Supplemental: Data Analyses for Manuscript

Debbie Yee

6/22/2018

Study 1: Age-Related Differences in Motivational Integration and Cognitive Control: Liquid Feedback as Reinforcement

This is an analysis of subject task performance in study 1 in the motivation aging study, in which we examine age-related differences in how individuals integrate the motivational value of monetary and liquid studies, and whether and how this integrated motivational value interacts with cognitive control. In the study, subjects perform a cued task-switching paradigm, where they have classify a letter (vowel/consonant) or digit (odd/even). During the baseline runs, they don't receive any feedback and are told to respond "as quickly and accurate as possible." During the incentive runs, they receive a drop of liquid (2 mL) to indicate successful attainment of monetary reward in a single trial. Each subject performs 3 incentive runs in which they must respond accurately and faster than a criterion RT to earn monetary reward. Liquid feedback (blocked) served as reinforcement and signaled successful attainment of monetary reward. Criterion RT is calculated on subject performance during the baseline run (30%).

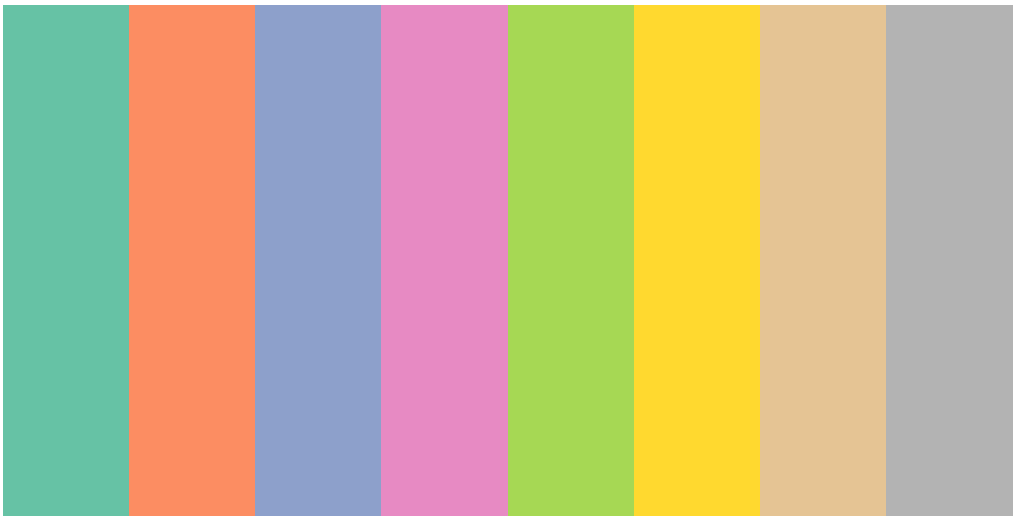
All relevant experimental scripts, subject data, and data analyses located in the online repository in Open Science Framework: https://osf.io/3mztb/

Loading relevant packages

```
library(ggplot2)
library(gridExtra)
library(dplyr)
library(tidyr)
library(broom)
library(lme4)
library(lmerTest)
library(sjPlot)
library(pander)
source("summarySEwithin2.R")
library(RColorBrewer)
```

Specify colors

```
display.brewer.pal(n = 8, name = 'Set2')
```



Set2 (qualitative)

```
brewer.pal(n = 8, name = "Set2")
```

```
## [1] "#66C2A5" "#FC8D62" "#8DA0CB" "#E78AC3" "#A6D854" "#FFD92F" "#E5C494"
## [8] "#B3B3B3"
```

```
colors.OAYA<-c("#66C2A5","#FC8D62")
```

Path directories of data input/output

```
# data directories
data.path<-paste0("/Users/debbieyee/Box Sync/CCPLab_Liquid_Studies_ARCHIVE/",
                  "2018_MotivationAging/Study1_OA_Reinforcement/SubjectData/",
                  "TrimmedData/OAYA_LiqPos_RewardData.csv")
data.path.base<-paste0("/Users/debbieyee/Box Sync/CCPLab_Liquid_Studies_ARCHIVE/",
                  "2018_MotivationAging/Study1_OA_Reinforcement/SubjectData/",
                  "TrimmedData/OAYA_LiqPos_BaselineData.csv")
data.path.selfreport<-paste0("/Users/debbieyee/Box Sync/CCPLab_Liquid_Studies_ARCHIVE/",
                       "2018_MotivationAging/Study1_OA_Reinforcement/SubjectData/Redcap/",
                       "OAYA_selfreport.csv")
runkey.path<-paste0("/Users/debbieyee/Box Sync/CCPLab_Liquid_Studies_ARCHIVE/",
                    "2018_MotivationAging/Study1_OA_Reinforcement/SubjectData/",
                    "TrimmedData/OAYA_LiqPos_runkey.csv")
figure.path<-paste0("/Users/debbieyee/Box Sync/CCPLab_Liquid_Studies_ARCHIVE/",
                    "2018_MotivationAging/MotivationAging_Analyses/Figures")
```

Format data for analysis

```
# Read in the data
data<-read.csv(data.path,header = TRUE) %>% select(-X)
```

```
data.base<-read.csv(data.path.base, header = TRUE) %>% select(-X)
runkey<-read.csv(runkey.path, header = TRUE) %>% filter(include=="yes")

# Formatting incentive data
incentive<- data %>% inner_join(y = runkey, by = c("subID","block","group"))  %>%
  mutate(subRewarded=(RT<critRT & ACC==1)*1,
         ERR=ifelse(ACC==0,1,0),
         condition="incentive",
         block=factor(block, levels=c(7,8,9), labels=c(1,2,3)),
         money=factor(rewType, levels=c("Reward1","Reward2","Reward4"), labels=c("$","$$","$$$$")),
         moneyCode=factor(rewType, levels=c("Reward1","Reward2","Reward4"), labels=c(-1,0,1)),
         moneyweight=factor(rewType, levels=c("Reward1","Reward2","Reward4"), labels=c(.25,.50,1)),
         liqCode=factor(liquid, levels=c("saltwater","neutral","juice"), labels=c(-1,0,1)),
         liqCodeJvN=factor(liquid, levels=c("saltwater","neutral","juice"), labels=c(0,-1,1)),
         liqCodeSvN=factor(liquid, levels=c("saltwater","neutral","juice"), labels=c(-1,1,0)),
         groupCode=factor(group, levels=c("YA","OA"), labels=c(0,1)),
         blockCode=factor(block, levels=c(1,2,3), labels=c(-1,0,1)))
incentive$moneyCode<-as.numeric(levels(incentive$moneyCode)[incentive$moneyCode])
incentive$moneyweight<-as.numeric(levels(incentive$moneyweight)[incentive$moneyweight])
incentive$liqCode<-as.numeric(levels(incentive$liqCode)[incentive$liqCode])
incentive$liqCodeJvN<-as.numeric(levels(incentive$liqCodeJvN)[incentive$liqCodeJvN])
incentive$liqCodeSvN<-as.numeric(levels(incentive$liqCodeSvN)[incentive$liqCodeSvN])
incentive$groupCode<-as.numeric(levels(incentive$groupCode)[incentive$groupCode])
incentive$blockCode<-as.numeric(levels(incentive$blockCode)[incentive$blockCode])
```

```
# Calculate average monetary earnings per group
test<-incentive %>% filter(group=="YA") %>% group_by(subID) %>%
  summarise(totalreward=sum(moneyearned))
mean(test$totalreward)
```

```
## [1] 4.499444
```

```
sd(test$totalreward)
```

```
## [1] 0.7665148
```

```
test<-incentive %>% filter(group=="OA") %>% group_by(subID) %>%
  summarise(totalreward=sum(moneyearned))
mean(test$totalreward)
```

```
## [1] 3.940227
```

```
sd(test$totalreward)
```

```
## [1] 0.7635672
```

Summarise/consolidate incentive data

```
# summarise means by subject
groupRT.means = incentive %>% group_by(subID, group) %>%
  filter(!is.na(subRewarded), ACC==1) %>% filter(!is.na(subRewarded), ACC==1) %>%
  summarise(n=n(),meanRT = mean(RT))
group.means = incentive %>% group_by(subID, group) %>% filter(!is.na(subRewarded)) %>%
  summarise(n=n(), meanRR = mean(subRewarded), seRR= sd(subRewarded)/sqrt(length(subRewarded)),
            meanACC = mean(ACC), meanERR = mean(ERR))
```

```r
# summarise means by monetary reward only
rewRT.means = incentive %>% group_by(subID, money, group) %>%
  filter(!is.na(subRewarded), ACC==1) %>% filter(!is.na(subRewarded), ACC==1) %>%
  summarise(n=n(),meanRT = mean(RT))
rew.means = incentive %>% group_by(subID,money, group) %>% filter(!is.na(subRewarded)) %>%
  summarise(n=n(), meanRR = mean(subRewarded), meanACC = mean(ACC), meanERR = mean(ERR))

# summarise means by liquid incentive type only
liqRT.means = incentive %>% group_by(subID, liquid, group, block) %>%
  filter(!is.na(subRewarded), ACC==1) %>%
  summarise(meanRT = mean(RT))
liq.means=incentive %>% group_by(subID, liquid, group, block) %>% filter(!is.na(subRewarded)) %>%
  summarise(n=n(), meanRR = mean(subRewarded), meanACC = mean(ACC), meanERR = mean(ERR))

# summarise the means of the incentive data for each subject, grouped by condition
incentive9RT.means <- incentive %>% group_by(subID, liquid, money, group, block) %>%
  filter(!is.na(subRewarded), ACC==1) %>% summarise(n=n(), meanRT = mean(RT)) %>%
  mutate(moneycode = as.numeric(as.character(factor(money,levels=c("$","$$","$$$$"),
                                                    labels=c(-1,0,1)))),
         liqcode = as.numeric(as.character(factor(liquid,levels=c("saltwater","neutral","juice"),
                                                  labels=c(-1,0,1))))) %>%
  ungroup(subID) %>% mutate(subID=as.factor(subID))
incentive9.means = incentive %>% group_by(subID, liquid, money, group, block) %>%
  filter(!is.na(subRewarded)) %>%
  summarise(n = n(), meanRR = mean(subRewarded), meanACC = mean(ACC), meanERR = mean(ERR)) %>%
  mutate(moneycode = as.numeric(as.character(factor(money,levels=c("$","$$","$$$$"),
                                                    labels=c(-1,0,1)))),
         liqcode = as.numeric(as.character(factor(liquid,levels=c("saltwater","neutral","juice"),
                                                  labels=c(-1,0,1))))) %>%
  ungroup(subID) %>% mutate(subID=as.factor(subID))
```

Monetary Rewards Improve Cognitive Task Performance for Both Older and Younger Adults

Plot: histogram of reward rate by age group

```
RR.sum=summarySE2(data=group.means, measurevar = "meanRR", groupvars = c("group"))
```

```
##
## Attaching package: 'data.table'
```

```
## The following objects are masked from 'package:dplyr':
##
##     between, first, last
```

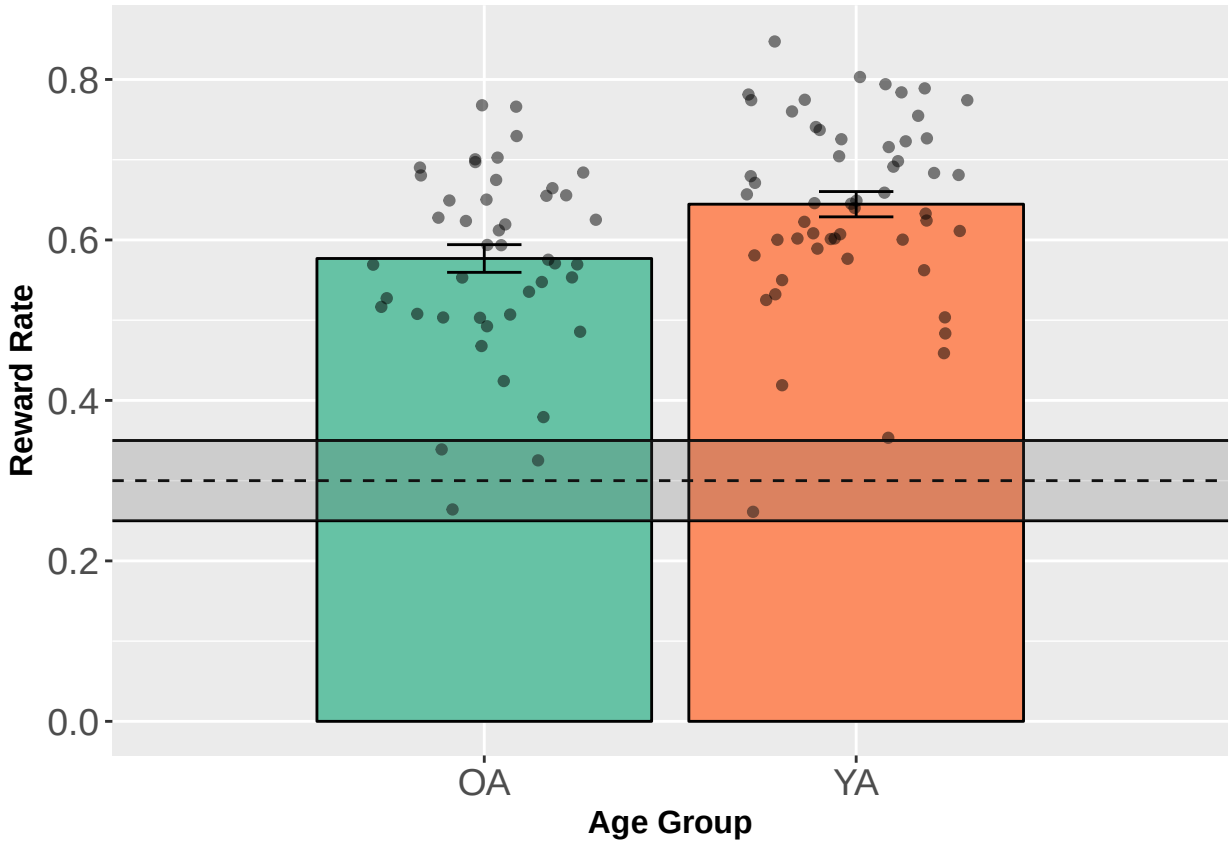
```
pandoc.table(RR.sum)
```

```
##
## ------------------------------------------------
##  group   N    meanRR     sd       se        ci
## ------- ---- -------- -------- --------- ---------
##   OA     44   0.5769   0.1146   0.01727   0.03483
##
##   YA     54   0.6445   0.1159   0.01577   0.03162
## ------------------------------------------------
```

```
p.RR.0<-ggplot() +
  geom_bar(data = RR.sum, aes(x=group, y=meanRR, fill=group),
           color="black",stat="identity") +
  geom_errorbar(data = RR.sum,
                mapping=aes(x=group, y=meanRR,
                            ymin=meanRR-se, ymax=meanRR+se),
                stat="identity", width=0.2) +
  geom_point(data = group.means, aes(x=group, y=meanRR),
             stat="identity", position=position_jitter(w=.3), alpha=0.5) +
  geom_hline(yintercept = .30, linetype="dashed") +
  geom_hline(yintercept = .35) +
  geom_hline(yintercept = .25) +
  annotate("rect", xmin = 0, xmax = 3, ymin = .25, ymax = .35,
        alpha = .2) +
  xlab("Age Group") + ylab("Reward Rate") +
  coord_cartesian(ylim=c(0,.85)) +
  scale_fill_brewer(palette="Set2") +
  theme(#plot.title=element_text(size=22,face="bold", vjust=2),
        axis.title=element_text(size=12,face = "bold"),
        axis.text=element_text(size=14),
        legend.position="none",
        strip.text.x = element_text(size = 12))
```

```
## Warning: Ignoring unknown aesthetics: y
```

```
p.RR.0
```



Binomial test

```
binom.test(x = 86, n = 288, p = .05, alternative = "two.sided")
```

```
##
##  Exact binomial test
##
## data:  86 and 288
## number of successes = 86, number of trials = 288, p-value <
## 2.2e-16
## alternative hypothesis: true probability of success is not equal to 0.05
## 95 percent confidence interval:
##  0.2463360 0.3550857
## sample estimates:
## probability of success
##              0.2986111
```

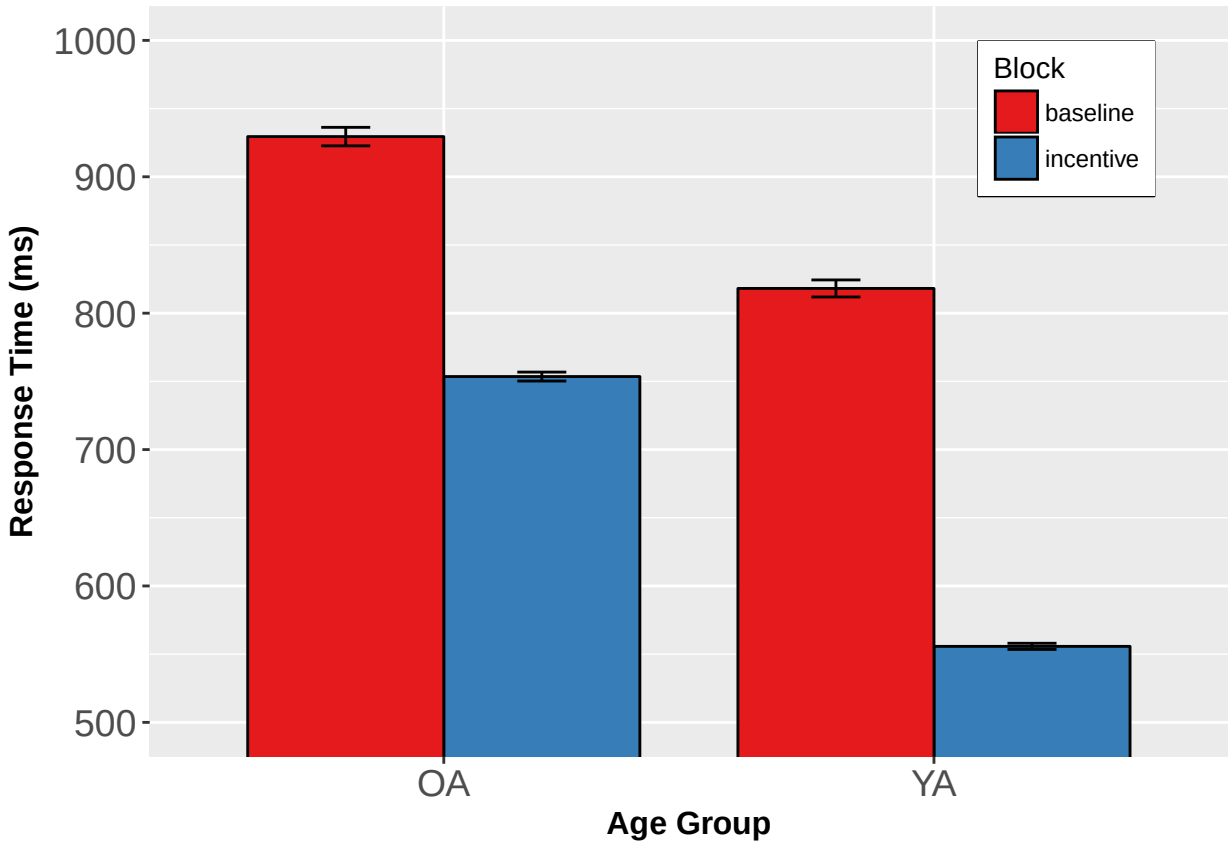
Plot: RT between baseline and incentive blocks.

```
# Merge baseline and incentive data
cond.RT.base <- data.base %>%
  mutate(block=0) %>%
  select(subID, group, Trial, RT, ACC, condition, block, taskswitch=taskSwitch) %>%
  filter(ACC==1)
cond.RT.rew <- incentive %>%
  select(subID, group, Trial, RT, ACC, condition, block, taskswitch) %>%
  filter(ACC==1)
cond.RT<-rbind(cond.RT.base,cond.RT.rew)

RT.sum=summarySEwithin2(data=cond.RT, measurevar = "RT", withinvars = c("condition"),
                        betweenvars = c("group"), idvar = "subID")
pandoc.table(RT.sum)
```

```
##
## ------------------------------------------------------------------------
##  group   condition     N      RT     RTNormed    sd      se      ci
## ------- ----------- ------- ------- ---------- ------- ------- -------
##   OA     baseline    3703    929.5    842.9     412.7   6.782   13.3
##
##   OA     incentive   10983   753.5    659.2     342.4   3.267   6.403
##
##   YA     baseline    4620    818.1    897.4     424.6   6.247   12.25
##
##   YA     incentive   12525   555.7    634.8     254.3   2.272   4.454
## ------------------------------------------------------------------------
```

```
p.RT.0<-ggplot(data = RT.sum, aes(x=group, y = RT, fill=condition)) +
  geom_bar(position=position_dodge(width=0.8), color="black",
           stat="identity", width=0.8) +
  geom_errorbar(position=position_dodge(width=0.8),
                aes(ymin=RT-se, ymax=RT+se), width=.2) +
  xlab("Age Group") + ylab("Response Time (ms)") +
  labs(fill = "Block") +
  coord_cartesian(ylim=c(500,1000)) +
  scale_fill_brewer(palette="Set1") +
  theme(#plot.title=element_text(size=22,face="bold", vjust=2),
    axis.title=element_text(size=12,face = "bold"),
    axis.text=element_text(size=14),
    legend.position=c(.85,.85),
    legend.box.background = element_rect(colour = "black"),
    strip.text.x = element_text(size = 12))
p.RT.0
```



RT by baseline vs incentive block for each age group

```
# consolidating RT data between baseline and incentive
cond.RT<-cond.RT %>%
  mutate(groupCode=factor(group, levels=c("YA","OA"), labels=c(0,1)),
         conditionCode=factor(condition, levels=c("baseline","incentive"), labels=c(1,0)))
cond.RT$groupCode<-as.numeric(levels(cond.RT$groupCode)[cond.RT$groupCode])
cond.RT$conditionCode<-as.numeric(levels(cond.RT$conditionCode)[cond.RT$conditionCode])

# summarizing to have one datapoint per subject per condition.
cond.RT.sum <- cond.RT %>% group_by(subID,group,condition) %>%
  summarise(meanRT = mean(RT))

# OA baseline vs incentive block
t.test(x = subset(cond.RT.sum, group=="OA" & condition=="baseline")$meanRT,
       y = subset(cond.RT.sum, group=="OA" & condition=="incentive")$meanRT,
       paired = TRUE)
```

```
##
##  Paired t-test
##
## data:  subset(cond.RT.sum, group == "OA" & condition == "baseline")$meanRT and subset(cond.RT.sum, g
## t = 11.035, df = 43, p-value = 4.001e-14
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
```

```
##  156.1623 226.0082
## sample estimates:
## mean of the differences
##                191.0853
```

```r
# YA baseline vs incentive block
t.test(x = subset(cond.RT.sum, group=="YA" & condition=="baseline")$meanRT,
       y = subset(cond.RT.sum, group=="YA" & condition=="incentive")$meanRT,
       paired = TRUE)
```

```
##
##  Paired t-test
##
## data:  subset(cond.RT.sum, group == "YA" & condition == "baseline")$meanRT and subset(cond.RT.sum, g
## t = 16.346, df = 53, p-value < 2.2e-16
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  235.1593 300.9423
## sample estimates:
## mean of the differences
##                268.0508
```

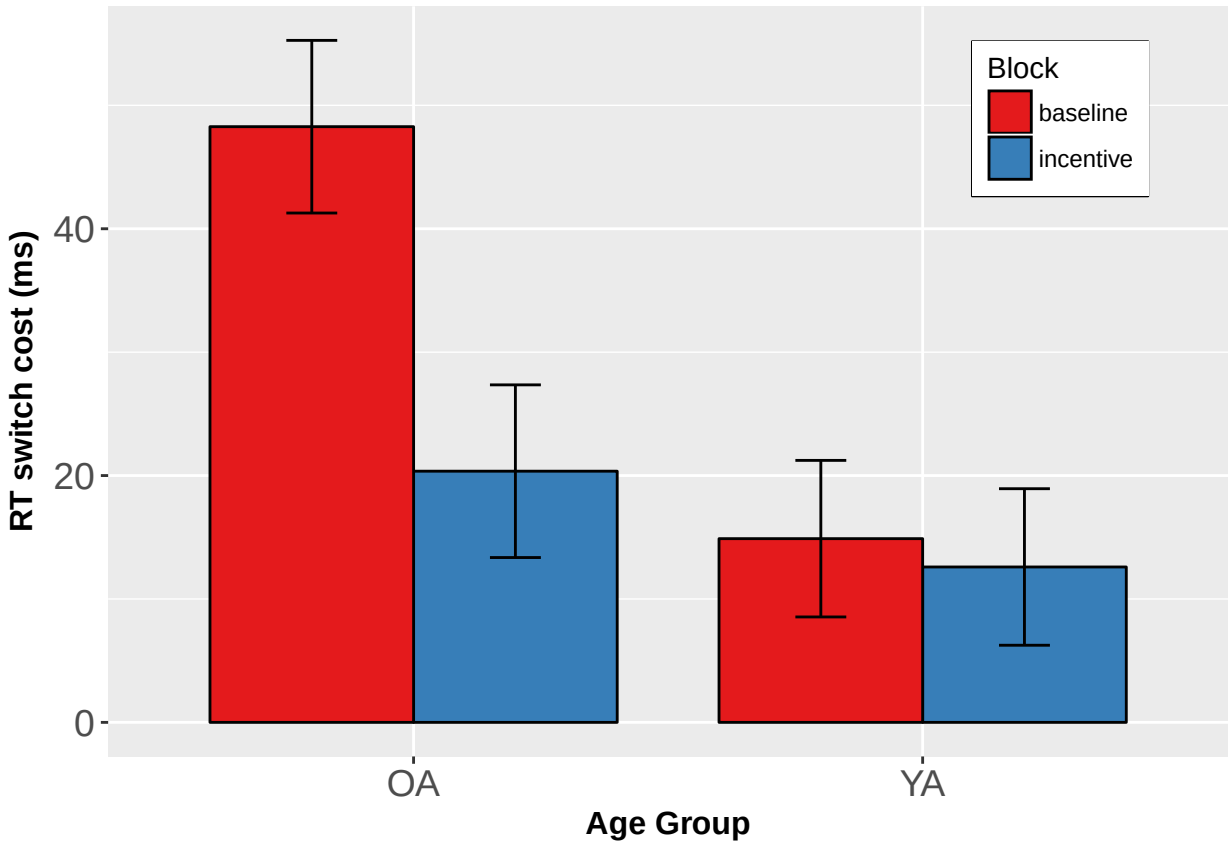
Plot: RT Switch costs between baseline and incentive blocks

```
cond.RT.switch <- cond.RT %>%
  group_by(subID,group,condition,taskswitch) %>%
  filter(Trial!=1, ACC==1) %>%
  summarise(meanRT = mean(RT)) %>%
  spread(key = taskswitch, value = meanRT) %>%
  rename(taskrepeat="0",taskswitch="1") %>%
  mutate(switchcost = taskswitch-taskrepeat)

SW.sum=summarySEwithin2(data=cond.RT.switch, measurevar = "switchcost",
                        withinvars = c("condition"), betweenvars = c("group"),
                        idvar = "subID")
pandoc.table(SW.sum)
```

```
##
## ------------------------------------------------------------------------------
##  group   condition   N    switchcost   switchcostNormed    sd      se      ci
## ------- ----------- ---- ------------ ------------------ ------- ------- -------
##   OA     baseline    44     48.27           35.47         46.4    6.995   14.11
##
##   OA     incentive   44     20.35           10.48         46.4    6.995   14.11
##
##   YA     baseline    54     14.89           24.12         46.61   6.343   12.72
##
##   YA     incentive   54     12.59           21.83         46.61   6.343   12.72
## ------------------------------------------------------------------------------
```

```
p.SW.1<-ggplot(data = SW.sum, aes(x=group, y = switchcost, fill=condition)) +
  geom_bar(position=position_dodge(width=0.8), color="black",
           stat="identity", width=0.8) +
  geom_errorbar(position=position_dodge(width=0.8),
                aes(ymin=switchcost-se, ymax=switchcost+se), width=.2) +
  xlab("Age Group") + ylab("RT switch cost (ms)") +
  labs(fill = "Block") +
  #coord_cartesian(ylim=c(500,1000)) +
  scale_fill_brewer(palette="Set1") +
  theme(#plot.title=element_text(size=22,face="bold", vjust=2),
    axis.title=element_text(size=12,face = "bold"),
    axis.text=element_text(size=14),
    legend.position=c(.85,.85),
    legend.box.background = element_rect(colour = "black"),
    strip.text.x = element_text(size = 12))
p.SW.1
```



