Speed Gaps: Supplementary Materials Including ELLs in Analyses

The analyses for Gender and Ethnicity are repeated here including ELLs. Just the tables and the figures are produced.

Since this is an online document, I am going to echo the R code. The only bits missing will be the LaTeX code and information in the **knitr** headers.

```
suppressPackageStartupMessages(require(xtable))
```

```
sdp <- function(x1,x2)
  sqrt( ((sum(is.na(x1)==FALSE)-1)*var(x1,na.rm=TRUE) +
         (sum(is.na(x2)==FALSE)-1)*var(x2,na.rm=TRUE))/
        (sum(is.na(x1)==FALSE)+sum(is.na(x2)==FALSE)-2))
nvalidm1 <- function(x) sum(is.na(x)==FALSE)-1
sdpooled <- function(x,na.rm=TRUE)
{ vars <- tapply(x[,2],x[,1],var,na.rm=na.rm)
  ns <- tapply(x[,2],x[,1],nvalidm1)
  return(sqrt(sum(vars*ns)/sum(ns)))
  }
```

```
s12 <- readRDS(paste0("C:\\PassportJuly2019\\My Passport",
  "\\alder\\PersLearning\\RTwSL\\Study1.Rda"))


#on other machine
#  "C:\\Users\\dwright\\Documents\\PersLearning\\RTwSL\\Study1.Rda")
nmiss <- function(x) sum(is.na(x)) + sum(x=="",na.rm=TRUE)
mmiss <- function(x) mean(is.na(x)) + mean(x=="",na.rm=TRUE)
suppressPackageStartupMessages(require(e1071))
suppressPackageStartupMessages(require(splines))
suppressPackageStartupMessages(require(stringr))
suppressPackageStartupMessages(require(pscl))
suppressPackageStartupMessages(require(optimx))
suppressPackageStartupMessages(require(plotrix))
suppressPackageStartupMessages(require(Hmisc))
#suppressPackageStartupMessages(require(grattanCharts))
suppressPackageStartupMessages(require(lme4))
```

```
suppressPackageStartupMessages(require(TTR))
#options(warn=0)
#install.packages("biglm", repos='http://cran.us.r-project.org')
#suppressPackageStartupMessages(require(biglm))

#This assumes in order without NAs
#when around > 1 doesn't smoother those next to extreme
ma <- function(x,around=1){
  nx <- length(x)
  vals <- c(x[1:around],SMA(x,1+2*around)[(1+2*around):nx],
           x[(nx-around + 1):nx])
  return(vals)}

gmean <- function(x)
  ifelse(any(x<=0),stop("some negatives"),
     return(exp(mean(log(x), na.rm=TRUE))))
gsd  <- function(x)
  ifelse(any(x<=0),stop("some negatives"),
     return(exp(sd(log(x), na.rm=TRUE))))
s12$time[s12$time <= 1] <- NA
s12$time[s12$time > 60*60] <- NA
s12 <- s12[is.na(s12$time)==FALSE,]
```

```
s12$ELL <- rep(NA,nrow(s12))
s12$ELL[s12$engProf== "Eng Learner"] <- 1
s12$ELL[s12$engProf== "English Only"] <- 0
s12$ELL[s12$engProf== "Initially Id Fluent Eng Profic"] <- 0
s12$ELL[s12$engProf== "Redesignated Fluent Eng Profic"] <- 0
```

```
s12$SN <- s12$SubName
s12$SN[s12$SN=="Expeditions"] <- NA
s12$SN <- droplevels(s12$SN)
s12$time[s12$time <= 1] <- NA
s12$time[s12$time > 60*60] <- NA
s12 <- s12[is.na(s12$time)==FALSE,]
s12$ltime <- scale(log(s12$time))
s13 <- s12 # this is the difference for Supplementary Materials
```

```
Cohenh <- function(prop1,prop2) 2*(asin(sqrt(prop1)) - asin(sqrt(prop2)))
```

Gender Differences

```
options(warn = -1) #this got deleted somewhere.
# The alignment L{xcm} produces a warning
s13$gender <- droplevels(s13$gender)
tab1 <- t(with(s13[is.na(s13$time)==FALSE,],
               tapply(time,list(gender,SN),gmean)))
sn <- levels(s13$SN)
ds <- vector(length=length(sn))
for (i in 1:length(sn))
     ds[i] <- (mean(log(s13[s13$gender=="F" & s13$SN==sn[i],]$time),
        na.rm=TRUE)-
        mean(log(s13[s13$gender=="M" & s13$SN==sn[i],]$time),
             na.rm=TRUE)) /
           sdp(log(s13[s13$gender== "F" & s13$SN==sn[i],]$time),
               log(s13[s13$gender== "M" & s13$SN==sn[i],]$time))
tab1 <- cbind(tab1,ds)
colnames(tab1) <- c("Female \\mbox{Time}","Male \\mbox{Time}",
                    "Cohen's d  \\mbox{Time} ")
rownames(tab1)[3] <- "Mathematics"
tab2 <- t(with(s13,tapply(Correct,list(gender,SN),mean,na.rm=TRUE)))
hs <- vector(length=length(sn))
for (i in 1:length(sn))
     hs[i] <- 2*(asin(sqrt(mean(s13[s13$gender=="F" &
                      s13$SN==sn[i],]$Correct,na.rm=TRUE)))-
                 asin(sqrt(mean(s13[s13$gender=="M" &
                      s13$SN==sn[i],]$Correct,na.rm=TRUE))))
tab2 <- cbind(tab2,hs)
colnames(tab2) <- c("Female Accuracy","Male \\mbox{Accuracy}",
                    "Cohen's h \\mbox{Accuracy}")
rownames(tab2)[3] <- "Mathematics"
tab <- cbind(tab1,tab2)
tab <- rbind(tab,colMeans(tab))
rownames(tab)[nrow(tab)] <- "Means"
rownames(tab)[nrow(tab)] <- "Means"
comment          <- list()
comment$pos      <- list()
comment$pos[[1]] <- c(nrow(tab))
comment$command  <- paste0("\\hline \n \\multicolumn{7}{p{\\linewidth}}",
  "{\\footnotesize{Note: Positive Cohen's \\emph{d} values refer to
   males being faster. Positive Cohen's \\emph{h} values mean the
   females were more accurate.}} \\\\ \n")
print(xtable(tab,label="tab:genderunis",caption="The geometric means of the
       response times (in seconds) for females and males, and their
       proportions correct for each of the five subject areas.",
```

```
       align = "lp{1.6cm}p{1.6cm}p{1.8cm}p{1.7cm}p{1.6cm}p{1.9cm}"),
       add.to.row = comment,
       hline.after = c(-1,0,nrow(tab)-1,nrow(tab)),
       sanitize.colnames.function = identity,caption.placement="top")
```

Table SM.1

The geometric means of the response times (in seconds) for females and males, and their proportions correct for each of the five subject areas.

