Correlation of all pre-test measures

	1	2	3	4
1. Child Age	--			
2. Highest Count	.21[a]	--		
3. Knower Level	.14	.29*	--	
4. Vocabulary	-.03	.36**	.46**	--
5. Executive Function	-.08	-.04	.51**	.48**

[a]p < .10; *p < .05; **p < .01

Analysis Output

```
library(car)

library(lme4)

library(lmerTest)

library(tidyverse)

library(rstanarm)

library(dplyr)
```

```
cbdata = read.csv("CB Data_FINAL.csv")
cbdata$ID = as.factor(cbdata$ï..ID)
cbdata$C_num = as.factor(cbdata$C_num)
cbdata$MomEd = as.numeric(cbdata$MomEd)

cbdata$SES = as.numeric(cbdata$SES)

cbdatalong = read.csv("CB Data_long.csv")
cbdatalong$ID = as.factor(cbdatalong$ï..ID)
```

Cardinality

Children's knower-level over time

```
gnovertime <- lmer(KnowerLevel ~ Condition*Session + Vocab + EF + Age + (Sess
ion|ID), data = cbdatalong)
Anova(gnovertime)

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

```
## Response: KnowerLevel
##                     Chisq Df Pr(>Chisq)
## Condition          0.1113  2  0.9458574
## Session           12.0161  1  0.0005274 ***
## Vocab              5.5525  1  0.0184546 *
## EF                 9.5000  1  0.0020547 **
## Age                3.3898  1  0.0656020 .
## Condition:Session  9.1687  2  0.0102102 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
summary(gnovertime)
```

```
## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: KnowerLevel ~ Condition * Session + Vocab + EF + Age + (Session |
##     ID)
##    Data: cbdatalong
##
## REML criterion at convergence: 644.3
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -3.12972 -0.32316 -0.04413  0.28264  3.14423
##
## Random effects:
##  Groups   Name        Variance Std.Dev. Corr
##  ID       (Intercept) 0.7927   0.8903
##           Session     0.2356   0.4854   0.00
##  Residual             0.4202   0.6482
## Number of obs: 213, groups:  ID, 71
##
## Fixed effects:
##                    Estimate Std. Error       df t value Pr(>|t|)
## (Intercept)        -8.37141    4.40107 65.10598  -1.902  0.06158 .
## ConditionR         -0.64950    0.39244 66.81442  -1.655  0.10261
## ConditionS         -0.22672    0.38831 66.25099  -0.584  0.56129
## Session             0.04000    0.13352 67.97888   0.300  0.76541
## Vocab               0.06185    0.02625 64.99945   2.356  0.02148 *
## EF                  0.99359    0.32236 64.99944   3.082  0.00301 **
## Age                 0.22119    0.12014 64.99938   1.841  0.07017 .
## ConditionR:Session  0.56870    0.19289 67.97879   2.948  0.00438 **
## ConditionS:Session  0.15565    0.19289 67.97880   0.807  0.42251
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr) CndtnR CndtnS Sessin Vocab  EF     Age    CndR:S
## ConditionR   0.073
## ConditionS   0.044  0.478
```

```
## Session     -0.029  0.322  0.325
## Vocab       -0.036  0.155  0.029  0.000
## EF          -0.110 -0.112  0.060  0.000 -0.492
## Age         -0.994 -0.123 -0.094  0.000 -0.033  0.089
## CndtnR:Sssn  0.020 -0.465 -0.225 -0.692  0.000  0.000  0.000
## CndtnS:Sssn  0.020 -0.223 -0.470 -0.692  0.000  0.000  0.000  0.479
```

Knower-Level improvement by post-test

```
gnimprovement <- glmer(KL_Improvement ~ C_num + (1|ID), data = cbdata, family
= binomial)

Anova(gnimprovement)

## Analysis of Deviance Table (Type II Wald chisquare tests)
##
## Response: KL_Improvement
##       Chisq Df Pr(>Chisq)
## C_num 17.58  2  0.0001522 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

summary(gnimprovement)

