age\_predictability\_preview

2024-06-03

Version: Rtudio: 2023.12.0 Build 369 R:4.4.0 lme4:1.1-35.1 lattice:0.22-6 MASS:7.3-60.2 plyr:1.8.9 simr:1.0.7 plotrix:3.8-4

Load the packages that we used

library(lme4)

## Loading required package: Matrix

library(lattice)  
library(MASS)  
library(plyr)   
library(simr)

##   
## Attaching package: 'simr'

## The following object is masked from 'package:lme4':  
##   
## getData

library(plotrix)

rm(list=ls()) # clear objects from the workspace  
datafile <- read.csv("datafile.csv", sep = ",", dec = ".") # open the datafile  
colnames(datafile) #retrieve the column names of the datafile

## [1] "Participant" "Item"   
## [3] "Age" "Predictability"   
## [5] "Preview" "Age\_Predictability"   
## [7] "Age\_Preview" "Predictability\_Preview"   
## [9] "Condition" "TRT"   
## [11] "IA\_SKIP" "FFD"   
## [13] "SFD" "GD"   
## [15] "RO" "RI"   
## [17] "sentence.reading.time" "average.fixation.duration"   
## [19] "number.of.fixations" "number.of.regressions"   
## [21] "average.forwary.saccade.length"

nrow(datafile) #the number of observations of the datafile

## [1] 6811

datafile$pp = datafile[,1]  
datafile$Item = datafile[,2]  
datafile$Age = datafile[,3]  
datafile$Predictability = datafile[,4]  
datafile$Preview = datafile[,5]  
datafile$Age\_Pred = datafile[,6]  
datafile$Age\_Preview = datafile[,7]  
datafile$Pred\_Preview = datafile[,8]  
datafile$Condition = datafile[,9]  
# Let's make sure all the variables are from the correct class  
datafile$Item = as.factor(datafile$Item)  
datafile$Age = factor(datafile$Age, levels = c("Y","O"))  
datafile$Predictability = factor(datafile$Predictability, levels = c("H","L"))  
datafile$Preview = factor(datafile$Preview, levels = c("I","T","S"))  
datafile$Age\_Pred = factor(datafile$Age\_Pred, levels = c("YH","YL","OH","OL"))  
datafile$Age\_Preview = factor(datafile$Age\_Preview, levels = c("YI","YT","YS","OI","OT","OS"))  
datafile$Pred\_Preview = factor(datafile$Pred\_Preview, levels = c("HI","HT","HS","LI","LT","LS"))  
datafile$Condition = factor(datafile$Condition, levels = c("YHI","YHT","YHS","YLI","YLT","YLS","OHI","OHT","OHS","OLI","OLT","OLS"))

# MEAN AND STANDARD ERROR FOR EACH DV

mean.matrix = tapply(datafile$IA\_SKIP, list(datafile$pp, datafile$Condition), mean, na.rm = T)  
sd.matrix = tapply(datafile$IA\_SKIP, list(datafile$pp, datafile$Condition), sd, na.rm = T)  
se.matrix = tapply(datafile$IA\_SKIP, list(datafile$pp, datafile$Condition), std.error, na.rm = T)  
grand.mean=apply(mean.matrix, 2, mean, na.rm = T)  
grand.sd=apply(sd.matrix,2,mean, na.rm = T)  
grand.se=apply(se.matrix,2, mean, na.rm = T)  
data.frame\_SKIP <- data.frame(grand.mean,grand.sd,grand.se)  
data.frame\_SKIP

## grand.mean grand.sd grand.se  
## YHI 0.44953454 0.4838945 0.14818002  
## YHT 0.42905641 0.4711276 0.14200672  
## YHS 0.34765175 0.4336410 0.12998943  
## YLI 0.42947899 0.4727216 0.14231752  
## YLT 0.41337015 0.4675030 0.13955814  
## YLS 0.40667462 0.4662613 0.13750929  
## OHI 0.16696960 0.3025578 0.08570965  
## OHT 0.15016041 0.2752476 0.08063997  
## OHS 0.09885917 0.2104082 0.05945635  
## OLI 0.12865838 0.2264032 0.06533977  
## OLT 0.10646992 0.2166867 0.06226292  
## OLS 0.09251620 0.2028124 0.05843970

mean.matrix = tapply(datafile$FFD, list(datafile$pp, datafile$Condition), mean, na.rm = T)  
sd.matrix = tapply(datafile$FFD, list(datafile$pp, datafile$Condition), sd, na.rm = T)  
se.matrix = tapply(datafile$FFD, list(datafile$pp, datafile$Condition), std.error, na.rm = T)  
grand.mean=apply(mean.matrix, 2, mean, na.rm = T)  
grand.sd=apply(sd.matrix,2,mean, na.rm = T)  
grand.se=apply(se.matrix,2, mean, na.rm = T)  
data.frame\_FFD <- data.frame(grand.mean,grand.sd,grand.se)  
data.frame\_FFD

## grand.mean grand.sd grand.se  
## YHI 218.5856 49.62715 19.57273  
## YHT 242.0486 72.62637 28.83117  
## YHS 281.8441 90.12798 33.58090  
## YLI 231.0825 64.23899 26.66019  
## YLT 256.8270 80.48413 32.47402  
## YLS 271.9941 82.90532 32.35708  
## OHI 249.0510 70.25537 22.02645  
## OHT 255.4054 68.25031 21.75871  
## OHS 288.4676 88.32028 26.47007  
## OLI 263.1077 71.78277 21.92170  
## OLT 280.0290 84.37934 26.27029  
## OLS 296.8774 101.93269 32.30137

mean.matrix = tapply(datafile$SFD, list(datafile$pp, datafile$Condition), mean, na.rm = T)  
sd.matrix = tapply(datafile$SFD, list(datafile$pp, datafile$Condition), sd, na.rm = T)  
se.matrix = tapply(datafile$SFD, list(datafile$pp, datafile$Condition), std.error, na.rm = T)  
grand.mean=apply(mean.matrix, 2, mean, na.rm = T)  
grand.sd=apply(sd.matrix,2,mean, na.rm = T)  
grand.se=apply(se.matrix,2, mean, na.rm = T)  
data.frame\_SFD <- data.frame(grand.mean,grand.sd,grand.se)  
data.frame\_SFD

## grand.mean grand.sd grand.se  
## YHI 219.3674 49.94975 20.16707  
## YHT 241.4623 72.59293 29.95352  
## YHS 283.0044 90.26685 35.55924  
## YLI 231.1423 65.24812 27.77878  
## YLT 255.5997 79.13454 33.77642  
## YLS 275.3478 82.73918 34.58001  
## OHI 250.5511 69.65236 23.07751  
## OHT 252.6949 66.06497 23.13370  
## OHS 295.6707 88.09403 32.09090  
## OLI 258.9821 69.91050 23.69865  
## OLT 273.1292 77.22562 26.81511  
## OLS 302.3901 106.41411 40.16253

mean.matrix = tapply(datafile$GD, list(datafile$pp, datafile$Condition), mean, na.rm = T)  
sd.matrix = tapply(datafile$GD, list(datafile$pp, datafile$Condition), sd, na.rm = T)  
se.matrix = tapply(datafile$GD, list(datafile$pp, datafile$Condition), std.error, na.rm = T)  
grand.mean=apply(mean.matrix, 2, mean, na.rm = T)  
grand.sd=apply(sd.matrix,2,mean, na.rm = T)  
grand.se=apply(se.matrix,2, mean, na.rm = T)  
data.frame\_GD <- data.frame(grand.mean,grand.sd,grand.se)  
data.frame\_GD

## grand.mean grand.sd grand.se  
## YHI 223.6111 55.24619 21.72036  
## YHT 254.3420 89.83786 35.21489  
## YHS 303.1415 110.91180 41.43746  
## YLI 240.1905 76.48871 31.36468  
## YLT 274.4044 101.38720 40.20607  
## YLS 304.3483 107.31149 41.18930  
## OHI 271.6815 90.25655 27.73525  
## OHT 290.7327 102.86677 32.73693  
## OHS 357.2404 134.00473 39.95929  
## OLI 310.2763 127.64626 38.31281  
## OLT 343.3064 146.62733 44.95629  
## OLS 380.9726 161.89016 50.01643

mean.matrix = tapply(datafile$TRT, list(datafile$pp, datafile$Condition), mean, na.rm = T)  
sd.matrix = tapply(datafile$TRT, list(datafile$pp, datafile$Condition), sd, na.rm = T)  
se.matrix = tapply(datafile$TRT, list(datafile$pp, datafile$Condition), std.error, na.rm = T)  
grand.mean=apply(mean.matrix, 2, mean, na.rm = T)  
grand.sd=apply(sd.matrix,2,mean, na.rm = T)  
grand.se=apply(se.matrix,2, mean, na.rm = T)  
data.frame\_TRT <- data.frame(grand.mean,grand.sd,grand.se)  
data.frame\_TRT

