# EDF 5401 Midterm, Part 2: Depression and the internet

2013-10-15

These data come from the Data and Story Library

These household were given free internet access in return for agreeing to being tracked. Several statistics were reported before and after.

Note that in 1998, home internet access was probably dial-up and not the cable/DSL speeds of the current internet.

```
library(tidyverse)
```

```
-- Attaching core tidyverse packages ------------------------ tidyverse 2.0.0 --
v dplyr     1.1.3     v readr     2.1.4
v forcats   1.0.0     v stringr   1.5.0
v ggplot2   3.4.3     v tibble    3.2.1
v lubridate 1.9.2     v tidyr     1.3.0
v purrr     1.0.2
-- Conflicts ------------------------------------------ tidyverse_conflicts() --
x dplyr::filter() masks stats::filter()
x dplyr::lag()    masks stats::lag()
i Use the conflicted package (<http://conflicted.r-lib.org/>) to force all conflicts to beco
```

```
library(DescTools)
```

# Part 2: Depression and the Internet

## Analysis

### Load the data

Load the data. Force category to be an ordered category.

```
depress <- read_delim("depression-and-the-internet.txt")
```

```
Rows: 169 Columns: 8
-- Column specification --------------------------------------------------------
Delimiter: "\t"
chr (2): Gender, Age
dbl (6): Internet use (mean hours per week), DepressionBefore, DepressionAft...

i Use `spec()` to retrieve the full column specification for this data.
i Specify the column types or set `show_col_types = FALSE` to quiet this message.
```

```
depress$Gender <- factor(depress$Gender)
depress$Age <- factor(depress$Age)
depress$Race <- factor(depress$`Race (white = 1, minority = 0)`,0:1,
                       c("minority","white"))
summary(depress)
```

```
 Internet use (mean hours per week) DepressionBefore DepressionAfter
 Min.   : 0.0000                    Min.   :0.0000   Min.   :0.0000
 1st Qu.: 0.1750                    1st Qu.:0.3452   1st Qu.:0.3393
 Median : 0.8554                    Median :0.6666   Median :0.5000
 Mean   : 2.4287                    Mean   :0.7348   Mean   :0.6176
 3rd Qu.: 2.1532                    3rd Qu.:1.0000   3rd Qu.:0.7856
 Max.   :35.6186                    Max.   :2.5332   Max.   :3.0000
 NA's   :2                          NA's   :2        NA's   :5
   Gender   Race (white = 1, minority = 0)    Age      Household income ($000)
 female:94   Min.   :0.0000                 Adult:121   Min.   : 5.00
 male  :75   1st Qu.:1.0000                 Teen : 48   1st Qu.:36.56
             Median :1.0000                             Median :52.50
             Mean   :0.7515                             Mean   :54.41
             3rd Qu.:1.0000                             3rd Qu.:85.00
```

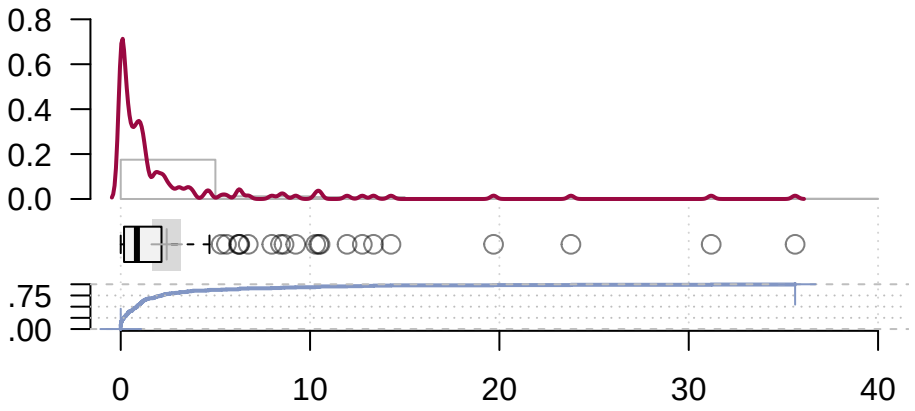
```
            Max.   :1.0000                                  Max.   :85.00
                                                            NA's   :5
 Household size        Race
 Min.   :1.000   minority: 42
 1st Qu.:3.000   white   :127
 Median :4.000
 Mean   :3.784
 3rd Qu.:5.000
 Max.   :6.000
 NA's   :2
```

### One Dimensional Summaries

```
Desc(depress$`Internet use (mean hours per week)`)
```

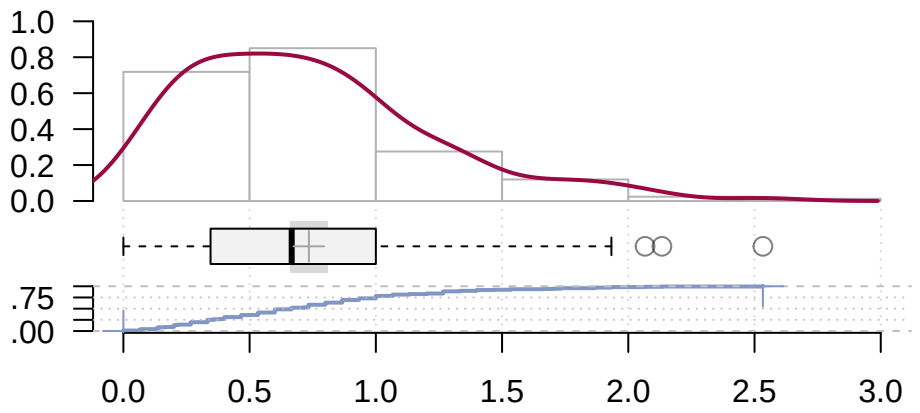
```
------------------------------------------------------------------------------
depress$`Internet use (mean hours per week)` (numeric)

      length          n        NAs     unique         0s       mean      meanCI'
         169        167          2        157         10  2.4286482   1.6743700
                  98.8%       1.2%                5.9%              3.1829264

         .05        .10        .25     median        .75        .90        .95
   0.0000000  0.0112612  0.1750310  0.8554280  2.1531645  6.2751618  10.5071260

       range         sd       vcoef        mad        IQR       skew        kurt
  35.6186200  4.9370090  2.0328218  1.1668047  1.9781335  4.0803913  19.8697044

lowest : 0.0 (10), 0.000265, 0.000285, 0.000352, 0.001923
highest: 14.27382, 19.69108, 23.77727, 31.18628, 35.61862

' 95%-CI (classic)
```

## depress$‘Internet use (mean hours per week)‘ (numeric)




```
Desc(depress$DepressionBefore)
```

```
------------------------------------------------------------------------------
depress$DepressionBefore (numeric)

     length         n       NAs    unique        0s      mean    meanCI'
        169       167         2        38         2  0.734790  0.660560
                98.8%      1.2%               1.2%             0.809020

       .05       .10       .25    median       .75       .90       .95
  0.133331  0.199982  0.345215  0.666626  1.000000  1.359912  1.723193

      range        sd     vcoef       mad       IQR      skew      kurt
  2.533203  0.485862  0.661225  0.494170  0.654785  0.945713  0.811305

lowest : 0.0 (2), 0.066666 (5), 0.133331 (6), 0.142853, 0.166656
highest: 1.866455 (2), 1.933105 (2), 2.066406, 2.133301, 2.533203

' 95%-CI (classic)
```




