

Synchrony in Psychotherapy, example with F1044 patient data

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Lists

Functions list

MeanMomentumByTime

Function that takes raw motion history data and make 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

```
MeanMomentumByTime <- 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 make 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)
}

```

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")

Number0fvideos <- length(indexlist)

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

```

Participants list

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

Presentation of the data

The timeMin is corresponding to a frame rate 25/sec.

```

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 ...
## $ 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.   : 1.00000   Min.   :0.0000000   Min.   :0.0000000   Min.   :0.0000000
##  1st Qu.: 1.00000   1st Qu.:0.0000000   1st Qu.:0.0000000   1st Qu.:0.0000000
##  Median : 1.00000   Median :0.0000000   Median :0.0000000   Median :0.0000000
##  Mean   : 1.00000   Mean   :0.0000000   Mean   :0.0000000   Mean   :0.0000000
##  3rd Qu.: 1.00000   3rd Qu.:0.0000000   3rd Qu.:0.0000000   3rd Qu.:0.0000000
##  Max.   : 1.00000   Max.   :0.0000000   Max.   :0.0000000   Max.   :0.0000000
## 
##          file
##  F1044C.VOB : 1
##  F1044D1.VOB: 1
##  F1044D2.VOB: 1
##  F1044E.VOB : 1
##  F1044F.VOB : 1
##  F1044G.VOB : 1
##  F1044H.VOB : 1
##  F1044I.VOB : 1
##  F1044L.VOB : 1
##  F1044M1.VOB: 1
##  F1044M2.VOB: 1
##  F1044N.VOB : 1
##  F1044O.VOB : 1
##  F1044P.VOB : 1
##  F1044Q.VOB : 1
##  F1044R1.VOB: 1
##  F1044R2.VOB: 1
## 
```

```

##  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

```

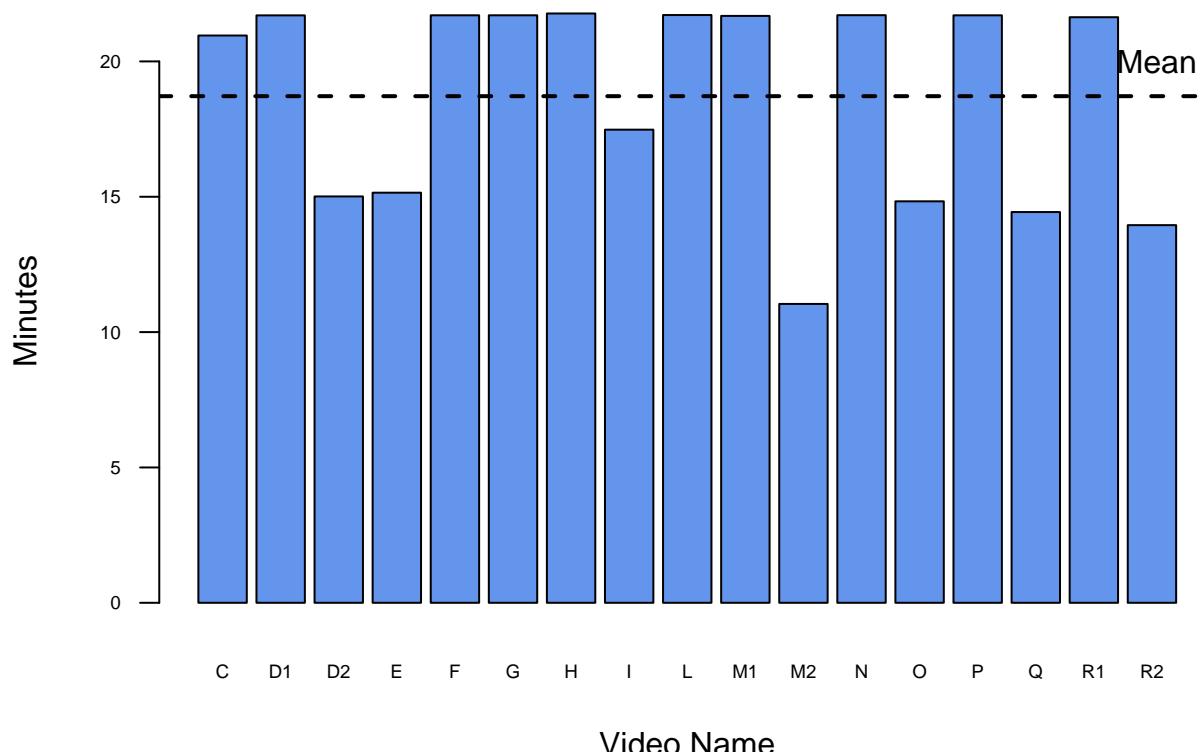
Length of the videos in minutes