RT switch costs analysis

```
# OA baseline vs incentive block
t.test(x = subset(cond.RT.switch, group=="OA" & condition=="baseline")$switchcost,
       y = subset(cond.RT.switch, group=="OA" & condition=="incentive")$switchcost,
       paired = TRUE)
```

```
##
##  Paired t-test
##
## data:  subset(cond.RT.switch, group == "OA" & condition == "baseline")$switchcost and subset(cond.RT
## t = 2.7703, df = 43, p-value = 0.008236
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##   7.594471 48.238163
## sample estimates:
## mean of the differences
##                27.91632
```

```
# YA baseline vs incentive block
t.test(x = subset(cond.RT.switch, group=="YA" & condition=="baseline")$switchcost,
       y = subset(cond.RT.switch, group=="YA" & condition=="incentive")$switchcost,
       paired = TRUE)
```

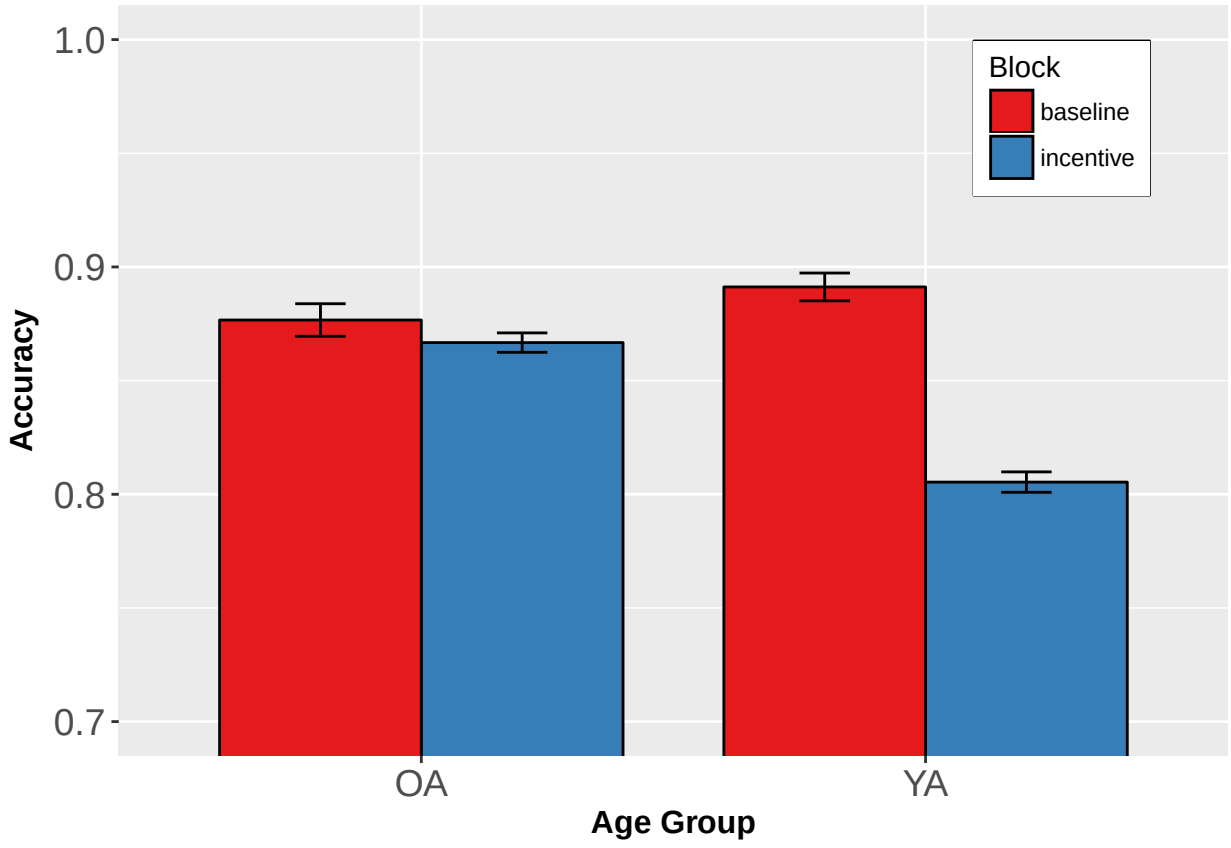
```
##
##  Paired t-test
```

```
##
## data:  subset(cond.RT.switch, group == "YA" & condition == "baseline")$switchcost and subset(cond.RT
## t = 0.25574, df = 53, p-value = 0.7991
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -15.69783  20.28578
## sample estimates:
## mean of the differences
##                2.293979
```

Plot: accuracy between baseline and incentive blocks

```
# Merge baseline and incentive data
cond.ACC.base <- data.base %>% mutate(block=0) %>%
  select(subID, group, Trial, RT, ACC, condition, block)
cond.ACC.rew <- incentive %>% select(subID, group, Trial, RT, ACC, condition, block)
cond.ACC<-rbind(cond.ACC.base,cond.ACC.rew)

ACC.sum=summarySEwithin2(data=cond.ACC, measurevar = "ACC", withinvars = c("condition"),
                         betweenvars = c("group"), idvar = "block")
p.ACC.0<-ggplot(data = ACC.sum, aes(x=group, y = ACC, fill=condition)) +
  geom_bar(position=position_dodge(width=0.8), color="black",
           stat="identity", width = 0.8) +
  geom_errorbar(position=position_dodge(width=0.8),
                aes(ymin=ACC-se, ymax=ACC+se), width=.2) +
  xlab("Age Group") + ylab("Accuracy") +
  labs(fill = "Block") +
  coord_cartesian(ylim=c(.7,1)) +
  scale_fill_brewer(palette="Set1") +
  theme(#plot.title=element_text(size=22,face="bold", vjust=2),
    axis.title=element_text(size=12,face = "bold"),
    axis.text=element_text(size=14),
    legend.position=c(.85,.85),
    legend.box.background = element_rect(colour = "black"),
    strip.text.x = element_text(size = 12))
p.ACC.0
```



Accuracy by baseline vs incentive block for each age group

```
# consolidating accuracy data between baseline and incentive
cond.ACC<-cond.ACC %>%
  mutate(groupCode=factor(group, levels=c("YA","OA"), labels=c(0,1)),
         conditionCode=factor(condition, levels=c("baseline","incentive"), labels=c(1,0)))
cond.ACC$groupCode<-as.numeric(levels(cond.ACC$groupCode)[cond.ACC$groupCode])
cond.ACC$conditionCode<-as.numeric(levels(cond.ACC$conditionCode)[cond.ACC$conditionCode])

# summarizing to have one datapoint per subject per condition.
cond.ACC.sum <- cond.ACC %>% group_by(subID,group,condition) %>%
  summarise(meanACC = mean(ACC))

# OA baseline vs incentive block
t.test(x = subset(cond.ACC.sum, group=="OA" & condition=="baseline")$meanACC,
       y = subset(cond.ACC.sum, group=="OA" & condition=="incentive")$meanACC,
       paired = TRUE)
```

```
##
##  Paired t-test
##
## data:  subset(cond.ACC.sum, group == "OA" & condition == "baseline")$meanACC and subset(cond.ACC.sum
## t = 0.58738, df = 43, p-value = 0.56
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.02419529  0.04408165
## sample estimates:
## mean of the differences
##             0.009943182
```

```
# YA baseline vs incentive block
t.test(x = subset(cond.ACC.sum, group=="YA" & condition=="baseline")$meanACC,
       y = subset(cond.ACC.sum, group=="YA" & condition=="incentive")$meanACC,
       paired = TRUE)
```

```
##
##  Paired t-test
##
## data:  subset(cond.ACC.sum, group == "YA" & condition == "baseline")$meanACC and subset(cond.ACC.sum
## t = 5.0377, df = 53, p-value = 5.814e-06
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  0.05166385 0.12001825
## sample estimates:
## mean of the differences
##              0.08584105
```

Generalized Linear Mixed Effects Models: Reward Rate Effects by Monetary Reward and Age

```
# Monetary Reward Effect
m.RR.money<-glmer(formula = subRewarded ~ moneyCode * groupCode + (1+moneyCode|subID),
          data = incentive, family = binomial)
summary(m.RR.money)
```

```
## Generalized linear mixed model fit by maximum likelihood (Laplace
##   Approximation) [glmerMod]
##  Family: binomial  ( logit )
## Formula: subRewarded ~ moneyCode * groupCode + (1 + moneyCode | subID)
##    Data: incentive
##
##      AIC      BIC   logLik deviance df.resid
##  36155.7  36213.4 -18070.9  36141.7    28217
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -2.5238 -1.0790  0.6020  0.7781  1.8581
##
## Random effects:
##  Groups Name        Variance Std.Dev. Corr
##  subID  (Intercept) 0.23811  0.4880
##         moneyCode   0.01212  0.1101   -0.16
## Number of obs: 28224, groups:  subID, 98
##
## Fixed effects:
##                     Estimate Std. Error z value Pr(>|z|)
## (Intercept)          0.63110    0.06859   9.201  < 2e-16 ***
## moneyCode            0.24920    0.02613   9.536  < 2e-16 ***
## groupCode           -0.30862    0.10215  -3.021  0.00252 **
## moneyCode:groupCode -0.16710    0.03835  -4.358 1.31e-05 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr) monyCd gropCd
## moneyCode   -0.075
## groupCode   -0.670  0.050
## mnyCd:grpCd  0.051 -0.681 -0.083
```

```
# YA
m.RR.money.YA <-glmer(formula = subRewarded ~ moneyCode + (1+moneyCode|subID),
          data = subset(incentive,groupCode==0), family = binomial)
summary(m.RR.money.YA)
```

```
## Generalized linear mixed model fit by maximum likelihood (Laplace
##   Approximation) [glmerMod]
##  Family: binomial  ( logit )
## Formula: subRewarded ~ moneyCode + (1 + moneyCode | subID)
##    Data: subset(incentive, groupCode == 0)
##
##      AIC      BIC   logLik deviance df.resid
```

```
##  19409.8  19448.0  -9699.9  19399.8    15547
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -2.5666 -1.0924  0.5779  0.7372  1.8434
##
## Random effects:
##  Groups Name        Variance Std.Dev. Corr
##  subID  (Intercept) 0.25574  0.5057
##         moneyCode   0.01781  0.1335   -0.05
## Number of obs: 15552, groups:  subID, 54
##
## Fixed effects:
##             Estimate Std. Error z value Pr(>|z|)
## (Intercept)  0.63220    0.07102   8.902   <2e-16 ***
## moneyCode    0.25050    0.02813   8.904   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##           (Intr)
## moneyCode -0.019
```

```
# OA
m.RR.money.OA <-glmer(formula = subRewarded ~ moneyCode + (1+moneyCode|subID),
          data = subset(incentive,group=="OA"), family = binomial)
summary(m.RR.money.OA)
```

```
## Generalized linear mixed model fit by maximum likelihood (Laplace
##   Approximation) [glmerMod]
##  Family: binomial  ( logit )
## Formula: subRewarded ~ moneyCode + (1 + moneyCode | subID)
##    Data: subset(incentive, group == "OA")
##
##      AIC      BIC   logLik deviance df.resid
##  16749.7  16786.9  -8369.8  16739.7    12667
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -1.7980 -1.0783  0.6617  0.8247  1.7064
##
## Random effects:
##  Groups Name        Variance Std.Dev. Corr
##  subID  (Intercept) 0.217087 0.46593
##         moneyCode   0.005865 0.07659  -0.39
## Number of obs: 12672, groups:  subID, 44
##
## Fixed effects:
##             Estimate Std. Error z value Pr(>|z|)
## (Intercept)  0.32200    0.07264   4.433 9.29e-06 ***
## moneyCode    0.08181    0.02542   3.218  0.00129 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
```

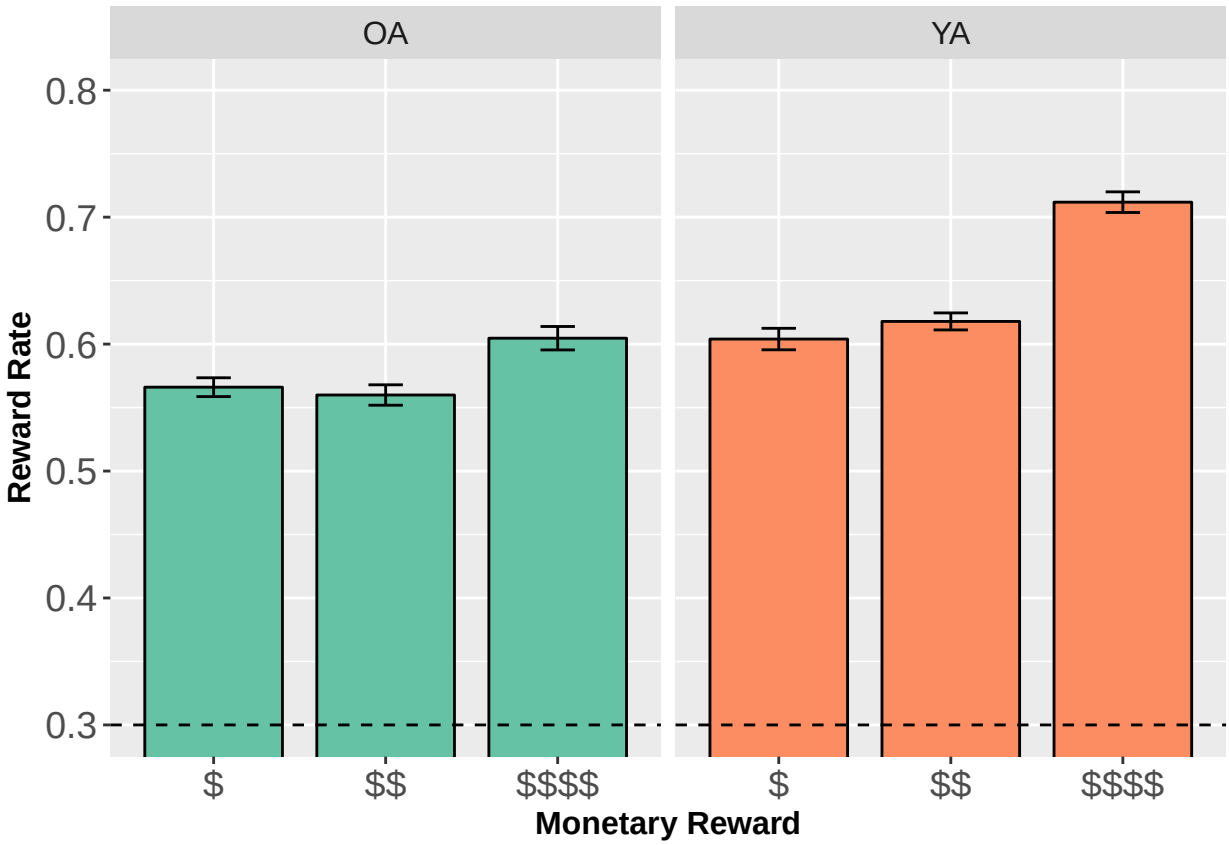
```
##            (Intr)
## moneyCode -0.171
```

Plot: barplot of reward rate by monetary reward and age group

```
RR.sum=summarySEwithin2(data=rew.means, measurevar = "meanRR", withinvars = c("money"),
                        betweenvars = c("group"), idvar = "subID")
pandoc.table(RR.sum)
```

```
##
## ------------------------------------------------------------------------
##  group   money   N    meanRR   meanRRNormed     sd          se         ci
## ------- ------- ---- -------- -------------- --------- ---------- ---------
##   OA       $     44   0.5661       0.6033      0.04918   0.007414   0.01495
##
##   OA      $$     44   0.5599       0.5972      0.05329   0.008034   0.0162
##
##   OA     $$$$    44   0.6046       0.6419      0.06127   0.009237   0.01863
##
##   YA       $     54   0.604        0.5736      0.06216   0.008459   0.01697
##
##   YA      $$     54   0.6179       0.5875      0.04929   0.006707   0.01345
##
##   YA     $$$$    54   0.7118       0.6814      0.05975   0.008131   0.01631
## ------------------------------------------------------------------------
```

```
p.RR.1<-ggplot(RR.sum, aes(x=money, y=meanRR,fill=group)) +
  geom_bar(position=position_dodge(width=0.8), color="black",
           stat="identity", width=0.8) +
  geom_errorbar(position=position_dodge(width=0.8),
                aes(ymin=meanRR-se, ymax=meanRR+se), width=.2) +
  facet_grid(.~group) +
  geom_hline(yintercept = .30, linetype="dashed") +
  xlab("Monetary Reward") + ylab("Reward Rate") +
  #ggtitle("Task Performance Across Money") +
  coord_cartesian(ylim=c(.3,.8)) +
  #scale_fill_discrete(name="Monetary Reward") +
  scale_fill_brewer(palette="Set2") +
  theme(#plot.title=element_text(size=22,face="bold", vjust=2),
        axis.title=element_text(size=12,face = "bold"),
        axis.text=element_text(size=14),
        legend.position="none",
        strip.text.x = element_text(size = 12))
p.RR.1
```

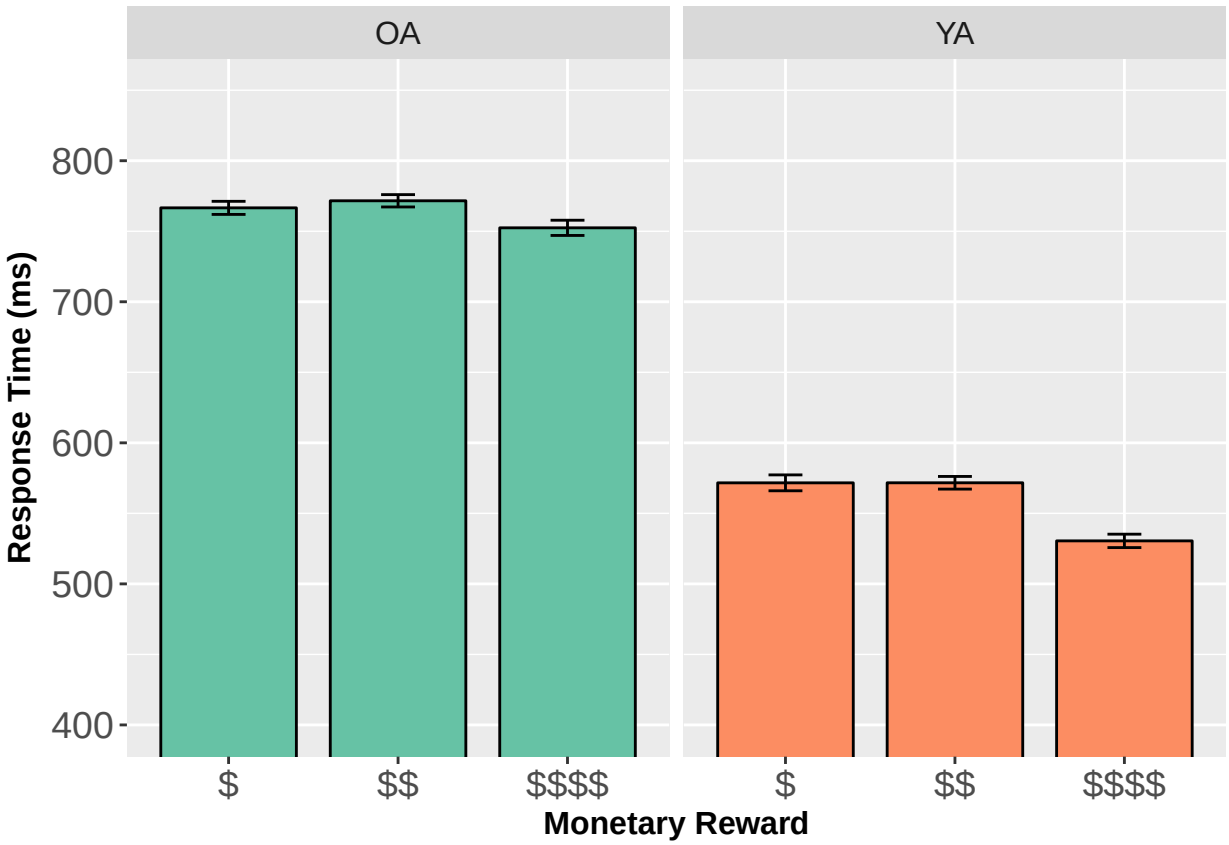

OA
YA
0.8
0.7
0.6
0.5
0.4
0.3
Reward Rate
$
$$
$$$$
$
$$
$$$$
Monetary Reward

Plot: RT by age group and money

```
RT.sum=summarySEwithin2(data=rewRT.means, measurevar = "meanRT", withinvars = c("money"),
                        betweenvars = c("group"), idvar = "subID")
pandoc.table(RT.sum)
```

```
##
## ------------------------------------------------------------------
##  group   money   N    meanRT   meanRTNormed    sd      se      ci
## ------- ------- ---- -------- -------------- ------- ------- -------
##   OA       $     44   766.6       653.3       30.77   4.639   9.355
##
##   OA      $$     44   771.6       658.3       29.02   4.374   8.822
##
##   OA     $$$$    44   752.4       639.1       35.8    5.397   10.88
##
##   YA       $     54   571.6       663.9       41.44   5.639   11.31
##
##   YA      $$     54   571.7        664        32.99   4.49    9.006
##
##   YA     $$$$    54   530.5       622.8       34.94   4.754   9.536
## ------------------------------------------------------------------
```

```
p.RT.1<-ggplot(RT.sum, aes(x=money, y=meanRT, fill=group)) +
  geom_bar(position=position_dodge(width=0.8), color="black",
           stat="identity", width=0.8) +
  geom_errorbar(position=position_dodge(width=0.8),
                aes(ymin=meanRT-se, ymax=meanRT+se), width=.2) +
  facet_grid(.~group) +
  xlab("Monetary Reward") + ylab("Response Time (ms)") +
  #ggtitle("Task Performance Across Money") +
  coord_cartesian(ylim=c(400,850)) +
  #scale_fill_discrete(name="Monetary Reward") +
  scale_fill_brewer(palette="Set2") +
  theme(#plot.title=element_text(size=22,face="bold", vjust=2),
        axis.title=element_text(size=12,face = "bold"),
        axis.text=element_text(size=14),
        legend.position="none",
        strip.text.x = element_text(size = 12))
p.RT.1
```