Identify outliers

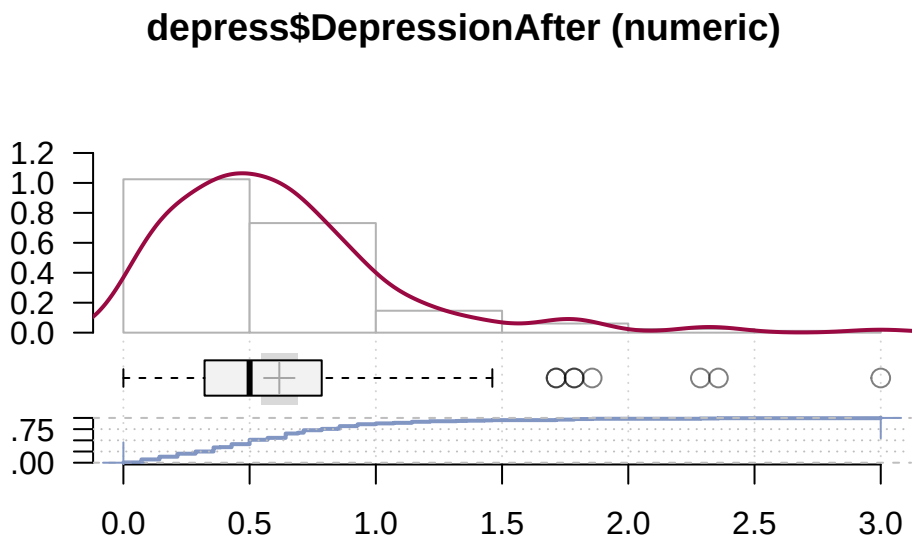
```
hbefore <- which (depress$DepressionBefore > 2)
hbefore
```

```
[1]  11  66 135
```

```
Desc(depress$DepressionAfter)
```

```
-------------------------------------------------------------------------------
depress$DepressionAfter (numeric)

     length           n         NAs      unique          0s        mean     meanCI'
        169         164           5          32           1   0.6176045   0.5461457
                  97.0%        3.0%                   0.6%               0.6890632

        .05         .10         .25      median         .75         .90         .95
  0.0714260   0.1428530   0.3392642   0.5000000   0.7856450   1.1428220   1.4564821

      range          sd       vcoef         mad         IQR        skew        kurt
  3.0000000   0.4634394   0.7503821   0.3177123   0.4463808   1.8551112   5.2592718

lowest : 0.0, 0.071426 (11), 0.142853 (10), 0.214264 (11), 0.285706 (8)
highest: 1.785645 (2), 1.856934, 2.285645, 2.356934, 3.0
```

```
heap(?): remarkable frequency (9.8%) for the mode(s) (= 0.5, 0.642822)

' 95%-CI (classic)
```




Identify outliers

```
hafter <- which (depress$DepressionAfter > 1.5)
hafter
```

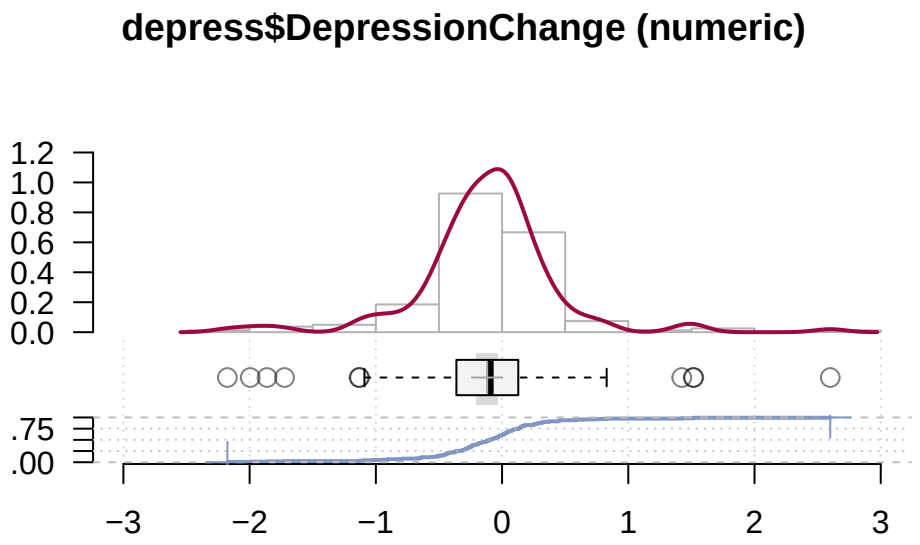
```
[1]  13  18  21  37  47  86 136 169
```

Subtract before from after to get change.

```
depress$DepressionChange <- depress$DepressionAfter - depress$DepressionBefore
Desc(depress$DepressionChange)
```

```
------------------------------------------------------------------------------
depress$DepressionChange (numeric)

      length           n         NAs      unique          0s        mean'
         169         162           7         135           0  -0.1180701
                   95.9%        4.1%                   0.0%
```

```
       .05         .10         .25      median         .75         .90
-0.9636996  -0.6419248  -0.3523030  -0.0904540   0.1237792   0.3328587

     range          sd       vcoef         mad         IQR        skew
 4.7761230   0.5525114  -4.6795221   0.3424168   0.4760822   0.2044767

    meanCI
-0.2037953
-0.0323448

       .95
 0.5901001

      kurt
 5.6532503

lowest : -2.1760860, -1.9949800, -1.8616790, -1.7236020, -1.1333010
highest: 0.828491, 1.423706, 1.514129, 1.518982, 2.600037

' 95%-CI (classic)
```




Identify outliers (There is one point near the lower fence at -1.13, mark anything beyond that as an outlier.)