	Female Time	Male Time	Cohen's d Time	Female Accuracy	Male Accuracy	Cohen's h Accuracy
English	36.33	35.05	0.03	0.67	0.64	0.06
History	37.06	34.42	0.07	0.68	0.68	0.01
Mathematics	57.65	50.98	0.10	0.63	0.63	0.02
Science	37.71	35.87	0.04	0.67	0.66	0.01
World Language	29.50	30.43	-0.03	0.67	0.65	0.05
Means	39.65	37.35	0.04	0.67	0.65	0.03

Note: Positive Cohen's d values refer to males being faster. Positive Cohen's h values mean the females were more accurate.

```
y <- log(s13$time); x <- s13$gender=="M"; id <- s13$StudID; sn <- s13$SN
correct <- s13$Correct
```

```
invisible(with(s13[s13$SN=="English",],
             list(
  engT0g <<- lmer(log(time) ~ 1 + (1|StudID),REML=FALSE,
                 control = lmerControl(calc.derivs = FALSE,
        optimizer ='optimx', optCtrl=list(method='L-BFGS-B'))),
  engT1g <<- update(engT0g, .~. + gender)
)))
```

```
invisible(with(s13[s13$SN=="English" & is.na(s13$time)==FALSE,],
  list(
   engC0g <<- glmer(Correct ~ 1 + (1|StudID),family="binomial",
      control = glmerControl(calc.derivs = FALSE,
          optimizer ='Nelder_Mead')),
  engC1ag <<- update(engC0g, .~. + gender),
  engC1bg <<- update(engC0g, .~. + bs(log(time),degree=3,df=4)),
  engC2g <<- update(engC1bg, .~. + gender),
  engC3g <<- update(engC2g, .~. + gender:bs(log(time),degree=1,df=2))
     )))
```

```
anovasGenderTab <- matrix(ncol=5,nrow=6)
```

```
anovasGenderTab[,1] <- c(
 anova(engT0g,engT1g)$Pr[2],
 anova(engC0g,engC1ag)$Pr[2],
 anova(engC0g,engC1bg)$Pr[2],
 anova(engC1ag,engC2g)$Pr[2],
 anova(engC1bg,engC2g)$Pr[2],
 anova(engC2g,engC3g)$Pr[2])
```

```
invisible(with(s13[s13$SN=="History",],list(
  HistT0g <<- lmer(log(time) ~ 1 + (1|StudID),REML=FALSE,
                 control = lmerControl(calc.derivs = FALSE,
          optimizer ='optimx', optCtrl=list(method='L-BFGS-B'))),
  HistT1g <<- update(HistT0g, .~. + gender)
)))
```

```
invisible(with(s13[s13$SN=="History" & is.na(s13$time)==FALSE,],
  list(
  HistC0g <<- glmer(Correct ~ 1 + (1|StudID),family="binomial",
        control = glmerControl(calc.derivs = FALSE,
          optimizer ='Nelder_Mead')),
  HistC1ag <<- update(HistC0g, .~. + gender),
  HistC1bg <<- update(HistC0g, .~. + bs(log(time),degree=3,df=4)),
  HistC2g <<- update(HistC1bg, .~. + gender),
  HistC3g <<- update(HistC2g, .~. + gender:bs(log(time),degree=1,df=2))
     )))
```

```
anovasGenderTab[,2] <- c(
 anova(HistT0g,HistT1g)$Pr[2],
 anova(HistC0g,HistC1ag)$Pr[2],
 anova(HistC0g,HistC1bg)$Pr[2],
 anova(HistC1ag,HistC2g)$Pr[2],
 anova(HistC1bg,HistC2g)$Pr[2],
 anova(HistC2g,HistC3g)$Pr[2])
```

```
invisible(with(s13[s13$SN=="Math",],list(
  MathT0g <<- lmer(log(time) ~ 1 + (1|StudID),REML=FALSE,
                 control = lmerControl(calc.derivs = FALSE,
          optimizer ='optimx', optCtrl=list(method='L-BFGS-B'))),
  MathT1g <<- update(MathT0g, .~. + gender)
)))
```

```
invisible(with(s13[s13$SN=="Math" & is.na(s13$time)==FALSE,],
  list(
  MathC0g <<- glmer(Correct ~ 1 + (1|StudID),family="binomial",
        control = glmerControl(calc.derivs = FALSE,
          optimizer ='Nelder_Mead')),
  MathC1ag <<- update(MathC0g, .~. + gender),
  MathC1bg <<- update(MathC0g, .~. + bs(log(time),degree=3,df=4)),
  MathC2g <<- update(MathC1bg, .~. + gender),
  MathC3g <<- update(MathC2g, .~. + gender:bs(log(time),degree=1,df=2))
    )))
```

```
anovasGenderTab[,3] <- c(
 anova(MathT0g,MathT1g)$Pr[2],
 anova(MathC0g,MathC1ag)$Pr[2],
 anova(MathC0g,MathC1bg)$Pr[2],
 anova(MathC1ag,MathC2g)$Pr[2],
 anova(MathC1bg,MathC2g)$Pr[2],
 anova(MathC2g,MathC3g)$Pr[2])
```

```
invisible(with(s13[s13$SN=="Science",],list(
  SciT0g <<- lmer(log(time) ~ 1 + (1|StudID),REML=FALSE,
                  control = lmerControl(calc.derivs = FALSE,
          optimizer ='optimx', optCtrl=list(method='L-BFGS-B'))),
  SciT1g <<- update(SciT0g, .~. + gender)
)))
```

```
invisible(with(s13[s13$SN=="Science" & is.na(s13$time)==FALSE,],
  list(
  SciC0g <<- glmer(Correct ~ 1 + (1|StudID),family="binomial",
       control = glmerControl(calc.derivs = FALSE,
         optimizer ='Nelder_Mead')),
  SciC1ag <<- update(SciC0g, .~. + gender),
  SciC1bg <<- update(SciC0g, .~. + bs(log(time),degree=3,df=4)),
  SciC2g <<- update(SciC1bg, .~. + gender),
  SciC3g <<- update(SciC2g, .~. + gender:bs(log(time),degree=1,df=2))
    )))
```

```
anovasGenderTab[,4] <- c(
 anova(SciT0g,SciT1g)$Pr[2],
 anova(SciC0g,SciC1ag)$Pr[2],
 anova(SciC0g,SciC1bg)$Pr[2],
```

```
 anova(SciC1ag,SciC2g)$Pr[2],
 anova(SciC1bg,SciC2g)$Pr[2],
 anova(SciC2g,SciC3g)$Pr[2])
```

```
invisible(with(s13[s13$SN=="World Language",],list(
  WLT0g <<- lmer(log(time) ~ 1 + (1|StudID),REML=FALSE,
                control = lmerControl(calc.derivs = FALSE,
          optimizer ='optimx', optCtrl=list(method='L-BFGS-B'))),
  WLT1g <<- update(WLT0g, .~. + gender)
)))
```

```
invisible(with(s13[s13$SN=="World Language" & is.na(s13$time)==FALSE,],
  list(
  WLC0g <<- glmer(Correct ~ 1 + (1|StudID),family="binomial",
       control = glmerControl(calc.derivs = FALSE,
         optimizer ='Nelder_Mead')),
  WLC1ag <<- update(WLC0g, .~. + gender),
  WLC1bg <<- update(WLC0g, .~. + bs(log(time),degree=3,df=4)),
  WLC2g <<- update(WLC1bg, .~. + gender),
  WLC3g <<- update(WLC2g, .~. + gender:bs(log(time),degree=1,df=2))
     )))
```

```
anovasGenderTab[,5] <- c(
 anova(WLT0g,WLT1g)$Pr[2],
 anova(WLC0g,WLC1ag)$Pr[2],
 anova(WLC0g,WLC1bg)$Pr[2],
 anova(WLC1ag,WLC2g)$Pr[2],
 anova(WLC1bg,WLC2g)$Pr[2],
 anova(WLC2g,WLC3g)$Pr[2])
rownames(anovasGenderTab) <- c(
  "Gender -> Time",
  "Gender -> Correct","Time -> Correct",
  "T -> C|G","G -> C|T","T by G -> C")
colnames(anovasGenderTab) <- c("English","History","Math",
                   "Science","WL")
```

```
suppressPackageStartupMessages(library(stringr))
anovasGenderTabS <- sprintf("%.3f",anovasGenderTab)
anovasGenderTabS <- matrix(
    str_replace(as.character(anovasGenderTabS), "^0\\.", "."),
    ncol=5,nrow=6)
```

```
anovasGenderTabS[anovasGenderTab < .001] <- "< .001"
rownames(anovasGenderTabS) <- c(
  "Main effect of Gender on Time",
  "Main effect of Gender on Accuracy",
  "Main effect of Time on Accuracy",
  "Effect of Time on Accuracy after conditioning on Gender",
  "Effect of Gender on Accuracy after conditioning on Time",
  "Time by Gender Interaction")
colnames(anovasGenderTabS) <- c("English","History","Math",
                   "Science","WL")

#print(xtable(anovasGenderTab,caption="p-values by Gender."),
#      hline.after=c(-1,0,1,nrow(anovasGenderTab)))
print(xtable(anovasGenderTabS,caption="The \\emph{p}-values associated with adding Gender t
      align="L{6cm}rrrrr"),
      hline.after=c(-1,0,1,nrow(anovasGenderTab)),caption.placement="top")
```