## grand.mean grand.sd grand.se  
## YHI 271.4301 118.4900 42.40986  
## YHT 316.4804 167.3906 59.31093  
## YHS 360.8067 186.1129 60.87364  
## YLI 286.8940 138.9066 51.36275  
## YLT 333.9630 159.3779 55.49687  
## YLS 371.7162 181.8111 59.87398  
## OHI 389.7834 207.3736 63.44909  
## OHT 396.2372 186.7496 57.32708  
## OHS 475.8945 231.8007 66.93870  
## OLI 480.3875 285.6906 84.22433  
## OLT 504.1094 265.8512 80.56296  
## OLS 542.1281 269.4393 77.90704

mean.matrix = tapply(datafile$RO, list(datafile$pp, datafile$Condition), mean, na.rm = T)  
sd.matrix = tapply(datafile$RO, list(datafile$pp, datafile$Condition), sd, na.rm = T)  
se.matrix = tapply(datafile$RO, list(datafile$pp, datafile$Condition), std.error, na.rm = T)  
grand.mean=apply(mean.matrix, 2, mean, na.rm = T)  
grand.sd=apply(sd.matrix,2,mean, na.rm = T)  
grand.se=apply(se.matrix,2, mean, na.rm = T)  
data.frame\_RO <- data.frame(grand.mean,grand.sd,grand.se)  
data.frame\_RO

## grand.mean grand.sd grand.se  
## YHI 0.10424242 0.1909523 0.07834300  
## YHT 0.10918549 0.1863763 0.07846131  
## YHS 0.17513408 0.3032077 0.11626435  
## YLI 0.11670702 0.1965133 0.08405747  
## YLT 0.12801768 0.2182430 0.08749618  
## YLS 0.20399647 0.3399557 0.13963128  
## OHI 0.06147841 0.1575021 0.04951462  
## OHT 0.06312623 0.1579259 0.05181566  
## OHS 0.13818666 0.2870953 0.08566264  
## OLI 0.10315996 0.2286432 0.07360018  
## OLT 0.11309840 0.2464438 0.07680748  
## OLS 0.18193157 0.3267067 0.10586303

contrasts(datafile$Age) <- contr.sdif(2)   
contrasts(datafile$Predictability) <- contr.sdif(2)

# LME OF WORD SKIPPING RATE

measure = "IA\_SKIP"  
datafile$depvar = datafile[,measure]  
datafile$depvar = as.numeric(datafile$depvar)

## identical vs. transposed, transposed vs. substituted

contrasts(datafile$Preview) <- contr.sdif(3)   
SKIP\_model = glmer(depvar~Age\*Predictability\*Preview+(1|pp)+(1|Item),datafile,family=binomial,control=glmerControl(optimizer="bobyqa", optCtrl=list(maxfun=200000)))  
summary(SKIP\_model, corr = FALSE)

## Generalized linear mixed model fit by maximum likelihood (Laplace  
## Approximation) [glmerMod]  
## Family: binomial ( logit )  
## Formula: depvar ~ Age \* Predictability \* Preview + (1 | pp) + (1 | Item)  
## Data: datafile  
## Control: glmerControl(optimizer = "bobyqa", optCtrl = list(maxfun = 2e+05))  
##   
## AIC BIC logLik deviance df.resid   
## 7246.7 7342.3 -3609.4 7218.7 6797   
##   
## Scaled residuals:   
## Min 1Q Median 3Q Max   
## -1.7525 -0.6691 -0.3378 0.8733 5.8379   
##   
## Random effects:  
## Groups Name Variance Std.Dev.  
## pp (Intercept) 0.54426 0.7377   
## Item (Intercept) 0.07741 0.2782   
## Number of obs: 6811, groups: pp, 96; Item, 90  
##   
## Fixed effects:  
## Estimate Std. Error z value Pr(>|z|)   
## (Intercept) -1.34900 0.09297 -14.510 < 2e-16 \*\*\*  
## Age2-1 -1.88635 0.17570 -10.736 < 2e-16 \*\*\*  
## Predictability2-1 -0.12811 0.07018 -1.825 0.06793 .   
## Preview2-1 -0.13791 0.08305 -1.661 0.09681 .   
## Preview3-2 -0.27144 0.08859 -3.064 0.00218 \*\*   
## Age2-1:Predictability2-1 -0.34834 0.14040 -2.481 0.01310 \*   
## Age2-1:Preview2-1 -0.11519 0.16587 -0.694 0.48739   
## Age2-1:Preview3-2 -0.11851 0.17696 -0.670 0.50304   
## Predictability2-1:Preview2-1 0.03083 0.16588 0.186 0.85254   
## Predictability2-1:Preview3-2 0.32004 0.17680 1.810 0.07027 .   
## Age2-1:Predictability2-1:Preview2-1 0.06966 0.33174 0.210 0.83367   
## Age2-1:Predictability2-1:Preview3-2 -0.12294 0.35365 -0.348 0.72812   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

confint(SKIP\_model, method="Wald")

## 2.5 % 97.5 %  
## .sig01 NA NA  
## .sig02 NA NA  
## (Intercept) -1.53121127 -1.166785727  
## Age2-1 -2.23072323 -1.541975303  
## Predictability2-1 -0.26566870 0.009440875  
## Preview2-1 -0.30069345 0.024868974  
## Preview3-2 -0.44507028 -0.097803133  
## Age2-1:Predictability2-1 -0.62351172 -0.073171176  
## Age2-1:Preview2-1 -0.44027922 0.209904011  
## Age2-1:Preview3-2 -0.46534941 0.228323508  
## Predictability2-1:Preview2-1 -0.29427979 0.355944027  
## Predictability2-1:Preview3-2 -0.02648593 0.666574810  
## Age2-1:Predictability2-1:Preview2-1 -0.58053710 0.719864890  
## Age2-1:Predictability2-1:Preview3-2 -0.81607881 0.570202315

## identical vs. transposed, identical vs. substituted

contrasts(datafile$Preview) <-contr.treatment(3)  
SKIP\_model = glmer(depvar~Age\*Predictability\*Preview+(1|pp)+(1|Item),datafile,family=binomial,control=glmerControl(optimizer="bobyqa", optCtrl=list(maxfun=200000)))  
summary(SKIP\_model, corr = FALSE)

## Generalized linear mixed model fit by maximum likelihood (Laplace  
## Approximation) [glmerMod]  
## Family: binomial ( logit )  
## Formula: depvar ~ Age \* Predictability \* Preview + (1 | pp) + (1 | Item)  
## Data: datafile  
## Control: glmerControl(optimizer = "bobyqa", optCtrl = list(maxfun = 2e+05))  
##   
## AIC BIC logLik deviance df.resid   
## 7246.7 7342.3 -3609.4 7218.7 6797   
##   
## Scaled residuals:   
## Min 1Q Median 3Q Max   
## -1.7525 -0.6691 -0.3378 0.8733 5.8379   
##   
## Random effects:  
## Groups Name Variance Std.Dev.  
## pp (Intercept) 0.54426 0.7377   
## Item (Intercept) 0.07741 0.2782   
## Number of obs: 6811, groups: pp, 96; Item, 90  
##   
## Fixed effects:  
## Estimate Std. Error z value Pr(>|z|)   
## (Intercept) -1.16658 0.10298 -11.328 < 2e-16 \*\*\*  
## Age2-1 -1.77005 0.19696 -8.987 < 2e-16 \*\*\*  
## Predictability2-1 -0.25535 0.11412 -2.238 0.0252 \*   
## Preview2 -0.13791 0.08305 -1.661 0.0968 .   
## Preview3 -0.40935 0.08653 -4.731 2.24e-06 \*\*\*  
## Age2-1:Predictability2-1 -0.35379 0.22824 -1.550 0.1211   
## Age2-1:Preview2 -0.11519 0.16586 -0.694 0.4874   
## Age2-1:Preview3 -0.23370 0.17285 -1.352 0.1763   
## Predictability2-1:Preview2 0.03083 0.16588 0.186 0.8526   
## Predictability2-1:Preview3 0.35087 0.17269 2.032 0.0422 \*   
## Age2-1:Predictability2-1:Preview2 0.06965 0.33174 0.210 0.8337   
## Age2-1:Predictability2-1:Preview3 -0.05329 0.34526 -0.154 0.8773   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

confint(SKIP\_model, method="Wald")

