mfccGamms

```
#setwd(choose.dir())
```

```
require(tidyverse)
require(mgcv)
require(mgcViz)
require(itsadug)
```

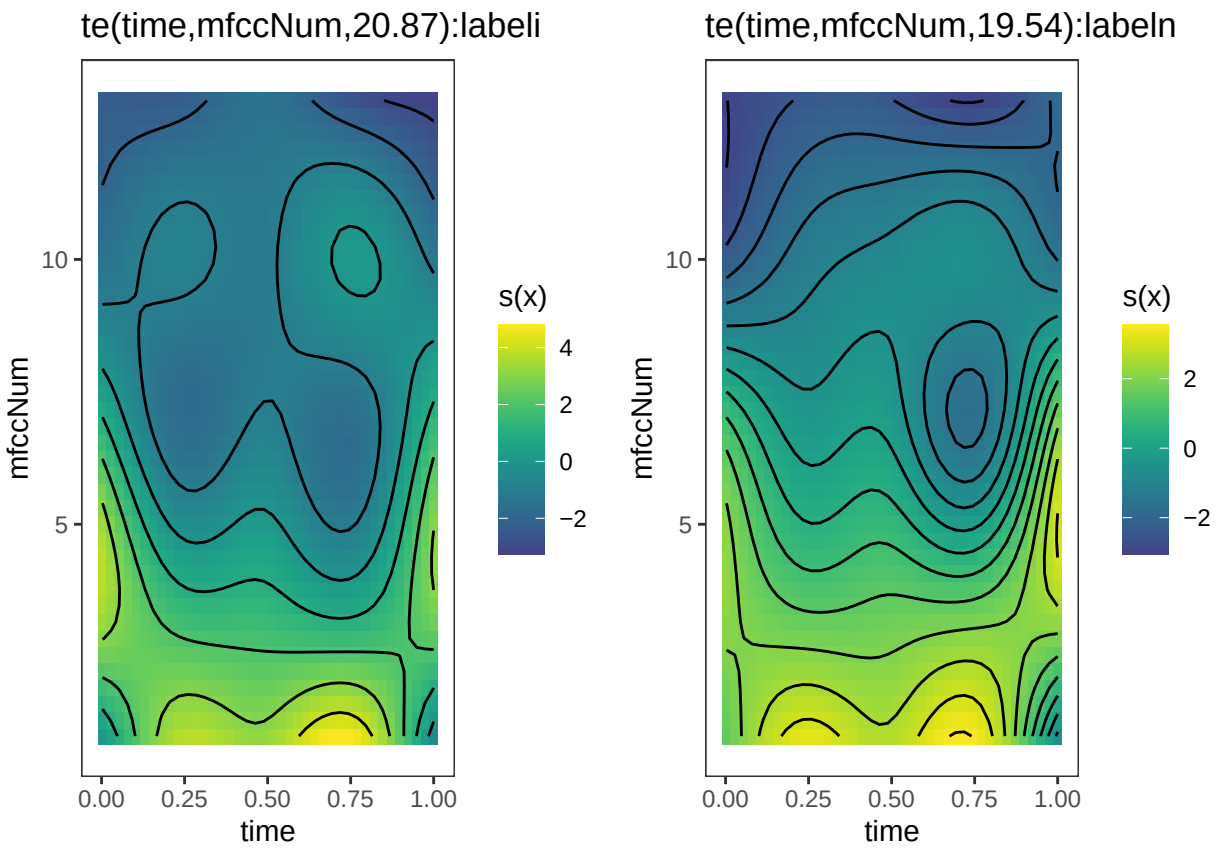
Load prepared mfcc data

```
mfccData = read.csv("mfcc_ready_for_gamms.csv")
bmfcc = filter(mfccData, mfccData$speaker=="b")
gmfcc = filter(mfccData, mfccData$speaker=="g")
pmfcc = filter(mfccData, mfccData$speaker=="p")
rmfcc = filter(mfccData, mfccData$speaker=="r")
ymfcc = filter(mfccData, mfccData$speaker=="y")

mfccData$speaker = as.factor(mfccData$speaker)
mfccData$label = as.factor(mfccData$label)

bmfcc$speaker = as.factor(bmfcc$speaker)
bmfcc$label = as.factor(bmfcc$label)
gmfcc$speaker = as.factor(gmfcc$speaker)
gmfcc$label = as.factor(gmfcc$label)
pmfcc$speaker = as.factor(pmfcc$speaker)
pmfcc$label = as.factor(pmfcc$label)
rmfcc$speaker = as.factor(rmfcc$speaker)
rmfcc$label = as.factor(rmfcc$label)
ymfcc$speaker = as.factor(ymfcc$speaker)
ymfcc$label = as.factor(ymfcc$label)
```

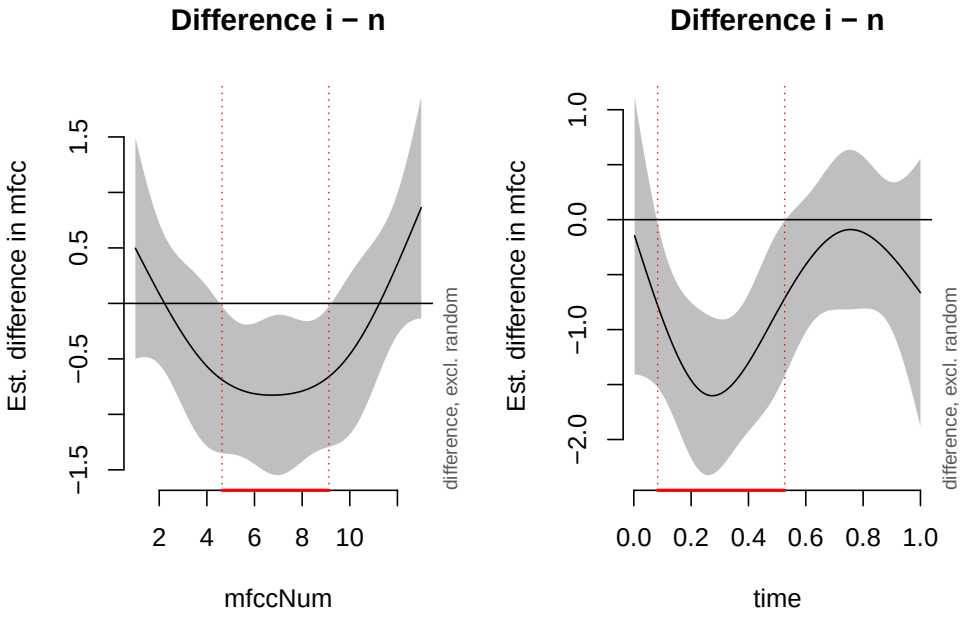
GAM with tensor product interaction for mfcc

```
m1mfcc=bam(mfcc ~ label + te(time, mfccNum, by=label) + s(time, speaker, bs="fs", m=1)
           + s(mfccNum, speaker, bs="fs", m=1), data=mfccData)
m1mfccViz = getViz(m1mfcc)
```

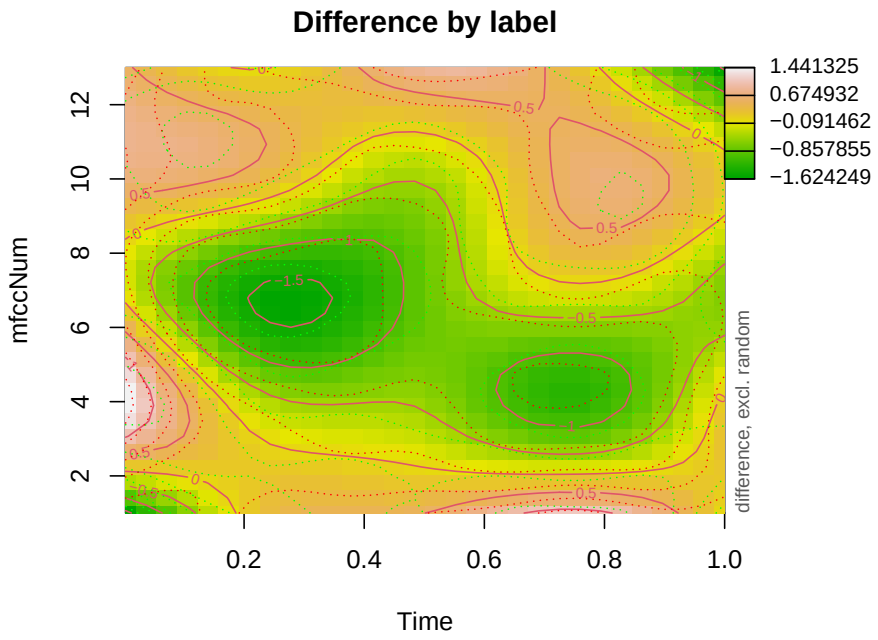
```
print(plot(m1mfccViz, allTerms=T), pages=3)
```