## Generalized linear mixed model fit by maximum likelihood (Laplace
##   Approximation) [glmerMod]
##  Family: binomial  ( logit )
## Formula: KL_Improvement ~ C_num + (1 | ID)
##    Data: cbdata
##
##      AIC      BIC   logLik deviance df.resid
##     76.6     85.7    -34.3     68.6       67
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -1.6833 -0.6614 -0.2949  0.5941  3.3912
##
## Random effects:
##  Groups Name        Variance  Std.Dev.
##  ID     (Intercept) 1.743e-08 0.000132
## Number of obs: 71, groups:  ID, 71
##
## Fixed effects:
##             Estimate Std. Error z value Pr(>|z|)
## (Intercept)  -2.4423     0.7388  -3.306 0.000947 ***
## C_num1        1.6157     0.8657   1.866 0.062011 .
## C_num2        3.4838     0.8802   3.958 7.57e-05 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
```

```
##        (Intr) C_num1
## C_num1 -0.852
## C_num2 -0.841  0.716
```

Counting Skill

```
cbdatalong_cd <- na.omit(cbdatalong)
```

Children's counting skill over time

```
cdovertime <- lmer(CountDisks ~ Session * Condition + Vocab + EF + Age + (Ses
sion | ID), data = cbdatalong_cd, control = lmerControl(optimizer = "bobyqa",
optCtrl = list(maxfun = 10000)), REML = FALSE)
Anova(cdovertime)

## Analysis of Deviance Table (Type II Wald chisquare tests)
##
## Response: CountDisks
##                     Chisq Df Pr(>Chisq)
## Session           24.9264  1  5.956e-07 ***
## Condition          5.8864  2  0.0526980 .
## Vocab             11.2704  1  0.0007875 ***
## EF                 3.5844  1  0.0583237 .
## Age                1.1083  1  0.2924536
## Session:Condition  9.0249  2  0.0109715 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

summary(cdovertime)

## Linear mixed model fit by maximum likelihood . t-tests use Satterthwaite's
##   method [lmerModLmerTest]
## Formula: CountDisks ~ Session * Condition + Vocab + EF + Age + (Session |
##     ID)
##    Data: cbdatalong_cd
## Control: lmerControl(optimizer = "bobyqa", optCtrl = list(maxfun = 10000))
##
##      AIC      BIC   logLik deviance df.resid
##   1185.6   1229.1   -579.8   1159.6      197
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -2.07400 -0.42521 -0.03899  0.43426  2.22279
##
## Random effects:
##  Groups   Name        Variance Std.Dev. Corr
##  ID       (Intercept) 25.094   5.009
##           Session      2.600   1.612    -0.64
##  Residual              5.687   2.385
## Number of obs: 210, groups:  ID, 71
##
```

```
## Fixed effects:
##                     Estimate Std. Error        df t value Pr(>|t|)
## (Intercept)        -13.55038   15.36694  71.54853  -0.882  0.38084
## Session              0.44000    0.46660  66.42597   0.943  0.34910
## ConditionR          -1.60077    1.82184  67.40659  -0.879  0.38271
## ConditionS          -2.05385    1.81090  66.38704  -1.134  0.26081
## Vocab                0.30706    0.09147  70.88245   3.357  0.00127 **
## EF                  -2.12659    1.12324  70.85855  -1.893  0.06241 .
## Age                  0.44097    0.41888  71.02259   1.053  0.29602
## Session:ConditionR   2.03784    0.67845  67.21810   3.004  0.00374 **
## Session:ConditionS   0.93130    0.67845  67.21811   1.373  0.17441
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr) Sessin CndtnR CndtnS Vocab  EF     Age    Sss:CR
## Session     -0.061
## ConditionR   0.033  0.511
## ConditionS   0.006  0.514  0.472
## Vocab       -0.036  0.000  0.116  0.023
## EF          -0.110  0.000 -0.084  0.046 -0.491
## Age         -0.992  0.000 -0.095 -0.067 -0.033  0.090
## Sssn:CndtnR  0.039 -0.688 -0.747 -0.354  0.000  0.000  0.003
## Sssn:CndtnS  0.045 -0.688 -0.351 -0.751 -0.001 -0.001 -0.003  0.473
```

Highest count improved by post-test

```
cdimprovement_raw <- glmer(CD_Improvement_Raw ~ C_num + (1|ID), data = cbdata
, family = binomial)

