JEP LMC: Lexical Retrieval Manuscript Analyses

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1 Reading the File

2 Percent State Analysis

```
> j ← read.csv("MainJulieagg_5studies.csv", header = TRUE, sep = ",")
> j ← subset(j, j$value.Subject!= 198 & j$value.Subject!= 95)
> #j_statepercent = j[,c(2,3,4,5,104:119)] # use for state percents
>
> j_statepercent = j[,c(2,3,4,5,120:135)] # use for prime percents
> j_statepercent$value.Subject = as.factor(j_statepercent$value.Subject)
> library(tidyr)
> library(dplyr)
> # use comments for state wise percent
> # statepercent ← j_statepercent %>%
> #   gather(StatePrime, Percent,
> #          know_r_percent, know_p_percent,know_b_percent, know_u_percent,
> #          dontknow_r_percent, dontknow_p_percent,
> #          dontknow_b_percent,dontknow_u_percent,
> #          other_r_percent,other_p_percent,other_b_percent,other_u_percent,
> #          TOT_r_percent, TOT_p_percent, TOT_b_percent, TOT_u_percent) %>%
> #   separate(StatePrime, c('State', 'Prime'), sep = "_") %>%
> #   arrange(value.Subject)
>
> # use below for prime wise percent
> statepercent ← j_statepercent %>%
+   gather(StatePrime, Percent,
+          r_know_new, r_dontknow_new,r_other_new, r_TOT_new,
+          p_know_new, p_dontknow_new,p_other_new, p_TOT_new,
+          b_know_new, b_dontknow_new,b_other_new, b_TOT_new,
+          u_know_new, u_dontknow_new,u_other_new, u_TOT_new) %>%
+   separate(StatePrime, c('Prime', 'State'), sep = "_") %>%
+   arrange(value.Subject)
> # state wise percent
> # colnames(statepercent) = c("AgeGroup", "Subject", "StudyNo", "PrimeInstruction", "St
>
> ## prime wise percent
```

```
> colnames(statepercent) = c("AgeGroup", "Subject", "StudyNo", "PrimeInstruction", "Prim
> statepercent$AgeGroup ← as.factor(statepercent$AgeGroup)
> statepercent$Subject ← as.factor(statepercent$Subject)
> statepercent$StudyNo ← as.factor(statepercent$StudyNo)
> statepercent$PrimeInstruction ← as.factor(statepercent$PrimeInstruction)
> statepercent$PrimeCondition ← as.factor(statepercent$PrimeCondition)
> statepercent$State ← as.factor(statepercent$State)
> statepercent$Percent ← as.numeric(as.character(statepercent$Percent))
> for(i in 1:nrow(statepercent)){
+   if(is.na(statepercent[i,7])) {
+     print(i)
+     statepercent[i,7] = 0
+   }
+   else
+     statepercent[i,7] = statepercent[i,7]
+ }
> statepercent_exp1 = statepercent %>% filter(StudyNo == '2' | StudyNo == '4')
> statepercent_exp2 = statepercent %>% filter(StudyNo == '5' | StudyNo == '6')
> statepercent_exp3 = statepercent %>% filter(StudyNo == '1')
>
```

2.1 Experiment 1

2.1.1 MANOVA

```
> ## we want to do a manova on our data for exp 1
> ## first need to convert each state to wide format
> e1_data_wide ← spread(statepercent_exp1, State, Percent)
> ## grouping
>
> e1_wide_agg = group_by(e1_data_wide, AgeGroup, PrimeCondition) %>%
+   summarise_at(vars(dontknow, know, other, TOT), mean)
> output1 ← manova(cbind(dontknow, know,
+           other, TOT)~AgeGroup*PrimeCondition, data = e1_data_wide )
> summary.aov(output1)
```

```
 Response dontknow :
                         Df  Sum Sq Mean Sq F value    Pr(>F)
AgeGroup                  1  1.2800 1.28000 31.1289 5.694e-08 ***
PrimeCondition            3  0.2651 0.08837  2.1491   0.09429 .
AgeGroup:PrimeCondition   3  0.0078 0.00259  0.0631   0.97928
Residuals               280 11.5134 0.04112
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

 Response know :
                         Df  Sum Sq  Mean Sq F value   Pr(>F)
```

```
AgeGroup                    1  0.2006 0.200556  4.7449 0.030220 *
PrimeCondition              3  0.6211 0.207037  4.8982 0.002468 **
AgeGroup:PrimeCondition     3  0.0139 0.004630  0.1095 0.954488
Residuals                 280 11.8350 0.042268
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

 Response other :
                           Df Sum Sq Mean Sq  F value Pr(>F)
AgeGroup                    1 1.9668 1.96681 141.4984 <2e-16 ***
PrimeCondition              3 0.0496 0.01652   1.1888 0.3143
AgeGroup:PrimeCondition     3 0.0108 0.00361   0.2594 0.8546
Residuals                 280 3.8920 0.01390
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

 Response TOT :
                           Df  Sum Sq   Mean Sq F value  Pr(>F)
AgeGroup                    1 0.03125 0.0312500  3.0356 0.08255 .
PrimeCondition              3 0.04553 0.0151759  1.4742 0.22177
AgeGroup:PrimeCondition     3 0.02571 0.0085685  0.8323 0.47703
Residuals                 280 2.88244 0.0102944
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1
```

2.1.2 overall

```
> e1_all_aov = aov(data = statepercent_exp1,
+                    Percent ~ AgeGroup*State*PrimeCondition +
+                  Error(Subject/(State*PrimeCondition)))
> summary(e1_all_aov)
```

```
Error: Subject
          Df    Sum Sq   Mean Sq F value Pr(>F)
AgeGroup   1 5.430e-29 5.428e-29   3.975 0.0501 .
Residuals 70 9.558e-28 1.365e-29
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Subject:State
                Df Sum Sq Mean Sq F value   Pr(>F)
State            3 20.351   6.784   62.62  < 2e-16 ***
AgeGroup:State   3  3.479   1.160   10.70 1.41e-06 ***
Residuals      210 22.750   0.108
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1
```

```
Error: Subject:PrimeCondition
                         Df    Sum Sq   Mean Sq F value Pr(>F)
PrimeCondition            3 1.030e-29 3.420e-30   0.672  0.570
AgeGroup:PrimeCondition   3 9.600e-30 3.205e-30   0.630  0.596
Residuals               210 1.068e-27 5.087e-30

Error: Subject:State:PrimeCondition
                               Df Sum Sq Mean Sq F value   Pr(>F)
State:PrimeCondition            9  0.981 0.10904   9.316 2.38e-13 ***
AgeGroup:State:PrimeCondition   9  0.058 0.00647   0.552    0.836
Residuals                     630  7.373 0.01170
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1
```

2.1.3 know

```
> e1_know = statepercent_exp1 %>% filter(State == "know")
> e1_know_aov = aov(data = e1_know,
+                            Percent ~ AgeGroup*PrimeCondition +
+                          Error(Subject/PrimeCondition))
> summary(e1_know_aov)
```

```
Error: Subject
          Df Sum Sq Mean Sq F value Pr(>F)
AgeGroup   1  0.201  0.2006   1.636  0.205
Residuals 70  8.580  0.1226

Error: Subject:PrimeCondition
                         Df Sum Sq Mean Sq F value   Pr(>F)
PrimeCondition            3  0.621 0.20704  13.359 5.16e-08 ***
AgeGroup:PrimeCondition   3  0.014 0.00463   0.299    0.826
Residuals               210  3.255 0.01550
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1
```

```
> options(contrasts = c('contr.sum', 'contr.poly'))
> library(lsmeans)
> library(multcomp)
> target_lsm = lsmeans::lsmeans(e1_know_aov,
+                                c("AgeGroup","PrimeCondition"))
> prime_effect = cld(target_lsm, alpha = 0.05,
+                  adjust = "tukey", details = TRUE, by = "AgeGroup")
> library(knitr)
> kable(subset(prime_effect$comparisons,prime_effect$comparisons$p.value < 0.05 ))
```

```
|   |contrast |AgeGroup |  estimate|         SE| df|  t.ratio|   p.value|
|:--|:--------|:--------|---------:|----------:|---:|--------:|---------:|
```

```
|1  |r - u    |Old      | 0.0955556| 0.0293429| 210| 3.256515| 0.0071461|
|2  |b - u    |Old      | 0.1133333| 0.0293429| 210| 3.862378| 0.0008559|
|4  |p - u    |Old      | 0.1366667| 0.0293429| 210| 4.657573| 0.0000335|
|8  |b - u    |Young    | 0.0811111| 0.0293429| 210| 2.764251| 0.0313385|
|10 |p - u    |Young    | 0.1133333| 0.0293429| 210| 3.862378| 0.0008559|
```

```
> target_p = e1_know %>% filter(PrimeCondition == "p")
> target_r = e1_know %>% filter(PrimeCondition == "r")
> target_b = e1_know %>% filter(PrimeCondition == "b")
> target_u = e1_know %>% filter(PrimeCondition == "u")
> t.test(target_u$Percent, target_r$Percent, paired = TRUE)
```

```
        Paired t-test

data:  target_u$Percent and target_r$Percent
t = -3.4694, df = 71, p-value = 0.0008909
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -0.12247907 -0.03307648
sample estimates:
mean of the differences
            -0.07777778
```

```
> t.test(target_u$Percent, target_b$Percent, paired = TRUE)
```

```
        Paired t-test

data:  target_u$Percent and target_b$Percent
t = -4.9679, df = 71, p-value = 4.506e-06
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -0.1362439 -0.0582005
sample estimates:
mean of the differences
            -0.09722222
```

```
> t.test(target_u$Percent, target_p$Percent, paired = TRUE)
```

```
        Paired t-test

data:  target_u$Percent and target_p$Percent
t = -6.1735, df = 71, p-value = 3.698e-08
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -0.16537312 -0.08462688
sample estimates:
mean of the differences
                 -0.125
```

```
> ## old diff in know semantic and know unrelated
>
> old_semantic = e1_know %>% filter(PrimeCondition == "r" & AgeGroup == "Old")
> old_unrel = e1_know %>% filter(PrimeCondition == "u" & AgeGroup == "Old")
> t.test(old_semantic$Percent, old_unrel$Percent, paired = TRUE)
```

```
        Paired t-test

data:  old_semantic$Percent and old_unrel$Percent
t = 3.361, df = 35, p-value = 0.001889
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 0.03783746 0.15327365
sample estimates:
mean of the differences
             0.09555556
```

2.1.4 dont know

```
> e1_dontknow = statepercent_exp1 %>% filter(State == "dontknow")
> e1_dontknow_aov = aov(data = e1_dontknow,
+                           Percent ~ AgeGroup*PrimeCondition +
+                         Error(Subject/PrimeCondition))
> summary(e1_dontknow_aov)
```

```
Error: Subject
          Df Sum Sq Mean Sq F value  Pr(>F)
AgeGroup   1  1.280  1.2800   9.417 0.00306 **
Residuals 70  9.514  0.1359
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Subject:PrimeCondition
                         Df Sum Sq Mean Sq F value   Pr(>F)
PrimeCondition            3 0.2651 0.08837   9.283 8.61e-06 ***
AgeGroup:PrimeCondition   3 0.0078 0.00259   0.272    0.845
Residuals               210 1.9991 0.00952
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1
```

```
> options(contrasts = c('contr.sum', 'contr.poly'))
> library(lsmeans)
> library(multcomp)
> target_lsm = lsmeans::lsmeans(e1_dontknow_aov,
+                                   c("AgeGroup","PrimeCondition"))
> prime_effect = cld(target_lsm, alpha = 0.05,
```

```
+                   adjust = "tukey", details = TRUE, by = "AgeGroup")
> library(knitr)
> kable(subset(prime_effect$comparisons,prime_effect$comparisons$p.value < 0.05 ))
```

```
|   |contrast |AgeGroup |  estimate|        SE|  df|  t.ratio|   p.value|
|:--|:--------|:--------|---------:|---------:|---:|--------:|---------:|
|4  |u - r    |Old      | 0.0866667| 0.0229971| 210| 3.768595| 0.0012136|
|5  |u - p    |Old      | 0.0766667| 0.0229971| 210| 3.333758| 0.0055511|
|6  |u - b    |Old      | 0.0633333| 0.0229971| 210| 2.753974| 0.0322399|
|10 |u - r    |Young    | 0.0722222| 0.0229971| 210| 3.140496| 0.0103363|
|11 |u - p    |Young    | 0.0611111| 0.0229971| 210| 2.657343| 0.0418744|
```

```
> target_p = e1_dontknow %>% filter(PrimeCondition == "p")
> target_r = e1_dontknow %>% filter(PrimeCondition == "r")
> target_b = e1_dontknow %>% filter(PrimeCondition == "b")
> target_u = e1_dontknow %>% filter(PrimeCondition == "u")
> t.test(target_u$Percent, target_r$Percent, paired = TRUE)
```

```
        Paired t-test

data:  target_u$Percent and target_r$Percent
t = 4.1572, df = 71, p-value = 8.878e-05
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 0.03844905 0.10932873
sample estimates:
mean of the differences
             0.07388889
```

```
> t.test(target_u$Percent, target_b$Percent, paired = TRUE)
```

```
        Paired t-test

data:  target_u$Percent and target_b$Percent
t = 3.8613, df = 71, p-value = 0.0002463
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 0.02606076 0.08171702
sample estimates:
mean of the differences
             0.05388889
```

```
> t.test(target_u$Percent, target_p$Percent, paired = TRUE)
```

```
        Paired t-test

data:  target_u$Percent and target_p$Percent
```

```
t = 4.3341, df = 71, p-value = 4.735e-05
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 0.04019578 0.10869311
sample estimates:
mean of the differences
             0.07444444
```

```
> target_y = e1_dontknow %>% filter(AgeGroup == "Young")
> target_o = e1_dontknow %>% filter(AgeGroup == "Old")
> t.test(target_y$Percent, target_o$Percent, paired = FALSE)
```

```
        Welch Two Sample t-test

data:  target_y$Percent and target_o$Percent
t = -5.5731, df = 258.87, p-value = 6.273e-08
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -0.18044440 -0.08622227
sample estimates:
mean of x mean of y
0.2688889 0.4022222
```

```
>
```

2.1.5 other

```
> e1_other = statepercent_exp1 %>% filter(State == "other")
> e1_other_aov = aov(data = e1_other,
+                           Percent ~ AgeGroup*PrimeCondition +
+                         Error(Subject/PrimeCondition))
> summary(e1_other_aov)
```

```
Error: Subject
          Df Sum Sq Mean Sq F value   Pr(>F)
AgeGroup   1  1.967  1.9668   51.85 5.37e-10 ***
Residuals 70  2.655  0.0379
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Subject:PrimeCondition
                         Df Sum Sq  Mean Sq F value Pr(>F)
PrimeCondition            3 0.0496 0.016524   2.806 0.0407 *
AgeGroup:PrimeCondition   3 0.0108 0.003606   0.612 0.6078
Residuals               210 1.2368 0.005890
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1
```

```
> options(contrasts = c('contr.sum', 'contr.poly'))
> library(lsmeans)
> library(multcomp)
> target_lsm = lsmeans::lsmeans(e1_other_aov,
+                                  c("AgeGroup","PrimeCondition"))
> prime_effect = cld(target_lsm, alpha = 0.05,
+                 adjust = "tukey", details = TRUE, by = "AgeGroup")
> library(knitr)
> kable(subset(prime_effect$comparisons,prime_effect$comparisons$p.value < 0.1 ))
```

```
|   |contrast |AgeGroup |  estimate|        SE|  df|  t.ratio|   p.value|
|:--|:--------|:--------|---------:|---------:|---:|--------:|---------:|
|10 |r - b    |Young    | 0.0433333| 0.0180886| 210| 2.395611| 0.0810306|
```

```
> target_y = e1_other %>% filter(AgeGroup == "Young")
> target_o = e1_other %>% filter(AgeGroup == "Old")
> t.test(target_y$Percent, target_o$Percent, paired = FALSE)
```

```
        Welch Two Sample t-test

data:  target_y$Percent and target_o$Percent
t = 11.93, df = 232.16, p-value < 2.2e-16
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 0.1379820 0.1925736
sample estimates:
 mean of x  mean of y
0.21888889 0.05361111
```

2.1.6 TOT

```
> e1_TOT = statepercent_exp1 %>% filter(State == "TOT")
> e1_TOT_aov = aov(data = e1_TOT,
+                            Percent ~ AgeGroup*PrimeCondition +
+                          Error(Subject/PrimeCondition))
> summary(e1_TOT_aov)
```

```
Error: Subject
          Df Sum Sq Mean Sq F value Pr(>F)
AgeGroup   1 0.0312 0.03125   1.094  0.299
Residuals 70 1.9997 0.02857

Error: Subject:PrimeCondition
                         Df Sum Sq  Mean Sq F value Pr(>F)
PrimeCondition            3 0.0455 0.015176   3.610 0.0142 *
AgeGroup:PrimeCondition   3 0.0257 0.008569   2.038 0.1096
```

```
Residuals                210 0.8828 0.004204
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1
```

```
> options(contrasts = c('contr.sum', 'contr.poly'))
> library(lsmeans)
> library(multcomp)
> target_lsm = lsmeans::lsmeans(e1_TOT_aov,
+                                    c("AgeGroup","PrimeCondition"))
> prime_effect = cld(target_lsm, alpha = 0.05,
+                 adjust = "tukey", details = TRUE, by = "AgeGroup")
> library(knitr)
> kable(subset(prime_effect$comparisons,prime_effect$comparisons$p.value < 0.05 ))
```

```
|   |contrast |AgeGroup |  estimate|        SE|  df|  t.ratio|   p.value|
|:--|:--------|:--------|---------:|---------:|---:|--------:|---------:|
|4  |u - p    |Old      | 0.0600000| 0.0152819| 210| 3.926216| 0.0006721|
|5  |u - b    |Old      | 0.0411111| 0.0152819| 210| 2.690185| 0.0383542|
```

```
> target_o_u = e1_TOT %>% filter(AgeGroup == "Old" & PrimeCondition == "u")
> target_o_p = e1_TOT %>% filter(AgeGroup == "Old" & PrimeCondition == "p")
> target_o_b = e1_TOT %>% filter(AgeGroup == "Old" & PrimeCondition == "b")
> target_o_r = e1_TOT %>% filter(AgeGroup == "Old" & PrimeCondition == "r")
> t.test(target_o_u$Percent, target_o_p$Percent, paired = TRUE)
```

```
        Paired t-test

data:  target_o_u$Percent and target_o_p$Percent
t = 4.9651, df = 35, p-value = 1.783e-05
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 0.03546745 0.08453255
sample estimates:
mean of the differences
                   0.06
```

```
> t.test(target_o_u$Percent, target_o_r$Percent, paired = TRUE)
```

```
        Paired t-test

data:  target_o_u$Percent and target_o_r$Percent
t = 1.5792, df = 35, p-value = 0.1233
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -0.007930356  0.063485911
sample estimates:
mean of the differences
             0.02777778
```

```
> t.test(target_o_u$Percent, target_o_b$Percent, paired = TRUE)
```

```
        Paired t-test

data:  target_o_u$Percent and target_o_b$Percent
t = 2.4882, df = 35, p-value = 0.01775
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 0.007569415 0.074652807
sample estimates:
mean of the differences
             0.04111111
```

```
> target_u = e1_TOT %>% filter(PrimeCondition == "u")
> target_p = e1_TOT %>% filter(PrimeCondition == "p")
> target_b = e1_TOT %>% filter(PrimeCondition == "b")
> target_r = e1_TOT %>% filter(PrimeCondition == "r")
> t.test(target_u$Percent, target_r$Percent, paired = TRUE)
```

```
        Paired t-test

data:  target_u$Percent and target_r$Percent
t = 1.5348, df = 71, p-value = 0.1293
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -0.005484392  0.042151058
sample estimates:
mean of the differences
             0.01833333
```

```
> t.test(target_u$Percent, target_b$Percent, paired = TRUE)
```

```
        Paired t-test

data:  target_u$Percent and target_b$Percent
t = 2.3211, df = 71, p-value = 0.02316
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 0.003680573 0.048541650
sample estimates:
mean of the differences
             0.02611111
```

```
> t.test(target_u$Percent, target_p$Percent, paired = TRUE)
```

```
        Paired t-test

data:  target_u$Percent and target_p$Percent
t = 3.6375, df = 71, p-value = 0.0005182
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 0.01531223 0.05246555
sample estimates:
mean of the differences
             0.03388889
```

```
> t.test(target_p$Percent, target_r$Percent, paired = TRUE)
```

```
        Paired t-test

data:  target_p$Percent and target_r$Percent
t = -1.3179, df = 71, p-value = 0.1918
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -0.039090415  0.007979304
sample estimates:
mean of the differences
            -0.01555556
```

```
> t.test(target_b$Percent, target_r$Percent, paired = TRUE)
```

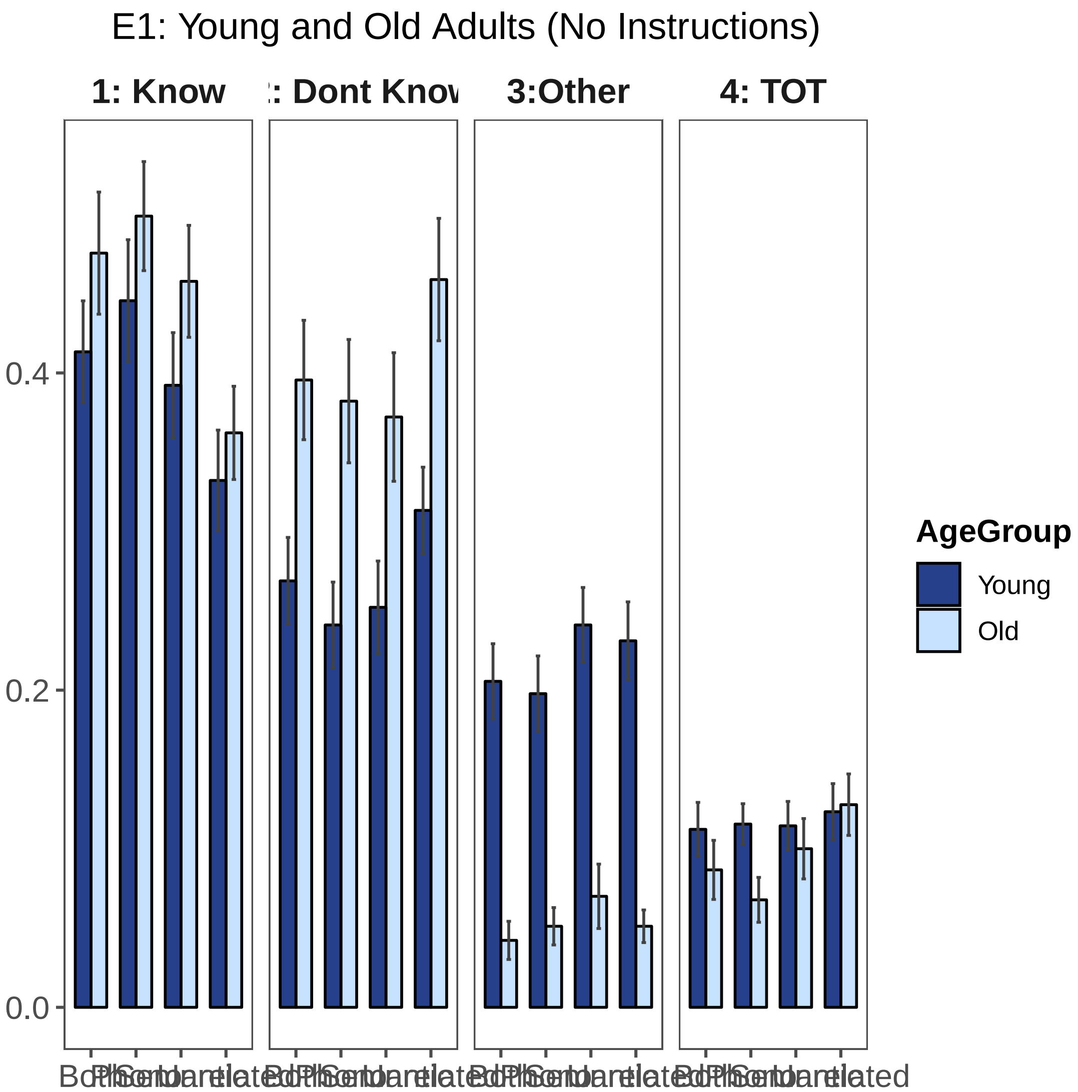
```
        Paired t-test

data:  target_b$Percent and target_r$Percent
t = -0.88769, df = 71, p-value = 0.3777
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -0.025248324  0.009692769
sample estimates:
mean of the differences
           -0.007777778
```

```
>
```

2.1.7 plot

```
> exp1_statepercent= Rmisc::summarySE(statepercent_exp1,
+                         measurevar = "Percent",
+                         groupvars = c("State", "AgeGroup", "PrimeCondition"))
> exp1_statepercent$RetrievalState = factor(exp1_statepercent$State,levels(exp1_stateper
> exp1_statepercent$AgeGroup = factor(exp1_statepercent$AgeGroup,levels(exp1_statepercen
```

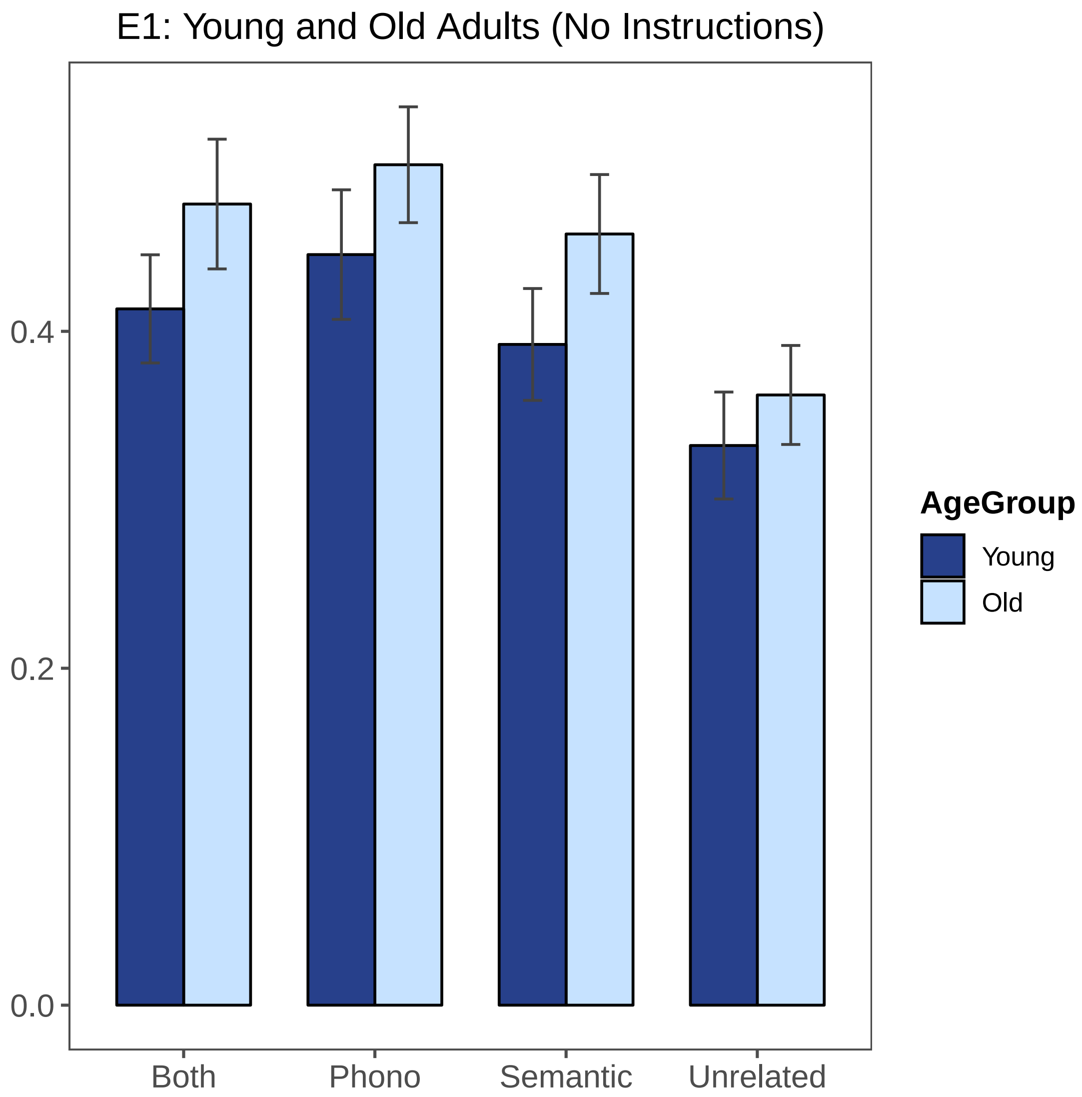
```
> #write.csv(exp1_statepercent, file = "exp1_statepercent.csv")
> exp1_statepercent = read.csv("exp1_statepercent.csv", sep = ",",
+                              header = TRUE)
> exp1_statepercent$AgeGroup = factor(exp1_statepercent$AgeGroup,levels(exp1_statepercen
> library(ggplot2)
> library(ggthemes)
> e1_percentplot = exp1_statepercent %>%
+   mutate(PrimeType = factor(PrimeCondition, levels = unique(PrimeCondition),
+                      labels = c("Both", "Phono",
+                                 "Semantic", "Unrelated")),
+    R = factor(RetrievalState, levels = unique(RetrievalState),
+                                  labels = c( "1: Know","2: Dont Know",
+                                              "3:Other", "4: TOT")))%>%
+
+ ggplot(aes(x = PrimeType, y = Percent,
+            group = AgeGroup, fill = AgeGroup))+
+  geom_bar(stat = "identity", position = "dodge", width = 0.7,
+           color= "black")+
+   geom_errorbar(aes(ymin=Percent - se, ymax=Percent + se),
+              width=.2, color = "gray26",
+              position = position_dodge(0.7))+
+  theme_few()+
+   facet_wrap(~R, nrow =1)+
+   scale_fill_manual(values = c( "royalblue4", "slategray1"))+
+     xlab("") + ylab("") +
+   ggtitle("E1: Young and Old Adults (No Instructions)")  +
+    theme(axis.text = element_text(size = rel(1)),
+           axis.title = element_text(face = "bold", size = rel(1)),
+           legend.title = element_text(face = "bold", size = rel(1)),
+          plot.title = element_text(hjust = .5),
+                   axis.text.x = element_text(size = rel(1)),
+          strip.text.x = element_text(face = "bold", size = rel(1.4)))
> e1_percentplot
>
```



2.1.8 Know Only

```
> exp1_statepercent_know = exp1_statepercent %>% filter(RetrievalState == "know")
> e1_percentplot_know = exp1_statepercent_know %>%
+   mutate(PrimeType = factor(PrimeCondition, levels = unique(PrimeCondition),
+                        labels = c("Both", "Phono",
+                                   "Semantic", "Unrelated")))%>%
+ ggplot(aes(x = PrimeType, y = Percent,
+             group = AgeGroup, fill = AgeGroup))+
+  geom_bar(stat = "identity", position = "dodge", width = 0.7,
+            color= "black")+
```

```
+   geom_errorbar(aes(ymin=Percent - se, ymax=Percent + se),
+                width=.2, color = "gray26",
+                position = position_dodge(0.7))+
+  theme_few()+
+   scale_fill_manual(values = c( "royalblue4", "slategray1"))+
+     xlab("") + ylab("") +
+   ggtitle("E1: Young and Old Adults (No Instructions)")  +
+    theme(axis.text = element_text(size = rel(1)),
+           axis.title = element_text(face = "bold", size = rel(1)),
+           legend.title = element_text(face = "bold", size = rel(1)),
+          plot.title = element_text(hjust = .5),
+          strip.text.x = element_text(face = "bold", size = rel(1.4)))
> e1_percentplot_know
```



2.2 Experiment 2

2.2.1 MANOVA

```
> ## we want to do a manova on our data for exp 1
> ## first need to convert each state to wide format
> e2_data_wide <- spread(statepercent_exp2, State, Percent)
> ## grouping
>
> e1_wide_agg = group_by(e2_data_wide, AgeGroup, PrimeCondition) %>%
+   summarise_at(vars(dontknow, know, other, TOT), mean)
```

```
> output2 ← manova(cbind(dontknow, know,
+           other, TOT)~AgeGroup*PrimeCondition, data = e2_data_wide )
> summary.aov(output2)
```

```
 Response dontknow :
                         Df Sum Sq Mean Sq F value    Pr(>F)
AgeGroup                  1 2.1536 2.15356 55.7314 1.407e-12 ***
PrimeCondition            3 0.2640 0.08801  2.2775   0.08018 .
AgeGroup:PrimeCondition   3 0.0419 0.01397  0.3616   0.78079
Residuals               248 9.5831 0.03864
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

 Response know :
                         Df Sum Sq  Mean Sq F value  Pr(>F)
AgeGroup                  1 0.1722 0.172225  4.4640 0.03562 *
PrimeCondition            3 0.3836 0.127875  3.3145 0.02064 *
AgeGroup:PrimeCondition   3 0.0649 0.021642  0.5609 0.64127
Residuals               248 9.5680 0.038581
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

 Response other :
                         Df  Sum Sq Mean Sq  F value Pr(>F)
AgeGroup                  1 1.24881 1.24881 155.6184 <2e-16 ***
PrimeCondition            3 0.01657 0.00552   0.6882 0.5600
AgeGroup:PrimeCondition   3 0.00627 0.00209   0.2604 0.8539
Residuals               248 1.99015 0.00802
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

 Response TOT :
                         Df  Sum Sq Mean Sq F value    Pr(>F)
AgeGroup                  1 0.58523 0.58523 55.7850 1.376e-12 ***
PrimeCondition            3 0.01645 0.00548  0.5227    0.6671
AgeGroup:PrimeCondition   3 0.00372 0.00124  0.1184    0.9493
Residuals               248 2.60170 0.01049
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1
```

2.2.2 overall

```
> e2_all_aov = aov(data = statepercent_exp2,
+                    Percent ~ AgeGroup*State*PrimeCondition +
+                  Error(Subject/(State*PrimeCondition)))
> summary(e2_all_aov)
```

```
Error: Subject
          Df    Sum Sq   Mean Sq F value Pr(>F)
AgeGroup   1 2.190e-30 2.191e-30    1.58  0.213
Residuals 62 8.598e-29 1.387e-30

Error: Subject:State
                Df Sum Sq Mean Sq F value   Pr(>F)
State            3  20.89   6.962   69.44  < 2e-16 ***
AgeGroup:State   3   4.16   1.387   13.83 3.52e-08 ***
Residuals      186  18.65   0.100
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Subject:PrimeCondition
                        Df    Sum Sq   Mean Sq F value Pr(>F)
PrimeCondition           3 4.000e-32 1.320e-32   0.024  0.995
AgeGroup:PrimeCondition  3 1.000e-31 3.470e-32   0.063  0.979
Residuals              186 1.022e-28 5.494e-31

Error: Subject:State:PrimeCondition
                              Df Sum Sq Mean Sq F value   Pr(>F)
State:PrimeCondition           9  0.681 0.07563   8.284 1.27e-11 ***
AgeGroup:State:PrimeCondition  9  0.117 0.01298   1.422    0.175
Residuals                    558  5.095 0.00913
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1
```

2.2.3 know

```
> e2_know = statepercent_exp2 %>% filter(State == "know")
> e2_know_aov = aov(data = e2_know,
+                          Percent ~ AgeGroup*PrimeCondition +
+                        Error(Subject/PrimeCondition))
> summary(e2_know_aov)
```

```
Error: Subject
          Df Sum Sq Mean Sq F value Pr(>F)
AgeGroup   1  0.172  0.1722   1.425  0.237
Residuals 62  7.491  0.1208

Error: Subject:PrimeCondition
                        Df Sum Sq Mean Sq F value   Pr(>F)
PrimeCondition           3 0.3836 0.12788  11.451 6.33e-07 ***
AgeGroup:PrimeCondition  3 0.0649 0.02164   1.938    0.125
Residuals              186 2.0771 0.01117
---
```

```
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1
```

```
> options(contrasts = c('contr.sum', 'contr.poly'))
> library(lsmeans)
> library(multcomp)
> target_lsm = lsmeans::lsmeans(e2_know_aov,
+                                       c("AgeGroup","PrimeCondition"))
> prime_effect = cld(target_lsm, alpha = 0.05,
+                 adjust = "tukey", details = TRUE, by = "AgeGroup")
> library(knitr)
> kable(subset(prime_effect$comparisons,prime_effect$comparisons$p.value < 0.05 ))
```

```
|   |contrast |AgeGroup |  estimate|        SE|  df|  t.ratio|   p.value|
|:--|:--------|:--------|---------:|---------:|---:|--------:|---------:|
|7  |b - u    |Young    |   0.09750| 0.0264184| 186| 3.690605| 0.0016599|
|8  |r - u    |Young    |   0.10375| 0.0264184| 186| 3.927183| 0.0006942|
|10 |p - u    |Young    |   0.14875| 0.0264184| 186| 5.630539| 0.0000004|
```

```
> target_p = e2_know %>% filter(PrimeCondition == "p")
> target_r = e2_know %>% filter(PrimeCondition == "r")
> target_b = e2_know %>% filter(PrimeCondition == "b")
> target_u = e2_know %>% filter(PrimeCondition == "u")
> t.test(target_u$Percent, target_r$Percent, paired = TRUE)
```

```
        Paired t-test

data:  target_u$Percent and target_r$Percent
t = -3.9791, df = 63, p-value = 0.0001813
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -0.1136042 -0.0376458
sample estimates:
mean of the differences
              -0.075625
```

```
> t.test(target_u$Percent, target_b$Percent, paired = TRUE)
```

```
        Paired t-test

data:  target_u$Percent and target_b$Percent
t = -4.4743, df = 63, p-value = 3.277e-05
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -0.10578469 -0.04046531
sample estimates:
mean of the differences
              -0.073125
```

```
> t.test(target_u$Percent, target_p$Percent, paired = TRUE)
```

```
        Paired t-test

data:  target_u$Percent and target_p$Percent
t = -5.3881, df = 63, p-value = 1.129e-06
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -0.14394262 -0.06605738
sample estimates:
mean of the differences
                 -0.105
```

```
> ## old diff in know semantic and know unrelated
>
> old_semantic = e2_know %>% filter(PrimeCondition == "r" & AgeGroup == "Old")
> old_unrel = e2_know %>% filter(PrimeCondition == "u" & AgeGroup == "Old")
> t.test(old_semantic$Percent, old_unrel$Percent, paired = TRUE)
```

```
        Paired t-test

data:  old_semantic$Percent and old_unrel$Percent
t = 2.3047, df = 31, p-value = 0.02804
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 0.0061851 0.1013149
sample estimates:
mean of the differences
                0.05375
```

2.2.4 dont know

```
> e2_dontknow = statepercent_exp2 %>% filter(State == "dontknow")
> e2_dontknow_aov = aov(data = e2_dontknow,
+                           Percent ~ AgeGroup*PrimeCondition +
+                         Error(Subject/PrimeCondition))
> summary(e2_dontknow_aov)
```

```
Error: Subject
          Df Sum Sq Mean Sq F value   Pr(>F)
AgeGroup   1  2.154  2.1536   16.55 0.000137 ***
Residuals 62  8.070  0.1302
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Subject:PrimeCondition
```

```
                          Df Sum Sq Mean Sq F value    Pr(>F)
PrimeCondition             3 0.2640 0.08801  10.820 1.38e-06 ***
AgeGroup:PrimeCondition    3 0.0419 0.01397   1.718    0.165
Residuals                186 1.5129 0.00813
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1
```

```
> options(contrasts = c('contr.sum', 'contr.poly'))
> library(lsmeans)
> library(multcomp)
> target_lsm = lsmeans::lsmeans(e2_dontknow_aov,
+                                c("AgeGroup","PrimeCondition"))
> prime_effect = cld(target_lsm, alpha = 0.05,
+                   adjust = "tukey", details = TRUE, by = "AgeGroup")
> library(knitr)
> kable(subset(prime_effect$comparisons,prime_effect$comparisons$p.value < 0.05 ))
```

```
|   |contrast |AgeGroup | estimate|        SE|  df|  t.ratio|   p.value|
|:--|:--------|:--------|--------:|---------:|---:|--------:|---------:|
|4  |u - b    |Old      |  0.06125| 0.0225467| 186| 2.716582| 0.0360154|
|5  |u - r    |Old      |  0.06000| 0.0225467| 186| 2.661142| 0.0417764|
|10 |u - b    |Young    |  0.10500| 0.0225467| 186| 4.656998| 0.0000359|
|11 |u - r    |Young    |  0.10125| 0.0225467| 186| 4.490677| 0.0000730|
|12 |u - p    |Young    |  0.07250| 0.0225467| 186| 3.215546| 0.0082895|
```

```
> target_p = e2_dontknow %>% filter(PrimeCondition == "p")
> target_r = e2_dontknow %>% filter(PrimeCondition == "r")
> target_b = e2_dontknow %>% filter(PrimeCondition == "b")
> target_u = e2_dontknow %>% filter(PrimeCondition == "u")
> t.test(target_u$Percent, target_r$Percent, paired = TRUE)
```

```
        Paired t-test

data:  target_u$Percent and target_r$Percent
t = 3.9738, df = 63, p-value = 0.0001846
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 0.03293392 0.09956608
sample estimates:
mean of the differences
                0.06625
```

```
> t.test(target_u$Percent, target_b$Percent, paired = TRUE)
```

```
        Paired t-test

data:  target_u$Percent and target_b$Percent
```

```
t = 6.0538, df = 63, p-value = 8.598e-08
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 0.05442948 0.10807052
sample estimates:
mean of the differences
               0.08125
```

```
> t.test(target_u$Percent, target_p$Percent, paired = TRUE)
```

```
        Paired t-test

data:  target_u$Percent and target_p$Percent
t = 4.8548, df = 63, p-value = 8.3e-06
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 0.04228942 0.10146058
sample estimates:
mean of the differences
              0.071875
```

```
> target_y = e2_dontknow %>% filter(AgeGroup == "Young")
> target_o = e2_dontknow %>% filter(AgeGroup == "Old")
> t.test(target_y$Percent, target_o$Percent, paired = FALSE)
```

```
        Welch Two Sample t-test

data:  target_y$Percent and target_o$Percent
t = -7.4373, df = 207.49, p-value = 2.667e-12
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -0.2320625 -0.1348125
sample estimates:
mean of x mean of y
0.2940625 0.4775000
```

```
>
```

2.2.5 other

```
> e2_other = statepercent_exp2 %>% filter(State == "other")
> e2_other_aov = aov(data = e2_other,
+                            Percent ~ AgeGroup*PrimeCondition +
+                          Error(Subject/PrimeCondition))
> summary(e2_other_aov)
```

```
Error: Subject
          Df Sum Sq Mean Sq F value   Pr(>F)
AgeGroup   1  1.249  1.2488   60.39 9.89e-11 ***
Residuals 62  1.282  0.0207
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Subject:PrimeCondition
                        Df Sum Sq  Mean Sq F value Pr(>F)
PrimeCondition           3 0.0166 0.005523   1.451  0.229
AgeGroup:PrimeCondition  3 0.0063 0.002090   0.549  0.649
Residuals              186 0.7080 0.003806
```

```
> options(contrasts = c('contr.sum', 'contr.poly'))
> library(lsmeans)
> library(multcomp)
> target_lsm = lsmeans::lsmeans(e2_other_aov,
+                                    c("AgeGroup","PrimeCondition"))
> prime_effect = cld(target_lsm, alpha = 0.05,
+                  adjust = "tukey", details = TRUE, by = "PrimeCondition")
> library(knitr)
> kable(subset(prime_effect$comparisons,prime_effect$comparisons$p.value < 0.05 ))
```

```
|contrast    |PrimeCondition | estimate|        SE|       df|  t.ratio| p.value|
|:-----------|:--------------|--------:|---------:|--------:|--------:|-------:|
|Young - Old |b              |  0.14875| 0.0223953| 135.5897| 6.642016|   0e+00|
|Young - Old |p              |  0.13625| 0.0223953| 135.5897| 6.083863|   0e+00|
|Young - Old |r              |  0.12500| 0.0223953| 135.5897| 5.581526|   1e-07|
|Young - Old |u              |  0.14875| 0.0223953| 135.5897| 6.642016|   0e+00|
```

```
> target_y = e2_other %>% filter(AgeGroup == "Young")
> target_o = e2_other %>% filter(AgeGroup == "Old")
> t.test(target_y$Percent, target_o$Percent, paired = FALSE)
```

```
        Welch Two Sample t-test

data:  target_y$Percent and target_o$Percent
t = 12.553, df = 173, p-value < 2.2e-16
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 0.1177235 0.1616515
sample estimates:
mean of x mean of y
0.1775000 0.0378125
```

```
>
```

2.2.6 TOT

```
> e2_TOT = statepercent_exp2 %>% filter(State == "TOT")
> e2_TOT_aov = aov(data = e2_TOT,
+                          Percent ~ AgeGroup*PrimeCondition +
+                        Error(Subject/PrimeCondition))
> summary(e2_TOT_aov)
```

```
Error: Subject
          Df Sum Sq Mean Sq F value   Pr(>F)
AgeGroup   1 0.5852  0.5852    20.1 3.24e-05 ***
Residuals 62 1.8051  0.0291
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Subject:PrimeCondition
                         Df Sum Sq  Mean Sq F value Pr(>F)
PrimeCondition            3 0.0165 0.005483    1.28  0.283
AgeGroup:PrimeCondition   3 0.0037 0.001242    0.29  0.833
Residuals               186 0.7966 0.004283
```

```
> options(contrasts = c('contr.sum', 'contr.poly'))
> library(lsmeans)
> library(multcomp)
> target_lsm = lsmeans::lsmeans(e2_TOT_aov,
+                                 c("AgeGroup","PrimeCondition"))
> prime_effect = cld(target_lsm, alpha = 0.05,
+                 adjust = "tukey", details = TRUE, by = "AgeGroup")
> library(knitr)
> kable(subset(prime_effect$comparisons,prime_effect$comparisons$p.value < 0.05 ))
```

```
|contrast |AgeGroup | estimate| SE| df| t.ratio| p.value|
|:--------|:--------|--------:|--:|--:|-------:|-------:|
```

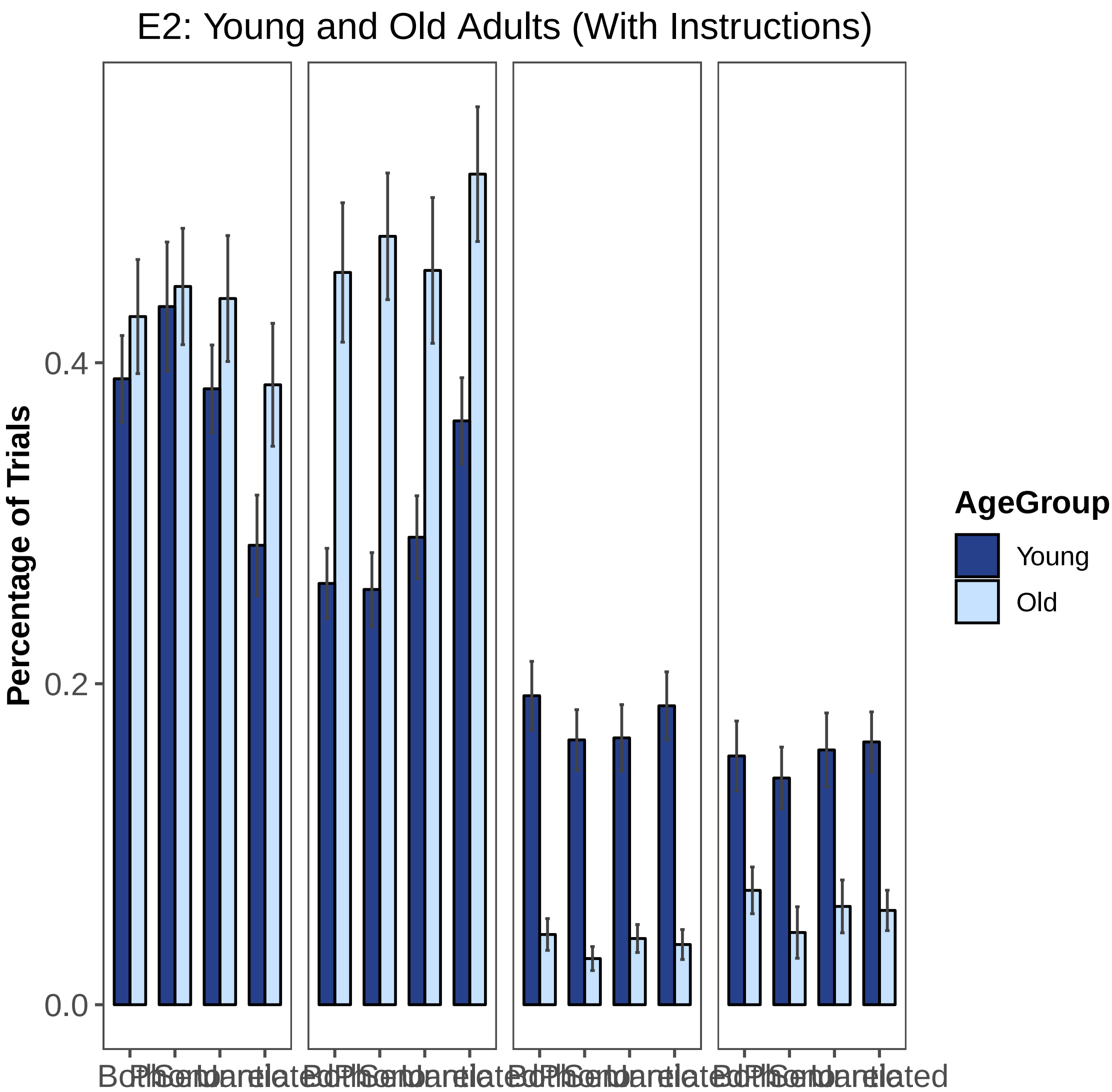
```
> target_y = e2_TOT %>% filter(AgeGroup == "Young")
> target_o = e2_TOT %>% filter(AgeGroup == "Old")
> t.test(target_y$Percent, target_o$Percent, paired = FALSE)
```

```
        Welch Two Sample t-test

data:  target_y$Percent and target_o$Percent
t = 7.5296, df = 231.5, p-value = 1.13e-12
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 0.07060291 0.12064709
sample estimates:
mean of x mean of y
0.1546875 0.0590625
```

```
>
```

2.2.7 plot

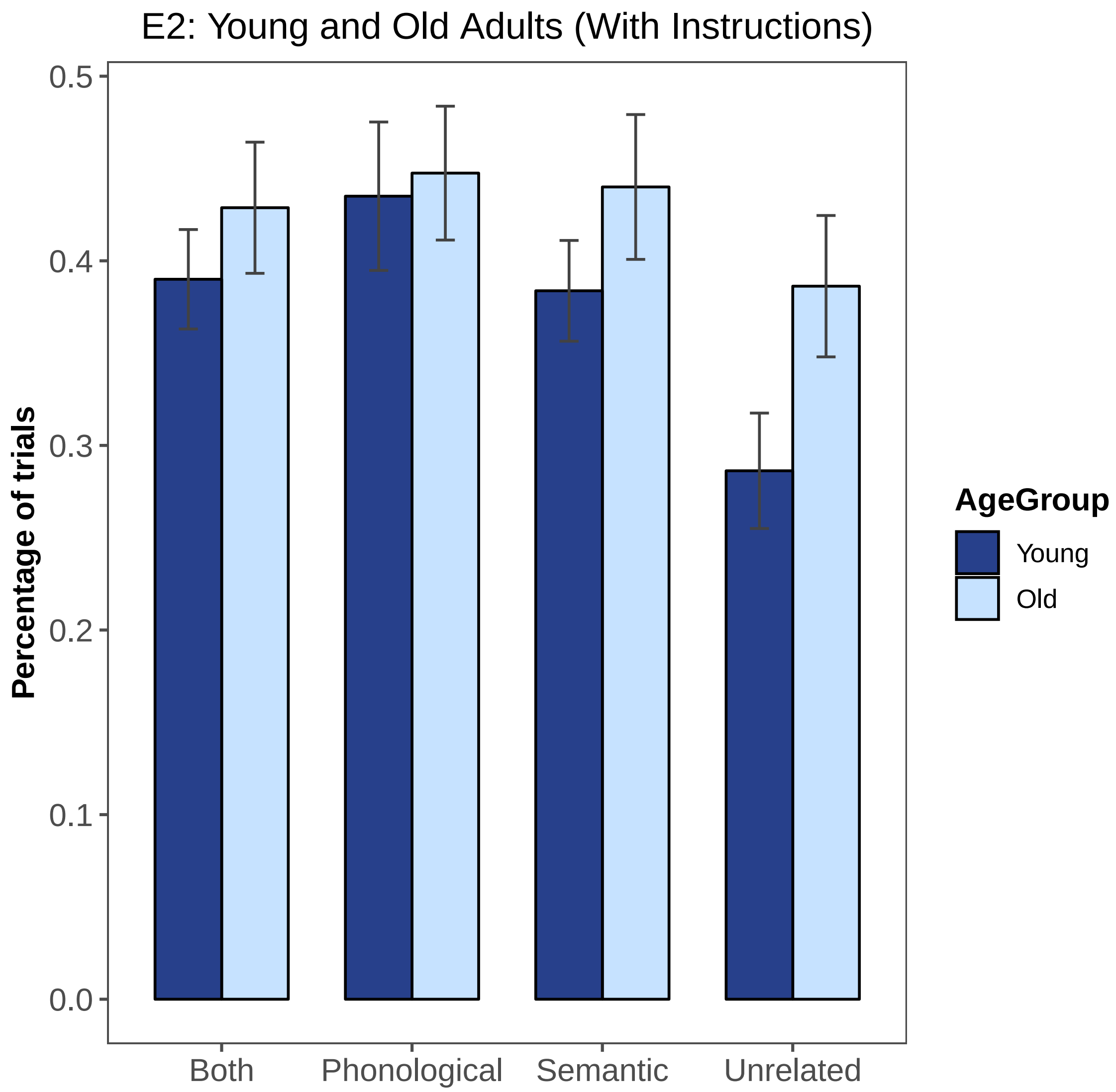
```
> exp2_statepercent= Rmisc::summarySE(statepercent_exp2,
+                         measurevar = "Percent",
+                         groupvars = c("State", "AgeGroup", "PrimeCondition"))
> exp2_statepercent$RetrievalState = factor(exp2_statepercent$State,levels(exp2_stateper
> exp2_statepercent$AgeGroup = factor(exp2_statepercent$AgeGroup,levels(exp2_statepercen
> #write.csv(exp2_statepercent, file = "exp2_statepercent.csv")
> exp2_statepercent = read.csv("exp2_statepercent.csv", sep = ",",
+                              header = TRUE)
> exp2_statepercent$AgeGroup = factor(exp2_statepercent$AgeGroup,levels(exp2_statepercen
> library(ggplot2)
> library(ggthemes)
> e2_percentplot = exp2_statepercent %>%
+   mutate(PrimeType = factor(PrimeCondition, levels = unique(PrimeCondition),
+                       labels = c("Both", "Phono",
+                                  "Semantic", "Unrelated")),
+         RetrievalState = factor(RetrievalState, levels = unique(RetrievalState),
+                                  labels = c("1: Know","2: Dont Know",  "3: Other", "4:
+
+ ggplot(aes(x = PrimeType, y = Percent,
+            group = AgeGroup, fill = AgeGroup))+
+  geom_bar(stat = "identity", position = "dodge", width = 0.7,
+           color= "black")+
+   geom_errorbar(aes(ymin=Percent - se, ymax=Percent + se),
+              width=.2, color = "gray26",
+              position = position_dodge(0.7))+
+  theme_few()+
+   facet_wrap(~RetrievalState, nrow = 1)+
+   scale_fill_manual(values = c("royalblue4", "slategray1"))+
+     xlab("") + ylab("Percentage of Trials") +
+   ggtitle("E2: Young and Old Adults (With Instructions)")  +
+    theme(axis.text = element_text(size = rel(1)),
+           axis.title = element_text(face = "bold", size = rel(1)),
+           legend.title = element_text(face = "bold", size = rel(1)),
+          plot.title = element_text(hjust = .5),
+          axis.text.x = element_text( size = rel(1)),
+          strip.text.x = element_blank())
> e2_percentplot
>
```



2.2.8 Know Only

```
> exp2_statepercent_know = exp2_statepercent %>% filter(RetrievalState == "know")
> e2_percentplot_know = exp2_statepercent_know %>%
+   mutate(PrimeType = factor(PrimeCondition, levels = unique(PrimeCondition),
+                       labels = c("Both", "Phonological",
+                                  "Semantic", "Unrelated")))%>%
+ ggplot(aes(x = PrimeType, y = Percent,
+            group = AgeGroup, fill = AgeGroup))+
+  geom_bar(stat = "identity", position = "dodge", width = 0.7,
+           color= "black")+
```

```
+    geom_errorbar(aes(ymin=Percent - se, ymax=Percent + se),
+                  width=.2, color = "gray26",
+                  position = position_dodge(0.7))+
+   theme_few()+
+    scale_fill_manual(values = c( "royalblue4", "slategray1"))+
+      xlab("") + ylab("Percentage of trials") +
+    ggtitle("E2: Young and Old Adults (With Instructions)")  +
+     theme(axis.text = element_text(size = rel(1)),
+            axis.title = element_text(face = "bold", size = rel(1)),
+            legend.title = element_text(face = "bold", size = rel(1)),
+           plot.title = element_text(hjust = .5),
+           strip.text.x = element_text(face = "bold", size = rel(1.4)))
> e2_percentplot_know
```



2.3 Experiment 3

2.3.1 MANOVA

```
> ## we want to do a manova on our data for exp 1
> ## first need to convert each state to wide format
> e3_data_wide ← spread(statepercent_exp3, State, Percent)
> ## grouping
>
> e3_wide_agg = group_by(e3_data_wide, AgeGroup, PrimeCondition) %>%
+   summarise_at(vars(dontknow, know, other, TOT), mean)
```

```
> output3 ← manova(cbind(dontknow, know,
+           other, TOT)~ PrimeCondition, data = e3_data_wide )
> summary.aov(output3)
```

```
 Response dontknow :
                Df  Sum Sq  Mean Sq F value Pr(>F)
PrimeCondition   3 0.08756 0.029185  1.6243 0.1865
Residuals      140 2.51547 0.017968

 Response know :
                Df Sum Sq  Mean Sq F value  Pr(>F)
PrimeCondition   3 0.2729 0.090974  2.3291 0.07709 .
Residuals      140 5.4684 0.039060
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

 Response other :
                Df  Sum Sq  Mean Sq F value Pr(>F)
PrimeCondition   3 0.00199 0.000663  0.0417 0.9886
Residuals      140 2.22600 0.015900

 Response TOT :
                Df  Sum Sq  Mean Sq F value Pr(>F)
PrimeCondition   3 0.03689 0.012296  0.9118  0.437
Residuals      140 1.88791 0.013485
```

2.3.2 overall

```
> e3_all_aov = aov(data = statepercent_exp3,
+                           Percent ~ State*PrimeCondition +
+                          Error(Subject/(State*PrimeCondition)))
> summary(e3_all_aov)
```

```
Error: Subject
          Df    Sum Sq  Mean Sq F value Pr(>F)
Residuals 35 1.123e-29 3.21e-31

Error: Subject:State
           Df Sum Sq Mean Sq F value   Pr(>F)
State       3  5.464  1.8215    21.8 4.71e-11 ***
Residuals 105  8.772  0.0835
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Subject:PrimeCondition
                Df    Sum Sq   Mean Sq F value Pr(>F)
PrimeCondition   3 1.141e-30 3.802e-31    1.88  0.138
```

```
Residuals       105 2.124e-29 2.023e-31

Error: Subject:State:PrimeCondition
                      Df Sum Sq Mean Sq F value   Pr(>F)
State:PrimeCondition   9  0.399 0.04437   4.202 3.79e-05 ***
Residuals            315  3.326 0.01056
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1
```

2.3.3 know

```
> e3_know = statepercent_exp3 %>% filter(State == "know")
> e3_know_aov = aov(data = e3_know,
+                            Percent ~ PrimeCondition +
+                          Error(Subject/PrimeCondition))
> summary(e3_know_aov)
```

```
Error: Subject
          Df Sum Sq Mean Sq F value Pr(>F)
Residuals 35  4.082  0.1166

Error: Subject:PrimeCondition
                Df Sum Sq Mean Sq F value  Pr(>F)
PrimeCondition   3 0.2729 0.09097   6.889 0.00028 ***
Residuals      105 1.3867 0.01321
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1
```

```
> options(contrasts = c('contr.sum', 'contr.poly'))
> library(lsmeans)
> library(multcomp)
> target_lsm = lsmeans::lsmeans(e3_know_aov,
+                                  c("PrimeCondition"))
> prime_effect = cld(target_lsm, alpha = 0.05,
+                  adjust = "tukey", details = TRUE)
> library(knitr)
> kable(subset(prime_effect$comparisons,prime_effect$comparisons$p.value < 0.05 ))
```

```
|   |contrast |  estimate|        SE|  df|  t.ratio|   p.value|
|:--|:--------|---------:|---------:|---:|--------:|---------:|
|2  |b - u    | 0.0944444| 0.0270867| 105| 3.486740| 0.0039328|
|4  |r - u    | 0.1155556| 0.0270867| 105| 4.266129| 0.0002524|
```

```
> target_p = e3_know %>% filter(PrimeCondition == "p")
> target_r = e3_know %>% filter(PrimeCondition == "r")
> target_b = e3_know %>% filter(PrimeCondition == "b")
> target_u = e3_know %>% filter(PrimeCondition == "u")
```

```
> t.test(target_u$Percent, target_r$Percent, paired = TRUE)
```

```
        Paired t-test

data:  target_u$Percent and target_r$Percent
t = -4.174, df = 35, p-value = 0.0001881
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -0.17175765 -0.05935346
sample estimates:
mean of the differences
             -0.1155556
```

```
> t.test(target_u$Percent, target_b$Percent, paired = TRUE)
```

```
        Paired t-test

data:  target_u$Percent and target_b$Percent
t = -3.2616, df = 35, p-value = 0.002474
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -0.15322942 -0.03565947
sample estimates:
mean of the differences
            -0.09444444
```

```
> t.test(target_u$Percent, target_p$Percent, paired = TRUE)
```

```
        Paired t-test

data:  target_u$Percent and target_p$Percent
t = -2.6248, df = 35, p-value = 0.01276
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -0.11822819 -0.01510515
sample estimates:
mean of the differences
            -0.06666667
```

2.3.4 dont know

```
> e3_dontknow = statepercent_exp3 %>% filter(State == "dontknow")
> e3_dontknow_aov = aov(data = e3_dontknow,
+                          Percent ~ PrimeCondition +
+                        Error(Subject/PrimeCondition))
> summary(e3_dontknow_aov)
```

```
Error: Subject
          Df Sum Sq Mean Sq F value Pr(>F)
Residuals 35  1.664 0.04754

Error: Subject:PrimeCondition
                Df Sum Sq  Mean Sq F value Pr(>F)
PrimeCondition   3 0.0876 0.029185   3.598  0.016 *
Residuals      105 0.8516 0.008111
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1
```

```
> options(contrasts = c('contr.sum', 'contr.poly'))
> library(lsmeans)
> library(multcomp)
> target_lsm = lsmeans::lsmeans(e3_dontknow_aov,
+                               c("PrimeCondition"))
> prime_effect = cld(target_lsm, alpha = 0.05,
+                 adjust = "tukey", details = TRUE)
> library(knitr)
> kable(subset(prime_effect$comparisons,prime_effect$comparisons$p.value < 0.05 ))
```

```
|   |contrast |  estimate|        SE|  df|  t.ratio|   p.value|
|:--|:--------|---------:|---------:|---:|--------:|---------:|
|4  |u - r    | 0.0644444| 0.0212275| 105| 3.035898| 0.0157648|
```

```
> target_p = e3_dontknow %>% filter(PrimeCondition == "p")
> target_r = e3_dontknow %>% filter(PrimeCondition == "r")
> target_b = e3_dontknow %>% filter(PrimeCondition == "b")
> target_u = e3_dontknow %>% filter(PrimeCondition == "u")
> t.test(target_u$Percent, target_r$Percent, paired = TRUE)
```

```
        Paired t-test

data:  target_u$Percent and target_r$Percent
t = 3.136, df = 35, p-value = 0.003461
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 0.02272621 0.10616268
sample estimates:
mean of the differences
             0.06444444
```

```
> t.test(target_u$Percent, target_b$Percent, paired = TRUE)
```

```
        Paired t-test
```

```
data:  target_u$Percent and target_b$Percent
t = 2.8858, df = 35, p-value = 0.006645
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 0.01614348 0.09274541
sample estimates:
mean of the differences
             0.05444444
```

```
> t.test(target_u$Percent, target_p$Percent, paired = TRUE)
```

```
        Paired t-test

data:  target_u$Percent and target_p$Percent
t = 1.9488, df = 35, p-value = 0.05936
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -0.001899482  0.093010593
sample estimates:
mean of the differences
             0.04555556
```

2.3.5 other

```
> e3_other = statepercent_exp3 %>% filter(State == "other")
> e3_other_aov = aov(data = e3_other,
+                             Percent ~ PrimeCondition +
+                           Error(Subject/PrimeCondition))
> summary(e3_other_aov)
```

```
Error: Subject
          Df Sum Sq Mean Sq F value Pr(>F)
Residuals 35   1.615 0.04614

Error: Subject:PrimeCondition
                Df Sum Sq   Mean Sq F value Pr(>F)
PrimeCondition   3 0.0020 0.000663   0.114  0.952
Residuals      105 0.6112 0.005821
```

```
>
```

2.3.6 TOT

```
> e3_TOT = statepercent_exp3 %>% filter(State == "TOT")
> e3_TOT_aov = aov(data = e3_TOT,
+                             Percent ~ PrimeCondition +
```

```
+                           Error(Subject/PrimeCondition))
> summary(e3_TOT_aov)
```

```
Error: Subject
          Df Sum Sq Mean Sq F value Pr(>F)
Residuals 35  1.411 0.04032

Error: Subject:PrimeCondition
                Df Sum Sq Mean Sq F value Pr(>F)
PrimeCondition   3 0.0369 0.01230   2.708 0.0489 *
Residuals      105 0.4767 0.00454
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1
```

```
> options(contrasts = c('contr.sum', 'contr.poly'))
> library(lsmeans)
> library(multcomp)
> target_lsm = lsmeans::lsmeans(e3_TOT_aov,
+                               c("PrimeCondition"))
> prime_effect = cld(target_lsm, alpha = 0.05,
+                 adjust = "tukey", details = TRUE)
> library(knitr)
> kable(subset(prime_effect$comparisons,prime_effect$comparisons$p.value < 0.05 ))
```

```
|   |contrast |   estimate|         SE|  df|  t.ratio|   p.value|
|:--|:--------|----------:|----------:|---:|--------:|---------:|
|4  |u - r    |  0.0433333|  0.0158817| 105| 2.728509| 0.0369009|
```

```
> target_p = e3_TOT %>% filter(PrimeCondition == "p")
> target_r = e3_TOT %>% filter(PrimeCondition == "r")
> target_b = e3_TOT %>% filter(PrimeCondition == "b")
> target_u = e3_TOT %>% filter(PrimeCondition == "u")
> t.test(target_u$Percent, target_r$Percent, paired = TRUE)
```

```
        Paired t-test

data:  target_u$Percent and target_r$Percent
t = 3.1114, df = 35, p-value = 0.003695
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 0.01505952 0.07160715
sample estimates:
mean of the differences
             0.04333333
```

```
> t.test(target_u$Percent, target_b$Percent, paired = TRUE)
```

```
	Paired t-test

data:  target_u$Percent and target_b$Percent
t = 2.0797, df = 35, p-value = 0.04494
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 0.0007425523 0.0614796700
sample estimates:
mean of the differences
             0.03111111
```

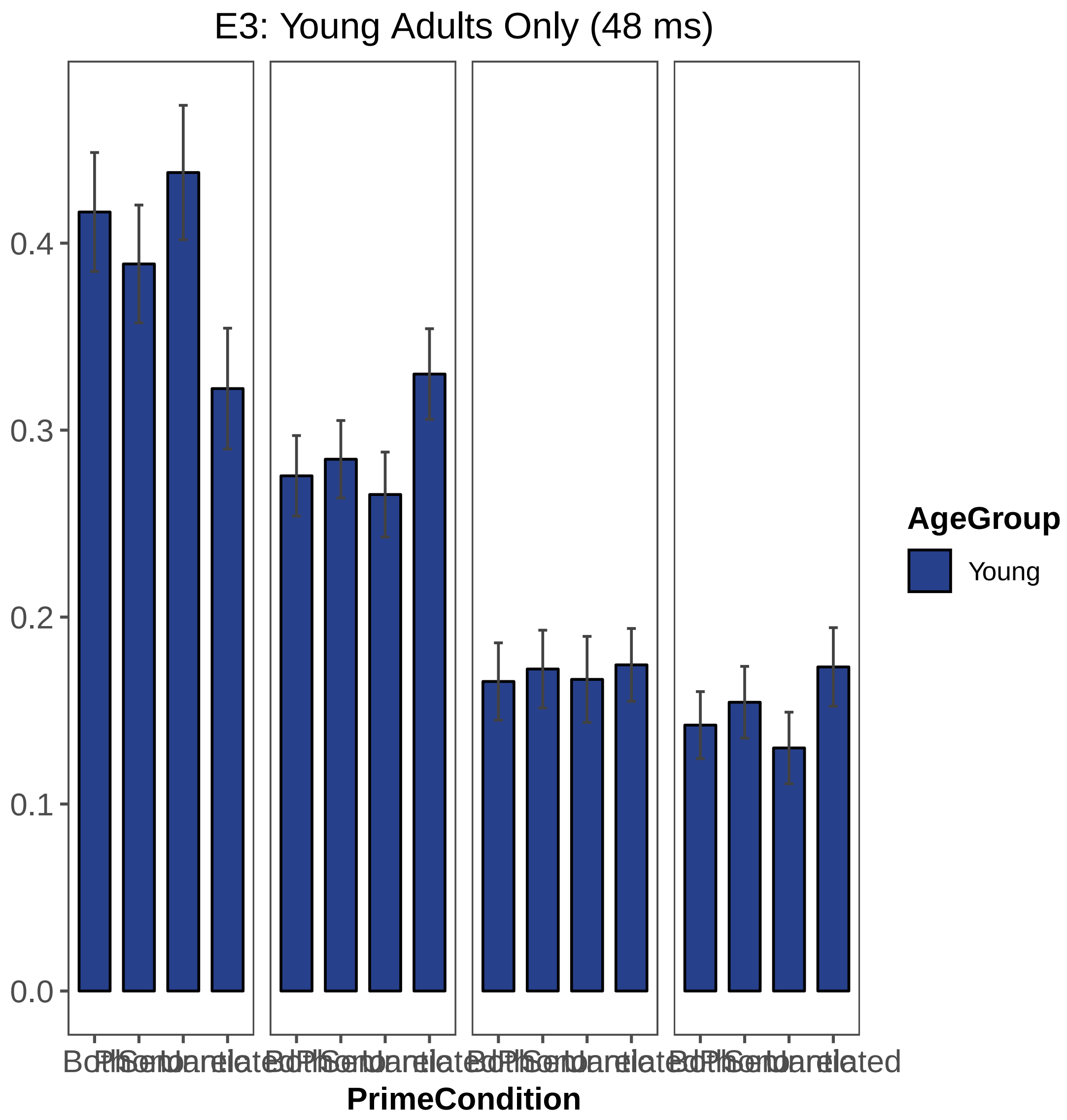
```
> t.test(target_u$Percent, target_p$Percent, paired = TRUE)
```

```
	Paired t-test

data:  target_u$Percent and target_p$Percent
t = 1.2259, df = 35, p-value = 0.2284
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -0.01239224  0.05017002
sample estimates:
mean of the differences
             0.01888889
```

2.3.7 plot

```
> exp3_statepercent= Rmisc::summarySE(statepercent_exp3,
+                         measurevar = "Percent",
+                         groupvars = c("State","AgeGroup", "PrimeCondition"))
> exp3_statepercent$RetrievalState = factor(exp3_statepercent$State,levels(exp3_stateper
> #write.csv(exp3_statepercent, file = "exp3_statepercent.csv")
> exp3_statepercent = read.csv("exp3_statepercent.csv", sep = ",",
+                              header = TRUE)
> library(ggplot2)
> library(ggthemes)
> e3_percentplot = exp3_statepercent %>%
+   mutate(PrimeType = factor(PrimeCondition, levels = unique(PrimeCondition),
+                     labels = c("Both", "Phono",
+                                "Semantic", "Unrelated")),
+         RetrievalState = factor(RetrievalState, levels = unique(RetrievalState),
+                                 labels = c("1: Know","2: Dont Know",  "3: Other", "4:
+ ggplot(aes(x = PrimeType, y = Percent,
+            group = AgeGroup, fill = AgeGroup))+
+  geom_bar(stat = "identity", position = "dodge", width = 0.7,
+           color= "black")+
+   geom_errorbar(aes(ymin=Percent - se, ymax=Percent + se),
```

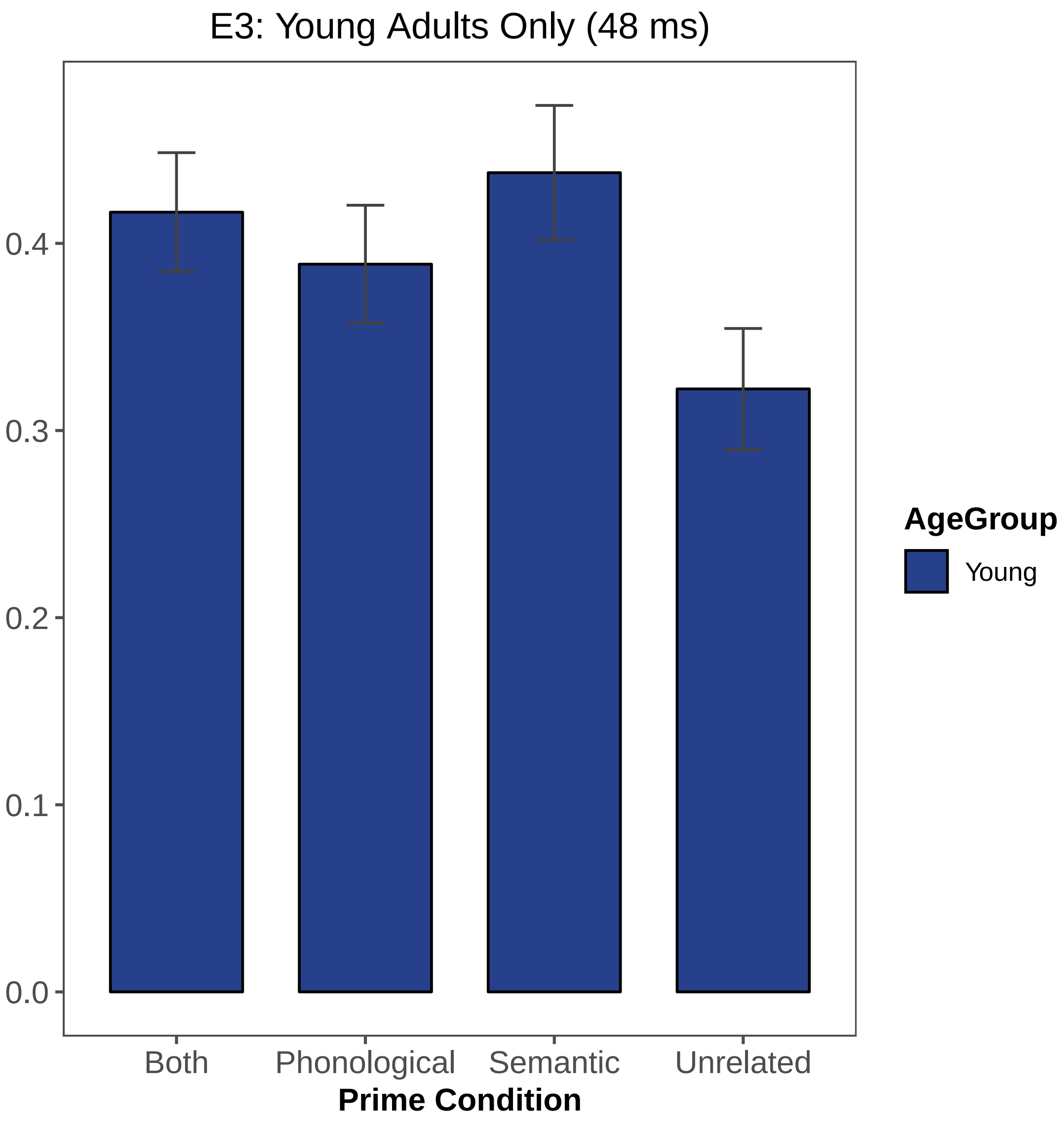
```
+                width=.2, color = "gray26",
+                position = position_dodge(0.7))+
+   theme_few()+
+    facet_wrap(~RetrievalState, nrow =1 )+
+      scale_fill_manual(values = c("royalblue4"))+
+        xlab("PrimeCondition") + ylab("") +
+    ggtitle("E3: Young Adults Only (48 ms)")  +
+     theme(axis.text = element_text(size = rel(1)),
+            axis.title = element_text(face = "bold", size = rel(1)),
+            legend.title = element_text(face = "bold", size = rel(1)),
+           plot.title = element_text(hjust = .5),
+                   axis.text.x = element_text(size = rel(1)),
+           strip.text.x = element_blank())
> e3_percentplot
>
```



2.3.8 Know Only

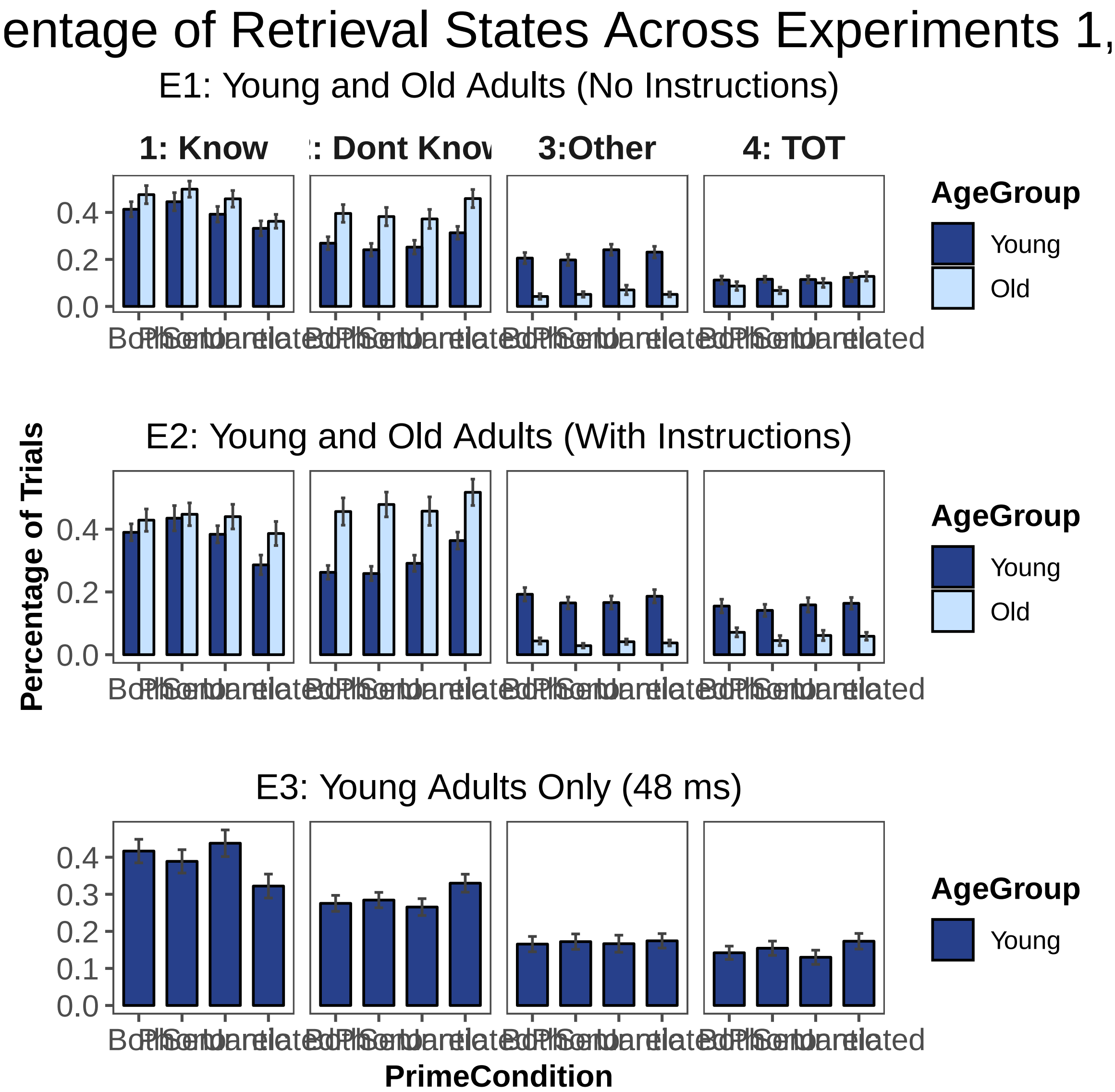
```
> exp3_statepercent_know = exp3_statepercent %>% filter(RetrievalState == "know")
> e3_percentplot_know = exp3_statepercent_know %>%
+   mutate(PrimeType = factor(PrimeCondition, levels = unique(PrimeCondition),
+                     labels = c("Both", "Phonological",
+                                "Semantic", "Unrelated")))%>%
+ ggplot(aes(x = PrimeType, y = Percent,
+            group = AgeGroup, fill = AgeGroup))+
+  geom_bar(stat = "identity", position = "dodge", width = 0.7,
+           color= "black")+
```

```
+    geom_errorbar(aes(ymin=Percent - se, ymax=Percent + se),
+                 width=.2, color = "gray26",
+                 position = position_dodge(0.7))+
+   theme_few()+
+    scale_fill_manual(values = c( "royalblue4", "slategray1"))+
+      xlab("Prime Condition") + ylab("") +
+    ggtitle("E3: Young Adults Only (48 ms)")  +
+     theme(axis.text = element_text(size = rel(1)),
+            axis.title = element_text(face = "bold", size = rel(1)),
+            legend.title = element_text(face = "bold", size = rel(1)),
+           plot.title = element_text(hjust = .5),
+           strip.text.x = element_text(face = "bold", size = rel(1.4)))
> e3_percentplot_know
```



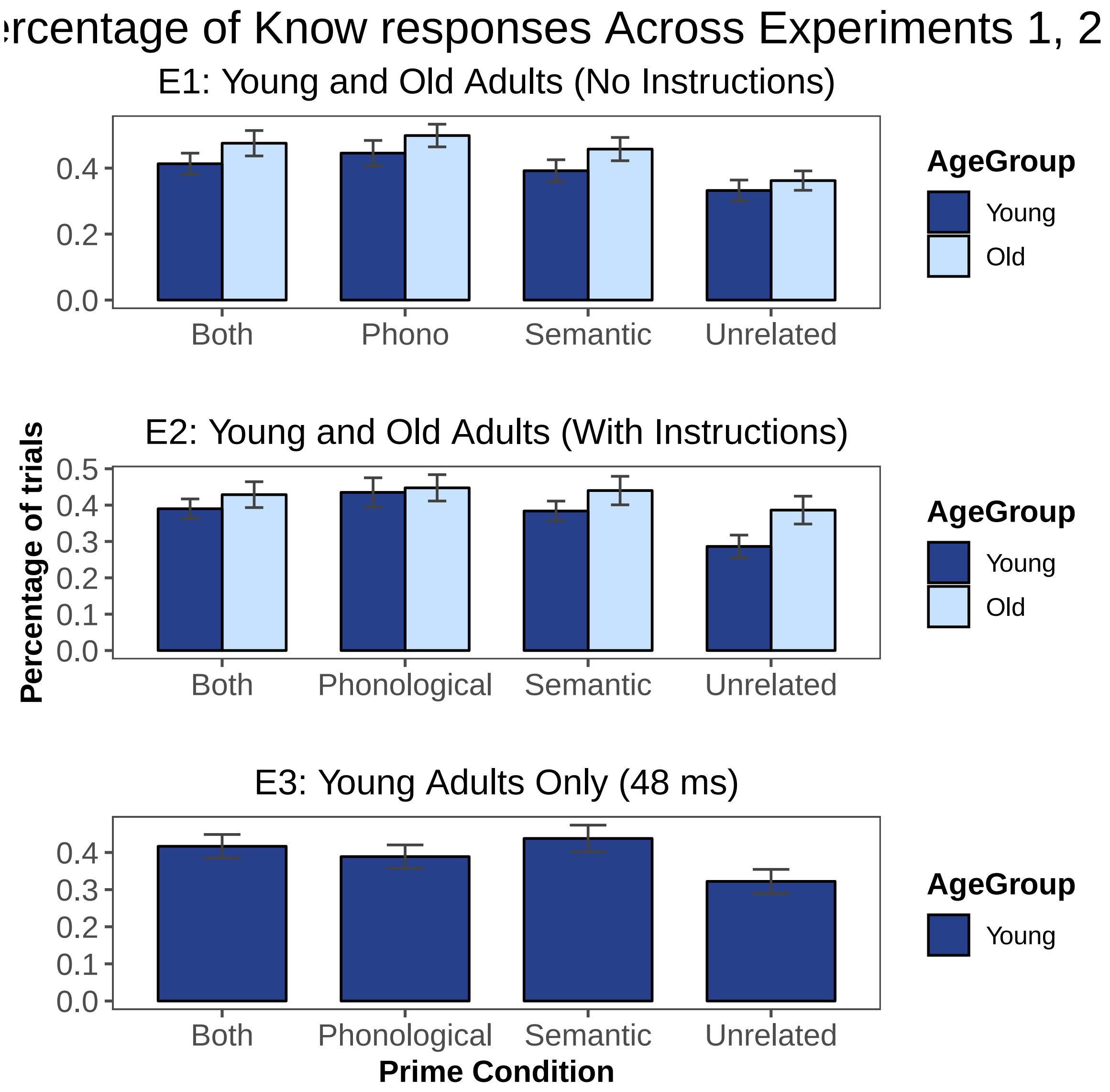
2.4 Combined Plot for State Percent

```
> library(grid)
> gridExtra::grid.arrange(e1_percentplot, e2_percentplot, e3_percentplot, nrow = 3, ncol
+                 top=textGrob("Percentage of Retrieval States Across Experiments 1, 2,
+                                 gp=gpar(fontsize=20)))
```



2.4.1 Combined Plot for Know Percent

```
> library(grid)
> gridExtra::grid.arrange(e1_percentplot_know, e2_percentplot_know, e3_percentplot_know,
+                   top=textGrob("Percentage of Know responses Across Experiments 1, 2, 3"
+                                              gp=gpar(fontsize=18)))
```



3 Combined TOT Other Analyses

```
> j ← read.csv("MainJulieagg_5studies.csv", header = TRUE, sep = ",")
> j ← subset(j, j$value.Subject != 198 & j$value.Subject != 95)
> #j_statepercent = j[,c(2,3,4,5,104:119)] # use for state percents
>
> j_statepercent = j[,c(2,3,4,5,120, 121,136,
+                       124, 125, 137,
+                       128, 129, 138,
+                       132,133, 139)] # use for prime percents
```

```
> j_statepercent$value.Subject = as.factor(j_statepercent$value.Subject)
> library(tidyr)
> library(dplyr)
> # use comments for state wise percent
> # statepercent <- j_statepercent %>%
> #   gather(StatePrime, Percent,
> #          know_r_percent, know_p_percent,know_b_percent, know_u_percent,
> #          dontknow_r_percent, dontknow_p_percent,
> #          dontknow_b_percent,dontknow_u_percent,
> #          other_r_percent,other_p_percent,other_b_percent,other_u_percent,
> #          TOT_r_percent, TOT_p_percent, TOT_b_percent, TOT_u_percent) %>%
> #   separate(StatePrime, c('State', 'Prime'), sep = "_") %>%
> #   arrange(value.Subject)
>
> # use below for prime wise percent
> statepercent <- j_statepercent %>%
+   gather(StatePrime, Percent,
+          r_know_new, r_dontknow_new,r_TO_new,
+          p_know_new, p_dontknow_new,p_TO_new,
+          b_know_new, b_dontknow_new,b_TO_new,
+          u_know_new, u_dontknow_new,u_TO_new) %>%
+   separate(StatePrime, c('Prime', 'State'), sep = "_") %>%
+   arrange(value.Subject)
> # state wise percent
> # colnames(statepercent) = c("AgeGroup", "Subject", "StudyNo", "PrimeInstruction", "St
>
> ## prime wise percent
> colnames(statepercent) = c("AgeGroup", "Subject", "StudyNo", "PrimeInstruction", "Prim
> statepercent$AgeGroup <- as.factor(statepercent$AgeGroup)
> statepercent$Subject <- as.factor(statepercent$Subject)
> statepercent$StudyNo <- as.factor(statepercent$StudyNo)
> statepercent$PrimeInstruction <- as.factor(statepercent$PrimeInstruction)
> statepercent$PrimeCondition <- as.factor(statepercent$PrimeCondition)
> statepercent$State <- as.factor(statepercent$State)
> statepercent$Percent <- as.numeric(as.character(statepercent$Percent))
> for(i in 1:nrow(statepercent)){
+   if(is.na(statepercent[i,7])) {
+     print(i)
+     statepercent[i,7] = 0
+   }
+   else
+     statepercent[i,7] = statepercent[i,7]
+ }
> statepercent_exp1 = statepercent %>% filter(StudyNo == '2' | StudyNo == '4')
> statepercent_exp2 = statepercent %>% filter(StudyNo == '5' | StudyNo == '6')
> statepercent_exp3 = statepercent %>% filter(StudyNo == '1')
>
```

3.1 E1

```
> e1_TO = statepercent_exp1 %>% filter(State == "TO")
> e1_TO_aov = aov(data = e1_TO,
+                  Percent ~ AgeGroup*PrimeCondition +
+                 Error(Subject/PrimeCondition))
> summary(e1_TO_aov)
```

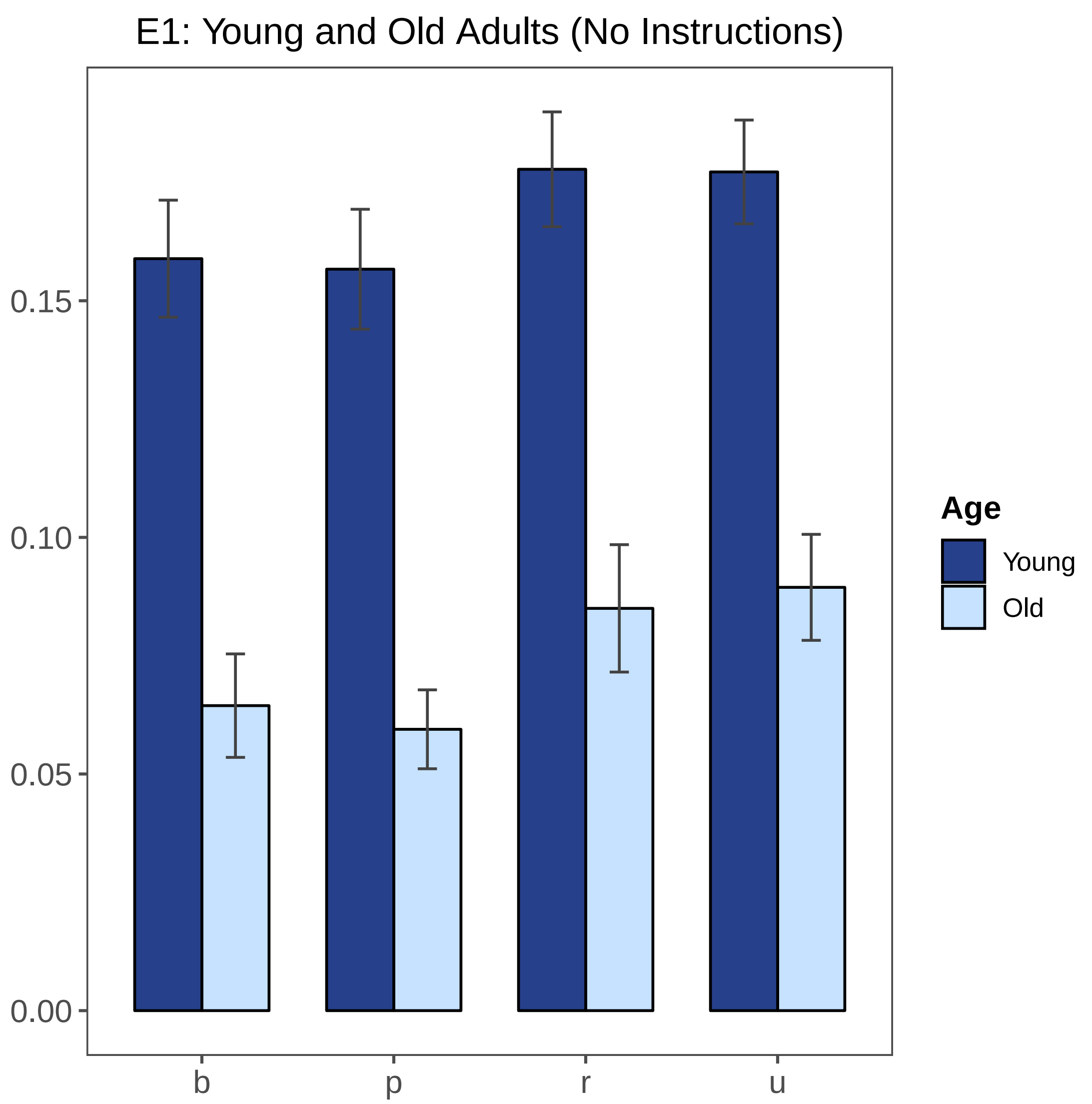
```
Error: Subject
          Df Sum Sq Mean Sq F value   Pr(>F)
AgeGroup   1 0.6235  0.6235   47.42 2.01e-09 ***
Residuals 70 0.9204  0.0131
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Subject:PrimeCondition
                         Df Sum Sq  Mean Sq F value   Pr(>F)
PrimeCondition            3 0.0371 0.012352   5.956 0.000646 ***
AgeGroup:PrimeCondition   3 0.0008 0.000283   0.137 0.938075
Residuals               210 0.4355 0.002074
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1
```

```
> options(contrasts = c('contr.sum', 'contr.poly'))
> library(lsmeans)
> library(multcomp)
> target_lsm = lsmeans::lsmeans(e1_TO_aov,
+                                c("AgeGroup","PrimeCondition"))
> prime_effect = cld(target_lsm, alpha = 0.05,
+                 adjust = "tukey", details = TRUE, by = "AgeGroup")
> library(knitr)
> # x = prime_effect$comparisons
> # x[which(x$p.value < 0.05),]
```

3.1.1 plot

```
> exp1_statepercent= Rmisc::summarySE(statepercent_exp1,
+                        measurevar = "Percent",
+                        groupvars = c("State", "AgeGroup", "PrimeCondition"))
> exp1_statepercent$RetrievalState = ordered(as.factor(as.character(exp1_statepercent$St
> exp1_statepercent$Age = ordered(as.factor(as.character(exp1_statepercent$AgeGroup)), l
> exp1_statepercent = exp1_statepercent %>% filter(RetrievalState == "TO")
> library(ggplot2)
> library(ggthemes)
> e1_percentplot = exp1_statepercent %>%
+ ggplot(aes(x = PrimeCondition, y = Percent,
+            group = Age, fill = Age))+
```

```
+   geom_bar(stat = "identity", position = "dodge", width = 0.7,
+            color= "black")+
+    geom_errorbar(aes(ymin=Percent - se, ymax=Percent + se),
+                width=.2, color = "gray26",
+                position = position_dodge(0.7))+
+   theme_few()+
+    scale_fill_manual(values = c( "royalblue4", "slategray1"))+
+      xlab("") + ylab("") +
+    ggtitle("E1: Young and Old Adults (No Instructions)")  +
+     theme(axis.text = element_text(size = rel(1)),
+            axis.title = element_text(face = "bold", size = rel(1)),
+            legend.title = element_text(face = "bold", size = rel(1)),
+           plot.title = element_text(hjust = .5),
+                   axis.text.x = element_text(size = rel(1)),
+           strip.text.x = element_text(face = "bold", size = rel(1.4)))
> e1_percentplot
>
```



3.2 E2

```
> e2_TO = statepercent_exp2 %>% filter(State == "TO")
> e2_TO_aov = aov(data = e2_TO,
+                         Percent ~ AgeGroup*PrimeCondition +
+                        Error(Subject/PrimeCondition))
> summary(e2_TO_aov)
```

```
Error: Subject
          Df Sum Sq Mean Sq F value   Pr(>F)
```