OA
YA
800
700
600
500
400
Response Time (ms)
$
$$
$$$$
$
$$
$$$$
Monetary Reward

Generalized Linear Mixed Effects Models of RT by Monetary Reward and Age Group

```
incentiveRT<- incentive %>% filter(ACC==1)

# Monetary Reward x Group Effects
m.RT.money <-lmer(formula = RT ~ moneyCode * groupCode + (1+moneyCode|subID),
          data = incentiveRT, REML = FALSE)
summary(m.RT.money)
```

```
## Linear mixed model fit by maximum likelihood t-tests use Satterthwaite
##   approximations to degrees of freedom [lmerMod]
## Formula: RT ~ moneyCode * groupCode + (1 + moneyCode | subID)
##    Data: incentiveRT
##
##       AIC       BIC    logLik  deviance  df.resid
##  318351.4  318415.9 -159167.7  318335.4     23500
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -5.5253 -0.5813 -0.1843  0.3304  6.9152
##
## Random effects:
##  Groups   Name        Variance Std.Dev. Corr
##  subID    (Intercept) 18453.4  135.84
##           moneyCode     427.9   20.69   -0.19
##  Residual             43503.7  208.58
## Number of obs: 23508, groups:  subID, 98
##
## Fixed effects:
##                     Estimate Std. Error      df t value Pr(>|t|)
## (Intercept)          557.859     18.583  97.870  30.021  < 2e-16 ***
## moneyCode            -21.130      3.635 100.930  -5.814 7.19e-08 ***
## groupCode            205.569     27.726  97.780   7.414 4.45e-11 ***
## moneyCode:groupCode   13.919      5.380  97.800   2.587   0.0111 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr) monyCd gropCd
## moneyCode   -0.146
## groupCode   -0.670  0.098
## mnyCd:grpCd  0.098 -0.676 -0.146
```

```
# YA
m.RT.money.YA <-lmer(formula = RT ~ moneyCode + (1+moneyCode|subID),
          data = subset(incentiveRT,group=="YA"))
summary(m.RT.money.YA)
```

```
## Linear mixed model fit by REML t-tests use Satterthwaite approximations
##   to degrees of freedom [lmerMod]
## Formula: RT ~ moneyCode + (1 + moneyCode | subID)
##    Data: subset(incentiveRT, group == "YA")
##
```

```
## REML criterion at convergence: 165228.7
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -2.8377 -0.5686 -0.1826  0.3125  8.2562
##
## Random effects:
##  Groups   Name        Variance Std.Dev. Corr
##  subID    (Intercept)  9260.8   96.23
##           moneyCode     614.1   24.78   -0.30
##  Residual             30669.9  175.13
## Number of obs: 12525, groups:  subID, 54
##
## Fixed effects:
##             Estimate Std. Error      df t value Pr(>|t|)
## (Intercept)  557.869     13.192  52.990  42.289  < 2e-16 ***
## moneyCode    -21.019      3.888  53.990  -5.407  1.5e-06 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##           (Intr)
## moneyCode -0.262
```

```
# OA
m.RT.money.OA <-lmer(formula = RT ~ moneyCode + (1+moneyCode|subID),
          data = subset(incentive,group=="OA"))
summary(m.RT.money.OA)
```

```
## Linear mixed model fit by REML t-tests use Satterthwaite approximations
##   to degrees of freedom [lmerMod]
## Formula: RT ~ moneyCode + (1 + moneyCode | subID)
##    Data: subset(incentive, group == "OA")
##
## REML criterion at convergence: 180042.8
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -3.4909 -0.5143 -0.1527  0.3869  4.5245
##
## Random effects:
##  Groups   Name        Variance Std.Dev. Corr
##  subID    (Intercept) 16829.1  129.73
##           moneyCode     160.5   12.67   0.11
##  Residual             85479.7  292.37
## Number of obs: 12672, groups:  subID, 44
##
## Fixed effects:
##             Estimate Std. Error      df t value Pr(>|t|)
## (Intercept)  739.524     19.729  43.000  37.484   <2e-16 ***
## moneyCode     -3.792      3.710  43.000  -1.022    0.312
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
```

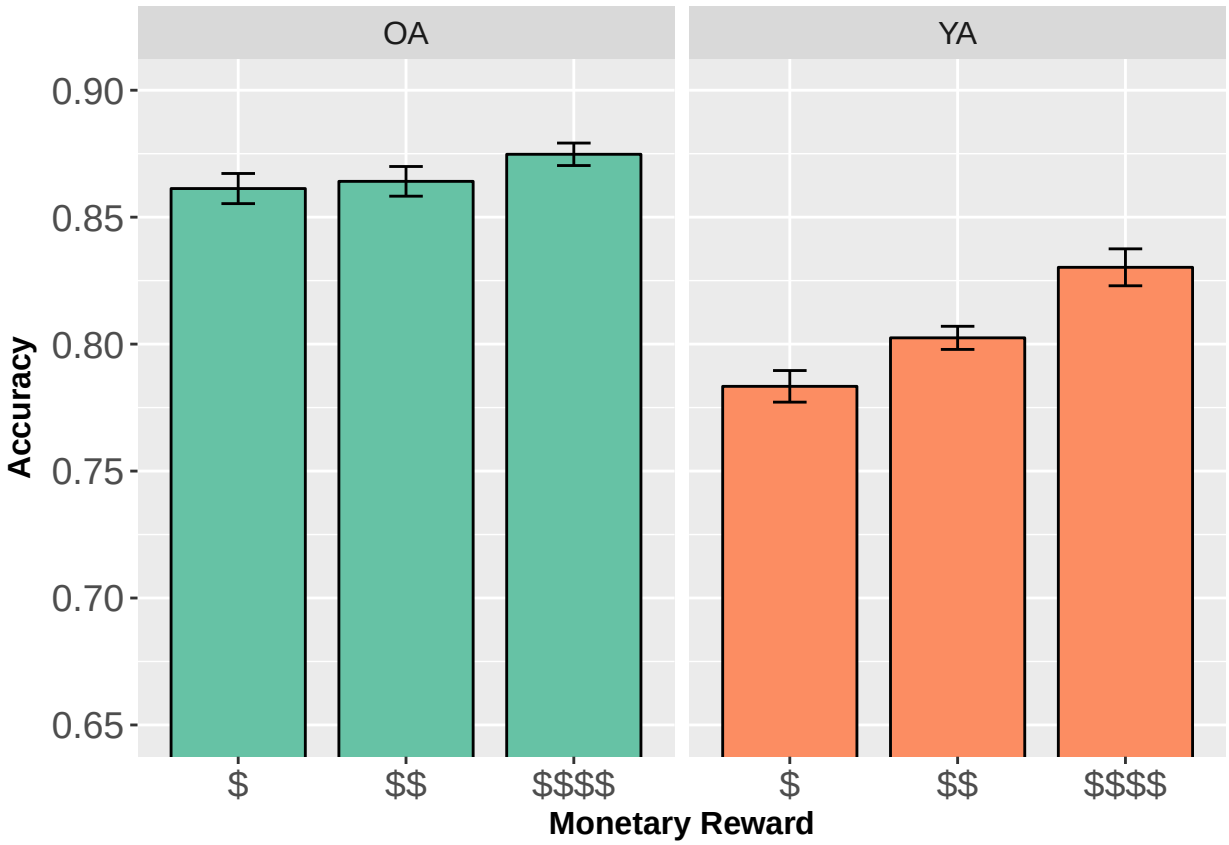
```
##           (Intr)
## moneyCode 0.054
```

Plot: Accuracy by age group and money

```
ACC.sum=summarySEwithin2(data=rew.means, measurevar = "meanACC", withinvars = c("money"),
                         betweenvars = c("group"), idvar = "subID")
pandoc.table(ACC.sum)
```

```
##
## ------------------------------------------------------------------------------
##  group   money   N    meanACC   meanACCNormed     sd          se          ci
## ------- ------- ---- --------- --------------- --------- ---------- ----------
##   OA       $     44   0.8613        0.8275       0.03938   0.005936   0.01197
##
##   OA      $$     44   0.8641        0.8303       0.03879   0.005848   0.01179
##
##   OA     $$$$    44   0.8748         0.841       0.02936   0.004426   0.008926
##
##   YA       $     54   0.7834        0.8109       0.04576   0.006227   0.01249
##
##   YA      $$     54   0.8025         0.83        0.03346   0.004554   0.009133
##
##   YA     $$$$    54   0.8302        0.8578       0.05348   0.007277    0.0146
## ------------------------------------------------------------------------------
```

```
p.ACC.1<-ggplot(ACC.sum, aes(x=money, y=meanACC, fill=group)) +
  geom_bar(position=position_dodge(width=0.8), color="black",
           stat="identity", width=0.8) +
  geom_errorbar(position=position_dodge(width=0.8),
                aes(ymin=meanACC-se, ymax=meanACC+se), width=.2) +
  facet_grid(.~group) +
  xlab("Monetary Reward") + ylab("Accuracy") +
  #ggtitle("Task Performance Across Money") +
  coord_cartesian(ylim=c(.65,.9)) +
  #scale_fill_discrete(name="Monetary Reward") +
  scale_fill_brewer(palette="Set2") +
  theme(#plot.title=element_text(size=22,face="bold", vjust=2),
        axis.title=element_text(size=12,face = "bold"),
        axis.text=element_text(size=14),
        legend.position="none",
        strip.text.x = element_text(size = 12))
p.ACC.1
```


OA
YA
0.90
0.85
0.80
0.75
0.70
0.65
Accuracy
$
$$
$$$$
$
$$
$$$$
Monetary Reward

Generalized Linear Mixed Effects Models of Accuracy by Monetary Reward and Age Group

```
# Monetary Reward
m.ACC.money <-glmer(formula = ACC ~ moneyCode * groupCode + (1+moneyCode|subID),
          data = incentive, family="binomial")
summary(m.ACC.money)
```

```
## Generalized linear mixed model fit by maximum likelihood (Laplace
##   Approximation) [glmerMod]
##  Family: binomial  ( logit )
## Formula: ACC ~ moneyCode * groupCode + (1 + moneyCode | subID)
##    Data: incentive
##
##      AIC      BIC   logLik deviance df.resid
##  23423.8  23481.6 -11704.9  23409.8    28217
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -5.4982  0.2460  0.3464  0.4617  1.5154
##
## Random effects:
##  Groups Name        Variance Std.Dev. Corr
##  subID  (Intercept) 0.54827  0.7405
##         moneyCode   0.01096  0.1047   -0.47
## Number of obs: 28224, groups:  subID, 98
##
## Fixed effects:
##                     Estimate Std. Error z value Pr(>|z|)
## (Intercept)          1.56118    0.10311  15.141  < 2e-16 ***
## moneyCode            0.14528    0.03053   4.759 1.94e-06 ***
## groupCode            0.53770    0.15481   3.473 0.000514 ***
## moneyCode:groupCode -0.10763    0.04830  -2.228 0.025862 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr) monyCd gropCd
## moneyCode   -0.201
## groupCode   -0.664  0.134
## mnyCd:grpCd  0.128 -0.583 -0.194
```

```
# YA
m.ACC.money.YA <-glmer(formula = ACC ~ moneyCode + (1+moneyCode|subID),
          data = subset(incentive,group=="YA"), family="binomial")
summary(m.ACC.money.YA)
```

```
## Generalized linear mixed model fit by maximum likelihood (Laplace
##   Approximation) [glmerMod]
##  Family: binomial  ( logit )
## Formula: ACC ~ moneyCode + (1 + moneyCode | subID)
##    Data: subset(incentive, group == "YA")
##
##      AIC      BIC   logLik deviance df.resid
```

```
##  14339.3  14377.5  -7164.6  14329.3    15547
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -4.1840  0.2554  0.4097  0.5006  1.5224
##
## Random effects:
##  Groups Name        Variance Std.Dev. Corr
##  subID  (Intercept) 0.48144  0.6939
##         moneyCode   0.01926  0.1388   -0.45
## Number of obs: 15552, groups:  subID, 54
##
## Fixed effects:
##             Estimate Std. Error z value Pr(>|z|)
## (Intercept)  1.56017    0.09716   16.06  < 2e-16 ***
## moneyCode    0.14068    0.03357    4.19 2.79e-05 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##           (Intr)
## moneyCode -0.232
```

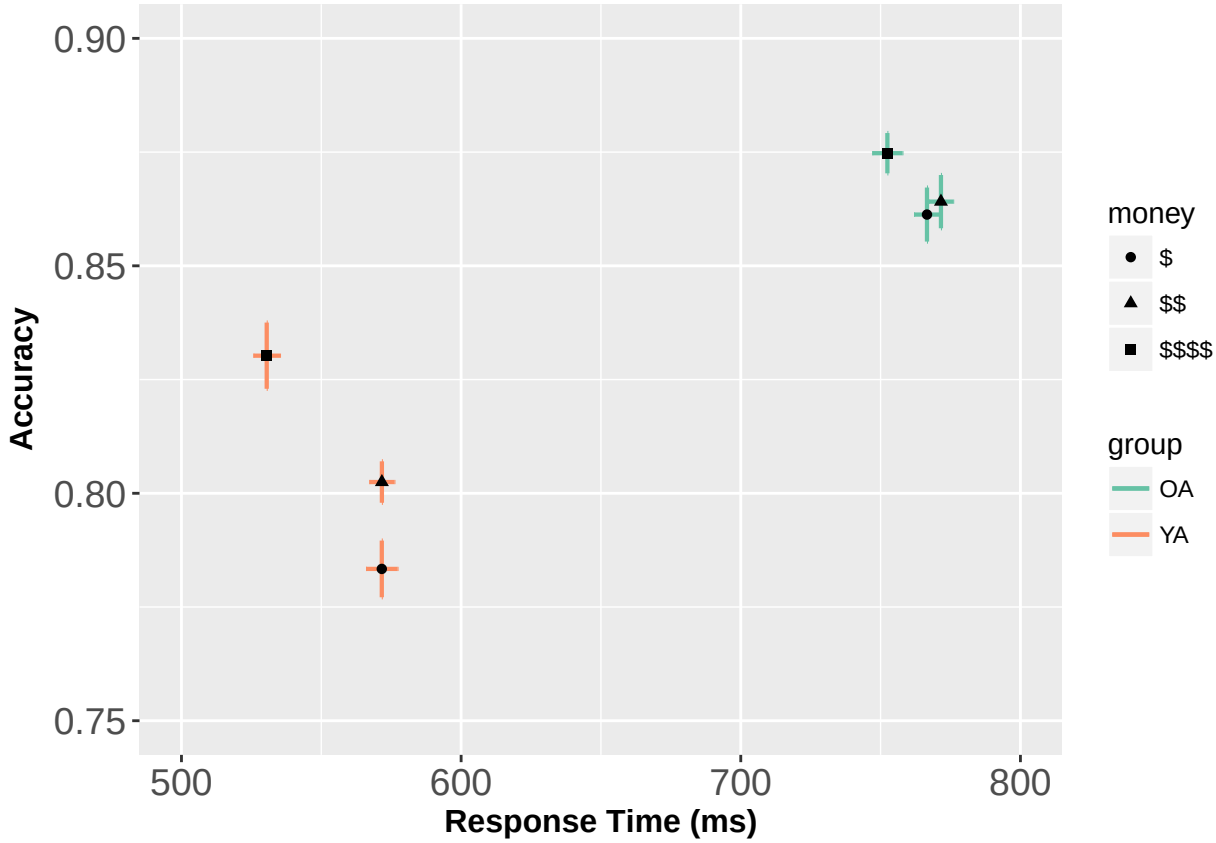
```
# OA
m.ACC.money.OA <-glmer(formula = ACC ~ moneyCode + (1+moneyCode|subID),
          data = subset(incentive,group=="OA"), family="binomial")
summary(m.ACC.money.OA)
```

```
## Generalized linear mixed model fit by maximum likelihood (Laplace
##   Approximation) [glmerMod]
##  Family: binomial  ( logit )
## Formula: ACC ~ moneyCode + (1 + moneyCode | subID)
##    Data: subset(incentive, group == "OA")
##
##      AIC      BIC   logLik deviance df.resid
##   9087.0   9124.3  -4538.5   9077.0    12667
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -5.5497  0.2295  0.3177  0.3742  0.9756
##
## Random effects:
##  Groups Name        Variance Std.Dev. Corr
##  subID  (Intercept) 0.632999 0.79561
##         moneyCode   0.001222 0.03495  -1.00
## Number of obs: 12672, groups:  subID, 44
##
## Fixed effects:
##             Estimate Std. Error z value Pr(>|z|)
## (Intercept)  2.10104    0.12399  16.945   <2e-16 ***
## moneyCode    0.04530    0.03808   1.189    0.234
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
```

```
##           (Intr)
## moneyCode -0.128
```

Combined RT-Accuracy Plot

```
RTACC.sum<-full_join(x = RT.sum, y = ACC.sum, by=c("group","money","N"))
p.RTACC.1<-ggplot(data = RTACC.sum, aes(x = meanRT, y = meanACC, color=group)) +
  geom_errorbar(aes(ymin=meanACC-se.y, ymax=meanACC+se.y), width=0, size=.75) +
  geom_errorbarh(aes(xmin=meanRT-se.x, xmax=meanRT+se.x), height=0, size=.75) +
  geom_point(aes(shape=money), size=1.5, color="black") +
  xlab("Response Time (ms)") + ylab("Accuracy") +
  coord_cartesian(xlim=c(500,800), ylim=c(.75,.9)) +
  scale_color_brewer(palette="Set2") +
  scale_fill_brewer(palette = "Set2") +
  theme(#plot.title=element_text(size=22,face="bold", vjust=2),
        axis.title=element_text(size=12,face = "bold"),
        axis.text=element_text(size=14),
        #legend.position="none",
        strip.text.x = element_text(size = 12))
p.RTACC.1
```



Transition Effects From Baseline to Incentive Blocks

Plot: Transition between last 20 trials of baseline and first 20 trials of first incentive block.

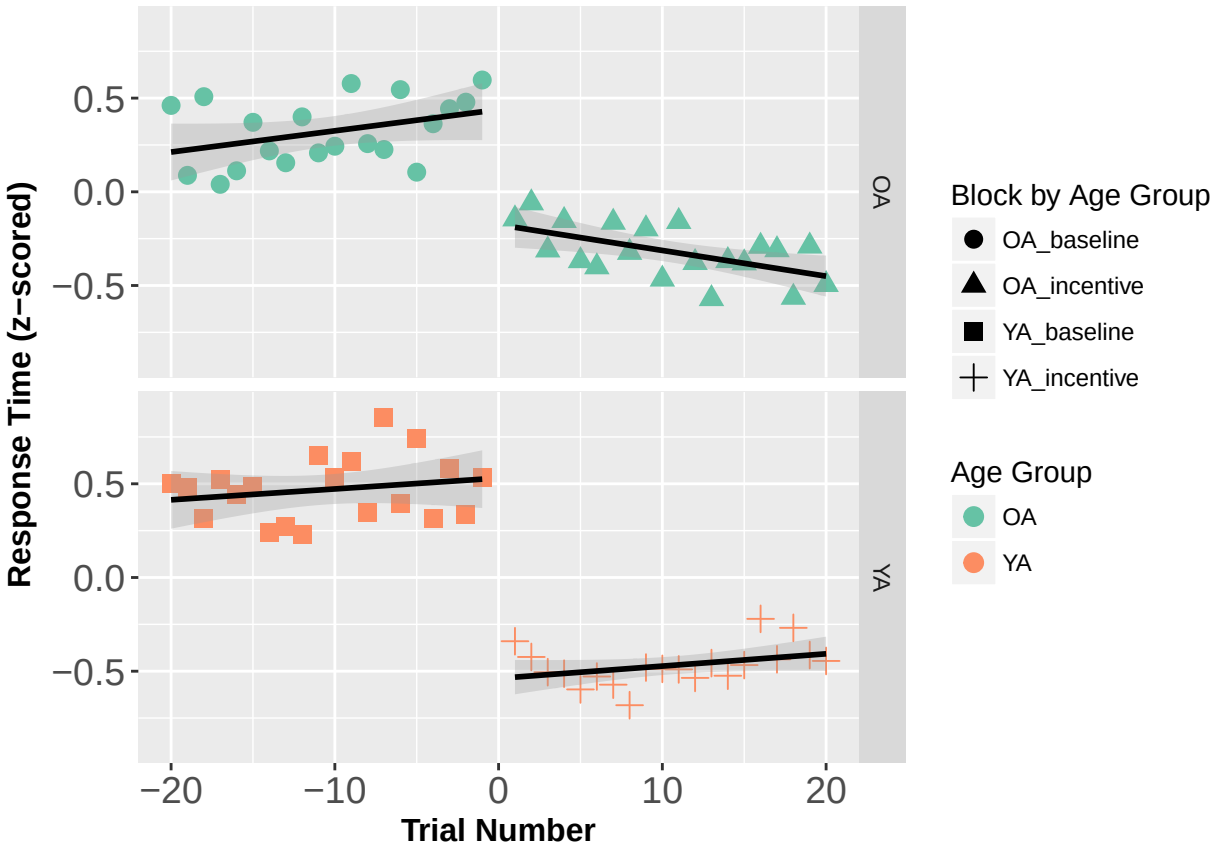
```
transition.base <- data.base %>% select(subID, group, Trial, RT, ACC, condition) %>%
  filter(Trial>=77) %>%
  mutate(Trial=Trial-97)
transition.reward <- incentive %>% filter(block==3 & Trial<=20) %>%
  select(subID, group, Trial, RT, ACC) %>%
  mutate(condition="incentive")
transition=rbind(transition.base,transition.reward)
transition <- transition %>% arrange(subID, condition, Trial) %>%
  group_by(subID) %>%
  mutate(RT_zscore = scale(RT),
         ACC=as.numeric(ACC),
         groupCode=factor(group, levels=c("YA","OA"), labels=c(0,1)),
         conditionCode=factor(condition, levels=c("baseline","incentive"), labels=c(1,0)))
transition$groupCode<-as.numeric(levels(transition$groupCode)[transition$groupCode])
transition$conditionCode<-as.numeric(levels(transition$conditionCode)[transition$conditionCode])
ix_NA<-which(transition$ACC==0)
transition$RT[ix_NA]<-""

trans.sum<-summarySEwithin2(data = transition, measurevar = "RT_zscore", betweenvars = "group",
                            withinvars = c("Trial","condition"), idvar = "subID", na.rm = TRUE)
```

```
## Automatically converting the following non-factors to factors: Trial
```

```
trans.sum <- trans.sum  %>% arrange(group,Trial) %>%
  unite("group_cond", c("group","condition"), sep="_", remove = FALSE)
trans.sum$Trial<-as.numeric(levels(trans.sum$Trial)[trans.sum$Trial])

# Plotting z-scored RT
p.trans.1<-ggplot(data = trans.sum, mapping = aes(x = Trial, y = RT_zscore, shape=group_cond)) +
  geom_point(aes(color=group),size=3) +
  geom_smooth(method="lm", aes(group=group_cond), color="black", alpha=.3) +
  facet_grid(group~.) +
  coord_cartesian( ylim=c(-.9,.9)) +
  scale_color_brewer(palette="Set2") +
  scale_fill_brewer(palette = "Set2") +
  xlab("Trial Number") + ylab("Response Time (z-scored)") +
  labs(shape = "Block by Age Group", color = "Age Group") +
  theme(#plot.title=element_text(size=22,face="bold", vjust=2),
        axis.title=element_text(size=12,face="bold"),
        axis.text=element_text(size=14),
        #legend.position="none",
        #legend.title=element_text(),
        strip.text.x = element_text(size = 10))
p.trans.1
```


Response Time (z−scored)
0.5
0.0
−0.5
OA
YA
−20
−10
0
10
20
Trial Number
Block by Age Group
OA_baseline
OA_incentive
YA_baseline
YA_incentive
Age Group
OA
YA

GLM: RT by trial, condition, and age group

Transition between last 20 trials of baseline and first 20 trials of first incentive block.

```
# GLM on zscored RT
m.trans <-lmer(formula = RT_zscore ~ Trial * conditionCode * groupCode + (1|subID),
          data = transition)
summary(m.trans)
```

```
## Linear mixed model fit by REML t-tests use Satterthwaite approximations
##   to degrees of freedom [lmerMod]
## Formula: RT_zscore ~ Trial * conditionCode * groupCode + (1 | subID)
##    Data: transition
##
## REML criterion at convergence: 10327
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -4.3958 -0.5923 -0.1487  0.4729  5.2296
##
## Random effects:
##  Groups   Name        Variance  Std.Dev.
##  subID    (Intercept) 1.157e-32 1.076e-16
##  Residual             8.060e-01 8.978e-01
## Number of obs: 3920, groups:  subID, 99
##
## Fixed effects:
##                                 Estimate Std. Error         df t value
## (Intercept)                   -5.382e-01  5.675e-02  3.912e+03  -9.483
## Trial                          6.542e-03  4.738e-03  3.912e+03   1.381
## conditionCode                  1.069e+00  8.026e-02  3.912e+03  13.315
## groupCode                      3.625e-01  8.470e-02  3.912e+03   4.280
## Trial:conditionCode           -7.316e-04  6.700e-03  3.912e+03  -0.109
## Trial:groupCode               -2.026e-02  7.070e-03  3.912e+03  -2.866
## conditionCode:groupCode       -4.542e-01  1.198e-01  3.912e+03  -3.792
## Trial:conditionCode:groupCode  2.578e-02  9.999e-03  3.912e+03   2.578
##                                Pr(>|t|)
## (Intercept)                     < 2e-16 ***
## Trial                          0.167391
## conditionCode                   < 2e-16 ***
## groupCode                      1.92e-05 ***
## Trial:conditionCode            0.913049
## Trial:groupCode                0.004184 **
## conditionCode:groupCode        0.000151 ***
## Trial:conditionCode:groupCode 0.009963 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr) Trial  cndtnC gropCd Trl:cC Trl:gC cndC:C
## Trial       -0.877
## conditionCd -0.707  0.620
## groupCode   -0.670  0.587  0.474
## Trl:cndtnCd  0.620 -0.707  0.000 -0.415
## Trial:grpCd  0.587 -0.670 -0.415 -0.877  0.474
```

```
## cndtnCd:grC  0.474 -0.415 -0.670 -0.707  0.000  0.620
## Trl:cndtC:C -0.415  0.474  0.000  0.620 -0.670 -0.707  0.000
```

```
# YA only
m.trans.YA <-lmer(formula = RT_zscore ~ Trial * conditionCode + (1|subID),
          data = subset(transition, group=="YA"))
summary(m.trans.YA)
```

```
## Linear mixed model fit by REML t-tests use Satterthwaite approximations
##   to degrees of freedom [lmerMod]
## Formula: RT_zscore ~ Trial * conditionCode + (1 | subID)
##    Data: subset(transition, group == "YA")
##
## REML criterion at convergence: 5546.7
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -3.4800 -0.5912 -0.1485  0.4322  5.4043
##
## Random effects:
##  Groups   Name        Variance  Std.Dev.
##  subID    (Intercept) 1.037e-32 1.018e-16
##  Residual             7.547e-01 8.687e-01
## Number of obs: 2160, groups:  subID, 54
##
## Fixed effects:
##                       Estimate Std. Error         df t value Pr(>|t|)
## (Intercept)         -5.382e-01  5.492e-02  2.156e+03  -9.800   <2e-16 ***
## Trial                6.542e-03  4.584e-03  2.156e+03   1.427    0.154
## conditionCode        1.069e+00  7.766e-02  2.156e+03  13.760   <2e-16 ***
## Trial:conditionCode -7.316e-04  6.483e-03  2.156e+03  -0.113    0.910
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr) Trial  cndtnC
## Trial       -0.877
## conditionCd -0.707  0.620
## Trl:cndtnCd  0.620 -0.707  0.000
```

```
# OA only
m.trans.OA <-lmer(formula = RT_zscore ~ Trial * conditionCode + (1|subID),
          data = subset(transition, group=="OA"))
summary(m.trans.OA)
```

```
## Linear mixed model fit by REML t-tests use Satterthwaite approximations
##   to degrees of freedom [lmerMod]
## Formula: RT_zscore ~ Trial * conditionCode + (1 | subID)
##    Data: subset(transition, group == "OA")
##
## REML criterion at convergence: 4770.7
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -4.2336 -0.5949 -0.1491  0.5297  4.7458
##
```

```
## Random effects:
##  Groups   Name        Variance  Std.Dev.
##  subID    (Intercept) 1.310e-32 1.144e-16
##  Residual             8.689e-01 9.321e-01
## Number of obs: 1760, groups:  subID, 45
##
## Fixed effects:
##                       Estimate Std. Error         df t value Pr(>|t|)
## (Intercept)         -1.757e-01  6.528e-02  1.756e+03  -2.692  0.00718 **
## Trial               -1.372e-02  5.449e-03  1.756e+03  -2.518  0.01191 *
## conditionCode        6.144e-01  9.232e-02  1.756e+03   6.656 3.76e-11 ***
## Trial:conditionCode  2.505e-02  7.707e-03  1.756e+03   3.250  0.00117 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr) Trial  cndtnC
## Trial       -0.877
## conditionCd -0.707  0.620
## Trl:cndtnCd  0.620 -0.707  0.000
```

```
# OA baseline
m.trans.OA.base <-lmer(formula = RT_zscore ~ Trial * conditionCode + (1|subID),
          data = subset(transition, group=="OA" & condition=="baseline"))
```

```
## fixed-effect model matrix is rank deficient so dropping 2 columns / coefficients
```

```
summary(m.trans.OA.base)
```

```
## fixed-effect model matrix is rank deficient so dropping 2 columns / coefficients
## fixed-effect model matrix is rank deficient so dropping 2 columns / coefficients
## fixed-effect model matrix is rank deficient so dropping 2 columns / coefficients
```

```
## Linear mixed model fit by REML t-tests use Satterthwaite approximations
##   to degrees of freedom [lmerMod]
## Formula: RT_zscore ~ Trial * conditionCode + (1 | subID)
##    Data: subset(transition, group == "OA" & condition == "baseline")
##
## REML criterion at convergence: 2629.3
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -3.6844 -0.6174 -0.1337  0.5681  4.1301
##
## Random effects:
##  Groups   Name        Variance  Std.Dev.
##  subID    (Intercept) 6.692e-21 8.180e-11
##  Residual             1.147e+00 1.071e+00
## Number of obs: 880, groups:  subID, 44
##
## Fixed effects:
##              Estimate Std. Error        df t value Pr(>|t|)
## (Intercept) 4.387e-01  7.501e-02 8.780e+02   5.849 6.98e-09 ***
## Trial       1.133e-02  6.262e-03 8.780e+02   1.809   0.0707 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
##
## Correlation of Fixed Effects:
##       (Intr)
## Trial 0.877
## fit warnings:
## fixed-effect model matrix is rank deficient so dropping 2 columns / coefficients
```

```
# OA incentive
m.trans.OA.incentive <-lmer(formula = RT_zscore ~ Trial * conditionCode + (1|subID),
          data = subset(transition, group=="OA" & condition=="incentive"))
```

```
## fixed-effect model matrix is rank deficient so dropping 2 columns / coefficients
```

```
summary(m.trans.OA.incentive)
```

```
## fixed-effect model matrix is rank deficient so dropping 2 columns / coefficients
## fixed-effect model matrix is rank deficient so dropping 2 columns / coefficients
## fixed-effect model matrix is rank deficient so dropping 2 columns / coefficients
```

```
## Linear mixed model fit by REML t-tests use Satterthwaite approximations
##   to degrees of freedom [lmerMod]
## Formula: RT_zscore ~ Trial * conditionCode + (1 | subID)
##    Data: subset(transition, group == "OA" & condition == "incentive")
##
## REML criterion at convergence: 2042.9
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -4.4097 -0.6102 -0.1643  0.5044  5.5568
##
## Random effects:
##  Groups   Name        Variance Std.Dev.
##  subID    (Intercept) 0.01358  0.1165
##  Residual             0.57726  0.7598
## Number of obs: 880, groups:  subID, 44
##
## Fixed effects:
##               Estimate Std. Error         df t value Pr(>|t|)
## (Intercept)  -0.175706   0.056032 361.100000  -3.136  0.00185 **
## Trial        -0.013719   0.004442 835.000000  -3.089  0.00208 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##       (Intr)
## Trial -0.832
## fit warnings:
## fixed-effect model matrix is rank deficient so dropping 2 columns / coefficients
```