```

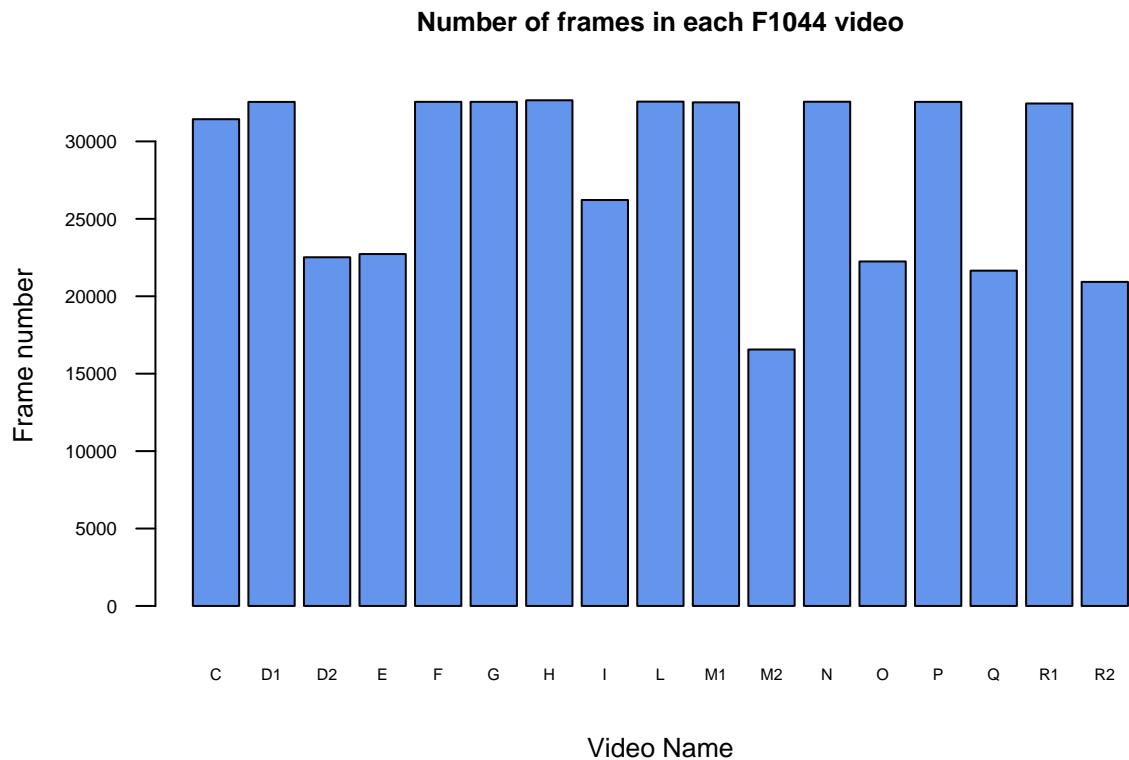
## [1] 20.95667 21.70067 15.01133 15.15067 21.70333 21.70400 21.77067
## [8] 17.47800 21.71333 21.68133 11.04000 21.70800 14.83133 21.70267
## [15] 14.43533 21.63267 13.95200

```

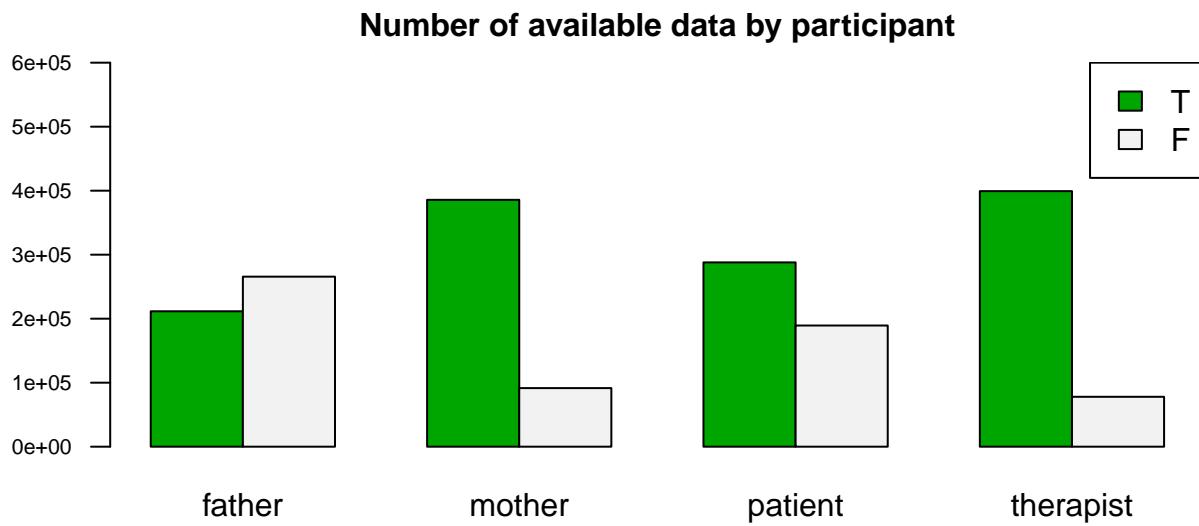
Length in each F1044 video (min)



Length of the videos in number of frames



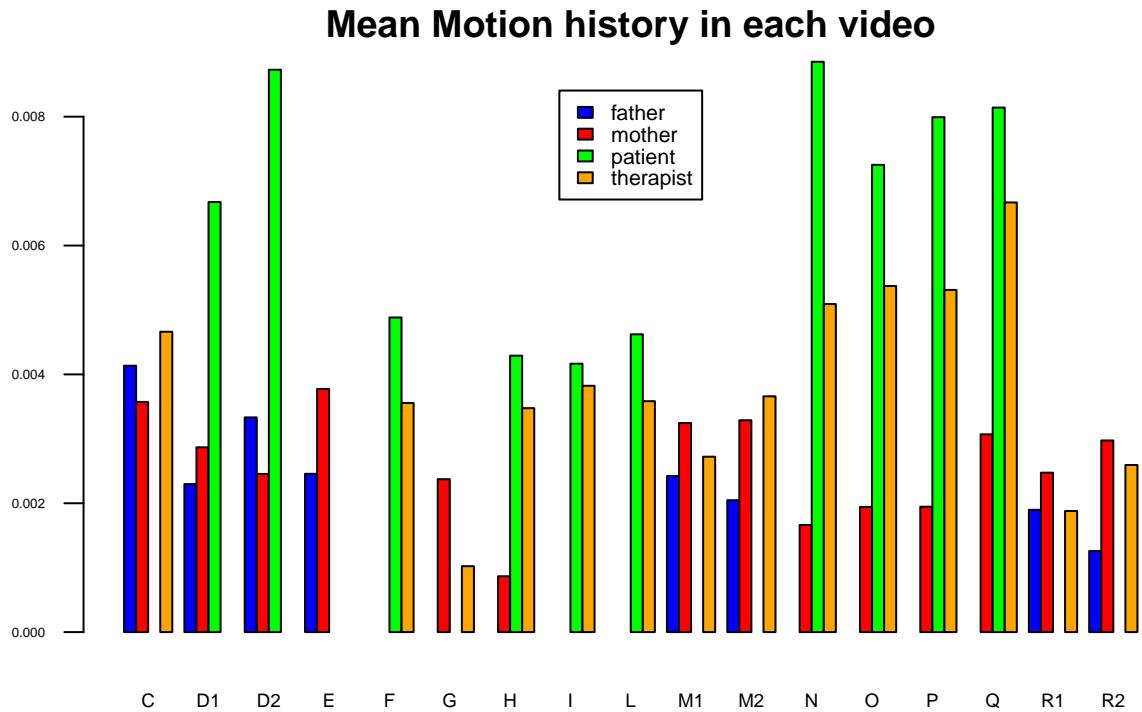
Number of Available (True) and Not Available (False) data for each participant



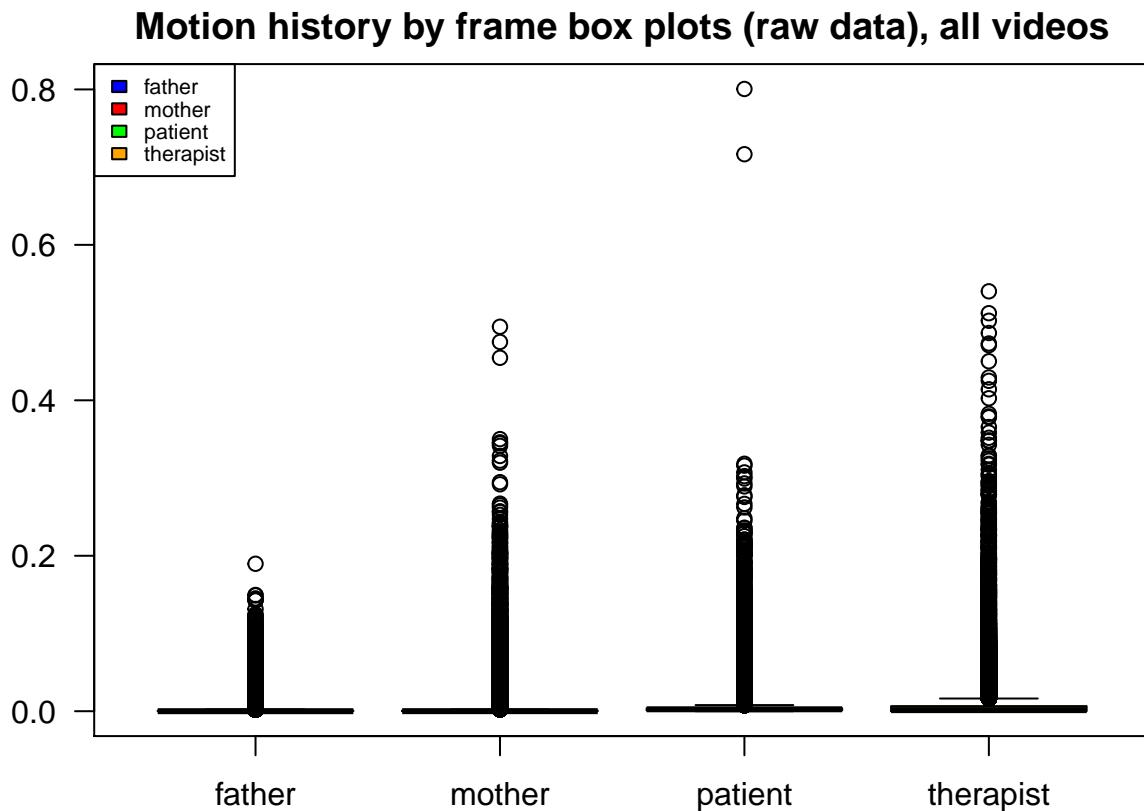
Mother and therapist are the more often present participants.

Global Motion history

Mean Motion history by video by participant



Motion history box plots by frame (raw data), all videos



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

F1044C video

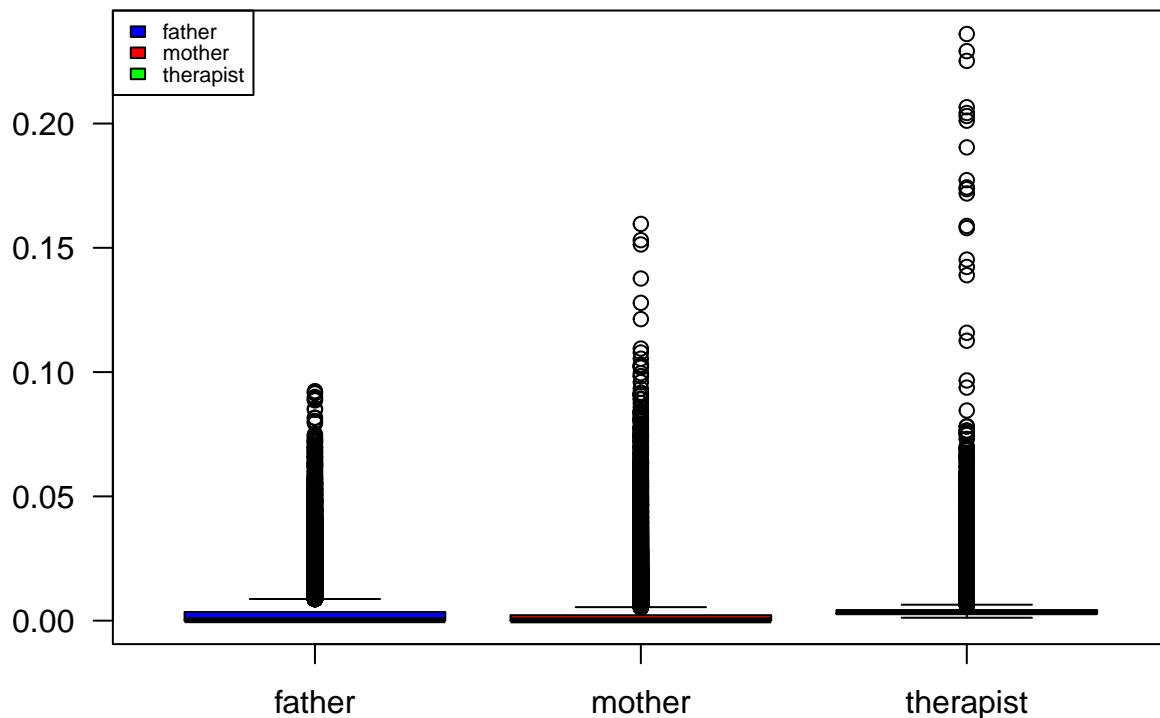
It is the first video of F10044C. The father, mother and therapist are present. The patient is absent.

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

par(mar=c(3,3,3,2))
boxplot(rawdatafather, rawdataMother, rawdataTherapist,
        col=colOrderList[c(1,2,4)],
        names=ParticipantsList[c(1,2,4)],
        main= "Box plots of motion history mean
on 11 frames rawdata 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)
```

Box plots of motion history mean on 11 frames rawdata on F1044C video



```
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
```

```
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

```
slidedefather <- SlidingInterval("father", 1, 11, data)
slidedefather <- SlidingInterval("mother", 1, 11, data)
slidedefather <- SlidingInterval("therapist", 1, 11, data)
slidedefather <- SlidingInterval("patient", 1, 11, data)

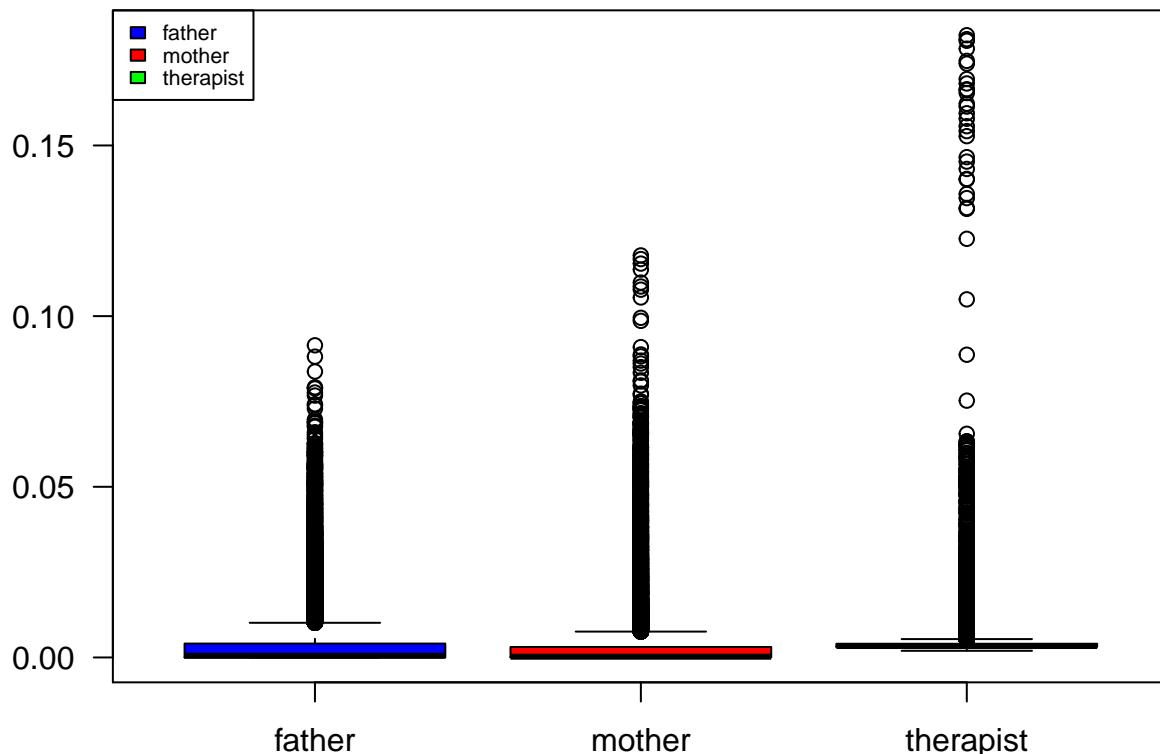
par(mar=c(3,3,2,2))
```

```

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)

```

Box plot of motion history sliding interval on F1044C video



```
summary(slidedfather)
```

```

##      Min.    1st Qu.     Median      Mean    3rd Qu.      Max.
## 0.000e+00 5.560e-06 4.862e-04 4.145e-03 4.066e-03 9.145e-02

```

```
summary(slidedmother)
```

```

##      Min.    1st Qu.     Median      Mean    3rd Qu.      Max.
## 0.000e+00 4.298e-05 2.132e-04 3.581e-03 3.056e-03 1.178e-01

```

```
summary(slidedtherapist)
```

```

##      Min.    1st Qu.     Median      Mean    3rd Qu.      Max.
## 0.001948 0.003099 0.003345 0.004688 0.004012 0.182300

```

Non overlapping interval

```

fatherEleven<- MeanMomentumByTime("father", indexOfvideos=1, interval=11, data)