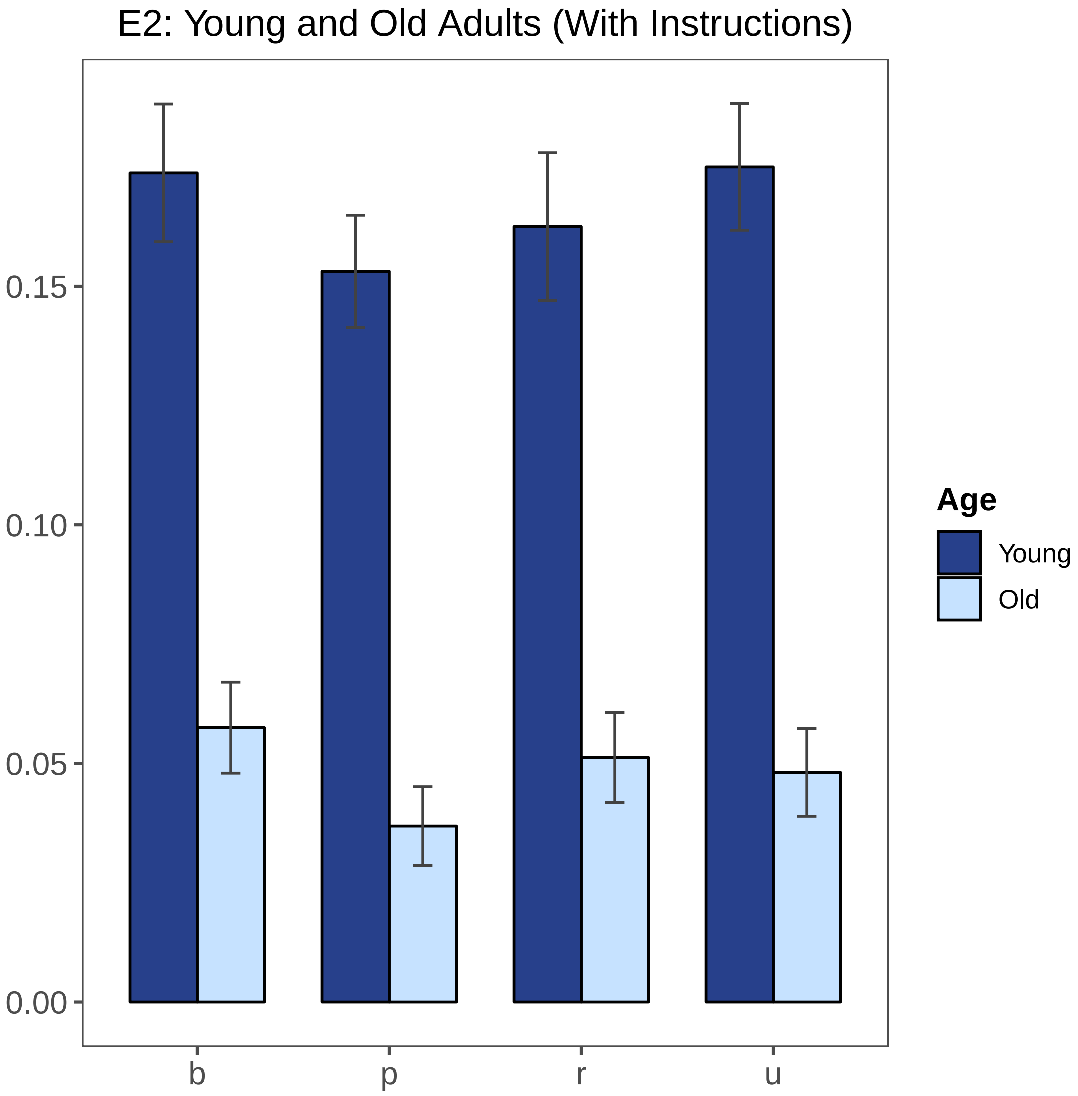
```
AgeGroup    1 0.8860  0.8860   71.19 6.92e-12 ***
Residuals 62 0.7716  0.0124
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Subject:PrimeCondition
                          Df  Sum Sq  Mean Sq F value Pr(>F)
PrimeCondition             3 0.01529 0.005097   3.024 0.0309 *
AgeGroup:PrimeCondition    3 0.00208 0.000693   0.411 0.7451
Residuals                186 0.31353 0.001686
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1
```

```
> options(contrasts = c('contr.sum', 'contr.poly'))
> library(lsmeans)
> library(multcomp)
> target_lsm = lsmeans::lsmeans(e2_TO_aov,
+                               c("AgeGroup","PrimeCondition"))
> prime_effect = cld(target_lsm, alpha = 0.05,
+                 adjust = "tukey", details = TRUE, by = "PrimeCondition")
> library(knitr)
> # x = prime_effect$comparisons
> # x[which(x$p.value < 0.05),]
```

3.2.1 plot

```
> exp2_statepercent= Rmisc::summarySE(statepercent_exp2,
+                         measurevar = "Percent",
+                         groupvars = c("State", "AgeGroup", "PrimeCondition"))
> exp2_statepercent$RetrievalState = ordered(as.factor(as.character(exp2_statepercent$St
> exp2_statepercent$Age = ordered(as.factor(as.character(exp2_statepercent$AgeGroup)), l
> exp2_statepercent = exp2_statepercent %>% filter(RetrievalState == "TO")
> library(ggplot2)
> library(ggthemes)
> e2_percentplot = exp2_statepercent %>%
+ ggplot(aes(x = PrimeCondition, y = Percent,
+            group = Age, fill = Age))+
+  geom_bar(stat = "identity", position = "dodge", width = 0.7,
+           color= "black")+
+   geom_errorbar(aes(ymin=Percent - se, ymax=Percent + se),
+              width=.2, color = "gray26",
+              position = position_dodge(0.7))+
+  theme_few()+
+   scale_fill_manual(values = c( "royalblue4", "slategray1"))+
+     xlab("") + ylab("") +
+   ggtitle("E2: Young and Old Adults (With Instructions)")  +
+    theme(axis.text = element_text(size = rel(1)),
```

```
+          axis.title = element_text(face = "bold", size = rel(1)),
+          legend.title = element_text(face = "bold", size = rel(1)),
+         plot.title = element_text(hjust = .5),
+                   axis.text.x = element_text(size = rel(1)),
+         strip.text.x = element_text(face = "bold", size = rel(1.4)))
> e2_percentplot
>
```



3.3 E3

```
> e3_TO = statepercent_exp2 %>% filter(State == "TO")
> e3_TO_aov = aov(data = e3_TO,
+                          Percent ~ PrimeCondition +
+                        Error(Subject/PrimeCondition))
> summary(e3_TO_aov)
```

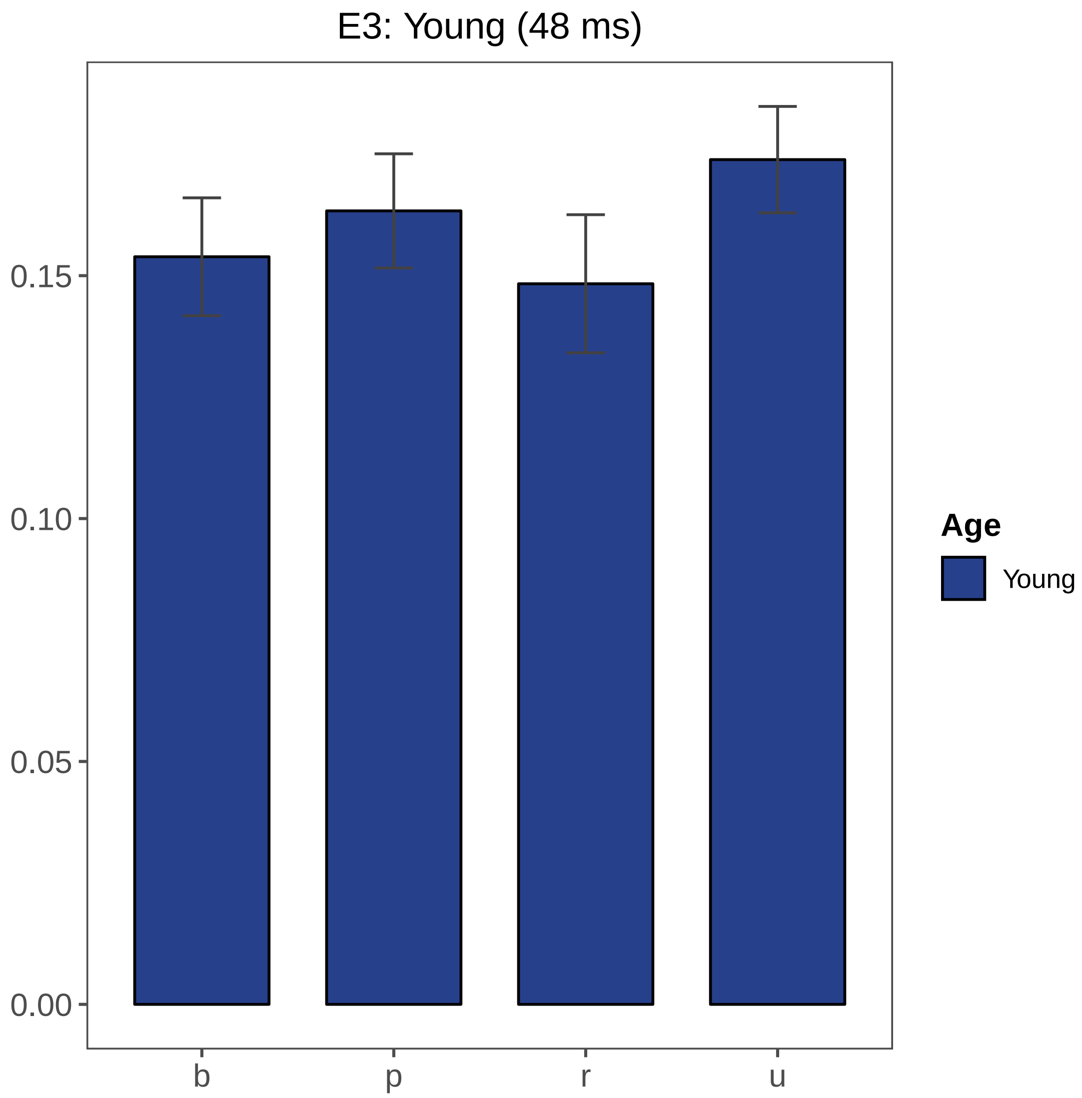
```
Error: Subject
          Df Sum Sq Mean Sq F value Pr(>F)
Residuals 63  1.658 0.02631

Error: Subject:PrimeCondition
                Df  Sum Sq  Mean Sq F value Pr(>F)
PrimeCondition   3 0.01529 0.005097   3.053 0.0297 *
Residuals      189 0.31561 0.001670
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1
```

```
> options(contrasts = c('contr.sum', 'contr.poly'))
> library(lsmeans)
> library(multcomp)
> target_lsm = lsmeans::lsmeans(e3_TO_aov,
+                                    c("PrimeCondition"))
> prime_effect = cld(target_lsm, alpha = 0.05,
+                 adjust = "tukey", details = TRUE)
> library(knitr)
> # x = prime_effect$comparisons
> # x[which(x$p.value < 0.05),]
```

3.3.1 plot

```
> exp3_statepercent= Rmisc::summarySE(statepercent_exp3,
+                        measurevar = "Percent",
+                        groupvars = c("State", "AgeGroup", "PrimeCondition"))
> exp3_statepercent$RetrievalState = ordered(as.factor(as.character(exp3_statepercent$St
> exp3_statepercent$Age = ordered(as.factor(as.character(exp3_statepercent$AgeGroup)), l
> exp3_statepercent = exp3_statepercent %>% filter(RetrievalState == "TO")
> library(ggplot2)
> library(ggthemes)
> e3_percentplot = exp3_statepercent %>%
+ ggplot(aes(x = PrimeCondition, y = Percent,
+            group = Age, fill = Age))+
+  geom_bar(stat = "identity", position = "dodge", width = 0.7,
+           color= "black")+
+   geom_errorbar(aes(ymin=Percent - se, ymax=Percent + se),
+              width=.2, color = "gray26",
+              position = position_dodge(0.7))+
+  theme_few()+
```

```
+   scale_fill_manual(values = c( "royalblue4", "slategray1"))+
+     xlab("") + ylab("") +
+   ggtitle("E3: Young (48 ms)")  +
+    theme(axis.text = element_text(size = rel(1)),
+           axis.title = element_text(face = "bold", size = rel(1)),
+           legend.title = element_text(face = "bold", size = rel(1)),
+          plot.title = element_text(hjust = .5),
+                   axis.text.x = element_text(size = rel(1)),
+          strip.text.x = element_text(face = "bold", size = rel(1.4)))
> e3_percentplot
>
```



4 Experiment 1: YA-OA No Instruction

```
> final_j$primefac = ordered(as.factor(as.character(final_j$PrimeCondition)), levels = c
> final_j$agefac = ordered(as.factor(as.character(final_j$AgeGroup)), levels = c("Young"
> exp1_target = subset(final_j, final_j$StudyNo == '2' | final_j$StudyNo == '4')
> exp1_mcq = subset(final_mcq, final_mcq$StudyNo == '2' | final_mcq$StudyNo == '4')
> exp1_state = subset(final_statedata, final_statedata$StudyNo == '2' |
+                                  final_statedata$StudyNo == '4')
> exp1_state_prime = subset(statedata_primetype_long, statedata_primetype_long$StudyNo =
+                                  statedata_primetype_long$StudyNo == '4')
> exp1_state_prime$PrimeCondition = as.factor(as.character(exp1_state_prime$PrimeConditi
> exp1_state_prime$State = as.factor(as.character(exp1_state_prime$State))
> exp1_state_prime$Subject = as.factor(as.character(exp1_state_prime$Subject))
>
```

Exp 1: Target Accuracy

```
> ### TARGET RETRIEVAL ACCURACY
>
> exp1_target_aov = aov(data = exp1_target, Accuracy ~ AgeGroup*PrimeCondition +
+                                Error (Subject/PrimeCondition))
> summary(exp1_target_aov)
```

```
Error: Subject
          Df Sum Sq Mean Sq F value Pr(>F)
AgeGroup   1  0.000 0.00020   0.003  0.957
Residuals 70  4.877 0.06966

Error: Subject:PrimeCondition
                         Df Sum Sq Mean Sq F value   Pr(>F)
PrimeCondition            3 0.7761 0.25871  21.765 2.59e-12 ***
AgeGroup:PrimeCondition   3 0.0117 0.00389   0.327    0.806
Residuals               210 2.4962 0.01189
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1
```

```
> options(contrasts = c('contr.sum', 'contr.poly'))
> library(lsmeans)
> library(multcomp)
> exp1_target_lsm = lsmeans::lsmeans(exp1_target_aov, c("AgeGroup", "PrimeCondition"))
> prime_effect = cld(exp1_target_lsm, alpha = 0.05,
+                adjust = "tukey", details = TRUE, by = c("AgeGroup"))
> library(knitr)
> kable(subset(prime_effect$comparisons,prime_effect$comparisons$p.value < 0.05 ))
```

```
|   |contrast                  |AgeGroup |  estimate|        SE|  df|  t.ratio|
p.value|
|:--|:-------------------------|:--------|---------:|---------:|---:|--------:|---------:
|4  |Phonological - Related    |Old      | 0.1366667| 0.0256977| 210| 5.318251| 0.0000016
|5  |Phonological - Unrelated  |Old      | 0.1366667| 0.0256977| 210| 5.318251| 0.0000016
|6  |Phonological - Both       |Old      | 0.0833333| 0.0256977| 210| 3.242836| 0.0074688
|10 |Phonological - Related    |Young    | 0.1255556| 0.0256977| 210| 4.885873| 0.0000121
|11 |Phonological - Unrelated  |Young    | 0.1088889| 0.0256977| 210| 4.237305| 0.0001974
|12 |Phonological - Both       |Young    | 0.0888889| 0.0256977| 210| 3.459025| 0.0036435
```

```
> ## specific t-tests
> target_p = exp1_target %>% filter(PrimeCondition == "Phonological")
> target_r = exp1_target %>% filter(PrimeCondition == "Related")
> target_b = exp1_target %>% filter(PrimeCondition == "Both")
> target_u = exp1_target %>% filter(PrimeCondition == "Unrelated")
> t.test(target_p$Accuracy, target_r$Accuracy, paired = TRUE)
```

```
        Paired t-test

data:  target_p$Accuracy and target_r$Accuracy
t = 7.0518, df = 71, p-value = 9.434e-10
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 0.09403883 0.16818339
sample estimates:
mean of the differences
              0.1311111
```

```
> t.test(target_p$Accuracy, target_b$Accuracy, paired = TRUE)
```

```
        Paired t-test

data:  target_p$Accuracy and target_b$Accuracy
t = 4.0628, df = 71, p-value = 0.0001235
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 0.04384895 0.12837327
sample estimates:
mean of the differences
             0.08611111
```

```
> t.test(target_p$Accuracy, target_u$Accuracy, paired = TRUE)
```

```
        Paired t-test

data:  target_p$Accuracy and target_u$Accuracy
```

```
t = 7.3454, df = 71, p-value = 2.72e-10
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 0.08944906 0.15610650
sample estimates:
mean of the differences
              0.1227778
```

```
> t.test(target_b$Accuracy, target_r$Accuracy, paired = TRUE)
```

```
        Paired t-test

data:  target_b$Accuracy and target_r$Accuracy
t = 2.8803, df = 71, p-value = 0.005249
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 0.01384772 0.07615228
sample estimates:
mean of the differences
                  0.045
```

```
> t.test(target_b$Accuracy, target_u$Accuracy, paired = TRUE)
```

```
        Paired t-test

data:  target_b$Accuracy and target_u$Accuracy
t = 2.233, df = 71, p-value = 0.02871
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 0.00392468 0.06940865
sample estimates:
mean of the differences
             0.03666667
```

```
> t.test(target_r$Accuracy, target_u$Accuracy, paired = TRUE)
```

```
        Paired t-test

data:  target_r$Accuracy and target_u$Accuracy
t = -0.43074, df = 71, p-value = 0.668
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -0.04690961  0.03024294
sample estimates:
mean of the differences
           -0.008333333
```

```
>
>
```

Exp 1: Multiple Choice

```
> ## MULTIPLE CHOICE ACCURACY
> library(dplyr)
> exp1_mcq_acc = group_by(exp1_mcq, Subject, PrimeType, AgeGroup) %>%
+     summarise_at(vars(MCQAcc), mean)
> exp1_mcq_acc_aov = aov(data = exp1_mcq_acc, MCQAcc ~ AgeGroup*PrimeType +
+                            Error(Subject/PrimeType))
> summary(exp1_mcq_acc_aov)
```

```
Error: Subject
          Df Sum Sq Mean Sq F value Pr(>F)
AgeGroup   1  0.045 0.04500    0.62  0.434
Residuals 70  5.084 0.07262

Error: Subject:PrimeType
                    Df Sum Sq Mean Sq F value   Pr(>F)
PrimeType            3 0.3792 0.12640   16.89 7.27e-10 ***
AgeGroup:PrimeType   3 0.0114 0.00381    0.51    0.676
Residuals          210 1.5718 0.00748
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1
```

```
> # ez::ezANOVA(data = exp1_mcq_acc, wid = .(Subject),
> #          dv = .(MCQAcc), within =.(PrimeType),
> #          between = .(AgeGroup))
>
>
> exp1_mcqacc_lsm = lsmeans::lsmeans(exp1_mcq_acc_aov, c("AgeGroup", "PrimeType"))
> prime_effect = cld(exp1_mcqacc_lsm, alpha = 0.05,
+                  adjust = "tukey", details = TRUE, by = c("AgeGroup"))
> kable(subset(prime_effect$comparisons, prime_effect$comparisons$p.value < 0.05))
```

```
|   |contrast |AgeGroup |  estimate|         SE|  df|  t.ratio|   p.value|
|:--|:--------|:--------|---------:|----------:|---:|--------:|---------:|
|2  |u - r    |Old      | 0.0588889| 0.0203914| 210| 2.887931| 0.0220951|
|4  |p - r    |Old      | 0.0777778| 0.0203914| 210| 3.814248| 0.0010248|
|5  |p - b    |Old      | 0.0622222| 0.0203914| 210| 3.051398| 0.0136071|
|8  |u - r    |Young    | 0.0855556| 0.0203914| 210| 4.195673| 0.0002336|
|10 |p - r    |Young    | 0.1088889| 0.0203914| 210| 5.339947| 0.0000014|
|11 |p - b    |Young    | 0.0644444| 0.0203914| 210| 3.160377| 0.0097114|
```

```
> ## SPECIFIC T TESTS
>
> e1_mcq_p = exp1_mcq_acc %>% filter(PrimeType == "p")
> e1_mcq_r = exp1_mcq_acc %>% filter(PrimeType == "r")
> e1_mcq_b = exp1_mcq_acc %>% filter(PrimeType == "b")
> e1_mcq_u = exp1_mcq_acc %>% filter(PrimeType == "u")
> t.test(e1_mcq_p$MCQAcc, e1_mcq_r$MCQAcc, paired = TRUE)
```

```
        Paired t-test

data:  e1_mcq_p$MCQAcc and e1_mcq_r$MCQAcc
t = 5.8474, df = 71, p-value = 1.401e-07
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 0.06150678 0.12515989
sample estimates:
mean of the differences
             0.09333333
```

```
> t.test(e1_mcq_p$MCQAcc, e1_mcq_b$MCQAcc, paired = TRUE)
```

```
        Paired t-test

data:  e1_mcq_p$MCQAcc and e1_mcq_b$MCQAcc
t = 4.1686, df = 71, p-value = 8.53e-05
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 0.03303921 0.09362746
sample estimates:
mean of the differences
             0.06333333
```

```
> t.test(e1_mcq_p$MCQAcc, e1_mcq_u$MCQAcc)
```

```
        Welch Two Sample t-test

data:  e1_mcq_p$MCQAcc and e1_mcq_u$MCQAcc
t = 0.85891, df = 136.93, p-value = 0.3919
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -0.02749250  0.06971473
sample estimates:
mean of x mean of y
0.7350000 0.7138889
```

```
> t.test(e1_mcq_r$MCQAcc, e1_mcq_u$MCQAcc, paired = TRUE)
```

```
        Paired t-test

data:  e1_mcq_r$MCQAcc and e1_mcq_u$MCQAcc
t = -4.8541, df = 71, p-value = 6.946e-06
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -0.10188914 -0.04255531
sample estimates:
mean of the differences
            -0.07222222
```

```
> ## MULTIPLE CHOICE ERRORS
>
> ## before we do ANOVA, we need to replace NAs with 0.
>
> for (i in 1: nrow(exp1_mcq)){
+    if(is.na(exp1_mcq[i,7])){
+      exp1_mcq[i,7] = 0
+    }
+
+ }
> exp1_mcq_aov = aov(data = exp1_mcq, Proportion ~ AgeGroup*PrimeType*ChosenPrime +
+                                  Error(Subject/(PrimeType*ChosenPrime)))
> summary(exp1_mcq_aov)
```

```
Error: Subject
          Df Sum Sq Mean Sq F value   Pr(>F)
AgeGroup   1 0.1648 0.16480   17.15 9.51e-05 ***
Residuals 70 0.6727 0.00961
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Subject:PrimeType
                    Df Sum Sq  Mean Sq F value Pr(>F)
PrimeType            3 0.0099 0.003296   0.670  0.572
AgeGroup:PrimeType   3 0.0228 0.007595   1.543  0.204
Residuals          210 1.0338 0.004923

Error: Subject:ChosenPrime
                      Df Sum Sq Mean Sq F value Pr(>F)
ChosenPrime            3  50.51  16.836 543.313 <2e-16 ***
AgeGroup:ChosenPrime   3   0.31   0.104   3.359 0.0198 *
Residuals            210   6.51   0.031
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Subject:PrimeType:ChosenPrime
```

```
                               Df  Sum Sq  Mean Sq  F value    Pr(>F)
PrimeType:ChosenPrime           9   3.150   0.3500    8.704 2.23e-12 ***
AgeGroup:PrimeType:ChosenPrime  9   0.461   0.0512    1.273    0.248
Residuals                     630  25.331   0.0402
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1
```

```
> library(ez)
> # ezANOVA(data = exp1_mcq, wid = .(Subject),
> #         dv = .(Proportion), within =.(PrimeType, ChosenPrime),
> #         between = .(AgeGroup))
>
> options(contrasts = c('contr.sum', 'contr.poly'))
> exp1_errors_lsm = lsmeans::lsmeans(exp1_mcq_aov, c("AgeGroup", "PrimeType", "ChosenPri
> prime_effect = cld(exp1_errors_lsm, alpha = 0.05,
+                    adjust = "tukey", details = TRUE, by = c("AgeGroup", "PrimeType"))
> kable(subset(prime_effect$comparisons, prime_effect$comparisons$p.value < 0.05))
```

```
|   |contrast |AgeGroup |PrimeType |  estimate|        SE|       df|   t.ratio|
p.value|
|:--|:--------|:--------|:---------|---------:|---------:|--------:|---------:|---------
|2  |r - u    |Old      |b         | 0.3946738| 0.0458883| 830.7801|  8.600747| 0.000000
|3  |r - p    |Old      |b         | 0.3744043| 0.0458883| 830.7801|  8.159034| 0.000000
|4  |b - u    |Old      |b         | 0.4507613| 0.0458883| 830.7801|  9.823009| 0.000000
|5  |b - p    |Old      |b         | 0.4304918| 0.0458883| 830.7801|  9.381296| 0.000000
|8  |r - u    |Old      |p         | 0.3505613| 0.0458883| 830.7801|  7.639446| 0.000000
|9  |r - p    |Old      |p         | 0.2691239| 0.0458883| 830.7801|  5.864759| 0.000000
|10 |b - u    |Old      |p         | 0.4614647| 0.0458883| 830.7801| 10.056257| 0.000000
|11 |b - p    |Old      |p         | 0.3800273| 0.0458883| 830.7801|  8.281570| 0.000000
|14 |r - u    |Old      |r         | 0.2237887| 0.0458883| 830.7801|  4.876812| 0.000007
|15 |r - p    |Old      |r         | 0.2191375| 0.0458883| 830.7801|  4.775453| 0.000012
|16 |b - u    |Old      |r         | 0.6648968| 0.0458883| 830.7801| 14.489458| 0.000000
|17 |b - p    |Old      |r         | 0.6602456| 0.0458883| 830.7801| 14.388098| 0.000000
|18 |b - r    |Old      |r         | 0.4411081| 0.0458883| 830.7801|  9.612646| 0.000000
|20 |r - u    |Old      |u         | 0.2966159| 0.0458883| 830.7801|  6.463865| 0.000000
|21 |r - p    |Old      |u         | 0.2461617| 0.0458883| 830.7801|  5.364367| 0.000000
|22 |b - u    |Old      |u         | 0.4209759| 0.0458883| 830.7801|  9.173923| 0.000000
|23 |b - p    |Old      |u         | 0.3705217| 0.0458883| 830.7801|  8.074424| 0.000000
|24 |b - r    |Old      |u         | 0.1243600| 0.0458883| 830.7801|  2.710058| 0.034592
|26 |r - u    |Young    |b         | 0.4198547| 0.0458883| 830.7801|  9.149489| 0.000000
|27 |r - p    |Young    |b         | 0.3813881| 0.0458883| 830.7801|  8.311224| 0.000000
|28 |b - u    |Young    |b         | 0.5026215| 0.0458883| 830.7801| 10.953148| 0.000000
|29 |b - p    |Young    |b         | 0.4641549| 0.0458883| 830.7801| 10.114882| 0.000000
|32 |r - u    |Young    |p         | 0.3784371| 0.0458883| 830.7801|  8.246916| 0.000000
|33 |r - p    |Young    |p         | 0.3354865| 0.0458883| 830.7801|  7.310935| 0.000000
|34 |b - u    |Young    |p         | 0.4690886| 0.0458883| 830.7801| 10.222396| 0.000000
|35 |b - p    |Young    |p         | 0.4261380| 0.0458883| 830.7801|  9.286416| 0.000000
|38 |r - u    |Young    |r         | 0.3487971| 0.0458883| 830.7801|  7.601000| 0.000000
```

```
|39 |r - p     |Young     |r          | 0.3464828| 0.0458883| 830.7801|  7.550567| 0.000000
|40 |b - u     |Young     |r          | 0.5527607| 0.0458883| 830.7801| 12.045784| 0.000000
|41 |b - p     |Young     |r          | 0.5504465| 0.0458883| 830.7801| 11.995351| 0.000000
|42 |b - r     |Young     |r          | 0.2039636| 0.0458883| 830.7801|  4.444784| 0.000059
|44 |r - u     |Young     |u          | 0.3687962| 0.0458883| 830.7801|  8.036821| 0.000000
|45 |r - p     |Young     |u          | 0.3671763| 0.0458883| 830.7801|  8.001522| 0.000000
|46 |b - u     |Young     |u          | 0.4966483| 0.0458883| 830.7801| 10.822980| 0.000000
|47 |b - p     |Young     |u          | 0.4950285| 0.0458883| 830.7801| 10.787681| 0.000000
|48 |b - r     |Young     |u          | 0.1278522| 0.0458883| 830.7801|  2.786159| 0.027895
```

```
> ## SPECIFIC OLD COMPARISION T TEST
>
> e1mcq_old_r = exp1_mcq %>% filter(AgeGroup == "Old" & PrimeType == "r")
> e1mcq_old_r_r = e1mcq_old_r %>% filter(ChosenPrime == "r")
> e1mcq_old_r_p = e1mcq_old_r %>% filter(ChosenPrime == "p")
> e1mcq_old_r_b = e1mcq_old_r %>% filter(ChosenPrime == "b")
> e1mcq_old_r_u = e1mcq_old_r %>% filter(ChosenPrime == "u")
> t.test(e1mcq_old_r_r$Proportion, e1mcq_old_r_p$Proportion, paired = TRUE)
```

```
        Paired t-test

data:  e1mcq_old_r_r$Proportion and e1mcq_old_r_p$Proportion
t = 18.837, df = 35, p-value < 2.2e-16
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 0.5890888 0.7314023
sample estimates:
mean of the differences
              0.6602456
```

```
> t.test(e1mcq_old_r_r$Proportion, e1mcq_old_r_b$Proportion, paired = TRUE)
```

```
        Paired t-test

data:  e1mcq_old_r_r$Proportion and e1mcq_old_r_b$Proportion
t = 7.7643, df = 35, p-value = 4.055e-09
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 0.3257728 0.5564434
sample estimates:
mean of the differences
              0.4411081
```

```
> t.test(e1mcq_old_r_r$Proportion, e1mcq_old_r_u$Proportion, paired = TRUE)
```

```
        Paired t-test
```

```
data:  e1mcq_old_r_r$Proportion and e1mcq_old_r_u$Proportion
t = 19.02, df = 35, p-value < 2.2e-16
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 0.5939301 0.7358636
sample estimates:
mean of the differences
              0.6648968
```

```
> e1mcq_young_r = exp1_mcq %>% filter(AgeGroup == "Young" & PrimeType == "r")
> e1mcq_young_r_r = e1mcq_young_r %>% filter(ChosenPrime == "r")
> ## comparing young and old
> t.test(e1mcq_young_r_r$Proportion, e1mcq_old_r_r$Proportion)
```

```
        Welch Two Sample t-test

data:  e1mcq_young_r_r$Proportion and e1mcq_old_r_r$Proportion
t = -1.6868, df = 68.083, p-value = 0.09621
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -0.20057038  0.01680856
sample estimates:
mean of x mean of y
0.5744779 0.6663588
```

```
>
```

Exp 1: State Data

```
> ## just state
> exp1_state_aov = aov(data = exp1_state, Trials ~ AgeGroup*State +
+                                          Error(Subject/State))
> summary(exp1_state_aov)
```

```
Error: Subject
          Df    Sum Sq   Mean Sq F value Pr(>F)
AgeGroup   1 4.450e-27 4.454e-27   6.776 0.0113 *
Residuals 70 4.602e-26 6.570e-28
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Subject:State
                Df Sum Sq Mean Sq F value   Pr(>F)
State            3  50878   16959   62.62  < 2e-16 ***
AgeGroup:State   3   8697    2899   10.70 1.41e-06 ***
Residuals      210  56874     271
```

```
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1
```

```
> options(contrasts = c('contr.sum', 'contr.poly'))
> exp1_state_lsm = lsmeans::lsmeans(exp1_state_aov, c("AgeGroup", "State"))
> prime_effect = cld(exp1_state_lsm, alpha = 0.05,
+                 adjust = "tukey", details = TRUE, by = c("State"))
> kable(subset(prime_effect$comparisons, prime_effect$comparisons$p.value < 0.05))
```

```
|   |contrast     |State     | estimate|       SE|  df|  t.ratio|  p.value|
|:--|:------------|:---------|--------:|--------:|---:|--------:|--------:|
|1  |Old - Young  |dontknow  | 13.33333| 3.359241| 210| 3.969150| 9.9e-05|
|3  |Old - Young  |other     | 16.52778| 3.359241| 210| 4.920092| 1.7e-06|
```

```
> ##state by prime
> exp1_stateprime_aov = aov(data = exp1_state_prime, Trials ~ AgeGroup*PrimeCondition*St
+                                    Error(Subject/(PrimeCondition*State)))
> summary(exp1_stateprime_aov)
```

```
Error: Subject
          Df    Sum Sq   Mean Sq F value   Pr(>F)
AgeGroup   1 1.543e-26 1.543e-26   16.12 0.000148 ***
Residuals 70 6.701e-26 9.570e-28
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Subject:PrimeCondition
                        Df    Sum Sq   Mean Sq F value Pr(>F)
PrimeCondition           3 3.560e-27 1.186e-27   2.140 0.0963 .
AgeGroup:PrimeCondition  3 3.520e-27 1.174e-27   2.117 0.0991 .
Residuals              210 1.164e-25 5.544e-28
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Subject:State
                Df Sum Sq Mean Sq F value   Pr(>F)
State            3  12719    4240   62.62  < 2e-16 ***
AgeGroup:State   3   2174     725   10.70 1.41e-06 ***
Residuals      210  14218      68
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Subject:PrimeCondition:State
                              Df Sum Sq Mean Sq F value   Pr(>F)
PrimeCondition:State           9    613   68.15   9.316 2.38e-13 ***
AgeGroup:PrimeCondition:State  9     36    4.04   0.552    0.836
Residuals                    630   4608    7.31
---
```

```
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1
```

```
> library(ez)
> # ezANOVA(data = exp1_state_prime, wid = .(Subject),
> #         dv = .(Trials), within =.(PrimeCondition, State),
> #         between = .(AgeGroup))
>
> options(contrasts = c('contr.sum', 'contr.poly'))
> exp1_state_lsm = lsmeans::lsmeans(exp1_stateprime_aov, c("AgeGroup","PrimeCondition",
> prime_effect = cld(exp1_state_lsm, alpha = 0.05,
+                    adjust = "tukey", details = TRUE, by = c("PrimeCondition", "AgeGroup")
> kable(subset(prime_effect$comparisons, prime_effect$comparisons$p.value < 0.05))
```

```
|   |contrast          |PrimeCondition |AgeGroup |  estimate|       SE|        df|
t.ratio|   p.value|
|:--|:-----------------|:--------------|:--------|---------:|--------:|---------:|---------
|2  |dontknow - other |b              |Old      |  8.833333| 1.115866| 355.7286|
7.916123| 0.0000000|
|3  |dontknow - TOT   |b              |Old      |  7.722222| 1.115866| 355.7286|
6.920384| 0.0000000|
|4  |know - other     |b              |Old      | 10.833333| 1.115866| 355.7286|
9.708452| 0.0000000|
|5  |know - TOT       |b              |Old      |  9.722222| 1.115866| 355.7286|
8.712714| 0.0000000|
|8  |dontknow - other |b              |Young    |  3.916667| 1.115866| 355.7286|
3.509979| 0.0028337|
|10 |know - other     |b              |Young    |  7.527778| 1.115866| 355.7286|
6.746130| 0.0000000|
|11 |know - TOT       |b              |Young    |  5.194444| 1.115866| 355.7286|
4.655078| 0.0000271|
|12 |know - dontknow  |b              |Young    |  3.611111| 1.115866| 355.7286|
3.236151| 0.0072208|
|14 |dontknow - other |p              |Old      |  8.277778| 1.115866| 355.7286|
7.418253| 0.0000000|
|15 |dontknow - TOT   |p              |Old      |  7.861111| 1.115866| 355.7286|
7.044851| 0.0000000|
|16 |know - other     |p              |Old      | 11.194444| 1.115866| 355.7286| 10.0320
|17 |know - TOT       |p              |Old      | 10.777778| 1.115866| 355.7286|
9.658665| 0.0000000|
|18 |know - dontknow  |p              |Old      |  2.916667| 1.115866| 355.7286|
2.613814| 0.0458882|
|20 |dontknow - other |p              |Young    |  3.138889| 1.115866| 355.7286|
2.812962| 0.0265119|
|22 |know - other     |p              |Young    |  8.250000| 1.115866| 355.7286|
7.393360| 0.0000000|
|23 |know - TOT       |p              |Young    |  6.194444| 1.115866| 355.7286|
5.551243| 0.0000003|
```

```
|24 |know - dontknow  |p              |Young    |  5.111111| 1.115866| 355.7286|
4.580398| 0.0000380|
|26 |dontknow - other |r              |Old      |  7.555556| 1.115866| 355.7286|
6.771023| 0.0000000|
|27 |dontknow - TOT   |r              |Old      |  6.805556| 1.115866| 355.7286|
6.098900| 0.0000000|
|28 |know - other     |r              |Old      |  9.694444| 1.115866| 355.7286|
8.687820| 0.0000000|
|29 |know - TOT       |r              |Old      |  8.944444| 1.115866| 355.7286|
8.015697| 0.0000000|
|31 |TOT - other      |r              |Young    |  3.166667| 1.115866| 355.7286|
2.837855| 0.0246829|
|32 |dontknow - other |r              |Young    |  3.444444| 1.115866| 355.7286|
3.086790| 0.0116638|
|34 |know - other     |r              |Young    |  6.944444| 1.115866| 355.7286|
6.223367| 0.0000000|
|35 |know - TOT       |r              |Young    |  3.777778| 1.115866| 355.7286|
3.385512| 0.0043739|
|36 |know - dontknow  |r              |Young    |  3.500000| 1.115866| 355.7286|
3.136577| 0.0099652|
|38 |dontknow - other |u              |Old      |  7.777778| 1.115866| 355.7286|
6.970171| 0.0000000|
|39 |dontknow - TOT   |u              |Old      |  5.861111| 1.115866| 355.7286|
5.252522| 0.0000015|
|40 |know - other     |u              |Old      | 10.194444| 1.115866| 355.7286|
9.135903| 0.0000000|
|41 |know - TOT       |u              |Old      |  8.277778| 1.115866| 355.7286|
7.418253| 0.0000000|
|44 |dontknow - other |u              |Young    |  4.750000| 1.115866| 355.7286|
4.256783| 0.0001555|
|46 |know - other     |u              |Young    |  5.222222| 1.115866| 355.7286|
4.679972| 0.0000242|
```

```
> ### INDIVIDUAL T-TESTS FOR AGExSTATE interaction
>
> e1_young_dk = exp1_state %>% filter(AgeGroup == "Young" & State == "dontknow")
> e1_old_dk = exp1_state %>% filter(AgeGroup == "Old" & State == "dontknow")
> t.test(e1_old_dk$Trials, e1_young_dk$Trials, var.equal = TRUE)
```

```
        Two Sample t-test

data:  e1_old_dk$Trials and e1_young_dk$Trials
t = 3.0688, df = 70, p-value = 0.003057
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
  4.667831 21.998836
sample estimates:
mean of x mean of y
```

```
 40.22222  26.88889
```

```
> e1_young_other = exp1_state %>% filter(AgeGroup == "Young" & State == "other")
> e1_old_other = exp1_state %>% filter(AgeGroup == "Old" & State == "other")
> t.test(e1_young_other$Trials, e1_old_other$Trials)
```

```
	Welch Two Sample t-test

data:  e1_young_other$Trials and e1_old_other$Trials
t = 7.2009, df = 57.112, p-value = 1.457e-09
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 11.93183 21.12373
sample estimates:
mean of x mean of y
21.888889  5.361111
```

5 Experiment 2: YA-OA Not The Prime

```
> exp2_target = subset(final_j, final_j$StudyNo == '5' | final_j$StudyNo == '6')
> exp2_mcq = subset(final_mcq, final_mcq$StudyNo == '5' | final_mcq$StudyNo == '6')
> exp2_state = subset(final_statedata, final_statedata$StudyNo == '5' |
+                                     final_statedata$StudyNo == '6')
> exp2_state_prime = subset(statedata_primetype_long, statedata_primetype_long$StudyNo =
+                                     statedata_primetype_long$StudyNo == '6')
> exp2_state_prime$PrimeCondition = as.factor(as.character(exp2_state_prime$PrimeConditi
> exp2_state_prime$State = as.factor(as.character(exp2_state_prime$State))
> exp2_state_prime$Subject = as.factor(as.character(exp2_state_prime$Subject))
>
```

Exp 2: Target Accuracy

```
> ### TARGET RETRIEVAL ACCURACY
>
> exp2_target_aov = aov(data = exp2_target, Accuracy ~ AgeGroup*PrimeCondition +
+                                   Error (Subject/PrimeCondition))
> summary(exp2_target_aov)
```

```
Error: Subject
          Df Sum Sq Mean Sq F value Pr(>F)
AgeGroup   1  0.146 0.14631   2.324  0.132
Residuals 62  3.903 0.06295

Error: Subject:PrimeCondition
                         Df Sum Sq Mean Sq F value   Pr(>F)
```

```
PrimeCondition              3 0.3279 0.10929   8.844 1.65e-05 ***
AgeGroup:PrimeCondition     3 0.0580 0.01932   1.564      0.2
Residuals                 186 2.2986 0.01236
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1
```

```
> library(ez)
> # ezANOVA(data = exp2_target, wid = .(Subject),
> #         dv = .(Accuracy), within =.(PrimeCondition),
> #         between = .(AgeGroup))
>
> options(contrasts = c('contr.sum', 'contr.poly'))
> library(lsmeans)
> library(multcomp)
> exp2_target_lsm = lsmeans::lsmeans(exp2_target_aov, c("AgeGroup", "PrimeCondition"))
> prime_effect = cld(exp2_target_lsm, alpha = 0.05,
+                    adjust = "tukey", details = TRUE, by = c("AgeGroup"))
> kable(subset(prime_effect$comparisons,prime_effect$comparisons$p.value < 1 ))
```

```
|   |contrast                  |AgeGroup | estimate|        SE|  df|   t.ratio|
p.value|
|:--|:-------------------------|:--------|--------:|---------:|---:|---------:|---------:
|1  |Unrelated - Related       |Old      |  0.00750| 0.0277915| 186| 0.2698669| 0.9931058
|2  |Both - Related            |Old      |  0.02875| 0.0277915| 186| 1.0344897| 0.7294303
|3  |Both - Unrelated          |Old      |  0.02125| 0.0277915| 186| 0.7646228| 0.8702573
|4  |Phonological - Related    |Old      |  0.06375| 0.0277915| 186| 2.2938684| 0.1031449
|5  |Phonological - Unrelated  |Old      |  0.05625| 0.0277915| 186| 2.0240015| 0.1828861
|6  |Phonological - Both       |Old      |  0.03500| 0.0277915| 186| 1.2593787| 0.5899313
|7  |Unrelated - Related       |Young    |  0.05000| 0.0277915| 186| 1.7991125| 0.2770324
|8  |Both - Related            |Young    |  0.05000| 0.0277915| 186| 1.7991125| 0.2770324
|10 |Phonological - Related    |Young    |  0.13625| 0.0277915| 186| 4.9025814| 0.0000122
|11 |Phonological - Unrelated  |Young    |  0.08625| 0.0277915| 186| 3.1034690| 0.0117671
|12 |Phonological - Both       |Young    |  0.08625| 0.0277915| 186| 3.1034690| 0.0117671
```

```
> ## specific t-tests
> target_p = exp2_target %>% filter(PrimeCondition == "Phonological")
> target_r = exp2_target %>% filter(PrimeCondition == "Related")
> target_b = exp2_target %>% filter(PrimeCondition == "Both")
> target_u = exp2_target %>% filter(PrimeCondition == "Unrelated")
> t.test(target_p$Accuracy, target_r$Accuracy, paired = TRUE)
```

```
        Paired t-test

data:  target_p$Accuracy and target_r$Accuracy
t = 3.8169, df = 63, p-value = 0.0003109
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 0.03573319 0.11426681
```

```
sample estimates:
mean of the differences
                  0.075
```

```
> t.test(target_p$Accuracy, target_b$Accuracy, paired = TRUE)
```

```
        Paired t-test

data:  target_p$Accuracy and target_b$Accuracy
t = 2.6942, df = 63, p-value = 0.009033
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 0.01565821 0.10559179
sample estimates:
mean of the differences
               0.060625
```

```
> t.test(target_p$Accuracy, target_u$Accuracy, paired = TRUE)
```

```
        Paired t-test

data:  target_p$Accuracy and target_u$Accuracy
t = 4.6462, df = 63, p-value = 1.772e-05
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 0.0548529 0.1376471
sample estimates:
mean of the differences
                0.09625
```

```
> t.test(target_b$Accuracy, target_u$Accuracy, paired = TRUE)
```

```
        Paired t-test

data:  target_b$Accuracy and target_u$Accuracy
t = 2.2178, df = 63, p-value = 0.03018
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 0.003525062 0.067724938
sample estimates:
mean of the differences
               0.035625
```

```
> t.test(target_b$Accuracy, target_r$Accuracy, paired = TRUE)
```

```
        Paired t-test

data:  target_b$Accuracy and target_r$Accuracy
t = 0.8146, df = 63, p-value = 0.4184
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -0.02088892  0.04963892
sample estimates:
mean of the differences
               0.014375
```

```
> t.test(target_r$Accuracy, target_u$Accuracy, paired = TRUE)
```

```
        Paired t-test

data:  target_r$Accuracy and target_u$Accuracy
t = 1.0053, df = 63, p-value = 0.3186
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -0.02099024  0.06349024
sample estimates:
mean of the differences
                0.02125
```

```
>
>
```

Exp 2: Multiple Choice

```
> ## MULTIPLE CHOICE ACCURACY
> library(dplyr)
> exp2_mcq_acc = group_by(exp2_mcq, Subject, PrimeType, AgeGroup) %>%
+     summarise_at(vars(MCQAcc), mean)
> exp2_mcq_acc_aov = aov(data = exp2_mcq_acc, MCQAcc ~ AgeGroup*PrimeType +
+                              Error(Subject/PrimeType))
> summary(exp2_mcq_acc_aov)
```

```
Error: Subject
          Df Sum Sq Mean Sq F value Pr(>F)
AgeGroup   1  0.339  0.3393    4.89 0.0307 *
Residuals 62  4.302  0.0694
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Subject:PrimeType
                    Df Sum Sq Mean Sq F value  Pr(>F)
```

```
PrimeType              3 0.1183 0.03944   5.414 0.00136 **
AgeGroup:PrimeType     3 0.0726 0.02421   3.323 0.02095 *
Residuals            186 1.3551 0.00729
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1
```

```
> ## SPECIFIC T TESTS
>
> e2_mcq_p = exp2_mcq_acc %>% filter(PrimeType == "p")
> e2_mcq_r = exp2_mcq_acc %>% filter(PrimeType == "r")
> e2_mcq_b = exp2_mcq_acc %>% filter(PrimeType == "b")
> e2_mcq_u = exp2_mcq_acc %>% filter(PrimeType == "u")
> e2mcq_y_p = e2_mcq_p %>% filter(AgeGroup == "Young")
> e2mcq_o_p = e2_mcq_p %>% filter(AgeGroup == "Old")
> t.test(e2mcq_y_p$MCQAcc, e2mcq_o_p$MCQAcc)
```

```
        Welch Two Sample t-test

data:  e2mcq_y_p$MCQAcc and e2mcq_o_p$MCQAcc
t = 2.7587, df = 57.666, p-value = 0.007763
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 0.02880191 0.18119809
sample estimates:
mean of x mean of y
  0.77875   0.67375
```

```
> e2mcq_y_b = e2_mcq_b %>% filter(AgeGroup == "Young")
> e2mcq_o_b = e2_mcq_b %>% filter(AgeGroup == "Old")
> t.test(e2mcq_y_b$MCQAcc, e2mcq_o_b$MCQAcc)
```

```
        Welch Two Sample t-test

data:  e2mcq_y_b$MCQAcc and e2mcq_o_b$MCQAcc
t = 2.6633, df = 52.43, p-value = 0.01025
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 0.02312916 0.16437084
sample estimates:
mean of x mean of y
  0.78000   0.68625
```

```
> e2mcq_y_r = e2_mcq_r %>% filter(AgeGroup == "Young")
> e2mcq_o_r = e2_mcq_r %>% filter(AgeGroup == "Old")
> t.test(e2mcq_y_r$MCQAcc, e2mcq_o_r$MCQAcc)
```

```
        Welch Two Sample t-test

data:  e2mcq_y_r$MCQAcc and e2mcq_o_r$MCQAcc
t = 1.9968, df = 59.366, p-value = 0.05044
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -0.0001485681  0.1501485681
sample estimates:
mean of x mean of y
  0.74625   0.67125
```

```
> # ezANOVA(data = exp2_mcq_acc, wid = .(Subject),
> #          dv = .(MCQAcc), within =.(PrimeType),
> #          between = .(AgeGroup))
>
>
> exp2_mcqacc_lsm = lsmeans::lsmeans(exp2_mcq_acc_aov, c("AgeGroup", "PrimeType"))
> prime_effect = cld(exp2_mcqacc_lsm, alpha = 0.05,
+                    adjust = "tukey", details = TRUE, by = c("PrimeType"))
> kable(subset(prime_effect$comparisons, prime_effect$comparisons$p.value < 0.1))
```

```
|contrast    |PrimeType | estimate|        SE|       df|  t.ratio|   p.value|
|:-----------|:---------|--------:|---------:|--------:|--------:|---------:|
|Young - Old |b         |  0.09375| 0.0377587| 103.7754| 2.482873| 0.0146353|
|Young - Old |p         |  0.10500| 0.0377587| 103.7754| 2.780817| 0.0064404|
|Young - Old |r         |  0.07500| 0.0377587| 103.7754| 1.986298| 0.0496371|
```

```
> ## MULTIPLE CHOICE ERRORS
>
> ## before we do ANOVA, we need to replace NAs with 0.
>
> for (i in 1: nrow(exp2_mcq)){
+    if(is.na(exp2_mcq[i,7])){
+      exp2_mcq[i,7] = 0
+    }
+
+ }
> exp2_mcq_aov = aov(data = exp2_mcq, Proportion ~ AgeGroup*PrimeType*ChosenPrime +
+                               Error(Subject/(PrimeType*ChosenPrime)))
> summary(exp2_mcq_aov)
```

```
Error: Subject
          Df Sum Sq Mean Sq F value   Pr(>F)
AgeGroup   1 0.1068 0.10684   27.79 1.82e-06 ***
Residuals 62 0.2384 0.00384
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1
```

```
Error: Subject:PrimeType
                    Df Sum Sq  Mean Sq F value Pr(>F)
PrimeType            3 0.0107 0.003571   1.134  0.337
AgeGroup:PrimeType   3 0.0100 0.003322   1.055  0.369
Residuals          186 0.5856 0.003148

Error: Subject:ChosenPrime
                      Df Sum Sq Mean Sq F value Pr(>F)
ChosenPrime            3  48.69  16.231 549.806 <2e-16 ***
AgeGroup:ChosenPrime   3   0.20   0.065   2.204 0.0891 .
Residuals            186   5.49   0.030
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Subject:PrimeType:ChosenPrime
                                Df Sum Sq Mean Sq F value   Pr(>F)
PrimeType:ChosenPrime            9  0.317 0.03524   0.752    0.661
AgeGroup:PrimeType:ChosenPrime   9  2.514 0.27931   5.961 5.51e-08 ***
Residuals                      558 26.145 0.04686
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1
```

```
> library(ez)
> # ezANOVA(data = exp2_mcq, wid = .(Subject),
> #         dv = .(Proportion), within =.(PrimeType, ChosenPrime),
> #         between = .(AgeGroup))
>
> options(contrasts = c('contr.sum', 'contr.poly'))
> exp2_errors_lsm = lsmeans::lsmeans(exp2_mcq_aov, c("AgeGroup", "PrimeType", "ChosenPri
> prime_effect = cld(exp2_errors_lsm, alpha = 0.05,
+                 adjust = "tukey", details = TRUE, by = c("PrimeType", "ChosenPrime"))
> kable(subset(prime_effect$comparisons, prime_effect$comparisons$p.value < 0.05))
```

```
|   |contrast     |PrimeType |ChosenPrime |  estimate|        SE|       df|  t.ratio|
p.value|
|:--|:-----------|:---------|:-----------|---------:|---------:|--------:|--------:|----
|1  |Old - Young |b         |b           | 0.1390686| 0.0452231| 758.0838| 3.075170| 0.0
|3  |Old - Young |b         |r           | 0.1790249| 0.0452231| 758.0838| 3.958708| 0.0
|9  |Old - Young |r         |b           | 0.2871214| 0.0452231| 758.0838| 6.349003| 0.0
|11 |Old - Young |r         |r           | 0.1757002| 0.0452231| 758.0838| 3.885190| 0.0
```

```
> ## SPECIFIC OLD COMPARISION T TEST
>
> e2mcq_old_r = exp2_mcq %>% filter(AgeGroup == "Old" & PrimeType == "r")
> e2mcq_young_r = exp2_mcq %>% filter(AgeGroup == "Young" & PrimeType == "r")
> e2mcq_old_r_r = e2mcq_old_r %>% filter(ChosenPrime == "r")
> e2mcq_young_r_r = e2mcq_young_r %>% filter(ChosenPrime == "r")
```

```
> ## comparing young and old
> t.test(e2mcq_young_r_r$Proportion, e2mcq_old_r_r$Proportion)
```

```
        Welch Two Sample t-test

data:  e2mcq_young_r_r$Proportion and e2mcq_old_r_r$Proportion
t = -2.7008, df = 51.599, p-value = 0.009336
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -0.30626887 -0.04513155
sample estimates:
mean of x mean of y
0.4227143 0.5984145
```

```
> e2mcq_old_b = exp2_mcq %>% filter(AgeGroup == "Old" & PrimeType == "b")
> e2mcq_young_b = exp2_mcq %>% filter(AgeGroup == "Young" & PrimeType == "b")
> e2mcq_old_b_b = e2mcq_old_b %>% filter(ChosenPrime == "b")
> e2mcq_young_b_b = e2mcq_young_b %>% filter(ChosenPrime == "b")
> ## comparing young and old
> t.test(e2mcq_young_b_b$Proportion, e2mcq_old_b_b$Proportion)
```

```
        Welch Two Sample t-test

data:  e2mcq_young_b_b$Proportion and e2mcq_old_b_b$Proportion
t = -2.3168, df = 61.942, p-value = 0.02384
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -0.25906269 -0.01907454
sample estimates:
mean of x mean of y
0.2898719 0.4289405
```

Exp 2: State Data

```
> ## just state
> exp2_state_aov = aov(data = exp2_state, Trials ~ AgeGroup*State +
+                          Error(Subject/State))
> summary(exp2_state_aov)
```

```
Error: Subject
          Df    Sum Sq   Mean Sq F value   Pr(>F)
AgeGroup   1 3.832e-27 3.832e-27   12.44 0.000797 ***
Residuals 62 1.910e-26 3.080e-28
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1
```

```
Error: Subject:State
                Df Sum Sq Mean Sq F value    Pr(>F)
State            3  52217   17406   69.44  < 2e-16 ***
AgeGroup:State   3  10400    3467   13.83 3.52e-08 ***
Residuals      186  46621     251
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1
```

```
> options(contrasts = c('contr.sum', 'contr.poly'))
> exp2_state_lsm = lsmeans::lsmeans(exp2_state_aov, c("AgeGroup", "State"))
> prime_effect = cld(exp2_state_lsm, alpha = 0.05,
+                 adjust = "tukey", details = TRUE, by = c("State"))
> knitr::kable(subset(prime_effect$comparisons, prime_effect$comparisons$p.value < 0.05)
```

```
|   |contrast    |State    | estimate|        SE|  df|  t.ratio|   p.value|
|:--|:-----------|:--------|--------:|---------:|---:|--------:|---------:|
|1  |Old - Young |dontknow | 18.34375| 3.427726| 186| 5.351580| 0.0000003|
|3  |Old - Young |other    | 13.96875| 3.427726| 186| 4.075223| 0.0000680|
|4  |Old - Young |TOT      |  9.56250| 3.427726| 186| 2.789750| 0.0058243|
```

```
> ## Specfic t test for Old-Young TOT Differece
>
> y_TOT = exp2_state %>% filter(AgeGroup == "Young" & State == "TOT")
> o_TOT = exp2_state %>% filter(AgeGroup == "Old" & State == "TOT")
> t.test(y_TOT$Trials, o_TOT$Trials)
```

```
        Welch Two Sample t-test

data:  y_TOT$Trials and o_TOT$Trials
t = 4.4834, df = 59.013, p-value = 3.443e-05
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
  5.294682 13.830318
sample estimates:
mean of x mean of y
 15.46875   5.90625
```

```
> ##state by prime
> exp2_stateprime_aov = aov(data = exp2_state_prime, Trials ~ AgeGroup*PrimeCondition*St
+                                          Error(Subject/(PrimeCondition*State)))
> summary(exp2_stateprime_aov)
```

```
Error: Subject
          Df    Sum Sq   Mean Sq F value Pr(>F)
AgeGroup   1 1.000e-27 1.002e-27   1.025  0.315
Residuals 62 6.065e-26 9.783e-28
```

```
Error: Subject:PrimeCondition
                           Df    Sum Sq   Mean Sq F value Pr(>F)
PrimeCondition              3 5.670e-27 1.889e-27   1.522  0.210
AgeGroup:PrimeCondition     3 5.850e-27 1.949e-27   1.570  0.198
Residuals                 186 2.309e-25 1.241e-27

Error: Subject:State
                  Df Sum Sq Mean Sq F value   Pr(>F)
State              3  13054    4351   69.44  < 2e-16 ***
AgeGroup:State     3   2600     867   13.83 3.52e-08 ***
Residuals        186  11655      63
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Subject:PrimeCondition:State
                                 Df Sum Sq Mean Sq F value   Pr(>F)
PrimeCondition:State              9    425   47.27   8.284 1.27e-11 ***
AgeGroup:PrimeCondition:State     9     73    8.11   1.422    0.175
Residuals                       558   3184    5.71
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1
```

```
> library(ez)
> # ezANOVA(data = exp2_state_prime, wid = .(Subject),
> #          dv = .(Trials), within =.(PrimeCondition, State),
> #          between = .(AgeGroup))
>
> options(contrasts = c('contr.sum', 'contr.poly'))
> exp2_state_lsm = lsmeans::lsmeans(exp2_stateprime_aov, c("AgeGroup", "PrimeCondition",
> prime_effect = cld(exp2_state_lsm, alpha = 0.05,
+                 adjust = "tukey", details = TRUE, by = c("PrimeCondition", "State"))
> kable(subset(prime_effect$comparisons, prime_effect$comparisons$p.value < 0.05))
```

```
|   |contrast    |PrimeCondition |State    | estimate|        SE|       df|  t.ratio|
p.value|
|:--|:-----------|:--------------|:--------|--------:|---------:|--------:|--------:|---
|1  |Old - Young |b              |dontknow |  4.84375| 0.9669232| 294.1878| 5.009447| 0.
|3  |Old - Young |b              |other    |  3.71875| 0.9669232| 294.1878| 3.845962| 0.
|4  |Old - Young |b              |TOT      |  2.09375| 0.9669232| 294.1878| 2.165374| 0.
|5  |Old - Young |p              |dontknow |  5.50000| 0.9669232| 294.1878| 5.688146| 0.
|7  |Old - Young |p              |other    |  3.40625| 0.9669232| 294.1878| 3.522772| 0.
|8  |Old - Young |p              |TOT      |  2.40625| 0.9669232| 294.1878| 2.488564| 0.
|9  |Old - Young |r              |dontknow |  4.15625| 0.9669232| 294.1878| 4.298428| 0.
|11 |Old - Young |r              |other    |  3.12500| 0.9669232| 294.1878| 3.231901| 0.
|12 |Old - Young |r              |TOT      |  2.43750| 0.9669232| 294.1878| 2.520883| 0.
|13 |Old - Young |u              |dontknow |  3.84375| 0.9669232| 294.1878| 3.975238| 0.
|14 |Old - Young |u              |know     |  2.50000| 0.9669232| 294.1878| 2.585521| 0.
|15 |Old - Young |u              |other    |  3.71875| 0.9669232| 294.1878| 3.845962| 0.
```

```
|16 |Old - Young |u                |TOT       |   2.62500|  0.9669232|  294.1878|  2.714797|  0.
```

```
> ### INDIVIDUAL T-TESTS FOR AGExSTATE interaction
>
> e2_young_dk = exp2_state %>% filter(AgeGroup == "Young" & State == "dontknow")
> e2_old_dk = exp2_state %>% filter(AgeGroup == "Old" & State == "dontknow")
> t.test(e2_old_dk$Trials, e2_young_dk$Trials)
```

```
        Welch Two Sample t-test

data:  e2_old_dk$Trials and e2_young_dk$Trials
t = 4.0675, df = 44.691, p-value = 0.0001904
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
  9.258782 27.428718
sample estimates:
mean of x mean of y
 47.75000  29.40625
```

```
> e2_young_other = exp2_state %>% filter(AgeGroup == "Young" & State == "other")
> e2_old_other = exp2_state %>% filter(AgeGroup == "Old" & State == "other")
> t.test(e2_young_other$Trials, e2_old_other$Trials)
```

```
        Welch Two Sample t-test

data:  e2_young_other$Trials and e2_old_other$Trials
t = 7.7708, df = 44.146, p-value = 8.441e-10
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 10.34629 17.59121
sample estimates:
mean of x mean of y
 17.75000   3.78125
```

```
> e2_young_TOT = exp2_state %>% filter(AgeGroup == "Young" & State == "TOT")
> e2_old_TOT = exp2_state %>% filter(AgeGroup == "Old" & State == "TOT")
> t.test(e2_young_TOT$Trials, e2_old_TOT$Trials)
```

```
        Welch Two Sample t-test

data:  e2_young_TOT$Trials and e2_old_TOT$Trials
t = 4.4834, df = 59.013, p-value = 3.443e-05
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
  5.294682 13.830318
sample estimates:
mean of x mean of y
 15.46875   5.90625
```

6 Experiment 3: 48ms

```
> exp3_target = subset(final_j, final_j$StudyNo == '1')
> exp3_mcq = subset(final_mcq, final_mcq$StudyNo == '1')
> exp3_state = subset(final_statedata, final_statedata$StudyNo == '1')
> exp3_state_prime = subset(statedata_primetype_long, statedata_primetype_long$StudyNo =
> exp3_state_prime$PrimeCondition = as.factor(as.character(exp3_state_prime$PrimeConditi
> exp3_state_prime$State = as.factor(as.character(exp3_state_prime$State))
> exp3_state_prime$Subject = as.factor(as.character(exp3_state_prime$Subject))
```

Exp 3: Target Accuracy

```
> ### TARGET RETRIEVAL ACCURACY
>
> exp3_target_aov = aov(data = exp3_target, Accuracy ~ PrimeCondition +
+                                  Error (Subject/PrimeCondition))
> summary(exp3_target_aov)
```

```
Error: Subject
          Df Sum Sq Mean Sq F value Pr(>F)
Residuals 35  1.994 0.05699

Error: Subject:PrimeCondition
                Df Sum Sq Mean Sq F value Pr(>F)
PrimeCondition   3 0.1051 0.03503   2.929 0.0371 *
Residuals      105 1.2561 0.01196
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1
```

```
> ## specific t-tests
> target_p = exp3_target %>% filter(PrimeCondition == "Phonological")
> target_r = exp3_target %>% filter(PrimeCondition == "Related")
> target_b = exp3_target %>% filter(PrimeCondition == "Both")
> target_u = exp3_target %>% filter(PrimeCondition == "Unrelated")
> t.test(target_p$Accuracy, target_u$Accuracy, paired = TRUE)
```

```
        Paired t-test

data:  target_p$Accuracy and target_u$Accuracy
t = 3.0567, df = 35, p-value = 0.004268
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 0.0242553 0.1201891
sample estimates:
mean of the differences
             0.07222222
```

```
> library(ez)
> # ezANOVA(data = exp3_target, wid = .(Subject),
> #          dv = .(Accuracy), within =.(PrimeCondition))
>
> options(contrasts = c('contr.sum', 'contr.poly'))
> library(lsmeans)
> library(multcomp)
> exp3_target_lsm = lsmeans::lsmeans(exp3_target_aov, c("PrimeCondition"))
> prime_effect = cld(exp3_target_lsm, alpha = 0.05,
+                 adjust = "tukey", details = TRUE)
> kable(subset(prime_effect$comparisons,prime_effect$comparisons$p.value < 1 ))
```

```
|contrast                  |  estimate|        SE|  df|   t.ratio|   p.value|
|:-------------------------|---------:|---------:|---:|---------:|---------:|
|Related - Unrelated       | 0.0155556| 0.0257799| 105| 0.6033986| 0.9307815|
|Both - Unrelated          | 0.0355556| 0.0257799| 105| 1.3791969| 0.5151504|
|Both - Related            | 0.0200000| 0.0257799| 105| 0.7757982| 0.8652374|
|Phonological - Unrelated  | 0.0722222| 0.0257799| 105| 2.8014936| 0.0303803|
|Phonological - Related    | 0.0566667| 0.0257799| 105| 2.1980950| 0.1304819|
|Phonological - Both       | 0.0366667| 0.0257799| 105| 1.4222968| 0.4883835|
```

```
> ## specific t-tests
> target_p = exp3_target %>% filter(PrimeCondition == "Phonological")
> target_r = exp3_target %>% filter(PrimeCondition == "Related")
> target_b = exp3_target %>% filter(PrimeCondition == "Both")
> target_u = exp3_target %>% filter(PrimeCondition == "Unrelated")
> t.test(target_p$Accuracy, target_r$Accuracy, paired = TRUE)
```

```
        Paired t-test

data:  target_p$Accuracy and target_r$Accuracy
t = 2.2164, df = 35, p-value = 0.03326
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 0.004763719 0.108569614
sample estimates:
mean of the differences
             0.05666667
```

```
> t.test(target_p$Accuracy, target_b$Accuracy, paired = TRUE)
```

```
        Paired t-test

data:  target_p$Accuracy and target_b$Accuracy
t = 1.3342, df = 35, p-value = 0.1907
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
```

```
 -0.01912394  0.09245727
sample estimates:
mean of the differences
             0.03666667
```

```
> t.test(target_p$Accuracy, target_u$Accuracy, paired = TRUE)
```

```
        Paired t-test

data:  target_p$Accuracy and target_u$Accuracy
t = 3.0567, df = 35, p-value = 0.004268
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 0.0242553 0.1201891
sample estimates:
mean of the differences
             0.07222222
```

```
> t.test(target_b$Accuracy, target_r$Accuracy, paired = TRUE)
```

```
        Paired t-test

data:  target_b$Accuracy and target_r$Accuracy
t = 0.99061, df = 35, p-value = 0.3287
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -0.02098702  0.06098702
sample estimates:
mean of the differences
                   0.02
```

```
> t.test(target_b$Accuracy, target_u$Accuracy, paired = TRUE)
```

```
        Paired t-test

data:  target_b$Accuracy and target_u$Accuracy
t = 1.3711, df = 35, p-value = 0.1791
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -0.01708853  0.08819964
sample estimates:
mean of the differences
             0.03555556
```

```
> t.test(target_r$Accuracy, target_u$Accuracy, paired = TRUE)
```

```
        Paired t-test

data:  target_r$Accuracy and target_u$Accuracy
t = 0.50726, df = 35, p-value = 0.6152
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -0.04669922  0.07781033
sample estimates:
mean of the differences
             0.01555556
```

```
>
```

Exp 3: Multiple Choice

```
> ## MULTIPLE CHOICE ACCURACY
> library(dplyr)
> exp3_mcq_acc = group_by(exp3_mcq, Subject, PrimeType) %>%
+     summarise_at(vars(MCQAcc), mean)
> exp3_mcq_acc_aov = aov(data = exp3_mcq_acc, MCQAcc ~ PrimeType +
+                                Error(Subject/PrimeType))
> summary(exp3_mcq_acc_aov)
```

```
Error: Subject
          Df Sum Sq Mean Sq F value Pr(>F)
Residuals 35  1.638  0.0468

Error: Subject:PrimeType
           Df Sum Sq  Mean Sq F value Pr(>F)
PrimeType   3 0.0790 0.026326   3.293 0.0235 *
Residuals 105 0.8394 0.007994
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1
```

```
> ## SPECIFIC T TESTS
>
> e3_mcq_p = exp3_mcq_acc %>% filter(PrimeType == "p")
> e3_mcq_r = exp3_mcq_acc %>% filter(PrimeType == "r")
> e3_mcq_b = exp3_mcq_acc %>% filter(PrimeType == "b")
> e3_mcq_u = exp3_mcq_acc %>% filter(PrimeType == "u")
> t.test(e3_mcq_r$MCQAcc, e3_mcq_u$MCQAcc, paired = TRUE) ##sig
```

```
        Paired t-test

data:  e3_mcq_r$MCQAcc and e3_mcq_u$MCQAcc
t = -2.8619, df = 35, p-value = 0.007063
```

```
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -0.09686401 -0.01646933
sample estimates:
mean of the differences
            -0.05666667
```

```
> t.test(e3_mcq_r$MCQAcc, e3_mcq_p$MCQAcc, paired = TRUE) ##not sig
```

```
        Paired t-test

data:  e3_mcq_r$MCQAcc and e3_mcq_p$MCQAcc
t = -2.3095, df = 35, p-value = 0.02694
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -0.10856663 -0.00698893
sample estimates:
mean of the differences
            -0.05777778
```

```
> # ezANOVA(data = exp3_mcq_acc, wid = .(Subject),
> #           dv = .(MCQAcc), within =.(PrimeType))
>
>
> exp3_mcqacc_lsm = lsmeans::lsmeans(exp3_mcq_acc_aov, c("PrimeType"))
> prime_effect = cld(exp3_mcqacc_lsm, alpha = 0.05,
+                 adjust = "tukey", details = TRUE)
> kable(subset(prime_effect$comparisons, prime_effect$comparisons$p.value < 0.1))
```

```
|   |contrast |  estimate|         SE|  df|  t.ratio|   p.value|
|:--|:--------|---------:|----------:|---:|--------:|---------:|
|2  |u - r    | 0.0566667| 0.0210746| 105| 2.688861| 0.0409296|
|4  |p - r    | 0.0577778| 0.0210746| 105| 2.741584| 0.0356502|
```

```
> ## MULTIPLE CHOICE ERRORS
>
> ## before we do ANOVA, we need to replace NAs with 0.
>
> for (i in 1: nrow(exp3_mcq)){
+    if(is.na(exp3_mcq[i,7])){
+      exp3_mcq[i,7] = 0
+    }
+
+ }
> exp3_mcq_aov = aov(data = exp3_mcq, Proportion ~ PrimeType*ChosenPrime +
+                                  Error(Subject/(PrimeType*ChosenPrime)))
> summary(exp3_mcq_aov)
```

```
Error: Subject
          Df    Sum Sq   Mean Sq F value Pr(>F)
Residuals 35 0.0005022 1.435e-05

Error: Subject:PrimeType
           Df    Sum Sq   Mean Sq F value Pr(>F)
PrimeType   3 0.000043 1.435e-05       1  0.396
Residuals 105 0.001507 1.435e-05

Error: Subject:ChosenPrime
             Df Sum Sq Mean Sq F value Pr(>F)
ChosenPrime   3 30.305  10.102     448 <2e-16 ***
Residuals   105  2.368   0.023
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Subject:PrimeType:ChosenPrime
                       Df Sum Sq Mean Sq F value   Pr(>F)
PrimeType:ChosenPrime   9  2.021 0.22458    6.86 5.07e-09 ***
Residuals             315 10.313 0.03274
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1
```

```
> library(ez)
> # ezANOVA(data = exp3_mcq, wid = .(Subject),
> #          dv = .(Proportion), within =.(PrimeType, ChosenPrime))
>
> options(contrasts = c('contr.sum', 'contr.poly'))
> exp3_errors_lsm = lsmeans::lsmeans(exp3_mcq_aov, c("PrimeType", "ChosenPrime"))
> prime_effect = cld(exp3_errors_lsm, alpha = 0.05,
+                 adjust = "tukey", details = TRUE, by = c("PrimeType"))
> kable(subset(prime_effect$comparisons, prime_effect$comparisons$p.value < 0.8))
```

```
|   |contrast |PrimeType |  estimate|        SE|        df|    t.ratio|   p.value|
|:--|:--------|:---------|---------:|---------:|---------:|----------:|---------:|
|2  |r - u    |b         | 0.4447289| 0.040955| 411.2189| 10.8589586| 0.0000000|
|3  |r - p    |b         | 0.4414320| 0.040955| 411.2189| 10.7784591| 0.0000000|
|4  |b - u    |b         | 0.5154182| 0.040955| 411.2189| 12.5849824| 0.0000000|
|5  |b - p    |b         | 0.5121214| 0.040955| 411.2189| 12.5044829| 0.0000000|
|6  |b - r    |b         | 0.0706893| 0.040955| 411.2189|  1.7260238| 0.3114464|
|7  |p - u    |p         | 0.0395395| 0.040955| 411.2189|  0.9654384| 0.7691747|
|8  |r - u    |p         | 0.3744838| 0.040955| 411.2189|  9.1437816| 0.0000000|
|9  |r - p    |p         | 0.3349442| 0.040955| 411.2189|  8.1783432| 0.0000000|
|10 |b - u    |p         | 0.5006592| 0.040955| 411.2189| 12.2246113| 0.0000000|
|11 |b - p    |p         | 0.4611197| 0.040955| 411.2189| 11.2591729| 0.0000000|
|12 |b - r    |p         | 0.1261754| 0.040955| 411.2189|  3.0808297| 0.0117776|
|14 |r - u    |r         | 0.2877852| 0.040955| 411.2189|  7.0268602| 0.0000000|
```

```
|15 |r - p     |r          | 0.2702963| 0.040955| 411.2189|  6.5998337| 0.0000000|
|16 |b - u     |r          | 0.6669481| 0.040955| 411.2189| 16.2848929| 0.0000000|
|17 |b - p     |r          | 0.6494593| 0.040955| 411.2189| 15.8578664| 0.0000000|
|18 |b - r     |r          | 0.3791629| 0.040955| 411.2189|  9.2580327| 0.0000000|
|20 |r - u     |u          | 0.4185845| 0.040955| 411.2189| 10.2205905| 0.0000000|
|21 |r - p     |u          | 0.3879087| 0.040955| 411.2189|  9.4715784| 0.0000000|
|22 |b - u     |u          | 0.4818965| 0.040955| 411.2189| 11.7664814| 0.0000000|
|23 |b - p     |u          | 0.4512207| 0.040955| 411.2189| 11.0174693| 0.0000000|
|24 |b - r     |u          | 0.0633120| 0.040955| 411.2189|  1.5458909| 0.4110525|
```

Exp 3: State Data

```
> ## just state
> exp3_state_aov = aov(data = exp3_state, Trials ~ State +
+                                         Error(Subject/State))
> summary(exp3_state_aov)
```

```
Error: Subject
          Df    Sum Sq   Mean Sq F value Pr(>F)
Residuals 35 1.598e-26 4.564e-28

Error: Subject:State
           Df Sum Sq Mean Sq F value   Pr(>F)
State       3  13661    4554    21.8 4.71e-11 ***
Residuals 105  21929     209
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1
```

```
> options(contrasts = c('contr.sum', 'contr.poly'))
> exp3_state_lsm = lsmeans::lsmeans(exp3_state_aov, c("State"))
> prime_effect = cld(exp3_state_lsm, alpha = 0.05,
+                   adjust = "tukey", details = TRUE)
> kable(subset(prime_effect$comparisons, prime_effect$comparisons$p.value < 0.05))
```

```
|   |contrast          | estimate|       SE|  df|  t.ratio|   p.value|
|:--|:-----------------|--------:|--------:|---:|--------:|---------:|
|2  |dontknow - TOT    | 13.88889| 3.406253| 105| 4.077469| 0.0005089|
|3  |dontknow - other  | 11.91667| 3.406253| 105| 3.498468| 0.0037854|
|4  |know - TOT        | 24.13889| 3.406253| 105| 7.086641| 0.0000000|
|5  |know - other      | 22.16667| 3.406253| 105| 6.507640| 0.0000000|
|6  |know - dontknow   | 10.25000| 3.406253| 105| 3.009172| 0.0170295|
```

```
> ##state by prime
> exp3_stateprime_aov = aov(data = exp3_state_prime, Trials ~ PrimeCondition*State +
+                                         Error(Subject/(PrimeCondition*State)))
> summary(exp3_stateprime_aov)
```

```
Error: Subject
          Df    Sum Sq   Mean Sq F value Pr(>F)
Residuals 35 1.729e-27 4.939e-29

Error: Subject:PrimeCondition
                Df    Sum Sq   Mean Sq F value Pr(>F)
PrimeCondition   3 2.480e-28 8.258e-29   1.256  0.293
Residuals      105 6.905e-27 6.576e-29

Error: Subject:State
           Df Sum Sq Mean Sq F value   Pr(>F)
State       3   3415  1138.4    21.8 4.71e-11 ***
Residuals 105   5482    52.2
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Subject:PrimeCondition:State
                      Df Sum Sq Mean Sq F value   Pr(>F)
PrimeCondition:State   9  249.6   27.73   4.202 3.79e-05 ***
Residuals            315 2078.9    6.60
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1
```

```
> library(ez)
> # ezANOVA(data = exp3_state_prime, wid = .(Subject),
> #          dv = .(Trials), within =.(PrimeCondition, State))
>
> options(contrasts = c('contr.sum', 'contr.poly'))
> exp3_state_lsm = lsmeans::lsmeans(exp3_stateprime_aov, c("PrimeCondition", "State"))
> prime_effect = cld(exp3_state_lsm, alpha = 0.05,
+                adjust = "tukey", details = TRUE, by = c("PrimeCondition"))
> kable(subset(prime_effect$comparisons, prime_effect$comparisons$p.value < 0.1))
```

```
|   |contrast          |PrimeCondition |  estimate|        SE|        df|  t.ratio|
p.value|
|:--|:-----------------|:--------------|---------:|---------:|---------:|---------:|---------
|2  |dontknow - TOT    |b              |  3.333333|  1.000074|  190.5969|  3.333088|  0.005648
|3  |dontknow - other  |b              |  2.750000|  1.000074|  190.5969|  2.749798|  0.032842
|4  |know - TOT        |b              |  6.861111|  1.000074|  190.5969|  6.860607|  0.000000
|5  |know - other      |b              |  6.277778|  1.000074|  190.5969|  6.277317|  0.000000
|6  |know - dontknow   |b              |  3.527778|  1.000074|  190.5969|  3.527519|  0.002932
|8  |dontknow - TOT    |p              |  3.250000|  1.000074|  190.5969|  3.249761|  0.007404
|9  |dontknow - other  |p              |  2.805556|  1.000074|  190.5969|  2.805349|  0.028162
|10 |know - TOT        |p              |  5.861111|  1.000074|  190.5969|  5.860680|  0.000000
|11 |know - other      |p              |  5.416667|  1.000074|  190.5969|  5.416269|  0.000001
|12 |know - dontknow   |p              |  2.611111|  1.000074|  190.5969|  2.610919|  0.047588
|14 |dontknow - TOT    |r              |  3.388889|  1.000074|  190.5969|  3.388640|  0.004699
```

```
|15 |dontknow - other |r          | 2.472222| 1.000074| 190.5969| 2.472041| 0.067621
|16 |know - TOT       |r          | 7.694444| 1.000074| 190.5969| 7.693879| 0.000000
|17 |know - other     |r          | 6.777778| 1.000074| 190.5969| 6.777280| 0.000000
|18 |know - dontknow  |r          | 4.305556| 1.000074| 190.5969| 4.305239| 0.000155
|20 |dontknow - TOT   |u          | 3.722222| 1.000074| 190.5969| 3.721949| 0.001473
|21 |dontknow - other |u          | 3.694444| 1.000074| 190.5969| 3.694173| 0.001628
|22 |know - TOT       |u          | 3.916667| 1.000074| 190.5969| 3.916379| 0.000717
|23 |know - other     |u          | 3.888889| 1.000074| 190.5969| 3.888603| 0.000796
```

```
> ## specific t
>
> ## for related primes
> e3mcq_r = exp3_mcq %>% filter(PrimeType == "r")
> e3mcq_r_r = e3mcq_r %>% filter(ChosenPrime == "r")
> e3mcq_r_b = e3mcq_r %>% filter(ChosenPrime == "b")
> t.test(e3mcq_r_r$Proportion, e3mcq_r_b$Proportion, paired = TRUE)
```

```
        Paired t-test

data:  e3mcq_r_r$Proportion and e3mcq_r_b$Proportion
t = 6.3399, df = 35, p-value = 2.761e-07
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 0.2577504 0.5005755
sample estimates:
mean of the differences
              0.3791629
```

```
> ## for both primes
> e3mcq_b = exp3_mcq %>% filter(PrimeType == "b")
> e3mcq_b_r = e3mcq_b %>% filter(ChosenPrime == "r")
> e3mcq_b_b = e3mcq_b %>% filter(ChosenPrime == "b")
> t.test(e3mcq_b_r$Proportion, e3mcq_b_b$Proportion, paired = TRUE)
```

```
        Paired t-test

data:  e3mcq_b_r$Proportion and e3mcq_b_b$Proportion
t = -0.94029, df = 35, p-value = 0.3535
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -0.2233092  0.0819305
sample estimates:
mean of the differences
            -0.07068934
```

```
>
```

7 Comparing YA 48 ms with OA NotthePrime

```
> for (i in 1: nrow(final_mcq)){
+    if(is.na(final_mcq[i,7])){
+      final_mcq[i,7] = 0
+    }
+ }
> exp3_compare_1 = subset(final_mcq, final_mcq$StudyNo == '6' |
+                         final_mcq$StudyNo == '1')
> compare_aov_1 = aov(data = exp3_compare_1, Proportion ~ StudyNo*PrimeType*ChosenPrime
> summary(compare_aov_1)
```

```
Error: Subject
          Df Sum Sq Mean Sq F value   Pr(>F)
StudyNo    1 0.1373 0.13726   50.99 9.1e-10 ***
Residuals 66 0.1777 0.00269
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Subject:PrimeType
                   Df Sum Sq  Mean Sq F value Pr(>F)
PrimeType           3 0.0063 0.002101   1.031  0.380
StudyNo:PrimeType   3 0.0068 0.002255   1.107  0.347
Residuals         198 0.4034 0.002038

Error: Subject:ChosenPrime
                     Df Sum Sq Mean Sq F value Pr(>F)
ChosenPrime           3  52.52  17.508 698.864 <2e-16 ***
StudyNo:ChosenPrime   3   0.21   0.070   2.777 0.0424 *
Residuals           198   4.96   0.025
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Subject:PrimeType:ChosenPrime
                               Df Sum Sq Mean Sq F value   Pr(>F)
PrimeType:ChosenPrime           9  2.722 0.30247   8.898 1.22e-12 ***
StudyNo:PrimeType:ChosenPrime   9  0.187 0.02075   0.610    0.789
Residuals                     594 20.192 0.03399
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1
```

```
> ## specific t
>
> e3_old_b = exp3_compare_1 %>% filter(AgeGroup == "Old" & ChosenPrime == "b")
> mean_old = group_by(e3_old_b, Subject) %>%
+              summarise_at(vars(Proportion), mean)
> e3_young_b = exp3_compare_1 %>% filter(AgeGroup == "Young" & ChosenPrime == "b")
> mean_young = group_by(e3_young_b, Subject) %>%
```

```
+               summarise_at(vars(Proportion), mean)
> t.test(mean_young$Proportion, mean_old$Proportion)
```

```
        Welch Two Sample t-test

data:  mean_young$Proportion and mean_old$Proportion
t = 3.1003, df = 65.235, p-value = 0.002854
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 0.02334383 0.10784904
sample estimates:
mean of x mean of y
0.4125660 0.3469696
```

```
> ### e2 young and e3 young
> exp3_compare_2 = subset(final_mcq, final_mcq$StudyNo == '1' |
+                         final_mcq$StudyNo == '5')
> compare_aov_2 = aov(data = exp3_compare_2, Proportion ~ StudyNo*PrimeType*ChosenPrime
> summary(compare_aov_2)
```

```
Error: Subject
          Df  Sum Sq   Mean Sq F value Pr(>F)
StudyNo    1 0.00117 0.0011663   1.247  0.268
Residuals 66 0.06173 0.0009353

Error: Subject:PrimeType
                   Df  Sum Sq   Mean Sq F value Pr(>F)
PrimeType           3 0.00343 0.0011444   1.224  0.302
StudyNo:PrimeType   3 0.00426 0.0014210   1.519  0.211
Residuals         198 0.18518 0.0009353

Error: Subject:ChosenPrime
                     Df Sum Sq Mean Sq F value Pr(>F)
ChosenPrime           3  56.76  18.921 711.408 <2e-16 ***
StudyNo:ChosenPrime   3   0.00   0.001   0.028  0.994
Residuals           198   5.27   0.027
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Subject:PrimeType:ChosenPrime
                              Df Sum Sq Mean Sq F value  Pr(>F)
PrimeType:ChosenPrime          9  0.123  0.0136   0.305   0.973
StudyNo:PrimeType:ChosenPrime  9  3.842  0.4269   9.540 1.2e-13 ***
Residuals                    594 26.579  0.0447
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1
```

```
> options(contrasts = c('contr.sum', 'contr.poly'))
> compare_lsm = lsmeans::lsmeans(compare_aov_1, c("StudyNo", "ChosenPrime"))
> prime_effect = multcomp::cld(compare_lsm, alpha = 0.05,
+                    adjust = "tukey", details = TRUE, by = c("ChosenPrime"))
> knitr::kable(subset(prime_effect$comparisons, prime_effect$comparisons$p.value < 0.05)
```

```
|contrast |ChosenPrime |  estimate|       SE|       df|  t.ratio|   p.value|
|:--------|:-----------|---------:|--------:|--------:|--------:|---------:|
|1 - 6    |b           | 0.0655964| 0.016947| 211.6232| 3.870686| 0.0001446|
```

```
>
```

8 Comparing Prime Type Across Experiments

```
> ## final_j contains all experiments
>
> for(i in 1:nrow(final_j)){
+
+   if(final_j[i,3] == "2" | final_j[i,3] == "4"){
+     final_j[i,"Experiment"] = "Experiment1"
+   }
+   else if(final_j[i,3] == "5" | final_j[i,3] == "6"){
+     final_j[i,"Experiment"] = "Experiment2"
+   }
+   else
+     final_j[i,"Experiment"] = "Experiment3"
+ }
> final_j$Experiment = as.factor(as.character(final_j$Experiment))
> combined_targetacc = aov(data = final_j, Accuracy ~ PrimeCondition +
+                            Error(Subject/PrimeCondition))
> summary(combined_targetacc)
```

```
Error: Subject
           Df Sum Sq Mean Sq F value Pr(>F)
Residuals 171  11.01  0.0644

Error: Subject:PrimeCondition
                Df Sum Sq Mean Sq F value Pr(>F)
PrimeCondition   3  1.117  0.3725   30.76 <2e-16 ***
Residuals      513  6.212  0.0121
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1
```

```
> options(contrasts = c('contr.sum', 'contr.poly'))
> library(lsmeans)
```

```
> library(multcomp)
> combined_targetacc_lsm = lsmeans::lsmeans(combined_targetacc,
+                                           c("PrimeCondition"))
> prime_effect = cld(combined_targetacc_lsm, alpha = 0.05,
+                    adjust = "tukey", details = TRUE)
> kable(subset(prime_effect$comparisons,prime_effect$comparisons$p.value < 1 ))
```

```
|contrast                  |   estimate|         SE|  df|   t.ratio|   p.value|
|:-------------------------|----------:|----------:|---:|---------:|---------:|
|Related - Unrelated       |  0.0076744|  0.0118663| 513| 0.6467402| 0.9166711|
|Both - Unrelated          |  0.0360465|  0.0118663| 513| 3.0377192| 0.0133283|
|Both - Related            |  0.0283721|  0.0118663| 513| 2.3909790| 0.0800700|
|Phonological - Unrelated  |  0.1023256|  0.0118663| 513| 8.6232028| 0.0000000|
|Phonological - Related    |  0.0946512|  0.0118663| 513| 7.9764626| 0.0000000|
|Phonological - Both       |  0.0662791|  0.0118663| 513| 5.5854837| 0.0000002|
```

```
> ## PAIRWISE COMPARISONS
>
> compare_p = final_j %>% filter(PrimeCondition == "Phonological")
> compare_r = final_j %>% filter(PrimeCondition == "Related")
> compare_b = final_j %>% filter(PrimeCondition == "Both")
> compare_u = final_j %>% filter(PrimeCondition == "Unrelated")
> t.test(compare_p$Accuracy, compare_r$Accuracy, paired = TRUE)
```

```
        Paired t-test

data:  compare_p$Accuracy and compare_r$Accuracy
t = 7.81, df = 171, p-value = 5.503e-13
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 0.07072869 0.11857364
sample estimates:
mean of the differences
             0.09465116
```

9 Multiple Choice: Only R and B

```
> ### EXPERIMENT 1 ####
> ## MULTIPLE CHOICE ACCURACY
> exp1_mcqacc_subset = subset(exp1_mcq_acc, exp1_mcq_acc$PrimeType == 'r' |
+                             exp1_mcq_acc$PrimeType == 'b')
> exp1_mcqacc_subset_aov = aov(data = exp1_mcqacc_subset, MCQAcc ~ PrimeType +
+                              Error(Subject/PrimeType))
> summary(exp1_mcqacc_subset_aov)
```

```
Error: Subject
          Df Sum Sq Mean Sq F value Pr(>F)
Residuals 71  3.301 0.04649

Error: Subject:PrimeType
          Df Sum Sq Mean Sq F value  Pr(>F)
PrimeType  1 0.0324 0.03240   7.126 0.00941 **
Residuals 71 0.3228 0.00455
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1
```

```
> # ezANOVA(data = exp1_mcqacc_subset, wid = .(Subject),
> #          dv = .(MCQAcc), within =.(PrimeType),
> #          between = .(AgeGroup))
>
> ## MULTIPLE CHOICE ERRORS: only when they chose b or r
>
> exp1_mcq_subset = subset(exp1_mcq, exp1_mcq$ChosenPrime == "r" |
+                             exp1_mcq$ChosenPrime == 'b')
> ## before we do ANOVA, we need to replace NAs with 0.
>
> for (i in 1: nrow(exp1_mcq_subset)){
+    if(is.na(exp1_mcq_subset[i,7])){
+      exp1_mcq_subset[i,7] = 0
+    }
+
+ }
> exp1_mcq_subset_aov = aov(data = exp1_mcq_subset, Proportion ~ AgeGroup*PrimeType*Chos
+                                  Error(Subject/(PrimeType*ChosenPrime)))
> summary(exp1_mcq_subset_aov)
```

```
Error: Subject
          Df Sum Sq Mean Sq F value   Pr(>F)
AgeGroup   1 0.2977 0.29768   14.65 0.000278 ***
Residuals 70 1.4220 0.02031
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Subject:PrimeType
                    Df Sum Sq Mean Sq F value Pr(>F)
PrimeType            3 0.1540 0.05133   3.567  0.015 *
AgeGroup:PrimeType   3 0.0729 0.02430   1.689  0.171
Residuals          210 3.0219 0.01439
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Subject:ChosenPrime
```

```
                         Df Sum Sq Mean Sq F value    Pr(>F)
ChosenPrime               1  2.074  2.0735  28.457 1.12e-06 ***
AgeGroup:ChosenPrime      1  0.177  0.1771   2.431    0.123
Residuals                70  5.101  0.0729
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Subject:PrimeType:ChosenPrime
                              Df Sum Sq Mean Sq F value   Pr(>F)
PrimeType:ChosenPrime          3  2.783  0.9277   9.172 9.93e-06 ***
AgeGroup:PrimeType:ChosenPrime 3  0.339  0.1131   1.118    0.343
Residuals                    210 21.241  0.1011
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1
```

```
> library(ez)
> # ezANOVA(data = exp1_mcq_subset, wid = .(Subject),
> #         dv = .(Proportion), within =.(PrimeType, ChosenPrime),
> #         between = .(AgeGroup))
>
> #### EXPERIMENT 2 #####
>
> exp2_mcq_subset = subset(exp2_mcq, exp2_mcq$ChosenPrime == "r" |
+                              exp2_mcq$ChosenPrime == 'b')
> ## before we do ANOVA, we need to replace NAs with 0.
>
> for (i in 1: nrow(exp2_mcq_subset)){
+    if(is.na(exp2_mcq_subset[i,7])){
+      exp2_mcq_subset[i,7] = 0
+    }
+
+ }
> exp2_mcq_subset_aov = aov(data = exp2_mcq_subset, Proportion ~ AgeGroup*PrimeType*Chos
+                                  Error(Subject/(PrimeType*ChosenPrime)))
> summary(exp2_mcq_subset_aov)
```

```
Error: Subject
          Df Sum Sq Mean Sq F value   Pr(>F)
AgeGroup   1 0.2348 0.23477   13.82 0.000435 ***
Residuals 62 1.0534 0.01699
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Subject:PrimeType
                    Df Sum Sq  Mean Sq F value Pr(>F)
PrimeType            3 0.0373 0.012425   1.252  0.292
AgeGroup:PrimeType   3 0.0265 0.008833   0.890  0.447
Residuals          186 1.8458 0.009924
```

```
Error: Subject:ChosenPrime
                    Df Sum Sq Mean Sq F value   Pr(>F)
ChosenPrime          1  2.529  2.5291  41.372 2.05e-08 ***
AgeGroup:ChosenPrime 1  0.062  0.0621   1.016    0.317
Residuals           62  3.790  0.0611
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Subject:PrimeType:ChosenPrime
                              Df Sum Sq Mean Sq F value   Pr(>F)
PrimeType:ChosenPrime          3  0.262  0.0875   0.710 0.547338
AgeGroup:PrimeType:ChosenPrime 3  2.467  0.8222   6.669 0.000267 ***
Residuals                    186 22.931  0.1233
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1
```

```
> library(ez)
> # ezANOVA(data = exp2_mcq_subset, wid = .(Subject),
> #         dv = .(Proportion), within =.(PrimeType, ChosenPrime),
> #         between = .(AgeGroup))
>
> options(contrasts = c('contr.sum', 'contr.poly'))
> exp2_errors_subset_lsm = lsmeans::lsmeans(exp2_mcq_subset_aov,
+                                           c("AgeGroup", "PrimeType", "ChosenPrime"))
> prime_effect = cld(exp2_errors_subset_lsm, alpha = 0.05,
+                 adjust = "tukey", details = TRUE, by = c("PrimeType", "ChosenPrime"))
> kable(subset(prime_effect$comparisons, prime_effect$comparisons$p.value < 0.05))
```

```
|   |contrast    |PrimeType |ChosenPrime |  estimate|        SE|        df|  t.ratio|
p.value|
|:--|:-----------|:---------|:-----------|---------:|---------:|---------:|--------:|----
|1  |Old - Young |b         |b           | 0.1390686| 0.0610935| 283.4801| 2.276325| 0.0
|2  |Old - Young |b         |r           | 0.1790249| 0.0610935| 283.4801| 2.930344| 0.0
|5  |Old - Young |r         |b           | 0.2871214| 0.0610935| 283.4801| 4.699706| 0.0
|6  |Old - Young |r         |r           | 0.1757002| 0.0610935| 283.4801| 2.875924| 0.0
```

10 Recoding RPBU to Sound Meaning

```
> for(i in 1: nrow(final_j)) {
+
+   if(final_j[i,5] == "Related"){
+     final_j[i,7] = "No"
+     final_j[i,8] = "Yes"
+   }
+   else if(final_j[i,5] == "Both"){
```

```
+      final_j[i,7] = "Yes"
+      final_j[i,8] = "Yes"
+    }
+
+    else if(final_j[i,5] == "Phonological"){
+      final_j[i,7] = "Yes"
+      final_j[i,8] = "No"
+
+    }
+    else {
+      final_j[i,7] = "No"
+      final_j[i,8] = "No"
+    }
+ }
> colnames(final_j) = c("AgeGroup", "Subject", "StudyNo", "PrimeInstruction", "PrimeCond
+                       "Accuracy", "Sound", "Meaning")
>
```

