## [5] "dat$marijuana:dat$cigarette"
## attr(,"order")
## [1] 1 1 1 2 2
## attr(,"intercept")
## [1] 1
## attr(,"response")
## [1] 0
## attr(,".Environment")
## <environment: R_GlobalEnv>
##
## Statistics:
##                       X^2 df P(> X^2)
## Likelihood Ratio 187.7543  2        0
## Pearson          177.6149  2        0
```

Model 3: H0: *All two-way* relationships are best model fit i.e. alternative hypothesis is lenient model

```
model3 <- loglm(~dat$alcohol*dat$cigarette + dat$alcohol*dat$marijuana + dat$cigarette*dat$marijuana, my
summary(model3)
```

```
## Formula:
## ~dat$alcohol * dat$cigarette + dat$alcohol * dat$marijuana +
##     dat$cigarette * dat$marijuana
## attr(,"variables")
## list(dat$alcohol, dat$cigarette, dat$marijuana)
## attr(,"factors")
##               dat$alcohol dat$cigarette dat$marijuana
## dat$alcohol             1             0             0
## dat$cigarette           0             1             0
## dat$marijuana           0             0             1
##               dat$alcohol:dat$cigarette dat$alcohol:dat$marijuana
## dat$alcohol                           1                         1
## dat$cigarette                         1                         0
## dat$marijuana                         0                         1
##               dat$cigarette:dat$marijuana
## dat$alcohol                             0
## dat$cigarette                           1
## dat$marijuana                           1
## attr(,"term.labels")
## [1] "dat$alcohol"                 "dat$cigarette"
## [3] "dat$marijuana"               "dat$alcohol:dat$cigarette"
## [5] "dat$alcohol:dat$marijuana"   "dat$cigarette:dat$marijuana"
## attr(,"order")
## [1] 1 1 1 2 2 2
## attr(,"intercept")
```

```
## [1] 1
## attr(,"response")
## [1] 0
## attr(,".Environment")
## <environment: R_GlobalEnv>
##
## Statistics:
##                       X^2 df  P(> X^2)
## Likelihood Ratio 0.3739859  1 0.5408396
## Pearson          0.4010998  1 0.5265218
```

Model 4: All two-way relationships *and the three-way* relationship i.e. strict model

```
#saturated model or "overfit model""
# this takes us one step past parsimony
# this means that the three-way relationship does not add to the model

# i.e. Chi-squared is zero
# e.g., no degrees of freedom
model4 <- loglm(~dat$cigarette*dat$marijuana*dat$alcohol, mytable)
summary(model4)
```

```
## Formula:
## ~dat$cigarette * dat$marijuana * dat$alcohol
## attr(,"variables")
## list(dat$cigarette, dat$marijuana, dat$alcohol)
## attr(,"factors")
##               dat$cigarette dat$marijuana dat$alcohol
## dat$cigarette             1             0           0
## dat$marijuana             0             1           0
## dat$alcohol               0             0           1
##               dat$cigarette:dat$marijuana dat$cigarette:dat$alcohol
## dat$cigarette                           1                         1
## dat$marijuana                           1                         0
## dat$alcohol                             0                         1
##               dat$marijuana:dat$alcohol
## dat$cigarette                         0
## dat$marijuana                         1
## dat$alcohol                           1
##               dat$cigarette:dat$marijuana:dat$alcohol
## dat$cigarette                                       1
## dat$marijuana                                       1
## dat$alcohol                                         1
## attr(,"term.labels")
## [1] "dat$cigarette"
## [2] "dat$marijuana"
## [3] "dat$alcohol"
## [4] "dat$cigarette:dat$marijuana"
## [5] "dat$cigarette:dat$alcohol"
## [6] "dat$marijuana:dat$alcohol"
## [7] "dat$cigarette:dat$marijuana:dat$alcohol"
## attr(,"order")
## [1] 1 1 1 2 2 2 3
## attr(,"intercept")
## [1] 1
```

```
## attr(,"response")
## [1] 0
## attr(,".Environment")
## <environment: R_GlobalEnv>
##
## Statistics:
##                   X^2 df P(> X^2)
## Likelihood Ratio   0  0        1
## Pearson            0  0        1
```

##Compare models

```
stats::anova(model1, model2a, model2b, model2c, model3, model4)
```

```
## LR tests for hierarchical log-linear models
##
## Model 1:
##  ~dat$cigarette + dat$marijuana + dat$alcohol
## Model 2:
##  ~dat$alcohol * dat$cigarette + dat$alcohol * dat$marijuana
## Model 3:
##  ~dat$alcohol * dat$cigarette + dat$cigarette * dat$marijuana
## Model 4:
##  ~dat$alcohol * dat$marijuana + dat$cigarette * dat$marijuana
## Model 5:
##  ~dat$alcohol * dat$cigarette + dat$alcohol * dat$marijuana + dat$cigarette * dat$marijuana
## Model 6:
##  ~dat$cigarette * dat$marijuana * dat$alcohol
##
##               Deviance df  Delta(Dev) Delta(df) P(> Delta(Dev)
## Model 1   1286.0199544  4
## Model 2    497.3692752  2 788.6506792         2        0.00000
## Model 3     92.0183606  2 405.3509146         0        0.00000
## Model 4    187.7543029  2 -95.7359423         0        1.00000
## Model 5      0.3739859  1 187.3803170         1        0.00000
## Model 6      0.0000000  0   0.3739859         1        0.54084
## Saturated    0.0000000  0   0.0000000         0        1.00000
```

JMV Model comparisons