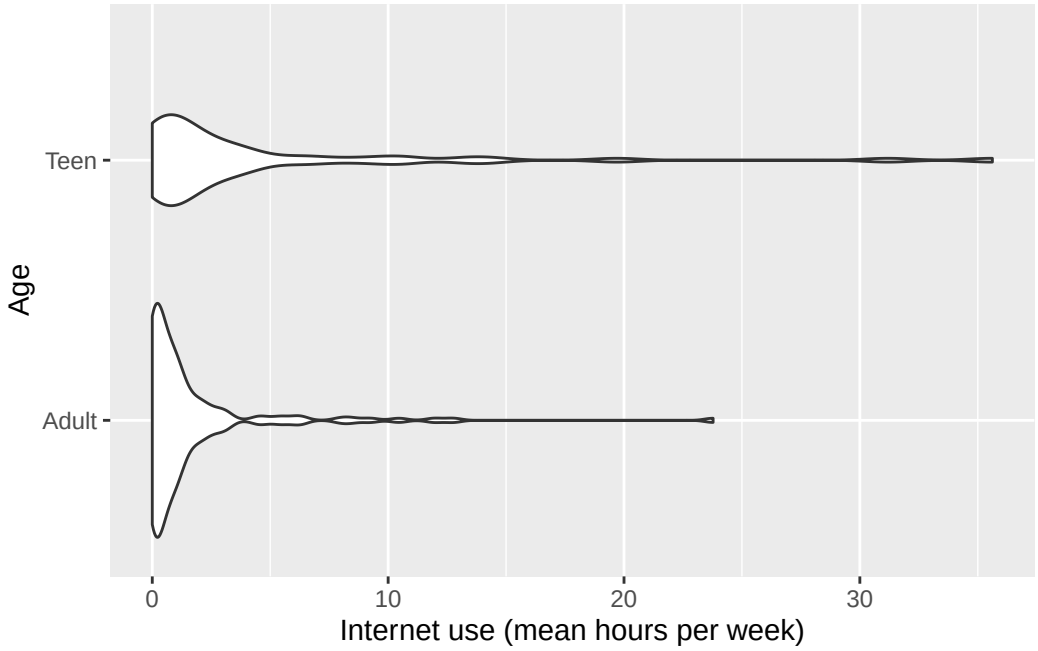
```
hchange <- which (abs(depress$DepressionChange) > 1.25)
hchange
```

```
[1]  11  13  21  37  60  86 135 149
```

### Relationships with Age

```
ggplot(depress,aes(x=`Internet use (mean hours per week)`,y=Age)) +
  geom_violin()
```

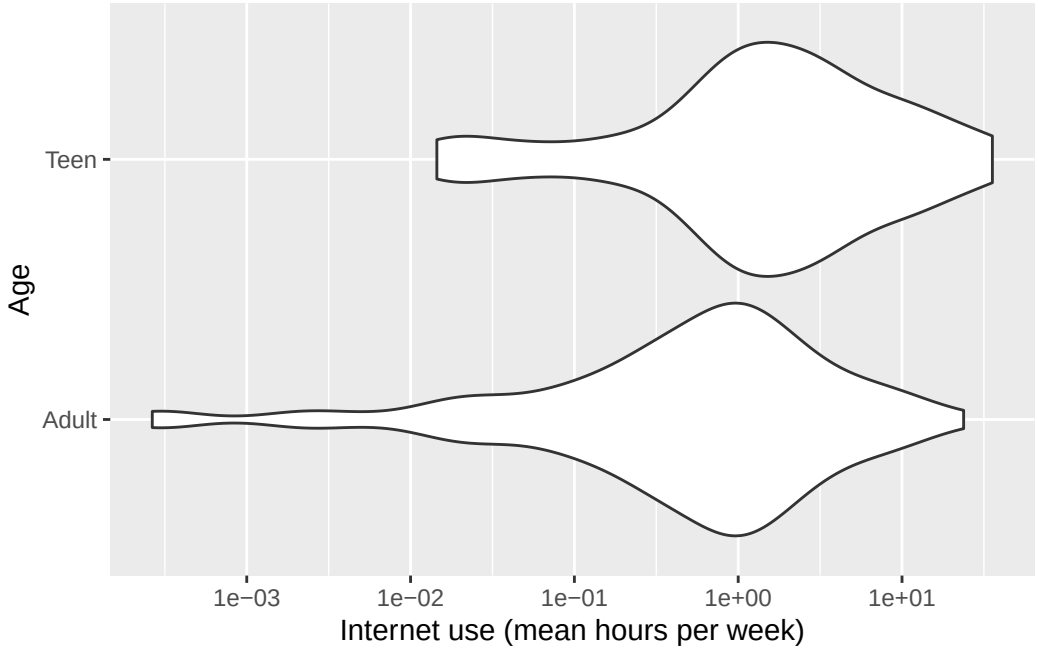
```
Warning: Removed 2 rows containing non-finite values (`stat_ydensity()`).
```




```
ggplot(depress,aes(x=`Internet use (mean hours per week)`,y=Age)) +
  geom_violin() + scale_x_log10()
```

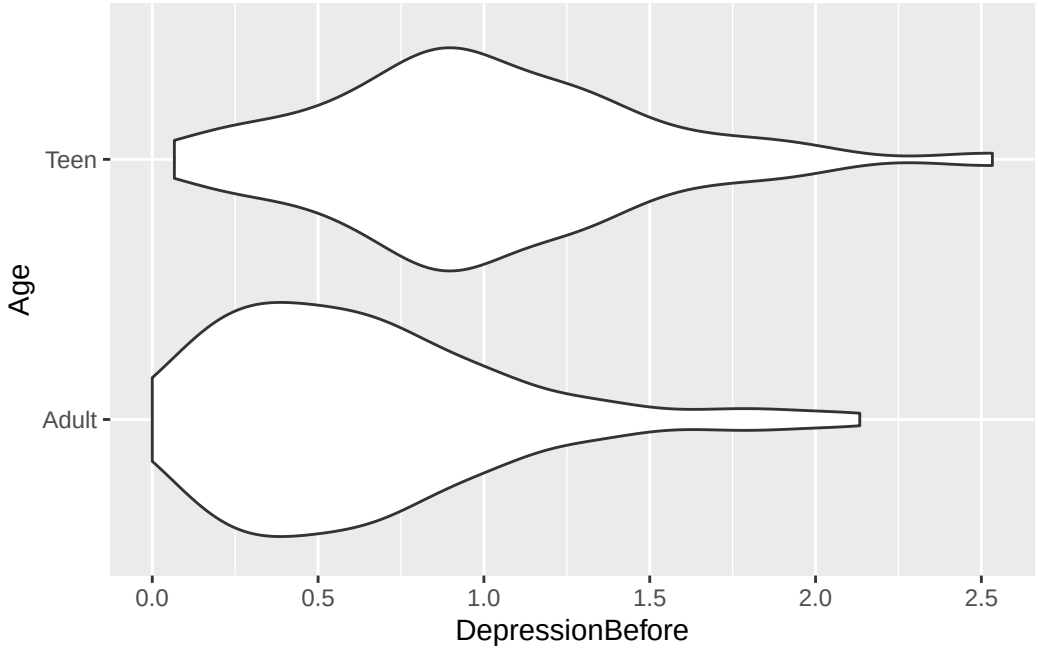
```
Warning: Transformation introduced infinite values in continuous x-axis
```

```
Warning: Removed 12 rows containing non-finite values (`stat_ydensity()`).
```



