Synchrony in Psychotherapy, example with F1044 patient data

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Contents

Aim and Hypothesis

The aim of this project is to evaluate if it is possible to detect automatic signals that could predict the outcomes of a familial psychotherapy.

Here is the analysis of the F1044 subject, his familly (2 parents) and the therapist. Is there synchrony signals between himself, his parents and the therapist ? Is there synchrony signal between his parents and the therapist ?

Could this synchrony signal predict outcomes of the psychotherapy ?

We used this data since they come from a large european psychotherapy study and they come from almost real life practice of psychotherapy. This INCANT study aimed to evaluate the efficacy of the MultiDimensioinal Family Therapy for cannabis use disorders in adolescents.

Nomenclature

F1044 is the name of the subject studied (called pa for patient). He has a mother (mo) a father (fa) helped by a therapist (th). When a variable is referring to several participants, it is organised in alphabetical order separated by underscores, eg. SSI_fa_mo refers to the synchrony index (SSI) between the father and the mother. SSI_mo_fa doesn't exist. This familly had several consultations with the psychotherapist. Some of them were video recorded. These videos are names with the name of the subject + an index letter. They can subdivised after that with numbers (eg F1044C).

```
## Warning: package 'lme4' was built under R version 3.2.3
```

```
## Loading required package: Matrix
```

Lists

Functions list

MeanMotionByTime

Function that takes raw motion history data and compute the mean on a given interval. Intervals don't overlap, so the frequency of the data change (from 25 frames by seconde to 25 frames/interval by second).

Arguments:

- subject : Subject studied (patient, mother, father or therapist)
- indexOfvideos : List of videos studied (element eg 3 or list eg 1:3 or c(1,2,4))
- interval : number of frames in the studied interval
- data : data frame where there is data

```
MeanMotionByTime <- function(subject, indexOfvideos=1:NumberOfvideos, interval, data){
  x <- c()
  for (file in indexlist[indexOfvideos]){
        dataVector <- data[which(data$file==file), subject]
        ## with ceiling : superior limit of the round
        IntervalNumbersVideo <- ceiling(length(dataVector)/interval)
        for (i in 1:IntervalNumbersVideo){
                borneinf<- 1+(i-1)*interval
                bornesup <-i*interval
                dataVectorInterval <- dataVector[borneinf:bornesup]
                mean <- mean(dataVectorInterval, na.rm=TRUE)
                x <- c(x, mean)}}
  return (x)}
```

Slidinginterval

Function that takes raw motion history data and compute the mean on a given interval. The interval overlap, so the frequency of the data don't change. It stays at 25 frames/s.

Arguments:

- subject : subject studied (patient, mother, father or therapist)
- indexOfvideos : list of videos studied (element eg. 3 or list eg 1:3 or c(1,2,4))
- interval : number of frames in the studied interval
- data : data frame where there is data

```
SlidingInterval <- function(subject, indexOfvideos=1:NumberOfvideos, interval, data)
  {x <- c()
  for (file in indexlist[indexOfvideos]){
      dataVector <- data[which(data$file==file), subject]
      NBofAnalysedFrames <- length(dataVector)-interval+1
          for (i in 1:NBofAnalysedFrames){
              borneinf<- (i)
              bornesup <-(interval-1+i)
              dataVectorInterval <- dataVector[borneinf:bornesup]
              mean <- mean(dataVectorInterval, na.rm=TRUE)
              x <- c(x, mean)}}
  return (x)}
```

MeanSynchronyByTime (TODO)

File lists

```
indexlist <- c("F1044C.VOB","F1044D1.VOB","F1044D2.VOB","F1044E.VOB","F1044F.VOB",
               "F1044G.VOB","F1044H.VOB","F1044I.VOB","F1044L.VOB","F1044M1.VOB",
               "F1044M2.VOB","F1044N.VOB", "F1044O.VOB", "F1044P.VOB", "F1044Q.VOB",
               "F1044R1.VOB","F1044R2.VOB")

labelvideolist<- c("C","D1","D2","E","F", "G","H","I","L","M1",
```

```
                  "M2","N", "O", "P", "Q","R1","R2")

NumberOfvideos <- length(indexlist)

colOrderList <- c("blue","red", "green","orange")
```

Participants list

```
## [1] "father"    "mother"    "patient"   "therapist"
```

Presentation of the data

```
str(data)
```

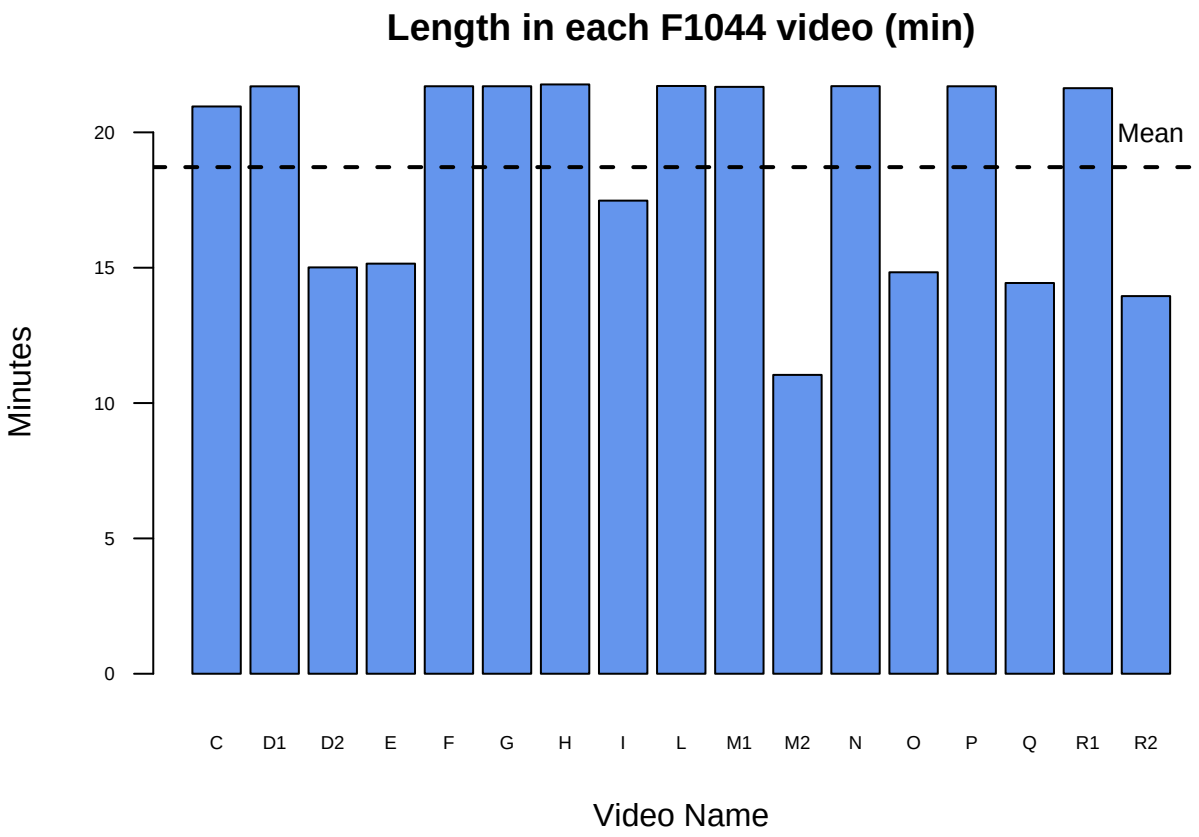
```
## 'data.frame':    477258 obs. of  7 variables:
##  $ frame    : int  1 2 3 4 5 6 7 8 9 10 ...
##  $ father   : num  0.01996 0.00915 0.01355 0.01787 0.01758 ...
##  $ mother   : num  1.82e-05 1.82e-05 3.64e-05 1.82e-05 9.09e-05 ...
##  $ patient  : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ therapist: num  0.00162 0.00506 0.00349 0.00223 0.00249 ...
##  $ file     : Factor w/ 17 levels "F1044C.VOB","F1044D1.VOB",..: 1 1 1 1 1 1 1 1 1 1 ...
##  $ timeMin  : num  0.000667 0.001333 0.002 0.002667 0.003333 ...
```

```
summary(data)
```

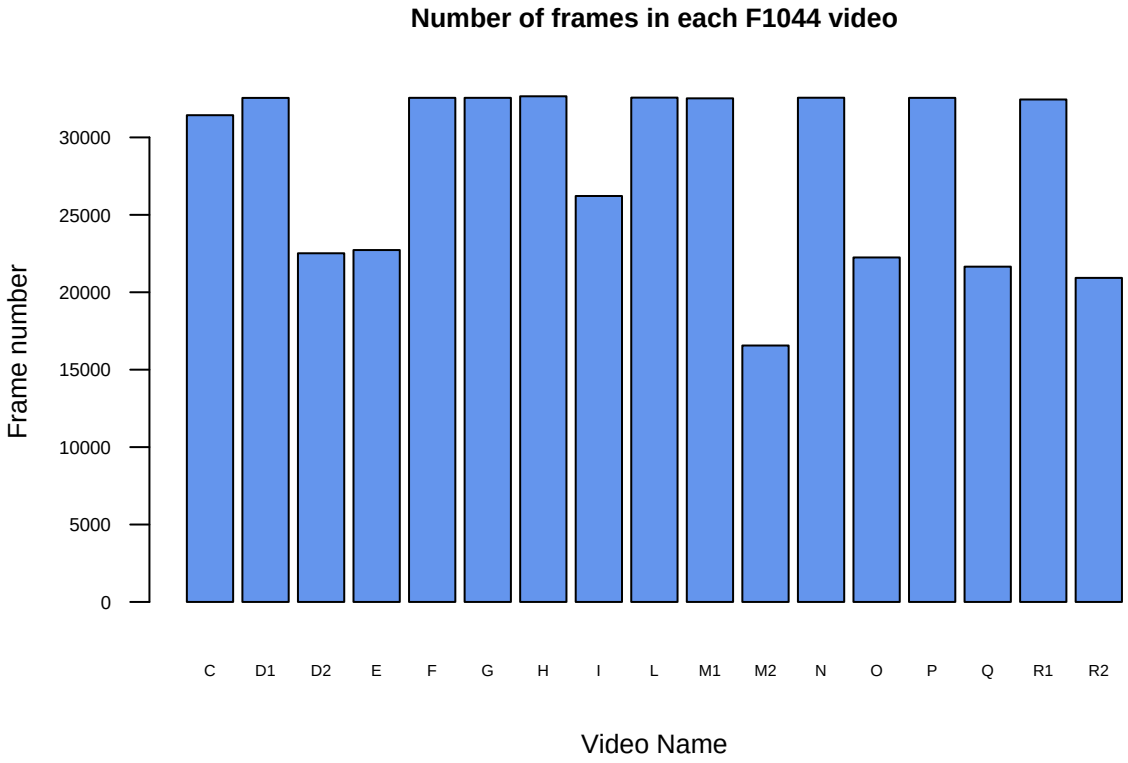
```
##      frame           father           mother         patient
##  Min.   :    1   Min.   :0.00     Min.   :0.00    Min.   :0.00
##  1st Qu.: 7019   1st Qu.:0.00     1st Qu.:0.00    1st Qu.:0.00
##  Median :14038   Median :0.00     Median :0.00    Median :0.00
##  Mean   :14576   Mean   :0.00     Mean   :0.00    Mean   :0.01
##  3rd Qu.:21364   3rd Qu.:0.00     3rd Qu.:0.00    3rd Qu.:0.01
##  Max.   :32656   Max.   :0.19     Max.   :0.49    Max.   :0.54
##                  NA's   :265686   NA's   :91545   NA's   :189317
##    therapist             file           timeMin
##  Min.   :0.0     F1044H.VOB: 32656   Min.   : 0.000667
##  1st Qu.:0.0     F1044L.VOB: 32570   1st Qu.: 4.679333
##  Median :0.0     F1044N.VOB: 32562   Median : 9.358333
##  Mean   :0.0     F1044G.VOB: 32556   Mean   : 9.717052
##  3rd Qu.:0.0     F1044F.VOB: 32555   3rd Qu.:14.242667
##  Max.   :0.8     F1044P.VOB: 32554   Max.   :21.770667
##  NA's   :77972   (Other)   :281805
```

The timeMin is calculated with a frame rate of 25/sec.

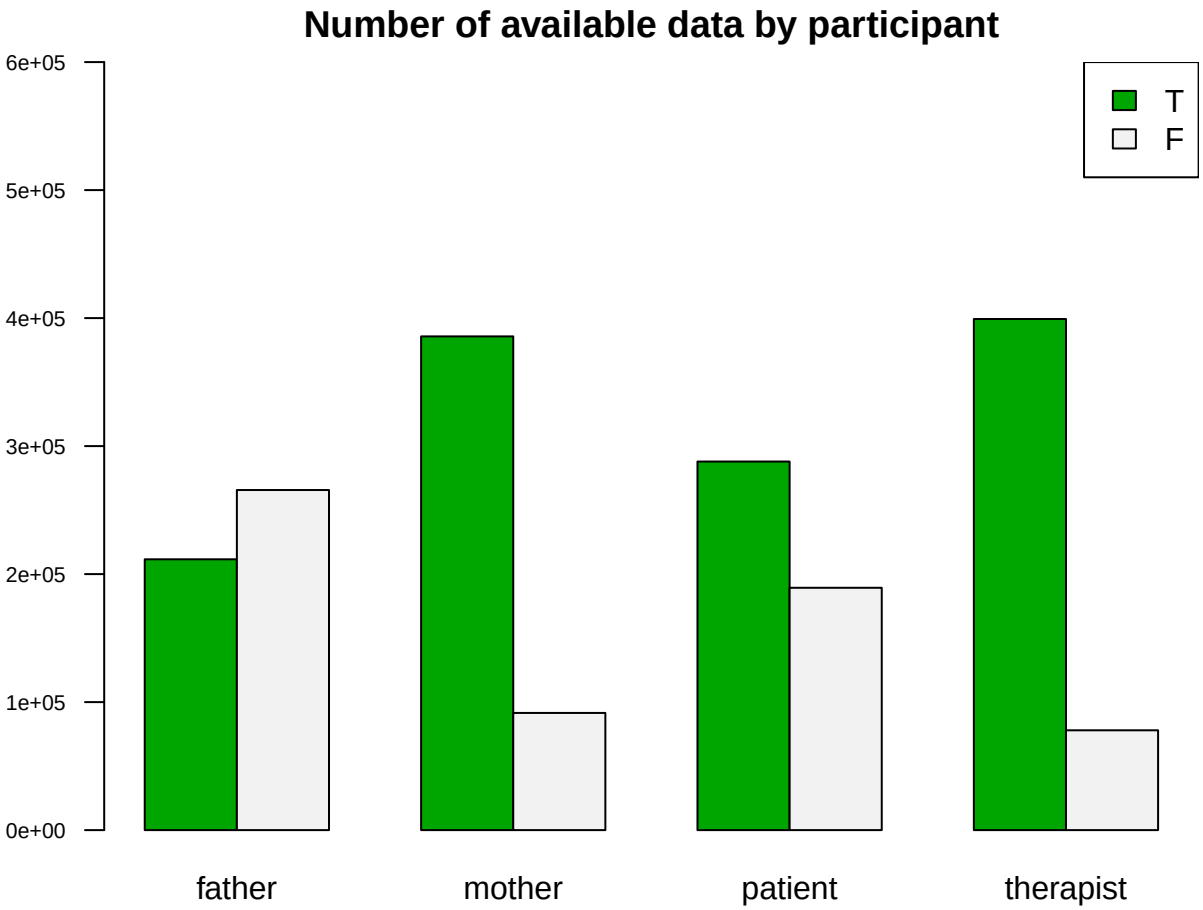
Length of the videos in minutes



Length of the videos in number of frames



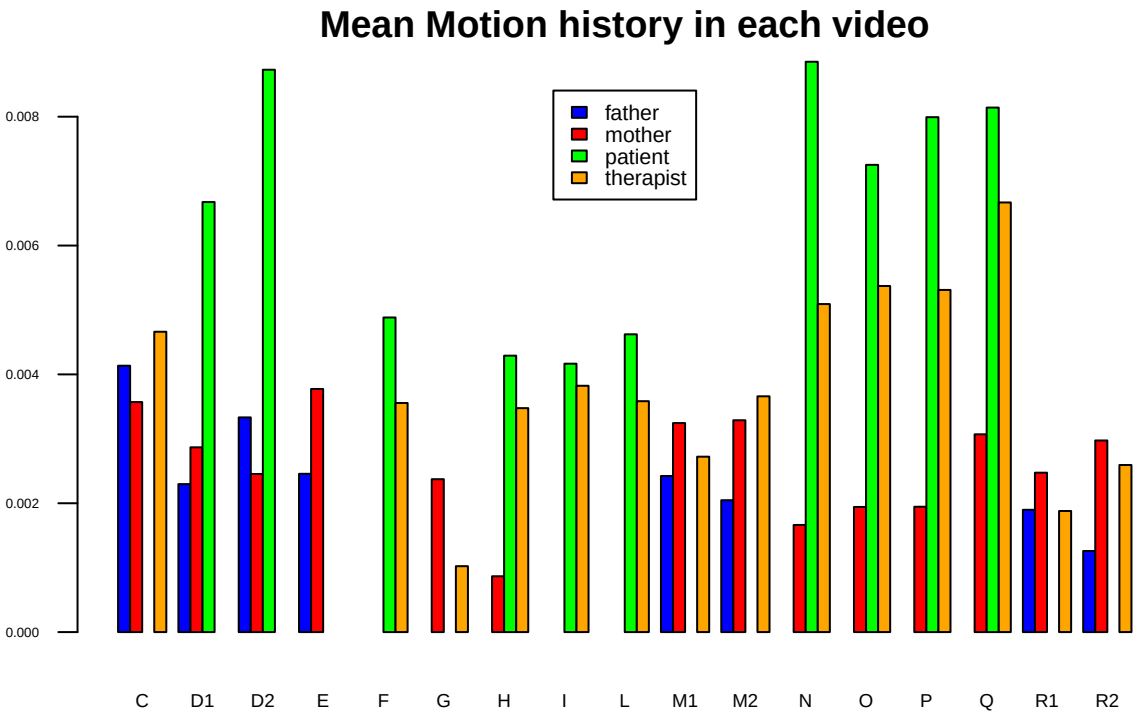
Number of Available (True) and Not Available (False) data for each participant



Some participants are not filmed (eg therapist) or don't come in the sessions. Mother and therapist are the more often present participants.

Global Motion history

Mean Motion history by video by participant



Raw data and mean of Motion History on sliding and non overlapping intervals on F1044C video

F1044C video

It is the first video of F1044C. The father, mother and therapist are present. The patient is absent. ## Raw data

```
rawdatafather <- data[which(data$file=="F1044C.VOB"),]$father
rawdataMother <- data[which(data$file=="F1044C.VOB"),]$mother
rawdataTherapist <- data[which(data$file=="F1044C.VOB"),]$therapist

summary(rawdatafather)
```

```
##     Min.  1st Qu.   Median     Mean  3rd Qu.     Max.     NA's
## 0.000000 0.000000 0.000196 0.004135 0.003488 0.092340       10
```

```
summary(rawdataMother)
```

```
##     Min.  1st Qu.   Median     Mean  3rd Qu.     Max.     NA's
## 0.000000 0.000036 0.000127 0.003570 0.002200 0.159600       10
```

```r
summary(rawdataTherapist)
```

```
##     Min.  1st Qu.   Median     Mean  3rd Qu.     Max.     NA's
## 0.001179 0.002750 0.003405 0.004662 0.004234 0.236000       10
```

Sliding interval

```r
## REMINDER:
# SlidingInterval <- function(subject, indexOfvideos=1:NumberOfvideos, interval, data) with :
# subject : subject studied (patient, mother, father or therapist)
# indexOfvideos : list of videos studied (element eg. 3 or list eg 1:3 or c(1,2,4))
# interval : number of frames in the studied interval
# data : data frame where there is data

slidedfather <- SlidingInterval("father", 1 , 5, data)
slidedmother <- SlidingInterval("mother", 1 , 5, data)
slidedtherapist <- SlidingInterval("therapist", 1 , 5, data)
slidedpatient <- SlidingInterval("patient", 1 , 5, data)

summary(slidedfather)
```

```
##     Min.  1st Qu.   Median     Mean  3rd Qu.     Max.     NA's
## 0.000000 0.000005 0.000335 0.004139 0.003691 0.091450        6
```

```r
summary(slidedmother)
```

```
##     Min.  1st Qu.   Median     Mean  3rd Qu.     Max.     NA's
## 0.000000 0.000036 0.000156 0.003574 0.002520 0.145900        6
```

```r
summary(slidedpatient)
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.    NA's
##      NA      NA      NA     NaN      NA      NA   31431
```

```r
summary(slidedtherapist)
```

```
##     Min.  1st Qu.   Median     Mean  3rd Qu.     Max.     NA's
## 0.001702 0.003029 0.003352 0.004672 0.003955 0.219600        6
```

```r
par(mar=c(3,3,2,2))
boxplot(slidedfather, slidedmother, slidedtherapist,
        col=colOrderList[c(1,2,4)],
        names=ParticipantsList[c(1,2,4)],
        main= "Box plot of motion history sliding interval on F1044C video", las=1)
par(mar=c(1,0.5,0.5,1))
legend("topleft", ParticipantsList[c(1,2,4)], fill=colOrderList, cex=0.7)
```

Non overlapping interval

```
fatherFive<- MeanMotionByTime("father", indexOfvideos=1, interval=5, data)

motherFive <- MeanMotionByTime("mother", indexOfvideos=1, interval=5, data)

therapistFive <- MeanMotionByTime("therapist", indexOfvideos=1, interval=5, data)

summary(fatherFive)
```

```
##      Min.   1st Qu.    Median      Mean   3rd Qu.      Max.      NA's
## 0.0000000 0.0000049 0.0003305 0.0041350 0.0036840 0.0883000         2
```

```
summary(motherFive)
```

```
##      Min.   1st Qu.    Median      Mean   3rd Qu.      Max.      NA's
## 0.0000000 0.0000364 0.0001564 0.0035700 0.0025310 0.1459000         2
```

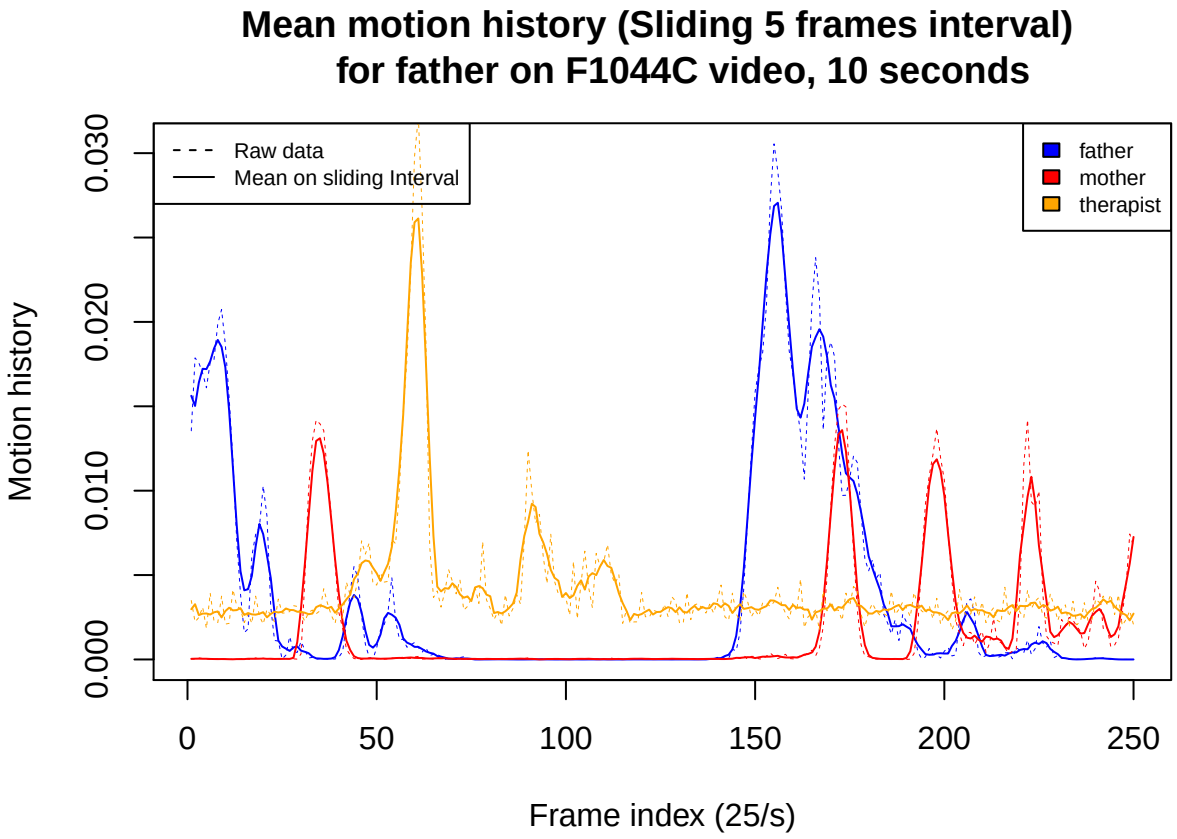
```
summary(therapistFive)
```

```
##     Min.  1st Qu.   Median     Mean  3rd Qu.     Max.     NA's
## 0.001807 0.003029 0.003352 0.004662 0.003972 0.219600        2
```

Focus on the motion history of the first 20 seconds of the first video(C)

