Relations between Neural Reward Regions, ELS, and Social Support

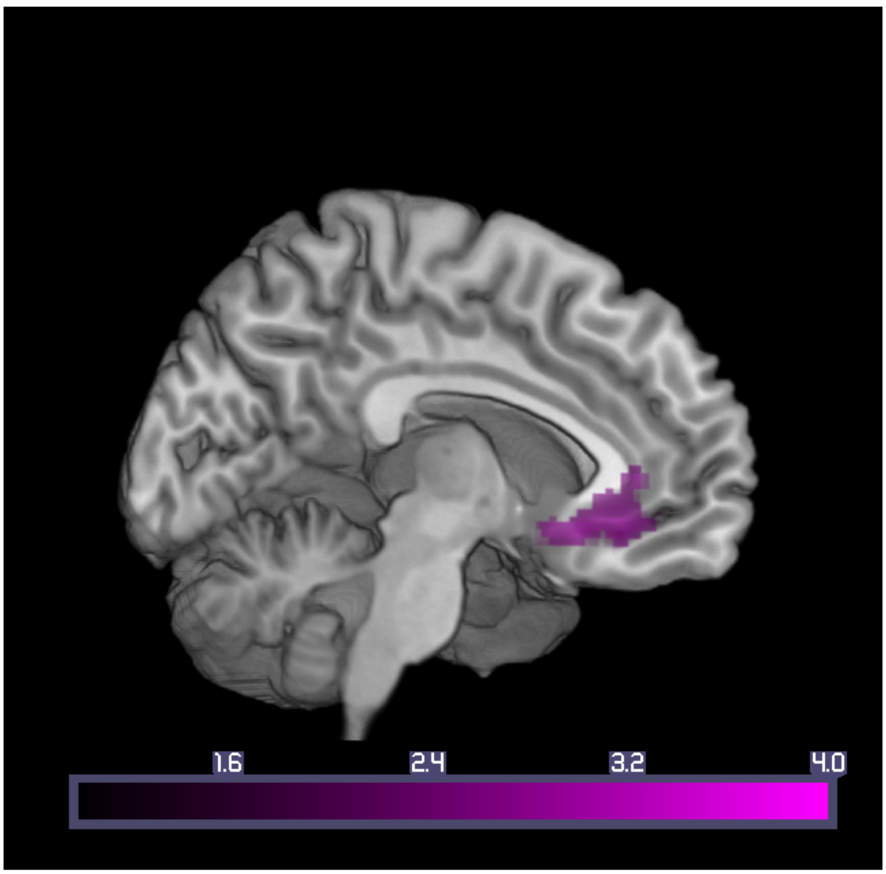
subgenual cingulate, vmPFC (Brodmann's areas 25 and 11)

```
require(ggplot2)
```

```
## Loading required package: ggplot2
```

```
setwd("~/Documents/ELS/KIDMID/Analysis/ROI/52N_MSPSS.total")  #sgACC region from ant loss > gain cope 2
d = read.csv("anticipation_58subs_sgACC05-Sep-2014.csv") #contains ant PEs (1-4), ELS, MSPSS, age, and
```

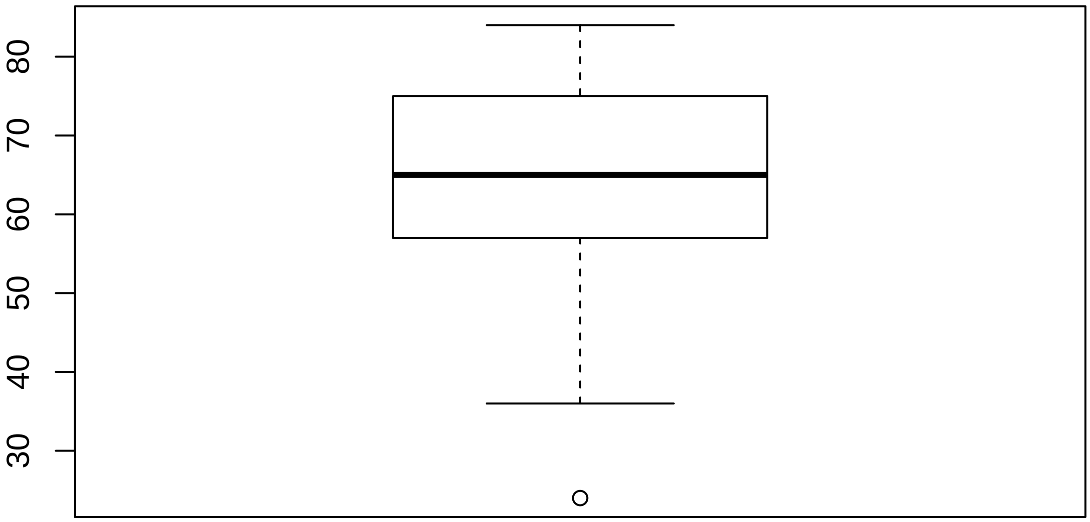
```
library("png")
library("grid")