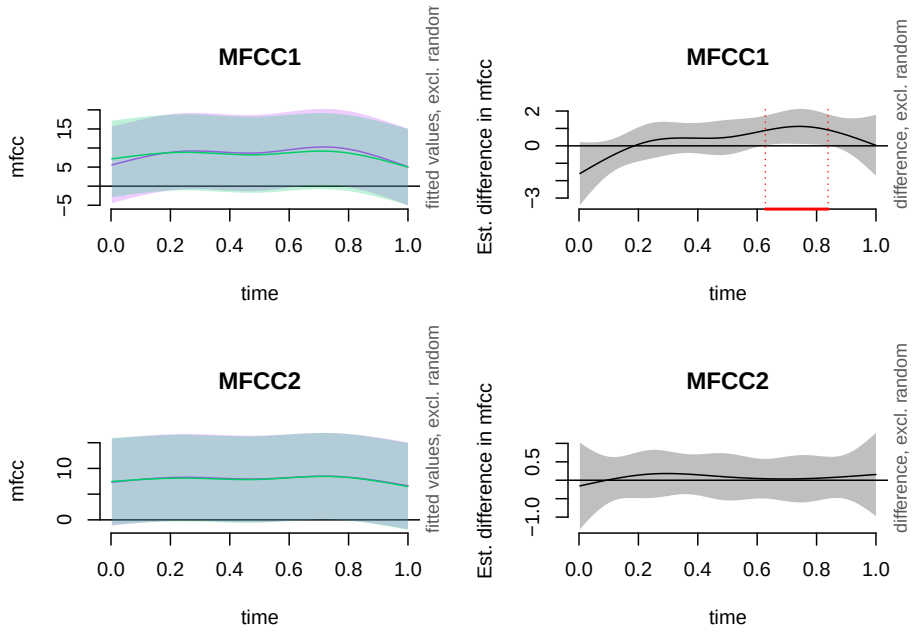

```
par(mfrow=c(1, 2))
plot_diff(m1mfcc, view="mfccNum", shade=TRUE, comp=list(label=c("i", "n")))
plot_diff(m1mfcc, view="time", shade=TRUE, comp=list(label=c("i", "n")))
```



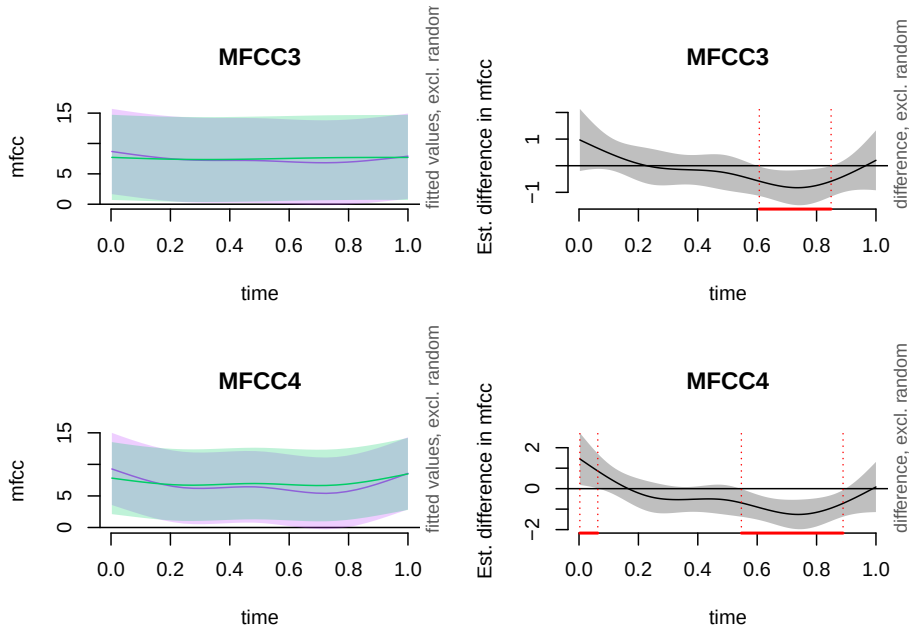
```
par(mfrow=c(1, 1))
par(mar=c(5, 5, 3, 8))
plot_diff2(m1mfcc, view=c('time', "mfccNum"), comp=list(label=c("i", "n")),
           main="Difference by label", xlab="Time", ylab="mfccNum")
```



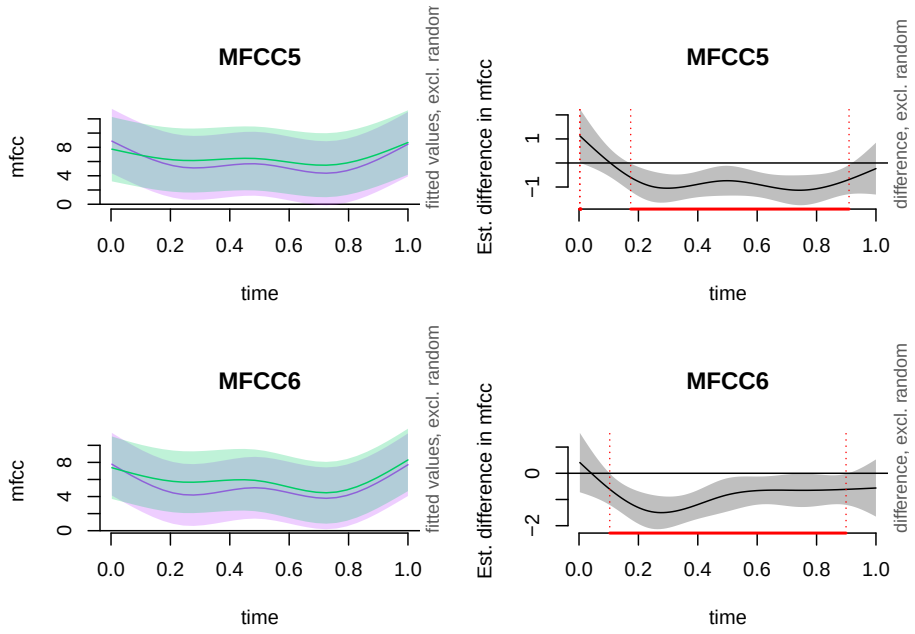

```
par(mfrow=c(2, 2))
plot.new
plot_smooth(m1mfcc, view="time", cond=list("label"="i", mfccNum=1),
            col="darkorchid1", main="MFCC1")
plot_smooth(m1mfcc, view="time", cond=list("label"="n", mfccNum=1),
            col="springgreen3", main="", add=TRUE)
plot_diff(m1mfcc, view="time", shade=TRUE, comp=list(label=c("i", "n")),
          cond=list(mfccNum=1), main="MFCC1")

plot_smooth(m1mfcc, view="time", cond=list("label"="i", mfccNum=2),
            col="darkorchid1", main="MFCC2")
plot_smooth(m1mfcc, view="time", cond=list("label"="n", mfccNum=2),
            col="springgreen3", main="", add=TRUE)
plot_diff(m1mfcc, view="time", shade=TRUE, comp=list(label=c("i", "n")),
          cond=list(mfccNum=2), main="MFCC2")
```