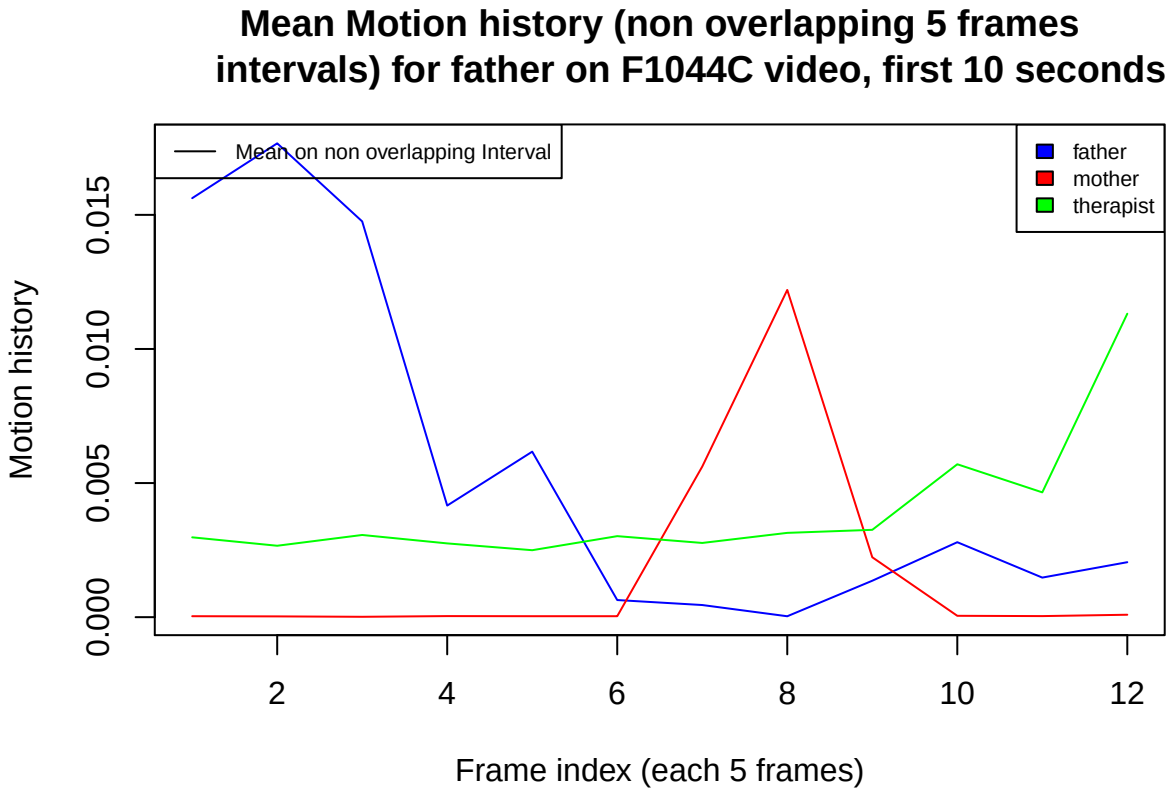
Sliding interval function on a 5 frames interval

```
par(mar=c(4,4,4,2))
plot(1:250, data$father[3:252], main="Mean motion history (Sliding 5 frames interval)
     for father on F1044C video, 10 seconds ", xlab="Frame index (25/s)",
     ylab="Motion history",
     col="blue", type="l", lty=2, lwd=0.5)
lines(slidedfather[1:250],  col="blue", lty=1)
lines(data$mother[3:252],  col="red", lty=2, lwd=0.5)
lines(slidedmother[1:250],  col="red", lty=1)
lines(data$therapist[3:252],  col="orange", lty=2, lwd=0.5)
lines(slidedtherapist[1:250],  col="orange", lty=1)
legend("topleft", c("Raw data", "Mean on sliding Interval") , lty=c(2, 1), cex=0.7)
legend("topright", ParticipantsList[c(1,2,4)], fill=colOrderList[c(1,2,4)], cex=0.7)
```



Non overlapping interval function on a 5 frames interval

```
plot (1:12, fatherFive[1:12], type="l", col="blue",
main="Mean Motion history (non overlapping 5 frames
      intervals) for father on F1044C video, first 10 seconds",
ylab="Motion history", xlab="Frame index (each 5 frames)" )
lines(motherFive[1:12], col="red", lty=1)
lines(therapistFive[1:12], col="green", lty=1)
legend("topleft", "Mean on non overlapping Interval" , lty=1, cex=0.7)
legend("topright", ParticipantsList[c(1,2,4)], fill=colOrderList, cex=0.7)
```



Non overlapping interval function on a 5 frames interval with shifting of therapist (substraction of min value of therapist)

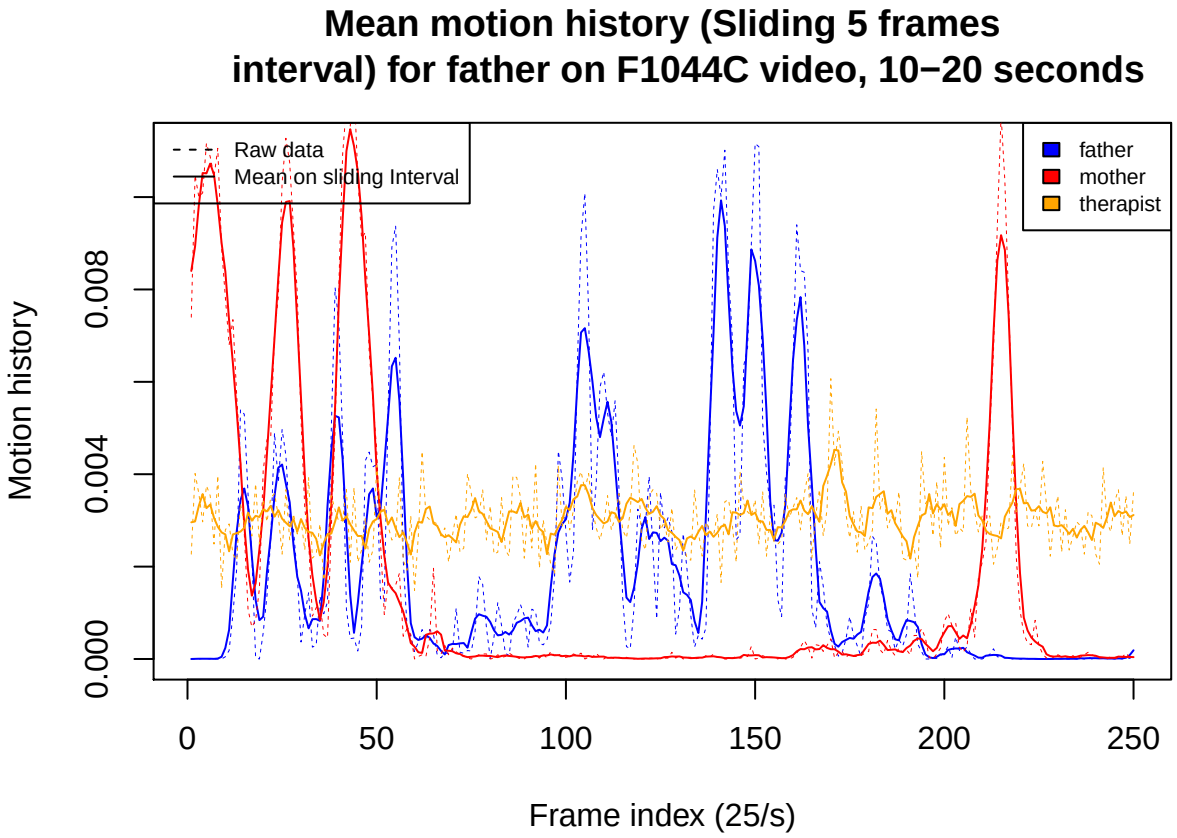
```
plot (1:24, fatherFive[1:12], type="l", col="blue",
main="Mean motion history (non overlapping 5 frames
      intervals) for father on F1044C video, first 10 seconds, data therapist shifted",
ylab="Motion history", xlab="Frame index (each 5 frames)" )
lines(motherFive[1:12], col="red", lty=1)
lines(therapistFive[1:12]-min(slidedtherapist), col="green", lty=1)
legend("topleft", "Mean on non overlapping Interval" , lty=1, cex=0.7)
legend("topright", ParticipantsList[c(1,2,4)], fill=colOrderList, cex=0.7)
```

Motion history of the father during 10-20 seconds of the first video(C)

Non overlapping interval function on a 5 frames interval

```
par(mar=c(4,4,4,2))
plot(1:250, data$father[253:502], main="Mean motion history (Sliding 5 frames
     interval) for father on F1044C video, 10-20 seconds", xlab="Frame index (25/s)",
     ylab="Motion history", col="blue", type="l", lty=2, lwd=0.5)
lines(slidedfather[251:500],  col="blue", lty=1)
lines(data$mother[253:502],  col="red", lty=2, lwd=0.5)
lines(slidedmother[251:500],  col="red", lty=1)
lines(data$therapist[253:502],  col="orange", lty=2, lwd=0.5)
```

```
lines(slidedtherapist[251:500],  col="orange", lty=1)
legend("topleft", c("Raw data", "Mean on sliding Interval") , lty=c(2, 1), cex=0.7)
legend("topright", ParticipantsList[c(1,2,4)], fill=colOrderList[c(1,2,4)], cex=0.7)
```

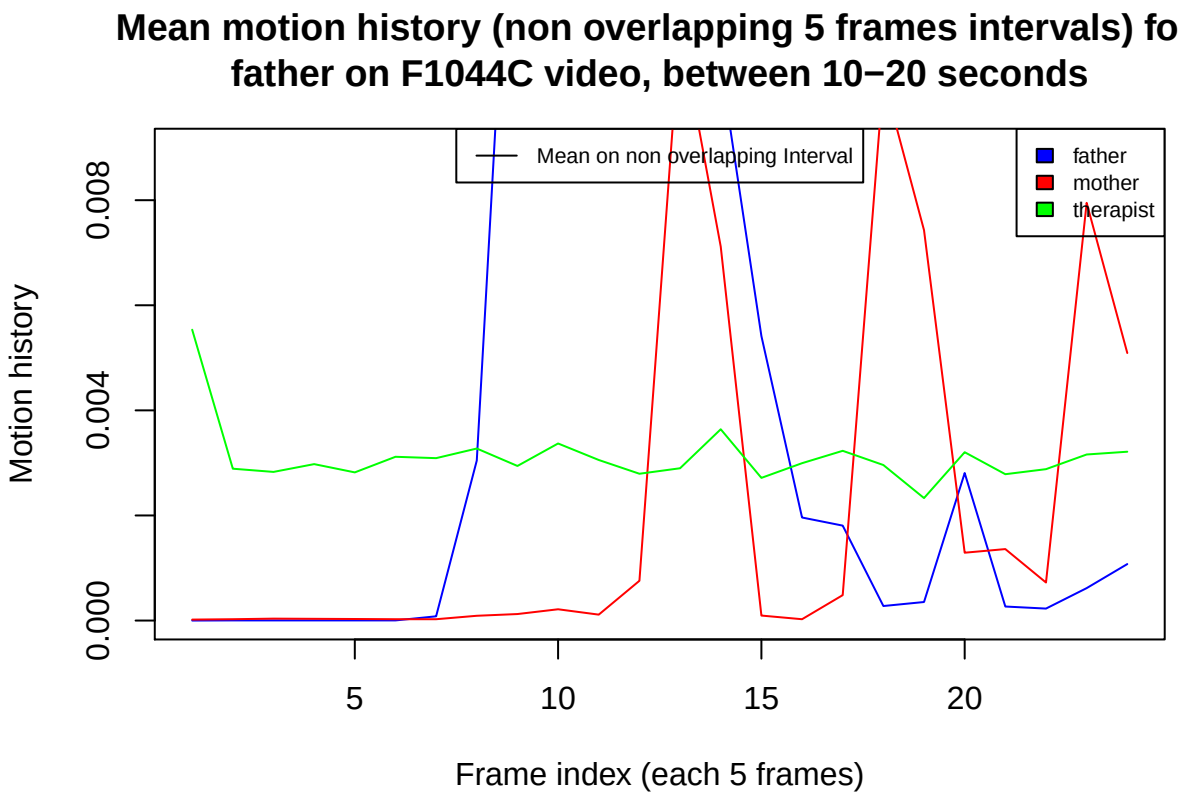



```
### Non overlapping interval function on a 5 frames interval with shifting
### of therapist (substraction of min value of therapist)
par(mar=c(4,4,4,2))
plot(1:250, data$father[256:505], main="Mean motion history (Sliding 5 frames
     interval) for father on F1044C video, 10-20 seconds,
     data therapist shifted", xlab="Frame index (25/s)", ylab="Motion history", col="blue",
     type="l", lty=2, lwd=0.5)
lines(slidedfather[251:500],  col="blue", lty=1)
lines(data$mother[256:505],  col="red", lty=2, lwd=0.5)
lines(slidedmother[251:500],  col="red", lty=1)
lines(data$therapist[256:505],  col="orange", lty=2, lwd=0.5)
lines(slidedtherapist[251:500]-min(slidedtherapist),  col="orange", lty=1)
legend("topleft", c("Raw data", "Mean on sliding Interval") , lty=c(2, 1), cex=0.7)
legend("topright", ParticipantsList[c(1,2,4)], fill=colOrderList[c(1,2,4)], cex=0.7)
```

Non overlapping interval function on a 5 frames interval

```
plot (1:24, fatherFive[23:46], type="l", col="blue",
main="Mean motion history (non overlapping 5 frames intervals) for
father on F1044C video, between 10-20 seconds",
```

```
ylab="Motion history", xlab="Frame index (each 5 frames)", ylim=c(0, 0.009))
lines(motherFive[23:46], col="red", lty=1)
lines(therapistFive[23:46], col="green", lty=1)
legend("top", "Mean on non overlapping Interval" , lty=1, cex=0.7)
legend("topright", ParticipantsList[c(1,2,4)], fill=colOrderList, cex=0.7)
```

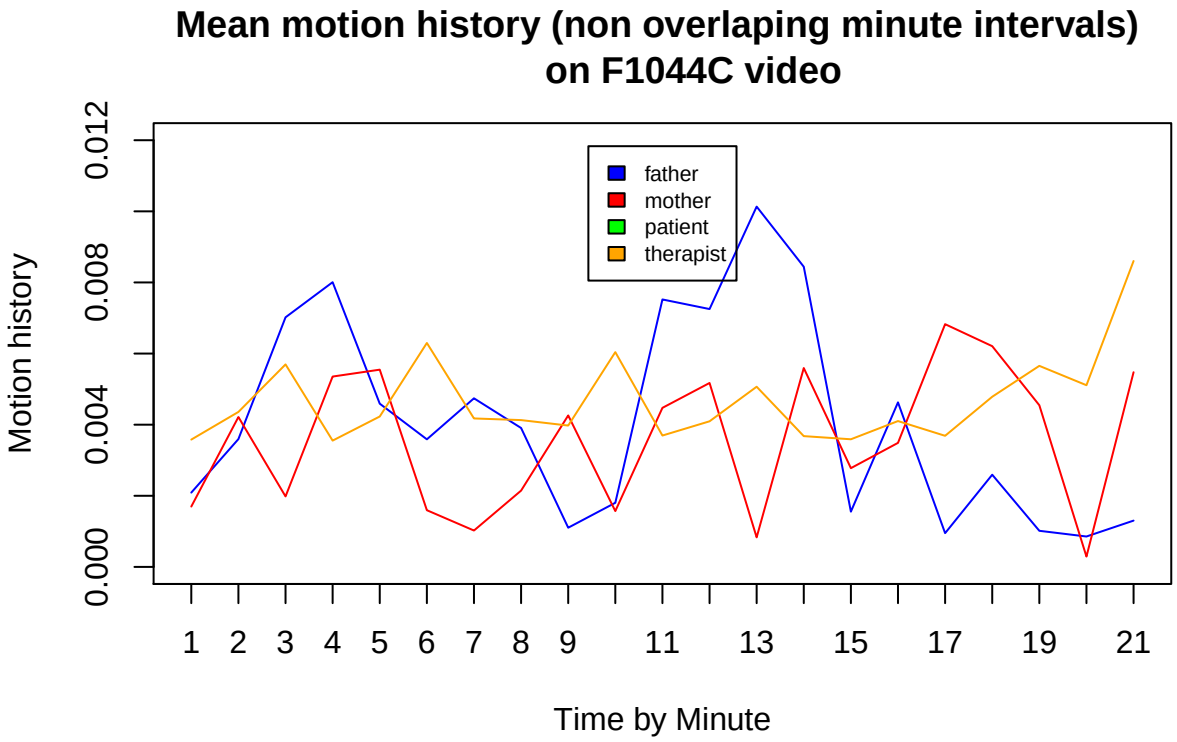


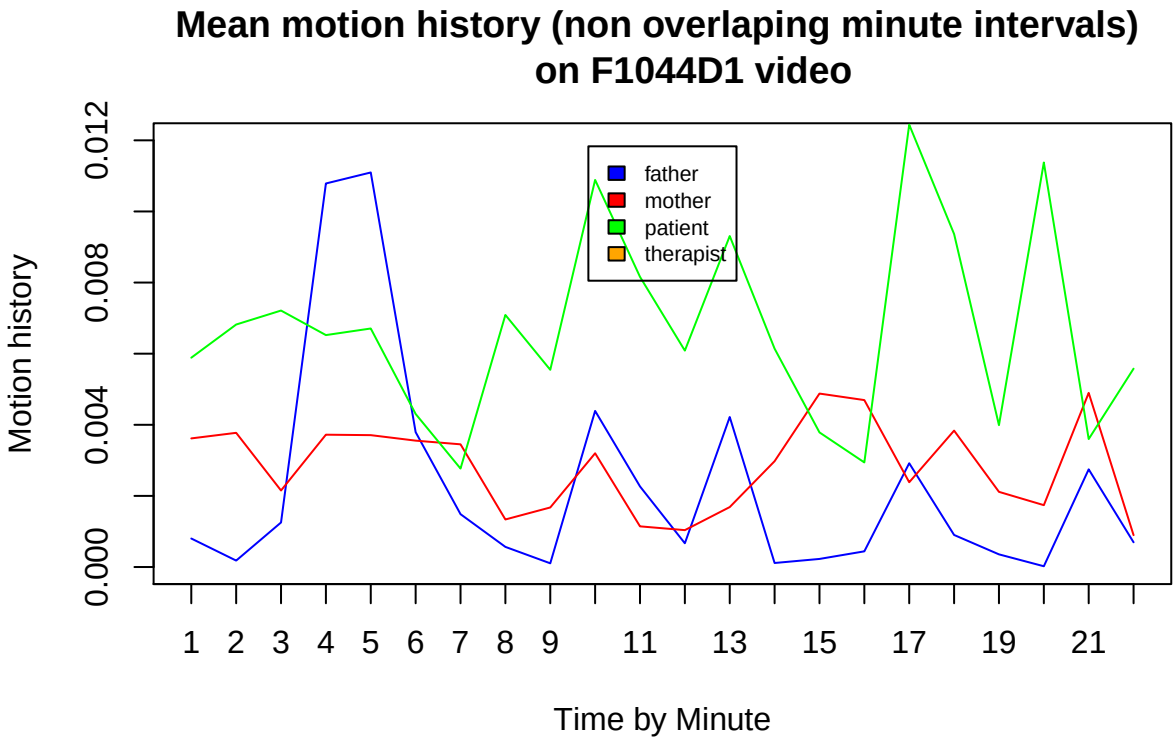

```
### Non overlapping interval function on a 5 frames interval with shifting of therapist (substraction o
plot (1:24, fatherFive[23:46], type="l", col="blue",
main="Mean motion history (non overlapping 5 frames intervals) for
father on F1044C video, between 10-20 seconds,
data therapist shifted",
ylab="Motion history", xlab="Frame index (each 5 frames)", ylim=c(0, 0.009))
lines(motherFive[23:46], col="red", lty=1)
lines(therapistFive[23:46]-min(slidedtherapist), col="green", lty=1)
legend("top", "Mean on non overlapping Interval" , lty=1, cex=0.7)
legend("topright", ParticipantsList[c(1,2,4)], fill=colOrderList, cex=0.7)
```

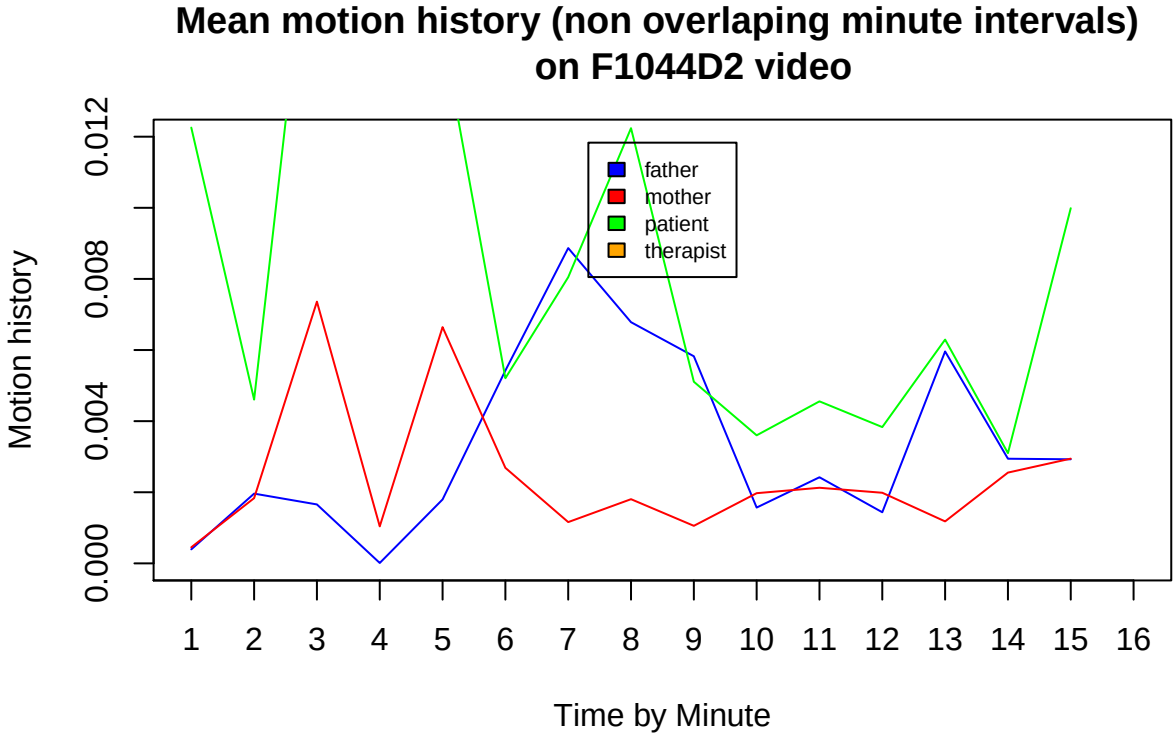
Mean motion history by minute plots

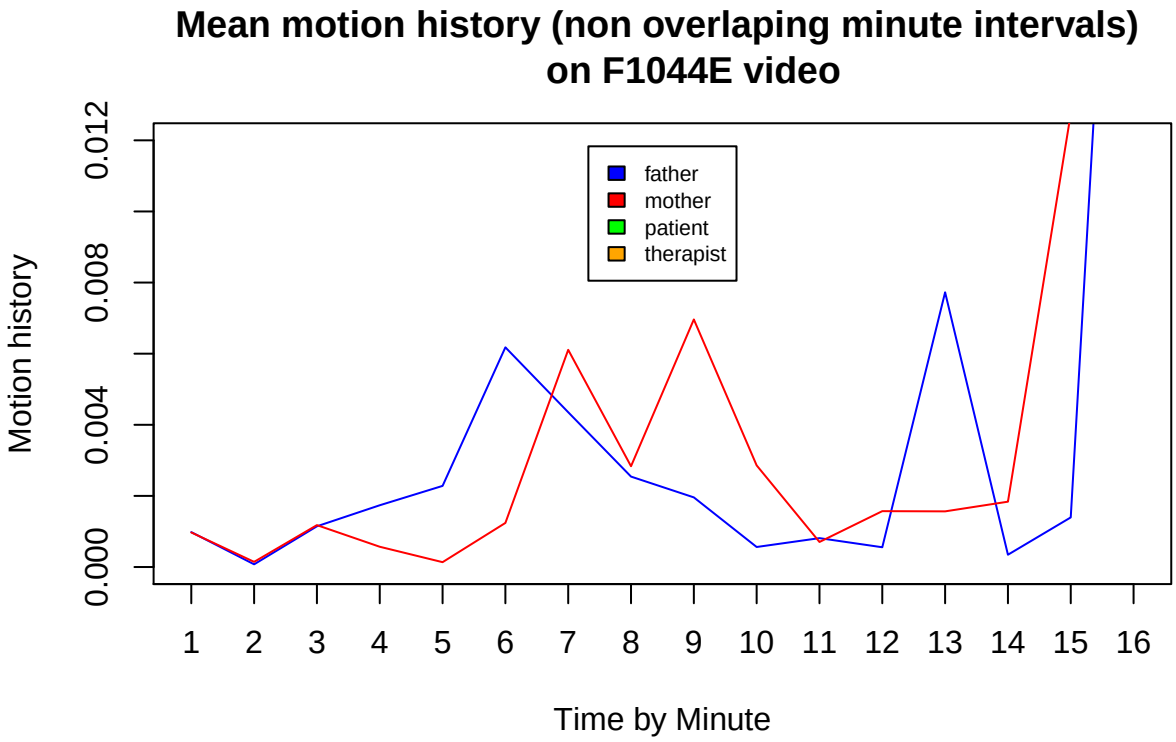
```
for (i in 1:NumberOfvideos){
  fatherMinute<- MeanMotionByTime("father", indexOfvideos=i, interval=1500, data)

  MotherMinute<- MeanMotionByTime("mother", indexOfvideos=i, interval=1500, data)
```