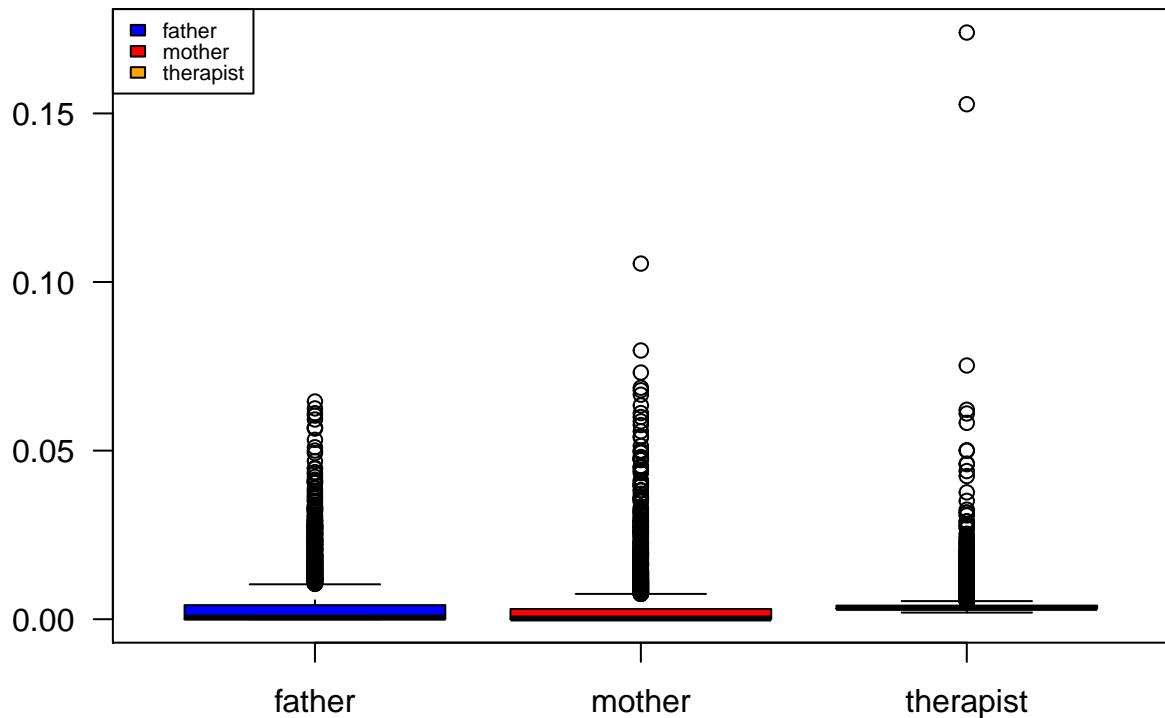
motherEleven <- MeanMomentumByTime("mother", indexOfvideos=1, interval=11, data)

therapistEleven <- MeanMomentumByTime("therapist", indexOfvideos=1, interval=11, data)

par(mar=c(3,3,3,2))
boxplot(fatherEleven, motherEleven, therapistEleven,
        col=colOrderList[c(1,2,4)],
        names=ParticipantsList[c(1,2,4)],
        main= "Box plots of motion history mean
on 11 frames non overlapping interval for F1044C video", las=1)
par(mar=c(1,0.5,0.5,1))
legend("topleft", ParticipantsList[c(1,2,4)], fill=colOrderList[c(1,2,4)], cex=0.7)

```

**Box plots of motion history mean
on 11 frames non overlapping interval for F1044C video**



```
summary(fatherEleven)
```

```

##      Min.    1st Qu.     Median      Mean    3rd Qu.      Max.    NA's
## 0.0000000 0.0000056 0.0004807 0.0041380 0.0041740 0.0645600      1

```

```
summary(motherEleven)
```

```

##      Min.    1st Qu.     Median      Mean    3rd Qu.      Max.    NA's
## 0.0000033 0.0000430 0.0002248 0.0035770 0.0030270 0.1055000      1

```

```
summary(therapistEleven)
```

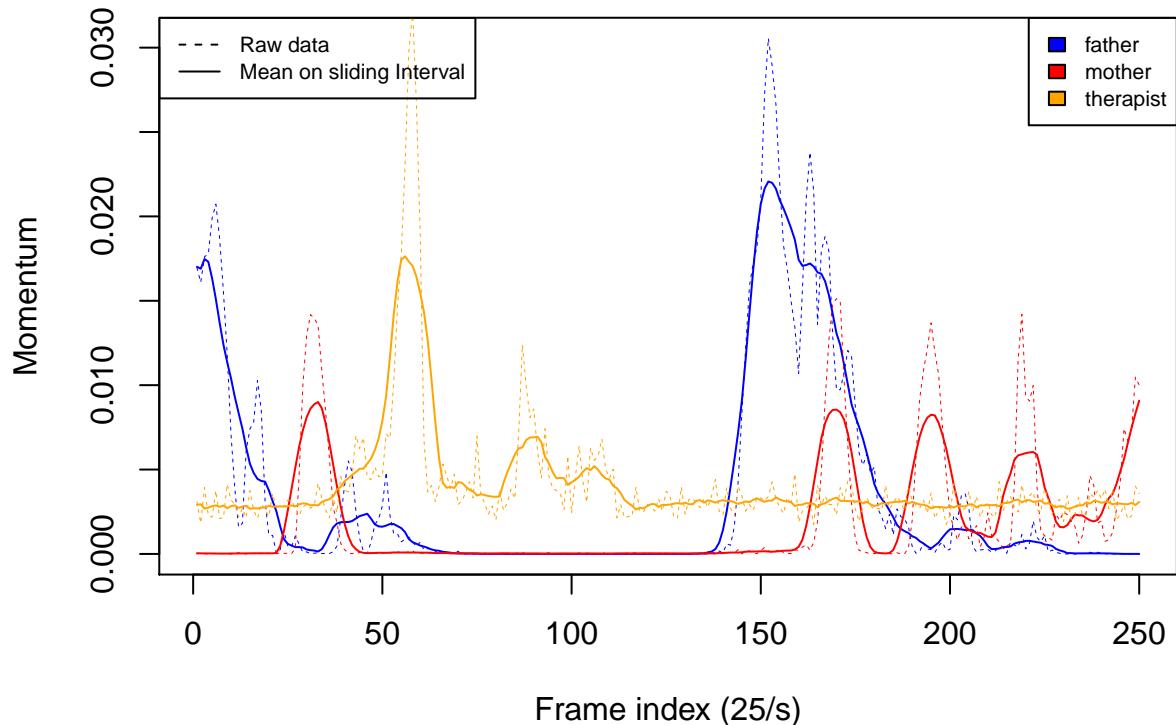
```
##      Min. 1st Qu. Median     Mean 3rd Qu.    Max. NA's
## 0.001964 0.003099 0.003349 0.004673 0.004016 0.174000      1
```

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

Sliding interval function on a 11 frames interval

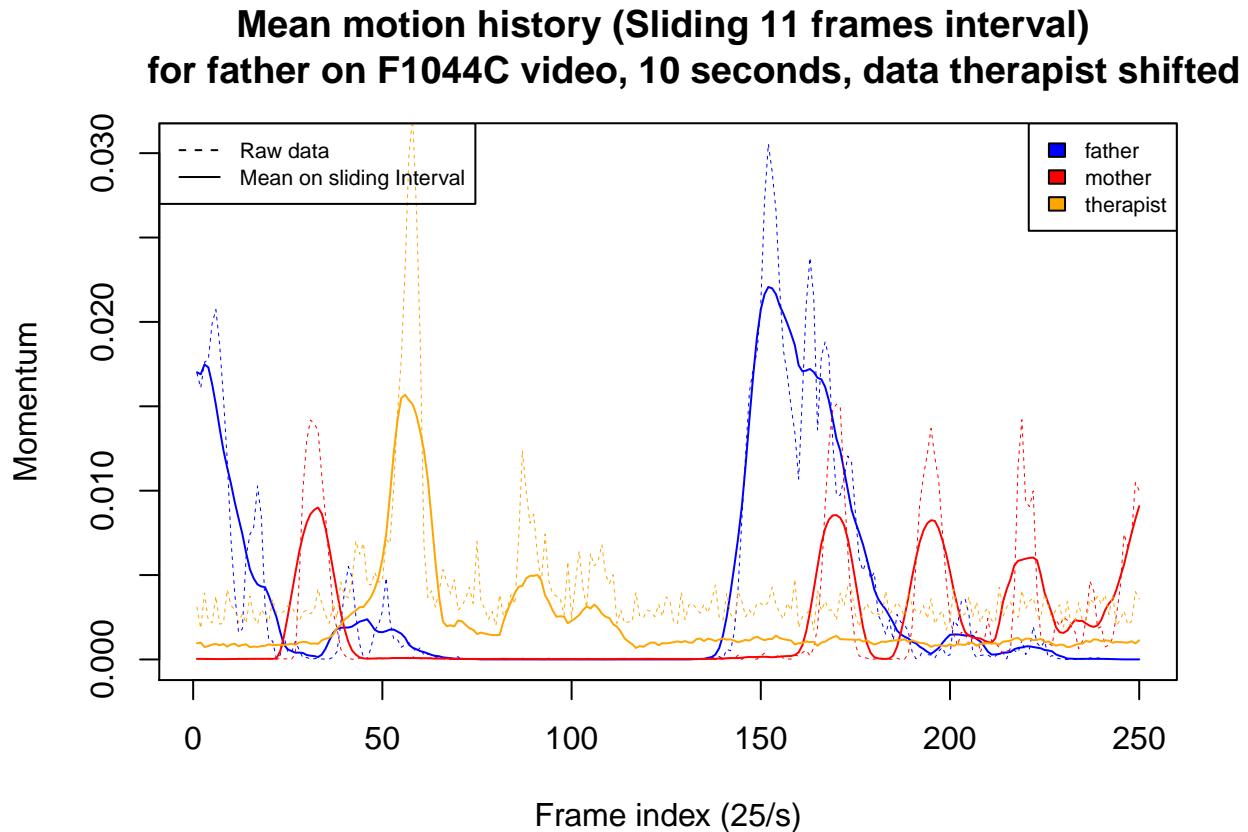
```
par(mar=c(4,4,4,2))
plot(1:250, data$father[6:255], main="Mean motion history (Sliding 11 frames interval)
for father on F1044C video, 10 seconds ", xlab="Frame index (25/s)", ylab="Momentum",
col="blue", type="l", lty=2, lwd=0.5)
lines(slidedfather[1:250], col="blue", lty=1)
lines(data$mother[6:255], col="red", lty=2, lwd=0.5)
lines(slidemother[1:250], col="red", lty=1)
lines(data$therapist[6:255], col="orange", lty=2, lwd=0.5)
lines(slidetherapist[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)
```

**Mean motion history (Sliding 11 frames interval)
for father on F1044C video, 10 seconds**



Sliding interval function on a 11 frames interval with shifting of therapist (subtraction of min value of therapist)

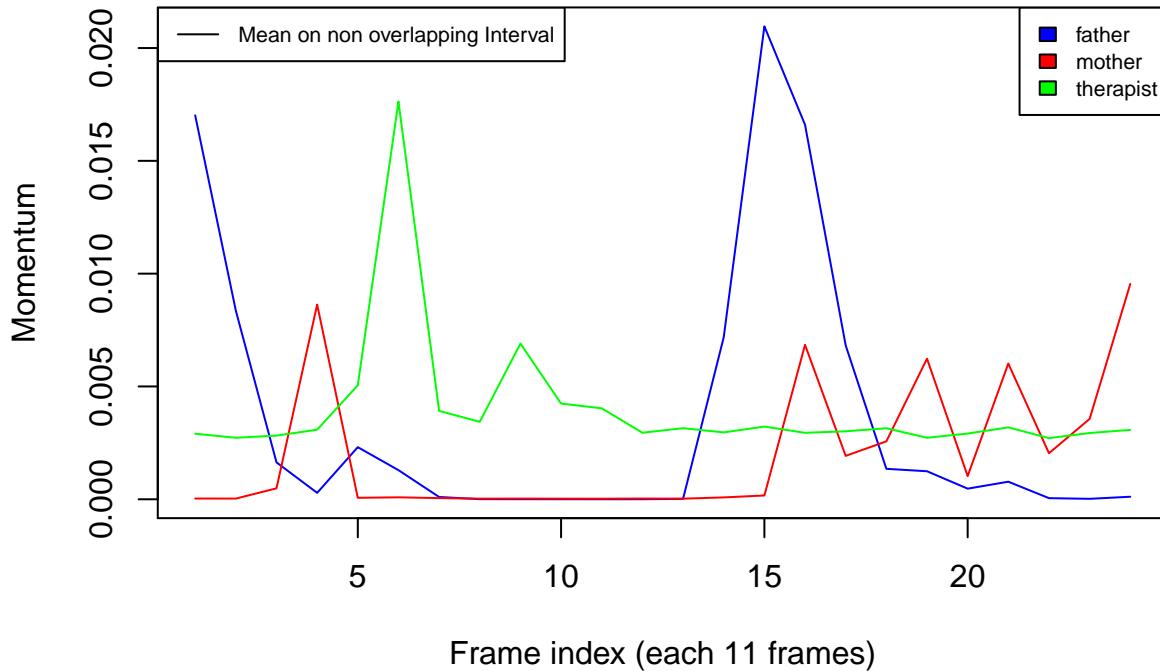
```
par(mar=c(4,4,4,2))
plot(1:250, data$father[6:255], main="Mean motion history (Sliding 11 frames interval)
for father on F1044C video, 10 seconds, data therapist shifted", xlab="Frame index (25/s)", ylab="Momentum")
for father on F1044C video, 10 seconds, data therapist shifted", xlab="Frame index (25/s)", ylab="Momentum")
  for father on F1044C video, 10 seconds, data therapist shifted", xlab="Frame index (25/s)", ylab="Momentum")
    col="blue", type="l", lty=2, lwd=0.5)
lines(slidedfather[1:250], col="blue", lty=1)
lines(data$mother[6:255], col="red", lty=2, lwd=0.5)
lines(slidemother[1:250], col="red", lty=1)
lines(data$therapist[6:255], col="orange", lty=2, lwd=0.5)
lines(slidetherapist[1:250]-min(slidetherapist), 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 11 frames interval

```
plot (1:24, fatherEleven[1:24], type="l", col="blue", main="Mean Momentum (non overlapping 11 frames
intervals) for father on F1044C video, first 10 seconds", ylab="Momentum", xlab="Frame index (each
lines(motherEleven[1:24], col="red", lty=1)
lines(therapistEleven[1:24], 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)
```