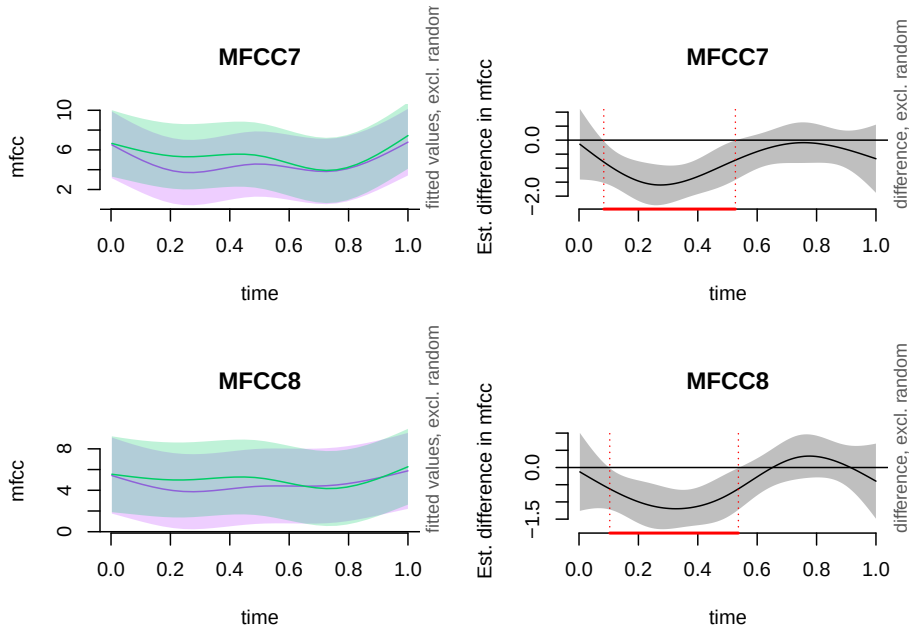

```
plot_smooth(m1mfcc, view="time", cond=list("label"="i", mfccNum=3),
            col="darkorchid1", main="MFCC3")
plot_smooth(m1mfcc, view="time", cond=list("label"="n", mfccNum=3),
            col="springgreen3", main="", add=TRUE)
plot_diff(m1mfcc, view="time", shade=TRUE, comp=list(label=c("i", "n")),
          cond=list(mfccNum=3), main="MFCC3")

plot_smooth(m1mfcc, view="time", cond=list("label"="i", mfccNum=4),
            col="darkorchid1", main="MFCC4")
plot_smooth(m1mfcc, view="time", cond=list("label"="n", mfccNum=4),
            col="springgreen3", main="", add=TRUE)
plot_diff(m1mfcc, view="time", shade=TRUE, comp=list(label=c("i", "n")),
          cond=list(mfccNum=4), main="MFCC4")
```



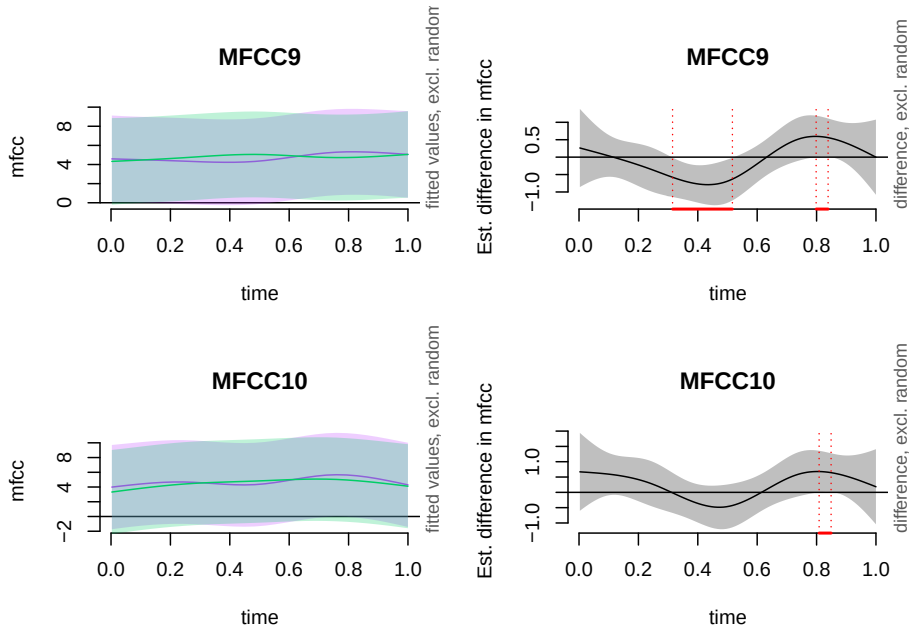

```
plot_smooth(m1mfcc, view="time", cond=list("label"="i", mfccNum=5),
            col="darkorchid1", main="MFCC5")
plot_smooth(m1mfcc, view="time", cond=list("label"="n", mfccNum=5),
            col="springgreen3", main="", add=TRUE)
plot_diff(m1mfcc, view="time", shade=TRUE, comp=list(label=c("i", "n")),
          cond=list(mfccNum=5), main="MFCC5")

plot_smooth(m1mfcc, view="time", cond=list("label"="i", mfccNum=6),
            col="darkorchid1", main="MFCC6")
plot_smooth(m1mfcc, view="time", cond=list("label"="n", mfccNum=6),
            col="springgreen3", main="", add=TRUE)
plot_diff(m1mfcc, view="time", shade=TRUE, comp=list(label=c("i", "n")),
          cond=list(mfccNum=6), main="MFCC6")
```



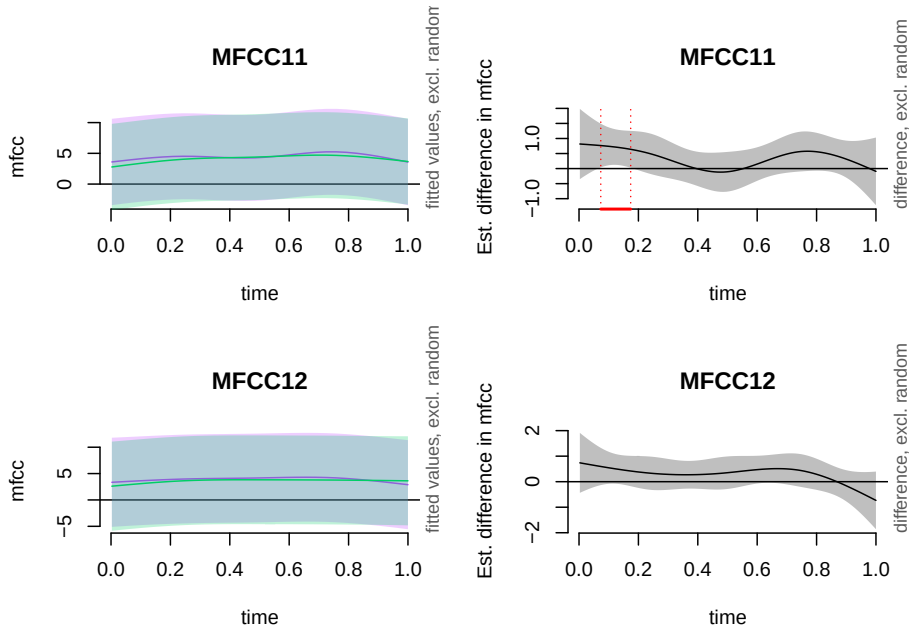

```
plot_smooth(m1mfcc, view="time", cond=list("label"="i", mfccNum=7),
            col="darkorchid1", main="MFCC7")
plot_smooth(m1mfcc, view="time", cond=list("label"="n", mfccNum=7),
            col="springgreen3", main="", add=TRUE)
plot_diff(m1mfcc, view="time", shade=TRUE, comp=list(label=c("i", "n")),
          cond=list(mfccNum=7), main="MFCC7")

plot_smooth(m1mfcc, view="time", cond=list("label"="i", mfccNum=8),
            col="darkorchid1", main="MFCC8")
plot_smooth(m1mfcc, view="time", cond=list("label"="n", mfccNum=8),
            col="springgreen3", main="", add=TRUE)
plot_diff(m1mfcc, view="time", shade=TRUE, comp=list(label=c("i", "n")),
          cond=list(mfccNum=8), main="MFCC8")
```