sgACC = readPNG("~/Documents/ELS/KIDMID/Analysis/ROI/52N_MSPSS.total/sgACC.png")
  grid.raster(sgACC)
```




```
#<img src="~/Documents/ELS/KIDMID/Analysis/ROI/52N_MSPSS.total/sgACC.png" / >
#![sgACC]("~/Documents/ELS/KIDMID/Analysis/ROI/52N_MSPSS.total/sgACC.png")
```

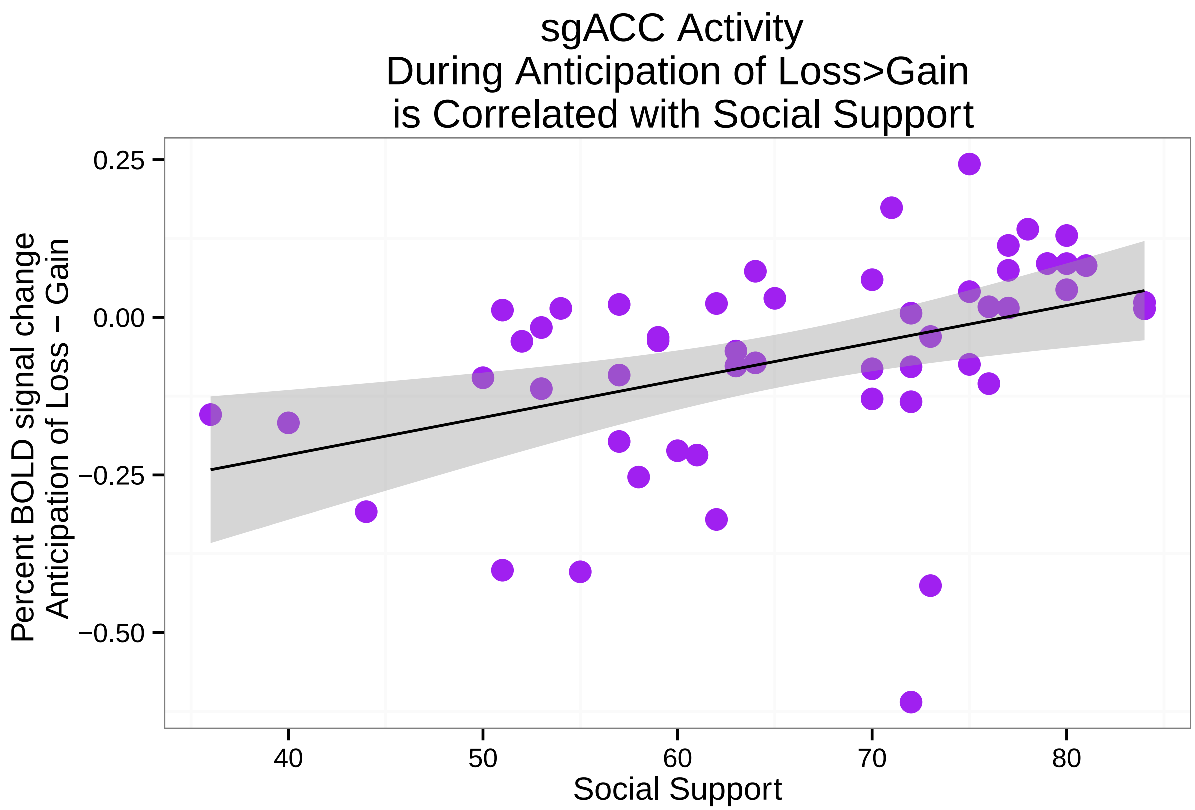
The whole-brain MSPSS analyses excluded subject 17, which is an outlier for social support. Accordingly, I will exclude this participant when calculating the correlation coefficient and plotting the relation between social support and neural activation in sgACC for anticipation of loss > gain.

