

[1]

(a) The study involves repeated measurements of reaction time in a hand-eye coordination test among individuals from 5 trials. Since we are only interested in the magnitude between the breaking of the beam and the arrival of the light, the outcome variable plotted was the absolute value of the reaction time. Various plotting techniques were used to explore the mean and covariance structures of the data.

On average, there is very little change in the mean reaction time over time (from trial 1 through trial 5) (Figure 1). However, the range in reaction times is narrow, making it difficult to detect small changes with this scale. Figure 2 shows profile plots of reaction time over time for males and females. The trend in reaction time does not appear to differ by gender, as the overall reaction time, represented by a Loess smooth line, shows little change over time. In general, as a group, males had slightly faster reaction times compared with females. An outlying observation is visible in the plot of males. A summary plot of the reaction time by age is a cross sectional look at the effect of age on reaction time for each trial (Figure 3). In general, the reaction times tended to be slightly higher for younger children (< 10 years of age) and also slightly higher for older adults (> 40 years of age). When the reaction time across time was explored for kids (<18 years old) vs. adults, there was evidence of greater variability in reaction times and one potential outlier among kids (Figure 4.). However, the mean trend in reaction time across trials does not differ by the 2 age groups. There was no evidence of an age*gender interaction as the summary curves have the same trend for both genders (Figure 5.). Both genders show slightly higher rates for young children (<10 years of age) as well as older adults (>40 years of age).

Box plots were used to provide summary measures of the median reaction times as well as the variability across trials. Overall, the variability of the reaction times across trials appears to decrease slightly over the first 3 trials, and then level off (Figure 6.) The number of outliers appears fairly consistent across trials. The variability in reaction times is more stable across trials for males, than in females, where there is more evidence of reduced variability over time (Figure 7.). These box plots also show the outliers are more extreme among males compared with females. Figure 8 clearly shows more variability in reaction times for each trial among kids compared with adults. There is a slight decrease in variability across trials for kids. There are many more outliers, with more extreme values among kids compared with adults. There was no pattern to the change in variability across levels of reaction times (Figure 9.) Examination of the ordinary least squares residuals suggests moderate correlation of reaction times between trials (Figure 10). As seen in the correlation matrix below, the correlation values range from 0.477 to 0.711. The pattern within lag is not straightforward, as the lag 1 values are similar (range 0.505-0.645), but the lag 2 and lag 3 values are more different (0.477-0.632 and 0.526-0.711,

10
10
10

respectively). However, examining the correlation between later trials, i.e., trials 2-5, suggests fairly consistent correlation within and across lags, with correlations ranging from 0.613 to 0.711. Depending on whether we believe 0.477 is similar or different from 0.711, potential correlation structures to fit these data include compound symmetry and unstructured.

Correlation Matrix for all visitors

	res1	res2	res3	res4	res5
res1	1.0000000	0.5052682	0.4771839	0.5261857	0.5151733
res2	0.5052682	1.0000000	0.6132707	0.6319575	0.7114982
res3	0.4771839	0.6132707	1.0000000	0.6452381	0.6288598
res4	0.5261857	0.6319575	0.6452381	1.0000000	0.6355513
res5	0.5151733	0.7114982	0.6288598	0.6355513	1.0000000

(b) Potentially family groups could represent a cluster effect such that individuals within a family group would perform more similarly compared with members of other families. Family members could share a genetic trait related to test performance or there could be a learned response from watching other family members take the test. However, it is likely that age or gender would have a larger effect on reaction time compared with a family effect.

[2]

(a) The MMSE-blind was used to measure cognitive status in a study of Mexican Americans aged 65 and older. These measures were repeated 2, 5, and 7 years after the baseline measure. The results of the MMSE-blind were scores ranging from 0 to 22, but the primary outcome variable presented in Figure 1 was the unadjusted absolute decline in scores over time.

(b) A general linear mixed model was fit to absolute decline in MMSE scores using SAS PROC MIXED.

(c) Neither the methods nor the results section describe any attempts to check the model assumptions. The authors only mentioned the choice of a mixed model was based on unbalanced data and the need to model a covariate structure.

(d) The source of correlation is the individual; cognitive status was examined for each individual on four separate visits.

(e) The overall conclusion of the study is that near vision impairment is associated with cognitive decline in elderly Mexican Americans. There was no association between distance vision or hearing impairments and cognitive decline.