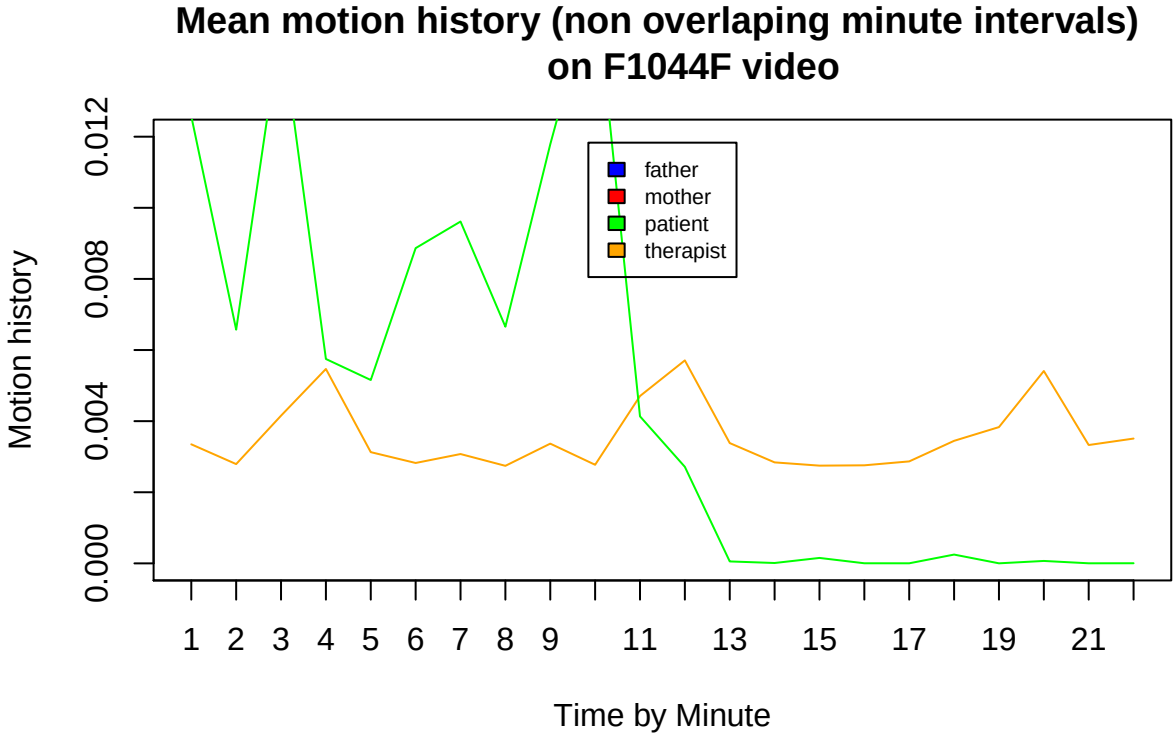
```
TherapistMinute<- MeanMotionByTime("therapist", indexOfvideos=i, interval=1500, data)

PatientMinute<- MeanMotionByTime("patient", indexOfvideos=i, interval=1500, data)

par(mar=c(4,4,4,2))
    plot (1:length(fatherMinute), fatherMinute, type="l", col="blue",
    main=paste("Mean motion history (non overlaping minute intervals)
    on F1044", labelvideolist[i], " video" , sep=""),
    ylab="Motion history", xlab="Time by Minute", ylim=c(0, 12E-03),
    xaxp=c(0, length(fatherMinute), length(fatherMinute)))
    lines(MotherMinute, col="red")
    lines(TherapistMinute, col="orange")
    lines(PatientMinute, col="green")
    legend("top", inset=.05, ParticipantsList,
           fill=colOrderList, cex=0.7)}
```

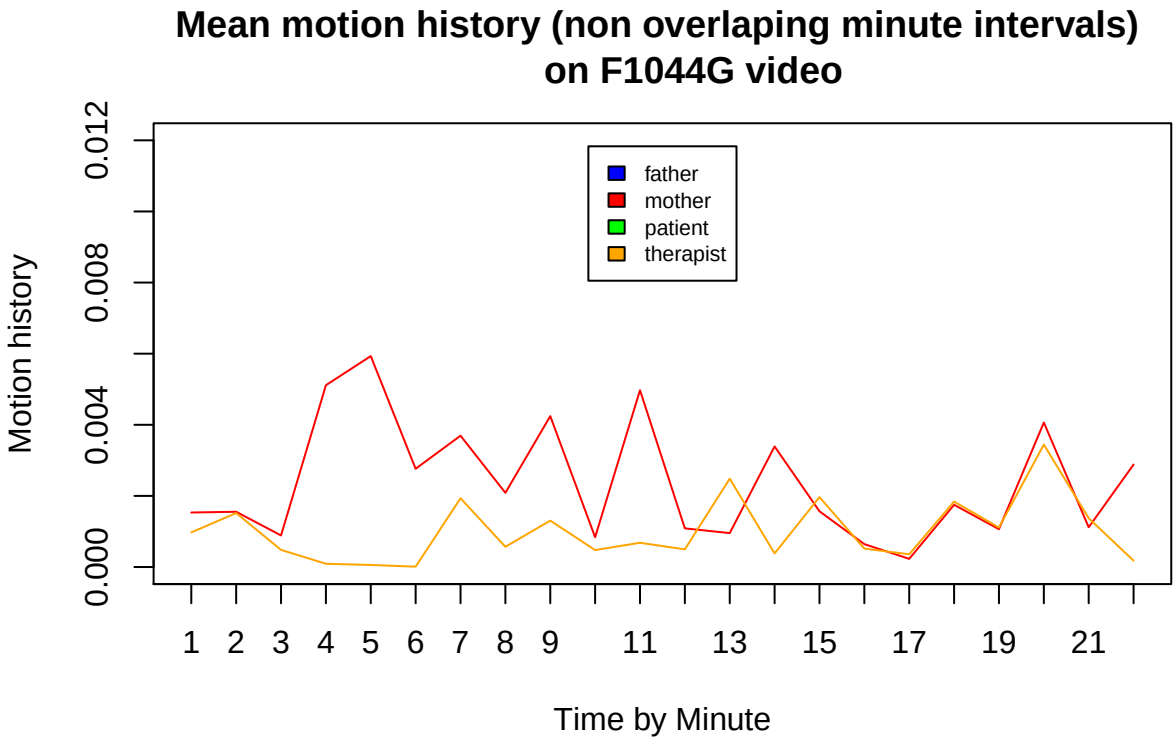


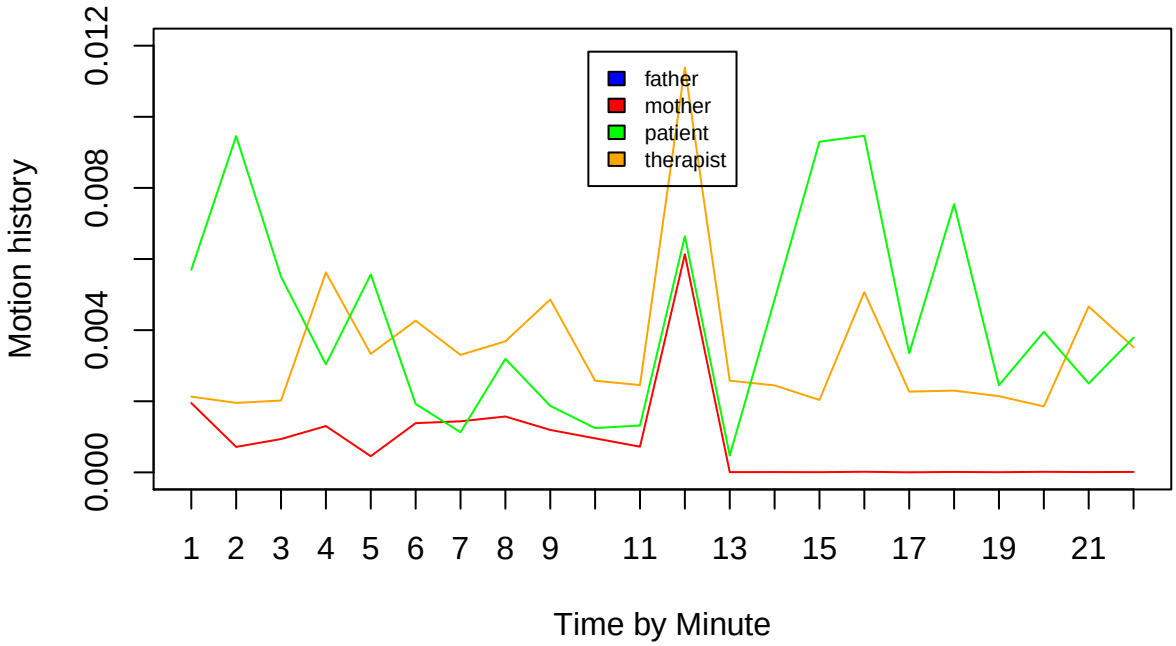

Mean motion history (non overlaping minute intervals)
on F1044D1 video
Motion history
0.000
0.004
0.008
0.012
father
mother
patient
therapist
1 2 3 4 5 6 7 8 9 11 13 15 17 19 21
Time by Minute

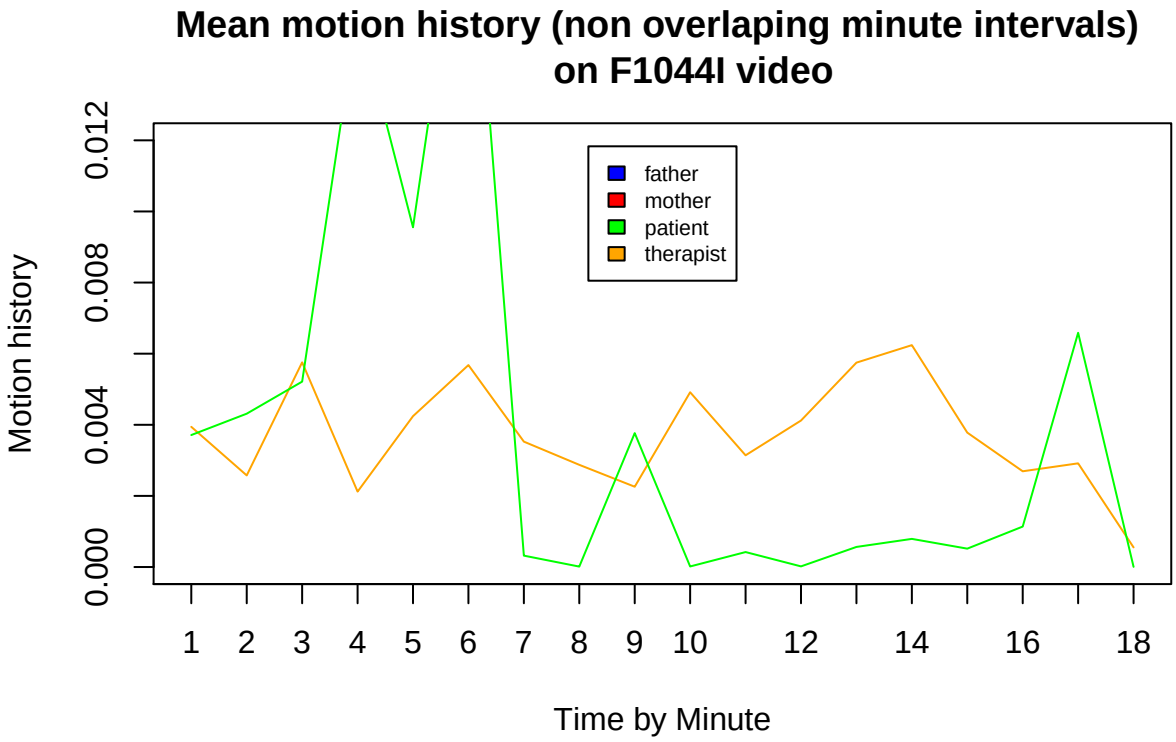

Mean motion history (non overlaping minute intervals)
on F1044D2 video
Motion history
0.000
0.004
0.008
0.012
father
mother
patient
therapist
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Time by Minute

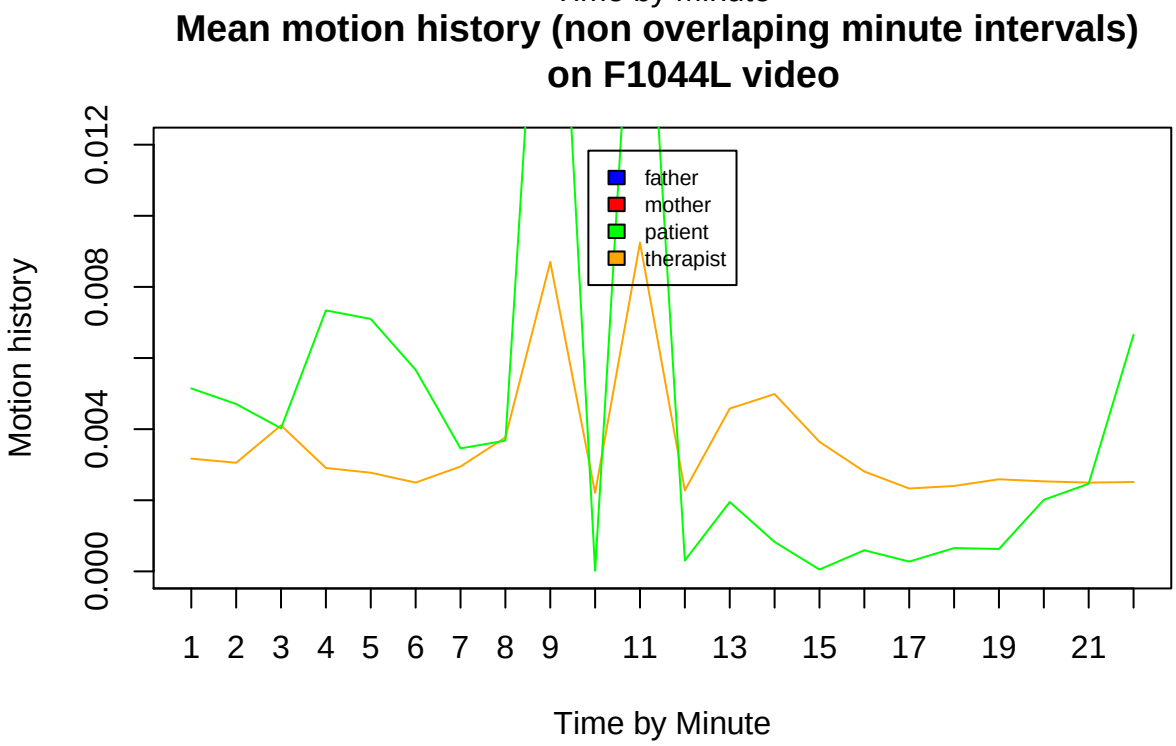

Mean motion history (non overlaping minute intervals)
on F1044E video
Motion history
0.000
0.004
0.008
0.012
father
mother
patient
therapist
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Time by Minute

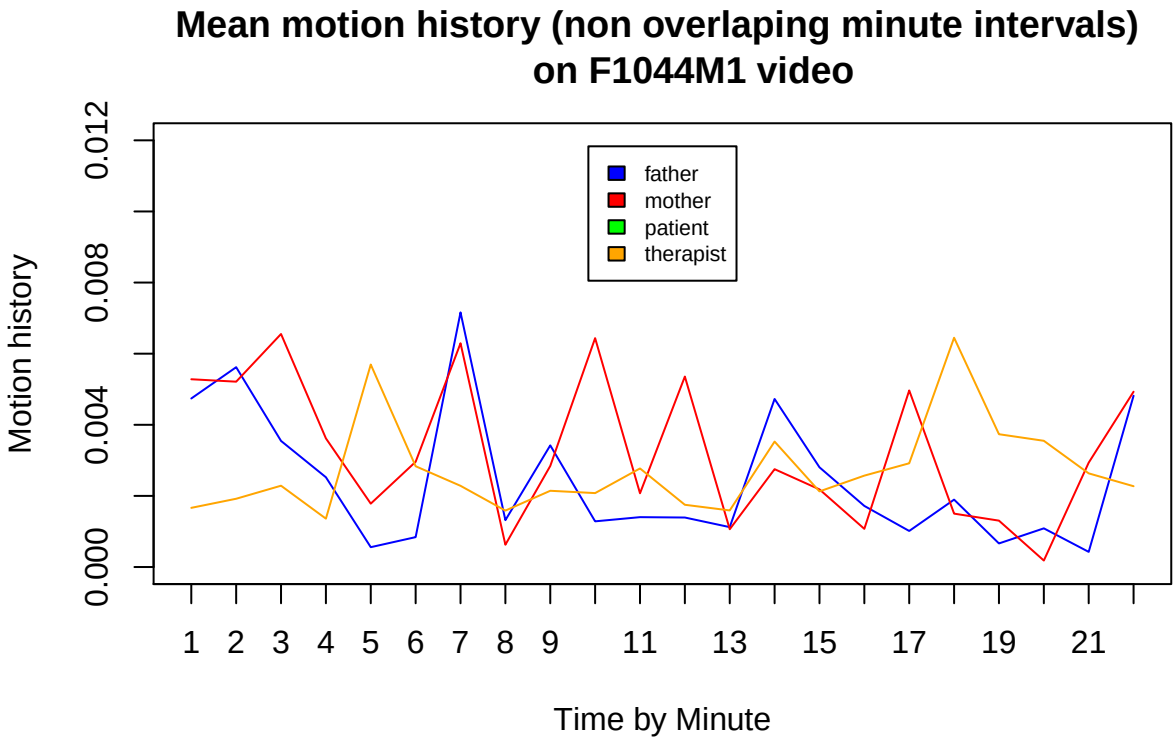

Mean motion history (non overlaping minute intervals)
on F1044F video
Motion history
0.000
0.004
0.008
0.012
father
mother
patient
therapist
1 2 3 4 5 6 7 8 9 11 13 15 17 19 21
Time by Minute

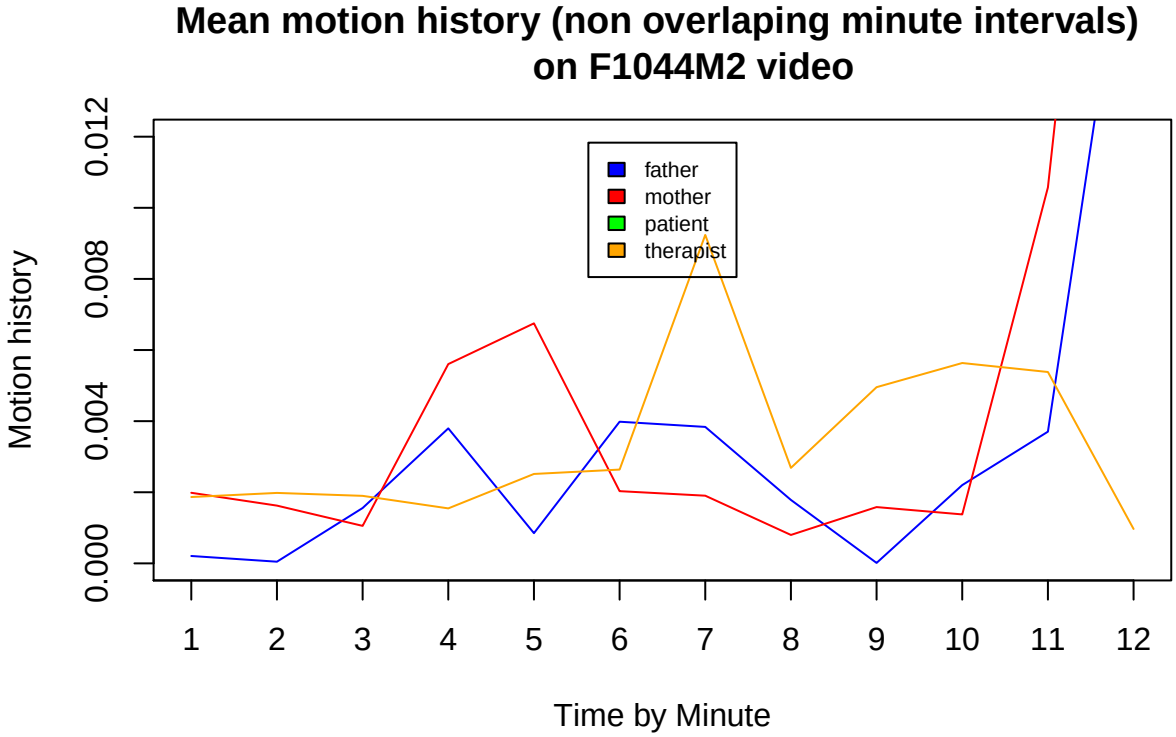

Mean motion history (non overlaping minute intervals)
on F1044G video
Motion history
0.000
0.004
0.008
0.012
father
mother
patient
therapist
1 2 3 4 5 6 7 8 9 11 13 15 17 19 21
Time by Minute

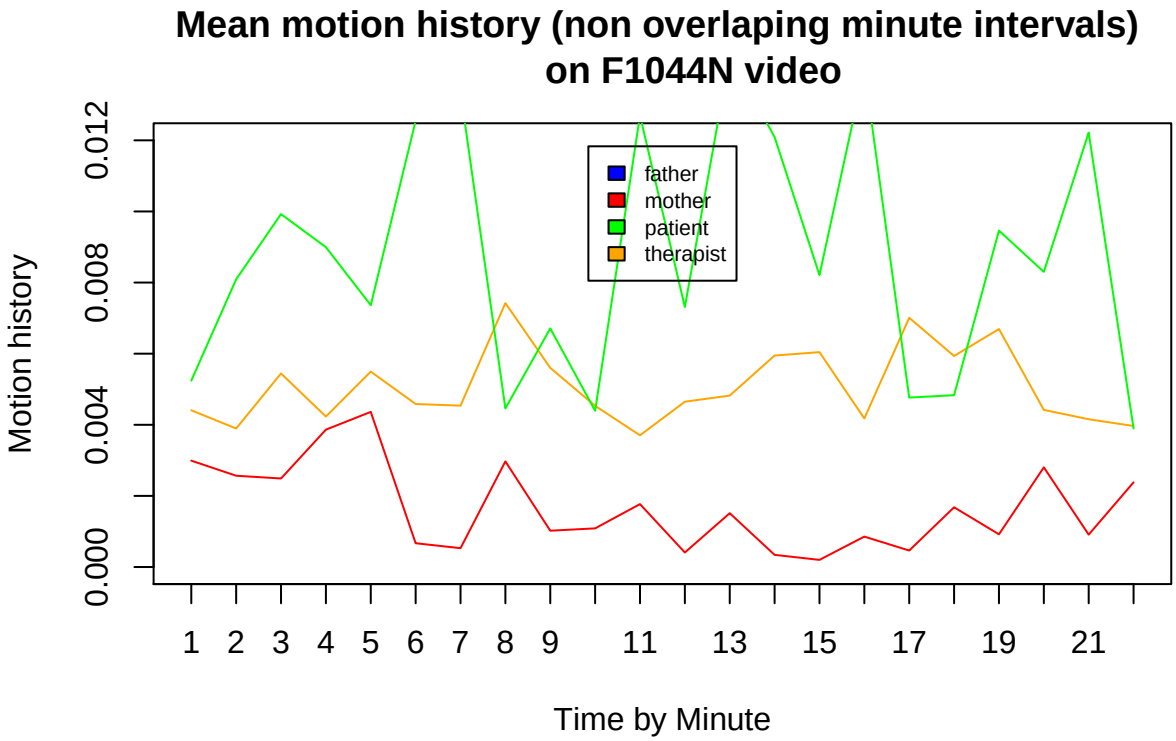

Mean motion history (non overlaping minute intervals)
on F1044H video
Motion history
0.000
0.004
0.008
0.012
father
mother
patient
therapist
1 2 3 4 5 6 7 8 9 11 13 15 17 19 21
Time by Minute

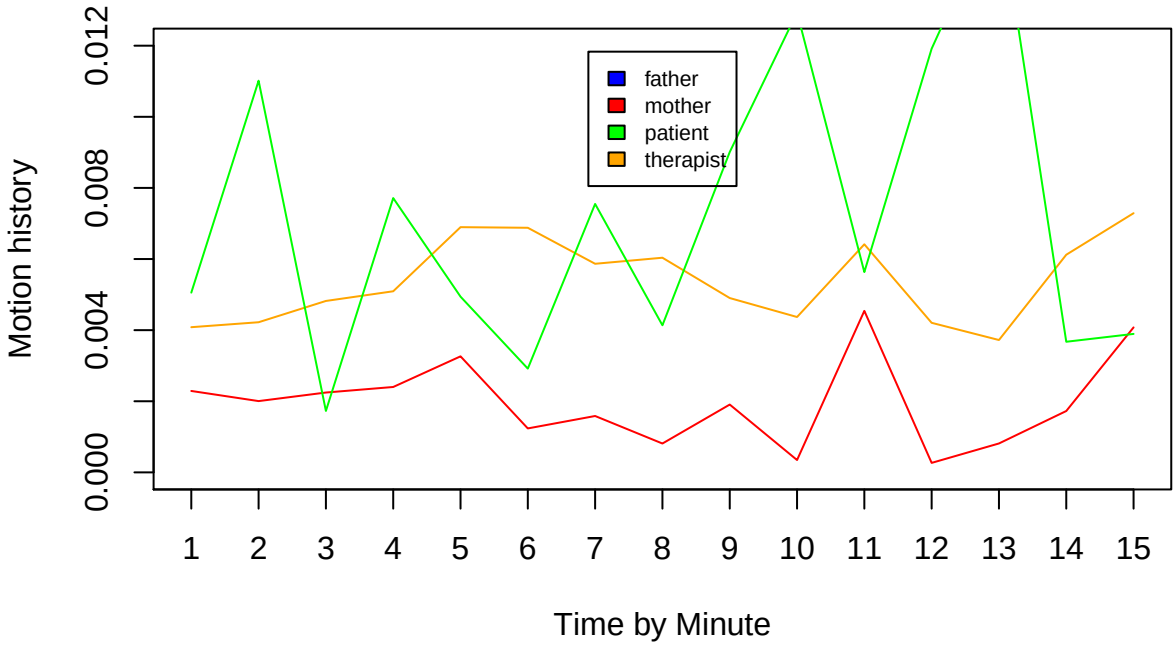

Mean motion history (non overlaping minute intervals)
on F1044I video
Motion history
0.000
0.004
0.008
0.012
father
mother
patient
therapist
1 2 3 4 5 6 7 8 9 10 12 14 16 18
Time by Minute

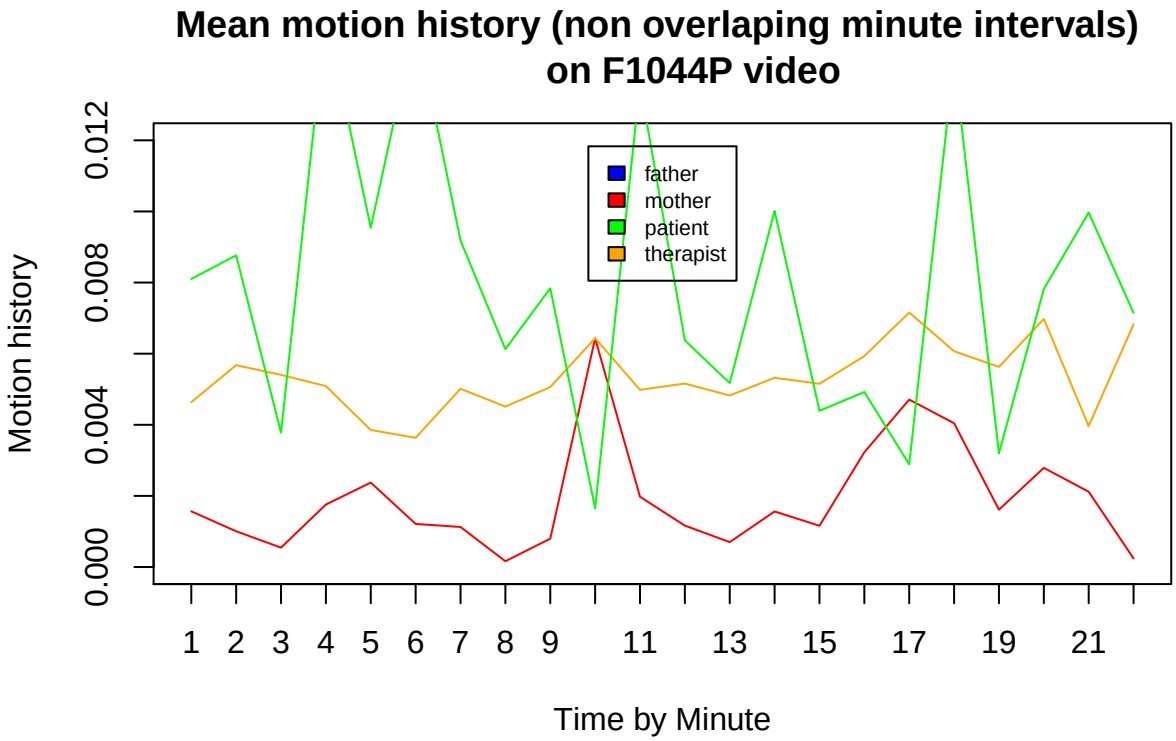

Mean motion history (non overlaping minute intervals)
on F1044L video
Motion history
0.000
0.004
0.008
0.012
father
mother
patient
therapist
1 2 3 4 5 6 7 8 9 11 13 15 17 19 21
Time by Minute