Table SM.2

The p*-values associated with adding Gender to predict the log of response time, and adding Gender and the log of response time to predict accuracy. WL stands for World Language.*

	English	History	Math	Science	WL
Main effect of Gender on Time	.703	.318	< .001	.020	.225
Main effect of Gender on Accuracy	< .001	.046	.798	.406	.002
Main effect of Time on Accuracy	< .001	< .001	< .001	< .001	< .001
Effect of Time on Accuracy after conditioning on Gender	< .001	< .001	< .001	< .001	< .001
Effect of Gender on Accuracy after conditioning on Time	< .001	.024	.908	.286	.005
Time by Gender Interaction	.008	.007	.146	.085	< .001

```
#range(s13$time)
timeF <- s13$time[s13$gender=="F"]
timeF[timeF <= 1] <- NA
tt <- 30
sn<-5
vals <- matrix(ncol=sn,nrow=(tt))
for (k in 2:tt)
 vals[(k-1),] <- with(s13[s13$gender=="F",],
    t(tapply(Correct,list(SN,timeF==k),mean,na.rm=TRUE)[1:sn,2]))
colnames(vals) <- levels(s13$SN)
vals[tt,] <- with(s13[s13$gender=="F",],
    t(tapply(Correct,list(SN,timeF > tt),mean,na.rm=TRUE)[1:sn,2]))
rownames(vals) <- c(2:tt,paste0(">",tt))
```

```
valsF <- vals
#valsF[1:(tt-1),] <- apply(valsF[1:(tt-1),],2,ma,around=1)
```

```
timeM <- s13$time[s13$gender=="M"]
timeM[timeM <= 1] <- NA
tt <- 30
sn<-5
vals <- matrix(ncol=sn,nrow=(tt))
for (k in 2:tt)
 vals[(k-1),] <- with(s13[s13$gender=="M",],
    t(tapply(Correct,list(SN,timeM==k),mean,na.rm=TRUE)[1:sn,2]))
vals[tt,] <- with(s13[s13$gender=="M",],
    t(tapply(Correct,list(SN,timeM > tt),mean,na.rm=TRUE)[1:sn,2]))
rownames(vals) <- c(2:tt,paste0(">",tt))
colnames(vals) <- levels(s12$SN)
valsM <- vals
```

```
par(mfrow=c(2,3))
for (i in 1:5){
plot(2:(tt+1),valsF[,i],ylim=c(0,1),las=1,xlab="RT in seconds",xlim=c(0,40),
     ylab = "Proportion correct",col="white",las=1,cex.axis=1.2,cex.lab=1.2,
     cex.main=1.3,main=levels(s12$SN)[i],xaxt='n',font.main=1)
axis(1,seq(0,30,10),paste0(seq(0,30,10),"s"),tcl=.0,cex.axis=1.2,lwd=0)
axis(1,seq(0,30,5),FALSE,tcl=-.3,cex=1.2,lwd=0,lwd.ticks=.8)
axis(1,38,">30s",tick=FALSE,cex.axis=1.2,lwd=0)
lines(2:tt,valsF[1:(tt-1),i],col="blue")
lines(2:tt,valsM[1:(tt-1),i],col="red")
lines(33:39,rep(valsF[tt,i],7),col="blue")
lines(33:39,rep(valsM[tt,i],7),col="red")
legend("bottomright",c("Female","Male"),text.col=c("blue","red"),bty='n')
points(2:tt,valsF[1:(tt-1),i],col="blue",pch=19,cex=.1)
points(2:tt,valsM[1:(tt-1),i],col="red",pch=19,cex=.1)
}
```