```r
#removing ss outlier
boxplot(d$ss.total) ## sub 17 is an outlier
```



Above shows a boxplot for the social support data - sub 17 is excluded (total social support score = 24) in below analyses.

```r
d1 = d[-c(1,2,3,4,5,14),]
d1$lossvgain = d1$antloss - d1$antgain #contrast of ant loss > gain

ggplot(d1, aes(x=ss.total, y=lossvgain)) +
  geom_point(size=4, color="purple") +
  theme_bw() +
  theme(panel.grid.major = element_blank(), plot.title = element_text(size = 15, hjust=0.5)) +
  labs(x = "Social Support", y = "Percent BOLD signal change \n Anticipation of Loss - Gain") +
  ggtitle("sgACC Activity \n During Anticipation of Loss>Gain \n is Correlated with Social Support") +
  geom_smooth(method=lm, color="black")
```




```r
cor1 = cor.test(d1$lossvgain, d1$ss.total)
cor1
```

```
##
##  Pearson's product-moment correlation
##
## data:  d1$lossvgain and d1$ss.total
## t = 3.263, df = 50, p-value = 0.001989
## alternative hypothesis: true correlation is not equal to 0
## 95 percent confidence interval:
##  0.1650 0.6209
## sample estimates:
##   cor
## 0.419
```

```r
summary(lm(d1$lossvgain ~ d1$ss.total)) # r = .419, p = .002
```

```
##
## Call:
## lm(formula = d1$lossvgain ~ d1$ss.total)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -0.5816 -0.0677  0.0282  0.1002  0.2540
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
```

```
## (Intercept) -0.45486    0.12110   -3.76  0.00045 ***
## d1$ss.total  0.00592    0.00181    3.26  0.00199 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.152 on 50 degrees of freedom
## Multiple R-squared:  0.176,  Adjusted R-squared:  0.159
## F-statistic: 10.6 on 1 and 50 DF,  p-value: 0.00199
```