Figure 1. Reaction time for all visitors

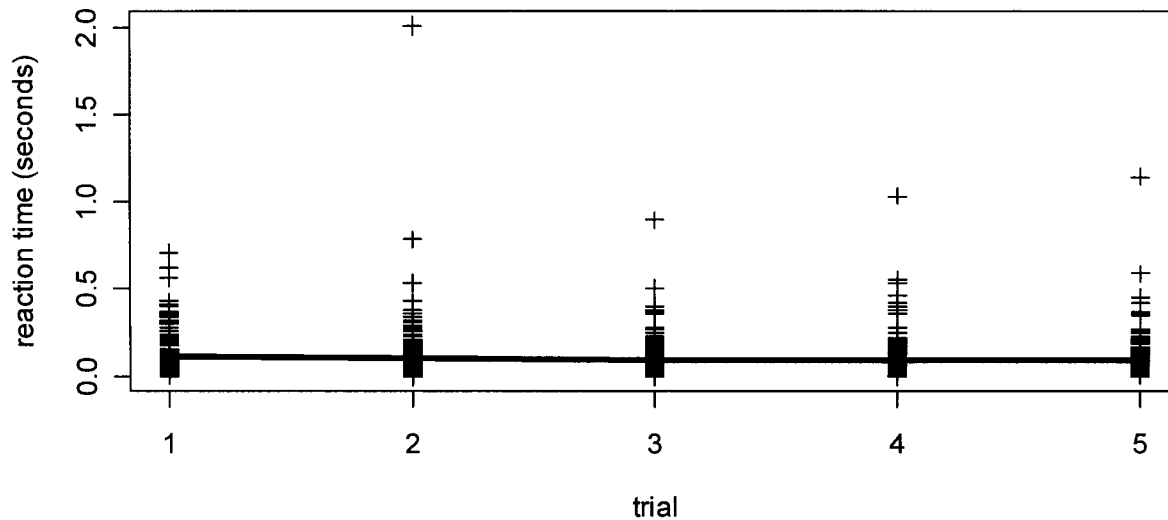


Figure 2. Main effect of gender

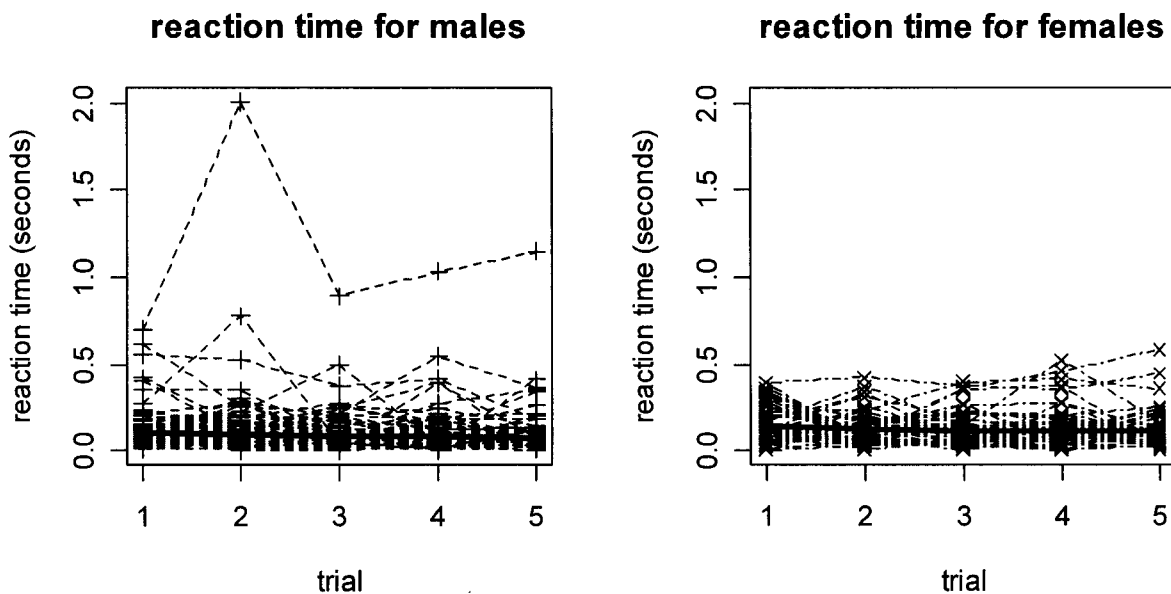


Figure 3. Summary plot of reaction time by age

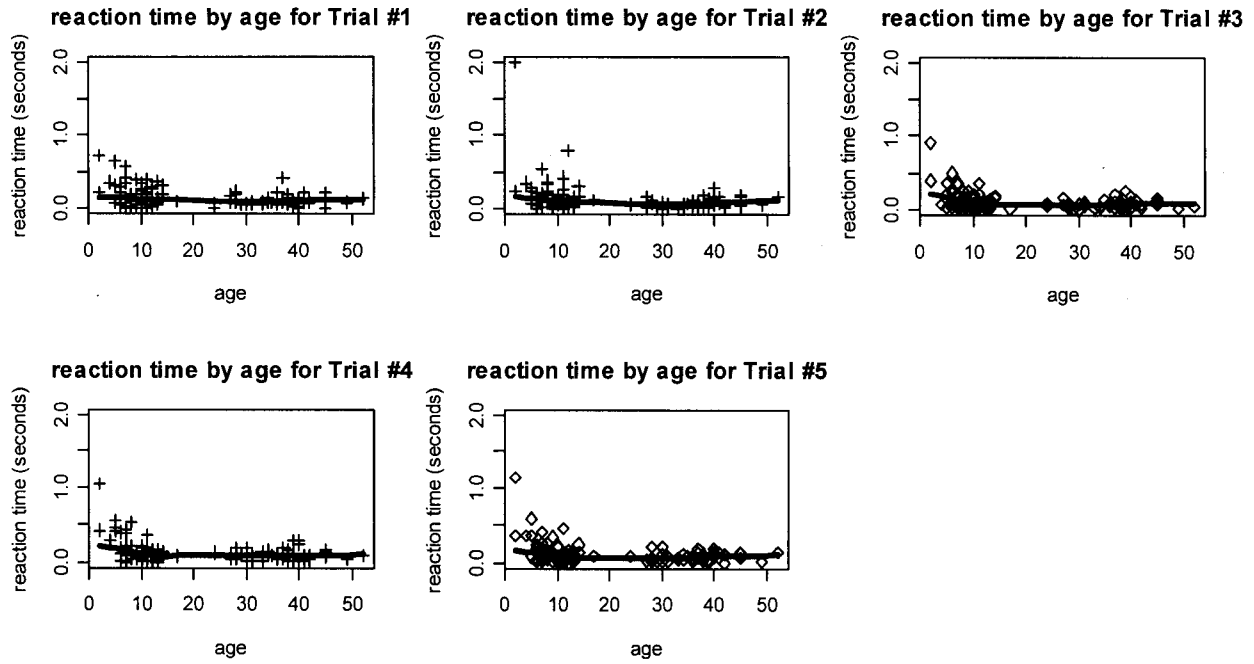


Figure 4. Main effect of age (kids vs. adults)