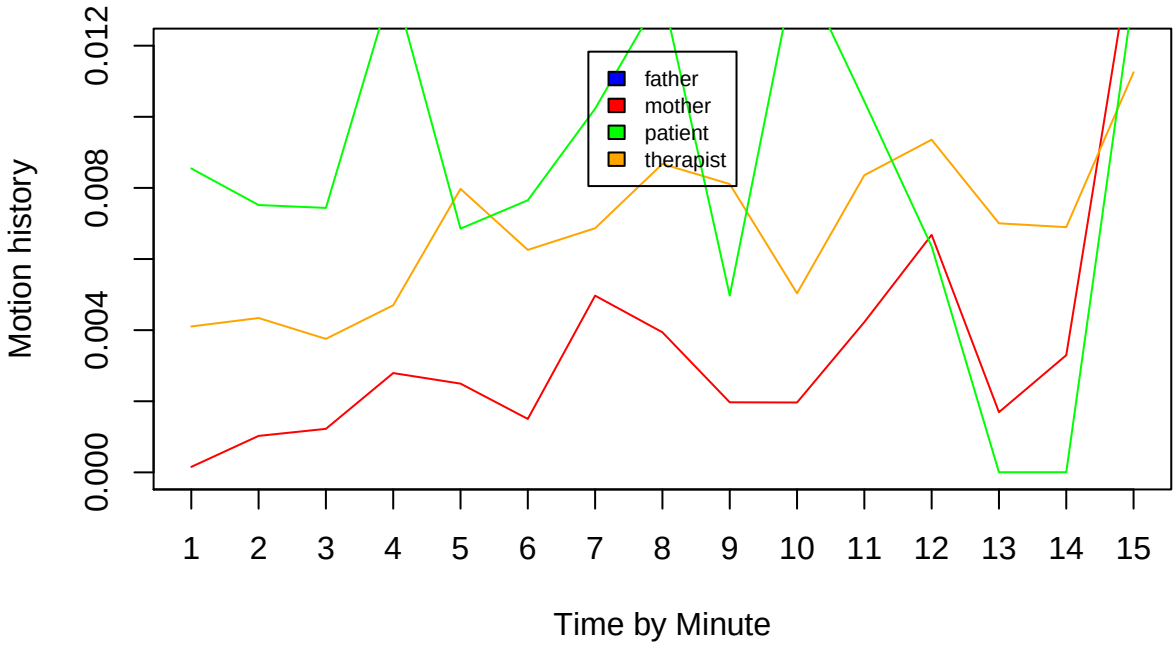

Mean motion history (non overlaping minute intervals)
on F1044M1 video
Motion history
0.000
0.004
0.008
0.012
father
mother
patient
therapist
1 2 3 4 5 6 7 8 9 11 13 15 17 19 21
Time by Minute

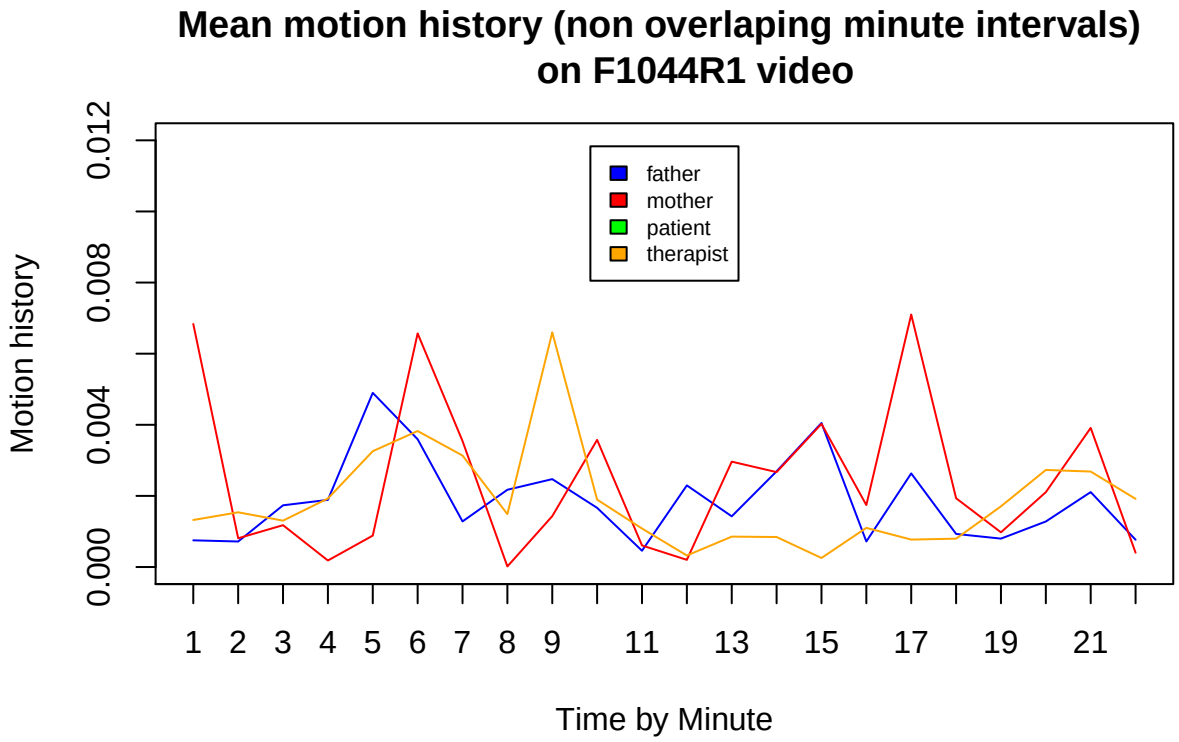

Mean motion history (non overlaping minute intervals)
on F1044M2 video
Motion history
0.000
0.004
0.008
0.012
father
mother
patient
therapist
1 2 3 4 5 6 7 8 9 10 11 12
Time by Minute

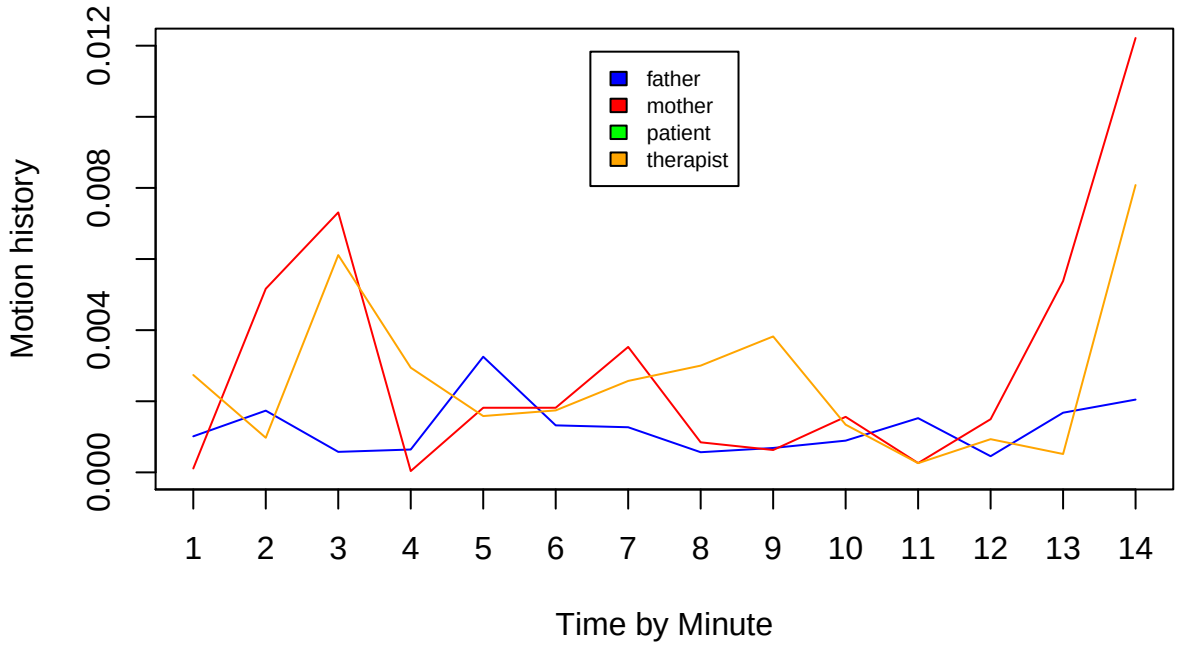

Mean motion history (non overlaping minute intervals)
on F1044N video
Motion history
0.000
0.004
0.008
0.012
father
mother
patient
therapist
1 2 3 4 5 6 7 8 9 11 13 15 17 19 21
Time by Minute


Mean motion history (non overlaping minute intervals)
on F1044O video
Motion history
0.000
0.004
0.008
0.012
father
mother
patient
therapist
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
Time by Minute


Mean motion history (non overlaping minute intervals)
on F1044P video
Motion history
0.000
0.004
0.008
0.012
father
mother
patient
therapist
1 2 3 4 5 6 7 8 9 11 13 15 17 19 21
Time by Minute


Mean motion history (non overlaping minute intervals)
on F1044Q video
Motion history
0.000
0.004
0.008
0.012
father
mother
patient
therapist
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
Time by Minute






```
# slidedfatherwoNA <- slidedfather[which(is.na(slidedfather)==FALSE)]
# slidedmotherwoNA <- slidedmother[which(is.na(slidedmother)==FALSE)]
# slidedtherapistwoNA <- slidedtherapist[which(is.na(slidedtherapist)==FALSE)]
# slidedpatientwoNA <- slidedpatient[which(is.na(slidedpatient)==FALSE)]
```

Export data in text files

```
## REMINDER:
#SlidingInterval <- function(subject, indexOfvideos=1:NumberOfvideos, interval, data) with :
# subject : subject studied (patient, mother, father or therapist)
# indexOfvideos : list of videos studied (element eg. 3 or list eg 1:3 or c(1,2,4))
# interval : number of frames in the studied interval
# data : data frame where there is data

#index de la vid?eo de 1ere a la length de indexvideo
videoIndex <- 1
# videoName est le nom de la video actuelle
for (videoName in indexlist){
# Compute slinding interval for each participant
      print(paste("Computing slidedFather", videoName))
      slidedFather <- SlidingInterval("father", videoIndex, 5, data)

      print(paste("Computing slidedMother", videoName))
      slidedMother <- SlidingInterval("mother", videoIndex, 5, data)

      print(paste("Computing slidedTherapist", videoName))
      slidedTherapist <- SlidingInterval("therapist", videoIndex, 5, data)

      print(paste("Computing slidedPatient", videoName))
      slidedPatient <- SlidingInterval("patient", videoIndex, 5, data)

# create a data frame to store temporarily this data with NA
      slidedVideo <- data.frame(slidedFather, slidedMother, slidedTherapist, slidedPatient)

###### Creating  a data frame if the information is available #############
      dataFrame <- FALSE
      dfSliding <- data.frame()
      for (participant in 1:4){
# If the colum is not empty, takes its length and begin a data frame with it
            if (dataFrame==FALSE){
#if (length(slidedVideo[participant][!is.na(slidedVideo[participant])]) > 0 & dataFrame==FALSE){
              dfSliding <- data.frame("video"=rep(indexlist[videoIndex],length(slidedVideo[participant]]
                      dataFrame <- TRUE}

# if (length(slidedVideo[participant][!is.na(slidedVideo[participant])]) > 0 & dataFrame==TRUE){
            if (dataFrame==TRUE){
                      dfSliding <- cbind(dfSliding, slidedVideo[participant])}}

      print(str(dfSliding))
################### Removing lines with only NA ####################
#      CCdfSliding <- complete.cases(dfSliding)
      emptyLine <- c()
      for (i in 1:nrow(dfSliding)){
          dfLine <- dfSliding[i,3:6]
          NaLine <- is.na(dfLine)
          if (all(NaLine)){
              emptyLine <- c(emptyLine, i)}}
      print (emptyLine)
```

```
        if (length(emptyLine)>0){
    dfSliding <- dfSliding[-emptyLine,]}

    write.csv(dfSliding, paste("/Users/Ofix/Documents/Fac/internat/Recherche/projets/synchro/synchroDa
    videoIndex <-(videoIndex+1)}
```

SyncPy utilisation for creating synchrony dataframe

After extracting filtered motion motion history with mean on sliding interval (overlapping interval) of 5 frames

And after puting this data on a CSV file slideddata.csv

We import this data on python Script with panda module Call_S_Estimator.py

This script will compute the synchrony between each dyad of the interaction and of the whole group

It will return a csv file for each video SSIXXXX.csv with XXXX the name of the video (F1044C, F1044D1, etc) that we can import with R with

this following function

```
## factor(0)
## 17 Levels: F1044C.VOB F1044D1.VOB F1044D2.VOB F1044E.VOB ... F1044R2.VOB
```

```
## [1] "SSI Files Directory"
```

```
## [1] "/Users/Ofix/Documents/Fac/internat/Recherche/projets/synchro/synchroData"
```

```
## [1] "SS Files List"
```

```
##  [1] "SSIF1044C.csv"  "SSIF1044D1.csv" "SSIF1044D2.csv" "SSIF1044E.csv"
##  [5] "SSIF1044F.csv"  "SSIF1044G.csv"  "SSIF1044H.csv"  "SSIF1044I.csv"
##  [9] "SSIF1044L.csv"  "SSIF1044M1.csv" "SSIF1044M2.csv" "SSIF1044N.csv"
## [13] "SSIF1044O.csv"  "SSIF1044P.csv"  "SSIF1044Q.csv"  "SSIF1044R1.csv"
## [17] "SSIF1044R2.csv"
```

Description of SSI data frame

```
str(SSIdataFrame)
```

```
## 'data.frame':    1900 obs. of  14 variables:
##  $ X           : int  0 1 2 3 4 5 6 7 8 9 ...
##  $ Interval    : int  1 2 3 4 5 6 7 8 9 10 ...
##  $ Time_min    : num  0 0.167 0.333 0.5 0.667 ...
##  $ video       : Factor w/ 17 levels "F1044C.VOB","F1044D1.VOB",..: 1 1 1 1 1 1 1 1 1 1 ...
##  $ date        : chr  "07/02/08" "07/02/08" "07/02/08" "07/02/08" ...
```

```
##  $ SSI_fa_mo   : num  3.55e-04 4.27e-03 4.76e-05 1.61e-02 5.53e-02 ...
##  $ SSI_fa_mo_th: num  0.01428 0.00538 0.02604 0.02166 0.02527 ...
##  $ SSI_fa_th   : num  0.014475 0.000896 0.01422 0.005114 0.004301 ...
##  $ SSI_mo_th   : num  0.018606 0.007802 0.047529 0.031851 0.000883 ...
##  $ SSI_fa_pa   : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ SSI_fa_mo_pa: num  NA NA NA NA NA NA NA NA NA NA ...
##  $ SSI_mo_pa   : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ SSI_pa_th   : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ SSI_mo_pa_th: num  NA NA NA NA NA NA NA NA NA NA ...
```

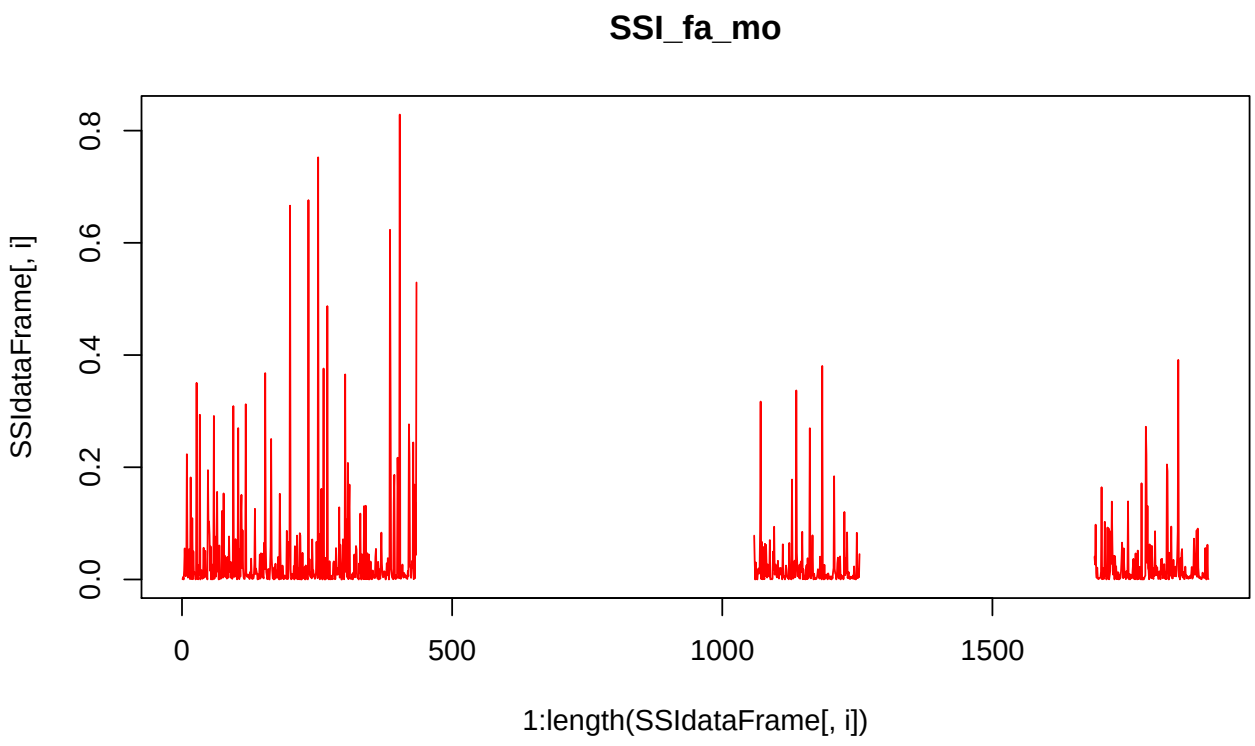
Synchrony scores for each dyad and for the whole group

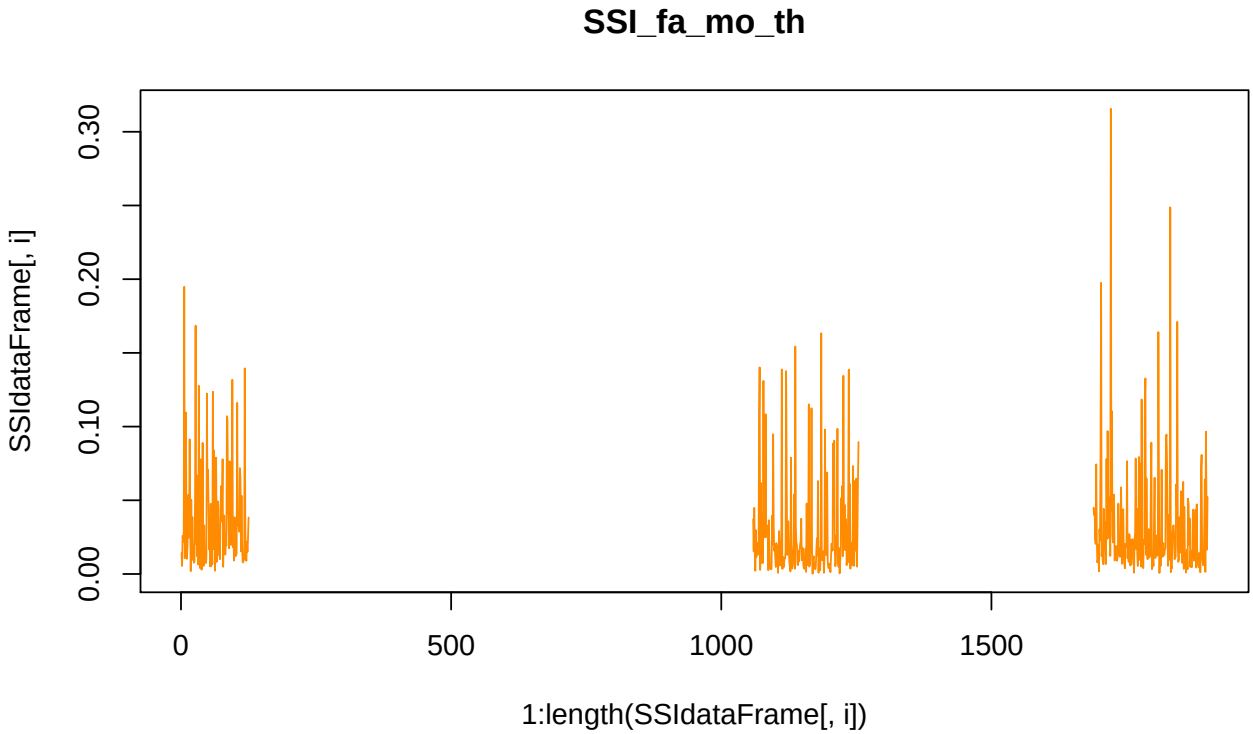
```
for (i in unique(SSIdataFrame$video))
      {par(mar=c(4,4,4,3), mfrow=c(1,1))
      plot(SSIdataFrame[which(SSIdataFrame$video==i),]$Time_min,
           SSIdataFrame[which(SSIdataFrame$video==i),]$SSI_fa_mo,
           type="l", col=rainbow(4)[1],
           main=paste("Synchrony scores for each dyad and for \n the whole group in", i, "video"),
           xlab = "Time (minute)", ylab="Synchrony score", lwd=2,
xaxp=c(0,length(SSIdataFrame$Time_min), length(SSIdataFrame$Time_min)))
#, ylim=c(0,0.5))
      abline(h=mean(SSIdataFrame$SSI_fa_mo, na.rm=TRUE), col=rainbow(11)[1], lwd=2, lty=2)

      lines(SSIdataFrame[which(SSIdataFrame$video==i),]$SSI_fa_mo_pa, col=rainbow(11)[2], lwd=2)
      abline(h= mean(SSIdataFrame$SSI_fa_mo_pa, na.rm=TRUE), col=rainbow(11)[2], lwd=2, lty=2)

#      lines(SSIdataFrame[which(SSIdataFrame$video==i),]$SSI_fa_mo_pa_th, col=rainbow(11)[3], lwd=2)
#      abline(h= mean(SSIdataFrame$SSI_fa_mo_pa_th, na.rm=TRUE), col=rainbow(11)[3], lwd=2, lty=2)

      lines(SSIdataFrame[which(SSIdataFrame$video==i),]$SSI_fa_mo_th, col=rainbow(11)[4], lwd=2)
      abline(h= mean(SSIdataFrame$SSI_fa_mo_th, na.rm=TRUE), col=rainbow(11)[4], lwd=2, lty=2)

      lines(SSIdataFrame[which(SSIdataFrame$video==i),]$SSI_fa_pa, col=rainbow(11)[5], lwd=2)
      abline(h= mean(SSIdataFrame$SSI_fa_pa, na.rm=TRUE), col=rainbow(11)[5], lwd=2, lty=2)

#      lines(SSIdataFrame[which(SSIdataFrame$video==i),]$SSI_fa_pa_th, col=rainbow(11)[6], lwd=2)
#      abline(h= mean(SSIdataFrame$SSI_fa_pa_th, na.rm=TRUE), col=rainbow(11)[6], lwd=2, lty=2)

lines(SSIdataFrame[which(SSIdataFrame$video==i),]$SSI_fa_th, col=rainbow(11)[7], lwd=2)
abline(h= mean(SSIdataFrame$SSI_fa_th, na.rm=TRUE), col=rainbow(11)[7], lwd=2, lty=2)

lines(SSIdataFrame[which(SSIdataFrame$video==i),]$SSI_mo_pa, col=rainbow(11)[8], lwd=2)
abline(h= mean(SSIdataFrame$SSI_mo_pa, na.rm=TRUE), col=rainbow(11)[8], lwd=2, lty=2)

lines(SSIdataFrame[which(SSIdataFrame$video==i),]$SSI_mo_pa_th, col=rainbow(11)[9], lwd=2)
abline(h= mean(SSIdataFrame$SSI_mo_pa_th, na.rm=TRUE), col=rainbow(11)[9], lwd=2, lty=2)
lines(SSIdataFrame[which(SSIdataFrame$video==i),]$SSI_mo_th, col=rainbow(11)[10], lwd=2)
abline(h= mean(SSIdataFrame$SSI_mo_th, na.rm=TRUE), col=rainbow(11)[10], lwd=2, lty=2)

      lines(SSIdataFrame[which(SSIdataFrame$video==i),]$SSI_pa_th, col=rainbow(11)[11], lwd=2)
      abline(h= mean(SSIdataFrame$SSI_pa_th, na.rm=TRUE), col=rainbow(11)[11], lwd=2, lty=2)
```