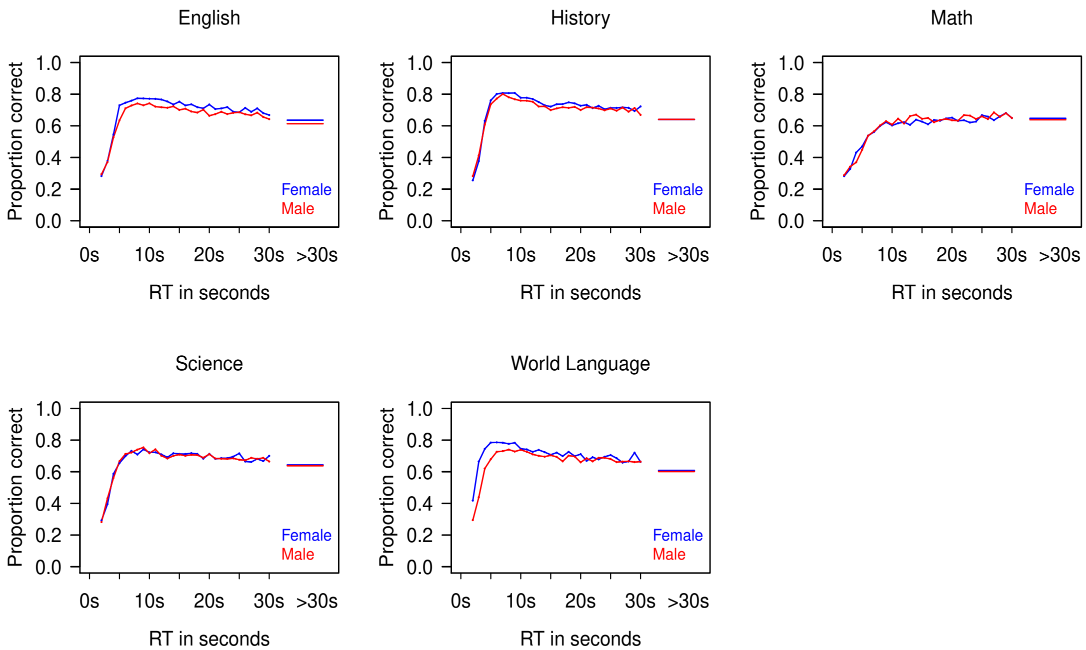

Figure SM.1. The relationship between response accuracy and response time for the five subject areas differentiating Female students (blue) and Male students (red). The mean values are shown from 2s to 30s and the horizontal lines beyond 30s is the mean proportional accurate for times greater than 30s. Some of these are nearly identical for the two groups so the blue line is covered.

Ethnicity Differences

```
s13$ETH <- rep("Other",nrow(s13))
s13$ETH[s13$ethnicity=="Asian"] <- "Asian"
s13$ETH[s13$ethnicity=="Hispanic"] <- "Hispanic"
s13$ETH[s13$ethnicity=="White"] <- "White"
s13$ETH[s13$ethnicity=="Two or More Races"] <- "TwoPlus"
s13$ETH <- as.factor(s13$ETH)
contrasts(s13$ETH) <- contrasts(s13$ETH,contrasts=FALSE)
#with(s13,table(ETH,ethnicity,useNA="always"))
```

```
#using gmean defined above
s13w <- s13[is.na(s13$time)==FALSE,]
tab1 <- t(with(s13w,tapply(time,list(ETH,SN),gmean)))
colnames(tab1) <- levels(s13$ETH)
rownames(tab1)[3] <- "Mathematics"
tab1 <- rbind(tab1,with(s13w,tapply(time,ETH,gmean)))
rownames(tab1)[nrow(tab1)] <- "Total"
print(xtable(tab1,caption="The geometric means in seconds for
  response times for the different subject groups and different
  ethnicities.",label="tab:meansETHtime"),
  hline.after = c(-1,0,nrow(tab1)-1,nrow(tab1)),
  sanitize.colnames.function = identity,caption.placement="top")
```

Table SM.3
The geometric means in seconds for response times for the different subject groups and different ethnicities.

	Asian	Hispanic	Other	TwoPlus	White
English	30.91	37.99	36.01	36.80	35.26
History	31.07	39.71	37.40	34.48	34.15
Mathematics	52.26	53.78	48.03	54.76	56.90
Science	32.44	39.44	36.53	36.81	36.11
World Language	30.63	29.56	32.47	29.58	29.82
Total	34.73	40.53	37.97	38.45	38.09

```
tab2 <- t(with(s13,tapply(Correct,list(ETH,SN),mean,na.rm=TRUE)))
colnames(tab2) <- levels(s13$ETH)
rownames(tab2)[3] <- "Mathematics"
tab2 <- rbind(tab2,
              with(s13,tapply(Correct,ETH,mean,na.rm=TRUE)))
rownames(tab2)[nrow(tab2)] <- "Total"
print(xtable(tab2,caption="The proportions correct for the
```

```
              different subject groups and different ethnicities.",
              label="tab:meansETHacc"),
        hline.after = c(-1,0,nrow(tab2)-1,nrow(tab2)),
        sanitize.colnames.function = identity,caption.placement="top")
```

Table SM.4

The proportions correct for the different subject groups and different ethnicities.