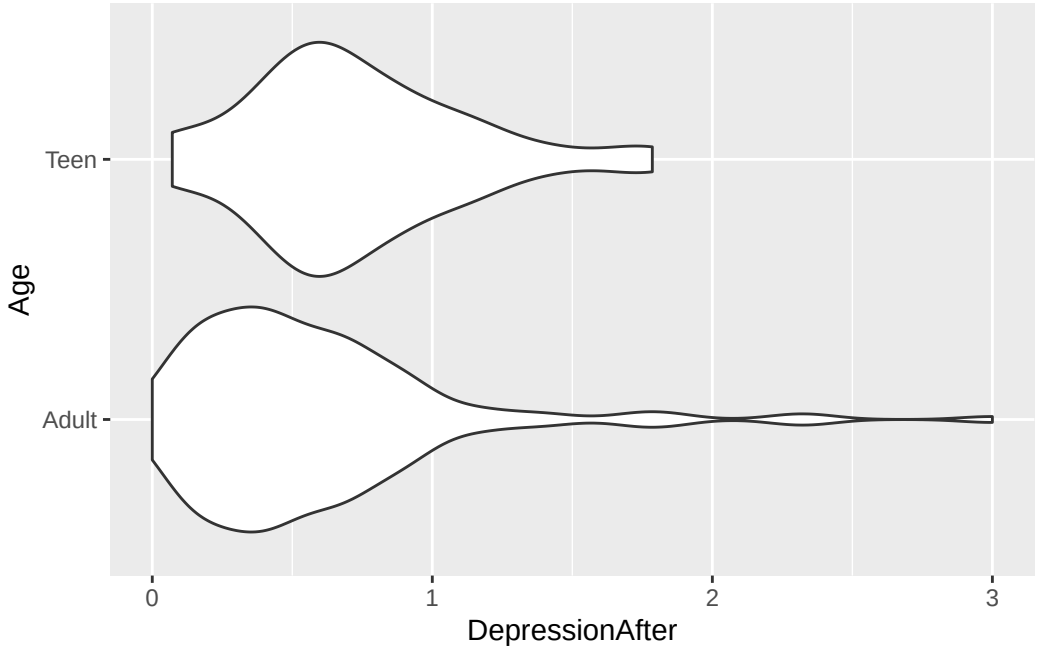

```
ggplot(depress,aes(x=DepressionBefore,y=Age)) +
  geom_violin()
```

```
Warning: Removed 2 rows containing non-finite values (`stat_ydensity()`).
```



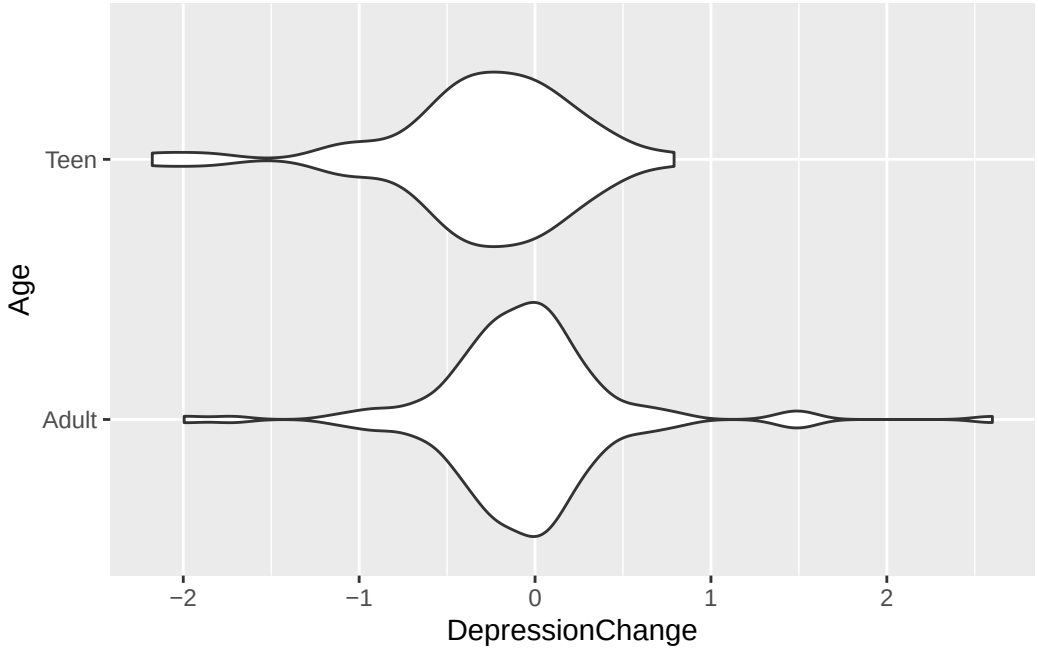

```
ggplot(depress,aes(x=DepressionAfter,y=Age)) +
  geom_violin()
```

```
Warning: Removed 5 rows containing non-finite values (`stat_ydensity()`).
```




```
ggplot(depress,aes(x=DepressionChange,y=Age)) +
  geom_violin()
```

```
Warning: Removed 7 rows containing non-finite values (`stat_ydensity()`).
```




## Scatterplots

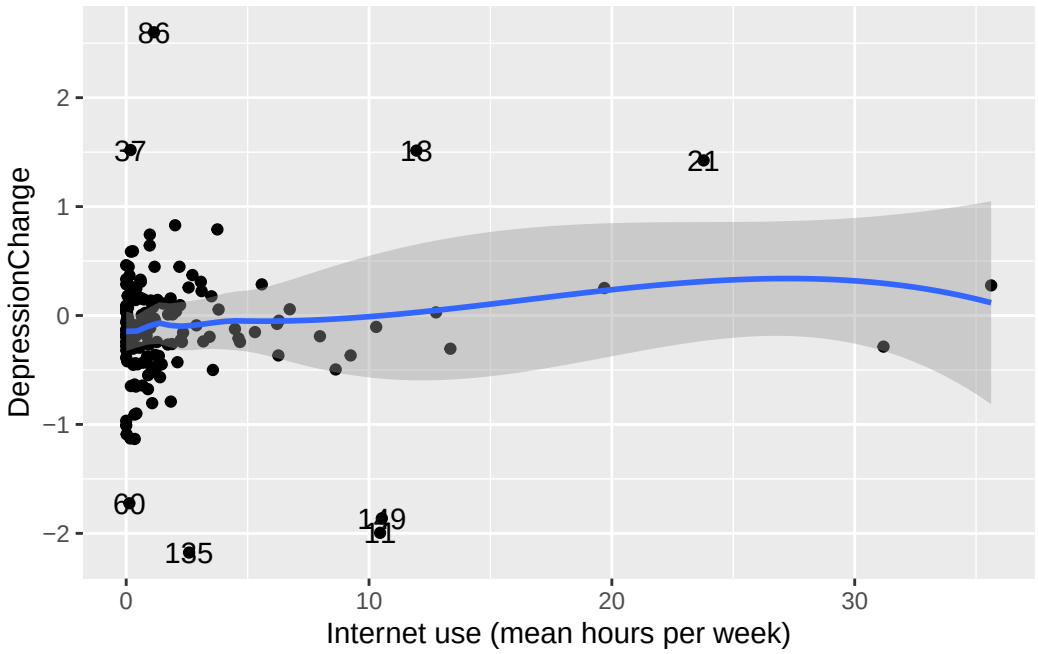
### X, Y

```
ggplot(depress,aes(x=`Internet use (mean hours per week)`,
                   y=DepressionChange)) +
  geom_point() + geom_smooth()+
  geom_text(data=depress[hchange,],aes(label=hchange))
```

```
`geom_smooth()` using method = 'loess' and formula = 'y ~ x'
```

```
Warning: Removed 9 rows containing non-finite values (`stat_smooth()`).
```