11 Collapsing the 4 experiments

```
> final_mcq_main4 = subset(final_mcq, final_mcq$StudyNo != '1')
> for (i in 1: nrow(final_mcq_main4)){
+    if(is.na(final_mcq_main4[i,7])){
+      final_mcq_main4[i,7] = 0
+    }
+ }
> fourway_aov = aov(data = final_mcq_main4, Proportion ~ AgeGroup*PrimeInstruction*Prime
> summary(fourway_aov)
```

```
Error: Subject
                            Df Sum Sq Mean Sq F value   Pr(>F)
AgeGroup                     1 0.2700 0.26998  39.117 5.15e-09 ***
PrimeInstruction             1 0.0201 0.02009   2.911   0.0903 .
AgeGroup:PrimeInstruction    1 0.0017 0.00165   0.239   0.6254
Residuals                  132 0.9111 0.00690
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Subject:PrimeType
                                      Df Sum Sq  Mean Sq F value Pr(>F)
PrimeType                              3 0.0103 0.003432   0.839  0.473
AgeGroup:PrimeType                     3 0.0227 0.007556   1.848  0.138
PrimeInstruction:PrimeType             3 0.0103 0.003435   0.840  0.473
AgeGroup:PrimeInstruction:PrimeType    3 0.0101 0.003361   0.822  0.482
Residuals                            396 1.6194 0.004089
```

```
Error: Subject:ChosenPrime
                                         Df  Sum Sq  Mean Sq   F value  Pr(>F)
ChosenPrime                               3   99.14    33.05  1090.679  <2e-16 ***
AgeGroup:ChosenPrime                      3    0.49     0.16     5.392  0.0012 **
PrimeInstruction:ChosenPrime              3    0.06     0.02     0.680  0.5649
AgeGroup:PrimeInstruction:ChosenPrime     3    0.02     0.01     0.190  0.9030
Residuals                               396   12.00     0.03
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Subject:PrimeType:ChosenPrime
                                                    Df  Sum Sq  Mean Sq F value
PrimeType:ChosenPrime                                9    1.39  0.15483   3.573
AgeGroup:PrimeType:ChosenPrime                       9    2.23  0.24759   5.714
PrimeInstruction:PrimeType:ChosenPrime               9    2.07  0.23039   5.317
AgeGroup:PrimeInstruction:PrimeType:ChosenPrime      9    0.75  0.08290   1.913
Residuals                                         1188   51.48  0.04333
                                                    Pr(>F)
PrimeType:ChosenPrime                             0.000213 ***
AgeGroup:PrimeType:ChosenPrime                    8.70e-08 ***
PrimeInstruction:PrimeType:ChosenPrime            3.84e-07 ***
AgeGroup:PrimeInstruction:PrimeType:ChosenPrime   0.046489 *
Residuals
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1
```

```
> library(ez)
> # ezANOVA(data = final_mcq_main4, wid = .(Subject),
> #         dv = .(Proportion), within =.(PrimeType, ChosenPrime),
> #         between = .(AgeGroup, PrimeInstruction)) ## IMPORTANT SPHERICITY
>
> options(contrasts = c('contr.sum', 'contr.poly'))
> fourway_lsm = lsmeans::lsmeans(fourway_aov,
+                              c("AgeGroup", "PrimeInstruction", "PrimeType", "Chos
> prime_effect = cld(fourway_lsm, alpha = 0.05,
+                    adjust = "tukey", details = TRUE, by = c("AgeGroup", "PrimeType", "Cho
> kable(subset(prime_effect$comparisons, prime_effect$comparisons$p.value < 0.05))
```

```
|   |contrast                       |AgeGroup |PrimeType |ChosenPrime |   estimate|
SE|        df|  t.ratio|   p.value|
|:--|:------------------------------|:--------|:---------|:-----------|----------:|---------
|17 |NoInstruction - NotThePrime |Young    |b         |b           |  0.2183051| 0.042950
|19 |NoInstruction - NotThePrime |Young    |b         |r           |  0.2253158| 0.042950
|25 |NoInstruction - NotThePrime |Young    |r         |b           |  0.1720295| 0.042950
|27 |NoInstruction - NotThePrime |Young    |r         |r           |  0.1517636| 0.042950
```

```
> ## SPECIFIC T-TEST
>
```

```
> ## Effect of Instruction on Young
>
> ## Semantic
>
> y_r = final_mcq_main4 %>% filter(AgeGroup == "Young" & PrimeType == "r")
> y_r_r_no = y_r %>% filter(PrimeInstruction == "NoInstruction" & ChosenPrime == "r")
> y_r_r_yes = y_r %>% filter(PrimeInstruction != "NoInstruction" & ChosenPrime == "r")
> t.test(y_r_r_no$Proportion, y_r_r_yes$Proportion)
```

```
        Welch Two Sample t-test

data:  y_r_r_no$Proportion and y_r_r_yes$Proportion
t = 2.1908, df = 59.19, p-value = 0.03241
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 0.01316032 0.29036684
sample estimates:
mean of x mean of y
0.5744779 0.4227143
```

```
> ## Both
>
> y_b = final_mcq_main4 %>% filter(AgeGroup == "Young" & PrimeType == "b")
> y_b_b_no = y_b %>% filter(PrimeInstruction == "NoInstruction" & ChosenPrime == "b")
> y_b_b_yes = y_b %>% filter(PrimeInstruction != "NoInstruction" & ChosenPrime == "b")
> t.test(y_b_b_no$Proportion, y_b_b_yes$Proportion)
```

```
        Welch Two Sample t-test

data:  y_b_b_no$Proportion and y_b_b_yes$Proportion
t = 3.8063, df = 63.702, p-value = 0.0003192
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 0.1037192 0.3328911
sample estimates:
mean of x mean of y
0.5081771 0.2898719
```

```
> ## Effect of Instruction on Old
>
> ## Semantic
> o_r = final_mcq_main4 %>% filter(AgeGroup == "Old" & PrimeType == "r")
> o_r_r_no = o_r %>% filter(PrimeInstruction == "NoInstruction" & ChosenPrime == "r")
> o_r_r_yes = o_r %>% filter(PrimeInstruction != "NoInstruction" & ChosenPrime == "r")
> t.test(o_r_r_no$Proportion, o_r_r_yes$Proportion)
```

```
        Welch Two Sample t-test
```

```
data:  o_r_r_no$Proportion and o_r_r_yes$Proportion
t = 1.3867, df = 65.932, p-value = 0.1702
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -0.02988145  0.16577001
sample estimates:
mean of x mean of y
0.6663588 0.5984145
```

```
> ## Both
>
> o_b = final_mcq_main4 %>% filter(AgeGroup == "Old" & PrimeType == "b")
> o_b_b_no = o_b %>% filter(PrimeInstruction == "NoInstruction" & ChosenPrime == "b")
> o_b_b_yes = o_b %>% filter(PrimeInstruction != "NoInstruction" & ChosenPrime == "b")
> t.test(o_b_b_no$Proportion, o_b_b_yes$Proportion)
```

```
        Welch Two Sample t-test

data:  o_b_b_no$Proportion and o_b_b_yes$Proportion
t = 0.38076, df = 64.995, p-value = 0.7046
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -0.09263325  0.13627479
sample estimates:
mean of x mean of y
0.4507613 0.4289405
```

```
>
>
>
```

12 Tables and Figures

Experiment 1

State data

```
> exp1_fig_state = Rmisc::summarySE(exp1_state_prime,
+                          measurevar = "Trials",
+                          groupvars = c("AgeGroup", "PrimeCondition", "State"))
> library(ggplot2)
> library(ggthemes)
> state_1 = exp1_fig_state %>% mutate(PrimeType = factor(PrimeCondition,
+                                                  levels = unique(PrimeCondition),
+                      labels = c("Both", "Phonological",
+                                 "Semantic", "Unrelated")),
```

```
+                    RetrievalState = factor(State, levels = unique(State),
+                            labels = c("Dont Know", "Know", "Other", "TOT")))%>%
+ ggplot(aes(x = PrimeType, y = Trials,
+                              fill = RetrievalState, group = RetrievalState))+
+  geom_bar(stat = "identity", position = "dodge", width = 0.7, color= "black")+
+   geom_errorbar(aes(ymin=Trials - ci, ymax=Trials + ci),
+              width=.2, color = "gray26",
+              position = position_dodge(0.7))+
+   facet_wrap(~AgeGroup)+
+  theme_few()+
+   scale_fill_colorblind()+
+     xlab("") + ylab("") +
+   ggtitle("E1: Young and Old Adults (Without Instructions)")  +
+   ggtitle("E1: Young vs. Old (Without Instructions)")  +
+    theme(axis.text = element_text(size = rel(1)),
+           axis.title = element_text(face = "bold", size = rel(1)),
+           legend.title = element_text(face = "bold", size = rel(1)),
+          plot.title = element_text(hjust = .5),
+          strip.text.x = element_text(face = "bold", size = rel(1.4)))
```

State by Prime

```
> exp1_fig_state_prime = Rmisc::summarySE(exp1_state_prime,
+                         measurevar = "Trials",
+                         groupvars = c("PrimeCondition","State"))
> library(ggplot2)
> library(ggthemes)
> state_1_prime = exp1_fig_state_prime %>% mutate(PrimeType =
+                                                  factor(PrimeCondition,
+                                                 levels = unique(PrimeCondition),
+                    labels = c("Both", "Phonological",
+                               "Semantic", "Unrelated")),
+                    RetrievalState = factor(State,
+                                    levels = unique(State),
+                            labels = c("Dont Know", "Know", "Other", "TOT")))%>%
+ ggplot(aes(x = PrimeType, y = Trials,
+           group = RetrievalState, fill = RetrievalState))+
+  geom_bar(stat = "identity", position = "dodge", width = 0.7, color= "black")+
+   geom_errorbar(aes(ymin=Trials - ci, ymax=Trials + ci),
+              width=.2, color = "gray26",
+              position = position_dodge(0.7))+
+  theme_few()+
+ scale_fill_colorblind()+
+   xlab("") + ylab("") +
+   ggtitle("E1: Young and Old Adults (Without Instructions)")  +
+    theme(axis.text = element_text(size = rel(1)),
+           axis.title = element_text(face = "bold", size = rel(1)),
```

```
+           legend.title = element_text(face = "bold", size = rel(1)),
+          plot.title = element_text(hjust = .5),
+          strip.text.x = element_text(face = "bold", size = rel(1.4)))
>
```

State ONLY

```
> exp1_fig_state_only = Rmisc::summarySE(exp1_state,
+                        measurevar = "Trials",
+                        groupvars = c("AgeGroup", "State"))
> exp1_fig_state_only =  arrange(exp1_fig_state_only,
+                                desc(AgeGroup))
> library(ggplot2)
> library(ggthemes)
> state_1_only = exp1_fig_state_only %>% mutate(RetrievalState = factor(State,
+                                     levels = unique(State),
+                            labels = c("Dont Know", "Know", "Other", "TOT")),
+                            Age = factor(AgeGroup, levels = unique(AgeGroup),
+                    labels = c("Young", "Old")))%>%
+ ggplot(aes(x = RetrievalState, y = Trials,
+            group = Age, fill = Age))+
+  geom_bar(stat = "identity", position = "dodge", width = 0.7, color= "black")+
+   geom_errorbar(aes(ymin=Trials - ci, ymax=Trials + ci),
+             width=.2, color = "gray26",
+             position = position_dodge(0.7))+
+  theme_few()+
+   scale_fill_manual(values = c("royalblue4", "slategray1"))+
+     xlab("") + ylab("") +
+   ggtitle("E1: Young and Old Adults (Without Instructions)")  +
+   ggtitle("E1: Young vs. Old (Without Instructions)")  +
+    theme(axis.text = element_text(size = rel(1)),
+           axis.title = element_text(face = "bold", size = rel(1)),
+           legend.title = element_text(face = "bold", size = rel(1)),
+          plot.title = element_text(hjust = .5),
+          strip.text.x = element_text(face = "bold", size = rel(1.4)))
>
```

State ONLY

```
> exp1_fig_state_only = Rmisc::summarySE(exp1_state,
+                        measurevar = "Trials",
+                        groupvars = c("AgeGroup", "State"))
> exp1_fig_state_only =  arrange(exp1_fig_state_only,
+                                desc(AgeGroup))
> library(ggplot2)
> library(ggthemes)
```

```
> state_1_only = exp1_fig_state_only %>% mutate(RetrievalState = factor(State,
+                                     levels = unique(State),
+                             labels = c("Dont Know", "Know", "Other", "TOT")),
+                             Age = factor(AgeGroup, levels = unique(AgeGroup),
+                     labels = c("Young", "Old")))%>%
+ ggplot(aes(x = RetrievalState, y = Trials,
+            group = Age, fill = Age))+
+  geom_bar(stat = "identity", position = "dodge", width = 0.7, color= "black")+
+   geom_errorbar(aes(ymin=Trials - ci, ymax=Trials + ci),
+              width=.2, color = "gray26",
+              position = position_dodge(0.7))+
+  theme_few()+
+   scale_fill_manual(values = c("royalblue4", "slategray1"))+
+     xlab("") + ylab("") +
+   ggtitle("E1: Young vs. Old (Without Instructions)")  +
+    theme(axis.text = element_text(size = rel(1)),
+           axis.title = element_text(face = "bold", size = rel(1)),
+           legend.title = element_text(face = "bold", size = rel(1)),
+          plot.title = element_text(hjust = .5),
+          strip.text.x = element_text(face = "bold", size = rel(1.4)))
```

Target Accuracy

```
> exp1_fig_target = Rmisc::summarySE(exp1_target,
+                         measurevar = "Accuracy",
+                         groupvars = c("AgeGroup", "primefac"))
> exp1_fig_target =  arrange(exp1_fig_target, desc(AgeGroup))
> library(ggplot2)
> library(ggthemes)
> targetacc_1 = exp1_fig_target %>% mutate(PrimeType = factor(primefac,
+                                                  levels = unique(primefac),
+                     labels = c("Both",      "Semantic",
+                           "Phonological",  "Unrelated")),
+                     Age = factor(AgeGroup, levels = unique(AgeGroup),
+                     labels = c("Young", "Old")))%>%
+ ggplot(aes(x = PrimeType, y = Accuracy,
+                              fill = Age, group = Age))+
+  geom_bar(stat = "identity", position = "dodge", width = 0.7, color = "black")+
+   geom_errorbar(aes(ymin=Accuracy - se, ymax=Accuracy + se),
+              width=.2, color = "gray26",
+              position = position_dodge(0.7))+
+  theme_few()+
+   scale_fill_manual(values = c("royalblue4", "slategray1"))+
+     xlab("") + ylab("Mean Target Accuracy") +
+   ggtitle("")  +
+   theme(axis.text = element_text(size = rel(1)),
+           axis.title = element_text(face = "bold", size = rel(1)),
```

```
+           legend.title = element_text(face = "bold", size = rel(1.2)),
+          plot.title = element_text(hjust = .5),
+           legend.text = element_text(face = "bold", size = rel(1.1)),
+          axis.text.x = element_text(face = "bold", size = rel(1.2)),
+          strip.text.x = element_text(face = "bold", size = rel(1.4)))
```

For masters presentation

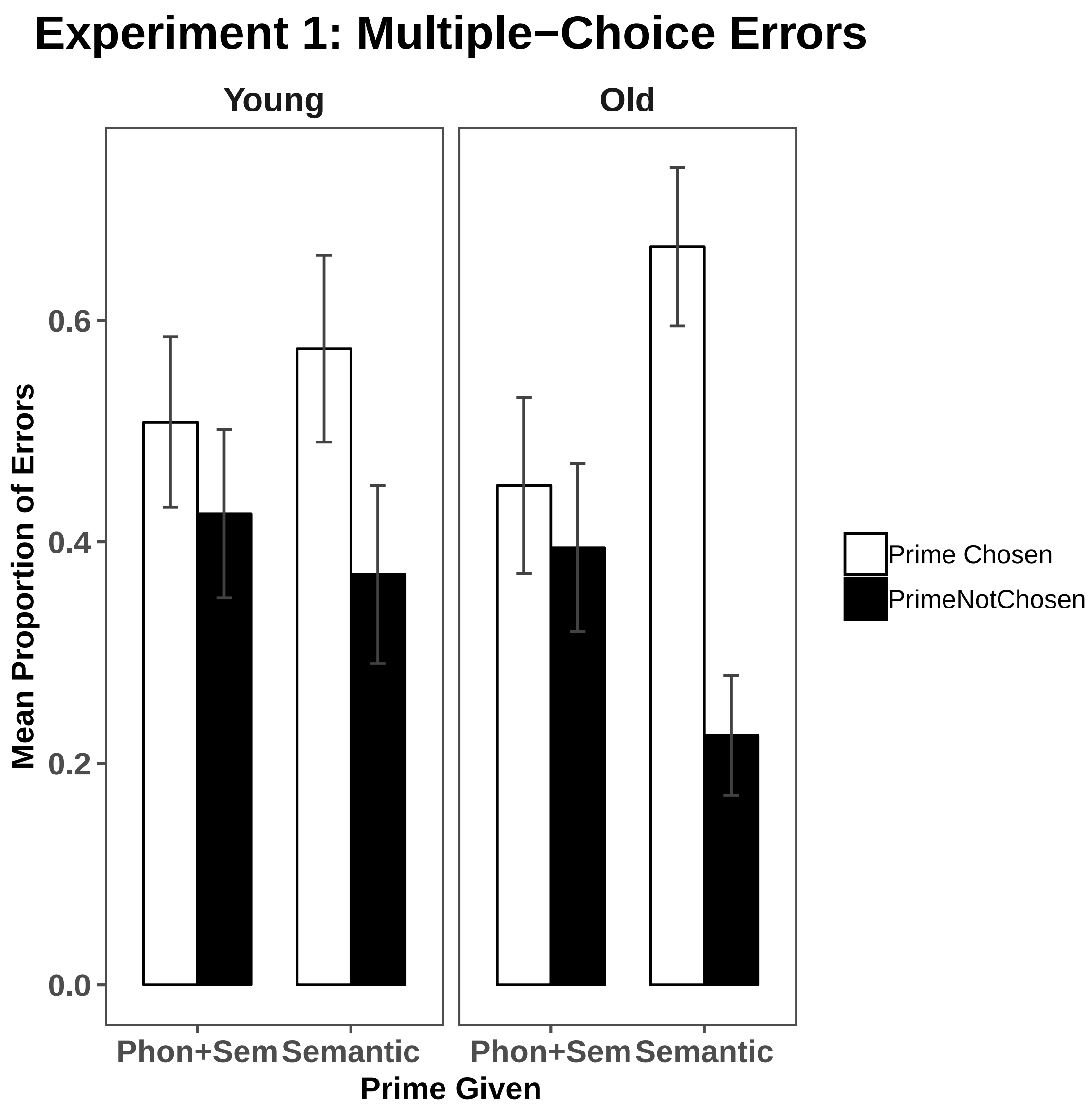
```
> exp1_fig_target = Rmisc::summarySE(exp1_target,
+                         measurevar = "Accuracy",
+                         groupvars = c("agefac", "primefac"))
> exp1_fig_target =  arrange(exp1_fig_target, desc(agefac))
> library(ggplot2)
> library(ggthemes)
> targetacc_1 = exp1_fig_target %>% mutate(PrimeType = factor(primefac,
+                                              levels = unique(primefac),
+                    labels = c("Both",      "Semantic",
+                          "Phonological",  "Unrelated")),
+                    Age = factor(agefac, levels = unique(agefac),
+                    labels = c("Young", "Old")))%>%
+ ggplot(aes(x = Age, y = Accuracy,
+                              fill = PrimeType, group = PrimeType))+
+  geom_bar(stat = "identity", position = "dodge", width = 0.7, color = "black")+
+   geom_errorbar(aes(ymin=Accuracy - se, ymax=Accuracy + se),
+              width=.2, color = "gray26",
+              position = position_dodge(0.7))+
+  theme_few()+
+  scale_fill_manual(values = c( "lightsalmon", "red",
+                               "paleturquoise3","lightgreen"))+
+   xlab("") + ylab("Mean Target Accuracy") +
+   ggtitle("")  +
+   theme(axis.text = element_text(size = rel(1)),
+           axis.title = element_text(face = "bold", size = rel(1)),
+           legend.title = element_text(face = "bold", size = rel(1.2)),
+          plot.title = element_text(hjust = .5),
+           legend.text = element_text(face = "bold", size = rel(1.1)),
+          axis.text.x = element_text(face = "bold", size = rel(1.2)),
+          strip.text.x = element_text(face = "bold", size = rel(1.4)))
```

MCQ Table

```
> ## CODE BELOW IS IF WE WANT MCQ NUMBERS FOR SAME/DIFFERENT PRIME CHOICE
> # for(i in 1:nrow(exp1_mcq)){
> #   if(exp1_mcq[i,"PrimeType"] == exp1_mcq[i,"ChosenPrime"]){
> #     exp1_mcq[i,"MCQChoice"] = "Same"
> #   }
```

```
> #    else {
> #      exp1_mcq[i,"MCQChoice"] = "Different"
> #    }
> #
> # }
> #
> # e1_mcq_yn = group_by(exp1_mcq, Subject, AgeGroup, StudyNo,
> #                             PrimeType, MCQChoice) %>%
> #                       summarise_at(vars(Proportion), sum)
> # library(Rmisc)
> # e1_mcq_agg_yn = summarySE(e1_mcq_agg,
> #                           measurevar = "Proportion",
> #                           groupvars = c("AgeGroup", "PrimeType", "MCQChoice"))
>
> ## CODE BELOW ONLY FOR R AND B CHOICES in MCQ
>
> e1_mcq_agg = Rmisc::summarySE(exp1_mcq,
+                         measurevar = "Proportion",
+                         groupvars = c("AgeGroup", "PrimeType", "ChosenPrime"))
> e1_mcq_main = e1_mcq_agg %>% filter(PrimeType %in% c("b", "r") &
+                                       ChosenPrime %in% c("b", "r"))
> e1_mcq_main$ChoseThePrime = c("1_Yes", "2_No", "2_No", "1_Yes",
+                              "1_Yes", "2_No", "2_No", "1_Yes")
> e1_mcq_main = dplyr::arrange(e1_mcq_main, desc(AgeGroup))
> library(ggplot2)
> library(ggthemes)
> e1_mcq_main %>% mutate(PrimeCondition = factor(PrimeType,
+                                         levels = unique(PrimeType),
+                    labels = c("Phon+Sem","Semantic")),
+                    Choice = factor(ChoseThePrime,
+                                         levels = unique(ChoseThePrime),
+                    labels = c("Prime Chosen","PrimeNotChosen")),
+                    Age = factor(AgeGroup, levels = unique(AgeGroup),
+                    labels = c("Young", "Old")))%>%
+ ggplot(aes(x = PrimeCondition, y = Proportion,
+                              fill = Choice, group = Choice))+
+  geom_bar(stat = "identity", position = "dodge", width = 0.7, color = "black")+
+   geom_errorbar(aes(ymin=Proportion - ci, ymax=Proportion + ci),
+               width=.2, color = "gray26",
+               position = position_dodge(0.7))+
+   facet_wrap(~Age)+
+  theme_few()+
+   scale_fill_manual(values = c("white", "black"))+
+     xlab("Prime Given") + ylab("Mean Proportion of Errors") +
+   ggtitle("Experiment 1: Multiple-Choice Errors")  +
+    theme(axis.text = element_text(face = "bold", size = rel(1)),
+           axis.title = element_text(face = "bold", size = rel(1)),
+           legend.title = element_blank(),
```

```
+           plot.title = element_text(face = "bold", size = rel(1.5), hjust = .5),
+          strip.text.x = element_text(face = "bold", size = rel(1.4)))
>
> ## Stored and formatted in excel file: JuliePaperTables.xlsx
```



Experiment 2

State data

```
> exp1_fig_state = Rmisc::summarySE(exp2_state_prime,
+                            measurevar = "Trials",
```

```
+                          groupvars = c("AgeGroup", "PrimeCondition", "State"))
> library(ggplot2)
> library(ggthemes)
> state_2 = exp1_fig_state %>% mutate(PrimeType = factor(PrimeCondition,
+                                                   levels = unique(PrimeCondition),
+                     labels = c("Both", "Phonological",
+                                "Semantic", "Unrelated")),
+                     RetrievalState = factor(State, levels = unique(State),
+                             labels = c("Dont Know", "Know", "Other", "TOT")))%>%
+ ggplot(aes(x = PrimeType, y = Trials,
+                               fill = RetrievalState, group = RetrievalState))+
+  geom_bar(stat = "identity", position = "dodge", width = 0.7, color= "black")+
+   geom_errorbar(aes(ymin=Trials - ci, ymax=Trials + ci),
+              width=.2, color = "gray26",
+              position = position_dodge(0.7))+
+   facet_wrap(~AgeGroup)+
+  theme_few()+
+  scale_fill_colorblind()+
+     xlab("") + ylab("Mean Number of Trials") +
+   ggtitle("E2: Young and Old Adults (With Instructions)")  +
+    theme(axis.text = element_text(size = rel(1)),
+           axis.title = element_text(face = "bold", size = rel(1)),
+           legend.title = element_text(face = "bold", size = rel(1)),
+          plot.title = element_text(hjust = .5),
+          strip.text.x = element_text(face = "bold", size = rel(1.4)))
```

State by Prime

```
> exp2_fig_state_prime = Rmisc::summarySE(exp2_state_prime,
+                          measurevar = "Trials",
+                          groupvars = c("PrimeCondition","State"))
> library(ggplot2)
> library(ggthemes)
> state_2_prime = exp2_fig_state_prime %>% mutate(PrimeType =
+                                                    factor(PrimeCondition,
+                                                   levels = unique(PrimeCondition),
+                     labels = c("Both", "Phonological",
+                                "Semantic", "Unrelated")),
+                     RetrievalState = factor(State,
+                                     levels = unique(State),
+                             labels = c("Dont Know", "Know", "Other", "TOT")))%>%
+ ggplot(aes(x = PrimeType, y = Trials,
+            group = RetrievalState, fill = RetrievalState))+
+  geom_bar(stat = "identity", position = "dodge", width = 0.7, color= "black")+
+   geom_errorbar(aes(ymin=Trials - ci, ymax=Trials + ci),
+              width=.2, color = "gray26",
+              position = position_dodge(0.7))+
```

```
+  theme_few()+
+ scale_fill_colorblind()+
+    xlab("") + ylab("Mean Number of Trials") +
+   ggtitle("E2: Young and Old Adults (With Instructions)")  +
+    theme(axis.text = element_text(size = rel(1)),
+           axis.title = element_text(face = "bold", size = rel(1)),
+           legend.title = element_text(face = "bold", size = rel(1)),
+          plot.title = element_text(hjust = .5),
+          strip.text.x = element_text(face = "bold", size = rel(1.4)))
```

State ONLY

```
> exp2_fig_state_only = Rmisc::summarySE(exp2_state,
+                          measurevar = "Trials",
+                          groupvars = c("AgeGroup", "State"))
> exp2_fig_state_only =  arrange(exp2_fig_state_only,
+                                 desc(AgeGroup))
> library(ggplot2)
> library(ggthemes)
> state_2_only = exp2_fig_state_only %>% mutate(RetrievalState = factor(State,
+                                      levels = unique(State),
+                               labels = c("Dont Know", "Know", "Other", "TOT")),
+                               Age = factor(AgeGroup, levels = unique(AgeGroup),
+                        labels = c("Young", "Old")))%>%
+ ggplot(aes(x = RetrievalState, y = Trials,
+            group = Age, fill = Age))+
+  geom_bar(stat = "identity", position = "dodge", width = 0.7, color= "black")+
+   geom_errorbar(aes(ymin=Trials - ci, ymax=Trials + ci),
+              width=.2, color = "gray26",
+              position = position_dodge(0.7))+
+  theme_few()+
+   scale_fill_manual(values = c("royalblue4", "slategray1"))+
+    xlab("") + ylab("Mean Number of Trials") +
+   ggtitle("E2: Young and Old Adults (With Instructions)")  +
+   ggtitle("E2: Young vs. Old (With Instructions)")  +
+    theme(axis.text = element_text(size = rel(1)),
+           axis.title = element_text(face = "bold", size = rel(1)),
+           legend.title = element_text(face = "bold", size = rel(1)),
+          plot.title = element_text(hjust = .5),
+          strip.text.x = element_text(face = "bold", size = rel(1.4)))
```

State by Prime

```
> exp2_fig_state_prime = Rmisc::summarySE(exp2_state_prime,
+                          measurevar = "Trials",
+                          groupvars = c("PrimeCondition","State"))
```

```
> library(ggplot2)
> library(ggthemes)
> state_2_prime = exp2_fig_state_prime %>% mutate(PrimeType =
+                                                 factor(PrimeCondition,
+                                                 levels = unique(PrimeCondition),
+                   labels = c("Both", "Phonological",
+                              "Semantic", "Unrelated")),
+                   RetrievalState = factor(State,
+                                   levels = unique(State),
+                           labels = c("Dont Know", "Know", "Other", "TOT")))%>%
+ ggplot(aes(x = PrimeType, y = Trials,
+            group = RetrievalState, fill = RetrievalState))+
+  geom_bar(stat = "identity", position = "dodge", width = 0.7, color= "black")+
+   geom_errorbar(aes(ymin=Trials - ci, ymax=Trials + ci),
+              width=.2, color = "gray26",
+              position = position_dodge(0.7))+
+  theme_few()+
+ scale_fill_colorblind()+
+    xlab("") + ylab("Mean Number of Trials") +
+   ggtitle("E2: Young vs. Old (With Instructions)")  +
+    theme(axis.text = element_text(size = rel(1)),
+           axis.title = element_text(face = "bold", size = rel(1)),
+           legend.title = element_text(face = "bold", size = rel(1)),
+          plot.title = element_text(hjust = .5),
+          strip.text.x = element_text(face = "bold", size = rel(1.4)))
```

State ONLY

```
> exp2_fig_state_only = Rmisc::summarySE(exp2_state,
+                         measurevar = "Trials",
+                         groupvars = c("AgeGroup", "State"))
> exp2_fig_state_only =  arrange(exp2_fig_state_only,
+                              desc(AgeGroup))
> library(ggplot2)
> library(ggthemes)
> state_2_only = exp2_fig_state_only %>% mutate(RetrievalState = factor(State,
+                                   levels = unique(State),
+                           labels = c("Dont Know", "Know", "Other", "TOT")),
+                           Age = factor(AgeGroup, levels = unique(AgeGroup),
+                   labels = c("Young", "Old")))%>%
+ ggplot(aes(x = RetrievalState, y = Trials,
+            group = Age, fill = Age))+
+  geom_bar(stat = "identity", position = "dodge", width = 0.7, color= "black")+
+   geom_errorbar(aes(ymin=Trials - ci, ymax=Trials + ci),
+              width=.2, color = "gray26",
+              position = position_dodge(0.7))+
+  theme_few()+
```

```
+   scale_fill_manual(values = c("royalblue4", "slategray1"))+
+     xlab("") + ylab("") +
+   ggtitle("E2: Young vs. Old (With Instructions)")  +
+    theme(axis.text = element_text(size = rel(1)),
+           axis.title = element_text(face = "bold", size = rel(1)),
+           legend.title = element_text(face = "bold", size = rel(1)),
+          plot.title = element_text(hjust = .5),
+          strip.text.x = element_text(face = "bold", size = rel(1.4)))
```

Target Accuracy

```
> exp2_fig_target = Rmisc::summarySE(exp2_target,
+                         measurevar = "Accuracy",
+                         groupvars = c("AgeGroup", "PrimeCondition"))
> exp2_fig_target =  arrange(exp2_fig_target,desc(AgeGroup))
> library(ggplot2)
> library(ggthemes)
> targetacc_2 = exp2_fig_target %>% mutate(PrimeType = factor(PrimeCondition,
+                                                 levels = unique(PrimeCondition),
+                     labels = c("Both", "Phonological",
+                                "Semantic", "Unrelated")),
+                     Age = factor(AgeGroup, levels = unique(AgeGroup),
+                     labels = c("Young", "Old")))%>%
+ ggplot(aes(x = PrimeType, y = Accuracy,
+                               fill = Age, group = Age))+
+  geom_bar(stat = "identity", position = "dodge", width = 0.7, color = "black")+
+   geom_errorbar(aes(ymin=Accuracy - se, ymax=Accuracy + se),
+              width=.2, color = "gray26",
+              position = position_dodge(0.7))+
+  theme_few()+
+   scale_fill_manual(values = c("royalblue4", "slategray1"))+
+    xlab("") + ylab("Mean Target Accuracy") +
+   ggtitle("Young and Old Adults (With Instructions)")  +
+    theme(axis.text = element_text(size = rel(1)),
+           axis.title = element_text(face = "bold", size = rel(1)),
+           legend.title = element_text(face = "bold", size = rel(1.2)),
+          plot.title = element_text(hjust = .5),
+           legend.text = element_text(face = "bold", size = rel(1.1)),
+          axis.text.x = element_text(face = "bold", size = rel(1.2)),
+          strip.text.x = element_text(face = "bold", size = rel(1.4)))
```

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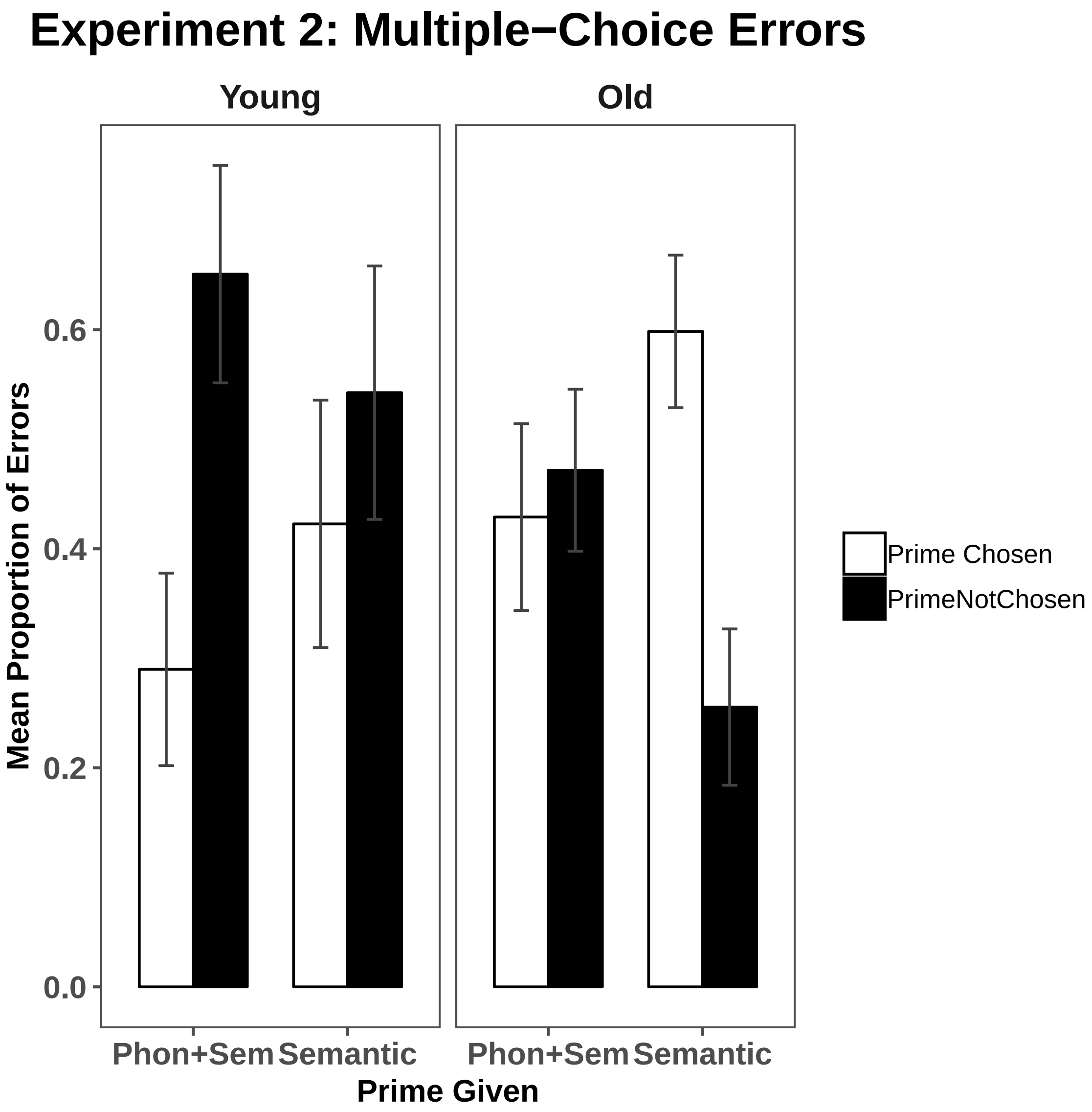
```
> exp2_fig_target = Rmisc::summarySE(exp2_target,
+                         measurevar = "Accuracy",
+                         groupvars = c("agefac", "primefac"))
```

```
> exp2_fig_target =  arrange(exp2_fig_target, desc(agefac))
> library(ggplot2)
> library(ggthemes)
> targetacc_2 = exp2_fig_target %>% mutate(PrimeType = factor(primefac,
+                                                   levels = unique(primefac),
+                    labels = c("Both",      "Semantic",
+                          "Phonological",  "Unrelated")),
+                    Age = factor(agefac, levels = unique(agefac),
+                    labels = c("Young", "Old")))%>%
+ ggplot(aes(x = Age, y = Accuracy,
+                              fill = PrimeType, group = PrimeType))+
+  geom_bar(stat = "identity", position = "dodge", width = 0.7, color = "black")+
+   geom_errorbar(aes(ymin=Accuracy - se, ymax=Accuracy + se),
+              width=.2, color = "gray26",
+              position = position_dodge(0.7))+
+  theme_few()+
+  scale_fill_manual(values = c( "lightsalmon", "red",
+                                "paleturquoise3","lightgreen"))+
+   xlab("") + ylab("Mean Target Accuracy") +
+   ggtitle("")  +
+   theme(axis.text = element_text(size = rel(1)),
+           axis.title = element_text(face = "bold", size = rel(1)),
+           legend.title = element_text(face = "bold", size = rel(1.2)),
+          plot.title = element_text(hjust = .5),
+           legend.text = element_text(face = "bold", size = rel(1.1)),
+          axis.text.x = element_text(face = "bold", size = rel(1.2)),
+          strip.text.x = element_text(face = "bold", size = rel(1.4)))
```

MCQ Table

```
> e2_mcq_agg = Rmisc::summarySE(exp2_mcq,
+                         measurevar = "Proportion",
+                         groupvars = c("AgeGroup", "PrimeType", "ChosenPrime"))
> e2_mcq_main = e2_mcq_agg %>% filter(PrimeType %in% c("b", "r") &
+                                             ChosenPrime %in% c("b", "r"))
> e2_mcq_main$ChoseThePrime = c("1_Yes", "2_No", "2_No", "1_Yes",
+                               "1_Yes", "2_No", "2_No", "1_Yes")
> e2_mcq_main = arrange(e2_mcq_main, desc(AgeGroup))
> library(ggplot2)
> library(ggthemes)
> e2_mcq_main %>% mutate(PrimeCondition = factor(PrimeType,
+                                                   levels = unique(PrimeType),
+                    labels = c("Phon+Sem","Semantic")),
+                    Choice = factor(ChoseThePrime,
+                                                   levels = unique(ChoseThePrime),
+                    labels = c("Prime Chosen","PrimeNotChosen")),
+                    Age = factor(AgeGroup, levels = unique(AgeGroup),
```

```
+                         labels = c("Young", "Old")))%>%
+ ggplot(aes(x = PrimeCondition, y = Proportion,
+                                    fill = Choice, group = Choice))+
+  geom_bar(stat = "identity", position = "dodge", width = 0.7, color = "black")+
+   geom_errorbar(aes(ymin=Proportion - ci, ymax=Proportion + ci),
+                width=.2, color = "gray26",
+                position = position_dodge(0.7))+
+   facet_wrap(~Age)+
+  theme_few()+
+   scale_fill_manual(values = c("white", "black"))+
+     xlab("Prime Given") + ylab("Mean Proportion of Errors") +
+   ggtitle("Experiment 2: Multiple-Choice Errors")  +
+    theme(axis.text = element_text(face = "bold", size = rel(1)),
+           axis.title = element_text(face = "bold", size = rel(1)),
+           legend.title = element_blank(),
+           plot.title = element_text(face = "bold", size = rel(1.5), hjust = .5),
+          strip.text.x = element_text(face = "bold", size = rel(1.4)))
>
> ## Stored and formatted in excel file: JuliePaperTables.xlsx
>
```



Experiment 3

State data

```
> exp3_fig_state =Rmisc::summarySE(exp3_state_prime,
+                             measurevar = "Trials",
+                             groupvars = c("AgeGroup", "PrimeCondition", "State"))
> library(ggplot2)
> library(ggthemes)
> state_3 = exp3_fig_state %>% mutate(PrimeType = factor(PrimeCondition,
+                                                    levels = unique(PrimeCondition),
```

```
+                     labels = c("Both", "Phonological",
+                                "Semantic", "Unrelated")),
+                     RetrievalState = factor(State, levels = unique(State),
+                             labels = c("Dont Know", "Know", "Other", "TOT")))%>%
+ ggplot(aes(x = PrimeType, y = Trials,
+                               fill = RetrievalState, group = RetrievalState))+
+  geom_bar(stat = "identity", position = "dodge", width = 0.7, color= "black")+
+   geom_errorbar(aes(ymin=Trials - ci, ymax=Trials + ci),
+              width=.2, color = "gray26",
+              position = position_dodge(0.7))+
+  theme_few()+
+  scale_fill_colorblind()+
+     xlab("Prime Condition") + ylab("") +
+   ggtitle("E3: Young Adults (Threshold Priming: 48 ms)")  +
+   ggtitle("E3: Young (Threshold Priming: 48 ms)")  +
+    theme(axis.text = element_text(size = rel(1)),
+           axis.title = element_text(face = "bold", size = rel(1)),
+           legend.title = element_text(face = "bold", size = rel(1)),
+          plot.title = element_text(hjust = .5),
+          strip.text.x = element_text(face = "bold", size = rel(1.4)))
```

State by Prime

```
> exp3_fig_state_prime = Rmisc::summarySE(exp3_state_prime,
+                         measurevar = "Trials",
+                         groupvars = c("PrimeCondition","State"))
> library(ggplot2)
> library(ggthemes)
> state_3_prime = exp3_fig_state_prime %>% mutate(PrimeType =
+                                                  factor(PrimeCondition,
+                                                 levels = unique(PrimeCondition),
+                     labels = c("Both", "Phonological",
+                                "Semantic", "Unrelated")),
+                     RetrievalState = factor(State,
+                                     levels = unique(State),
+                             labels = c("Dont Know", "Know", "Other", "TOT")))%>%
+ ggplot(aes(x = PrimeType, y = Trials,
+           group = RetrievalState, fill = RetrievalState))+
+  geom_bar(stat = "identity", position = "dodge", width = 0.7, color= "black")+
+   geom_errorbar(aes(ymin=Trials - ci, ymax=Trials + ci),
+              width=.2, color = "gray26",
+              position = position_dodge(0.7))+
+  theme_few()+
+ scale_fill_colorblind()+
+     xlab("Prime Condition") + ylab("") +
+   ggtitle("E3: Young Adults (Threshold Priming: 48 ms)")  +
+    theme(axis.text = element_text(size = rel(1)),
```

```
+            axis.title = element_text(face = "bold", size = rel(1)),
+            legend.title = element_text(face = "bold", size = rel(1)),
+           plot.title = element_text(hjust = .5),
+           strip.text.x = element_text(face = "bold", size = rel(1.4)))
```

State ONLY

```
> exp3_fig_state_only = Rmisc::summarySE(exp3_state,
+                            measurevar = "Trials",
+                            groupvars = c("AgeGroup", "State"))
> library(ggplot2)
> library(ggthemes)
> state_3_only = exp3_fig_state_only %>% mutate(RetrievalState = factor(State,
+                                        levels = unique(State),
+                                labels = c("Dont Know", "Know", "Other", "TOT")),
+                        Age = factor(AgeGroup, levels = unique(AgeGroup),
+                        labels = c("Young")))%>%
+ ggplot(aes(x = RetrievalState, y = Trials,
+            fill = Age, group = Age))+
+  geom_bar(stat = "identity", position = "dodge", width = 0.7,
+           color= "black")+
+   geom_errorbar(aes(ymin=Trials - ci, ymax=Trials + ci),
+              width=.2, color = "gray26",
+              position = position_dodge(0.7))+
+       scale_fill_manual(values = c("royalblue4"))+
+  theme_few()+
+     xlab("") + ylab("") +
+   ggtitle("E3: Young Adults (Threshold Priming: 48 ms)")  +
+   ggtitle("E3: Young (Threshold Priming: 48 ms)")  +
+    theme(axis.text = element_text(size = rel(1)),
+            axis.title = element_text(face = "bold", size = rel(1)),
+            legend.title = element_text(face = "bold", size = rel(1)),
+           plot.title = element_text(hjust = .5),
+           strip.text.x = element_text(face = "bold", size = rel(1.4)))
```

State ONLY

```
> exp3_fig_state_only = Rmisc::summarySE(exp3_state,
+                            measurevar = "Trials",
+                            groupvars = c("AgeGroup", "State"))
> library(ggplot2)
> library(ggthemes)
> state_3_only = exp3_fig_state_only %>% mutate(RetrievalState = factor(State,
+                                        levels = unique(State),
+                                labels = c("Dont Know", "Know", "Other", "TOT")),
+                        Age = factor(AgeGroup, levels = unique(AgeGroup),
```

```
+                     labels = c("Young")))%>%
+ ggplot(aes(x = RetrievalState, y = Trials,
+            fill = Age, group = Age))+
+  geom_bar(stat = "identity", position = "dodge", width = 0.7,
+          color= "black")+
+   geom_errorbar(aes(ymin=Trials - ci, ymax=Trials + ci),
+             width=.2, color = "gray26",
+             position = position_dodge(0.7))+
+      scale_fill_manual(values = c("royalblue4"))+
+  theme_few()+
+     xlab("") + ylab("") +
+   ggtitle("E3: Young (48 ms)")  +
+    theme(axis.text = element_text(size = rel(1)),
+           axis.title = element_text(face = "bold", size = rel(1)),
+           legend.title = element_text(face = "bold", size = rel(1)),
+          plot.title = element_text(hjust = .5),
+          strip.text.x = element_text(face = "bold", size = rel(1.4)))
```

Target Accuracy

```
> exp3_fig_target = Rmisc::summarySE(exp3_target,
+                         measurevar = "Accuracy",
+                         groupvars = c("AgeGroup", "PrimeCondition"))
> library(ggplot2)
> library(ggthemes)
> targetacc_3 = exp3_fig_target %>% mutate(PrimeType = factor(PrimeCondition,
+                                                  levels = unique(PrimeCondition),
+                     labels = c("Both", "Phonological",
+                                "Semantic", "Unrelated")),
+                     Age = factor(AgeGroup, levels = unique(AgeGroup),
+                     labels = c("Young")))%>%
+ ggplot(aes(x = PrimeType, y = Accuracy, fill = Age, group = Age))+
+  geom_bar(stat = "identity", position = "dodge", width = 0.7, color = "black")+
+    geom_errorbar(aes(ymin=Accuracy - se, ymax=Accuracy + se),
+             width=.2, color = "gray26",
+             position = position_dodge(0.7))+
+  theme_few()+
+   scale_fill_manual(values = c("royalblue4", "slategray1"))+
+   #scale_fill_manual(values = c("darkred", "forestgreen"))+
+    xlab("") + ylab("Mean Target Accuracy") +
+   ggtitle("")  +
+    theme(axis.text = element_text(size = rel(1)),
+           axis.title = element_text(face = "bold", size = rel(1)),
+           legend.title = element_text(face = "bold", size = rel(1.2)),
+          plot.title = element_text(hjust = .5),
+           legend.text = element_text(face = "bold", size = rel(1.1)),
+          axis.text.x = element_text(face = "bold", size = rel(1.2)),
```

```
+          strip.text.x = element_text(face = "bold", size = rel(1.4)))
```

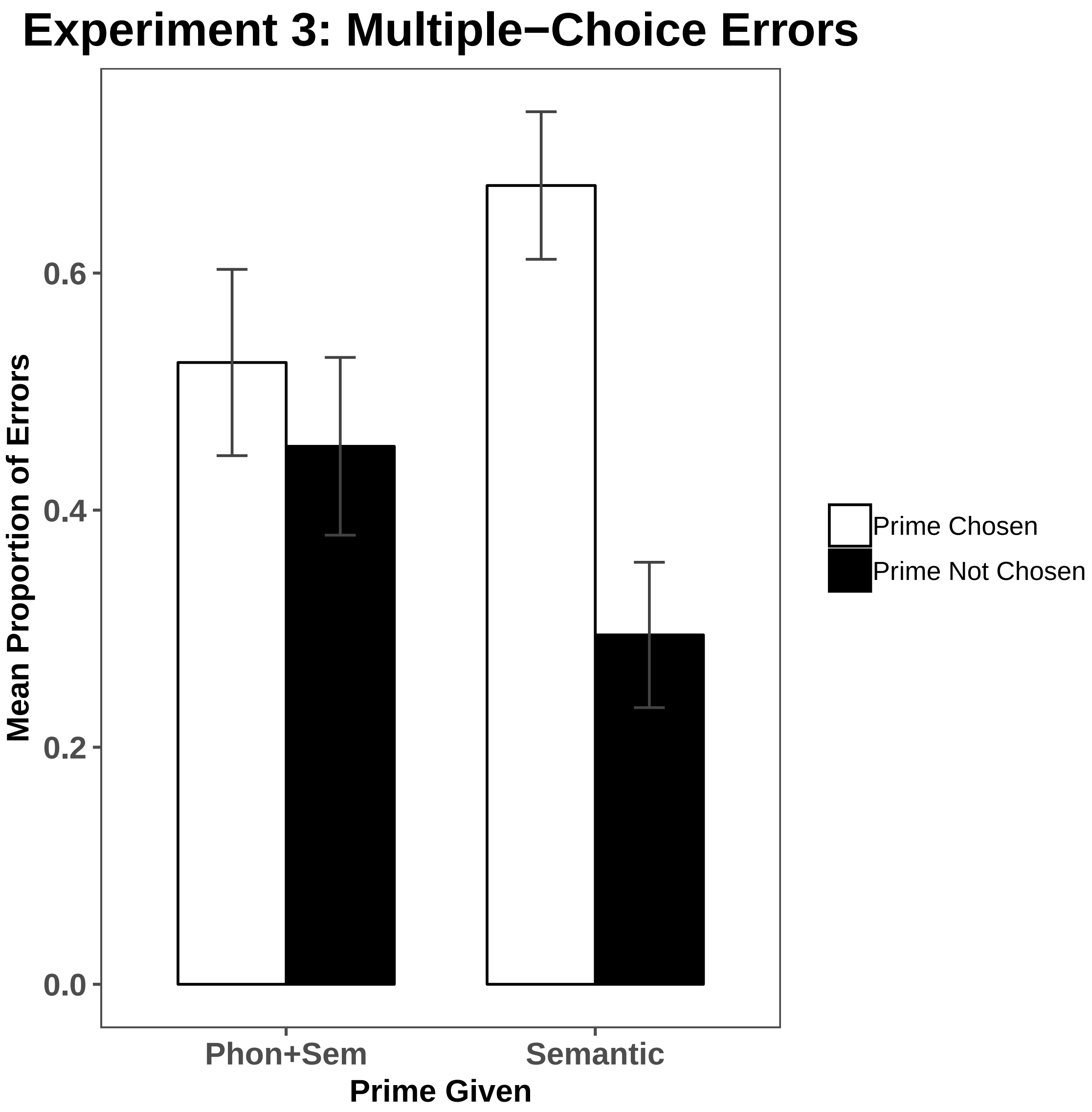
For masters presentation

```
> exp3_fig_target = Rmisc::summarySE(exp3_target,
+                         measurevar = "Accuracy",
+                         groupvars = c("agefac", "primefac"))
> exp3_fig_target =  arrange(exp3_fig_target, desc(agefac))
> library(ggplot2)
> library(ggthemes)
> targetacc_3 = exp3_fig_target %>% mutate(PrimeType = factor(primefac,
+                                                  levels = unique(primefac),
+                    labels = c("Both",      "Semantic",
+                          "Phonological",  "Unrelated")),
+                    Age = factor(agefac, levels = unique(agefac),
+                    labels = c("Young")))%>%
+ ggplot(aes(x = Age, y = Accuracy,
+                               fill = PrimeType, group = PrimeType))+
+  geom_bar(stat = "identity", position = "dodge", width = 0.7, color = "black")+
+   geom_errorbar(aes(ymin=Accuracy - se, ymax=Accuracy + se),
+              width=.2, color = "gray26",
+              position = position_dodge(0.7))+
+  theme_few()+
+  scale_fill_manual(values = c( "lightsalmon", "red",
+                                "paleturquoise3","lightgreen"))+
+   xlab("") + ylab("Mean Target Accuracy") +
+   ggtitle("")  +
+   theme(axis.text = element_text(size = rel(1)),
+           axis.title = element_text(face = "bold", size = rel(1)),
+           legend.title = element_text(face = "bold", size = rel(1.2)),
+          plot.title = element_text(hjust = .5),
+           legend.text = element_text(face = "bold", size = rel(1.1)),
+          axis.text.x = element_text(face = "bold", size = rel(1.2)),
+          strip.text.x = element_text(face = "bold", size = rel(1.4)))
```

MCQ Table

```
> e3_mcqoverall_agg = group_by(exp3_mcq, AgeGroup, PrimeType, ChosenPrime)%>%
+   summarise_at(vars(MCQAcc), mean)
> ## Plotting
>
> e3_mcq_agg = Rmisc::summarySE(exp3_mcq,
+                         measurevar = "Proportion",
+                         groupvars = c("PrimeType", "ChosenPrime"))
> e3_mcq_main = e3_mcq_agg %>% filter(PrimeType %in% c("b", "r") &
+                                             ChosenPrime %in% c("b", "r"))
```

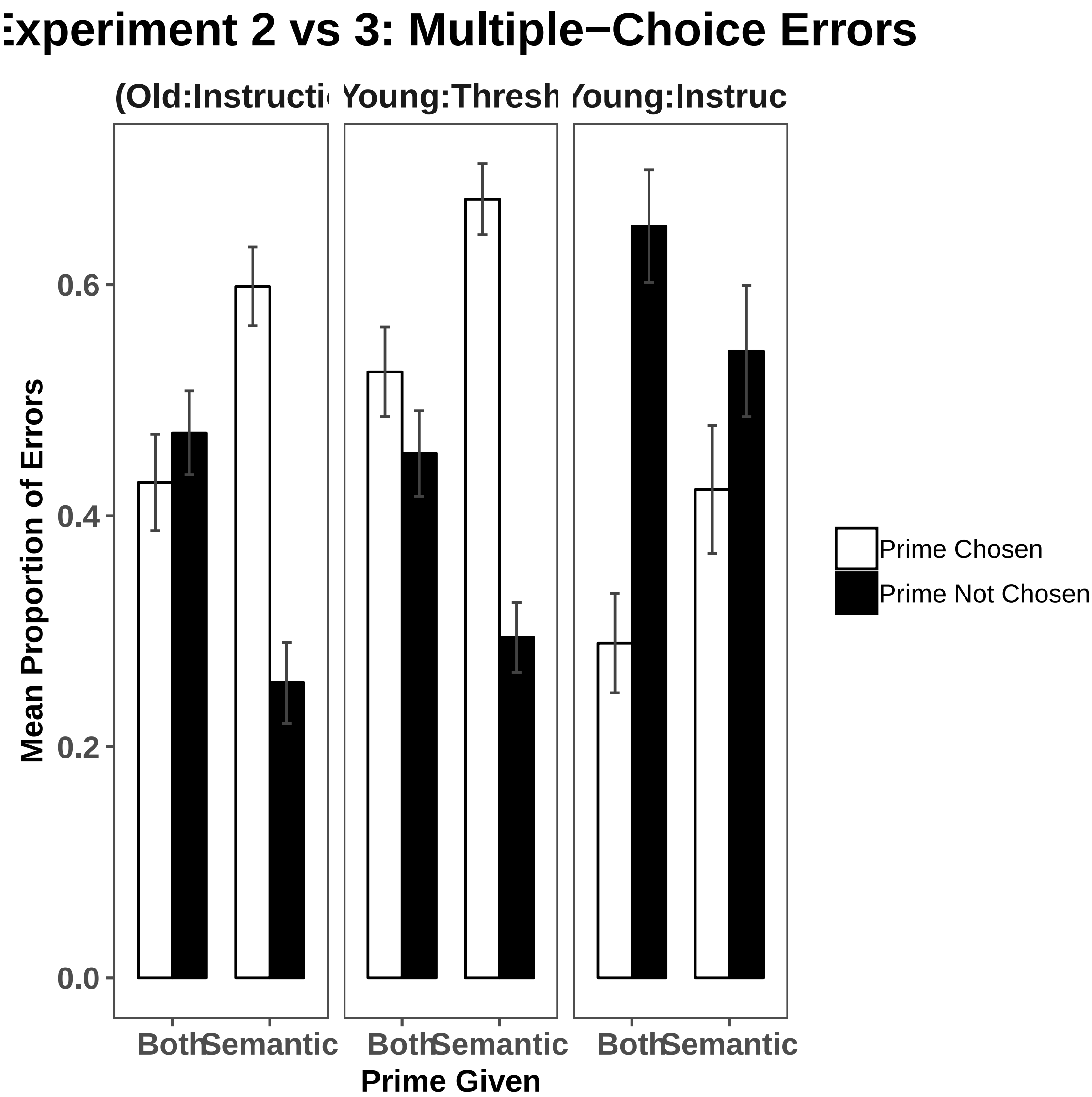
```
> e3_mcq_main$ChoseThePrime = c("1_Yes", "2_No", "2_No", "1_Yes")
> library(ggplot2)
> library(ggthemes)
> e3_mcq_main %>% mutate(PrimeCondition = factor(PrimeType,
+                                                levels = unique(PrimeType),
+                     labels = c("Phon+Sem","Semantic")),
+                     Choice = factor(ChoseThePrime,
+                                                levels = unique(ChoseThePrime),
+                     labels = c("Prime Chosen","Prime Not Chosen")))%>%
+ ggplot(aes(x = PrimeCondition, y = Proportion,
+                               fill = Choice, group = Choice))+
+  geom_bar(stat = "identity", position = "dodge", width = 0.7, color = "black")+
+   geom_errorbar(aes(ymin=Proportion - ci, ymax=Proportion + ci),
+               width=.2, color = "gray26",
+               position = position_dodge(0.7))+
+  theme_few()+
+   scale_fill_manual(values = c("white", "black"))+
+     xlab("Prime Given") + ylab("Mean Proportion of Errors") +
+   ggtitle("Experiment 3: Multiple-Choice Errors")  +
+    theme(axis.text = element_text(face = "bold", size = rel(1)),
+           axis.title = element_text(face = "bold", size = rel(1)),
+           legend.title = element_blank(),
+           plot.title = element_text(face = "bold", size = rel(1.5), hjust = .5),
+          strip.text.x = element_text(face = "bold", size = rel(1.4)))
>
> ## Stored and formatted in excel file: JuliePaperTables.xlsx
>
```



E3 and E2 compare

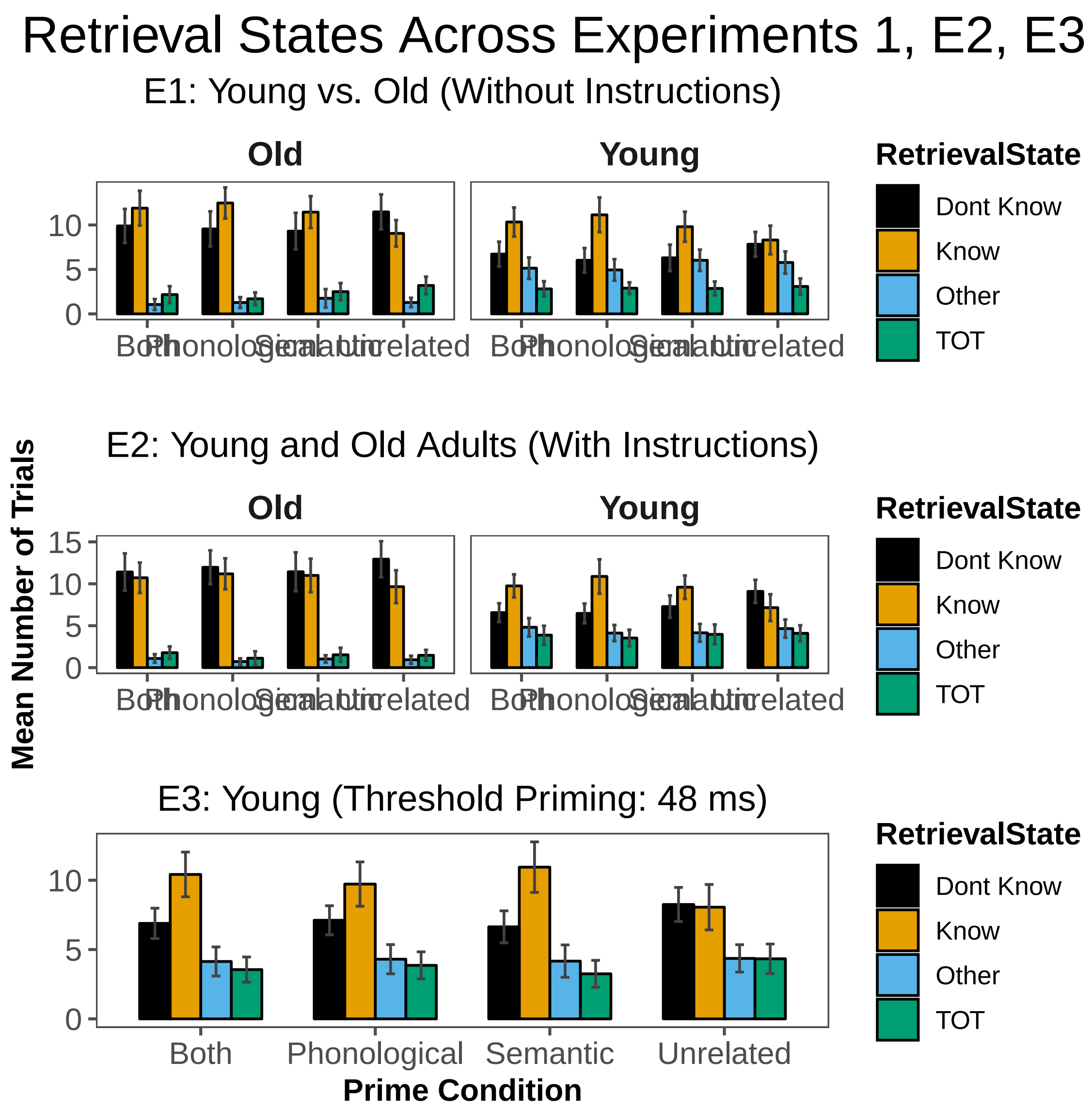
```
> exp3_fig_compare_1 = Rmisc::summarySE(exp3_compare_1,
+                            measurevar = "Proportion",
+                            groupvars = c("StudyNo", "PrimeType", "ChosenPrime"))
> exp3_fig_compare_2 = Rmisc::summarySE(exp3_compare_2,
+                            measurevar = "Proportion",
+                            groupvars = c("StudyNo", "PrimeType", "ChosenPrime"))
> e3_main_1 = exp3_fig_compare_1 %>% filter(PrimeType %in% c("b", "r") &
+                                              ChosenPrime %in% c("b", "r"))
```

```
> e3_main_2 = exp3_fig_compare_2 %>% filter(PrimeType %in% c("b", "r") &
+                                                  ChosenPrime %in% c("b", "r"))
> exp3_mainfig =  full_join(e3_main_1, e3_main_2)
> exp3_mainfig$ChoseThePrime = c("1_Yes", "2_No", "2_No", "1_Yes",
+                              "1_Yes", "2_No", "2_No", "1_Yes",
+                              "1_Yes", "2_No", "2_No", "1_Yes")
> exp3_mainfig5 = exp3_mainfig %>% filter(StudyNo== "5")
> exp3_mainfig1 = exp3_mainfig %>% filter(StudyNo == "1")
> exp3_mainfig6 = exp3_mainfig %>% filter(StudyNo == "6")
> final_mainfig = rbind(exp3_mainfig6, exp3_mainfig1, exp3_mainfig5)
> library(ggplot2)
> library(ggthemes)
> final_mainfig %>% mutate(PrimeCondition = factor(PrimeType,
+                                                  levels = unique(PrimeType),
+                    labels = c("Both","Semantic")),
+                    ChosenPrime = factor(ChosenPrime,
+                                                  levels = unique(PrimeType),
+                    labels = c("Both","Semantic")),
+                    Experiment = factor(StudyNo,
+                                                  levels = unique(StudyNo),
+                    labels = c("E2 (Old:Instruction)","E3 (Young:Threshold)",
+                              "E2 (Young:Instruction)")),
+                    Choice = factor(ChoseThePrime,
+                                                  levels = unique(ChoseThePrime),
+                    labels = c("Prime Chosen","Prime Not Chosen")))%>%
+ ggplot(aes(x = PrimeCondition, y = Proportion,
+                              fill = Choice, group = Choice))+
+  geom_bar(stat = "identity", position = "dodge", width = 0.7, color = "black")+
+   geom_errorbar(aes(ymin=Proportion - se, ymax=Proportion + se),
+              width=.2, color = "gray26",
+              position = position_dodge(0.7))+
+   facet_wrap(~Experiment)+
+  theme_few()+
+   scale_fill_manual(values = c("white", "black"))+
+     xlab("Prime Given") + ylab("Mean Proportion of Errors") +
+   ggtitle("Experiment 2 vs 3: Multiple-Choice Errors")  +
+    theme(axis.text = element_text(face = "bold", size = rel(1)),
+           axis.title = element_text(face = "bold", size = rel(1)),
+           legend.title = element_blank(),
+           plot.title = element_text(face = "bold", size = rel(1.5), hjust = .5),
+          strip.text.x = element_text(face = "bold", size = rel(1.4)))
```



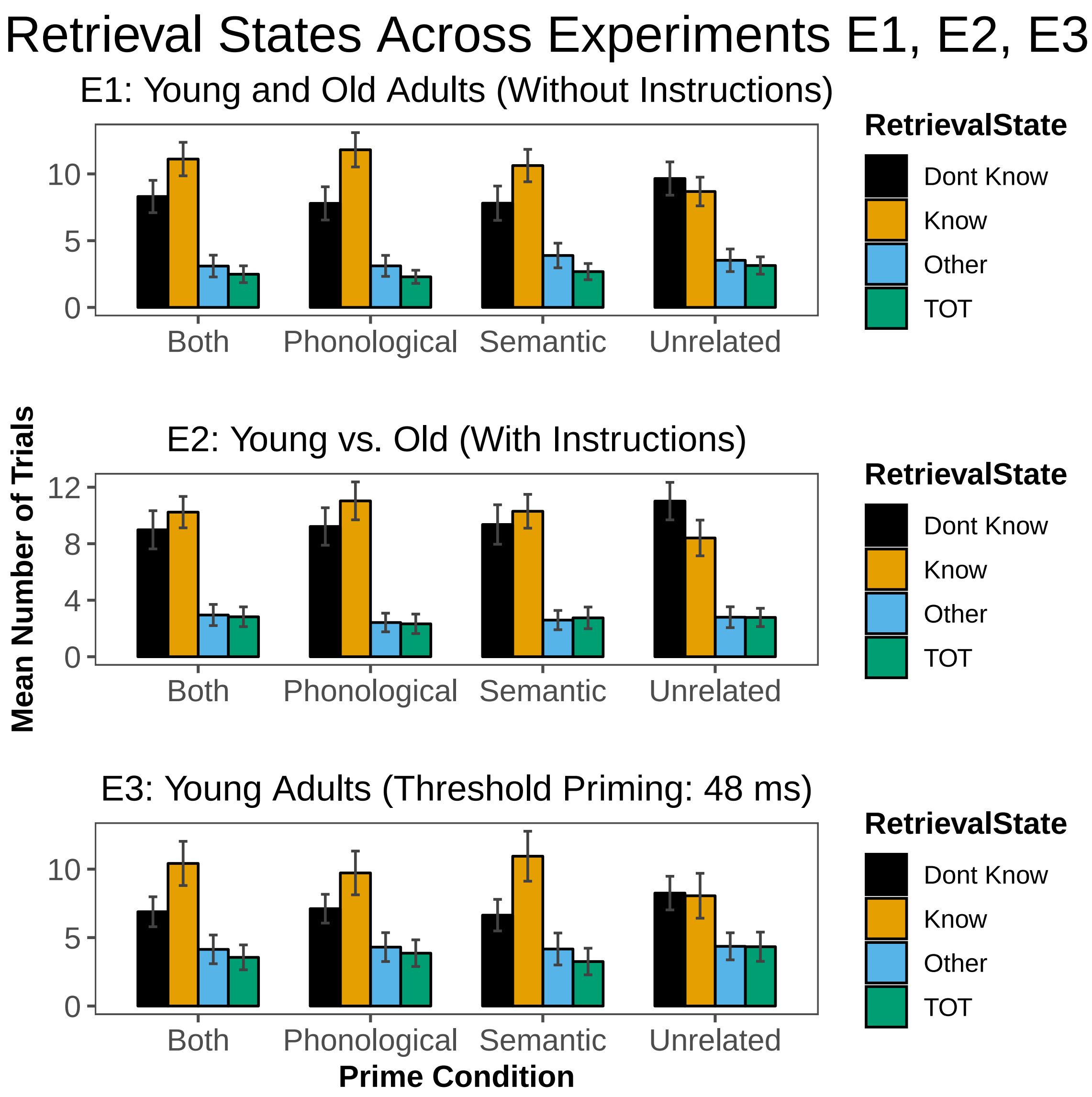
Combined State Data

```
> library(grid)
> gridExtra::grid.arrange(state_1, state_2, state_3, nrow = 3, ncol = 1,
+                 top=textGrob("Retrieval States Across Experiments 1, E2, E3",
+                                   gp=gpar(fontsize=20)))
```



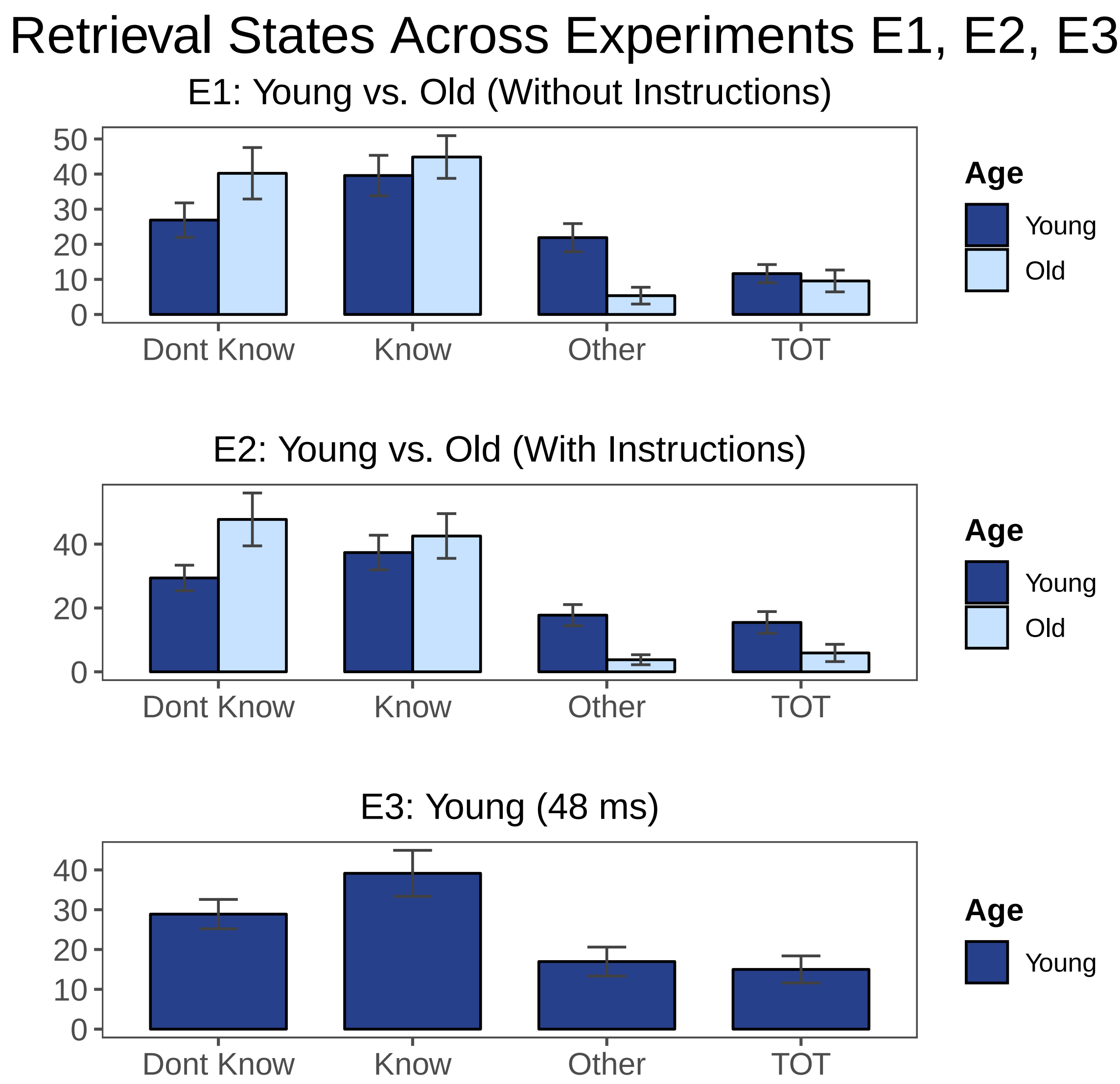
Combined State Prime Data

```
> library(grid)
> gridExtra::grid.arrange(state_1_prime, state_2_prime, state_3_prime,
+                         nrow = 3, ncol = 1,
+                 top=textGrob("Retrieval States Across Experiments E1, E2, E3",
+                              gp=gpar(fontsize=20)))
```



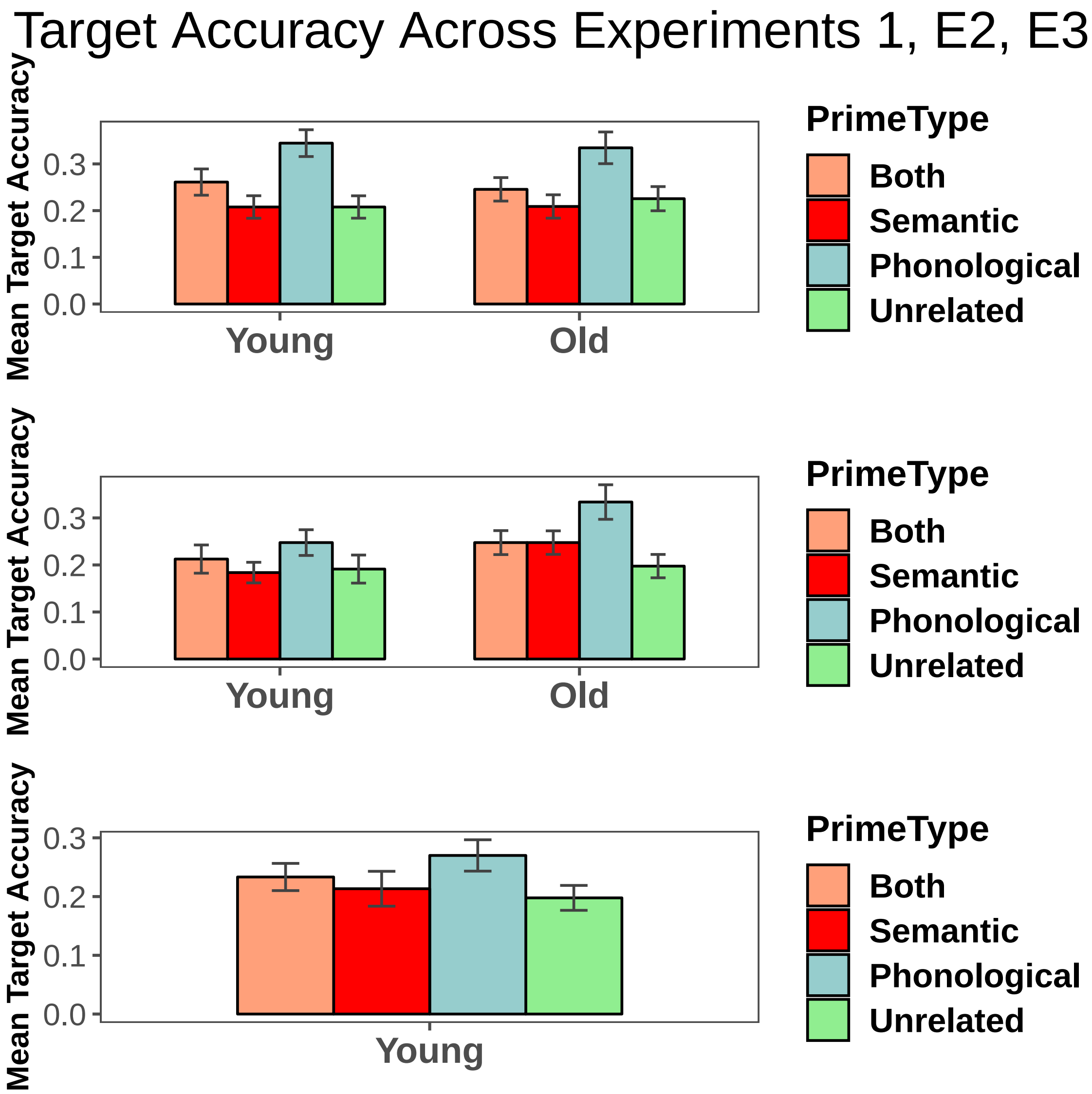
Combined State ONLY Data

```
> library(grid)
> gridExtra::grid.arrange(state_1_only, state_2_only, state_3_only,
+                         nrow = 3, ncol = 1,
+                     top=textGrob("Retrieval States Across Experiments E1, E2, E3",
+                                  gp=gpar(fontsize=20)))
```



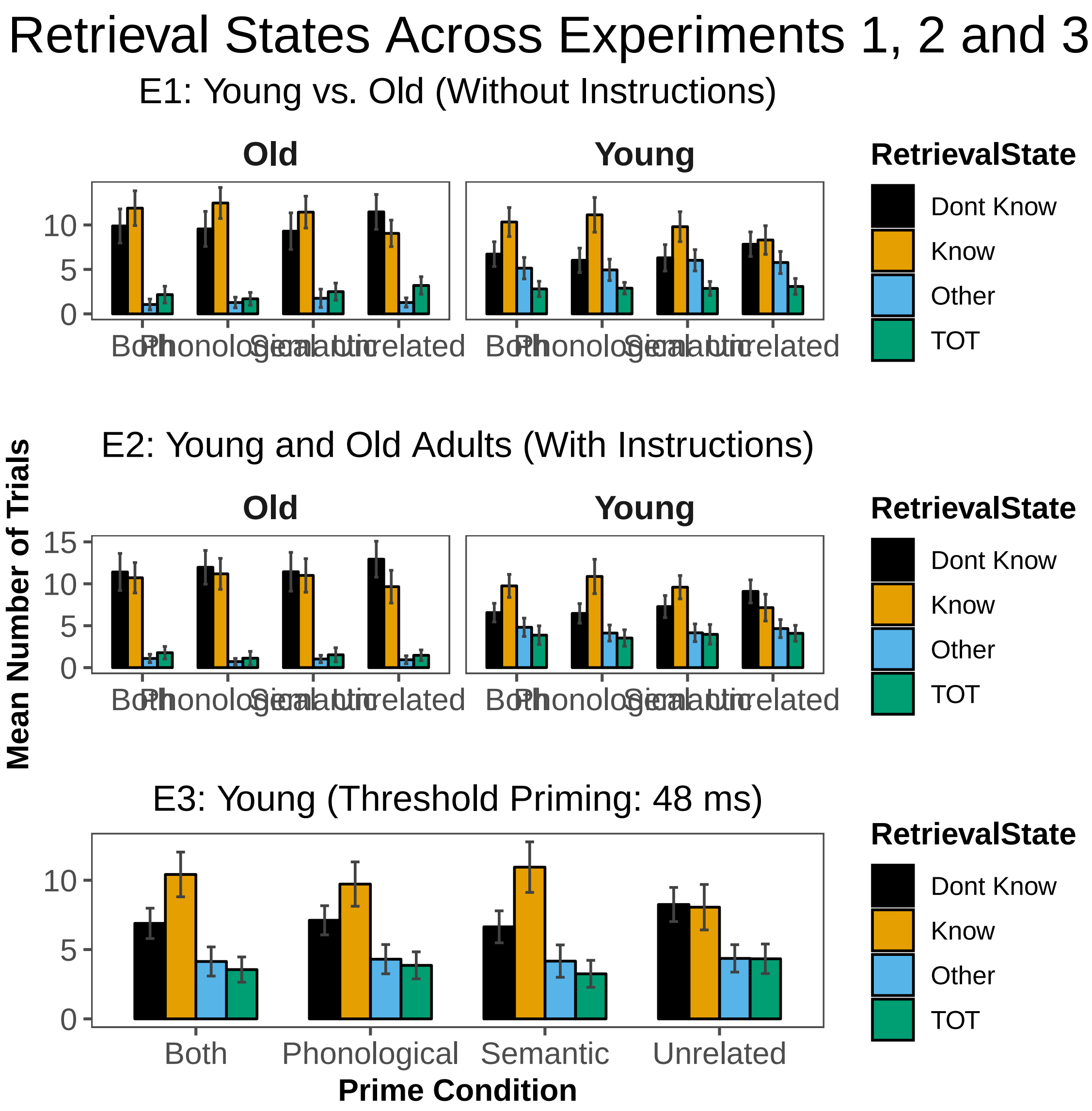
Combined Target Accuracy Data

```
> library(grid)
> gridExtra::grid.arrange(targetacc_1, targetacc_2, targetacc_3, nrow = 3, ncol = 1,
+                   top=textGrob("Target Accuracy Across Experiments 1, E2, E3",
+                                           gp=gpar(fontsize=20)))
```



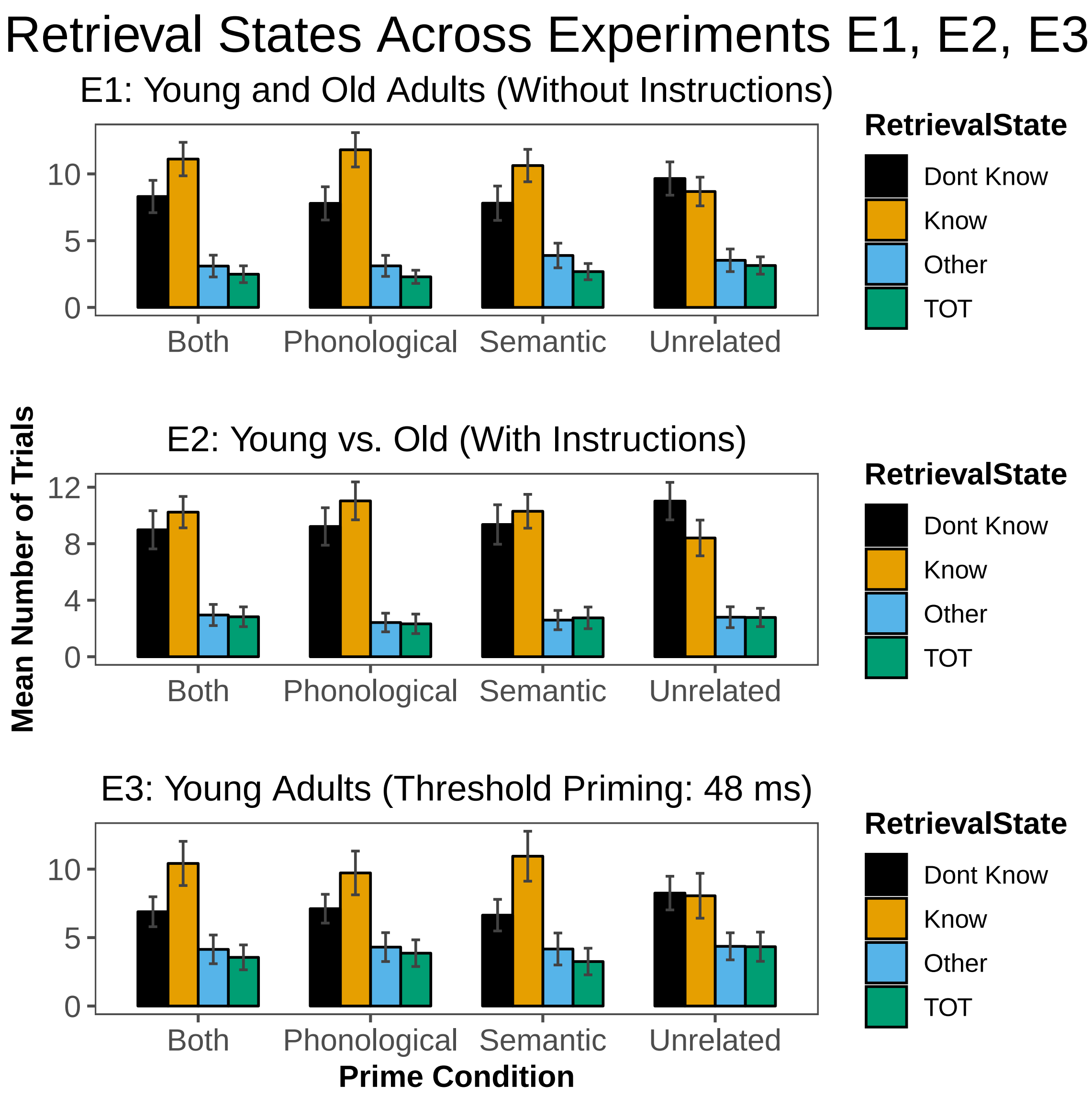
13 HLM Approaches

```
> library(grid)
> gridExtra::grid.arrange(state_1, state_2, state_3, nrow = 3, ncol = 1,
+                  top=textGrob("Retrieval States Across Experiments 1, 2 and 3",
+                                              gp=gpar(fontsize=20)))
```



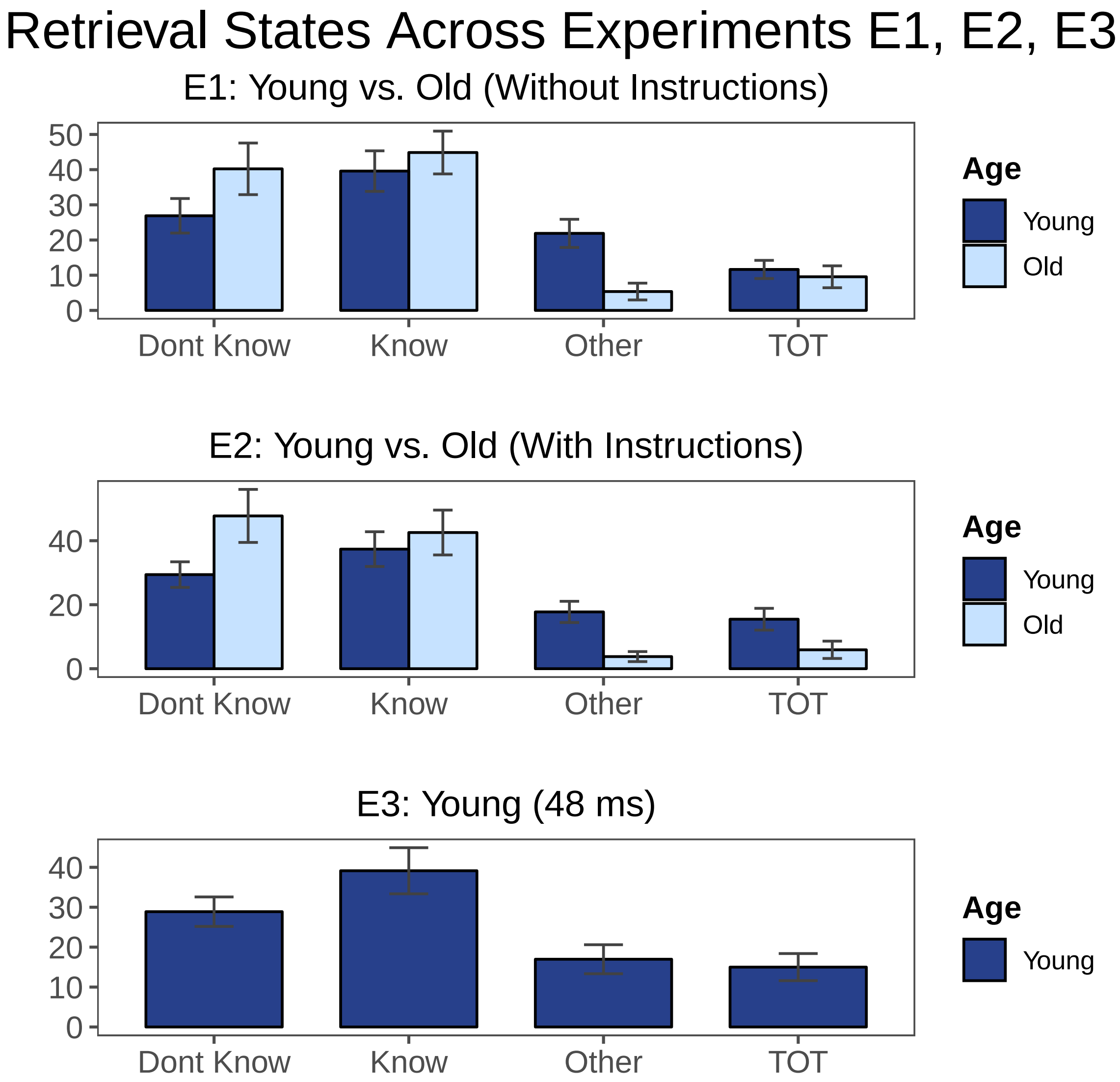
Combined State Prime Data

```
> library(grid)
> gridExtra::grid.arrange(state_1_prime, state_2_prime, state_3_prime,
+                         nrow = 3, ncol = 1,
+                   top=textGrob("Retrieval States Across Experiments E1, E2, E3",
+                                gp=gpar(fontsize=20)))
```



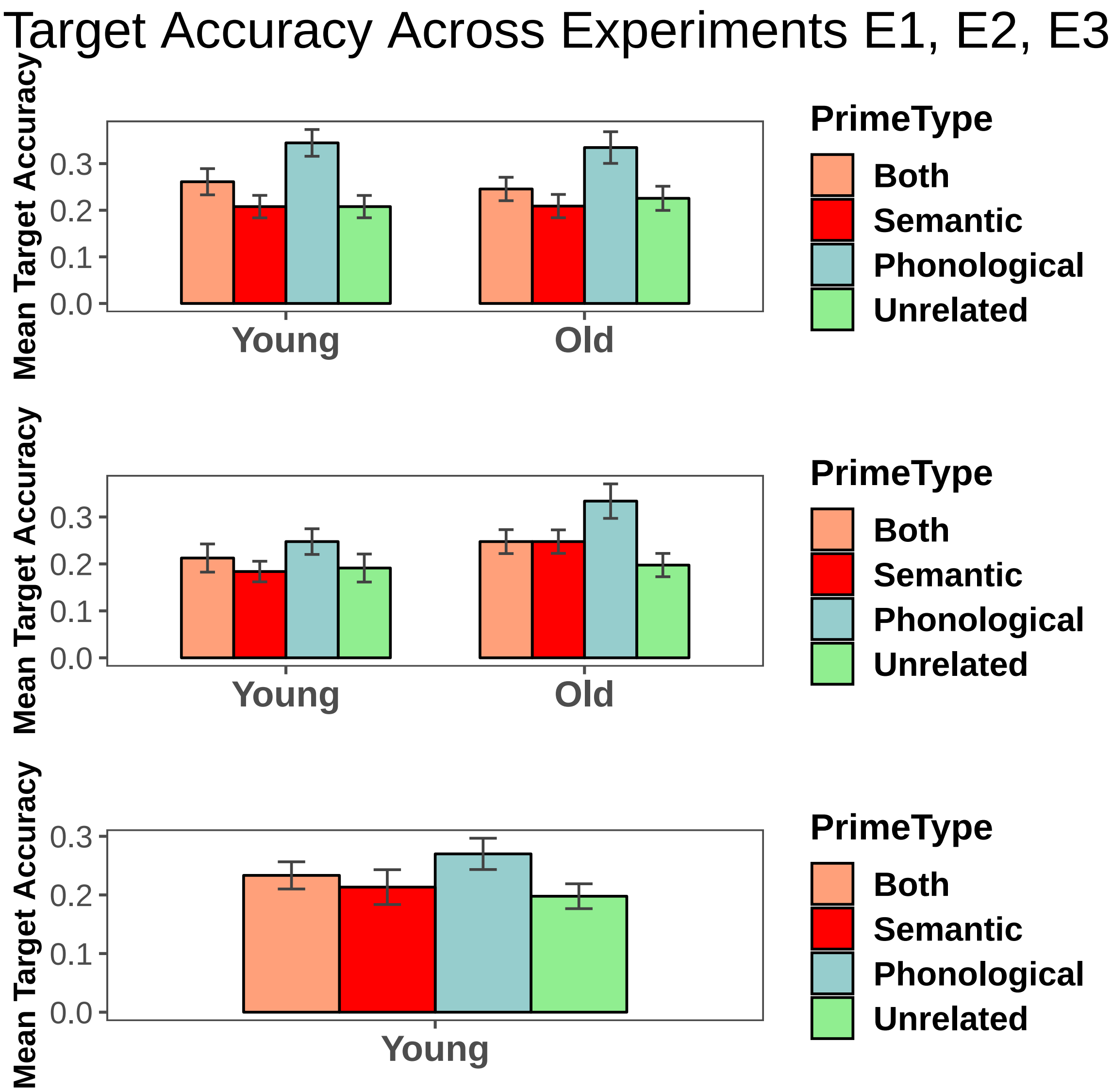
Combined State ONLY Data

```
> library(grid)
> gridExtra::grid.arrange(state_1_only, state_2_only, state_3_only,
+                         nrow = 3, ncol = 1,
+                 top=textGrob("Retrieval States Across Experiments E1, E2, E3",
+                              gp=gpar(fontsize=20)))
```



Combined Target Accuracy Data

```
> library(grid)
> gridExtra::grid.arrange(targetacc_1, targetacc_2, targetacc_3, nrow = 3, ncol = 1,
+                     top=textGrob("Target Accuracy Across Experiments E1, E2, E3",
+                                          gp=gpar(fontsize=20)))
```



14 M Turk Rating Data

Calculating item level accuracies

```
> itemratings= read.csv("item_ratings_wide.csv",
+                              header = TRUE, sep = ",")
> main = read.csv("Julie_Main5Studies.csv", header = TRUE, sep = ",")
> ## in the main data there are also unrelated trials. when merge() happens these
> ## unrelated trials will go away. 17400-4350 = 13050
>
```

```
> main_item = merge(main, itemratings, by = c("Target", "PrimeCondition"))
> main_item = dplyr::arrange(main_item, StudyNo, Subject, TargetNo, PrimeType)
> ## but we also need item-level accuracy data
> library(dplyr)
> item_acc = group_by(main_item, TargetNo) %>%
+   summarise_at(vars(Accuracy), mean)
> colnames(item_acc) = c("TargetNo", "ItemAcc")
> main_item = merge(main_item, item_acc, by = c("TargetNo"))
> main_item = dplyr::arrange(main_item, StudyNo, Subject, TargetNo, PrimeType)
> ## we will also center item accuracy
>
> main_item$ItemAcc.c = as.numeric(scale(main_item$ItemAcc, center = TRUE,
+                                        scale = FALSE))
> ## Now we run an HLM for each prime condition separately
```

Predicting Accuracy Using Rating

```
> main_item$StudyNo = as.factor(as.character(main_item$StudyNo))
> Phon = main_item %>% filter(PrimeCondition == "P" &
+                                 PrimeType == "Phonological")
> Sem = main_item %>% filter(PrimeCondition == "R" &
+                            PrimeType == "Semantic")
> Both_Phon = main_item %>% filter(PrimeCondition == "B" &
+                                  PrimeType == "Both")
> Both_Sem = main_item %>% filter(PrimeCondition == "B" &
+                                 PrimeType == "Both")
```

Models

Models with Only Rating

```
> library(lme4)
> phon_model = glmer(data = Phon, Accuracy ~ SoundRating +
+                      (1|Subject), family = "binomial")
> summary(phon_model)
```

```
Generalized linear mixed model fit by maximum likelihood (Laplace
  Approximation) [glmerMod]
 Family: binomial  ( logit )
Formula: Accuracy ~ SoundRating + (1 | Subject)
   Data: Phon

     AIC      BIC   logLik deviance df.resid
  5066.7   5085.8  -2530.3   5060.7     4347

Scaled residuals:
```

```
    Min      1Q  Median      3Q     Max
-1.6039 -0.6436 -0.4663  0.9428  3.0318

Random effects:
 Groups  Name        Variance Std.Dev.
 Subject (Intercept) 0.7018   0.8377
Number of obs: 4350, groups:  Subject, 174

Fixed effects:
            Estimate Std. Error z value Pr(>|z|)
(Intercept) -1.48902    0.24847  -5.993 2.06e-09 ***
SoundRating  0.11782    0.05108   2.307   0.0211 *
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Correlation of Fixed Effects:
            (Intr)
SoundRating -0.955
convergence code: 0
Model failed to converge with max|grad| = 0.00167732 (tol = 0.001, component 1)
```

```
> phon_model_2 = glmer(data = Phon, Accuracy ~ SoundRating +
+                      (1|Subject), family = "binomial")
> summary(phon_model_2)
```

```
Generalized linear mixed model fit by maximum likelihood (Laplace
  Approximation) [glmerMod]
 Family: binomial  ( logit )
Formula: Accuracy ~ SoundRating + (1 | Subject)
   Data: Phon

     AIC      BIC   logLik deviance df.resid
  5066.7   5085.8  -2530.3   5060.7     4347

Scaled residuals:
    Min      1Q  Median      3Q     Max
-1.6039 -0.6436 -0.4663  0.9428  3.0318

Random effects:
 Groups  Name        Variance Std.Dev.
 Subject (Intercept) 0.7018   0.8377
Number of obs: 4350, groups:  Subject, 174

Fixed effects:
            Estimate Std. Error z value Pr(>|z|)
(Intercept) -1.48902    0.24847  -5.993 2.06e-09 ***
SoundRating  0.11782    0.05108   2.307   0.0211 *
---
```

```
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Correlation of Fixed Effects:
            (Intr)
SoundRating -0.955
convergence code: 0
Model failed to converge with max|grad| = 0.00167732 (tol = 0.001, component 1)
```

```
> sem_model = glmer(data = Sem, Accuracy ~ MeaningRating*ItemAcc  +
+                       (1|Subject), family = "binomial")
> summary(sem_model)
```

```
Generalized linear mixed model fit by maximum likelihood (Laplace
  Approximation) [glmerMod]
 Family: binomial  ( logit )
Formula: Accuracy ~ MeaningRating * ItemAcc + (1 | Subject)
   Data: Sem

     AIC      BIC   logLik deviance df.resid
  3319.1   3351.0  -1654.5   3309.1     4345

Scaled residuals:
    Min      1Q  Median      3Q     Max
-9.7944 -0.3966 -0.2263 -0.1143  8.1662

Random effects:
 Groups  Name        Variance Std.Dev.
 Subject (Intercept) 1.054    1.027
Number of obs: 4350, groups:  Subject, 174

Fixed effects:
                      Estimate Std. Error z value Pr(>|z|)
(Intercept)            -2.2571     0.4956  -4.555 5.25e-06 ***
MeaningRating          -0.3062     0.1052  -2.910  0.00362 **
ItemAcc                 3.9573     1.3365   2.961  0.00307 **
MeaningRating:ItemAcc   0.6241     0.2808   2.223  0.02624 *
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Correlation of Fixed Effects:
            (Intr) MnngRt ItmAcc
MeaningRtng -0.963
ItemAcc     -0.832  0.818
MnngRtng:IA  0.824 -0.848 -0.980
```

```
> both_sem_model = glmer(data = Both_Sem, Accuracy ~ MeaningRating*ItemAcc  +
+                       (1|Subject), family = "binomial",
+     control=glmerControl(optimizer="bobyqa",
```

```
+              optCtrl=list(maxfun=100000)))
> summary(both_sem_model)
```

```
Generalized linear mixed model fit by maximum likelihood (Laplace
  Approximation) [glmerMod]
 Family: binomial  ( logit )
Formula: Accuracy ~ MeaningRating * ItemAcc + (1 | Subject)
   Data: Both_Sem
Control: glmerControl(optimizer = "bobyqa", optCtrl = list(maxfun = 1e+05))

     AIC      BIC   logLik deviance df.resid
  3645.0   3676.9  -1817.5   3635.0     4345

Scaled residuals:
    Min      1Q  Median      3Q     Max
-4.5524 -0.4396 -0.2575 -0.1188  6.1718

Random effects:
 Groups  Name        Variance Std.Dev.
 Subject (Intercept) 0.8929   0.9449
Number of obs: 4350, groups:  Subject, 174

Fixed effects:
                      Estimate Std. Error z value Pr(>|z|)
(Intercept)           -2.98209    0.38379  -7.770 7.84e-15 ***
MeaningRating         -0.07562    0.08561  -0.883    0.377
ItemAcc                7.04062    0.94324   7.464 8.38e-14 ***
MeaningRating:ItemAcc -0.09483    0.20048  -0.473    0.636
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Correlation of Fixed Effects:
            (Intr) MnngRt ItmAcc
MeaningRtng -0.948
ItemAcc     -0.798  0.753
MnngRtng:IA  0.799 -0.817 -0.963
```

```
> both_phon_model = glmer(data = Both_Phon, Accuracy ~ SoundRating*ItemAcc  +
+                    (1|Subject), family = "binomial",
+      control=glmerControl(optimizer="bobyqa",
+              optCtrl=list(maxfun=100000)))
> summary(both_phon_model)
```

```
Generalized linear mixed model fit by maximum likelihood (Laplace
  Approximation) [glmerMod]
 Family: binomial  ( logit )
Formula: Accuracy ~ SoundRating * ItemAcc + (1 | Subject)
   Data: Both_Phon
```

```
Control: glmerControl(optimizer = "bobyqa", optCtrl = list(maxfun = 1e+05))

     AIC      BIC   logLik deviance df.resid
  3644.9   3676.7  -1817.4   3634.9     4345

Scaled residuals:
    Min      1Q  Median      3Q     Max
-4.0873 -0.4331 -0.2586 -0.1243  5.7720

Random effects:
 Groups  Name        Variance Std.Dev.
 Subject (Intercept) 0.8946   0.9459
Number of obs: 4350, groups:  Subject, 174

Fixed effects:
                    Estimate Std. Error z value Pr(>|z|)
(Intercept)         -4.23885    0.45866  -9.242  < 2e-16 ***
SoundRating          0.21984    0.09933   2.213   0.0269 *
ItemAcc              8.23678    1.17426   7.014 2.31e-12 ***
SoundRating:ItemAcc -0.39251    0.25795  -1.522   0.1281
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Correlation of Fixed Effects:
            (Intr) SndRtn ItmAcc
SoundRating -0.965
ItemAcc     -0.853  0.835
SndRtng:ItA  0.831 -0.852 -0.978
```

```
>
>
> ## seems that ratings have an overall effect on accuracy, but not above and beyond the
```