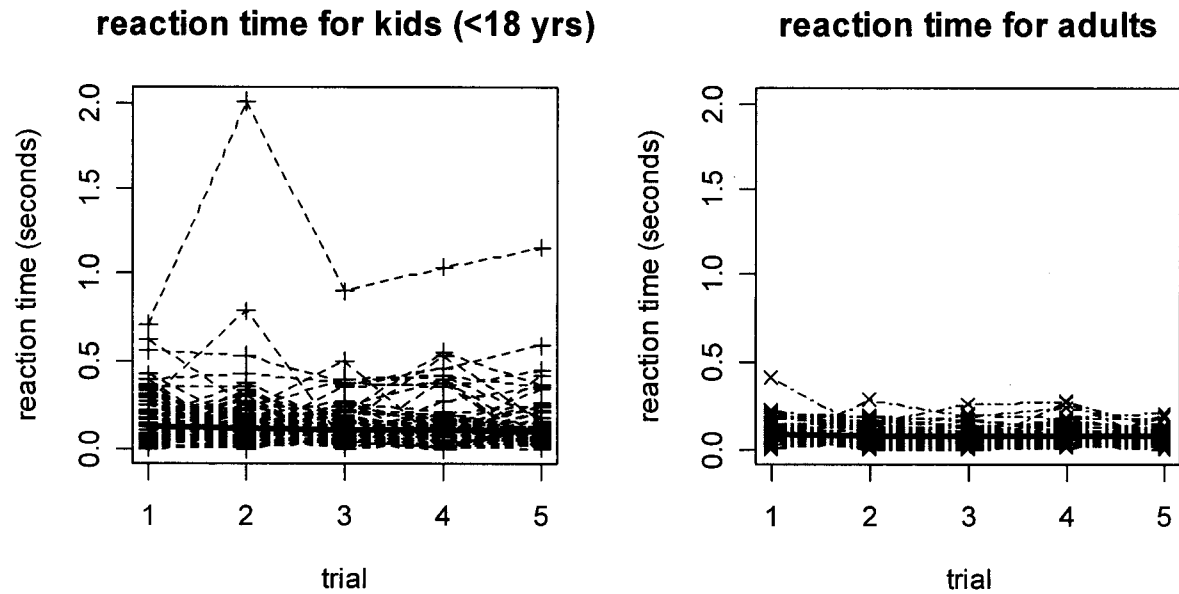


Figure 5. Examine age*gender interaction

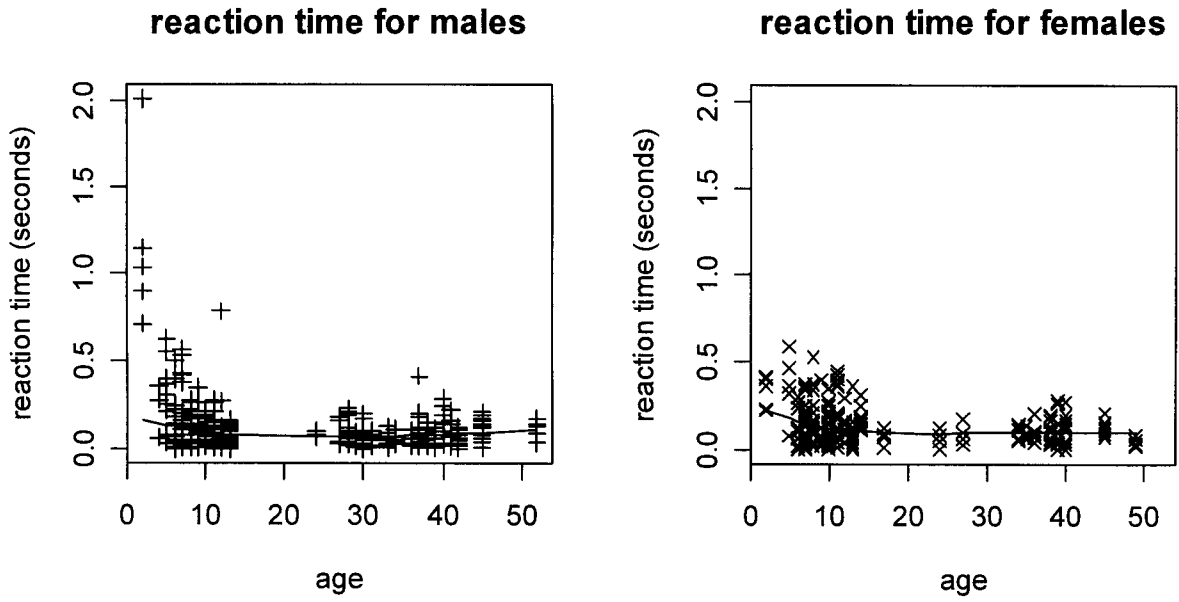


Figure 6. Reaction time by trial