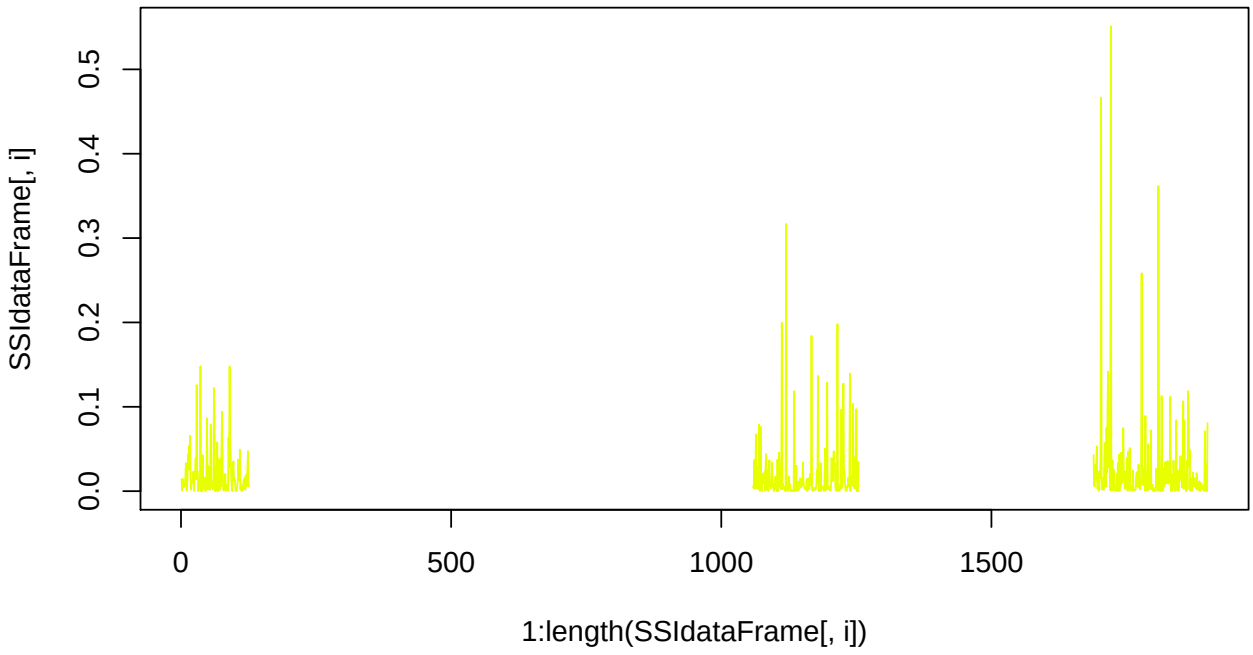
```
legend("topleft", inset=.05, c("fa_mo", "fa_mo_pa", "fa_mo_pa_th",
"fa_mo_th", "fa_pa", "fa_pa_th", "fa_th",
"mo_pa", "mo_pa_th", "mo_th", "pa_th"),
col=rainbow(11), cex=0.6, lwd=2)

legend("topright", inset=.05, c(paste ("Mean fa_mo :",
                                       round(mean(SSIdataFrame$SSI_fa_mo, na.rm=TRUE),3)),
      paste ("Mean fa_mo_pa :", round(mean(SSIdataFrame$SSI_fa_mo_pa,na.rm=TRUE),3)),
#      paste ("Mean fa_mo_pa_th :", #round(mean(SSIdataFrame$SSI_fa_mo_pa_th),3)),
      paste ("Mean fa_mo_th :", round(mean(SSIdataFrame$SSI_fa_mo_th,na.rm=TRUE),3)),
      paste ("Mean fa_pa :", round(mean(SSIdataFrame$SSI_fa_pa, na.rm=TRUE),3)),
#      paste ("Mean fa_pa_th :", round(mean(SSIdataFrame$SSI_fa_pa_th,na.rm=TRUE),3)),
      paste ("Mean fa_th :", round(mean(SSIdataFrame$SSI_fa_th,na.rm=TRUE),3)),
      paste ("Mean mo_pa :", round(mean(SSIdataFrame$SSI_mo_pa,na.rm=TRUE),3)),
      paste ("Mean mo_pa_th :", round(mean(SSIdataFrame$SSI_mo_pa_th,na.rm=TRUE),3)),
      paste ("Mean mo_th :", round(mean(SSIdataFrame$SSI_mo_th,na.rm=TRUE),3)),
      paste ("Mean pa_th :", round(mean(SSIdataFrame$SSI_pa_th,na.rm=TRUE),3))),
col=rainbow(11), cex=0.5, lty=2, lwd=1)}
```

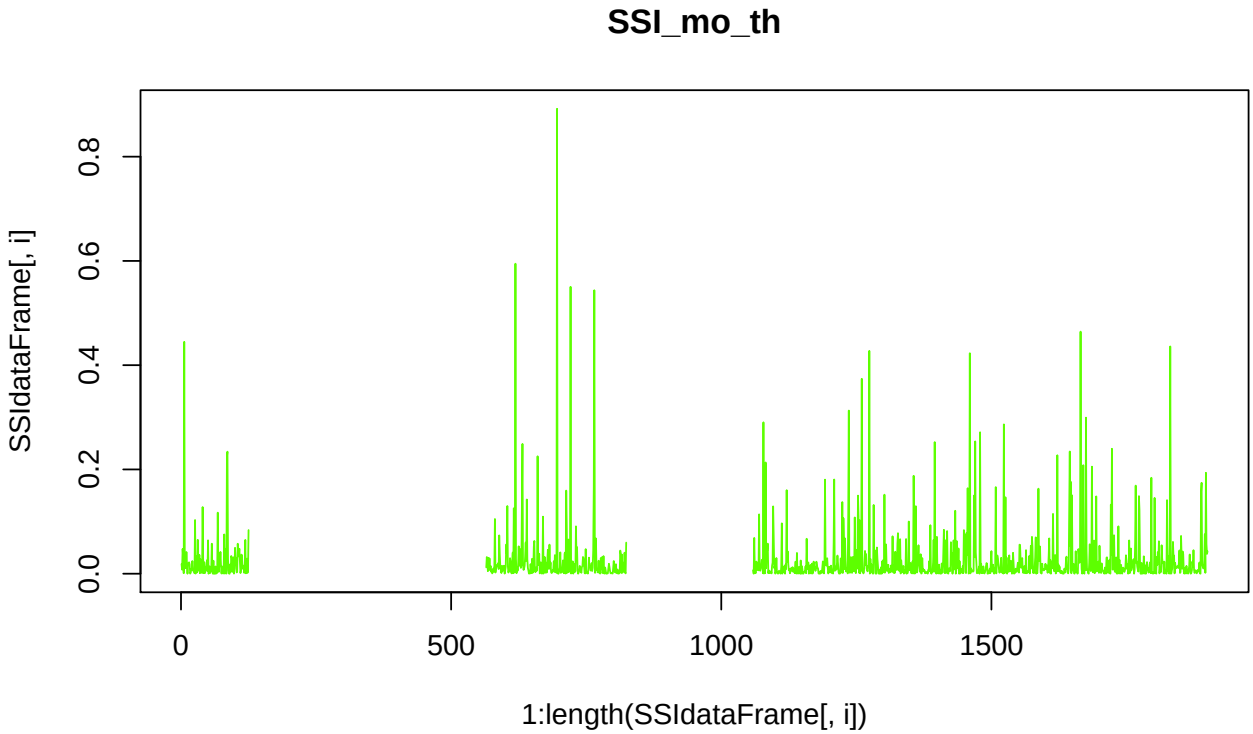
Evolution of synchrony through time, raw each second

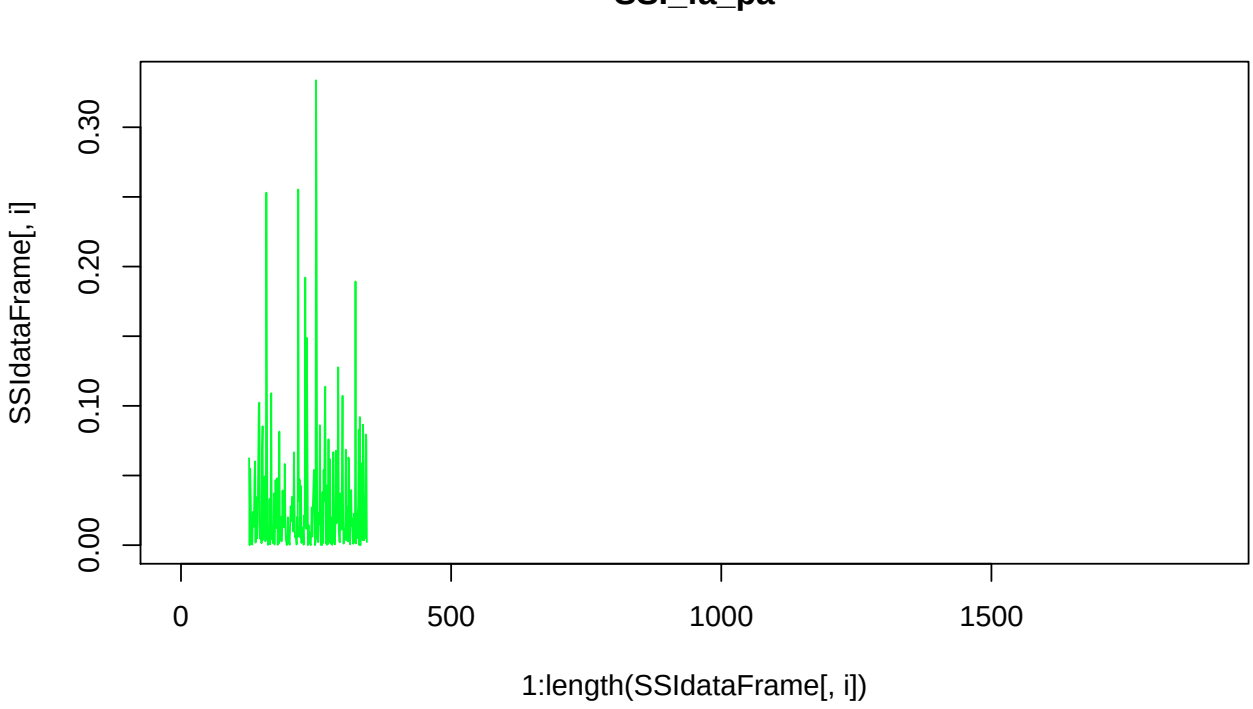
```
par(mar=c(4,4,4,4))
    col <- 1
for (i in 6:length(SSIdataFrame)){
    plot(1:length(SSIdataFrame[,i]), SSIdataFrame[,i], type="l",
    col=rainbow(11)[col], main = names(SSIdataFrame)[i])
    col <- col+1}
```

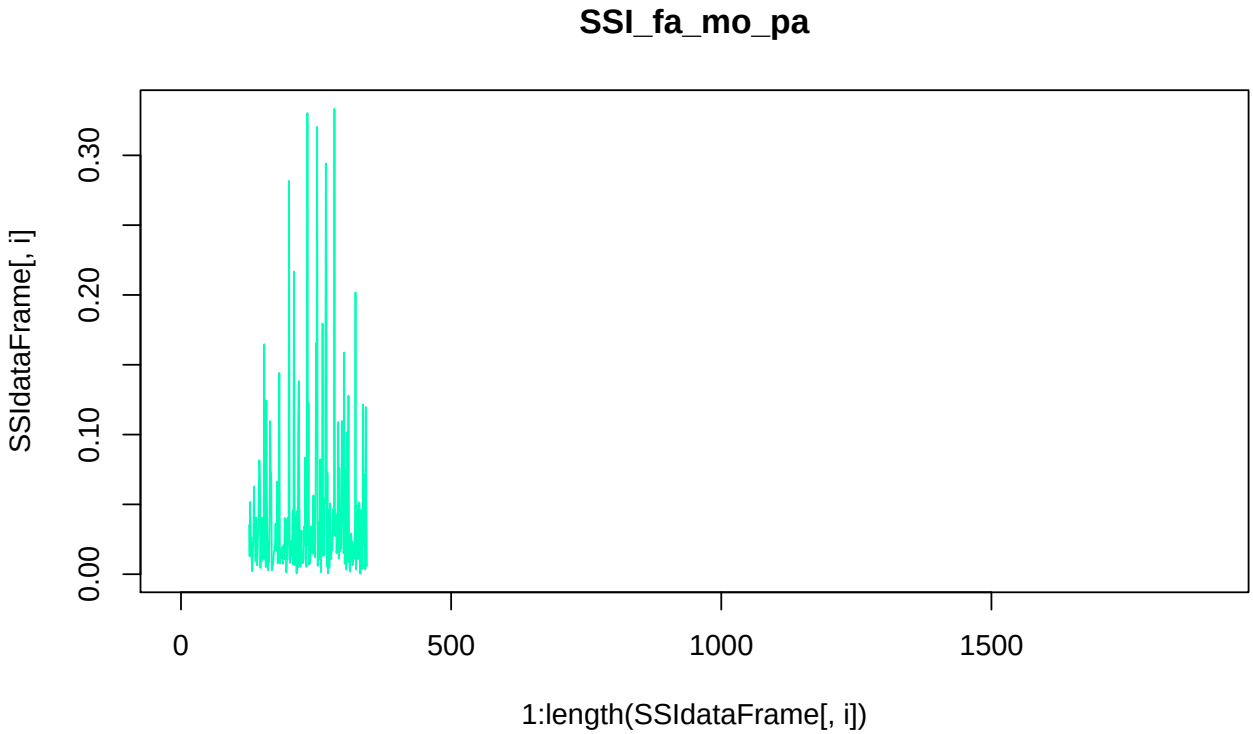


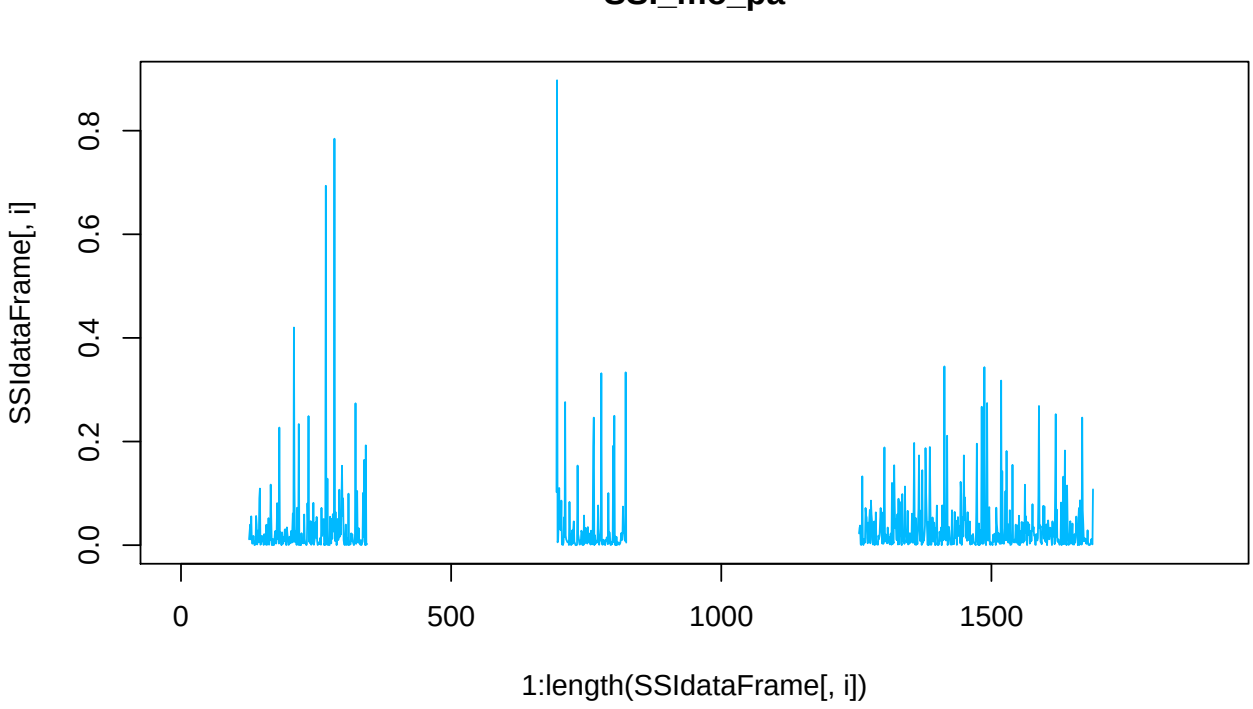

SSI_fa_mo_th
SSIdataFrame[, i]
0.00
0.10
0.20
0.30
0
500
1000
1500
1:length(SSIdataFrame[, i])

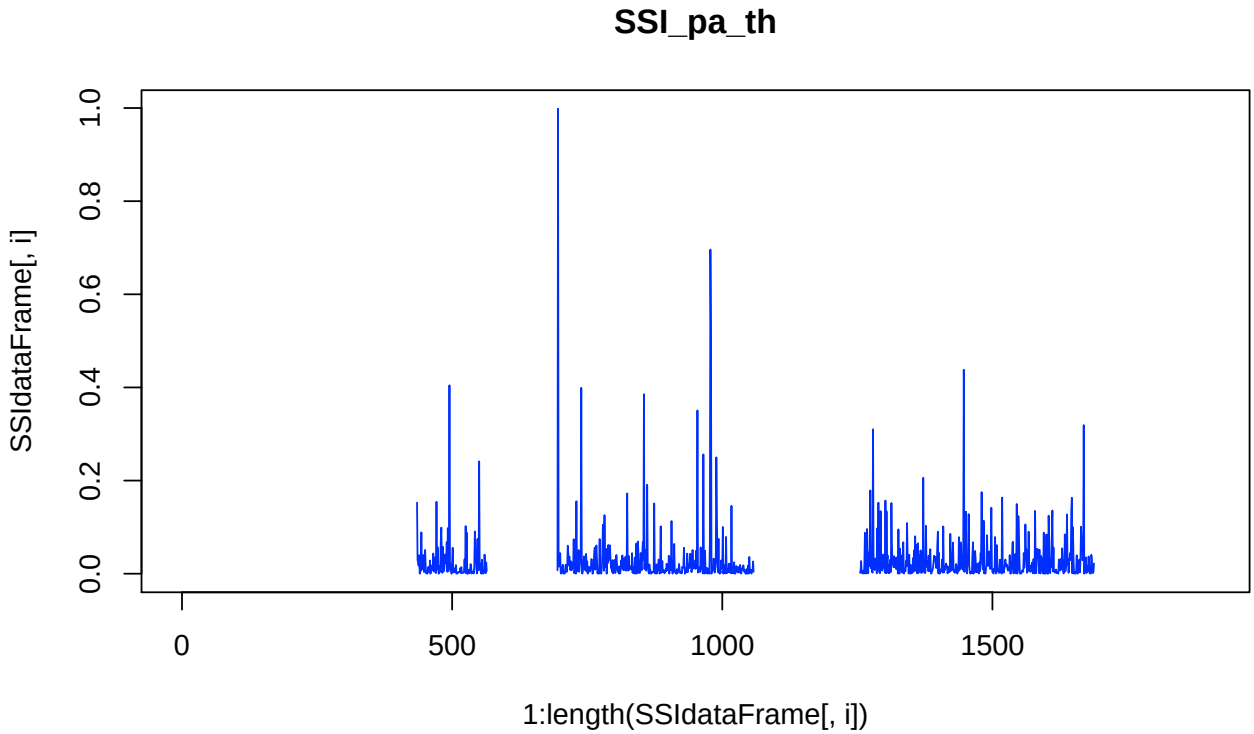

SSI_fa_th
SSIdataFrame[, i]
0.0
0.1
0.2
0.3
0.4
0.5
0
500
1000
1500
1:length(SSIdataFrame[, i])

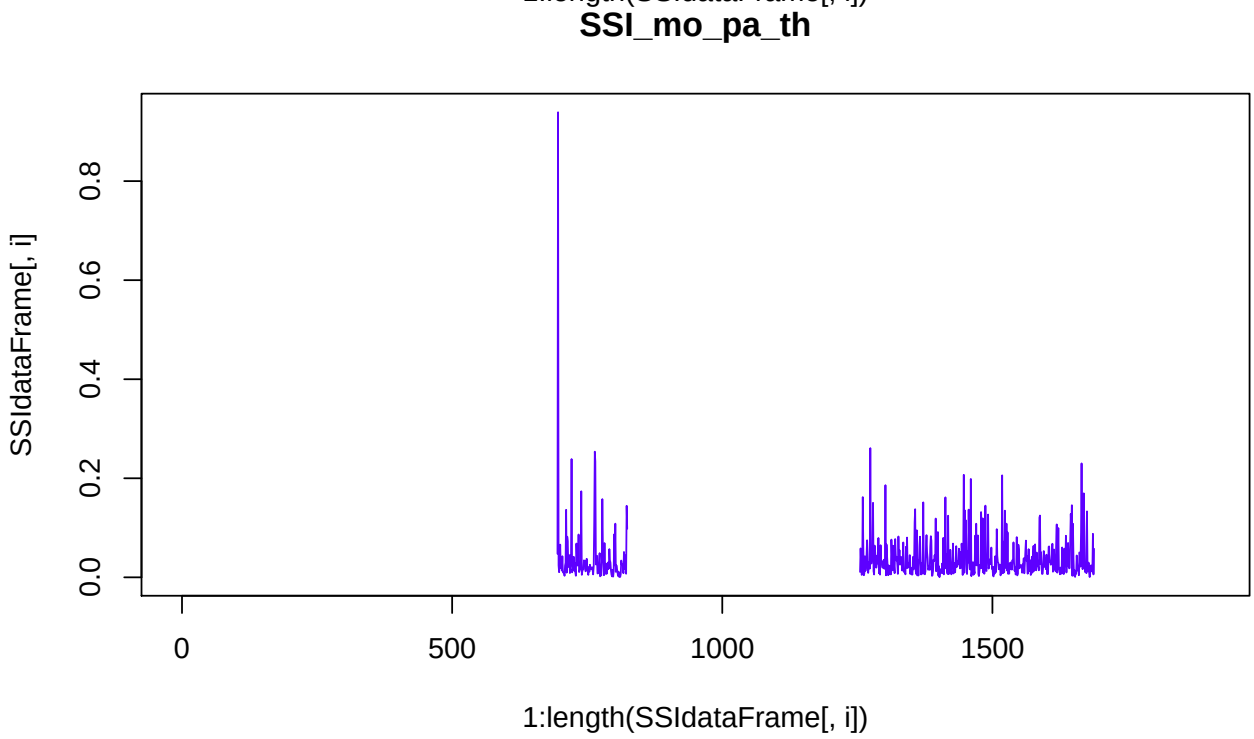

SSI_mo_th
SSIdataFrame[, i]
0.0
0.2
0.4
0.6
0.8
0
500
1000
1500
1:length(SSIdataFrame[, i])


SSI_fa_pa
SSIdataFrame[, i]
0.00
0.10
0.20
0.30
0
500
1000
1500
1:length(SSIdataFrame[, i])


SSI_fa_mo_pa
SSIdataFrame[, i]
0.00
0.10
0.20
0.30
0
500
1000
1500
1:length(SSIdataFrame[, i])


SSI_mo_pa
SSIdataFrame[, i]
0.0
0.2
0.4
0.6
0.8
0
500
1000
1500
1:length(SSIdataFrame[, i])