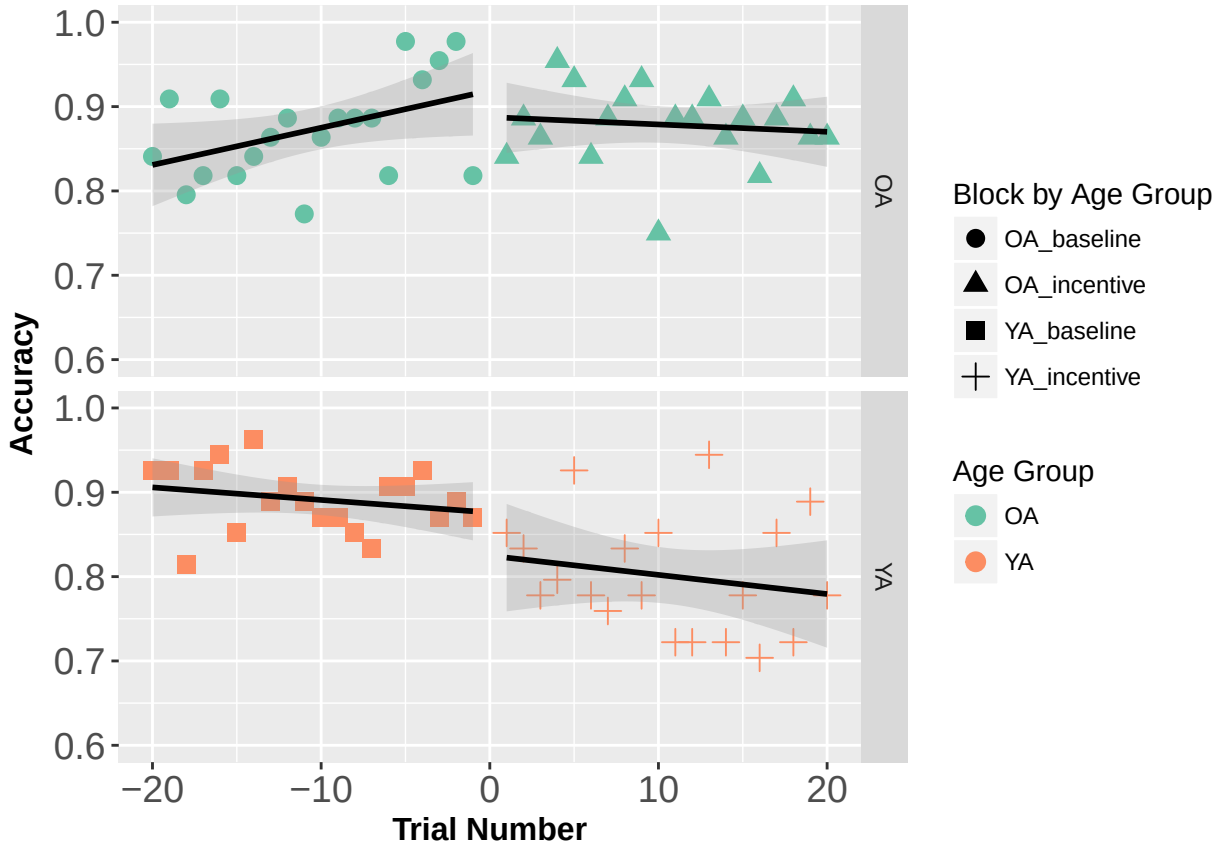
Plot: Transition of Accuracy between baseline and incentive block

```
trans.sum<-summarySEwithin2(data = transition, measurevar = "ACC", betweenvars = "group",
                            withinvars = c("Trial","condition"), idvar = "subID", na.rm = TRUE)
```

```
## Automatically converting the following non-factors to factors: Trial
```

```
trans.sum <- trans.sum  %>% arrange(group,Trial) %>%
  unite("group_cond", c("group","condition"), sep="_", remove = FALSE)
trans.sum$Trial<-as.numeric(levels(trans.sum$Trial)[trans.sum$Trial])

# Plotting Accuracy
p.trans.2<-ggplot(data = trans.sum, mapping = aes(x = Trial, y = ACC, shape=group_cond)) +
  geom_point(aes(color=group),size=3) +
  geom_smooth(method="lm", aes(group=group_cond), color="black", alpha=.3) +
  facet_grid(group~.) +
  coord_cartesian( ylim=c(0.6,1)) +
  scale_color_brewer(palette="Set2") +
  scale_fill_brewer(palette = "Set2") +
  xlab("Trial Number") + ylab("Accuracy") +
  labs(shape = "Block by Age Group", color = "Age Group") +
  theme(#plot.title=element_text(size=22,face="bold", vjust=2),
        axis.title=element_text(size=12,face="bold"),
        axis.text=element_text(size=14),
        #legend.position="none",
        #legend.title=element_text(),
        strip.text.x = element_text(size = 10))
p.trans.2
```



GLM: Accuracy by trial, condition, and age group

Transition between last 20 trials of baseline and first 20 trials of first incentive block.

```r
# GLM on zscored ACC
m.trans.ACC <-glmer(formula = ACC ~ Trial * conditionCode * groupCode + (1|subID),
          data = transition, family="binomial")
```

```
## Warning in checkConv(attr(opt, "derivs"), opt$par, ctrl = control
## $checkConv, : Model failed to converge with max|grad| = 0.0132619 (tol =
## 0.001, component 1)
```

```r
summary(m.trans.ACC)
```

```
## Generalized linear mixed model fit by maximum likelihood (Laplace
##   Approximation) [glmerMod]
##  Family: binomial  ( logit )
## Formula: ACC ~ Trial * conditionCode * groupCode + (1 | subID)
##    Data: transition
##
##      AIC      BIC   logLik deviance df.resid
##   2957.4   3013.8  -1469.7   2939.4     3911
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -4.8049  0.2254  0.3063  0.3948  1.2049
##
## Random effects:
##  Groups Name        Variance Std.Dev.
##  subID  (Intercept) 0.7367   0.8583
## Number of obs: 3920, groups:  subID, 99
##
## Fixed effects:
##                                Estimate Std. Error z value Pr(>|z|)
## (Intercept)                   1.7472164  0.2069024   8.445   <2e-16 ***
## Trial                        -0.0158345  0.0137817  -1.149   0.2506
## conditionCode                 0.4423966  0.2632333   1.681   0.0928 .
## groupCode                     0.6429966  0.3343616   1.923   0.0545 .
## Trial:conditionCode          -0.0007676  0.0221812  -0.035   0.9724
## Trial:groupCode               0.0066958  0.0231625   0.289   0.7725
## conditionCode:groupCode      -0.1049462  0.4200173  -0.250   0.8027
## Trial:conditionCode:groupCode  0.0548964  0.0343923   1.596   0.1104
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr) Trial  cndtnC gropCd Trl:cC Trl:gC cndC:C
## Trial       -0.719
## conditionCd -0.517  0.563
## groupCode   -0.612  0.444  0.321
## Trl:cndtnCd  0.446 -0.621  0.174 -0.276
## Trial:grpCd  0.427 -0.595 -0.335 -0.743  0.370
## cndtnCd:grC  0.324 -0.353 -0.627 -0.564 -0.109  0.591
## Trl:cndtC:C -0.286  0.400 -0.112  0.503 -0.645 -0.674  0.085
## convergence code: 0
## Model failed to converge with max|grad| = 0.0132619 (tol = 0.001, component 1)
```

```r
# YA only
m.trans.ACC.YA <-glmer(formula = ACC ~ Trial * conditionCode + (1|subID),
```

```
          data = subset(transition, group=="YA"), family="binomial")
summary(m.trans.ACC.YA)
```

```
## Generalized linear mixed model fit by maximum likelihood (Laplace
##   Approximation) [glmerMod]
##  Family: binomial  ( logit )
## Formula: ACC ~ Trial * conditionCode + (1 | subID)
##    Data: subset(transition, group == "YA")
##
##      AIC      BIC   logLik deviance df.resid
##   1739.4   1767.8   -864.7   1729.4     2155
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -4.6821  0.2358  0.3289  0.4332  1.1777
##
## Random effects:
##  Groups Name        Variance Std.Dev.
##  subID  (Intercept) 0.6118   0.7822
## Number of obs: 2160, groups:  subID, 54
##
## Fixed effects:
##                       Estimate Std. Error z value Pr(>|z|)
## (Intercept)          1.7307084  0.2013711   8.595   <2e-16 ***
## Trial               -0.0157202  0.0137502  -1.143   0.2529
## conditionCode        0.4398910  0.2628023   1.674   0.0942 .
## Trial:conditionCode -0.0007862  0.0221448  -0.036   0.9717
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr) Trial  cndtnC
## Trial       -0.737
## conditionCd -0.529  0.562
## Trl:cndtnCd  0.457 -0.621  0.175
```

```
# OA only
m.trans.ACC.OA <-glmer(formula = ACC ~ Trial * conditionCode + (1|subID),
          data = subset(transition, group=="OA"), family="binomial")
summary(m.trans.ACC.OA)
```

```
## Generalized linear mixed model fit by maximum likelihood (Laplace
##   Approximation) [glmerMod]
##  Family: binomial  ( logit )
## Formula: ACC ~ Trial * conditionCode + (1 | subID)
##    Data: subset(transition, group == "OA")
##
##      AIC      BIC   logLik deviance df.resid
##   1219.0   1246.4   -604.5   1209.0     1755
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -4.7496  0.2154  0.2840  0.3613  1.1949
##
```

```
## Random effects:
##  Groups Name        Variance Std.Dev.
##  subID  (Intercept) 0.9054   0.9515
## Number of obs: 1760, groups:  subID, 45
##
## Fixed effects:
##                      Estimate Std. Error z value Pr(>|z|)
## (Intercept)          2.420810   0.273901   8.838   <2e-16 ***
## Trial               -0.009221   0.018659  -0.494   0.6212
## conditionCode        0.340209   0.328025   1.037   0.2997
## Trial:conditionCode  0.054605   0.026349   2.072   0.0382 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr) Trial  cndtnC
## Trial       -0.730
## conditionCd -0.568  0.608
## Trl:cndtnCd  0.524 -0.709  0.025
```

```
# OA only baseline
m.trans.ACC.OA.baseline <-glmer(formula = ACC ~ Trial + (1|subID),
          data = subset(transition, group=="OA" & condition=="baseline"), family="binomial")
summary(m.trans.ACC.OA.baseline)
```

```
## Generalized linear mixed model fit by maximum likelihood (Laplace
##   Approximation) [glmerMod]
##  Family: binomial  ( logit )
## Formula: ACC ~ Trial + (1 | subID)
##    Data: subset(transition, group == "OA" & condition == "baseline")
##
##      AIC      BIC   logLik deviance df.resid
##    584.3    598.6   -289.1    578.3      877
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -4.8457  0.1651  0.2281  0.3211  1.4316
##
## Random effects:
##  Groups Name        Variance Std.Dev.
##  subID  (Intercept) 1.809    1.345
## Number of obs: 880, groups:  subID, 44
##
## Fixed effects:
##             Estimate Std. Error z value Pr(>|z|)
## (Intercept)  3.08108    0.35539   8.670   <2e-16 ***
## Trial        0.04998    0.01997   2.503   0.0123 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##       (Intr)
## Trial 0.668
```

```r
# OA only incentive
m.trans.ACC.OA.incentive <-glmer(formula = ACC ~ Trial + (1|subID),
          data = subset(transition, group=="OA" & condition=="incentive"), family="binomial")
```

```
## Warning in checkConv(attr(opt, "derivs"), opt$par, ctrl = control
## $checkConv, : Model failed to converge with max|grad| = 0.0488536 (tol =
## 0.001, component 1)
```

```r
summary(m.trans.ACC.OA.incentive)
```

```
## Generalized linear mixed model fit by maximum likelihood (Laplace
##   Approximation) [glmerMod]
##  Family: binomial  ( logit )
## Formula: ACC ~ Trial + (1 | subID)
##    Data: subset(transition, group == "OA" & condition == "incentive")
##
##      AIC      BIC   logLik deviance df.resid
##    639.2    653.5   -316.6    633.2      877
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -3.5938  0.2543  0.2997  0.3688  0.7749
##
## Random effects:
##  Groups Name        Variance Std.Dev.
##  subID  (Intercept) 0.5531   0.7437
## Number of obs: 880, groups:  subID, 44
##
## Fixed effects:
##             Estimate Std. Error z value Pr(>|z|)
## (Intercept)  2.276739   0.001444    1576  < 2e-16 ***
## Trial       -0.008720   0.001445      -6 1.59e-09 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##       (Intr)
## Trial 0.000
## convergence code: 0
## Model failed to converge with max|grad| = 0.0488536 (tol = 0.001, component 1)
```

Integration of Primary and Secondary Motivational Incentives in Older and Younger Adults

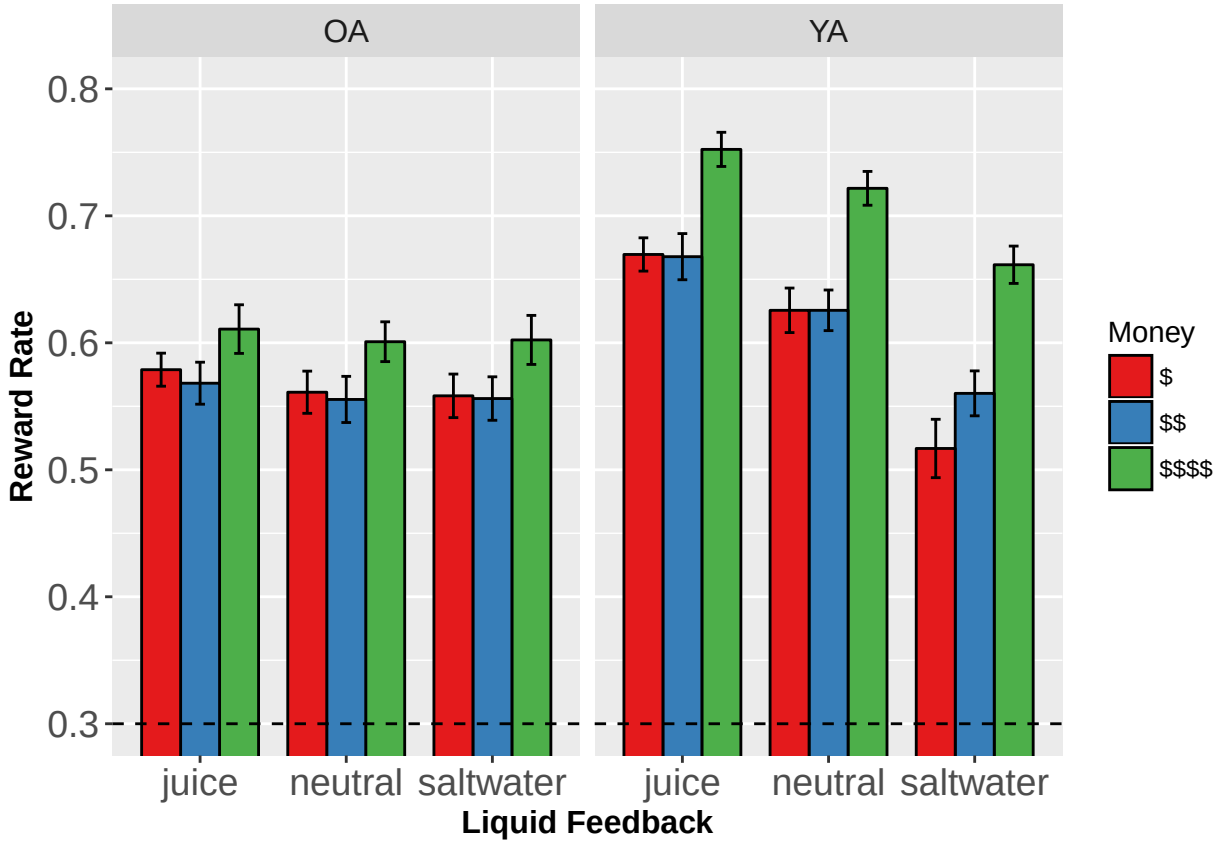
Plot: Reward rate by monetary reward, liquid, and age group

```
RR.sum=summarySEwithin2(data=incentive9.means, measurevar = "meanRR",
                        withinvars = c("money","liquid"), betweenvars = c("group"),
                        idvar = "subID")
pandoc.table(RR.sum)
```

```
##
## ---------------------------------------------------------------------------------------
##  group   money    liquid     N    meanRR   meanRRNormed     sd        se        ci
## ------- ------- ----------- ---- -------- -------------- --------- --------- ---------
##   OA       $       juice     44   0.5788      0.6161      0.08623    0.013    0.02622
##
##   OA       $      neutral    44   0.5611      0.5984      0.1102    0.01662   0.03351
##
##   OA       $     saltwater   44   0.5582      0.5955      0.1138    0.01715   0.03459
##
##   OA      $$       juice     44   0.5682      0.6055      0.1097    0.01654   0.03335
##
##   OA      $$      neutral    44   0.5554      0.5927      0.1206    0.01818   0.03667
##
##   OA      $$     saltwater   44   0.5561      0.5934      0.1135    0.01711   0.03451
##
##   OA     $$$$      juice     44   0.6108      0.6481       0.127    0.01915   0.03861
##
##   OA     $$$$     neutral    44   0.6009      0.6381       0.104    0.01567   0.0316
##
##   OA     $$$$    saltwater   44   0.6023      0.6396      0.1281    0.01931   0.03895
##
##   YA       $       juice     54   0.6696      0.6392      0.09627   0.0131    0.02628
##
##   YA       $      neutral    54   0.6256      0.5952      0.1288    0.01753   0.03516
##
##   YA       $     saltwater   54   0.5168      0.4864      0.1689    0.02299   0.0461
##
##   YA      $$       juice     54   0.6678      0.6374      0.1336    0.01818   0.03645
##
##   YA      $$      neutral    54   0.6256      0.5952      0.1175     0.016    0.03208
##
##   YA      $$     saltwater   54   0.5602      0.5298      0.1301    0.0177    0.0355
##
##   YA     $$$$      juice     54   0.7523      0.7219      0.09888   0.01346   0.02699
##
##   YA     $$$$     neutral    54   0.7216      0.6913      0.09788   0.01332   0.02672
##
##   YA     $$$$    saltwater   54   0.6615      0.6311      0.1081    0.01471   0.0295
## ---------------------------------------------------------------------------------------
```

```
# first plot
p.RR.2<-ggplot(RR.sum, aes(x=liquid, y=meanRR, fill=money)) +
```

```
  geom_bar(position=position_dodge(width=0.8), color="black",
           stat="identity", width=0.8) +
  geom_errorbar(position=position_dodge(width=0.8),
                aes(ymin=meanRR-se, ymax=meanRR+se), width=.2) +
  xlab("Liquid Feedback") + ylab("Reward Rate") +
  labs(fill = "Money") +
  facet_grid(.~group) +
  geom_hline(yintercept = .30, linetype="dashed") +
  scale_fill_brewer(palette="Set1") +
  coord_cartesian(ylim=c(.3,.8)) +
  #scale_fill_discrete(name="Monetary Reward") +
  theme(#plot.title=element_text(size=22,face="bold", vjust=2),
        axis.title=element_text(size=12,face = "bold"),
        axis.text=element_text(size=14),
        legend.position="right",
        strip.text.x = element_text(size = 12))
p.RR.2
```