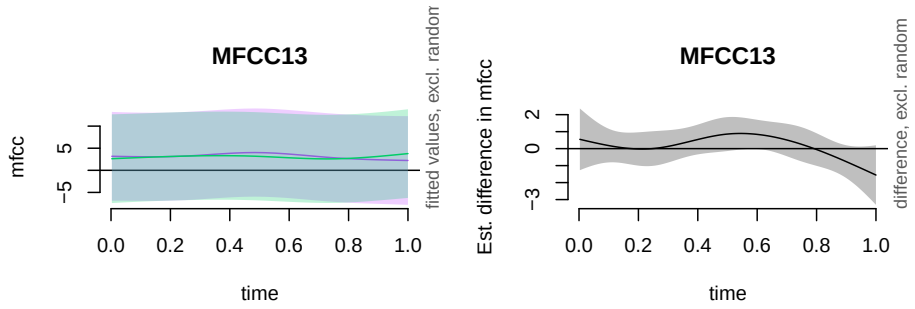

```
plot_smooth(m1mfcc, view="time", cond=list("label"="i", mfccNum=9),
            col="darkorchid1", main="MFCC9")
plot_smooth(m1mfcc, view="time", cond=list("label"="n", mfccNum=9),
            col="springgreen3", main="", add=TRUE)
plot_diff(m1mfcc, view="time", shade=TRUE, comp=list(label=c("i", "n")),
          cond=list(mfccNum=9), main="MFCC9")

plot_smooth(m1mfcc, view="time", cond=list("label"="i", mfccNum=10),
            col="darkorchid1", main="MFCC10")
plot_smooth(m1mfcc, view="time", cond=list("label"="n", mfccNum=10),
            col="springgreen3", main="", add=TRUE)
plot_diff(m1mfcc, view="time", shade=TRUE, comp=list(label=c("i", "n")),
          cond=list(mfccNum=10), main="MFCC10")
```




```
plot_smooth(m1mfcc, view="time", cond=list("label"="i", mfccNum=11),
            col="darkorchid1", main="MFCC11")
plot_smooth(m1mfcc, view="time", cond=list("label"="n", mfccNum=11),
            col="springgreen3", main="", add=TRUE)
plot_diff(m1mfcc, view="time", shade=TRUE, comp=list(label=c("i", "n")),
          cond=list(mfccNum=11), main="MFCC11")

plot_smooth(m1mfcc, view="time", cond=list("label"="i", mfccNum=12),
            col="darkorchid1", main="MFCC12")
plot_smooth(m1mfcc, view="time", cond=list("label"="n", mfccNum=12),
            col="springgreen3", main="", add=TRUE)
plot_diff(m1mfcc, view="time", shade=TRUE, comp=list(label=c("i", "n")),
          cond=list(mfccNum=12), main="MFCC12")
```




```
plot_smooth(m1mfcc, view="time", cond=list("label"="i", mfccNum=13),
            col="darkorchid1", main="MFCC13")
plot_smooth(m1mfcc, view="time", cond=list("label"="n", mfccNum=13),
            col="springgreen3", main="", add=TRUE)
plot_diff(m1mfcc, view="time", shade=TRUE, comp=list(label=c("i", "n")),
          cond=list(mfccNum=13), main="MFCC13")
```



summary

```
summary(m1mfcc)
```

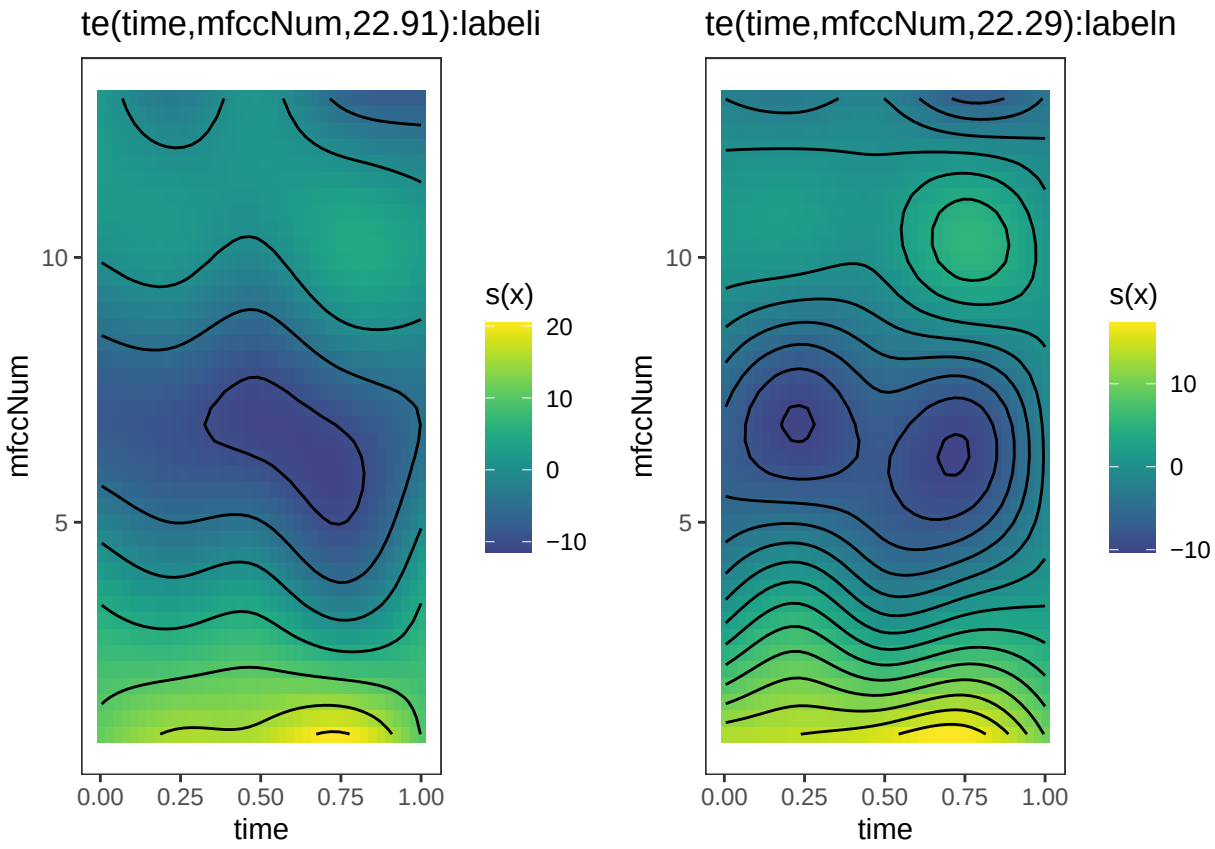
```
##
```

```
## Family: gaussian
## Link function: identity
##
## Formula:
## mfcc ~ label + te(time, mfccNum, by = label) + s(time, speaker,
##     bs = "fs", m = 1) + s(mfccNum, speaker, bs = "fs", m = 1)
##
## Parametric coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)  5.48629    0.98587   5.565 2.63e-08 ***
## labeln       0.14574    0.08044   1.812     0.07 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Approximate significance of smooth terms:
##                            edf Ref.df       F p-value
## te(time,mfccNum):labeli 20.87  22.44   8.459 < 2e-16 ***
## te(time,mfccNum):labeln 19.54  21.60   4.364 < 2e-16 ***
## s(time,speaker)         11.81  44.00   0.525 0.00145 **
## s(mfccNum,speaker)      41.12  44.00 305.909 < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## R-sq.(adj) =  0.178   Deviance explained = 17.9%
## fREML = 6.0734e+05  Scale est. = 236.25    n = 146250
```