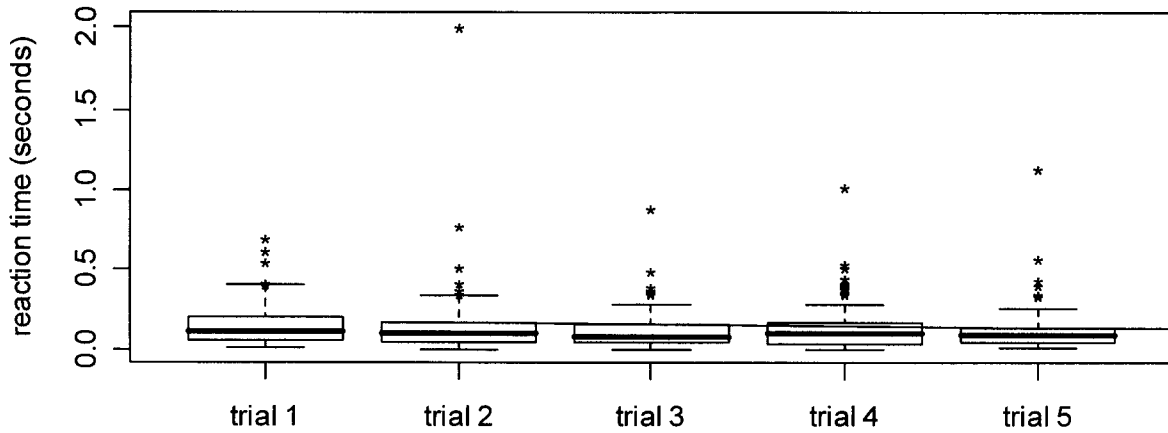


Figure 7. Reaction time across time, by gender

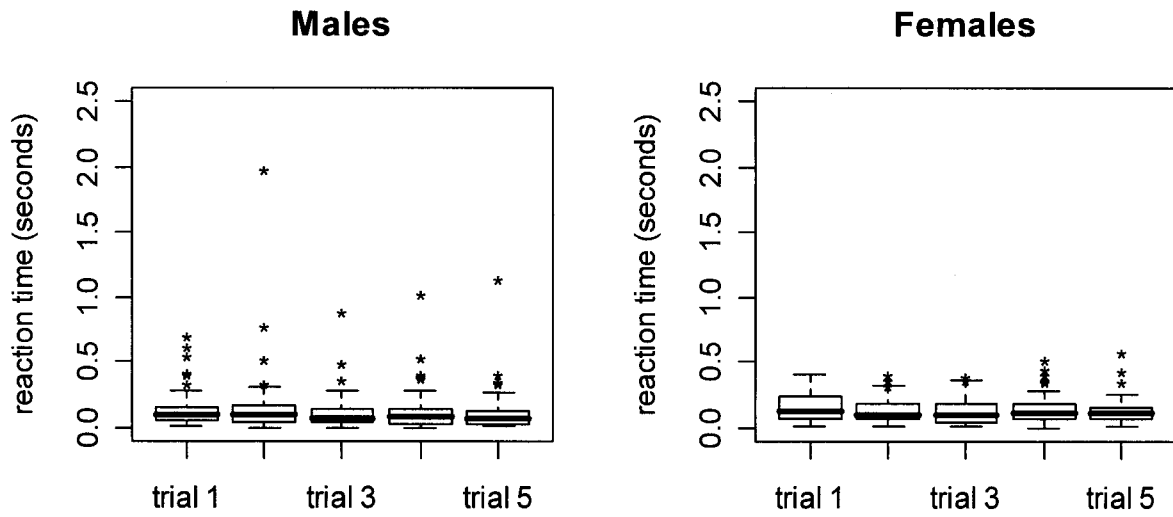