## 2.5 % 97.5 %  
## .sig01 NA NA  
## .sig02 NA NA  
## (Intercept) -1.36841820 -0.96473762  
## Age2-1 -2.15608474 -1.38401320  
## Predictability2-1 -0.47900916 -0.03168455  
## Preview2 -0.30069405 0.02486718  
## Preview3 -0.57894375 -0.23975708  
## Age2-1:Predictability2-1 -0.80113565 0.09354776  
## Age2-1:Preview2 -0.44027508 0.20989524  
## Age2-1:Preview3 -0.57247568 0.10506653  
## Predictability2-1:Preview2 -0.29428513 0.35594186  
## Predictability2-1:Preview3 0.01241085 0.68933192  
## Age2-1:Predictability2-1:Preview2 -0.58055215 0.71985290  
## Age2-1:Predictability2-1:Preview3 -0.72999299 0.62341272

## simple effect analysis for age:predictability on skipping rate

contrast.matrix <- matrix(c(  
 -1, 1, 0, 0, # Y.L-H   
 0, 0, -1, +1 ), 4, 2, # O.L-H  
 dimnames=list(c("YH", "YL", "OH", "OL"),   
 c("Y.L-H","O.L-H")))  
inv.contrast.matrix <- matrix(t(ginv(contrast.matrix)), 4, 2,  
 dimnames=list(c("YH", "YL", "OH", "OL"),   
 c("Y.L-H","O.L-H")))  
(contrasts(datafile$Age\_Pred) <- fractions(inv.contrast.matrix))

## Y.L-H O.L-H  
## YH -1/2 0   
## YL 1/2 0   
## OH 0 -1/2   
## OL 0 1/2

depvar.lmer1 = glmer(depvar ~ Age\_Pred + (1|pp) + (1|Item), datafile,family = binomial)  
summary(depvar.lmer1, corr = FALSE)

## Generalized linear mixed model fit by maximum likelihood (Laplace  
## Approximation) [glmerMod]  
## Family: binomial ( logit )  
## Formula: depvar ~ Age\_Pred + (1 | pp) + (1 | Item)  
## Data: datafile  
##   
## AIC BIC logLik deviance df.resid   
## 7265.0 7306.0 -3626.5 7253.0 6805   
##   
## Scaled residuals:   
## Min 1Q Median 3Q Max   
## -1.5959 -0.6736 -0.3444 0.8885 5.2046   
##   
## Random effects:  
## Groups Name Variance Std.Dev.  
## pp (Intercept) 0.53529 0.7316   
## Item (Intercept) 0.07687 0.2772   
## Number of obs: 6811, groups: pp, 96; Item, 90  
##   
## Fixed effects:  
## Estimate Std. Error z value Pr(>|z|)   
## (Intercept) -1.33876 0.09221 -14.518 < 2e-16 \*\*\*  
## Age\_PredY.L-H 0.04451 0.06632 0.671 0.50215   
## Age\_PredO.L-H -0.31993 0.12200 -2.622 0.00873 \*\*   
## Age\_Pred -1.86734 0.17419 -10.720 < 2e-16 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

# LME OF FIRST FIXATION DURATION

measure = "FFD"  
datafile$depvar = datafile[,measure]  
datafile$depvar = as.numeric(datafile$depvar)  
datafile$depvar=log(datafile$depvar)

## identical vs. transposed, transposed vs. substituted

contrasts(datafile$Preview) <- contr.sdif(3)   
FFD\_model=lmer(depvar~Age\*Predictability\*Preview+(1+Predictability|pp)+(1|Item),datafile,control=lmerControl(optimizer = "bobyqa",optCtrl=list(maxfun=200000)))  
summary(FFD\_model, corr = FALSE)

## Linear mixed model fit by REML ['lmerMod']  
## Formula: depvar ~ Age \* Predictability \* Preview + (1 + Predictability |   
## pp) + (1 | Item)  
## Data: datafile  
## Control: lmerControl(optimizer = "bobyqa", optCtrl = list(maxfun = 2e+05))  
##   
## REML criterion at convergence: 2580.4  
##   
## Scaled residuals:   
## Min 1Q Median 3Q Max   
## -4.0065 -0.6201 0.0043 0.5927 3.8424   
##   
## Random effects:  
## Groups Name Variance Std.Dev. Corr  
## pp (Intercept) 0.015494 0.12448   
## Predictability2-1 0.001593 0.03991 0.31  
## Item (Intercept) 0.001688 0.04108   
## Residual 0.093354 0.30554   
## Number of obs: 4788, groups: pp, 96; Item, 90  
##   
## Fixed effects:  
## Estimate Std. Error t value  
## (Intercept) 5.506401 0.014552 378.406  
## Age2-1 0.082569 0.027783 2.972  
## Predictability2-1 0.033012 0.009881 3.341  
## Preview2-1 0.068849 0.011039 6.237  
## Preview3-2 0.090828 0.010806 8.405  
## Age2-1:Predictability2-1 0.029750 0.019754 1.506  
## Age2-1:Preview2-1 -0.054509 0.022074 -2.469  
## Age2-1:Preview3-2 -0.022953 0.021613 -1.062  
## Predictability2-1:Preview2-1 0.021055 0.022089 0.953  
## Predictability2-1:Preview3-2 -0.070533 0.021619 -3.262  
## Age2-1:Predictability2-1:Preview2-1 0.012513 0.044176 0.283  
## Age2-1:Predictability2-1:Preview3-2 0.034467 0.043215 0.798

confint(FFD\_model, method="Wald")

## 2.5 % 97.5 %  
## .sig01 NA NA  
## .sig02 NA NA  
## .sig03 NA NA  
## .sig04 NA NA  
## .sigma NA NA  
## (Intercept) 5.477880945 5.53492205  
## Age2-1 0.028115663 0.13702214  
## Predictability2-1 0.013645431 0.05237865  
## Preview2-1 0.047212927 0.09048536  
## Preview3-2 0.069649015 0.11200777  
## Age2-1:Predictability2-1 -0.008966192 0.06846719  
## Age2-1:Preview2-1 -0.097774189 -0.01124441  
## Age2-1:Preview3-2 -0.065313512 0.01940732  
## Predictability2-1:Preview2-1 -0.022238968 0.06434870  
## Predictability2-1:Preview3-2 -0.112906115 -0.02815936  
## Age2-1:Predictability2-1:Preview2-1 -0.074071278 0.09909686  
## Age2-1:Predictability2-1:Preview3-2 -0.050233051 0.11916777

## identical vs. transposed, identical vs. substituted

contrasts(datafile$Preview) <-contr.treatment(3)  
FFD\_model=lmer(depvar~Age\*Predictability\*Preview+(1+Predictability|pp)+(1|Item),datafile,control=lmerControl(optimizer = "bobyqa",optCtrl=list(maxfun=200000)))  
summary(FFD\_model, corr = FALSE)

## Linear mixed model fit by REML ['lmerMod']  
## Formula: depvar ~ Age \* Predictability \* Preview + (1 + Predictability |   
## pp) + (1 | Item)  
## Data: datafile  
## Control: lmerControl(optimizer = "bobyqa", optCtrl = list(maxfun = 2e+05))  
##   
## REML criterion at convergence: 2580.4  
##   
## Scaled residuals:   
## Min 1Q Median 3Q Max   
## -4.0065 -0.6201 0.0043 0.5927 3.8424   
##   
## Random effects:  
## Groups Name Variance Std.Dev. Corr  
## pp (Intercept) 0.015494 0.12448   
## Predictability2-1 0.001593 0.03991 0.31  
## Item (Intercept) 0.001688 0.04108   
## Residual 0.093354 0.30554   
## Number of obs: 4788, groups: pp, 96; Item, 90  
##   
## Fixed effects:  
## Estimate Std. Error t value  
## (Intercept) 5.43023 0.01593 340.978  
## Age2-1 0.12656 0.03064 4.130  
## Predictability2-1 0.04249 0.01626 2.613  
## Preview2 0.06885 0.01104 6.237  
## Preview3 0.15968 0.01085 14.712  
## Age2-1:Predictability2-1 0.00992 0.03252 0.305  
## Age2-1:Preview2 -0.05451 0.02207 -2.469  
## Age2-1:Preview3 -0.07746 0.02171 -3.568  
## Predictability2-1:Preview2 0.02106 0.02209 0.953  
## Predictability2-1:Preview3 -0.04948 0.02173 -2.277  
## Age2-1:Predictability2-1:Preview2 0.01251 0.04418 0.283  
## Age2-1:Predictability2-1:Preview3 0.04698 0.04342 1.082

confint(FFD\_model, method="Wald")