Analysis: Reward Rate by money, liquid, and age group

```
# Monetary Reward
m.RR.mot9<-glmer(formula = subRewarded ~ moneyCode * liqCode * groupCode +
                   (1+moneyCode+liqCode|subID),
          data = incentive, family="binomial")
summary(m.RR.mot9)
```

```
## Generalized linear mixed model fit by maximum likelihood (Laplace
##   Approximation) [glmerMod]
##  Family: binomial  ( logit )
## Formula: subRewarded ~ moneyCode * liqCode * groupCode + (1 + moneyCode +
##     liqCode | subID)
##    Data: incentive
##
##      AIC      BIC   logLik deviance df.resid
##  35732.2  35847.7 -17852.1  35704.2    28210
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -3.8151 -1.0627  0.5715  0.7703  5.3667
##
## Random effects:
##  Groups Name        Variance Std.Dev. Corr
##  subID  (Intercept) 0.26075  0.5106
##         moneyCode   0.01387  0.1178   -0.20
##         liqCode     0.11329  0.3366   -0.24  0.53
## Number of obs: 28224, groups:  subID, 98
##
## Fixed effects:
##                             Estimate Std. Error z value Pr(>|z|)
## (Intercept)                  0.63846    0.07178   8.894  < 2e-16 ***
## moneyCode                    0.25760    0.02702   9.534  < 2e-16 ***
## liqCode                      0.28281    0.05083   5.564 2.64e-08 ***
## groupCode                   -0.31271    0.10692  -2.925 0.003448 **
## moneyCode:liqCode           -0.06045    0.02669  -2.265 0.023530 *
## moneyCode:groupCode         -0.17426    0.03955  -4.407 1.05e-05 ***
## liqCode:groupCode           -0.25305    0.07538  -3.357 0.000788 ***
## moneyCode:liqCode:groupCode  0.04840    0.03866   1.252 0.210587
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr) monyCd liqCod gropCd mnyCd:lC mnyCd:gC lqCd:C
## moneyCode   -0.105
## liqCode     -0.208  0.292
## groupCode   -0.672  0.071  0.140
## monyCd:lqCd  0.005  0.032  0.021 -0.003
## mnyCd:grpCd  0.072 -0.683 -0.200 -0.113 -0.021
## liqCd:grpCd  0.141 -0.197 -0.674 -0.213 -0.014    0.297
## mnyCd:lqC:C -0.003 -0.021 -0.014  0.003 -0.690    0.014    0.011
```

```
# YA
m.RR.mot9.YA <-glmer(formula = subRewarded ~ moneyCode * liqCode +
```

```
                        (1+moneyCode+liqCode|subID),
          data = subset(incentive,group=="YA"), family="binomial")
summary(m.RR.mot9.YA)
```

```
## Generalized linear mixed model fit by maximum likelihood (Laplace
##   Approximation) [glmerMod]
##  Family: binomial  ( logit )
## Formula: subRewarded ~ moneyCode * liqCode + (1 + moneyCode + liqCode |
##     subID)
##    Data: subset(incentive, group == "YA")
##
##      AIC      BIC   logLik deviance df.resid
##  19053.6  19130.1  -9516.8  19033.6    15542
##
## Scaled residuals:
##    Min     1Q Median     3Q    Max
## -3.917 -1.060  0.540  0.723  5.970
##
## Random effects:
##  Groups Name        Variance Std.Dev. Corr
##  subID  (Intercept) 0.29499  0.5431
##         moneyCode   0.02097  0.1448   -0.13
##         liqCode     0.15128  0.3890   -0.37  0.59
## Number of obs: 15552, groups:  subID, 54
##
## Fixed effects:
##                   Estimate Std. Error z value Pr(>|z|)
## (Intercept)        0.63853    0.07606   8.396  < 2e-16 ***
## moneyCode          0.26060    0.02942   8.857  < 2e-16 ***
## liqCode            0.28410    0.05738   4.951 7.37e-07 ***
## moneyCode:liqCode -0.05965    0.02677  -2.228   0.0259 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr) monyCd liqCod
## moneyCode   -0.073
## liqCode     -0.327  0.373
## monyCd:lqCd  0.005  0.030  0.019
```

```
# Juice vs Neutral
m.RR.mot9.YA.JvN <-glmer(formula = subRewarded ~ moneyCode * liqCode +
                           (1+moneyCode+liqCode|subID),
          data = subset(incentive,group=="YA" && liquid!="saltwater"),
          family="binomial")
summary(m.RR.mot9.YA.JvN)
```

```
## Generalized linear mixed model fit by maximum likelihood (Laplace
##   Approximation) [glmerMod]
##  Family: binomial  ( logit )
## Formula: subRewarded ~ moneyCode * liqCode + (1 + moneyCode + liqCode |
##     subID)
##    Data: subset(incentive, group == "YA" && liquid != "saltwater")
##
```

```
##      AIC      BIC   logLik deviance df.resid
##  35759.3  35841.8 -17869.6  35739.3    28214
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -3.9996 -1.0548  0.5694  0.7729  5.1123
##
## Random effects:
##  Groups Name        Variance Std.Dev. Corr
##  subID  (Intercept) 0.28475  0.5336
##         moneyCode   0.02149  0.1466    0.03
##         liqCode     0.12923  0.3595   -0.11  0.61
## Number of obs: 28224, groups:  subID, 98
##
## Fixed effects:
##                    Estimate Std. Error z value Pr(>|z|)
## (Intercept)         0.49829    0.05544   8.988  < 2e-16 ***
## moneyCode           0.17942    0.02164   8.292  < 2e-16 ***
## liqCode             0.16957    0.03965   4.276  1.9e-05 ***
## moneyCode:liqCode -0.03710    0.01932  -1.920   0.0548 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr) monyCd liqCod
## moneyCode    0.024
## liqCode     -0.096  0.388
## monyCd:lqCd  0.003  0.017  0.012
```

```
# Saltwater vs Neutral
m.RR.mot9.YA.SvN <-glmer(formula = subRewarded ~ moneyCode * liqCode +
                           (1+moneyCode+liqCode|subID),
          data = subset(incentive,group=="YA" & liquid!="juice"),
          family="binomial")
summary(m.RR.mot9.YA.SvN)
```

```
## Generalized linear mixed model fit by maximum likelihood (Laplace
##   Approximation) [glmerMod]
##  Family: binomial  ( logit )
## Formula: subRewarded ~ moneyCode * liqCode + (1 + moneyCode + liqCode |
##     subID)
##    Data: subset(incentive, group == "YA" & liquid != "juice")
##
##      AIC      BIC   logLik deviance df.resid
##  12849.7  12922.2  -6414.9  12829.7    10358
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -2.5054 -1.0367  0.5555  0.7256  6.6775
##
## Random effects:
##  Groups Name        Variance Std.Dev. Corr
##  subID  (Intercept) 0.35580  0.5965
##         moneyCode   0.05532  0.2352   -0.36
##         liqCode     0.35280  0.5940    0.06  0.17
```

```
## Number of obs: 10368, groups:  subID, 54
##
## Fixed effects:
##                   Estimate Std. Error z value Pr(>|z|)
## (Intercept)        0.69132    0.08689   7.956 1.77e-15 ***
## moneyCode          0.23193    0.04957   4.679 2.89e-06 ***
## liqCode            0.36250    0.09188   3.945 7.96e-05 ***
## moneyCode:liqCode -0.11141    0.05315  -2.096   0.0361 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr) monyCd liqCod
## moneyCode   -0.205
## liqCode      0.169  0.107
## monyCd:lqCd  0.012  0.541  0.015
```

```
# OA
m.RR.mot9.OA <-glmer(formula = subRewarded ~ moneyCode * liqCode +
                       (1+moneyCode+liqCode|subID),
          data = subset(incentive,group=="OA"), family="binomial")
summary(m.RR.mot9.OA)
```

```
## Generalized linear mixed model fit by maximum likelihood (Laplace
##   Approximation) [glmerMod]
##  Family: binomial  ( logit )
## Formula: subRewarded ~ moneyCode * liqCode + (1 + moneyCode + liqCode |
##     subID)
##    Data: subset(incentive, group == "OA")
##
##      AIC      BIC   logLik deviance df.resid
##  16681.9  16756.4  -8330.9  16661.9    12662
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -2.1172 -1.0652  0.6329  0.8276  2.1987
##
## Random effects:
##  Groups Name        Variance Std.Dev. Corr
##  subID  (Intercept) 0.223904 0.47319
##         moneyCode   0.006182 0.07862  -0.39
##         liqCode     0.073080 0.27033  -0.03  0.37
## Number of obs: 12672, groups:  subID, 44
##
## Fixed effects:
##                   Estimate Std. Error z value Pr(>|z|)
## (Intercept)        0.32497    0.07373   4.408 1.05e-05 ***
## moneyCode          0.08277    0.02567   3.225  0.00126 **
## liqCode            0.03034    0.04673   0.649  0.51620
## moneyCode:liqCode -0.01235    0.02793  -0.442  0.65841
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr) monyCd liqCod
```

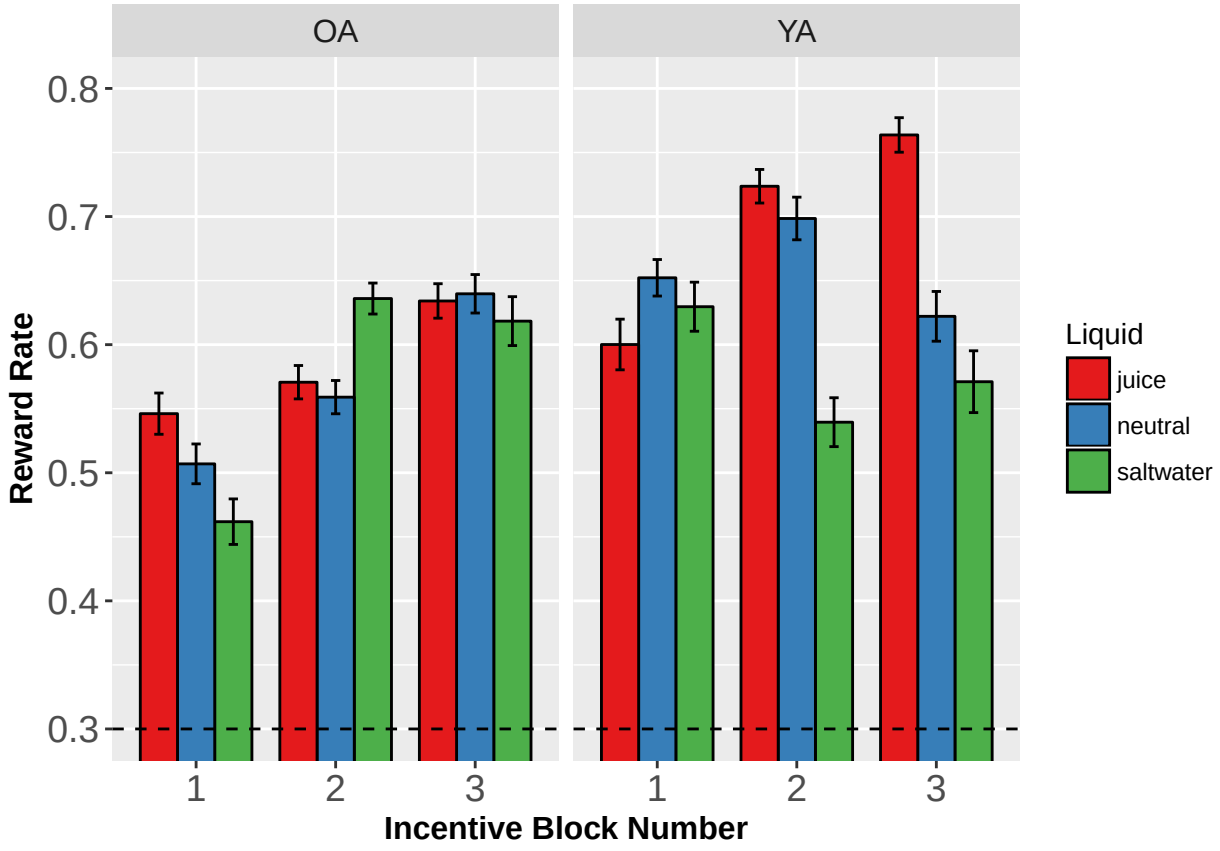
```
## moneyCode   -0.173
## liqCode     -0.021  0.149
## monyCd:lqCd  0.000  0.003  0.002
```

Plot: mean reward rate by block, money, and age group

```
RR.sum=summarySEwithin2(data=incentive9.means, measurevar = "meanRR",
                        withinvars = c("block","liquid"), betweenvars = c("group"),
                        idvar = "subID")
pandoc.table(RR.sum)
```

```
##
## ------------------------------------------------------------------------------------------
##  group   block    liquid     N    meanRR   meanRRNormed     sd        se         ci
## ------- ------- ----------- ---- -------- -------------- --------- --------- ---------
##   OA       1       juice     42   0.5461      0.5497      0.1044    0.01611   0.03253
##
##   OA       1      neutral    45   0.5069      0.5378      0.1042    0.01553   0.0313
##
##   OA       1     saltwater   45   0.4618      0.5371      0.1192    0.01776   0.0358
##
##   OA       2       juice     42   0.5707      0.6323      0.08449   0.01304   0.02633
##
##   OA       2      neutral    36   0.559       0.6347      0.07792   0.01299   0.02637
##
##   OA       2     saltwater   54   0.636       0.6288      0.0889    0.0121    0.02427
##
##   OA       3       juice     48   0.6341      0.6797      0.0932    0.01345   0.02706
##
##   OA       3      neutral    51   0.6397      0.6556      0.1073    0.01502   0.03017
##
##   OA       3     saltwater   33   0.6184      0.6767      0.1096    0.01908   0.03886
##
##   YA       1       juice     54   0.6001      0.6344      0.1453    0.01977   0.03966
##
##   YA       1      neutral    54   0.6522      0.6082      0.1047    0.01424   0.02857
##
##   YA       1     saltwater   54   0.6296      0.5482      0.1408    0.01917   0.03844
##
##   YA       2       juice     51   0.7237      0.6724      0.09358   0.0131    0.02632
##
##   YA       2      neutral    54   0.6985      0.6444      0.1224    0.01665   0.0334
##
##   YA       2     saltwater   57   0.5395      0.5502       0.144    0.01907   0.03821
##
##   YA       3       juice     57   0.7637      0.6907      0.1017    0.01347   0.02698
##
##   YA       3      neutral    54   0.6221      0.629       0.1427    0.01942   0.03894
##
##   YA       3     saltwater   51   0.5711      0.5488      0.1723    0.02413   0.04847
## ------------------------------------------------------------------------------------------
```

```
# first plot
p.RR.3<-ggplot(RR.sum, aes(x=block, y=meanRR, fill=liquid)) +
  geom_bar(position=position_dodge(width=0.8), color="black",
           stat="identity", width=0.8) +
  geom_errorbar(position=position_dodge(width=0.8),
                aes(ymin=meanRR-se, ymax=meanRR+se), width=.2) +
  xlab("Incentive Block Number") + ylab("Reward Rate") +
  labs(fill = "Liquid") +
  facet_grid(.~group) +
  geom_hline(yintercept = .30, linetype="dashed") +
  scale_fill_brewer(palette="Set1") +
  coord_cartesian(ylim=c(.3,.8)) +
  theme(#plot.title=element_text(size=22,face="bold", vjust=2),
        axis.title=element_text(size=12,face = "bold"),
        axis.text=element_text(size=14),
        legend.position="right",
        strip.text.x = element_text(size = 12))
p.RR.3
```



Analysis: RR by liquid, block, and age group

```
# Monetary Reward
m.RR.motblock <-glmer(formula = subRewarded ~ liqCode * blockCode * groupCode +
                        moneyCode + (1+moneyCode+liqCode|subID),
          data = incentive, family="binomial")
summary(m.RR.motblock)
```

```
## Generalized linear mixed model fit by maximum likelihood (Laplace
##   Approximation) [glmerMod]
##  Family: binomial  ( logit )
## Formula: subRewarded ~ liqCode * blockCode * groupCode + moneyCode + (1 +
##     moneyCode + liqCode | subID)
##    Data: incentive
##
##      AIC      BIC   logLik deviance df.resid
##  35654.5  35778.2 -17812.3  35624.5    28209
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -3.9435 -1.0556  0.5710  0.7645  5.0085
##
## Random effects:
##  Groups Name        Variance Std.Dev. Corr
##  subID  (Intercept) 0.24656  0.4965
##         moneyCode   0.02148  0.1466   -0.20
##         liqCode     0.09213  0.3035   -0.30  0.47
## Number of obs: 28224, groups:  subID, 98
##
## Fixed effects:
##                              Estimate Std. Error z value Pr(>|z|)
## (Intercept)                   0.66229    0.07278   9.100  < 2e-16 ***
## liqCode                       0.25012    0.04784   5.229 1.71e-07 ***
## blockCode                     0.06688    0.02725   2.454 0.014114 *
## groupCode                    -0.36059    0.11395  -3.165 0.001553 **
## moneyCode                     0.17849    0.02165   8.245  < 2e-16 ***
## liqCode:blockCode             0.16939    0.04520   3.748 0.000178 ***
## liqCode:groupCode            -0.19524    0.07321  -2.667 0.007655 **
## blockCode:groupCode           0.19275    0.03944   4.887 1.02e-06 ***
## liqCode:blockCode:groupCode -0.25673    0.06752  -3.803 0.000143 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr) liqCod blckCd gropCd monyCd lqCd:bC lqCd:gC blcC:C
## liqCode     -0.238
## blockCode    0.004  0.023
## groupCode   -0.702  0.156 -0.002
## moneyCode   -0.097  0.202 -0.001  0.012
## lqCd:blckCd  0.010 -0.001 -0.046 -0.016  0.002
## liqCd:grpCd  0.160 -0.691 -0.030 -0.232  0.011  0.015
## blckCd:grpC -0.005  0.001 -0.688  0.009  0.003  0.027  -0.024
## lqCd:blcC:C  0.006  0.008  0.032 -0.021 -0.005 -0.671  -0.005  -0.070
```

```r
# OA
m.RR.motblock.OA <-glmer(formula = subRewarded ~ liqCode * blockCode + moneyCode +
                           (1+moneyCode+liqCode|subID),
          data = subset(incentive,group=="OA"), family="binomial")
summary(m.RR.motblock.OA)
```

```
## Generalized linear mixed model fit by maximum likelihood (Laplace
##   Approximation) [glmerMod]
##  Family: binomial  ( logit )
## Formula: subRewarded ~ liqCode * blockCode + moneyCode + (1 + moneyCode +
##     liqCode | subID)
##    Data: subset(incentive, group == "OA")
##
##      AIC      BIC   logLik deviance df.resid
##  16589.7  16671.6  -8283.8  16567.7    12661
##
## Scaled residuals:
##    Min     1Q Median     3Q    Max
## -2.138 -1.048  0.619  0.822  2.131
##
## Random effects:
##  Groups Name        Variance Std.Dev. Corr
##  subID  (Intercept) 0.222844 0.47206
##         moneyCode   0.006331 0.07957  -0.34
##         liqCode     0.030644 0.17505   0.12 -0.14
## Number of obs: 12672, groups:  subID, 44
##
## Fixed effects:
##                   Estimate Std. Error z value Pr(>|z|)
## (Intercept)        0.32959    0.07361   4.478 7.55e-06 ***
## liqCode            0.01075    0.03500   0.307  0.75867
## blockCode          0.27235    0.02712  10.042  < 2e-16 ***
## moneyCode          0.08321    0.02579   3.226  0.00126 **
## liqCode:blockCode -0.05635    0.04704  -1.198  0.23100
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr) liqCod blckCd monyCd
## liqCode      0.088
## blockCode    0.008 -0.052
## moneyCode   -0.152 -0.050  0.004
## lqCd:blckCd -0.028  0.042 -0.025 -0.005
```

```r
# Money & Liquid Effects in Block 1
m.RR.motblock.OA.b1 <-glmer(formula = subRewarded ~ liqCode + moneyCode +
                              (1+moneyCode+liqCode|subID),
          data = subset(incentive,group=="OA" & block==1), family="binomial")
summary(m.RR.motblock.OA.b1)
```

```
## Generalized linear mixed model fit by maximum likelihood (Laplace
##   Approximation) [glmerMod]
##  Family: binomial  ( logit )
## Formula: subRewarded ~ liqCode + moneyCode + (1 + moneyCode + liqCode |
##     subID)
```

```
##    Data: subset(incentive, group == "OA" & block == 1)
##
##      AIC      BIC   logLik deviance df.resid
##   5722.5   5779.6  -2852.2   5704.5     4215
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -1.6734 -0.9748  0.5976  0.9310  1.8984
##
## Random effects:
##  Groups Name        Variance Std.Dev. Corr
##  subID  (Intercept) 0.164805 0.40596
##         moneyCode   0.003403 0.05833  0.18
##         liqCode     0.077317 0.27806  0.10 0.10
## Number of obs: 4224, groups:  subID, 44
##
## Fixed effects:
##             Estimate Std. Error z value Pr(>|z|)
## (Intercept)  0.01995    0.08068   0.247   0.8047
## liqCode      0.18550    0.10823   1.714   0.0865 .
## moneyCode    0.03127    0.03975   0.787   0.4315
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##           (Intr) liqCod
## liqCode   0.119
## moneyCode 0.041  0.005
```

```
# Money & Liquid Effects in Block 2
m.RR.motblock.OA.b2 <-glmer(formula = subRewarded ~ liqCode + moneyCode +
                              (1+moneyCode+liqCode|subID),
          data = subset(incentive,group=="OA" & block==2), family="binomial")
summary(m.RR.motblock.OA.b2)
```

```
## Generalized linear mixed model fit by maximum likelihood (Laplace
##   Approximation) [glmerMod]
##  Family: binomial  ( logit )
## Formula: subRewarded ~ liqCode + moneyCode + (1 + moneyCode + liqCode |
##     subID)
##    Data: subset(incentive, group == "OA" & block == 2)
##
##      AIC      BIC   logLik deviance df.resid
##   5542.0   5599.2  -2762.0   5524.0     4215
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -2.2945 -1.0912  0.6454  0.7949  1.8075
##
## Random effects:
##  Groups Name        Variance Std.Dev. Corr
##  subID  (Intercept) 0.27706  0.52636
##         moneyCode   0.00557  0.07463  -1.00
##         liqCode     0.03000  0.17322   1.00 -1.00
## Number of obs: 4224, groups:  subID, 44
```

```
##
## Fixed effects:
##             Estimate Std. Error z value Pr(>|z|)
## (Intercept)  0.38457    0.09071   4.239 2.24e-05 ***
## liqCode     -0.16117    0.10069  -1.601    0.109
## moneyCode    0.03905    0.04127   0.946    0.344
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##           (Intr) liqCod
## liqCode    0.529
## moneyCode -0.243 -0.076
```

```
# Money & Effects in Block 3
m.RR.motblock.OA.b3 <-glmer(formula = subRewarded ~ liqCode + moneyCode +
                              (1+moneyCode+liqCode|subID),
          data = subset(incentive,group=="OA" & block==3), family="binomial")
summary(m.RR.motblock.OA.b3)
```

```
## Generalized linear mixed model fit by maximum likelihood (Laplace
##   Approximation) [glmerMod]
##  Family: binomial  ( logit )
## Formula: subRewarded ~ liqCode + moneyCode + (1 + moneyCode + liqCode |
##     subID)
##    Data: subset(incentive, group == "OA" & block == 3)
##
##      AIC      BIC   logLik deviance df.resid
##   5371.0   5428.1  -2676.5   5353.0     4215
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -2.3554 -1.1029  0.5802  0.7455  1.5151
##
## Random effects:
##  Groups Name        Variance Std.Dev. Corr
##  subID  (Intercept) 0.263441 0.51326
##         moneyCode   0.004076 0.06385  -0.26
##         liqCode     0.057171 0.23910  -0.06 -0.95
## Number of obs: 4224, groups:  subID, 44
##
## Fixed effects:
##             Estimate Std. Error z value Pr(>|z|)
## (Intercept)  0.58050    0.08988   6.459 1.05e-10 ***
## liqCode      0.03633    0.11869   0.306     0.76
## moneyCode    0.18430    0.04200   4.388 1.14e-05 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##           (Intr) liqCod
## liqCode   -0.169
## moneyCode -0.035 -0.076
```

```r
# YA
m.RR.motblock.YA <-glmer(formula = subRewarded ~ liqCode * blockCode + moneyCode +
                           (1+moneyCode+liqCode|subID),
          data = subset(incentive,group=="YA"), family="binomial")
summary(m.RR.motblock.YA)
```

```
## Generalized linear mixed model fit by maximum likelihood (Laplace
##   Approximation) [glmerMod]
##  Family: binomial  ( logit )
## Formula: subRewarded ~ liqCode * blockCode + moneyCode + (1 + moneyCode +
##     liqCode | subID)
##    Data: subset(incentive, group == "YA")
##
##      AIC      BIC   logLik deviance df.resid
##  19038.8  19122.9  -9508.4  19016.8    15541
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -4.1708 -1.0655  0.5390  0.7158  6.1846
##
## Random effects:
##  Groups Name        Variance Std.Dev. Corr
##  subID  (Intercept) 0.27079  0.5204
##         moneyCode   0.02136  0.1462   -0.15
##         liqCode     0.14841  0.3852   -0.48  0.62
## Number of obs: 15552, groups:  subID, 54
##
## Fixed effects:
##                   Estimate Std. Error z value Pr(>|z|)
## (Intercept)        0.63788    0.07307   8.729  < 2e-16 ***
## liqCode            0.28885    0.05694   5.073 3.93e-07 ***
## blockCode          0.06885    0.02783   2.474 0.013347 *
## moneyCode          0.26292    0.02954   8.901  < 2e-16 ***
## liqCode:blockCode  0.17881    0.04614   3.876 0.000106 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr) liqCod blckCd monyCd
## liqCode     -0.425
## blockCode    0.003  0.004
## moneyCode   -0.085  0.396 -0.002
## lqCd:blckCd -0.004  0.013 -0.069  0.004
```

```r
# block 1
m.RR.motblock.YA.b1 <-glmer(formula = subRewarded ~ liqCode + moneyCode +
                              (1+moneyCode+liqCode|subID),
          data = subset(incentive,group=="YA" & block==1), family="binomial")
summary(m.RR.motblock.YA.b1)
```

```
## Generalized linear mixed model fit by maximum likelihood (Laplace
##   Approximation) [glmerMod]
##  Family: binomial  ( logit )
## Formula: subRewarded ~ liqCode + moneyCode + (1 + moneyCode + liqCode |
##     subID)
```

```
##    Data: subset(incentive, group == "YA" & block == 1)
##
##      AIC      BIC   logLik deviance df.resid
##   6698.8   6757.7  -3340.4   6680.8     5175
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -2.0039 -1.1322  0.6226  0.7447  1.4254
##
## Random effects:
##  Groups Name        Variance Std.Dev. Corr
##  subID  (Intercept) 0.11870  0.3445
##         moneyCode   0.04040  0.2010   -0.10
##         liqCode     0.09093  0.3016    0.15  0.97
## Number of obs: 5184, groups:  subID, 54
##
## Fixed effects:
##             Estimate Std. Error z value Pr(>|z|)
## (Intercept)  0.59193    0.06510   9.093  < 2e-16 ***
## liqCode     -0.09227    0.08689  -1.062    0.288
## moneyCode    0.20272    0.04558   4.447  8.7e-06 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##           (Intr) liqCod
## liqCode    0.142
## moneyCode -0.008  0.293
```

```
# block 2
m.RR.motblock.YA.b2 <-glmer(formula = subRewarded ~ liqCode + moneyCode +
                              (1+moneyCode+liqCode|subID),
          data = subset(incentive,group=="YA" & block==2), family="binomial")
```

```
## Warning in checkConv(attr(opt, "derivs"), opt$par, ctrl = control
## $checkConv, : Model failed to converge with max|grad| = 0.00225551 (tol =
## 0.001, component 1)
```

```
summary(m.RR.motblock.YA.b2)
```

```
## Generalized linear mixed model fit by maximum likelihood (Laplace
##   Approximation) [glmerMod]
##  Family: binomial  ( logit )
## Formula: subRewarded ~ liqCode + moneyCode + (1 + moneyCode + liqCode |
##     subID)
##    Data: subset(incentive, group == "YA" & block == 2)
##
##      AIC      BIC   logLik deviance df.resid
##   6205.0   6264.0  -3093.5   6187.0     5175
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -2.5748 -1.0683  0.5376  0.6636  5.6509
##
## Random effects:
```

```
##  Groups Name        Variance Std.Dev. Corr
##  subID  (Intercept) 0.15184  0.3897
##         moneyCode   0.03717  0.1928   -0.56
##         liqCode     0.61801  0.7861   -0.99  0.42
## Number of obs: 5184, groups:  subID, 54
##
## Fixed effects:
##             Estimate Std. Error z value Pr(>|z|)
## (Intercept)  0.76017    0.08707   8.730  < 2e-16 ***
## liqCode      0.30629    0.12591   2.433    0.015 *
## moneyCode    0.19350    0.04709   4.109 3.97e-05 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##           (Intr) liqCod
## liqCode   -0.455
## moneyCode -0.198  0.176
## convergence code: 0
## Model failed to converge with max|grad| = 0.00225551 (tol = 0.001, component 1)
```

```
# block 3
m.RR.motblock.YA.b3 <-glmer(formula = subRewarded ~ liqCode + moneyCode +
                              (1+moneyCode+liqCode|subID),
          data = subset(incentive,group=="YA" & block==3), family="binomial")
summary(m.RR.motblock.YA.b3)
```

```
## Generalized linear mixed model fit by maximum likelihood (Laplace
##   Approximation) [glmerMod]
##  Family: binomial  ( logit )
## Formula: subRewarded ~ liqCode + moneyCode + (1 + moneyCode + liqCode |
##     subID)
##    Data: subset(incentive, group == "YA" & block == 3)
##
##      AIC      BIC   logLik deviance df.resid
##   6100.7   6159.7  -3041.4   6082.7     5175
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -3.4693 -0.9137  0.4960  0.6602  3.5257
##
## Random effects:
##  Groups Name        Variance Std.Dev. Corr
##  subID  (Intercept) 0.46513  0.6820
##         moneyCode   0.09152  0.3025   -0.51
##         liqCode     0.01677  0.1295   -0.97  0.69
## Number of obs: 5184, groups:  subID, 54
##
## Fixed effects:
##             Estimate Std. Error z value Pr(>|z|)
## (Intercept)  0.70623    0.10245   6.893 5.45e-12 ***
## liqCode      0.42913    0.12582   3.411 0.000648 ***
## moneyCode    0.38989    0.05752   6.779 1.21e-11 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
##
## Correlation of Fixed Effects:
##           (Intr) liqCod
## liqCode   -0.189
## moneyCode -0.302  0.136
```