Figure 8. Reaction time across time, age groups

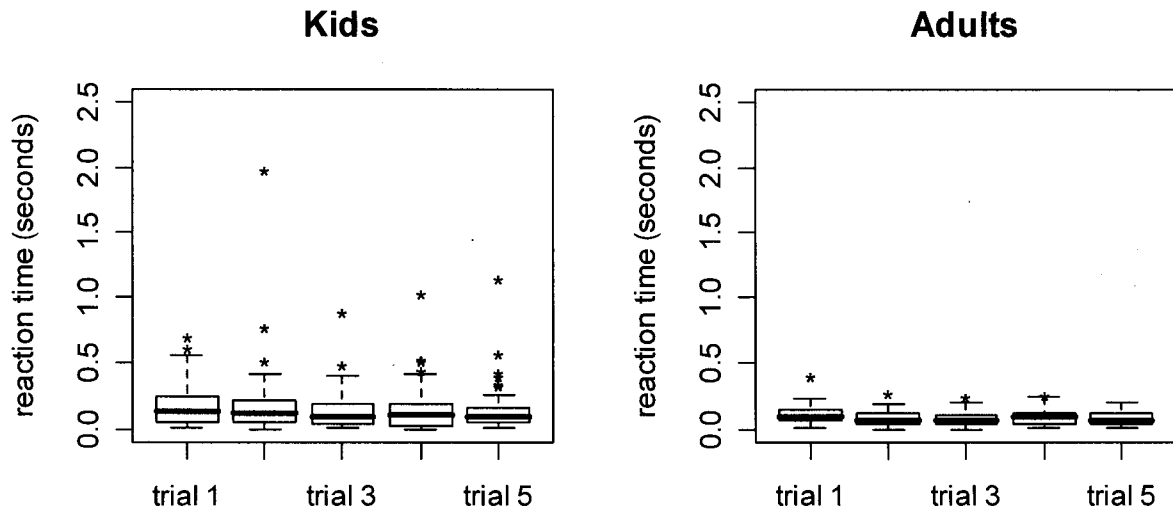
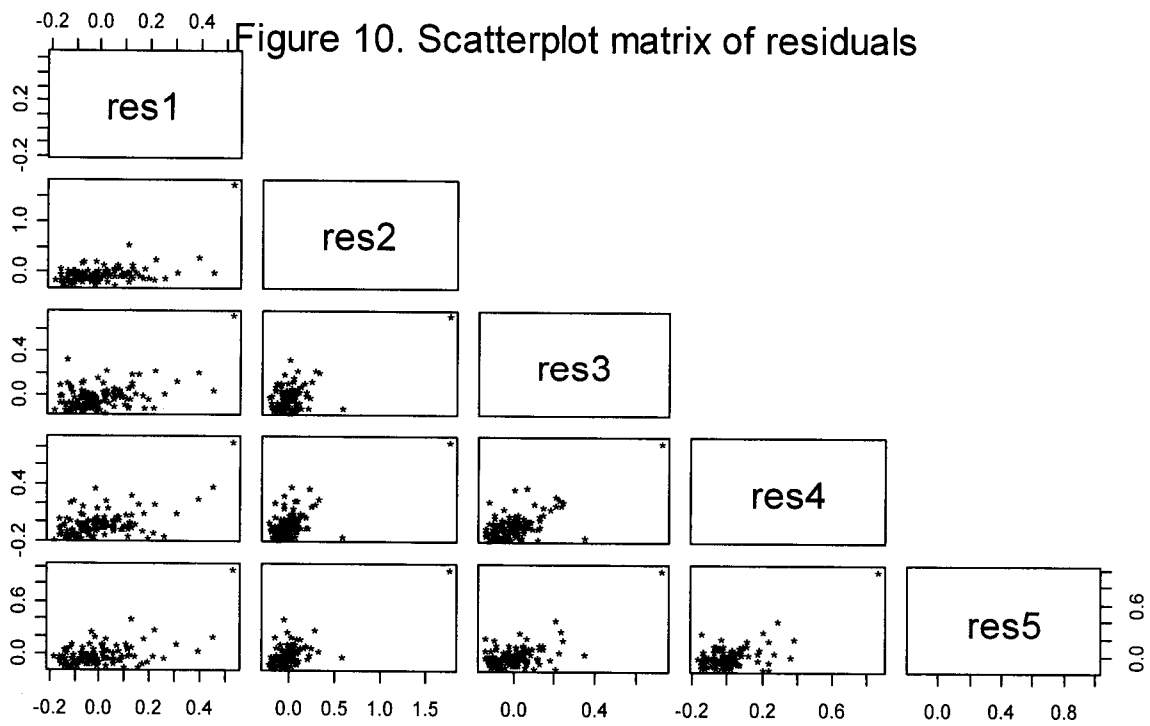
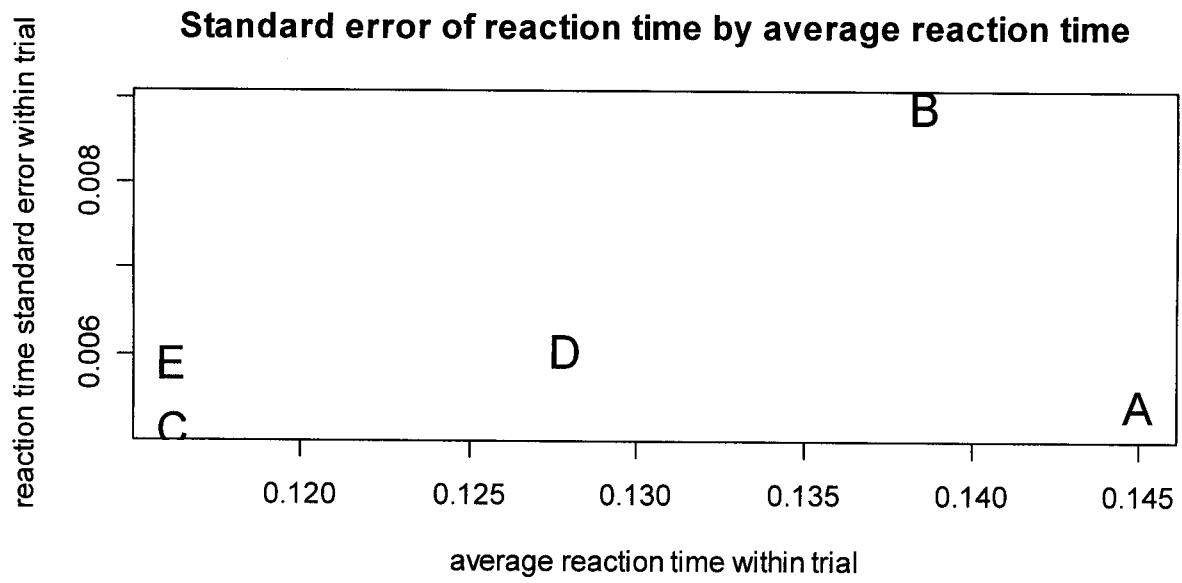