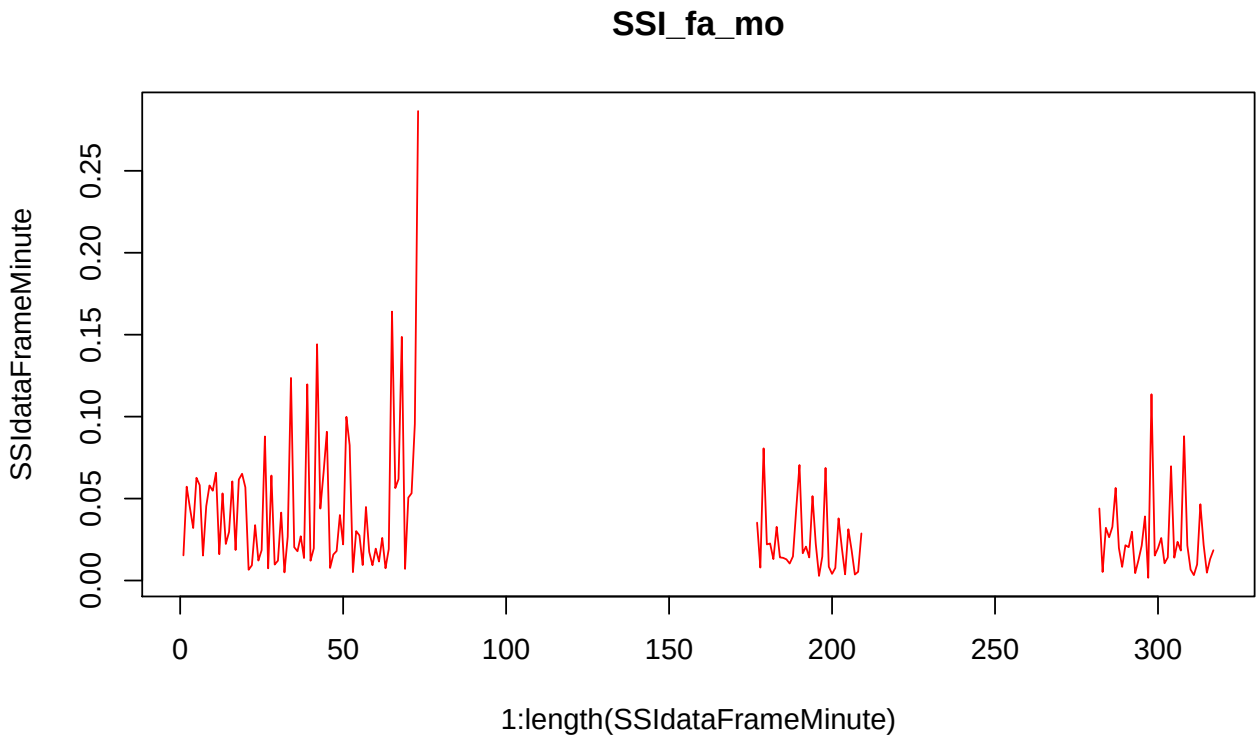


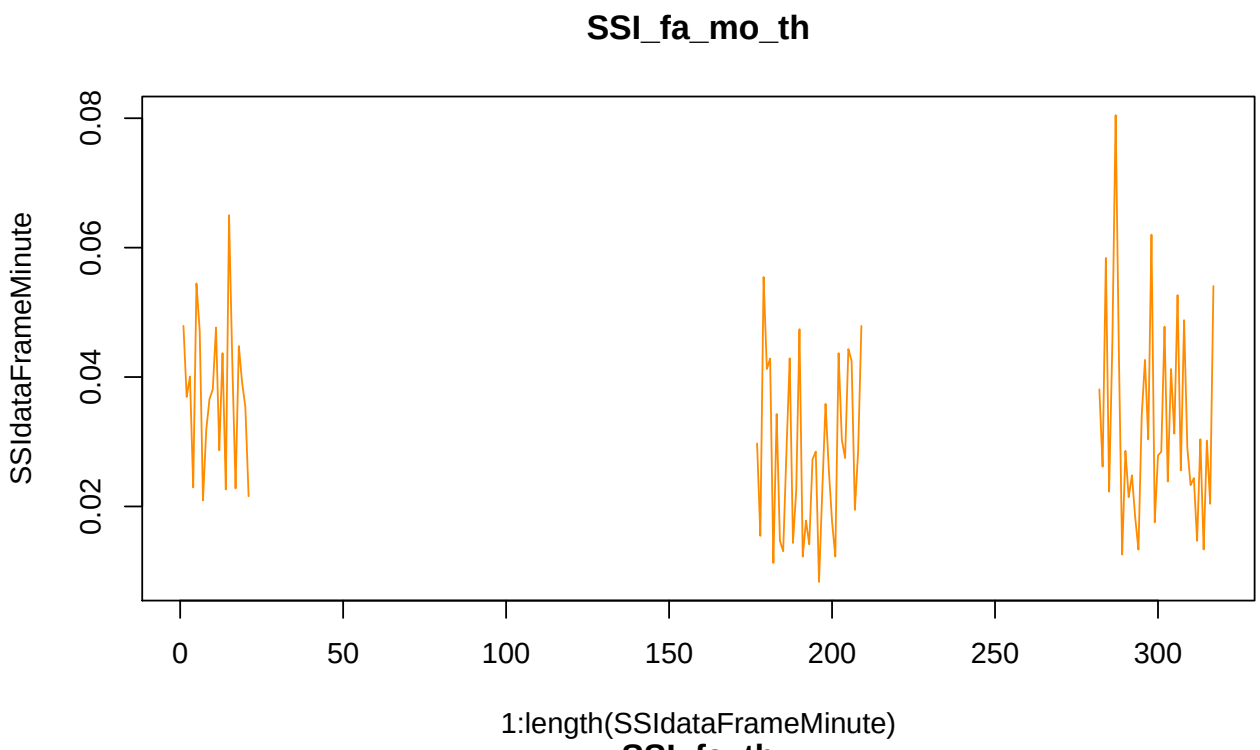


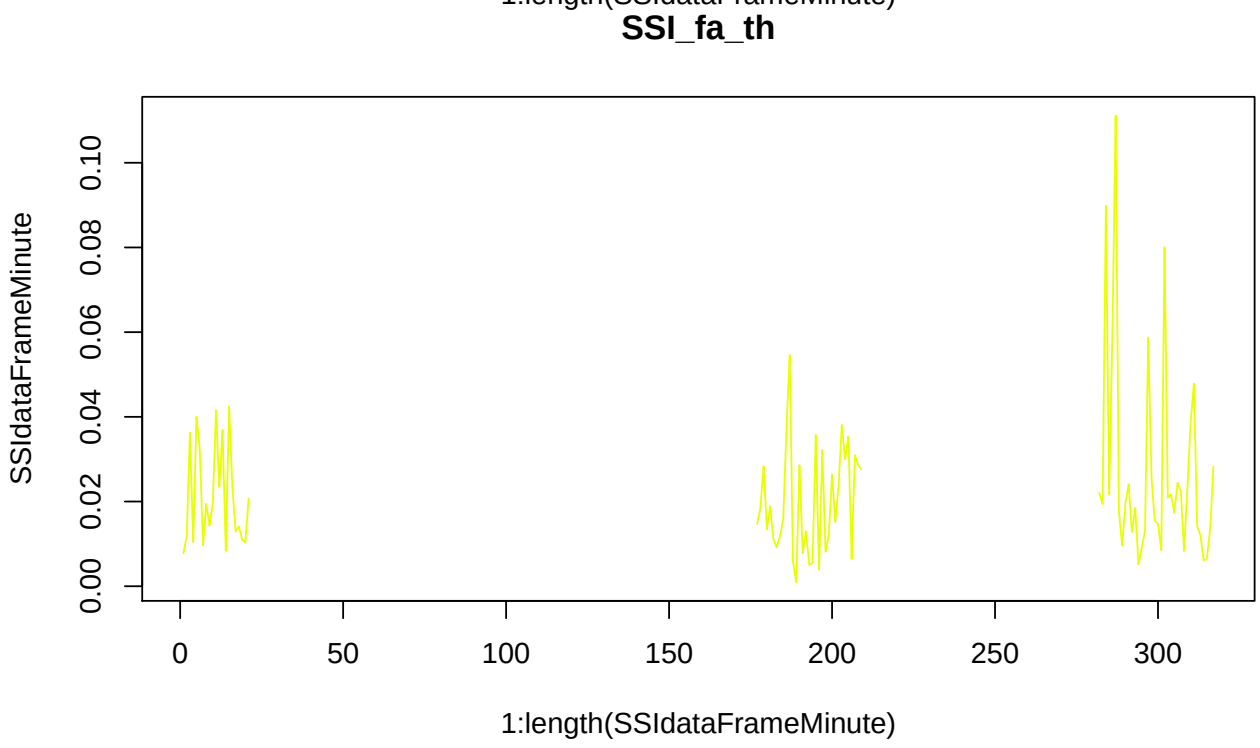
Evolution of synchrony through time, mean by minute

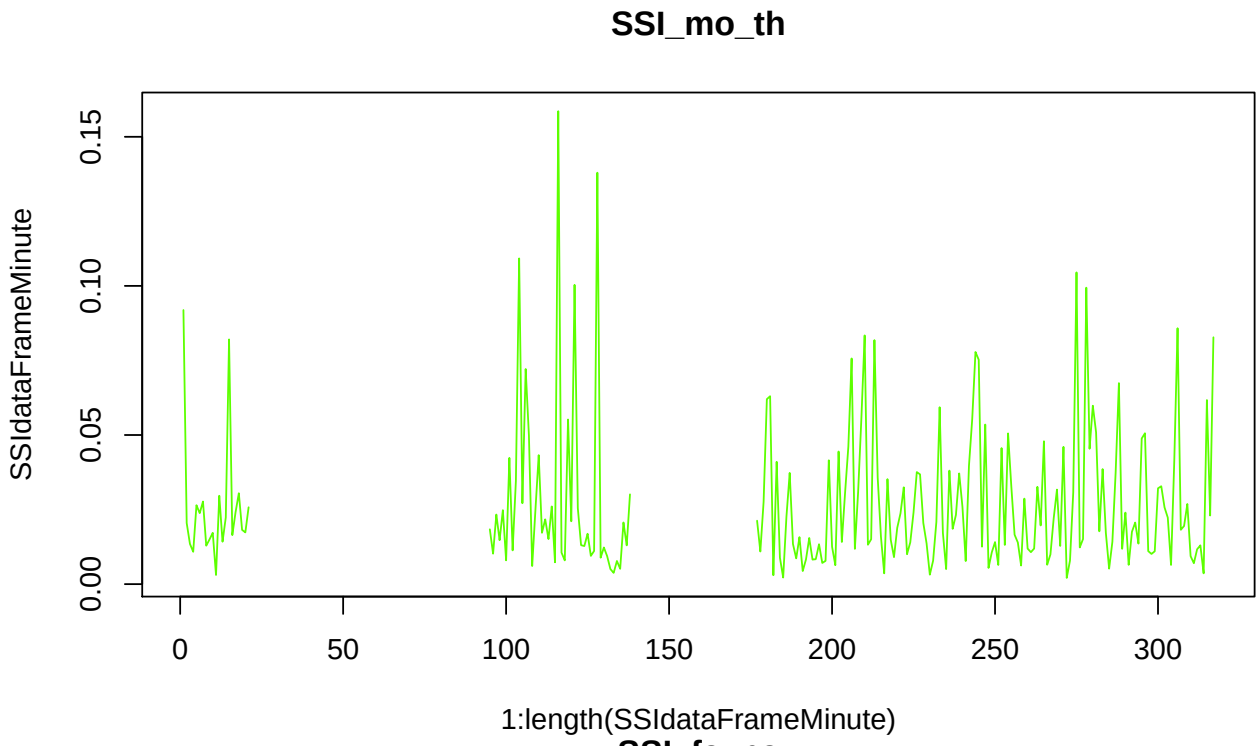
```
par(mar=c(4,4,4,4))
    col = 1
for (indexSSI in 6:length(SSIdataFrame)){
```

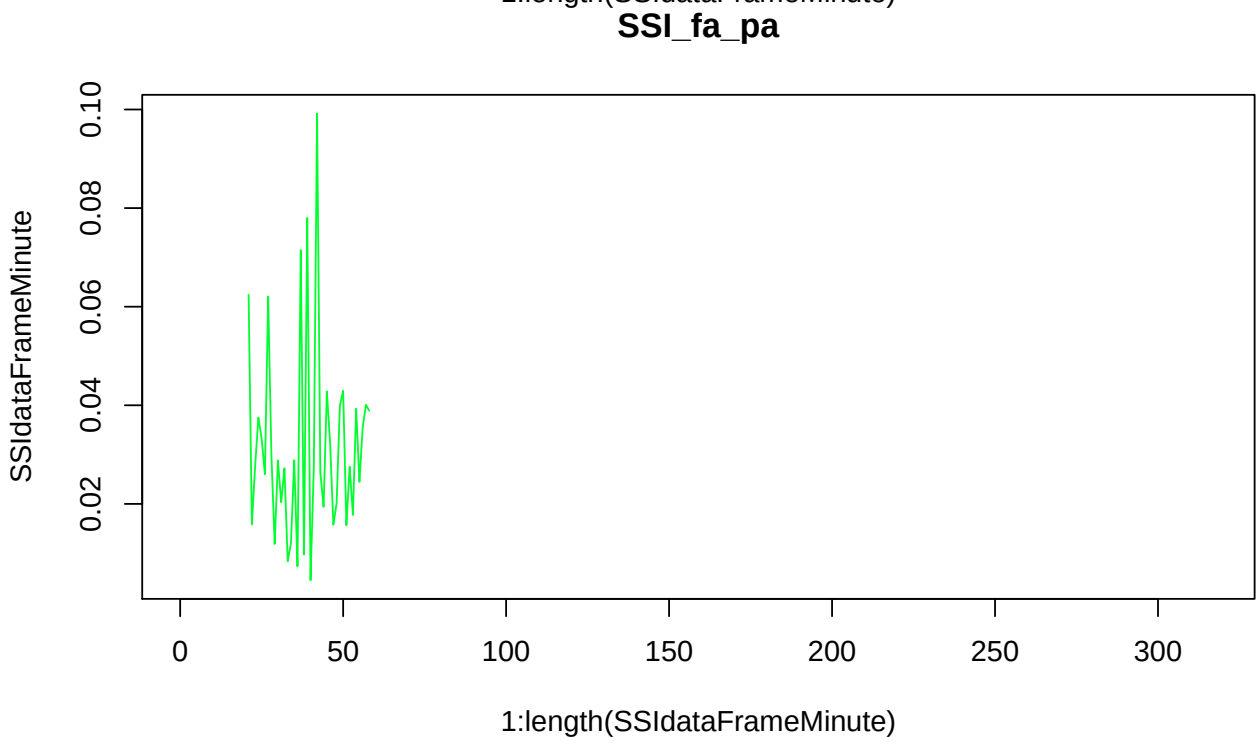
```
    IntervalNumbersVideo <- ceiling(length(SSIdataFrame[,indexSSI])/6)
    SSIColumn <- SSIdataFrame[,indexSSI]
    SSIdataFrameMinute <- c()
    for (i in 1:IntervalNumbersVideo){
          borneInf <- 1+(i-1)*6
          borneSup <- i * 6
          SSIVectorInterval <- SSIColumn[borneInf:borneSup]
          mean <- mean(SSIVectorInterval, na.rm=TRUE)
          SSIdataFrameMinute <- c(SSIdataFrameMinute, mean)}
    plot(1:length(SSIdataFrameMinute), SSIdataFrameMinute, type="l", col=rainbow(11)[col], main = names
    col <- col+1}
```

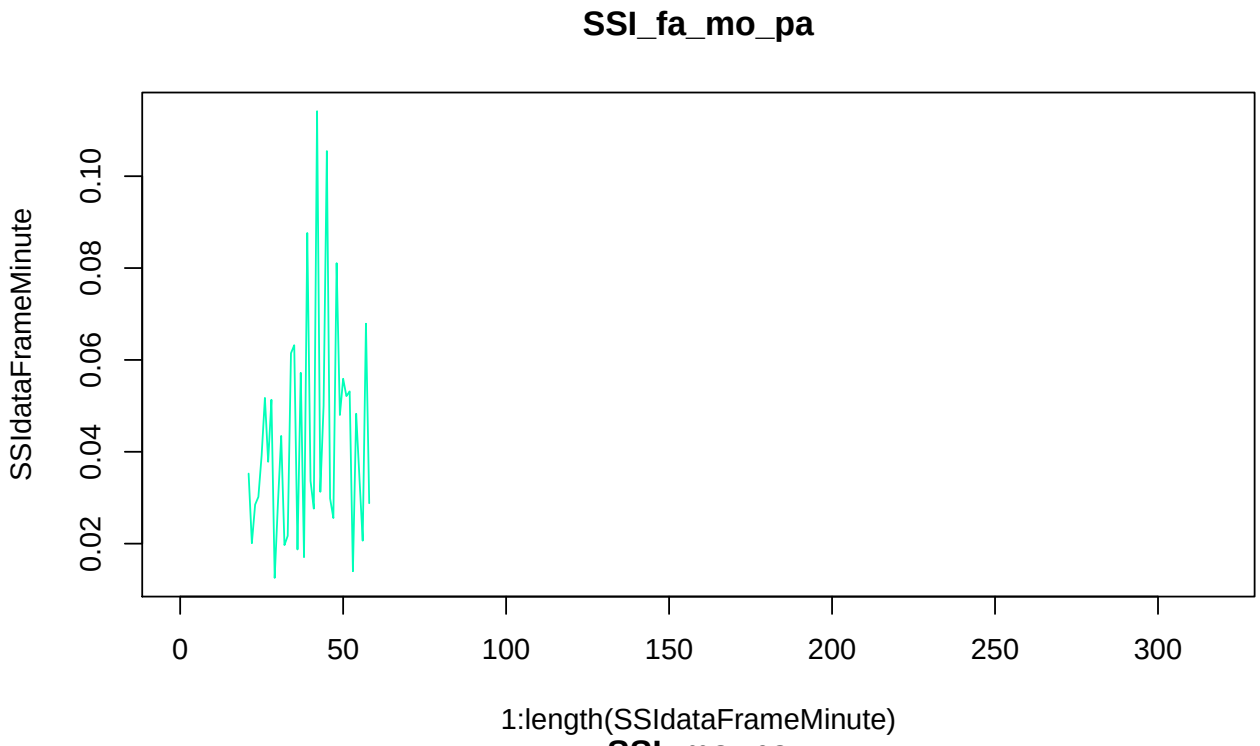


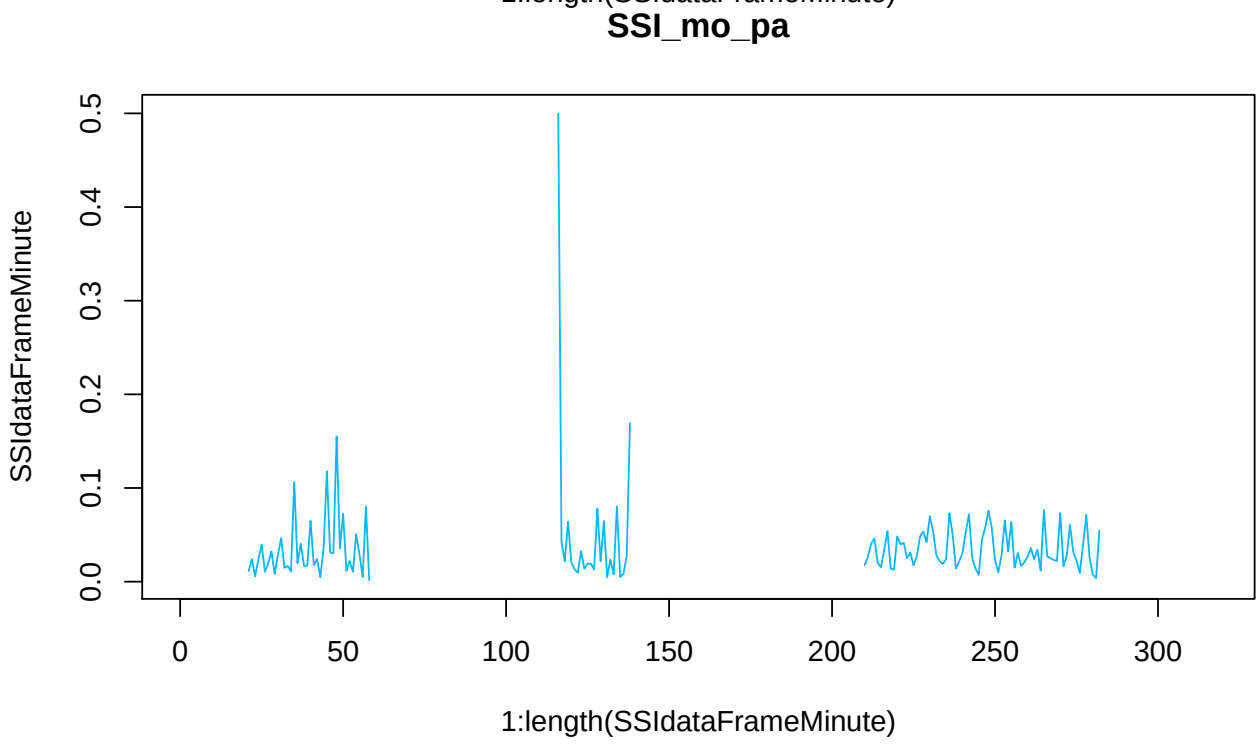

SSI_fa_mo_th
SSIdataFrameMinute
0.02
0.04
0.06
0.08
0
50
100
150
200
250
300
1:length(SSIdataFrameMinute)

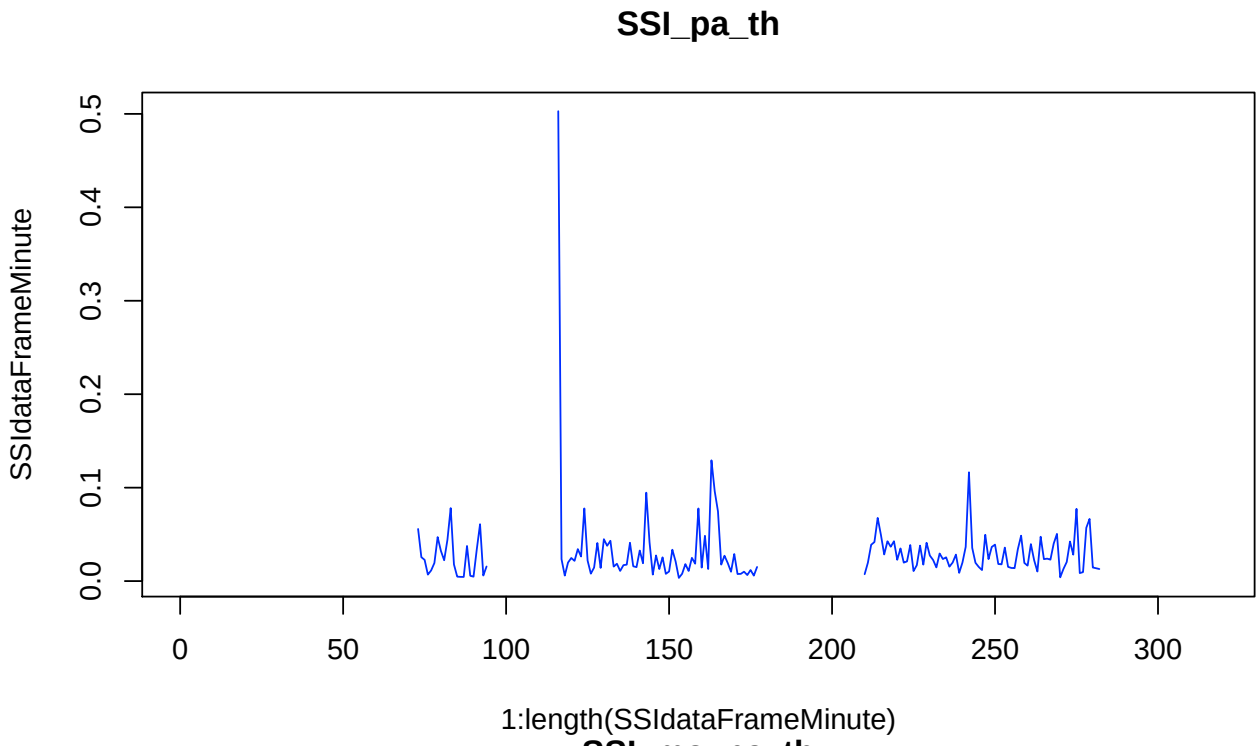

SSI_fa_th
SSIdataFrameMinute
0.00
0.02
0.04
0.06
0.08
0.10
0
50
100
150
200
250
300
1:length(SSIdataFrameMinute)

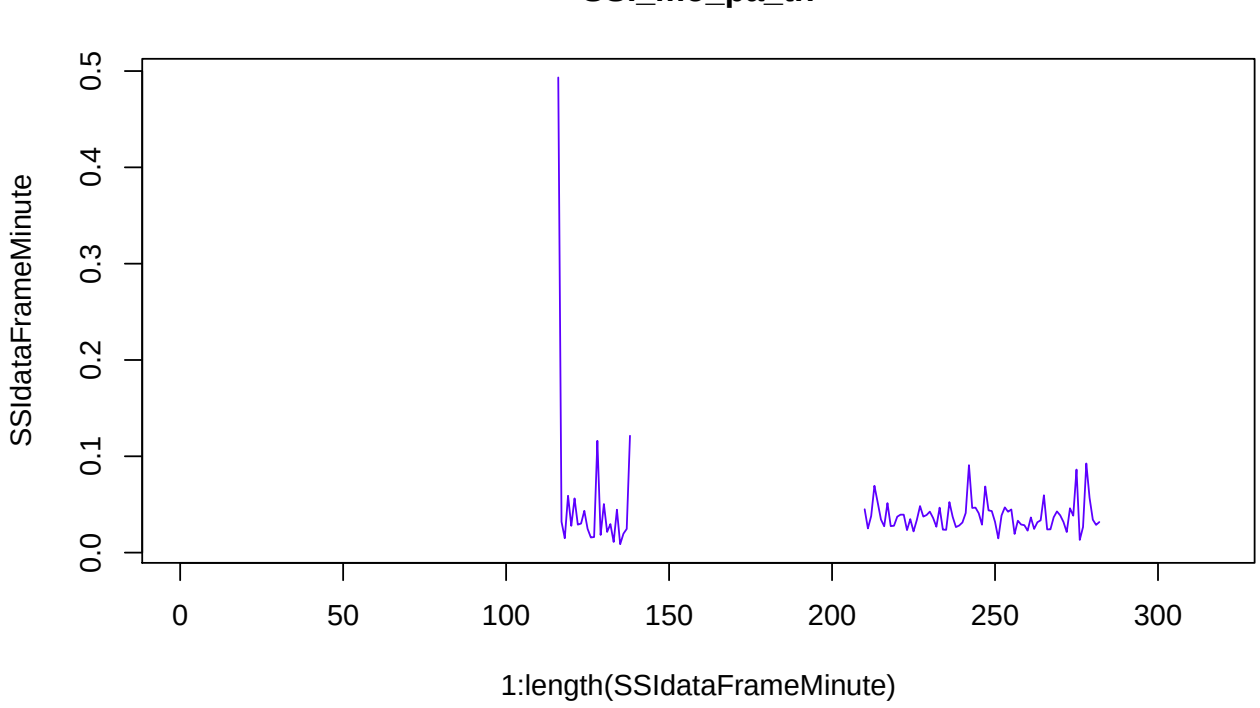

SSI_mo_th
SSIdataFrameMinute
0.00
0.05
0.10
0.15
0
50
100
150
200
250
300
1:length(SSIdataFrameMinute)


SSI_fa_pa
SSIdataFrameMinute
0.02
0.04
0.06
0.08
0.10
0
50
100
150
200
250
300
1:length(SSIdataFrameMinute)


SSI_fa_mo_pa
SSIdataFrameMinute
0.02
0.04
0.06
0.08
0.10
0
50
100
150
200
250
300
1:length(SSIdataFrameMinute)


SSI_mo_pa
SSIdataFrameMinute
0.0
0.1
0.2
0.3
0.4
0.5
0
50
100
150
200
250
300
1:length(SSIdataFrameMinute)