```
summary(lm(d1$lossvgain ~ d1$ss.total + d1$Age.at.scan)) # still holds controlling for age
```

```
##
## Call:
## lm(formula = d1$lossvgain ~ d1$ss.total + d1$Age.at.scan)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -0.5817 -0.0682  0.0286  0.1008  0.2539
##
## Coefficients:
##                Estimate Std. Error t value Pr(>|t|)
## (Intercept)    -0.44424    0.27602   -1.61   0.1140
## d1$ss.total     0.00593    0.00184    3.22   0.0023 **
## d1$Age.at.scan -0.00096    0.02234   -0.04   0.9659
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.153 on 49 degrees of freedom
## Multiple R-squared:  0.176,  Adjusted R-squared:  0.142
## F-statistic: 5.22 on 2 and 49 DF,  p-value: 0.00881
```

```
summary(lm(d1$lossvgain ~ d1$ss.total + d1$Sex)) #still holds controlling for gender
```

```
##
## Call:
## lm(formula = d1$lossvgain ~ d1$ss.total + d1$Sex)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -0.5570 -0.0599  0.0277  0.0937  0.2407
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) -0.42293    0.12653   -3.34   0.0016 **
## d1$ss.total  0.00567    0.00184    3.08   0.0033 **
## d1$SexM     -0.03870    0.04342   -0.89   0.3772
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.152 on 49 degrees of freedom
## Multiple R-squared:  0.189,  Adjusted R-squared:  0.156
## F-statistic:  5.7 on 2 and 49 DF,  p-value: 0.00595
```

```r
summary(lm(d1$antloss ~ d1$ss.total)) # r = .26, p = .06
```

```