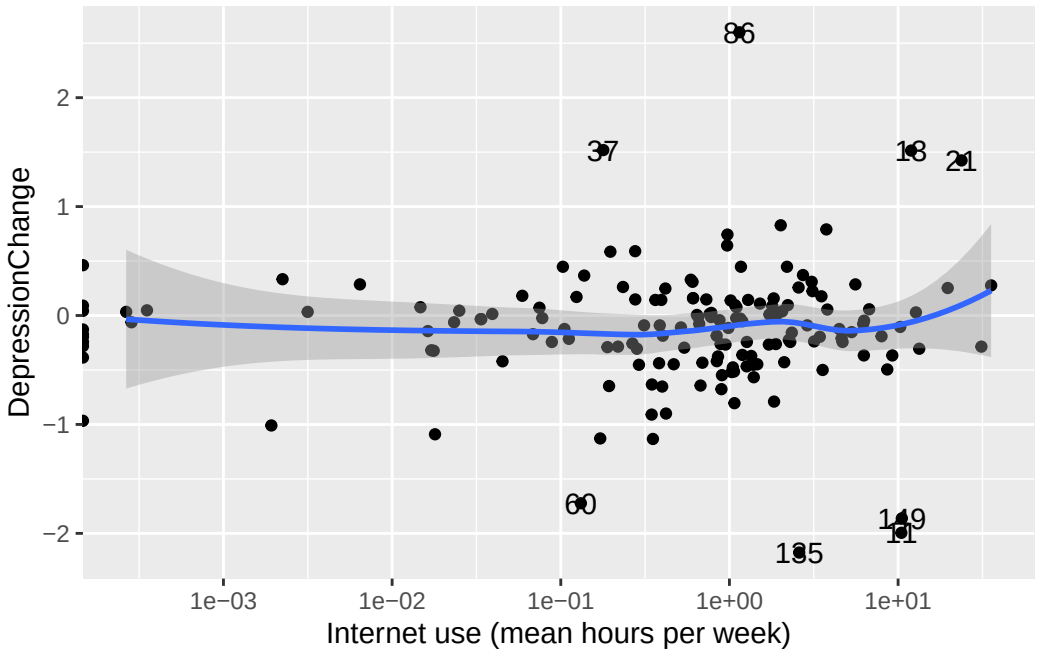
```
Warning: Removed 9 rows containing missing values (`geom_point()`).
```




**log(X), Y**

```
ggplot(depress,aes(x=`Internet use (mean hours per week)`,
                   y=DepressionChange)) +
  geom_point() + geom_smooth()+ scale_x_log10() +
  geom_text(data=depress[hchange,],aes(label=hchange))
```

```
Warning: Transformation introduced infinite values in continuous x-axis
Transformation introduced infinite values in continuous x-axis

`geom_smooth()` using method = 'loess' and formula = 'y ~ x'

Warning: Removed 19 rows containing non-finite values (`stat_smooth()`).

Warning: Removed 9 rows containing missing values (`geom_point()`).
```




Hmm. Note a number of points piled up on the $y$-axis. The problem is $\log(0) = -\infty$. The solution is to add a small number before taking the logs. Looks like most values are above .001, so add .0001.

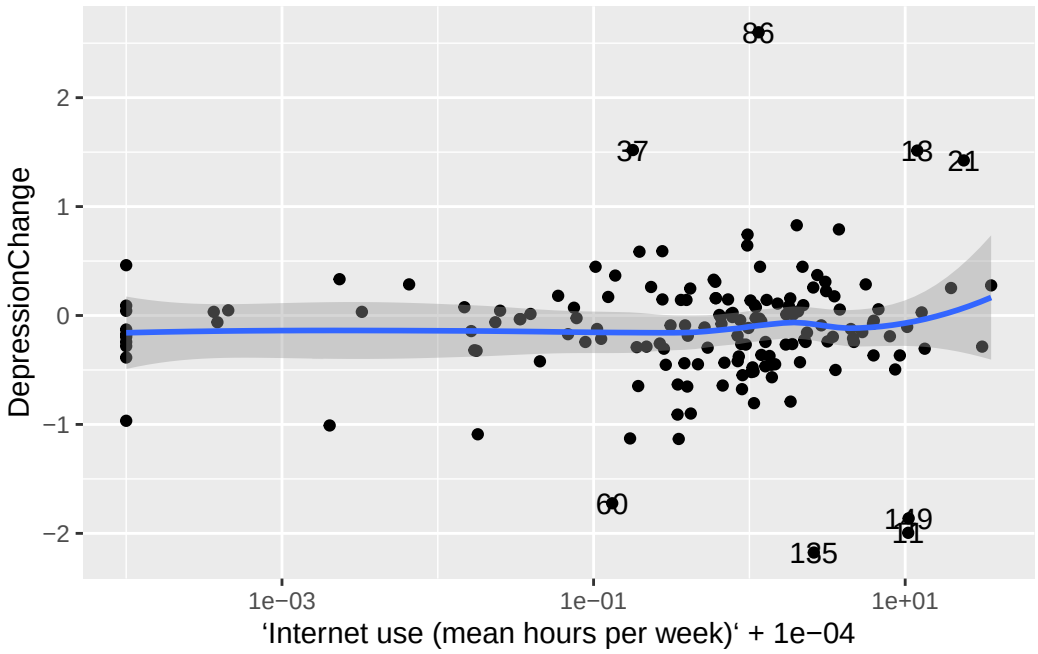
An alternative would be to exclude these people from the model.

```
ggplot(depress,aes(x=`Internet use (mean hours per week)`+.0001,
                   y=DepressionChange)) +
  geom_point() + geom_smooth()+ scale_x_log10() +
  geom_text(data=depress[hchange,],aes(label=hchange))
```

```
`geom_smooth()` using method = 'loess' and formula = 'y ~ x'
```

```
Warning: Removed 9 rows containing non-finite values (`stat_smooth()`).
```

```
Warning: Removed 9 rows containing missing values (`geom_point()`).
```




**By Age**

```
ggplot(depress,aes(x=`Internet use (mean hours per week)`,
                   y=DepressionChange, color=Age)) +
  geom_point() + geom_smooth() +
  geom_text(data=depress[hchange,],aes(label=hchange))
```

```
`geom_smooth()` using method = 'loess' and formula = 'y ~ x'
```