Models with Rating and Average Performance

```
> library(lme4)
> phon_model_2 = glmer(data = Phon, Accuracy ~ SoundRating*ItemAcc.c +
+                     (1|Subject), family = "binomial",
+                     control=glmerControl(optimizer="bobyqa",
+           optCtrl=list(maxfun=100000)))
> summary(phon_model_2)
```

```
Generalized linear mixed model fit by maximum likelihood (Laplace
  Approximation) [glmerMod]
 Family: binomial  ( logit )
Formula: Accuracy ~ SoundRating * ItemAcc.c + (1 | Subject)
   Data: Phon
```

```
Control: glmerControl(optimizer = "bobyqa", optCtrl = list(maxfun = 1e+05))

     AIC      BIC   logLik deviance df.resid
  4029.1   4061.0  -2009.5   4019.1     4345

Scaled residuals:
    Min      1Q  Median      3Q     Max
-5.2907 -0.4847 -0.2791  0.4188  8.1477

Random effects:
 Groups  Name        Variance Std.Dev.
 Subject (Intercept) 1.137    1.066
Number of obs: 4350, groups:  Subject, 174

Fixed effects:
                      Estimate Std. Error z value Pr(>|z|)
(Intercept)           -1.81987    0.29573  -6.154 7.57e-10 ***
SoundRating            0.14031    0.06047   2.320   0.0203 *
ItemAcc.c              6.15433    1.45823   4.220 2.44e-05 ***
SoundRating:ItemAcc.c  0.09169    0.30689   0.299   0.7651
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Correlation of Fixed Effects:
            (Intr) SndRtn ItmAc.
SoundRating -0.950
ItemAcc.c   -0.173  0.170
SndRtng:IA.  0.161 -0.166 -0.986
```

```
> # computed profile likelihood CIs for each model
>
> # > confint(phon_model_2)
> # Computing profile confidence intervals ...
> #                          2.5 %   97.5 %
> # .sig01                 0.92257   1.2354
> # (Intercept)           -2.40873  -1.2388
> # SoundRating            0.02088   0.2602
> # ItemAcc.c              3.29535   9.0498
> # SoundRating:ItemAcc.c -0.51451   0.6982
>
> sem_model_2 = glmer(data = Sem, Accuracy ~ MeaningRating*ItemAcc.c  +
+                      (1|Subject), family = "binomial",
+                      control=glmerControl(optimizer="bobyqa",
+           optCtrl=list(maxfun=100000)))
> summary(sem_model_2)
```

```
Generalized linear mixed model fit by maximum likelihood (Laplace
  Approximation) [glmerMod]
```

```
 Family: binomial  ( logit )
Formula: Accuracy ~ MeaningRating * ItemAcc.c + (1 | Subject)
   Data: Sem
Control: glmerControl(optimizer = "bobyqa", optCtrl = list(maxfun = 1e+05))

     AIC      BIC   logLik deviance df.resid
  3319.1   3351.0  -1654.5   3309.1     4345

Scaled residuals:
    Min      1Q  Median      3Q     Max
-9.7944 -0.3966 -0.2263 -0.1143  8.1662

Random effects:
 Groups  Name        Variance Std.Dev.
 Subject (Intercept) 1.054    1.027
Number of obs: 4350, groups:  Subject, 174

Fixed effects:
                        Estimate Std. Error z value Pr(>|z|)
(Intercept)             -1.25513    0.28451  -4.412 1.03e-05 ***
MeaningRating           -0.14821    0.05861  -2.529  0.01144 *
ItemAcc.c                3.95729    1.33542   2.963  0.00304 **
MeaningRating:ItemAcc.c  0.62411    0.28059   2.224  0.02613 *
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Correlation of Fixed Effects:
            (Intr) MnngRt ItmAc.
MeaningRtng -0.939
ItemAcc.c   -0.260  0.279
MnngRtn:IA.  0.269 -0.311 -0.980
```

```
> # > confint(sem_model_2)
> # Computing profile confidence intervals ...
> #                            2.5 %    97.5 %
> # .sig01                    0.8742   1.20718
> # (Intercept)              -1.8260  -0.69259
> # MeaningRating            -0.2655  -0.03193
> # ItemAcc.c                 1.3353   6.63141
> # MeaningRating:ItemAcc.c   0.0662   1.18024
>
> both_phon_model_2 = glmer(data = Both_Phon, Accuracy ~ SoundRating*ItemAcc.c  +
+                         (1|Subject), family = "binomial",
+                         control=glmerControl(optimizer="bobyqa",
+          optCtrl=list(maxfun=100000)))
> summary(both_phon_model_2)
```

```
Generalized linear mixed model fit by maximum likelihood (Laplace
```

```
  Approximation) [glmerMod]
 Family: binomial  ( logit )
Formula: Accuracy ~ SoundRating * ItemAcc.c + (1 | Subject)
   Data: Both_Phon
Control: glmerControl(optimizer = "bobyqa", optCtrl = list(maxfun = 1e+05))

     AIC      BIC   logLik deviance df.resid
  3644.9   3676.7  -1817.4   3634.9     4345

Scaled residuals:
    Min      1Q  Median      3Q     Max
-4.0873 -0.4331 -0.2586 -0.1243  5.7720

Random effects:
 Groups  Name        Variance Std.Dev.
 Subject (Intercept) 0.8946   0.9459
Number of obs: 4350, groups:  Subject, 174

Fixed effects:
                      Estimate Std. Error z value Pr(>|z|)
(Intercept)           -2.15346    0.25692  -8.382  < 2e-16 ***
SoundRating            0.12047    0.05553   2.169    0.030 *
ItemAcc.c              8.23678    1.17320   7.021 2.21e-12 ***
SoundRating:ItemAcc.c -0.39251    0.25773  -1.523    0.128
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Correlation of Fixed Effects:
            (Intr) SndRtn ItmAc.
SoundRating -0.939
ItemAcc.c   -0.366  0.343
SndRtng:IA.  0.352 -0.347 -0.978
```

```
> # > confint(both_phon_model_2)
> # Computing profile confidence intervals ...
> #                          2.5 %   97.5 %
> # .sig01                 0.80811   1.1067
> # (Intercept)           -2.6667  -1.6472
> # SoundRating            0.01014   0.2304
> # ItemAcc.c              5.93256  10.5726
> # SoundRating:ItemAcc.c -0.90151   0.1174
>
> both_sem_model_2 = glmer(data = Both_Sem, Accuracy ~ MeaningRating*ItemAcc.c  +
+                     (1|Subject), family = "binomial",
+                     control=glmerControl(optimizer="bobyqa",
+         optCtrl=list(maxfun=100000)))
> summary(both_sem_model_2)
```

```
Generalized linear mixed model fit by maximum likelihood (Laplace
  Approximation) [glmerMod]
 Family: binomial  ( logit )
Formula: Accuracy ~ MeaningRating * ItemAcc.c + (1 | Subject)
   Data: Both_Sem
Control: glmerControl(optimizer = "bobyqa", optCtrl = list(maxfun = 1e+05))

     AIC      BIC   logLik deviance df.resid
  3645.0   3676.9  -1817.5   3635.0     4345

Scaled residuals:
    Min      1Q  Median      3Q     Max
-4.5524 -0.4396 -0.2575 -0.1188  6.1718

Random effects:
 Groups  Name        Variance Std.Dev.
 Subject (Intercept) 0.8929   0.9449
Number of obs: 4350, groups:  Subject, 174

Fixed effects:
                        Estimate Std. Error z value Pr(>|z|)
(Intercept)             -1.19955    0.24089  -4.980 6.37e-07 ***
MeaningRating           -0.09963    0.05296  -1.881    0.060 .
ItemAcc.c                7.04063    0.94263   7.469 8.07e-14 ***
MeaningRating:ItemAcc.c -0.09484    0.20036  -0.473    0.636
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Correlation of Fixed Effects:
            (Intr) MnngRt ItmAc.
MeaningRtng -0.930
ItemAcc.c   -0.280  0.294
MnngRtn:IA.  0.319 -0.362 -0.963
```

```
>
> # > confint(both_sem_model_2)
> # Computing profile confidence intervals ...
> #                            2.5 %    97.5 %
> # .sig01                     0.8072   1.105831
> # (Intercept)               -1.6794  -0.724465
> # MeaningRating             -0.2052   0.004835
> # ItemAcc.c                  5.2050   8.924420
> # MeaningRating:ItemAcc.c   -0.4912   0.299697
>
>
```

Plotting Model Fits: Rating and Mean Accuracy

Phonological

```
> fixed.frame <- Phon %>%
+   dplyr::summarise(mean = mean(ItemAcc.c, na.rm = T),
+             sd = sd(ItemAcc.c, na.rm = T))
> fixed.frame <-
+   data.frame(
+     expand.grid(
+       # here, you add values for your time variable and predictors
+       SoundRating = seq(1,7,1),
+        ItemAcc.c = c(fixed.frame$mean-fixed.frame$sd,
+                      fixed.frame$mean,
+                      fixed.frame$mean+fixed.frame$sd)))
> fixed.frame$pred = predict(phon_model_2, newdata = fixed.frame, re.form = NA)
> fixed.frame$odds = exp(fixed.frame$pred)
> fixed.frame$prob = fixed.frame$odds/(1+fixed.frame$odds)
> a2 = fixed.frame %>%
+ mutate(ItemAccuracy = factor(ItemAcc.c, levels = unique(ItemAcc.c),
+                                 labels = c("-1SD", "0SD", "1SD"))) %>%
+   ggplot(aes(x = SoundRating, y = prob, color = ItemAccuracy)) +
+   geom_line(size = 1) +
+         labs(x = "Sound Rating",
+              y = "",
+          title = "Phonological Condition (Sound Rating)") +
+   theme_few()+
+     theme(axis.text = element_text(face = "bold", size = rel(1)),
+          axis.title = element_text(face = "bold", size = rel(1)),
+          legend.title = element_text(face = "bold", size = rel(1)),
+          plot.title = element_text(face = "bold", size = rel(1), hjust = .5))
```

Semantic

```
> fixed.frame <- Sem %>%
+   dplyr::summarise(mean = mean(ItemAcc.c, na.rm = T),
+             sd = sd(ItemAcc.c, na.rm = T))
> fixed.frame <-
+   data.frame(
+     expand.grid(
+       # here, you add values for your time variable and predictors
+       MeaningRating = seq(1,7,1),
+        ItemAcc.c = c(fixed.frame$mean-fixed.frame$sd,
+                      fixed.frame$mean,
+                      fixed.frame$mean+fixed.frame$sd)))
> fixed.frame$pred = predict(sem_model_2, newdata = fixed.frame, re.form = NA)
> fixed.frame$odds = exp(fixed.frame$pred)
> fixed.frame$prob = fixed.frame$odds/(1+fixed.frame$odds)
```

```
> b2 = fixed.frame %>%
+ mutate(ItemAccuracy = factor(ItemAcc.c, levels = unique(ItemAcc.c),
+                                  labels = c("-1SD", "0SD", "1SD"))) %>%
+   ggplot(aes(x = MeaningRating, y = prob, color = ItemAccuracy)) +
+   geom_line(size = 1) +
+           labs(x = "Meaning Rating",
+              y = "",
+          title = "Semantic Condition (Meaning Rating)") +
+   theme_few()+
+     theme(axis.text = element_text(face = "bold", size = rel(1)),
+           axis.title = element_text(face = "bold", size = rel(1)),
+           legend.title = element_text(face = "bold", size = rel(1)),
+           plot.title = element_text(face = "bold", size = rel(1), hjust = .5))
```

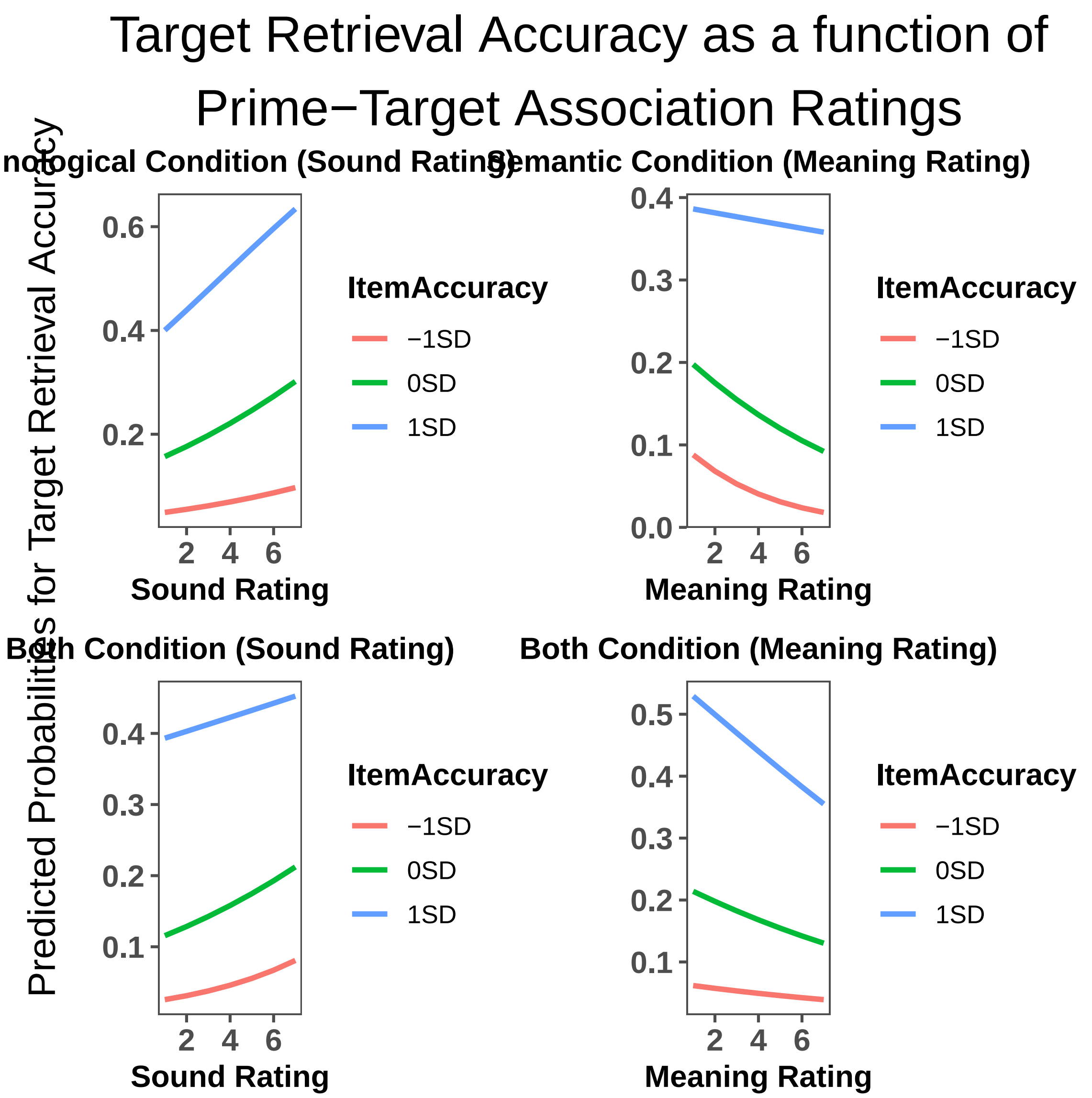
14.0.1 BothSem

```
> fixed.frame <- Both_Phon %>%
+   dplyr::summarise(mean = mean(ItemAcc.c, na.rm = T),
+            sd = sd(ItemAcc.c, na.rm = T))
> fixed.frame <-
+   data.frame(
+     expand.grid(
+       # here, you add values for your time variable and predictors
+       MeaningRating = seq(1,7,1),
+        ItemAcc.c = c(fixed.frame$mean-fixed.frame$sd,
+                      fixed.frame$mean,
+                      fixed.frame$mean+fixed.frame$sd)))
> fixed.frame$pred = predict(both_sem_model_2,
+                            newdata = fixed.frame, re.form = NA)
> fixed.frame$odds = exp(fixed.frame$pred)
> fixed.frame$prob = fixed.frame$odds/(1+fixed.frame$odds)
> c2 = fixed.frame %>%
+ mutate(ItemAccuracy = factor(ItemAcc.c, levels = unique(ItemAcc.c),
+                                  labels = c("-1SD", "0SD", "1SD"))) %>%
+   ggplot(aes(x = MeaningRating, y = prob, color = ItemAccuracy)) +
+   geom_line(size = 1) +
+            labs(x = "Meaning Rating",
+              y = "",
+          title = "Both Condition (Meaning Rating)") +
+   theme_few()+
+     theme(axis.text = element_text(face = "bold", size = rel(1)),
+           axis.title = element_text(face = "bold", size = rel(1)),
+           legend.title = element_text(face = "bold", size = rel(1)),
+           plot.title = element_text(face = "bold", size = rel(1), hjust = .5))
```

14.0.2 BothPhon

```
> fixed.frame <- Both_Sem %>%
+   dplyr::summarise(mean = mean(ItemAcc.c, na.rm = T),
+             sd = sd(ItemAcc.c, na.rm = T))
> fixed.frame <-
+   data.frame(
+     expand.grid(
+       # here, you add values for your time variable and predictors
+       SoundRating = seq(1,7,1),
+        ItemAcc.c = c(fixed.frame$mean-fixed.frame$sd,
+                      fixed.frame$mean,
+                      fixed.frame$mean+fixed.frame$sd)))
> fixed.frame$pred = predict(both_phon_model_2,
+                            newdata = fixed.frame, re.form = NA)
> fixed.frame$odds = exp(fixed.frame$pred)
> fixed.frame$prob = fixed.frame$odds/(1+fixed.frame$odds)
> d2 = fixed.frame %>%
+ mutate(ItemAccuracy = factor(ItemAcc.c, levels = unique(ItemAcc.c),
+                                   labels = c("-1SD", "0SD", "1SD"))) %>%
+   ggplot(aes(x = SoundRating, y = prob, color = ItemAccuracy)) +
+   geom_line(size = 1) +
+          labs(x = "Sound Rating",
+              y = "",
+          title = "Both Condition (Sound Rating)") +
+   theme_few()+
+     theme(axis.text = element_text(face = "bold", size = rel(1)),
+           axis.title = element_text(face = "bold", size = rel(1)),
+           legend.title = element_text(face = "bold", size = rel(1)),
+           plot.title = element_text(face = "bold", size = rel(1), hjust = .5))
```

```
> library(gridExtra)
> grid.arrange(a2,b2,d2,c2,
+             top=textGrob("Target Retrieval Accuracy as a function of\nPrime-Target Ass
+                                          gp=gpar(fontsize=20)),
+              left = textGrob("Predicted Probabilities for Target Retrieval Accuracy",
```



14.1 State RT data

14.1.1 z-scoring RTs

```
> state_firsttrim = main # %>% filter(State.RT > 250 )
> ## aggregate per subject all IVs and DVs
> meanRT = group_by(state_firsttrim, Subject) %>%
+   summarise_at(vars(State.RT), mean)
> colnames(meanRT) = c("Subject", "MeanRT")
> sdRT = group_by(state_firsttrim, Subject) %>%
+   summarise_at(vars(State.RT), sd)
```

```
> colnames(sdRT) = c("Subject", "sdRT")
> RT_agg = merge(meanRT, sdRT, by = "Subject")
> ## merge aggregate info with long data
> state_z = merge(state_firsttrim, RT_agg, by = "Subject", all.x = T)
> ## person and grand-mean centered scores using original and aggregate
> library(dplyr)
> ## trimming z rt
> state_z$Upper = state_z$MeanRT + 2.5*state_z$sdRT
> state_z$Lower = state_z$MeanRT - 2.5*state_z$sdRT
> state_z_trimmed = subset(state_z, state_z$State.RT < state_z$Upper &
+                          state_z$State.RT > state_z$Lower)
```

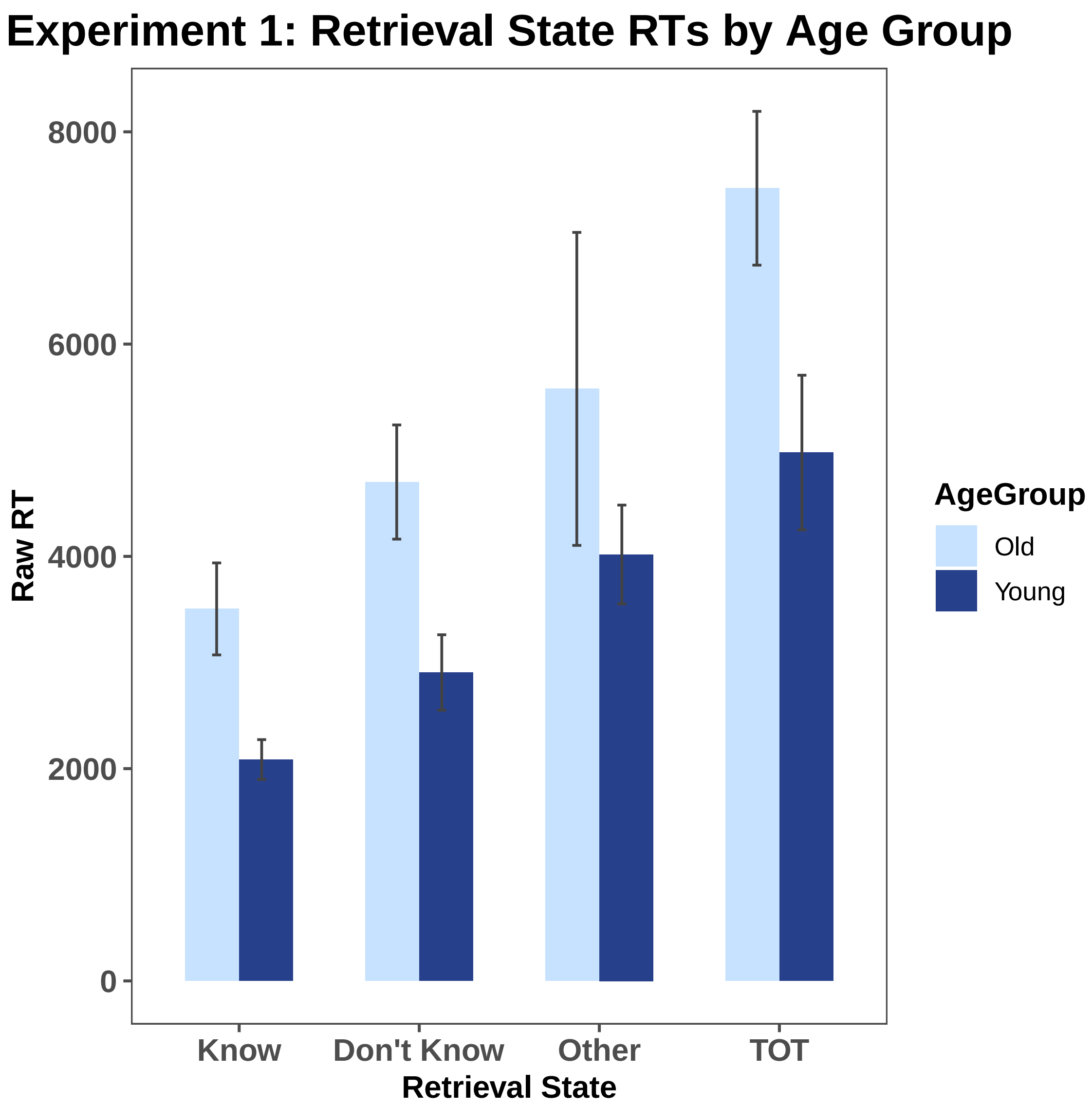
14.1.2 State by Age by RT

```
> state_z_trimmed$Question.RESP = as.factor(state_z_trimmed$Question.RESP)
> e1_stateRT = state_z_trimmed %>% filter(StudyNo == "2" | StudyNo == "4")
> e2_stateRT = state_z_trimmed %>% filter(StudyNo == "5" | StudyNo == "6")
> e3_stateRT = state_z_trimmed %>% filter(StudyNo == "1")
>
```

14.1.3 E1

```
> e1_stateRT_agg = group_by(e1_stateRT, AgeGroup, Subject, Question.RESP) %>%
+    summarize_at(vars(State.RT), mean)
> e1_stateRT_rmisc = Rmisc::summarySE(e1_stateRT_agg,
+                                     measurevar = "State.RT",
+                                     groupvars = c("AgeGroup", "Question.RESP"))
> e1_stateRT_rmisc %>% mutate(RetrievalState = factor(Question.RESP,
+                                     levels = unique(Question.RESP),
+                              labels = c("Know", "Don't Know", "Other", "TOT")),
+                              Age = factor(AgeGroup, levels = unique(AgeGroup),
+                       labels = c("Young", "Old")))%>%
+   ggplot(aes(x = RetrievalState, y = State.RT, group = AgeGroup,
+              fill = AgeGroup)) +
+    geom_bar(stat = "identity", position = "dodge", width = 0.6)+
+   geom_errorbar(aes(ymin=State.RT - ci, ymax=State.RT + ci),
+              width=.1, color = "gray26",
+              position = position_dodge(0.5))+
+  theme_few()+
+   scale_fill_manual(values = c("slategray1", "royalblue4"))+
+     xlab("Retrieval State") + ylab("Raw RT") +
+   ggtitle("Experiment 1: Retrieval State RTs by Age Group")  +
+    theme(axis.text = element_text(face = "bold", size = rel(1)),
+           axis.title = element_text(face = "bold", size = rel(1)),
+           legend.title = element_text(face = "bold", size = rel(1)),
+           plot.title = element_text(face = "bold", size = rel(1.4), hjust = .5),
```

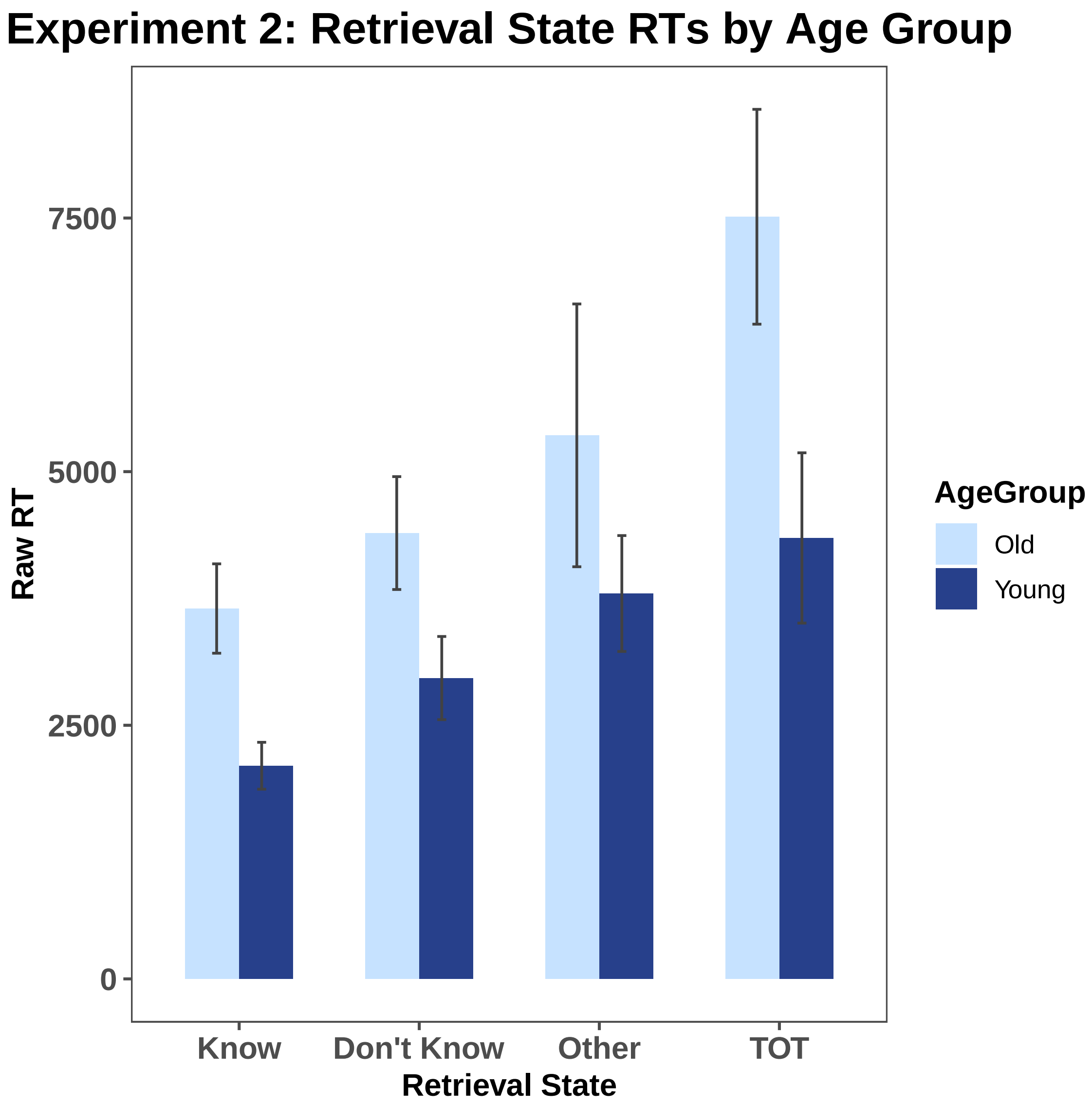
```
+          strip.text.x = element_text(face = "bold", size = rel(1.4)))
>
```



14.1.4 E2

```
> e2_stateRT_agg = group_by(e2_stateRT, AgeGroup, Subject, Question.RESP) %>%
+     summarize_at(vars(State.RT), mean)
> e2_stateRT_rmisc = Rmisc::summarySE(e2_stateRT_agg,
+                                      measurevar = "State.RT",
+                                      groupvars = c("AgeGroup", "Question.RESP"))
> e2_stateRT_rmisc %>% mutate(RetrievalState = factor(Question.RESP,
```

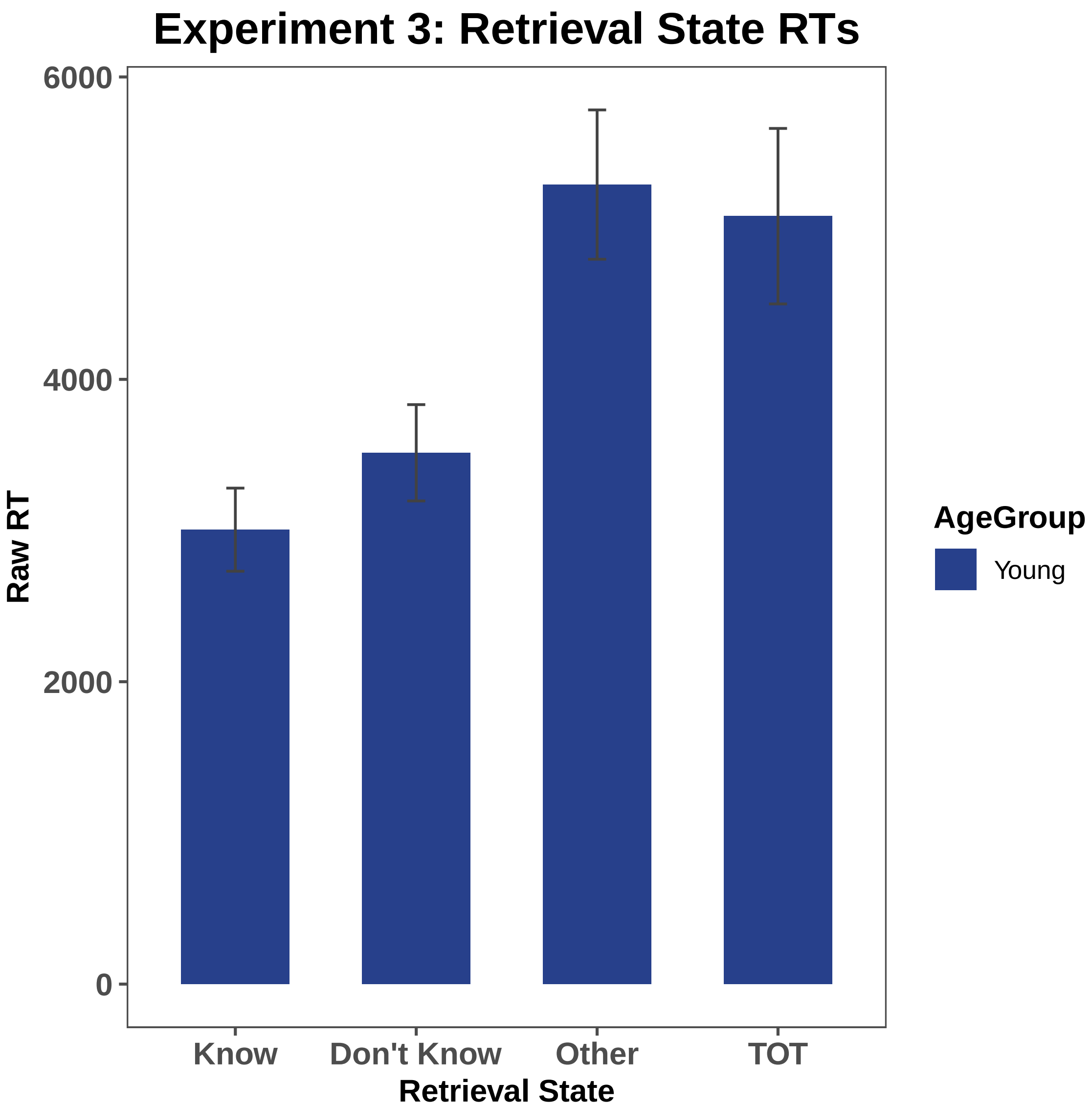
```
+                                       levels = unique(Question.RESP),
+                               labels = c("Know", "Don't Know", "Other", "TOT")),
+                               Age = factor(AgeGroup, levels = unique(AgeGroup),
+                       labels = c("Young", "Old")))%>%
+   ggplot(aes(x = RetrievalState, y = State.RT, group = AgeGroup,
+              fill = AgeGroup)) +
+    geom_bar(stat = "identity", position = "dodge", width = 0.6)+
+   geom_errorbar(aes(ymin=State.RT - ci, ymax=State.RT + ci),
+              width=.1, color = "gray26",
+              position = position_dodge(0.5))+
+  theme_few()+
+   scale_fill_manual(values = c("slategray1", "royalblue4"))+
+     xlab("Retrieval State") + ylab("Raw RT") +
+   ggtitle("Experiment 2: Retrieval State RTs by Age Group")  +
+    theme(axis.text = element_text(face = "bold", size = rel(1)),
+           axis.title = element_text(face = "bold", size = rel(1)),
+           legend.title = element_text(face = "bold", size = rel(1)),
+           plot.title = element_text(face = "bold", size = rel(1.4), hjust = .5),
+          strip.text.x = element_text(face = "bold", size = rel(1.4)))
>
```



14.1.5 E3

```
> e3_stateRT_agg = group_by(e3_stateRT, AgeGroup, Subject, Question.RESP) %>%
+    summarize_at(vars(State.RT), mean)
> e3_stateRT_rmisc = Rmisc::summarySE(e3_stateRT_agg,
+                                    measurevar = "State.RT",
+                                    groupvars = c("AgeGroup", "Question.RESP"))
> e3_stateRT_rmisc %>% mutate(RetrievalState = factor(Question.RESP,
+                                    levels = unique(Question.RESP),
+                              labels = c("Know", "Don't Know", "Other", "TOT")),
+                              Age = factor(AgeGroup, levels = unique(AgeGroup),
```

```
+                      labels = c("Young")))%>%
+    ggplot(aes(x = RetrievalState, y = State.RT, group = AgeGroup,
+               fill = AgeGroup)) +
+     geom_bar(stat = "identity", position = "dodge", width = 0.6)+
+    geom_errorbar(aes(ymin=State.RT - ci, ymax=State.RT + ci),
+               width=.1, color = "gray26",
+               position = position_dodge(0.5))+
+   theme_few()+
+    scale_fill_manual(values = c("royalblue4"))+
+      xlab("Retrieval State") + ylab("Raw RT") +
+    ggtitle("Experiment 3: Retrieval State RTs")  +
+     theme(axis.text = element_text(face = "bold", size = rel(1)),
+            axis.title = element_text(face = "bold", size = rel(1)),
+            legend.title = element_text(face = "bold", size = rel(1)),
+            plot.title = element_text(face = "bold", size = rel(1.4), hjust = .5),
+           strip.text.x = element_text(face = "bold", size = rel(1.4)))
>
```



14.2 HLMs

```
> library(lme4)
> e1_stateRT_hlm = lmer (data = e1_stateRT_agg, State.RT ~ Question.RESP*AgeGroup +
+                           (1|Subject))
> summary(e1_stateRT_hlm)
```

```
Linear mixed model fit by REML ['lmerMod']
Formula: State.RT ~ Question.RESP * AgeGroup + (1 | Subject)
   Data: e1_stateRT_agg
```

```
REML criterion at convergence: 4828.9

Scaled residuals:
    Min      1Q  Median      3Q     Max
-3.3841 -0.3753 -0.0328  0.3429  4.6352

Random effects:
 Groups   Name        Variance Std.Dev.
 Subject  (Intercept) 1011246  1006
 Residual             2473381  1573
Number of obs: 277, groups:  Subject, 73

Fixed effects:
                         Estimate Std. Error t value
(Intercept)               4377.57     151.73  28.851
Question.RESP1           -1582.19     161.59  -9.791
Question.RESP2            -574.21     161.59  -3.554
Question.RESP3             365.48     170.83   2.139
AgeGroup1                  878.79     151.73   5.792
Question.RESP1:AgeGroup1  -169.27     161.59  -1.048
Question.RESP2:AgeGroup1    18.25     161.59   0.113
Question.RESP3:AgeGroup1  -160.54     170.83  -0.940

Correlation of Fixed Effects:
            (Intr) Qs.RESP1 Qs.RESP2 Qs.RESP3 AgGrp1 Q.RESP1: Q.RESP2:
Qustn.RESP1 -0.028
Qustn.RESP2 -0.028 -0.298
Qustn.RESP3  0.038 -0.342   -0.342
AgeGroup1    0.040 -0.026   -0.026    0.030
Q.RESP1:AG1 -0.026  0.037    0.020   -0.032   -0.028
Q.RESP2:AG1 -0.026  0.020    0.037   -0.032   -0.028 -0.298
Q.RESP3:AG1  0.030 -0.032   -0.032    0.120    0.038 -0.342   -0.342
```

```
> car::Anova(e1_stateRT_hlm)
```

```
Analysis of Deviance Table (Type II Wald chisquare tests)

Response: State.RT
                          Chisq Df Pr(>Chisq)
Question.RESP          168.1878  3  < 2.2e-16 ***
AgeGroup                33.4383  1  7.356e-09 ***
Question.RESP:AgeGroup   4.0654  3     0.2545
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1
```

```
> e2_stateRT_hlm = lmer (data = e2_stateRT_agg, State.RT ~ Question.RESP*AgeGroup +
+                           (1|Subject))
```

```
> summary(e2_stateRT_hlm)
```

```
Linear mixed model fit by REML ['lmerMod']
Formula: State.RT ~ Question.RESP * AgeGroup + (1 | Subject)
   Data: e2_stateRT_agg

REML criterion at convergence: 4259.7

Scaled residuals:
    Min      1Q  Median      3Q     Max
-3.3331 -0.4054 -0.0413  0.3798  3.7284

Random effects:
 Groups   Name        Variance Std.Dev.
 Subject  (Intercept) 1367769  1170
 Residual             2136278  1462
Number of obs: 246, groups:  Subject, 65

Fixed effects:
                         Estimate Std. Error t value
(Intercept)                4236.7      173.3  24.454
Question.RESP1            -1360.8      159.4  -8.537
Question.RESP2             -556.7      159.4  -3.493
Question.RESP3              248.4      167.7   1.481
AgeGroup1                   929.5      173.3   5.365
Question.RESP1:AgeGroup1   -154.6      159.4  -0.970
Question.RESP2:AgeGroup1   -214.8      159.4  -1.348
Question.RESP3:AgeGroup1   -243.2      167.7  -1.450

Correlation of Fixed Effects:
            (Intr) Qs.RESP1 Qs.RESP2 Qs.RESP3 AgGrp1 Q.RESP1: Q.RESP2:
Qustn.RESP1 -0.027
Qustn.RESP2 -0.027 -0.294
Qustn.RESP3  0.028 -0.337   -0.337
AgeGroup1    0.037 -0.024   -0.024    0.030
Q.RESP1:AG1 -0.024  0.041    0.022   -0.038   -0.027
Q.RESP2:AG1 -0.024  0.022    0.041   -0.038   -0.027 -0.294
Q.RESP3:AG1  0.030 -0.038   -0.038    0.134    0.028 -0.337   -0.337
```

```
> car::Anova(e2_stateRT_hlm)
```

```
Analysis of Deviance Table (Type II Wald chisquare tests)

Response: State.RT
                         Chisq Df Pr(>Chisq)
Question.RESP          133.723  3  < 2.2e-16 ***
AgeGroup                27.953  1  1.243e-07 ***
Question.RESP:AgeGroup  13.518  3    0.00364 **
```

```
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1
```

```
> e3_stateRT_hlm = lmer (data = e3_stateRT_agg, State.RT ~ Question.RESP +
+                            (1|Subject))
> summary(e3_stateRT_hlm)
```

```
Linear mixed model fit by REML ['lmerMod']
Formula: State.RT ~ Question.RESP + (1 | Subject)
   Data: e3_stateRT_agg

REML criterion at convergence: 2380.6

Scaled residuals:
     Min       1Q   Median       3Q      Max
-1.78497 -0.58810 -0.06558  0.46680  3.09878

Random effects:
 Groups   Name        Variance Std.Dev.
 Subject  (Intercept) 804737   897.1
 Residual             849748   921.8
Number of obs: 144, groups:  Subject, 36

Fixed effects:
               Estimate Std. Error t value
(Intercept)      4221.9      168.1  25.117
Question.RESP1  -1216.1      133.1  -9.140
Question.RESP2   -707.6      133.1  -5.318
Question.RESP3   1066.4      133.1   8.014

Correlation of Fixed Effects:
            (Intr) Q.RESP1 Q.RESP2
Qustn.RESP1  0.000
Qustn.RESP2  0.000 -0.333
Qustn.RESP3  0.000 -0.333  -0.333
```

```
> car::Anova(e3_stateRT_hlm)
```

```
Analysis of Deviance Table (Type II Wald chisquare tests)

Response: State.RT
               Chisq Df Pr(>Chisq)
Question.RESP 163.18  3  < 2.2e-16 ***
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1
```

```
>
```

15 Word Type Analysis

```
> main = read.csv("Julie_Main5Studies.csv", header = TRUE, sep = ",")
> main$StudyNo = as.factor(main$StudyNo)
> main$PrimeCondition = as.factor(main$PrimeCondition)
> word_type = read.csv("ItemWordTypes.csv", header = TRUE, sep = ",")
> main_word = merge(main, word_type, by = c("Target"))
> library(dplyr)
> word_type_prime = group_by(main_word,
+                          ExperimentName, AgeGroup,Subject, PrimeCondition, Proper) %>%
+   summarise_at(vars(Accuracy), mean)
> word_type_prime$Subject = as.factor(word_type_prime$Subject)
> word_type_prime_E1 = word_type_prime %>%
+   filter(ExperimentName == "tot extended prime")
> word_type_prime_E2 = word_type_prime %>%
+   filter(ExperimentName == "tot not the prime")
> word_type_prime_E3 = word_type_prime %>%
+   filter(ExperimentName == "tot 48 ms")
> word_type_age = group_by(main_word, ExperimentName,
+                          AgeGroup, Proper) %>%
+   summarise_at(vars(Accuracy), mean)
> word_type_state_sub = group_by(main_word, Subject,
+                            Proper, Question.RESP) %>%
+   summarise(Trials = n())
> word_type_state_experiment = group_by(main_word, ExperimentName,
+                            Proper, Question.RESP) %>%
+   summarise(Trials = n())
> word_type_state_sub_age = group_by(main_word, Subject, AgeGroup,
+                            Proper, Question.RESP) %>%
+   summarise(Trials = n())
>
```

15.1 E1 E2 E3: proper name ANOVA

```
> e1_proper_aov = aov(data = word_type_prime_E1, Accuracy ~ AgeGroup*PrimeCondition*Prop
+                                   Error(Subject/(PrimeCondition*Proper)))
> summary(e1_proper_aov)
```

```
Error: Subject
          Df Sum Sq Mean Sq F value Pr(>F)
AgeGroup   1  0.058 0.05821   0.364  0.548
Residuals 71 11.355 0.15993

Error: Subject:PrimeCondition
                        Df Sum Sq  Mean Sq F value   Pr(>F)
PrimeCondition           3  1.456  0.4852  24.974 6.93e-14 ***
AgeGroup:PrimeCondition  3  0.032  0.0108   0.556    0.645
```

```
Residuals                213  4.139  0.0194
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Subject:Proper
               Df Sum Sq Mean Sq F value   Pr(>F)
Proper          1  4.728   4.728 107.969 6.71e-16 ***
AgeGroup:Proper 1  0.218   0.218   4.981   0.0288 *
Residuals      71  3.109   0.044
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Subject:PrimeCondition:Proper
                              Df Sum Sq Mean Sq F value Pr(>F)
PrimeCondition:Proper          3  0.069 0.02313   1.433  0.234
AgeGroup:PrimeCondition:Proper 3  0.065 0.02172   1.346  0.261
Residuals                    213  3.437 0.01614
```

```
> e2_proper_aov = aov(data = word_type_prime_E2, Accuracy ~ AgeGroup*PrimeCondition*Prop
+                                        Error(Subject/(PrimeCondition*Proper)))
> summary(e2_proper_aov)
```

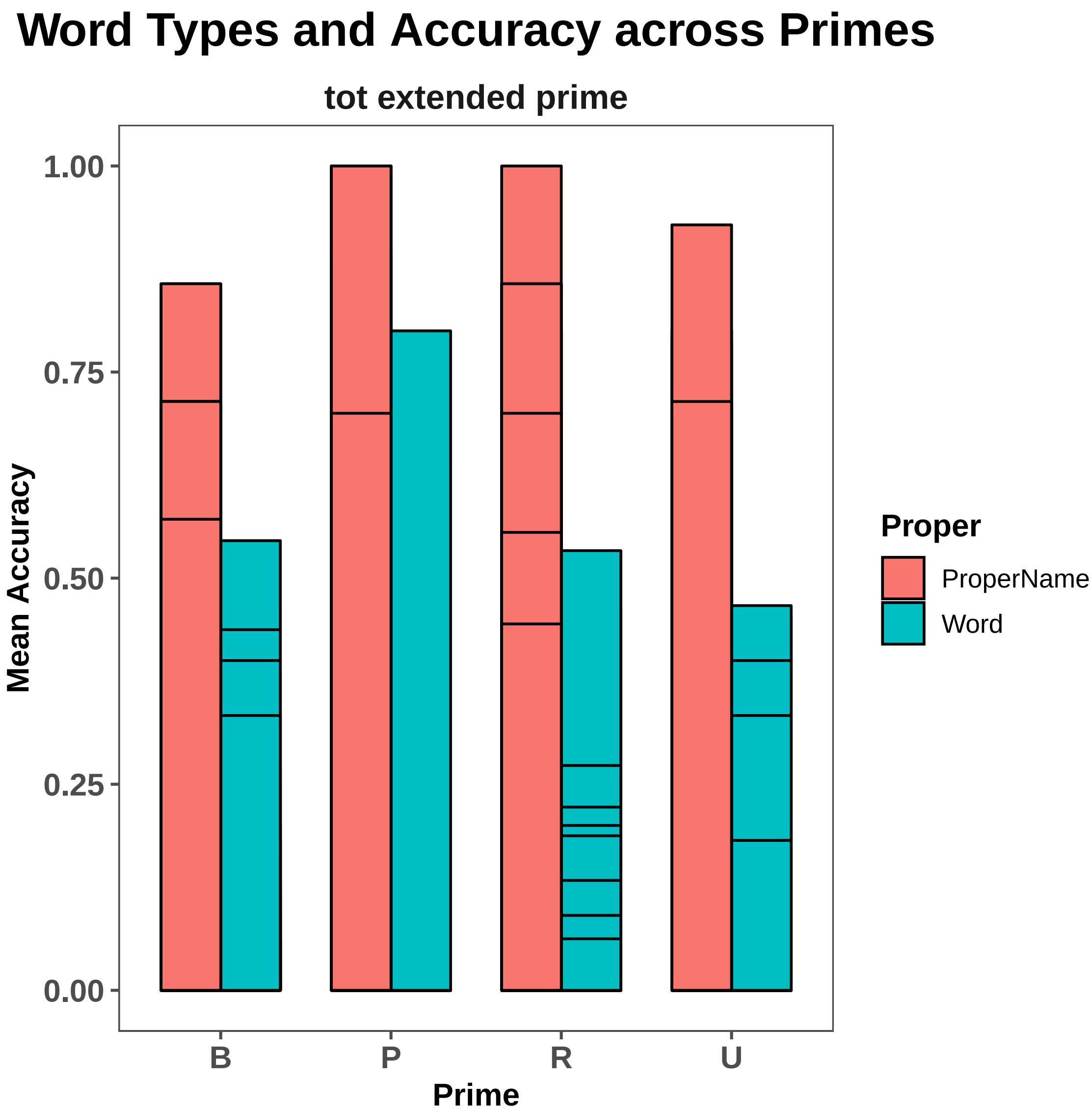
```
Error: Subject
          Df Sum Sq Mean Sq F value Pr(>F)
AgeGroup   1  0.214  0.2136   1.391  0.243
Residuals 63  9.677  0.1536

Error: Subject:PrimeCondition
                        Df Sum Sq Mean Sq F value   Pr(>F)
PrimeCondition           3  0.625  0.2082   10.26 2.74e-06 ***
AgeGroup:PrimeCondition  3  0.083  0.0276    1.36    0.256
Residuals              189  3.836  0.0203
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Subject:Proper
               Df Sum Sq Mean Sq F value   Pr(>F)
Proper          1  3.584   3.584  65.795 2.28e-11 ***
AgeGroup:Proper 1  0.080   0.080   1.468     0.23
Residuals      63  3.432   0.054
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Subject:PrimeCondition:Proper
                              Df Sum Sq  Mean Sq F value Pr(>F)
PrimeCondition:Proper          3  0.009 0.002969   0.170  0.916
AgeGroup:PrimeCondition:Proper 3  0.004 0.001365   0.078  0.972
Residuals                    189  3.293 0.017425
```

```
> e3_proper_aov = aov(data = word_type_prime_E3, Accuracy ~ PrimeCondition*Proper +
+                                       Error(Subject/(PrimeCondition*Proper)))
> summary(e3_proper_aov)
```

```
Error: Subject
          Df Sum Sq Mean Sq F value Pr(>F)
Residuals 35  4.794   0.137

Error: Subject:PrimeCondition
                Df Sum Sq Mean Sq F value Pr(>F)
PrimeCondition   3 0.2251 0.07503   3.914 0.0108 *
Residuals      105 2.0128 0.01917
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Subject:Proper
          Df Sum Sq Mean Sq F value   Pr(>F)
Proper     1  1.095   1.095   35.28 9.28e-07 ***
Residuals 35  1.086   0.031
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Subject:PrimeCondition:Proper
                       Df Sum Sq  Mean Sq F value Pr(>F)
PrimeCondition:Proper   3 0.0216 0.007189   0.465  0.707
Residuals             105 1.6237 0.015464
```

Word Type, Experiment and Prime Type

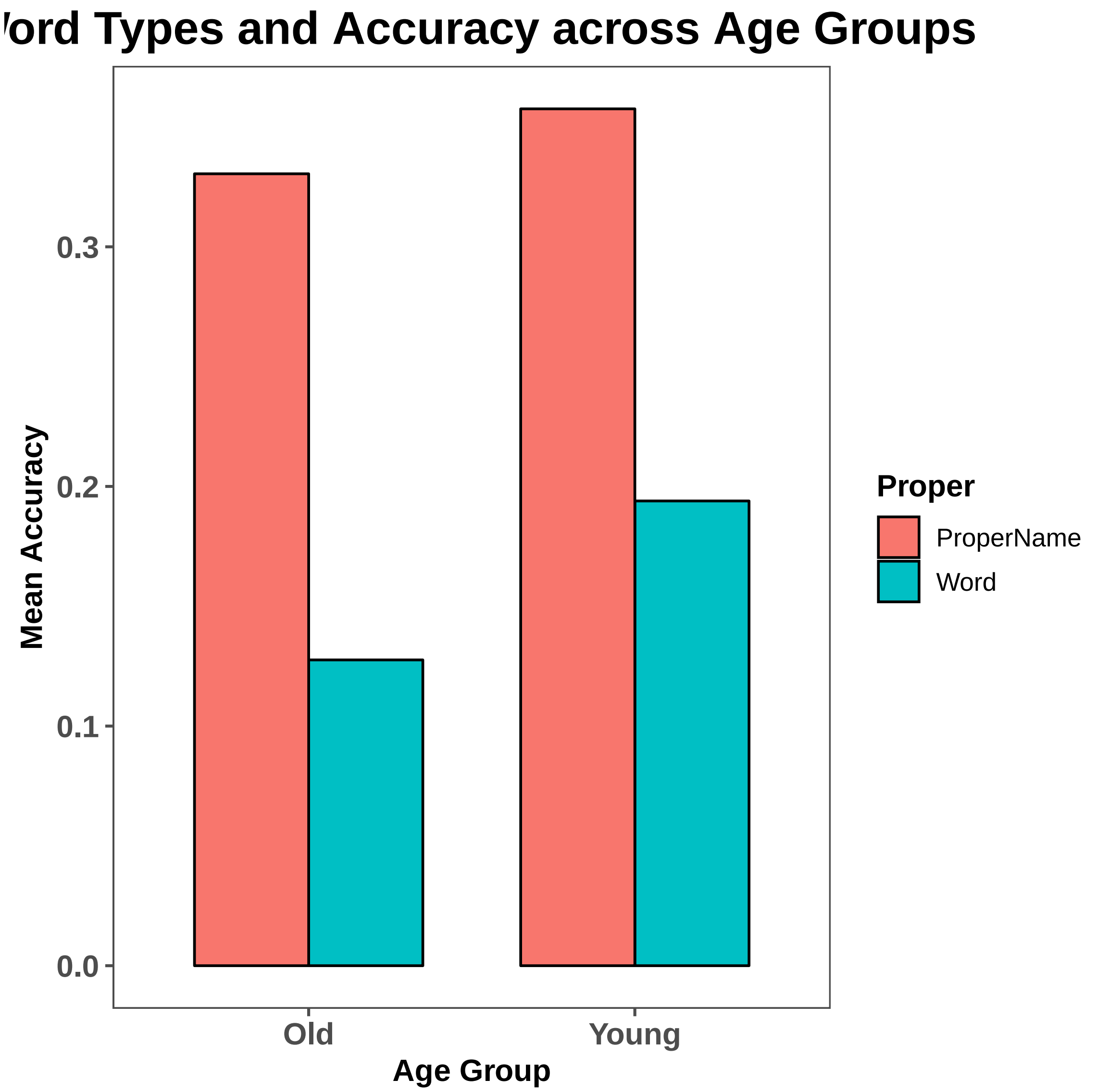
```
> library(ggplot2)
> library(ggthemes)
> word_type_prime_E1 %>%
+ ggplot(aes(x = PrimeCondition, y = Accuracy,
+            group = Proper, fill = Proper))+
+  geom_bar(stat = "identity", position = "dodge",
+           width = 0.7, color = "black")+
+  theme_few()+
+   facet_wrap(~ExperimentName)+
+   xlab("Prime") + ylab("Mean Accuracy") +
+   ggtitle("Word Types and Accuracy across Primes")  +
+    theme(axis.text = element_text(face = "bold", size = rel(1)),
+           axis.title = element_text(face = "bold", size = rel(1)),
+           legend.title = element_text(face = "bold", size = rel(1)),
+      plot.title = element_text(face = "bold", size = rel(1.5), hjust = .5),
+          strip.text.x = element_text(face = "bold", size = rel(1.4)))
```



Word Type and AgeGroup

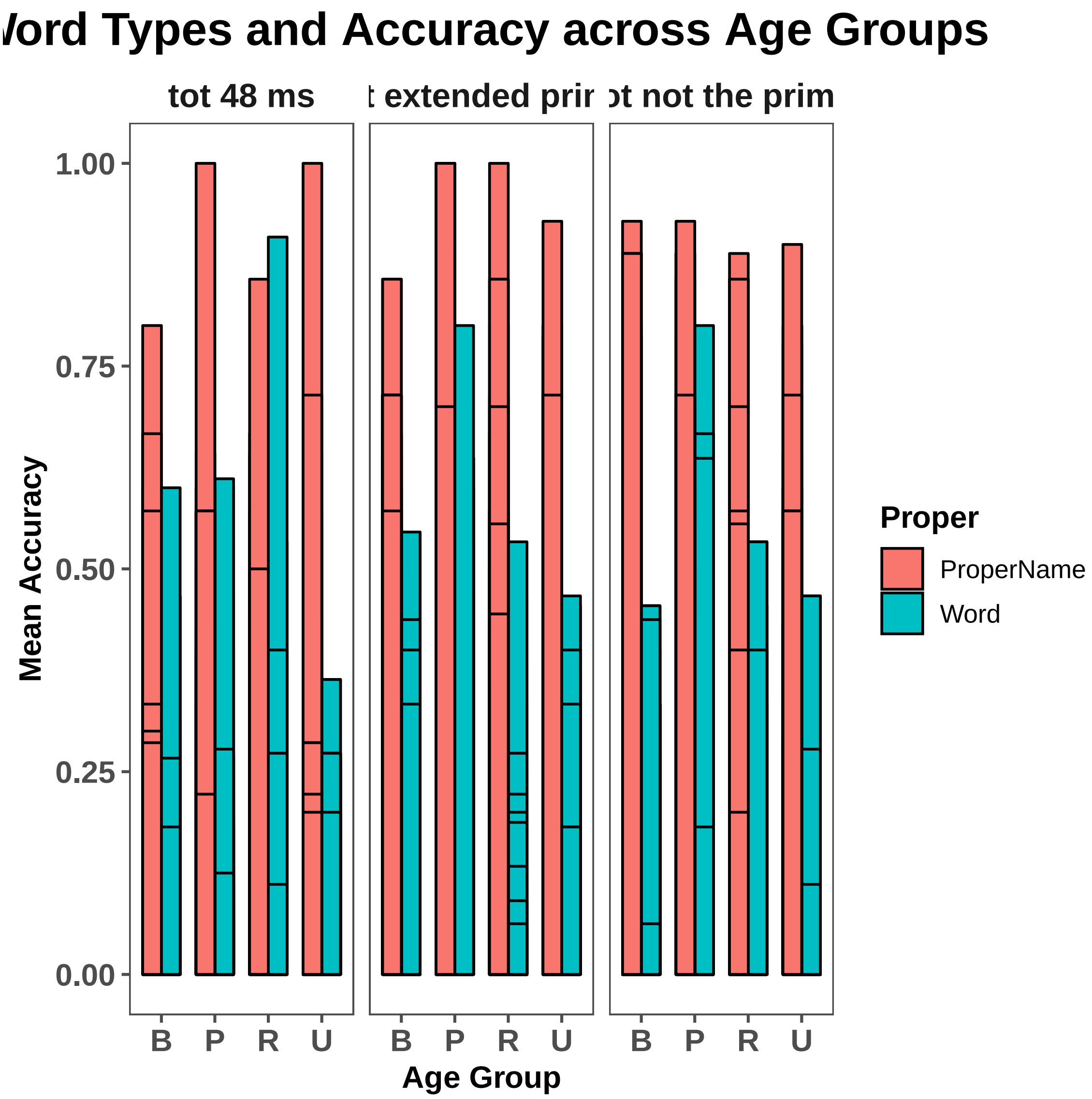
```
> library(ggplot2)
> library(ggthemes)
> word_type_age %>% filter(ExperimentName == "tot not the prime") %>%
+ ggplot(aes(x = AgeGroup, y = Accuracy,
+            group = Proper, fill = Proper))+
+  geom_bar(stat = "identity", position = "dodge",
+           width = 0.7, color = "black")+
+  theme_few()+
```

```
+      #facet_wrap(~ExperimentName)+
+    xlab("Age Group") + ylab("Mean Accuracy") +
+    ggtitle("Word Types and Accuracy across Age Groups")  +
+     theme(axis.text = element_text(face = "bold", size = rel(1)),
+            axis.title = element_text(face = "bold", size = rel(1)),
+            legend.title = element_text(face = "bold", size = rel(1)),
+      plot.title = element_text(face = "bold", size = rel(1.5), hjust = .5),
+           strip.text.x = element_text(face = "bold", size = rel(1.4)))
```



Word Type and Prime

```
> library(ggplot2)
> library(ggthemes)
> word_type_prime %>%
+ ggplot(aes(x = PrimeCondition, y = Accuracy,
+             group = Proper, fill = Proper))+
+  geom_bar(stat = "identity", position = "dodge",
+            width = 0.7, color = "black")+
+  theme_few()+
+     facet_wrap(~ExperimentName)+
+   xlab("Age Group") + ylab("Mean Accuracy") +
+   ggtitle("Word Types and Accuracy across Age Groups")  +
+    theme(axis.text = element_text(face = "bold", size = rel(1)),
+            axis.title = element_text(face = "bold", size = rel(1)),
+            legend.title = element_text(face = "bold", size = rel(1)),
+      plot.title = element_text(face = "bold", size = rel(1.5), hjust = .5),
+           strip.text.x = element_text(face = "bold", size = rel(1.4)))
```



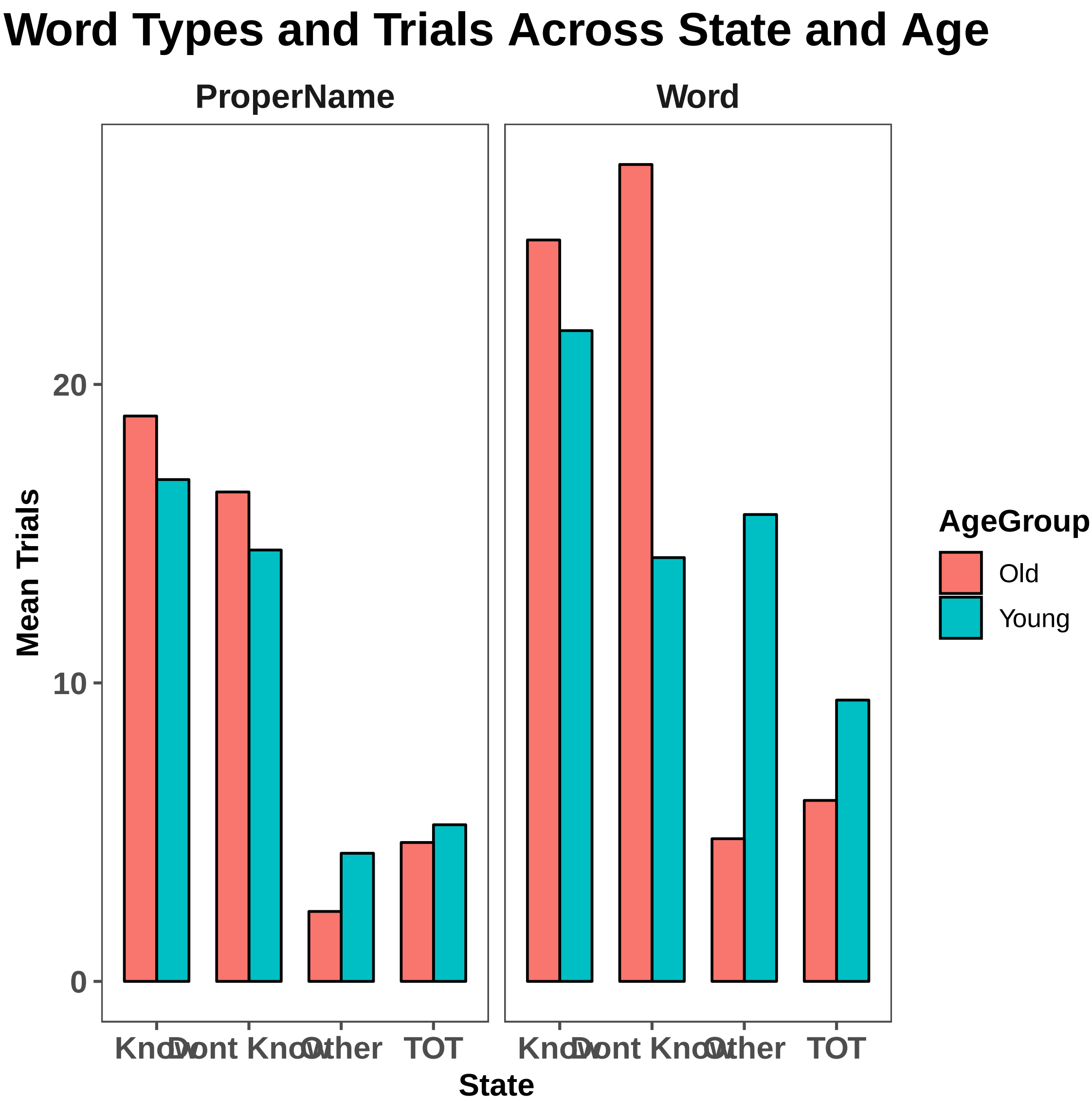
Word Type and State

```
> library(ggplot2)
> library(ggthemes)
> word_type_state_sub$Question.RESP = as.factor(word_type_state_sub$Question.RESP)
> word_type_state = Rmisc::summarySE(word_type_state_sub,
+                               measurevar = "Trials",
+                               groupvars = c("Proper", "Question.RESP"))
> word_type_state %>%
+   mutate(RetrievalState = factor(Question.RESP,
```

```
+                                    levels = unique(Question.RESP),
+                  labels = c("Know", "Dont Know", "Other", "TOT")))%>%
+ ggplot(aes(x = RetrievalState, y = Trials,
+            group = Proper, fill = Proper))+
+  geom_bar(stat = "identity", position = "dodge",
+           width = 0.7, color = "black")+
+  theme_few()+
+   xlab("State") + ylab("Mean Trials") +
+   ggtitle("Word Types and Trials across States")  +
+    theme(axis.text = element_text(face = "bold", size = rel(1)),
+           axis.title = element_text(face = "bold", size = rel(1)),
+           legend.title = element_text(face = "bold", size = rel(1)),
+      plot.title = element_text(face = "bold", size = rel(1.5), hjust = .5),
+          strip.text.x = element_text(face = "bold", size = rel(1.4)))
```

Word Type, Age and State

```
> library(ggplot2)
> library(ggthemes)
> word_type_state_age = Rmisc::summarySE(word_type_state_sub_age,
+                           measurevar = "Trials",
+                           groupvars = c("AgeGroup", "Proper", "Question.RESP"))
> word_type_state_age %>%
+   mutate(RetrievalState = factor(Question.RESP,
+                                    levels = unique(Question.RESP),
+                  labels = c("Know", "Dont Know", "Other", "TOT")))%>%
+ ggplot(aes(x = RetrievalState, y = Trials,
+            group = AgeGroup, fill = AgeGroup))+
+  geom_bar(stat = "identity", position = "dodge",
+           width = 0.7, color = "black")+
+  theme_few()+
+   facet_wrap(~Proper)+
+   xlab("State") + ylab("Mean Trials") +
+   ggtitle("Word Types and Trials Across State and Age")  +
+    theme(axis.text = element_text(face = "bold", size = rel(1)),
+           axis.title = element_text(face = "bold", size = rel(1)),
+           legend.title = element_text(face = "bold", size = rel(1)),
+      plot.title = element_text(face = "bold", size = rel(1.5), hjust = .5),
+          strip.text.x = element_text(face = "bold", size = rel(1.4)))
```



15.2 HLMs with WordType

15.2.1 Target Accuracy

```
> contrasts(main_word$PrimeCondition) = contr.treatment(4, base = 2)
> contrasts(main_word$AgeGroup) = contr.treatment(2, base = 1)
> contrasts(main_word$Proper) = contr.treatment(2, base = 1)
> e1_proper = main_word %>% filter(StudyNo == "2" | StudyNo == "4")
> e2_proper = main_word %>% filter(StudyNo == "5" | StudyNo == "6")
> e3_proper = main_word %>% filter(StudyNo == "1")
> exp1_acc_hlm_M1 = glmer(data = e1_proper ,
```

```
+                          Accuracy ~ AgeGroup*PrimeCondition*Proper +
+                          (1|Subject) + (1|Target), family = "binomial",
+      control=glmerControl(optimizer="bobyqa",
+              optCtrl=list(maxfun=100000)))
> summary(exp1_acc_hlm_M1)
```

```
Generalized linear mixed model fit by maximum likelihood (Laplace
  Approximation) [glmerMod]
 Family: binomial  ( logit )
Formula: Accuracy ~ AgeGroup * PrimeCondition * Proper + (1 | Subject) +
    (1 | Target)
   Data: e1_proper
Control: glmerControl(optimizer = "bobyqa", optCtrl = list(maxfun = 1e+05))

     AIC      BIC   logLik deviance df.resid
  6177.2   6301.3  -3070.6   6141.2     7282

Scaled residuals:
    Min      1Q  Median      3Q     Max
-4.7354 -0.4659 -0.2271  0.2196 10.3404

Random effects:
 Groups  Name        Variance Std.Dev.
 Target  (Intercept) 1.802    1.343
 Subject (Intercept) 1.016    1.008
Number of obs: 7300, groups:  Target, 100; Subject, 73

Fixed effects:
                                  Estimate Std. Error z value Pr(>|z|)
(Intercept)                        0.01153    0.29777   0.039 0.969106
AgeGroup2                         -0.53684    0.29446  -1.823 0.068283 .
PrimeCondition1                   -0.51641    0.17659  -2.924 0.003452 **
PrimeCondition3                   -0.95925    0.18078  -5.306 1.12e-07 ***
PrimeCondition4                   -1.01087    0.18144  -5.571 2.53e-08 ***
Proper2                           -1.74437    0.32705  -5.334 9.63e-08 ***
AgeGroup2:PrimeCondition1          0.29016    0.24979   1.162 0.245392
AgeGroup2:PrimeCondition3          0.45516    0.25408   1.791 0.073231 .
AgeGroup2:PrimeCondition4          0.46021    0.25545   1.802 0.071617 .
AgeGroup2:Proper2                  0.84169    0.24448   3.443 0.000576 ***
PrimeCondition1:Proper2           -0.27540    0.25768  -1.069 0.285180
PrimeCondition3:Proper2           -0.25521    0.26784  -0.953 0.340670
PrimeCondition4:Proper2           -0.13164    0.26817  -0.491 0.623513
AgeGroup2:PrimeCondition1:Proper2 -0.58325    0.35979  -1.621 0.105000
AgeGroup2:PrimeCondition3:Proper2 -0.65124    0.37342  -1.744 0.081161 .
AgeGroup2:PrimeCondition4:Proper2 -0.36841    0.36998  -0.996 0.319365
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1
```

```
> car::Anova(exp1_acc_hlm_M1)
```

```
Analysis of Deviance Table (Type II Wald chisquare tests)

Response: Accuracy
                                 Chisq Df Pr(>Chisq)
AgeGroup                        0.0243  1  0.8760249
PrimeCondition                151.0413  3  < 2.2e-16 ***
Proper                         33.0953  1  8.775e-09 ***
AgeGroup:PrimeCondition         2.8165  3  0.4207988
AgeGroup:Proper                12.2214  1  0.0004724 ***
PrimeCondition:Proper          13.7021  3  0.0033399 **
AgeGroup:PrimeCondition:Proper  3.9393  3  0.2680885
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1
```

```
> sjPlot::plot_model(exp1_acc_hlm_M1, type = "pred",
+                    terms = c("AgeGroup","Proper"))
> ## OA better than YA for proper names than words
>
> #sjPlot::plot_model(exp1_acc_hlm_M1, type = "pred",
>  #                  terms = c("Proper","PrimeCondition"))
>
> ## Words show more phon. facilitation than Proper Names
>
> exp2_acc_hlm_M1 = glmer(data = e2_proper ,
+                         Accuracy ~ AgeGroup*PrimeCondition*Proper +
+                         (1|Subject) + (1|Target), family = "binomial",
+     control=glmerControl(optimizer="bobyqa",
+             optCtrl=list(maxfun=100000)))
> summary(exp2_acc_hlm_M1)
```

```
Generalized linear mixed model fit by maximum likelihood (Laplace
  Approximation) [glmerMod]
 Family: binomial  ( logit )
Formula: Accuracy ~ AgeGroup * PrimeCondition * Proper + (1 | Subject) +
    (1 | Target)
   Data: e2_proper
Control: glmerControl(optimizer = "bobyqa", optCtrl = list(maxfun = 1e+05))

     AIC      BIC   logLik deviance df.resid
  5308.2   5430.3  -2636.1   5272.2     6482

Scaled residuals:
    Min      1Q  Median      3Q     Max
-3.7065 -0.4408 -0.2260 -0.0637 13.4160
```

```
Random effects:
 Groups  Name        Variance Std.Dev.
 Target  (Intercept) 1.834    1.354
 Subject (Intercept) 1.003    1.002
Number of obs: 6500, groups:  Target, 100; Subject, 65

Fixed effects:
                                  Estimate Std. Error z value Pr(>|z|)
(Intercept)                        -0.7536     0.3106  -2.426   0.0153 *
AgeGroup2                           0.4502     0.3128   1.439   0.1500
PrimeCondition1                    -0.2305     0.1979  -1.165   0.2441
PrimeCondition3                    -0.3809     0.1992  -1.913   0.0558 .
PrimeCondition4                    -0.4404     0.1994  -2.209   0.0272 *
Proper2                            -1.6923     0.3442  -4.916 8.83e-07 ***
AgeGroup2:PrimeCondition1          -0.2973     0.2725  -1.091   0.2752
AgeGroup2:PrimeCondition3          -0.1817     0.2729  -0.666   0.5054
AgeGroup2:PrimeCondition4          -0.4869     0.2770  -1.758   0.0788 .
AgeGroup2:Proper2                   0.4739     0.2714   1.747   0.0807 .
PrimeCondition1:Proper2            -0.2817     0.2951  -0.955   0.3398
PrimeCondition3:Proper2            -0.3989     0.3019  -1.321   0.1864
PrimeCondition4:Proper2            -0.3825     0.3057  -1.251   0.2109
AgeGroup2:PrimeCondition1:Proper2   0.2116     0.3962   0.534   0.5933
AgeGroup2:PrimeCondition3:Proper2   0.2224     0.4028   0.552   0.5809
AgeGroup2:PrimeCondition4:Proper2   0.2172     0.4125   0.527   0.5985
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1
```

```
> car::Anova(exp2_acc_hlm_M1)
```

```
Analysis of Deviance Table (Type II Wald chisquare tests)

Response: Accuracy
                            Chisq Df Pr(>Chisq)
AgeGroup                   3.6418  1    0.05634 .
PrimeCondition            73.2380  3  8.644e-16 ***
Proper                    29.6173  1  5.263e-08 ***
AgeGroup:PrimeCondition    3.9008  3    0.27238
AgeGroup:Proper           18.6134  1  1.601e-05 ***
PrimeCondition:Proper      2.4348  3    0.48719
AgeGroup:PrimeCondition:Proper  0.4567  3    0.92829
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1
```

```
> #sjPlot::plot_model(exp2_acc_hlm_M1, type = "pred",
>  #                  terms = c("AgeGroup","Proper"))
>
> # Not clear what this interaction is: OA worse than YA in Words
>
```

```
>
> exp3_acc_hlm_M1 = glmer(data = e3_proper ,
+                         Accuracy ~ PrimeCondition*Proper +
+                         (1|Subject) + (1|Target), family = "binomial",
+     control=glmerControl(optimizer="bobyqa",
+             optCtrl=list(maxfun=100000)))
> summary(exp1_acc_hlm_M1)
```

```
Generalized linear mixed model fit by maximum likelihood (Laplace
  Approximation) [glmerMod]
 Family: binomial  ( logit )
Formula: Accuracy ~ AgeGroup * PrimeCondition * Proper + (1 | Subject) +
    (1 | Target)
   Data: e1_proper
Control: glmerControl(optimizer = "bobyqa", optCtrl = list(maxfun = 1e+05))

     AIC      BIC   logLik deviance df.resid
  6177.2   6301.3  -3070.6   6141.2     7282

Scaled residuals:
    Min      1Q  Median      3Q     Max
-4.7354 -0.4659 -0.2271  0.2196 10.3404

Random effects:
 Groups  Name        Variance Std.Dev.
 Target  (Intercept) 1.802    1.343
 Subject (Intercept) 1.016    1.008
Number of obs: 7300, groups:  Target, 100; Subject, 73

Fixed effects:
                                  Estimate Std. Error z value Pr(>|z|)
(Intercept)                        0.01153    0.29777   0.039 0.969106
AgeGroup2                         -0.53684    0.29446  -1.823 0.068283 .
PrimeCondition1                   -0.51641    0.17659  -2.924 0.003452 **
PrimeCondition3                   -0.95925    0.18078  -5.306 1.12e-07 ***
PrimeCondition4                   -1.01087    0.18144  -5.571 2.53e-08 ***
Proper2                           -1.74437    0.32705  -5.334 9.63e-08 ***
AgeGroup2:PrimeCondition1          0.29016    0.24979   1.162 0.245392
AgeGroup2:PrimeCondition3          0.45516    0.25408   1.791 0.073231 .
AgeGroup2:PrimeCondition4          0.46021    0.25545   1.802 0.071617 .
AgeGroup2:Proper2                  0.84169    0.24448   3.443 0.000576 ***
PrimeCondition1:Proper2           -0.27540    0.25768  -1.069 0.285180
PrimeCondition3:Proper2           -0.25521    0.26784  -0.953 0.340670
PrimeCondition4:Proper2           -0.13164    0.26817  -0.491 0.623513
AgeGroup2:PrimeCondition1:Proper2 -0.58325    0.35979  -1.621 0.105000
AgeGroup2:PrimeCondition3:Proper2 -0.65124    0.37342  -1.744 0.081161 .
AgeGroup2:PrimeCondition4:Proper2 -0.36841    0.36998  -0.996 0.319365
---
```

```
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1
```

```
> car::Anova(exp3_acc_hlm_M1)
```

```
Analysis of Deviance Table (Type II Wald chisquare tests)

Response: Accuracy
                        Chisq Df Pr(>Chisq)
PrimeCondition         19.757  3  0.0001906 ***
Proper                 16.383  1  5.175e-05 ***
PrimeCondition:Proper   0.630  3  0.8895350
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1
```

```
> #sjPlot::plot_model(exp3_acc_hlm_M1, type = "int")
>
>
> exp1_plot_data <- effects::effect("PrimeCondition*Proper",
+                                    exp2_acc_hlm_M1,
+  xlevels = list(PrimeCondition = c("B", "P","R", "U"),
+                 AgeGroup = c("Young", "Old"),
+                 Proper = c("ProperName", "Word")))
> # plot(exp1_plot_data, main = "Exp1: WordType x PrimeCondition")
>
>  exp1_plot_data <- effects::effect("AgeGroup*Proper",
+                                    exp1_acc_hlm_M1,
+  xlevels = list(PrimeCondition = c("B", "P","R", "U"),
+                 AgeGroup = c("Young", "Old"),
+                 Proper = c("ProperName", "Word")))
>  t1 = plot(exp1_plot_data, main = "Exp1: WordType x Age")
>  exp2_plot_data <- effects::effect("AgeGroup*Proper",
+                                    exp2_acc_hlm_M1,
+  xlevels = list(PrimeCondition = c("B", "P","R", "U"),
+                 AgeGroup = c("Young", "Old"),
+                 Proper = c("ProperName", "Word")))
>  t2 =plot(exp1_plot_data, main = "Exp2: WordType x Age")
>
>  #gridExtra::grid.arrange(t1,t2, nrow = 1, ncol = 2)
```

15.2.2 States: E3

```
> ### MULTINOMIAL LOGISTIC REGRESSION ###
>
> library(nnet)
> library(dplyr)
> e3_proper$State = ifelse(e3_proper$Question.RESP == "1", "Know",
+                       (ifelse(e3_proper$Question.RESP == "2", "DontKnow",
```

```
+                    ifelse(e3_proper$Question.RESP == "3", "Other", "TOT"))))
> e3_proper_state_multinomial = nnet::multinom(data = e3_proper,
+                          State ~ Proper*PrimeCondition +
+                         (1|Subject))
```

```
# weights:  40 (27 variable)
initial  value 4990.659700
iter  10 value 4653.511178
iter  20 value 4631.521716
iter  30 value 4630.791291
iter  30 value 4630.791288
iter  30 value 4630.791288
final  value 4630.791288
converged
```

```
> summary(e3_proper_state_multinomial)
```

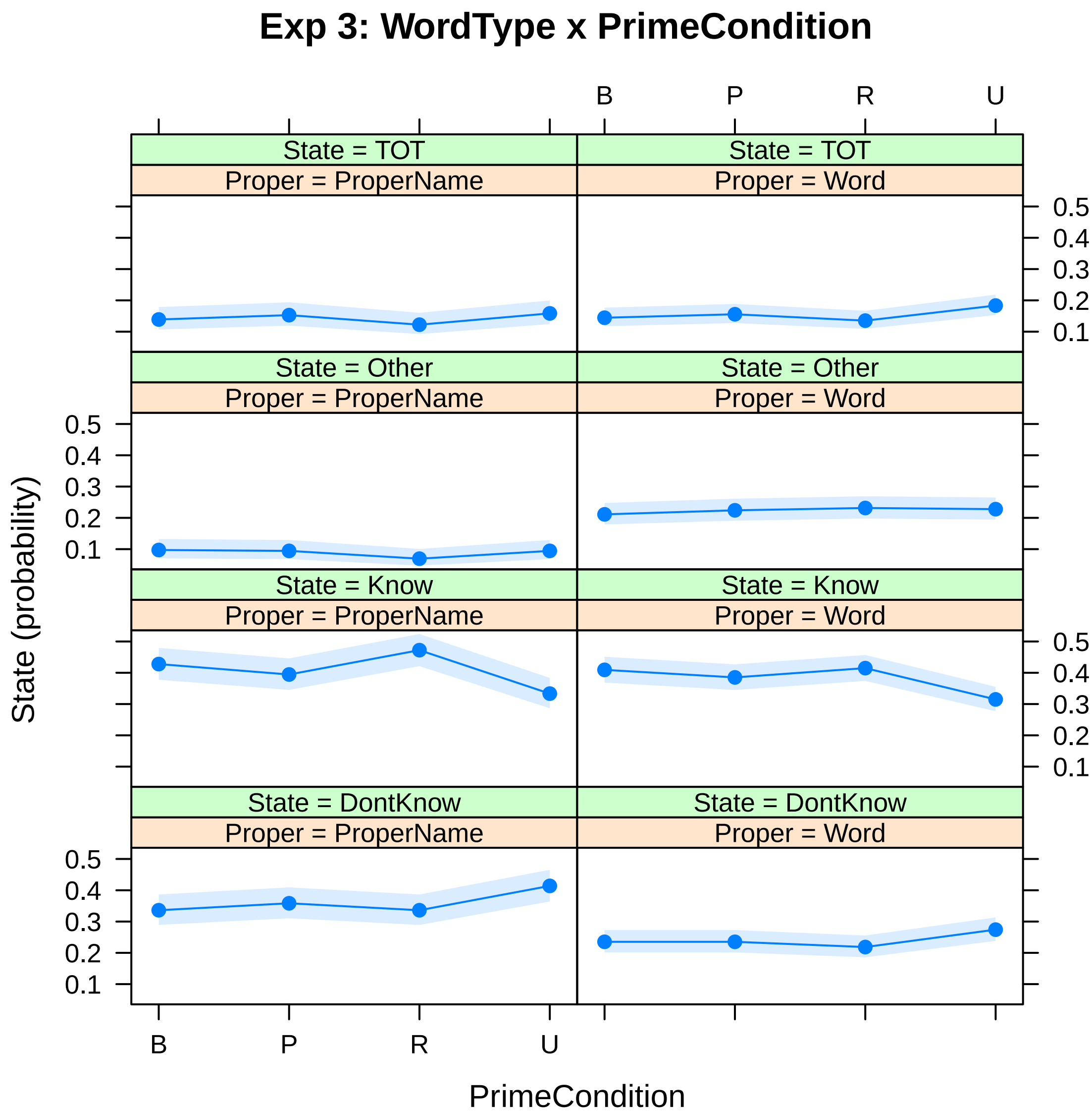
```
Call:
nnet::multinom(formula = State ~ Proper * PrimeCondition + (1 |
    Subject), data = e3_proper)

Coefficients:
      (Intercept)   Proper2 PrimeCondition1 PrimeCondition3 PrimeCondition4
Know   0.04800516 0.3973448      0.14515455       0.2439883      -0.3124643
Other -0.66673875 1.2850940      0.09306014      -0.2434206      -0.1440636
TOT   -0.42625599 0.4391525     -0.03124165      -0.1590846      -0.1083642
      1 | Subject1 Proper2:PrimeCondition1 Proper2:PrimeCondition3
Know   -0.04800516             -0.08453683             -0.09638129
Other   0.66673875             -0.15267999              0.34942559
TOT     0.42625599             -0.04287940              0.09222280
      Proper2:PrimeCondition4
Know             -0.042301717
Other             0.007411718
TOT               0.119629224

Std. Errors:
      (Intercept)   Proper2 PrimeCondition1 PrimeCondition3 PrimeCondition4
Know   0.06081547 0.1657584       0.1719073       0.1701203       0.1727395
Other  0.09638998 0.2308735       0.2720285       0.2922803       0.2707143
TOT    0.08052036 0.2138057       0.2328056       0.2385910       0.2240295
      1 | Subject1 Proper2:PrimeCondition1 Proper2:PrimeCondition3
Know    0.06081547               0.2337365               0.2335841
Other   0.09638998               0.3267782               0.3435708
TOT     0.08052036               0.3076877               0.3144480
      Proper2:PrimeCondition4
Know                0.2348612
Other               0.3229731
TOT                 0.2946621
```

```
Residual Deviance: 9261.583
AIC: 9309.583
```

```
> car::Anova(e3_proper_state_multinomial)
```

```
Analysis of Deviance Table (Type II tests)

Response: State
                      LR Chisq Df Pr(>Chisq)
Proper                 145.521  3  < 2.2e-16 ***
PrimeCondition          31.750  9  0.0002199 ***
1 | Subject              0.000  3  1.0000000
Proper:PrimeCondition    3.581  9  0.9367561
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1
```

```
> exp3_state_data ← effects::effect("Proper*PrimeCondition",
+                                     e3_proper_state_multinomial,
+  xlevels = list(PrimeCondition = c("B", "P","R", "U"),
+                                 Proper = c("ProperName", "Word")))
>  plot(exp3_state_data,main = "Exp 3: WordType x PrimeCondition")
>
```



15.2.3 States: E2

```
> ### MULTINOMIAL LOGISTIC REGRESSION ###
>
> library(nnet)
> library(dplyr)
> e2_proper$State = ifelse(e2_proper$Question.RESP == "1", "Know",
+                          (ifelse(e2_proper$Question.RESP == "2", "DontKnow",
+                    ifelse(e2_proper$Question.RESP == "3", "Other", "TOT"))))
> e2_proper_state_multinomial = nnet::multinom(data = e2_proper,
+                               State ~Proper*PrimeCondition*AgeGroup +
```

```
+                              (1|Subject))
```

```
# weights:  72 (51 variable)
initial  value 9010.913347
iter  10 value 7811.823044
iter  20 value 7553.190151
iter  30 value 7472.761587
iter  40 value 7462.492857
iter  50 value 7461.858412
final  value 7461.842801
converged
```

```
> summary(e2_proper_state_multinomial)
```

```
Call:
nnet::multinom(formula = State ~ Proper * PrimeCondition * AgeGroup +
    (1 | Subject), data = e2_proper)

Coefficients:
      (Intercept)    Proper2 PrimeCondition1 PrimeCondition3 PrimeCondition4
Know  -0.04605436 0.04177174       0.1683075      0.09196541     -0.06624657
Other -1.84117972 1.21532388       0.9460282      1.00788145      0.70594995
TOT   -1.29207768 0.35070157       0.7408157      0.60294131      0.57263636
      AgeGroup2 1 | Subject1 Proper2:PrimeCondition1 Proper2:PrimeCondition3
Know  0.6878776   0.04605436              -0.2758295              -0.1070695
Other 2.3265961   1.84117972              -0.6415156              -0.8031425
TOT   1.5930197   1.29207768              -0.3724929              -0.4002630
      Proper2:PrimeCondition4 Proper2:AgeGroup2 PrimeCondition1:AgeGroup2
Know               -0.2677480       -0.15795239                -0.5803799
Other              -0.6968838        0.06042764                -0.7156478
TOT                -0.6302659        0.22201732                -0.7724448
      PrimeCondition3:AgeGroup2 PrimeCondition4:AgeGroup2
Know                 -0.5645414                -0.7978126
Other                -1.0886618                -0.7365658
TOT                  -0.7022868                -0.5239481
      Proper2:PrimeCondition1:AgeGroup2 Proper2:PrimeCondition3:AgeGroup2
Know                          0.7489188                         0.5387847
Other                         0.6560719                         0.8660903
TOT                           0.5779225                         0.6131484
      Proper2:PrimeCondition4:AgeGroup2
Know                          0.4245608
Other                         0.4771057
TOT                           0.2386811

Std. Errors:
      (Intercept)   Proper2 PrimeCondition1 PrimeCondition3 PrimeCondition4
Know   0.05741465 0.1494824       0.1644601       0.1642517       0.1643719
Other  0.25309740 0.5597510       0.6119170       0.6026219       0.6225425
```

```
TOT    0.14969807 0.3684620        0.3772072        0.3828057        0.3789712
      AgeGroup2 1 | Subject1 Proper2:PrimeCondition1 Proper2:PrimeCondition3
Know  0.1708129   0.05741465                0.2140385                0.2132930
Other 0.5536606   0.25309740                0.6887814                0.6842729
TOT   0.3573848   0.14969807                0.4705378                0.4813230
      Proper2:PrimeCondition4 Proper2:AgeGroup2 PrimeCondition1:AgeGroup2
Know                0.2139691         0.2284169                 0.2431238
Other               0.7028435         0.6176036                 0.6786374
TOT                 0.4817688         0.4420235                 0.4620980
      PrimeCondition3:AgeGroup2 PrimeCondition4:AgeGroup2
Know                  0.2416883                 0.2449029
Other                 0.6753763                 0.6889354
TOT                   0.4660618                 0.4559898
      Proper2:PrimeCondition1:AgeGroup2 Proper2:PrimeCondition3:AgeGroup2
Know                          0.3265596                         0.3235821
Other                         0.7718589                         0.7725509
TOT                           0.5793727                         0.5863865
      Proper2:PrimeCondition4:AgeGroup2
Know                          0.3257103
Other                         0.7830637
TOT                           0.5803039

Residual Deviance: 14923.69
AIC: 15019.69
```

```
> car::Anova(e2_proper_state_multinomial)
```

```
Analysis of Deviance Table (Type II tests)

Response: State
                               LR Chisq Df Pr(>Chisq)
Proper                           135.67  3  < 2.2e-16 ***
PrimeCondition                    54.16  9  1.764e-08 ***
AgeGroup                         611.11  3  < 2.2e-16 ***
1 | Subject                        0.00  3   1.000000
Proper:PrimeCondition              8.15  9   0.518755
Proper:AgeGroup                   13.87  3   0.003086 **
PrimeCondition:AgeGroup           15.98  9   0.067324 .
Proper:PrimeCondition:AgeGroup     6.70  9   0.668549
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1
```

```
> exp2_state_data ← effects::effect("Proper*AgeGroup",
+                                   e2_proper_state_multinomial,
+  xlevels = list(PrimeCondition = c("B", "P","R", "U"),
+                 AgeGroup = c("Young", "Old"),
Proper = c("ProperName", "Word")))
>  s2 = plot(exp2_state_data,main = "Exp 2: WordType x Age")
```

```
>
```

15.2.4 States: E1

```
> ### MULTINOMIAL LOGISTIC REGRESSION ###
>
> library(nnet)
> library(dplyr)
> e1_proper$State = ifelse(e1_proper$Question.RESP == "1", "Know",
+                       (ifelse(e1_proper$Question.RESP == "2", "DontKnow",
+                  ifelse(e1_proper$Question.RESP == "3", "Other", "TOT"))))
> e1_proper_state_multinomial = nnet::multinom(data = e1_proper,
+                          State ~ Proper*PrimeCondition*AgeGroup +
+                         (1|Subject))
```

```
# weights:  72 (51 variable)
initial  value 10119.948836
iter  10 value 9271.488209
iter  20 value 8831.561438
iter  30 value 8673.637604
iter  40 value 8631.678731
iter  50 value 8625.341128
final  value 8625.321329
converged
```

```
> summary(e1_proper_state_multinomial)
```

```
Call:
nnet::multinom(formula = State ~ Proper * PrimeCondition * AgeGroup +
    (1 | Subject), data = e1_proper)

Coefficients:
      (Intercept)    Proper2 PrimeCondition1 PrimeCondition3 PrimeCondition4
Know    0.2933956 -0.5276913     -0.20485606      -0.1671933      -0.6743378
Other  -1.2694970  0.7118370     -0.12381978       0.7723939      -0.7129614
TOT    -0.6352209 -0.8003760     -0.09290331       0.3149625       0.2700682
        AgeGroup2 1 | Subject1 Proper2:PrimeCondition1 Proper2:PrimeCondition3
Know  -0.18411374   -0.2933956               0.1972837               0.1789249
Other  1.28625178    1.2694970              -0.1066329              -0.5684689
TOT    0.07482917    0.6352209               0.5454646               0.1780069
      Proper2:PrimeCondition4 Proper2:AgeGroup2 PrimeCondition1:AgeGroup2
Know                0.2772082         0.9348691                0.09967292
Other               0.6760643         0.9947307                0.16999641
TOT                 0.3082846         1.6435956               -0.02929692
      PrimeCondition3:AgeGroup2 PrimeCondition4:AgeGroup2
Know               0.0004757543                 0.2071155
Other             -0.2968425901                 0.7570896
```

```
TOT              -0.3561390090                   -0.1941856
      Proper2:PrimeCondition1:AgeGroup2 Proper2:PrimeCondition3:AgeGroup2
Know                         -0.3650391                        -0.21424712
Other                        -0.1265846                         0.08027801
TOT                          -0.6325761                        -0.26535038
      Proper2:PrimeCondition4:AgeGroup2
Know                         -0.4906433
Other                        -0.9577954
TOT                          -0.8187783

Std. Errors:
      (Intercept)   Proper2 PrimeCondition1 PrimeCondition3 PrimeCondition4
Know   0.05841647 0.1486476       0.1633792       0.1667778       0.1647533
Other  0.17312138 0.3889202       0.4886421       0.4224196       0.5413440
TOT    0.10002608 0.2808074       0.2794221       0.2660621       0.2530152
      AgeGroup2 1 | Subject1 Proper2:PrimeCondition1 Proper2:PrimeCondition3
Know  0.1663470   0.05841647               0.2091133               0.2124187
Other 0.3971132   0.17312138               0.5559073               0.4874986
TOT   0.2760481   0.10002608               0.3788611               0.3693655
      Proper2:PrimeCondition4 Proper2:AgeGroup2 PrimeCondition1:AgeGroup2
Know                0.2118977         0.2245530                 0.2333156
Other               0.5943935         0.4530610                 0.5574723
TOT                 0.3520869         0.3728538                 0.3892869
      PrimeCondition3:AgeGroup2 PrimeCondition4:AgeGroup2
Know                  0.2372134                 0.2356200
Other                 0.4917936                 0.6008895
TOT                   0.3779072                 0.3583581
      Proper2:PrimeCondition1:AgeGroup2 Proper2:PrimeCondition3:AgeGroup2
Know                          0.3144418                         0.3192572
Other                         0.6417329                         0.5763741
TOT                           0.5135621                         0.5061991
      Proper2:PrimeCondition4:AgeGroup2
Know                          0.3170767
Other                         0.6707914
TOT                           0.4841503

Residual Deviance: 17250.64
AIC: 17346.64
```