##
## Call:
## lm(formula = d1$antloss ~ d1$ss.total)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -0.6899 -0.2206  0.0315  0.1793  0.6824
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) -0.72690    0.24824   -2.93   0.0051 **
## d1$ss.total  0.00716    0.00372    1.92   0.0599 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.311 on 50 degrees of freedom
## Multiple R-squared:  0.069,  Adjusted R-squared:  0.0504
## F-statistic: 3.71 on 1 and 50 DF,  p-value: 0.0599
```

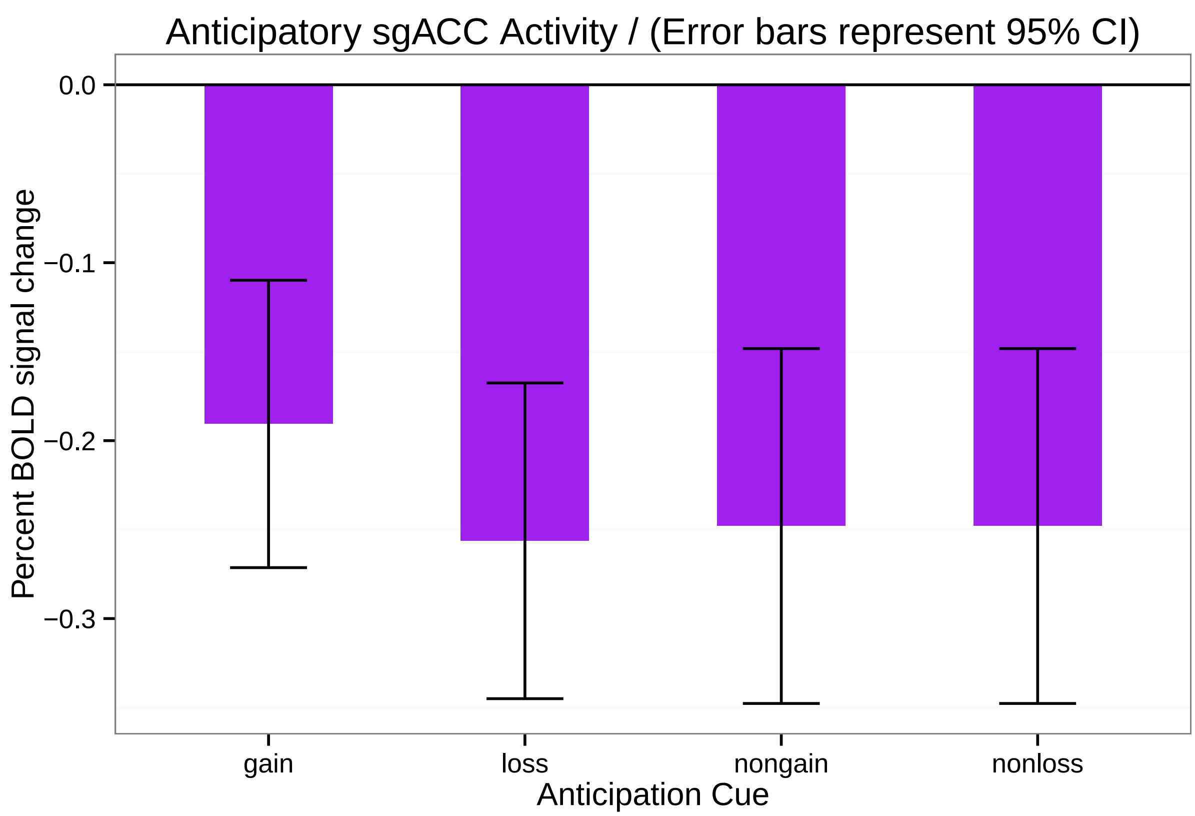
```r
summary(lm(d1$antgain ~ d1$ss.total)) # r = .05, p = .725
```

```
##
## Call:
## lm(formula = d1$antgain ~ d1$ss.total)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -0.6937 -0.1520  0.0413  0.1845  0.7713
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) -0.27203    0.23385   -1.16     0.25
## d1$ss.total  0.00124    0.00350    0.35     0.73
##
## Residual standard error: 0.293 on 50 degrees of freedom
## Multiple R-squared:  0.00249,    Adjusted R-squared:  -0.0175
## F-statistic: 0.125 on 1 and 50 DF,  p-value: 0.725
```

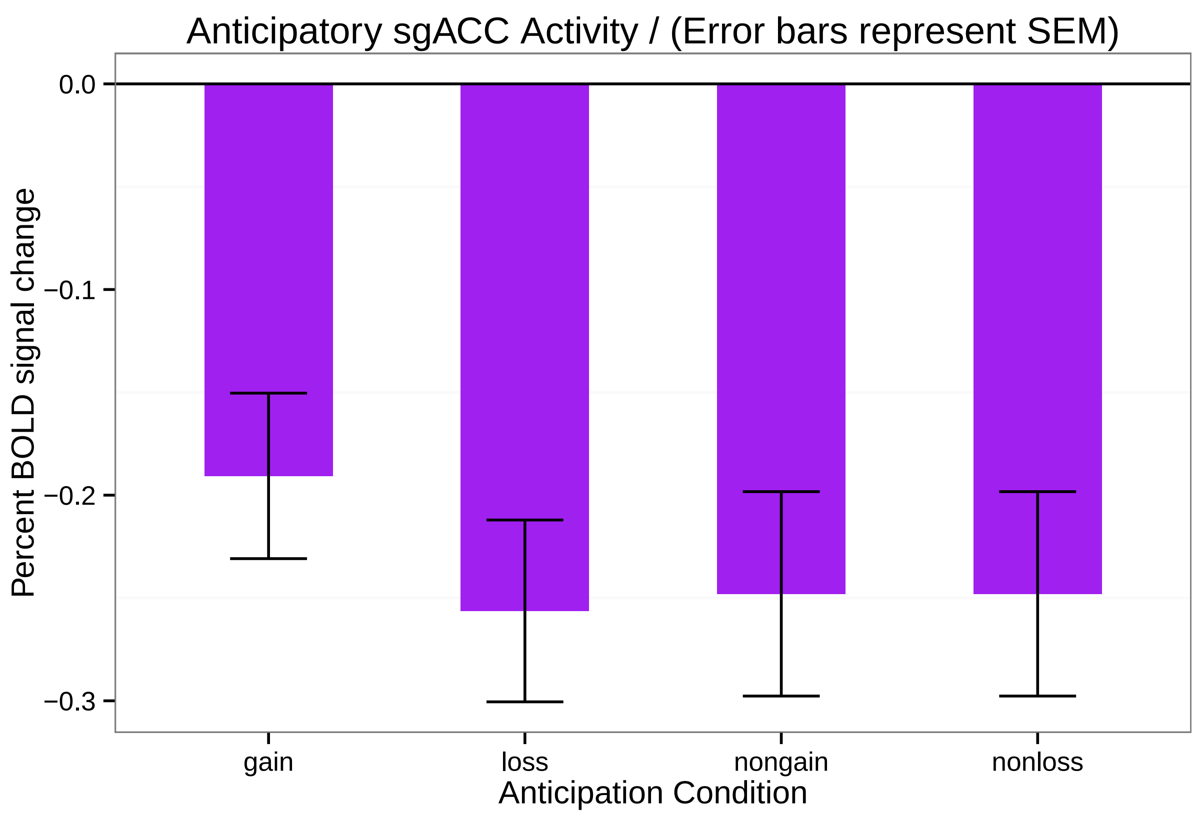
The correlation between activity in this region and social support seems to be strongest when considering the difference between anticipatory activity for gains v losses ($r = .419$, $p = .002$). When examining the relation between social support and anticipation of losses > baseline, the correlation is weaker ($r = .26$, $p = .06$), and it is non-existent for the anticipation of gains > baseline ($r = .05$, $p = .73$). This finding is a little puzzling in light of the below bar graph, which shows that the difference between anticipation of gains and losses is driven by the anticipation of gains.