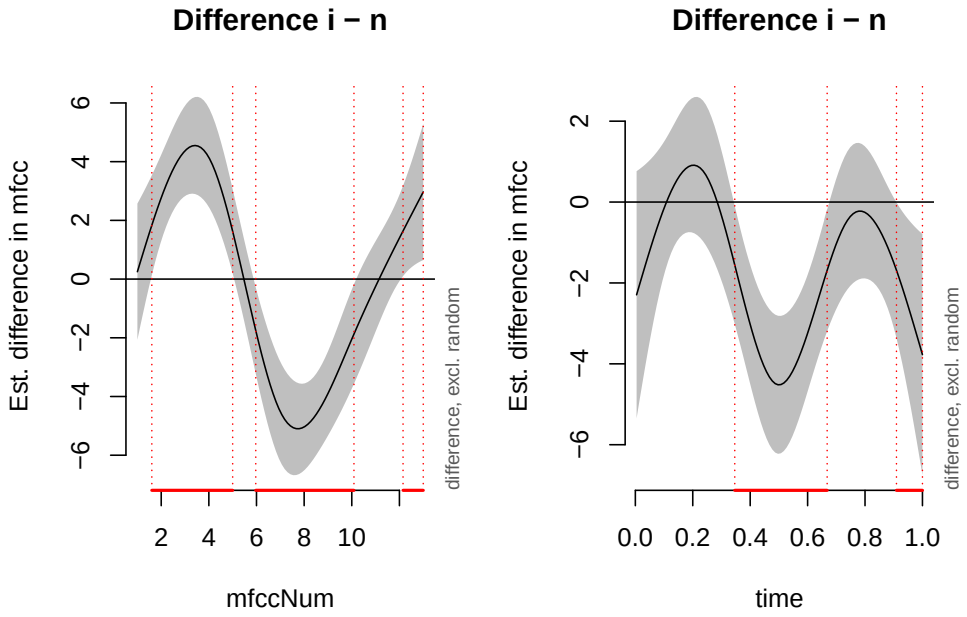
Individual Speaker Models Speaker B

```
mBmfcc=bam(mfcc ~ label + te(time, mfccNum, by=label), data=bmfcc)
mBmfccViz = getViz(mBmfcc)
```

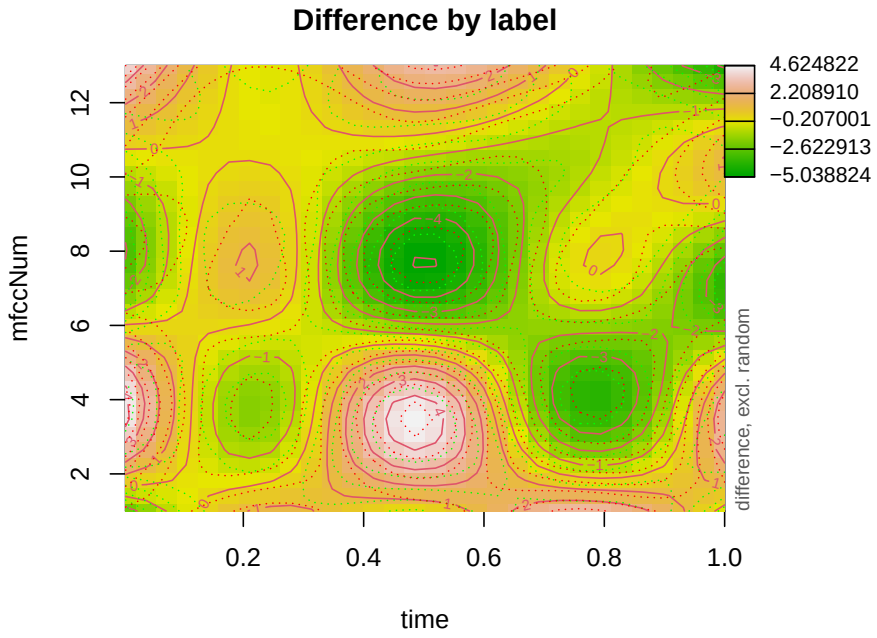
```
print(plot(mBmfccViz, allTerms=T), pages=2)
```



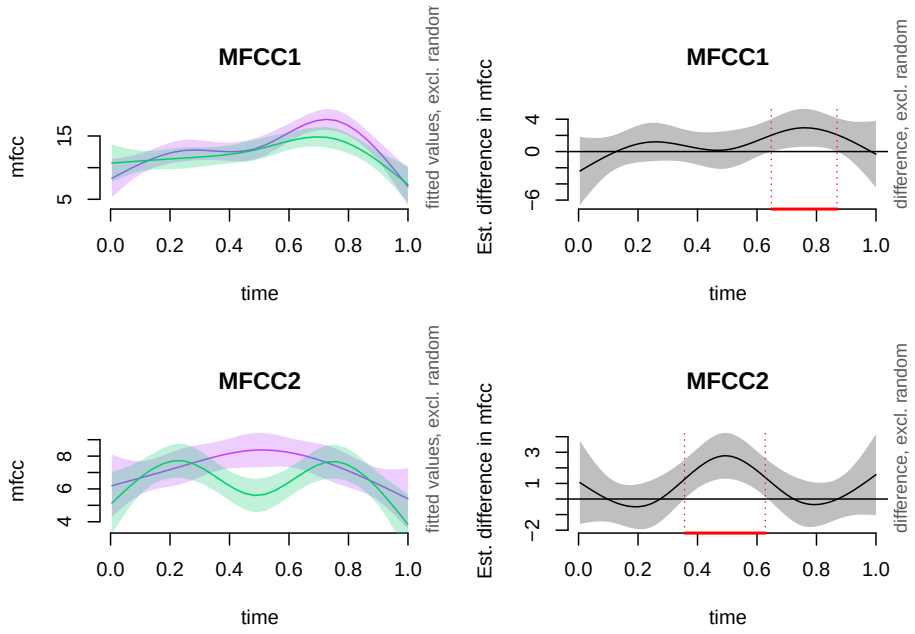

```
par(mfrow=c(1, 2))
plot_diff(mBmfcc, view="mfccNum", shade=TRUE, comp=list(label=c("i", "n")))
plot_diff(mBmfcc, view="time", shade=TRUE, comp=list(label=c("i", "n")))
```



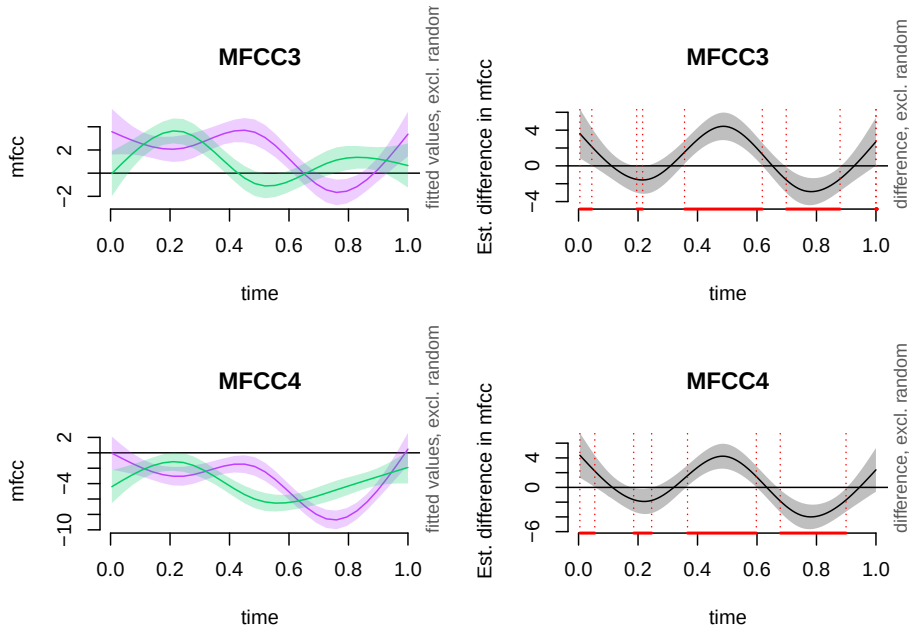
```
par(mfrow=c(1, 1))
par(mar=c(5, 5, 3, 8))
plot_diff2(mBmfcc, view=c("time", "mfccNum"), comp=list(label=c("i", "n")),
           main="Difference by label")
```