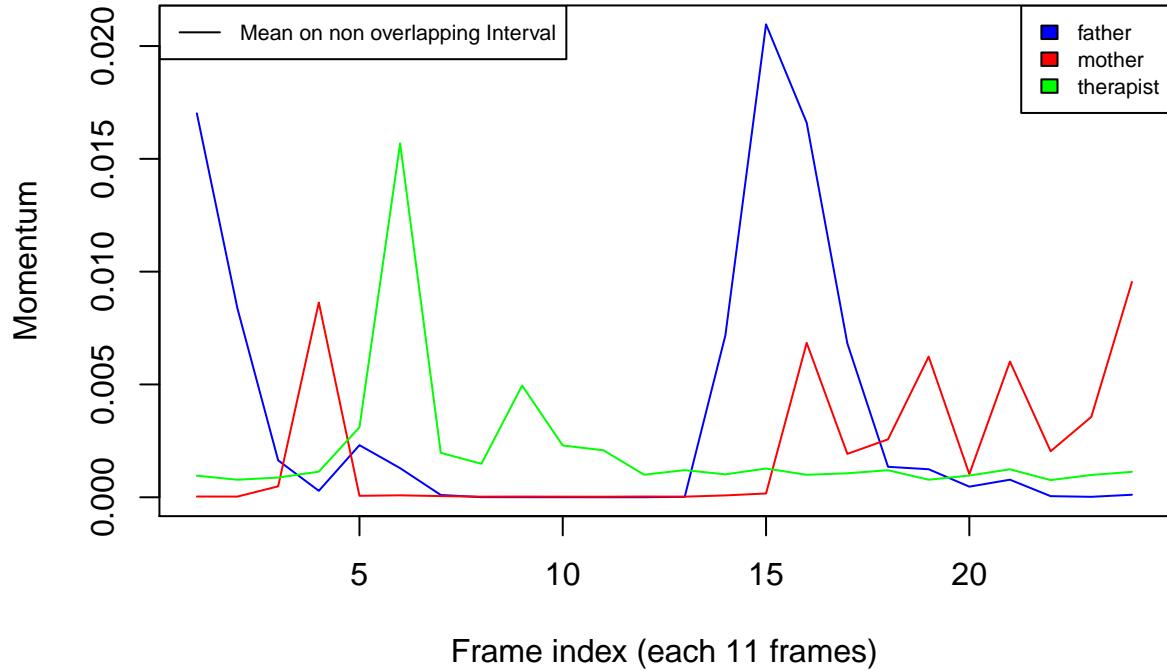
Mean Momentum (non overlapping 11 frames intervals) for father on F1044C video, first 10 seconds



Non overlapping interval function on a 11 frames interval with shifting of therapist (substraction of min value of therapist)

```
plot (1:24, fatherEleven[1:24], type="l", col="blue", main="Mean Momentum (non overlapping 11 frames intervals) for father on F1044C video, first 10 seconds, data therapist shifted", ylab="Momentum")
lines(motherEleven[1:24], col="red", lty=1)
lines(therapistEleven[1:24]-min(slidetherapist), 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)
```

Mean Momentum (non overlapping 11 frames intervals) for father on F1044C video, first 10 seconds, data therapist

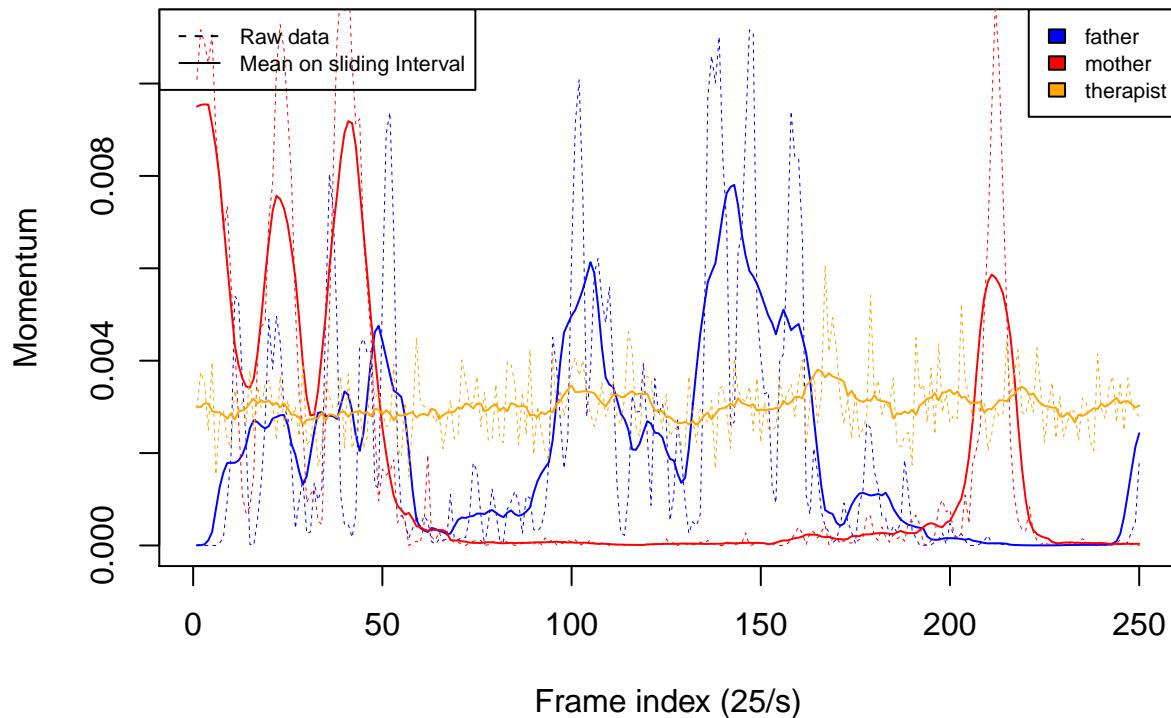


Motion history of the father during 10-20 seconds of the first video(C)

Non overlapping interval function on a 11 frames interval

```
par(mar=c(4,4,4,2))
plot(1:250, data$father[256:505], main="Mean motion history (Sliding 11 frames interval) for father on F1044C video, 10-20 seconds", xlab="Frame index (25/s)", ylab="Momentum", cex=0.7)
lines(slidedfather[251:500], col="blue", lty=1)
lines(data$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], 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)
```

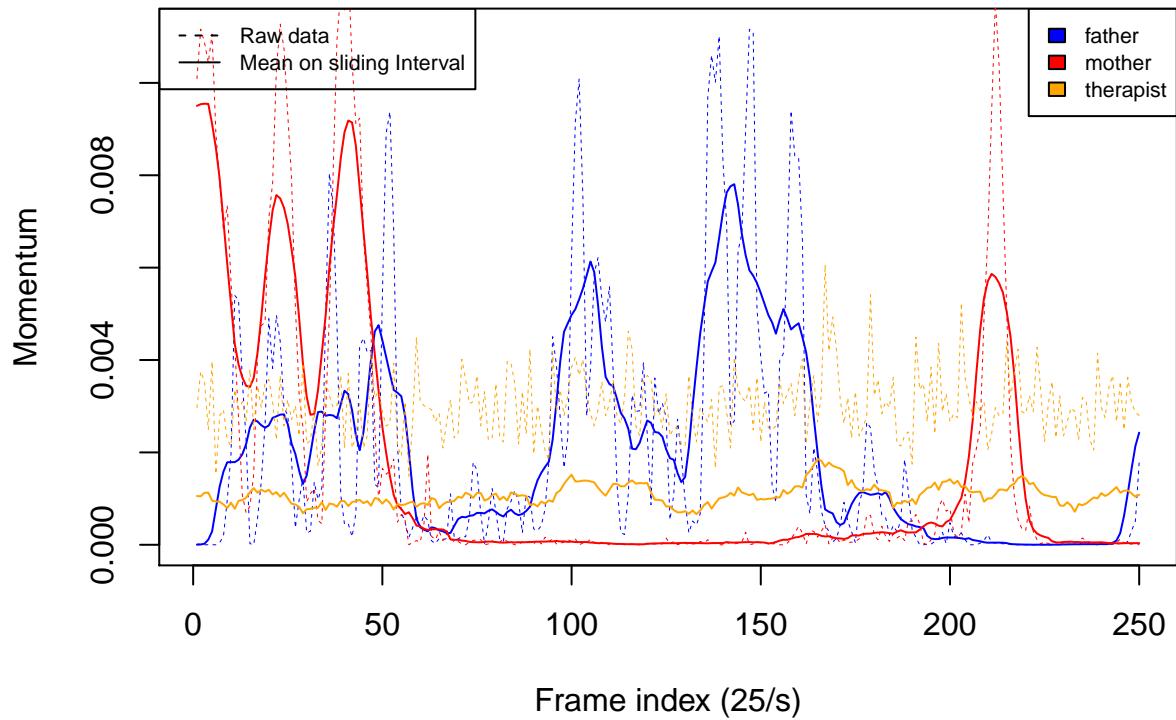
Mean motion history (Sliding 11 frames interval) for father on F1044C video, 10–20 seconds