Analysis comparing OA performance in block 3 vs YA performance in block 1

```r
# OA block 3 vs YA block 1
t.test(x = subset(liq.means, group=="OA" & block==3)$meanRR,
       y = subset(liq.means, group=="YA" & block==1)$meanRR,
       paired=FALSE)
```

```
##
##  Welch Two Sample t-test
##
## data:  subset(liq.means, group == "OA" & block == 3)$meanRR and subset(liq.means, group == "YA" & bl
## t = 0.20309, df = 83.311, p-value = 0.8396
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.04417837  0.05422678
## sample estimates:
## mean of x mean of y
## 0.6323390 0.6273148
```

Reinforcement Effects Model: Trialwise Estimated Values

```
# Define constant parameters
L = 0.5
val_init = 0.5

# Loop over subjects and add estimated value based on previously rewarded trial
SUBJECTS = unique(incentive$subID)
#SUBJECTS = 1
incentive$value_est=999
for (subj.id in SUBJECTS) {
  # filter data for subject
  tmp.data<-filter(incentive,subID==subj.id)

  # remove values_subj vector
  if (exists("values_subj")) {rm(values_subj)}
  if (exists("values_subj_param")) {rm(values_subj_param)}

  # loop over blocks (1,2,3)
  BLOCKS=as.numeric(unique(tmp.data$block))
  for (b in BLOCKS) {
    # filter data for block
    tmp.data.block<-filter(tmp.data,block==b)
    # loop over trials within each block
    values = vector(mode = "numeric", length=96)
    values_param = vector(mode = "numeric", length=96)
    for (t in tmp.data.block$Trial) {
      # calculate estimated value per trial based on reinforcement/previous reward
      # non-parametric version: based only previous reward only
      # parametric version: based on previous reward & monetary value
      if (t==1) {
        values[t]=val_init
        values_param[t]=val_init
      } else {
        # nonparametric
        values[t]=((1-L)*values[t-1]) + L*as.numeric(tmp.data.block$subRewarded[t-1])
        # parametric
        w = tmp.data.block$moneyweight[t-1]
        values_param[t]=((1-L)*values_param[t-1]) +
          L*as.numeric(w*tmp.data.block$subRewarded[t-1])
      }

    } # end for loop over trials

    # concatenate the values from blocks for each subject
    if (exists("values_subj")) {values_subj<-c(values_subj,values)
    } else {values_subj<-values}

    # concatenate the values from blocks for each subject: parametric
    if (exists("values_subj_param")) {values_subj_param<-c(values_subj_param,values_param)
    } else {values_subj_param<-values_param}

  } # end for loop over blocks
```

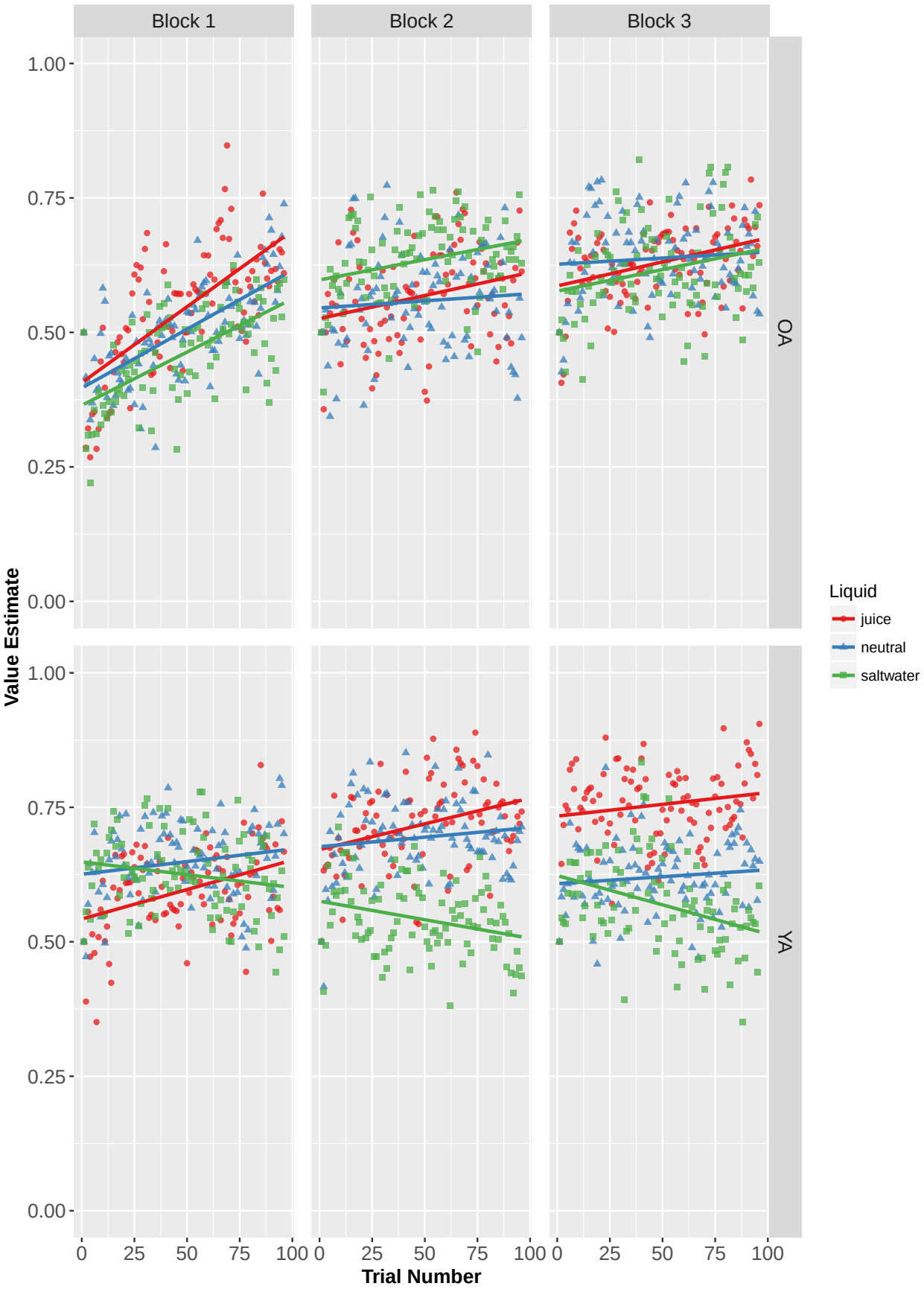
```
  # identify indices for where in data frame to enter value estimates
  ix<-which(incentive$subID==subj.id)
  # add value estimates to the data frame
  incentive[ix,"value_est"]=round(values_subj,4)
  incentive[ix,"value_est_param"]=round(values_subj_param,4)

} # end for loop over subjects
```

Plotting Group Averaged Value Estimates

```
data.group.value.estimates <- incentive %>% group_by(Trial,group,liquid,block) %>%
  summarise(n=n(),value_est_mean = mean(value_est),
            value_est_param_mean = mean(value_est_param)) %>%
  arrange(block,liquid,group,Trial)
levels(data.group.value.estimates$block)[levels(data.group.value.estimates$block)=="1"] <- "Block 1"
levels(data.group.value.estimates$block)[levels(data.group.value.estimates$block)=="2"] <- "Block 2"
levels(data.group.value.estimates$block)[levels(data.group.value.estimates$block)=="3"] <- "Block 3"
names(data.group.value.estimates)[3]<-"Liquid"

# Plotting group value estimates
p.val.1<-ggplot(data = data.group.value.estimates,
                mapping=aes(x=Trial,y=value_est_mean,
                            color=Liquid, shape=Liquid)) +
  geom_point(alpha=0.75) +
  geom_smooth(method="lm", se=FALSE) +
  coord_cartesian(ylim=c(0,1), xlim=c(1,96)) +
  facet_grid(group~block) +
  xlab("Trial Number") + ylab("Value Estimate") +
  #labs(shape = "Liquid") +
  scale_color_brewer(palette="Set1") +
  theme(#plot.title=element_text(size=22,face="bold", vjust=2),
        axis.title=element_text(size=12,face = "bold"),
        axis.text=element_text(size=12),
        #legend.position="none",
        strip.text.x = element_text(size = 12),
        strip.text.y = element_text(size = 12),
        panel.spacing = unit(.75, "lines"))
p.val.1
```


Block 1
Block 2
Block 3
OA
YA
Value Estimate
1.00
0.75
0.50
0.25
0.00
0
25
50
75
100
Trial Number
Liquid
juice
neutral
saltwater

Generalized Linear Mixed Model

Logistic regression of Estimated Reward Value and Experimental Conditions (money, liquid, blocks), as well as group (older adults vs younger adults).

```
# Reward Rate predicted by estimated value (reinforcement)
m.val.1 <-glmer(formula = subRewarded ~ value_est + (1|subID),
          data = incentive, family=binomial)
summary(m.val.1)
```

```
## Generalized linear mixed model fit by maximum likelihood (Laplace
##   Approximation) [glmerMod]
##  Family: binomial  ( logit )
## Formula: subRewarded ~ value_est + (1 | subID)
##    Data: incentive
##
##      AIC      BIC   logLik deviance df.resid
##  36233.2  36258.0 -18113.6  36227.2    28221
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -2.2937 -1.1009  0.6028  0.7804  1.6912
##
## Random effects:
##  Groups Name        Variance Std.Dev.
##  subID  (Intercept) 0.2101   0.4583
## Number of obs: 28224, groups:  subID, 98
##
## Fixed effects:
##             Estimate Std. Error z value Pr(>|z|)
## (Intercept)  0.23437    0.05515   4.250 2.14e-05 ***
## value_est    0.41763    0.04484   9.314  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##           (Intr)
## value_est -0.492
```

```
# money, liquid, age group effects, including estimated value
m.val.2 <-glmer(formula = subRewarded ~ moneyCode*liqCode + value_est*blockCode*groupCode +
                  value_est:liqCode +
                  (1+moneyCode+liqCode|subID),
          data = incentive, family=binomial)
summary(m.val.2)
```

```
## Generalized linear mixed model fit by maximum likelihood (Laplace
##   Approximation) [glmerMod]
##  Family: binomial  ( logit )
## Formula:
## subRewarded ~ moneyCode * liqCode + value_est * blockCode * groupCode +
##     value_est:liqCode + (1 + moneyCode + liqCode | subID)
##    Data: incentive
##
##      AIC      BIC   logLik deviance df.resid
```

```
##  35667.8  35816.2 -17815.9  35631.8    28206
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -3.6985 -1.0564  0.5669  0.7640  5.1816
##
## Random effects:
##  Groups Name        Variance Std.Dev. Corr
##  subID  (Intercept) 0.24843  0.4984
##         moneyCode   0.02138  0.1462   -0.23
##         liqCode     0.10239  0.3200   -0.29  0.57
## Number of obs: 28224, groups:  subID, 98
##
## Fixed effects:
##                               Estimate Std. Error z value Pr(>|z|)
## (Intercept)                    0.63727    0.08530   7.471 7.95e-14 ***
## moneyCode                      0.17872    0.02163   8.264  < 2e-16 ***
## liqCode                        0.16828    0.05052   3.331 0.000866 ***
## value_est                      0.08312    0.06643   1.251 0.210893
## blockCode                      0.05506    0.05583   0.986 0.324012
## groupCode                     -0.49130    0.12947  -3.795 0.000148 ***
## moneyCode:liqCode             -0.03807    0.01934  -1.969 0.048976 *
## value_est:blockCode            0.02267    0.07711   0.294 0.768734
## value_est:groupCode            0.12709    0.09364   1.357 0.174691
## blockCode:groupCode            0.22545    0.07758   2.906 0.003661 **
## liqCode:value_est             -0.01797    0.05790  -0.310 0.756239
## value_est:blockCode:groupCode -0.09617    0.11077  -0.868 0.385283
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr) monyCd liqCod val_st blckCd gropCd mnyC:C vl_st:bC
## moneyCode   -0.097
## liqCode     -0.070  0.251
## value_est   -0.511  0.003 -0.086
## blockCode    0.074 -0.003  0.053 -0.084
## groupCode   -0.714  0.010 -0.005  0.341 -0.068
## monyCd:lqCd -0.009  0.017  0.002  0.002  0.000  0.012
## vl_st:blckC -0.058  0.003 -0.053  0.075 -0.870  0.049 -0.003
## vl_st:grpCd  0.356 -0.002  0.059 -0.698  0.058 -0.451  0.005 -0.050
## blckCd:grpC -0.053  0.011 -0.059  0.062 -0.721  0.090 -0.002  0.627
## liqCd:vl_st -0.021  0.003 -0.699  0.059 -0.032 -0.015  0.010  0.028
## vl_st:blC:C  0.041 -0.012  0.058 -0.053  0.607 -0.065  0.002 -0.697
##             vl_st:gC blcC:C lqCd:_
## moneyCode
## liqCode
## value_est
## blockCode
## groupCode
## monyCd:lqCd
## vl_st:blckC
## vl_st:grpCd
## blckCd:grpC -0.107
## liqCd:vl_st -0.043    0.040
```

```
## vl_st:blC:C  0.069   -0.857 -0.043
```

```
# younger adults value estimate
m.val.2a <-glmer(formula = subRewarded ~ liqCode*moneyCode + blockCode*value_est +
                   value_est:liqCode + (1+moneyCode+liqCode|subID),
         data = filter(incentive,group=="YA" & liquid!="neutral"), family=binomial)
summary(m.val.2a)
```

```
## Generalized linear mixed model fit by maximum likelihood (Laplace
##   Approximation) [glmerMod]
##  Family: binomial  ( logit )
## Formula:
## subRewarded ~ liqCode * moneyCode + blockCode * value_est + value_est:liqCode +
##     (1 + moneyCode + liqCode | subID)
##    Data: filter(incentive, group == "YA" & liquid != "neutral")
##
##      AIC      BIC   logLik deviance df.resid
##  12667.9  12769.3  -6319.9  12639.9    10354
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -3.6251 -1.0473  0.5331  0.7220  4.6647
##
## Random effects:
##  Groups Name        Variance Std.Dev. Corr
##  subID  (Intercept) 0.29392  0.5421
##         moneyCode   0.02011  0.1418   -0.02
##         liqCode     0.14271  0.3778   -0.58  0.67
## Number of obs: 10368, groups:  subID, 54
##
## Fixed effects:
##                       Estimate Std. Error z value Pr(>|z|)
## (Intercept)           0.621990   0.094514   6.581 4.67e-11 ***
## liqCode               0.327795   0.078316   4.186 2.85e-05 ***
## moneyCode             0.280133   0.033133   8.455  < 2e-16 ***
## blockCode             0.242138   0.092526   2.617  0.00887 **
## value_est            -0.004148   0.084352  -0.049  0.96078
## liqCode:moneyCode    -0.059937   0.026798  -2.237  0.02531 *
## blockCode:value_est  -0.036371   0.099485  -0.366  0.71467
## liqCode:value_est    -0.085001   0.084046  -1.011  0.31185
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr) liqCod monyCd blckCd val_st lqCd:C blcC:_
## liqCode     -0.174
## moneyCode   -0.003  0.261
## blockCode    0.089  0.074 -0.004
## value_est   -0.576 -0.139  0.006 -0.126
## liqCd:mnyCd  0.007  0.014  0.031 -0.005  0.001
## blckCd:vl_s -0.093 -0.118  0.002 -0.719  0.120 -0.011
## liqCd:vl_st -0.114 -0.694  0.001 -0.062  0.103  0.003  0.095
```

```
# older adults value estimate
m.val.2b <-glmer(formula = subRewarded ~ liqCode*moneyCode + blockCode*value_est +
```

```
                  value_est:liqCode + (1+moneyCode+liqCode|subID),
          data = filter(incentive,group=="OA"), family=binomial)
summary(m.val.2b)
```

```
## Generalized linear mixed model fit by maximum likelihood (Laplace
##   Approximation) [glmerMod]
##  Family: binomial  ( logit )
## Formula:
## subRewarded ~ liqCode * moneyCode + blockCode * value_est + value_est:liqCode +
##     (1 + moneyCode + liqCode | subID)
##    Data: filter(incentive, group == "OA")
##
##      AIC      BIC   logLik deviance df.resid
##  16581.4  16685.6  -8276.7  16553.4    12658
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -2.0904 -1.0467  0.6185  0.8178  2.1509
##
## Random effects:
##  Groups Name        Variance Std.Dev. Corr
##  subID  (Intercept) 0.200844 0.44816
##         moneyCode   0.006291 0.07931  -0.37
##         liqCode     0.022389 0.14963   0.07 -0.24
## Number of obs: 12672, groups:  subID, 44
##
## Fixed effects:
##                     Estimate Std. Error z value Pr(>|z|)
## (Intercept)          0.19314    0.08026   2.407 0.016104 *
## liqCode             -0.04322    0.05741  -0.753 0.451605
## moneyCode            0.08424    0.02579   3.267 0.001088 **
## blockCode            0.30862    0.05214   5.919 3.23e-09 ***
## value_est            0.23903    0.06770   3.531 0.000414 ***
## liqCode:moneyCode   -0.01155    0.02794  -0.413 0.679248
## blockCode:value_est -0.08901    0.07844  -1.135 0.256504
## liqCode:value_est    0.09454    0.08276   1.142 0.253309
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr) liqCod monyCd blckCd val_st lqCd:C blcC:_
## liqCode      0.022
## moneyCode   -0.141 -0.056
## blockCode    0.096 -0.059  0.024
## value_est   -0.485  0.005  0.001 -0.126
## liqCd:mnyCd -0.007 -0.005  0.004 -0.004  0.014
## blckCd:vl_s -0.068  0.054 -0.026 -0.857  0.063  0.001
## liqCd:vl_st  0.002 -0.828  0.013  0.041 -0.007  0.009 -0.050
```

Self-Report Ratings

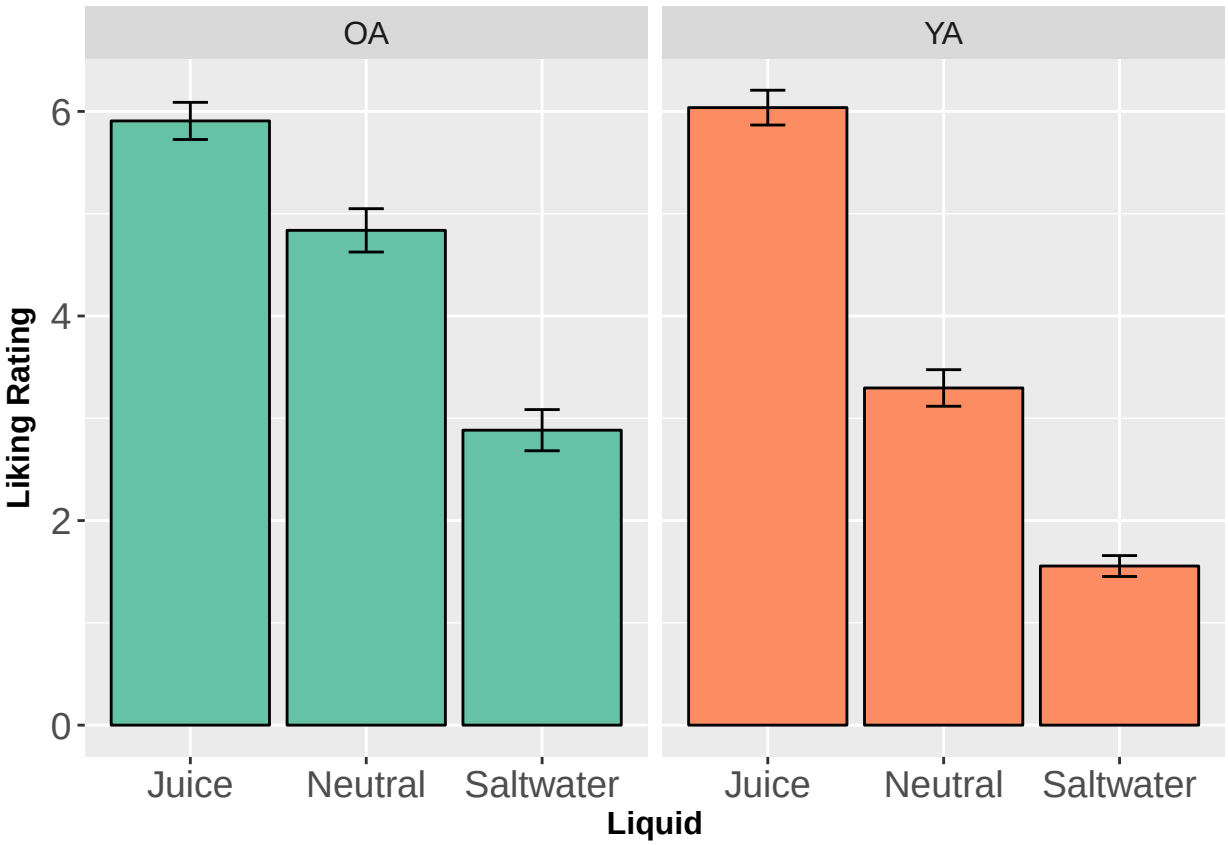
Formatting Data

```
data.selfreport<-read.csv(data.path.selfreport) %>%
  filter(include=="yes")
```

Plot of Self-Report Liking Ratings per Liquid

```
# formatting the liking data from wide to long form
data.liking<-data.selfreport %>%
  select(subID, group, Juice=juice_like, Neutral=neut_like, Saltwater=salt_like) %>%
  gather(key = liquid, value = rating, Juice:Saltwater, factor_key=TRUE) %>%
  mutate(liqCode = factor(liquid, levels = c("Saltwater","Neutral","Juice"), labels=c(-1,0,1)),
         groupCode = factor(group, levels=c("YA","OA"), labels=c(0,1)))
data.liking$liqCode<-as.numeric(levels(data.liking$liqCode)[data.liking$liqCode])
data.liking$groupCode<-as.numeric(levels(data.liking$groupCode)[data.liking$groupCode])

selfreport.sum<-summarySEwithin2(data = data.liking, measurevar = "rating",
                                 withinvars = c("liquid"), betweenvars = "group",
                                 idvar = "subID")
p.rating.1<-ggplot(data = selfreport.sum, aes(x = liquid, y = rating, fill=group)) +
  geom_bar(stat = "identity", color="black") +
  geom_errorbar(mapping = aes(ymin=rating-se, ymax=rating+se), width=.2) +
  xlab("Liquid") + ylab("Liking Rating") +
  scale_x_discrete(labels=c("juice_like" = "Juice",
                            "neut_like" = "Neutral",
                            "salt_like" = "Saltwater")) +
  facet_grid(.~group) +
  scale_fill_brewer(palette = "Set2") +
  #coord_cartesian(ylim=c(1,7)) +
  theme(#plot.title=element_text(size=22,face="bold", vjust=2),
    axis.title=element_text(size=12,face = "bold"),
    axis.text=element_text(size=14),
    legend.position="none",
    strip.text.x = element_text(size = 12))
p.rating.1
```


OA
YA
6
4
2
0
Liking Rating
Juice
Neutral
Saltwater
Juice
Neutral
Saltwater
Liquid