## 2.5 % 97.5 %  
## .sig01 NA NA  
## .sig02 NA NA  
## .sig03 NA NA  
## .sig04 NA NA  
## .sigma NA NA  
## (Intercept) 5.39901263 5.461439252  
## Age2-1 0.06649684 0.186622095  
## Predictability2-1 0.01061799 0.074354767  
## Preview2 0.04721293 0.090485355  
## Preview3 0.13840485 0.180950223  
## Age2-1:Predictability2-1 -0.05381068 0.073649714  
## Age2-1:Preview2 -0.09777419 -0.011244411  
## Age2-1:Preview3 -0.12001246 -0.034912331  
## Predictability2-1:Preview2 -0.02223897 0.064348698  
## Predictability2-1:Preview3 -0.09206277 -0.006892971  
## Age2-1:Predictability2-1:Preview2 -0.07407127 0.099096860  
## Age2-1:Predictability2-1:Preview3 -0.03812268 0.132082984

## Simple effect analysis for predictability:preview on FFD

contrast.matrix <- matrix(c(  
 -1, 0, 0, 1, 0, 0, #I.L-H  
 0, -1, 0, 0, 1, 0, #T.L-H   
 0, 0, -1, 0, 0, 1 #S.L-H  
 ), 6, 3,   
 dimnames=list(c("HI", "HT", "HS", "LI", "LT", "LS"),   
 c("I.L-H","T.L-H", "S.L\_H")))  
  
inv.contrast.matrix <- matrix(t(ginv(contrast.matrix)), 6, 3,  
 dimnames=list(c("HI", "HT", "HS", "LI", "LT", "LS"),   
 c("I.L-H","T.L-H", "S.L\_H")))  
  
(contrasts(datafile$Pred\_Preview) <- fractions(inv.contrast.matrix))

## I.L-H T.L-H S.L\_H  
## HI -1/2 0 0   
## HT 0 -1/2 0   
## HS 0 0 -1/2   
## LI 1/2 0 0   
## LT 0 1/2 0   
## LS 0 0 1/2

# for continuous dependent variables  
depvar.lmer1 = lmer(depvar~Pred\_Preview+(1+Predictability|pp)+(1|Item), datafile)  
summary(depvar.lmer1, corr = FALSE)

## Linear mixed model fit by REML ['lmerMod']  
## Formula: depvar ~ Pred\_Preview + (1 + Predictability | pp) + (1 | Item)  
## Data: datafile  
##   
## REML criterion at convergence: 2572  
##   
## Scaled residuals:   
## Min 1Q Median 3Q Max   
## -4.0020 -0.6183 -0.0013 0.5974 3.8387   
##   
## Random effects:  
## Groups Name Variance Std.Dev. Corr  
## pp (Intercept) 0.016857 0.12983   
## Predictability2-1 0.001779 0.04217 0.38  
## Item (Intercept) 0.001676 0.04094   
## Residual 0.093568 0.30589   
## Number of obs: 4788, groups: pp, 96; Item, 90  
##   
## Fixed effects:  
## Estimate Std. Error t value  
## (Intercept) 5.49745 0.01471 373.761  
## Pred\_PreviewI.L-H 0.04119 0.01633 2.522  
## Pred\_PreviewT.L-H 0.06160 0.01620 3.801  
## Pred\_PreviewS.L\_H -0.01007 0.01568 -0.642  
## Pred\_Preview -0.01954 0.01095 -1.785  
## Pred\_Preview 0.15938 0.01088 14.655

# LME OF SINGLE FIXATION DURATION

measure = "SFD"  
datafile$depvar = datafile[,measure]  
datafile$depvar = as.numeric(datafile$depvar)  
datafile$depvar=log(datafile$depvar)

## identical vs. transposed, transposed vs. substituted

contrasts(datafile$Preview) <- contr.sdif(3)   
SFD\_model = lmer(depvar~Age\*Predictability\*Preview+(1+Predictability|pp)+(1|Item),datafile,control=lmerControl(optimizer = "bobyqa",optCtrl=list(maxfun=200000)))  
summary(SFD\_model, corr = FALSE)

## Linear mixed model fit by REML ['lmerMod']  
## Formula: depvar ~ Age \* Predictability \* Preview + (1 + Predictability |   
## pp) + (1 | Item)  
## Data: datafile  
## Control: lmerControl(optimizer = "bobyqa", optCtrl = list(maxfun = 2e+05))  
##   
## REML criterion at convergence: 2186.1  
##   
## Scaled residuals:   
## Min 1Q Median 3Q Max   
## -4.0993 -0.6122 0.0001 0.5919 3.7923   
##   
## Random effects:  
## Groups Name Variance Std.Dev. Corr  
## pp (Intercept) 0.015854 0.12591   
## Predictability2-1 0.002210 0.04701 0.22  
## Item (Intercept) 0.002118 0.04602   
## Residual 0.091876 0.30311   
## Number of obs: 4089, groups: pp, 96; Item, 90  
##   
## Fixed effects:  
## Estimate Std. Error t value  
## (Intercept) 5.508594 0.014962 368.178  
## Age2-1 0.086450 0.028308 3.054  
## Predictability2-1 0.028164 0.010871 2.591  
## Preview2-1 0.065645 0.011711 5.605  
## Preview3-2 0.107281 0.011898 9.017  
## Age2-1:Predictability2-1 0.023247 0.021740 1.069  
## Age2-1:Preview2-1 -0.056617 0.023420 -2.417  
## Age2-1:Preview3-2 -0.002719 0.023787 -0.114  
## Predictability2-1:Preview2-1 0.029423 0.023443 1.255  
## Predictability2-1:Preview3-2 -0.062249 0.023783 -2.617  
## Age2-1:Predictability2-1:Preview2-1 0.031830 0.046875 0.679  
## Age2-1:Predictability2-1:Preview3-2 0.034609 0.047542 0.728

confint(SFD\_model, method="Wald")

## 2.5 % 97.5 %  
## .sig01 NA NA  
## .sig02 NA NA  
## .sig03 NA NA  
## .sig04 NA NA  
## .sigma NA NA  
## (Intercept) 5.479269119 5.53791813  
## Age2-1 0.030967632 0.14193335  
## Predictability2-1 0.006856286 0.04947079  
## Preview2-1 0.042690947 0.08859820  
## Preview3-2 0.083961866 0.13059973  
## Age2-1:Predictability2-1 -0.019363066 0.06585804  
## Age2-1:Preview2-1 -0.102519418 -0.01071533  
## Age2-1:Preview3-2 -0.049341671 0.04390352  
## Predictability2-1:Preview2-1 -0.016524520 0.07537013  
## Predictability2-1:Preview3-2 -0.108863844 -0.01563446  
## Age2-1:Predictability2-1:Preview2-1 -0.060043440 0.12370246  
## Age2-1:Predictability2-1:Preview3-2 -0.058571408 0.12778945

## identical vs. transposed, identical vs. substituted

contrasts(datafile$Preview) <- contr.treatment(3)  
SFD\_model = lmer(depvar~Age\*Predictability\*Preview+(1+Predictability|pp)+(1|Item),datafile,control=lmerControl(optimizer = "bobyqa",optCtrl=list(maxfun=200000)))  
summary(SFD\_model, corr = FALSE)