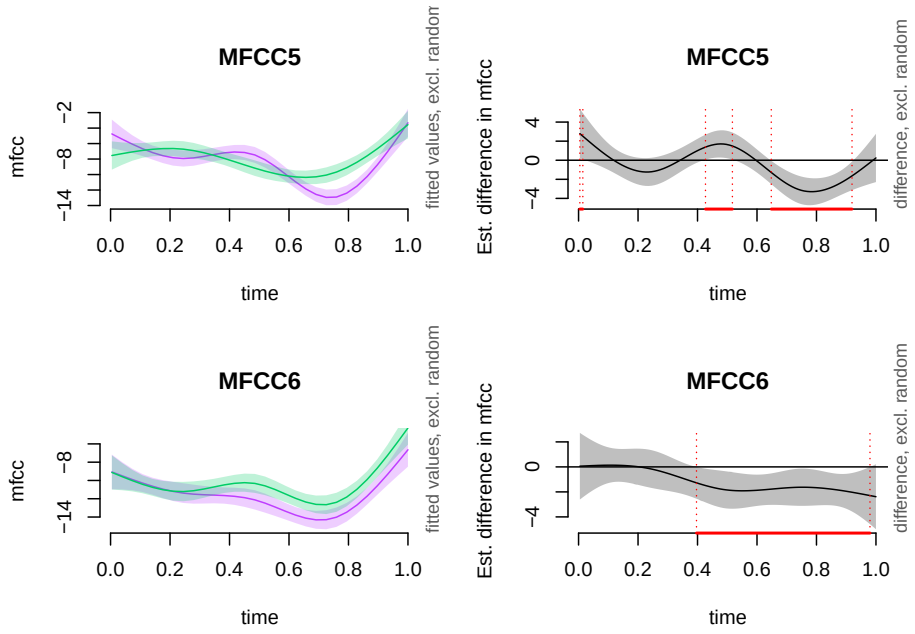

```
par(mfrow=c(2, 2))
plot.new
plot_smooth(mBmfcc, view="time", cond=list("label"="i", mfccNum=1),
            col="darkorchid1", main="MFCC1")
plot_smooth(mBmfcc, view="time", cond=list("label"="n", mfccNum=1),
            col="springgreen3", main="", add=TRUE)
plot_diff(mBmfcc, view="time", shade=TRUE, comp=list(label=c("i", "n")),
          cond=list(mfccNum=1), main="MFCC1")

plot_smooth(mBmfcc, view="time", cond=list("label"="i", mfccNum=2),
            col="darkorchid1", main="MFCC2")
plot_smooth(mBmfcc, view="time", cond=list("label"="n", mfccNum=2),
            col="springgreen3", main="", add=TRUE)
plot_diff(mBmfcc, view="time", shade=TRUE, comp=list(label=c("i", "n")),
          cond=list(mfccNum=2), main="MFCC2")
```



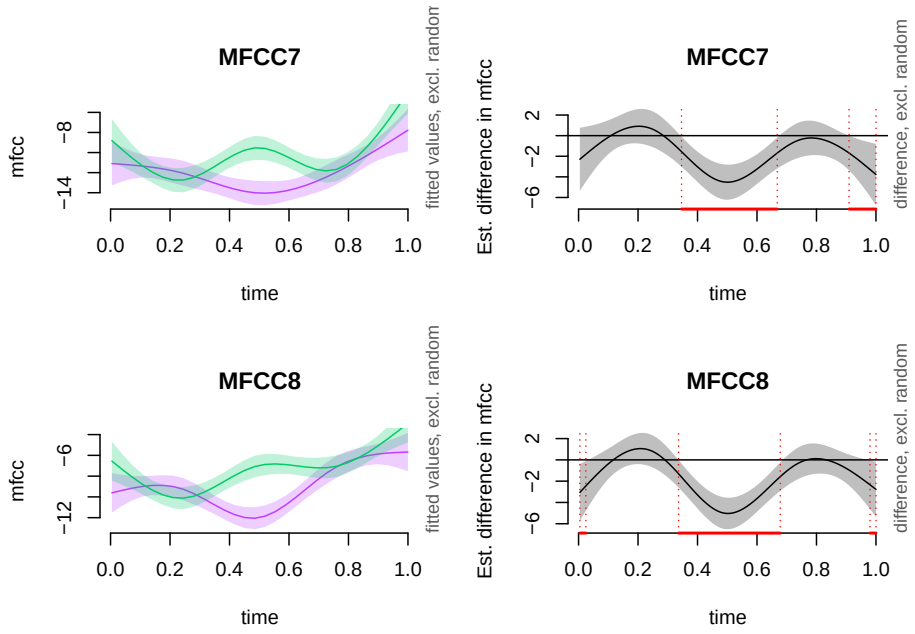

```
plot_smooth(mBmfcc, view="time", cond=list("label"="i", mfccNum=3),
            col="darkorchid1", main="MFCC3")
plot_smooth(mBmfcc, view="time", cond=list("label"="n", mfccNum=3),
            col="springgreen3", main="", add=TRUE)
plot_diff(mBmfcc, view="time", shade=TRUE, comp=list(label=c("i", "n")),
          cond=list(mfccNum=3), main="MFCC3")

plot_smooth(mBmfcc, view="time", cond=list("label"="i", mfccNum=4),
            col="darkorchid1", main="MFCC4")
plot_smooth(mBmfcc, view="time", cond=list("label"="n", mfccNum=4),
            col="springgreen3", main="", add=TRUE)
plot_diff(mBmfcc, view="time", shade=TRUE, comp=list(label=c("i", "n")),
          cond=list(mfccNum=4), main="MFCC4")
```



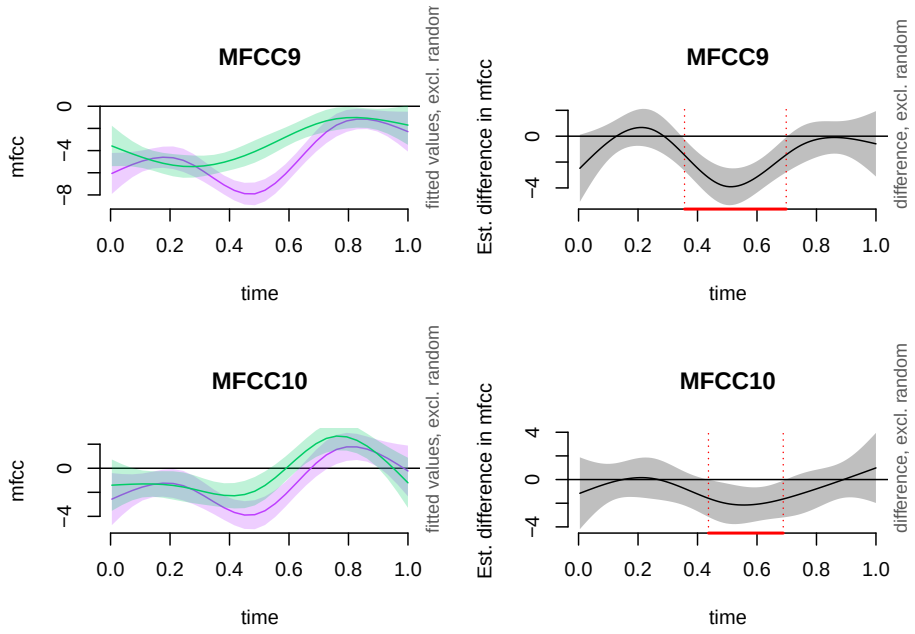

```
plot_smooth(mBmfcc, view="time", cond=list("label"="i", mfccNum=5),
            col="darkorchid1", main="MFCC5")
plot_smooth(mBmfcc, view="time", cond=list("label"="n", mfccNum=5),
            col="springgreen3", main="", add=TRUE)
plot_diff(mBmfcc, view="time", shade=TRUE, comp=list(label=c("i", "n")),
          cond=list(mfccNum=5), main="MFCC5")

plot_smooth(mBmfcc, view="time", cond=list("label"="i", mfccNum=6),
            col="darkorchid1", main="MFCC6")
plot_smooth(mBmfcc, view="time", cond=list("label"="n", mfccNum=6),
            col="springgreen3", main="", add=TRUE)
plot_diff(mBmfcc, view="time", shade=TRUE, comp=list(label=c("i", "n")),
          cond=list(mfccNum=6), main="MFCC6")
```