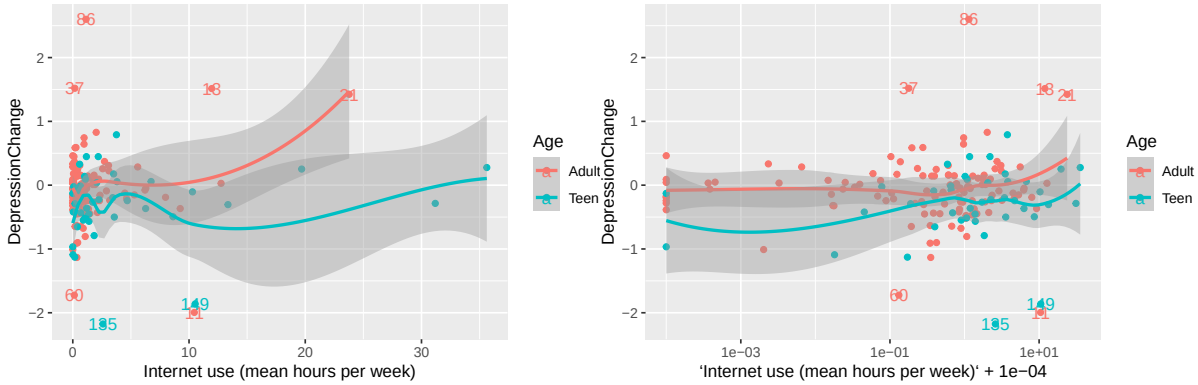
```
Warning: Removed 9 rows containing non-finite values (`stat_smooth()`).
```

```
Warning: Removed 9 rows containing missing values (`geom_point()`).
```

```
ggplot(depress,aes(x=`Internet use (mean hours per week)`+.0001,
                   y=DepressionChange,color=Age)) +
  geom_point() + geom_smooth()+ scale_x_log10() +
  geom_text(data=depress[hchange,],aes(label=hchange))
```

```
`geom_smooth()` using method = 'loess' and formula = 'y ~ x'
```

```
Warning: Removed 9 rows containing non-finite values (`stat_smooth()`).
Removed 9 rows containing missing values (`geom_point()`).
```




### By Gender

```
ggplot(depress,aes(x=`Internet use (mean hours per week)`,
                   y=DepressionChange, color=Gender)) +
  geom_point() + geom_smooth() +
  geom_text(data=depress[hchange,],aes(label=hchange))
```

```
`geom_smooth()` using method = 'loess' and formula = 'y ~ x'
```

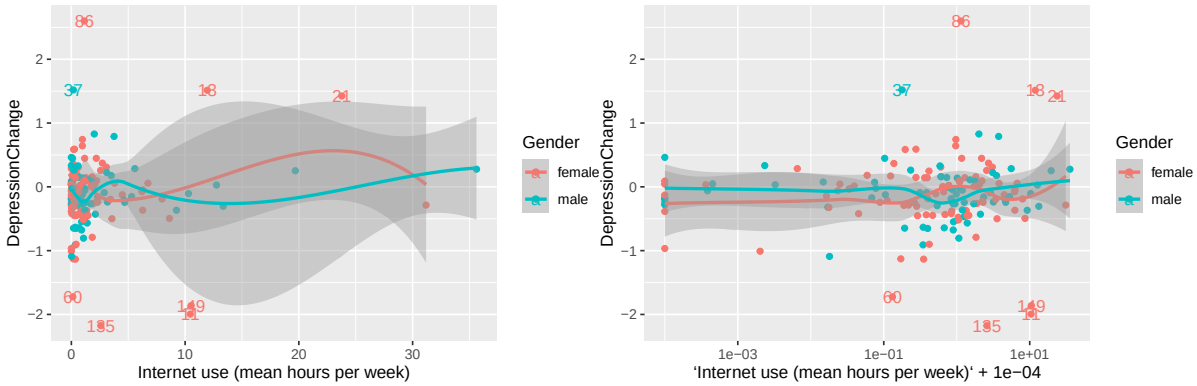
```
Warning: Removed 9 rows containing non-finite values (`stat_smooth()`).
```

```
Warning: Removed 9 rows containing missing values (`geom_point()`).
```

```
ggplot(depress,aes(x=`Internet use (mean hours per week)`+.0001,
                   y=DepressionChange,color=Gender)) +
  geom_point() + geom_smooth()+ scale_x_log10() +
  geom_text(data=depress[hchange,],aes(label=hchange))
```

```
`geom_smooth()` using method = 'loess' and formula = 'y ~ x'
```

```
Warning: Removed 9 rows containing non-finite values (`stat_smooth()`).
Removed 9 rows containing missing values (`geom_point()`).
```




### By Race (Whiteness)

Race is coded white/non-white. So this is essentially looking at the effect of "whiteness" (whatever that is).

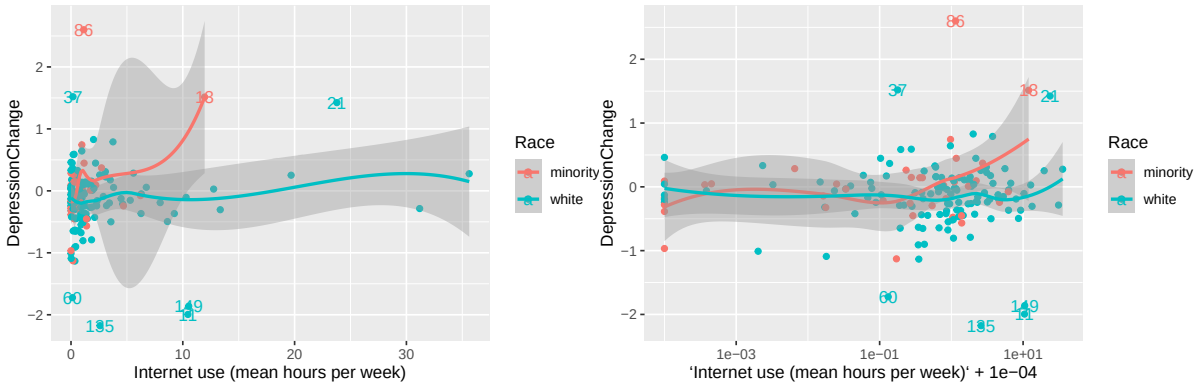
```
ggplot(depress,aes(x=`Internet use (mean hours per week)`,
                   y=DepressionChange, color=Race)) +
  geom_point() + geom_smooth() +
  geom_text(data=depress[hchange,],aes(label=hchange))
```

```
`geom_smooth()` using method = 'loess' and formula = 'y ~ x'

Warning: Removed 9 rows containing non-finite values (`stat_smooth()`).

Warning: Removed 9 rows containing missing values (`geom_point()`).
```

```
ggplot(depress,aes(x=`Internet use (mean hours per week)`+.0001,
                   y=DepressionChange,color=Race)) +
  geom_point() + geom_smooth()+ scale_x_log10() +
  geom_text(data=depress[hchange,],aes(label=hchange))
```

```
`geom_smooth()` using method = 'loess' and formula = 'y ~ x'

Warning: Removed 9 rows containing non-finite values (`stat_smooth()`).
Removed 9 rows containing missing values (`geom_point()`).
```