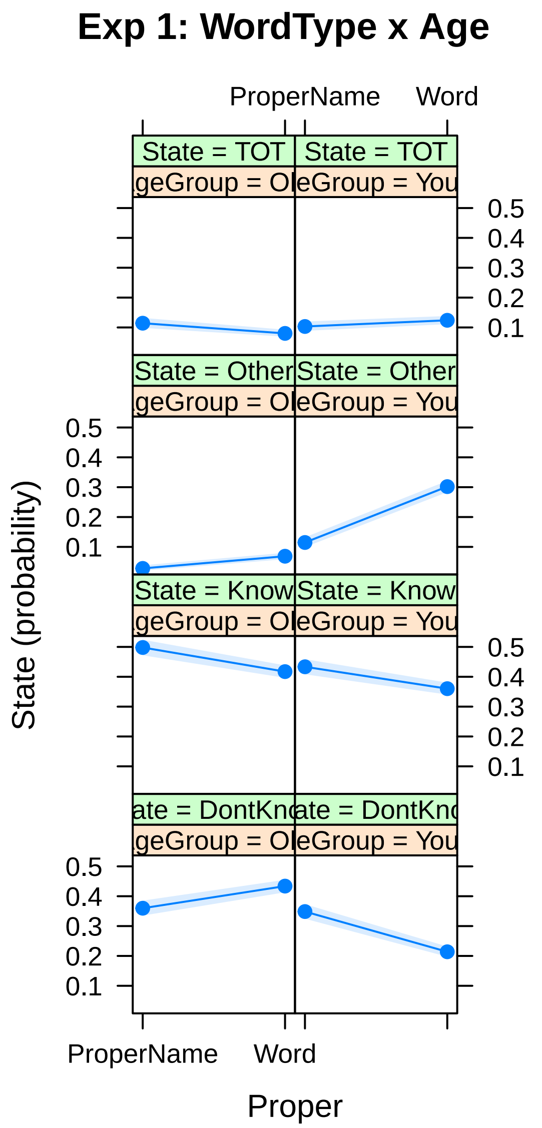
```
> car::Anova(e1_proper_state_multinomial)
```

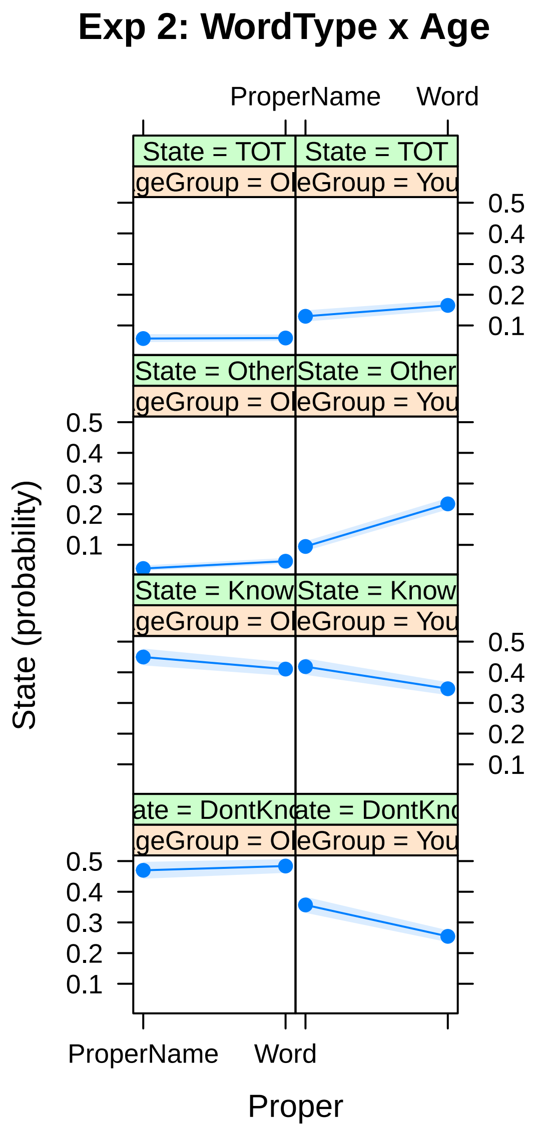
```
Analysis of Deviance Table (Type II tests)

Response: State
                               LR Chisq Df Pr(>Chisq)
Proper                           213.11  3  < 2.2e-16 ***
PrimeCondition                    78.88  9  2.691e-13 ***
AgeGroup                         553.44  3  < 2.2e-16 ***
```

```
1 | Subject                            0.00  3      1.0000
Proper:PrimeCondition              9.91  9      0.3578
Proper:AgeGroup                   63.50  3   1.050e-13 ***
PrimeCondition:AgeGroup           10.87  9      0.2851
Proper:PrimeCondition:AgeGroup     6.90  9      0.6477
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1
```

```
> exp1_state_data <- effects::effect("Proper*AgeGroup",
+                                      e1_proper_state_multinomial,
+   xlevels = list(PrimeCondition = c("B", "P","R", "U"),
+                  AgeGroup = c("Young", "Old"),
Proper = c("ProperName", "Word")))
> s1 = plot(exp1_state_data, main = "Exp 1: WordType x Age")
>
```

```
> gridExtra::grid.arrange(s1,s2, nrow = 1, ncol = 2)
```





15.2.5 E3: Multiple Choice Errors

```
> library(nnet)
> library(dplyr)
> e3_proper_hlm_multinomial = e3_proper %>% filter(!WhichPrime %in% c("0", "X"))
> contrasts(e3_proper_hlm_multinomial$WhichPrime) = contr.treatment(6, base = 2)
> contrasts(e3_proper_hlm_multinomial$PrimeCondition) = contr.treatment(4, base = 1)
> e3_proper_mcq_error_multinomial = nnet::multinom(data =
+                                                     e3_proper_hlm_multinomial,
+                             WhichPrime ~ Proper*PrimeCondition +
+                             (1|Subject))
```

```
# weights:  40 (27 variable)
initial  value 1687.120237
iter  10 value 1030.012554
iter  20 value 1013.430504
iter  30 value 1012.411813
iter  40 value 1012.391301
final  value 1012.391176
converged
```

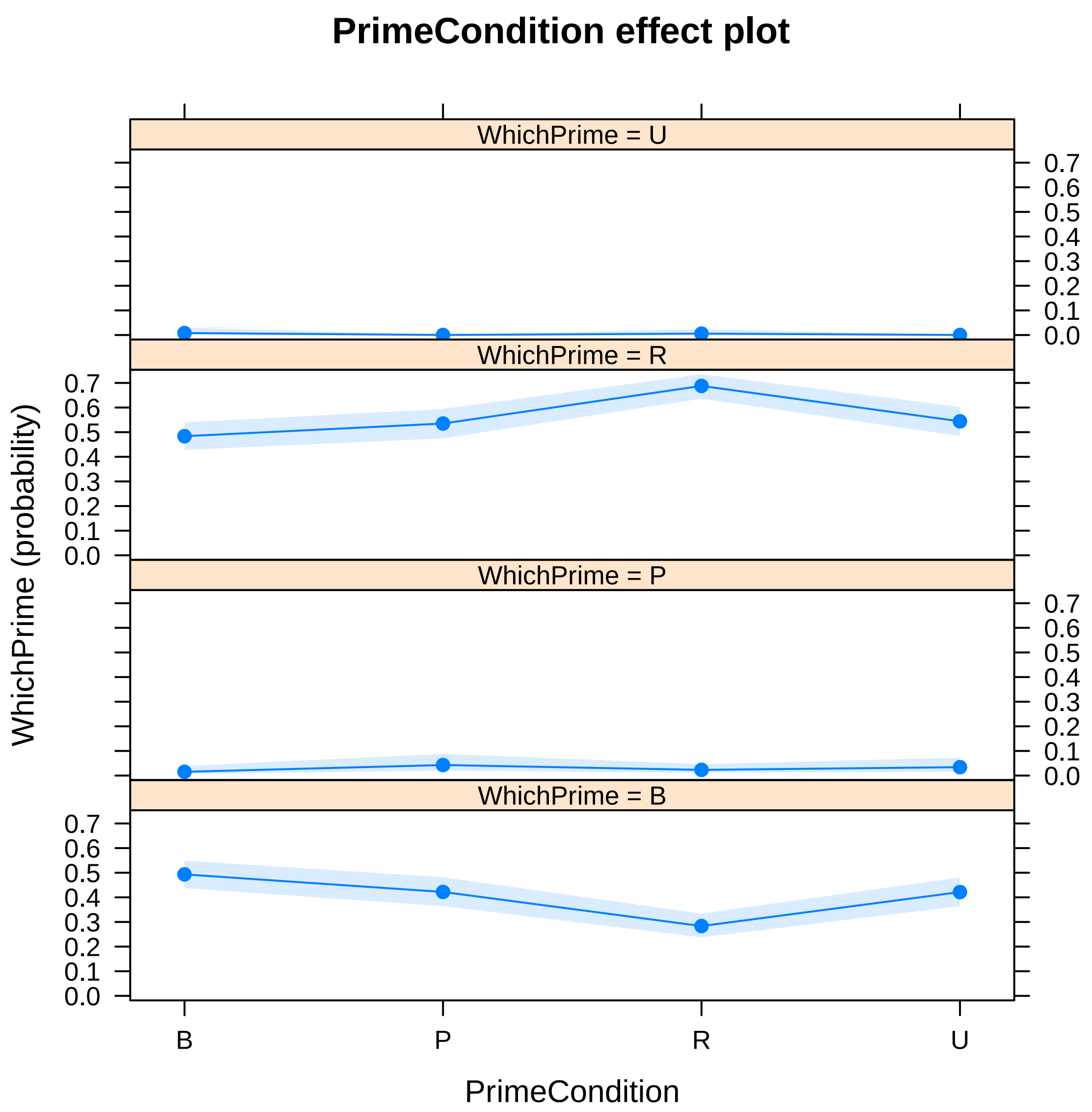
```
> summary(e3_proper_mcq_error_multinomial)
```

```
Call:
nnet::multinom(formula = WhichPrime ~ Proper * PrimeCondition +
    (1 | Subject), data = e3_proper_hlm_multinomial)

Coefficients:
  (Intercept)     Proper2 PrimeCondition2 PrimeCondition3 PrimeCondition4
P -2.01350322  0.85959013       0.1989375       1.0567554       0.3377421
R -0.03708411  0.08465132       0.1968128       0.8765347       0.3926347
U -1.66622911 -1.22078817     -12.1246504      -0.3307636     -12.1355193
  1 | Subject1 Proper2:PrimeCondition2 Proper2:PrimeCondition3
P   2.01350322              1.53899202             -0.14070864
R   0.03708411              0.09437654              0.04665017
U   1.66622911             13.51388140              0.84107642
  Proper2:PrimeCondition4
P               0.9707791
R              -0.1825748
U              13.9543295

Std. Errors:
  (Intercept)  Proper2 PrimeCondition2 PrimeCondition3 PrimeCondition4
P  0.50484271 1.131350       1.4285167       1.2429939       1.4299836
R  0.09629031 0.240895       0.2793878       0.2724391       0.2833179
U  0.35984541 1.236062       0.5825275       1.2422863       0.5529343
  1 | Subject1 Proper2:PrimeCondition2 Proper2:PrimeCondition3
P   0.50484271               1.5407976               1.4105825
R   0.09629031               0.3514282               0.3458416
U   0.35984541               0.5825061               1.8895992
  Proper2:PrimeCondition4
P               1.5497293
R               0.3530096
U               0.5529156

Residual Deviance: 2024.782
AIC: 2072.782
```

```
> car::Anova(e3_proper_mcq_error_multinomial)
```

```
Analysis of Deviance Table (Type II tests)

Response: WhichPrime
                        LR Chisq Df Pr(>Chisq)
Proper                    15.001  3   0.001816 **
PrimeCondition            45.354  9  7.934e-07 ***
1 | Subject                0.000  3   1.000000
Proper:PrimeCondition     10.052  9   0.346273
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1
```

```
> exp3_plot_data ← effects::effect("PrimeCondition",
+                                        e3_proper_mcq_error_multinomial,
+  xlevels = list(PrimeCondition = c("B", "P","R", "U"),
+                                    Proper = c("ProperName", "Word")))
>  plot(exp3_plot_data)
```



15.2.6 E2:Multiple Choice Errors

```
> ### MULTINOMIAL LOGISTIC REGRESSION ###
>
> library(nnet)
> library(dplyr)
> e2_proper_hlm_multinomial = e2_proper %>% filter(!WhichPrime %in% c("0", "X"))
> contrasts(e2_proper_hlm_multinomial$WhichPrime) = contr.treatment(6, base = 2)
> contrasts(e2_proper_hlm_multinomial$PrimeCondition) = contr.treatment(4, base = 1)
> e2_proper_mcq_error_multinomial = nnet::multinom(data =
+                                                  e2_proper_hlm_multinomial,
```

```
+                              WhichPrime ~ Proper*PrimeCondition*AgeGroup +
+                             (1|Subject))
```

```
# weights:  72 (51 variable)
initial  value 2467.603963
iter  10 value 1814.785830
iter  20 value 1590.768991
iter  30 value 1574.569417
iter  40 value 1571.235113
iter  50 value 1570.925684
iter  60 value 1570.890476
final  value 1570.889633
converged
```

```
> summary(e2_proper_mcq_error_multinomial)
```

```
Call:
nnet::multinom(formula = WhichPrime ~ Proper * PrimeCondition *
    AgeGroup + (1 | Subject), data = e2_proper_hlm_multinomial)

Coefficients:
  (Intercept)     Proper2 PrimeCondition2 PrimeCondition3 PrimeCondition4
P  -1.2628385   0.5798065       1.1393988       1.3017553      -0.3643811
R   0.2223507  -0.3940291       0.3207092       0.4109248       0.4491930
U  -1.6094372 -12.3351537       0.2220121     -18.1672062       1.0220784
  AgeGroup2 1 | Subject1 Proper2:PrimeCondition2 Proper2:PrimeCondition3
P 0.2745237    1.2628385             -0.54804179               -1.336918
R 0.1944068   -0.2223507             -0.05584338                0.196473
U 0.2750750    1.6094372             12.30351468               10.408530
  Proper2:PrimeCondition4 Proper2:AgeGroup2 PrimeCondition2:AgeGroup2
P               0.4740931        -0.3568257               -20.8639157
R              -0.2565918         0.4867881                -0.9975065
U              12.2437876        11.6413849                -0.5732274
  PrimeCondition3:AgeGroup2 PrimeCondition4:AgeGroup2
P                 -2.879018                 0.6415789
R                 -1.743193                -0.7800052
U                 -5.610964                -1.6610867
  Proper2:PrimeCondition2:AgeGroup2 Proper2:PrimeCondition3:AgeGroup2
P                       20.20367941                          2.377417
R                        0.06859764                          0.434255
U                      -11.66446548                         13.526044
  Proper2:PrimeCondition4:AgeGroup2
P                         -1.303064
R                          0.198545
U                        -11.057545

Std. Errors:
  (Intercept)   Proper2 PrimeCondition2 PrimeCondition3 PrimeCondition4
```

```
P   0.3674166 0.8024177       0.8887992        0.893769       1.2630501
R   0.1281028 0.3016190       0.3726858        0.386604       0.3793782
U   0.5099007 0.9142098       1.4460501        0.310408       1.2630794
  AgeGroup2 1 | Subject1 Proper2:PrimeCondition2 Proper2:PrimeCondition3
P 1.0452563     0.3674166               0.9861472               1.0222346
R 0.3821682     0.1281028               0.4383164               0.4482917
U 1.4463761     0.5099007               1.1413207               0.3104080
  Proper2:PrimeCondition4 Proper2:AgeGroup2 PrimeCondition2:AgeGroup2
P               1.3433502         1.1928018                 0.3772377
R               0.4417207         0.4586494                 0.5429599
U               1.0360272         0.9141904                 2.0443366
  PrimeCondition3:AgeGroup2 PrimeCondition4:AgeGroup2
P                 1.5404275                 1.5413085
R                 0.5432235                 0.5220399
U                 0.3104080                 1.9168845
  Proper2:PrimeCondition2:AgeGroup2 Proper2:PrimeCondition3:AgeGroup2
P                         0.3772377                         1.7495037
R                         0.6488017                         0.6448865
U                         1.5291683                         0.3104080
  Proper2:PrimeCondition4:AgeGroup2
P                          1.739643
R                          0.623373
U                          1.410742

Residual Deviance: 3141.779
AIC: 3237.779
```

```
> car::Anova(e2_proper_mcq_error_multinomial)
```

```
Analysis of Deviance Table (Type II tests)

Response: WhichPrime
                               LR Chisq Df Pr(>Chisq)
Proper                            2.340  3  0.5048566
PrimeCondition                   15.152  9  0.0868543 .
AgeGroup                         11.465  3  0.0094586 **
1 | Subject                       0.000  3  1.0000000
Proper:PrimeCondition             9.386  9  0.4024761
Proper:AgeGroup                   9.298  3  0.0255852 *
PrimeCondition:AgeGroup          33.017  9  0.0001326 ***
Proper:PrimeCondition:AgeGroup   10.376  9  0.3209049
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1
```

```
> exp2_plot_data ← effects::effect("Proper*AgeGroup",
+                                  e2_proper_mcq_error_multinomial,
+  xlevels = list(PrimeCondition = c("B", "P","R", "U"),
+                  AgeGroup = c("Young", "Old")))
```

```
> m2= plot(exp2_plot_data, main = "Exp2: Multiple Choice Errors")
>
```

15.2.7 E1: Multiple Choice Errors

```
> ### MULTINOMIAL LOGISTIC REGRESSION ###
>
> library(nnet)
> library(dplyr)
> e1_proper_hlm_multinomial = e1_proper %>% filter(!WhichPrime %in% c("0", "X"))
> contrasts(e1_proper_hlm_multinomial$WhichPrime) = contr.treatment(6, base = 2)
> contrasts(e1_proper_hlm_multinomial$PrimeCondition) = contr.treatment(4, base = 1)
> e1_proper_mcq_error_multinomial = nnet::multinom(data =
+                                                          e1_proper_hlm_multinomial,
+                            WhichPrime ~ Proper*PrimeCondition*AgeGroup +
+                           (1|Subject))
```

```
# weights:  72 (51 variable)
initial  value 2951.420695
iter  10 value 2086.053171
iter  20 value 1856.329288
iter  30 value 1827.632429
iter  40 value 1822.067187
iter  50 value 1821.289065
iter  60 value 1821.277652
final  value 1821.276515
converged
```

```
> summary(e1_proper_mcq_error_multinomial)
```

```
Call:
nnet::multinom(formula = WhichPrime ~ Proper * PrimeCondition *
    AgeGroup + (1 | Subject), data = e1_proper_hlm_multinomial)

Coefficients:
  (Intercept)    Proper2 PrimeCondition2 PrimeCondition3 PrimeCondition4
P -1.71737624  0.2651641      1.35540919      -10.497523       1.1326940
R  0.06069293 -0.4118583      0.06788236        1.447261       0.2841144
U -8.38822994 -2.7389318     -6.03760719       -1.923290      15.3901737
   AgeGroup2  1 | Subject1 Proper2:PrimeCondition2 Proper2:PrimeCondition3
P -0.5547238    1.71737624               0.8825657             10.83394494
R -0.4215059   -0.06069293               0.3636624             -0.05813348
U 12.7869978    8.38822994               4.2612542             17.50560812
  Proper2:PrimeCondition4 Proper2:AgeGroup2 PrimeCondition2:AgeGroup2
P              -0.2488410         1.7894176               -0.02837614
R               0.4061841         0.6665401               -0.03245388
U               3.2664944       -10.4776685                6.26640158
```

```
  PrimeCondition3:AgeGroup2 PrimeCondition4:AgeGroup2
P                10.6382433               -14.6864765
R                -0.8541192                 0.1929604
U                 3.1616226               -14.8329444
  Proper2:PrimeCondition2:AgeGroup2 Proper2:PrimeCondition3:AgeGroup2
P                        -1.6835926                       -11.4677210
R                         0.3723014                         0.2109068
U                         9.6026012                        -4.6594324
  Proper2:PrimeCondition4:AgeGroup2
P                        13.8354305
R                        -0.4677391
U                        11.2571489

Std. Errors:
  (Intercept)   Proper2 PrimeCondition2 PrimeCondition3 PrimeCondition4
P   0.5081856 1.1141781       1.1865853       0.8166578       1.2580806
R   0.1233175 0.2836691       0.3701065       0.3760132       0.3796896
U   0.3587192 0.3893380       0.7144422       0.6984064       0.6968840
  AgeGroup2 1 | Subject1 Proper2:PrimeCondition2 Proper2:PrimeCondition3
P 1.4324749    0.5081856               1.2922777               0.8166537
R 0.3230279    0.1233175               0.4300317               0.4326308
U 0.6294696    0.3587192               0.4965092               0.4686026
  Proper2:PrimeCondition4 Proper2:AgeGroup2 PrimeCondition2:AgeGroup2
P               1.4052611         1.5324496                 1.6683837
R               0.4383105         0.3830474                 0.4837938
U               0.3937528         0.5587619                 0.7144422
  PrimeCondition3:AgeGroup2 PrimeCondition4:AgeGroup2
P                 0.8166249                 0.3856697
R                 0.4712268                 0.4969598
U                 0.6636088                 0.9069269
  Proper2:PrimeCondition2:AgeGroup2 Proper2:PrimeCondition3:AgeGroup2
P                         1.8018543                         0.8953089
R                         0.5811357                         0.5590902
U                         0.4965092                         0.5516610
  Proper2:PrimeCondition4:AgeGroup2
P                         0.3856671
R                         0.5855723
U                         0.7795470

Residual Deviance: 3642.553
AIC: 3738.553
```

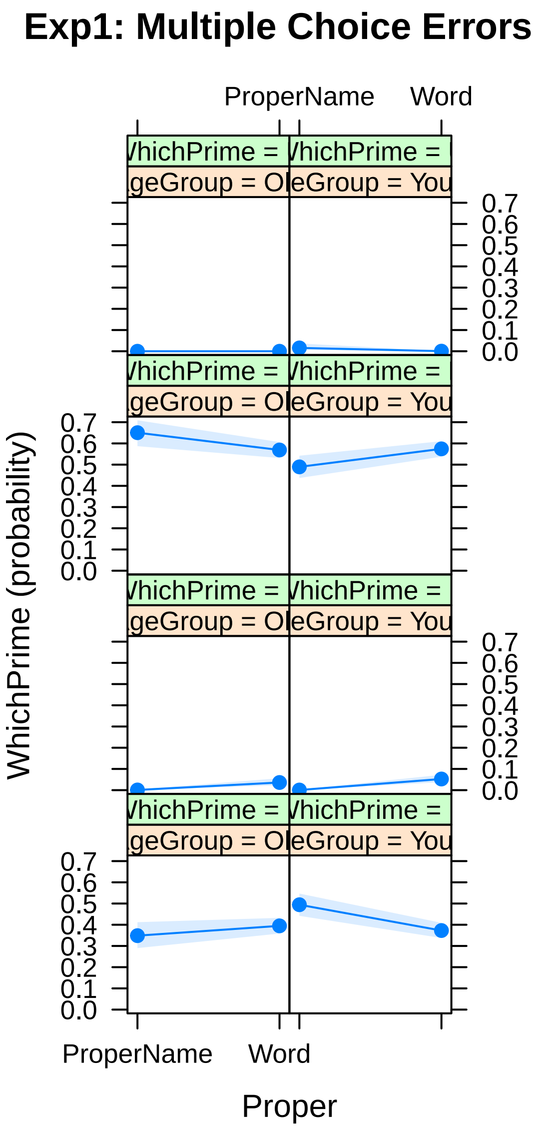
```
> car::Anova(e1_proper_mcq_error_multinomial)
```

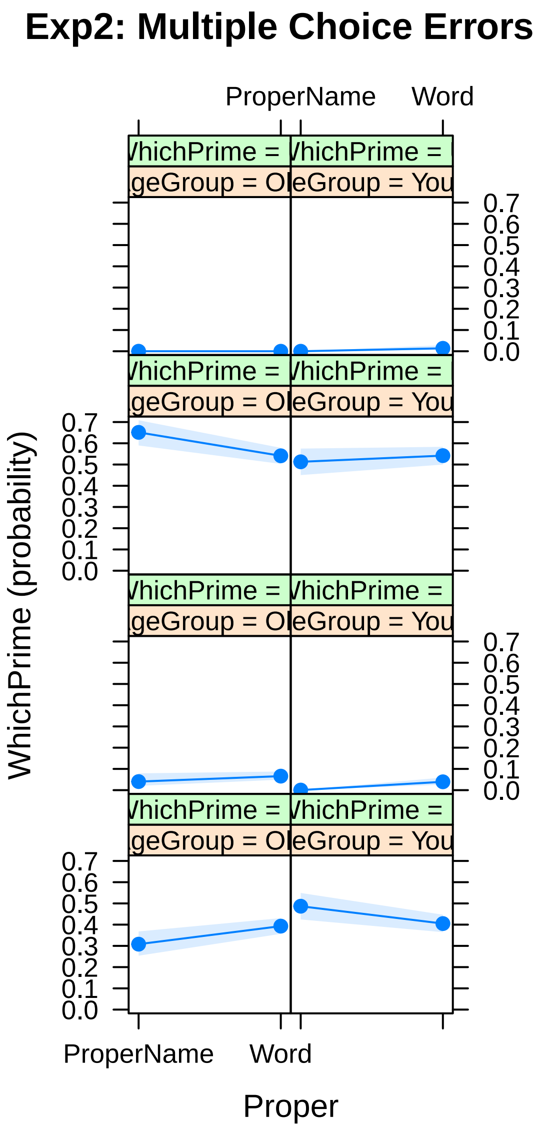
```
Analysis of Deviance Table (Type II tests)

Response: WhichPrime
                               LR Chisq Df Pr(>Chisq)
```

```
Proper                                  18.731  3   0.0003107 ***
PrimeCondition                         182.733  9   < 2.2e-16 ***
AgeGroup                                 5.955  3   0.1137991
1 | Subject                              0.000  3   1.0000000
Proper:PrimeCondition                    8.062  9   0.5278638
Proper:AgeGroup                         12.236  3   0.0066182 **
PrimeCondition:AgeGroup                 41.276  9   4.455e-06 ***
Proper:PrimeCondition:AgeGroup           8.551  9   0.4797450
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1
```

```
> exp1_plot_data ← effects::effect("Proper*AgeGroup",
+                                      e1_proper_mcq_error_multinomial,
+  xlevels = list(PrimeCondition = c("B", "P","R", "U"),
+                 AgeGroup = c("Young", "Old")))
>  m1 = plot(exp1_plot_data, main = "Exp1: Multiple Choice Errors")
>
```

```
>  gridExtra::grid.arrange(m1,m2, nrow = 1, ncol = 2)
```





16 Item Analyses

16.1 Using AGG data

```
> main = read.csv("Julie_Main5Studies.csv", header = TRUE, sep = ",")
> main$StudyNo = as.factor(main$StudyNo)
> main$PrimeCondition = as.factor(main$PrimeCondition)
> main_wide = read.csv("MainJulieagg_5studies.csv", header = TRUE, sep = ",")
> library(dplyr)
> e1_hlm = main %>% filter(StudyNo == "2" | StudyNo == "4")
```

```
> e2_hlm = main %>% filter(StudyNo == "5" | StudyNo == "6")
> e3_hlm = main %>% filter(StudyNo == "1")
```

16.2 Experiment 1

```
> e1_item_acc = group_by(e1_hlm, Target, AgeGroup, PrimeCondition) %>%
+   summarise_at(vars(Accuracy), mean)
> e1_item_state = group_by(e1_hlm, Target, AgeGroup, Question.RESP) %>%
+   summarise(StateCount = n())
> e1_item_mcqacc = group_by(e1_hlm, Target, AgeGroup, PrimeCondition) %>%
+   summarise_at(vars(McAcc), mean)
```

16.2.1 Target Accuracy

```
> ### TARGET RETRIEVAL ACCURACY
>
> exp1_item_acc = aov(data = e1_item_acc, Accuracy ~ AgeGroup*PrimeCondition +
+                                 Error (Target/(AgeGroup*PrimeCondition)))
> summary(exp1_item_acc)
```

```
Error: Target
          Df Sum Sq Mean Sq F value Pr(>F)
Residuals 99  33.22  0.3355

Error: Target:AgeGroup
          Df Sum Sq Mean Sq F value Pr(>F)
AgeGroup   1  0.002 0.00201   0.036  0.851
Residuals 99  5.585 0.05641

Error: Target:PrimeCondition
                Df Sum Sq Mean Sq F value Pr(>F)
PrimeCondition   3  2.119  0.7062   44.66 <2e-16 ***
Residuals      297  4.697  0.0158
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Target:AgeGroup:PrimeCondition
                         Df Sum Sq Mean Sq F value Pr(>F)
AgeGroup:PrimeCondition   3  0.036 0.01189   0.828   0.48
Residuals               297  4.268 0.01437
```

```
> options(contrasts = c('contr.sum', 'contr.poly'))
> library(lsmeans)
> library(multcomp)
> exp1_target_lsm = lsmeans::lsmeans(exp1_item_acc,
+                                     c("AgeGroup", "PrimeCondition"))
```

```
> prime_effect = cld(exp1_target_lsm, alpha = 0.05,
+                   adjust = "tukey", details = TRUE, by = c("AgeGroup"))
> library(knitr)
> kable(subset(prime_effect$comparisons,prime_effect$comparisons$p.value < 0.05 ))
```

```
|   |contrast |AgeGroup |  estimate|        SE|       df|  t.ratio|   p.value|
|:--|:--------|:--------|---------:|---------:|--------:|--------:|---------:|
|2  |B - U    |Old      | 0.0533333| 0.0173738| 592.6483| 3.069753| 0.0119826|
|3  |B - R    |Old      | 0.0533333| 0.0173738| 592.6483| 3.069753| 0.0119826|
|4  |P - U    |Old      | 0.1366667| 0.0173738| 592.6483| 7.866242| 0.0000000|
|5  |P - R    |Old      | 0.1366667| 0.0173738| 592.6483| 7.866242| 0.0000000|
|6  |P - B    |Old      | 0.0833333| 0.0173738| 592.6483| 4.796489| 0.0000122|
|10 |P - U    |Young    | 0.1240000| 0.0173738| 592.6483| 7.137176| 0.0000000|
|11 |P - R    |Young    | 0.1058889| 0.0173738| 592.6483| 6.094739| 0.0000000|
|12 |P - B    |Young    | 0.0865556| 0.0173738| 592.6483| 4.981954| 0.0000049|
```

```
> ## specific t-tests
> e1_item_acc_collapsed = group_by(e1_hlm, Target, PrimeCondition) %>%
+   summarise_at(vars(Accuracy), mean)
> target_p = e1_item_acc_collapsed %>% filter(PrimeCondition == "P")
> target_r = e1_item_acc_collapsed %>% filter(PrimeCondition == "R")
> target_b = e1_item_acc_collapsed %>% filter(PrimeCondition == "B")
> target_u = e1_item_acc_collapsed %>% filter(PrimeCondition == "U")
> t.test(target_p$Accuracy, target_r$Accuracy, paired = TRUE)
```

```
        Paired t-test

data:  target_p$Accuracy and target_r$Accuracy
t = 10.011, df = 99, p-value < 2.2e-16
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 0.1037881 0.1551008
sample estimates:
mean of the differences
              0.1294444
```

```
> t.test(target_p$Accuracy, target_b$Accuracy, paired = TRUE)
```

```
        Paired t-test

data:  target_p$Accuracy and target_b$Accuracy
t = 5.9487, df = 99, p-value = 4.089e-08
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 0.0563947 0.1128451
sample estimates:
mean of the differences
             0.08461988
```

```
> t.test(target_p$Accuracy, target_u$Accuracy, paired = TRUE)
```

```
        Paired t-test

data:  target_p$Accuracy and target_u$Accuracy
t = 9.7028, df = 99, p-value = 4.869e-16
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 0.09618115 0.14563171
sample estimates:
mean of the differences
              0.1209064
```

```
> t.test(target_b$Accuracy, target_r$Accuracy, paired = TRUE)
```

```
        Paired t-test

data:  target_b$Accuracy and target_r$Accuracy
t = 3.8146, df = 99, p-value = 0.0002375
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 0.02150844 0.06814068
sample estimates:
mean of the differences
             0.04482456
```

```
> t.test(target_b$Accuracy, target_u$Accuracy, paired = TRUE)
```

```
        Paired t-test

data:  target_b$Accuracy and target_u$Accuracy
t = 3.0836, df = 99, p-value = 0.002651
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 0.01293676 0.05963634
sample estimates:
mean of the differences
             0.03628655
```

```
> t.test(target_r$Accuracy, target_u$Accuracy, paired = TRUE)
```

```
        Paired t-test

data:  target_r$Accuracy and target_u$Accuracy
t = -0.70346, df = 99, p-value = 0.4834
alternative hypothesis: true difference in means is not equal to 0
```

```
95 percent confidence interval:
 -0.03262062  0.01554460
sample estimates:
mean of the differences
           -0.008538012
```

16.2.2 State Data

```
> ## e1_item_state has many rows missing so we cannot use that dataset.
> ## we will use the Julieagg.R file to create an agg file for items.
>
> exp1_state = subset(final_statedata, final_statedata$StudyNo == '2' |
+                                   final_statedata$StudyNo == '4')
> exp1_state_prime = subset(statedata_primetype_long,
+                          statedata_primetype_long$StudyNo == '2' |
+                                  statedata_primetype_long$StudyNo == '4')
> exp1_state_prime$PrimeCondition = as.factor(as.character(exp1_state_prime$PrimeConditi
> exp1_state_prime$State = as.factor(as.character(exp1_state_prime$State))
> exp1_state_prime$Target = as.factor(as.character(exp1_state_prime$Target))
> ## just state
> exp1_state_aov = aov(data = exp1_state, Trials ~ AgeGroup*State +
+                                        Error(Target/(AgeGroup*State)))
> summary(exp1_state_aov)
```

```
Error: Target
          Df     Sum Sq   Mean Sq F value Pr(>F)
Residuals 99 2.227e-25 2.25e-27

Error: Target:AgeGroup
          Df     Sum Sq   Mean Sq F value Pr(>F)
AgeGroup   1 2.700e-27 2.688e-27   0.331  0.566
Residuals 99 8.037e-25 8.118e-27

Error: Target:State
           Df Sum Sq Mean Sq F value Pr(>F)
State       3  18316    6105   131.9 <2e-16 ***
Residuals 297  13744      46
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Target:AgeGroup:State
                Df Sum Sq Mean Sq F value Pr(>F)
AgeGroup:State   3   3131    1044    57.9 <2e-16 ***
Residuals      297   5353      18
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1
```

```
> options(contrasts = c('contr.sum', 'contr.poly'))
> exp1_state_lsm = lsmeans::lsmeans(exp1_state_aov, c("AgeGroup", "State"))
> prime_effect = cld(exp1_state_lsm, alpha = 0.05,
+                    adjust = "tukey", details = TRUE, by = c("State"))
> kable(subset(prime_effect$comparisons, prime_effect$comparisons$p.value < 0.05))
```

```
|contrast     |State     | estimate|         SE|  df|    t.ratio|    p.value|
|:------------|:---------|--------:|----------:|---:|----------:|----------:|
|Old - Young  |dontknow  |     4.80|  0.5199675| 297|   9.231347|  0.0000000|
|Old - Young  |know      |     1.90|  0.5199675| 297|   3.654075|  0.0003051|
|Old - Young  |other     |     5.95|  0.5199675| 297|  11.443024|  0.0000000|
```

```
> ##state by prime
> exp1_stateprime_aov = aov(data = exp1_state_prime,
+                           Trials ~ AgeGroup*PrimeCondition*State +
+                           Error(Target/(AgeGroup*PrimeCondition*State)))
> summary(exp1_stateprime_aov)
```

```
Error: Target
          Df    Sum Sq   Mean Sq F value Pr(>F)
Residuals 99 6.432e-25 6.497e-27

Error: Target:AgeGroup
          Df    Sum Sq   Mean Sq F value Pr(>F)
AgeGroup   1 1.620e-27 1.619e-27   0.514  0.475
Residuals 99 3.122e-25 3.153e-27

Error: Target:PrimeCondition
                Df    Sum Sq   Mean Sq F value Pr(>F)
PrimeCondition   3 4.800e-27 1.590e-27    0.97  0.407
Residuals      297 4.868e-25 1.639e-27

Error: Target:State
           Df Sum Sq Mean Sq F value Pr(>F)
State       3   4579  1526.3   131.9 <2e-16 ***
Residuals 297   3436    11.6
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Target:AgeGroup:PrimeCondition
                         Df    Sum Sq   Mean Sq F value Pr(>F)
AgeGroup:PrimeCondition   3 5.600e-27 1.860e-27   0.928  0.428
Residuals               297 5.953e-25 2.004e-27

Error: Target:AgeGroup:State
                Df Sum Sq Mean Sq F value Pr(>F)
AgeGroup:State   3  782.7  260.90    57.9 <2e-16 ***
```

```
Residuals       297  1338.3    4.51
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Target:PrimeCondition:State
                       Df  Sum Sq  Mean Sq  F value  Pr(>F)
PrimeCondition:State    9   220.8   24.533    13.52  <2e-16 ***
Residuals             891  1617.2    1.815
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Target:AgeGroup:PrimeCondition:State
                                Df  Sum Sq  Mean Sq  F value  Pr(>F)
AgeGroup:PrimeCondition:State    9    13.1    1.455    0.911   0.515
Residuals                      891  1422.9    1.597
```

```
>  library(ez)
> # ezANOVA(data = exp1_state_prime, wid = .(Target),
> #          dv = .(Trials), within =.(PrimeCondition, State),
> #          between = .(AgeGroup))
>
> options(contrasts = c('contr.sum', 'contr.poly'))
> exp1_state_lsm = lsmeans::lsmeans(exp1_stateprime_aov, c("AgeGroup","PrimeCondition",
> prime_effect = cld(exp1_state_lsm, alpha = 0.05,
+                  adjust = "tukey", details = TRUE, by = c("PrimeCondition", "AgeGroup")
> kable(subset(prime_effect$comparisons, prime_effect$comparisons$p.value < 0.05))
```

```
|   |contrast          |PrimeCondition |AgeGroup | estimate|        SE|        df|
t.ratio|   p.value|
|:--|:-----------------|:--------------|:--------|--------:|---------:|--------:|--------
|2  |dontknow - other  |b              |Old      |     3.18| 0.2564724| 1197.602| 12.3989
|3  |dontknow - TOT    |b              |Old      |     2.78| 0.2564724| 1197.602| 10.8393
|4  |know - other      |b              |Old      |     3.90| 0.2564724| 1197.602| 15.2063
|5  |know - TOT        |b              |Old      |     3.50| 0.2564724| 1197.602| 13.6466
|6  |know - dontknow   |b              |Old      |     0.72| 0.2564724| 1197.602|
2.807319| 0.0260869|
|7  |TOT - other       |b              |Young    |     0.84| 0.2564724| 1197.602|
3.275206| 0.0059743|
|8  |dontknow - other  |b              |Young    |     1.41| 0.2564724| 1197.602|
5.497667| 0.0000003|
|10 |know - other      |b              |Young    |     2.71| 0.2564724| 1197.602| 10.5664
|11 |know - TOT        |b              |Young    |     1.87| 0.2564724| 1197.602|
7.291232| 0.0000000|
|12 |know - dontknow   |b              |Young    |     1.30| 0.2564724| 1197.602|
5.068771| 0.0000028|
|14 |dontknow - other  |p              |Old      |     2.98| 0.2564724| 1197.602| 11.6191
|15 |dontknow - TOT    |p              |Old      |     2.83| 0.2564724| 1197.602| 11.0343
|16 |know - other      |p              |Old      |     4.03| 0.2564724| 1197.602| 15.7131
```

```
|17 |know - TOT       |p               |Old       |       3.88| 0.2564724| 1197.602| 15.1283
|18 |know - dontknow  |p               |Old       |       1.05| 0.2564724| 1197.602|
4.094007| 0.0002640|
|19 |TOT - other      |p               |Young     |       0.74| 0.2564724| 1197.602|
2.885300| 0.0207377|
|20 |dontknow - other |p               |Young     |       1.13| 0.2564724| 1197.602|
4.405931| 0.0000677|
|22 |know - other     |p               |Young     |       2.97| 0.2564724| 1197.602| 11.5801
|23 |know - TOT       |p               |Young     |       2.23| 0.2564724| 1197.602|
8.694891| 0.0000000|
|24 |know - dontknow  |p               |Young     |       1.84| 0.2564724| 1197.602|
7.174260| 0.0000000|
|26 |dontknow - other |r               |Old       |       2.72| 0.2564724| 1197.602| 10.6054
|27 |dontknow - TOT   |r               |Old       |       2.45| 0.2564724| 1197.602|
9.552683| 0.0000000|
|28 |know - other     |r               |Old       |       3.49| 0.2564724| 1197.602| 13.6077
|29 |know - TOT       |r               |Old       |       3.22| 0.2564724| 1197.602| 12.5549
|30 |know - dontknow  |r               |Old       |       0.77| 0.2564724| 1197.602|
3.002272| 0.0145194|
|31 |TOT - other      |r               |Young     |       1.14| 0.2564724| 1197.602|
4.444922| 0.0000567|
|32 |dontknow - other |r               |Young     |       1.24| 0.2564724| 1197.602|
4.834827| 0.0000090|
|34 |know - other     |r               |Young     |       2.50| 0.2564724| 1197.602|
9.747636| 0.0000000|
|35 |know - TOT       |r               |Young     |       1.36| 0.2564724| 1197.602|
5.302714| 0.0000008|
|36 |know - dontknow  |r               |Young     |       1.26| 0.2564724| 1197.602|
4.912808| 0.0000061|
|37 |TOT - other      |u               |Old       |       0.69| 0.2564724| 1197.602|
2.690348| 0.0363528|
|38 |dontknow - other |u               |Old       |       2.80| 0.2564724| 1197.602| 10.9173
|39 |dontknow - TOT   |u               |Old       |       2.11| 0.2564724| 1197.602|
8.227005| 0.0000000|
|40 |know - other     |u               |Old       |       3.67| 0.2564724| 1197.602| 14.3095
|41 |know - TOT       |u               |Old       |       2.98| 0.2564724| 1197.602| 11.6191
|42 |know - dontknow  |u               |Old       |       0.87| 0.2564724| 1197.602|
3.392177| 0.0039876|
|43 |TOT - other      |u               |Young     |       0.97| 0.2564724| 1197.602|
3.782083| 0.0009373|
|44 |dontknow - other |u               |Young     |       1.71| 0.2564724| 1197.602|
6.667383| 0.0000000|
|45 |dontknow - TOT   |u               |Young     |       0.74| 0.2564724| 1197.602|
2.885300| 0.0207377|
|46 |know - other     |u               |Young     |       1.88| 0.2564724| 1197.602|
7.330222| 0.0000000|
|47 |know - TOT       |u               |Young     |       0.91| 0.2564724| 1197.602|
3.548140| 0.0022760|
```

```
> ### INDIVIDUAL T-TESTS FOR AGExSTATE interaction
>
> e1_young_dk = exp1_state %>% filter(AgeGroup == "Young" & State == "dontknow")
> e1_old_dk = exp1_state %>% filter(AgeGroup == "Old" & State == "dontknow")
> t.test(e1_old_dk$Trials, e1_young_dk$Trials)
```

```
        Welch Two Sample t-test

data:  e1_old_dk$Trials and e1_young_dk$Trials
t = 5.837, df = 197.87, p-value = 2.146e-08
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 3.178335 6.421665
sample estimates:
mean of x mean of y
    14.48      9.68
```

```
> e1_young_other = exp1_state %>% filter(AgeGroup == "Young" & State == "other")
> e1_old_other = exp1_state %>% filter(AgeGroup == "Old" & State == "other")
> t.test(e1_young_other$Trials, e1_old_other$Trials)
```

```
        Welch Two Sample t-test

data:  e1_young_other$Trials and e1_old_other$Trials
t = 12.087, df = 119.23, p-value < 2.2e-16
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 4.975274 6.924726
sample estimates:
mean of x mean of y
     7.88      1.93
```

```
>
```

16.2.3 Multiple Choice

```
> exp1_mcq = subset(final_mcq, final_mcq$StudyNo == '2' | final_mcq$StudyNo == '4')
> ## MULTIPLE CHOICE ACCURACY
> library(dplyr)
> exp1_mcq_acc = group_by(exp1_mcq, Target, PrimeType, AgeGroup) %>%
+     summarise_at(vars(MCQAcc), mean)
> exp1_mcq_acc_aov = aov(data = exp1_mcq_acc, MCQAcc ~ AgeGroup*PrimeType +
+                            Error(Target/(AgeGroup*PrimeType)))
> summary(exp1_mcq_acc_aov)
```

```
Error: Target
          Df Sum Sq Mean Sq F value Pr(>F)
Residuals 99  29.58  0.2988

Error: Target:AgeGroup
          Df Sum Sq Mean Sq F value Pr(>F)
AgeGroup   1  0.125 0.12500   2.406  0.124
Residuals 99  5.144 0.05195

Error: Target:PrimeType
           Df Sum Sq Mean Sq F value   Pr(>F)
PrimeType   3  1.053  0.3511   18.55 4.69e-11 ***
Residuals 297  5.623  0.0189
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Target:AgeGroup:PrimeType
                    Df Sum Sq Mean Sq F value Pr(>F)
AgeGroup:PrimeType   3  0.032 0.01060   0.477  0.699
Residuals          297  6.601 0.02223
```

```
> exp1_mcqacc_lsm = lsmeans::lsmeans(exp1_mcq_acc_aov, c("AgeGroup", "PrimeType"))
> prime_effect = cld(exp1_mcqacc_lsm, alpha = 0.05,
+                 adjust = "tukey", details = TRUE, by = c("AgeGroup"))
> kable(subset(prime_effect$comparisons, prime_effect$comparisons$p.value < 0.05))
```

```
|   |contrast |AgeGroup |  estimate|        SE|       df|  t.ratio|   p.value|
|:--|:--------|:--------|---------:|---------:|--------:|--------:|---------:|
|2  |u - r    |Old      | 0.0588889| 0.0202871| 590.2191| 2.902776| 0.0200024|
|4  |p - r    |Old      | 0.0777778| 0.0202871| 590.2191| 3.833855| 0.0008035|
|5  |p - b    |Old      | 0.0622222| 0.0202871| 590.2191| 3.067084| 0.0120858|
|8  |u - r    |Young    | 0.0855556| 0.0202871| 590.2191| 4.217240| 0.0001676|
|10 |p - r    |Young    | 0.1088889| 0.0202871| 590.2191| 5.367396| 0.0000007|
|11 |p - b    |Young    | 0.0644444| 0.0202871| 590.2191| 3.176622| 0.0085051|
```

```
> ## SPECIFIC T TESTS
>
> e1_mcq_p = exp1_mcq_acc %>% filter(PrimeType == "p")
> e1_mcq_r = exp1_mcq_acc %>% filter(PrimeType == "r")
> e1_mcq_b = exp1_mcq_acc %>% filter(PrimeType == "b")
> e1_mcq_u = exp1_mcq_acc %>% filter(PrimeType == "u")
> t.test(e1_mcq_p$MCQAcc, e1_mcq_r$MCQAcc, paired = TRUE)
```

```
        Paired t-test

data:  e1_mcq_p$MCQAcc and e1_mcq_r$MCQAcc
t = 6.2072, df = 199, p-value = 3.08e-09
```

```
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 0.0636822 0.1229845
sample estimates:
mean of the differences
             0.09333333
```

```
> t.test(e1_mcq_p$MCQAcc, e1_mcq_b$MCQAcc, paired = TRUE)
```

```
        Paired t-test

data:  e1_mcq_p$MCQAcc and e1_mcq_b$MCQAcc
t = 4.4499, df = 199, p-value = 1.429e-05
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 0.03526759 0.09139908
sample estimates:
mean of the differences
             0.06333333
```

```
> t.test(e1_mcq_p$MCQAcc, e1_mcq_u$MCQAcc, paired = TRUE)
```

```
        Paired t-test

data:  e1_mcq_p$MCQAcc and e1_mcq_u$MCQAcc
t = 1.3927, df = 199, p-value = 0.1653
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -0.008781092  0.051003314
sample estimates:
mean of the differences
             0.02111111
```

```
> t.test(e1_mcq_b$MCQAcc, e1_mcq_r$MCQAcc, paired = TRUE)
```

```
        Paired t-test

data:  e1_mcq_b$MCQAcc and e1_mcq_r$MCQAcc
t = 2.2001, df = 199, p-value = 0.02895
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 0.003110736 0.056889264
sample estimates:
mean of the differences
                   0.03
```

```
> t.test(e1_mcq_b$MCQAcc, e1_mcq_u$MCQAcc, paired = TRUE)
```

```
        Paired t-test

data:  e1_mcq_b$MCQAcc and e1_mcq_u$MCQAcc
t = -2.9048, df = 199, p-value = 0.004091
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -0.07088545 -0.01355899
sample estimates:
mean of the differences
            -0.04222222
```

```
> t.test(e1_mcq_r$MCQAcc, e1_mcq_r$MCQAcc, paired = TRUE)
```

```
        Paired t-test

data:  e1_mcq_r$MCQAcc and e1_mcq_r$MCQAcc
t = NaN, df = 199, p-value = NA
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 NaN NaN
sample estimates:
mean of the differences
                      0
```

```
> ### MULTIPLE CHOICE ERRORS
> ## before we do ANOVA, we need to replace NAs with 0.
> for (i in 1: nrow(exp1_mcq)){
+    if(is.na(exp1_mcq[i,9])){
+      exp1_mcq[i,9] = 0
+    }
+
+ }
> exp1_mcq_aov = aov(data = exp1_mcq,
+                   Proportion ~ AgeGroup*PrimeType*ChosenPrime +
+                          Error(Target/(AgeGroup*PrimeType*ChosenPrime)))
> summary(exp1_mcq_aov)
```

```
Error: Target
          Df Sum Sq Mean Sq F value Pr(>F)
Residuals 99  10.09  0.1019

Error: Target:AgeGroup
          Df Sum Sq Mean Sq F value  Pr(>F)
AgeGroup   1  0.337  0.3373   7.379 0.00779 **
Residuals 99  4.526  0.0457
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1
```

```
Error: Target:PrimeType
           Df Sum Sq Mean Sq F value  Pr(>F)
PrimeType   3  0.324 0.10814   4.146 0.00671 **
Residuals 297  7.747 0.02608
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Target:ChosenPrime
             Df Sum Sq Mean Sq F value Pr(>F)
ChosenPrime   3  89.19  29.730   117.6 <2e-16 ***
Residuals   297  75.07   0.253
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Target:AgeGroup:PrimeType
                    Df Sum Sq Mean Sq F value Pr(>F)
AgeGroup:PrimeType   3  0.112 0.03742   1.422  0.236
Residuals          297  7.814 0.02631

Error: Target:AgeGroup:ChosenPrime
                      Df Sum Sq Mean Sq F value Pr(>F)
AgeGroup:ChosenPrime   3  0.686 0.22877   2.508  0.059 .
Residuals            297 27.089 0.09121
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Target:PrimeType:ChosenPrime
                       Df Sum Sq Mean Sq F value Pr(>F)
PrimeType:ChosenPrime   9  11.64  1.2932   20.24 <2e-16 ***
Residuals             891  56.92  0.0639
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Target:AgeGroup:PrimeType:ChosenPrime
                                Df Sum Sq Mean Sq F value Pr(>F)
AgeGroup:PrimeType:ChosenPrime   9   1.31  0.1458   2.652 0.0049 **
Residuals                      891  49.00  0.0550
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1
```

```
> library(ez)
> # ezANOVA(data = exp1_mcq, wid = .(Target),
> #         dv = .(Proportion), within =.(AgeGroup, PrimeType, ChosenPrime))
>
> options(contrasts = c('contr.sum', 'contr.poly'))
> exp1_errors_lsm = lsmeans::lsmeans(exp1_mcq_aov, c("AgeGroup", "PrimeType", "ChosenPri
> prime_effect = cld(exp1_errors_lsm, alpha = 0.05,
```

```
+                  adjust = "tukey", details = TRUE, by = c("AgeGroup", "PrimeType"))
> kable(subset(prime_effect$comparisons, prime_effect$comparisons$p.value < 0.05))
```

```
|   |contrast |AgeGroup |PrimeType |   estimate|         SE|        df|    t.ratio|
p.value|
|:--|:--------|:--------|:---------|----------:|----------:|---------:|----------:|----------
|2  |r - u    |Old      |b         |  0.3352857|  0.0418508|  1558.848|   8.011452|  0.000000
|3  |r - p    |Old      |b         |  0.3204524|  0.0418508|  1558.848|   7.657019|  0.000000
|4  |b - u    |Old      |b         |  0.4353254|  0.0418508|  1558.848|  10.401841|  0.000000
|5  |b - p    |Old      |b         |  0.4204921|  0.0418508|  1558.848|  10.047407|  0.000000
|8  |r - u    |Old      |p         |  0.2703849|  0.0418508|  1558.848|   6.460686|  0.000000
|9  |r - p    |Old      |p         |  0.1852500|  0.0418508|  1558.848|   4.426438|  0.000060
|10 |b - u    |Old      |p         |  0.2954563|  0.0418508|  1558.848|   7.059753|  0.000000
|11 |b - p    |Old      |p         |  0.2103214|  0.0418508|  1558.848|   5.025505|  0.000003
|14 |r - u    |Old      |r         |  0.1548810|  0.0418508|  1558.848|   3.700788|  0.001271
|15 |r - p    |Old      |r         |  0.1495476|  0.0418508|  1558.848|   3.573351|  0.002056
|16 |b - u    |Old      |r         |  0.5780119|  0.0418508|  1558.848|  13.811250|  0.000000
|17 |b - p    |Old      |r         |  0.5726786|  0.0418508|  1558.848|  13.683813|  0.000000
|18 |b - r    |Old      |r         |  0.4231310|  0.0418508|  1558.848|  10.110462|  0.000000
|20 |r - u    |Old      |u         |  0.1931905|  0.0418508|  1558.848|   4.616171|  0.000025
|21 |r - p    |Old      |u         |  0.1590833|  0.0418508|  1558.848|   3.801201|  0.000860
|22 |b - u    |Old      |u         |  0.3071667|  0.0418508|  1558.848|   7.339564|  0.000000
|23 |b - p    |Old      |u         |  0.2730595|  0.0418508|  1558.848|   6.524594|  0.000000
|24 |b - r    |Old      |u         |  0.1139762|  0.0418508|  1558.848|   2.723393|  0.033056
|26 |r - u    |Young    |b         |  0.3335437|  0.0418508|  1558.848|   7.969827|  0.000000
|27 |r - p    |Young    |b         |  0.2902817|  0.0418508|  1558.848|   6.936109|  0.000000
|28 |b - u    |Young    |b         |  0.4461944|  0.0418508|  1558.848|  10.661550|  0.000000
|29 |b - p    |Young    |b         |  0.4029325|  0.0418508|  1558.848|   9.627833|  0.000000
|30 |b - r    |Young    |b         |  0.1126508|  0.0418508|  1558.848|   2.691724|  0.036117
|32 |r - u    |Young    |p         |  0.3125714|  0.0418508|  1558.848|   7.468708|  0.000000
|33 |r - p    |Young    |p         |  0.2664048|  0.0418508|  1558.848|   6.365583|  0.000000
|34 |b - u    |Young    |p         |  0.3949286|  0.0418508|  1558.848|   9.436583|  0.000000
|35 |b - p    |Young    |p         |  0.3487619|  0.0418508|  1558.848|   8.333458|  0.000000
|38 |r - u    |Young    |r         |  0.2849524|  0.0418508|  1558.848|   6.808767|  0.000000
|39 |r - p    |Young    |r         |  0.2820119|  0.0418508|  1558.848|   6.738506|  0.000000
|40 |b - u    |Young    |r         |  0.5042262|  0.0418508|  1558.848|  12.048184|  0.000000
|41 |b - p    |Young    |r         |  0.5012857|  0.0418508|  1558.848|  11.977923|  0.000000
|42 |b - r    |Young    |r         |  0.2192738|  0.0418508|  1558.848|   5.239417|  0.000001
|44 |r - u    |Young    |u         |  0.2771905|  0.0418508|  1558.848|   6.623301|  0.000000
|45 |r - p    |Young    |u         |  0.2692857|  0.0418508|  1558.848|   6.434422|  0.000000
|46 |b - u    |Young    |u         |  0.3540238|  0.0418508|  1558.848|   8.459188|  0.000000
|47 |b - p    |Young    |u         |  0.3461190|  0.0418508|  1558.848|   8.270308|  0.000000
```

```
> ## SPECIFIC OLD COMPARISION T TEST
>
> e1mcq_old_r = exp1_mcq %>% filter(AgeGroup == "Old" & PrimeType == "r")
> e1mcq_old_r_r = e1mcq_old_r %>% filter(ChosenPrime == "r")
> e1mcq_old_r_p = e1mcq_old_r %>% filter(ChosenPrime == "p")
```

```
> e1mcq_old_r_b = e1mcq_old_r %>% filter(ChosenPrime == "b")
> e1mcq_old_r_u = e1mcq_old_r %>% filter(ChosenPrime == "u")
> t.test(e1mcq_old_r_r$Proportion, e1mcq_old_r_p$Proportion, paired = TRUE)
```

```
        Paired t-test

data:  e1mcq_old_r_r$Proportion and e1mcq_old_r_p$Proportion
t = 13.942, df = 99, p-value < 2.2e-16
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 0.4911778 0.6541794
sample estimates:
mean of the differences
              0.5726786
```

```
> t.test(e1mcq_old_r_r$Proportion, e1mcq_old_r_b$Proportion, paired = TRUE)
```

```
        Paired t-test

data:  e1mcq_old_r_r$Proportion and e1mcq_old_r_b$Proportion
t = 7.5982, df = 99, p-value = 1.723e-11
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 0.3126333 0.5336286
sample estimates:
mean of the differences
               0.423131
```

```
> t.test(e1mcq_old_r_r$Proportion, e1mcq_old_r_u$Proportion, paired = TRUE)
```

```
        Paired t-test

data:  e1mcq_old_r_r$Proportion and e1mcq_old_r_u$Proportion
t = 14.334, df = 99, p-value < 2.2e-16
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 0.4980003 0.6580235
sample estimates:
mean of the differences
              0.5780119
```

```
> e1mcq_young_r = exp1_mcq %>% filter(AgeGroup == "Young" & PrimeType == "r")
> e1mcq_young_r_r = e1mcq_young_r %>% filter(ChosenPrime == "r")
> ## comparing young and old
> t.test(e1mcq_young_r_r$Proportion, e1mcq_old_r_r$Proportion)
```

```
        Welch Two Sample t-test

data:  e1mcq_young_r_r$Proportion and e1mcq_old_r_r$Proportion
t = -1.0687, df = 197.62, p-value = 0.2865
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -0.16911974  0.05023879
sample estimates:
mean of x mean of y
0.5205714 0.5800119
```

16.3 Experiment 2

```
> e2_item_acc = group_by(e2_hlm, Target, AgeGroup, PrimeCondition) %>%
+   summarise_at(vars(Accuracy), mean)
> e2_item_state = group_by(e2_hlm, Target, AgeGroup, Question.RESP) %>%
+   summarise(StateCount = n())
> e2_item_mcqacc = group_by(e2_hlm, Target, AgeGroup, PrimeCondition) %>%
+   summarise_at(vars(McAcc), mean)
```

16.3.1 Target Accuracy

```
> ### TARGET RETRIEVAL ACCURACY
>
> exp2_item_acc = aov(data = e2_item_acc, Accuracy ~ AgeGroup*PrimeCondition +
+                                 Error (Target/(AgeGroup*PrimeCondition)))
> summary(exp2_item_acc)
```

```
Error: Target
          Df Sum Sq Mean Sq F value Pr(>F)
Residuals 99   32.1  0.3242

Error: Target:AgeGroup
          Df Sum Sq Mean Sq F value  Pr(>F)
AgeGroup   1  0.471  0.4706   9.914 0.00217 **
Residuals 99  4.699  0.0475
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Target:PrimeCondition
                Df Sum Sq Mean Sq F value   Pr(>F)
PrimeCondition   3  0.999  0.3330   18.75 3.67e-11 ***
Residuals      297  5.276  0.0178
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1
```

```
Error: Target:AgeGroup:PrimeCondition
                          Df Sum Sq Mean Sq F value Pr(>F)
AgeGroup:PrimeCondition    3  0.165 0.05487   2.595 0.0527 .
Residuals                297  6.279 0.02114
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1
```

```
> options(contrasts = c('contr.sum', 'contr.poly'))
> library(lsmeans)
> library(multcomp)
> exp1_target_lsm = lsmeans::lsmeans(exp2_item_acc,
+                                    c("AgeGroup", "PrimeCondition"))
> prime_effect = cld(exp1_target_lsm, alpha = 0.05,
+                    adjust = "tukey", details = TRUE, by = c("PrimeCondition"))
> library(knitr)
> kable(subset(prime_effect$comparisons,prime_effect$comparisons$p.value < 0.05 ))
```

```
|   |contrast    |PrimeCondition |  estimate|        SE|       df|  t.ratio|   p.value|
|:--|:-----------|:--------------|---------:|---------:|--------:|--------:|---------:|
|2  |Young - Old |P              | 0.0854167| 0.0235474| 338.7317| 3.627433| 0.0003303|
|3  |Young - Old |R              | 0.0629167| 0.0235474| 338.7317| 2.671914| 0.0079065|
```

```
> ## specific t-tests
> e2_item_acc_collapsed = group_by(e2_hlm, Target, PrimeCondition) %>%
+   summarise_at(vars(Accuracy), mean)
> target_p = e2_item_acc_collapsed %>% filter(PrimeCondition == "P")
> target_r = e2_item_acc_collapsed %>% filter(PrimeCondition == "R")
> target_b = e2_item_acc_collapsed %>% filter(PrimeCondition == "B")
> target_u = e2_item_acc_collapsed %>% filter(PrimeCondition == "U")
> t.test(target_p$Accuracy, target_r$Accuracy, paired = TRUE)
```

```
        Paired t-test

data:  target_p$Accuracy and target_r$Accuracy
t = 5.432, df = 99, p-value = 3.993e-07
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 0.04802359 0.10329994
sample estimates:
mean of the differences
             0.07566176
```

```
> t.test(target_p$Accuracy, target_b$Accuracy, paired = TRUE)
```

```
        Paired t-test
```

```
data:  target_p$Accuracy and target_b$Accuracy
t = 4.6166, df = 99, p-value = 1.173e-05
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 0.03412787 0.08557802
sample estimates:
mean of the differences
             0.05985294
```

```
> t.test(target_p$Accuracy, target_u$Accuracy, paired = TRUE)
```

```
        Paired t-test

data:  target_p$Accuracy and target_u$Accuracy
t = 6.4934, df = 99, p-value = 3.376e-09
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 0.06658307 0.12518163
sample estimates:
mean of the differences
             0.09588235
```

```
> t.test(target_b$Accuracy, target_r$Accuracy, paired = TRUE)
```

```
        Paired t-test

data:  target_b$Accuracy and target_r$Accuracy
t = 1.2695, df = 99, p-value = 0.2072
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -0.008899978  0.040517625
sample estimates:
mean of the differences
             0.01580882
```

```
> t.test(target_b$Accuracy, target_u$Accuracy, paired = TRUE)
```

```
        Paired t-test

data:  target_b$Accuracy and target_u$Accuracy
t = 2.6395, df = 99, p-value = 0.009646
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 0.008945084 0.063113740
sample estimates:
mean of the differences
             0.03602941
```

```
> t.test(target_r$Accuracy, target_u$Accuracy, paired = TRUE)
```

```
        Paired t-test

data:  target_r$Accuracy and target_u$Accuracy
t = 1.6247, df = 99, p-value = 0.1074
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -0.004475157  0.044916333
sample estimates:
mean of the differences
             0.02022059
```

```
> ### age effect
> e2_item_age_collapsed = group_by(e2_hlm, Target, AgeGroup) %>%
+   summarise_at(vars(Accuracy), mean)
> target_young = e2_item_age_collapsed %>% filter(AgeGroup == "Young")
> target_old = e2_item_age_collapsed %>% filter(AgeGroup == "Old")
> t.test(target_young$Accuracy, target_old$Accuracy, paired = TRUE)
```

```
        Paired t-test

data:  target_young$Accuracy and target_old$Accuracy
t = 3.281, df = 99, p-value = 0.001429
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 0.02001686 0.08127102
sample estimates:
mean of the differences
             0.05064394
```

```
>
```

16.3.2 State Data

```
> ## e1_item_state has many rows missing so we cannot use that dataset.
> ## we will use the Julieagg.R file to create an agg file for items.
>
> exp2_state = subset(final_statedata, final_statedata$StudyNo == '5' |
+                                   final_statedata$StudyNo == '6')
> exp2_state_prime = subset(statedata_primetype_long, statedata_primetype_long$StudyNo =
+                                   statedata_primetype_long$StudyNo == '6')
> exp2_state_prime$PrimeCondition = as.factor(as.character(exp2_state_prime$PrimeConditi
> exp2_state_prime$State = as.factor(as.character(exp2_state_prime$State))
> exp2_state_prime$Target = as.factor(as.character(exp2_state_prime$Target))
> ## just state
```

```
> exp2_state_aov = aov(data = exp2_state, Trials ~ AgeGroup*State +
+                                         Error(Target/(AgeGroup*State)))
> summary(exp2_state_aov)
```

```
Error: Target
          Df   Sum Sq   Mean Sq F value Pr(>F)
Residuals 99 1.91e-25 1.929e-27

Error: Target:AgeGroup
          Df    Sum Sq   Mean Sq F value Pr(>F)
AgeGroup   1 2.900e-27 2.853e-27   0.324   0.57
Residuals 99 8.714e-25 8.802e-27

Error: Target:State
           Df Sum Sq Mean Sq F value Pr(>F)
State       3  16710    5570   145.6 <2e-16 ***
Residuals 297  11360      38
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Target:AgeGroup:State
                Df Sum Sq Mean Sq F value Pr(>F)
AgeGroup:State   3   3328  1109.3   83.74 <2e-16 ***
Residuals      297   3934    13.2
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1
```

```
> options(contrasts = c('contr.sum', 'contr.poly'))
> exp1_state_lsm = lsmeans::lsmeans(exp1_state_aov, c("AgeGroup", "State"))
> prime_effect = cld(exp1_state_lsm, alpha = 0.05,
+                 adjust = "tukey", details = TRUE, by = c("State"))
> kable(subset(prime_effect$comparisons, prime_effect$comparisons$p.value < 0.05))
```

```
|contrast     |State     | estimate|        SE|  df|   t.ratio|   p.value|
|:------------|:---------|--------:|---------:|---:|---------:|---------:|
|Old - Young  |dontknow  |     4.80| 0.5199675| 297|  9.231347| 0.0000000|
|Old - Young  |know      |     1.90| 0.5199675| 297|  3.654075| 0.0003051|
|Old - Young  |other     |     5.95| 0.5199675| 297| 11.443024| 0.0000000|
```

```
> ##state by prime
> exp2_stateprime_aov = aov(data = exp2_state_prime,
+                           Trials ~ AgeGroup*PrimeCondition*State +
+                           Error(Target/(AgeGroup*PrimeCondition*State)))
> summary(exp2_stateprime_aov)
```

```
Error: Target
          Df    Sum Sq   Mean Sq F value Pr(>F)
```

```
Residuals 99 9.085e-25 9.177e-27

Error: Target:AgeGroup
          Df    Sum Sq   Mean Sq F value Pr(>F)
AgeGroup   1 1.700e-28 1.732e-28   0.233   0.63
Residuals 99 7.361e-26 7.436e-28

Error: Target:PrimeCondition
                Df    Sum Sq   Mean Sq F value Pr(>F)
PrimeCondition   3 3.300e-27 1.113e-27   0.991  0.397
Residuals      297 3.334e-25 1.123e-27

Error: Target:State
           Df Sum Sq Mean Sq F value Pr(>F)
State       3   4177  1392.5   145.6 <2e-16 ***
Residuals 297   2840     9.6
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Target:AgeGroup:PrimeCondition
                         Df    Sum Sq   Mean Sq F value Pr(>F)
AgeGroup:PrimeCondition   3 3.220e-27 1.072e-27   1.033  0.378
Residuals               297 3.084e-25 1.038e-27

Error: Target:AgeGroup:State
                Df Sum Sq Mean Sq F value Pr(>F)
AgeGroup:State   3  832.0  277.32   83.74 <2e-16 ***
Residuals      297  983.5    3.31
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Target:PrimeCondition:State
                      Df Sum Sq Mean Sq F value   Pr(>F)
PrimeCondition:State   9  136.1  15.126   8.989 4.55e-13 ***
Residuals            891 1499.4   1.683
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Target:AgeGroup:PrimeCondition:State
                               Df Sum Sq Mean Sq F value Pr(>F)
AgeGroup:PrimeCondition:State   9   23.4   2.596   1.448  0.163
Residuals                     891 1598.1   1.794
```

```
> library(ez)
> # ezANOVA(data = exp1_state_prime, wid = .(Target),
> #         dv = .(Trials), within =.(PrimeCondition, State),
> #         between = .(AgeGroup))
>
```

```
> options(contrasts = c('contr.sum', 'contr.poly'))
> exp1_state_lsm = lsmeans::lsmeans(exp1_stateprime_aov, c("AgeGroup","PrimeCondition",
> prime_effect = cld(exp1_state_lsm, alpha = 0.05,
+                    adjust = "tukey", details = TRUE, by = c("PrimeCondition", "AgeGroup")
> kable(subset(prime_effect$comparisons, prime_effect$comparisons$p.value < 0.05))
```

```
|   |contrast           |PrimeCondition  |AgeGroup  | estimate|         SE|        df|
t.ratio|   p.value|
|:--|:------------------|:---------------|:---------|--------:|----------:|---------:|--------
|2  |dontknow - other   |b               |Old       |     3.18|  0.2564724|  1197.602|  12.3989
|3  |dontknow - TOT     |b               |Old       |     2.78|  0.2564724|  1197.602|  10.8393
|4  |know - other       |b               |Old       |     3.90|  0.2564724|  1197.602|  15.2063
|5  |know - TOT         |b               |Old       |     3.50|  0.2564724|  1197.602|  13.6466
|6  |know - dontknow    |b               |Old       |     0.72|  0.2564724|  1197.602|
2.807319|  0.0260869|
|7  |TOT - other        |b               |Young     |     0.84|  0.2564724|  1197.602|
3.275206|  0.0059743|
|8  |dontknow - other   |b               |Young     |     1.41|  0.2564724|  1197.602|
5.497667|  0.0000003|
|10 |know - other       |b               |Young     |     2.71|  0.2564724|  1197.602|  10.5664
|11 |know - TOT         |b               |Young     |     1.87|  0.2564724|  1197.602|
7.291232|  0.0000000|
|12 |know - dontknow    |b               |Young     |     1.30|  0.2564724|  1197.602|
5.068771|  0.0000028|
|14 |dontknow - other   |p               |Old       |     2.98|  0.2564724|  1197.602|  11.6191
|15 |dontknow - TOT     |p               |Old       |     2.83|  0.2564724|  1197.602|  11.0343
|16 |know - other       |p               |Old       |     4.03|  0.2564724|  1197.602|  15.7131
|17 |know - TOT         |p               |Old       |     3.88|  0.2564724|  1197.602|  15.1283
|18 |know - dontknow    |p               |Old       |     1.05|  0.2564724|  1197.602|
4.094007|  0.0002640|
|19 |TOT - other        |p               |Young     |     0.74|  0.2564724|  1197.602|
2.885300|  0.0207377|
|20 |dontknow - other   |p               |Young     |     1.13|  0.2564724|  1197.602|
4.405931|  0.0000677|
|22 |know - other       |p               |Young     |     2.97|  0.2564724|  1197.602|  11.5801
|23 |know - TOT         |p               |Young     |     2.23|  0.2564724|  1197.602|
8.694891|  0.0000000|
|24 |know - dontknow    |p               |Young     |     1.84|  0.2564724|  1197.602|
7.174260|  0.0000000|
|26 |dontknow - other   |r               |Old       |     2.72|  0.2564724|  1197.602|  10.6054
|27 |dontknow - TOT     |r               |Old       |     2.45|  0.2564724|  1197.602|
9.552683|  0.0000000|
|28 |know - other       |r               |Old       |     3.49|  0.2564724|  1197.602|  13.6077
|29 |know - TOT         |r               |Old       |     3.22|  0.2564724|  1197.602|  12.5549
|30 |know - dontknow    |r               |Old       |     0.77|  0.2564724|  1197.602|
3.002272|  0.0145194|
|31 |TOT - other        |r               |Young     |     1.14|  0.2564724|  1197.602|
4.444922|  0.0000567|
```

```
|32 |dontknow - other |r                |Young    |      1.24| 0.2564724| 1197.602|
4.834827| 0.0000090|
|34 |know - other     |r                |Young    |      2.50| 0.2564724| 1197.602|
9.747636| 0.0000000|
|35 |know - TOT       |r                |Young    |      1.36| 0.2564724| 1197.602|
5.302714| 0.0000008|
|36 |know - dontknow  |r                |Young    |      1.26| 0.2564724| 1197.602|
4.912808| 0.0000061|
|37 |TOT - other      |u                |Old      |      0.69| 0.2564724| 1197.602|
2.690348| 0.0363528|
|38 |dontknow - other |u                |Old      |      2.80| 0.2564724| 1197.602| 10.9173
|39 |dontknow - TOT   |u                |Old      |      2.11| 0.2564724| 1197.602|
8.227005| 0.0000000|
|40 |know - other     |u                |Old      |      3.67| 0.2564724| 1197.602| 14.3095
|41 |know - TOT       |u                |Old      |      2.98| 0.2564724| 1197.602| 11.6191
|42 |know - dontknow  |u                |Old      |      0.87| 0.2564724| 1197.602|
3.392177| 0.0039876|
|43 |TOT - other      |u                |Young    |      0.97| 0.2564724| 1197.602|
3.782083| 0.0009373|
|44 |dontknow - other |u                |Young    |      1.71| 0.2564724| 1197.602|
6.667383| 0.0000000|
|45 |dontknow - TOT   |u                |Young    |      0.74| 0.2564724| 1197.602|
2.885300| 0.0207377|
|46 |know - other     |u                |Young    |      1.88| 0.2564724| 1197.602|
7.330222| 0.0000000|
|47 |know - TOT       |u                |Young    |      0.91| 0.2564724| 1197.602|
3.548140| 0.0022760|
```

```
> ### INDIVIDUAL T-TESTS FOR AGExSTATE interaction
>
> e1_young_dk = exp1_state %>% filter(AgeGroup == "Young" & State == "dontknow")
> e1_old_dk = exp1_state %>% filter(AgeGroup == "Old" & State == "dontknow")
> t.test(e1_old_dk$Trials, e1_young_dk$Trials)
```

```
        Welch Two Sample t-test

data:  e1_old_dk$Trials and e1_young_dk$Trials
t = 5.837, df = 197.87, p-value = 2.146e-08
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 3.178335 6.421665
sample estimates:
mean of x mean of y
    14.48      9.68
```

```
> e1_young_other = exp1_state %>% filter(AgeGroup == "Young" & State == "other")
> e1_old_other = exp1_state %>% filter(AgeGroup == "Old" & State == "other")
> t.test(e1_young_other$Trials, e1_old_other$Trials)
```

```
        Welch Two Sample t-test

data:  e1_young_other$Trials and e1_old_other$Trials
t = 12.087, df = 119.23, p-value < 2.2e-16
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 4.975274 6.924726
sample estimates:
mean of x mean of y
     7.88      1.93
```

```
>
```

Multiple Choice

```
> exp2_mcq = subset(final_mcq, final_mcq$StudyNo == '5' | final_mcq$StudyNo == '6')
> ## MULTIPLE CHOICE ACCURACY
> library(dplyr)
> exp2_mcq_acc = group_by(exp2_mcq, Target, PrimeType, AgeGroup) %>%
+     summarise_at(vars(MCQAcc), mean)
> exp2_mcq_acc_aov = aov(data = exp2_mcq_acc, MCQAcc ~ AgeGroup*PrimeType +
+                        Error(Target/(AgeGroup*PrimeType)))
> summary(exp2_mcq_acc_aov)
```

```
Error: Target
          Df Sum Sq Mean Sq F value Pr(>F)
Residuals 99  25.84   0.261

Error: Target:AgeGroup
          Df Sum Sq Mean Sq F value   Pr(>F)
AgeGroup   1   1.06  1.0603   24.59 2.95e-06 ***
Residuals 99   4.27  0.0431
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Target:PrimeType
           Df Sum Sq Mean Sq F value  Pr(>F)
PrimeType   3  0.370 0.12325   4.688 0.00324 **
Residuals 297  7.808 0.02629
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Target:AgeGroup:PrimeType
                    Df Sum Sq Mean Sq F value Pr(>F)
AgeGroup:PrimeType   3  0.227 0.07564   3.408  0.018 *
Residuals          297  6.591 0.02219
```

```
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1
```

```
> ## SPECIFIC T TESTS
>
> e2_mcq_p = exp2_mcq_acc %>% filter(PrimeType == "p")
> e2_mcq_r = exp2_mcq_acc %>% filter(PrimeType == "r")
> e2_mcq_b = exp2_mcq_acc %>% filter(PrimeType == "b")
> e2_mcq_u = exp2_mcq_acc %>% filter(PrimeType == "u")
> e2mcq_y_p = e2_mcq_p %>% filter(AgeGroup == "Young")
> e2mcq_o_p = e2_mcq_p %>% filter(AgeGroup == "Old")
> t.test(e2mcq_y_p$MCQAcc, e2mcq_o_p$MCQAcc)
```

```
        Welch Two Sample t-test

data:  e2mcq_y_p$MCQAcc and e2mcq_o_p$MCQAcc
t = 3.4423, df = 197.18, p-value = 0.0007041
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 0.04484715 0.16515285
sample estimates:
mean of x mean of y
  0.77875   0.67375
```

```
> e2mcq_y_b = e2_mcq_b %>% filter(AgeGroup == "Young")
> e2mcq_o_b = e2_mcq_b %>% filter(AgeGroup == "Old")
> t.test(e2mcq_y_b$MCQAcc, e2mcq_o_b$MCQAcc)
```

```
        Welch Two Sample t-test

data:  e2mcq_y_b$MCQAcc and e2mcq_o_b$MCQAcc
t = 2.8466, df = 191.08, p-value = 0.004902
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 0.02878927 0.15871073
sample estimates:
mean of x mean of y
  0.78000   0.68625
```

```
> e2mcq_y_r = e2_mcq_r %>% filter(AgeGroup == "Young")
> e2mcq_o_r = e2_mcq_r %>% filter(AgeGroup == "Old")
> t.test(e2mcq_y_r$MCQAcc, e2mcq_o_r$MCQAcc)
```

```
        Welch Two Sample t-test

data:  e2mcq_y_r$MCQAcc and e2mcq_o_r$MCQAcc
t = 2.0973, df = 191.57, p-value = 0.03728
```

```
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 0.004466692 0.145533308
sample estimates:
mean of x mean of y
  0.74625   0.67125
```

```
> e2mcq_y_u = e2_mcq_u %>% filter(AgeGroup == "Young")
> e2mcq_o_u = e2_mcq_u %>% filter(AgeGroup == "Old")
> t.test(e2mcq_y_u$MCQAcc, e2mcq_o_u$MCQAcc)
```

```
        Welch Two Sample t-test

data:  e2mcq_y_u$MCQAcc and e2mcq_o_u$MCQAcc
t = 0.50471, df = 198, p-value = 0.6143
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -0.05087645  0.08587645
sample estimates:
mean of x mean of y
  0.68625   0.66875
```

```
> # ezANOVA(data = exp2_mcq_acc, wid = .(Target),
> #         dv = .(MCQAcc), within =.(PrimeType),
> #         between = .(AgeGroup))
>
>
> exp2_mcqacc_lsm = lsmeans::lsmeans(exp2_mcq_acc_aov, c("AgeGroup", "PrimeType"))
> prime_effect = cld(exp2_mcqacc_lsm, alpha = 0.05,
+                    adjust = "tukey", details = TRUE, by = c("PrimeType"))
> kable(subset(prime_effect$comparisons, prime_effect$comparisons$p.value < 0.1))
```

```
|contrast     |PrimeType |  estimate|        SE|        df|  t.ratio|   p.value|
|:------------|:---------|---------:|---------:|---------:|--------:|---------:|
|Young - Old  |b         |   0.09375|  0.023421|  356.9997| 4.002815| 0.0000762|
|Young - Old  |p         |   0.10500|  0.023421|  356.9997| 4.483153| 0.0000099|
|Young - Old  |r         |   0.07500|  0.023421|  356.9997| 3.202252| 0.0014861|
```

```
> ## MULTIPLE CHOICE ERRORS
>
> ## before we do ANOVA, we need to replace NAs with 0.
>
> for (i in 1: nrow(exp2_mcq)){
+    if(is.na(exp2_mcq[i,9])){
+      exp2_mcq[i,9] = 0
+    }
+
```

```
+ }
> exp2_mcq_aov = aov(data = exp2_mcq,
+                    Proportion ~ AgeGroup*PrimeType*ChosenPrime +
+                         Error(Target/(AgeGroup*PrimeType*ChosenPrime)))
> summary(exp2_mcq_aov)
```

```
Error: Target
          Df Sum Sq Mean Sq F value Pr(>F)
Residuals 99  10.58  0.1069

Error: Target:AgeGroup
          Df Sum Sq Mean Sq F value Pr(>F)
AgeGroup   1  0.000 0.00015   0.003  0.958
Residuals 99  5.345 0.05399

Error: Target:PrimeType
           Df Sum Sq Mean Sq F value Pr(>F)
PrimeType   3  0.135 0.04489    1.56  0.199
Residuals 297  8.543 0.02877

Error: Target:ChosenPrime
             Df Sum Sq Mean Sq F value Pr(>F)
ChosenPrime   3  86.10  28.698   117.1 <2e-16 ***
Residuals   297  72.81   0.245
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Target:AgeGroup:PrimeType
                     Df Sum Sq Mean Sq F value Pr(>F)
AgeGroup:PrimeType    3  0.117 0.03900   1.241  0.295
Residuals           297  9.336 0.03143

Error: Target:AgeGroup:ChosenPrime
                       Df Sum Sq Mean Sq F value Pr(>F)
AgeGroup:ChosenPrime    3  0.373 0.12426    1.36  0.255
Residuals             297 27.143 0.09139

Error: Target:PrimeType:ChosenPrime
                        Df Sum Sq Mean Sq F value Pr(>F)
PrimeType:ChosenPrime    9   0.24 0.02641   0.384  0.943
Residuals              891  61.32 0.06883

Error: Target:AgeGroup:PrimeType:ChosenPrime
                                 Df Sum Sq Mean Sq F value Pr(>F)
AgeGroup:PrimeType:ChosenPrime    9   2.91  0.3239   4.644  5e-06 ***
Residuals                       891  62.14  0.0697
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1
```

```
> library(ez)
> # ezANOVA(data = exp2_mcq, wid = .(Target),
> #         dv = .(Proportion), within =.(PrimeType, ChosenPrime),
> #         between = .(AgeGroup))
>
> options(contrasts = c('contr.sum', 'contr.poly'))
> exp2_errors_lsm = lsmeans::lsmeans(exp2_mcq_aov, c("AgeGroup", "PrimeType", "ChosenPri
> prime_effect = cld(exp2_errors_lsm, alpha = 0.05,
+                     adjust = "tukey", details = TRUE, by = c("PrimeType", "ChosenPrime"))
> kable(subset(prime_effect$comparisons, prime_effect$comparisons$p.value < 0.05))
```

```
|   |contrast     |PrimeType |ChosenPrime |  estimate|        SE|       df|  t.ratio|
p.value|
|:--|:-----------|:---------|:-----------|---------:|---------:|--------:|--------:|----
|1  |Old - Young |b         |b           | 0.1159167| 0.0362305| 1461.313| 3.199423| 0.0
|3  |Old - Young |b         |r           | 0.0835833| 0.0362305| 1461.313| 2.306989| 0.0
|9  |Old - Young |r         |b           | 0.1738333| 0.0362305| 1461.313| 4.797984| 0.0
|11 |Old - Young |r         |r           | 0.0809286| 0.0362305| 1461.313| 2.233714| 0.0
```

```
> ## SPECIFIC OLD COMPARISION T TEST
>
> e2mcq_old_r = exp2_mcq %>% filter(AgeGroup == "Old" & PrimeType == "r")
> e2mcq_young_r = exp2_mcq %>% filter(AgeGroup == "Young" & PrimeType == "r")
> e2mcq_old_r_r = e2mcq_old_r %>% filter(ChosenPrime == "r")
> e2mcq_young_r_r = e2mcq_young_r %>% filter(ChosenPrime == "r")
> ## comparing young and old
> t.test(e2mcq_young_r_r$Proportion, e2mcq_old_r_r$Proportion)
```

```
        Welch Two Sample t-test

data:  e2mcq_young_r_r$Proportion and e2mcq_old_r_r$Proportion
t = -1.4314, df = 197.31, p-value = 0.1539
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -0.19242763  0.03057048
sample estimates:
mean of x mean of y
0.3657619 0.4466905
```

```
> e2mcq_old_b = exp2_mcq %>% filter(AgeGroup == "Old" & PrimeType == "b")
> e2mcq_young_b = exp2_mcq %>% filter(AgeGroup == "Young" & PrimeType == "b")
> e2mcq_old_b_b = e2mcq_old_b %>% filter(ChosenPrime == "b")
> e2mcq_young_b_b = e2mcq_young_b %>% filter(ChosenPrime == "b")
> ## comparing young and old
> t.test(e2mcq_young_b_b$Proportion, e2mcq_old_b_b$Proportion)
```

```
        Welch Two Sample t-test

data:  e2mcq_young_b_b$Proportion and e2mcq_old_b_b$Proportion
t = -2.1749, df = 197.46, p-value = 0.03082
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -0.22102042 -0.01081291
sample estimates:
mean of x mean of y
0.2491667 0.3650833
```

16.4 Collapsing the 4 experiments

```
> final_mcq_main4 = subset(final_mcq, final_mcq$StudyNo != '1')
> for (i in 1: nrow(final_mcq_main4)){
+    if(is.na(final_mcq_main4[i,9])){
+      final_mcq_main4[i,9] = 0
+    }
+ }
> final_mcq_main4$PrimeInstruction = ifelse(final_mcq_main4$StudyNo == "2" |
+                              final_mcq_main4$StudyNo == "4",
+                              "NoInstruction", "WithInstruction")
> final_mcq_main4$PrimeInstruction = as.factor(final_mcq_main4$PrimeInstruction)
> fourway_aov = aov(data = final_mcq_main4,
+                 Proportion ~ AgeGroup*PrimeInstruction*PrimeType*ChosenPrime + Error(Tar
> summary(fourway_aov)
```

```
Error: Target
          Df Sum Sq Mean Sq F value Pr(>F)
Residuals 99   18.1  0.1828

Error: Target:AgeGroup
          Df Sum Sq Mean Sq F value Pr(>F)
AgeGroup   1  0.162 0.16161   2.106   0.15
Residuals 99  7.598 0.07675

Error: Target:PrimeType
           Df Sum Sq Mean Sq F value Pr(>F)
PrimeType   3  0.233 0.07762   2.981 0.0317 *
Residuals 297  7.732 0.02603
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Target:ChosenPrime
             Df Sum Sq Mean Sq F value Pr(>F)
ChosenPrime   3  175.2   58.41   133.3 <2e-16 ***
```

```
Residuals    297  130.2     0.44
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Target:AgeGroup:PrimeType
                    Df Sum Sq Mean Sq F value Pr(>F)
AgeGroup:PrimeType   3  0.099 0.03312   1.136  0.335
Residuals          297  8.659 0.02915

Error: Target:AgeGroup:ChosenPrime
                      Df Sum Sq Mean Sq F value Pr(>F)
AgeGroup:ChosenPrime   3   0.94  0.3134   2.458  0.063 .
Residuals            297  37.87  0.1275
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Target:PrimeType:ChosenPrime
                       Df Sum Sq Mean Sq F value   Pr(>F)
PrimeType:ChosenPrime   9   6.63  0.7362   10.85 3.99e-16 ***
Residuals             891  60.44  0.0678
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Target:AgeGroup:PrimeType:ChosenPrime
                                Df Sum Sq Mean Sq F value  Pr(>F)
AgeGroup:PrimeType:ChosenPrime   9   3.10  0.3447   5.244 5.6e-07 ***
Residuals                      891  58.57  0.0657
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Within
                                                  Df Sum Sq Mean Sq F value
PrimeInstruction                                   1   0.02  0.0195   0.372
AgeGroup:PrimeInstruction                          1   0.18  0.1759   3.350
PrimeInstruction:PrimeType                         3   0.23  0.0754   1.436
PrimeInstruction:ChosenPrime                       3   0.04  0.0141   0.268
AgeGroup:PrimeInstruction:PrimeType                3   0.13  0.0433   0.825
AgeGroup:PrimeInstruction:ChosenPrime              3   0.12  0.0396   0.754
PrimeInstruction:PrimeType:ChosenPrime             9   5.25  0.5834  11.113
AgeGroup:PrimeInstruction:PrimeType:ChosenPrime    9   1.12  0.1250   2.380
Residuals                                       3168 166.31  0.0525
                                                Pr(>F)
PrimeInstruction                                0.5419
AgeGroup:PrimeInstruction                       0.0673 .
PrimeInstruction:PrimeType                      0.2302
PrimeInstruction:ChosenPrime                    0.8483
AgeGroup:PrimeInstruction:PrimeType             0.4800
AgeGroup:PrimeInstruction:ChosenPrime           0.5197
```

```
PrimeInstruction:PrimeType:ChosenPrime          <2e-16 ***
AgeGroup:PrimeInstruction:PrimeType:ChosenPrime 0.0111 *
Residuals
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1
```

```
> library(ez)
> # ezANOVA(data = final_mcq_main4, wid = .(Target),
> #         dv = .(Proportion), within =.(AgeGroup, PrimeType, ChosenPrime),
> #         between = .(PrimeInstruction)) ## IMPORTANT SPHERICITY
```

16.5 Experiment 3

```
> e3_item_acc = group_by(e3_hlm, Target, PrimeCondition) %>%
+   summarise_at(vars(Accuracy), mean)
> e3_item_state = group_by(e3_hlm, Target, Question.RESP) %>%
+   summarise(StateCount = n())
> e3_item_mcqacc = group_by(e3_hlm, Target, PrimeCondition) %>%
+   summarise_at(vars(McAcc), mean)
```

16.5.1 Target Accuracy

```
> ### TARGET RETRIEVAL ACCURACY
>
> exp3_item_acc = aov(data = e3_item_acc, Accuracy ~ PrimeCondition +
+                         Error (Target/PrimeCondition))
> summary(exp3_item_acc)
```

```
Error: Target
          Df Sum Sq Mean Sq F value Pr(>F)
Residuals 99  19.69  0.1989

Error: Target:PrimeCondition
                Df Sum Sq Mean Sq F value  Pr(>F)
PrimeCondition   3  0.279 0.09288   5.559 0.00101 **
Residuals      297  4.962 0.01671
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1
```

```
> ## specific t-tests
> target_p = e3_item_acc %>% filter(PrimeCondition == "P")
> target_r = e3_item_acc %>% filter(PrimeCondition == "R")
> target_b = e3_item_acc %>% filter(PrimeCondition == "B")
> target_u = e3_item_acc %>% filter(PrimeCondition == "U")
> t.test(target_p$Accuracy, target_r$Accuracy, paired = TRUE)
```

```
        Paired t-test

data:  target_p$Accuracy and target_r$Accuracy
t = 2.7128, df = 99, p-value = 0.007869
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 0.01462240 0.09426649
sample estimates:
mean of the differences
             0.05444444
```

```
> t.test(target_p$Accuracy, target_b$Accuracy, paired = TRUE)
```

```
        Paired t-test

data:  target_p$Accuracy and target_b$Accuracy
t = 2.1645, df = 99, p-value = 0.03283
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 0.003054478 0.070278856
sample estimates:
mean of the differences
             0.03666667
```

```
> t.test(target_p$Accuracy, target_u$Accuracy, paired = TRUE)
```

```
        Paired t-test

data:  target_p$Accuracy and target_u$Accuracy
t = 3.6107, df = 99, p-value = 0.0004814
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 0.03203268 0.11018955
sample estimates:
mean of the differences
             0.07111111
```

```
> t.test(target_b$Accuracy, target_r$Accuracy, paired = TRUE)
```

```
        Paired t-test

data:  target_b$Accuracy and target_r$Accuracy
t = 1.042, df = 99, p-value = 0.3
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -0.01607674  0.05163230
```

```
sample estimates:
mean of the differences
             0.01777778
```

```
> t.test(target_b$Accuracy, target_u$Accuracy, paired = TRUE)
```

```
        Paired t-test

data:  target_b$Accuracy and target_u$Accuracy
t = 1.8723, df = 99, p-value = 0.06411
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -0.002058338  0.070947227
sample estimates:
mean of the differences
             0.03444444
```

```
> t.test(target_r$Accuracy, target_u$Accuracy, paired = TRUE)
```

```
        Paired t-test

data:  target_r$Accuracy and target_u$Accuracy
t = 0.96591, df = 99, p-value = 0.3364
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -0.01757073  0.05090406
sample estimates:
mean of the differences
             0.01666667
```

```
>
>
```

16.5.2 State Data

```
> exp3_state = subset(final_statedata, final_statedata$StudyNo == '1')
> exp3_state_prime = subset(statedata_primetype_long, statedata_primetype_long$StudyNo =
> exp3_state_prime$PrimeCondition = as.factor(as.character(exp3_state_prime$PrimeConditi
> exp3_state_prime$State = as.factor(as.character(exp3_state_prime$State))
> exp3_state_prime$Target = as.factor(as.character(exp3_state_prime$Target))
> ## just state
> exp3_state_aov = aov(data = exp3_state, Trials ~ State +
+                                         Error(Target/State))
> summary(exp3_state_aov)
```

```
Error: Target
          Df   Sum Sq   Mean Sq F value Pr(>F)
Residuals 99 2.09e-26 2.111e-28

Error: Target:State
           Df Sum Sq Mean Sq F value Pr(>F)
State       3   4918  1639.3   47.15 <2e-16 ***
Residuals 297  10326    34.8
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1
```

```
> options(contrasts = c('contr.sum', 'contr.poly'))
> exp3_state_lsm = lsmeans::lsmeans(exp3_state_aov, c("State"))
> prime_effect = cld(exp3_state_lsm, alpha = 0.05,
+                 adjust = "tukey", details = TRUE)
> kable(subset(prime_effect$comparisons, prime_effect$comparisons$p.value < 0.05))
```

```
|   |contrast          | estimate|        SE|  df|   t.ratio|  p.value|
|:--|:-----------------|--------:|---------:|---:|---------:|--------:|
|2  |dontknow - TOT    |     5.00| 0.8338778| 297|  5.996082| 0.00e+00|
|3  |dontknow - other  |     4.29| 0.8338778| 297|  5.144639| 2.90e-06|
|4  |know - TOT        |     8.69| 0.8338778| 297| 10.421191| 0.00e+00|
|5  |know - other      |     7.98| 0.8338778| 297|  9.569748| 0.00e+00|
|6  |know - dontknow   |     3.69| 0.8338778| 297|  4.425109| 7.97e-05|
```

```
> ##state by prime
> exp3_stateprime_aov = aov(data = exp3_state_prime,
+                           Trials ~ PrimeCondition*State +
+                                  Error(Target/(PrimeCondition*State)))
> summary(exp3_stateprime_aov)
```

```
Error: Target
          Df    Sum Sq   Mean Sq F value Pr(>F)
Residuals 99 5.699e-26 5.756e-28

Error: Target:PrimeCondition
                Df    Sum Sq   Mean Sq F value Pr(>F)
PrimeCondition   3 5.600e-28 1.861e-28   0.229  0.876
Residuals      297 2.417e-25 8.137e-28

Error: Target:State
           Df Sum Sq Mean Sq F value Pr(>F)
State       3   1230   409.8   47.15 <2e-16 ***
Residuals 297   2582     8.7
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1
```

```
Error: Target:PrimeCondition:State
                        Df Sum Sq Mean Sq F value   Pr(>F)
PrimeCondition:State     9   89.9   9.984   5.115 8.99e-07 ***
Residuals              891 1739.1   1.952
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1
```

```
> library(ez)
> # ezANOVA(data = exp3_state_prime, wid = .(Target),
> #          dv = .(Trials), within =.(PrimeCondition, State))
>
> options(contrasts = c('contr.sum', 'contr.poly'))
> exp3_state_lsm = lsmeans::lsmeans(exp3_stateprime_aov, c("PrimeCondition", "State"))
> prime_effect = cld(exp3_state_lsm, alpha = 0.05,
+                    adjust = "tukey", details = TRUE, by = c("PrimeCondition"))
> kable(subset(prime_effect$comparisons, prime_effect$comparisons$p.value < 0.1))
```

```
|   |contrast           |PrimeCondition | estimate|        SE|      df|  t.ratio|
p.value|
|:--|:------------------|:--------------|--------:|---------:|-------:|---------:|---------
|2  |dontknow - TOT     |b              |     1.20| 0.2696999| 722.646|  4.449389| 0.00005
|3  |dontknow - other   |b              |     0.99| 0.2696999| 722.646|  3.670746| 0.00147
|4  |know - TOT         |b              |     2.47| 0.2696999| 722.646|  9.158327| 0.00000
|5  |know - other       |b              |     2.26| 0.2696999| 722.646|  8.379684| 0.00000
|6  |know - dontknow    |b              |     1.27| 0.2696999| 722.646|  4.708937| 0.00001
|8  |dontknow - TOT     |p              |     1.17| 0.2696999| 722.646|  4.338155| 0.00009
|9  |dontknow - other   |p              |     1.01| 0.2696999| 722.646|  3.744903| 0.00111
|10 |know - TOT         |p              |     2.11| 0.2696999| 722.646|  7.823510| 0.00000
|11 |know - other       |p              |     1.95| 0.2696999| 722.646|  7.230258| 0.00000
|12 |know - dontknow    |p              |     0.94| 0.2696999| 722.646|  3.485355| 0.00292
|14 |dontknow - TOT     |r              |     1.22| 0.2696999| 722.646|  4.523546| 0.00004
|15 |dontknow - other   |r              |     0.89| 0.2696999| 722.646|  3.299964| 0.00558
|16 |know - TOT         |r              |     2.77| 0.2696999| 722.646| 10.270674| 0.00000
|17 |know - other       |r              |     2.44| 0.2696999| 722.646|  9.047092| 0.00000
|18 |know - dontknow    |r              |     1.55| 0.2696999| 722.646|  5.747128| 0.00000
|20 |dontknow - TOT     |u              |     1.34| 0.2696999| 722.646|  4.968485| 0.00000
|21 |dontknow - other   |u              |     1.33| 0.2696999| 722.646|  4.931407| 0.00000
|22 |know - TOT         |u              |     1.41| 0.2696999| 722.646|  5.228033| 0.00000
|23 |know - other       |u              |     1.40| 0.2696999| 722.646|  5.190954| 0.00000
```

```
>
```