	Asian	Hispanic	Other	TwoPlus	White
English	0.69	0.62	0.65	0.69	0.70
History	0.70	0.64	0.68	0.71	0.71
Mathematics	0.66	0.60	0.58	0.64	0.65
Science	0.70	0.63	0.62	0.69	0.70
World Language	0.67	0.63	0.61	0.67	0.69
Total	0.69	0.63	0.63	0.68	0.69

```
invisible(with(s13[s13$SN=="English" & is.na(s13$ETH)==FALSE,],list(
  EengT0 <<- lmer(log(time) ~ 1 + (1|StudID),REML=FALSE,
                control = lmerControl(calc.derivs = FALSE,
           optimizer ='optimx', optCtrl=list(method='L-BFGS-B'))),
  EengT1 <<- update(EengT0, .~. -1 + ETH)
)))
```

```
invisible(with(s13[s13$SN=="English" & is.na(s13$time)==FALSE
                & is.na(s13$ETH)==FALSE,],
  list(
  EengC0 <<- glm(Correct ~ 1,family="binomial"),
  EengC1a <<- update(EengC0, .~. -1 + ETH),
  EengC1b <<- update(EengC0, .~. + bs(scale(log(time)),degree=1,df=2)),
  EengC2 <<- update(EengC1b, .~. -1 + ETH),
  EengC3 <<- update(EengC2, .~. + ETH:bs(scale(log(time)),degree=1,df=2))
    )))
```

```
anovasETHTab <- matrix(ncol=5,nrow=6)
```

```
#anova(engT0,engT1)
#summary(engT1)
anovasETHTab[,1] <- c(
 anova(EengT0,EengT1)$Pr[2],
 anova(EengC0,EengC1a)$Pr[2],
 anova(EengC0,EengC1b)$Pr[2],
```

```
 anova(EengC1a,EengC2)$Pr[2],
 anova(EengC1b,EengC2)$Pr[2],
 anova(EengC2,EengC3)$Pr[2])
```

```
invisible(with(s13[s13$SN=="History"& is.na(s13$ETH)==FALSE,],list(
  EHistT0 <<- lmer(log(time) ~ 1 + (1|StudID),REML=FALSE,
                control = lmerControl(calc.derivs = FALSE,
          optimizer ='optimx', optCtrl=list(method='L-BFGS-B'))),
  EHistT1 <<- update(EHistT0, .~. -1 + ETH)
)))
```

```
invisible(with(s13[s13$SN=="History" & is.na(s13$time)==FALSE
                & is.na(s13$ETH)==FALSE,],
  list(
  EHistC0 <<- glm(Correct ~ 1,family="binomial"),
  EHistC1a <<- update(EHistC0, .~. -1 + ETH),
  EHistC1b <<- update(EHistC0, .~. + bs(scale(log(time)),degree=1,df=2)),
  EHistC2 <<- update(EHistC1b, .~. -1 + ETH),
  EHistC3 <<- update(EHistC2, .~. + ETH:bs(scale(log(time)),degree=1,df=2))
    )))
```

```
anovasETHTab[,2] <- c(
 anova(EHistT0,EHistT1)$Pr[2],
 anova(EHistC0,EHistC1a)$Pr[2],
 anova(EHistC0,EHistC1b)$Pr[2],
 anova(EHistC1a,EHistC2)$Pr[2],
 anova(EHistC1b,EHistC2)$Pr[2],
 anova(EHistC2,EHistC3)$Pr[2])
```

```
invisible(with(s13[s13$SN=="Math" & is.na(s13$ETH)==FALSE,],list(
  EMathT0 <<- lmer(log(time) ~ 1 + (1|StudID),REML=FALSE,
                control = lmerControl(calc.derivs = FALSE,
          optimizer ='optimx', optCtrl=list(method='L-BFGS-B'))),
  EMathT1 <<- update(EMathT0, .~. -1 + ETH)
)))
```

```
invisible(with(s13[s13$SN=="Math" & is.na(s13$time)==FALSE
                 & is.na(s13$ETH)==FALSE,],
  list(
  EMathC0 <<- glm(Correct ~ 1,family="binomial"),
```

```
  EMathC1a <<- update(EMathC0, .~. -1 + ETH),
  EMathC1b <<- update(EMathC0, .~. + bs(scale(log(time)),degree=1,df=2)),
  EMathC2 <<- update(EMathC1b, .~. -1 + ETH),
  EMathC3 <<- update(EMathC2, .~. + ETH:bs(scale(log(time)),degree=1,df=2))
     )))
```

```
anovasETHTab[,3] <- c(
 anova(EMathT0,EMathT1)$Pr[2],
 anova(EMathC0,EMathC1a)$Pr[2],
 anova(EMathC0,EMathC1b)$Pr[2],
 anova(EMathC1a,EMathC2)$Pr[2],
 anova(EMathC1b,EMathC2)$Pr[2],
 anova(EMathC2,EMathC3)$Pr[2])
```

```
invisible(with(s13[s13$SN=="Science" & is.na(s13$ETH)==FALSE,],list(
  ESciT0 <<- lmer(log(time) ~ 1 + (1|StudID),REML=FALSE,
                control = lmerControl(calc.derivs = FALSE,
          optimizer ='optimx', optCtrl=list(method='L-BFGS-B'))),
  ESciT1 <<- update(ESciT0, .~. -1 + ETH)
)))
```

```
invisible(with(s13[s13$SN=="Science" & is.na(s13$time)==FALSE
                & is.na(s13$ETH)==FALSE,],
  list(
  ESciC0 <<- glm(Correct ~ 1,family="binomial"),
  ESciC1a <<- update(ESciC0, .~. -1 + ETH),
  ESciC1b <<- update(ESciC0, .~. + bs(scale(log(time)),degree=1,df=2)),
  ESciC2 <<- update(ESciC1b, .~. -1 + ETH),
  ESciC3 <<- update(ESciC2, .~. + ETH:bs(scale(log(time)),degree=1,df=2))
     )))
```

```
anovasETHTab[,4] <- c(
 anova(ESciT0,ESciT1)$Pr[2],