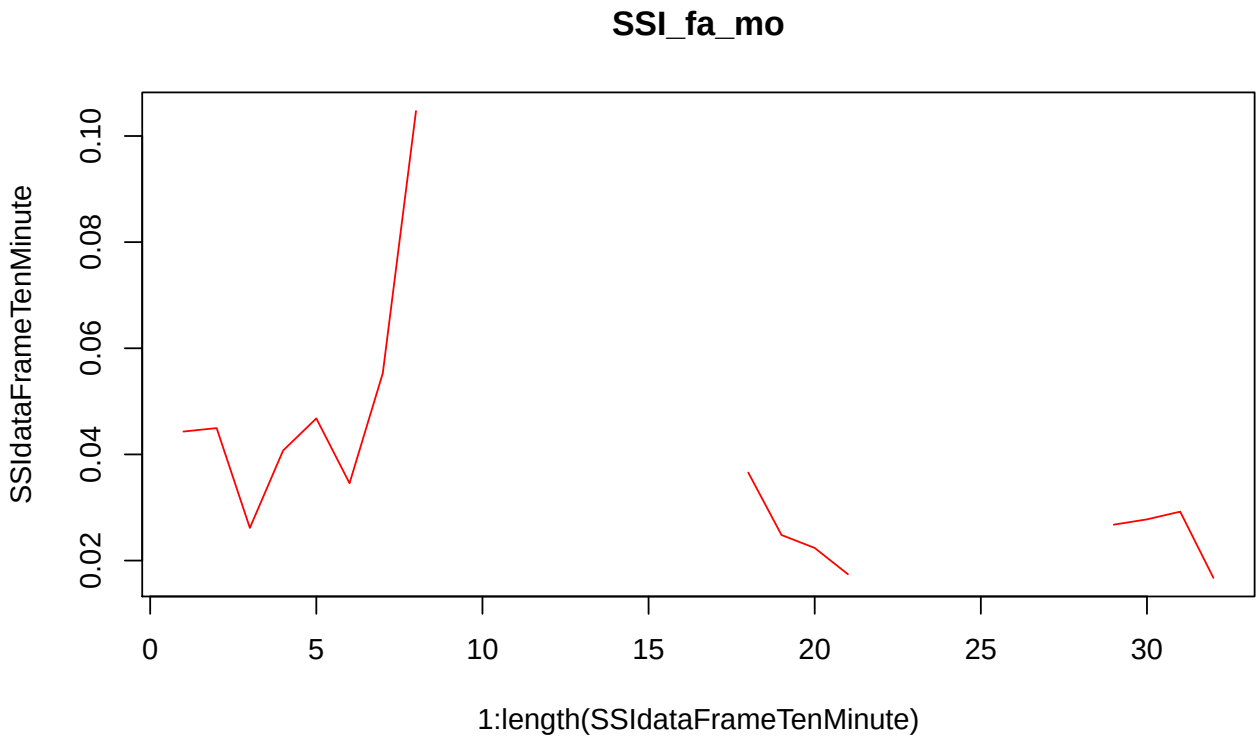


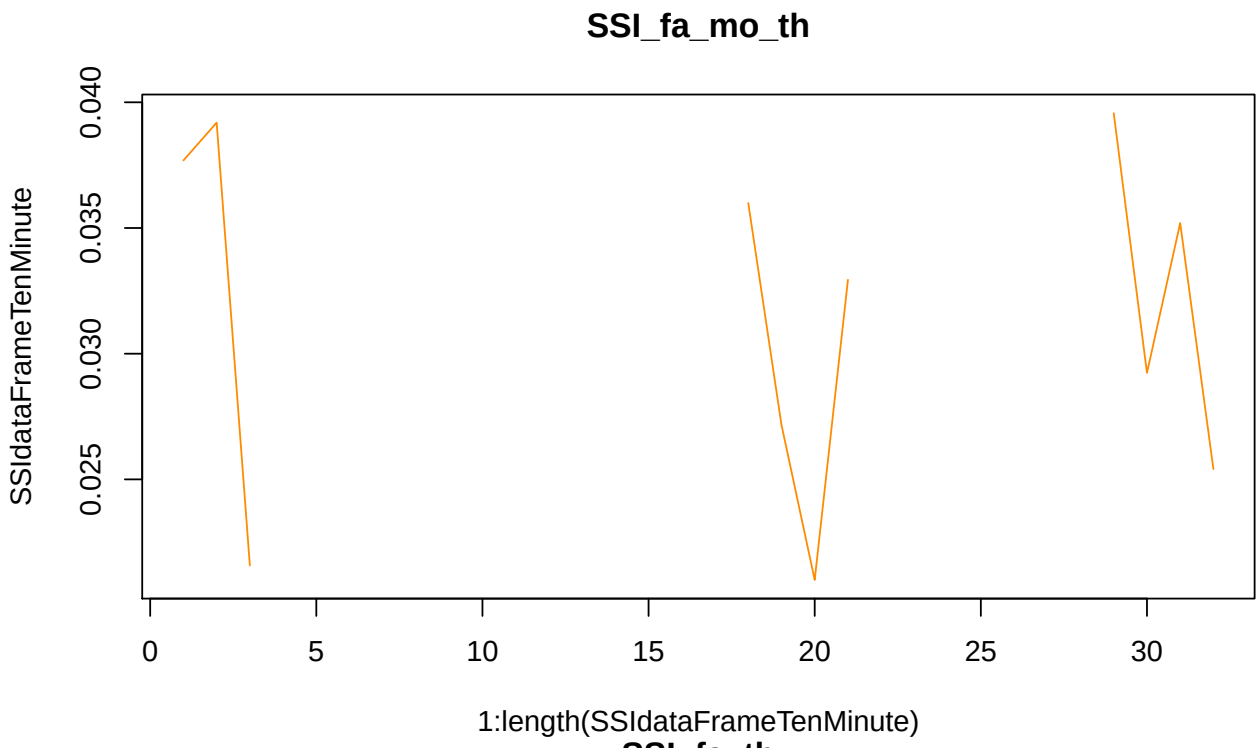


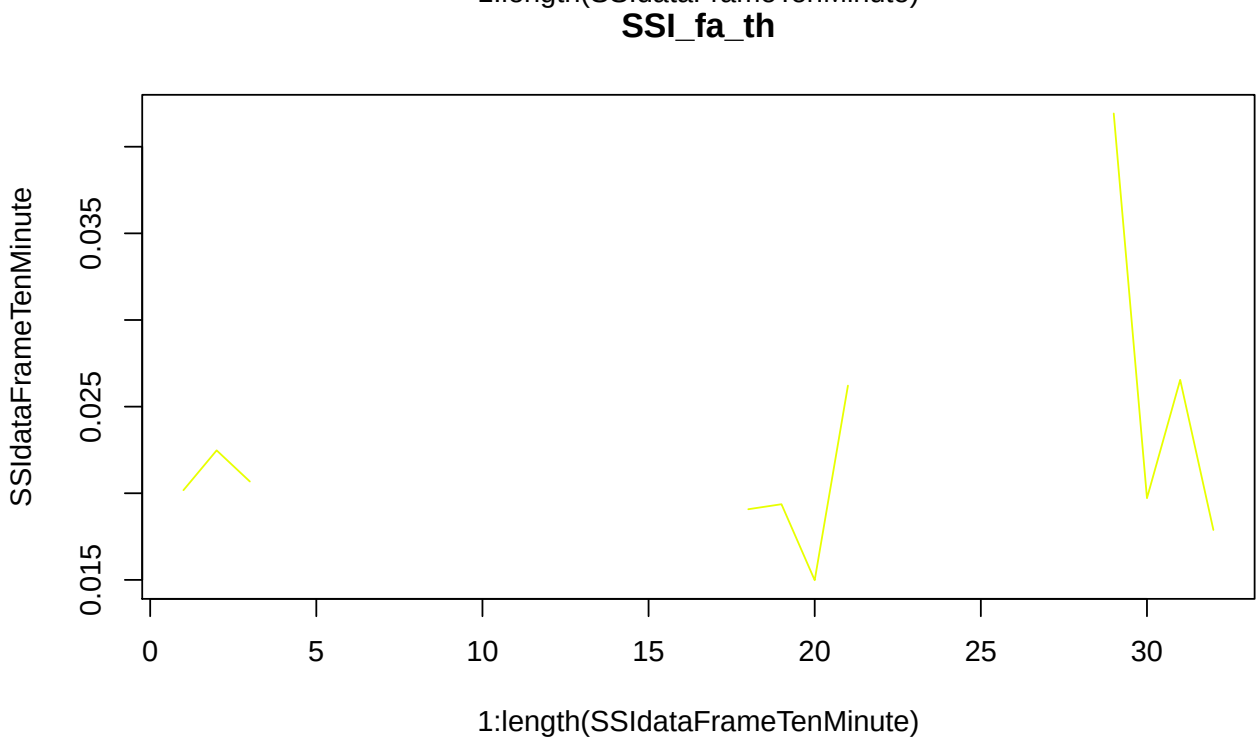
Evolution of synchrony through time, mean by 10 minutes

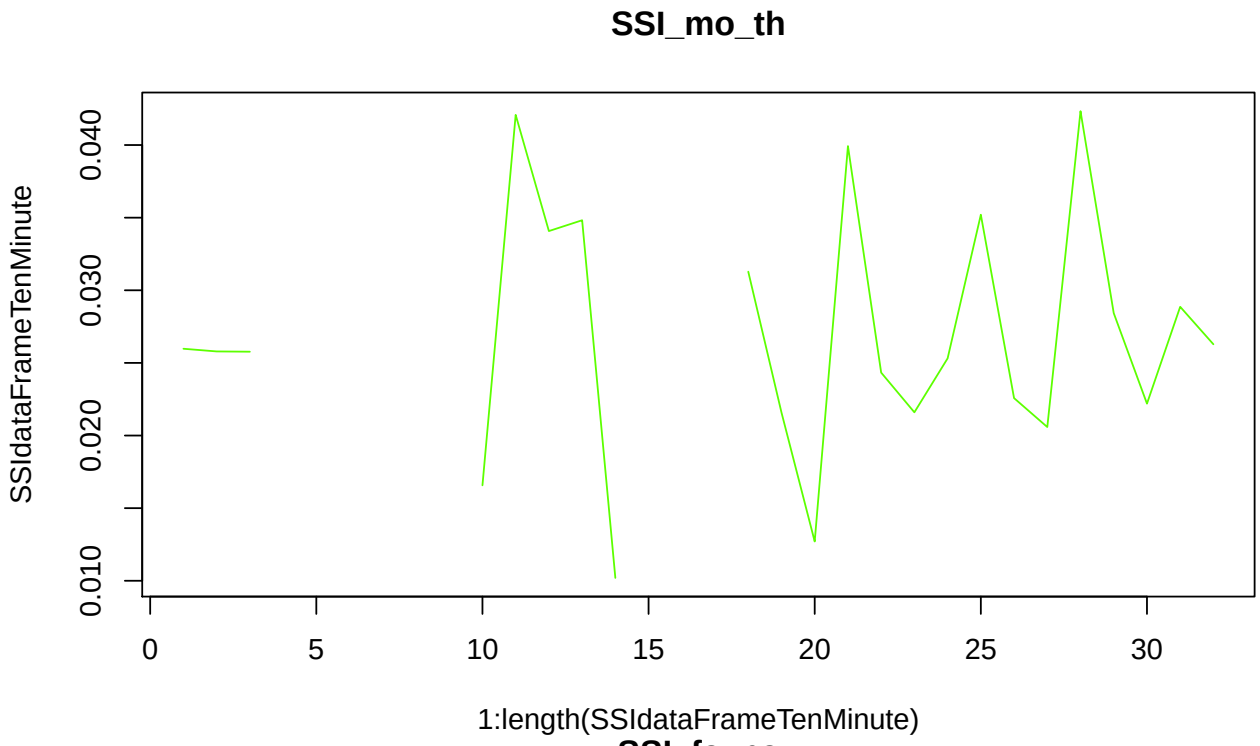
```
par(mar=c(4,4,4,4))
    col = 1
for (indexSSI in 6:length(SSIdataFrame)){
```

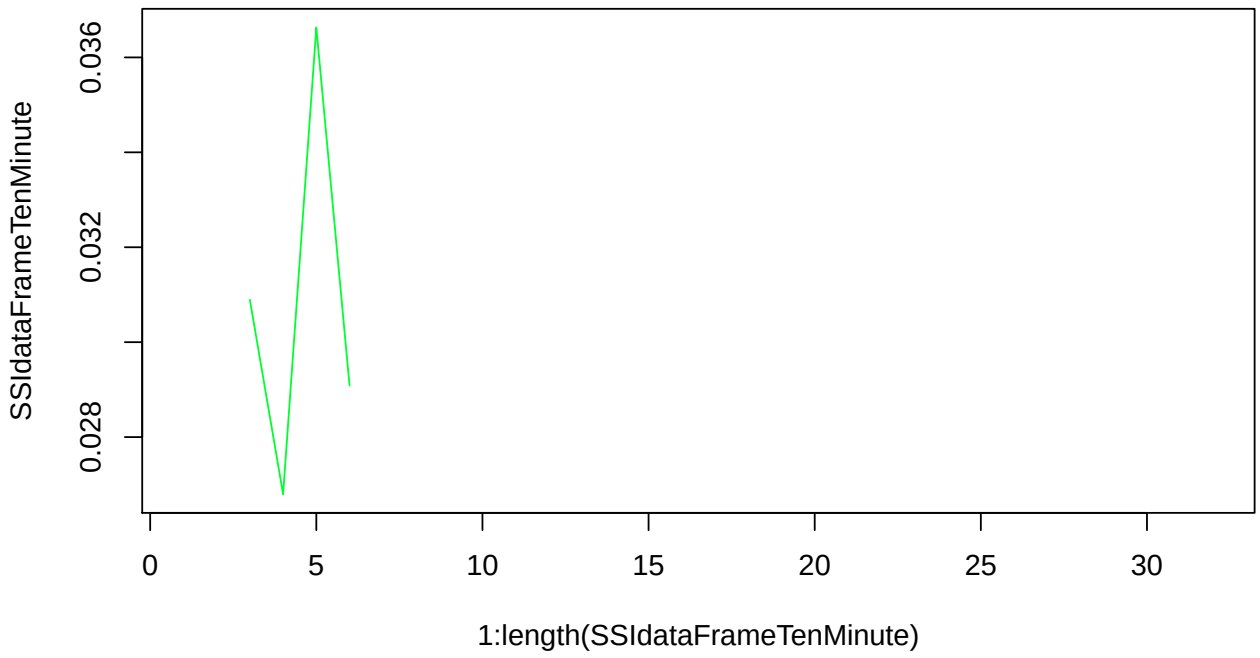
```
    IntervalNumbersVideo <- ceiling(length(SSIdataFrame[,indexSSI])/60)
    SSIColumn <- SSIdataFrame[,indexSSI]
    SSIdataFrameTenMinute <- c()
    for (i in 1:IntervalNumbersVideo){
          borneInf <- 1+(i-1)*60
          borneSup <- i * 60
          SSIVectorInterval <- SSIColumn[borneInf:borneSup]
          mean <- mean(SSIVectorInterval, na.rm=TRUE)
          SSIdataFrameTenMinute <- c(SSIdataFrameTenMinute, mean)}
    plot(1:length(SSIdataFrameTenMinute), SSIdataFrameTenMinute, type="l", col=rainbow(11)[col], main =
    col <- col+1}
```

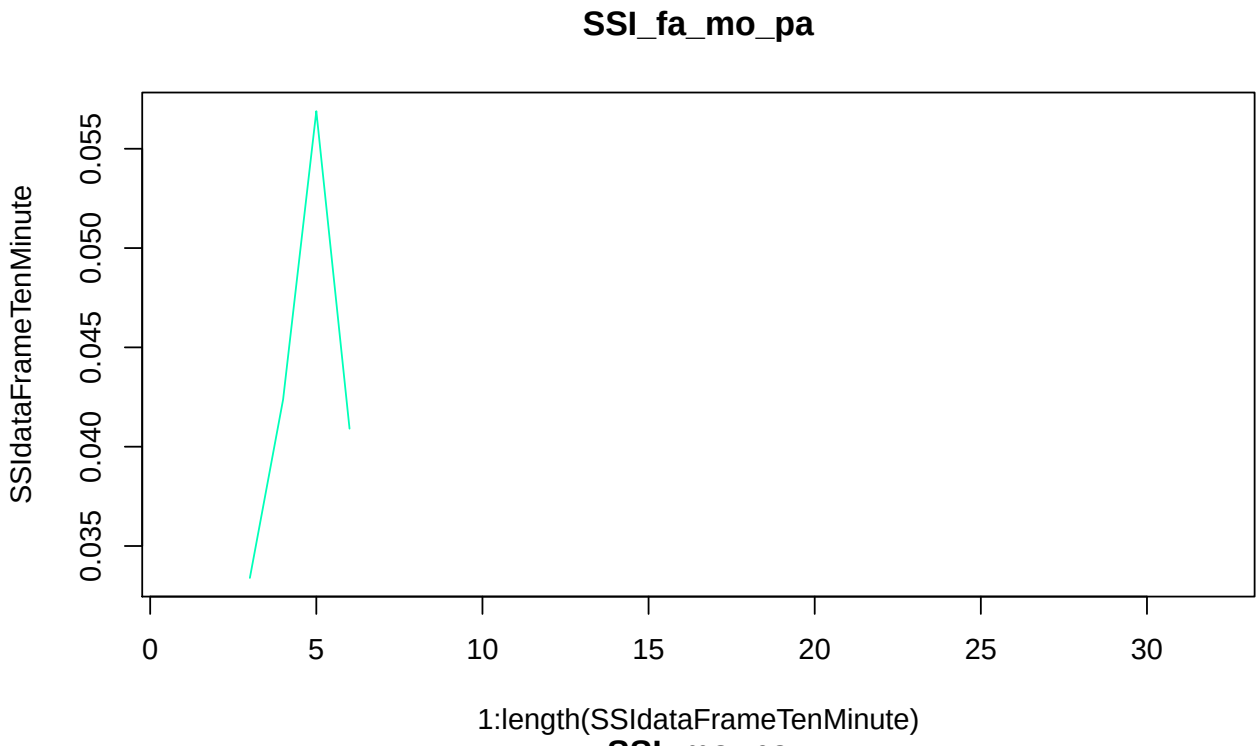


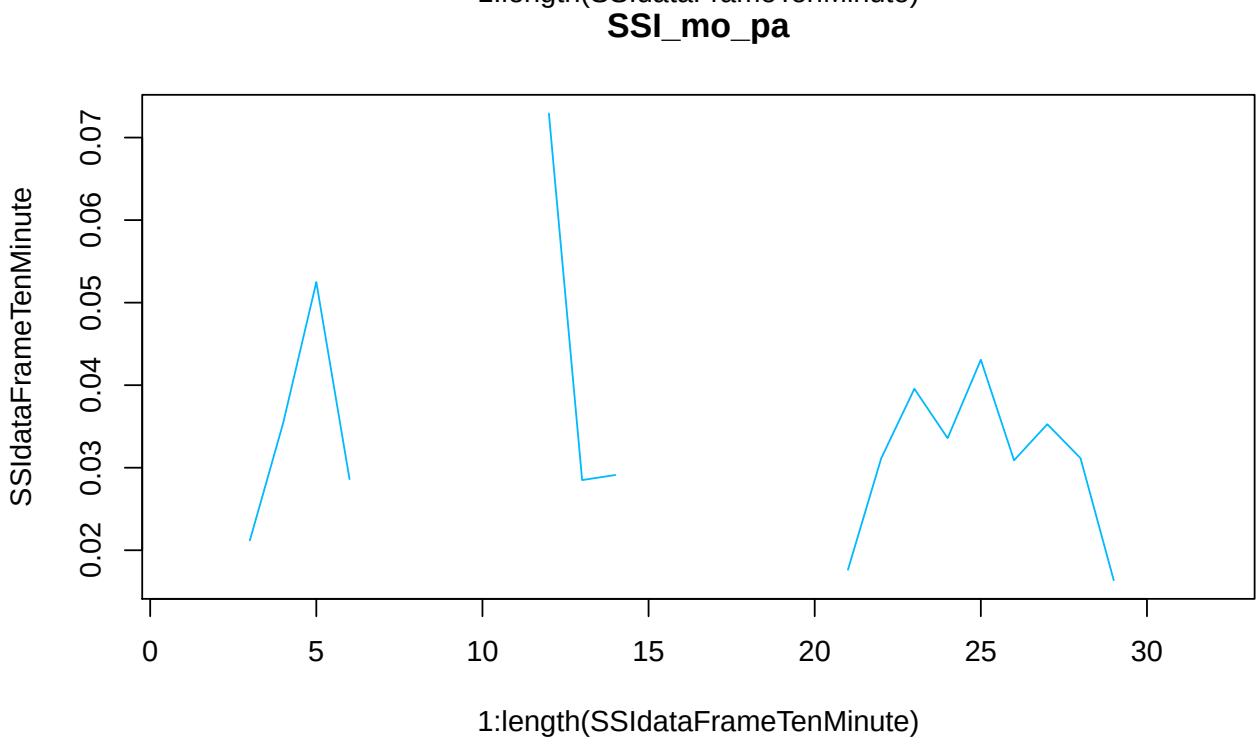

SSI_fa_mo_th
SSIdataFrameTenMinute
0.025
0.030
0.035
0.040
0
5
10
15
20
25
30
1:length(SSIdataFrameTenMinute)

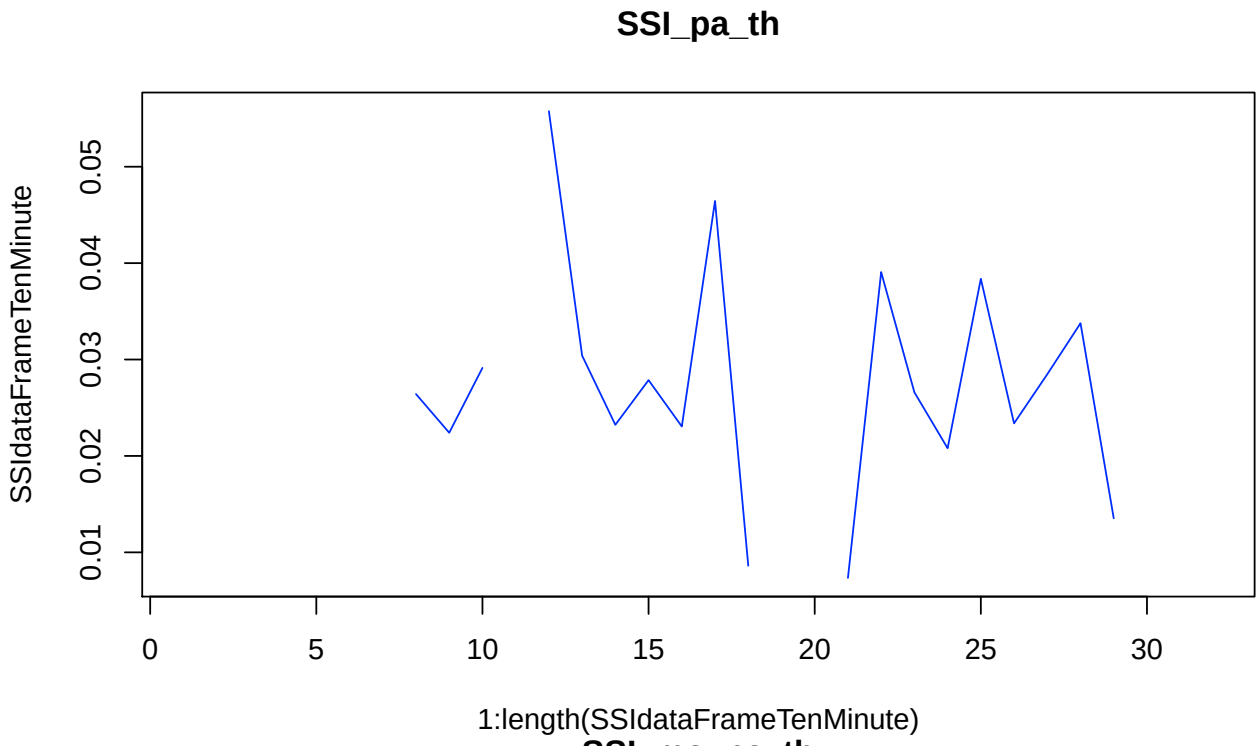

SSI_fa_th
SSIdataFrameTenMinute
0.015
0.025
0.035
0
5
10
15
20
25
30
1:length(SSIdataFrameTenMinute)

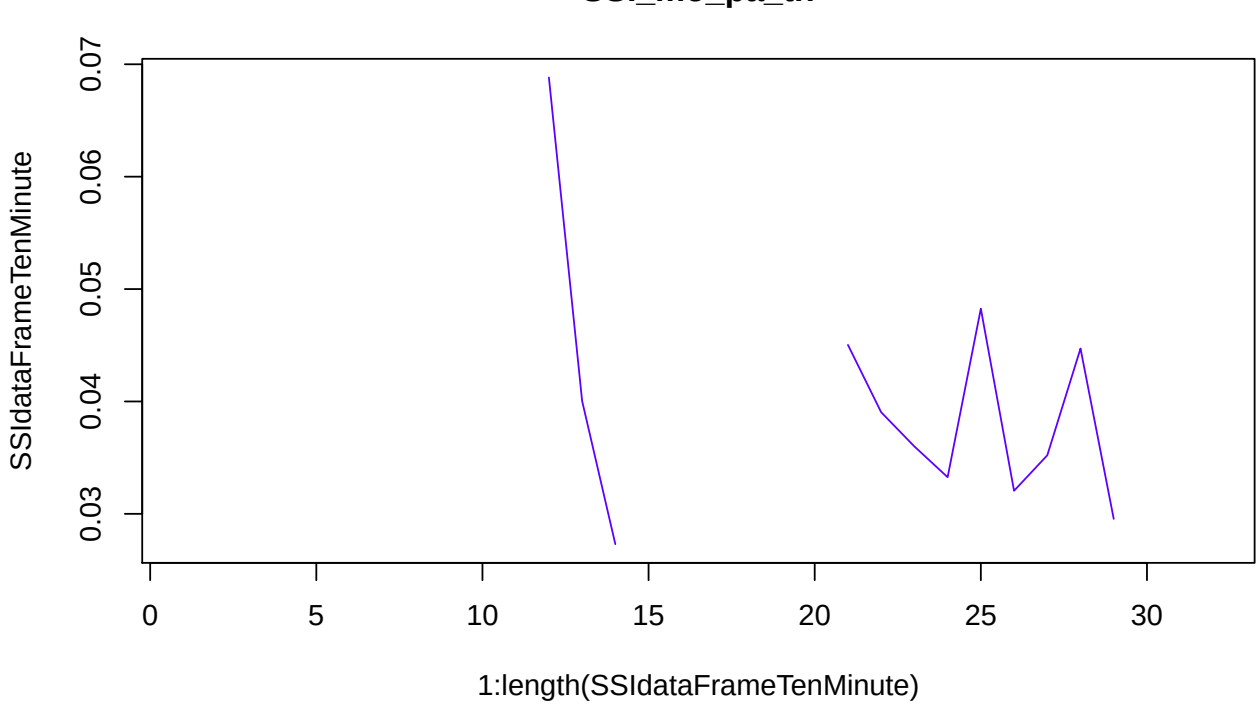

SSI_mo_th
SSIdataFrameTenMinute
0.010
0.020
0.030
0.040
0
5
10
15
20
25
30
1:length(SSIdataFrameTenMinute)


SSI_fa_pa
SSIdataFrameTenMinute
0.028
0.032
0.036
0
5
10
15
20
25
30
1:length(SSIdataFrameTenMinute)


SSI_fa_mo_pa
SSIdataFrameTenMinute
0.035
0.040
0.045
0.050
0.055
0
5
10
15
20
25
30
1:length(SSIdataFrameTenMinute)


SSI_mo_pa
SSIdataFrameTenMinute
0.02
0.03
0.04
0.05
0.06
0.07
0
5
10
15
20
25
30
1:length(SSIdataFrameTenMinute)