Multiple Choice

```
> exp3_mcq = subset(final_mcq, final_mcq$StudyNo == '1')
> ## MULTIPLE CHOICE ACCURACY
> library(dplyr)
```

```
> exp3_mcq_acc = group_by(exp3_mcq, Target, PrimeType) %>%
+     summarise_at(vars(MCQAcc), mean)
> exp3_mcq_acc_aov = aov(data = exp3_mcq_acc, MCQAcc ~ PrimeType +
+                                 Error(Target/PrimeType))
> summary(exp3_mcq_acc_aov)
```

```
Error: Target
          Df Sum Sq Mean Sq F value Pr(>F)
Residuals 99  19.77  0.1997

Error: Target:PrimeType
           Df Sum Sq Mean Sq F value Pr(>F)
PrimeType   3  0.219 0.07313   3.233 0.0227 *
Residuals 297  6.719 0.02262
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1
```

```
> ## SPECIFIC T TESTS
>
> e3_mcq_p = exp3_mcq_acc %>% filter(PrimeType == "p")
> e3_mcq_r = exp3_mcq_acc %>% filter(PrimeType == "r")
> e3_mcq_b = exp3_mcq_acc %>% filter(PrimeType == "b")
> e3_mcq_u = exp3_mcq_acc %>% filter(PrimeType == "u")
> t.test(e3_mcq_r$MCQAcc, e3_mcq_u$MCQAcc, paired = TRUE) ##sig
```

```
        Paired t-test

data:  e3_mcq_r$MCQAcc and e3_mcq_u$MCQAcc
t = -2.4791, df = 99, p-value = 0.01486
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -0.10202226 -0.01131107
sample estimates:
mean of the differences
            -0.05666667
```

```
> t.test(e3_mcq_r$MCQAcc, e3_mcq_p$MCQAcc, paired = TRUE)
```

```
        Paired t-test

data:  e3_mcq_r$MCQAcc and e3_mcq_p$MCQAcc
t = -2.5098, df = 99, p-value = 0.0137
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -0.1034554 -0.0121002
sample estimates:
mean of the differences
            -0.05777778
```

```
> # ezANOVA(data = exp3_mcq_acc, wid = .(Target),
> #          dv = .(MCQAcc), within =.(PrimeType))
>
>
> exp3_mcqacc_lsm = lsmeans::lsmeans(exp3_mcq_acc_aov, c("PrimeType"))
> prime_effect = cld(exp3_mcqacc_lsm, alpha = 0.05,
+                     adjust = "tukey", details = TRUE)
> kable(subset(prime_effect$comparisons, prime_effect$comparisons$p.value < 0.1))
```

```
|   |contrast |  estimate|         SE|  df|  t.ratio|   p.value|
|:--|:--------|---------:|---------:|---:|--------:|---------:|
|2  |u - r    | 0.0566667| 0.0212709| 297| 2.664049| 0.0404050|
|4  |p - r    | 0.0577778| 0.0212709| 297| 2.716285| 0.0350551|
```

```
> ## MULTIPLE CHOICE ERRORS
>
> ## before we do ANOVA, we need to replace NAs with 0.
>
> for (i in 1: nrow(exp3_mcq)){
+    if(is.na(exp3_mcq[i,9])){
+      exp3_mcq[i,9] = 0
+    }
+
+ }
> exp3_mcq_aov = aov(data = exp3_mcq, Proportion ~ PrimeType*ChosenPrime +
+                        Error(Target/(PrimeType*ChosenPrime)))
> summary(exp3_mcq_aov)
```

```
Error: Target
          Df Sum Sq Mean Sq F value Pr(>F)
Residuals 99  7.366  0.0744

Error: Target:PrimeType
           Df Sum Sq Mean Sq F value Pr(>F)
PrimeType   3  0.076 0.02525   1.414  0.239
Residuals 297  5.303 0.01785

Error: Target:ChosenPrime
             Df Sum Sq Mean Sq F value Pr(>F)
ChosenPrime   3  57.85  19.282   99.94 <2e-16 ***
Residuals   297  57.30   0.193
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Target:PrimeType:ChosenPrime
                       Df Sum Sq Mean Sq F value   Pr(>F)
PrimeType:ChosenPrime   9   4.19  0.4660   7.141 4.83e-10 ***
```

```
Residuals                891   58.15   0.0653
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1
```

```
> library(ez)
> # ezANOVA(data = exp3_mcq, wid = .(Target),
> #          dv = .(Proportion), within =.(PrimeType, ChosenPrime))
>
> options(contrasts = c('contr.sum', 'contr.poly'))
> exp3_errors_lsm = lsmeans::lsmeans(exp3_mcq_aov, c("PrimeType", "ChosenPrime"))
> prime_effect = cld(exp3_errors_lsm, alpha = 0.05,
+                    adjust = "tukey", details = TRUE, by = c("PrimeType"))
> kable(subset(prime_effect$comparisons, prime_effect$comparisons$p.value < 0.8))
```

```
|   |contrast |PrimeType |  estimate|        SE|       df|   t.ratio|   p.value|
|:--|:--------|:---------|---------:|---------:|--------:|---------:|---------:|
|2  |r - p    |b         | 0.3957976| 0.0440861| 897.5443|  8.977833| 0.0000000|
|3  |r - u    |b         | 0.3916310| 0.0440861| 897.5443|  8.883321| 0.0000000|
|4  |b - p    |b         | 0.4233690| 0.0440861| 897.5443|  9.603233| 0.0000000|
|5  |b - u    |b         | 0.4192024| 0.0440861| 897.5443|  9.508721| 0.0000000|
|7  |u - p    |p         | 0.0555952| 0.0440861| 897.5443|  1.261061| 0.5880485|
|8  |r - p    |p         | 0.3229286| 0.0440861| 897.5443|  7.324953| 0.0000000|
|9  |r - u    |p         | 0.2673333| 0.0440861| 897.5443|  6.063892| 0.0000000|
|10 |b - p    |p         | 0.3957619| 0.0440861| 897.5443|  8.977023| 0.0000000|
|11 |b - u    |p         | 0.3401667| 0.0440861| 897.5443|  7.715962| 0.0000000|
|12 |b - r    |p         | 0.0728333| 0.0440861| 897.5443|  1.652070| 0.3499954|
|14 |r - p    |r         | 0.2431310| 0.0440861| 897.5443|  5.514912| 0.0000003|
|15 |r - u    |r         | 0.2247024| 0.0440861| 897.5443|  5.096899| 0.0000025|
|16 |b - p    |r         | 0.5817738| 0.0440861| 897.5443| 13.196310| 0.0000000|
|17 |b - u    |r         | 0.5633452| 0.0440861| 897.5443| 12.778297| 0.0000000|
|18 |b - r    |r         | 0.3386429| 0.0440861| 897.5443|  7.681398| 0.0000000|
|20 |r - p    |u         | 0.2939444| 0.0440861| 897.5443|  6.667509| 0.0000000|
|21 |r - u    |u         | 0.2677778| 0.0440861| 897.5443|  6.073973| 0.0000000|
|22 |b - p    |u         | 0.4051270| 0.0440861| 897.5443|  9.189450| 0.0000000|
|23 |b - u    |u         | 0.3789603| 0.0440861| 897.5443|  8.595914| 0.0000000|
|24 |b - r    |u         | 0.1111825| 0.0440861| 897.5443|  2.521941| 0.0572549|
```

17 Comparing YA 48 ms with OA NotthePrime

```
> for (i in 1: nrow(final_mcq)){
+    if(is.na(final_mcq[i,9])){
+      final_mcq[i,9] = 0
+    }
+ }
> exp3_compare_1 = subset(final_mcq, final_mcq$StudyNo == '6' |
+                         final_mcq$StudyNo == '1')
```

```
> compare_aov_1 = aov(data = exp3_compare_1, Proportion ~ StudyNo*PrimeType*ChosenPrime
+                         Error(Target/(StudyNo*PrimeType*ChosenPrime)))
> summary(compare_aov_1)
```

```
Error: Target
          Df Sum Sq Mean Sq F value Pr(>F)
Residuals 99  8.959 0.09049

Error: Target:StudyNo
          Df Sum Sq Mean Sq F value  Pr(>F)
StudyNo    1  0.479  0.4793   9.569 0.00257 **
Residuals 99  4.959  0.0501
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Target:PrimeType
           Df Sum Sq  Mean Sq F value Pr(>F)
PrimeType   3  0.026 0.008629   0.353  0.787
Residuals 297  7.267 0.024468

Error: Target:ChosenPrime
             Df Sum Sq Mean Sq F value Pr(>F)
ChosenPrime   3   99.2   33.07   130.6 <2e-16 ***
Residuals   297   75.2    0.25
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Target:StudyNo:PrimeType
                   Df Sum Sq Mean Sq F value Pr(>F)
StudyNo:PrimeType   3  0.077 0.02551    1.12  0.341
Residuals         297  6.765 0.02278

Error: Target:StudyNo:ChosenPrime
                     Df Sum Sq Mean Sq F value Pr(>F)
StudyNo:ChosenPrime   3  0.686 0.22867   2.482 0.0611 .
Residuals           297 27.362 0.09213
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Target:PrimeType:ChosenPrime
                       Df Sum Sq Mean Sq F value   Pr(>F)
PrimeType:ChosenPrime   9   5.18  0.5759   8.778 1.01e-12 ***
Residuals             891  58.46  0.0656
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Target:StudyNo:PrimeType:ChosenPrime
                               Df Sum Sq Mean Sq F value Pr(>F)
```

```
StudyNo:PrimeType:ChosenPrime    9    0.66 0.07332    1.113   0.351
Residuals                      891   58.72 0.06590
```

```
> exp3_compare_1 = subset(final_mcq, final_mcq$StudyNo == '6' |
+                        final_mcq$StudyNo == '1')
> exp3_compare_2 = subset(final_mcq, final_mcq$StudyNo == '1' |
+                        final_mcq$StudyNo == '5')
> compare_aov_2 = aov(data = exp3_compare_2, Proportion ~ StudyNo*PrimeType*ChosenPrime
+                      Error(Target/(StudyNo*PrimeType*ChosenPrime)))
> summary(compare_aov_2)
```

```
Error: Target
          Df Sum Sq Mean Sq F value Pr(>F)
Residuals 99  13.49  0.1362

Error: Target:StudyNo
          Df Sum Sq Mean Sq F value   Pr(>F)
StudyNo    1  0.496  0.4964    15.1 0.000184 ***
Residuals 99  3.254  0.0329
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Target:PrimeType
           Df Sum Sq Mean Sq F value Pr(>F)
PrimeType   3  0.209 0.06977   2.942 0.0334 *
Residuals 297  7.043 0.02371
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Target:ChosenPrime
             Df Sum Sq Mean Sq F value Pr(>F)
ChosenPrime   3 101.56   33.85   111.1 <2e-16 ***
Residuals   297  90.52    0.30
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Target:StudyNo:PrimeType
                   Df Sum Sq Mean Sq F value Pr(>F)
StudyNo:PrimeType   3  0.091 0.03048   1.222  0.302
Residuals         297  7.410 0.02495

Error: Target:StudyNo:ChosenPrime
                     Df Sum Sq Mean Sq F value Pr(>F)
StudyNo:ChosenPrime   3  0.711 0.23690   3.278 0.0214 *
Residuals           297 21.464 0.07227
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1
```

```
Error: Target:PrimeType:ChosenPrime
                        Df Sum Sq Mean Sq F value Pr(>F)
PrimeType:ChosenPrime    9   1.10 0.12182   1.582  0.116
Residuals              891  68.62 0.07701

Error: Target:StudyNo:PrimeType:ChosenPrime
                                Df Sum Sq Mean Sq F value   Pr(>F)
StudyNo:PrimeType:ChosenPrime    9   4.60  0.5113   8.441 3.59e-12 ***
Residuals                      891  53.97  0.0606
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1
```

18 Item Percent State Analysis

```
> j ← read.csv("MainJulie_ItemAgg.csv", header = TRUE, sep = ",")
> # j_statepercent = j[,c(1,2,3,4,5,6,74:89)]
>
> j_statepercent = j[,c(1,2,3,4,5,6, 90:105)]
> j_statepercent$value.TargetNo = as.factor(j_statepercent$value.TargetNo)
> library(tidyr)
> library(dplyr)
> statepercent ← j_statepercent %>%
+   gather(StatePrime, Percent,
+          r_know, r_dontknow,r_other, r_TOT,
+          p_know, p_dontknow,p_other, p_TOT,
+          b_know, b_dontknow,b_other, b_TOT,
+          u_know, u_dontknow,u_other, u_TOT) %>%
+   separate(StatePrime, c('Prime', 'State'), sep = "_") %>%
+   arrange(value.Target)
> colnames(statepercent) = c("AgeGroup",  "StudyNo", "Target", "TargetNo",
+                            "WordType", "Proper",
+                            "PrimeCondition", "State","Percent")
> statepercent$AgeGroup ← as.factor(statepercent$AgeGroup)
> statepercent$Target ← as.factor(statepercent$Target)
> statepercent$StudyNo ← as.factor(statepercent$StudyNo)
> statepercent$PrimeCondition ← as.factor(statepercent$PrimeCondition)
> statepercent$State ← as.factor(statepercent$State)
> statepercent$Percent ← as.numeric(as.character(statepercent$Percent))
> for(i in 1:nrow(statepercent)){
+   if(is.na(statepercent[i,9])) {
+     statepercent[i,9] = 0
+   }
+   else
+     statepercent[i,9] = statepercent[i,9]
+ }
> statepercent_exp1 = statepercent %>% filter(StudyNo == '2' | StudyNo == '4')
```

```
> statepercent_exp2 = statepercent %>% filter(StudyNo == '5' | StudyNo == '6')
> statepercent_exp3 = statepercent %>% filter(StudyNo == '1')
```

18.1 Adding covariate info?

```
> itemratings= read.csv("item_ratings_wide.csv",
+                                    header = TRUE, sep = ",")
> main = read.csv("Julie_Main5Studies.csv", header = TRUE, sep = ",")
> main = main %>% filter(! PrimeCondition %in% c( "R", "U"))
> main_item = merge(main, itemratings, by = c("Target", "PrimeCondition"))
> main_item = dplyr::arrange(main_item, StudyNo, Subject, TargetNo, PrimeType)
> main_item = main_item[1:200,c(1,2,14, 55)]
> main_item = main_item %>% arrange(Target)
> main_item$PrimeCondition = tolower(main_item$PrimeCondition)
> state_cov_pb = statepercent %>% filter(!PrimeCondition %in% c("r","u"))
> state_cov = merge(state_cov_pb, main_item,
+                   by  = c("Target", "TargetNo", "PrimeCondition"))
> itemratings$PrimeCondition = tolower(itemratings$PrimeCondition)
> state_cov_final = merge(state_cov, itemratings,
+                         by = c("Target", "TargetNo", "PrimeCondition"))
>
```

18.2 Experiment 1

18.2.1 overall

```
> e1_all_aov = aov(data = statepercent_exp1,
+                          Percent ~ AgeGroup*State*PrimeCondition +
+                        Error(Target/(AgeGroup*State*PrimeCondition)))
> summary(e1_all_aov)
```

```
Error: Target
          Df    Sum Sq   Mean Sq F value Pr(>F)
Residuals 99 9.711e-18 9.809e-20

Error: Target:AgeGroup
          Df    Sum Sq   Mean Sq F value   Pr(>F)
AgeGroup   1 1.665e-18 1.665e-18   26.16 1.54e-06 ***
Residuals 99 6.303e-18 6.370e-20
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Target:State
           Df Sum Sq Mean Sq F value Pr(>F)
State       3  56.53  18.844   131.9 <2e-16 ***
Residuals 297  42.42   0.143
```

```
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Target:PrimeCondition
                Df   Sum Sq  Mean Sq F value  Pr(>F)
PrimeCondition   3 6.56e-19 2.186e-19    4.81 0.00275 **
Residuals      297 1.35e-17 4.546e-20
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Target:AgeGroup:State
                Df Sum Sq Mean Sq F value Pr(>F)
AgeGroup:State   3  9.663   3.221    57.9 <2e-16 ***
Residuals      297 16.522   0.056
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Target:AgeGroup:PrimeCondition
                         Df    Sum Sq   Mean Sq F value Pr(>F)
AgeGroup:PrimeCondition   3 6.800e-20 2.281e-20   0.428  0.733
Residuals               297 1.584e-17 5.333e-20

Error: Target:State:PrimeCondition
                      Df Sum Sq Mean Sq F value Pr(>F)
State:PrimeCondition   9  2.726 0.30288   13.52 <2e-16 ***
Residuals            891 19.965 0.02241
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Target:AgeGroup:State:PrimeCondition
                               Df Sum Sq Mean Sq F value Pr(>F)
AgeGroup:State:PrimeCondition   9  0.162 0.01796   0.911  0.515
Residuals                     891 17.567 0.01972
```

18.2.2 know

```
> e1_know = statepercent_exp1 %>% filter(State == "know")
> e1_know_aov = aov(data = e1_know,
+                          Percent ~ AgeGroup*PrimeCondition +
+                         Error(Target/(AgeGroup*PrimeCondition)))
> summary(e1_know_aov)
```

```
Error: Target
          Df Sum Sq Mean Sq F value Pr(>F)
Residuals 99  22.47   0.227

Error: Target:AgeGroup
```

```
          Df Sum Sq Mean Sq F value Pr(>F)
AgeGroup   1  0.557  0.5571   10.96 0.0013 **
Residuals 99  5.032  0.0508
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Target:PrimeCondition
                Df Sum Sq Mean Sq F value   Pr(>F)
PrimeCondition   3  1.725  0.5751   24.06 5.75e-14 ***
Residuals      297  7.099  0.0239
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Target:AgeGroup:PrimeCondition
                         Df Sum Sq Mean Sq F value Pr(>F)
AgeGroup:PrimeCondition   3  0.039 0.01286   0.603  0.614
Residuals               297  6.335 0.02133
```

```
> options(contrasts = c('contr.sum', 'contr.poly'))
> library(lsmeans)
> library(multcomp)
> target_lsm = lsmeans::lsmeans(e1_know_aov,
+                               c("AgeGroup","PrimeCondition"))
> prime_effect = cld(target_lsm, alpha = 0.05,
+                 adjust = "tukey", details = TRUE, by = "AgeGroup")
> library(knitr)
> kable(subset(prime_effect$comparisons,prime_effect$comparisons$p.value < 0.05 ))
```

```
|   |contrast |AgeGroup |  estimate|        SE|       df|  t.ratio|   p.value|
|:--|:--------|:--------|---------:|---------:|--------:|--------:|---------:|
|1  |r - u    |Old      | 0.0955556| 0.0212676| 592.0855| 4.493009| 0.0000499|
|2  |b - u    |Old      | 0.1133333| 0.0212676| 592.0855| 5.328918| 0.0000008|
|4  |p - u    |Old      | 0.1366667| 0.0212676| 592.0855| 6.426048| 0.0000000|
|7  |r - u    |Young    | 0.0600000| 0.0212676| 592.0855| 2.821192| 0.0254170|
|8  |b - u    |Young    | 0.0811111| 0.0212676| 592.0855| 3.813833| 0.0008684|
|10 |p - u    |Young    | 0.1133333| 0.0212676| 592.0855| 5.328918| 0.0000008|
```

```
> target_p = e1_know %>% filter(PrimeCondition == "p")
> target_r = e1_know %>% filter(PrimeCondition == "r")
> target_b = e1_know %>% filter(PrimeCondition == "b")
> target_u = e1_know %>% filter(PrimeCondition == "u")
> t.test(target_u$Percent, target_r$Percent, paired = TRUE)
```

```
        Paired t-test

data:  target_u$Percent and target_r$Percent
t = -5.5638, df = 199, p-value = 8.449e-08
alternative hypothesis: true difference in means is not equal to 0
```

```
95 percent confidence interval:
 -0.10534440 -0.05021115
sample estimates:
mean of the differences
            -0.07777778
```

```
> t.test(target_u$Percent, target_b$Percent, paired = TRUE)
```

```
        Paired t-test

data:  target_u$Percent and target_b$Percent
t = -6.5518, df = 199, p-value = 4.759e-10
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -0.12648424 -0.06796021
sample estimates:
mean of the differences
            -0.09722222
```

```
> t.test(target_u$Percent, target_p$Percent, paired = TRUE)
```

```
        Paired t-test

data:  target_u$Percent and target_p$Percent
t = -8.7905, df = 199, p-value = 7.015e-16
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -0.15304113 -0.09695887
sample estimates:
mean of the differences
                 -0.125
```

```
> ## effect of age
> target_y = e1_know %>% filter(AgeGroup == "Young")
> target_o = e1_know %>% filter(AgeGroup == "Old")
> t.test(target_y$Percent, target_o$Percent, paired = FALSE)
```

```
        Welch Two Sample t-test

data:  target_y$Percent and target_o$Percent
t = -3.2266, df = 795.5, p-value = 0.001304
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -0.08488612 -0.02066944
sample estimates:
mean of x mean of y
0.3958333 0.4486111
```

```
>
```

18.2.3 dont know

```
> e1_dontknow = statepercent_exp1 %>% filter(State == "dontknow")
> e1_dontknow_aov = aov(data = e1_dontknow,
+                         Percent ~ AgeGroup*PrimeCondition +
+                       Error(Target/(AgeGroup*PrimeCondition)))
> summary(e1_dontknow_aov)
```

```
Error: Target
          Df Sum Sq Mean Sq F value Pr(>F)
Residuals 99  13.37  0.1351

Error: Target:AgeGroup
          Df Sum Sq Mean Sq F value   Pr(>F)
AgeGroup   1  3.556   3.556   48.26 3.98e-10 ***
Residuals 99  7.293   0.074
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Target:PrimeCondition
                Df Sum Sq Mean Sq F value   Pr(>F)
PrimeCondition   3  0.736 0.24547   11.22 5.36e-07 ***
Residuals      297  6.495 0.02187
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Target:AgeGroup:PrimeCondition
                         Df Sum Sq  Mean Sq F value Pr(>F)
AgeGroup:PrimeCondition   3  0.022 0.007202   0.402  0.751
Residuals               297  5.315 0.017895
```

```
> options(contrasts = c('contr.sum', 'contr.poly'))
> library(lsmeans)
> library(multcomp)
> target_lsm = lsmeans::lsmeans(e1_dontknow_aov,
+                               c("AgeGroup","PrimeCondition"))
> prime_effect = cld(target_lsm, alpha = 0.05,
+                 adjust = "tukey", details = TRUE, by = "AgeGroup")
> library(knitr)
> kable(subset(prime_effect$comparisons,prime_effect$comparisons$p.value < 0.05 ))
```

```
|   |contrast |AgeGroup |   estimate|         SE|       df|  t.ratio|   p.value|
|:--|:--------|:--------|----------:|----------:|--------:|--------:|---------:|
|4  |u - r    |Old      |  0.0866667|  0.0199409| 588.1261| 4.346179| 0.0000960|
```

```
|5   |u - p     |Old        | 0.0766667| 0.0199409| 588.1261| 3.844697| 0.0007703|
|6   |u - b     |Old        | 0.0633333| 0.0199409| 588.1261| 3.176054| 0.0085223|
|10  |u - r     |Young      | 0.0722222| 0.0199409| 588.1261| 3.621816| 0.0018019|
|11  |u - p     |Young      | 0.0611111| 0.0199409| 588.1261| 3.064614| 0.0121820|
```

```
> target_p = e1_dontknow %>% filter(PrimeCondition == "p")
> target_r = e1_dontknow %>% filter(PrimeCondition == "r")
> target_b = e1_dontknow %>% filter(PrimeCondition == "b")
> target_u = e1_dontknow %>% filter(PrimeCondition == "u")
> t.test(target_u$Percent, target_r$Percent, paired = TRUE)
```

```
        Paired t-test

data:  target_u$Percent and target_r$Percent
t = 5.2419, df = 199, p-value = 4.041e-07
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 0.0460923 0.1016855
sample estimates:
mean of the differences
             0.07388889
```

```
> t.test(target_u$Percent, target_b$Percent, paired = TRUE)
```

```
        Paired t-test

data:  target_u$Percent and target_b$Percent
t = 3.7438, df = 199, p-value = 0.0002372
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 0.02550402 0.08227376
sample estimates:
mean of the differences
             0.05388889
```

```
> t.test(target_u$Percent, target_p$Percent, paired = TRUE)
```

```
        Paired t-test

data:  target_u$Percent and target_p$Percent
t = 5.5019, df = 199, p-value = 1.147e-07
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 0.04776233 0.10112656
sample estimates:
mean of the differences
             0.07444444
```

18.2.4 other

```
> e1_other = statepercent_exp1 %>% filter(State == "other")
> e1_other_aov = aov(data = e1_other,
+                             Percent ~ AgeGroup*PrimeCondition +
+                           Error(Target/(AgeGroup*PrimeCondition)))
> summary(e1_other_aov)
```

```
Error: Target
          Df Sum Sq Mean Sq F value Pr(>F)
Residuals 99  4.623 0.04669

Error: Target:AgeGroup
          Df Sum Sq Mean Sq F value Pr(>F)
AgeGroup   1  5.463   5.463   194.4 <2e-16 ***
Residuals 99  2.782   0.028
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Target:PrimeCondition
                Df Sum Sq Mean Sq F value  Pr(>F)
PrimeCondition   3  0.138 0.04590   4.297 0.00548 **
Residuals      297  3.172 0.01068
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Target:AgeGroup:PrimeCondition
                         Df Sum Sq Mean Sq F value Pr(>F)
AgeGroup:PrimeCondition   3  0.030 0.01001   0.952  0.416
Residuals               297  3.126 0.01052
```

```
> options(contrasts = c('contr.sum', 'contr.poly'))
> library(lsmeans)
> library(multcomp)
> target_lsm = lsmeans::lsmeans(e1_other_aov,
+                                       c("AgeGroup","PrimeCondition"))
> prime_effect = cld(target_lsm, alpha = 0.05,
+                 adjust = "tukey", details = TRUE, by = "PrimeCondition")
> library(knitr)
> kable(subset(prime_effect$comparisons,prime_effect$comparisons$p.value < 0.05 ))
```

```
|contrast     |PrimeCondition |  estimate|        SE|       df|   t.ratio| p.value|
|:------------|:--------------|---------:|---------:|--------:|---------:|-------:|
|Young - Old  |b              | 0.1633333| 0.0172736| 314.2215|  9.455687|       0|
|Young - Old  |p              | 0.1466667| 0.0172736| 314.2215|  8.490821|       0|
|Young - Old  |r              | 0.1711111| 0.0172736| 314.2215|  9.905957|       0|
|Young - Old  |u              | 0.1800000| 0.0172736| 314.2215| 10.420553|       0|
```

```
>
>
```

18.2.5 other cov

```
> statepercent_exp1_cov = state_cov_final %>%
+   filter(StudyNo == '2' | StudyNo == '4')
> statepercent_exp1_cov = statepercent_exp1_cov %>% filter(State == "other")
> statepercent_exp1_cov$zSoundRating = scale(statepercent_exp1_cov$SoundRating, center =
> statepercent_exp1_cov$zSoundRating = as.numeric(statepercent_exp1_cov$zSoundRating)
> statepercent_exp1_cov$Target = tolower(statepercent_exp1_cov$Target)
> statepercent_exp1_cov$Prime = tolower(statepercent_exp1_cov$Prime)
> statepercent_exp1_cov$LD = RecordLinkage::levenshteinDist(statepercent_exp1_cov$Target
> ## reverse scoring LD since higher LD means less overlap
>
> statepercent_exp1_cov$reverseLD = 11 - statepercent_exp1_cov$LD
> statepercent_exp1_cov$zLD = scale(statepercent_exp1_cov$reverseLD, center = TRUE, scal
> statepercent_exp1_cov$zLD = as.numeric(statepercent_exp1_cov$zLD)
> statepercent_exp1_cov$meanLDRating = (statepercent_exp1_cov$zLD +
+                                       statepercent_exp1_cov$zSoundRating)/2
> statepercent_exp1_cov_item_agg = statepercent_exp1_cov %>%
+   group_by(Target,AgeGroup, PrimeCondition ) %>%
+   summarize_at(vars(Percent, meanLDRating), mean)
> options(contrasts = c("contr.sum","contr.poly"))
> statepercent_exp1_cov_item_aov = lmer(data = statepercent_exp1_cov_item_agg,
+                        Percent ~ AgeGroup*PrimeCondition + meanLDRating +
+                          (1|Target))
> car::Anova(statepercent_exp1_cov_item_aov)
```

```
Analysis of Deviance Table (Type II Wald chisquare tests)

Response: Percent
                           Chisq Df Pr(>Chisq)
AgeGroup                176.6039  1     <2e-16 ***
PrimeCondition            0.0754  1     0.7837
meanLDRating              0.6926  1     0.4053
AgeGroup:PrimeCondition   0.5105  1     0.4749
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1
```

```
> summary(statepercent_exp1_cov_item_aov)
```

```
Linear mixed model fit by REML ['lmerMod']
Formula: Percent ~ AgeGroup * PrimeCondition + meanLDRating + (1 | Target)
   Data: statepercent_exp1_cov_item_agg
```

```
REML criterion at convergence: -473.8

Scaled residuals:
    Min      1Q  Median      3Q     Max
-1.8813 -0.6033 -0.0634  0.3916  4.1174

Random effects:
 Groups   Name        Variance Std.Dev.
 Target   (Intercept) 0.003745 0.06119
 Residual             0.013604 0.11664
Number of obs: 400, groups:  Target, 100

Fixed effects:
                           Estimate Std. Error t value
(Intercept)                0.124167   0.008453  14.689
AgeGroup1                 -0.077500   0.005832 -13.289
PrimeCondition1           -0.001665   0.006065  -0.275
meanLDRating              -0.006990   0.008399  -0.832
AgeGroup1:PrimeCondition1 -0.004167   0.005832  -0.714

Correlation of Fixed Effects:
            (Intr) AgGrp1 PrmCn1 mnLDRt
AgeGroup1   0.000
PrimeCndtn1 0.000  0.000
meanLDRatng 0.000  0.000  0.275
AgGrp1:PrC1 0.000  0.000  0.000  0.000
```

```
> anova(statepercent_exp1_cov_item_aov)
```

```
Analysis of Variance Table
                        Df  Sum Sq Mean Sq  F value
AgeGroup                 1 2.40250 2.40250 176.6039
PrimeCondition           1 0.00003 0.00003   0.0023
meanLDRating             1 0.00942 0.00942   0.6926
AgeGroup:PrimeCondition  1 0.00694 0.00694   0.5105
```

18.2.6 TOT

```
> e1_TOT = statepercent_exp1 %>% filter(State == "TOT")
> e1_TOT_aov = aov(data = e1_TOT,
+                             Percent ~ AgeGroup*PrimeCondition +
+                           Error(Target/(AgeGroup*PrimeCondition)))
> summary(e1_TOT_aov)
```

```
Error: Target
          Df Sum Sq Mean Sq F value Pr(>F)
Residuals 99  1.956 0.01976
```

```
Error: Target:AgeGroup
          Df Sum Sq Mean Sq F value Pr(>F)
AgeGroup   1 0.0868 0.08681   6.074 0.0154 *
Residuals 99 1.4147 0.01429
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Target:PrimeCondition
                Df Sum Sq Mean Sq F value  Pr(>F)
PrimeCondition   3  0.126 0.04216   3.914 0.00916 **
Residuals      297  3.199 0.01077
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Target:AgeGroup:PrimeCondition
                         Df Sum Sq  Mean Sq F value Pr(>F)
AgeGroup:PrimeCondition   3 0.0714 0.023801   2.533 0.0572 .
Residuals               297 2.7912 0.009398
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1
```

```
> options(contrasts = c('contr.sum', 'contr.poly'))
> library(lsmeans)
> library(multcomp)
> target_lsm = lsmeans::lsmeans(e1_TOT_aov,
+                               c("AgeGroup","PrimeCondition"))
> prime_effect = cld(target_lsm, alpha = 0.05,
+                    adjust = "tukey", details = TRUE)
> library(knitr)
> kable(subset(prime_effect$comparisons,prime_effect$comparisons$p.value < 0.05 ))
```

```
|   |contrast        |  estimate|         SE|        df|  t.ratio|   p.value|
|:--|:---------------|---------:|----------:|---------:|--------:|---------:|
|7  |Young,r - Old,p | 0.0466667| 0.0150385| 521.5407| 3.103138| 0.0419683|
|11 |Young,p - Old,p | 0.0477778| 0.0145748| 380.8502| 3.278118| 0.0249941|
|16 |Young,u - Old,p | 0.0555556| 0.0150385| 521.5407| 3.694212| 0.0059239|
|22 |Old,u - Old,p   | 0.0600000| 0.0142020| 591.2586| 4.224755| 0.0007249|
```

```
> target_o_u = e1_TOT %>% filter(AgeGroup == "Old" & PrimeCondition == "u")
> target_o_p = e1_TOT %>% filter(AgeGroup == "Old" & PrimeCondition == "p")
> target_o_b = e1_TOT %>% filter(AgeGroup == "Old" & PrimeCondition == "b")
> target_o_r = e1_TOT %>% filter(AgeGroup == "Old" & PrimeCondition == "r")
> t.test(target_o_u$Percent, target_o_p$Percent, paired = TRUE)
```

```
        Paired t-test

data:  target_o_u$Percent and target_o_p$Percent
```

```
t = 4.3747, df = 99, p-value = 3.012e-05
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 0.03278632 0.08721368
sample estimates:
mean of the differences
                   0.06
```

```
> t.test(target_o_u$Percent, target_o_r$Percent, paired = TRUE)
```

```
        Paired t-test

data:  target_o_u$Percent and target_o_r$Percent
t = 2.1117, df = 99, p-value = 0.03723
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 0.001677475 0.053878080
sample estimates:
mean of the differences
             0.02777778
```

```
> t.test(target_o_u$Percent, target_o_b$Percent, paired = TRUE)
```

```
        Paired t-test

data:  target_o_u$Percent and target_o_b$Percent
t = 3.3704, df = 99, p-value = 0.001071
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 0.01690821 0.06531401
sample estimates:
mean of the differences
             0.04111111
```

```
> target_p = e1_TOT %>% filter(PrimeCondition == "p")
> target_r = e1_TOT %>% filter(PrimeCondition == "r")
> target_b = e1_TOT %>% filter(PrimeCondition == "b")
> target_u = e1_TOT %>% filter(PrimeCondition == "u")
> t.test(target_u$Percent, target_r$Percent, paired = TRUE)
```

```
        Paired t-test

data:  target_u$Percent and target_r$Percent
t = 1.7759, df = 199, p-value = 0.07727
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -0.002023557  0.038690223
```

```
sample estimates:
mean of the differences
             0.01833333
```

```
> t.test(target_u$Percent, target_b$Percent, paired = TRUE)
```

```
        Paired t-test

data:  target_u$Percent and target_b$Percent
t = 2.621, df = 199, p-value = 0.009445
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 0.006465853 0.045756369
sample estimates:
mean of the differences
             0.02611111
```

```
> t.test(target_u$Percent, target_p$Percent, paired = TRUE)
```

```
        Paired t-test

data:  target_u$Percent and target_p$Percent
t = 2.9963, df = 199, p-value = 0.00308
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 0.01158554 0.05619223
sample estimates:
mean of the differences
             0.03388889
```

```
> target_y = e1_TOT %>% filter(AgeGroup == "Young")
> target_o = e1_TOT %>% filter(AgeGroup == "Old")
> t.test(target_y$Percent, target_o$Percent, paired = FALSE)
```

```
        Welch Two Sample t-test

data:  target_y$Percent and target_o$Percent
t = 2.692, df = 788.29, p-value = 0.007253
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 0.005641885 0.036024781
sample estimates:
 mean of x  mean of y
0.11638889 0.09555556
```

18.2.7 TOT cov

```
> statepercent_exp1_cov = state_cov_final %>%
+   filter(StudyNo == '2' | StudyNo == '4')
> statepercent_exp1_cov = statepercent_exp1_cov %>% filter(State == "TOT")
> statepercent_exp1_cov$zSoundRating = scale(statepercent_exp1_cov$SoundRating, center =
> statepercent_exp1_cov$zSoundRating = as.numeric(statepercent_exp1_cov$zSoundRating)
> statepercent_exp1_cov$Target = tolower(statepercent_exp1_cov$Target)
> statepercent_exp1_cov$Prime = tolower(statepercent_exp1_cov$Prime)
> statepercent_exp1_cov$LD = RecordLinkage::levenshteinDist(statepercent_exp1_cov$Target
> ## reverse scoring LD since higher LD means less overlap
>
> statepercent_exp1_cov$reverseLD = 11 - statepercent_exp1_cov$LD
> statepercent_exp1_cov$zLD = scale(statepercent_exp1_cov$reverseLD, center = TRUE, scal
> statepercent_exp1_cov$zLD = as.numeric(statepercent_exp1_cov$zLD)
> statepercent_exp1_cov$meanLDRating = (statepercent_exp1_cov$zLD +
+                                     statepercent_exp1_cov$zSoundRating)/2
> statepercent_exp1_cov_item_agg = statepercent_exp1_cov %>%
+   group_by(Target,AgeGroup, PrimeCondition ) %>%
+   summarize_at(vars(Percent, meanLDRating), mean)
> options(contrasts = c("contr.sum","contr.poly"))
> statepercent_exp1_cov_item_aov = lmer(data = statepercent_exp1_cov_item_agg,
+                    Percent ~ AgeGroup*PrimeCondition + meanLDRating +
+                      (1|Target))
> car::Anova(statepercent_exp1_cov_item_aov)
```

```
Analysis of Deviance Table (Type II Wald chisquare tests)

Response: Percent
                          Chisq Df Pr(>Chisq)
AgeGroup                13.1249  1  0.0002914 ***
PrimeCondition           0.1939  1  0.6596596
meanLDRating             1.5409  1  0.2144894
AgeGroup:PrimeCondition  1.2052  1  0.2722792
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1
```

```
> summary(statepercent_exp1_cov_item_aov)
```

```
Linear mixed model fit by REML ['lmerMod']
Formula: Percent ~ AgeGroup * PrimeCondition + meanLDRating + (1 | Target)
   Data: statepercent_exp1_cov_item_agg

REML criterion at convergence: -634.8

Scaled residuals:
    Min      1Q  Median      3Q     Max
-1.4155 -0.8174 -0.0544  0.4697  4.0080
```

```
Random effects:
 Groups   Name        Variance  Std.Dev.
 Target   (Intercept) 0.0007118 0.02668
 Residual             0.0102434 0.10121
Number of obs: 400, groups:  Target, 100

Fixed effects:
                           Estimate Std. Error t value
(Intercept)                 0.095556   0.005721  16.703
AgeGroup1                  -0.018333   0.005060  -3.623
PrimeCondition1             0.002299   0.005220   0.440
meanLDRating               -0.008011   0.006453  -1.241
AgeGroup1:PrimeCondition1   0.005556   0.005060   1.098

Correlation of Fixed Effects:
            (Intr) AgGrp1 PrmCn1 mnLDRt
AgeGroup1   0.000
PrimeCndtn1 0.000  0.000
meanLDRatng 0.000  0.000  0.245
AgGrp1:PrC1 0.000  0.000  0.000  0.000
```

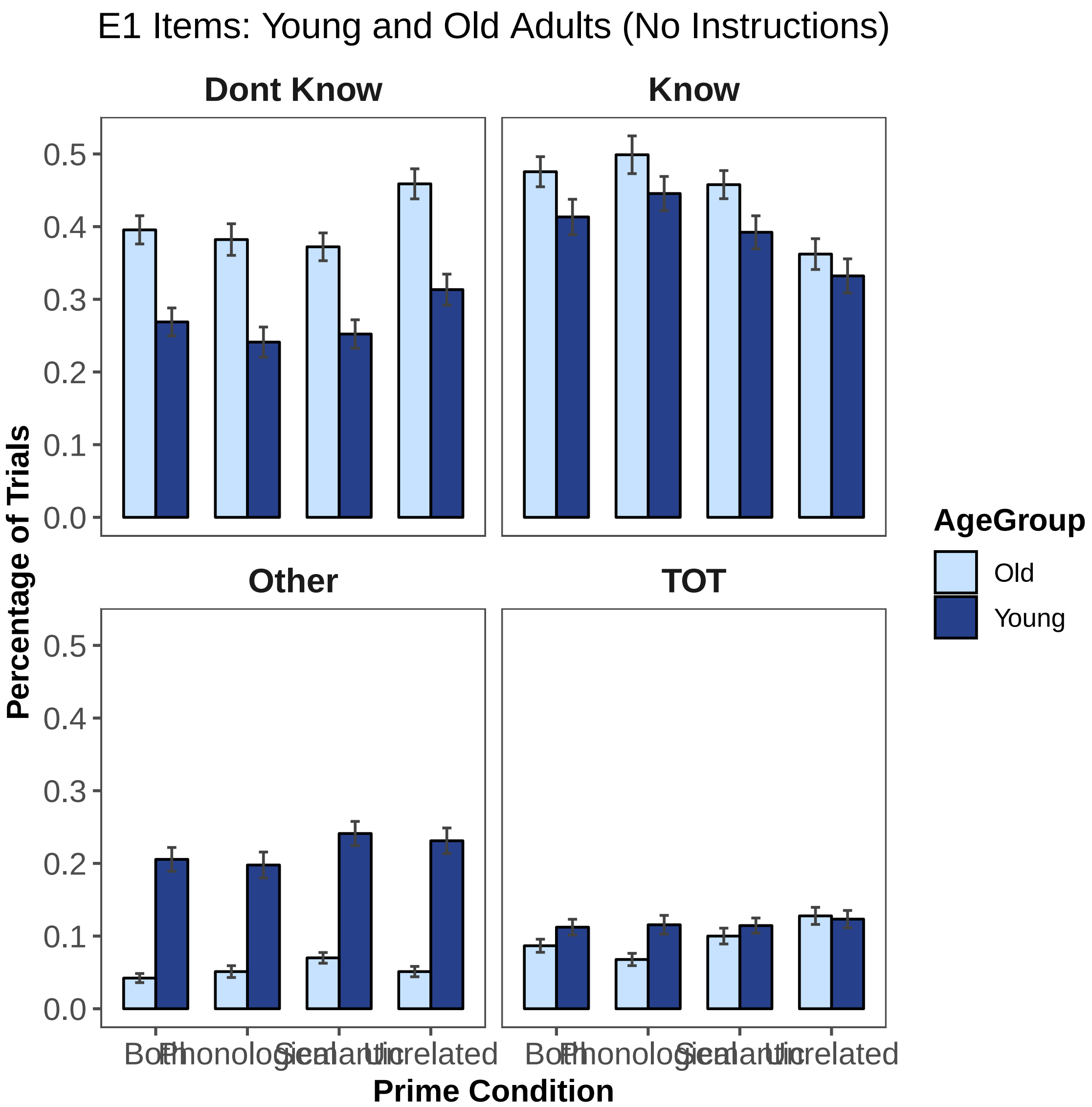
```
> anova(statepercent_exp1_cov_item_aov)
```

```
Analysis of Variance Table
                         Df   Sum Sq  Mean Sq F value
AgeGroup                  1 0.134444 0.134444 13.1249
PrimeCondition            1 0.006049 0.006049  0.5906
meanLDRating              1 0.015784 0.015784  1.5409
AgeGroup:PrimeCondition   1 0.012346 0.012346  1.2052
```

18.2.8 plot

```
> exp1_statepercent= Rmisc::summarySE(statepercent_exp1,
+                           measurevar = "Percent",
+                           groupvars = c("State", "AgeGroup", "PrimeCondition"))
> exp1_statepercent =  arrange(exp1_statepercent, desc(AgeGroup))
> library(ggplot2)
> library(ggthemes)
> e1_percentplot = exp1_statepercent %>%
+
+ mutate(PrimeType = factor(PrimeCondition, levels = unique(PrimeCondition),
+                       labels = c("Both", "Phonological",
+                                  "Semantic", "Unrelated")),
+        RetrievalState = factor(State, levels = unique(State),
+                                  labels = c("Dont Know", "Know", "Other", "TOT")))%>%
+
```

```
+ ggplot(aes(x = PrimeType, y = Percent,
+            group = AgeGroup, fill = AgeGroup))+
+  geom_bar(stat = "identity", position = "dodge", width = 0.7,
+           color= "black")+
+   geom_errorbar(aes(ymin=Percent - se, ymax=Percent + se),
+              width=.2, color = "gray26",
+              position = position_dodge(0.7))+
+  theme_few()+
+   facet_wrap(~RetrievalState)+
+   scale_fill_manual(values = c("slategray1", "royalblue4"))+
+     xlab("Prime Condition") + ylab("Percentage of Trials") +
+   ggtitle("E1 Items: Young and Old Adults (No Instructions)")  +
+    theme(axis.text = element_text(size = rel(1)),
+           axis.title = element_text(face = "bold", size = rel(1)),
+           legend.title = element_text(face = "bold", size = rel(1)),
+          plot.title = element_text(hjust = .5),
+          strip.text.x = element_text(face = "bold", size = rel(1.4)))
> e1_percentplot
>
```



18.3 Experiment 2

18.3.1 overall

```
> e2_all_aov = aov(data = statepercent_exp2,
+                   Percent ~ AgeGroup*State*PrimeCondition +
+                 Error(Target/(AgeGroup*State*PrimeCondition)))
> summary(e2_all_aov)
```

```
Error: Target
          Df    Sum Sq    Mean Sq F value Pr(>F)
```

```
Residuals 99 1.42e-26 1.434e-28

Error: Target:AgeGroup
          Df    Sum Sq   Mean Sq F value Pr(>F)
AgeGroup   1 2.70e-30 2.707e-30   0.233   0.63
Residuals 99 1.15e-27 1.162e-29

Error: Target:State
           Df Sum Sq Mean Sq F value Pr(>F)
State       3  65.27  21.757   145.6 <2e-16 ***
Residuals 297  44.38   0.149
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Target:PrimeCondition
                Df     Sum Sq   Mean Sq F value Pr(>F)
PrimeCondition   3 2.400e-30 8.110e-31   0.239  0.869
Residuals      297 1.009e-27 3.397e-30

Error: Target:AgeGroup:State
                Df Sum Sq Mean Sq F value Pr(>F)
AgeGroup:State   3  13.00   4.333   83.74 <2e-16 ***
Residuals      297  15.37   0.052
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Target:AgeGroup:PrimeCondition
                         Df     Sum Sq   Mean Sq F value Pr(>F)
AgeGroup:PrimeCondition   3 4.400e-29 1.466e-29   0.922   0.43
Residuals               297 4.723e-27 1.590e-29

Error: Target:State:PrimeCondition
                      Df Sum Sq Mean Sq F value   Pr(>F)
State:PrimeCondition   9  2.127 0.23634   8.989 4.55e-13 ***
Residuals            891 23.428 0.02629
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Target:AgeGroup:State:PrimeCondition
                               Df Sum Sq Mean Sq F value Pr(>F)
AgeGroup:State:PrimeCondition   9  0.365 0.04057   1.448  0.163
Residuals                     891 24.971 0.02803
```

18.3.2 know

```
> e2_know = statepercent_exp2 %>% filter(State == "know")
> e2_know_aov = aov(data = e2_know,
```

```
+                             Percent ~ AgeGroup*PrimeCondition +
+                           Error(Target/(AgeGroup*PrimeCondition)))
> summary(e2_know_aov)
```

```
Error: Target
          Df Sum Sq Mean Sq F value Pr(>F)
Residuals 99  21.96  0.2218

Error: Target:AgeGroup
          Df Sum Sq Mean Sq F value  Pr(>F)
AgeGroup   1  0.538  0.5382   9.386 0.00282 **
Residuals 99  5.677  0.0573
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Target:PrimeCondition
                Df Sum Sq Mean Sq F value   Pr(>F)
PrimeCondition   3  1.199  0.3996   14.37 9.09e-09 ***
Residuals      297  8.258  0.0278
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Target:AgeGroup:PrimeCondition
                         Df Sum Sq Mean Sq F value Pr(>F)
AgeGroup:PrimeCondition   3  0.203 0.06763   2.131 0.0964 .
Residuals               297  9.426 0.03174
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1
```

```
> options(contrasts = c('contr.sum', 'contr.poly'))
> library(lsmeans)
> library(multcomp)
> target_lsm = lsmeans::lsmeans(e2_know_aov,
+                                    c("AgeGroup","PrimeCondition"))
> prime_effect = cld(target_lsm, alpha = 0.05,
+                 adjust = "tukey", details = TRUE, by = "AgeGroup")
> library(knitr)
> kable(subset(prime_effect$comparisons,prime_effect$comparisons$p.value < 0.05 ))
```

```
|   |contrast |AgeGroup | estimate|         SE|       df|  t.ratio|   p.value|
|:--|:--------|:--------|--------:|----------:|--------:|--------:|---------:|
|7  |b - u    |Young    |  0.09750| 0.0244014| 591.4209| 3.995673| 0.0004215|
|8  |r - u    |Young    |  0.10375| 0.0244014| 591.4209| 4.251805| 0.0001445|
|10 |p - u    |Young    |  0.14875| 0.0244014| 591.4209| 6.095962| 0.0000000|
```

```
> target_p = e2_know %>% filter(PrimeCondition == "p")
> target_r = e2_know %>% filter(PrimeCondition == "r")
> target_b = e2_know %>% filter(PrimeCondition == "b")
```

```
> target_u = e2_know %>% filter(PrimeCondition == "u")
> t.test(target_u$Percent, target_r$Percent, paired = TRUE)
```

```
        Paired t-test

data:  target_u$Percent and target_r$Percent
t = -4.6637, df = 199, p-value = 5.69e-06
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -0.10760193 -0.04364807
sample estimates:
mean of the differences
              -0.075625
```

```
> t.test(target_u$Percent, target_b$Percent, paired = TRUE)
```

```
        Paired t-test

data:  target_u$Percent and target_b$Percent
t = -4.2944, df = 199, p-value = 2.736e-05
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -0.10670319 -0.03954681
sample estimates:
mean of the differences
              -0.073125
```

```
> t.test(target_u$Percent, target_p$Percent, paired = TRUE)
```

```
        Paired t-test

data:  target_u$Percent and target_p$Percent
t = -5.9969, df = 199, p-value = 9.326e-09
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -0.13952693 -0.07047307
sample estimates:
mean of the differences
                 -0.105
```

```
> target_y = e2_know %>% filter(AgeGroup == "Young")
> target_o = e2_know %>% filter(AgeGroup == "Old")
> t.test(target_y$Percent, target_o$Percent, paired = FALSE)
```

```
        Welch Two Sample t-test

data:  target_y$Percent and target_o$Percent
```

```
t = -3.0318, df = 789.97, p-value = 0.00251
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -0.0854618 -0.0182882
sample estimates:
mean of x mean of y
 0.373750  0.425625
```

```
>
```

18.3.3 dont know

```
> e2_dontknow = statepercent_exp2 %>% filter(State == "dontknow")
> e2_dontknow_aov = aov(data = e2_dontknow,
+                          Percent ~ AgeGroup*PrimeCondition +
+                        Error(Target/(AgeGroup*PrimeCondition)))
> summary(e2_dontknow_aov)
```

```
Error: Target
          Df Sum Sq Mean Sq F value Pr(>F)
Residuals 99  17.52  0.1769

Error: Target:AgeGroup
          Df Sum Sq Mean Sq F value Pr(>F)
AgeGroup   1  6.730   6.730   110.6 <2e-16 ***
Residuals 99  6.022   0.061
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Target:PrimeCondition
                Df Sum Sq Mean Sq F value   Pr(>F)
PrimeCondition   3  0.825 0.27502   9.761 3.68e-06 ***
Residuals      297  8.368 0.02818
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Target:AgeGroup:PrimeCondition
                         Df Sum Sq Mean Sq F value Pr(>F)
AgeGroup:PrimeCondition   3  0.131 0.04367    1.49  0.217
Residuals               297  8.703 0.02930
```

```
> options(contrasts = c('contr.sum', 'contr.poly'))
> library(lsmeans)
> library(multcomp)
> target_lsm = lsmeans::lsmeans(e2_dontknow_aov,
+                                  c("AgeGroup","PrimeCondition"))
> prime_effect = cld(target_lsm, alpha = 0.05,
```

```
+                        adjust = "tukey", details = TRUE, by = "AgeGroup")
> library(knitr)
> kable(subset(prime_effect$comparisons,prime_effect$comparisons$p.value < 0.05 ))
```

```
|   |contrast |AgeGroup | estimate|        SE|       df|  t.ratio|   p.value|
|:--|:--------|:--------|--------:|---------:|--------:|--------:|---------:|
|10 |u - b    |Young    |  0.10500| 0.0239748| 593.7718| 4.379599| 0.0000827|
|11 |u - r    |Young    |  0.10125| 0.0239748| 593.7718| 4.223185| 0.0001632|
|12 |u - p    |Young    |  0.07250| 0.0239748| 593.7718| 3.024009| 0.0138267|
```

```
> target_p = e2_dontknow %>% filter(PrimeCondition == "p")
> target_r = e2_dontknow %>% filter(PrimeCondition == "r")
> target_b = e2_dontknow %>% filter(PrimeCondition == "b")
> target_u = e2_dontknow %>% filter(PrimeCondition == "u")
> t.test(target_u$Percent, target_r$Percent, paired = TRUE)
```

```
        Paired t-test

data:  target_u$Percent and target_r$Percent
t = 3.7815, df = 199, p-value = 0.0002061
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 0.03170229 0.10079771
sample estimates:
mean of the differences
                0.06625
```

```
> t.test(target_u$Percent, target_b$Percent, paired = TRUE)
```

```
        Paired t-test

data:  target_u$Percent and target_b$Percent
t = 4.7493, df = 199, p-value = 3.9e-06
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 0.04751431 0.11498569
sample estimates:
mean of the differences
                0.08125
```

```
> t.test(target_u$Percent, target_p$Percent, paired = TRUE)
```

```
        Paired t-test

data:  target_u$Percent and target_p$Percent
t = 4.2031, df = 199, p-value = 3.975e-05
alternative hypothesis: true difference in means is not equal to 0
```

```
95 percent confidence interval:
 0.03815345 0.10559655
sample estimates:
mean of the differences
               0.071875
```

```
>
```

18.3.4 other

```
> e2_other = statepercent_exp2 %>% filter(State == "other")
> e2_other_aov = aov(data = e2_other,
+                            Percent ~ AgeGroup*PrimeCondition +
+                          Error(Target/(AgeGroup*PrimeCondition)))
> summary(e2_other_aov)
```

```
Error: Target
          Df Sum Sq Mean Sq F value Pr(>F)
Residuals 99  2.863 0.02892

Error: Target:AgeGroup
          Df Sum Sq Mean Sq F value Pr(>F)
AgeGroup   1  3.903   3.903   201.2 <2e-16 ***
Residuals 99  1.920   0.019
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Target:PrimeCondition
                Df Sum Sq Mean Sq F value Pr(>F)
PrimeCondition   3  0.052 0.01726   1.448  0.229
Residuals      297  3.540 0.01192

Error: Target:AgeGroup:PrimeCondition
                         Df Sum Sq Mean Sq F value Pr(>F)
AgeGroup:PrimeCondition   3 0.0196 0.00653   0.625  0.599
Residuals               297 3.1035 0.01045
```

```
> options(contrasts = c('contr.sum', 'contr.poly'))
> library(lsmeans)
> library(multcomp)
> target_lsm = lsmeans::lsmeans(e2_other_aov,
+                                  c("AgeGroup","PrimeCondition"))
> prime_effect = cld(target_lsm, alpha = 0.05,
+                   adjust = "tukey", details = TRUE, by = "PrimeCondition")
> library(knitr)
> kable(subset(prime_effect$comparisons,prime_effect$comparisons$p.value < 0.05 ))
```

```
|contrast     |PrimeCondition  | estimate|         SE|        df|  t.ratio| p.value|
|:-----------|:---------------|--------:|----------:|---------:|---------:|--------:|
|Young - Old |b               |  0.14875| 0.0159279| 362.2474| 9.338975|       0|
|Young - Old |p               |  0.13625| 0.0159279| 362.2474| 8.554187|       0|
|Young - Old |r               |  0.12500| 0.0159279| 362.2474| 7.847878|       0|
|Young - Old |u               |  0.14875| 0.0159279| 362.2474| 9.338975|       0|
```

```
> target_y = e2_other %>% filter(AgeGroup == "Young")
> target_o = e2_other %>% filter(AgeGroup == "Old")
> t.test(target_y$Percent, target_o$Percent, paired = FALSE)
```

```
        Welch Two Sample t-test

data:  target_y$Percent and target_o$Percent
t = 16.458, df = 543.84, p-value < 2.2e-16
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 0.123015 0.156360
sample estimates:
mean of x mean of y
0.1775000 0.0378125
```

18.3.5 TOT

```
> e2_TOT = statepercent_exp2 %>% filter(State == "TOT")
> e2_TOT_aov = aov(data = e2_TOT,
+                             Percent ~ AgeGroup*PrimeCondition +
+                           Error(Target/(AgeGroup*PrimeCondition)))
> summary(e2_TOT_aov)
```

```
Error: Target
          Df Sum Sq Mean Sq F value Pr(>F)
Residuals 99  2.034 0.02055

Error: Target:AgeGroup
          Df Sum Sq Mean Sq F value Pr(>F)
AgeGroup   1  1.829  1.8288   103.5 <2e-16 ***
Residuals 99  1.749  0.0177
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Target:PrimeCondition
                Df Sum Sq Mean Sq F value Pr(>F)
PrimeCondition   3  0.051 0.01714   1.561  0.199
Residuals      297  3.261 0.01098
```

```
Error: Target:AgeGroup:PrimeCondition
                          Df Sum Sq Mean Sq F value Pr(>F)
AgeGroup:PrimeCondition    3  0.012 0.00388   0.308  0.819
Residuals                297  3.738 0.01259
```

```
> options(contrasts = c('contr.sum', 'contr.poly'))
> library(lsmeans)
> library(multcomp)
> target_lsm = lsmeans::lsmeans(e2_TOT_aov,
+                               c("AgeGroup","PrimeCondition"))
> prime_effect = cld(target_lsm, alpha = 0.05,
+                 adjust = "tukey", details = TRUE, by = "PrimeCondition")
> library(knitr)
> kable(subset(prime_effect$comparisons,prime_effect$comparisons$p.value < 0.05 ))
```

```
|contrast     |PrimeCondition |  estimate|        SE|        df|  t.ratio| p.value|
|:------------|:--------------|---------:|---------:|---------:|--------:|-------:|
|Young - Old  |b              |   0.08375|  0.016648|  386.2576| 5.030648|   8e-07|
|Young - Old  |p              |   0.09625|  0.016648|  386.2576| 5.781491|   0e+00|
|Young - Old  |r              |   0.09750|  0.016648|  386.2576| 5.856576|   0e+00|
|Young - Old  |u              |   0.10500|  0.016648|  386.2576| 6.307081|   0e+00|
```

```
> target_p = e2_TOT %>% filter(PrimeCondition == "p")
> target_r = e2_TOT %>% filter(PrimeCondition == "r")
> target_b = e2_TOT %>% filter(PrimeCondition == "b")
> target_u = e2_TOT %>% filter(PrimeCondition == "u")
> t.test(target_p$Percent, target_r$Percent, paired = TRUE)
```

```
        Paired t-test

data:  target_p$Percent and target_r$Percent
t = -1.6533, df = 199, p-value = 0.09984
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -0.037002019  0.003252019
sample estimates:
mean of the differences
              -0.016875
```

```
> t.test(target_p$Percent, target_b$Percent, paired = TRUE)
```

```
        Paired t-test

data:  target_p$Percent and target_b$Percent
t = -1.734, df = 199, p-value = 0.08447
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
```

```
 -0.042745149  0.002745149
sample estimates:
mean of the differences
                  -0.02
```

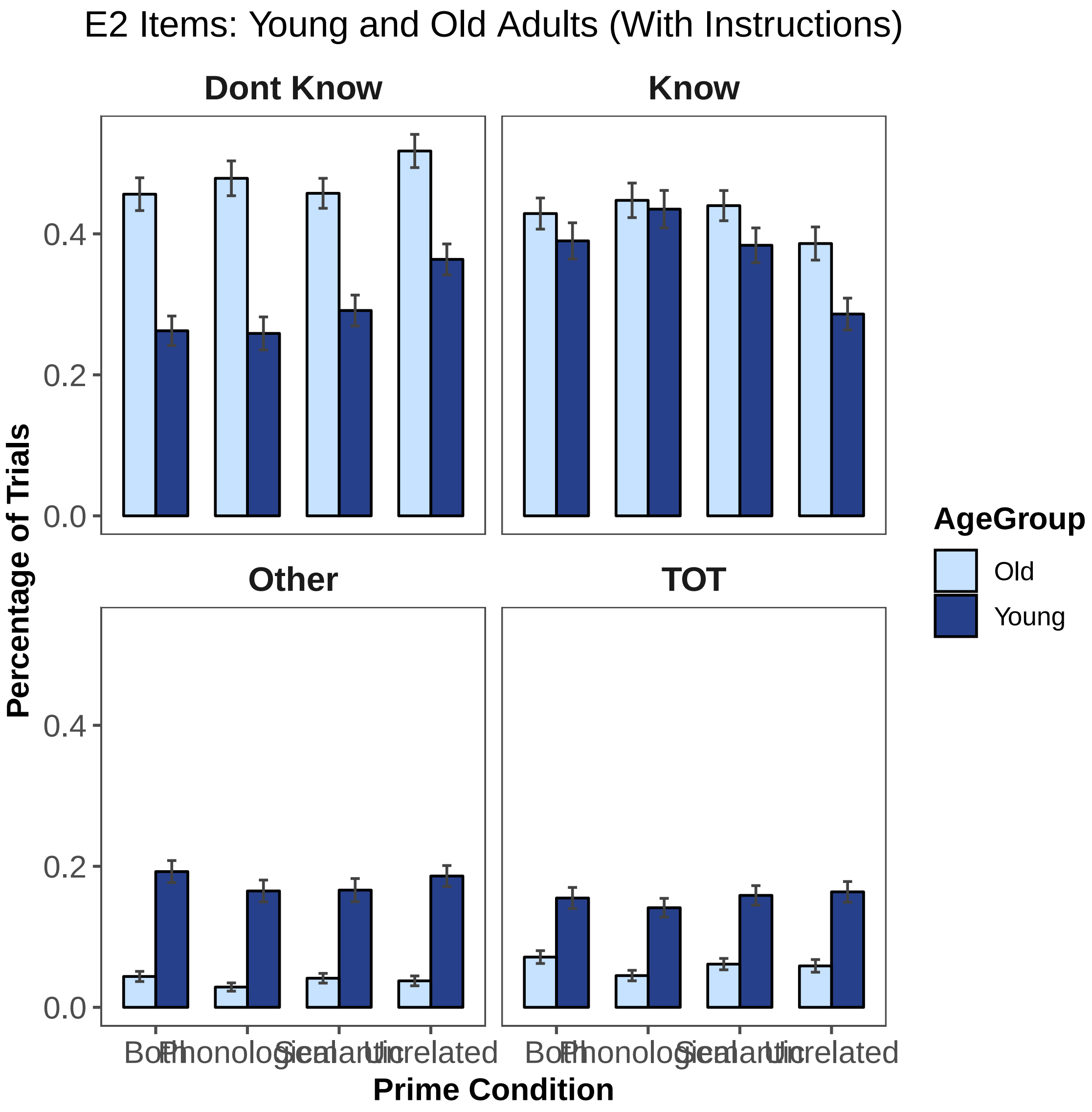
```
> t.test(target_p$Percent, target_u$Percent, paired = TRUE)
```

```
        Paired t-test

data:  target_p$Percent and target_u$Percent
t = -1.7081, df = 199, p-value = 0.08917
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -0.039049332  0.002799332
sample estimates:
mean of the differences
              -0.018125
```

18.3.6 plot

```
> exp2_statepercent= Rmisc::summarySE(statepercent_exp2,
+                         measurevar = "Percent",
+                         groupvars = c("State", "AgeGroup", "PrimeCondition"))
> library(ggplot2)
> library(ggthemes)
> e2_percentplot = exp2_statepercent %>%
+ mutate(PrimeType = factor(PrimeCondition, levels = unique(PrimeCondition),
+                     labels = c("Both", "Phonological",
+                                "Semantic", "Unrelated")),
+         RetrievalState = factor(State, levels = unique(State),
+                                 labels = c("Dont Know", "Know", "Other", "TOT")))%>%
+
+ ggplot(aes(x = PrimeType, y = Percent,
+            group = AgeGroup, fill = AgeGroup))+
+  geom_bar(stat = "identity", position = "dodge", width = 0.7,
+           color= "black")+
+   geom_errorbar(aes(ymin=Percent - se, ymax=Percent + se),
+              width=.2, color = "gray26",
+              position = position_dodge(0.7))+
+  theme_few()+
+   facet_wrap(~RetrievalState)+
+   scale_fill_manual(values = c("slategray1", "royalblue4"))+
+     xlab("Prime Condition") + ylab("Percentage of Trials") +
+   ggtitle("E2 Items: Young and Old Adults (With Instructions)")  +
+    theme(axis.text = element_text(size = rel(1)),
+           axis.title = element_text(face = "bold", size = rel(1)),
+           legend.title = element_text(face = "bold", size = rel(1)),
```

```
+           plot.title = element_text(hjust = .5),
+           strip.text.x = element_text(face = "bold", size = rel(1.4)))
> e2_percentplot
>
```



18.4 Experiment 3

18.4.1 know

```
> e3_know = statepercent_exp3 %>% filter(State == "know")
> e3_know_aov = aov(data = e3_know,
```

```
+                              Percent ~ PrimeCondition +
+                            Error(Target/PrimeCondition))
> summary(e3_know_aov)
```

```
Error: Target
          Df Sum Sq Mean Sq F value Pr(>F)
Residuals 99  12.78  0.1291

Error: Target:PrimeCondition
                Df Sum Sq Mean Sq F value   Pr(>F)
PrimeCondition   3  0.758 0.25271   9.816 3.42e-06 ***
Residuals      297  7.646 0.02574
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1
```

```
> options(contrasts = c('contr.sum', 'contr.poly'))
> library(lsmeans)
> library(multcomp)
> target_lsm = lsmeans::lsmeans(e3_know_aov,
+                                  c("PrimeCondition"))
> prime_effect = cld(target_lsm, alpha = 0.05,
+                    adjust = "tukey", details = TRUE)
> library(knitr)
> kable(subset(prime_effect$comparisons,prime_effect$comparisons$p.value < 0.05 ))
```

```
|   |contrast |  estimate|         SE|  df|  t.ratio|   p.value|
|:--|:--------|---------:|----------:|---:|--------:|---------:|
|1  |p - u    | 0.0666667| 0.0226913| 297| 2.937981| 0.0185958|
|2  |b - u    | 0.0944444| 0.0226913| 297| 4.162140| 0.0002408|
|4  |r - u    | 0.1155556| 0.0226913| 297| 5.092501| 0.0000037|
```

```
> target_p = e3_know %>% filter(PrimeCondition == "p")
> target_r = e3_know %>% filter(PrimeCondition == "r")
> target_b = e3_know %>% filter(PrimeCondition == "b")
> target_u = e3_know %>% filter(PrimeCondition == "u")
> t.test(target_u$Percent, target_r$Percent, paired = TRUE)
```

```
        Paired t-test

data:  target_u$Percent and target_r$Percent
t = -5.8043, df = 99, p-value = 7.806e-08
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -0.15505885 -0.07605226
sample estimates:
mean of the differences
             -0.1155556
```

```
> t.test(target_u$Percent, target_b$Percent, paired = TRUE)
```

```
        Paired t-test

data:  target_u$Percent and target_b$Percent
t = -4.1528, df = 99, p-value = 6.969e-05
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -0.13956997 -0.04931892
sample estimates:
mean of the differences
            -0.09444444
```

```
> t.test(target_u$Percent, target_p$Percent, paired = TRUE)
```

```
        Paired t-test

data:  target_u$Percent and target_p$Percent
t = -3.0308, df = 99, p-value = 0.003113
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -0.11031271 -0.02302062
sample estimates:
mean of the differences
            -0.06666667
```

18.4.2 dont know

```
> e3_dontknow = statepercent_exp3 %>% filter(State == "dontknow")
> e3_dontknow_aov = aov(data = e3_dontknow,
+                           Percent ~ PrimeCondition +
+                         Error(Target/PrimeCondition))
> summary(e3_dontknow_aov)
```

```
Error: Target
          Df Sum Sq Mean Sq F value Pr(>F)
Residuals 99   12.3  0.1243

Error: Target:PrimeCondition
                Df Sum Sq Mean Sq F value Pr(>F)
PrimeCondition   3  0.243 0.08107   3.887 0.0095 **
Residuals      297  6.195 0.02086
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1
```

```
> options(contrasts = c('contr.sum', 'contr.poly'))
> library(lsmeans)
> library(multcomp)
> target_lsm = lsmeans::lsmeans(e3_dontknow_aov,
+                                  c("PrimeCondition"))
> prime_effect = cld(target_lsm, alpha = 0.05,
+                    adjust = "tukey", details = TRUE)
> library(knitr)
> kable(subset(prime_effect$comparisons,prime_effect$comparisons$p.value < 0.05 ))
```

```
|   |contrast |   estimate|         SE|  df|  t.ratio|    p.value|
|:--|:--------|----------:|----------:|---:|--------:|----------:|
|4  |u - r    |  0.0644444|  0.0204249|  297|  3.155193|  0.0095257|
|5  |u - b    |  0.0544444|  0.0204249|  297|  2.665594|  0.0402372|
```

```
> target_p = e3_dontknow %>% filter(PrimeCondition == "p")
> target_r = e3_dontknow %>% filter(PrimeCondition == "r")
> target_b = e3_dontknow %>% filter(PrimeCondition == "b")
> target_u = e3_dontknow %>% filter(PrimeCondition == "u")
> t.test(target_u$Percent, target_r$Percent, paired = TRUE)
```

```
        Paired t-test

data:  target_u$Percent and target_r$Percent
t = 3.1466, df = 99, p-value = 0.002182
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 0.02380655 0.10508234
sample estimates:
mean of the differences
             0.06444444
```

```
> t.test(target_u$Percent, target_b$Percent, paired = TRUE)
```

```
        Paired t-test

data:  target_u$Percent and target_b$Percent
t = 2.4848, df = 99, p-value = 0.01464
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 0.01096802 0.09792086
sample estimates:
mean of the differences
             0.05444444
```

```
> t.test(target_u$Percent, target_p$Percent, paired = TRUE)
```

```
        Paired t-test

data:  target_u$Percent and target_p$Percent
t = 2.2249, df = 99, p-value = 0.02836
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 0.00492793 0.08618318
sample estimates:
mean of the differences
             0.04555556
```

18.4.3 other

```
> e3_other = statepercent_exp3 %>% filter(State == "other")
> e3_other_aov = aov(data = e3_other,
+                            Percent ~ PrimeCondition +
+                          Error(Target/PrimeCondition))
> summary(e3_other_aov)
```

```
Error: Target
          Df Sum Sq Mean Sq F value Pr(>F)
Residuals 99  4.499 0.04545

Error: Target:PrimeCondition
                Df Sum Sq  Mean Sq F value Pr(>F)
PrimeCondition   3  0.006 0.001842   0.156  0.926
Residuals      297  3.516 0.011839
```

```
>
```

18.4.4 TOT

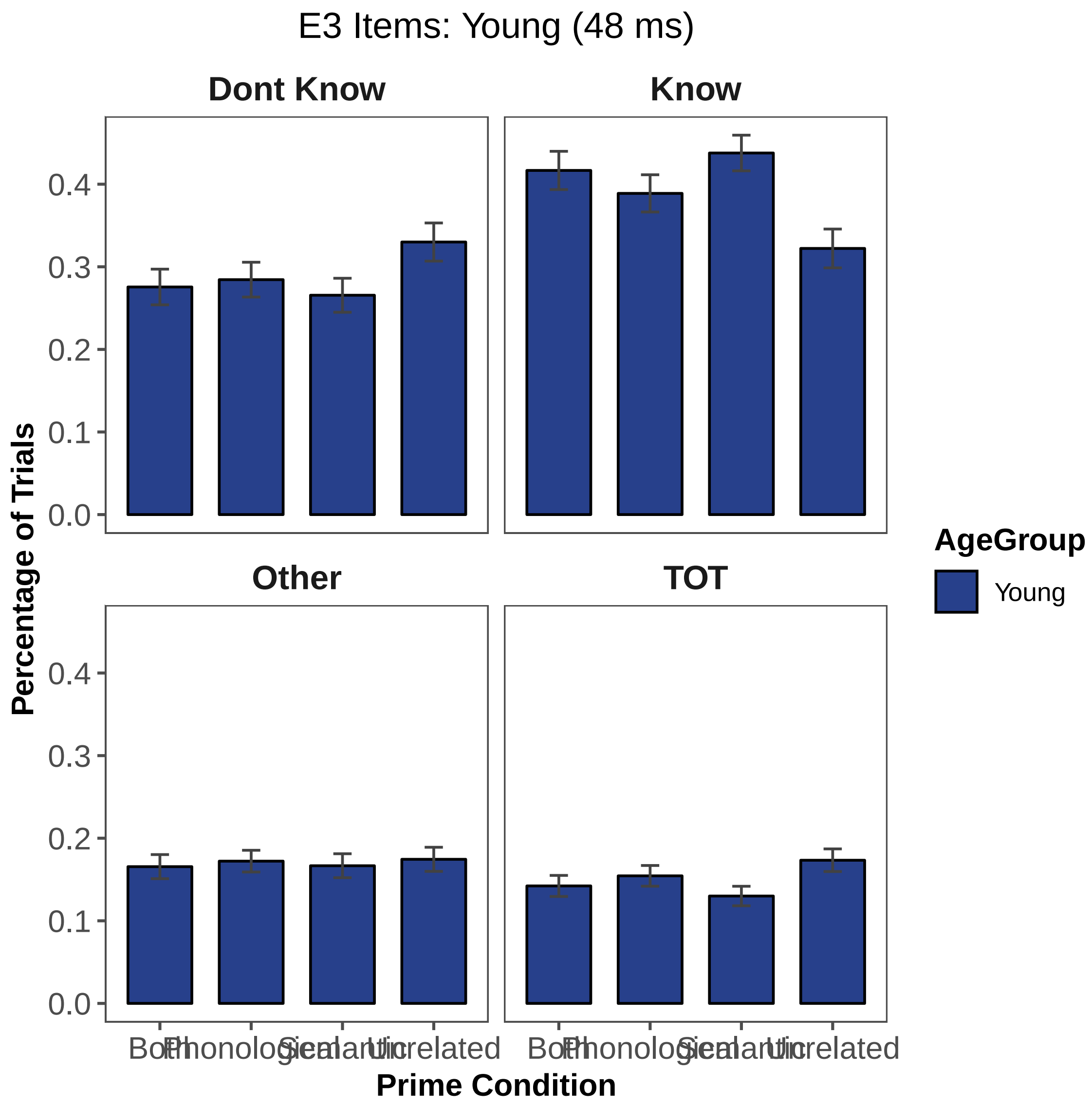
```
> e3_TOT = statepercent_exp3 %>% filter(State == "TOT")
> e3_TOT_aov = aov(data = e3_TOT,
+                            Percent ~ PrimeCondition +
+                          Error(Target/PrimeCondition))
> summary(e3_TOT_aov)
```

```
Error: Target
          Df Sum Sq Mean Sq F value Pr(>F)
Residuals 99   2.29 0.02313

Error: Target:PrimeCondition
                Df Sum Sq Mean Sq F value Pr(>F)
PrimeCondition   3  0.102 0.03416   2.466 0.0624 .
```

```
Residuals       297   4.114 0.01385
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1
```

18.4.5 plot

```
> exp3_statepercent= Rmisc::summarySE(statepercent_exp3,
+                         measurevar = "Percent",
+                         groupvars = c("State","AgeGroup", "PrimeCondition"))
> library(ggplot2)
> library(ggthemes)
> e3_percentplot = exp3_statepercent %>%
+ mutate(PrimeType = factor(PrimeCondition, levels = unique(PrimeCondition),
+                     labels = c("Both", "Phonological",
+                                "Semantic", "Unrelated")),
+         RetrievalState = factor(State, levels = unique(State),
+                                labels = c("Dont Know", "Know", "Other", "TOT")))%>%
+
+ ggplot(aes(x = PrimeType, y = Percent,
+            group = AgeGroup, fill = AgeGroup))+
+  geom_bar(stat = "identity", position = "dodge", width = 0.7,
+          color= "black")+
+   geom_errorbar(aes(ymin=Percent - se, ymax=Percent + se),
+             width=.2, color = "gray26",
+             position = position_dodge(0.7))+
+  theme_few()+
+   facet_wrap(~RetrievalState)+
+     scale_fill_manual(values = c("royalblue4"))+
+       xlab("Prime Condition") + ylab("Percentage of Trials") +
+   ggtitle("E3 Items: Young (48 ms)")  +
+    theme(axis.text = element_text(size = rel(1)),
+          axis.title = element_text(face = "bold", size = rel(1)),
+          legend.title = element_text(face = "bold", size = rel(1)),
+         plot.title = element_text(hjust = .5),
+         strip.text.x = element_text(face = "bold", size = rel(1.4)))
> e3_percentplot
>
```



19 TOT Other Combined Item

```
> j ← read.csv("MainJulie_ItemAgg.csv", header = TRUE, sep = ",")
> # j_statepercent = j[,c(1,2,3,4,5,6,74:89)]
>
> j_statepercent = j[,c(1,2,3,4,5,6, 90, 91, 106,
+                       94, 95, 107,
+                       98, 99, 108,
+                       102, 103, 109)]
> j_statepercent$value.TargetNo = as.factor(j_statepercent$value.TargetNo)
```

```
> library(tidyr)
> library(dplyr)
> statepercent <- j_statepercent %>%
+   gather(StatePrime, Percent,
+          r_know, r_dontknow,r_TO,
+          p_know, p_dontknow,p_TO,
+          b_know, b_dontknow,b_TO,
+          u_know, u_dontknow,u_TO) %>%
+   separate(StatePrime, c('Prime', 'State'), sep = "_") %>%
+   arrange(value.Target)
> colnames(statepercent) = c("AgeGroup", "StudyNo", "Target", "TargetNo",
+                            "WordType", "Proper",
+                            "PrimeCondition", "State","Percent")
> statepercent$AgeGroup <- as.factor(statepercent$AgeGroup)
> statepercent$Target <- as.factor(statepercent$Target)
> statepercent$StudyNo <- as.factor(statepercent$StudyNo)
> statepercent$PrimeCondition <- as.factor(statepercent$PrimeCondition)
> statepercent$State <- as.factor(statepercent$State)
> statepercent$Percent <- as.numeric(as.character(statepercent$Percent))
> for(i in 1:nrow(statepercent)){
+   if(is.na(statepercent[i,9])) {
+     statepercent[i,9] = 0
+   }
+   else
+     statepercent[i,9] = statepercent[i,9]
+ }
> statepercent_exp1 = statepercent %>% filter(StudyNo == '2' | StudyNo == '4')
> statepercent_exp2 = statepercent %>% filter(StudyNo == '5' | StudyNo == '6')
> statepercent_exp3 = statepercent %>% filter(StudyNo == '1')
```

19.1 E1

```
> e1_TO = statepercent_exp1 %>% filter(State == "TO")
> e1_TO_aov = aov(data = e1_TO,
+                          Percent ~ AgeGroup*PrimeCondition +
+                        Error(Target/(AgeGroup*PrimeCondition)))
> summary(e1_TO_aov)
```

```
Error: Target
          Df Sum Sq Mean Sq F value Pr(>F)
Residuals 99  1.658 0.01675

Error: Target:AgeGroup
          Df Sum Sq Mean Sq F value Pr(>F)
AgeGroup   1  1.732   1.732     158 <2e-16 ***
Residuals 99  1.085   0.011
---
```

```
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Target:PrimeCondition
                Df Sum Sq Mean Sq F value   Pr(>F)
PrimeCondition   3 0.1029 0.03431   8.329 2.46e-05 ***
Residuals      297 1.2235 0.00412
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Target:AgeGroup:PrimeCondition
                         Df Sum Sq  Mean Sq F value Pr(>F)
AgeGroup:PrimeCondition   3 0.0024 0.000787   0.182  0.908
Residuals               297 1.2824 0.004318
```

```
> options(contrasts = c('contr.sum', 'contr.poly'))
> library(lsmeans)
> library(multcomp)
> target_lsm = lsmeans::lsmeans(e1_TO_aov,
+                                 c("AgeGroup","PrimeCondition"))
> prime_effect = cld(target_lsm, alpha = 0.05,
+                 adjust = "tukey", details = TRUE, by = "AgeGroup")
> library(knitr)
> # x = prime_effect$comparisons
> # x[which(x$p.value < 0.05),]
```

19.2 E2

```
> e2_TO = statepercent_exp2 %>% filter(State == "TO")
> e2_TO_aov = aov(data = e2_TO,
+                          Percent ~ AgeGroup*PrimeCondition +
+                        Error(Target/(AgeGroup*PrimeCondition)))
> summary(e2_TO_aov)
```

```
Error: Target
          Df Sum Sq Mean Sq F value Pr(>F)
Residuals 99  1.179 0.01191

Error: Target:AgeGroup
          Df Sum Sq Mean Sq F value Pr(>F)
AgeGroup   1 2.1875  2.1875   253.7 <2e-16 ***
Residuals 99 0.8537  0.0086
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Target:PrimeCondition
                Df Sum Sq  Mean Sq F value Pr(>F)
PrimeCondition   3 0.0378 0.012586   3.091 0.0274 *
```

```
Residuals       297 1.2095 0.004073
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Target:AgeGroup:PrimeCondition
                          Df Sum Sq  Mean Sq F value Pr(>F)
AgeGroup:PrimeCondition    3 0.0051 0.001712   0.453  0.715
Residuals                297 1.1218 0.003777
```

```
> options(contrasts = c('contr.sum', 'contr.poly'))
> library(lsmeans)
> library(multcomp)
> target_lsm = lsmeans::lsmeans(e2_TO_aov,
+                                  c("AgeGroup","PrimeCondition"))
> prime_effect = cld(target_lsm, alpha = 0.05,
+                 adjust = "tukey", details = TRUE, by = "AgeGroup")
> library(knitr)
> # x = prime_effect$comparisons
> # x[which(x$p.value < 0.05),]
```

19.3 E3

```
> e3_TO = statepercent_exp3 %>% filter(State == "TO")
> e3_TO_aov = aov(data = e3_TO,
+                           Percent ~ PrimeCondition +
+                         Error(Target/(PrimeCondition)))
> summary(e3_TO_aov)
```

```
Error: Target
          Df Sum Sq Mean Sq F value Pr(>F)
Residuals 99   1.689 0.01706

Error: Target:PrimeCondition
                Df Sum Sq Mean Sq F value Pr(>F)
PrimeCondition   3 0.0377 0.01258   2.211 0.0869 .
Residuals      297 1.6899 0.00569
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1
```

20 State Prime Accuracy Figures

Experiment 1

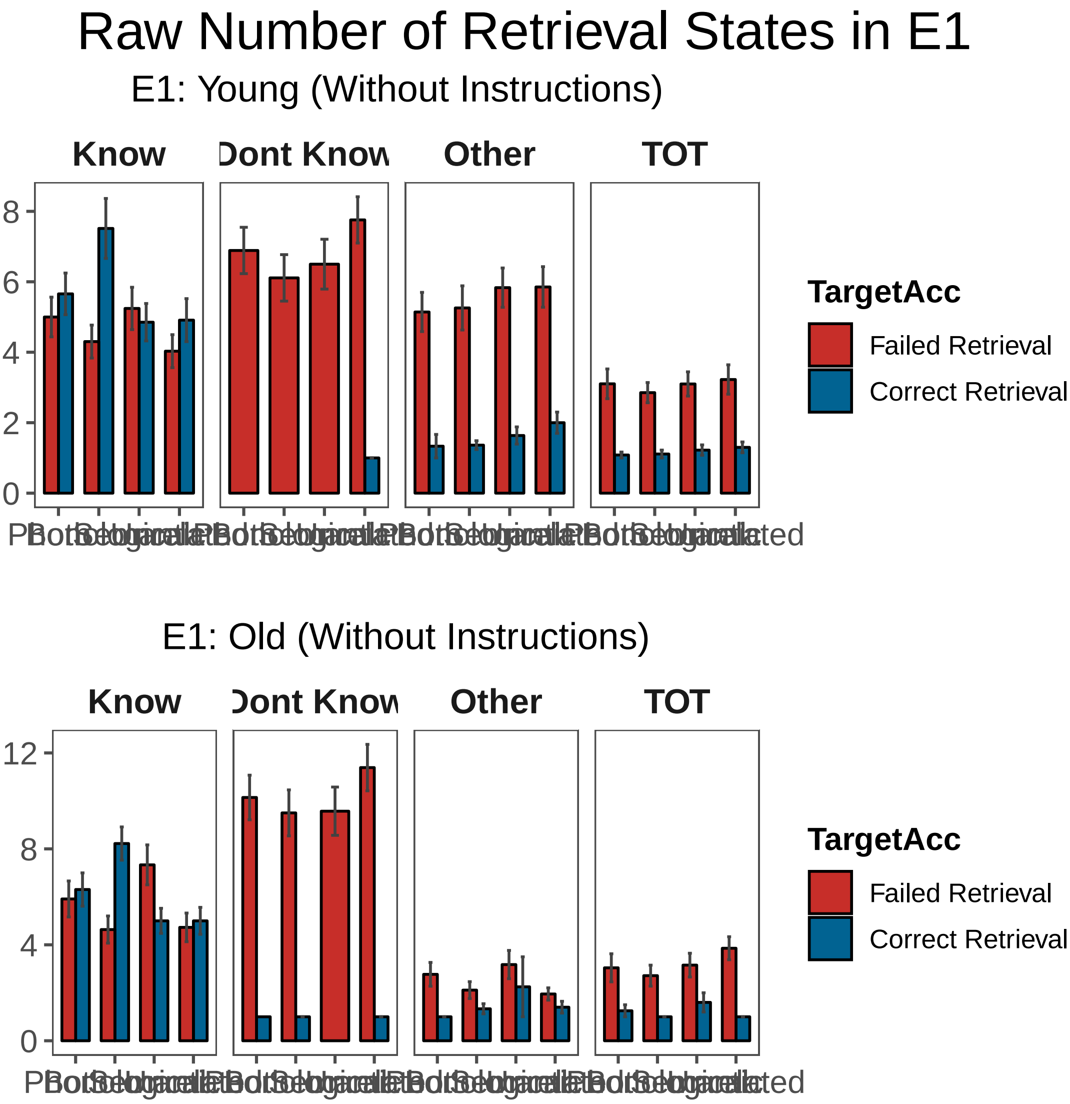
```
> exp1_fig_stateprime_acc = Rmisc::summarySE(exp_1_stateprime_acc,
+                           measurevar = "Trials",
```

```
+                        groupvars = c("AgeGroup","PrimeCondition", "Question.RESP", "A
> exp1_fig_stateprime_acc =  arrange(exp1_fig_stateprime_acc,
+                              desc(AgeGroup))
> exp1_fig_stateprime_acc$Accuracy = as.factor(as.character(exp1_fig_stateprime_acc$Accu
> exp1_fig_stateprime_acc_young = exp1_fig_stateprime_acc %>% filter(AgeGroup == "Young"
> exp1_fig_stateprime_acc_old = exp1_fig_stateprime_acc %>% filter(AgeGroup == "Old")
> library(ggplot2)
> library(ggthemes)
>  stateprime_1_acc_young = exp1_fig_stateprime_acc_young %>%
+    mutate(State = factor(Question.RESP, levels = unique(Question.RESP),
+                          labels = c("Know", "Dont Know", "Other", "TOT")),
+           PrimeType = factor(PrimeCondition, levels = unique(PrimeCondition),
+                labels = c("Both", "Phonological", "Semantic", "Unrelated")),
+                     TargetAcc = factor(Accuracy, levels = unique(Accuracy),
+                     labels = c("Failed Retrieval", "Correct Retrieval")))%>%
+ ggplot(aes(x = PrimeType, y = Trials,
+           group=TargetAcc, fill = TargetAcc))+
+  geom_bar(stat = "identity", position = "dodge", width = 0.7, color= "black")+
+   geom_errorbar(aes(ymin=Trials - se, ymax=Trials + se),
+              width=.2, color = "gray26",
+              position = position_dodge(0.7))+
+  theme_few()+
+   facet_wrap(~State, nrow =1)+
+    scale_fill_wsj()+
+  # scale_fill_manual(values = c("royalblue4", "slategray1"))+
+     xlab("") + ylab("") +
+   ggtitle("E1: Young (Without Instructions)")  +
+    theme(axis.text = element_text(size = rel(1)),
+           axis.title = element_text(face = "bold", size = rel(1)),
+           legend.title = element_text(face = "bold", size = rel(1)),
+          plot.title = element_text(hjust = .5),
+          strip.text.x = element_text(face = "bold", size = rel(1.4)))
>  stateprime_1_acc_young
>  stateprime_1_acc_old = exp1_fig_stateprime_acc_old %>%
+     mutate(State = factor(Question.RESP, levels = unique(Question.RESP),
+                          labels = c("Know", "Dont Know", "Other", "TOT")),
+           PrimeType = factor(PrimeCondition, levels = unique(PrimeCondition),
+                labels = c("Both", "Phonological", "Semantic", "Unrelated")),
+                     TargetAcc = factor(Accuracy, levels = unique(Accuracy),
+                     labels = c("Failed Retrieval", "Correct Retrieval")))%>%
+ ggplot(aes(x = PrimeType, y = Trials,
+           group=TargetAcc, fill = TargetAcc))+
+  geom_bar(stat = "identity", position = "dodge", width = 0.7, color= "black")+
+   geom_errorbar(aes(ymin=Trials - se, ymax=Trials + se),
+              width=.2, color = "gray26",
+              position = position_dodge(0.7))+
+  theme_few()+
+   facet_wrap(~State, nrow =1)+
```

```
+    scale_fill_wsj()+
+  # scale_fill_manual(values = c("royalblue4", "slategray1"))+
+     xlab("") + ylab("") +
+   ggtitle("E1: Old (Without Instructions)")  +
+    theme(axis.text = element_text(size = rel(1)),
+           axis.title = element_text(face = "bold", size = rel(1)),
+           legend.title = element_text(face = "bold", size = rel(1)),
+          plot.title = element_text(hjust = .5),
+          strip.text.x = element_text(face = "bold", size = rel(1.4)))
>  stateprime_1_acc_old
```

20.0.1 E1: Combined Plot

```
> library(grid)
> gridExtra::grid.arrange(stateprime_1_acc_young, stateprime_1_acc_old,
+                         nrow = 2, ncol = 1,
+       top=textGrob("Raw Number of Retrieval States in E1",
+                                            gp=gpar(fontsize=20)))
```



Experiment 2

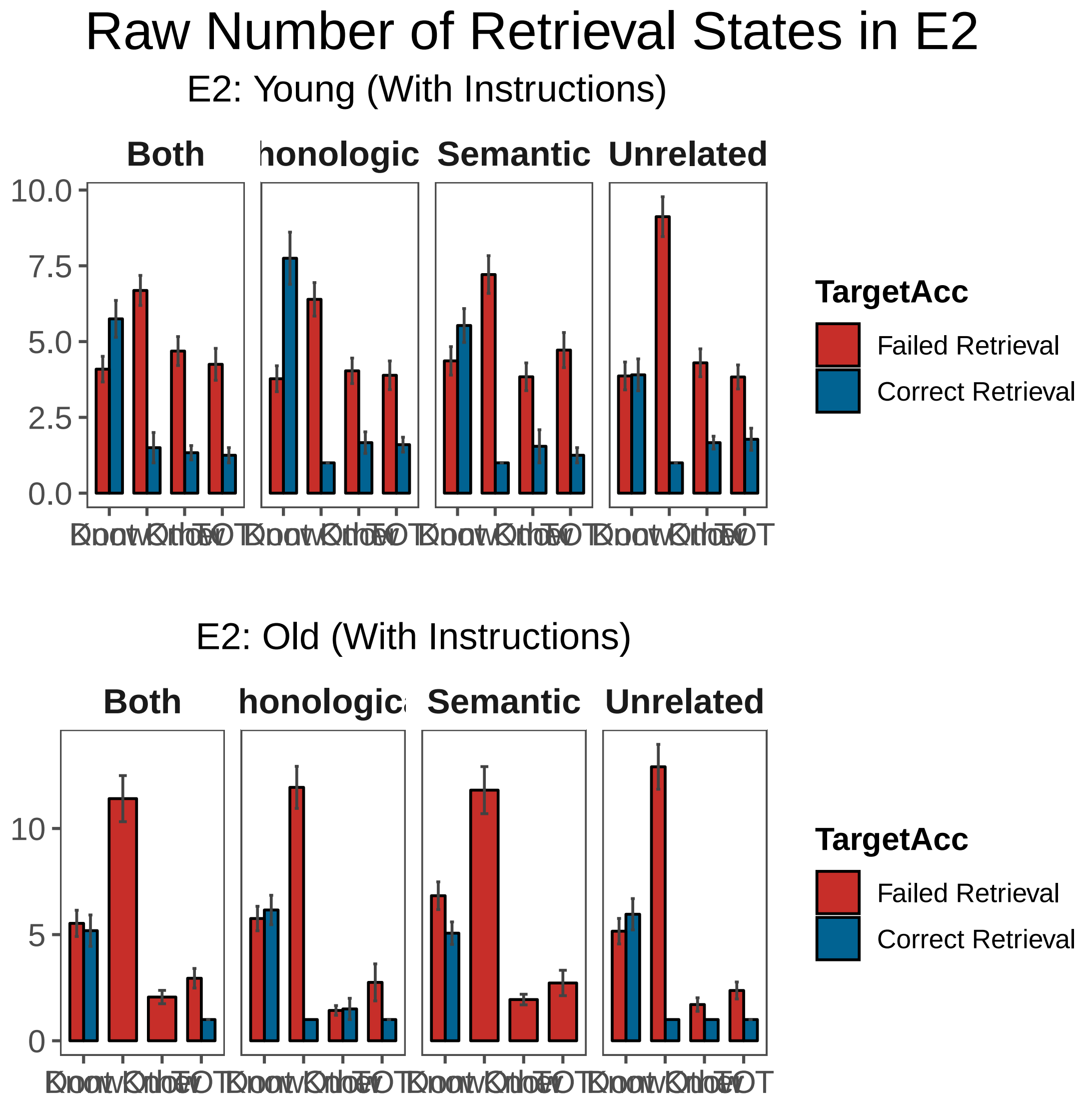
```
> exp2_fig_stateprime_acc = Rmisc::summarySE(exp_2_stateprime_acc,
+                          measurevar = "Trials",
+                          groupvars = c("AgeGroup","PrimeCondition", "Question.RESP", "A
> exp2_fig_stateprime_acc =  arrange(exp2_fig_stateprime_acc,
+                                desc(AgeGroup))
> exp2_fig_stateprime_acc$Accuracy = as.factor(as.character(exp2_fig_stateprime_acc$Accu
> exp2_fig_stateprime_acc_young = exp2_fig_stateprime_acc %>% filter(AgeGroup == "Young"
> exp2_fig_stateprime_acc_old = exp2_fig_stateprime_acc %>% filter(AgeGroup == "Old")
> library(ggplot2)
```

```
> library(ggthemes)
>  stateprime_2_acc_young = exp2_fig_stateprime_acc_young %>%
+    mutate(State = factor(Question.RESP, levels = unique(Question.RESP),
+                          labels = c("Know", "Dont Know", "Other", "TOT")),
+           PrimeType = factor(PrimeCondition, levels = unique(PrimeCondition),
+                labels = c("Both", "Phonological", "Semantic", "Unrelated")),
+                     TargetAcc = factor(Accuracy, levels = unique(Accuracy),
+                     labels = c("Failed Retrieval", "Correct Retrieval")))%>%
+ ggplot(aes(x = State, y = Trials,
+           group=TargetAcc, fill = TargetAcc))+
+  geom_bar(stat = "identity", position = "dodge", width = 0.7, color= "black")+
+   geom_errorbar(aes(ymin=Trials - se, ymax=Trials + se),
+              width=.2, color = "gray26",
+              position = position_dodge(0.7))+
+  theme_few()+
+   facet_wrap(~PrimeType, nrow =1)+
+    scale_fill_wsj()+
+  # scale_fill_manual(values = c("royalblue4", "slategray1"))+
+     xlab("") + ylab("") +
+   ggtitle("E2: Young (With Instructions)")  +
+    theme(axis.text = element_text(size = rel(1)),
+           axis.title = element_text(face = "bold", size = rel(1)),
+           legend.title = element_text(face = "bold", size = rel(1)),
+          plot.title = element_text(hjust = .5),
+          strip.text.x = element_text(face = "bold", size = rel(1.4)))
>  stateprime_2_acc_young
>  stateprime_2_acc_old = exp2_fig_stateprime_acc_old %>%
+     mutate(State = factor(Question.RESP, levels = unique(Question.RESP),
+                          labels = c("Know", "Dont Know", "Other", "TOT")),
+           PrimeType = factor(PrimeCondition, levels = unique(PrimeCondition),
+                labels = c("Both", "Phonological", "Semantic", "Unrelated")),
+                     TargetAcc = factor(Accuracy, levels = unique(Accuracy),
+                     labels = c("Failed Retrieval", "Correct Retrieval")))%>%
+ ggplot(aes(x = State, y = Trials,
+           group=TargetAcc, fill = TargetAcc))+
+  geom_bar(stat = "identity", position = "dodge", width = 0.7, color= "black")+
+   geom_errorbar(aes(ymin=Trials - se, ymax=Trials + se),
+              width=.2, color = "gray26",
+              position = position_dodge(0.7))+
+  theme_few()+
+   facet_wrap(~PrimeType, nrow =1)+
+    scale_fill_wsj()+
+  # scale_fill_manual(values = c("royalblue4", "slategray1"))+
+     xlab("") + ylab("") +
+   ggtitle("E2: Old (With Instructions)")  +
+    theme(axis.text = element_text(size = rel(1)),
+           axis.title = element_text(face = "bold", size = rel(1)),
+           legend.title = element_text(face = "bold", size = rel(1)),
```

```
+           plot.title = element_text(hjust = .5),
+           strip.text.x = element_text(face = "bold", size = rel(1.4)))
>  stateprime_2_acc_old
```