Non overlapping interval function on a 11 frames interval with shifting of therapist (substraction of min value of therapist)

```
par(mar=c(4,4,4,2))
plot(1:250, data$father[256:505], main="Mean motion history (Sliding 11 frames
interval) for father on F1044C video, 10–20 seconds,
data therapist shifted", xlab="Frame index (25/s)", ylab="Momentum", col="blue", type="l", lty=2, lwd=0.5)
lines(slidedfather[251:500], col="blue", lty=1)
lines(data$mother[256:505], col="red", lty=2, lwd=0.5)
lines(slidemother[251:500], col="red", lty=1)
lines(data$therapist[256:505], col="orange", lty=2, lwd=0.5)
lines(slidetherapist[251:500]-min(slidetherapist), 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)
```

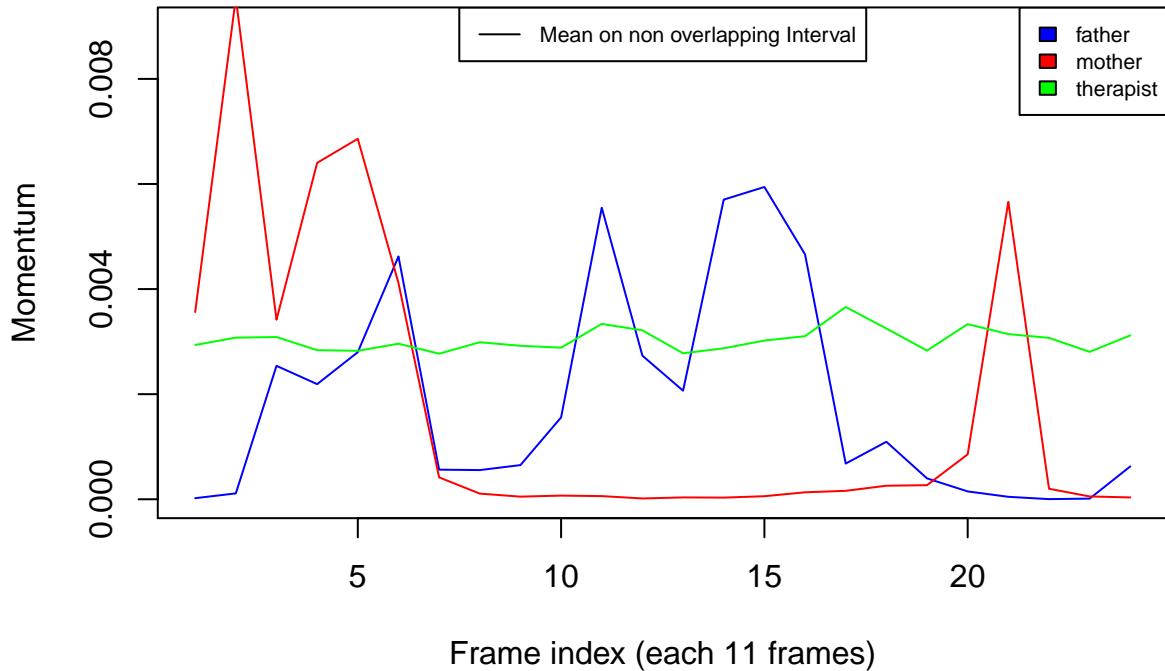
Mean motion history (Sliding 11 frames interval) for father on F1044C video, 10–20 seconds, data therapist shifted



Non overlapping interval function on a 11 frames interval

```
plot (1:24, fatherEleven[23:46], type="l", col="blue", main="Mean Momentum (non overlapping 11 frames interval for father on F1044C video, between 10-20 seconds", ylab="Momentum", xlab="Frame index (each 11 frames)", ylim=c(0,0.008))
lines(motherEleven[23:46], col="red", lty=1)
lines(therapistEleven[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)
```

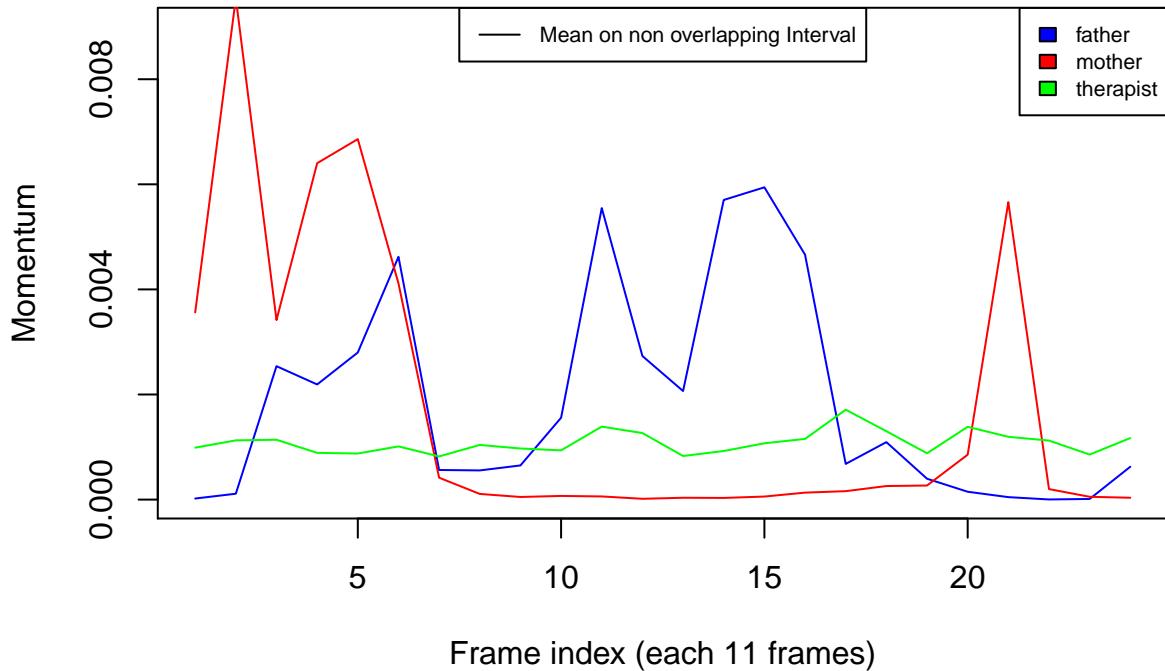
Mean Momentum (non overlapping 11 frames intervals) for father on F1044C video, between 10–20 seconds



Non overlapping interval function on a 11 frames interval with shifting of therapist (substraction of min value of therapist)

```
plot (1:24, fatherEleven[23:46], type="l", col="blue", main="Mean Momentum (non overlapping 11 frames intervals for father on F1044C video, between 10-20 seconds, data therapist shifted", ylab="Momentum", xlab="Frame index (each 11 frames)", ylim=c(0, 0.009)) lines(motherEleven[23:46], col="red", lty=1) lines(therapistEleven[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 Momentum (non overlapping 11 frames intervals) for father on F1044C video, between 10–20 seconds, data therapist shifted



Mean Momentum by minute plots

```

for (i in 1:NumberOfvideos){
  fatherMinute<- MeanMomentumByTime("father", index0fvideos=i, interval=1500, data)

  MotherMinute<- MeanMomentumByTime("mother", index0fvideos=i, interval=1500, data)

  TherapistMinute<- MeanMomentumByTime("therapist", index0fvideos=i, interval=1500, data)

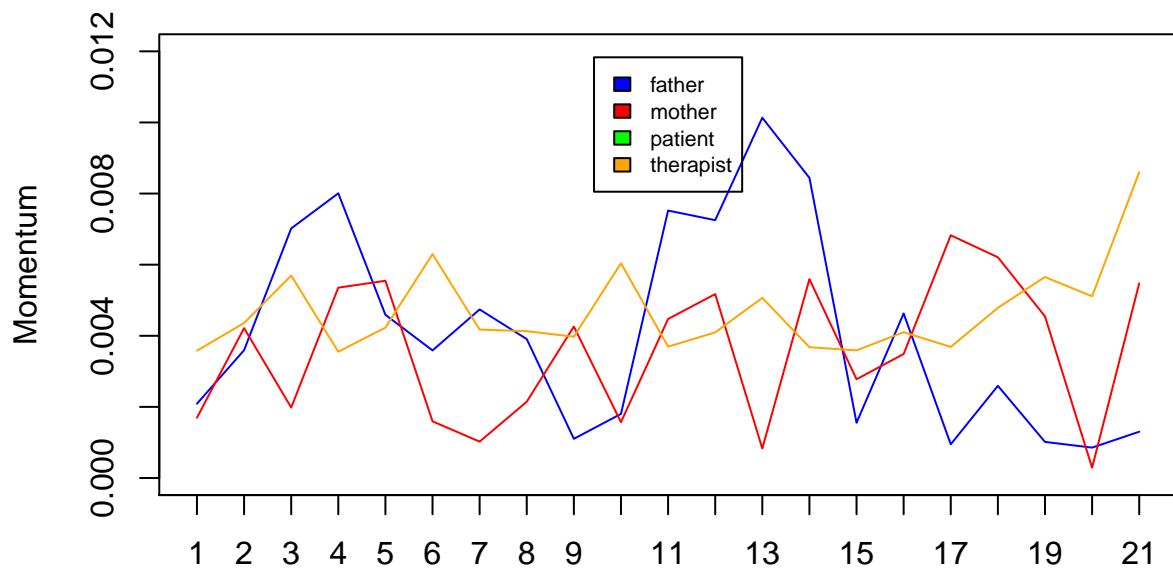
  PatientMinute<- MeanMomentumByTime("patient", index0fvideos=i, interval=1500, data)

length(fatherMinute)