## Linear mixed model fit by REML ['lmerMod']  
## Formula: depvar ~ Age \* Predictability \* Preview + (1 + Predictability |   
## pp) + (1 | Item)  
## Data: datafile  
## Control: lmerControl(optimizer = "bobyqa", optCtrl = list(maxfun = 2e+05))  
##   
## REML criterion at convergence: 2186.1  
##   
## Scaled residuals:   
## Min 1Q Median 3Q Max   
## -4.0993 -0.6122 0.0001 0.5919 3.7923   
##   
## Random effects:  
## Groups Name Variance Std.Dev. Corr  
## pp (Intercept) 0.015854 0.12591   
## Predictability2-1 0.002210 0.04701 0.22  
## Item (Intercept) 0.002118 0.04602   
## Residual 0.091876 0.30311   
## Number of obs: 4089, groups: pp, 96; Item, 90  
##   
## Fixed effects:  
## Estimate Std. Error t value  
## (Intercept) 5.429070 0.016368 331.689  
## Age2-1 0.125102 0.031267 4.001  
## Predictability2-1 0.029298 0.017169 1.706  
## Preview2 0.065645 0.011711 5.605  
## Preview3 0.172925 0.011807 14.646  
## Age2-1:Predictability2-1 -0.009509 0.034330 -0.277  
## Age2-1:Preview2 -0.056617 0.023420 -2.417  
## Age2-1:Preview3 -0.059336 0.023618 -2.512  
## Predictability2-1:Preview2 0.029423 0.023443 1.255  
## Predictability2-1:Preview3 -0.032826 0.023630 -1.389  
## Age2-1:Predictability2-1:Preview2 0.031830 0.046875 0.679  
## Age2-1:Predictability2-1:Preview3 0.066439 0.047241 1.406

confint(SFD\_model, method="Wald")

## 2.5 % 97.5 %  
## .sig01 NA NA  
## .sig02 NA NA  
## .sig03 NA NA  
## .sig04 NA NA  
## .sigma NA NA  
## (Intercept) 5.396989724 5.46115090  
## Age2-1 0.063819307 0.18638423  
## Predictability2-1 -0.004351952 0.06294805  
## Preview2 0.042690947 0.08859820  
## Preview3 0.149784081 0.19606666  
## Age2-1:Predictability2-1 -0.076794517 0.05777747  
## Age2-1:Preview2 -0.102519419 -0.01071533  
## Age2-1:Preview3 -0.105626050 -0.01304685  
## Predictability2-1:Preview2 -0.016524520 0.07537013  
## Predictability2-1:Preview3 -0.079139804 0.01348712  
## Age2-1:Predictability2-1:Preview2 -0.060043438 0.12370246  
## Age2-1:Predictability2-1:Preview3 -0.026152137 0.15902920

## Simple effect analysis for predictability:preview on SFD

contrast.matrix <- matrix(c(  
 -1, 0, 0, 1, 0, 0, #I.L-H  
 0, -1, 0, 0, 1, 0, #T.L-H   
 0, 0, -1, 0, 0, 1 #S.L-H  
 ), 6, 3,   
 dimnames=list(c("HI", "HT", "HS", "LI", "LT", "LS"),   
 c("I.L-H","T.L-H", "S.L\_H")))  
  
inv.contrast.matrix <- matrix(t(ginv(contrast.matrix)), 6, 3,  
 dimnames=list(c("HI", "HT", "HS", "LI", "LT", "LS"),   
 c("I.L-H","T.L-H", "S.L\_H")))  
  
(contrasts(datafile$Pred\_Preview) <- fractions(inv.contrast.matrix))

## I.L-H T.L-H S.L\_H  
## HI -1/2 0 0   
## HT 0 -1/2 0   
## HS 0 0 -1/2   
## LI 1/2 0 0   
## LT 0 1/2 0   
## LS 0 0 1/2

# for continuous dependent variables  
depvar.lmer1 = lmer(depvar~Pred\_Preview+(1+Predictability|pp)+(1|Item), datafile)  
summary(depvar.lmer1, corr = FALSE)

## Linear mixed model fit by REML ['lmerMod']  
## Formula: depvar ~ Pred\_Preview + (1 + Predictability | pp) + (1 | Item)  
## Data: datafile  
##   
## REML criterion at convergence: 2174.1  
##   
## Scaled residuals:   
## Min 1Q Median 3Q Max   
## -4.1208 -0.6124 -0.0009 0.5905 3.7915   
##   
## Random effects:  
## Groups Name Variance Std.Dev. Corr  
## pp (Intercept) 0.017422 0.13199   
## Predictability2-1 0.002279 0.04774 0.28  
## Item (Intercept) 0.002103 0.04586   
## Residual 0.092023 0.30335   
## Number of obs: 4089, groups: pp, 96; Item, 90  
##   
## Fixed effects:  
## Estimate Std. Error t value  
## (Intercept) 5.499033 0.015147 363.046  
## Pred\_PreviewI.L-H 0.028181 0.017154 1.643  
## Pred\_PreviewT.L-H 0.056810 0.017374 3.270  
## Pred\_PreviewS.L\_H -0.008828 0.017520 -0.504  
## Pred\_Preview -0.030466 0.011755 -2.592  
## Pred\_Preview 0.174263 0.011744 14.838

# LME OF GAZE DURATION

measure = "GD"  
datafile$depvar = datafile[,measure]  
datafile$depvar = as.numeric(datafile$depvar)  
datafile$depvar=log(datafile$depvar)

## identical vs. transposed, transposed vs. substituted

contrasts(datafile$Preview) <- contr.sdif(3)  
GD\_model = lmer(depvar~Age\*Predictability\*Preview+(1+Predictability|pp)+(1|Item),datafile,control=lmerControl(optimizer = "bobyqa",optCtrl=list(maxfun=200000)))  
summary(GD\_model, corr = FALSE)

## Linear mixed model fit by REML ['lmerMod']  
## Formula: depvar ~ Age \* Predictability \* Preview + (1 + Predictability |   
## pp) + (1 | Item)  
## Data: datafile  
## Control: lmerControl(optimizer = "bobyqa", optCtrl = list(maxfun = 2e+05))  
##   
## REML criterion at convergence: 4345.7  
##   
## Scaled residuals:   
## Min 1Q Median 3Q Max   
## -3.7509 -0.6282 -0.0485 0.5812 4.4960   
##   
## Random effects:  
## Groups Name Variance Std.Dev. Corr  
## pp (Intercept) 0.0204285 0.14293   
## Predictability2-1 0.0006824 0.02612 0.92  
## Item (Intercept) 0.0022507 0.04744   
## Residual 0.1358557 0.36859   
## Number of obs: 4788, groups: pp, 96; Item, 90  
##   
## Fixed effects:  
## Estimate Std. Error t value  
## (Intercept) 5.598906 0.016800 333.274  
## Age2-1 0.179526 0.032074 5.597  
## Predictability2-1 0.064649 0.011086 5.831  
## Preview2-1 0.097010 0.013305 7.291  
## Preview3-2 0.143491 0.013026 11.016  
## Age2-1:Predictability2-1 0.061401 0.022161 2.771  
## Age2-1:Preview2-1 -0.039308 0.026606 -1.477  
## Age2-1:Preview3-2 0.008128 0.026053 0.312  
## Predictability2-1:Preview2-1 0.031100 0.026627 1.168  
## Predictability2-1:Preview3-2 -0.071638 0.026060 -2.749  
## Age2-1:Predictability2-1:Preview2-1 0.028617 0.053252 0.537  
## Age2-1:Predictability2-1:Preview3-2 -0.014381 0.052091 -0.276

confint(GD\_model, method="Wald")

## 2.5 % 97.5 %  
## .sig01 NA NA  
## .sig02 NA NA  
## .sig03 NA NA  
## .sig04 NA NA  
## .sigma NA NA  
## (Intercept) 5.56597928 5.63183288  
## Age2-1 0.11666103 0.24239009  
## Predictability2-1 0.04292038 0.08637853  
## Preview2-1 0.07093270 0.12308779  
## Preview3-2 0.11796143 0.16902127  
## Age2-1:Predictability2-1 0.01796679 0.10483515  
## Age2-1:Preview2-1 -0.09145618 0.01283923  
## Age2-1:Preview3-2 -0.04293432 0.05919105  
## Predictability2-1:Preview2-1 -0.02108902 0.08328827  
## Predictability2-1:Preview3-2 -0.12271392 -0.02056221  
## Age2-1:Predictability2-1:Preview2-1 -0.07575497 0.13298899  
## Age2-1:Predictability2-1:Preview3-2 -0.11647830 0.08771573

## identical vs. transposed, identical vs. substituted

contrasts(datafile$Preview) <- contr.treatment(3)  
GD\_model = lmer(depvar~Age\*Predictability\*Preview+(1+Predictability|pp)+(1|Item),datafile,control=lmerControl(optimizer = "bobyqa",optCtrl=list(maxfun=200000)))  
summary(GD\_model, corr = FALSE)