20.0.2 E2: Combined Plot

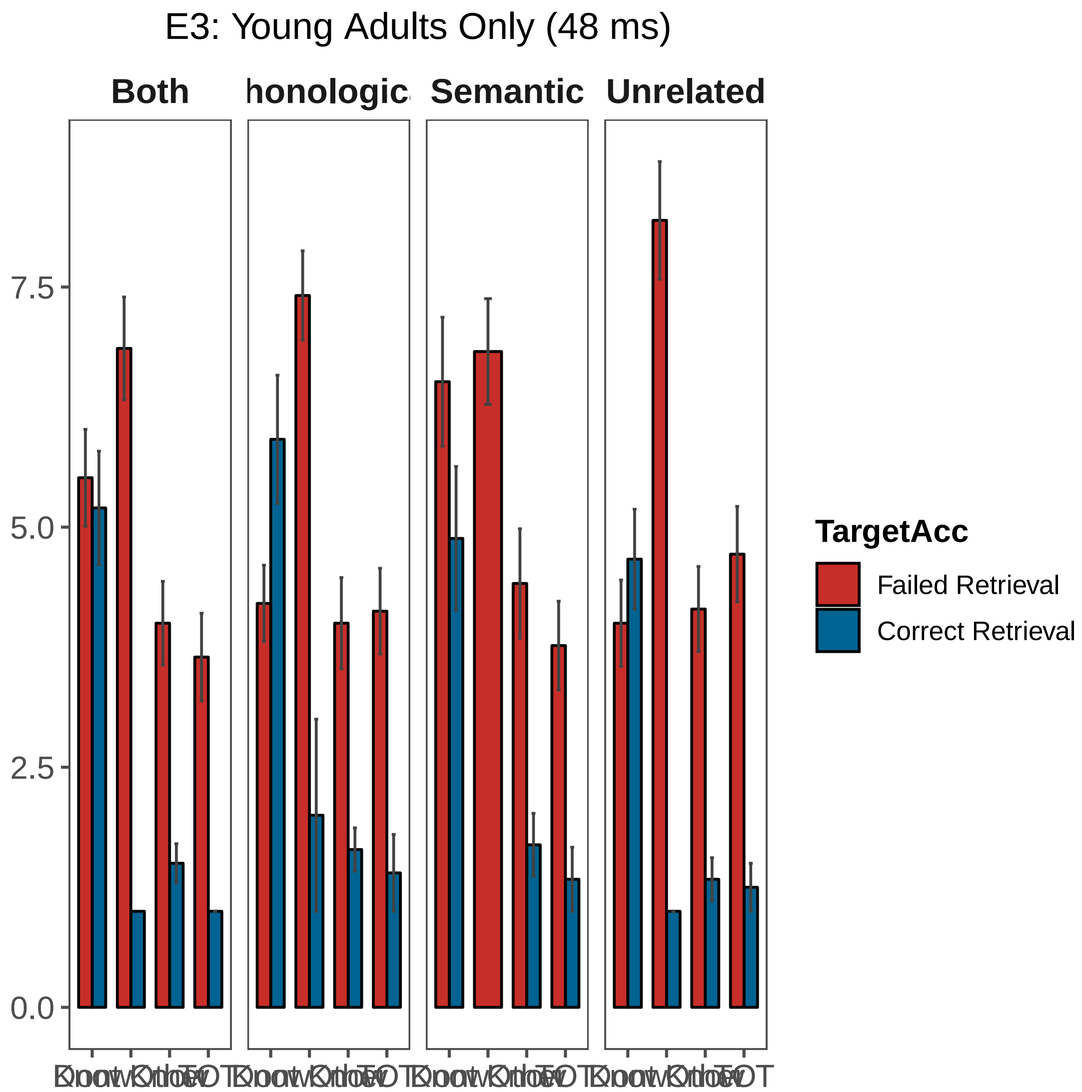
```
> library(grid)
> gridExtra::grid.arrange(stateprime_2_acc_young, stateprime_2_acc_old,
+                         nrow = 2, ncol = 1,
+       top=textGrob("Raw Number of Retrieval States in E2",
+                                       gp=gpar(fontsize=20)))
```



Experiment 3

```
> exp3_fig_stateprime_acc = Rmisc::summarySE(exp_3_stateprime_acc,
+                          measurevar = "Trials",
+                          groupvars = c("AgeGroup","PrimeCondition", "Question.RESP", "A
> exp3_fig_stateprime_acc$Accuracy = as.factor(as.character(exp3_fig_stateprime_acc$Accu
> library(ggplot2)
> library(ggthemes)
>  stateprime_3_acc_young = exp3_fig_stateprime_acc %>%
+    mutate(State = factor(Question.RESP, levels = unique(Question.RESP),
+                              labels = c("Know", "Dont Know", "Other", "TOT")),
```

```
+           PrimeType = factor(PrimeCondition, levels = unique(PrimeCondition),
+                labels = c("Both", "Phonological", "Semantic", "Unrelated")),
+                     TargetAcc = factor(Accuracy, levels = unique(Accuracy),
+                     labels = c("Failed Retrieval", "Correct Retrieval")))%>%
+ ggplot(aes(x = State, y = Trials,
+           group=TargetAcc, fill = TargetAcc))+
+  geom_bar(stat = "identity", position = "dodge", width = 0.7, color= "black")+
+   geom_errorbar(aes(ymin=Trials - se, ymax=Trials + se),
+              width=.2, color = "gray26",
+              position = position_dodge(0.7))+
+  theme_few()+
+   facet_wrap(~PrimeType, nrow =1)+
+    scale_fill_wsj()+
+  # scale_fill_manual(values = c("royalblue4", "slategray1"))+
+     xlab("") + ylab("") +
+   ggtitle("E3: Young Adults Only (48 ms)")  +
+    theme(axis.text = element_text(size = rel(1)),
+           axis.title = element_text(face = "bold", size = rel(1)),
+           legend.title = element_text(face = "bold", size = rel(1)),
+          plot.title = element_text(hjust = .5),
+          strip.text.x = element_text(face = "bold", size = rel(1.4)))
>  stateprime_3_acc_young
>
```



21 Know: PrimeType and Target Accuracy

```
> exp_1_knowacc = exp_1_stateprime_acc %>% filter(Question.RESP == "1")
> exp_2_knowacc = exp_2_stateprime_acc %>% filter(Question.RESP == "1")
> exp_3_knowacc = exp_3_stateprime_acc %>% filter(Question.RESP == "1")
```

21.1 Experiment 1

```
> ## HLM on trials
```

```
>
> library(lme4)
> contrasts(exp_1_knowacc$PrimeCondition) = contr.treatment(4, base = 3)
> exp_1_knowacc$Accuracy = as.factor(exp_1_knowacc$Accuracy)
> e1_know_hlm = lmer(data = exp_1_knowacc,
+                    Trials ~ AgeGroup*PrimeCondition*Accuracy +
+                      (1|Subject))
> summary(e1_know_hlm)
```

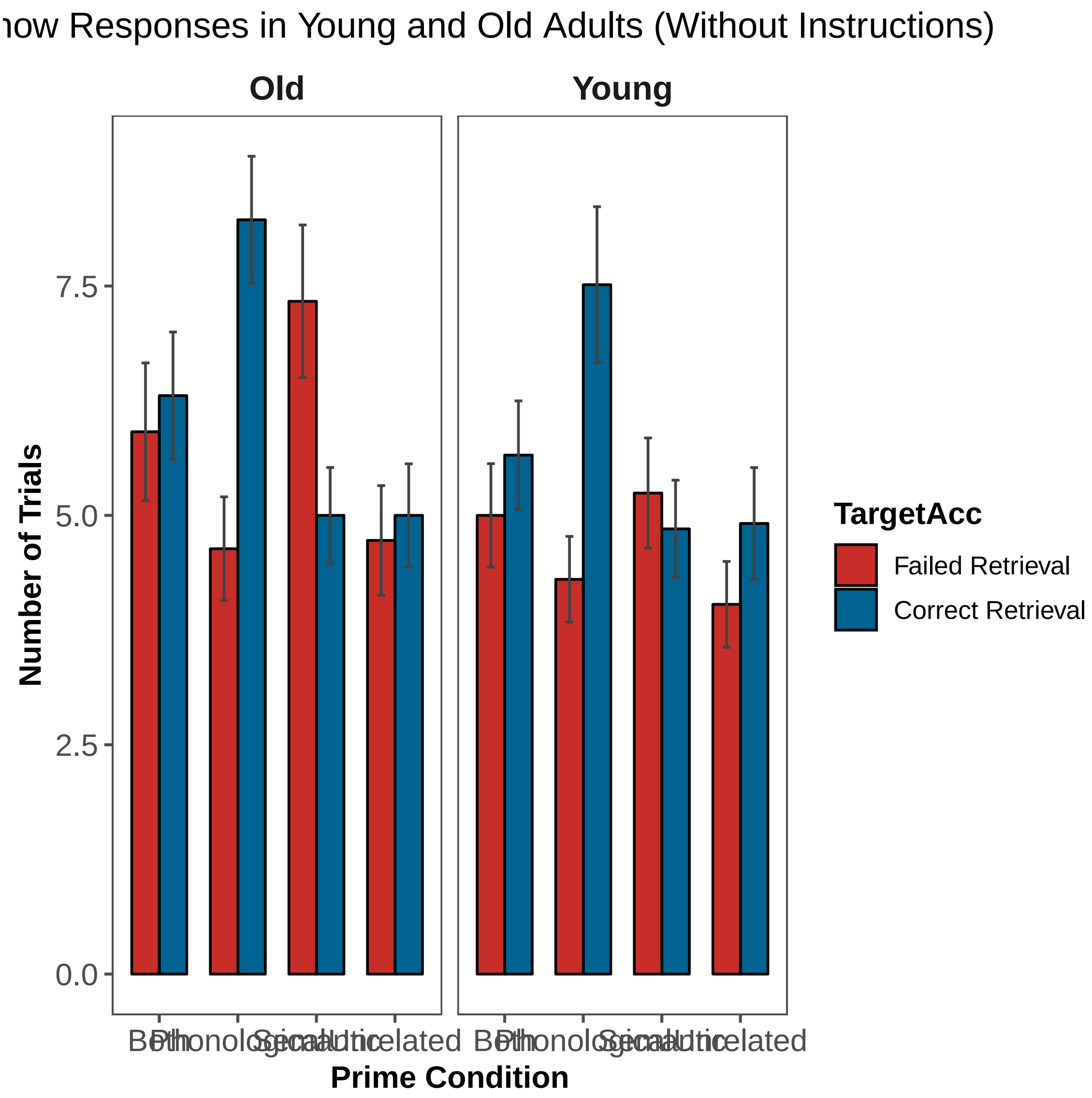
```
Linear mixed model fit by REML ['lmerMod']
Formula: Trials ~ AgeGroup * PrimeCondition * Accuracy + (1 | Subject)
   Data: exp_1_knowacc

REML criterion at convergence: 2943.9

Scaled residuals:
    Min      1Q  Median      3Q     Max
-1.8534 -0.6950 -0.1191  0.5296  3.1589

Random effects:
 Groups   Name        Variance Std.Dev.
 Subject  (Intercept)  2.86    1.691
 Residual             10.83    3.291
Number of obs: 550, groups:  Subject, 73

Fixed effects:
                                    Estimate Std. Error t value
(Intercept)                           5.5489     0.3438  16.138
AgeGroup1                             0.5594     0.3438   1.627
PrimeCondition1                       0.1241     0.3948   0.314
PrimeCondition2                       0.5340     0.3983   1.341
PrimeCondition4                      -0.9540     0.4006  -2.381
Accuracy1                             0.7253     0.2812   2.579
AgeGroup1:PrimeCondition1            -0.1627     0.3948  -0.412
AgeGroup1:PrimeCondition2            -0.3053     0.3983  -0.766
AgeGroup1:PrimeCondition4            -0.3491     0.4006  -0.872
AgeGroup1:Accuracy1                   0.4715     0.2812   1.677
PrimeCondition1:Accuracy1            -1.0061     0.3948  -2.548
PrimeCondition2:Accuracy1            -2.4700     0.3983  -6.202
PrimeCondition4:Accuracy1            -1.0601     0.4006  -2.646
AgeGroup1:PrimeCondition1:Accuracy1  -0.4265     0.3948  -1.080
AgeGroup1:PrimeCondition2:Accuracy1  -0.6120     0.3983  -1.537
AgeGroup1:PrimeCondition4:Accuracy1  -0.3472     0.4006  -0.867
```

```
> car::Anova(e1_know_hlm)
```

```
Analysis of Deviance Table (Type II Wald chisquare tests)
```

```
Response: Trials
                                  Chisq Df  Pr(>Chisq)
AgeGroup                         2.1831  1    0.139531
PrimeCondition                  15.6097  3    0.001363 **
Accuracy                         8.4850  1    0.003581 **
AgeGroup:PrimeCondition          0.9372  3    0.816441
AgeGroup:Accuracy                0.7839  1    0.375963
PrimeCondition:Accuracy         38.7657  3  1.946e-08 ***
AgeGroup:PrimeCondition:Accuracy  2.4898  3    0.477146
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1
```

```
> ## plotting
> library(ggplot2)
> library(ggthemes)
> e1_know_data = Rmisc::summarySE(exp_1_knowacc,
+                         measurevar = "Trials",
+                         groupvars = c( "AgeGroup","PrimeCondition", "Accuracy"))
> e1_know_plot = e1_know_data %>%
+    mutate(PrimeType = factor(PrimeCondition, levels = unique(PrimeCondition),
+                labels = c("Both", "Phonological", "Semantic", "Unrelated")),
+                     TargetAcc = factor(Accuracy, levels = unique(Accuracy),
+                     labels = c("Failed Retrieval", "Correct Retrieval")))%>%
+ ggplot(aes(x = PrimeType, y = Trials,
+           group=TargetAcc, fill = TargetAcc))+
+  geom_bar(stat = "identity", position = "dodge", width = 0.7, color= "black")+
+   geom_errorbar(aes(ymin=Trials - se, ymax=Trials + se),
+              width=.2, color = "gray26",
+              position = position_dodge(0.7))+
+  theme_few()+
+    scale_fill_wsj()+
+   facet_wrap(~AgeGroup)+
+  # scale_fill_manual(values = c("royalblue4", "slategray1"))+
+     xlab("Prime Condition") + ylab("Number of Trials") +
+   ggtitle("E1: Know Responses in Young and Old Adults (Without Instructions)")
+
+    theme(axis.text = element_text(size = rel(1)),
+           axis.title = element_text(face = "bold", size = rel(1)),
+           legend.title = element_text(face = "bold", size = rel(1)),
+          plot.title = element_text(hjust = .5),
+          strip.text.x = element_text(face = "bold", size = rel(1.4)))
>  e1_know_plot
```



21.2 Experiment 1 Collapsed Prime

```
> ## HLM on trials
> exp_1_knowacc2 = exp_1_state_acc %>% filter(Question.RESP == "1")
> library(lme4)
> exp_1_knowacc2$Accuracy = as.factor(exp_1_knowacc2$Accuracy)
> e1_know_hlm = lmer(data = exp_1_knowacc2,
+                       Trials ~ AgeGroup*Accuracy +
+                         (1|Subject))
> summary(e1_know_hlm)
```

```
Linear mixed model fit by REML ['lmerMod']
Formula: Trials ~ AgeGroup * Accuracy + (1 | Subject)
   Data: exp_1_knowacc2

REML criterion at convergence: 1142.4

Scaled residuals:
    Min      1Q  Median      3Q     Max
-1.6223 -0.7381 -0.1749  0.5987  4.0582

Random effects:
 Groups   Name        Variance  Std.Dev.
 Subject  (Intercept) 4.280e-14 2.069e-07
 Residual             1.586e+02 1.259e+01
Number of obs: 146, groups:  Subject, 73

Fixed effects:
                    Estimate Std. Error t value
(Intercept)          20.9585     1.0424  20.105
AgeGroup1             1.4720     1.0424   1.412
Accuracy1            -1.7438     1.0424  -1.673
AgeGroup1:Accuracy1   0.2021     1.0424   0.194

Correlation of Fixed Effects:
            (Intr) AgGrp1 Accrc1
AgeGroup1   0.014
Accuracy1   0.000  0.000
AgGrp1:Acc1 0.000  0.000  0.014
```

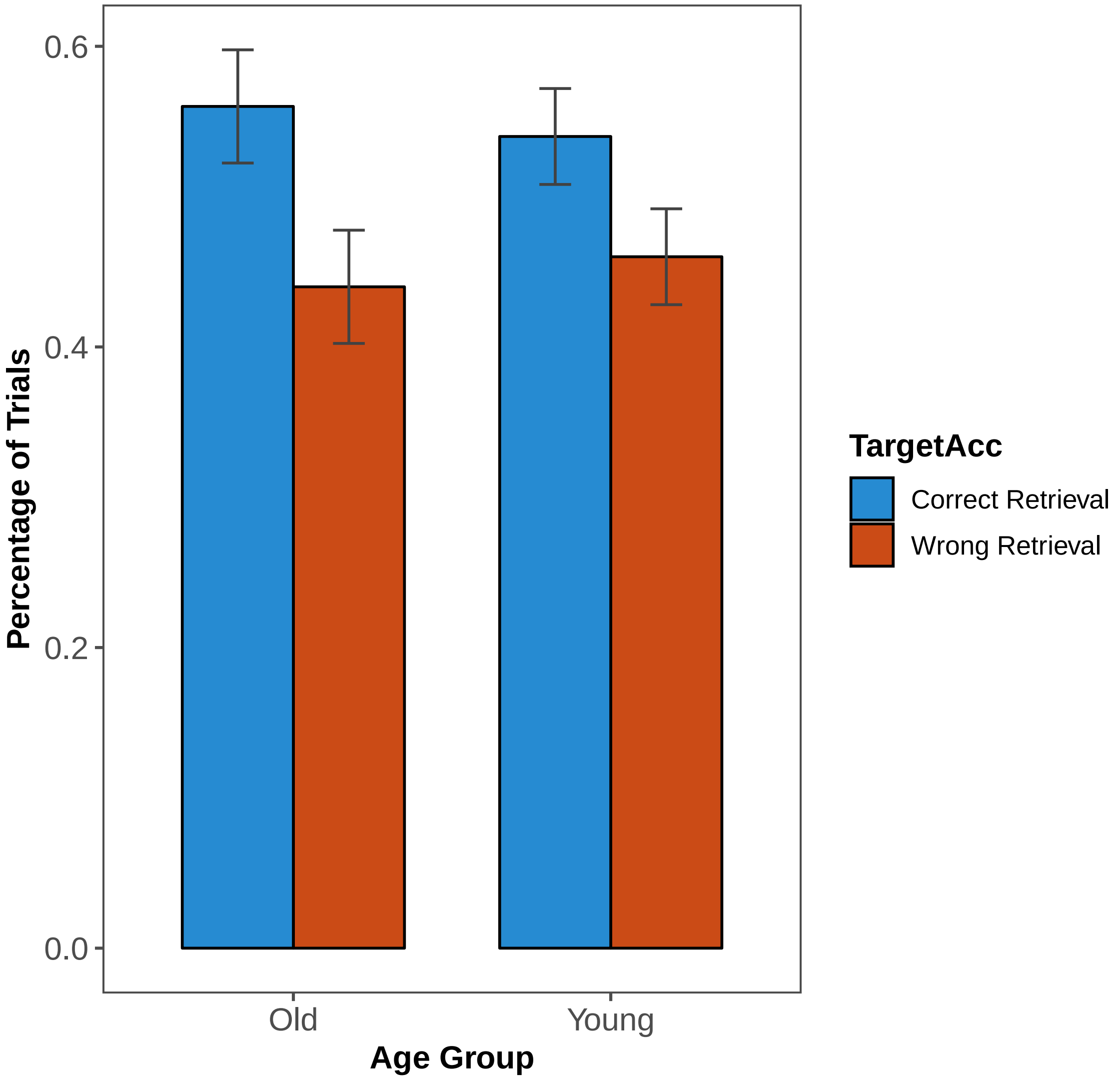
```
> car::Anova(e1_know_hlm)
```

```
Analysis of Deviance Table (Type II Wald chisquare tests)

Response: Trials
                  Chisq Df Pr(>Chisq)
AgeGroup         1.9940  1    0.15792
Accuracy         2.8077  1    0.09381 .
AgeGroup:Accuracy 0.0376  1    0.84625
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1
```

```
> ## percents
>
> exp1_knowacc_percent = spread(exp_1_knowacc2, Accuracy, Trials)
> exp1_knowacc_percent$`0` = ifelse(is.na(exp1_knowacc_percent$`0`),
+                                   0, exp1_knowacc_percent$`0`)
> exp1_knowacc_percent$`1` = ifelse(is.na(exp1_knowacc_percent$`1`),
```

```
+                                   0, exp1_knowacc_percent$`1`)
> exp1_knowacc_percent$total = exp1_knowacc_percent$`0` + exp1_knowacc_percent$`1`
> exp1_knowacc_percent$pcorrect = exp1_knowacc_percent$`1`/exp1_knowacc_percent$total
> exp1_knowacc_percent$pwrong = exp1_knowacc_percent$`0`/exp1_knowacc_percent$total
> exp1_knowacc_long = exp1_knowacc_percent %>% gather(Type,
+                                                     Percent,
+                                               pcorrect:pwrong)%>%
+    arrange(Subject)
> ## plotting
> library(ggplot2)
> library(ggthemes)
> e1_know_data = Rmisc::summarySE(exp1_knowacc_long,
+                         measurevar = "Percent",
+                         groupvars = c( "AgeGroup", "Type"))
> e1_know_data$Percent = round(e1_know_data$Percent, 2)
> e1_know_plot = e1_know_data %>%
+    mutate(TargetAcc = factor(Type, levels = unique(Type),
+                     labels = c("Correct Retrieval", "Wrong Retrieval")))%>%
+ ggplot(aes(x = AgeGroup, y = Percent,
+           group=TargetAcc, fill = TargetAcc))+
+  geom_bar(stat = "identity", position = "dodge", width = 0.7, color= "black")+
+   geom_errorbar(aes(ymin=Percent - se, ymax=Percent + se),
+              width=.2, color = "gray26",
+              position = position_dodge(0.7))+
+  theme_few()+
+    scale_fill_solarized()+
+  # scale_fill_manual(values = c("royalblue4", "slategray1"))+
+     xlab("Age Group") + ylab("Percentage of Trials") +
+   ggtitle("E1: Know Responses in Young and Old Adults (Without Instructions)")
+
+    theme(axis.text = element_text(size = rel(1)),
+           axis.title = element_text(face = "bold", size = rel(1)),
+           legend.title = element_text(face = "bold", size = rel(1)),
+          plot.title = element_text(hjust = .5),
+          strip.text.x = element_text(face = "bold", size = rel(1.4)))
>  e1_know_plot
```

ıow Responses in Young and Old Adults (Without Instructions)



21.3 Experiment 2

```
>  ###  EXPERIMENT  2
>
> contrasts(exp_2_knowacc$PrimeCondition) = contr.treatment(4, base = 3)
> e2_know_hlm = lmer(data = exp_2_knowacc, Trials ~ PrimeCondition*Accuracy +
+                      (1|Subject))
> summary(e2_know_hlm)
```

```
Linear mixed model fit by REML ['lmerMod']
```

```
Formula: Trials ~ PrimeCondition * Accuracy + (1 | Subject)
   Data: exp_2_knowacc

REML criterion at convergence: 2546.2

Scaled residuals:
    Min      1Q  Median      3Q     Max
-2.1487 -0.6850 -0.1042  0.5970  3.2616

Random effects:
 Groups   Name        Variance Std.Dev.
 Subject  (Intercept) 2.874    1.695
 Residual             8.853    2.975
Number of obs: 493, groups:  Subject, 65

Fixed effects:
                         Estimate Std. Error t value
(Intercept)                5.4792     0.4304  12.730
PrimeCondition1           -0.6792     0.5265  -1.290
PrimeCondition2           -0.9015     0.5380  -1.675
PrimeCondition4           -1.0417     0.5354  -1.945
Accuracy                  -0.2416     0.5360  -0.451
PrimeCondition1:Accuracy   0.8871     0.7497   1.183
PrimeCondition2:Accuracy   2.5611     0.7594   3.372
PrimeCondition4:Accuracy   0.4343     0.7709   0.563

Correlation of Fixed Effects:
            (Intr) PrmCn1 PrmCn2 PrmCn4 Accrcy PrC1:A PrC2:A
PrimeCndtn1 -0.622
PrimeCndtn2 -0.608  0.497
PrimeCndtn4 -0.611  0.499  0.489
Accuracy    -0.612  0.500  0.490  0.492
PrmCndtn1:A  0.437 -0.702 -0.350 -0.351 -0.715
PrmCndtn2:A  0.431 -0.352 -0.709 -0.346 -0.706  0.504
PrmCndtn4:A  0.426 -0.348 -0.340 -0.696 -0.696  0.498  0.490
```

```
> car::Anova(e2_know_hlm)
```

```
Analysis of Deviance Table (Type II Wald chisquare tests)

Response: Trials
                          Chisq Df Pr(>Chisq)
PrimeCondition          10.4190  3   0.015321 *
Accuracy                 7.4677  1   0.006282 **
PrimeCondition:Accuracy 12.9769  3   0.004687 **
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1
```

```
> e2_know_hlm_age = lmer(data = exp_2_knowacc, Trials ~ AgeGroup*PrimeCondition*Accuracy
+                    (1|Subject))
> summary(e2_know_hlm_age)
```

```
Linear mixed model fit by REML ['lmerMod']
Formula: Trials ~ AgeGroup * PrimeCondition * Accuracy + (1 | Subject)
   Data: exp_2_knowacc

REML criterion at convergence: 2518.7

Scaled residuals:
    Min      1Q  Median      3Q     Max
-1.9299 -0.6912 -0.1097  0.6052  2.9701

Random effects:
 Groups   Name        Variance Std.Dev.
 Subject  (Intercept) 2.767    1.663
 Residual             8.506    2.917
Number of obs: 493, groups:  Subject, 65

Fixed effects:
                                   Estimate Std. Error t value
(Intercept)                          5.5343     0.4224  13.101
AgeGroup1                            1.1707     0.4224   2.771
PrimeCondition1                     -0.7232     0.5165  -1.400
PrimeCondition2                     -0.9270     0.5279  -1.756
PrimeCondition4                     -1.0966     0.5252  -2.088
Accuracy                            -0.3238     0.5261  -0.615
AgeGroup1:PrimeCondition1           -0.4505     0.5165  -0.872
AgeGroup1:PrimeCondition2           -0.2543     0.5279  -0.482
AgeGroup1:PrimeCondition4           -0.5081     0.5252  -0.967
AgeGroup1:Accuracy                  -1.4498     0.5261  -2.756
PrimeCondition1:Accuracy             0.9620     0.7354   1.308
PrimeCondition2:Accuracy             2.6007     0.7450   3.491
PrimeCondition4:Accuracy             0.5872     0.7574   0.775
AgeGroup1:PrimeCondition1:Accuracy   0.4678     0.7354   0.636
AgeGroup1:PrimeCondition2:Accuracy  -0.2695     0.7450  -0.362
AgeGroup1:PrimeCondition4:Accuracy   1.5742     0.7574   2.078
```

```
> car::Anova(e2_know_hlm_age)
```

```
Analysis of Deviance Table (Type II Wald chisquare tests)

Response: Trials
                                   Chisq Df Pr(>Chisq)
AgeGroup                          2.0842  1  0.1488347
PrimeCondition                   11.4279  3  0.0096235 **
```

```
Accuracy                          8.0898  1  0.0044515 **
AgeGroup:PrimeCondition           3.2889  3  0.3491918
AgeGroup:Accuracy                15.0859  1  0.0001027 ***
PrimeCondition:Accuracy          13.6292  3  0.0034559 **
AgeGroup:PrimeCondition:Accuracy  6.8366  3  0.0772906 .
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1
```

```
> ## only older adults
> library(lmerTest)
> exp_2_knowacc_old = exp_2_knowacc %>% filter(AgeGroup == "Old")
> e2_know_hlm_old = lmer(data = exp_2_knowacc_old, Trials ~ PrimeCondition*Accuracy +
+                       (1|Subject))
> summary(e2_know_hlm_old)
```

```
Linear mixed model fit by REML. t-tests use Satterthwaite's method [
lmerModLmerTest]
Formula: Trials ~ PrimeCondition * Accuracy + (1 | Subject)
   Data: exp_2_knowacc_old

REML criterion at convergence: 1237.1

Scaled residuals:
     Min       1Q   Median       3Q      Max
-1.75096 -0.69565  0.00181  0.57269  2.70216

Random effects:
 Groups   Name        Variance Std.Dev.
 Subject  (Intercept) 3.514    1.875
 Residual             9.207    3.034
Number of obs: 239, groups:  Subject, 32

Fixed effects:
                         Estimate Std. Error       df t value Pr(>|t|)
(Intercept)                6.6975     0.6475 158.3643  10.344   <2e-16 ***
PrimeCondition1           -1.1663     0.7727 199.2643  -1.509   0.1328
PrimeCondition2           -1.1878     0.7928 199.8038  -1.498   0.1357
PrimeCondition4           -1.6007     0.7779 198.8680  -2.058   0.0409 *
Accuracy                  -1.7740     0.7944 200.4515  -2.233   0.0266 *
PrimeCondition1:Accuracy   1.4303     1.0984 199.5012   1.302   0.1944
PrimeCondition2:Accuracy   2.3402     1.1159 199.4057   2.097   0.0372 *
PrimeCondition4:Accuracy   2.1394     1.1425 200.5409   1.873   0.0626 .
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Correlation of Fixed Effects:
            (Intr) PrmCn1 PrmCn2 PrmCn4 Accrcy PrC1:A PrC2:A
PrimeCndtn1 -0.618
```

```
PrimeCndtn2 -0.601  0.503
PrimeCndtn4 -0.612  0.513  0.498
Accuracy    -0.602  0.505  0.492  0.499
PrmCndtn1:A  0.435 -0.704 -0.356 -0.361 -0.723
PrmCndtn2:A  0.427 -0.358 -0.711 -0.354 -0.710  0.514
PrmCndtn4:A  0.420 -0.352 -0.339 -0.683 -0.696  0.503  0.492
```

```
> car::Anova(e2_know_hlm_old)
```

```
Analysis of Deviance Table (Type II Wald chisquare tests)

Response: Trials
                        Chisq Df Pr(>Chisq)
PrimeCondition         1.7447  3     0.6270
Accuracy               0.5845  1     0.4445
PrimeCondition:Accuracy 5.3347  3     0.1489
```

```
> ## only young adults
> exp_2_knowacc_young = exp_2_knowacc %>% filter(AgeGroup == "Young")
> e2_know_hlm_young = lmer(data = exp_2_knowacc_young, Trials ~ PrimeCondition*Accuracy
+                      (1|Subject))
> summary(e2_know_hlm_young)
```

```
Linear mixed model fit by REML. t-tests use Satterthwaite's method [
lmerModLmerTest]
Formula: Trials ~ PrimeCondition * Accuracy + (1 | Subject)
   Data: exp_2_knowacc_young

REML criterion at convergence: 1267.9

Scaled residuals:
    Min      1Q  Median      3Q     Max
-2.0332 -0.6085 -0.1436  0.6315  3.1273

Random effects:
 Groups   Name        Variance Std.Dev.
 Subject  (Intercept) 2.080    1.442
 Residual             7.842    2.800
Number of obs: 254, groups:  Subject, 33

Fixed effects:
                        Estimate Std. Error       df t value Pr(>|t|)
(Intercept)               4.3636     0.5483 189.4977   7.958 1.55e-13 ***
PrimeCondition1          -0.2727     0.6894 213.8232  -0.396   0.6928
PrimeCondition2          -0.6665     0.7016 214.6981  -0.950   0.3432
PrimeCondition4          -0.5816     0.7081 215.0316  -0.821   0.4124
Accuracy                  1.1292     0.6954 214.3063   1.624   0.1059
PrimeCondition1:Accuracy  0.4936     0.9834 214.2773   0.502   0.6162
```

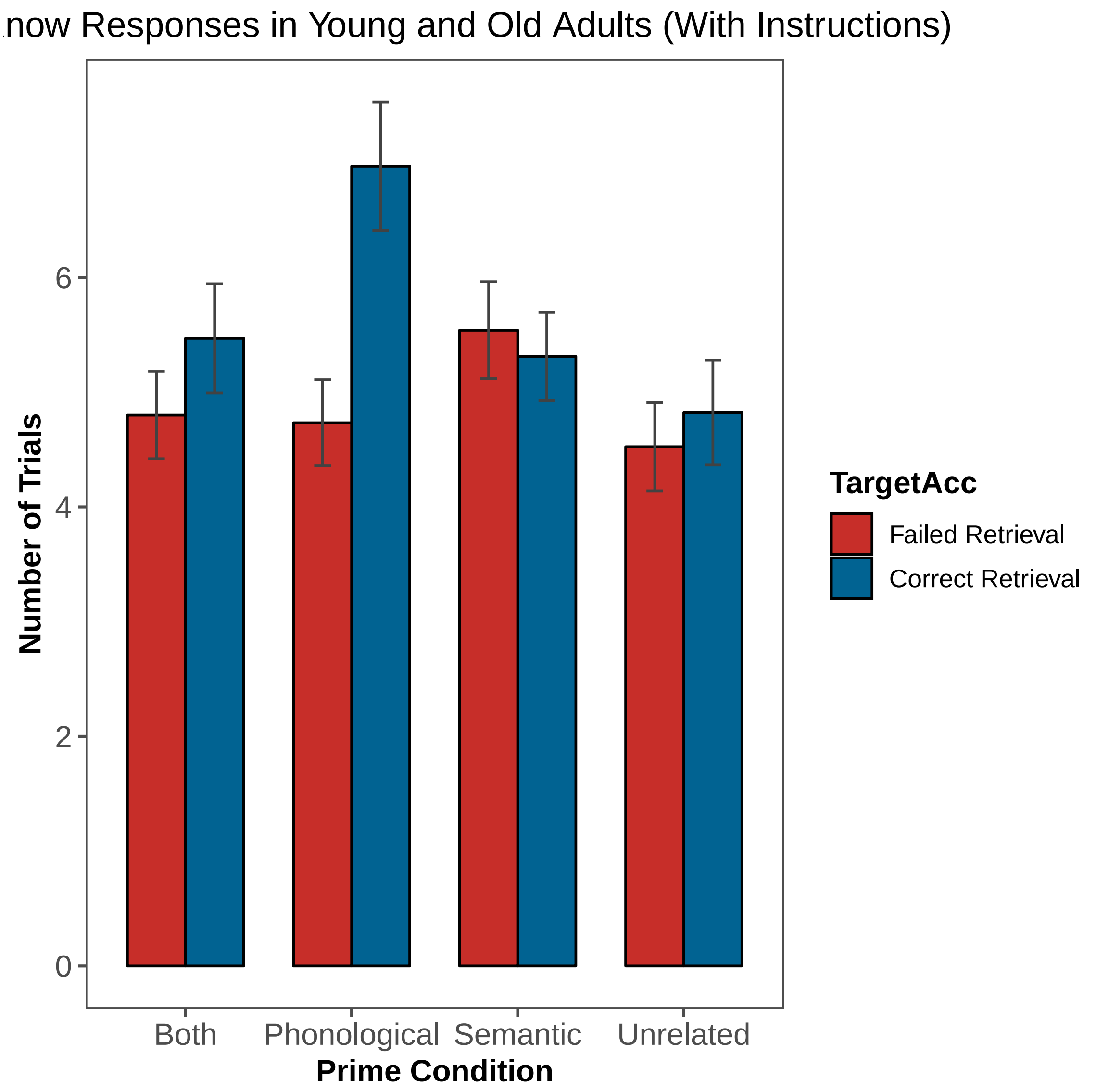
```
PrimeCondition2:Accuracy   2.8652      0.9929 215.2068   2.886   0.0043 **
PrimeCondition4:Accuracy  -0.9981      1.0019 215.5598  -0.996   0.3203
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Correlation of Fixed Effects:
            (Intr) PrmCn1 PrmCn2 PrmCn4 Accrcy PrC1:A PrC2:A
PrimeCndtn1 -0.629
PrimeCndtn2 -0.618  0.491
PrimeCndtn4 -0.612  0.487  0.480
Accuracy    -0.623  0.496  0.489  0.484
PrmCndtn1:A  0.441 -0.701 -0.345 -0.343 -0.707
PrmCndtn2:A  0.436 -0.347 -0.708 -0.339 -0.702  0.495
PrmCndtn4:A  0.433 -0.344 -0.341 -0.708 -0.695  0.492  0.488
```

```
> car::Anova(e2_know_hlm_young)
```

```
Analysis of Deviance Table (Type II Wald chisquare tests)

Response: Trials
                          Chisq Df Pr(>Chisq)
PrimeCondition           14.047  3   0.002842 **
Accuracy                 24.128  1  9.014e-07 ***
PrimeCondition:Accuracy  15.942  3   0.001166 **
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1
```

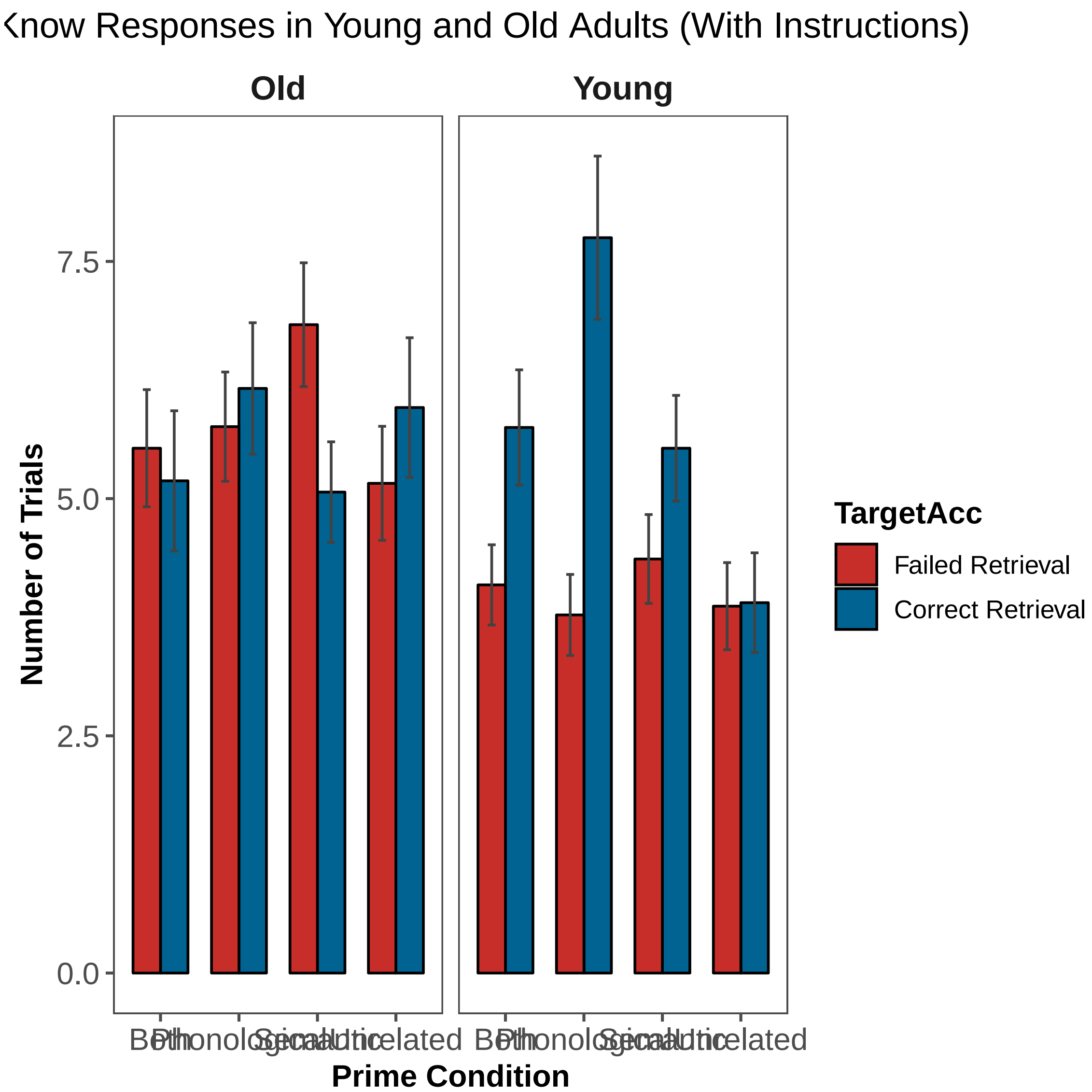
```
> #sjPlot::plot_model(e2_know_hlm, type = "int")
>
> ## plotting
>
> e2_know_data = Rmisc::summarySE(exp_2_knowacc,
+                         measurevar = "Trials",
+                         groupvars = c("PrimeCondition", "Accuracy"))
> e2_know_plot = e2_know_data %>%
+    mutate(PrimeType = factor(PrimeCondition, levels = unique(PrimeCondition),
+                 labels = c("Both", "Phonological", "Semantic", "Unrelated")),
+                     TargetAcc = factor(Accuracy, levels = unique(Accuracy),
+                     labels = c("Failed Retrieval", "Correct Retrieval")))%>%
+ ggplot(aes(x = PrimeType, y = Trials,
+           group=TargetAcc, fill = TargetAcc))+
+  geom_bar(stat = "identity", position = "dodge", width = 0.7, color= "black")+
+   geom_errorbar(aes(ymin=Trials - se, ymax=Trials + se),
+              width=.2, color = "gray26",
+              position = position_dodge(0.7))+
+  theme_few()+
+    scale_fill_wsj()+
+  # scale_fill_manual(values = c("royalblue4", "slategray1"))+
```

```
+     xlab("Prime Condition") + ylab("Number of Trials") +
+   ggtitle("E2: Know Responses in Young and Old Adults (With Instructions)")  +
+    theme(axis.text = element_text(size = rel(1)),
+           axis.title = element_text(face = "bold", size = rel(1)),
+           legend.title = element_text(face = "bold", size = rel(1)),
+          plot.title = element_text(hjust = .5),
+          strip.text.x = element_text(face = "bold", size = rel(1.4)))
>  e2_know_plot
```




```
>  e2_know_data_age = Rmisc::summarySE(exp_2_knowacc,
+                               measurevar = "Trials",
```

```
+                          groupvars = c("AgeGroup", "PrimeCondition", "Accuracy"))
> e2_know_plot_age = e2_know_data_age %>%
+    mutate(PrimeType = factor(PrimeCondition, levels = unique(PrimeCondition),
+                labels = c("Both", "Phonological", "Semantic", "Unrelated")),
+                     TargetAcc = factor(Accuracy, levels = unique(Accuracy),
+                     labels = c("Failed Retrieval", "Correct Retrieval")))%>%
+ ggplot(aes(x = PrimeType, y = Trials,
+           group=TargetAcc, fill = TargetAcc))+
+  geom_bar(stat = "identity", position = "dodge", width = 0.7, color= "black")+
+   geom_errorbar(aes(ymin=Trials - se, ymax=Trials + se),
+              width=.2, color = "gray26",
+              position = position_dodge(0.7))+
+  theme_few()+
+    scale_fill_wsj()+
+   facet_wrap(~AgeGroup)+
+  # scale_fill_manual(values = c("royalblue4", "slategray1"))+
+     xlab("Prime Condition") + ylab("Number of Trials") +
+   ggtitle("E2: Know Responses in Young and Old Adults (With Instructions)")  +
+    theme(axis.text = element_text(size = rel(1)),
+           axis.title = element_text(face = "bold", size = rel(1)),
+           legend.title = element_text(face = "bold", size = rel(1)),
+          plot.title = element_text(hjust = .5),
+          strip.text.x = element_text(face = "bold", size = rel(1.4)))
>  e2_know_plot_age
```



21.4 Experiment 2 Collapsed Prime

```
> ## HLM on trials
> exp_2_knowacc2 = exp_2_state_acc %>% filter(Question.RESP == "1")
> library(lme4)
> exp_2_knowacc2$Accuracy = as.factor(exp_2_knowacc2$Accuracy)
> e2_know_hlm = lmer(data = exp_2_knowacc2,
+                    Trials ~ AgeGroup*Accuracy +
+                      (1|Subject))
> summary(e2_know_hlm)
```

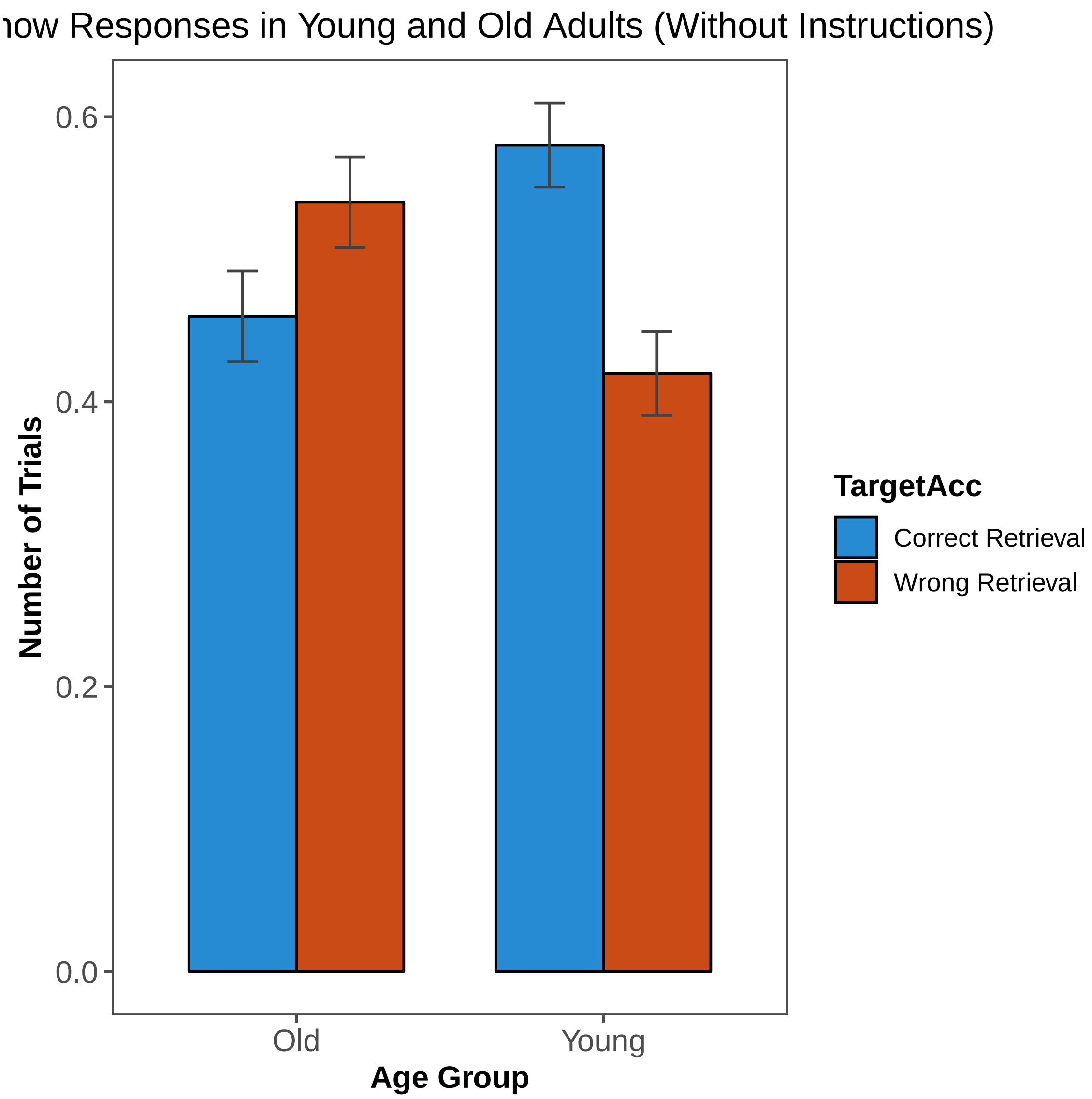
```
Linear mixed model fit by REML. t-tests use Satterthwaite's method [
lmerModLmerTest]
Formula: Trials ~ AgeGroup * Accuracy + (1 | Subject)
   Data: exp_2_knowacc2

REML criterion at convergence: 984.7

Scaled residuals:
    Min      1Q  Median      3Q     Max
-1.4485 -0.7203 -0.1295  0.5245  2.2902

Random effects:
 Groups   Name        Variance Std.Dev.
 Subject  (Intercept)  22.84    4.779
 Residual             103.52   10.175
Number of obs: 130, groups:  Subject, 65

Fixed effects:
                    Estimate Std. Error      df t value Pr(>|t|)
(Intercept)          20.0497     1.0714 63.0000  18.713   <2e-16 ***
AgeGroup1             1.2315     1.0714 63.0000   1.149   0.2547
Accuracy1            -1.2140     0.8925 63.0000  -1.360   0.1786
AgeGroup1:Accuracy1   2.0890     0.8925 63.0000   2.341   0.0224 *
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Correlation of Fixed Effects:
            (Intr) AgGrp1 Accrc1
AgeGroup1   0.015
Accuracy1   0.000  0.000
AgGrp1:Acc1 0.000  0.000  0.015
```

```
> car::Anova(e2_know_hlm)
```

```
Analysis of Deviance Table (Type II Wald chisquare tests)

Response: Trials
                   Chisq Df Pr(>Chisq)
AgeGroup          1.3212  1    0.25038
Accuracy          1.9501  1    0.16258
AgeGroup:Accuracy 5.4788  1    0.01925 *
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1
```

```
> ## percents
>
> exp2_knowacc_percent = spread(exp_2_knowacc2, Accuracy, Trials)
```

```
> exp2_knowacc_percent$`0` = ifelse(is.na(exp2_knowacc_percent$`0`),
+                                   0, exp2_knowacc_percent$`0`)
> exp2_knowacc_percent$`1` = ifelse(is.na(exp2_knowacc_percent$`1`),
+                                   0, exp2_knowacc_percent$`1`)
> exp2_knowacc_percent$total = exp2_knowacc_percent$`0` + exp2_knowacc_percent$`1`
> exp2_knowacc_percent$pcorrect = exp2_knowacc_percent$`1`/exp2_knowacc_percent$total
> exp2_knowacc_percent$pwrong = exp2_knowacc_percent$`0`/exp2_knowacc_percent$total
> exp2_knowacc_long = exp2_knowacc_percent %>% gather(Type,
+                                                      Percent,
+                                                pcorrect:pwrong)%>%
+    arrange(Subject)
> ## plotting
> library(ggplot2)
> library(ggthemes)
> e2_know_data = Rmisc::summarySE(exp2_knowacc_long,
+                         measurevar = "Percent",
+                         groupvars = c( "AgeGroup", "Type"))
> e2_know_data$Percent = round(e2_know_data$Percent, 2)
> e2_know_plot = e2_know_data %>%
+    mutate(TargetAcc = factor(Type, levels = unique(Type),
+                     labels = c("Correct Retrieval", "Wrong Retrieval")))%>%
+ ggplot(aes(x = AgeGroup, y = Percent,
+           group=TargetAcc, fill = TargetAcc))+
+  geom_bar(stat = "identity", position = "dodge", width = 0.7, color= "black")+
+   geom_errorbar(aes(ymin=Percent - se, ymax=Percent + se),
+              width=.2, color = "gray26",
+              position = position_dodge(0.7))+
+  theme_few()+
+    scale_fill_solarized()+
+  # scale_fill_manual(values = c("royalblue4", "slategray1"))+
+     xlab("Age Group") + ylab("Number of Trials") +
+   ggtitle("E2: Know Responses in Young and Old Adults (Without Instructions)")
+
+    theme(axis.text = element_text(size = rel(1)),
+           axis.title = element_text(face = "bold", size = rel(1)),
+           legend.title = element_text(face = "bold", size = rel(1)),
+          plot.title = element_text(hjust = .5),
+          strip.text.x = element_text(face = "bold", size = rel(1.4)))
>  e2_know_plot
```



21.5 Experiment 3

```
> contrasts(exp_3_knowacc$PrimeCondition) = contr.treatment(4, base = 3)
> e3_know_hlm = lmer(data = exp_3_knowacc, Trials ~ PrimeCondition*Accuracy +
+                     (1|Subject))
> summary(e3_know_hlm)
```

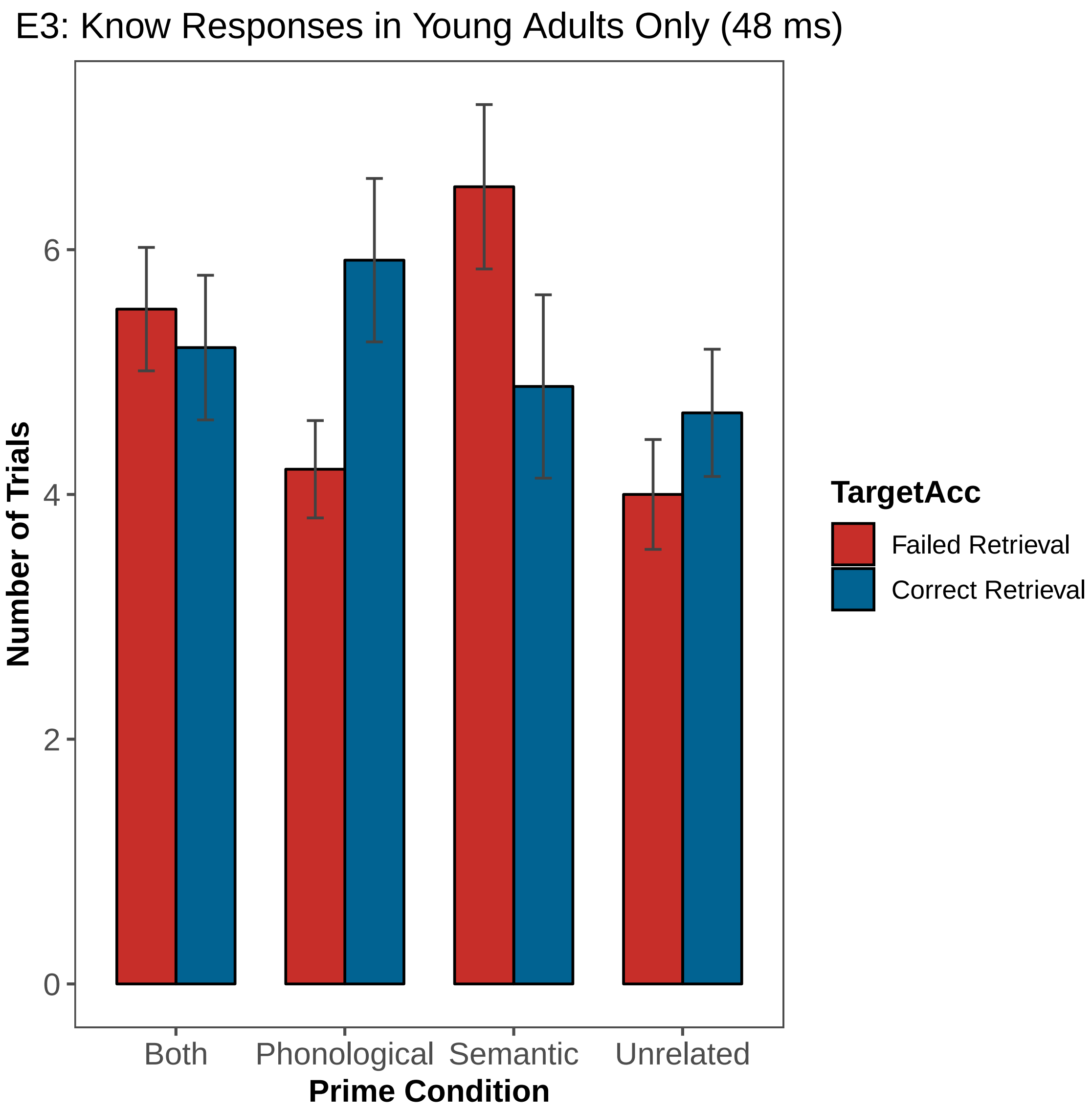
```
Linear mixed model fit by REML. t-tests use Satterthwaite's method [
lmerModLmerTest]
Formula: Trials ~ PrimeCondition * Accuracy + (1 | Subject)
```

```
   Data: exp_3_knowacc

REML criterion at convergence: 1405.7

Scaled residuals:
    Min      1Q  Median      3Q     Max 
-2.7868 -0.6504 -0.1098  0.6154  4.2753 

Random effects:
 Groups   Name        Variance Std.Dev.
 Subject  (Intercept) 3.066    1.751   
 Residual             8.574    2.928   
Number of obs: 275, groups:  Subject, 36

Fixed effects:
                         Estimate Std. Error       df t value Pr(>|t|)    
(Intercept)                6.4956     0.5752 185.9563  11.292  < 2e-16 ***
PrimeCondition1           -1.0015     0.7010 232.4584  -1.429 0.154442    
PrimeCondition2           -2.3782     0.7068 232.8951  -3.364 0.000897 ***
PrimeCondition4           -2.6208     0.7068 232.8951  -3.708 0.000261 ***
Accuracy                  -1.6786     0.7068 232.8951  -2.375 0.018372 *  
PrimeCondition1:Accuracy   1.3658     0.9963 233.0066   1.371 0.171738    
PrimeCondition2:Accuracy   3.4885     1.0005 233.2840   3.487 0.000584 ***
PrimeCondition4:Accuracy   2.3321     1.0088 233.6032   2.312 0.021664 *  
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Correlation of Fixed Effects:
            (Intr) PrmCn1 PrmCn2 PrmCn4 Accrcy PrC1:A PrC2:A
PrimeCndtn1 -0.609                                          
PrimeCndtn2 -0.605  0.496                                   
PrimeCndtn4 -0.605  0.496  0.494                            
Accuracy    -0.605  0.496  0.494  0.494                     
PrmCndtn1:A  0.430 -0.705 -0.351 -0.351 -0.711              
PrmCndtn2:A  0.427 -0.350 -0.708 -0.350 -0.708  0.503       
PrmCndtn4:A  0.424 -0.348 -0.347 -0.702 -0.702  0.499  0.498
```

```
> car::Anova(e3_know_hlm)
```

```
Analysis of Deviance Table (Type II Wald chisquare tests)

Response: Trials
                           Chisq Df Pr(>Chisq)   
PrimeCondition            9.3749  3   0.024701 * 
Accuracy                  0.0956  1   0.757140   
PrimeCondition:Accuracy 13.0918  3   0.004442 **
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1
```

```
> #sjPlot::plot_model(e3_know_hlm, type = "int")
>
> ## plotting
>
> e3_know_data = Rmisc::summarySE(exp_3_knowacc,
+                         measurevar = "Trials",
+                         groupvars = c("PrimeCondition", "Accuracy"))
> e3_know_plot = e3_know_data %>%
+    mutate(PrimeType = factor(PrimeCondition, levels = unique(PrimeCondition),
+                 labels = c("Both", "Phonological", "Semantic", "Unrelated")),
+                      TargetAcc = factor(Accuracy, levels = unique(Accuracy),
+                      labels = c("Failed Retrieval", "Correct Retrieval")))%>%
+ ggplot(aes(x = PrimeType, y = Trials,
+           group=TargetAcc, fill = TargetAcc))+
+  geom_bar(stat = "identity", position = "dodge", width = 0.7, color= "black")+
+   geom_errorbar(aes(ymin=Trials - se, ymax=Trials + se),
+              width=.2, color = "gray26",
+              position = position_dodge(0.7))+
+  theme_few()+
+    scale_fill_wsj()+
+  # scale_fill_manual(values = c("royalblue4", "slategray1"))+
+     xlab("Prime Condition") + ylab("Number of Trials") +
+   ggtitle("E3: Know Responses in Young Adults Only (48 ms)")  +
+    theme(axis.text = element_text(size = rel(1)),
+           axis.title = element_text(face = "bold", size = rel(1)),
+           legend.title = element_text(face = "bold", size = rel(1)),
+          plot.title = element_text(hjust = .5),
+          strip.text.x = element_text(face = "bold", size = rel(1.4)))
>  e3_know_plot
```



21.6 Experiment 3 Collapsed Prime

```
> ## HLM on trials
> exp_3_knowacc2 = exp_3_state_acc %>% filter(Question.RESP == "1")
> library(lme4)
> exp_3_knowacc2$Accuracy = as.factor(exp_3_knowacc2$Accuracy)
> e3_know_hlm = lmer(data = exp_3_knowacc2,
+                    Trials ~ Accuracy +
+                      (1|Subject))
> summary(e3_know_hlm)
```

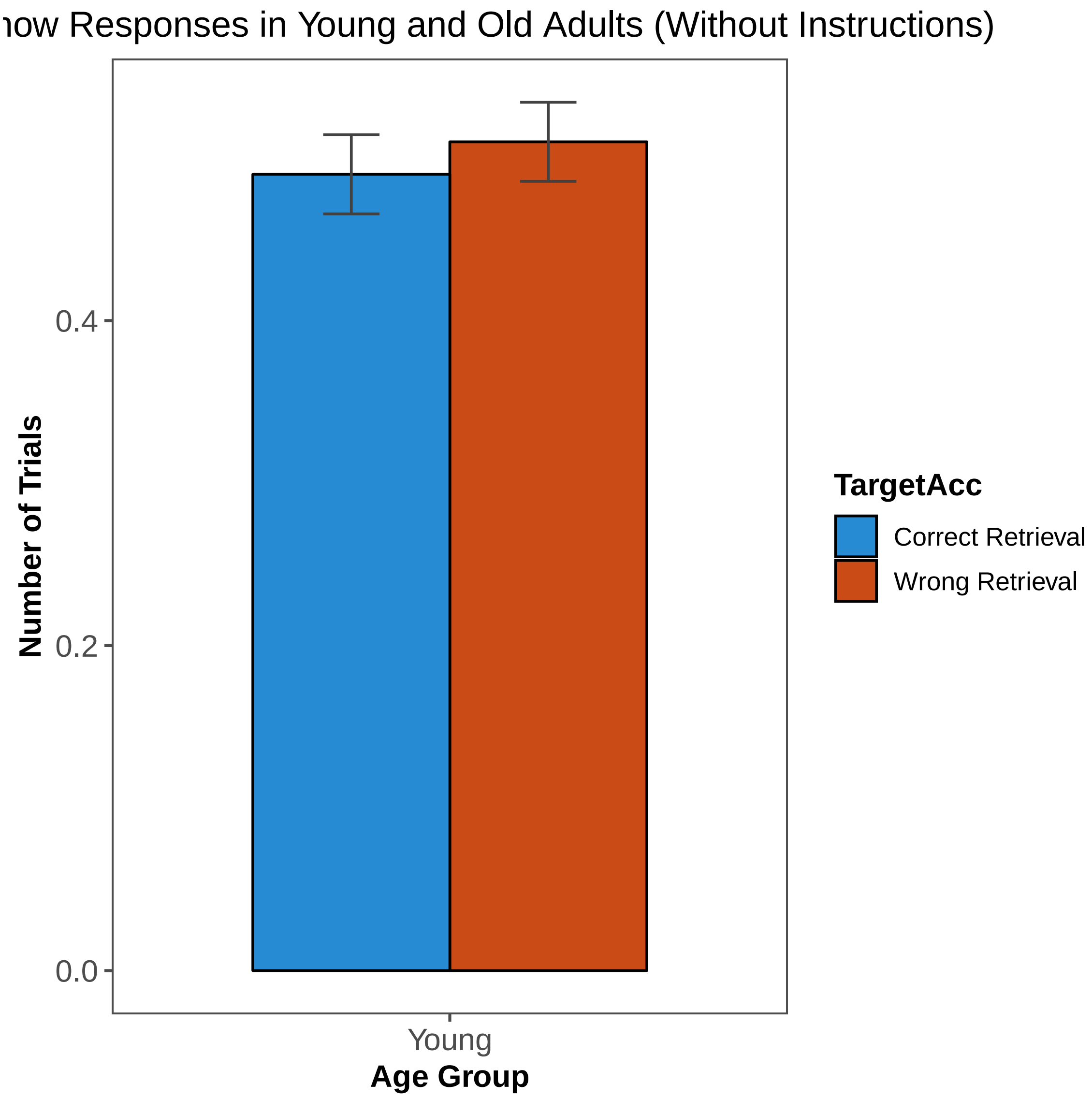
```
Linear mixed model fit by REML. t-tests use Satterthwaite's method [
lmerModLmerTest]
Formula: Trials ~ Accuracy + (1 | Subject)
   Data: exp_3_knowacc2

REML criterion at convergence: 541.9

Scaled residuals:
    Min      1Q  Median      3Q     Max
-1.3391 -0.6635 -0.1869  0.4674  4.1060

Random effects:
 Groups   Name        Variance Std.Dev.
 Subject  (Intercept) 24.17    4.916
 Residual             97.44    9.871
Number of obs: 72, groups:  Subject, 36

Fixed effects:
            Estimate Std. Error     df t value Pr(>|t|)
(Intercept)   19.569      1.423 35.000  13.753 1.12e-15 ***
Accuracy1     -0.125      1.163 35.000  -0.107    0.915
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Correlation of Fixed Effects:
          (Intr)
Accuracy1 0.000
```

```
> car::Anova(e3_know_hlm)
```

```
Analysis of Deviance Table (Type II Wald chisquare tests)

Response: Trials
          Chisq Df Pr(>Chisq)
Accuracy 0.0115  1     0.9144
```

```
> ## percents
>
> exp3_knowacc_percent = spread(exp_3_knowacc2, Accuracy, Trials)
> exp3_knowacc_percent$`0` = ifelse(is.na(exp3_knowacc_percent$`0`),
+                                   0, exp3_knowacc_percent$`0`)
> exp3_knowacc_percent$`1` = ifelse(is.na(exp3_knowacc_percent$`1`),
+                                   0, exp3_knowacc_percent$`1`)
> exp3_knowacc_percent$total = exp3_knowacc_percent$`0` + exp3_knowacc_percent$`1`
> exp3_knowacc_percent$pcorrect = exp3_knowacc_percent$`1`/exp3_knowacc_percent$total
> exp3_knowacc_percent$pwrong = exp3_knowacc_percent$`0`/exp3_knowacc_percent$total
> exp3_knowacc_long = exp3_knowacc_percent %>% gather(Type,
```

```
+                                               Percent,
+                                         pcorrect:pwrong)%>%
+   arrange(Subject)
> ## plotting
> library(ggplot2)
> library(ggthemes)
> e3_know_data = Rmisc::summarySE(exp3_knowacc_long,
+                          measurevar = "Percent",
+                          groupvars = c( "AgeGroup", "Type"))
> e3_know_data$Percent = round(e3_know_data$Percent, 2)
> e3_know_plot = e3_know_data %>%
+   mutate(TargetAcc = factor(Type, levels = unique(Type),
+                      labels = c("Correct Retrieval", "Wrong Retrieval")))%>%
+ ggplot(aes(x = AgeGroup, y = Percent,
+          group=TargetAcc, fill = TargetAcc))+
+  geom_bar(stat = "identity", position = "dodge", width = 0.7, color= "black")+
+   geom_errorbar(aes(ymin=Percent - se, ymax=Percent + se),
+              width=.2, color = "gray26",
+              position = position_dodge(0.7))+
+  theme_few()+
+    scale_fill_solarized()+
+  # scale_fill_manual(values = c("royalblue4", "slategray1"))+
+     xlab("Age Group") + ylab("Number of Trials") +
+   ggtitle("E2: Know Responses in Young and Old Adults (Without Instructions)")
+
+    theme(axis.text = element_text(size = rel(1)),
+           axis.title = element_text(face = "bold", size = rel(1)),
+           legend.title = element_text(face = "bold", size = rel(1)),
+          plot.title = element_text(hjust = .5),
+          strip.text.x = element_text(face = "bold", size = rel(1.4)))
>  e3_know_plot
```



22 Know: Across E1 E2 E3

```
> ## all data is in data_stateprime_acc
>
> ## only know responses in young and old
>
> data_stateprime_acc$Experiment = ifelse(data_stateprime_acc$StudyNo == "2" |
+                                         data_stateprime_acc$StudyNo == "4",
+                                         "No Instructions",
+                              ifelse(data_stateprime_acc$StudyNo == "5" |
```

```
+                                   data_stateprime_acc$StudyNo == "6",
+                                 "With Instructions", "Young 48 ms"))
> data_stateprime_acc$Experiment = as.factor(data_stateprime_acc$Experiment)
> stateprime_young_know_ru = data_stateprime_acc %>%
+   filter(AgeGroup == "Young" & Question.RESP == "1" &
+            PrimeCondition %in% c("R", "U"))
> stateprime_old_know_ru = data_stateprime_acc %>%
+   filter(AgeGroup == "Old" & Question.RESP == "1"&
+            PrimeCondition %in% c("R", "U"))
>
>
```

22.1 Young HLM and Plot

```
> ## hlm on young-know
> contrasts(stateprime_young_know_ru$PrimeCondition) =
+   contr.treatment(4, base = 3)
> contrasts(stateprime_young_know_ru$Experiment) =
+   contr.treatment(3, base = 2)
> library(lmerTest)
> library(lme4)
> hlm_young_know = lmer(data = stateprime_young_know_ru,
+                        Trials ~ Experiment*PrimeCondition*Accuracy +
+                       (1|Subject))
> summary(hlm_young_know)
```

```
Linear mixed model fit by REML. t-tests use Satterthwaite's method [
lmerModLmerTest]
Formula: Trials ~ Experiment * PrimeCondition * Accuracy + (1 | Subject)
   Data: stateprime_young_know_ru

REML criterion at convergence: 2056.9

Scaled residuals:
    Min      1Q  Median      3Q     Max
-2.1249 -0.6868 -0.1754  0.4797  4.7281

Random effects:
 Groups   Name        Variance Std.Dev.
 Subject  (Intercept) 1.505    1.227
 Residual             9.070    3.012
Number of obs: 400, groups:  Subject, 106

Fixed effects:
                                     Estimate Std. Error       df t value
(Intercept)                            4.0924     0.4367 230.2833   9.372
Experiment1                            0.5112     0.6018 231.3253   0.849
```

```
Experiment3                                 1.1202      0.6038 229.7806   1.855
PrimeCondition1                             0.2712      0.3809 291.1277   0.712
Accuracy                                    0.6284      0.5379 289.2495   1.168
Experiment1:PrimeCondition1                 0.3684      0.5253 291.4272   0.701
Experiment3:PrimeCondition1                 1.0101      0.5265 290.9252   1.919
Experiment1:Accuracy                       -0.3829      0.7453 292.6800  -0.514
Experiment3:Accuracy                       -1.1064      0.7467 289.7807  -1.482
PrimeCondition1:Accuracy                    0.5264      0.5390 293.6700   0.977
Experiment1:PrimeCondition1:Accuracy       -1.2006      0.7454 292.8142  -1.611
Experiment3:PrimeCondition1:Accuracy       -1.6866      0.7481 294.1242  -2.254
                                           Pr(>|t|)
(Intercept)                                 <2e-16 ***
Experiment1                                 0.3965
Experiment3                                 0.0648 .
PrimeCondition1                             0.4770
Accuracy                                    0.2437
Experiment1:PrimeCondition1                 0.4836
Experiment3:PrimeCondition1                 0.0560 .
Experiment1:Accuracy                        0.6078
Experiment3:Accuracy                        0.1395
PrimeCondition1:Accuracy                    0.3295
Experiment1:PrimeCondition1:Accuracy        0.1083
Experiment3:PrimeCondition1:Accuracy        0.0249 *
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Correlation of Fixed Effects:
            (Intr) Exprm1 Exprm3 PrmCn1 Accrcy Ex1:PC1 Ex3:PC1 Exp1:A Exp3:A
Experiment1 -0.726
Experiment3 -0.723  0.525
PrimeCndtn1 -0.046  0.033  0.033
Accuracy    -0.617  0.448  0.446  0.036
Exprmn1:PC1  0.033 -0.050 -0.024 -0.725 -0.026
Exprmn3:PC1  0.033 -0.024 -0.031 -0.723 -0.026  0.525
Exprmnt1:Ac  0.445 -0.615 -0.322 -0.026 -0.722  0.041   0.019
Exprmnt3:Ac  0.444 -0.322 -0.614 -0.026 -0.720  0.019   0.024   0.520
PrmCndtn1:A  0.034 -0.025 -0.025 -0.708 -0.035  0.514   0.512   0.026  0.026
Expr1:PC1:A -0.025  0.036  0.018  0.512  0.026 -0.706  -0.371  -0.034 -0.018
Expr3:PC1:A -0.024  0.018  0.023  0.510  0.026 -0.370  -0.705  -0.018 -0.026
            PrC1:A E1:PC1:
Experiment1
Experiment3
PrimeCndtn1
Accuracy
Exprmn1:PC1
Exprmn3:PC1
Exprmnt1:Ac
Exprmnt3:Ac
```

```
PrmCndtn1:A
Expr1:PC1:A -0.723
Expr3:PC1:A -0.720  0.521
```

```
> car::Anova(hlm_young_know)
```

```
Analysis of Deviance Table (Type II Wald chisquare tests)

Response: Trials
                                    Chisq Df Pr(>Chisq)
Experiment                         1.5074  2  0.4706268
PrimeCondition                    11.6825  1  0.0006309 ***
Accuracy                           0.1376  1  0.7107259
Experiment:PrimeCondition          1.2277  2  0.5412559
Experiment:Accuracy                2.4599  2  0.2923087
PrimeCondition:Accuracy            2.3254  1  0.1272813
Experiment:PrimeCondition:Accuracy 5.3435  2  0.0691300 .
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1
```

```
> sjPlot::plot_model(hlm_young_know, type= "int")
> stateprime_young_know_e2e3 = stateprime_young_know_ru %>%
+   filter(Experiment != "No Instructions")
> hlm_young_know_e2e3 = lmer(data = stateprime_young_know_e2e3,
+                       Trials ~ Experiment*PrimeCondition*Accuracy +
+                      (1|Subject))
> summary(hlm_young_know_e2e3)
```

```
Linear mixed model fit by REML. t-tests use Satterthwaite's method [
lmerModLmerTest]
Formula: Trials ~ Experiment * PrimeCondition * Accuracy + (1 | Subject)
   Data: stateprime_young_know_e2e3

REML criterion at convergence: 1348.6

Scaled residuals:
    Min      1Q  Median      3Q     Max
-2.2023 -0.6596 -0.1701  0.4564  4.7476

Random effects:
 Groups   Name        Variance Std.Dev.
 Subject  (Intercept) 1.652    1.285
 Residual             8.819    2.970
Number of obs: 262, groups:  Subject, 69

Fixed effects:
                                      Estimate Std. Error        df t value
(Intercept)                            4.64967    0.30233 145.51196  15.380
```

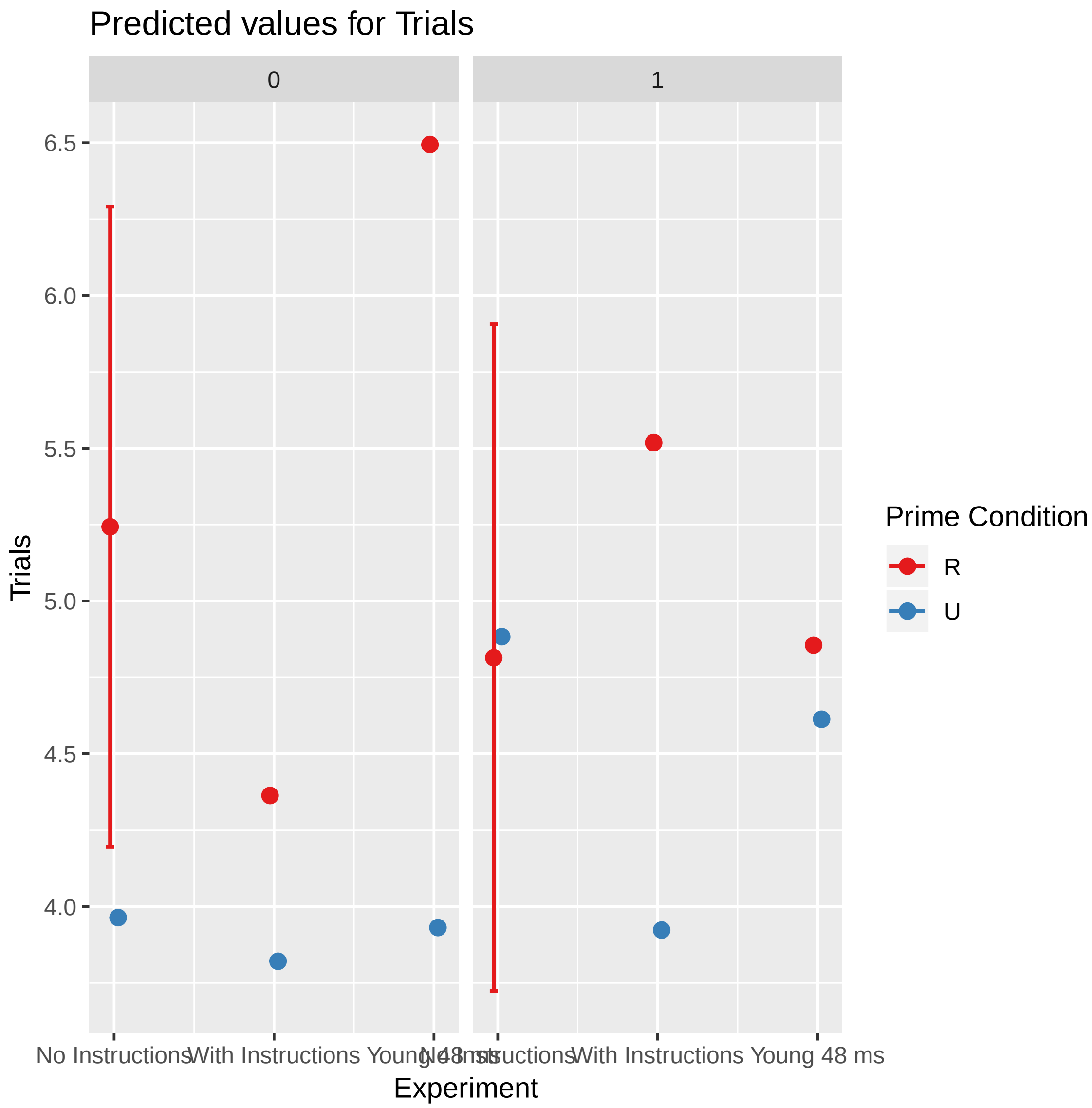
```
Experiment1                                -0.55920    0.30233 145.51196  -1.850
PrimeCondition1                             0.77835    0.25966 189.73844   2.998
Accuracy                                    0.07649    0.36823 188.98353   0.208
Experiment1:PrimeCondition1                -0.50518    0.25966 189.73844  -1.946
Experiment1:Accuracy                        0.55412    0.36823 188.98353   1.505
PrimeCondition1:Accuracy                   -0.31923    0.36901 191.81187  -0.865
Experiment1:PrimeCondition1:Accuracy        0.84223    0.36901 191.81187   2.282
                                           Pr(>|t|)
(Intercept)                                 < 2e-16 ***
Experiment1                                 0.06639 .
PrimeCondition1                             0.00309 **
Accuracy                                    0.83566
Experiment1:PrimeCondition1                 0.05319 .
Experiment1:Accuracy                        0.13404
PrimeCondition1:Accuracy                    0.38806
Experiment1:PrimeCondition1:Accuracy        0.02356 *
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Correlation of Fixed Effects:
            (Intr) Exprm1 PrmCn1 Accrcy Ex1:PC1 Exp1:A PrC1:A
Experiment1  0.046
PrimeCndtn1 -0.031 -0.017
Accuracy    -0.605 -0.028  0.024
Exprmn1:PC1 -0.017 -0.031  0.047  0.014
Exprmnt1:Ac -0.028 -0.605  0.014  0.038  0.024
PrmCndtn1:A  0.023  0.012 -0.705 -0.027 -0.033  -0.011
Expr1:PC1:A  0.012  0.023 -0.033 -0.011 -0.705  -0.027  0.038
```

```
> car::Anova(hlm_young_know_e2e3)
```

```
Analysis of Deviance Table (Type II Wald chisquare tests)

Response: Trials
                                     Chisq Df Pr(>Chisq)
Experiment                          1.4642  1  0.2262709
PrimeCondition                     11.6201  1  0.0006524 ***
Accuracy                            0.0221  1  0.8817086
Experiment:PrimeCondition           0.2244  1  0.6356940
Experiment:Accuracy                 2.4523  1  0.1173500
PrimeCondition:Accuracy             0.9076  1  0.3407588
Experiment:PrimeCondition:Accuracy  5.2094  1  0.0224652 *
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1
```

```
> sjPlot::plot_model(hlm_young_know_e2e3, type= "int")
> ## plotting young data
>
```

```
> young_know_data = Rmisc::summarySE(stateprime_young_know_ru,
+                         measurevar = "Trials",
+                         groupvars = c("Experiment" ,
+                                       "PrimeCondition", "Accuracy"))
> young_know_plot = young_know_data %>%
+    mutate(PrimeType = factor(PrimeCondition, levels = unique(PrimeCondition),
+                 labels = c("Semantic", "Unrelated")),
+                      TargetAcc = factor(Accuracy, levels = unique(Accuracy),
+                      labels = c("Failed Retrieval", "Correct Retrieval")))%>%
+ ggplot(aes(x = PrimeType, y = Trials,
+            group=TargetAcc, fill = TargetAcc))+
+  geom_bar(stat = "identity", position = "dodge", width = 0.7, color= "black")+
+   geom_errorbar(aes(ymin=Trials - se, ymax=Trials + se),
+                width=.2, color = "gray26",
+                position = position_dodge(0.7))+
+  theme_few()+
+    scale_fill_wsj()+
+   facet_wrap(~Experiment)+
+  # scale_fill_manual(values = c("royalblue4", "slategray1"))+
+     xlab("Prime Condition") + ylab("Number of Trials") +
+   ggtitle("Young Adults: Know Responses in E1, E2 and E3")  +
+    theme(axis.text = element_text(size = rel(1)),
+           axis.title = element_text(face = "bold", size = rel(1)),
+           legend.title = element_text(face = "bold", size = rel(1)),
+          plot.title = element_text(hjust = .5),
+          strip.text.x = element_text(face = "bold", size = rel(1.4)))
>  young_know_plot
```



22.2 Old HLM and Plot

```
> ## hlm on old-know
> contrasts(stateprime_old_know_ru$PrimeCondition) =
+   contr.treatment(4, base = 3)
> hlm_old_know = lmer(data = stateprime_old_know_ru,
+                        Trials ~ Experiment*PrimeCondition*Accuracy +
+                        (1|Subject))
> summary(hlm_old_know)
```

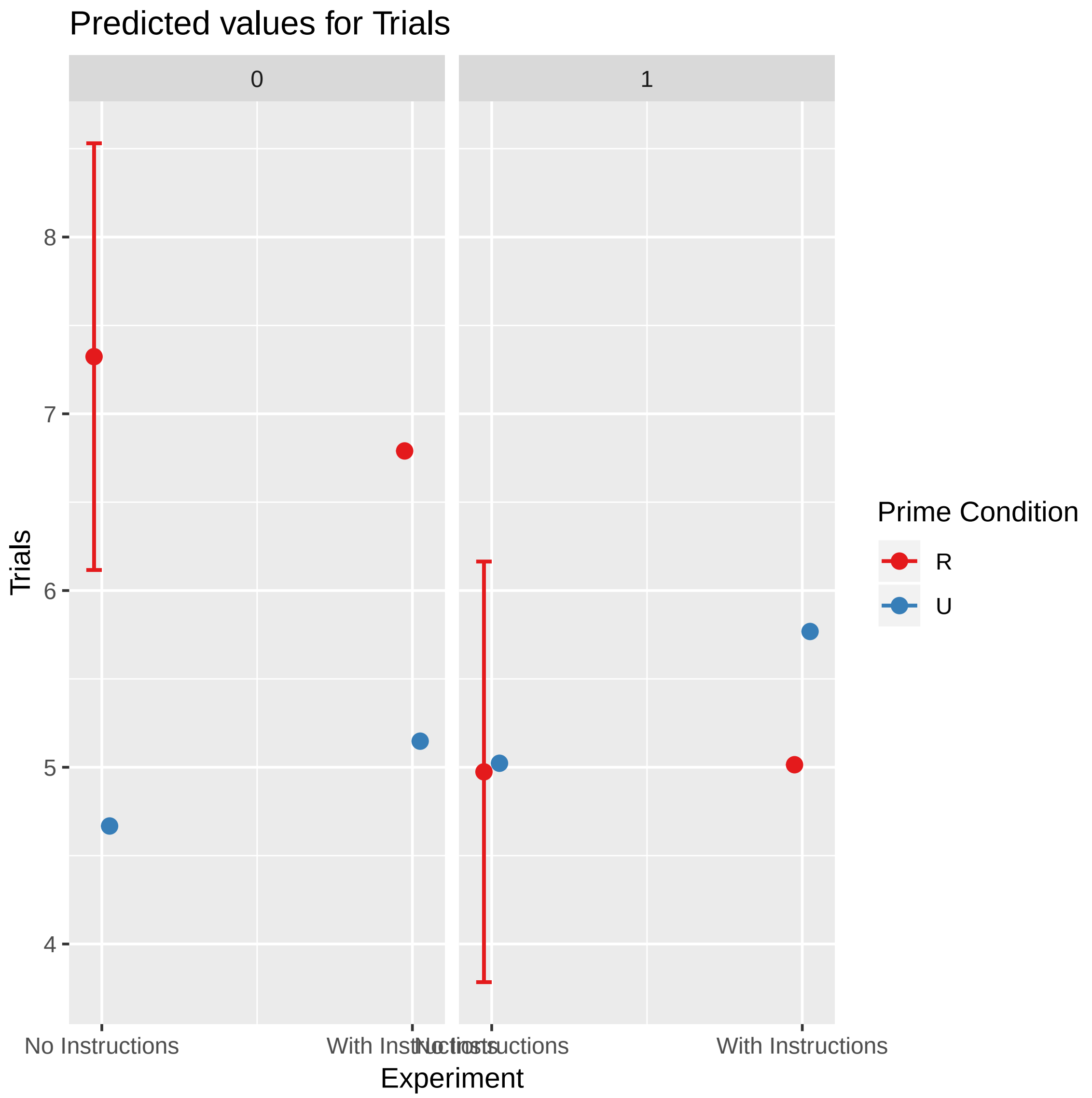
```
Linear mixed model fit by REML. t-tests use Satterthwaite's method [
lmerModLmerTest]
Formula: Trials ~ Experiment * PrimeCondition * Accuracy + (1 | Subject)
   Data: stateprime_old_know_ru

REML criterion at convergence: 1326.7

Scaled residuals:
    Min      1Q  Median      3Q     Max
-1.6132 -0.7257 -0.0348  0.5891  3.3797

Random effects:
 Groups   Name        Variance Std.Dev.
 Subject  (Intercept)  1.763   1.328
 Residual             10.804   3.287
Number of obs: 249, groups:  Subject, 68

Fixed effects:
                                      Estimate Std. Error        df t value
(Intercept)                            5.98214    0.33471 143.60060  17.873
Experiment1                            0.01338    0.33471 143.60060   0.040
PrimeCondition1                        1.07449    0.29277 178.97767   3.670
Accuracy                              -0.78724    0.42056 181.35345  -1.872
Experiment1:PrimeCondition1            0.25338    0.29277 178.97767   0.865
Experiment1:Accuracy                  -0.20983    0.42056 181.35345  -0.499
PrimeCondition1:Accuracy              -1.27513    0.42077 182.05088  -3.031
Experiment1:PrimeCondition1:Accuracy  -0.07706    0.42077 182.05088  -0.183
                                     Pr(>|t|)
(Intercept)                           < 2e-16 ***
Experiment1                           0.96816
PrimeCondition1                       0.00032 ***
Accuracy                              0.06283 .
Experiment1:PrimeCondition1           0.38794
Experiment1:Accuracy                  0.61843
PrimeCondition1:Accuracy              0.00280 **
Experiment1:PrimeCondition1:Accuracy  0.85489
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Correlation of Fixed Effects:
            (Intr) Exprm1 PrmCn1 Accrcy Ex1:PC1 Exp1:A PrC1:A
Experiment1 -0.045
PrimeCndtn1  0.008 -0.008
Accuracy    -0.610  0.023 -0.006
Exprmn1:PC1 -0.008  0.008 -0.036  0.006
Exprmnt1:Ac  0.023 -0.610  0.006 -0.081 -0.006
PrmCndtn1:A -0.008  0.008 -0.697 -0.018  0.026   0.018
```

```
Expr1:PC1:A  0.008 -0.008  0.026  0.018 -0.697  -0.018 -0.081
```

```
> car::Anova(hlm_old_know)
```

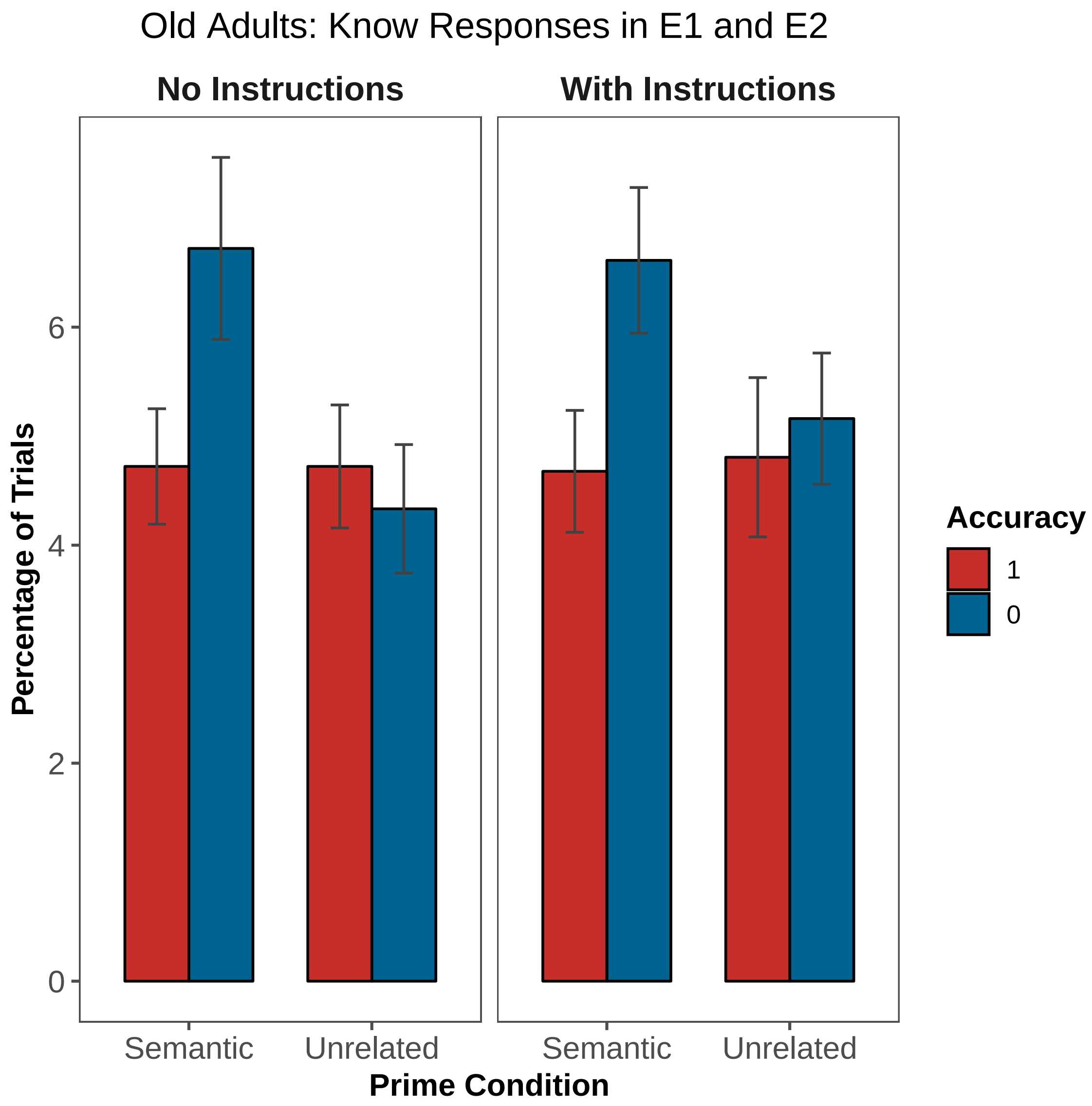
```
Analysis of Deviance Table (Type II Wald chisquare tests)

Response: Trials
                                 Chisq Df Pr(>Chisq)
Experiment                      0.1043  1   0.746703
PrimeCondition                  4.9814  1   0.025621 *
Accuracy                        3.8470  1   0.049834 *
Experiment:PrimeCondition       1.0578  1   0.303723
Experiment:Accuracy             0.2522  1   0.615503
PrimeCondition:Accuracy         9.3365  1   0.002246 **
Experiment:PrimeCondition:Accuracy 0.0335  1   0.854687
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1
```

```
> sjPlot::plot_model(hlm_old_know, type= "int")
> stateprime_old_know_ru1 = stateprime_old_know_ru %>% filter(Subject != "702")
> old_know_data = Rmisc::summarySE(stateprime_old_know_ru1,
+                        measurevar = "Trials",
+                        groupvars = c("Experiment" ,
+                                      "PrimeCondition", "Accuracy"))
> old_know_plot = old_know_data %>%
+   mutate(PrimeType = factor(PrimeCondition, levels = unique(PrimeCondition),
+              labels = c("Semantic", "Unrelated")),
+                   TargetAcc = factor(Accuracy, levels = unique(Accuracy),
+                   labels = c("Failed Retrieval", "Correct Retrieval")))%>%
+ ggplot(aes(x = PrimeType, y = Trials,
+           group=TargetAcc, fill = TargetAcc))+
+  geom_bar(stat = "identity", position = "dodge", width = 0.7, color= "black")+
+   geom_errorbar(aes(ymin=Trials - se, ymax=Trials + se),
+              width=.2, color = "gray26",
+              position = position_dodge(0.7))+
+  theme_few()+
+    scale_fill_wsj()+
+   facet_wrap(~Experiment)+
+  # scale_fill_manual(values = c("royalblue4", "slategray1"))+
+     xlab("Prime Condition") + ylab("Number of Trials") +
+   ggtitle("Old Adults: Know Responses in E1 and E2")  +
+    theme(axis.text = element_text(size = rel(1)),
+           axis.title = element_text(face = "bold", size = rel(1)),
+           legend.title = element_text(face = "bold", size = rel(1)),
+          plot.title = element_text(hjust = .5),
+          strip.text.x = element_text(face = "bold", size = rel(1.4)))
>  old_know_plot
```




```
>   ### ADDING ZEROS WHERE NEEDED
>
>   know_old_ru_trials =stateprime_old_know_ru1
>   old_know_ru_trials = know_old_ru_trials
>   oldtotaltrials_trials = spread(old_know_ru_trials, Accuracy, Trials)
>   oldtotaltrials_trials$`0` = ifelse(is.na(oldtotaltrials_trials$`0`),
+                                   0,oldtotaltrials_trials$`0`)
>   oldtotaltrials_trials$`1`= ifelse(is.na(oldtotaltrials_trials$`1`),
+                                  0,oldtotaltrials_trials$`1`)
> long_oldpercent_trials ← oldtotaltrials_trials %>% gather(Type,
+                                               Trials,
```

```
+                                               `0`:`1`)%>%
+    arrange(Subject, PrimeCondition)
>  long_oldpercent_trials$Type = as.factor(long_oldpercent_trials$Type)
>  old_know_data_all_trials = Rmisc::summarySE(long_oldpercent_trials,
+                          measurevar = "Trials",
+                          groupvars = c("Experiment" ,
+                                         "PrimeCondition", "Type"))
> old_know_data_all_trials$Accuracy = factor(old_know_data_all_trials$Type,
+                               levels(old_know_data_all_trials$Type)[c(2,1)])
> old_know_plot_all_trials = old_know_data_all_trials %>%
+    mutate(PrimeType = factor(PrimeCondition, levels = unique(PrimeCondition),
+                labels = c("Semantic", "Unrelated")))%>%
+ ggplot(aes(x = PrimeType, y = Trials,
+            group= Accuracy, fill= Accuracy))+
+  geom_bar(stat = "identity", position = "dodge", width = 0.7, color= "black")+
+   geom_errorbar(aes(ymin=Trials - se, ymax=Trials + se),
+              width=.2, color = "gray26",
+              position = position_dodge(0.7))+
+  theme_few()+
+    scale_fill_wsj()+
+   facet_wrap(~Experiment)+
+  # scale_fill_manual(values = c("royalblue4", "slategray1"))+
+     xlab("Prime Condition") + ylab("Percentage of Trials") +
+   ggtitle("Old Adults: Know Responses in E1 and E2 ")  +
+    theme(axis.text = element_text(size = rel(1)),
+           axis.title = element_text(face = "bold", size = rel(1)),
+           legend.title = element_text(face = "bold", size = rel(1)),
+          plot.title = element_text(hjust = .5),
+          strip.text.x = element_text(face = "bold", size = rel(1.4)))
> old_know_plot_all_trials
```



23 Know ANOVA

```
> stateprime_young_know_ru_complete = stateprime_young_know_ru %>%
+   filter(!Subject  %in% c(14,17, 24,26,28,30,44,68,67,72,79,80,85,86,90,95,164, 170,1
> stateprime_young_know_ru_complete$Subject = as.factor(stateprime_young_know_ru_comple
> know_aov = aov(data = stateprime_young_know_ru_complete, Trials ~ Experiment*PrimeCon
+                    Error(Subject/(PrimeCondition*Accuracy)))
> summary(know_aov)
```

```
Error: Subject
```

```
           Df Sum Sq Mean Sq F value Pr(>F)
Experiment  2   48.6   24.30   1.648  0.199
Residuals  82 1208.6   14.74

Error: Subject:PrimeCondition
                         Df Sum Sq Mean Sq F value   Pr(>F)
PrimeCondition            1  130.9  130.94  24.311 4.22e-06 ***
Experiment:PrimeCondition 2   12.6    6.31   1.172    0.315
Residuals                82  441.7    5.39
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Subject:Accuracy
                    Df Sum Sq Mean Sq F value Pr(>F)
Accuracy             1    2.1   2.144   0.154  0.695
Experiment:Accuracy  2   18.7   9.330   0.671  0.514
Residuals           82 1139.4  13.896

Error: Subject:PrimeCondition:Accuracy
                                  Df Sum Sq Mean Sq F value Pr(>F)
PrimeCondition:Accuracy            1   23.3   23.30   2.238  0.139
Experiment:PrimeCondition:Accuracy 2   37.3   18.65   1.792  0.173
Residuals                         82  853.6   10.41
```

```
>  onlye2e3 = stateprime_young_know_ru_complete %>% filter(Experiment != "Young 48 ms")
>  know_aov2 = aov(data = onlye2e3, Trials ~ Experiment*PrimeCondition*Accuracy +
+                 Error(Subject/(PrimeCondition*Accuracy)))
>  summary(know_aov2)
```

```
Error: Subject
           Df Sum Sq Mean Sq F value Pr(>F)
Experiment  1   21.3   21.25   1.593  0.212
Residuals  54  720.3   13.34

Error: Subject:PrimeCondition
                         Df Sum Sq Mean Sq F value  Pr(>F)
PrimeCondition            1   55.0   55.00   9.285 0.00357 **
Experiment:PrimeCondition 1    2.4    2.36   0.399 0.53044
Residuals                54  319.9    5.92
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Subject:Accuracy
                    Df Sum Sq Mean Sq F value Pr(>F)
Accuracy             1   13.5   13.50   1.161  0.286
Experiment:Accuracy  1    0.5    0.54   0.046  0.830
Residuals           54  628.2   11.63
```

```
Error: Subject:PrimeCondition:Accuracy
                                  Df Sum Sq Mean Sq F value Pr(>F)
PrimeCondition:Accuracy            1    2.8   2.790   0.301  0.585
Experiment:PrimeCondition:Accuracy 1   22.5  22.504   2.431  0.125
Residuals                         54  500.0   9.258
```

```
>
```