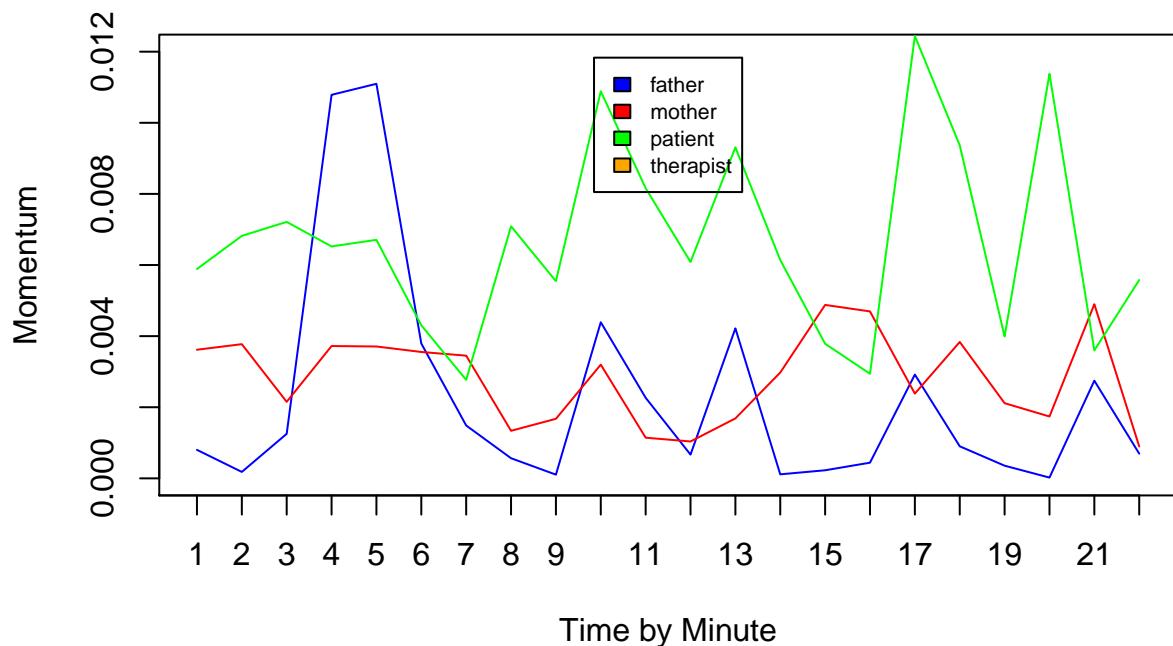
  par(mar=c(4,4,4,2))
  plot (1:length(fatherMinute), fatherMinute, type="l", col="blue",
  main=paste("Mean Momentum (non overlaping minute intervals)
on F1044", labelvideolist[i], " video" , sep=""),
  ylab="Momentum", xlab="Time by Minute", ylim=c(0, 12E-03),
  xaxp=c(0, length(fatherMinute), length(fatherMinute)))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

```

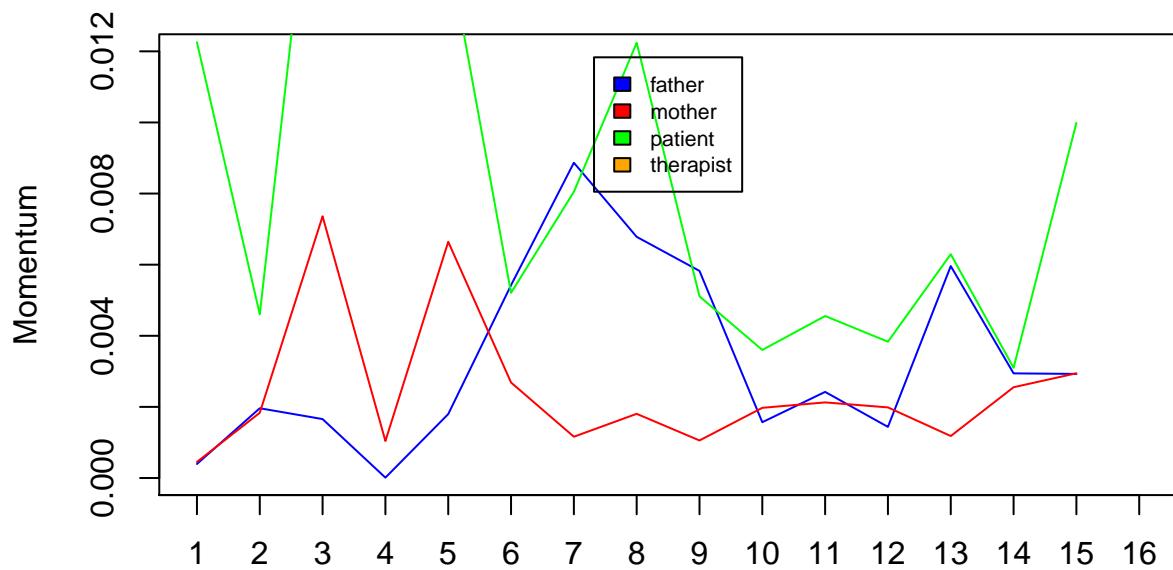
**Mean Momentum (non overlapping minute intervals)
on F1044C video**



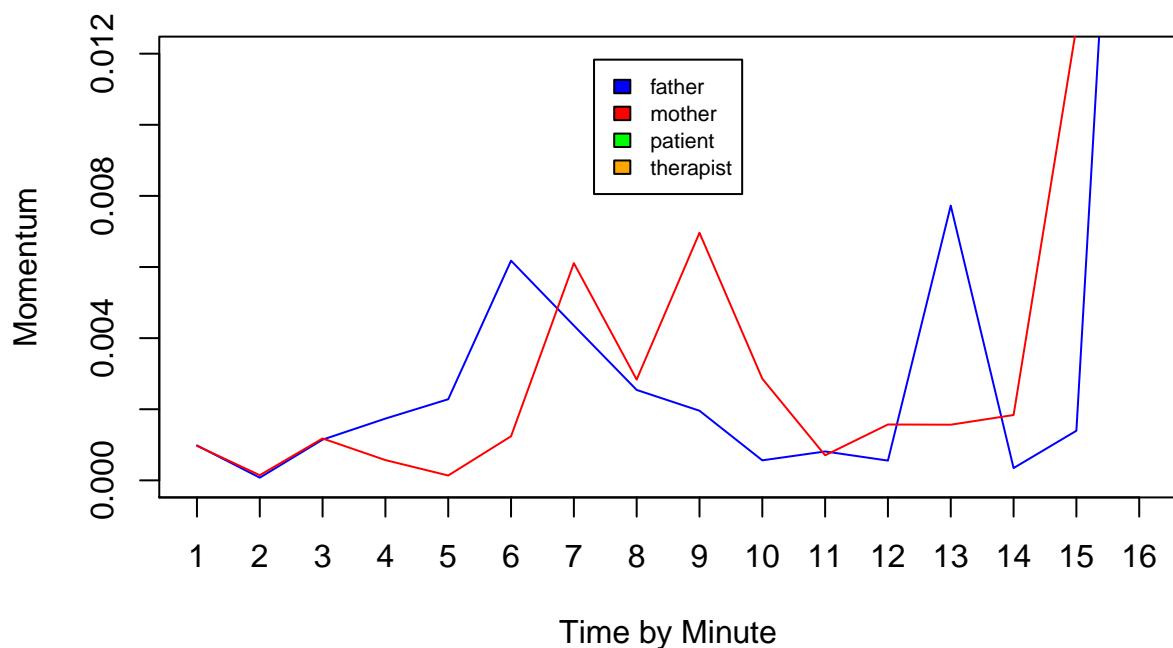
**Time by Minute
Mean Momentum (non overlapping minute intervals)
on F1044D1 video**



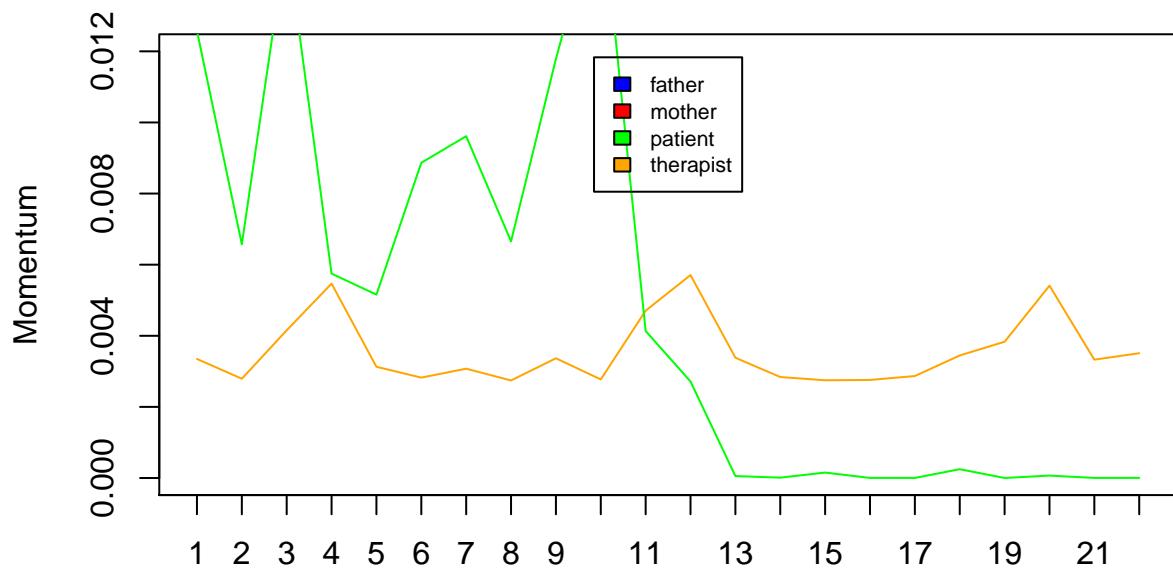
**Mean Momentum (non overlapping minute intervals)
on F1044D2 video**