 anova(ESciC0,ESciC1a)$Pr[2],
 anova(ESciC0,ESciC1b)$Pr[2],
 anova(ESciC1a,ESciC2)$Pr[2],
 anova(ESciC1b,ESciC2)$Pr[2],
 anova(ESciC2,ESciC3)$Pr[2])
```

```r
invisible(with(s13[s13$SN=="World Language" & is.na(s13$ETH)==FALSE,],list(
  EWLT0 <<- lmer(log(time) ~ 1 + (1|StudID),REML=FALSE,
                 control = lmerControl(calc.derivs = FALSE,
           optimizer ='optimx', optCtrl=list(method='L-BFGS-B'))),
  EWLT1 <<- update(EWLT0, .~. -1 + ETH)
)))
```

```r
invisible(with(s13[s13$SN=="World Language" & is.na(s13$time)==FALSE
                & is.na(s13$ETH)==FALSE,],
  list(
  EWLC0 <<- glm(Correct ~ 1,family="binomial"),
  EWLC1a <<- update(EWLC0, .~. -1 + ETH),
  EWLC1b <<- update(EWLC0, .~. + bs(scale(log(time)),degree=1,df=2)),
  EWLC2 <<- update(EWLC1b, .~. -1 + ETH),
  EWLC3 <<- update(EWLC2, .~. + ETH:bs(scale(log(time)),degree=1,df=2))
     )))
```

```r
anovasETHTab[,5] <- c(
 anova(EWLT0,EWLT1)$Pr[2],
 anova(EWLC0,EWLC1a)$Pr[2],
 anova(EWLC0,EWLC1b)$Pr[2],
 anova(EWLC1a,EWLC2)$Pr[2],
 anova(EWLC1b,EWLC2)$Pr[2],
 anova(EWLC2,EWLC3)$Pr[2])
rownames(anovasETHTab) <- c(
  "ETH -> Time",
  "ETH -> Correct","Time -> Correct",
  "T -> C|G","G -> C|T","T by G -> C")
colnames(anovasETHTab) <- c("English","History","Math",
                   "Science","WL")
```

```r
timeCIs <- matrix(nrow=5*5,ncol=2)
timeCIs[1:5,]   <-  confint(EengT1,method="Wald",level=.99)[3:7,]
timeCIs[6:10,]  <-  confint(EHistT1,method="Wald",level=.99)[3:7,]
timeCIs[11:15,] <-  confint(EMathT1,method="Wald",level=.99)[3:7,]
timeCIs[16:20,] <-  confint(ESciT1,method="Wald",level=.99)[3:7,]
timeCIs[21:25,] <-  confint(EWLT1,method="Wald",level=.99)[3:7,]
nCI <- function(X){
  nci <- function(x) mean(x) + c(-1,1)*diff(x)*sqrt(2)/4
  return(t(apply(X,1,nci)))}
timeCI <- exp(cbind(apply(timeCIs,1,mean),nCI(timeCIs)))
```

```
par(mar=c(5,11,2,6))
plot(1:2,1:2,xlab="",ylab="",xaxt="n",yaxt="n",ylim=c(23,80),xlim=c(0.5,6))
x <- c(outer(seq(0,.4,.1),1:5,"+"))
errbar(x,timeCI[,1],timeCI[,2],timeCI[,3],add=TRUE,col=2:6,pch="-",lwd=1.3,cap=0,
       xlab="",ylab="",xaxt="n",yaxt="n",errbar.col=2:6,cex=.6)
axis(1,.25+(1:5),c("English","History","Math","Science","WL"))
axis(2,seq(30,70,10),paste0(seq(30,70,10),"s"),las=1)
mtext("Subjects",1,3,at=3.25)
mtext("Response Times:\nGeometric means and\nadjusted 99% CIs",
      2,11,at=55,adj=0,las=1)

engm  <- exp(mean(log(s13[s13$SN=="English"        &
                          is.na(s13$ETH)==FALSE,]$time),na.rm=TRUE))
histm <- exp(mean(log(s13[s13$SN=="History"        &
                          is.na(s13$ETH)==FALSE,]$time),na.rm=TRUE))
mathm <- exp(mean(log(s13[s13$SN=="Math"
                        & is.na(s13$ETH)==FALSE,]$time),na.rm=TRUE))
scim  <- exp(mean(log(s13[s13$SN=="Science"
                        & is.na(s13$ETH)==FALSE,]$time),na.rm=TRUE))
wlm   <- exp(mean(log(s13[s13$SN=="World Language"
                        & is.na(s13$ETH)==FALSE,]$time),na.rm=TRUE))

lines(c(.83,1.6),c(engm,engm),lty=2,lwd=1.3)
lines(c(.83,1.6)+1,c(histm,histm),lty=2,lwd=1.3)
lines(c(.83,1.6)+2,c(mathm,mathm),lty=2,lwd=1.3)
lines(c(.83,1.6)+3,c(scim,scim),lty=2,lwd=1.3)
lines(c(.83,1.6)+4,c(wlm,wlm),lty=2,lwd=1.3)
legend("topleft",c("    Asian","    Hispanic",
      "Other","Two or More",""," White"),bty='n',text.col=c(2:6,6),
  title="Ethnicity",title.col=1,title.adj=.1,ncol=3,x.intersp = -.3)
axis.break(2,25,style="zigzag",brw=.04)
```

```
correctCIs <-  matrix(nrow=5*5,ncol=2)
correctCIs[1:5,]   <-  confint(EengC1a,method="Wald",level=.99)
correctCIs[6:10,]  <-  confint(EHistC1a,method="Wald",level=.99)
correctCIs[11:15,] <-  confint(EMathC1a,method="Wald",level=.99)
correctCIs[16:20,] <-  confint(ESciC1a,method="Wald",level=.99)
correctCIs[21:25,] <-  confint(EWLC1a,method="Wald",level=.99)
nCI <- function(X){
  nci <- function(x) mean(x) + c(-1,1)*diff(x)*sqrt(2)/4
  return(t(apply(X,1,nci)))}
correctCI <- plogis(cbind(apply(correctCIs,1,mean),nCI(correctCIs)))
```