24 Know Percent Rel Unrel

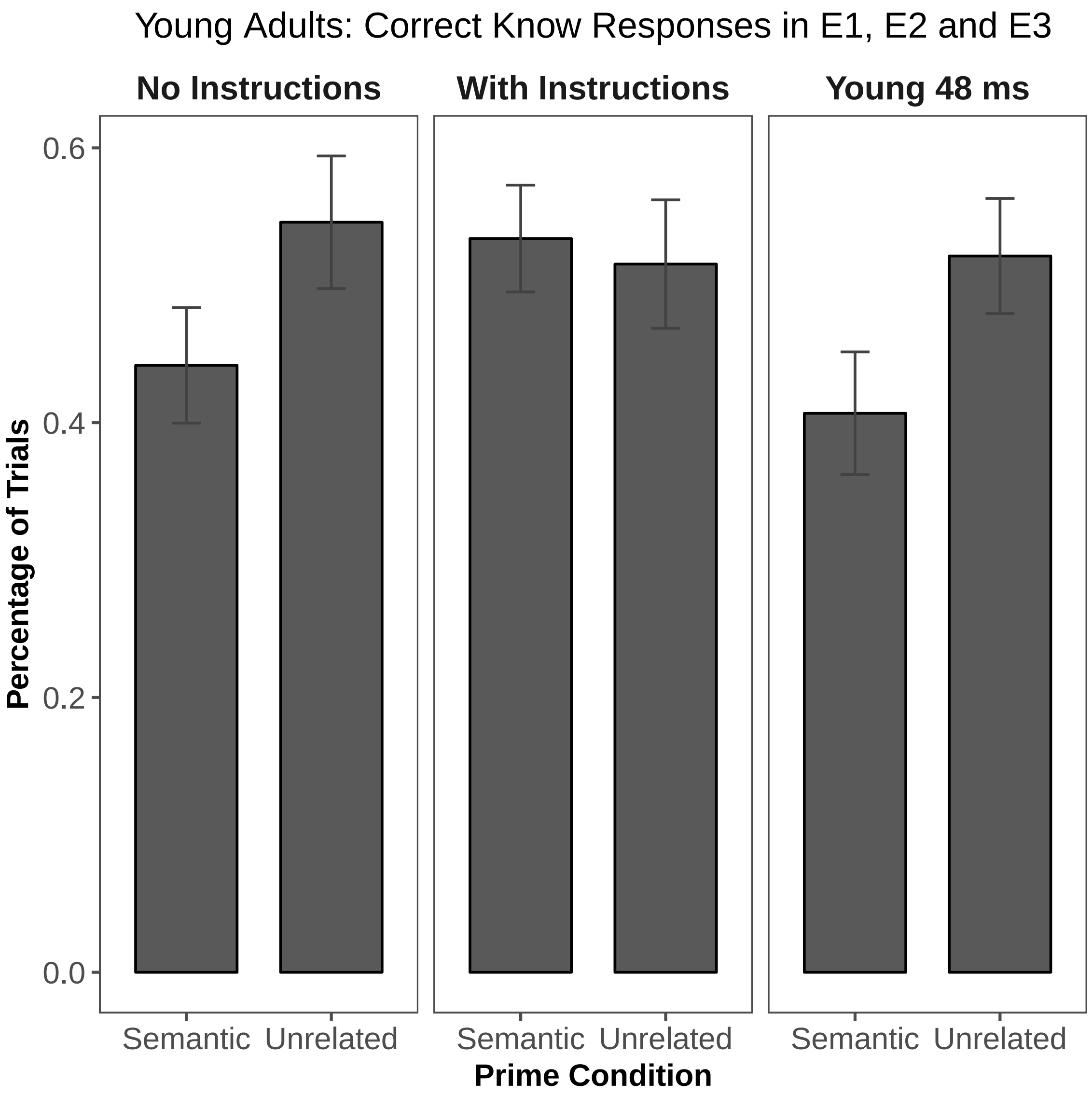
24.1 Young

```
> know_young_ru_percent = read.csv("young_know_ru.csv",
+                                  header = TRUE, sep = ",")
> young_know_ru = know_young_ru_percent[,-1]
>  youngtotaltrials = spread(young_know_ru, Accuracy, Trials)
>  youngtotaltrials$`0` = ifelse(is.na(youngtotaltrials$`0`), 0,youngtotaltrials$`0`)
>  youngtotaltrials$`1`= ifelse(is.na(youngtotaltrials$`1`), 0,youngtotaltrials$`1`)
>  youngtotaltrials$total = youngtotaltrials$`0` + youngtotaltrials$`1`
>  youngtotaltrials$PercentCorrect = youngtotaltrials$`1`/youngtotaltrials$total
> youngtotaltrials$PercentIncorrect = youngtotaltrials$`0`/youngtotaltrials$total
> ## remove NA trials
>
> #totaltrials = totaltrials %>% filter(!(is.na(Rpercent) & is.na(Upercent)))
>
> ## convert back to long
>
> # long_youngpercent <- totaltrials %>% gather(PrimeCondition,
> #                                              Percent,
> #                                        PercentCorrect:PercentIncorrect)%>%
> #    arrange(Subject)
>
> youngtotaltrials$Subject = as.factor(youngtotaltrials$Subject)
> anova_youngpercent = aov(data = youngtotaltrials,
+                          PercentCorrect ~ Experiment*PrimeCondition +
+                            Error(Subject/PrimeCondition))
> summary(anova_youngpercent)
```

```
Error: Subject
           Df Sum Sq Mean Sq F value Pr(>F)
Experiment   2  0.127 0.06329   0.882  0.417
Residuals  103  7.394 0.07179

Error: Subject:PrimeCondition
                         Df Sum Sq Mean Sq F value Pr(>F)
PrimeCondition            1  0.256 0.25569   3.937 0.0499 *
```

```
Experiment:PrimeCondition    2   0.187  0.09333    1.437  0.2424
Residuals                  103   6.690  0.06495
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1
```

```
> young_know_data = Rmisc::summarySE(youngtotaltrials,
+                         measurevar = "PercentCorrect",
+                         groupvars = c("Experiment" ,
+                                       "PrimeCondition"))
> young_know_plot = young_know_data %>%
+    mutate(PrimeType = factor(PrimeCondition, levels = unique(PrimeCondition),
+                labels = c("Semantic", "Unrelated")))%>%
+ ggplot(aes(x = PrimeType, y = PercentCorrect))+
+  geom_bar(stat = "identity", position = "dodge", width = 0.7, color= "black")+
+   geom_errorbar(aes(ymin=PercentCorrect - se, ymax=PercentCorrect + se),
+              width=.2, color = "gray26",
+              position = position_dodge(0.7))+
+  theme_few()+
+    scale_fill_wsj()+
+   facet_wrap(~Experiment)+
+  # scale_fill_manual(values = c("royalblue4", "slategray1"))+
+     xlab("Prime Condition") + ylab("Percentage of Trials") +
+   ggtitle("Young Adults: Correct Know Responses in E1, E2 and E3")  +
+    theme(axis.text = element_text(size = rel(1)),
+           axis.title = element_text(face = "bold", size = rel(1)),
+           legend.title = element_text(face = "bold", size = rel(1)),
+          plot.title = element_text(hjust = .5),
+          strip.text.x = element_text(face = "bold", size = rel(1.4)))
>  young_know_plot
```



24.2 Young Correct Incorrect

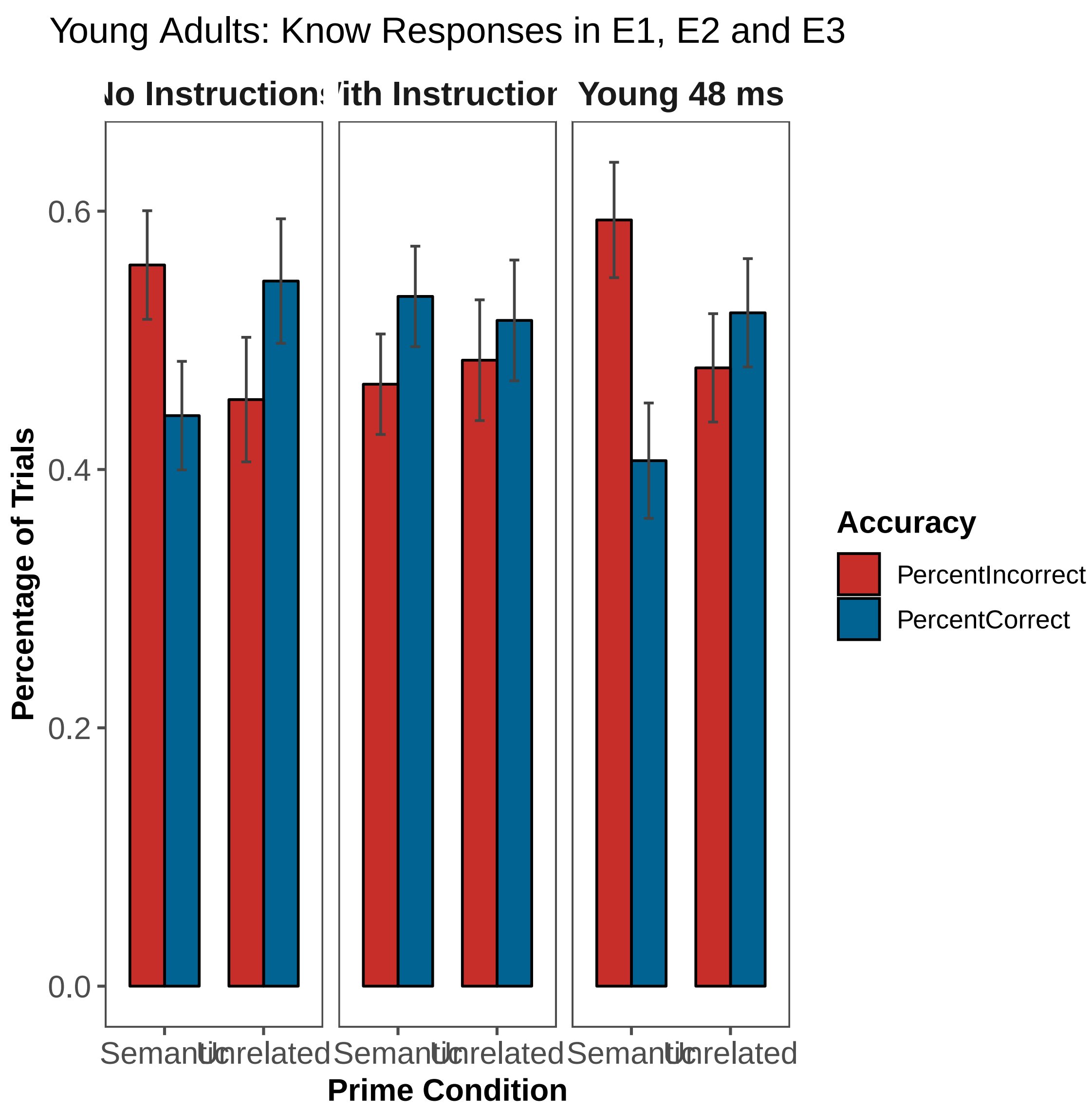
```
> know_young_ru_percent = read.csv("young_know_ru.csv",
+                                  header = TRUE, sep = ",")
> young_know_ru = know_young_ru_percent[,-1]
>  youngtotaltrials = spread(young_know_ru, Accuracy, Trials)
>  youngtotaltrials$`0` = ifelse(is.na(youngtotaltrials$`0`), 0,youngtotaltrials$`0`)
>  youngtotaltrials$`1`= ifelse(is.na(youngtotaltrials$`1`), 0,youngtotaltrials$`1`)
>  youngtotaltrials$total = youngtotaltrials$`0` + youngtotaltrials$`1`
>  youngtotaltrials$PercentCorrect = youngtotaltrials$`1`/youngtotaltrials$total
```

```
> youngtotaltrials$PercentIncorrect = youngtotaltrials$`0`/youngtotaltrials$total
> ## convert back to long
>
>  long_youngpercent ← youngtotaltrials %>% gather(Type,
+                                            Percent,
+                                      PercentCorrect:PercentIncorrect)%>%
+    arrange(Subject, PrimeCondition)
>  long_youngpercent$Type = as.factor(long_youngpercent$Type)
>   long_youngpercent$Subject = as.factor(long_youngpercent$Subject)
> ##   correct and incorrect anova
> anova_youngpercent_all = aov(data = long_youngpercent,
+                          Percent ~ Experiment*PrimeCondition*Type +
+                            Error(Subject/(PrimeCondition*Type)))
> summary(anova_youngpercent_all)
```

```
Error: Subject
             Df     Sum Sq   Mean Sq F value Pr(>F)
Experiment    2 2.400e-30 1.202e-30   1.915  0.153
Residuals   103 6.467e-29 6.278e-31

Error: Subject:PrimeCondition
                           Df   Sum Sq   Mean Sq F value Pr(>F)
PrimeCondition              1 3.32e-29 3.319e-29   3.417 0.0674 .
Experiment:PrimeCondition   2 6.82e-29 3.410e-29   3.511 0.0335 *
Residuals                 103 1.00e-27 9.710e-30
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Subject:Type
                 Df Sum Sq Mean Sq F value Pr(>F)
Type              1  0.019 0.01896   0.132  0.717
Experiment:Type   2  0.253 0.12659   0.882  0.417
Residuals       103 14.788 0.14357

Error: Subject:PrimeCondition:Type
                                Df Sum Sq Mean Sq F value Pr(>F)
PrimeCondition:Type              1  0.511  0.5114   3.937 0.0499 *
Experiment:PrimeCondition:Type   2  0.373  0.1867   1.437 0.2424
Residuals                      103 13.380  0.1299
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1
```

```
>  ## correct and incorrect
> young_know_data_all = Rmisc::summarySE(long_youngpercent,
+                         measurevar = "Percent",
+                         groupvars = c("Experiment" ,
+                                       "PrimeCondition", "Type"))
> young_know_data_all$Accuracy = factor(young_know_data_all$Type,
```

```
+                              levels(young_know_data_all$Type)[c(2,1)])
> young_know_plot_all = young_know_data_all %>%
+    mutate(PrimeType = factor(PrimeCondition, levels = unique(PrimeCondition),
+                labels = c("Semantic", "Unrelated")))%>%
+ ggplot(aes(x = PrimeType, y = Percent,
+            group = Accuracy, fill = Accuracy))+
+  geom_bar(stat = "identity", position = "dodge", width = 0.7, color= "black")+
+   geom_errorbar(aes(ymin=Percent - se, ymax=Percent + se),
+              width=.2, color = "gray26",
+              position = position_dodge(0.7))+
+  theme_few()+
+    scale_fill_wsj()+
+   facet_wrap(~Experiment)+
+  # scale_fill_manual(values = c("royalblue4", "slategray1"))+
+     xlab("Prime Condition") + ylab("Percentage of Trials") +
+   ggtitle("Young Adults: Know Responses in E1, E2 and E3")  +
+    theme(axis.text = element_text(size = rel(1)),
+           axis.title = element_text(face = "bold", size = rel(1)),
+           legend.title = element_text(face = "bold", size = rel(1)),
+          plot.title = element_text(hjust = .5),
+          strip.text.x = element_text(face = "bold", size = rel(1.4)))
>  young_know_plot_all
```



24.3 Old

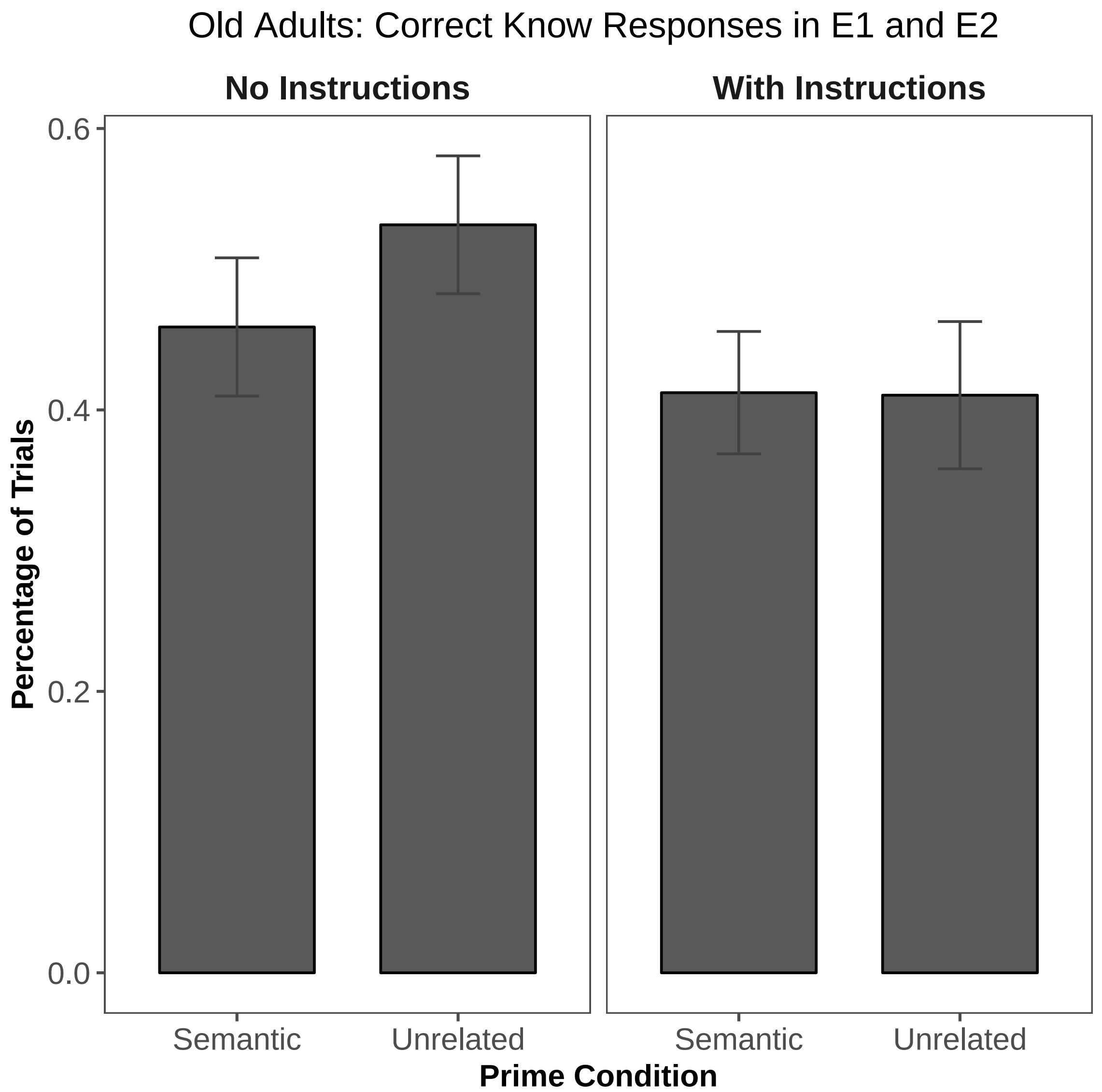
```
> know_old_ru_percent = read.csv("old_know_ru.csv",
+                                header = TRUE, sep = ",")
>  old_know_ru = know_old_ru_percent[,-1]
>  oldtotaltrials = spread(old_know_ru, Accuracy, Trials)
>  oldtotaltrials$`0` = ifelse(is.na(oldtotaltrials$`0`), 0,oldtotaltrials$`0`)
>  oldtotaltrials$`1`= ifelse(is.na(oldtotaltrials$`1`), 0,oldtotaltrials$`1`)
>  oldtotaltrials$total = oldtotaltrials$`0` + oldtotaltrials$`1`
>   oldtotaltrials$PercentCorrect = oldtotaltrials$`1`/oldtotaltrials$total
```

```
> oldtotaltrials$PercentIncorrect = oldtotaltrials$`0`/oldtotaltrials$total
> #totaltrials = totaltrials %>% filter(!(i1.s.na(Rpercent) & is.na(Upercent)))
>
>
> ## convert back to long
>
> # long_oldpercent ← totaltrials %>% gather(PrimeCondition,
> #                                              Percent, Rpercent:Upercent)%>%
> #   arrange(Subject)
>
>
> ## Subject 702 does not have U know trials at all
>
>
>  oldtotaltrials = oldtotaltrials %>% filter(Subject != "702")
>  oldtotaltrials$`0` = as.numeric(as.character(oldtotaltrials$`0`))
>  oldtotaltrials$`1` = as.numeric(as.character(oldtotaltrials$`1`))
> oldtotaltrials$Subject = as.factor(oldtotaltrials$Subject)
> anova_oldpercent = aov(data = oldtotaltrials,
+                          PercentCorrect ~ Experiment*PrimeCondition +
+                            Error(Subject/PrimeCondition))
> summary(anova_oldpercent)
```

```
Error: Subject
           Df Sum Sq Mean Sq F value Pr(>F)
Experiment  1  0.234  0.2344   2.114  0.151
Residuals  65  7.207  0.1109

Error: Subject:PrimeCondition
                          Df Sum Sq Mean Sq F value Pr(>F)
PrimeCondition             1  0.049 0.04888   1.005  0.320
Experiment:PrimeCondition  1  0.046 0.04608   0.947  0.334
Residuals                 65  3.163 0.04866
```

```
> old_know_data = Rmisc::summarySE(oldtotaltrials,
+                         measurevar = "PercentCorrect",
+                         groupvars = c("Experiment" ,
+                                       "PrimeCondition"))
> old_know_plot = old_know_data %>%
+    mutate(PrimeType = factor(PrimeCondition, levels = unique(PrimeCondition),
+             labels = c("Semantic", "Unrelated")))%>%
+ ggplot(aes(x = PrimeType, y = PercentCorrect))+
+  geom_bar(stat = "identity", position = "dodge", width = 0.7, color= "black")+
+   geom_errorbar(aes(ymin=PercentCorrect - se, ymax=PercentCorrect + se),
+            width=.2, color = "gray26",
+            position = position_dodge(0.7))+
+  theme_few()+
+    scale_fill_wsj()+
```

```
+   facet_wrap(~Experiment)+
+  # scale_fill_manual(values = c("royalblue4", "slategray1"))+
+     xlab("Prime Condition") + ylab("Percentage of Trials") +
+   ggtitle("Old Adults: Correct Know Responses in E1 and E2 ")  +
+    theme(axis.text = element_text(size = rel(1)),
+           axis.title = element_text(face = "bold", size = rel(1)),
+           legend.title = element_text(face = "bold", size = rel(1)),
+          plot.title = element_text(hjust = .5),
+          strip.text.x = element_text(face = "bold", size = rel(1.4)))
> old_know_plot
```



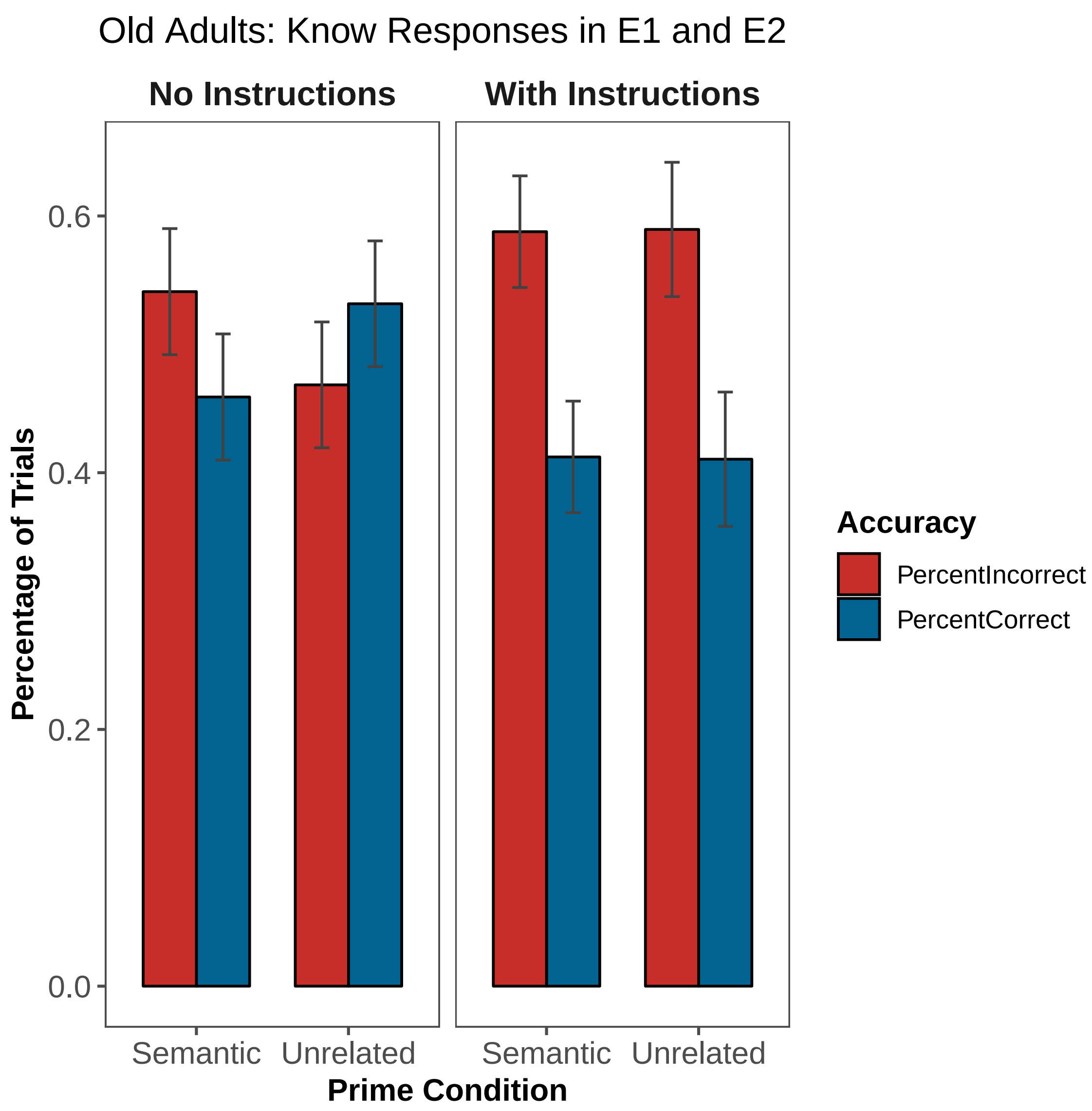
24.4 Old Correct Incorrect

```
> know_old_ru_percent = read.csv("old_know_ru.csv",
+                                 header = TRUE, sep = ",")
> old_know_ru = know_old_ru_percent[,-1]
>  oldtotaltrials = spread(old_know_ru, Accuracy, Trials)
>  oldtotaltrials$`0` = ifelse(is.na(oldtotaltrials$`0`), 0,oldtotaltrials$`0`)
>  oldtotaltrials$`1`= ifelse(is.na(oldtotaltrials$`1`), 0,oldtotaltrials$`1`)
>  oldtotaltrials$total = oldtotaltrials$`0` + oldtotaltrials$`1`
>   oldtotaltrials$PercentCorrect = oldtotaltrials$`1`/oldtotaltrials$total
> oldtotaltrials$PercentIncorrect = oldtotaltrials$`0`/oldtotaltrials$total
> #totaltrials = totaltrials %>% filter(!(i1.s.na(Rpercent) & is.na(Upercent)))
> ## convert back to long
>
> long_oldpercent ← oldtotaltrials %>% gather(Type,
+                                              Percent,
+                                        PercentCorrect:PercentIncorrect)%>%
+    arrange(Subject, PrimeCondition)
>  long_oldpercent$Type = as.factor(long_oldpercent$Type)
>  ## Subject 702 does not have U know trials at all
>
>
>  long_oldpercent = long_oldpercent %>% filter(Subject != "702")
> long_oldpercent$Subject = as.factor(long_oldpercent$Subject)
> ##  correct and incorrect anova
> anova_oldpercent_all = aov(data = long_oldpercent,
+                          Percent ~ Experiment*PrimeCondition*Type +
+                            Error(Subject/(PrimeCondition*Type)))
> summary(anova_oldpercent_all)
```

```
Error: Subject
           Df    Sum Sq   Mean Sq F value Pr(>F)
Experiment  1 9.760e-31 9.761e-31   2.821 0.0978 .
Residuals  65 2.249e-29 3.460e-31
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Subject:PrimeCondition
                          Df    Sum Sq   Mean Sq F value Pr(>F)
PrimeCondition             1 8.000e-31 7.982e-31   0.338  0.563
Experiment:PrimeCondition  1 1.150e-30 1.152e-30   0.487  0.488
Residuals                 65 1.537e-28 2.365e-30

Error: Subject:Type
                Df Sum Sq Mean Sq F value Pr(>F)
Type             1  0.508  0.5081   2.291  0.135
Experiment:Type  1  0.469  0.4688   2.114  0.151
Residuals       65 14.415  0.2218
```

```
Error: Subject:PrimeCondition:Type
                              Df Sum Sq Mean Sq F value Pr(>F)
PrimeCondition:Type            1  0.098 0.09776   1.005  0.320
Experiment:PrimeCondition:Type  1  0.092 0.09216   0.947  0.334
Residuals                     65  6.326 0.09732
```

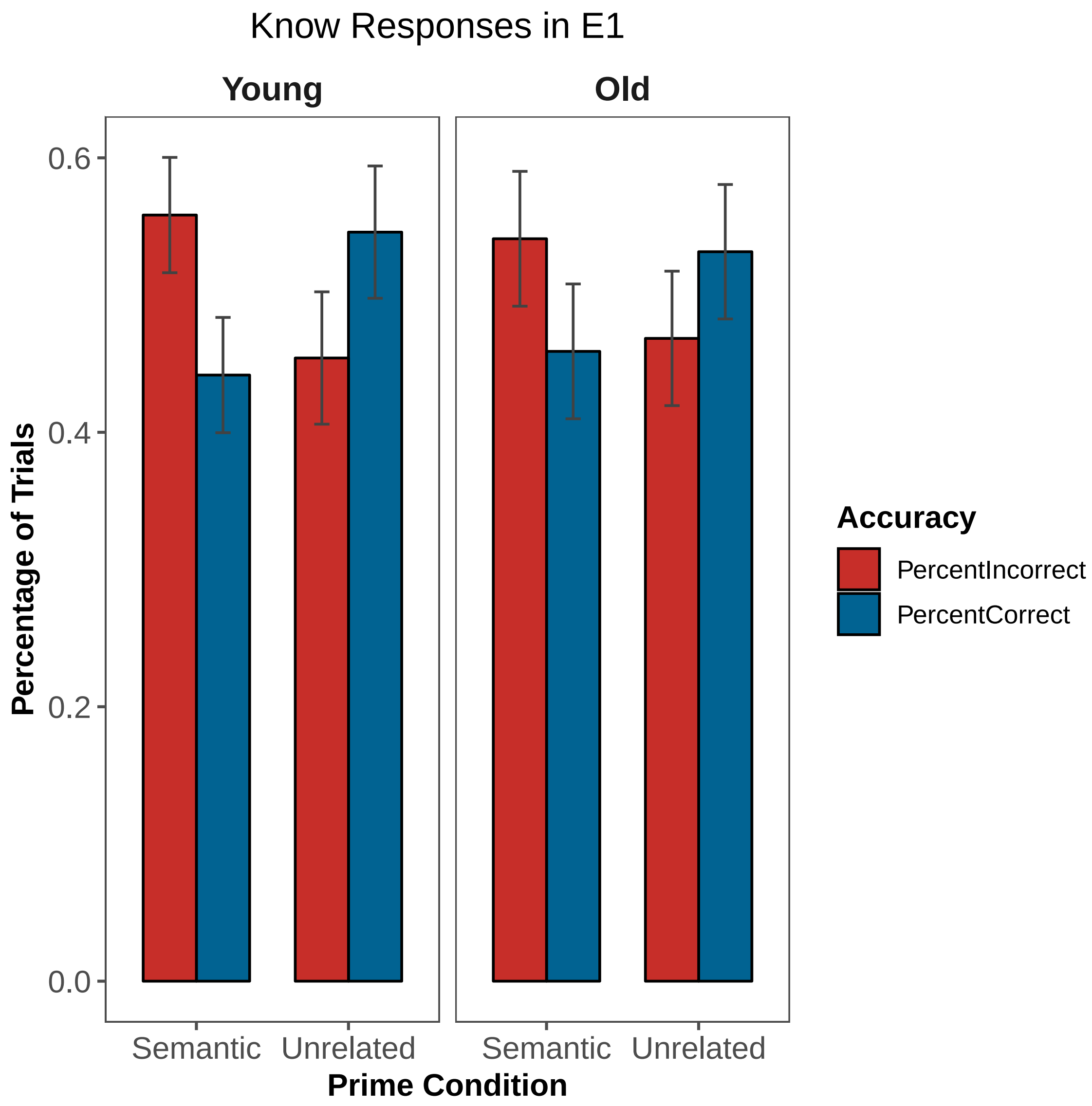
```
> old_know_data_all = Rmisc::summarySE(long_oldpercent,
+                       measurevar = "Percent",
+                       groupvars = c("Experiment" ,
+                                     "PrimeCondition", "Type"))
> old_know_data_all$Accuracy = factor(old_know_data_all$Type,
+                           levels(old_know_data_all$Type)[c(2,1)])
> old_know_plot_all = old_know_data_all %>%
+    mutate(PrimeType = factor(PrimeCondition, levels = unique(PrimeCondition),
+                 labels = c("Semantic", "Unrelated")))%>%
+ ggplot(aes(x = PrimeType, y = Percent,
+            group= Accuracy, fill= Accuracy))+
+  geom_bar(stat = "identity", position = "dodge", width = 0.7, color= "black")+
+   geom_errorbar(aes(ymin=Percent - se, ymax=Percent + se),
+              width=.2, color = "gray26",
+              position = position_dodge(0.7))+
+  theme_few()+
+    scale_fill_wsj()+
+   facet_wrap(~Experiment)+
+  # scale_fill_manual(values = c("royalblue4", "slategray1"))+
+     xlab("Prime Condition") + ylab("Percentage of Trials") +
+   ggtitle("Old Adults: Know Responses in E1 and E2 ")  +
+    theme(axis.text = element_text(size = rel(1)),
+           axis.title = element_text(face = "bold", size = rel(1)),
+           legend.title = element_text(face = "bold", size = rel(1)),
+          plot.title = element_text(hjust = .5),
+          strip.text.x = element_text(face = "bold", size = rel(1.4)))
>  old_know_plot_all
```



24.5 Age Differences

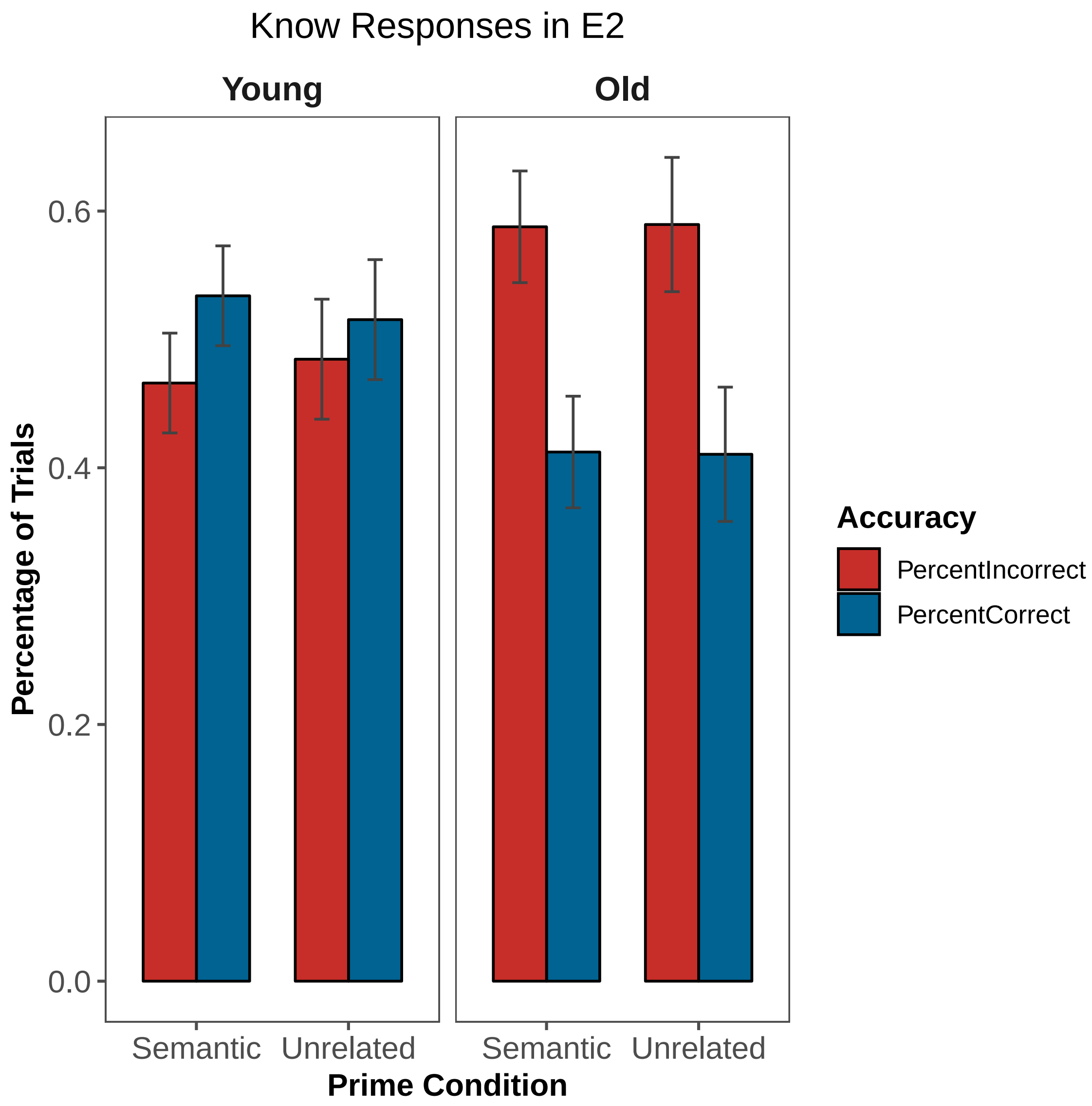
```
> long_oldyoung = rbind(long_youngpercent, long_oldpercent)
> long_e1 = long_oldyoung %>% filter(Experiment == "No Instructions")
> long_e2 = long_oldyoung %>% filter(Experiment == "With Instructions")
> ### Experiment 1
> long_e1_rmisc = Rmisc::summarySE(long_e1,
+                        measurevar = "Percent",
+                        groupvars = c("AgeGroup" ,
+                                      "PrimeCondition", "Type"))
```

```
> long_e1_rmisc$Accuracy = factor(long_e1_rmisc$Type,
+                              levels(long_e1_rmisc$Type)[c(2,1)])
> long_e1_rmisc_plot = long_e1_rmisc %>%
+    mutate(PrimeType = factor(PrimeCondition, levels = unique(PrimeCondition),
+                  labels = c("Semantic", "Unrelated")))%>%
+ ggplot(aes(x = PrimeType, y = Percent,
+            group= Accuracy, fill= Accuracy))+
+  geom_bar(stat = "identity", position = "dodge", width = 0.7, color= "black")+
+   geom_errorbar(aes(ymin=Percent - se, ymax=Percent + se),
+              width=.2, color = "gray26",
+              position = position_dodge(0.7))+
+  theme_few()+
+    scale_fill_wsj()+
+   facet_wrap(~AgeGroup)+
+  # scale_fill_manual(values = c("royalblue4", "slategray1"))+
+     xlab("Prime Condition") + ylab("Percentage of Trials") +
+   ggtitle("Know Responses in E1  ")  +
+    theme(axis.text = element_text(size = rel(1)),
+           axis.title = element_text(face = "bold", size = rel(1)),
+           legend.title = element_text(face = "bold", size = rel(1)),
+          plot.title = element_text(hjust = .5),
+          strip.text.x = element_text(face = "bold", size = rel(1.4)))
>  long_e1_rmisc_plot
```




```
>  ### Experiment 2
>  long_e2_rmisc = Rmisc::summarySE(long_e2,
+                             measurevar = "Percent",
+                             groupvars = c("AgeGroup" ,
+                                           "PrimeCondition", "Type"))
> long_e2_rmisc$Accuracy = factor(long_e2_rmisc$Type,
+                                   levels(long_e2_rmisc$Type)[c(2,1)])
> long_e2_rmisc_plot = long_e2_rmisc %>%
+    mutate(PrimeType = factor(PrimeCondition, levels = unique(PrimeCondition),
+                  labels = c("Semantic", "Unrelated")))%>%
+ ggplot(aes(x = PrimeType, y = Percent,
```

```
+             group= Accuracy, fill= Accuracy))+
+   geom_bar(stat = "identity", position = "dodge", width = 0.7, color= "black")+
+    geom_errorbar(aes(ymin=Percent - se, ymax=Percent + se),
+               width=.2, color = "gray26",
+               position = position_dodge(0.7))+
+   theme_few()+
+     scale_fill_wsj()+
+    facet_wrap(~AgeGroup)+
+   # scale_fill_manual(values = c("royalblue4", "slategray1"))+
+      xlab("Prime Condition") + ylab("Percentage of Trials") +
+    ggtitle("Know Responses in E2  ")  +
+     theme(axis.text = element_text(size = rel(1)),
+           axis.title = element_text(face = "bold", size = rel(1)),
+           legend.title = element_text(face = "bold", size = rel(1)),
+          plot.title = element_text(hjust = .5),
+          strip.text.x = element_text(face = "bold", size = rel(1.4)))
>   long_e2_rmisc_plot
```



24.5.1 HLMS

```
> long_e1_hlm = lmer(data = long_e1, Percent ~ AgeGroup*PrimeCondition*Type +
+                    (1|Subject))
>  car::Anova(long_e1_hlm)
```

```
Analysis of Deviance Table (Type II Wald chisquare tests)

Response: Percent
                               Chisq Df  Pr(>Chisq)
AgeGroup                      0.0000  1    1.000000
```

```
PrimeCondition                 0.0000  1   1.000000
Type                           0.1083  1   0.742059
AgeGroup:PrimeCondition        0.0000  1   1.000000
AgeGroup:Type                  0.0020  1   0.964385
PrimeCondition:Type            7.0686  1   0.007845 **
AgeGroup:PrimeCondition:Type   0.2241  1   0.635930
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1
```

```
>  long_e2_hlm = lmer(data = long_e2, Percent ~ AgeGroup*PrimeCondition*Type +
+                     (1|Subject))
>  car::Anova(long_e2_hlm)
```

```
Analysis of Deviance Table (Type II Wald chisquare tests)

Response: Percent
                                Chisq Df Pr(>Chisq)
AgeGroup                       0.0000  1  1.0000000
PrimeCondition                 0.0000  1  1.0000000
Type                           3.5245  1  0.0604677 .
AgeGroup:PrimeCondition        0.0000  1  1.0000000
AgeGroup:Type                 12.3983  1  0.0004297 ***
PrimeCondition:Type            0.1053  1  0.7455727
AgeGroup:PrimeCondition:Type   0.0682  1  0.7939437
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1
```

24.6 State Accuracy Figures

Experiment 1

```
> exp1_fig_state_acc = Rmisc::summarySE(exp_1_state_acc,
+                          measurevar = "Trials",
+                          groupvars = c("AgeGroup", "Question.RESP", "Accuracy"))
> exp1_fig_state_acc =  arrange(exp1_fig_state_acc,
+                                 desc(AgeGroup))
> exp1_fig_state_acc$Accuracy = as.factor(as.character(exp1_fig_state_acc$Accuracy))
> library(ggplot2)
> library(ggthemes)
>  state_1_acc = exp1_fig_state_acc %>% mutate(State = factor(Question.RESP,
+                                    levels = unique(Question.RESP),
+                              labels = c("Know", "Dont Know", "Other", "TOT")),
+                              Age = factor(AgeGroup, levels = unique(AgeGroup),
+                      labels = c("Young", "Old")),
+                      TargetAcc = factor(Accuracy, levels = unique(Accuracy),
+                      labels = c("Failed Retrieval", "Correct Retrieval")))%>%
+ ggplot(aes(x = State, y = Trials,
```

```
+             group = TargetAcc, fill = TargetAcc))+
+   geom_bar(stat = "identity", position = "dodge", width = 0.7, color= "black")+
+    geom_errorbar(aes(ymin=Trials - ci, ymax=Trials + ci),
+               width=.2, color = "gray26",
+               position = position_dodge(0.7))+
+   theme_few()+
+    facet_wrap(~Age)+
+     scale_fill_wsj()+
+   # scale_fill_manual(values = c("royalblue4", "slategray1"))+
+      xlab("") + ylab("") +
+    ggtitle("E1: Young vs. Old (Without Instructions)")  +
+     theme(axis.text = element_text(size = rel(1)),
+            axis.title = element_text(face = "bold", size = rel(1)),
+            legend.title = element_text(face = "bold", size = rel(1)),
+           plot.title = element_text(hjust = .5),
+           strip.text.x = element_text(face = "bold", size = rel(1.4)))
>
```

Experiment 2

```
>  exp2_fig_state_acc = Rmisc::summarySE(exp_2_state_acc,
+                         measurevar = "Trials",
+                         groupvars = c("AgeGroup", "Question.RESP", "Accuracy"))
> exp2_fig_state_acc =  arrange(exp2_fig_state_acc,
+                               desc(AgeGroup))
> exp2_fig_state_acc$Accuracy = as.factor(as.character(exp2_fig_state_acc$Accuracy))
> library(ggplot2)
> library(ggthemes)
>  state_2_acc = exp2_fig_state_acc %>% mutate(State = factor(Question.RESP,
+                                    levels = unique(Question.RESP),
+                             labels = c("Know", "Dont Know", "Other", "TOT")),
+                             Age = factor(AgeGroup, levels = unique(AgeGroup),
+                      labels = c("Young", "Old")),
+                      TargetAcc = factor(Accuracy, levels = unique(Accuracy),
+                      labels = c("Failed Retrieval", "Correct Retrieval")))%>%
+ ggplot(aes(x = State, y = Trials,
+             group = TargetAcc, fill = TargetAcc))+
+   geom_bar(stat = "identity", position = "dodge", width = 0.7, color= "black")+
+    geom_errorbar(aes(ymin=Trials - ci, ymax=Trials + ci),
+               width=.2, color = "gray26",
+               position = position_dodge(0.7))+
+   theme_few()+
+    facet_wrap(~Age)+
+     scale_fill_wsj()+
+   # scale_fill_manual(values = c("royalblue4", "slategray1"))+
+      xlab("") + ylab("") +
+    ggtitle("E2: Young vs. Old (With Instructions)")  +
```

```
+     theme(axis.text = element_text(size = rel(1)),
+            axis.title = element_text(face = "bold", size = rel(1)),
+            legend.title = element_text(face = "bold", size = rel(1)),
+           plot.title = element_text(hjust = .5),
+           strip.text.x = element_text(face = "bold", size = rel(1.4)))
```

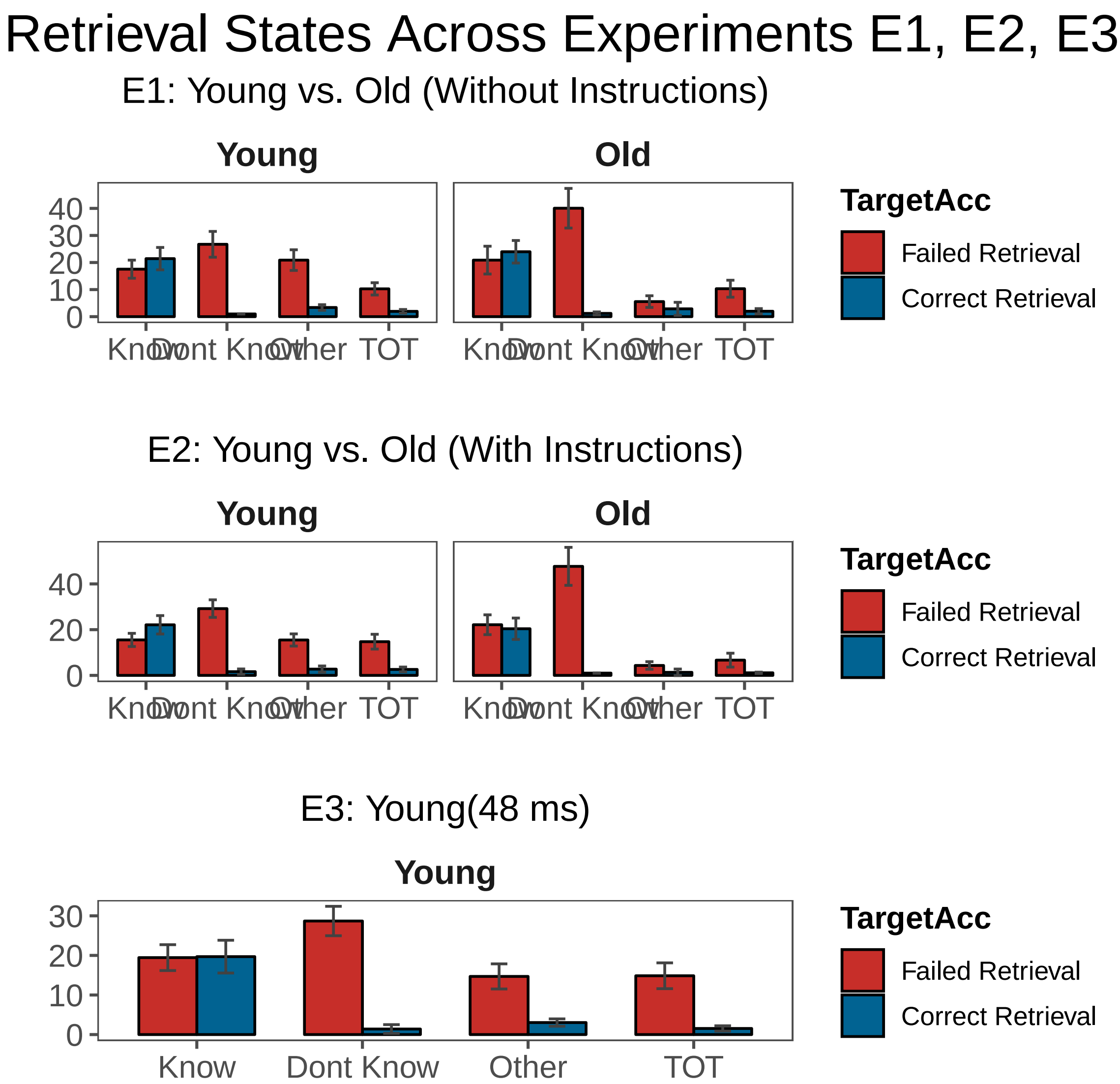
Experiment 3

```
>  exp3_fig_state_acc = Rmisc::summarySE(exp_3_state_acc,
+                          measurevar = "Trials",
+                          groupvars = c("AgeGroup", "Question.RESP", "Accuracy"))
> exp3_fig_state_acc =  arrange(exp3_fig_state_acc,
+                                 desc(AgeGroup))
> exp3_fig_state_acc$Accuracy = as.factor(as.character(exp3_fig_state_acc$Accuracy))
> library(ggplot2)
> library(ggthemes)
> state_3_acc= exp3_fig_state_acc %>% mutate(State = factor(Question.RESP,
+                                    levels = unique(Question.RESP),
+                              labels = c("Know", "Dont Know", "Other", "TOT")),
+                              Age = factor(AgeGroup, levels = unique(AgeGroup),
+                        labels = c("Young")),
+                        TargetAcc = factor(Accuracy, levels = unique(Accuracy),
+                        labels = c("Failed Retrieval", "Correct Retrieval")))%>%
+ ggplot(aes(x = State, y = Trials,
+            group = TargetAcc, fill = TargetAcc))+
+  geom_bar(stat = "identity", position = "dodge", width = 0.7, color= "black")+
+   geom_errorbar(aes(ymin=Trials - ci, ymax=Trials + ci),
+              width=.2, color = "gray26",
+              position = position_dodge(0.7))+
+  theme_few()+
+   facet_wrap(~Age)+
+    scale_fill_wsj()+
+   #scale_fill_manual(values = c("royalblue4", "slategray1"))+
+     xlab("") + ylab("") +
+   ggtitle("E3: Young(48 ms)")  +
+    theme(axis.text = element_text(size = rel(1)),
+           axis.title = element_text(face = "bold", size = rel(1)),
+           legend.title = element_text(face = "bold", size = rel(1)),
+          plot.title = element_text(hjust = .5),
+          strip.text.x = element_text(face = "bold", size = rel(1.4)))
```

Combined

```
> library(grid)
> gridExtra::grid.arrange(state_1_acc, state_2_acc, state_3_acc,
+                          nrow = 3, ncol = 1,
```

```
+         top=textGrob("Retrieval States Across Experiments E1, E2, E3",
+                                    gp=gpar(fontsize=20)))
```



25 Conditional TOT Analysis

```
> j ← read.csv("MainJulieagg_5studies.csv", header = TRUE, sep = ",")
> j ← subset(j, j$value.Subject != 198 & j$value.Subject != 95)
> j_condTOT = j[,c(2,3,4,5,95:103)]
> j_condTOT$value.Subject = as.factor(j_condTOT$value.Subject)
> library(tidyr)
```

```
> library(dplyr)
> condTOTprime ← j_condTOT %>%
+   gather(PrimeState, Proportion,
+          condpropTOT_r, condpropTOT_p,condpropTOT_b, condpropTOT_u) %>%
+   separate(PrimeState, c('State', 'Prime'), sep = "_") %>%
+   arrange(value.Subject)
> colnames(condTOTprime) = c("AgeGroup", "Subject", "StudyNo", "PrimeInstruction", "cond
+                            "r_TOT", "p_TOT", "b_TOT", "u_TOT", "State",
+                                        "PrimeCondition", "Proportion")
> condTOTprime$AgeGroup ← as.factor(condTOTprime$AgeGroup)
> condTOTprime$Subject ← as.factor(condTOTprime$Subject)
> condTOTprime$StudyNo ← as.factor(condTOTprime$StudyNo)
> condTOTprime$PrimeInstruction ← as.factor(condTOTprime$PrimeInstruction)
> condTOTprime$PrimeCondition ← as.factor(condTOTprime$PrimeCondition)
> condTOTprime$Proportion ← as.numeric(as.character(condTOTprime$Proportion))
> condTOT_exp1 = j_condTOT %>% filter(value.StudyNo == '2' | value.StudyNo == '4')
> condTOT_exp2 = j_condTOT %>% filter(value.StudyNo == '5' | value.StudyNo == '6')
> condTOT_exp3 = j_condTOT %>% filter(value.StudyNo == '1')
> condTOTprime_exp1 = condTOTprime %>% filter(StudyNo == '2' | StudyNo == '4')
> condTOTprime_exp2 = condTOTprime %>% filter(StudyNo == '5' | StudyNo == '6')
> condTOTprime_exp3 = condTOTprime %>% filter(StudyNo == '1')
>
```

25.1 Experiment 1

25.1.1 CondTOT: Young vs Old

```
> e1_condTOT_aov = aov(data = condTOT_exp1, condTOTprop ~ value.AgeGroup)
> summary(e1_condTOT_aov)
```

```
               Df Sum Sq  Mean Sq F value Pr(>F)
value.AgeGroup  1 0.0032 0.003247   0.104  0.748
Residuals      70 2.1829 0.031185
```

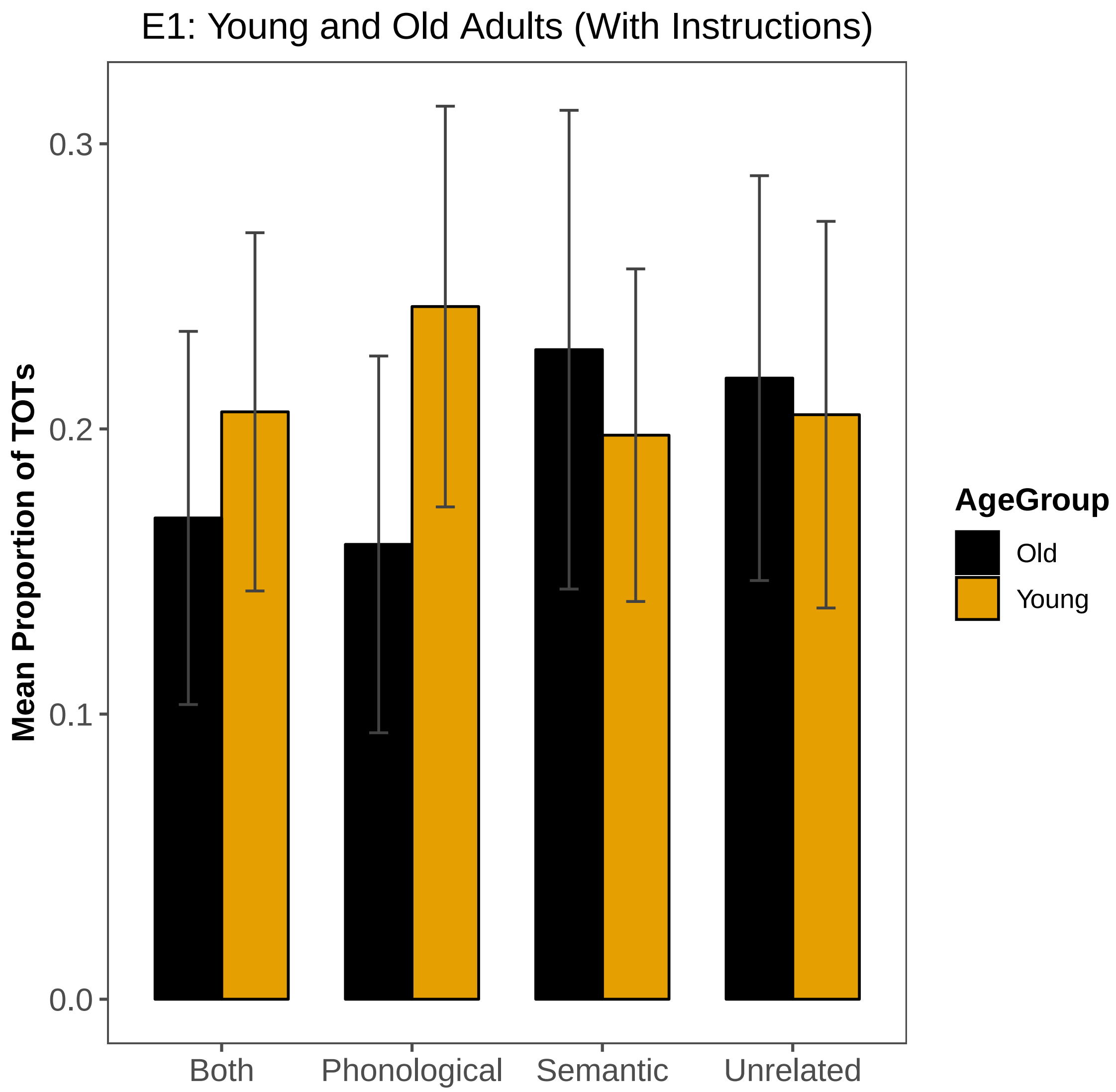
25.1.2 CondTOT: Age x PrimeType

```
> condTOTprime_exp1[179,12 ] = 0
> e1_condTOTprime_aov = aov(data = condTOTprime_exp1, Proportion ~ AgeGroup*PrimeConditi
+                             Error(Subject/PrimeCondition))
> summary(e1_condTOTprime_aov)
```

```
Error: Subject
          Df Sum Sq Mean Sq F value Pr(>F)
AgeGroup   1  0.027 0.02724   0.227  0.635
Residuals 70  8.403 0.12004
```

```
Error: Subject:PrimeCondition
                          Df Sum Sq Mean Sq F value Pr(>F)
PrimeCondition             3 0.0298 0.00992   0.673  0.570
AgeGroup:PrimeCondition    3 0.1421 0.04736   3.211  0.024 *
Residuals                210 3.0971 0.01475
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1
```

```
> exp1_fig_condTOT = Rmisc::summarySE(condTOTprime_exp1,
+                         measurevar = "Proportion",
+                         groupvars = c("AgeGroup", "PrimeCondition"))
> library(ggplot2)
> library(ggthemes)
> exp1_fig_condTOT = exp1_fig_condTOT %>% mutate(PrimeType = factor(PrimeCondition,
+                                                  levels = unique(PrimeCondition),
+                    labels = c("Both", "Phonological",
+                               "Semantic", "Unrelated")))%>%
+ ggplot(aes(x = PrimeType, y = Proportion,
+                               fill = AgeGroup, group = AgeGroup))+
+  geom_bar(stat = "identity", position = "dodge", width = 0.7, color= "black")+
+   geom_errorbar(aes(ymin=Proportion - ci, ymax=Proportion + ci),
+              width=.2, color = "gray26",
+              position = position_dodge(0.7))+
+  theme_few()+
+  scale_fill_colorblind()+
+     xlab("") + ylab("Mean Proportion of TOTs") +
+   ggtitle("E1: Young and Old Adults (With Instructions)")  +
+    theme(axis.text = element_text(size = rel(1)),
+           axis.title = element_text(face = "bold", size = rel(1)),
+           legend.title = element_text(face = "bold", size = rel(1)),
+          plot.title = element_text(hjust = .5),
+          strip.text.x = element_text(face = "bold", size = rel(1.4)))
> exp1_fig_condTOT
```



25.2 Experiment 2

25.2.1 CondTOT: Young vs Old

```
> e2_condTOT_aov = aov(data = condTOT_exp2, condTOTprop ~ value.AgeGroup)
> summary(e2_condTOT_aov)
```

```
               Df Sum Sq Mean Sq F value  Pr(>F)
value.AgeGroup  1  0.263 0.26297   11.11 0.00145 **
Residuals      62  1.467 0.02366
---
```

```
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1
```

```
> options(contrasts = c('contr.sum', 'contr.poly'))
> library(lsmeans)
> library(multcomp)
> exp2_target_lsm = lsmeans::lsmeans(e2_condTOT_aov, c("value.AgeGroup"))
> prime_effect = cld(exp2_target_lsm, alpha = 0.05,
+                    adjust = "tukey", details = TRUE)
> library(knitr)
> kable(subset(prime_effect$comparisons,prime_effect$comparisons$p.value < 0.05 ))
```

```
|contrast     |  estimate|        SE| df|  t.ratio|   p.value|
|:------------|---------:|---------:|--:|--------:|---------:|
|Young - Old  | 0.1282018| 0.0384561| 62| 3.333719| 0.0014496|
```

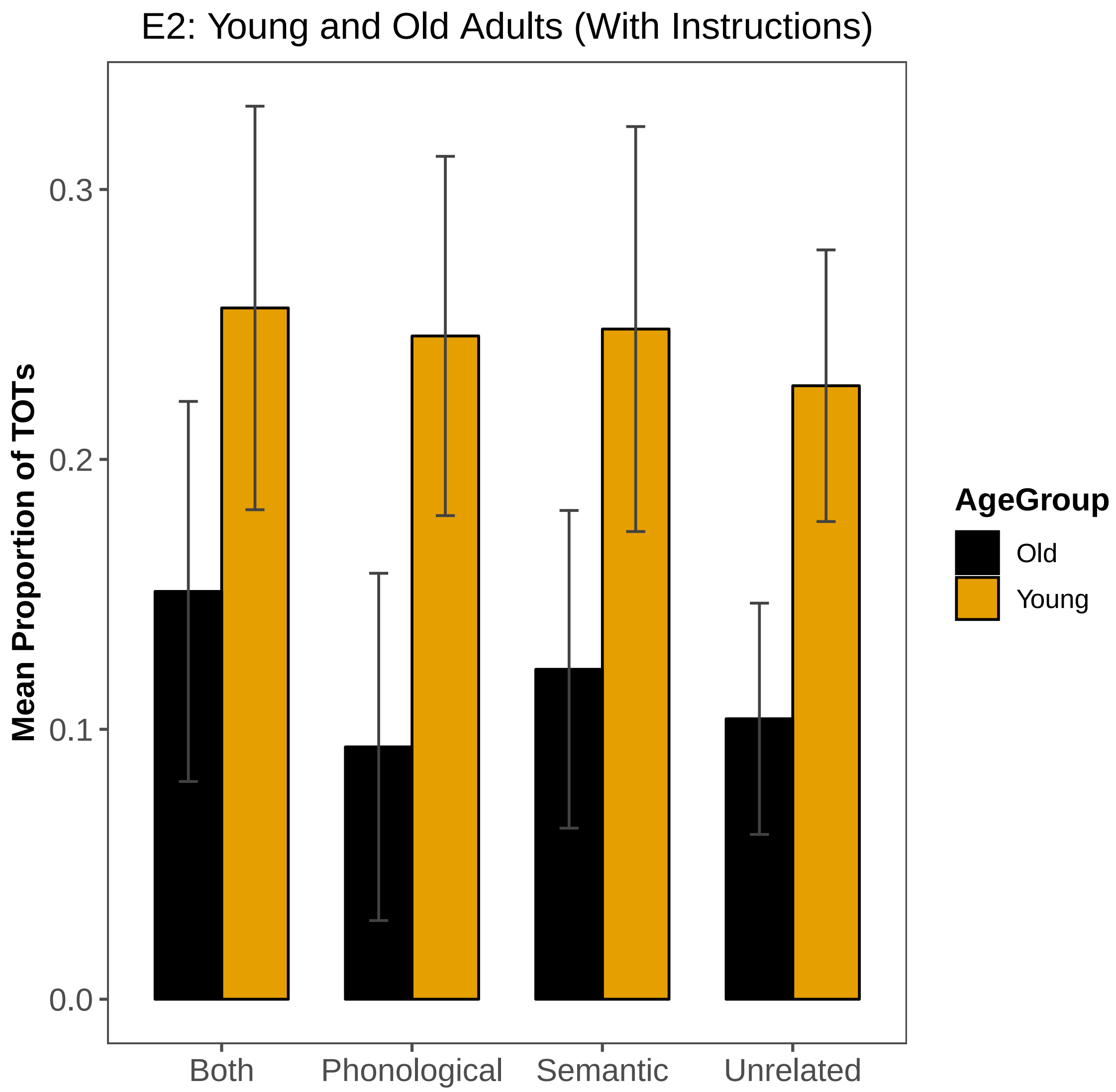
25.2.2 CondTOT: Age x PrimeType

```
> e2_condTOTprime_aov = aov(data = condTOTprime_exp2, Proportion ~ AgeGroup*PrimeConditi
+                                Error(Subject/PrimeCondition))
> summary(e2_condTOTprime_aov)
```

```
Error: Subject
          Df Sum Sq Mean Sq F value  Pr(>F)
AgeGroup   1  1.027  1.0270   10.65 0.00179 **
Residuals 62  5.976  0.0964
---
Signif. codes:  0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Error: Subject:PrimeCondition
                        Df Sum Sq  Mean Sq F value Pr(>F)
PrimeCondition           3 0.0573 0.019111   1.984  0.118
AgeGroup:PrimeCondition  3 0.0181 0.006047   0.628  0.598
Residuals              186 1.7914 0.009631
```

```
> exp2_fig_condTOT = Rmisc::summarySE(condTOTprime_exp2,
+                         measurevar = "Proportion",
+                         groupvars = c("AgeGroup", "PrimeCondition"))
> library(ggplot2)
> library(ggthemes)
> exp2_fig_condTOT = exp2_fig_condTOT %>% mutate(PrimeType = factor(PrimeCondition,
+                                                levels = unique(PrimeCondition),
+                      labels = c("Both", "Phonological",
+                                 "Semantic", "Unrelated")))%>%
+ ggplot(aes(x = PrimeType, y = Proportion,
+                              fill = AgeGroup, group = AgeGroup))+
+  geom_bar(stat = "identity", position = "dodge", width = 0.7, color= "black")+
+   geom_errorbar(aes(ymin=Proportion - ci, ymax=Proportion + ci),
```

```
+               width=.2, color = "gray26",
+               position = position_dodge(0.7))+
+  theme_few()+
+  scale_fill_colorblind()+
+     xlab("") + ylab("Mean Proportion of TOTs") +
+   ggtitle("E2: Young and Old Adults (With Instructions)")  +
+    theme(axis.text = element_text(size = rel(1)),
+           axis.title = element_text(face = "bold", size = rel(1)),
+           legend.title = element_text(face = "bold", size = rel(1)),
+          plot.title = element_text(hjust = .5),
+          strip.text.x = element_text(face = "bold", size = rel(1.4)))
> exp2_fig_condTOT
```



25.3 Experiment 3

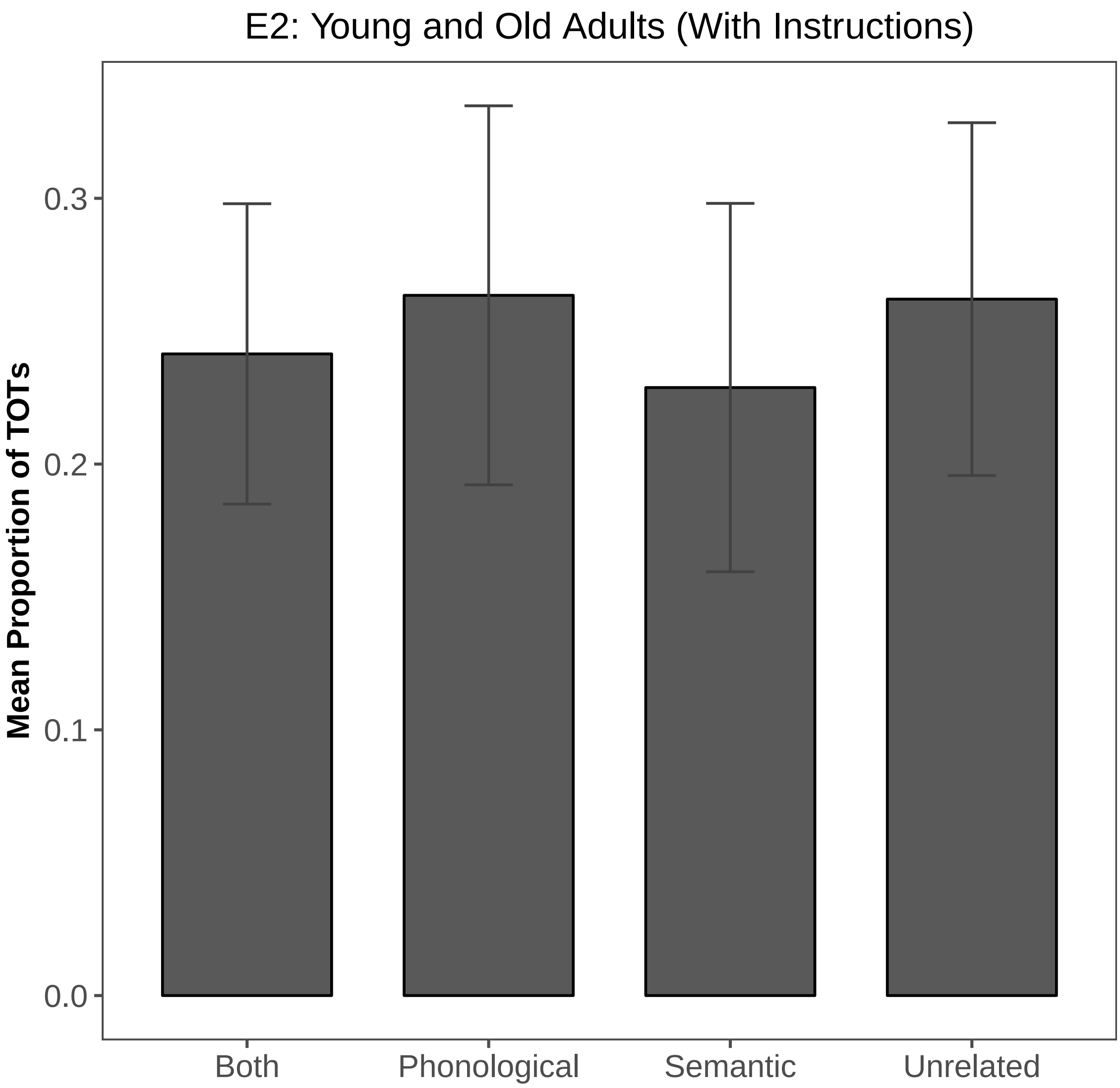
25.3.1 CondTOT:PrimeType

```
> e3_condTOTprime_aov = aov(data = condTOTprime_exp3, Proportion ~ PrimeCondition +
+                          Error(Subject/PrimeCondition))
> summary(e3_condTOTprime_aov)
```

```
Error: Subject
          Df Sum Sq Mean Sq F value Pr(>F)
Residuals 35  4.385  0.1253
```

```
Error: Subject:PrimeCondition
                Df Sum Sq  Mean Sq F value Pr(>F)
PrimeCondition   3 0.0305 0.010153   1.108  0.349
Residuals      105 0.9625 0.009167
```

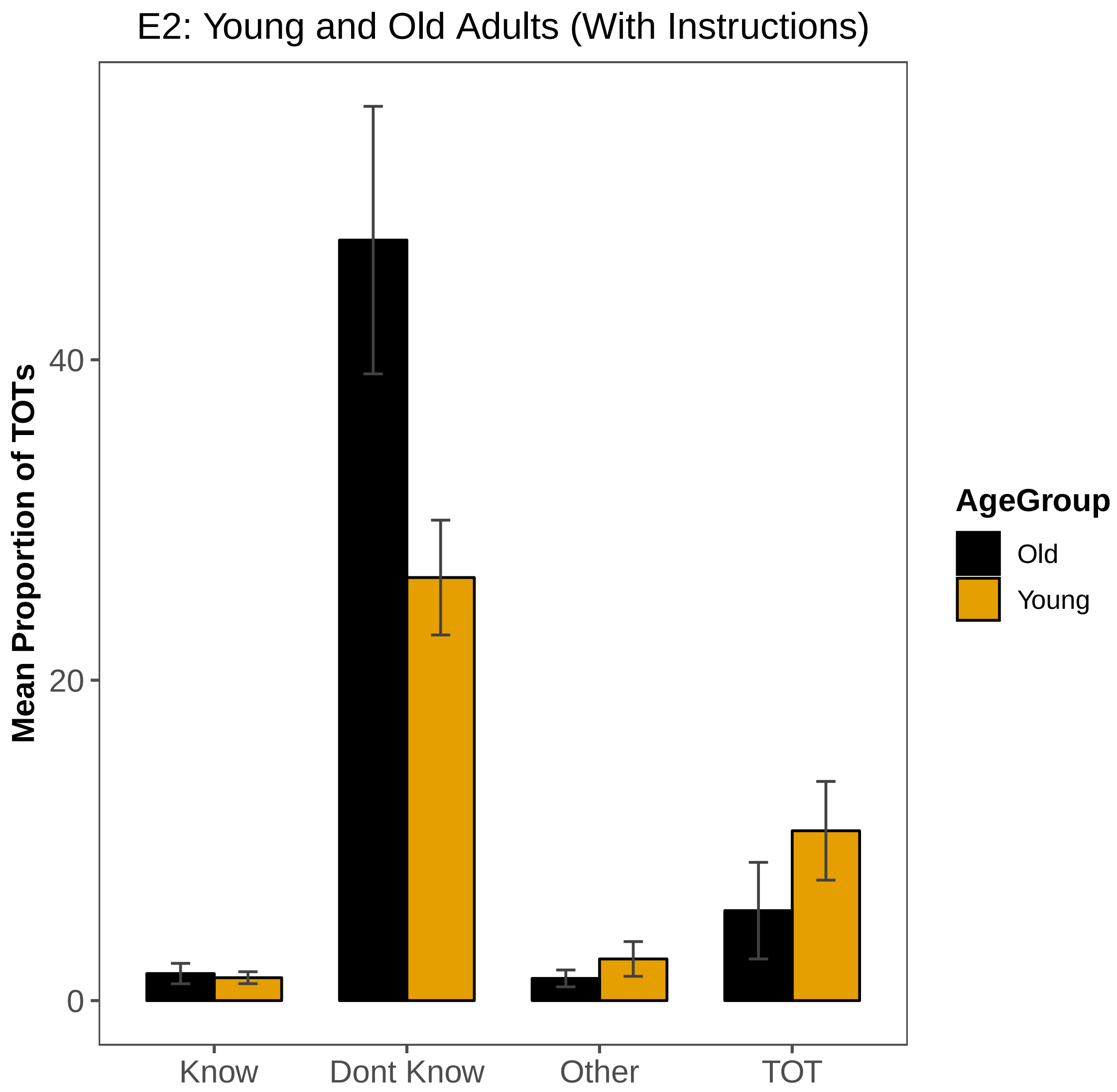
```
> exp3_fig_condTOT = Rmisc::summarySE(condTOTprime_exp3,
+                         measurevar = "Proportion",
+                         groupvars = c("PrimeCondition"))
> library(ggplot2)
> library(ggthemes)
> exp3_fig_condTOT = exp3_fig_condTOT %>% mutate(PrimeType = factor(PrimeCondition,
+                                                   levels = unique(PrimeCondition),
+                    labels = c("Both", "Phonological",
+                               "Semantic", "Unrelated")))%>%
+ ggplot(aes(x = PrimeType, y = Proportion))+
+  geom_bar(stat = "identity", position = "dodge", width = 0.7, color= "black")+
+   geom_errorbar(aes(ymin=Proportion - ci, ymax=Proportion + ci),
+              width=.2, color = "gray26",
+              position = position_dodge(0.7))+
+  theme_few()+
+  scale_fill_colorblind()+
+     xlab("") + ylab("Mean Proportion of TOTs") +
+   ggtitle("E2: Young and Old Adults (With Instructions)")  +
+    theme(axis.text = element_text(size = rel(1)),
+           axis.title = element_text(face = "bold", size = rel(1)),
+           legend.title = element_text(face = "bold", size = rel(1)),
+          plot.title = element_text(hjust = .5),
+          strip.text.x = element_text(face = "bold", size = rel(1.4)))
> exp3_fig_condTOT
```



26 TOT for No Responses

```
> statedata ← read.csv("Julie_Main5Studies.csv", header = TRUE, sep = ",")
> statedata ← subset(statedata, statedata$Subject!= 198 & statedata$Subject!= 95)
> statedata_TOT = statedata %>% filter(FreeResp %in% c("0", "", "1", "2", "3",
+                                                      "4", "9", "20", "40",
+                                                      "{-}", "{-}{SPACE}",
+                                                      "{SHIFT}", "{SPACE}"))
> ## now we are looking only at trials in which the participant did not respond at all
>
```

```
> NoResp_exp1 = statedata_TOT %>% filter(StudyNo == '2' | StudyNo == '4')
> NoResp_exp2 = statedata_TOT %>% filter(StudyNo == '5' | StudyNo == '6')
> NoResp_exp3 = statedata_TOT %>% filter(StudyNo == '1')
> NoResp_exp2_agg = group_by(NoResp_exp2, Subject, AgeGroup, Question.RESP) %>%
+   summarise(Trials = n())
> exp2_fig_noresp= Rmisc::summarySE(NoResp_exp2_agg,
+                         measurevar = "Trials",
+                         groupvars = c("AgeGroup", "Question.RESP"))
> library(ggplot2)
> library(ggthemes)
> exp2_fig_noresp_plot = exp2_fig_noresp %>%
+ mutate (RetrievalState = factor(Question.RESP, levels = unique(Question.RESP),
+                             labels = c(" Know", "Dont Know", "Other", "TOT")))%>%
+ ggplot(aes(x = RetrievalState, y = Trials,
+            group = AgeGroup, fill = AgeGroup))+
+  geom_bar(stat = "identity", position = "dodge", width = 0.7, color= "black")+
+   geom_errorbar(aes(ymin=Trials - ci, ymax=Trials + ci),
+              width=.2, color = "gray26",
+              position = position_dodge(0.7))+
+  theme_few()+
+  scale_fill_colorblind()+
+     xlab("") + ylab("Mean Proportion of TOTs") +
+   ggtitle("E2: Young and Old Adults (With Instructions)")  +
+    theme(axis.text = element_text(size = rel(1)),
+           axis.title = element_text(face = "bold", size = rel(1)),
+           legend.title = element_text(face = "bold", size = rel(1)),
+          plot.title = element_text(hjust = .5),
+          strip.text.x = element_text(face = "bold", size = rel(1.4)))
> exp2_fig_noresp_plot
```

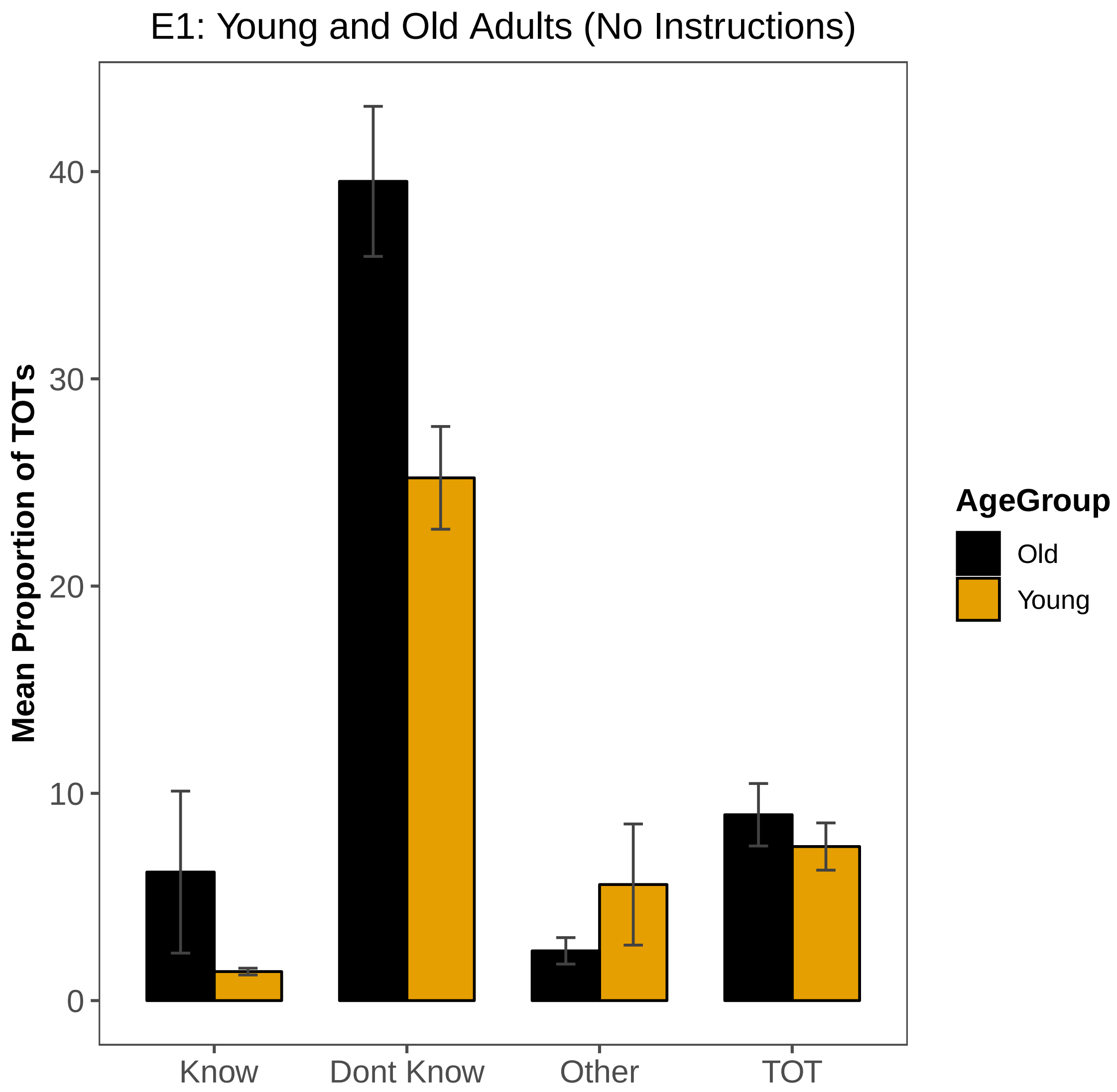



```
> e2_noresp_TOT = NoResp_exp2_agg %>% filter(Question.RESP == "4")
> y_TOT = e2_noresp_TOT %>% filter(AgeGroup == "Young")
> o_TOT = e2_noresp_TOT %>% filter(AgeGroup == "Old")
> t.test(y_TOT$Trials, o_TOT$Trials)
```

```
        Welch Two Sample t-test

data:  y_TOT$Trials and o_TOT$Trials
t = 2.3737, df = 53.888, p-value = 0.02121
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
```

```
 0.7742541 9.1949767
sample estimates:
mean of x mean of y
10.600000  5.615385
```

```
> ## E1
>
> NoResp_exp1_agg = group_by(NoResp_exp1, Subject, AgeGroup, Question.RESP) %>%
+   summarise(Trials = n())
> exp1_fig_noresp= Rmisc::summarySE(NoResp_exp1_agg,
+                          measurevar = "Trials",
+                          groupvars = c("AgeGroup", "Question.RESP"))
> library(ggplot2)
> library(ggthemes)
> exp1_fig_noresp_plot = exp1_fig_noresp %>%
+ mutate (RetrievalState = factor(Question.RESP, levels = unique(Question.RESP),
+                             labels = c(" Know", "Dont Know", "Other", "TOT")))%>%
+ ggplot(aes(x = RetrievalState, y = Trials,
+            group = AgeGroup, fill = AgeGroup))+
+  geom_bar(stat = "identity", position = "dodge", width = 0.7, color= "black")+
+   geom_errorbar(aes(ymin=Trials - se, ymax=Trials + se),
+              width=.2, color = "gray26",
+              position = position_dodge(0.7))+
+  theme_few()+
+  scale_fill_colorblind()+
+     xlab("") + ylab("Mean Proportion of TOTs") +
+   ggtitle("E1: Young and Old Adults (No Instructions)")  +
+    theme(axis.text = element_text(size = rel(1)),
+           axis.title = element_text(face = "bold", size = rel(1)),
+           legend.title = element_text(face = "bold", size = rel(1)),
+          plot.title = element_text(hjust = .5),
+          strip.text.x = element_text(face = "bold", size = rel(1.4)))
> exp1_fig_noresp_plot
```

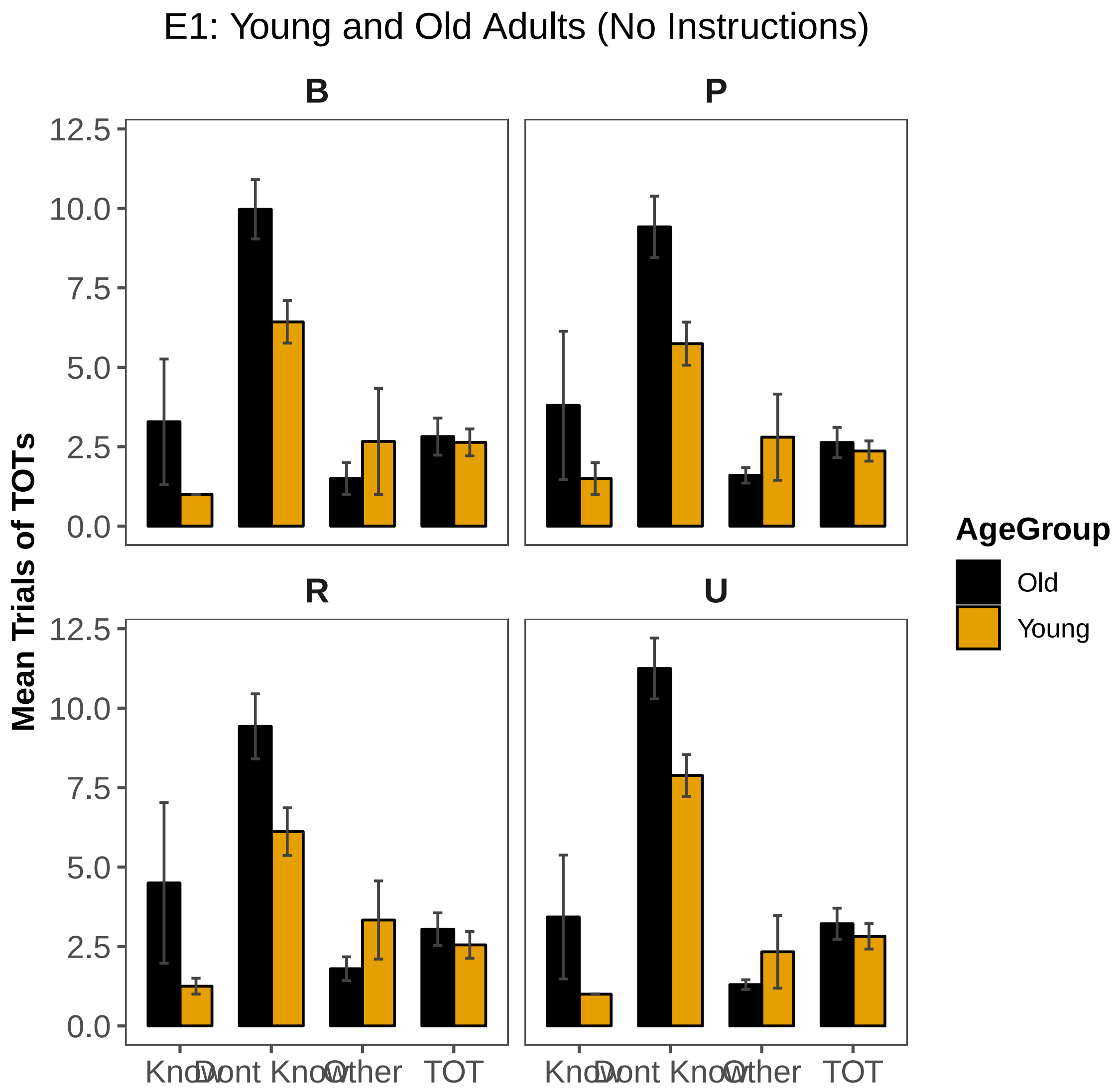



```
> ## OA more TOTs than YA when not producing a response: test this AOV
>
> e1_noresp_TOT = NoResp_exp1_agg %>% filter(Question.RESP == "4")
> y_TOT = e1_noresp_TOT %>% filter(AgeGroup == "Young")
> o_TOT = e1_noresp_TOT %>% filter(AgeGroup == "Old")
> t.test(y_TOT$Trials, o_TOT$Trials) ## no difference
```

```
        Welch Two Sample t-test

data:  y_TOT$Trials and o_TOT$Trials
t = -0.81147, df = 53.981, p-value = 0.4207
```

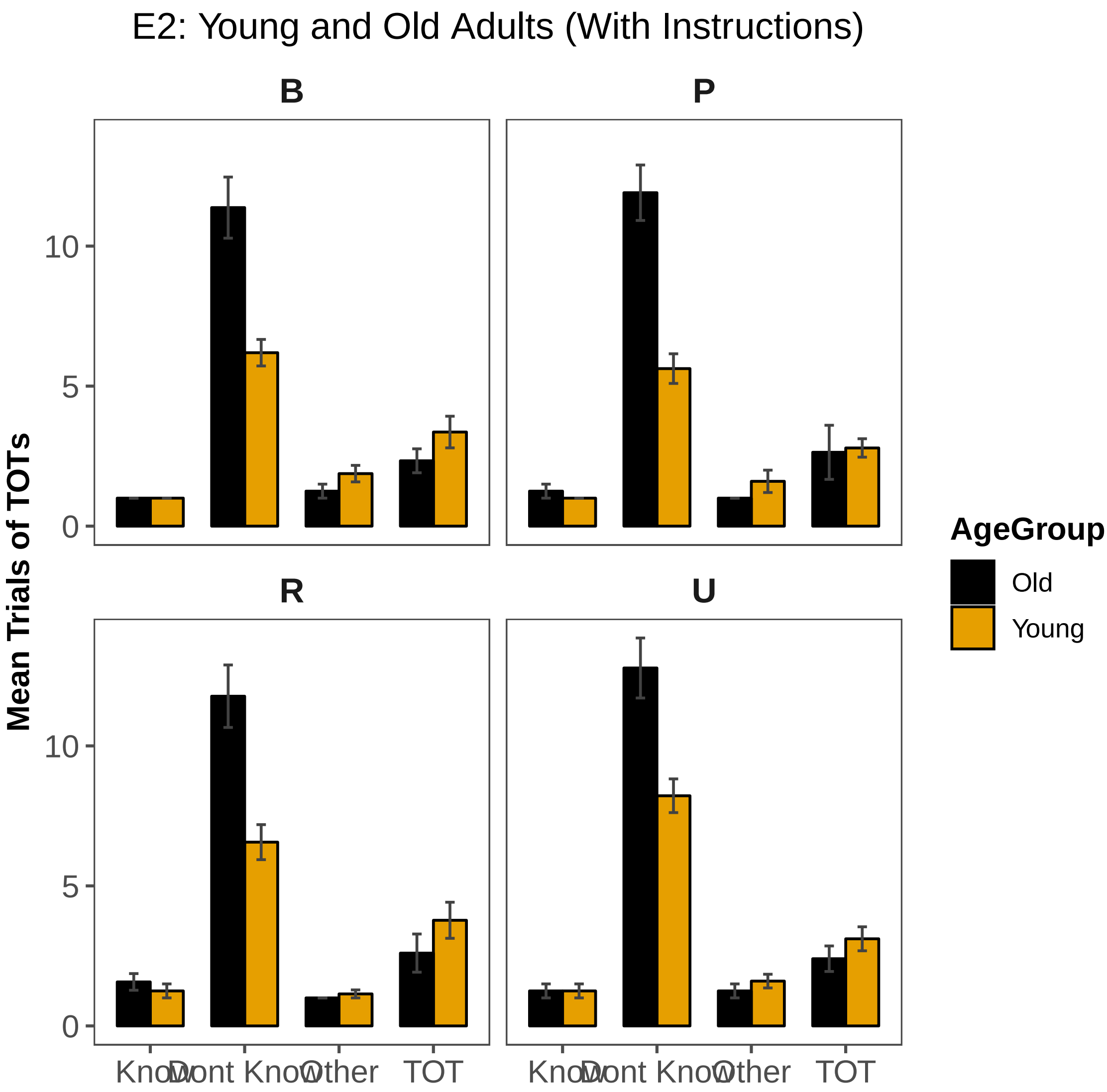
```
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -5.321736  2.255069
sample estimates:
mean of x mean of y
 7.433333  8.966667
```

```
> ## Does this vary with prime type? ## nope
>
> NoResp_exp1_prime_agg = group_by(NoResp_exp1, Subject, AgeGroup,PrimeCondition, Questi
+   summarise(Trials = n())
> exp1_fig_norespprime= Rmisc::summarySE(NoResp_exp1_prime_agg,
+                           measurevar = "Trials",
+                           groupvars = c("AgeGroup", "PrimeCondition", "Question.RESP"))
> library(ggplot2)
> library(ggthemes)
> exp1_fig_norespprime_plot = exp1_fig_norespprime %>%
+ mutate (RetrievalState = factor(Question.RESP, levels = unique(Question.RESP),
+                               labels = c(" Know", "Dont Know", "Other", "TOT")))%>%
+ ggplot(aes(x = RetrievalState, y = Trials,
+            group = AgeGroup, fill = AgeGroup))+
+  geom_bar(stat = "identity", position = "dodge", width = 0.7, color= "black")+
+   geom_errorbar(aes(ymin=Trials - se, ymax=Trials + se),
+              width=.2, color = "gray26",
+              position = position_dodge(0.7))+
+  theme_few()+
+   facet_wrap(~PrimeCondition)+
+  scale_fill_colorblind()+
+     xlab("") + ylab("Mean Trials of TOTs") +
+   ggtitle("E1: Young and Old Adults (No Instructions)")  +
+    theme(axis.text = element_text(size = rel(1)),
+           axis.title = element_text(face = "bold", size = rel(1)),
+           legend.title = element_text(face = "bold", size = rel(1)),
+          plot.title = element_text(hjust = .5),
+          strip.text.x = element_text(face = "bold", size = rel(1.4)))
> exp1_fig_norespprime_plot
```




```
> ## E2
> NoResp_exp2_prime_agg = group_by(NoResp_exp2, Subject, AgeGroup,PrimeCondition, Questi
+   summarise(Trials = n())
> exp2_fig_norespprime= Rmisc::summarySE(NoResp_exp2_prime_agg,
+                         measurevar = "Trials",
+                         groupvars = c("AgeGroup", "PrimeCondition", "Question.RESP"))
> library(ggplot2)
> library(ggthemes)
> exp2_fig_norespprime_plot = exp2_fig_norespprime %>%
+ mutate (RetrievalState = factor(Question.RESP, levels = unique(Question.RESP),
+                              labels = c(" Know", "Dont Know", "Other", "TOT")))%>%
```

```
+ ggplot(aes(x = RetrievalState, y = Trials,
+            group = AgeGroup, fill = AgeGroup))+
+  geom_bar(stat = "identity", position = "dodge", width = 0.7, color= "black")+
+   geom_errorbar(aes(ymin=Trials - se, ymax=Trials + se),
+               width=.2, color = "gray26",
+               position = position_dodge(0.7))+
+  theme_few()+
+   facet_wrap(~PrimeCondition)+
+  scale_fill_colorblind()+
+     xlab("") + ylab("Mean Trials of TOTs") +
+   ggtitle("E2: Young and Old Adults (With Instructions)")  +
+    theme(axis.text = element_text(size = rel(1)),
+          axis.title = element_text(face = "bold", size = rel(1)),
+          legend.title = element_text(face = "bold", size = rel(1)),
+         plot.title = element_text(hjust = .5),
+         strip.text.x = element_text(face = "bold", size = rel(1.4)))
> exp2_fig_norespprime_plot
```



27 TOT: Split by Target Accuracy