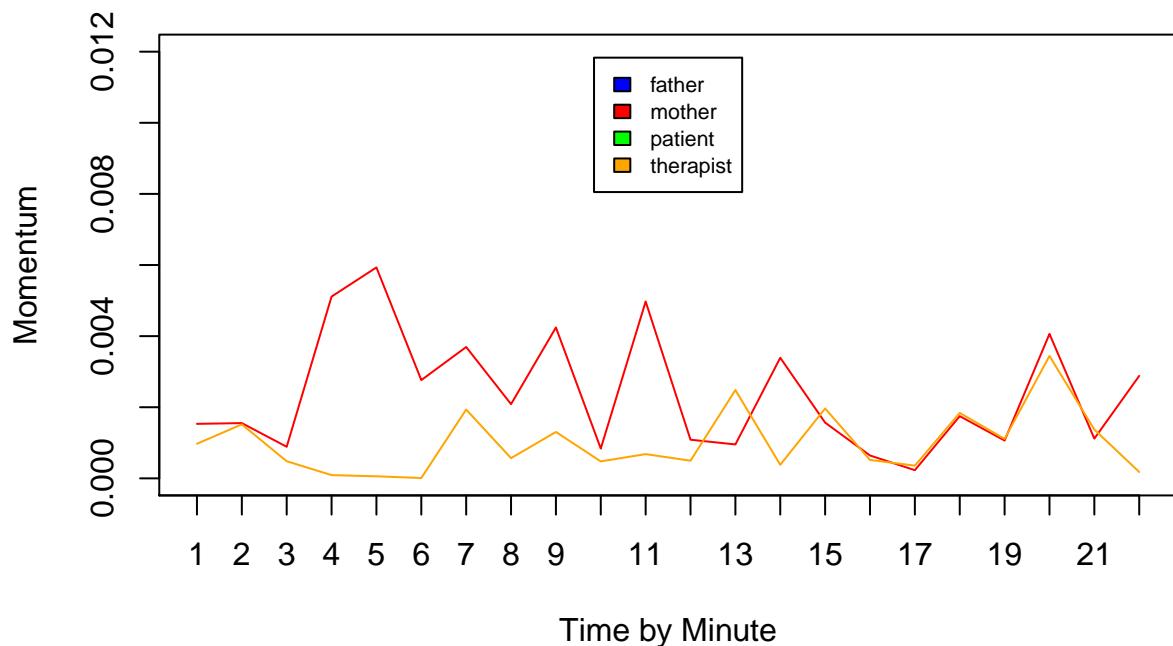
**Time by Minute
Mean Momentum (non overlapping minute intervals)
on F1044E video**



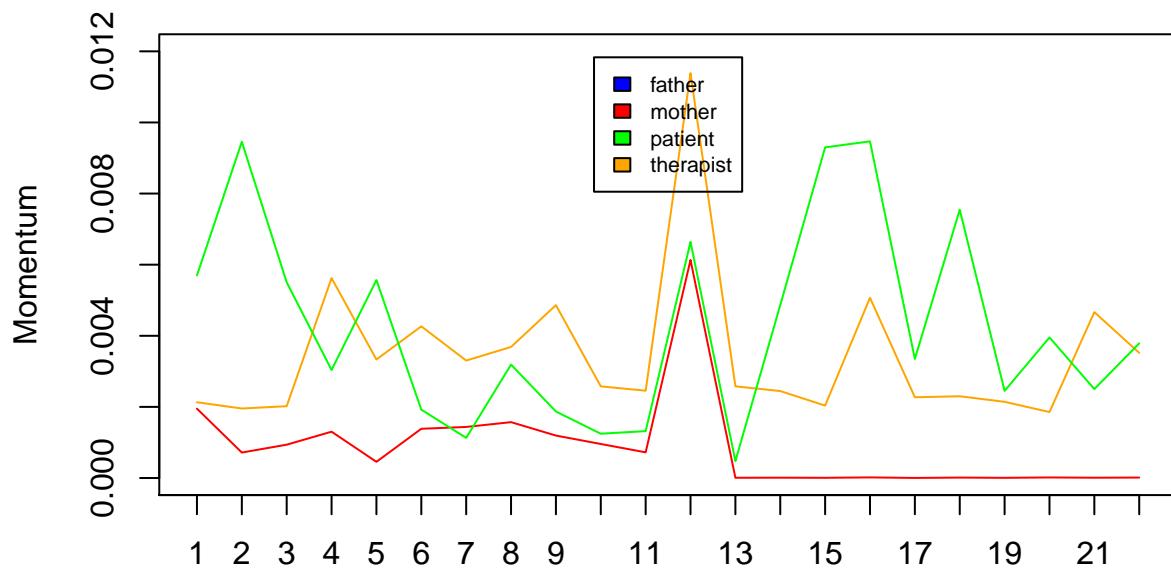
**Mean Momentum (non overlapping minute intervals)
on F1044F video**



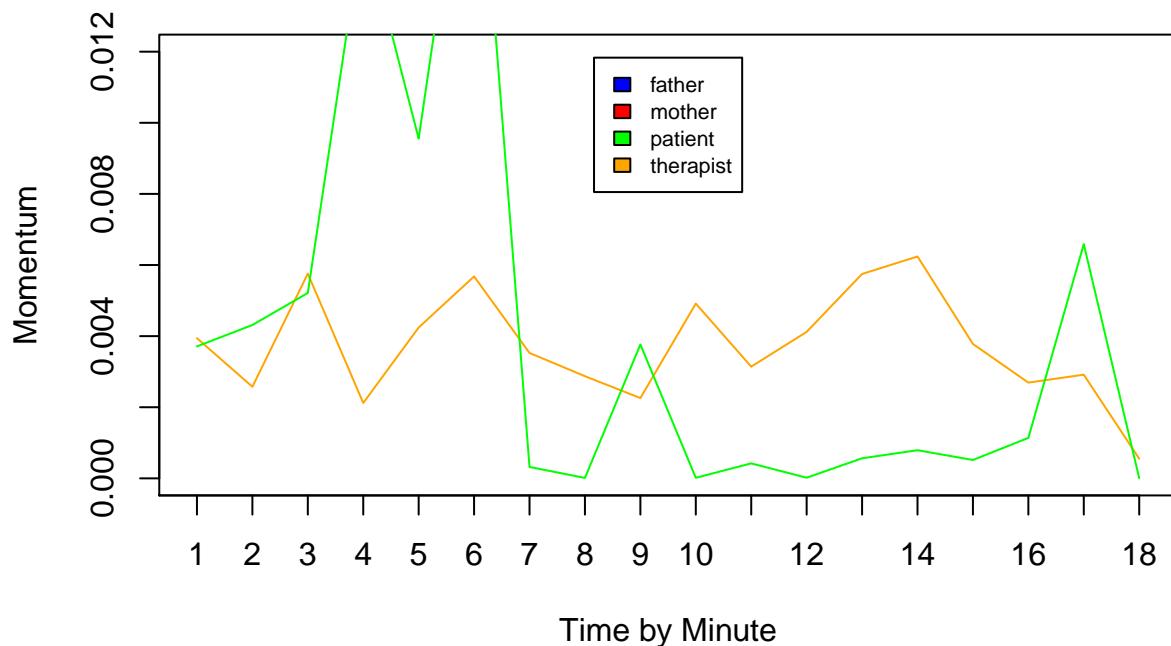
**Time by Minute
Mean Momentum (non overlapping minute intervals)
on F1044G video**



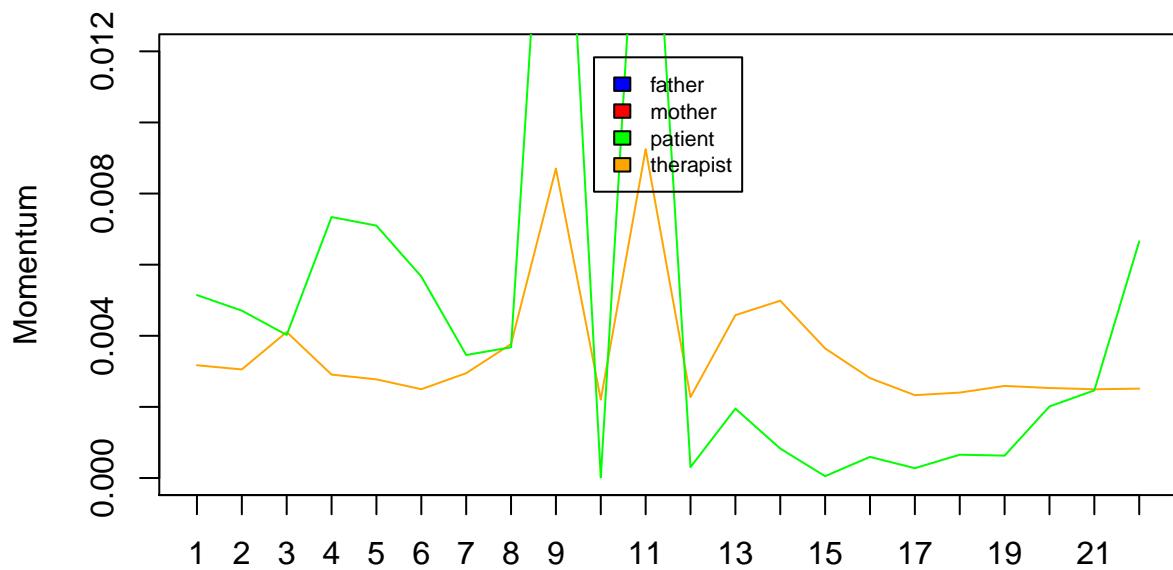
**Mean Momentum (non overlapping minute intervals)
on F1044H video**



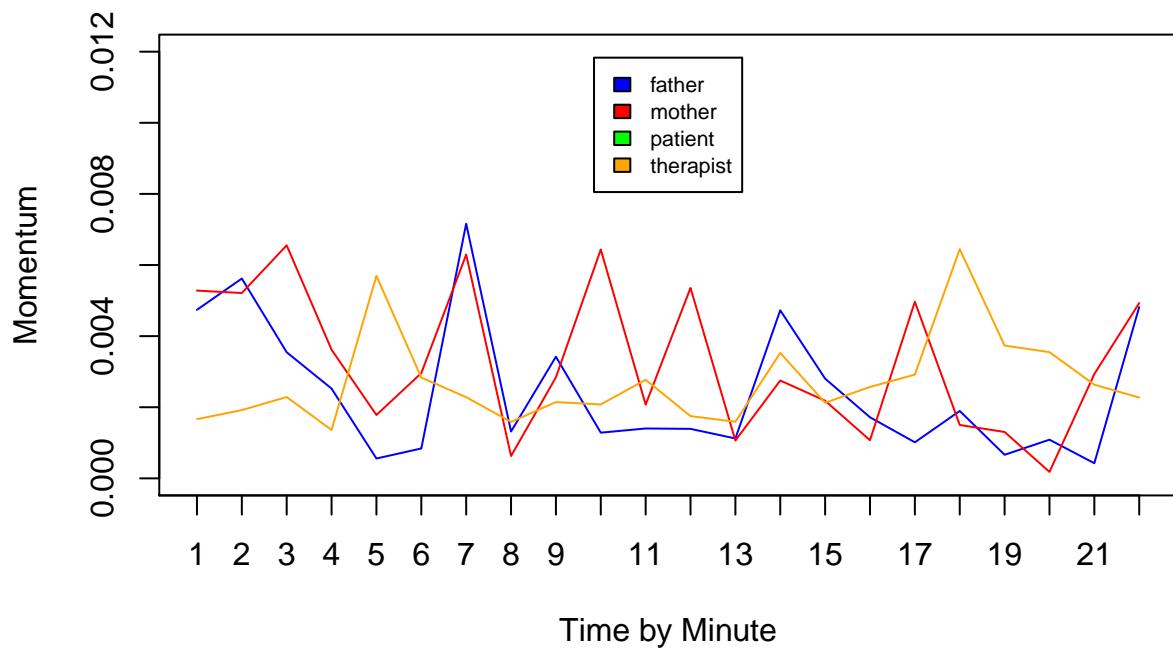
**Time by Minute
Mean Momentum (non overlapping minute intervals)
on F1044I video**



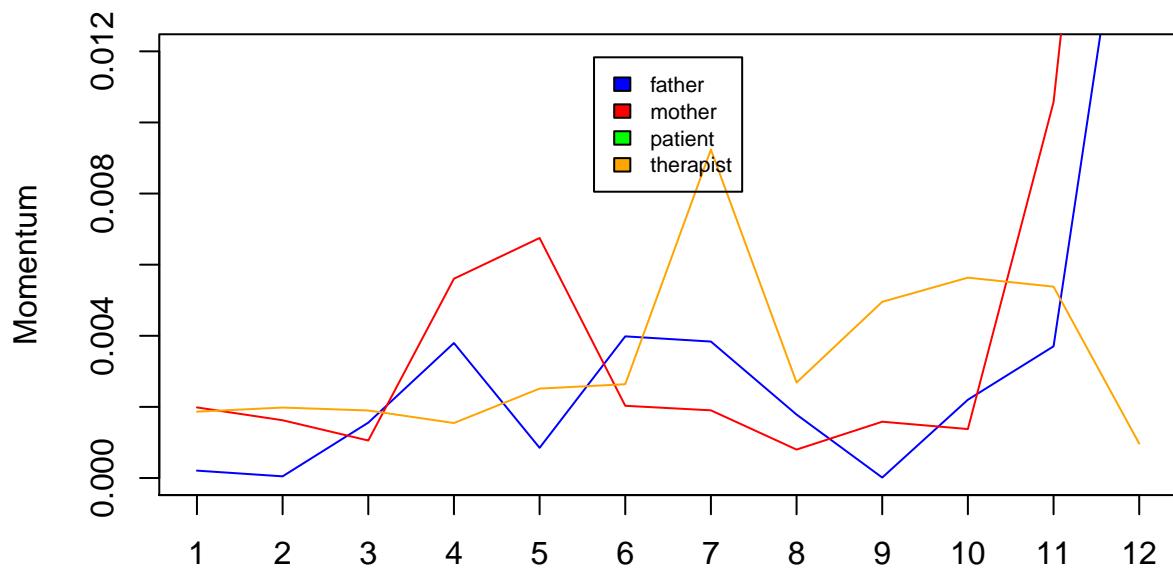
**Mean Momentum (non overlapping minute intervals)
on F1044L video**



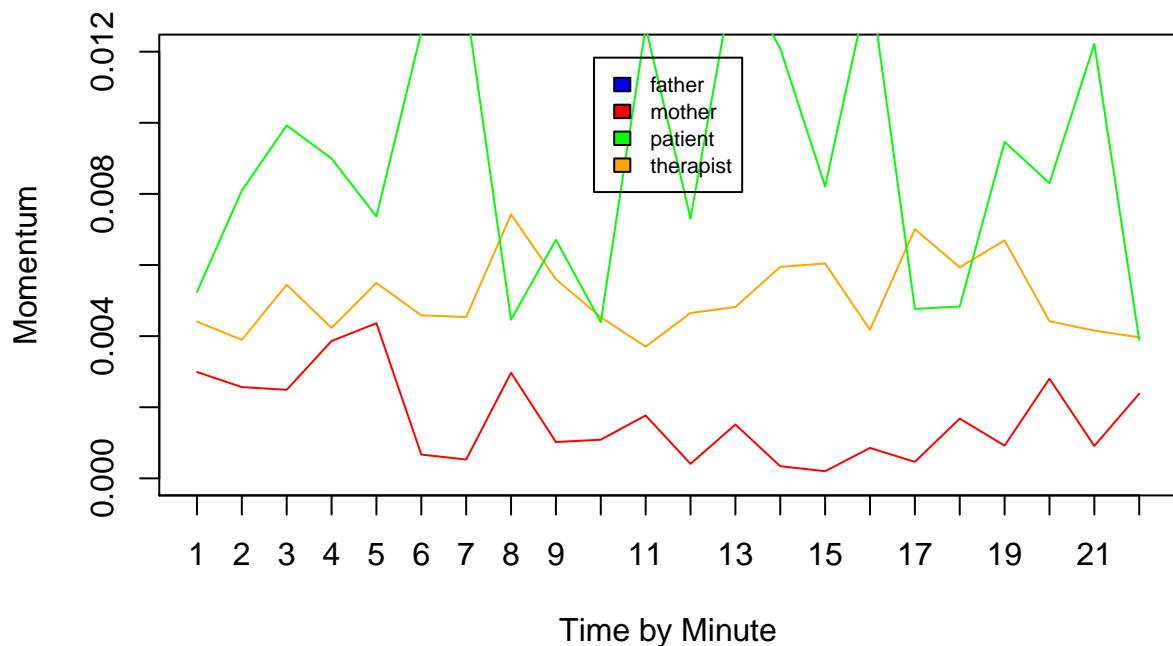