Figure 9.




```

/*****
*           Correlated Data                               *
*           Homework Assignment #1                       *
*           27 Sep 2007                                  *
*                                                                 *
*****/

libname a "E:\classes\correlated data\";
options PS=4000 LS=90 formdlm="^";

data raw_data;
  infile "E:\classes\correlated data\HW-1-timetrial.dat" firstobs=2;
  input Sex $ Age Trial1-Trial5;
run;

proc contents data=raw_data;
  title 'Contents of raw_data dataset';
run;

proc print data=raw_data;
run;

/* CONVERT DATASET FROM 1 ROW PER PERSON WITH SEPARATE VARIABLES FOR EACH TRIAL */
/* TO MULTIPLE ROWS PER PERSON, WITH EACH ROW BEING A SEPARATE TRIAL.          */
data repdata;
  set raw_data;
  time=trial1;  trial=1;  subj=_N_;  output;
  time=trial2;  trial=2;  subj=_N_;  output;
  time=trial3;  trial=3;  subj=_N_;  output;
  time=trial4;  trial=4;  subj=_N_;  output;
  time=trial5;  trial=5;  subj=_N_;  output;
run;
proc print data=repdata(obs=20); title 'intermediate dataset'; run;

/* SAVE VARIABLES TO ASCII FILE TO BE USED IN R */
data _NULL_;
  set repdata;
  file "E:\classes\correlated data\new.timetrial.dat";

  /* TRANSFORM OUTCOME VARIABLE. WE ARE ONLY INTERESTED IN THE MAGNITUDE */
  /* OF THE TIMING, NOT WHETHER THE SWING WAS TOO EARLY OR TOO LATE.      */
  time = abs(time);
  put time sex age trial subj;
run;

data _NULL_;
  set repdata;
  file "E:\classes\correlated data\new.timetrial2.dat";
  if trial = 2 and subj = 35 then delete;

  /* TRANSFORM OUTCOME VARIABLE. WE ARE ONLY INTERESTED IN THE MAGNITUDE */
  /* OF THE TIMING, NOT WHETHER THE SWING WAS TOO EARLY OR TOO LATE.      */
  time = abs(time);
  put time sex age trial subj;
run;

data temp;
  set repdata;
  time = abs(time);
  drop Trial1-Trial5;
run;
proc print data=temp(obs=30); title 'reformatted dataset'; run;
proc univariate data=temp; var time; run;
proc print data=temp; where time > 1.5; var trial subj time; run;
proc print data=temp; where subj = 35; var trial subj time; run;

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/* DESCRIPTIVE STATS ON REACTION TIME */  
proc means data=temp;  
  class sex;  
  var time;  
run;  
proc means data=temp;  
  class trial;  
  var time;  
run;  
  
proc univariate data=temp;  
  var age;  
run;  
proc freq data=temp;  
  where trial=1;  
  tables age;  
run;
```

```

# HW 1

/* SET WORKING DIRECTORY FIRST */
data =
read.table('new.timetrial.dat',header=F,col.names=c('time','sex','age','trial','
subj'))

# list data
data
data[1:30,]

data$female = ifelse(data$sex=='F',1,0)
data$male = ifelse(data$sex=='M',1,0)
data$kids = ifelse(data$age<=17,1,0)
data$adults = ifelse(data$age>17,1,0)

nsub = length(data$age)
ntimes = 5
nobs = ntimes*nsub

# ATTACH DATASET NAME, IN ORDER TO USE JUST VARIABLE NAMES
attach(data)

# SCATTERPLOT
plot(sex,time,xlab='sex',ylab='contact time (seconds)',pch=3)
plot(age,time,xlab='age',ylab='contact time (seconds)',pch=3)

plot(trial,time,type="n",xlab="trial",ylab="contact time (seconds)")
points(trial[male==1],time[male==1],type="p",pch=3)
points(trial[female==1],time[female==1],type="p",pch=4)

plot(trial,time,type="n",xlab="trial",ylab="contact time (seconds)")
points(trial[kids==1],time[kids==1],type="p",pch=3)
points(trial[adults==1],time[adults==1],type="p",pch=4)

#####      LINE PLOT - REACTION TIME VS TRIAL      #####
#####      ALL VISITORS      #####
ntimes=5
par(mfrow=c(1,2),oma=c(0,0,3,0),pch=42,font.sub=3,adj=0.5)
plot(trial,time,type="n",xlab="trial",ylab="reaction time (seconds)")
points(trial,time,type="p",pch=3)
lines(lowess(trial,time),lwd=3)
title("Figure 1. Reaction time for all visitors")

#####      LINE PLOT - REACTION TIME VS TRIAL      #####
#####      EXPLORE MAIN EFFECT OF GENDER      #####
ntimes=5
par(mfrow=c(1,2),oma=c(0,0,3,0),pch=42,font.sub=3,adj=0.5)
plot(trial,time,type="n",xlab="trial",ylab="reaction time (seconds)")
points(trial[male==1],time[male==1],type="p",pch=3)
for (i in unique(subj)) {
  if (male[ntimes*i]==1) { lines(trial[subj==i],time[subj==i],type="l",lty=2) }
}
lines(lowess(trial[male==1],time[male==1]),lwd=3)
title("reaction time for males")

plot(trial,time,type="n",xlab="trial",ylab="reaction time (seconds)")

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points(trial[female==1],time[female==1],type="p",pch=4)
for (i in unique(subj)) {
  if (female[ntimes*i]==1) { lines(trial[subj==i],time[subj==i],type="l",lty=4)
  }
}
lines(lowess(trial[female==1],time[female==1]),lwd=3)