```
# note the similarities between 'Deviance' values and the model comparison stats with the loglm output.
# the top table output is unknown - so look it up

jmv::logLinear(
  data = dat.case,
  counts = NULL,
  factors = c('cigarette', 'marijuana', 'alcohol'),
  blocks = list(
    list(
        'cigarette', 'marijuana', 'alcohol'), # Model 1: null model
    list(
      c('alcohol', 'cigarette'),              # Model 2b: alcohol and marijuana are independent
      c('cigarette', 'marijuana')),           # but alcohol/cigarette and cigarette/ marijuana are rela
    list(
      c('alcohol', 'marijuana')),             # Model 3: all two-way relationships - best fit
    list(
```

```
    c('cigarette', 'marijuana', 'alcohol'))), # Model 4: saturated model
  refLevels = list(
    list(
      var = 'cigarette',
      ref = 'no'),
    list(
      var = 'marijuana',
      ref = 'no'),
    list(
      var = 'alcohol',
      ref = 'no')),
  modelTest = TRUE)
```

```
##
##  LOG-LINEAR REGRESSION
##
##  Model Fit Measures
##  ---------------------------------------------------------------------
##    Model    Deviance     AIC       R²-McF    <U+03C7>²      df    p
##  ---------------------------------------------------------------------
##        1     1286.020    1343.1     0.549     1565     3    < .001
##        2       92.018     153.1     0.968     2759     5    < .001
##        3        0.374      63.4     1.000     2851     6    < .001
##        4    -1.17e-13      65.0     1.000     2851     7    < .001
##  ---------------------------------------------------------------------
##
##
##  Model Comparisons
##  ------------------------------------------------
##    Model          Model    <U+03C7>²          df    p
##  ------------------------------------------------
##        1    -         2    1194.002     2    < .001
##        2    -         3      91.644     1    < .001
##        3    -         4       0.374     1     0.541
##  ------------------------------------------------
##
##
##  MODEL SPECIFIC RESULTS
##
##  MODEL 1
##
##  Model Coefficients
##  ------------------------------------------------------
##    Predictor     Estimate    SE        Z        p
##  ------------------------------------------------------
##    Intercept        4.173    0.0650    64.23    < .001
##    cigarette:
##    yes - no         0.649    0.0442    14.71    < .001
##    marijuana:
##    yes - no        -0.315    0.0424    -7.43    < .001
##    alcohol:
##    yes - no         1.785    0.0598    29.87    < .001
##  ------------------------------------------------------
##
```

```
##
##  MODEL 2
##
##  Model Coefficients
##  ---------------------------------------------------------------------
##    Predictor                Estimate    SE        Z         p
##  ---------------------------------------------------------------------
##    Intercept                   5.578    0.0603     92.46    < .001
##    cigarette:
##    yes - no                   -2.694    0.1626    -16.57    < .001
##    marijuana:
##    yes - no                   -2.771    0.1520    -18.23    < .001
##    alcohol:
##    yes - no                    0.576    0.0746      7.73    < .001
##    alcohol:cigarette:
##    (yes - no)²                 2.874    0.1673     17.18    < .001
##    cigarette:marijuana:
##    (yes - no)²                 3.224    0.1610     20.03    < .001
##  ---------------------------------------------------------------------
##
##
##  MODEL 3
##
##  Model Coefficients
##  ---------------------------------------------------------------------
##    Predictor                Estimate    SE        Z         p
##  ---------------------------------------------------------------------
##    Intercept                   5.633    0.0597     94.36    < .001
##    cigarette:
##    yes - no                   -1.887    0.1627    -11.60    < .001
##    marijuana:
##    yes - no                   -5.309    0.4752    -11.17    < .001
##    alcohol:
##    yes - no                    0.488    0.0758      6.44    < .001
##    alcohol:cigarette:
##    (yes - no)²                 2.055    0.1741     11.80    < .001
##    cigarette:marijuana:
##    (yes - no)²                 2.848    0.1638     17.38    < .001
##    alcohol:marijuana:
##    (yes - no)²                 2.986    0.4647      6.43    < .001
##  ---------------------------------------------------------------------
##
##
##  MODEL 4
##
##  Model Coefficients
##  ---------------------------------------------------------------------------
##    Predictor                      Estimate    SE        Z          p
##  ---------------------------------------------------------------------------
##    Intercept                         5.631    0.0599     94.060    < .001
##    cigarette:
##    yes - no                         -1.870    0.1638    -11.414    < .001
##    marijuana:
##    yes - no                         -4.938    0.7096     -6.959    < .001
```