```r
#create dataframe to make bargraphs
anticipation = c(d1$antgain,d1$antloss,d1$antnongain,d1$antnongain)
condition = c(rep(x = "gain",times = 52), rep(x = "loss", times = 52), rep(x = "nongain", times = 52), :
brainbar = data.frame(condition,anticipation)
```

```
sgACC.summary = data.frame(
  condition = levels(brainbar$condition),
  mean = tapply(brainbar$anticipation, brainbar$condition, mean),
  n = tapply(brainbar$anticipation, brainbar$condition, length),
  sd = tapply(brainbar$anticipation, brainbar$condition, sd)
  )

#calculate standard error of the mean
sgACC.summary$sem = sgACC.summary$sd/sqrt(sgACC.summary$n)

#calculate margin of error for CI
alpha = .05 #95% confidence interval
sgACC.summary$me = qt(1-alpha/2, df = sgACC.summary$n)*sgACC.summary$sem

#error bars represent 95% CI
#png('barplot.CI.vSTR.anticipation.png')
g1.CI = ggplot(sgACC.summary, aes(x = condition, y = mean)) +
  geom_bar(position = position_dodge(), stat="identity", fill="purple", width=.5) +
  geom_errorbar(aes(ymin=mean-me, ymax=mean+me), width=.3) +
  ggtitle("Anticipatory sgACC Activity / (Error bars represent 95% CI)") + # plot title
  geom_hline(yintercept=0, linetype = 1) +
  labs(x = "Anticipation Cue", y = "Percent BOLD signal change") +
  theme_bw() +
  #theme_classic()
  theme(panel.grid.major = element_blank()) # remove x and y major grid lines
print(g1.CI)
```



```r
#dev.off()

#error bars represent standard error of the mean
g1.SE = ggplot(sgACC.summary, aes(x = condition, y = mean)) +
  geom_bar(position = position_dodge(), stat="identity", fill="purple", width=.5) +
  geom_errorbar(aes(ymin=mean-sem, ymax=mean+sem), width=.3) +
  labs(x = "Anticipation Condition", y = "Percent BOLD signal change") +
  ggtitle("Anticipatory sgACC Activity / (Error bars represent SEM)") +
  geom_hline(yintercept=0, linetype = 1) +
  theme_bw() +
  theme(panel.grid.major = element_blank())
print(g1.SE)
```




```r
# boxplot(d1$antloss,d1$antgain)
# antgain.out = boxplot.stats(d1$antgain, do.out=TRUE)
# antgain.out$out  #sub 58, 65, 72

# d2 = d1[-c(40, 46, 51),]
# cor4 = cor.test(d2$lossvgain, d2$ss.total)
# cor4
# ggplot(d2, aes(x=ss.total, y=lossvgain)) +
#   geom_point(size=4, color="purple") +
#   theme_bw() +
#   theme(panel.grid.major = element_blank(), plot.title = element_text(size = 15, hjust=0.5)) +
#   labs(x = "Social Support", y = "Percent BOLD signal change \n Anticipation of Loss - Gain") +
#   ggtitle("sgACC Activity \n During Anticipation of Loss>Gain \n is Correlated with Social Support")
#   geom_smooth(method=lm, color="black")
```

```r
r1 = t.test(d$antgain, d$antloss, paired=TRUE)
r1
```

```
##
##  Paired t-test
##
## data:  d$antgain and d$antloss
## t = 2.663, df = 57, p-value = 0.01005
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  0.01413 0.09981
## sample estimates:
## mean of the differences
##                 0.05697
```

```r
r2 = t.test(d$antloss, d$antnonloss, paired = TRUE)
r2
```

```
##
##  Paired t-test
##
## data:  d$antloss and d$antnonloss
## t = -0.4497, df = 57, p-value = 0.6546
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.08185  0.05183
## sample estimates:
## mean of the differences
##                -0.01501
```

```r
r3 = t.test(d$antgain, d$antnongain, paired=TRUE)
r3
```

```
##
##  Paired t-test
##
## data:  d$antgain and d$antnongain
## t = 2.155, df = 57, p-value = 0.03539
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  0.004551 0.123978
## sample estimates:
## mean of the differences
##                 0.06426
```

```r
cor1 = cor.test(d$antloss,d$ss.total, na.action=na.omit)
cor2 = cor.test(d1$antloss,d1$ss.total)
d$lossvgain = d$antloss - d$antgain
```

The relation with social support holds when controlling for ELS. There are no main effects of ELS and there is no interaction between social support and ELS in this region during anticipation.