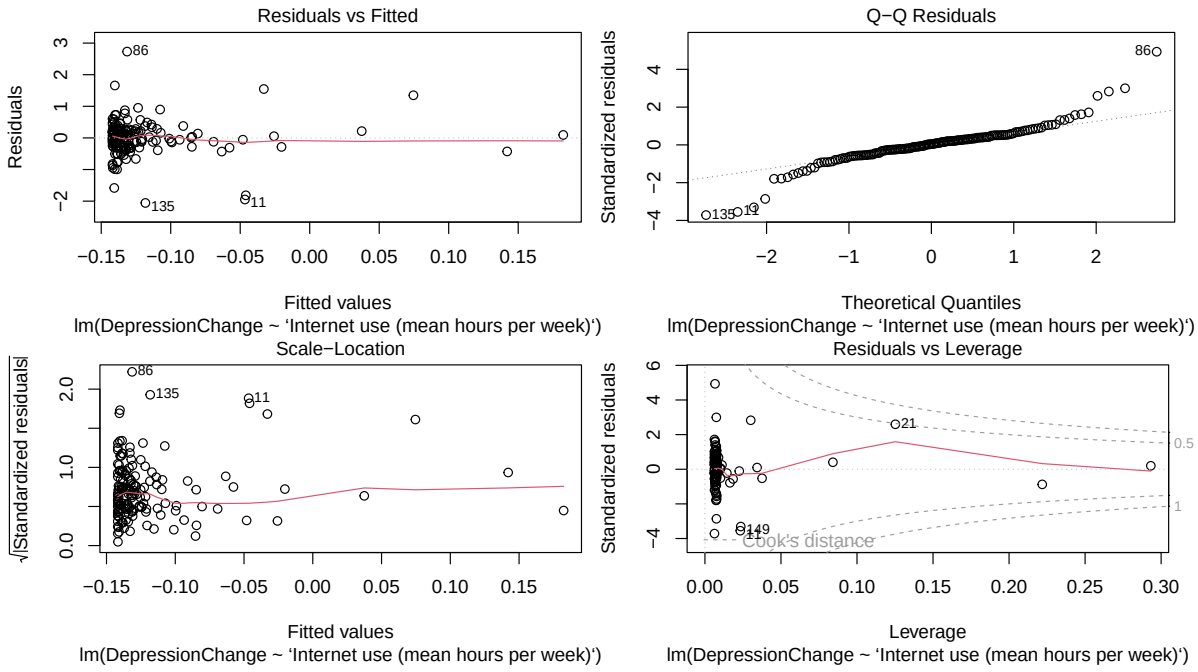
### Regression Model




```
dlm <- lm(DepressionChange ~ `Internet use (mean hours per week)`,
          data=depress)
summary(dlm)
```

```
Call:
lm(formula = DepressionChange ~ `Internet use (mean hours per week)`,
    data = depress)

Residuals:
    Min      1Q  Median      3Q     Max
-2.0579 -0.2426  0.0218  0.2285  2.7314

Coefficients:
                                    Estimate Std. Error t value Pr(>|t|)
(Intercept)                        -0.141812   0.048747  -2.909  0.00415 **
`Internet use (mean hours per week)`  0.009103   0.008949   1.017  0.31061
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.5555 on 158 degrees of freedom
  (9 observations deleted due to missingness)
Multiple R-squared:  0.006506,  Adjusted R-squared:  0.0002183
F-statistic: 1.035 on 1 and 158 DF,  p-value: 0.3106
```

```
plot(dlm)
```



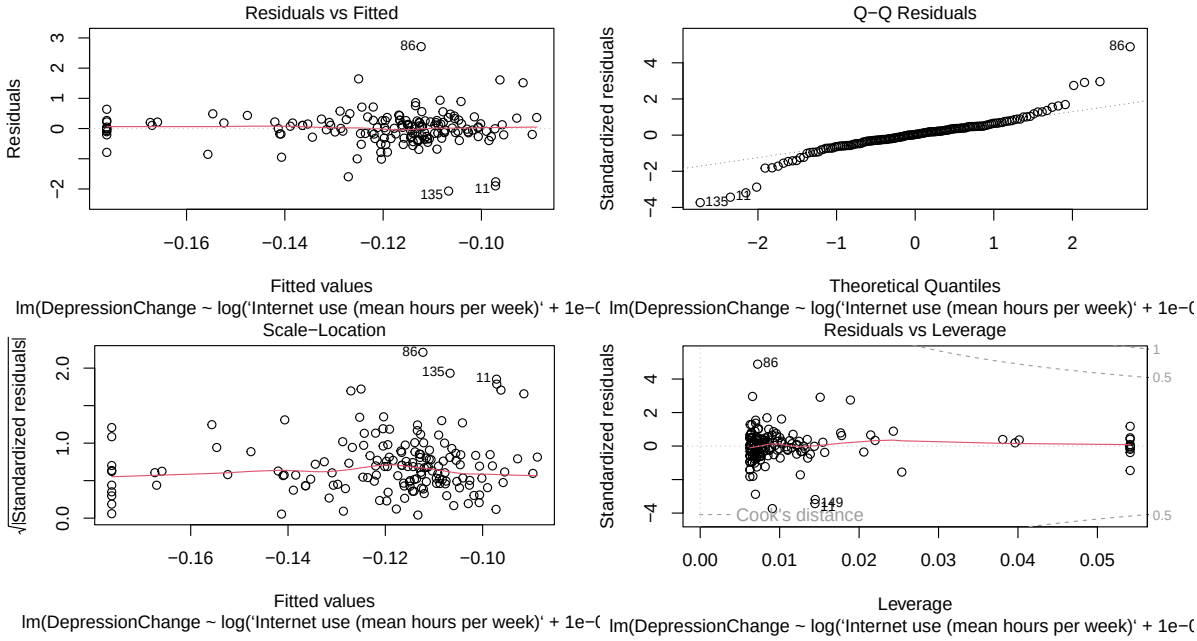

## Log X

```
dllm <- lm(DepressionChange ~ log(`Internet use (mean hours per week)`+.0001),
           data=depress)
summary(dllm)
```

```
Call:
lm(formula = DepressionChange ~ log(`Internet use (mean hours per week)` +
    1e-04), data = depress)

Residuals:
     Min       1Q   Median       3Q      Max
-2.06940 -0.21956  0.01958  0.25194  2.71231

Coefficients:
                                                 Estimate Std. Error t value
(Intercept)                                    -0.113204   0.046657  -2.426
log(`Internet use (mean hours per week)` + 1e-04)  0.006843   0.014907   0.459
                                                Pr(>|t|)
(Intercept)                                       0.0164 *
```

```
log(`Internet use (mean hours per week)` + 1e-04)   0.6468
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.5569 on 158 degrees of freedom
  (9 observations deleted due to missingness)
Multiple R-squared:  0.001332,  Adjusted R-squared:  -0.004989
F-statistic: 0.2108 on 1 and 158 DF,  p-value: 0.6468
```

```
plot(dllm)
```




## Leverage Points

Linear scale

```
dfblm <- dfbetas(dlm)
hlev <- which(abs(dfblm[,2])>2/sqrt(nrow(dfblm)))
dfblm[hlev,]
```

```
   (Intercept) `Internet use (mean hours per week)`
11  -0.05463073                         -0.4863923
```

```
13   0.01224088                          0.4538574
21  -0.22203477                          0.9756710
134  0.12886632                         -0.4591744
149 -0.04888997                         -0.4548981
```

Rerun without leverage points.