## Linear mixed model fit by REML ['lmerMod']  
## Formula: depvar ~ Age \* Predictability \* Preview + (1 + Predictability |   
## pp) + (1 | Item)  
## Data: datafile  
## Control: lmerControl(optimizer = "bobyqa", optCtrl = list(maxfun = 2e+05))  
##   
## REML criterion at convergence: 4345.7  
##   
## Scaled residuals:   
## Min 1Q Median 3Q Max   
## -3.7509 -0.6282 -0.0485 0.5812 4.4960   
##   
## Random effects:  
## Groups Name Variance Std.Dev. Corr  
## pp (Intercept) 0.0204285 0.14293   
## Predictability2-1 0.0006824 0.02612 0.92  
## Item (Intercept) 0.0022507 0.04744   
## Residual 0.1358557 0.36859   
## Number of obs: 4788, groups: pp, 96; Item, 90  
##   
## Fixed effects:  
## Estimate Std. Error t value  
## (Intercept) 5.48640 0.01852 296.210  
## Age2-1 0.20302 0.03566 5.693  
## Predictability2-1 0.06780 0.01911 3.548  
## Preview2 0.09701 0.01331 7.291  
## Preview3 0.24050 0.01308 18.382  
## Age2-1:Predictability2-1 0.04712 0.03821 1.233  
## Age2-1:Preview2 -0.03931 0.02661 -1.477  
## Age2-1:Preview3 -0.03118 0.02617 -1.191  
## Predictability2-1:Preview2 0.03110 0.02663 1.168  
## Predictability2-1:Preview3 -0.04054 0.02619 -1.548  
## Age2-1:Predictability2-1:Preview2 0.02862 0.05325 0.537  
## Age2-1:Predictability2-1:Preview3 0.01424 0.05235 0.272

confint(GD\_model, method="Wald")

## 2.5 % 97.5 %  
## .sig01 NA NA  
## .sig02 NA NA  
## .sig03 NA NA  
## .sig04 NA NA  
## .sigma NA NA  
## (Intercept) 5.45009964 5.52270463  
## Age2-1 0.13312676 0.27291675  
## Predictability2-1 0.03034804 0.10524340  
## Preview2 0.07093270 0.12308779  
## Preview3 0.21485871 0.26614448  
## Age2-1:Predictability2-1 -0.02776836 0.12200181  
## Age2-1:Preview2 -0.09145618 0.01283923  
## Age2-1:Preview3 -0.08247169 0.02011147  
## Predictability2-1:Preview2 -0.02108902 0.08328827  
## Predictability2-1:Preview3 -0.09187554 0.01079867  
## Age2-1:Predictability2-1:Preview2 -0.07575498 0.13298899  
## Age2-1:Predictability2-1:Preview3 -0.08835946 0.11683090

## the simple effect analysis of age:predictability on GD

contrast.matrix <- matrix(c(  
 -1, 1, 0, 0, # Y.L-H   
 0, 0, -1, +1 ), 4, 2, # O.L-H  
 dimnames=list(c("YH", "YL", "OH", "OL"),   
 c("Y.L-H","O.L-H")))  
inv.contrast.matrix <- matrix(t(ginv(contrast.matrix)), 4, 2,  
 dimnames=list(c("YH", "YL", "OH", "OL"),   
 c("Y.L-H","O.L-H")))  
(contrasts(datafile$Age\_Pred) <- fractions(inv.contrast.matrix))

## Y.L-H O.L-H  
## YH -1/2 0   
## YL 1/2 0   
## OH 0 -1/2   
## OL 0 1/2

(contrasts(datafile$Age\_Pred) <- fractions(inv.contrast.matrix))

## Y.L-H O.L-H  
## YH -1/2 0   
## YL 1/2 0   
## OH 0 -1/2   
## OL 0 1/2

depvar.lmer1 = lmer(depvar ~ Age\_Pred + (1|pp) + (1|Item), datafile)  
summary(depvar.lmer1, corr = FALSE)

## Linear mixed model fit by REML ['lmerMod']  
## Formula: depvar ~ Age\_Pred + (1 | pp) + (1 | Item)  
## Data: datafile  
##   
## REML criterion at convergence: 4647.5  
##   
## Scaled residuals:   
## Min 1Q Median 3Q Max   
## -3.5702 -0.6487 -0.1016 0.6193 4.3588   
##   
## Random effects:  
## Groups Name Variance Std.Dev.  
## pp (Intercept) 0.019865 0.14094   
## Item (Intercept) 0.001572 0.03965   
## Residual 0.146607 0.38289   
## Number of obs: 4788, groups: pp, 96; Item, 90  
##   
## Fixed effects:  
## Estimate Std. Error t value  
## (Intercept) 5.60369 0.01645 340.598  
## Age\_PredY.L-H 0.03108 0.01562 1.989  
## Age\_PredO.L-H 0.09422 0.01586 5.942  
## Age\_Pred 0.17575 0.03182 5.523

## Simple effect analysis for predictability:preview on GD

contrast.matrix <- matrix(c(  
 -1, 0, 0, 1, 0, 0, #I.L-H  
 0, -1, 0, 0, 1, 0, #T.L-H   
 0, 0, -1, 0, 0, 1 #S.L-H  
 ), 6, 3,   
 dimnames=list(c("HI", "HT", "HS", "LI", "LT", "LS"),   
 c("I.L-H","T.L-H", "S.L\_H")))  
  
inv.contrast.matrix <- matrix(t(ginv(contrast.matrix)), 6, 3,  
 dimnames=list(c("HI", "HT", "HS", "LI", "LT", "LS"),   
 c("I.L-H","T.L-H", "S.L\_H")))  
  
(contrasts(datafile$Pred\_Preview) <- fractions(inv.contrast.matrix))

## I.L-H T.L-H S.L\_H  
## HI -1/2 0 0   
## HT 0 -1/2 0   
## HS 0 0 -1/2   
## LI 1/2 0 0   
## LT 0 1/2 0   
## LS 0 0 1/2

# for continuous dependent variables  
depvar.lmer1 = lmer(depvar~Pred\_Preview+(1+Predictability|pp)+(1|Item), datafile)  
summary(depvar.lmer1, corr = FALSE)

## Linear mixed model fit by REML ['lmerMod']  
## Formula: depvar ~ Pred\_Preview + (1 + Predictability | pp) + (1 | Item)  
## Data: datafile  
##   
## REML criterion at convergence: 4346.9  
##   
## Scaled residuals:   
## Min 1Q Median 3Q Max   
## -3.7939 -0.6237 -0.0466 0.5828 4.4747   
##   
## Random effects:  
## Groups Name Variance Std.Dev. Corr  
## pp (Intercept) 0.027893 0.16701   
## Predictability2-1 0.001526 0.03906 0.93  
## Item (Intercept) 0.002238 0.04731   
## Residual 0.135816 0.36853   
## Number of obs: 4788, groups: pp, 96; Item, 90  
##   
## Fixed effects:  
## Estimate Std. Error t value  
## (Intercept) 5.57800 0.01864 299.219  
## Pred\_PreviewI.L-H 0.06283 0.01933 3.250  
## Pred\_PreviewT.L-H 0.09323 0.01918 4.860  
## Pred\_PreviewS.L\_H 0.02174 0.01854 1.172  
## Pred\_Preview -0.03660 0.01318 -2.778  
## Pred\_Preview 0.23916 0.01309 18.264

# LME OF TOTAL READING TIME (TRT)

measure = "TRT"  
datafile$depvar = datafile[,measure]  
datafile$depvar = as.numeric(datafile$depvar)  
datafile$depvar=log(datafile$depvar)

## identical vs. transposed, transposed vs. substituted

contrasts(datafile$Preview)<-contr.sdif(3)  
TRT\_model = lmer(depvar~Age\*Predictability\*Preview+(1+Preview|pp)+(1|Item),datafile,control=lmerControl(optimizer = "bobyqa",optCtrl=list(maxfun=200000)))  
summary(TRT\_model, corr = FALSE)