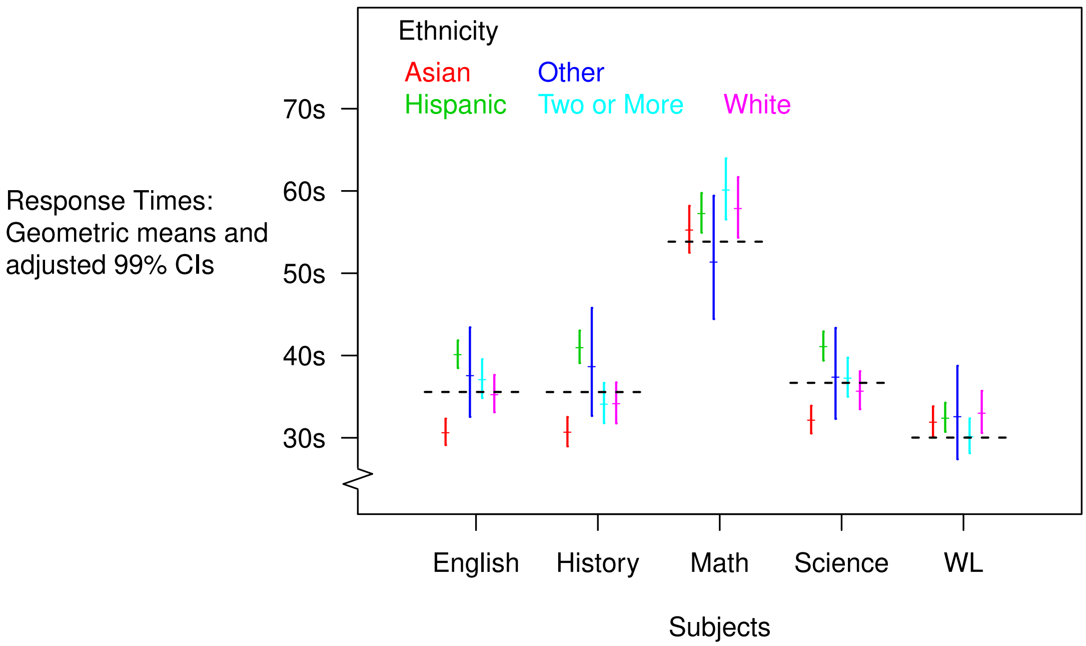

Figure SM.2. The geometric means for the times in seconds for the different ethnicities and the different subjects. The width of the 99% confidence intervals are adjusted by $\sqrt{2}/2$ to make comparing groups more straightforward. WL is World Language.

```
par(mar=c(5,11,2,6))
plot(1:2,1:2,xlab="",ylab="",xaxt="n",
     yaxt="n",ylim=c(.52,.8),xlim=c(0.5,6))
x <- c(outer(seq(0,.4,.1),1:5,"+"))
errbar(x,correctCI[,1],correctCI[,2],correctCI[,3],
       add=TRUE,col=2:6,pch="-",lwd=1.3,cap=0,
       xlab="",ylab="",xaxt="n",yaxt="n",errbar.col=2:6,cex=.6)
axis(1,.25+(1:5),c("English","History","Math","Science","WL"))
axis(2,seq(.55,.75,.05),c(".55",".60",".65",".70",".75"),las=1)
mtext("Subjects",1,3,at=3.25)
mtext("Estimated proportions \ncorrect and\nadjusted 99% CIs",
      2,11,at=.70,adj=0,las=1)

Cengm  <- mean(s13[s13$SN=="English"
                   & is.na(s13$ETH)==FALSE,]$Correct,na.rm=TRUE)
Chistm <- mean(s13[s13$SN=="History"
                   & is.na(s13$ETH)==FALSE,]$Correct,na.rm=TRUE)
Cmathm <- mean(s13[s13$SN=="Math"
                   & is.na(s13$ETH)==FALSE,]$Correct,na.rm=TRUE)
Cscim  <- mean(s13[s13$SN=="Science"
```

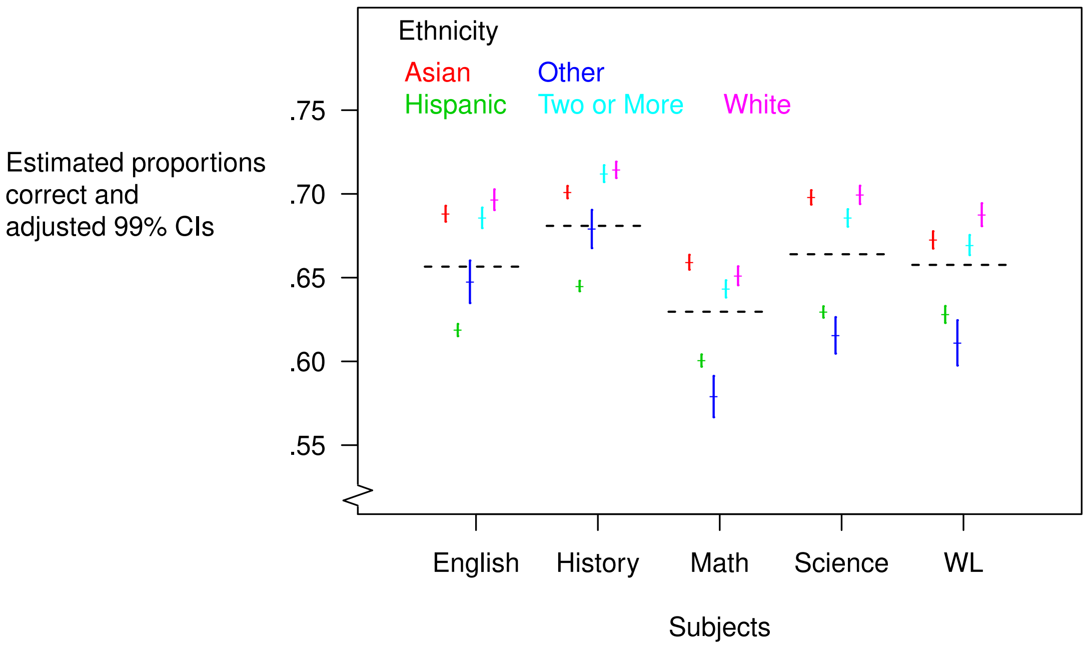

Figure SM.3. The estimated proportions correct for the different ethnicities and the different subjects. The width of the 99% confidence intervals are adjusted by $\sqrt{2}/2$ to make comparing groups more straightforward. WL is World Language.

```
                    & is.na(s13$ETH)==FALSE,]$Correct,na.rm=TRUE)
Cwlm   <- mean(s13[s13$SN=="World Language"
                    & is.na(s13$ETH)==FALSE,]$Correct,na.rm=TRUE)

lines(c(.83,1.6),c(Cengm,Cengm),lty=2,lwd=1.3)
lines(c(.83,1.6)+1,c(Chistm,Chistm),lty=2,lwd=1.3)
lines(c(.83,1.6)+2,c(Cmathm,Cmathm),lty=2,lwd=1.3)
lines(c(.83,1.6)+3,c(Cscim,Cscim),lty=2,lwd=1.3)
lines(c(.83,1.6)+4,c(Cwlm,Cwlm),lty=2,lwd=1.3)
legend("topleft",c("    Asian","    Hispanic","Other",
                   "Two or More","","    White"),bty='n',text.col=c(2:6,6),
  title="Ethnicity",title.col=1,title.adj=.1,ncol=3,x.intersp = -.3)
axis.break(2,.52,style="zigzag",brw=.04)
```

```
correctCIsCondit <-  matrix(nrow=5*5,ncol=2)
correctCIsCondit[1:5,]    <-  confint(EengC2,method="Wald",level=.99)[3:7,]
correctCIsCondit[6:10,]   <-  confint(EHistC2,method="Wald",level=.99)[3:7,]
#correctCIsCondit[11:15,] <-  confint(EMathC2,method="Wald",level=.99)[3:7,]
gc(verbose=FALSE) #This shouldn't be needed
```

```
#This won't be as reliable
profx <- profile(EMathC2,delta.cutoff = 1/2)
correctCIsCondit[11:15,] <-  confint(profx,level=.99)[3:7,]
correctCIsCondit[16:20,] <-  confint(ESciC2,method="Wald",level=.99)[3:7,]
correctCIsCondit[21:25,] <-  confint(EWLC2,method="Wald",level=.99)[3:7,]
print(correctCIsCondit)
nCI <- function(X){
  nci <- function(x) mean(x) + c(-1,1)*diff(x)*sqrt(2)/4
  return(t(apply(X,1,nci)))}
correctCICondit <- plogis(cbind(apply(correctCIsCondit,1,mean),
                          nCI(correctCIsCondit)))
```

```
xtable(correctCIsCondit)
```