Linear model.

```
summary(lm(DepressionChange ~ `Internet use (mean hours per week)`,
          data=depress,subset=-hlev))
```

```
Call:
lm(formula = DepressionChange ~ `Internet use (mean hours per week)`,
    data = depress, subset = -hlev)

Residuals:
     Min       1Q   Median       3Q      Max
-2.06071 -0.24484  0.01573  0.22688  2.72857

Coefficients:
                                    Estimate Std. Error t value Pr(>|t|)
(Intercept)                        -0.138959   0.046595  -2.982  0.00333 **
`Internet use (mean hours per week)`  0.009101   0.008696   1.047  0.29697
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.5267 on 153 degrees of freedom
  (9 observations deleted due to missingness)
Multiple R-squared:  0.007107,  Adjusted R-squared:  0.0006178
F-statistic: 1.095 on 1 and 153 DF,  p-value: 0.297
```

```
summary(lm(DepressionChange ~ log(`Internet use (mean hours per week)`+.0001),
          data=depress,subset=-hlev))
```

```
Call:
lm(formula = DepressionChange ~ log(`Internet use (mean hours per week)` +
    1e-04), data = depress, subset = -hlev)
```

```
Residuals:
    Min      1Q  Median      3Q     Max
-2.0721 -0.2112  0.0128  0.2502  2.7098

Coefficients:
                                                 Estimate Std. Error t value
(Intercept)                                     -0.110741   0.045264  -2.447
log(`Internet use (mean hours per week)` + 1e-04)  0.007048   0.014309   0.493
                                                Pr(>|t|)
(Intercept)                                       0.0156 *
log(`Internet use (mean hours per week)` + 1e-04)   0.6230
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.5281 on 153 degrees of freedom
  (9 observations deleted due to missingness)
Multiple R-squared:  0.001583,  Adjusted R-squared:  -0.004942
F-statistic: 0.2426 on 1 and 153 DF,  p-value: 0.623
```

## Sensitivity Analyses

### Outliers

Look at sensitivity to the outliers identified above.

```
summary(lm(DepressionChange ~ `Internet use (mean hours per week)`,
           data=depress,subset=-hchange))
```

```
Call:
lm(formula = DepressionChange ~ `Internet use (mean hours per week)`,
    data = depress, subset = -hchange)

Residuals:
     Min       1Q   Median       3Q      Max
-1.00055 -0.23690  0.02088  0.21819  0.95097

Coefficients:
                                  Estimate Std. Error t value Pr(>|t|)
(Intercept)                      -0.134920   0.032968  -4.092 6.95e-05 ***
```

```
`Internet use (mean hours per week)`  0.006176   0.006584   0.938     0.35
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.3694 on 150 degrees of freedom
  (9 observations deleted due to missingness)
Multiple R-squared:  0.005832,  Adjusted R-squared:  -0.0007962
F-statistic: 0.8799 on 1 and 150 DF,  p-value: 0.3497
```

```
summary(lm(DepressionChange ~ log(`Internet use (mean hours per week)`+.0001),
          data=depress,subset=-hchange))
```

```
Call:
lm(formula = DepressionChange ~ log(`Internet use (mean hours per week)` +
    1e-04), data = depress, subset = -hchange)

Residuals:
     Min       1Q   Median       3Q      Max
-1.01200 -0.19932  0.01898  0.22213  0.93676

Coefficients:
                                                 Estimate Std. Error t value
(Intercept)                                     -0.113503   0.032141  -3.531
log(`Internet use (mean hours per week)` + 1e-04)  0.007466   0.010123   0.738
                                                Pr(>|t|)
(Intercept)                                     0.000549 ***
log(`Internet use (mean hours per week)` + 1e-04) 0.461939
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.3698 on 150 degrees of freedom
  (9 observations deleted due to missingness)
Multiple R-squared:  0.003613,  Adjusted R-squared:  -0.003029
F-statistic: 0.544 on 1 and 150 DF,  p-value: 0.4619
```

### Internet Vegans

Take a closer look at the people who spend 0 hours per week on the internet. Call them *Internet Vegans*. Look at the sensitivity to them.

```r
vegans <- which(depress$`Internet use (mean hours per week)`<.0005)
summary(lm(DepressionChange ~ `Internet use (mean hours per week)`,
          data=depress,subset=-vegans))
```

```
Call:
lm(formula = DepressionChange ~ `Internet use (mean hours per week)`,
    data = depress, subset = -vegans)

Residuals:
     Min       1Q   Median       3Q      Max
-2.05730 -0.27993  0.02558  0.25470  2.73207

Coefficients:
                                    Estimate Std. Error t value Pr(>|t|)
(Intercept)                        -0.142527   0.052922  -2.693  0.00791 **
`Internet use (mean hours per week)`  0.009160   0.009312   0.984  0.32694
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.5721 on 145 degrees of freedom
  (9 observations deleted due to missingness)
Multiple R-squared:  0.006628,  Adjusted R-squared:  -0.0002224
F-statistic: 0.9675 on 1 and 145 DF,  p-value: 0.3269
```

```r
summary(lm(DepressionChange ~ log(`Internet use (mean hours per week)`+.0001),
          data=depress,subset=-vegans))
```

```
Call:
lm(formula = DepressionChange ~ log(`Internet use (mean hours per week)` +
    1e-04), data = depress, subset = -vegans)

Residuals:
     Min       1Q   Median       3Q      Max
-2.07530 -0.26061  0.02199  0.25812  2.71229

Coefficients:
                                                Estimate Std. Error t value
```

```
(Intercept)                                          -0.11417    0.04806  -2.375
log(`Internet use (mean hours per week)` + 1e-04)  0.01405    0.02518   0.558
                                                    Pr(>|t|)
(Intercept)                                           0.0188 *
log(`Internet use (mean hours per week)` + 1e-04)   0.5778
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.5734 on 145 degrees of freedom
  (9 observations deleted due to missingness)
Multiple R-squared:  0.002141,  Adjusted R-squared:  -0.004741
F-statistic: 0.3112 on 1 and 145 DF,  p-value: 0.5778
```