Anova(cdimprovement_raw)

## Analysis of Deviance Table (Type II Wald chisquare tests)
##
## Response: CD_Improvement_Raw
##                    Chisq Df Pr(>Chisq)
## C_num               9.0447  2    0.01086 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

summary(cdimprovement_raw)

## Generalized linear mixed model fit by maximum likelihood (Laplace
##   Approximation) [glmerMod]
##  Family: binomial  ( logit )
## Formula: CD_Improvement_Raw ~ C_num + (1 | ID)

##    Data: cbdata
##
##      AIC      BIC   logLik deviance df.resid
##     91.2    100.2    -41.6     83.2       67
```

```
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -2.1795 -0.8165  0.4588  0.6614  1.2247
##
## Random effects:
##  Groups Name        Variance  Std.Dev.
##  ID     (Intercept) 1.011e-07 0.0003179
## Number of obs: 71, groups:  ID, 71
##
## Fixed effects:
##             Estimate Std. Error z value Pr(>|z|)
## (Intercept)  -0.4055     0.4085  -0.993  0.32093
## C_num1        1.2321     0.6114   2.015  0.04389 *
## C_num2        1.9636     0.6878   2.855  0.00431 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##        (Intr) C_num1
## C_num1 -0.670
## C_num2 -0.596  0.403
```

Highest count of 10 by post-test

```
cdimprovement <- glmer(CD_Improvement ~ C_num + (1|ID), data = cbdata, family
= binomial)

Anova(cdimprovement)

## Analysis of Deviance Table (Type II Wald chisquare tests)
##
## Response: CD_Improvement
##        Chisq Df Pr(>Chisq)
## C_num 7.0792  2    0.02903 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

summary(cdimprovement)

## Generalized linear mixed model fit by maximum likelihood (Laplace
##   Approximation) [glmerMod]
##  Family: binomial  ( logit )
## Formula: CD_Improvement ~ C_num + (1 | ID)
##    Data: cbdata
##
##      AIC      BIC   logLik deviance df.resid
##     98.4    107.5    -45.2     90.4       67
##
```

```
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -1.5119 -0.8018 -0.6860  0.6614  1.4577
##
## Random effects:
##  Groups Name        Variance  Std.Dev.
##  ID     (Intercept) 9.799e-09 9.899e-05
## Number of obs: 71, groups:  ID, 71
##
## Fixed effects:
##             Estimate Std. Error z value Pr(>|z|)
## (Intercept)  -0.7538     0.4289  -1.757   0.0789 .
## C_num1        0.3119     0.6053   0.515   0.6063
## C_num2        1.5805     0.6244   2.531   0.0114 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##        (Intr) C_num1
## C_num1 -0.708
## C_num2 -0.688  0.487
```

Reading Logs

Across all four weeks

```
logs_all <- aov(Log_TotalReads ~ C, data = cbdata)
summary(logs_all)
```

```
##             Df Sum Sq Mean Sq F value Pr(>F)
## C            2     48    24.2   0.373   0.69
## Residuals   57   3699    64.9
## 11 observations deleted due to missingness
```

First two weeks

```
logs_1 <- aov(Log_S2Reads ~ C, data = cbdata)
summary(logs_1)
```

```
##             Df Sum Sq Mean Sq F value Pr(>F)
## C            2   19.5   9.771   0.358  0.701
## Residuals   57 1556.2  27.302
## 11 observations deleted due to missingness
```

Second two weeks

```
logs_2 <- aov(Log_S3Reads ~ C, data = cbdata)
summary(logs_2)
```

```
##             Df Sum Sq Mean Sq F value Pr(>F)
## C            2    7.6   3.812   0.241  0.787
```

```
## Residuals   57  902.1  15.826
## 11 observations deleted due to missingness
```

Proportion of Completed Reads

Across all four weeks

```
logs_prop <- aov(Prop.Read ~ C, data = cbdata)
summary(logs_prop)
```

```
##          Df Sum Sq Mean Sq F value Pr(>F)
##C         2 0.3087 0.15435   4.085 0.0221 *
##Residuals 56 2.1159 0.03778
##---
##Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```