```r
a = summary(lm(d1$lossvgain ~ d1$ss.total + d1$TotEventsExpUSE))
b = summary(lm(d1$lossvgain ~ d1$ss.total + d1$TotChildSubjRatUSE))
c = summary(lm(d1$lossvgain ~ d1$ss.total + d1$TotNumCategUSE))

#nothing sig for ant gain or ant loss
e = summary(lm(d1$antloss ~ d1$ss.total + d1$TotEventsExpUSE))
f = summary(lm(d1$antloss ~ d1$ss.total + d1$TotChildSubjRatUSE))
g = summary(lm(d1$antloss ~ d1$ss.total + d1$TotNumCategUSE))

h = summary(lm(d1$lossvgain ~ d1$ss.total * d1$TotEventsExpUSE))
i = summary(lm(d1$lossvgain ~ d1$ss.total * d1$TotChildSubjRatUSE))
j = summary(lm(d1$lossvgain ~ d1$ss.total * d1$TotNumCategUSE))

k = summary(lm(d$lossvgain ~ d$TotEventsExpUSE))
l = summary(lm(d$lossvgain ~ d$TotChildSubjRatUSE))
m = summary(lm(d$lossvgain ~ d$TotNumCategUSE))

n = summary(lm(d$antgain ~ d$TotEventsExpUSE))
o = summary(lm(d$antgain ~ d$TotChildSubjRatUSE))
p = summary(lm(d$antgain ~ d$TotNumCategUSE))

q = summary(lm(d$antgain ~ d$TotEventsExpUSE))
r = summary(lm(d$antgain ~ d$TotChildSubjRatUSE))
s = summary(lm(d$antgain ~ d$TotNumCategUSE))
```

The relation with social support holds when controlling for age and gender.

```r
summary(lm(d1$lossvgain ~ d1$ss.total + d1$Age.at.scan + d1$Sex))
```

```
##
## Call:
## lm(formula = d1$lossvgain ~ d1$ss.total + d1$Age.at.scan + d1$Sex)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -0.5543 -0.0558  0.0268  0.0929  0.2402
##
## Coefficients:
##                Estimate Std. Error t value Pr(>|t|)
## (Intercept)    -0.48287    0.27970   -1.73   0.0907 .
## d1$ss.total     0.00560    0.00188    2.97   0.0046 **
## d1$Age.at.scan  0.00567    0.02353    0.24   0.8107
## d1$SexM        -0.04212    0.04609   -0.91   0.3654
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.153 on 48 degrees of freedom
## Multiple R-squared:  0.19,   Adjusted R-squared:  0.139
## F-statistic: 3.75 on 3 and 48 DF,  p-value: 0.0169
```

```r
summary(lm(d1$lossvgain ~ d1$ss.fam + d1$Age.at.scan + d1$Sex))
```

```
##
```

```
## Call:
## lm(formula = d1$lossvgain ~ d1$ss.fam + d1$Age.at.scan + d1$Sex)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -0.5319 -0.0491  0.0380  0.0789  0.2394