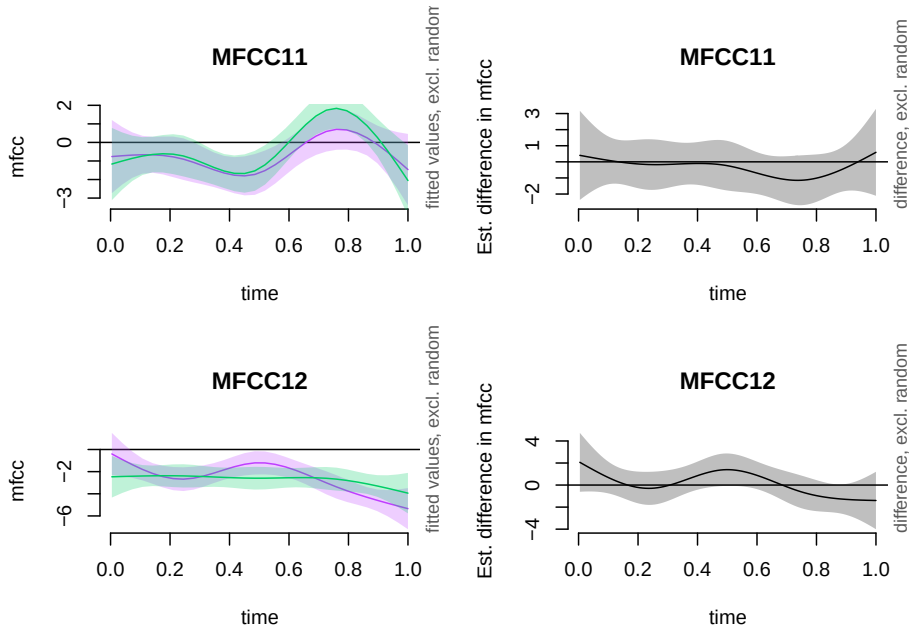

```
plot_smooth(mBmfcc, view="time", cond=list("label"="i", mfccNum=7),
            col="darkorchid1", main="MFCC7")
plot_smooth(mBmfcc, view="time", cond=list("label"="n", mfccNum=7),
            col="springgreen3", main="", add=TRUE)
plot_diff(mBmfcc, view="time", shade=TRUE, comp=list(label=c("i", "n")),
          cond=list(mfccNum=7), main="MFCC7")

plot_smooth(mBmfcc, view="time", cond=list("label"="i", mfccNum=8),
            col="darkorchid1", main="MFCC8")
plot_smooth(mBmfcc, view="time", cond=list("label"="n", mfccNum=8),
            col="springgreen3", main="", add=TRUE)
plot_diff(mBmfcc, view="time", shade=TRUE, comp=list(label=c("i", "n")),
          cond=list(mfccNum=8), main="MFCC8")
```




```
plot_smooth(mBmfcc, view="time", cond=list("label"="i", mfccNum=9),
            col="darkorchid1", main="MFCC9")
plot_smooth(mBmfcc, view="time", cond=list("label"="n", mfccNum=9),
            col="springgreen3", main="", add=TRUE)
plot_diff(mBmfcc, view="time", shade=TRUE, comp=list(label=c("i", "n")),
          cond=list(mfccNum=9), main="MFCC9")

plot_smooth(mBmfcc, view="time", cond=list("label"="i", mfccNum=10),
            col="darkorchid1", main="MFCC10")
plot_smooth(mBmfcc, view="time", cond=list("label"="n", mfccNum=10),
            col="springgreen3", main="", add=TRUE)
plot_diff(mBmfcc, view="time", shade=TRUE, comp=list(label=c("i", "n")),
          cond=list(mfccNum=10), main="MFCC10")
```




```
plot_smooth(mBmfcc, view="time", cond=list("label"="i", mfccNum=11),
            col="darkorchid1", main="MFCC11")
plot_smooth(mBmfcc, view="time", cond=list("label"="n", mfccNum=11),
            col="springgreen3", main="", add=TRUE)
plot_diff(mBmfcc, view="time", shade=TRUE, comp=list(label=c("i", "n")),
          cond=list(mfccNum=11), main="MFCC11")

plot_smooth(mBmfcc, view="time", cond=list("label"="i", mfccNum=12),
            col="darkorchid1", main="MFCC12")
plot_smooth(mBmfcc, view="time", cond=list("label"="n", mfccNum=12),
            col="springgreen3", main="", add=TRUE)
plot_diff(mBmfcc, view="time", shade=TRUE, comp=list(label=c("i", "n")),
          cond=list(mfccNum=12), main="MFCC12")
```




```
plot_smooth(mBmfcc, view="time", cond=list("label"="i", mfccNum=13),
            col="darkorchid1", main="MFCC13")
plot_smooth(mBmfcc, view="time", cond=list("label"="n", mfccNum=13),
            col="springgreen3", main="", add=TRUE)
plot_diff(mBmfcc, view="time", shade=TRUE, comp=list(label=c("i", "n")),
          cond=list(mfccNum=13), main="MFCC13")
```

```
summary(mBmfcc)
```

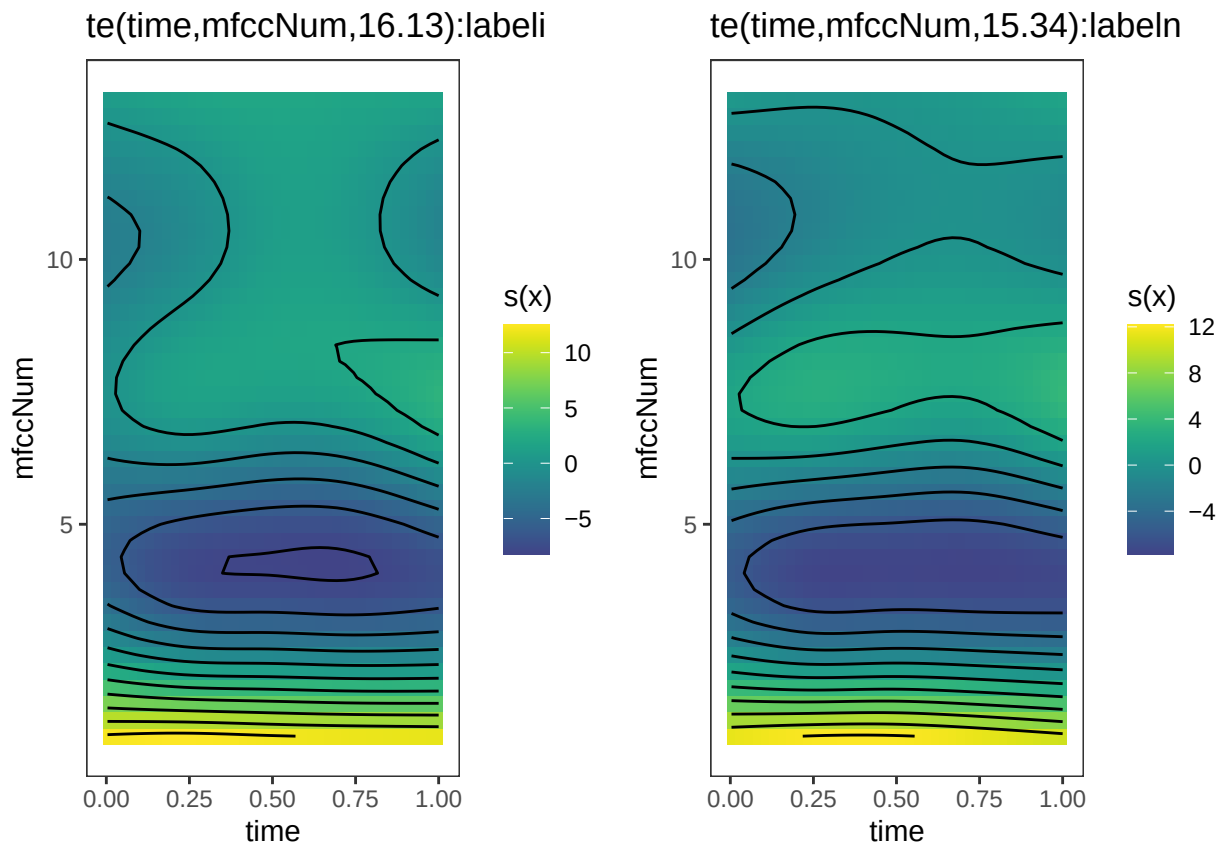
```
##
```

```
## Family: gaussian
## Link function: identity
##
## Formula:
## mfcc ~ label + te(time, mfccNum, by = label)
##
## Parametric coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)  -2.8560     0.1302 -21.928   <2e-16 ***
## labeln        0.3457     0.1842   1.877   0.0606 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Approximate significance of smooth terms:
##                            edf Ref.df     F p-value
## te(time,mfccNum):labeli 22.91  23.87 130.9  <2e-16 ***
## te(time,mfccNum):labeln 22.29  23.67 105.5  <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## R-sq.(adj) =  0.161   Deviance explained = 16.3%
## fREML = 1.2219e+05  Scale est. = 247.72    n = 29250
```