Stats on Liking Ratings

```
m.selfreport.1<-lmer(formula = rating ~ liqCode*groupCode + (1|subID), data = data.liking)
summary(m.selfreport.1)
```

```
## Linear mixed model fit by REML t-tests use Satterthwaite approximations
##   to degrees of freedom [lmerMod]
## Formula: rating ~ liqCode * groupCode + (1 | subID)
##    Data: data.liking
##
## REML criterion at convergence: 972.2
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -3.2081 -0.5144 -0.0159  0.6245  2.6332
##
## Random effects:
##  Groups   Name        Variance Std.Dev.
##  subID    (Intercept) 0.1007   0.3174
##  Residual             1.5272   1.2358
## Number of obs: 291, groups:  subID, 97
##
## Fixed effects:
##                   Estimate Std. Error       df t value Pr(>|t|)
## (Intercept)         3.6296     0.1063  95.0000  34.156  < 2e-16 ***
## liqCode             2.2407     0.1189 192.0000  18.843  < 2e-16 ***
## groupCode           0.9130     0.1596  95.0000   5.720 1.23e-07 ***
## liqCode:groupCode  -0.7291     0.1786 192.0000  -4.082 6.54e-05 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr) liqCod gropCd
## liqCode      0.000
## groupCode   -0.666  0.000
## liqCd:grpCd  0.000 -0.666  0.000
```

```
# OA
m.selfreport.1.OA<-lmer(formula = rating ~ liqCode + (1|subID),
                        data = subset(data.liking, group=="OA"))
summary(m.selfreport.1.OA)
```

```
## Linear mixed model fit by REML t-tests use Satterthwaite approximations
##   to degrees of freedom [lmerMod]
## Formula: rating ~ liqCode + (1 | subID)
##    Data: subset(data.liking, group == "OA")
##
## REML criterion at convergence: 458.6
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -2.92532 -0.71254  0.01504  0.68307  1.94733
##
## Random effects:
```

```
##  Groups   Name        Variance Std.Dev.
##  subID    (Intercept) 0.3186   0.5644
##  Residual             1.7430   1.3202
## Number of obs: 129, groups:  subID, 43
##
## Fixed effects:
##             Estimate Std. Error      df t value Pr(>|t|)
## (Intercept)   4.5426     0.1446 42.0000   31.41   <2e-16 ***
## liqCode       1.5116     0.1424 85.0000   10.62   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##         (Intr)
## liqCode 0.000
```

```
# OA JvN
t.test(x = subset(data.liking, liquid=="Juice" & group=="OA")$rating,
       y = subset(data.liking, liquid=="Neutral" & group=="OA")$rating,
       paired = TRUE)
```

```
##
##  Paired t-test
##
## data:  subset(data.liking, liquid == "Juice" & group == "OA")$rating and subset(data.liking, liquid =
## t = 3.8589, df = 42, p-value = 0.000386
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  0.510319 1.629216
## sample estimates:
## mean of the differences
##                1.069767
```

```
# OA NvS
t.test(x = subset(data.liking, liquid=="Neutral" & group=="OA")$rating,
       y = subset(data.liking, liquid=="Saltwater" & group=="OA")$rating,
       paired = TRUE)
```

```
##
##  Paired t-test
##
## data:  subset(data.liking, liquid == "Neutral" & group == "OA")$rating and subset(data.liking, liqui
## t = 6.4452, df = 42, p-value = 9.085e-08
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  1.341825 2.565151
## sample estimates:
## mean of the differences
##                1.953488
```

```
# YA
m.selfreport.1.YA<-lmer(formula = rating ~ liqCode + (1|subID),
                        data = subset(data.liking, group=="YA"))
summary(m.selfreport.1.YA)
```

```
## Linear mixed model fit by REML t-tests use Satterthwaite approximations
```

```
##   to degrees of freedom [lmerMod]
## Formula: rating ~ liqCode + (1 | subID)
##    Data: subset(data.liking, group == "YA")
##
## REML criterion at convergence: 503.9
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -3.4150 -0.5555  0.1144  0.5392  2.9738
##
## Random effects:
##  Groups   Name        Variance  Std.Dev.
##  subID    (Intercept) 1.599e-19 3.998e-10
##  Residual             1.284e+00 1.133e+00
## Number of obs: 162, groups:  subID, 54
##
## Fixed effects:
##              Estimate Std. Error        df t value Pr(>|t|)
## (Intercept)   3.62963    0.08904 160.00000   40.76   <2e-16 ***
## liqCode       2.24074    0.10906 160.00000   20.55   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##         (Intr)
## liqCode 0.000
```

```
# YA JuN
t.test(x = subset(data.liking, liquid=="Juice" & group=="YA")$rating,
       y = subset(data.liking, liquid=="Neutral" & group=="YA")$rating,
       paired = TRUE)
```

```
##
##  Paired t-test
##
## data:  subset(data.liking, liquid == "Juice" & group == "YA")$rating and subset(data.liking, liquid =
## t = 10.061, df = 53, p-value = 6.791e-14
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  2.194369 3.287112
## sample estimates:
## mean of the differences
##                2.740741
```

```
# YA NuS
t.test(x = subset(data.liking, liquid=="Neutral" & group=="YA")$rating,
       y = subset(data.liking, liquid=="Saltwater" & group=="YA")$rating,
       paired = TRUE)
```

```
##
##  Paired t-test
##
## data:  subset(data.liking, liquid == "Neutral" & group == "YA")$rating and subset(data.liking, liqui
## t = 9.0294, df = 53, p-value = 2.637e-12
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
```

```
##  1.354061 2.127421
## sample estimates:
## mean of the differences
##                1.740741
```

```
# OA vs YA
# Juice
t.test(x = subset(data.liking, liquid=="Juice" & group=="OA")$rating,
       y = subset(data.liking, liquid=="Juice" & group=="YA")$rating)
```

```
##
##  Welch Two Sample t-test
##
## data:  subset(data.liking, liquid == "Juice" & group == "OA")$rating and subset(data.liking, liquid =
## t = -0.53693, df = 84.27, p-value = 0.5927
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.6117368  0.3516163
## sample estimates:
## mean of x mean of y
##  5.906977  6.037037
```

```
# Neutral
t.test(x = subset(data.liking, liquid=="Neutral" & group=="OA")$rating,
       y = subset(data.liking, liquid=="Neutral" & group=="YA")$rating)
```

```
##
##  Welch Two Sample t-test
##
## data:  subset(data.liking, liquid == "Neutral" & group == "OA")$rating and subset(data.liking, liqui
## t = 5.1571, df = 84.267, p-value = 1.636e-06
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  0.9467597 2.1350663
## sample estimates:
## mean of x mean of y
##  4.837209  3.296296
```

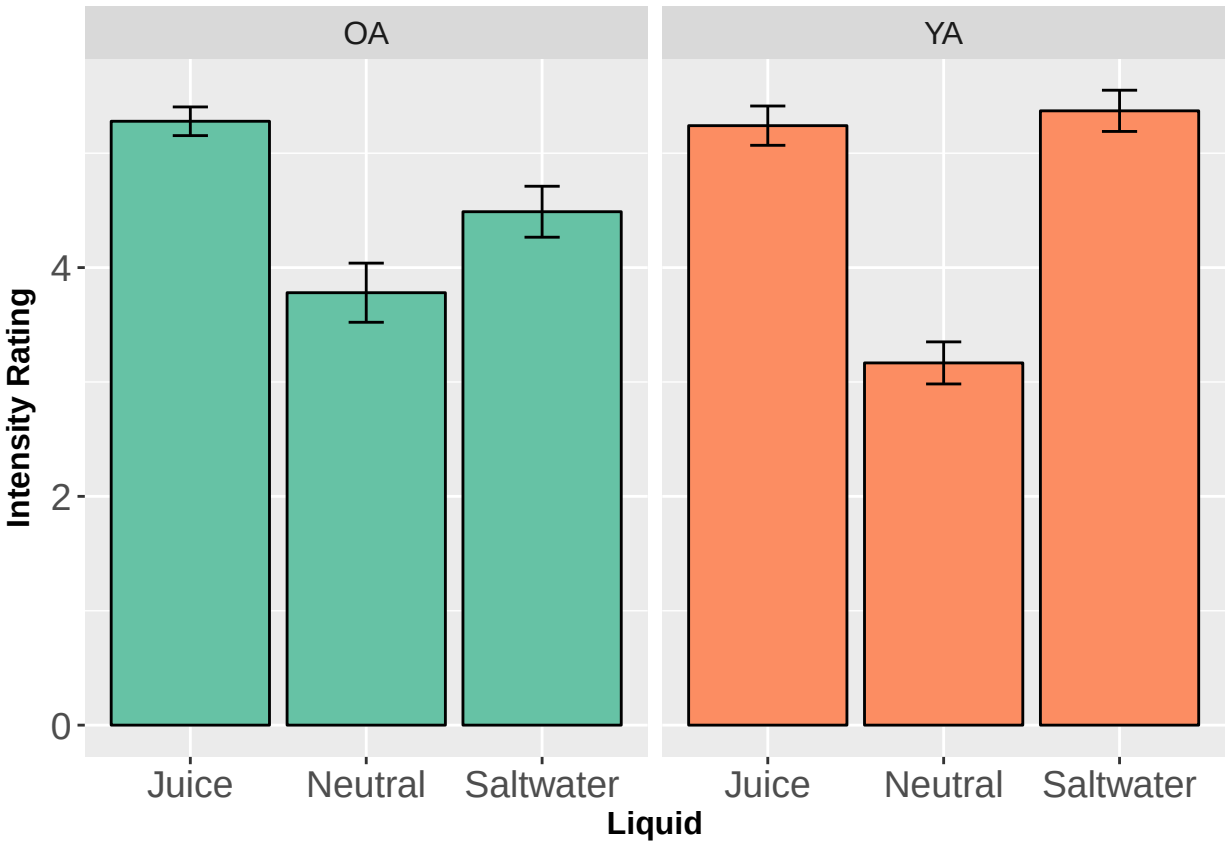
```
# Saltwater
t.test(x = subset(data.liking, liquid=="Saltwater" & group=="OA")$rating,
       y = subset(data.liking, liquid=="Saltwater" & group=="YA")$rating)
```

```
##
##  Welch Two Sample t-test
##
## data:  subset(data.liking, liquid == "Saltwater" & group == "OA")$rating and subset(data.liking, liq
## t = 5.3164, df = 62.267, p-value = 1.519e-06
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  0.8288196 1.8275111
## sample estimates:
## mean of x mean of y
##  2.883721  1.555556
```

Plot of Self-Report Intensity Ratings per Liquid

```
# formatting the intensity data from wide to long form
data.intensity<-data.selfreport %>%
  select(subID, group, Juice=juice_intense, Neutral=neut_intense, Saltwater=salt_intense) %>%
  gather(key = liquid, value = rating, Juice:Saltwater, factor_key=TRUE) %>%
  mutate(liqCode = factor(liquid, levels = c("Saltwater","Neutral","Juice"), labels=c(-1,0,1)),
         groupCode = factor(group, levels=c("YA","OA"), labels=c(0,1)))
data.intensity$liqCode<-as.numeric(levels(data.intensity$liqCode)[data.intensity$liqCode])
data.intensity$groupCode<-as.numeric(levels(data.intensity$groupCode)[data.intensity$groupCode])


selfreport.sum<-summarySEwithin2(data = data.intensity, measurevar = "rating",
                                 withinvars = c("liquid"), betweenvars = "group",
                                 idvar = "subID")
p.rating.2<-ggplot(data = selfreport.sum, aes(x = liquid, y = rating, fill=group)) +
  geom_bar(stat = "identity", color="black") +
  geom_errorbar(mapping = aes(ymin=rating-se, ymax=rating+se), width=.2) +
  xlab("Liquid") + ylab("Intensity Rating") +
  scale_x_discrete(labels=c("juice_intense" = "Juice",
                            "neut_intense" = "Neutral",
                            "salt_intense" = "Saltwater")) +
  facet_grid(.~group) +
  scale_fill_brewer(palette = "Set2") +
  #coord_cartesian(ylim=c(1,7)) +
  theme(#plot.title=element_text(size=22,face="bold", vjust=2),
    axis.title=element_text(size=12,face = "bold"),
    axis.text=element_text(size=14),
    legend.position="none",
    strip.text.x = element_text(size = 12))
p.rating.2
```


OA
YA
Intensity Rating
4
2
0
Juice
Neutral
Saltwater
Juice
Neutral
Saltwater
Liquid

Stats on Intensity Ratings

```
m.selfreport.2<-lmer(formula = rating ~ liqCode*groupCode + (1|subID),
                     data = data.intensity)
summary(m.selfreport.2)
```

```
## Linear mixed model fit by REML t-tests use Satterthwaite approximations
##   to degrees of freedom [lmerMod]
## Formula: rating ~ liqCode * groupCode + (1 | subID)
##    Data: data.intensity
##
## REML criterion at convergence: 1112.9
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -2.2181 -0.5597  0.2078  0.8142  1.7392
##
## Random effects:
##  Groups   Name        Variance  Std.Dev.
##  subID    (Intercept) 9.798e-16 3.130e-08
##  Residual             2.719e+00 1.649e+00
## Number of obs: 289, groups:  subID, 97
##
## Fixed effects:
##                    Estimate Std. Error        df t value Pr(>|t|)
## (Intercept)         4.59259    0.12955 285.00000  35.451   <2e-16 ***
## liqCode            -0.06481    0.15866 285.00000  -0.409   0.6832
## groupCode          -0.06503    0.19543 285.00000  -0.333   0.7395
## liqCode:groupCode   0.46016    0.23830 285.00000   1.931   0.0545 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr) liqCod gropCd
## liqCode      0.000
## groupCode   -0.663  0.000
## liqCd:grpCd  0.000 -0.666  0.000
```

```
# OA
m.selfreport.2.OA<-lmer(formula = rating ~ liqCode + (1|subID),
                        data = subset(data.intensity, group=="OA"))
summary(m.selfreport.2.OA)
```

```
## Linear mixed model fit by REML t-tests use Satterthwaite approximations
##   to degrees of freedom [lmerMod]
## Formula: rating ~ liqCode + (1 | subID)
##    Data: subset(data.intensity, group == "OA")
##
## REML criterion at convergence: 458.5
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -2.41722 -0.36150  0.05283  0.73806  1.96512
##
```

```
## Random effects:
##  Groups   Name        Variance Std.Dev.
##  subID    (Intercept) 0.00     0.000
##  Residual             2.13     1.459
## Number of obs: 127, groups:  subID, 43
##
## Fixed effects:
##             Estimate Std. Error       df t value Pr(>|t|)
## (Intercept)   4.5276     0.1295 125.0000  34.963   <2e-16 ***
## liqCode       0.3953     0.1574 125.0000   2.512   0.0133 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##         (Intr)
## liqCode 0.000
```

```
# OA JvN
t.test(x = subset(data.intensity, liquid=="Juice" & group=="OA")$rating,
       y = subset(data.intensity, liquid=="Neutral" & group=="OA")$rating,
       paired = TRUE)
```

```
##
##  Paired t-test
##
## data:  subset(data.intensity, liquid == "Juice" & group == "OA")$rating and subset(data.intensity, li
## t = 5.6293, df = 40, p-value = 1.568e-06
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  0.984905 2.088266
## sample estimates:
## mean of the differences
##                1.536585
```

```
# OA NvS
t.test(x = subset(data.intensity, liquid=="Saltwater" & group=="OA")$rating,
       y = subset(data.intensity, liquid=="Neutral" & group=="OA")$rating,
       paired = TRUE)
```

```
##
##  Paired t-test
##
## data:  subset(data.intensity, liquid == "Saltwater" & group == "OA")$rating and subset(data.intensity
## t = 1.8891, df = 40, p-value = 0.06615
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.05112942  1.51454405
## sample estimates:
## mean of the differences
##               0.7317073
```

```
# YA
m.selfreport.2.YA<-lmer(formula = rating ~ liqCode + (1|subID),
                        data = subset(data.intensity, group=="YA"))
summary(m.selfreport.2.YA)
```

```
## Linear mixed model fit by REML t-tests use Satterthwaite approximations
##   to degrees of freedom [lmerMod]
## Formula: rating ~ liqCode + (1 | subID)
##    Data: subset(data.intensity, group == "YA")
##
## REML criterion at convergence: 648.9
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -2.0513 -0.8841  0.2285  0.7893  1.3865
##
## Random effects:
##  Groups   Name        Variance Std.Dev.
##  subID    (Intercept) 0.000    0.000
##  Residual             3.179    1.783
## Number of obs: 162, groups:  subID, 54
##
## Fixed effects:
##             Estimate Std. Error        df t value Pr(>|t|)
## (Intercept)   4.59259    0.14009 160.00000  32.784   <2e-16 ***
## liqCode      -0.06481    0.17157 160.00000  -0.378    0.706
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##         (Intr)
## liqCode 0.000
```

```
# YA JvN
t.test(x = subset(data.intensity, liquid=="Juice" & group=="YA")$rating,
       y = subset(data.intensity, liquid=="Neutral" & group=="YA")$rating,
       paired = TRUE)
```

```
##
##  Paired t-test
##
## data:  subset(data.intensity, liquid == "Juice" & group == "YA")$rating and subset(data.intensity, li
## t = 8.2771, df = 53, p-value = 4.048e-11
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  1.571477 2.576671
## sample estimates:
## mean of the differences
##                2.074074
```

```
# YA NvS
t.test(x = subset(data.intensity, liquid=="Saltwater" & group=="YA")$rating,
       y = subset(data.intensity, liquid=="Neutral" & group=="YA")$rating,
       paired = TRUE)
```

```
##
##  Paired t-test
##
## data:  subset(data.intensity, liquid == "Saltwater" & group == "YA")$rating and subset(data.intensity
## t = 8.4047, df = 53, p-value = 2.54e-11
## alternative hypothesis: true difference in means is not equal to 0
```

```
## 95 percent confidence interval:
##  1.677797 2.729610
## sample estimates:
## mean of the differences
##                2.203704
```

```
# OA vs YA
# Juice
t.test(x = subset(data.intensity, liquid=="Juice" & group=="OA")$rating,
       y = subset(data.intensity, liquid=="Juice" & group=="YA")$rating)
```

```
##
##  Welch Two Sample t-test
##
## data:  subset(data.intensity, liquid == "Juice" & group == "OA")$rating and subset(data.intensity, li
## t = 0.17111, df = 92.49, p-value = 0.8645
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.4065377  0.4831957
## sample estimates:
## mean of x mean of y
##  5.279070  5.240741
```

```
# Neutral
t.test(x = subset(data.intensity, liquid=="Neutral" & group=="OA")$rating,
       y = subset(data.intensity, liquid=="Neutral" & group=="YA")$rating)
```

```
##
##  Welch Two Sample t-test
##
## data:  subset(data.intensity, liquid == "Neutral" & group == "OA")$rating and subset(data.intensity,
## t = 1.8983, df = 77.973, p-value = 0.06136
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.02993791  1.25758018
## sample estimates:
## mean of x mean of y
##  3.780488  3.166667
```

```
# Saltwater
t.test(x = subset(data.intensity, liquid=="Saltwater" & group=="OA")$rating,
       y = subset(data.intensity, liquid=="Saltwater" & group=="YA")$rating)
```

```
##
##  Welch Two Sample t-test
##
## data:  subset(data.intensity, liquid == "Saltwater" & group == "OA")$rating and subset(data.intensity
## t = -2.7841, df = 94.138, p-value = 0.006488
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -1.5109895 -0.2530071
## sample estimates:
## mean of x mean of y
##  4.488372  5.370370
```

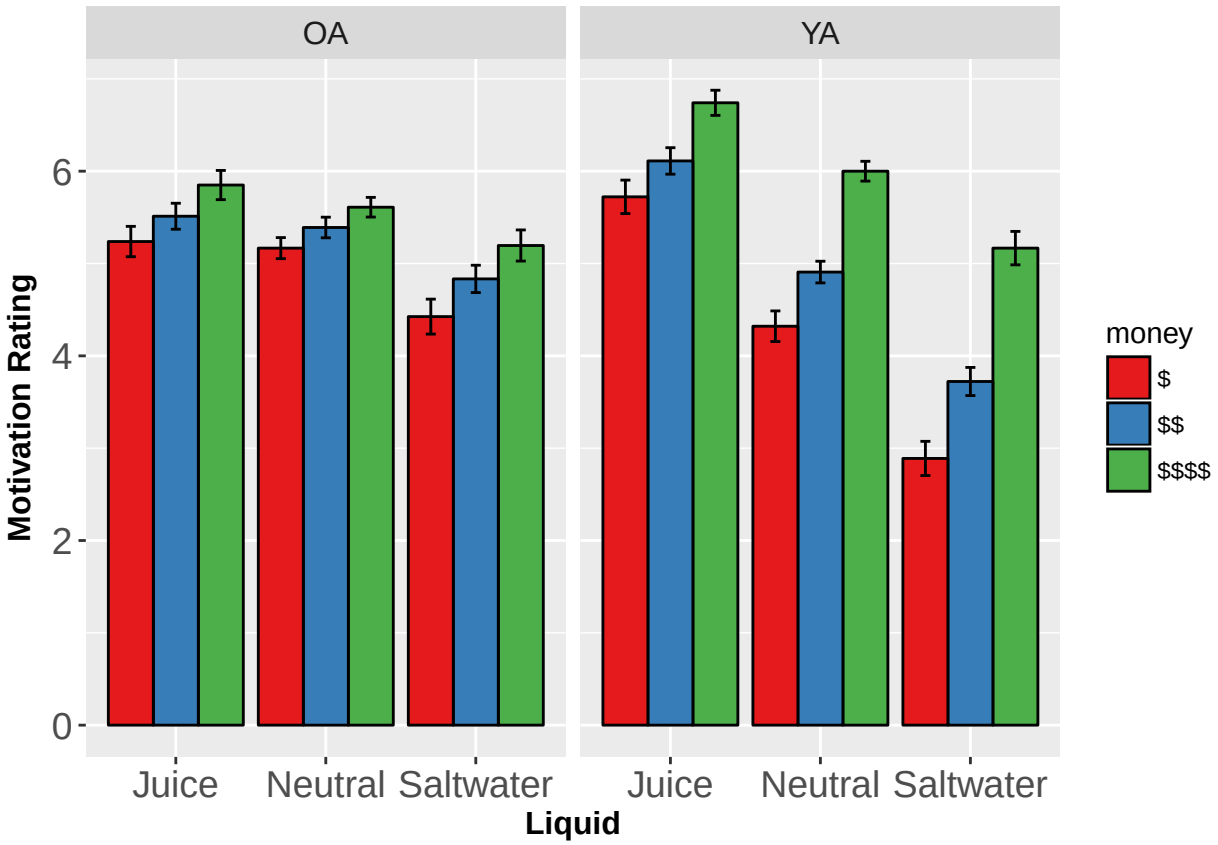
Plot of Self-Report Motivation Ratings per Trial Type

```
# 9 motivation ratings
data.motive9<-data.selfreport %>%
  select(subID, group,
         Juice_1=juice1_motivation, Juice_2=juice2_motivation, Juice_4=juice4_motivation,
         Neutral_1=neut1_motivation, Neutral_2=neut2_motivation, Neutral_4=neut4_motivation,
         Saltwater_1=salt1_motivation, Saltwater_2=salt2_motivation, Saltwater_4=salt4_motivation) %>%
  gather(key = condition, value = rating, Juice_1:Saltwater_4, factor_key = TRUE) %>%
  separate(col = condition, into=c("liquid","moneyreward"), sep = "_") %>%
  mutate(liqCode = factor(liquid, levels = c("Saltwater","Neutral","Juice"), labels=c(-1,0,1)),
         rewCode = factor(moneyreward, levels = c(1,2,4), labels=c(-1,0,1)),
         groupCode = factor(group, levels=c("YA","OA"), labels=c(0,1)),
         money=factor(moneyreward, levels=c(1,2,4), labels=c("$","$$","$$$$")))
data.motive9$liqCode<-as.numeric(levels(data.motive9$liqCode)[data.motive9$liqCode])
data.motive9$rewCode<-as.numeric(levels(data.motive9$rewCode)[data.motive9$rewCode])
data.motive9$groupCode<-as.numeric(levels(data.motive9$groupCode)[data.motive9$groupCode])
data.motive9$subID<-as.factor(data.motive9$subID)

selfreport.sum<-summarySEwithin2(data = data.motive9, measurevar = "rating",
                                 withinvars = c("liquid","money"), betweenvars = "group",
                                 idvar = "subID")
```

```
## Automatically converting the following non-factors to factors: liquid
```

```
p.rating.3<-ggplot(data = selfreport.sum, aes(x = liquid, y = rating, fill = money)) +
  geom_bar(position=position_dodge(), stat = "identity", color="black") +
  geom_errorbar(position=position_dodge(.9),
                mapping = aes(ymin=rating-se, ymax=rating+se), width=.2) +
  xlab("Liquid") + ylab("Motivation Rating") +
  scale_x_discrete(labels=c("juice_intense" = "Juice",
                            "neut_intense" = "Neutral",
                            "salt_intense" = "Saltwater")) +
  facet_grid(.~group) +
  scale_fill_brewer(palette = "Set1") +
  #coord_cartesian(ylim=c(1,7)) +
  theme(#plot.title=element_text(size=22,face="bold", vjust=2),
    axis.title=element_text(size=12,face = "bold"),
    axis.text=element_text(size=14),
    legend.position="right",
    strip.text.x = element_text(size = 12))
p.rating.3
```


OA
YA
Motivation Rating
0
2
4
6
Juice
Neutral
Saltwater
Juice
Neutral
Saltwater
Liquid
money
$
$$
$$$$