## Linear mixed model fit by REML ['lmerMod']  
## Formula: depvar ~ Age \* Predictability \* Preview + (1 + Preview | pp) +   
## (1 | Item)  
## Data: datafile  
## Control: lmerControl(optimizer = "bobyqa", optCtrl = list(maxfun = 2e+05))  
##   
## REML criterion at convergence: 8057.5  
##   
## Scaled residuals:   
## Min 1Q Median 3Q Max   
## -3.2505 -0.6810 -0.0538 0.6528 4.5039   
##   
## Random effects:  
## Groups Name Variance Std.Dev. Corr   
## pp (Intercept) 0.041303 0.20323   
## Preview2-1 0.002872 0.05359 1.00   
## Preview3-2 0.002694 0.05191 0.23 0.25  
## Item (Intercept) 0.007335 0.08564   
## Residual 0.231516 0.48116   
## Number of obs: 5574, groups: pp, 96; Item, 90  
##   
## Fixed effects:  
## Estimate Std. Error t value  
## (Intercept) 5.80429 0.02417 240.102  
## Age2-1 0.33614 0.04485 7.495  
## Predictability2-1 0.10326 0.01305 7.914  
## Preview2-1 0.09003 0.01721 5.231  
## Preview3-2 0.12310 0.01677 7.342  
## Age2-1:Predictability2-1 0.12832 0.02609 4.918  
## Age2-1:Preview2-1 -0.08316 0.03442 -2.416  
## Age2-1:Preview3-2 0.02235 0.03352 0.667  
## Predictability2-1:Preview2-1 0.04262 0.03252 1.311  
## Predictability2-1:Preview3-2 -0.06912 0.03166 -2.183  
## Age2-1:Predictability2-1:Preview2-1 0.04125 0.06500 0.635  
## Age2-1:Predictability2-1:Preview3-2 -0.05679 0.06332 -0.897

confint(TRT\_model, method="Wald")

## 2.5 % 97.5 %  
## .sig01 NA NA  
## .sig02 NA NA  
## .sig03 NA NA  
## .sig04 NA NA  
## .sig05 NA NA  
## .sig06 NA NA  
## .sig07 NA NA  
## .sigma NA NA  
## (Intercept) 5.75691361 5.851674973  
## Age2-1 0.24823354 0.424039080  
## Predictability2-1 0.07768679 0.128835005  
## Preview2-1 0.05629643 0.123761401  
## Preview3-2 0.09023984 0.155961282  
## Age2-1:Predictability2-1 0.07717624 0.179459804  
## Age2-1:Preview2-1 -0.15062711 -0.015698114  
## Age2-1:Preview3-2 -0.04335070 0.088057099  
## Predictability2-1:Preview2-1 -0.02111359 0.106346546  
## Predictability2-1:Preview3-2 -0.13117649 -0.007066886  
## Age2-1:Predictability2-1:Preview2-1 -0.08615672 0.168653990  
## Age2-1:Predictability2-1:Preview3-2 -0.18089018 0.067318537

## identical vs. transposed, identical vs. substituted

contrasts(datafile$Preview)<-contr.treatment(3)  
TRT\_model = lmer(depvar~Age\*Predictability\*Preview+(1+Preview|pp)+(1|Item),datafile,control=lmerControl(optimizer = "bobyqa",optCtrl=list(maxfun=200000)))

## boundary (singular) fit: see help('isSingular')

summary(TRT\_model, corr = FALSE)

## Linear mixed model fit by REML ['lmerMod']  
## Formula: depvar ~ Age \* Predictability \* Preview + (1 + Preview | pp) +   
## (1 | Item)  
## Data: datafile  
## Control: lmerControl(optimizer = "bobyqa", optCtrl = list(maxfun = 2e+05))  
##   
## REML criterion at convergence: 8057.5  
##   
## Scaled residuals:   
## Min 1Q Median 3Q Max   
## -3.2505 -0.6810 -0.0538 0.6528 4.5039   
##   
## Random effects:  
## Groups Name Variance Std.Dev. Corr   
## pp (Intercept) 0.027083 0.16457   
## Preview2 0.002872 0.05359 0.99   
## Preview3 0.006956 0.08340 0.71 0.80  
## Item (Intercept) 0.007335 0.08564   
## Residual 0.231516 0.48116   
## Number of obs: 5574, groups: pp, 96; Item, 90  
##   
## Fixed effects:  
## Estimate Std. Error t value  
## (Intercept) 5.70324 0.02273 250.952  
## Age2-1 0.38413 0.04171 9.209  
## Predictability2-1 0.09789 0.02303 4.250  
## Preview2 0.09003 0.01721 5.231  
## Preview3 0.21313 0.01815 11.741  
## Age2-1:Predictability2-1 0.11975 0.04606 2.600  
## Age2-1:Preview2 -0.08316 0.03442 -2.416  
## Age2-1:Preview3 -0.06081 0.03631 -1.675  
## Predictability2-1:Preview2 0.04262 0.03252 1.311  
## Predictability2-1:Preview3 -0.02651 0.03175 -0.835  
## Age2-1:Predictability2-1:Preview2 0.04125 0.06500 0.635  
## Age2-1:Predictability2-1:Preview3 -0.01554 0.06347 -0.245  
## optimizer (bobyqa) convergence code: 0 (OK)  
## boundary (singular) fit: see help('isSingular')

confint(TRT\_model, method="Wald")

## 2.5 % 97.5 %  
## .sig01 NA NA  
## .sig02 NA NA  
## .sig03 NA NA  
## .sig04 NA NA  
## .sig05 NA NA  
## .sig06 NA NA  
## .sig07 NA NA  
## .sigma NA NA  
## (Intercept) 5.65869857 5.74778441  
## Age2-1 0.30237265 0.46588132  
## Predictability2-1 0.05274961 0.14303133  
## Preview2 0.05629643 0.12376140  
## Preview3 0.17755211 0.24870684  
## Age2-1:Predictability2-1 0.02947541 0.21001966  
## Age2-1:Preview2 -0.15062711 -0.01569811  
## Age2-1:Preview3 -0.13197720 0.01035838  
## Predictability2-1:Preview2 -0.02111359 0.10634655  
## Predictability2-1:Preview3 -0.08873326 0.03572285  
## Age2-1:Predictability2-1:Preview2 -0.08615672 0.16865399  
## Age2-1:Predictability2-1:Preview3 -0.13993108 0.10885671

## the simple effect analysis of age:predictability on TRT

contrast.matrix <- matrix(c(  
 -1, 1, 0, 0, # Y.L-H   
 0, 0, -1, +1 ), 4, 2, # O.L-H  
 dimnames=list(c("YH", "YL", "OH", "OL"),   
 c("Y.L-H","O.L-H")))  
inv.contrast.matrix <- matrix(t(ginv(contrast.matrix)), 4, 2,  
 dimnames=list(c("YH", "YL", "OH", "OL"),   
 c("Y.L-H","O.L-H")))  
(contrasts(datafile$Age\_Pred) <- fractions(inv.contrast.matrix))

## Y.L-H O.L-H  
## YH -1/2 0   
## YL 1/2 0   
## OH 0 -1/2   
## OL 0 1/2

(contrasts(datafile$Age\_Pred) <- fractions(inv.contrast.matrix))

## Y.L-H O.L-H  
## YH -1/2 0   
## YL 1/2 0   
## OH 0 -1/2   
## OL 0 1/2

depvar.lmer1 = lmer(depvar ~ Age\_Pred + (1|pp) + (1|Item), datafile)  
summary(depvar.lmer1, corr = FALSE)

## Linear mixed model fit by REML ['lmerMod']  
## Formula: depvar ~ Age\_Pred + (1 | pp) + (1 | Item)  
## Data: datafile  
##   
## REML criterion at convergence: 8239.1  
##   
## Scaled residuals:   
## Min 1Q Median 3Q Max   
## -3.3356 -0.7052 -0.0532 0.6748 4.6212   
##   
## Random effects:  
## Groups Name Variance Std.Dev.  
## pp (Intercept) 0.040916 0.20228   
## Item (Intercept) 0.006847 0.08274   
## Residual 0.241782 0.49171   
## Number of obs: 5574, groups: pp, 96; Item, 90  
##   
## Fixed effects:  
## Estimate Std. Error t value  
## (Intercept) 5.80928 0.02401 241.959  
## Age\_PredY.L-H 0.03683 0.01784 2.065  
## Age\_PredO.L-H 0.16422 0.01973 8.322  
## Age\_Pred 0.32796 0.04474 7.331

## Simple effect analysis for predictability:preview on TRT

contrast.matrix <- matrix(c(  
 -1, 0, 0, 1, 0, 0, #I.L-H  
 0, -1, 0, 0, 1, 0, #T.L-H   
 0, 0, -1, 0, 0, 1 #S.L-H  
 ), 6, 3,   
 dimnames=list(c("HI", "HT", "HS", "LI", "LT", "LS"),   
 c("I.L-H","T.L-H", "S.L\_H")))  
  
inv.contrast.matrix <- matrix(t(ginv(contrast.matrix)), 6, 3,  
 dimnames=list(c("HI", "HT", "HS", "LI", "LT", "LS"),   
 c("I.L-H","T.L-H", "S.L\_H")))  
  
(contrasts(datafile$Pred\_Preview) <- fractions(inv.contrast.matrix))