	1	2
1	0.78	0.92
2	0.51	0.64
3	0.58	0.79
4	0.79	0.94
5	0.82	0.97
6	1.10	1.23
7	0.90	1.03
8	1.01	1.20
9	1.18	1.31
10	1.18	1.32
11	-0.11	0.01
12	-0.33	-0.22
13	-0.44	-0.27
14	-0.16	-0.04
15	-0.15	-0.02
16	0.84	0.97
17	0.56	0.68
18	0.47	0.64
19	0.79	0.93
20	0.85	0.99
21	1.11	1.28
22	0.91	1.08
23	0.83	1.06
24	1.09	1.27
25	1.17	1.35

```
#range(s13$time)
eths <- unique(s13$ETH)
tt <- 30
sn<-5

for (i in 1:length(eths)){
  vals <- matrix(ncol=sn,nrow=(tt))
  timevals <- s13$time[s13$ETH == eths[i]]
  for (k in 2:tt)
   vals[(k-1),] <- with(s13[s13$ETH==eths[i],],
      t(tapply(Correct,list(SN,timevals==k),mean,na.rm=TRUE)[1:sn,2]))
vals[tt,] <- with(s13[s13$ETH==eths[i],],
    t(tapply(Correct,list(SN,time > tt),mean,na.rm=TRUE)[1:sn,2]))
colnames(vals) <- levels(s13$SN)
rownames(vals) <- c(2:tt,">30")
assign(paste0("var",eths[i]),vals)
}
```

```
par(mfrow=c(2,3))
for (i in 1:sn){
  plot(2:tt,varAsian[1:(tt-1),i],ylim=c(0,1),xlim=c(0,40),las=1,xlab="RT in seconds",
     ylab = "Proportion correct",col="white",las=1,cex.axis=1.2,cex.lab=1.2,cex.main=1.3,
     main=levels(s12$SN)[i],xaxt='n',font.main=1)
axis(1,seq(0,30,10),paste0(seq(0,30,10),"s"),tcl=.0,cex.axis=1.2,lwd=0)
axis(1,seq(0,30,5),FALSE,tcl=-.3,cex=1.2,lwd=0,lwd.ticks=.8)
axis(1,38,">30s",tick=FALSE,cex.axis=1.2,lwd=0)
lines(2:tt,ma(varAsian[1:(tt-1),i]),col="red")
lines(2:tt,ma(varWhite[1:(tt-1),i]),col="blue")
lines(2:tt,ma(varTwoPlus[1:(tt-1),i]),col="green")
lines(2:tt,ma(varHispanic[1:(tt-1),i]),col="black")
lines(2:tt,ma(varOther[1:(tt-1),i]),col="purple")
lines(33:39,rep(varAsian[tt,i],7),col="red")
lines(33:39,rep(varWhite[tt,i],7),col="blue")
lines(33:39,rep(varTwoPlus[tt,i],7),col="green")
lines(33:39,rep(varHispanic[tt,i],7),col="black")
lines(33:39,rep(varOther[tt,i],7),col="purple")

points(2:tt,ma(varAsian[1:(tt-1),i]),col="red",pch=19,cex=.3)
points(2:tt,ma(varWhite[1:(tt-1),i]),col="blue",pch=19,cex=.3)
points(2:tt,ma(varTwoPlus[1:(tt-1),i]),col="green",pch=19,cex=.3)
points(2:tt,ma(varHispanic[1:(tt-1),i]),col="black",pch=19,cex=.3)
points(2:tt,ma(varOther[1:(tt-1),i]),col="purple",pch=19,cex=.3)
}
x <- .28; ce <- 1.8
```

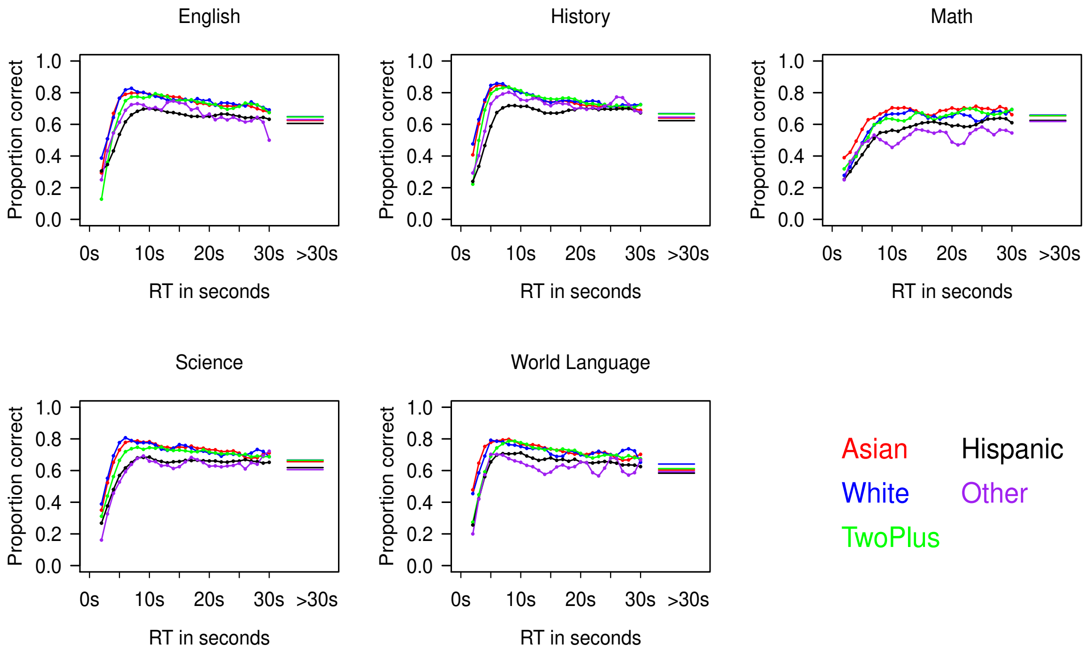

Figure SM.4. For each suject, the proportions correct with the response time for each ethnicity. The mean values are shown from 2s to 30s and the horizontal lines beyond 30s is the mean proportional accurate for times greater than 30s. Some of these are nearly identical. The curves all use a moving average of mean times including one second to each side.

```
plot.new()
text(0,1-x*1,"Asian",col="red",cex=ce,pos=4)
text(0,1-x*2,"White",col="blue",cex=ce,pos=4)
text(0,1-x*3,"TwoPlus",col="green",cex=ce,pos=4)
text(.5,1-x*1,"Hispanic",col="black",cex=ce,pos=4)
text(.5,1-x*2,"Other",col="purple",cex=ce,pos=4)
```