Stats on Motivation Ratings by Trial Type

```
m.selfreport.3<-lmer(formula = rating ~ liqCode*rewCode*groupCode + (1|subID),
                     data = data.motive9)
summary(m.selfreport.3)
```

```
## Linear mixed model fit by REML t-tests use Satterthwaite approximations
##   to degrees of freedom [lmerMod]
## Formula: rating ~ liqCode * rewCode * groupCode + (1 | subID)
##    Data: data.motive9
##
## REML criterion at convergence: 2758.1
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -3.4445 -0.5177  0.0441  0.5554  2.7243
##
## Random effects:
##  Groups   Name        Variance Std.Dev.
##  subID    (Intercept) 1.134    1.065
##  Residual             1.115    1.056
## Number of obs: 855, groups:  subID, 96
##
## Fixed effects:
##                             Estimate Std. Error        df t value Pr(>|t|)
## (Intercept)                  5.06488    0.15262  93.90000  33.186  < 2e-16
## liqCode                      1.13272    0.05867 753.00000  19.306  < 2e-16
## rewCode                      0.82861    0.05877 753.10000  14.099  < 2e-16
## groupCode                    0.18003    0.23089  94.10000   0.780   0.4375
## liqCode:rewCode             -0.31481    0.07186 753.00000  -4.381 1.35e-05
## liqCode:groupCode           -0.78471    0.08934 753.10000  -8.784  < 2e-16
## rewCode:groupCode           -0.51760    0.08943 753.30000  -5.788 1.05e-08
## liqCode:rewCode:groupCode    0.26366    0.10974 753.60000   2.403   0.0165
##
## (Intercept)                ***
## liqCode                    ***
## rewCode                    ***
## groupCode
## liqCode:rewCode            ***
## liqCode:groupCode          ***
## rewCode:groupCode          ***
## liqCode:rewCode:groupCode *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr) liqCod rewCod gropCd lqCd:rC lqCd:gC rwCd:C
## liqCode      0.000
## rewCode     -0.001  0.000
## groupCode   -0.661  0.000  0.001
## liqCod:rwCd  0.000  0.000  0.000  0.000
## liqCd:grpCd  0.000 -0.657  0.000  0.000  0.000
## rewCd:grpCd  0.001  0.000 -0.657  0.001  0.000   0.007
## lqCd:rwCd:C  0.000  0.000  0.000  0.003 -0.655   0.003  -0.003
```

```r
# OA
m.selfreport.3.OA<-lmer(formula = rating ~ liqCode*rewCode + (1|subID),
                        data = subset(data.motive9, group=="OA"))
summary(m.selfreport.3.OA)
```

```
## Linear mixed model fit by REML t-tests use Satterthwaite approximations
##   to degrees of freedom [lmerMod]
## Formula: rating ~ liqCode * rewCode + (1 | subID)
##    Data: subset(data.motive9, group == "OA")
##
## REML criterion at convergence: 1130
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -3.8790 -0.4159  0.0497  0.4907  2.7667
##
## Random effects:
##  Groups   Name        Variance Std.Dev.
##  subID    (Intercept) 1.4633   1.210
##  Residual             0.8893   0.943
## Number of obs: 370, groups:  subID, 42
##
## Fixed effects:
##                  Estimate Std. Error        df t value Pr(>|t|)
## (Intercept)       5.24479    0.19301  41.00000  27.174  < 2e-16 ***
## liqCode           0.34761    0.06016 325.10000   5.778 1.77e-08 ***
## rewCode           0.31137    0.06019 325.10000   5.173 4.03e-07 ***
## liqCode:rewCode  -0.05172    0.07407 325.30000  -0.698    0.485
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr) liqCod rewCod
## liqCode      0.000
## rewCode      0.002  0.012
## liqCod:rwCd  0.004  0.006 -0.006
```

```r
# OA JvN
m.selfreport.3.OA.JvN<-lmer(formula = rating ~ liqCode*rewCode + (1|subID),
                        data = subset(data.motive9, group=="OA" & liquid!="Saltwater"))
summary(m.selfreport.3.OA.JvN)
```

```
## Linear mixed model fit by REML t-tests use Satterthwaite approximations
##   to degrees of freedom [lmerMod]
## Formula: rating ~ liqCode * rewCode + (1 | subID)
##    Data: subset(data.motive9, group == "OA" & liquid != "Saltwater")
##
## REML criterion at convergence: 686
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -3.1450 -0.3963  0.0026  0.4432  3.2916
##
## Random effects:
##  Groups   Name        Variance Std.Dev.
```

```
##  subID    (Intercept) 1.3809   1.1751
##  Residual             0.5781   0.7604
## Number of obs: 247, groups:  subID, 42
##
## Fixed effects:
##                  Estimate Std. Error        df t value Pr(>|t|)
## (Intercept)       5.38965    0.19379  46.62000  27.811   <2e-16 ***
## liqCode           0.13017    0.09696 202.19000   1.343   0.1809
## rewCode           0.21684    0.08356 202.13000   2.595   0.0101 *
## liqCode:rewCode   0.08443    0.11861 202.18000   0.712   0.4774
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr) liqCod rewCod
## liqCode     -0.249
## rewCode      0.004 -0.008
## liqCod:rwCd -0.003  0.018 -0.705
```

```
# OA NvS
m.selfreport.3.OA.NvS<-lmer(formula = rating ~ liqCode*rewCode + (1|subID),
                      data = subset(data.motive9, group=="OA" & liquid!="Juice"))
summary(m.selfreport.3.OA.NvS)
```

```
## Linear mixed model fit by REML t-tests use Satterthwaite approximations
##   to degrees of freedom [lmerMod]
## Formula: rating ~ liqCode * rewCode + (1 | subID)
##    Data: subset(data.motive9, group == "OA" & liquid != "Juice")
##
## REML criterion at convergence: 734.4
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -4.1026 -0.4486 -0.0073  0.4802  2.8243
##
## Random effects:
##  Groups   Name        Variance Std.Dev.
##  subID    (Intercept) 1.8472   1.3591
##  Residual             0.6937   0.8329
## Number of obs: 247, groups:  subID, 42
##
## Fixed effects:
##                  Estimate Std. Error        df t value Pr(>|t|)
## (Intercept)       5.37799    0.22269  46.03000  24.150  < 2e-16 ***
## liqCode           0.54929    0.10620 202.14000   5.172 5.55e-07 ***
## rewCode           0.22138    0.09153 202.09000   2.419   0.0165 *
## liqCode:rewCode  -0.19108    0.13038 202.16000  -1.466   0.1443
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr) liqCod rewCod
## liqCode     0.237
## rewCode     0.004  0.008
## liqCod:rwCd 0.003  0.000  0.702
```

```r
# YA
m.selfreport.3.YA<-lmer(formula = rating ~ liqCode*rewCode + (1|subID),
                        data = subset(data.motive9, group=="YA"))
summary(m.selfreport.3.YA)
```

```
## Linear mixed model fit by REML t-tests use Satterthwaite approximations
##   to degrees of freedom [lmerMod]
## Formula: rating ~ liqCode * rewCode + (1 | subID)
##    Data: subset(data.motive9, group == "YA")
##
## REML criterion at convergence: 1613.7
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -2.86104 -0.60892  0.02475  0.62075  2.54297
##
## Random effects:
##  Groups   Name        Variance Std.Dev.
##  subID    (Intercept) 0.8799   0.938
##  Residual             1.2869   1.134
## Number of obs: 485, groups:  subID, 54
##
## Fixed effects:
##                  Estimate Std. Error        df t value Pr(>|t|)
## (Intercept)       5.06485    0.13766  53.00000  36.794  < 2e-16 ***
## liqCode           1.13272    0.06302 428.00000  17.973  < 2e-16 ***
## rewCode           0.82865    0.06313 428.10000  13.126  < 2e-16 ***
## liqCode:rewCode  -0.31481    0.07719 428.00000  -4.079  5.4e-05 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr) liqCod rewCod
## liqCode      0.000
## rewCode     -0.001  0.000
## liqCod:rwCd  0.000  0.000  0.000
```

```r
# YA JvN
m.selfreport.3.YA.JvN<-lmer(formula = rating ~ liqCode*rewCode + (1|subID),
                        data = subset(data.motive9, group=="YA" & liquid!="Saltwater"))
summary(m.selfreport.3.YA.JvN)
```

```
## Linear mixed model fit by REML t-tests use Satterthwaite approximations
##   to degrees of freedom [lmerMod]
## Formula: rating ~ liqCode * rewCode + (1 | subID)
##    Data: subset(data.motive9, group == "YA" & liquid != "Saltwater")
##
## REML criterion at convergence: 985.5
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -3.2893 -0.5954  0.0439  0.6285  2.3025
##
## Random effects:
##  Groups   Name        Variance Std.Dev.
```

```
##  subID    (Intercept) 0.5075   0.7124
##  Residual             0.9536   0.9765
## Number of obs: 323, groups:  subID, 54
##
## Fixed effects:
##                  Estimate Std. Error        df t value Pr(>|t|)
## (Intercept)       5.07501    0.12380  80.76000  40.992   <2e-16 ***
## liqCode           1.11635    0.10869 266.17000  10.270   <2e-16 ***
## rewCode           0.84119    0.09447 266.34000   8.904   <2e-16 ***
## liqCode:rewCode  -0.33193    0.13324 266.22000  -2.491   0.0133 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr) liqCod rewCod
## liqCode     -0.441
## rewCode     -0.005  0.006
## liqCod:rwCd  0.004 -0.004 -0.709
```

```
# YA NvS
m.selfreport.3.YA.NvS<-lmer(formula = rating ~ liqCode*rewCode + (1|subID),
                      data = subset(data.motive9, group=="YA" & liquid!="Juice"))
summary(m.selfreport.3.YA.NvS)
```

```
## Linear mixed model fit by REML t-tests use Satterthwaite approximations
##   to degrees of freedom [lmerMod]
## Formula: rating ~ liqCode * rewCode + (1 | subID)
##    Data: subset(data.motive9, group == "YA" & liquid != "Juice")
##
## REML criterion at convergence: 1081.9
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -2.55379 -0.61570  0.01909  0.63339  2.43058
##
## Random effects:
##  Groups   Name        Variance Std.Dev.
##  subID    (Intercept) 1.714    1.309
##  Residual             1.112    1.055
## Number of obs: 323, groups:  subID, 54
##
## Fixed effects:
##                 Estimate Std. Error       df t value Pr(>|t|)
## (Intercept)       5.0791     0.1966  63.8700  25.830  < 2e-16 ***
## liqCode           1.1532     0.1174 266.0700   9.824  < 2e-16 ***
## rewCode           0.8350     0.1020 266.1400   8.184 1.15e-14 ***
## liqCode:rewCode  -0.3038     0.1439 266.0900  -2.112   0.0357 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr) liqCod rewCod
## liqCode      0.300
## rewCode     -0.004 -0.006
## liqCod:rwCd -0.003 -0.004  0.709
```

```r
# OA vs YA
# Juice
m.selfreport.3.OAYA.Juice<-lmer(formula = rating ~ groupCode*rewCode + (1|subID),
                        data = subset(data.motive9, liquid=="Juice"))
summary(m.selfreport.3.OAYA.Juice)
```

```
## Linear mixed model fit by REML t-tests use Satterthwaite approximations
##   to degrees of freedom [lmerMod]
## Formula: rating ~ groupCode * rewCode + (1 | subID)
##    Data: subset(data.motive9, liquid == "Juice")
##
## REML criterion at convergence: 738.1
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -3.8615 -0.5779  0.0971  0.5903  2.7534
##
## Random effects:
##  Groups   Name        Variance Std.Dev.
##  subID    (Intercept) 0.9830   0.9914
##  Residual             0.3623   0.6019
## Number of obs: 285, groups:  subID, 96
##
## Fixed effects:
##                    Estimate Std. Error        df t value Pr(>|t|)
## (Intercept)         6.19136    0.14297  93.70000  43.307  < 2e-16 ***
## groupCode          -0.67007    0.21637  94.08000  -3.097  0.00258 **
## rewCode             0.50926    0.05792 187.01000   8.793 8.88e-16 ***
## groupCode:rewCode  -0.20633    0.08842 187.38000  -2.333  0.02069 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr) gropCd rewCod
## groupCode   -0.661
## rewCode      0.000  0.000
## gropCd:rwCd  0.000  0.005 -0.655
```

```r
# Neutral
m.selfreport.3.OAYA.Neutral<-lmer(formula = rating ~ groupCode*rewCode + (1|subID),
                        data = subset(data.motive9, liquid=="Neutral"))
summary(m.selfreport.3.OAYA.Neutral)
```

```
## Linear mixed model fit by REML t-tests use Satterthwaite approximations
##   to degrees of freedom [lmerMod]
## Formula: rating ~ groupCode * rewCode + (1 | subID)
##    Data: subset(data.motive9, liquid == "Neutral")
##
## REML criterion at convergence: 843.4
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -2.68395 -0.46180 -0.03077  0.40484  2.72582
##
## Random effects:
```

```
##  Groups   Name        Variance Std.Dev.
##  subID    (Intercept) 1.496    1.223
##  Residual             0.517    0.719
## Number of obs: 285, groups:  subID, 96
##
## Fixed effects:
##                    Estimate Std. Error        df t value Pr(>|t|)
## (Intercept)         5.07555    0.17584  94.10000  28.864  < 2e-16 ***
## groupCode           0.31211    0.26596  94.25000   1.174    0.244
## rewCode             0.84038    0.06965 187.47000  12.066  < 2e-16 ***
## groupCode:rewCode  -0.62687    0.10542 187.51000  -5.947 1.31e-08 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr) gropCd rewCod
## groupCode   -0.661
## rewCode     -0.003  0.002
## gropCd:rwCd  0.002  0.001 -0.661
```

```
# Saltwater
m.selfreport.3.OAYA.Saltwater<-lmer(formula = rating ~ groupCode*rewCode + (1|subID),
                       data = subset(data.motive9, liquid=="Saltwater"))
summary(m.selfreport.3.OAYA.Saltwater)
```

```
## Linear mixed model fit by REML t-tests use Satterthwaite approximations
##   to degrees of freedom [lmerMod]
## Formula: rating ~ groupCode * rewCode + (1 | subID)
##    Data: subset(data.motive9, liquid == "Saltwater")
##
## REML criterion at convergence: 974.1
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -3.2309 -0.5394  0.0077  0.4607  2.4381
##
## Random effects:
##  Groups   Name        Variance Std.Dev.
##  subID    (Intercept) 2.6002   1.6125
##  Residual             0.7925   0.8902
## Number of obs: 285, groups:  subID, 96
##
## Fixed effects:
##                    Estimate Std. Error        df t value Pr(>|t|)
## (Intercept)         3.92593    0.23031  93.78000  17.046  < 2e-16 ***
## groupCode           0.90804    0.34851  94.10000   2.606   0.0107 *
## rewCode             1.13889    0.08566 187.04000  13.295  < 2e-16 ***
## groupCode:rewCode  -0.72787    0.13146 187.55000  -5.537 1.03e-07 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr) gropCd rewCod
## groupCode   -0.661
## rewCode      0.000  0.000
```

```
## gropCd:rwCd  0.000 -0.002 -0.652
```

Comparing Motivation Ratings and Reward Rate

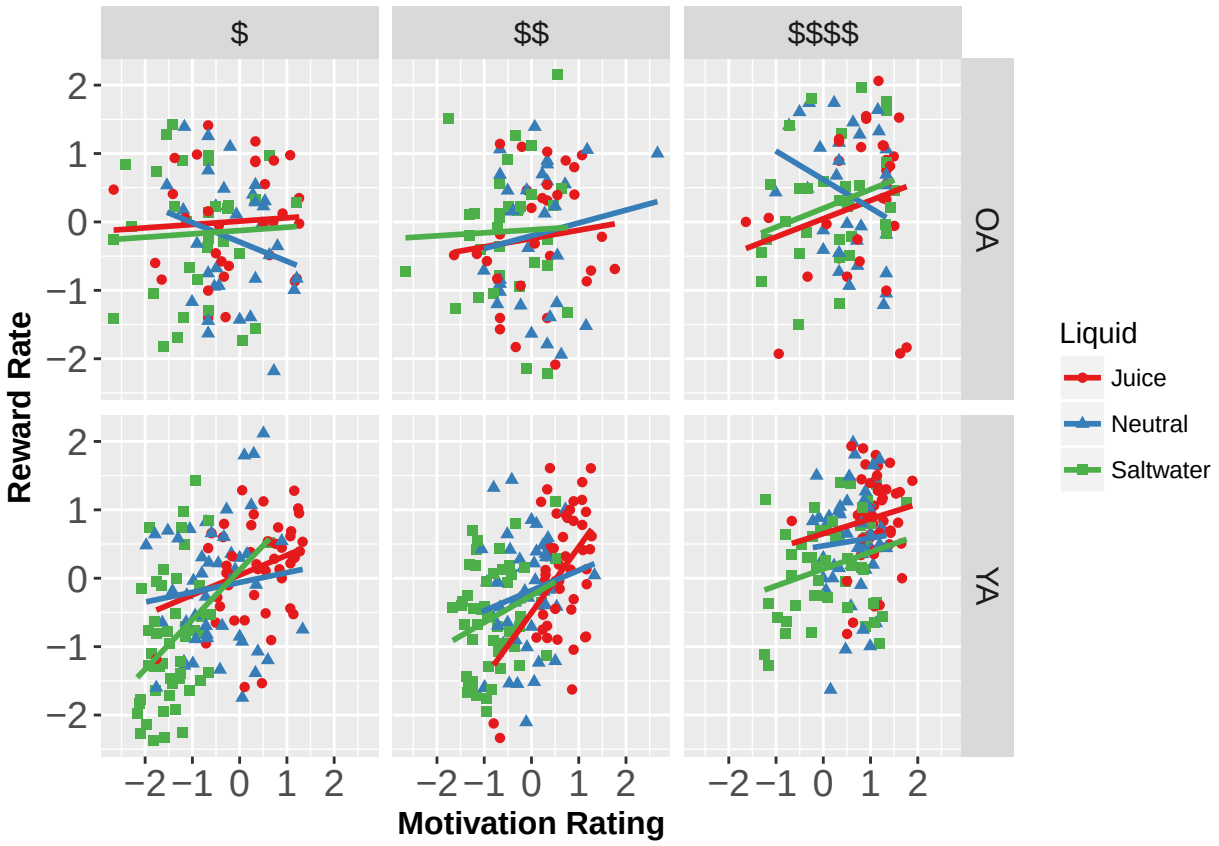
```
incentive9.means.indiv <- incentive9.means %>%
  mutate(liquid = factor(liquid, levels = c("saltwater","neutral","juice"),
                         labels=c("Saltwater","Neutral","Juice"))) %>%
  inner_join(y = data.motive9, by = c("subID","liquid","money","group")) %>%
  group_by(subID) %>%
  mutate(rating_zscore = scale(rating),
         meanRR_zscore = scale(meanRR))
```

```
## Warning: Column `liquid` joining factor and character vector, coercing into
## character vector
```

```
p.rating.4<-ggplot(data = incentive9.means.indiv,
                   aes(x = rating_zscore, y = meanRR_zscore, color=liquid, shape=liquid)) +
  geom_point() +
  geom_smooth(method="lm", se = FALSE) +
  xlab("Motivation Rating") + ylab("Reward Rate") +
  labs(shape = "Liquid", color="Liquid") +
  scale_color_brewer(palette="Set1") +
  facet_grid(group~money) +
    theme(#plot.title=element_text(size=22,face="bold", vjust=2),
    axis.title=element_text(size=12,face = "bold"),
    axis.text=element_text(size=14),
    legend.position="right",
    strip.text.x = element_text(size = 12),
    strip.text.y = element_text(size = 12))
p.rating.4
```

```
## Warning: Removed 148 rows containing non-finite values (stat_smooth).
```

```
## Warning: Removed 148 rows containing missing values (geom_point).
```




```
incentive9.means.indiv2<-filter(incentive9.means.indiv, is.na(rating)!=TRUE)
# OA Hierarchical Regression
# Model 1
m.selfreport.4.OA.L1<-lmer(formula = meanRR ~ rewCode*liqCode +
                             (1+rewCode|subID),
                   data = subset(incentive9.means.indiv2, group=="OA"))
summary(m.selfreport.4.OA.L1)
```

```
## Linear mixed model fit by REML t-tests use Satterthwaite approximations
##   to degrees of freedom [lmerMod]
## Formula: meanRR ~ rewCode * liqCode + (1 + rewCode | subID)
##    Data: subset(incentive9.means.indiv2, group == "OA")
##
## REML criterion at convergence: -444.7
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -3.4096 -0.6091  0.0769  0.6481  2.3120
##
## Random effects:
##  Groups   Name        Variance  Std.Dev. Corr
##  subID    (Intercept) 0.0119168 0.10916
##           rewCode     0.0001556 0.01247  -1.00
##  Residual             0.0127400 0.11287
## Number of obs: 370, groups:  subID, 42
##
## Fixed effects:
```

```
##                   Estimate Std. Error         df t value Pr(>|t|)
## (Intercept)       0.573834   0.017841  41.000000  32.164   <2e-16 ***
## rewCode           0.021475   0.007456 166.000000   2.880   0.0045 **
## liqCode           0.009036   0.007200 325.000000   1.255   0.2104
## rewCode:liqCode  -0.003049   0.008863 325.400000  -0.344   0.7310
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr) rewCod liqCod
## rewCode     -0.242
## liqCode      0.000  0.012
## rewCod:lqCd  0.005 -0.006  0.005
```

```
# Model 2
m.selfreport.4.OA.L2<-lmer(formula = meanRR ~ rewCode*liqCode + rating +
                           (1+rewCode|subID),
                     data = subset(incentive9.means.indiv2, group=="OA"))
summary(m.selfreport.4.OA.L2)
```

```
## Linear mixed model fit by REML t-tests use Satterthwaite approximations
##   to degrees of freedom [lmerMod]
## Formula: meanRR ~ rewCode * liqCode + rating + (1 + rewCode | subID)
##    Data: subset(incentive9.means.indiv2, group == "OA")
##
## REML criterion at convergence: -441.4
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -3.3915 -0.5970  0.0860  0.6394  2.2731
##
## Random effects:
##  Groups   Name        Variance  Std.Dev. Corr
##  subID    (Intercept) 0.0117185 0.10825
##           rewCode     0.0001474 0.01214  -1.00
##  Residual             0.0126074 0.11228
## Number of obs: 370, groups:  subID, 42
##
## Fixed effects:
##                   Estimate Std. Error         df t value Pr(>|t|)
## (Intercept)       0.503239   0.035935 213.400000  14.004   <2e-16 ***
## rewCode           0.017293   0.007634 182.200000   2.265   0.0247 *
## liqCode           0.004331   0.007459 332.300000   0.581   0.5619
## rating            0.013461   0.005963 339.700000   2.257   0.0246 *
## rewCode:liqCode  -0.002379   0.008822 324.900000  -0.270   0.7876
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr) rewCod liqCod rating
## rewCode      0.098
## liqCode      0.243  0.079
## rating      -0.870 -0.242 -0.279
## rewCod:lqCd -0.027 -0.014 -0.004  0.034
```

```r
# Model Comparison
anova(m.selfreport.4.OA.L1,m.selfreport.4.OA.L2)
```

```
## refitting model(s) with ML (instead of REML)
```

```
## Data: subset(incentive9.means.indiv2, group == "OA")
## Models:
## object: meanRR ~ rewCode * liqCode + (1 + rewCode | subID)
## ..1: meanRR ~ rewCode * liqCode + rating + (1 + rewCode | subID)
##        Df     AIC     BIC logLik deviance  Chisq Chi Df Pr(>Chisq)
## object  8 -458.63 -427.32 237.31  -474.63
## ..1     9 -461.76 -426.54 239.88  -479.76 5.1321      1    0.02349 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```r
# YA Hierarchical Regression
# Model 1
m.selfreport.4.YA.L1<-lmer(formula = meanRR ~ rewCode*liqCode +
                             (1+rewCode|subID),
                     data = subset(incentive9.means.indiv2, group=="YA"))
summary(m.selfreport.4.YA.L1)
```

```
## Linear mixed model fit by REML t-tests use Satterthwaite approximations
##   to degrees of freedom [lmerMod]
## Formula: meanRR ~ rewCode * liqCode + (1 + rewCode | subID)
##    Data: subset(incentive9.means.indiv2, group == "YA")
##
## REML criterion at convergence: -514.7
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -3.6105 -0.5431  0.0581  0.5902  2.8398
##
## Random effects:
##  Groups   Name        Variance  Std.Dev. Corr
##  subID    (Intercept) 1.173e-02 0.108312
##           rewCode     5.955e-05 0.007717 -1.00
##  Residual             1.523e-02 0.123427
## Number of obs: 485, groups:  subID, 54
##
## Fixed effects:
##                   Estimate Std. Error         df t value Pr(>|t|)
## (Intercept)       0.644515   0.015769  53.000000  40.871  < 2e-16 ***
## rewCode           0.053965   0.006949 316.200000   7.766 1.14e-13 ***
## liqCode           0.058546   0.006857 428.000000   8.538 2.22e-16 ***
## rewCode:liqCode  -0.015480   0.008398 428.000000  -1.843    0.066 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr) rewCod liqCod
## rewCode     -0.142
## liqCode      0.000  0.000
## rewCod:lqCd  0.000  0.000  0.000
```

```r
# Model 2
m.selfreport.4.YA.L2<-lmer(formula = meanRR ~ rewCode*liqCode + rating +
                             (1+rewCode|subID),
                           data = subset(incentive9.means.indiv2, group=="YA"))
summary(m.selfreport.4.YA.L2)
```

```
## Linear mixed model fit by REML t-tests use Satterthwaite approximations
##   to degrees of freedom [lmerMod]
## Formula: meanRR ~ rewCode * liqCode + rating + (1 + rewCode | subID)
##    Data: subset(incentive9.means.indiv2, group == "YA")
##
## REML criterion at convergence: -587.5
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -3.2698 -0.5695  0.0408  0.6759  2.6526
##
## Random effects:
##  Groups   Name        Variance Std.Dev. Corr
##  subID    (Intercept) 0.011328 0.10643
##           rewCode     0.000128 0.01131  -1.00
##  Residual             0.012690 0.11265
## Number of obs: 485, groups:  subID, 54
##
## Fixed effects:
##                   Estimate Std. Error         df t value Pr(>|t|)
## (Intercept)       0.423894   0.027894 287.900000  15.197   <2e-16 ***
## rewCode           0.017857   0.007496 296.800000   2.382   0.0178 *
## liqCode           0.009204   0.008141 455.000000   1.130   0.2589
## rating            0.043561   0.004597 477.800000   9.476   <2e-16 ***
## rewCode:liqCode  -0.001767   0.007800 429.700000  -0.226   0.8209
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr) rewCod liqCod rating
## rewCode      0.317
## liqCode      0.534  0.325
## rating      -0.835 -0.508 -0.640
## rewCod:lqCd -0.155 -0.094 -0.119  0.186
```

```r
# Model Comparison
anova(m.selfreport.4.YA.L1, m.selfreport.4.YA.L2)
```

```
## refitting model(s) with ML (instead of REML)
```

```
## Data: subset(incentive9.means.indiv2, group == "YA")
## Models:
## object: meanRR ~ rewCode * liqCode + (1 + rewCode | subID)
## ..1: meanRR ~ rewCode * liqCode + rating + (1 + rewCode | subID)
##        Df     AIC     BIC logLik deviance  Chisq Chi Df Pr(>Chisq)
## object  8 -529.13 -495.65 272.56  -545.13
## ..1     9 -609.53 -571.87 313.76  -627.53 82.401      1  < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Manuscript Figures

```
ms.path="/Users/debbieyee/Documents/Manuscripts/In Progress/Motivation Aging/Figures/"
ggsave(filename = "Figure2a_group.eps", plot = p.RR.0,
       device=cairo_ps, fallback_resolution = 600,
       path = ms.path, width = 3, height = 6, scale = 1)
ggsave(filename = "Figure2b_RT.eps", plot = p.RT.0, device = "eps",
       path = ms.path, width = 6, height = 6, scale = 1)
ggsave(filename = "Figure2c_ACC.eps", plot = p.ACC.0, device = "eps",
       path = ms.path, width = 6, height = 6, scale = 1)
ggsave(filename = "Figure3_Transition.eps", plot = p.trans.1,
       device = cairo_ps,
       path = ms.path, width = 12, height = 4, scale = 1)
ggsave(filename = "Figure4a_RR-mon-liq.eps", plot = p.RR.2,
       device = "eps",
       path = ms.path, width = 8, height = 4, scale = 1)
ggsave(filename = "Figure4b_RR-mon-block.eps", plot = p.RR.3,
       device = "eps",
       path = ms.path, width = 8, height = 4, scale = 1)
ggsave(filename = "Figure5_ValEst.eps", plot = p.val.1,
       device = cairo_ps,
       path = ms.path, width = 10, height = 6, scale = 1)
ggsave(filename = "Figure6a_Liking.eps", plot = p.rating.1,
       device = "eps",
       path = ms.path, width = 5.5, height = 5, scale = 1)
ggsave(filename = "Figure6b_Intensity.eps", plot = p.rating.2,
       device = "eps",
       path = ms.path, width = 5.5, height = 5, scale = 1)
ggsave(filename = "Figure6c_Motivation.eps", plot = p.rating.4,
       device = "eps",
       path = ms.path, width = 12, height = 6, scale = 1)
```

```
## Warning: Removed 148 rows containing non-finite values (stat_smooth).
```

```
## Warning: Removed 148 rows containing missing values (geom_point).
```