title("reaction time for females")
mtext(side=3,outer=T,line=0,"Figure 2. Main effect of gender",cex=1.3)

#####      LINE PLOT - REACTION TIME VS TRIAL      #####
#####      EXPLORE MAIN EFFECT OF AGE (KIDS VS. ADULTS)      #####
ntimes=5
par(mfrow=c(1,2),oma=c(0,0,3,0),pch=42,font.sub=3,adj=0.5)
plot(trial,time,type="n",xlab="trial",ylab="reaction time (seconds)")
points(trial[kids==1],time[kids==1],type="p",pch=3)
for (i in unique(subj)) {
  if (kids[ntimes*i]==1) { lines(trial[subj==i],time[subj==i],type="l",lty=2) }
}
lines(lowess(trial[kids==1],time[kids==1]),lwd=3)
title("reaction time for kids (<18 yrs)")

plot(trial,time,type="n",xlab="trial",ylab="reaction time (seconds)")
points(trial[adults==1],time[adults==1],type="p",pch=4)
for (i in unique(subj)) {
  if (adults[ntimes*i]==1) { lines(trial[subj==i],time[subj==i],type="l",lty=4)
  }
}
lines(lowess(trial[adults==1],time[adults==1]),lwd=3)
title("reaction time for adults")
mtext(side=3,outer=T,line=0,"Figure 4. Main effect of age (kids vs.
adults)",cex=1.3)

#####      SUMMARY PLOT - REACTION TIME VS AGE      #####
#####      CROSS SECTIONAL LOOK AT EACH TRIAL      #####
par(adj=1)
ntimes=5
par(mfrow=c(2,3),oma=c(0,0,3,0),pch=42,font.sub=3,adj=0.5)
plot(age,time,type="n",xlab="age",ylab="reaction time (seconds)")
points(age[trial==1],time[trial==1],type="p",pch=3)
lines(lowess(age[trial==1],time[trial==1]),lwd=3)
title("reaction time by age for Trial #1")
mtext(side=3,outer=T,line=0,"Figure 3. Summary plot of reaction time by
age",cex=1.3)

plot(age,time,type="n",xlab="age",ylab="reaction time (seconds)")
points(age[trial==2],time[trial==2],type="p",pch=3)
lines(lowess(age[trial==2],time[trial==2]),lwd=3)
title("reaction time by age for Trial #2")

plot(age,time,type="n",xlab="age",ylab="reaction time (seconds)")
points(age[trial==3],time[trial==3],type="p",pch=5)
lines(lowess(age[trial==3],time[trial==3]),lwd=3)
title("reaction time by age for Trial #3")

plot(age,time,type="n",xlab="age",ylab="reaction time (seconds)")
points(age[trial==4],time[trial==4],type="p",pch=3)
lines(lowess(age[trial==4],time[trial==4]),lwd=3)
title("reaction time by age for Trial #4")

plot(age,time,type="n",xlab="age",ylab="reaction time (seconds)")

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points (age [trial==5], time [trial==5], type="p", pch=5)
lines (lowess (age [trial==5], time [trial==5]), lwd=3)
title ("reaction time by age for Trial #5")

#####      LINE PLOT - REACTION TIME VS TRIAL      #####
#####      EXPLORE 2-WAY INTERACTION AGE*GENDER    #####
par (mfrow=c (1, 2), oma=c (0, 0, 3, 0), pch=42, font.sub=3, adj=0.5) .
plot (age, time, type="n", xlab="age", ylab="reaction time (seconds)")
points (age [male==1], time [male==1], type="p", pch=3)
lines (lowess (age [male==1], time [male==1]))
title ("reaction time for males", cex=0.8)

plot (age, time, type="n", xlab="age", ylab="reaction time (seconds)")
points (age [female==1], time [female==1], type="p", pch=4)
lines (lowess (age [female==1], time [female==1]))
title ("reaction time for females", cex=0.8)
mtext (side=3, outer=T, line=0, "Figure 5. Examine age*gender interaction", cex=1.3)

#####      BOX PLOT - REACTION TIME ACROSS TIME    #####
par (mfrow=c (1, 1), oma=c (0, 0, 3, 0), pch=42, font.sub=3, adj=0.5)
boxplot (time [trial==1], time [trial==2], time [trial==3], time [trial==4],
time [trial==5], names=c ("trial 1", "trial 2", "trial 3", "trial 4", "trial 5"),
ylab="reaction time (seconds)")
lines (lowess (age [male==1], time [male==1]))
title ("Figure 6. Reaction time by trial", cex=0.8)
par (adj=1)

#####      BOX PLOT - REACTION TIME ACROSS TIME    #####
#####      BY GENDER                                #####
nfemale = sum (data$female)
nmale = sum (data$male)
par (mfrow=c (1, 2), oma=c (0, 0, 3, 0), pch=42, font.sub=3, adj=0.5)
boxplot (time [trial==1 & male==1], time [trial==2 & male==1],
time [trial==3 & male==1], time [trial==4 & male==1],
time [trial==5 & male==1], width=rep (nmale, ntimes),
names=c ("trial 1", "trial 2", "trial 3", "trial 4", "trial 5"),
ylim=c (0, 2.5), ylab="reaction time (seconds)")
title ("Males", cex=0.8)
mtext (side=3, outer=T, line=0, "Figure 7. Reaction time across time, by
gender", cex=1.3)

boxplot (time [trial==1 & female==1], time [trial==2 & female==1],
time [trial==3 & female==1], time [trial==4 & female==1],
time [trial==5 & female==1], width=rep (nfemale, ntimes),
names=c ("trial 1", "trial 2", "trial 3", "trial 4", "trial 5"),
ylim=c (0, 2.5), ylab="reaction time (seconds)")