##
## Coefficients:
##                 Estimate Std. Error t value Pr(>|t|)
## (Intercept)    -0.52644    0.29229   -1.80    0.078 .
## d1$ss.fam       0.01367    0.00513    2.67    0.010 *
## d1$Age.at.scan  0.01525    0.02359    0.65    0.521
## d1$SexM        -0.05756    0.04612   -1.25    0.218
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.156 on 48 degrees of freedom
## Multiple R-squared:  0.164,  Adjusted R-squared:  0.112
## F-statistic: 3.14 on 3 and 48 DF,  p-value: 0.0336
```

```r
summary(lm(d1$lossvgain ~ d1$ss.fam * d1$Age.at.scan + d1$Sex))
```

```
##
## Call:
## lm(formula = d1$lossvgain ~ d1$ss.fam * d1$Age.at.scan + d1$Sex)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -0.5349 -0.0583  0.0413  0.0864  0.1922
##
## Coefficients:
##                           Estimate Std. Error t value Pr(>|t|)
## (Intercept)               -3.5237     1.5627   -2.25    0.029 *
## d1$ss.fam                  0.1460     0.0680    2.15    0.037 *
## d1$Age.at.scan             0.2675     0.1313    2.04    0.047 *
## d1$SexM                   -0.0600     0.0449   -1.34    0.187
## d1$ss.fam:d1$Age.at.scan  -0.0111     0.0057   -1.95    0.057 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.151 on 47 degrees of freedom
## Multiple R-squared:  0.227,  Adjusted R-squared:  0.161
## F-statistic: 3.45 on 4 and 47 DF,  p-value: 0.015
```

```r
summary(lm(d1$lossvgain ~ d1$ss.fri + d1$Age.at.scan + d1$Sex))
```

```
##
## Call:
## lm(formula = d1$lossvgain ~ d1$ss.fri + d1$Age.at.scan + d1$Sex)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -0.5480 -0.0547  0.0201  0.0995  0.3001
```

```
##
## Coefficients:
##                  Estimate Std. Error t value Pr(>|t|)
## (Intercept)    -0.282665   0.272866   -1.04    0.305
## d1$ss.fri       0.011291   0.004347    2.60    0.012 *
## d1$Age.at.scan -0.000981   0.024653   -0.04    0.968
## d1$SexM        -0.050481   0.046609   -1.08    0.284
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.156 on 48 degrees of freedom
## Multiple R-squared:  0.159,  Adjusted R-squared:  0.106
## F-statistic: 3.02 on 3 and 48 DF,  p-value: 0.0389
```

```
summary(lm(d1$lossvgain ~ d1$ss.so + d1$Age.at.scan + d1$Sex))
```

```
##
## Call:
## lm(formula = d1$lossvgain ~ d1$ss.so + d1$Age.at.scan + d1$Sex)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -0.5317 -0.0466  0.0395  0.0853  0.2471
##
## Coefficients:
##                 Estimate Std. Error t value Pr(>|t|)
## (Intercept)    -0.41039    0.29524   -1.39    0.171
## d1$ss.so        0.00926    0.00491    1.89    0.065 .
## d1$Age.at.scan  0.01423    0.02442    0.58    0.563
## d1$SexM        -0.04702    0.04884   -0.96    0.340
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.161 on 48 degrees of freedom
## Multiple R-squared:  0.107,  Adjusted R-squared:  0.0508
## F-statistic: 1.91 on 3 and 48 DF,  p-value: 0.141
```

bilateral NAcc

```
require(ggplot2)
setwd("~/Documents/ELS/KIDMID/Analysis/ROI/58N_maineffect_HOatlas_union/")  #NAcc - conjuntion of H-O a
nacc = read.csv("ant+out_58subs_bilateralNAcc09-Sep-2014.csv") #contains ant PEs (1-4), ELS, MSPSS, age
```

```
library("png")
library("grid")
nacc.png = readPNG("~/Documents/ELS/KIDMID/Analysis/ROI/58N_maineffect_HOatlas_union/NAcc.png")
  grid.raster(nacc.png)
```

image.pdf