## I.L-H T.L-H S.L\_H  
## HI -1/2 0 0   
## HT 0 -1/2 0   
## HS 0 0 -1/2   
## LI 1/2 0 0   
## LT 0 1/2 0   
## LS 0 0 1/2

# for continuous dependent variables  
depvar.lmer1 = lmer(depvar~Pred\_Preview+(1+Predictability|pp)+(1|Item), datafile)  
summary(depvar.lmer1, corr = FALSE)

## Linear mixed model fit by REML ['lmerMod']  
## Formula: depvar ~ Pred\_Preview + (1 + Predictability | pp) + (1 | Item)  
## Data: datafile  
##   
## REML criterion at convergence: 8103.3  
##   
## Scaled residuals:   
## Min 1Q Median 3Q Max   
## -3.3339 -0.6823 -0.0593 0.6559 4.4988   
##   
## Random effects:  
## Groups Name Variance Std.Dev. Corr  
## pp (Intercept) 0.067913 0.26060   
## Predictability2-1 0.004247 0.06517 0.90  
## Item (Intercept) 0.007405 0.08605   
## Residual 0.232933 0.48263   
## Number of obs: 5574, groups: pp, 96; Item, 90  
##   
## Fixed effects:  
## Estimate Std. Error t value  
## (Intercept) 5.76310 0.02889 199.476  
## Pred\_PreviewI.L-H 0.08623 0.02404 3.587  
## Pred\_PreviewT.L-H 0.12311 0.02385 5.161  
## Pred\_PreviewS.L\_H 0.05595 0.02266 2.469  
## Pred\_Preview -0.02285 0.01605 -1.424  
## Pred\_Preview 0.21894 0.01586 13.807

# LME OF REGRESSION OUT RATE (RO)

measure = "RO"  
datafile$depvar = datafile[,measure]  
datafile$depvar = as.numeric(datafile$depvar)

## identical vs. transposed, transposed vs. substituted

contrasts(datafile$Preview)<-contr.sdif(3)  
RO\_model = glmer(depvar~Age\*Predictability\*Preview+(1|pp)+(1|Item),datafile,family=binomial,control=glmerControl(optimizer="bobyqa", optCtrl=list(maxfun=200000)))  
summary(RO\_model, corr = FALSE)

## Generalized linear mixed model fit by maximum likelihood (Laplace  
## Approximation) [glmerMod]  
## Family: binomial ( logit )  
## Formula: depvar ~ Age \* Predictability \* Preview + (1 | pp) + (1 | Item)  
## Data: datafile  
## Control: glmerControl(optimizer = "bobyqa", optCtrl = list(maxfun = 2e+05))  
##   
## AIC BIC logLik deviance df.resid   
## 3322.3 3413.0 -1647.2 3294.3 4774   
##   
## Scaled residuals:   
## Min 1Q Median 3Q Max   
## -1.2215 -0.3876 -0.2853 -0.1986 6.5660   
##   
## Random effects:  
## Groups Name Variance Std.Dev.  
## pp (Intercept) 0.4962 0.7044   
## Item (Intercept) 0.3763 0.6134   
## Number of obs: 4788, groups: pp, 96; Item, 90  
##   
## Fixed effects:  
## Estimate Std. Error z value Pr(>|z|)   
## (Intercept) -2.339715 0.115172 -20.315 < 2e-16 \*\*\*  
## Age2-1 -0.282825 0.180933 -1.563 0.118017   
## Predictability2-1 0.335850 0.097355 3.450 0.000561 \*\*\*  
## Preview2-1 -0.001392 0.128642 -0.011 0.991366   
## Preview3-2 0.781312 0.113916 6.859 6.95e-12 \*\*\*  
## Age2-1:Predictability2-1 0.372782 0.194616 1.915 0.055433 .   
## Age2-1:Preview2-1 0.147960 0.257415 0.575 0.565433   
## Age2-1:Preview3-2 -0.017338 0.227353 -0.076 0.939210   
## Predictability2-1:Preview2-1 0.265172 0.257895 1.028 0.303848   
## Predictability2-1:Preview3-2 -0.298078 0.227230 -1.312 0.189591   
## Age2-1:Predictability2-1:Preview2-1 -0.084109 0.516065 -0.163 0.870533   
## Age2-1:Predictability2-1:Preview3-2 -0.388222 0.454653 -0.854 0.393168   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

confint(RO\_model, method="Wald")

## 2.5 % 97.5 %  
## .sig01 NA NA  
## .sig02 NA NA  
## (Intercept) -2.565448037 -2.11398231  
## Age2-1 -0.637445855 0.07179667  
## Predictability2-1 0.145036570 0.52666243  
## Preview2-1 -0.253525108 0.25074102  
## Preview3-2 0.558041139 1.00458338  
## Age2-1:Predictability2-1 -0.008659528 0.75422295  
## Age2-1:Preview2-1 -0.356564107 0.65248364  
## Age2-1:Preview3-2 -0.462941313 0.42826442  
## Predictability2-1:Preview2-1 -0.240292844 0.77063587  
## Predictability2-1:Preview3-2 -0.743440339 0.14728413  
## Age2-1:Predictability2-1:Preview2-1 -1.095577182 0.92735933  
## Age2-1:Predictability2-1:Preview3-2 -1.279325372 0.50288198

## identical vs. transposed, identical vs. substituted

contrasts(datafile$Preview)<-contr.treatment(3)  
RO\_model = glmer(depvar~Age\*Predictability\*Preview+(1|pp)+(1|Item),datafile,family=binomial,control=glmerControl(optimizer="bobyqa", optCtrl=list(maxfun=200000)))  
summary(RO\_model, corr = FALSE)

## Generalized linear mixed model fit by maximum likelihood (Laplace  
## Approximation) [glmerMod]  
## Family: binomial ( logit )  
## Formula: depvar ~ Age \* Predictability \* Preview + (1 | pp) + (1 | Item)  
## Data: datafile  
## Control: glmerControl(optimizer = "bobyqa", optCtrl = list(maxfun = 2e+05))  
##   
## AIC BIC logLik deviance df.resid   
## 3322.3 3413.0 -1647.2 3294.3 4774   
##   
## Scaled residuals:   
## Min 1Q Median 3Q Max   
## -1.2215 -0.3876 -0.2853 -0.1986 6.5660   
##   
## Random effects:  
## Groups Name Variance Std.Dev.  
## pp (Intercept) 0.4962 0.7044   
## Item (Intercept) 0.3763 0.6134   
## Number of obs: 4788, groups: pp, 96; Item, 90  
##   
## Fixed effects:  
## Estimate Std. Error z value Pr(>|z|)   
## (Intercept) -2.599225 0.139214 -18.671 < 2e-16 \*\*\*  
## Age2-1 -0.375688 0.238079 -1.578 0.115   
## Predictability2-1 0.258430 0.182201 1.418 0.156   
## Preview2 -0.001392 0.128642 -0.011 0.991   
## Preview3 0.779920 0.113760 6.856 7.09e-12 \*\*\*  
## Age2-1:Predictability2-1 0.558257 0.364790 1.530 0.126   
## Age2-1:Preview2 0.147962 0.257425 0.575 0.565   
## Age2-1:Preview3 0.130624 0.227361 0.575 0.566   
## Predictability2-1:Preview2 0.265168 0.257900 1.028 0.304   
## Predictability2-1:Preview3 -0.032908 0.227505 -0.145 0.885   
## Age2-1:Predictability2-1:Preview2 -0.084099 0.516159 -0.163 0.871   
## Age2-1:Predictability2-1:Preview3 -0.472328 0.455109 -1.038 0.299   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

confint(RO\_model, method="Wald")

## 2.5 % 97.5 %  
## .sig01 NA NA  
## .sig02 NA NA  
## (Intercept) -2.8720789 -2.32637096  
## Age2-1 -0.8423151 0.09093901  
## Predictability2-1 -0.0986780 0.61553738  
## Preview2 -0.2535255 0.25074157  
## Preview3 0.5569555 1.00288527  
## Age2-1:Predictability2-1 -0.1567174 1.27323176  
## Age2-1:Preview2 -0.3565822 0.65250649  
## Age2-1:Preview3 -0.3149958 0.57624436  
## Predictability2-1:Preview2 -0.2403066 0.77064268  
## Predictability2-1:Preview3 -0.4788089 0.41299263  
## Age2-1:Predictability2-1:Preview2 -1.0957518 0.92755290  
## Age2-1:Predictability2-1:Preview3 -1.3643250 0.41966840