title ("Females", cex=0.8)

#####      BOX PLOT - REACTION TIME ACROSS TIME    #####
#####      BY AGE (KIDS VS. ADULTS)                #####
nkids = sum (data$kids)
nadults = sum (data$adults)
par (mfrow=c (1, 2), oma=c (0, 0, 3, 0), pch=42, font.sub=3, adj=0.5)
boxplot (time [trial==1 & kids==1], time [trial==2 & kids==1],
time [trial==3 & kids==1], time [trial==4 & kids==1],
time [trial==5 & kids==1], width=rep (nkids, ntimes),
names=c ("trial 1", "trial 2", "trial 3", "trial 4", "trial 5"),
ylim=c (0, 2.5), ylab="reaction time (seconds)")

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title("Kids", cex=0.8)
mtext(side=3,outer=T,line=0,"Figure 8. Reaction time across time, age
groups",cex=1.3)

boxplot(time[trial==1 & adults==1],time[trial==2 & adults==1],
time[trial==3 & adults==1],time[trial==4 & adults==1],
time[trial==5 & adults==1],width=rep(nadults,ntimes),
names=c("trial 1","trial 2","trial 3","trial 4","trial 5"),
ylim=c(0,2.5),ylab="reaction time (seconds)")
title("Adults", cex=0.8)

#####
##### create scatterplot of reaction time average vs reaction time se #####
#####
avg1 = mean(time[trial==1],na.rm=T)
avg2 = mean(time[trial==2],na.rm=T)
avg3 = mean(time[trial==3],na.rm=T)
avg4 = mean(time[trial==4],na.rm=T)
avg5 = mean(time[trial==5],na.rm=T)
var1 = var(na.omit(time[trial==1]))
var2 = var(na.omit(time[trial==2]))
var3 = var(na.omit(time[trial==3]))
var4 = var(na.omit(time[trial==4]))
var5 = var(na.omit(time[trial==5]))

par(mfrow=c(1,1),oma=c(0,0,3,0),pch=42,font.sub=3,adj=0.5)
plot(c(avg1,avg2,avg3,avg4,avg5),
sqrt(c(var1/nsub,var2/nsub,var3/nsub,var4/nsub,var5/nsub)),type="n",
xlab="average reaction time within trial",
ylab="reaction time standard error within trial")
points(avg1,sqrt(var1/nsub),pch=65,cex=1.6)
points(avg2,sqrt(var2/nsub),pch=66,cex=1.6)
points(avg3,sqrt(var3/nsub),pch=67,cex=1.6)
points(avg4,sqrt(var4/nsub),pch=68,cex=1.6)
points(avg5,sqrt(var5/nsub),pch=69,cex=1.6)
legend(0.06,0.022,c("trial 1","trial 2","trial 3","trial 4","trial 5"),
pch=c(65,66,67,68,69))
title("Standard error of reaction time by average reaction time",cex=0.8)
mtext(side=3,outer=T,line=0,"Figure 9.",cex=1.3)
par(adj=1)

##### GET ORDINARY LEAST SQUARES (OLS) RESIDUALS #####
cage = age - mean(age)
ols.fit = lm(time ~ male*cage*factor(trial))

res = ols.fit$residuals
res1 = res[trial==1]
res2 = res[trial==2]
res3 = res[trial==3]
res4 = res[trial==4]
res5 = res[trial==5]

cor(cbind(res1,res2,res3,res4,res5))

# SEND THE CORRELATION MATRIX TO A TEXT FILE
sink("correlation_matrix.out.txt")
cor(cbind(res1,res2,res3,res4,res5))
sink()

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```
##### MULTIVARIATE SCATTER PLOTS #####
pairs(cbind(res1,res2,res3,res4,res5),upper.panel=NULL,pch=42)
title("OLS residuals scatter plots")

##### SEPARATE RESIDUALS BY GENDER #####
mres1 = res[trial==1 & male==1]
mres2 = res[trial==2 & male==1]
mres3 = res[trial==3 & male==1]
mres4 = res[trial==4 & male==1]
mres5 = res[trial==5 & male==1]

fres1 = res[trial==1 & female==1]
fres2 = res[trial==2 & female==1]
fres3 = res[trial==3 & female==1]
fres4 = res[trial==4 & female==1]
fres5 = res[trial==5 & female==1]

par(mfrow=c(1,1),oma=c(3,0,3,0),pch=42,font.sub=3,adj=0.5)
pairs(cbind(res1,res2,res3,res4,res5),upper.panel=NULL)
mtext(side=1, line=2, cex=1.2, outer=T,
      "Row variable plotted on vertical axis. Column variable plotted on horizontal
      axis.",cex=0.6)
mtext(side=3,outer=T,line=0,"Figure 10. Scatterplot matrix of
residuals",cex=1.3)
par(adj=1)
mtext(side=1,line=4,outer=T,font=3,"")

##### create plot of residuals against each other #####
##### separately by gender #####
#####
par(mfrow=c(1,1),oma=c(3,0,3,0),pch=42,font.sub=3,adj=0.5)
pairs(cbind(mres1,mres2,mres3,mres4,mres5),upper.panel=NULL)
mtext(side=1, line=2, cex=1.2, outer=T,
      "Row variable plotted on vertical axis. Column variable plotted on horizontal
      axis.")
mtext(side=3,outer=T,line=0,
      "Figure 10. Scatterplot matrix of residuals for males",cex=1.2)
par(adj=1)
mtext(side=1,line=4,outer=T,font=3,"")

par(mfrow=c(1,1),oma=c(3,0,3,0),pch=42,font.sub=3,adj=0.5)
pairs(cbind(fres1,fres2,fres3,fres4,fres5),upper.panel=NULL)
mtext(side=1, line=2, cex=1.2, outer=T,
      "Row variable plotted on vertical axis. Column variable plotted on horizontal
      axis.")
mtext(side=3,outer=T,line=0,
      "CONTACT TIME STUDY: residuals for females",cex=1.2)
par(adj=1)
mtext(side=1,line=4,outer=T,font=3,"")
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(2002)