```
##    alcohol:
##    yes - no                          0.491    0.0760      6.464    < .001
##    alcohol:cigarette:
##    (yes - no)²                       2.035    0.1758     11.580    < .001
##    cigarette:marijuana:
##    (yes - no)²                       2.275    0.9275      2.453     0.014
##    alcohol:marijuana:
##    (yes - no)²                       2.600    0.7270      3.576    < .001
##    cigarette:marijuana:alcohol:
##    (yes - no)³                       0.590    0.9424      0.626     0.532
##  ------------------------------------------------------------------------
```

Model performance - expected values, deviations, and odds glm model

```
dat[,-4] <- lapply(dat[,-4], relevel, ref = "no") # relevel reference group (intercept) to "no"

mod1 <- glm(Freq ~ alcohol + marijuana + cigarette, data = dat, family = poisson) # orthogonal model
mod3 <- glm(Freq ~ alcohol*cigarette + alcohol*marijuana + cigarette*marijuana, data = dat, family = po
summary(mod3)
```

```
##
## Call:
## glm(formula = Freq ~ alcohol * cigarette + alcohol * marijuana +
##     cigarette * marijuana, family = poisson, data = dat)
##
## Deviance Residuals:
##        1         2         3         4         5         6         7
##  0.02044  -0.09256  -0.02658   0.02890  -0.33428   0.49134   0.09452
##        8
## -0.03690
##
## Coefficients:
##                            Estimate Std. Error z value Pr(>|z|)
## (Intercept)                 5.63342    0.05970  94.361  < 2e-16 ***
## alcoholyes                  0.48772    0.07577   6.437 1.22e-10 ***
## cigaretteyes               -1.88667    0.16270 -11.596  < 2e-16 ***
## marijuanayes               -5.30904    0.47520 -11.172  < 2e-16 ***
## alcoholyes:cigaretteyes     2.05453    0.17406  11.803  < 2e-16 ***
## alcoholyes:marijuanayes     2.98601    0.46468   6.426 1.31e-10 ***
## cigaretteyes:marijuanayes   2.84789    0.16384  17.382  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for poisson family taken to be 1)
##
##     Null deviance: 2851.46098  on 7  degrees of freedom
## Residual deviance:    0.37399  on 1  degrees of freedom
## AIC: 63.417
##
## Number of Fisher Scoring iterations: 4
```

```
fittedmod3 <- as.data.frame(fitted(mod3))

tab3 <- cbind(mod3$data, fittedmod3)
tab3$Dev <- tab3$Freq - tab3$`fitted(mod3)`
tab3
```

```
##   cigarette marijuana alcohol Freq fitted(mod3)        Dev
## 1       yes       yes     yes  911    910.38317  0.6168303
## 2        no       yes     yes   44     44.61683 -0.6168303
## 3       yes        no     yes  538    538.61683 -0.6168303
## 4        no        no     yes  456    455.38317  0.6168303
## 5       yes       yes      no    3      3.61683 -0.6168303
## 6        no       yes      no    2      1.38317  0.6168303
## 7       yes        no      no   43     42.38317  0.6168303
## 8        no        no      no  279    279.61683 -0.6168303
```

```
# odds someone used [X] using orthogonal model (Z to 1 ratio)
exp(coef(mod1)[2])
```

```
## alcoholyes
##   5.960245
```

```
exp(coef(mod1)[3])
```

```
## marijuanayes
##    0.7294833
```

```
exp(coef(mod1)[4])
```

```
## cigaretteyes
##     1.914213
```

```
# for X:Y output Z
# Student who used X have estimated odds of having tried Y that are Z times the estimated odds for stud
exp(coef(mod3)["alcoholyes:cigaretteyes"])
```

```
## alcoholyes:cigaretteyes
##                7.803201
```

```
exp(coef(mod3)["alcoholyes:marijuanayes"])
```

```
## alcoholyes:marijuanayes
##                19.80658
```

```
exp(coef(mod3)["cigaretteyes:marijuanayes"])
```

```
## cigaretteyes:marijuanayes
##                  17.25133
```

```
#1/exp(coef(mod3))
```

Proportions broken down by alcohol use

```
prop.table(as.table(AMCtable), margin = c(1,3))
```

```
## , , alcohol = yes
##
##          marijuana
## cigarette         yes          no
##       yes 0.628709455 0.371290545
##       no  0.088000000 0.912000000
##
## , , alcohol = no
```

```
##
##          marijuana
## cigarette         yes          no
##       yes 0.065217391 0.934782609
##       no  0.007117438 0.992882562
```

from students who used cigarettes and alcohol, 62% used marijuana. Conversely, from students who did not use cigarettes or alcohol, 99% did not use marijuana.