**Time by Minute
Mean Momentum (non overlapping minute intervals)
on F1044M1 video**



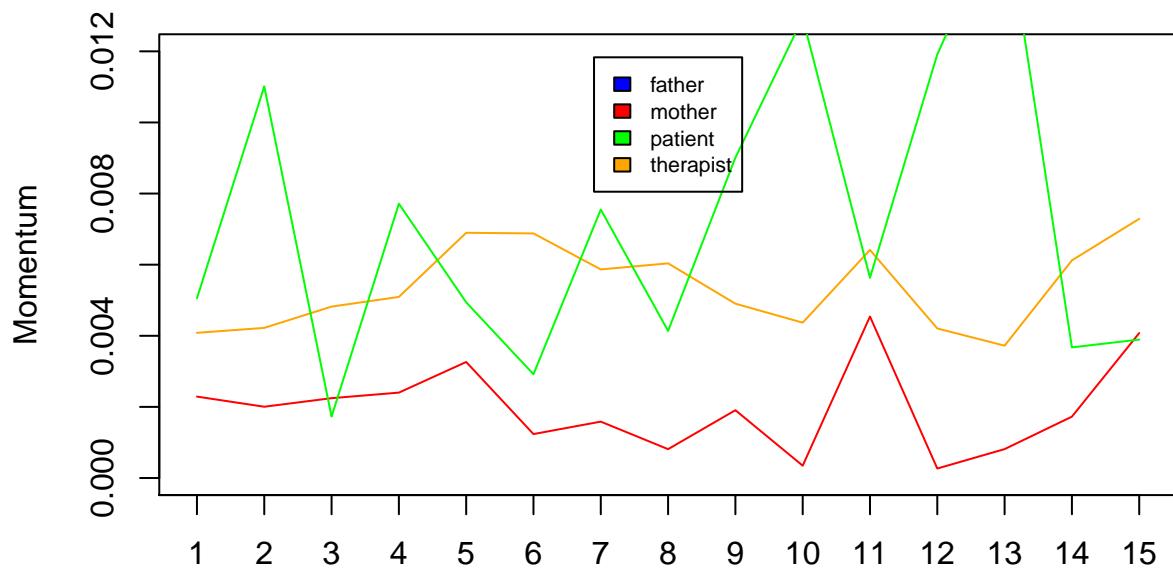
**Mean Momentum (non overlapping minute intervals)
on F1044M2 video**



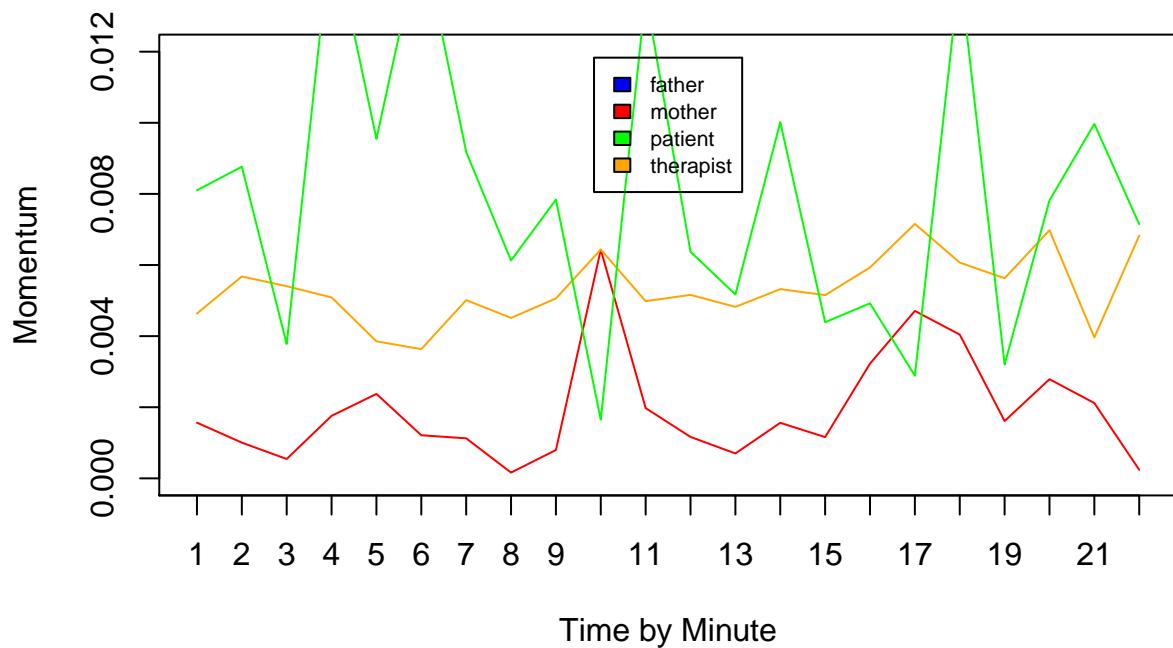
**Time by Minute
Mean Momentum (non overlapping minute intervals)
on F1044N video**



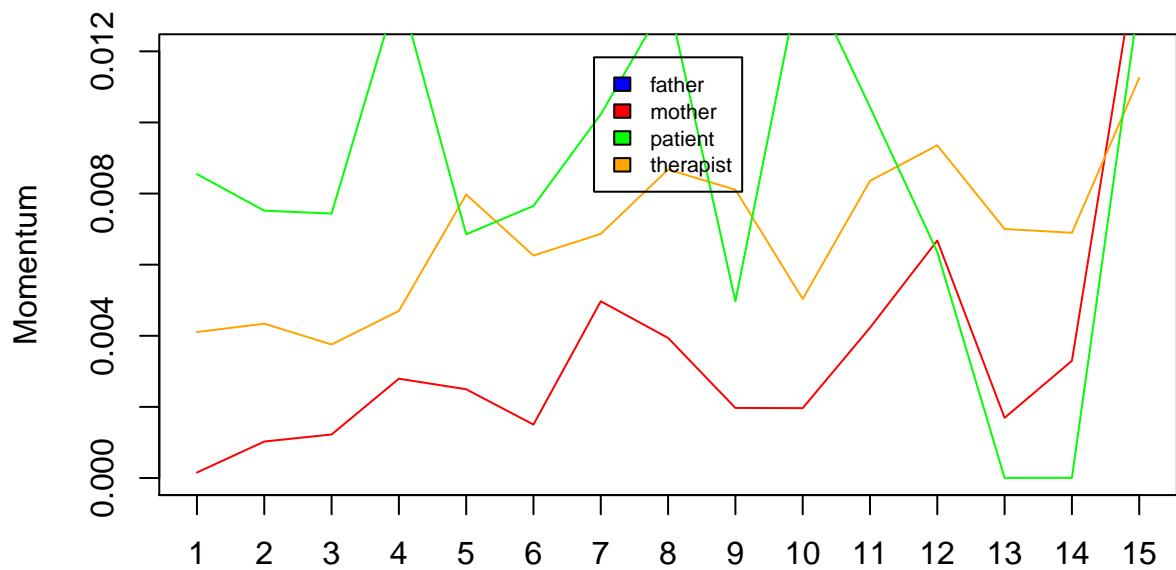
**Mean Momentum (non overlapping minute intervals)
on F1044O video**



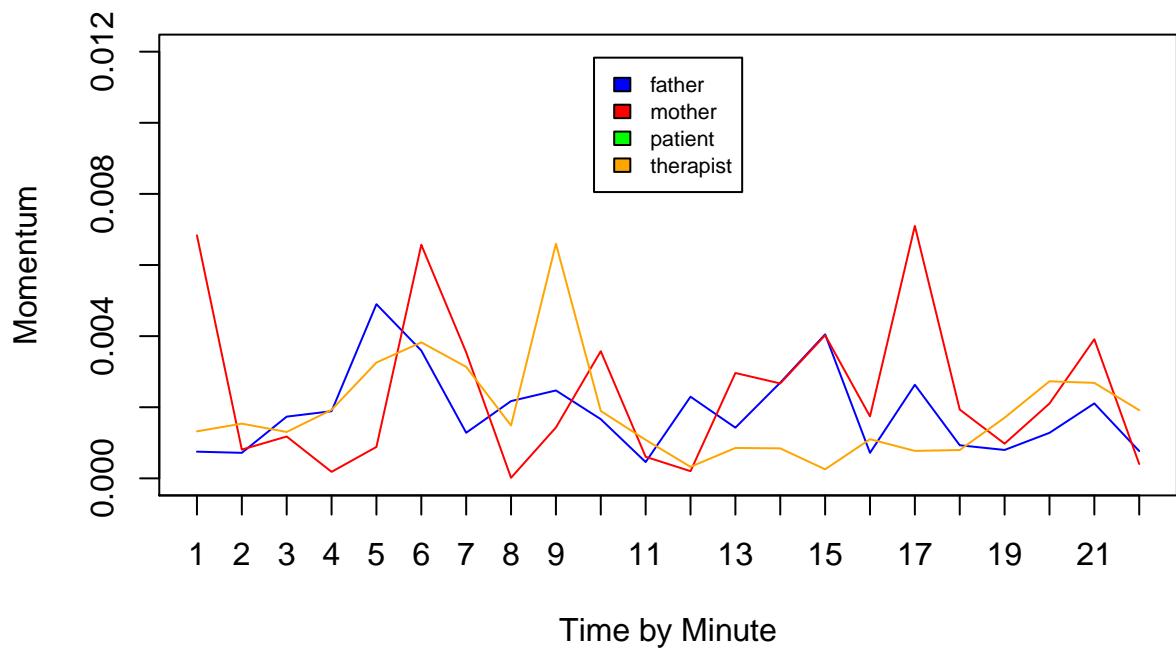
**Time by Minute
Mean Momentum (non overlapping minute intervals)
on F1044P video**



**Mean Momentum (non overlapping minute intervals)
on F1044Q video**



**Time by Minute
Mean Momentum (non overlapping minute intervals)
on F1044R1 video**



**Mean Momentum (non overlapping minute intervals)
on F1044R2 video**