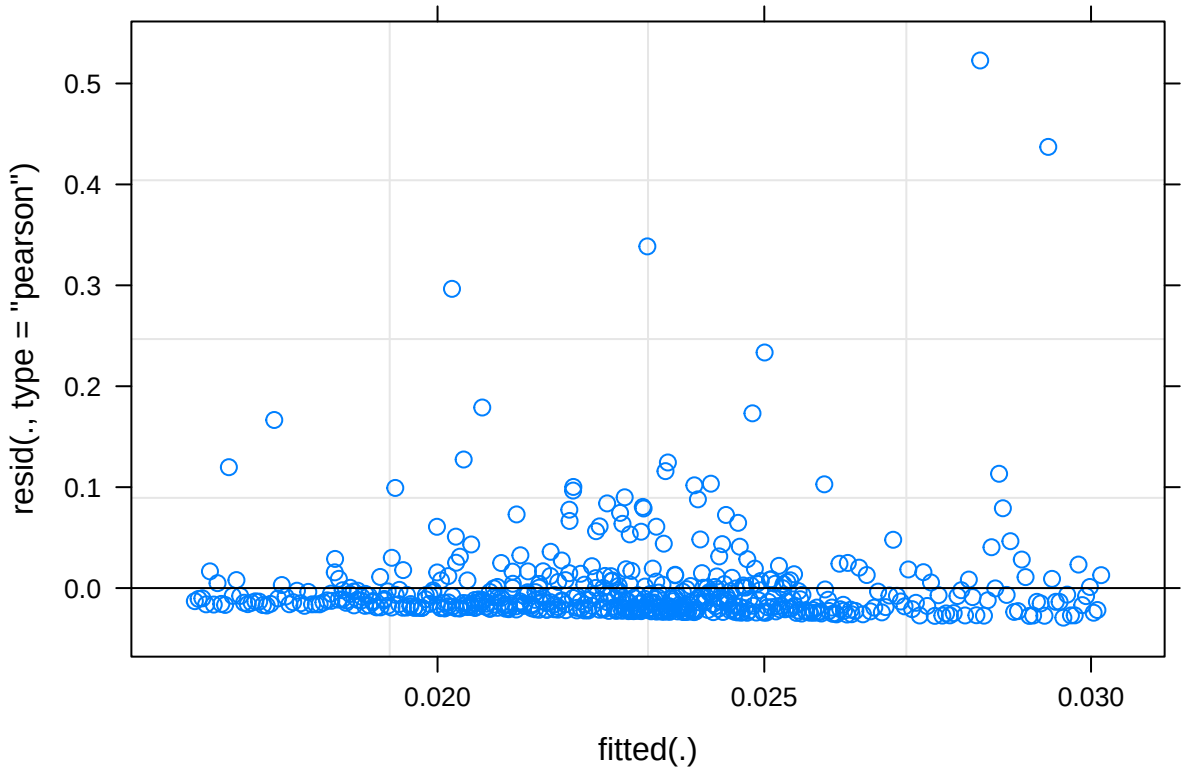



```
SSI_fa_th_lme <- lmer(SSI_fa_th ~ Time_min + (1|video), data=SSIdataFrame)
summary(SSI_fa_th_lme)
```

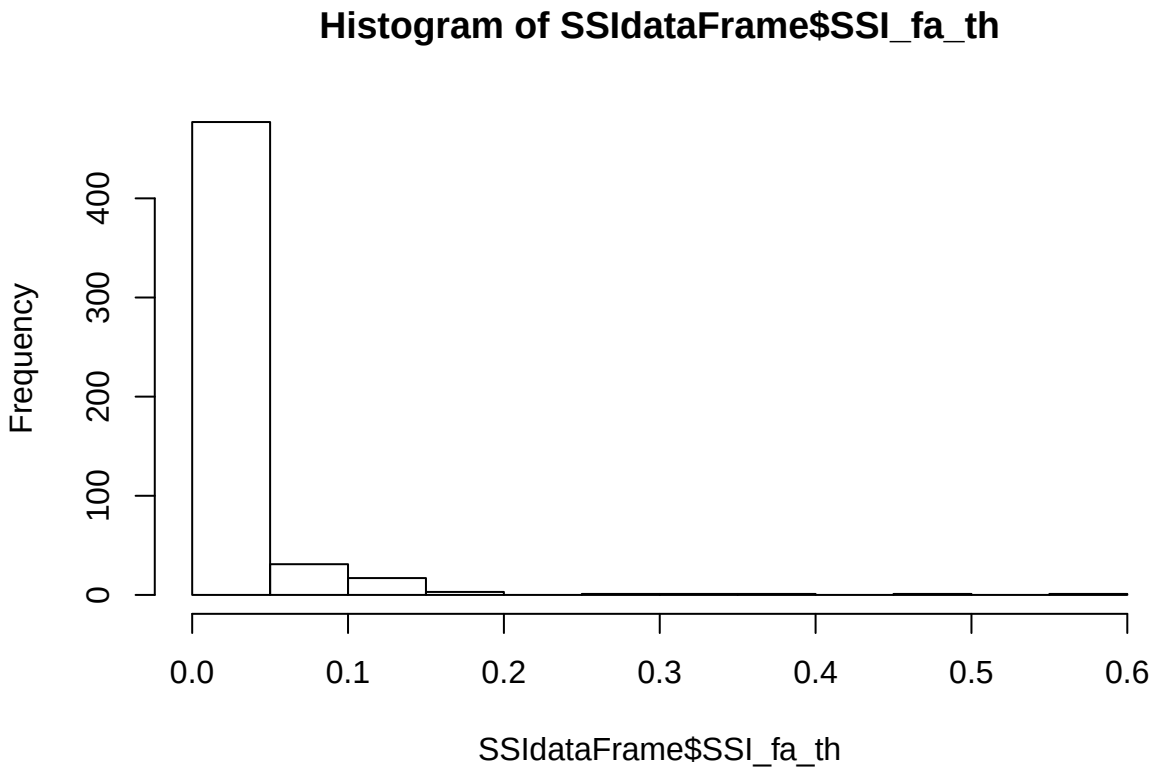
```
## Linear mixed model fit by REML ['lmerMod']
## Formula: SSI_fa_th ~ Time_min + (1 | video)
##    Data: SSIdataFrame
##
```

```
## REML criterion at convergence: -1708.1
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -0.6153 -0.4189 -0.2830  0.0065 10.9778
##
## Random effects:
##  Groups   Name        Variance  Std.Dev.
##  video    (Intercept) 1.514e-05 0.00389
##  Residual             2.268e-03 0.04762
## Number of obs: 533, groups:  video, 5
##
## Fixed effects:
##               Estimate Std. Error t value
## (Intercept)  0.0261037  0.0042446   6.150
## Time_min    -0.0003472  0.0003557  -0.976
##
## Correlation of Fixed Effects:
##          (Intr)
## Time_min -0.767
```

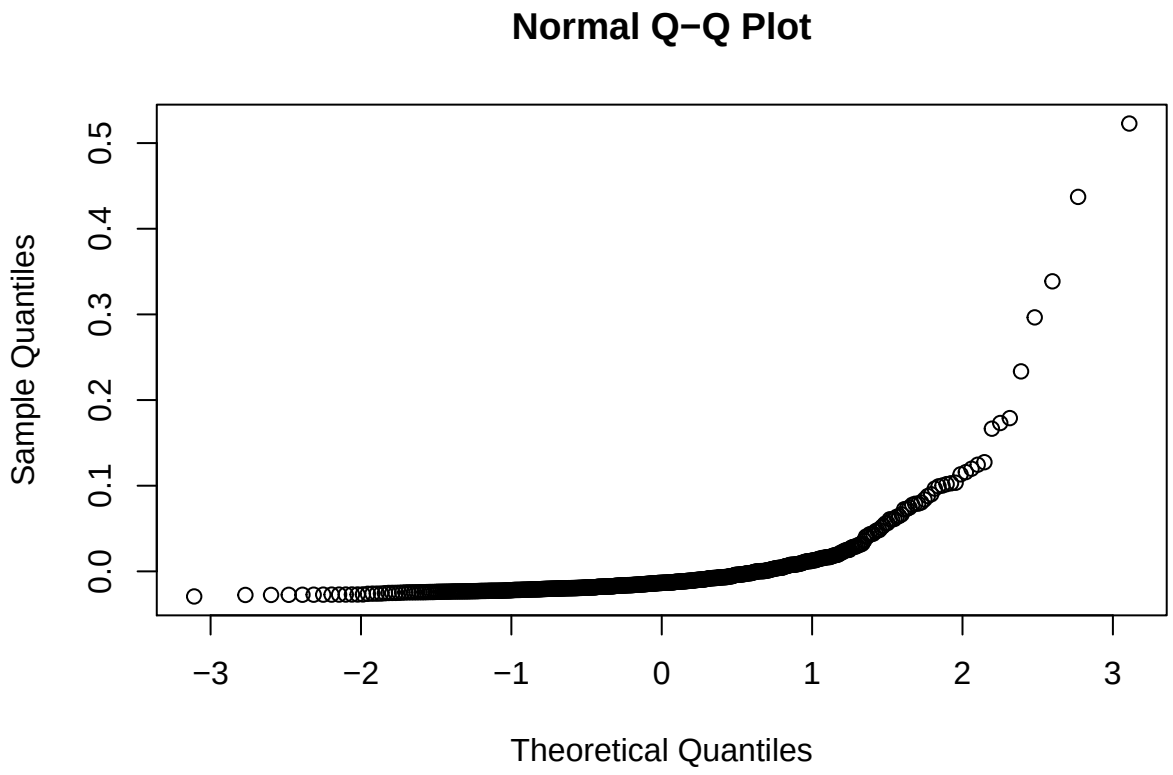
```
plot(SSI_fa_th_lme)
```




```
res <- residuals(SSI_fa_th_lme)
hist(SSIdataFrame$SSI_fa_th)
```


Histogram of SSIdataFrame$SSI_fa_th
Frequency
0
100
200
300
400
0.0
0.1
0.2
0.3
0.4
0.5
0.6
SSIdataFrame$SSI_fa_th

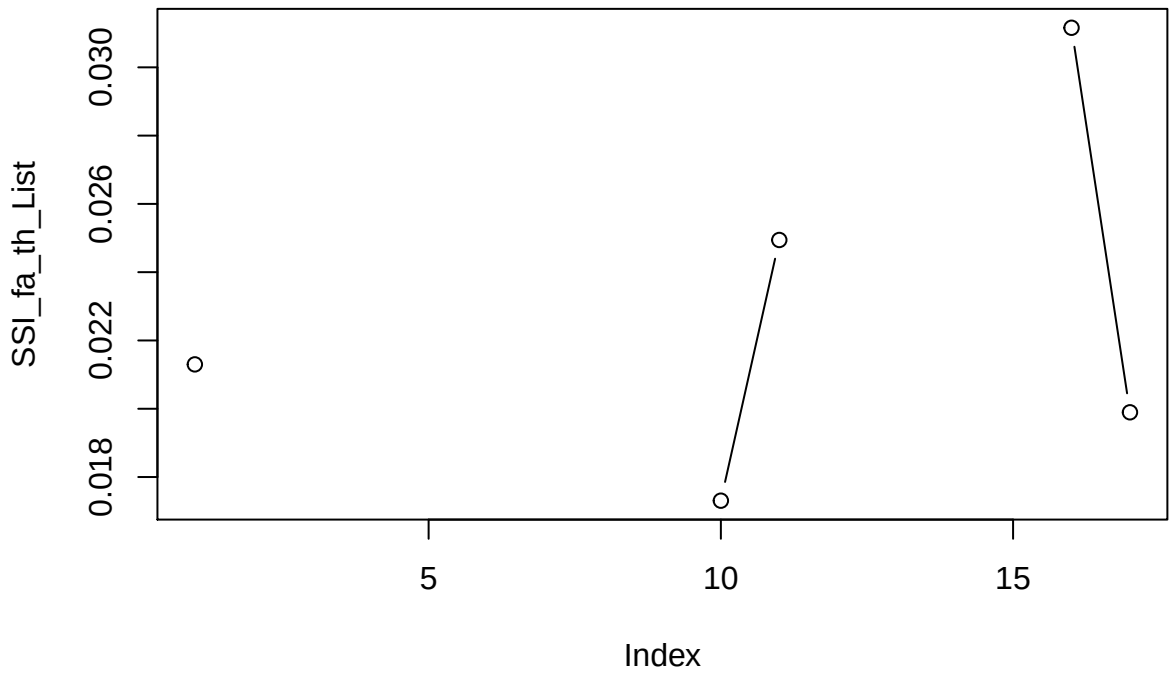
```
qqnorm(res)
```


Normal Q−Q Plot
Sample Quantiles
0.0
0.1
0.2
0.3
0.4
0.5
−3
−2
−1
0
1
2
3
Theoretical Quantiles

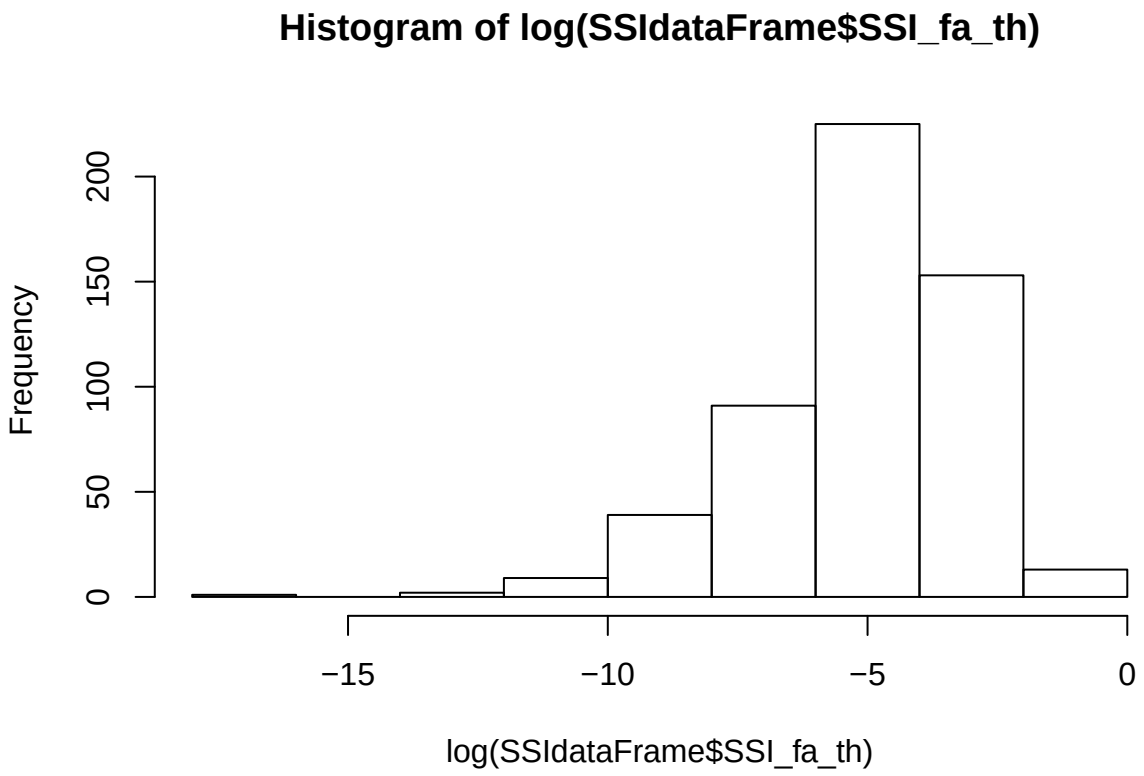
```
SSI_fa_th_List <- c()
for (i in indexlist){
  SSI_fa_th_List <- c(SSI_fa_th_List, mean(SSIdataFrame[which(SSIdataFrame$video==i),]$SSI_fa_th, na.rm=
}
print(SSI_fa_th_List)
```

```
##  [1] 0.02129936        NaN        NaN        NaN        NaN        NaN
##  [7]        NaN        NaN        NaN 0.01730778 0.02494321        NaN
## [13]        NaN        NaN        NaN 0.03115848 0.01989619
```

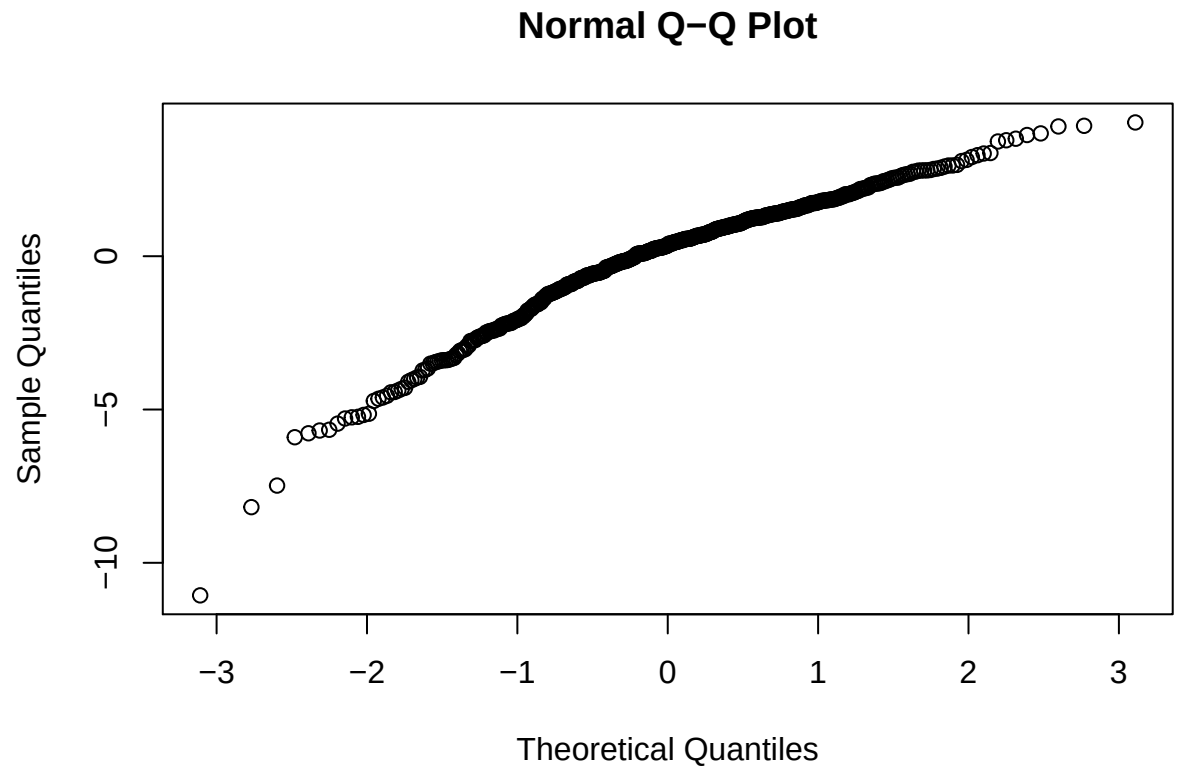
```
plot(SSI_fa_th_List, type="b")
```




```
# log of the data
log_SSI_fa_th <- hist(log(SSIdataFrame$SSI_fa_th))
```



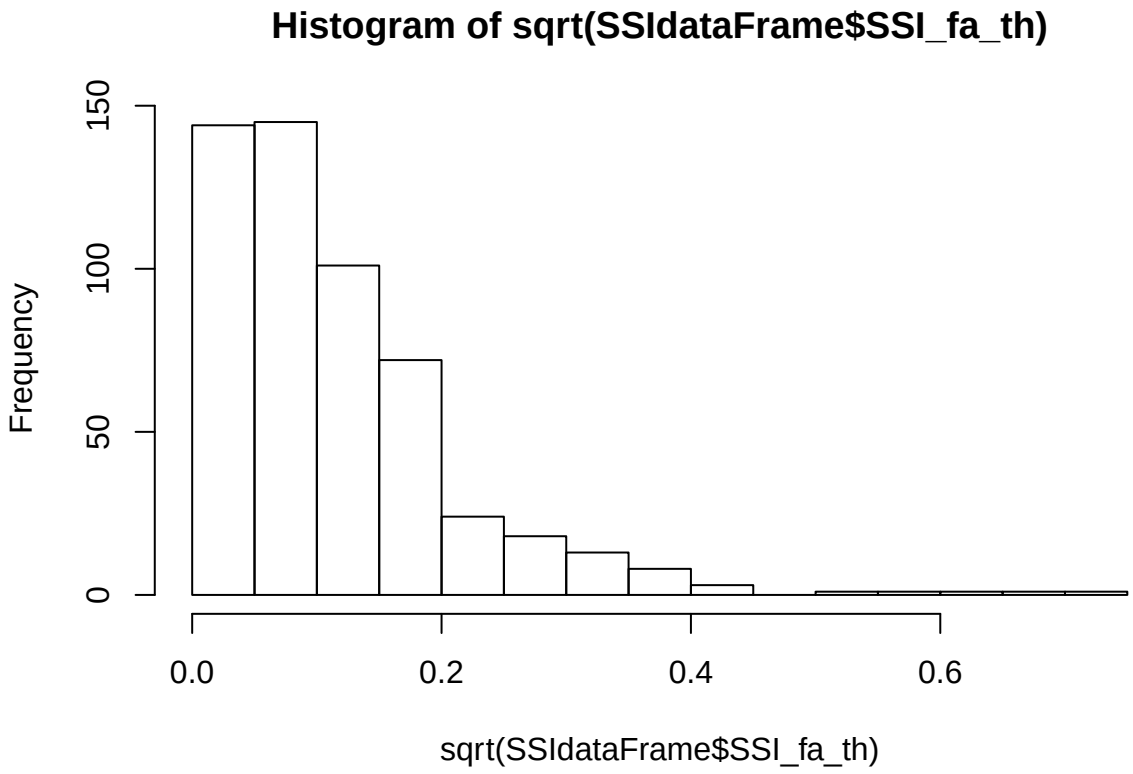

```
SSI_fa_th_log_lme <- lmer(log(SSI_fa_th) ~ Time_min + (1|video), data=SSIdataFrame)
res_log <- residuals(SSI_fa_th_log_lme)
qqnorm(res_log)
```



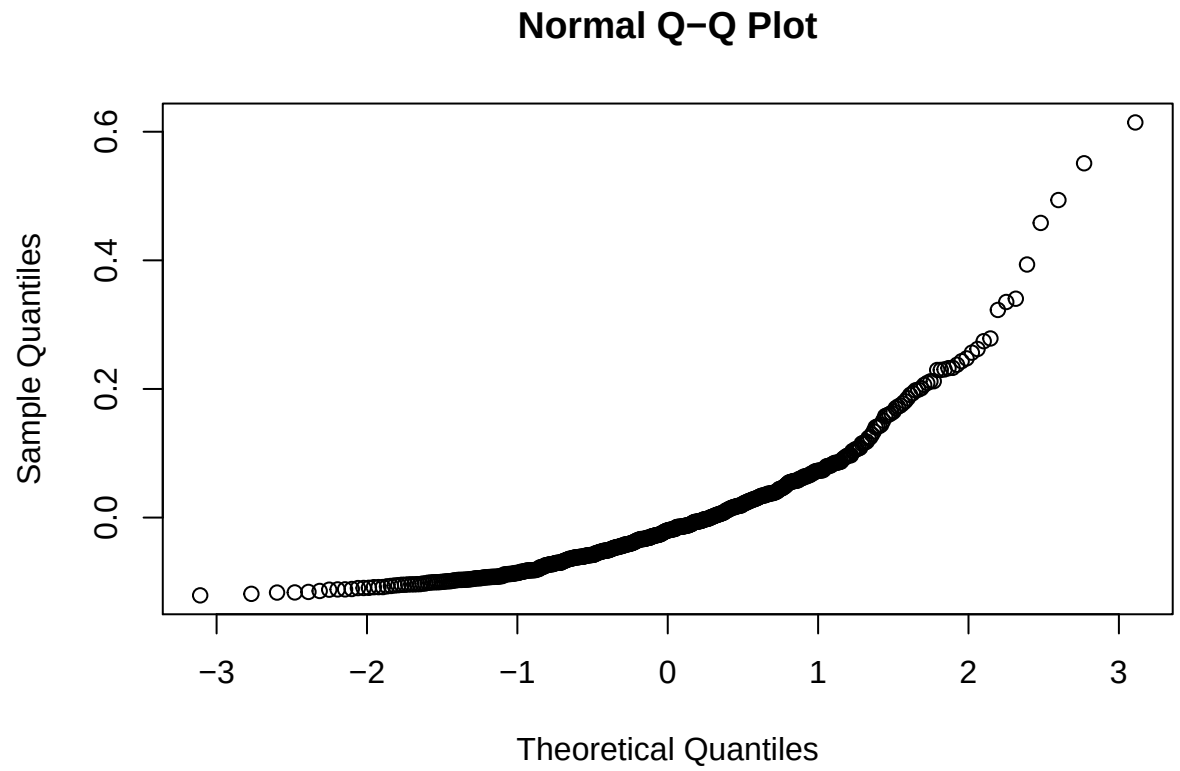
```r
summary(SSI_fa_th_log_lme)
```

```
## Linear mixed model fit by REML ['lmerMod']
## Formula: log(SSI_fa_th) ~ Time_min + (1 | video)
##    Data: SSIdataFrame
##
## REML criterion at convergence: 2281.3
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -5.4326 -0.4610  0.1755  0.6616  2.1427
##
## Random effects:
##  Groups   Name        Variance Std.Dev.
##  video    (Intercept) 0.04711  0.2171
##  Residual             4.14617  2.0362
## Number of obs: 533, groups:  video, 5
##
## Fixed effects:
##             Estimate Std. Error t value
## (Intercept) -4.78183    0.19209 -24.893
## Time_min    -0.03758    0.01533  -2.451
##
## Correlation of Fixed Effects:
##          (Intr)
## Time_min -0.725
```

```r
# root square of the data
sq_SSI_fa_th <- hist(sqrt(SSIdataFrame$SSI_fa_th))
```




```
SSI_fa_th_sq_lme <- lmer(sqrt(SSI_fa_th) ~ Time_min + (1|video), data=SSIdataFrame)
res_sq <- residuals(SSI_fa_th_sq_lme)
qqnorm(res_sq)
```



```r
summary(SSI_fa_th_sq_lme)
```

```
## Linear mixed model fit by REML ['lmerMod']
## Formula: sqrt(SSI_fa_th) ~ Time_min + (1 | video)
##    Data: SSIdataFrame
##
## REML criterion at convergence: -937.9
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -1.2301 -0.6704 -0.2018  0.3764  6.2496
##
## Random effects:
##  Groups   Name        Variance  Std.Dev.
##  video    (Intercept) 8.351e-05 0.009139
##  Residual             9.665e-03 0.098313
## Number of obs: 533, groups:  video, 5
##
## Fixed effects:
##               Estimate Std. Error t value
## (Intercept)  0.1276072  0.0089814  14.208
## Time_min    -0.0013773  0.0007371  -1.868
##
## Correlation of Fixed Effects:
##          (Intr)
## Time_min -0.749
```