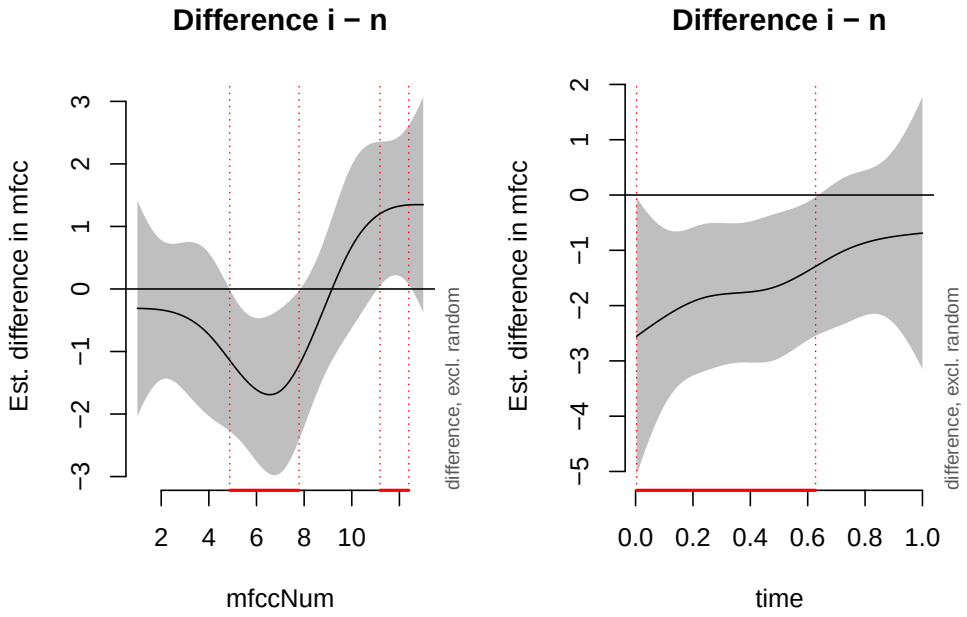
Speaker G

```
mGmfcc=bam(mfcc ~ label + te(time, mfccNum, by=label), data=gmfcc)
mGmfccViz = getViz(mGmfcc)
```

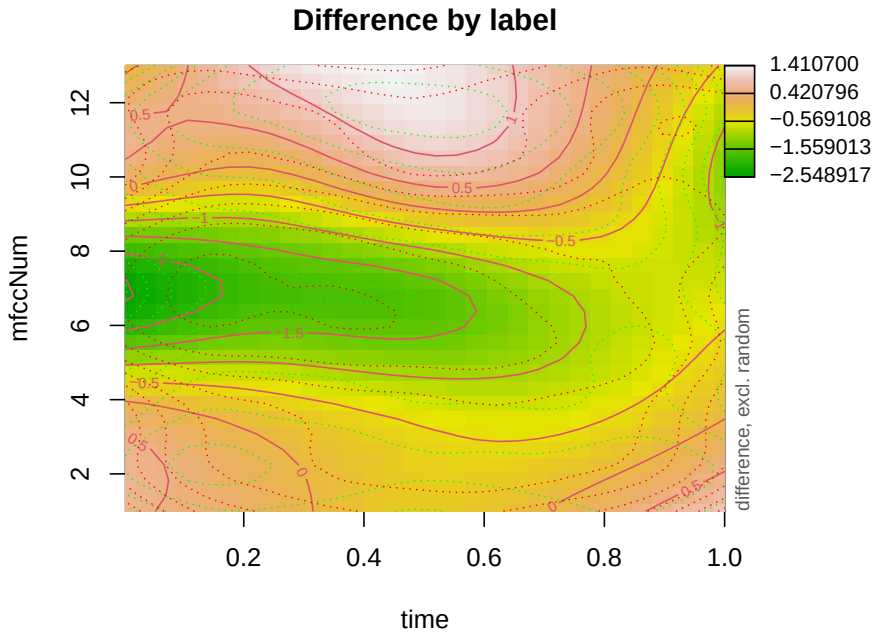
```
print(plot(mGmfccViz, allTerms=T), pages=2)
```



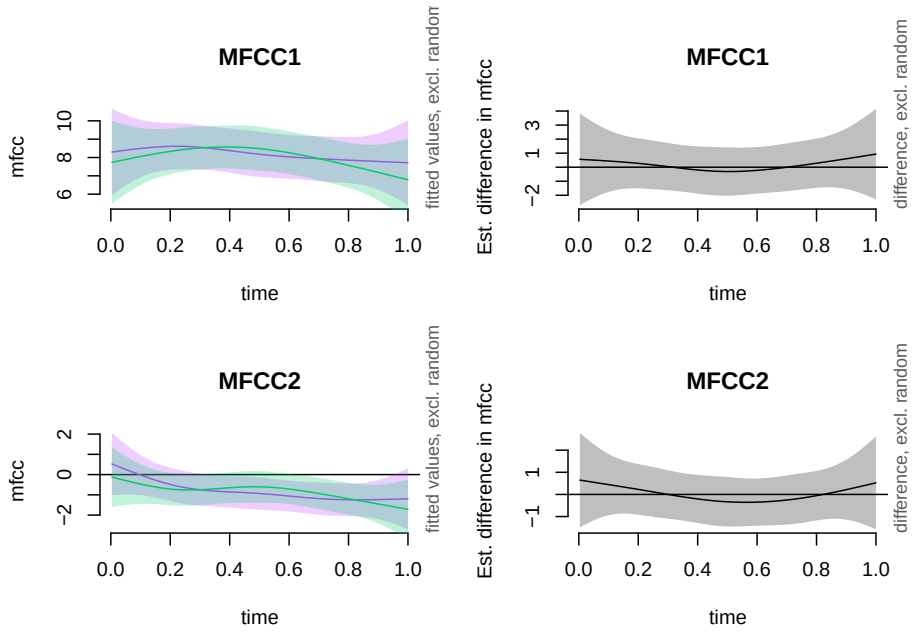

```
par(mfrow=c(1, 2))
plot_diff(mGmfcc, view="mfccNum", shade=TRUE, comp=list(label=c("i", "n")))
plot_diff(mGmfcc, view="time", shade=TRUE, comp=list(label=c("i", "n")))
```



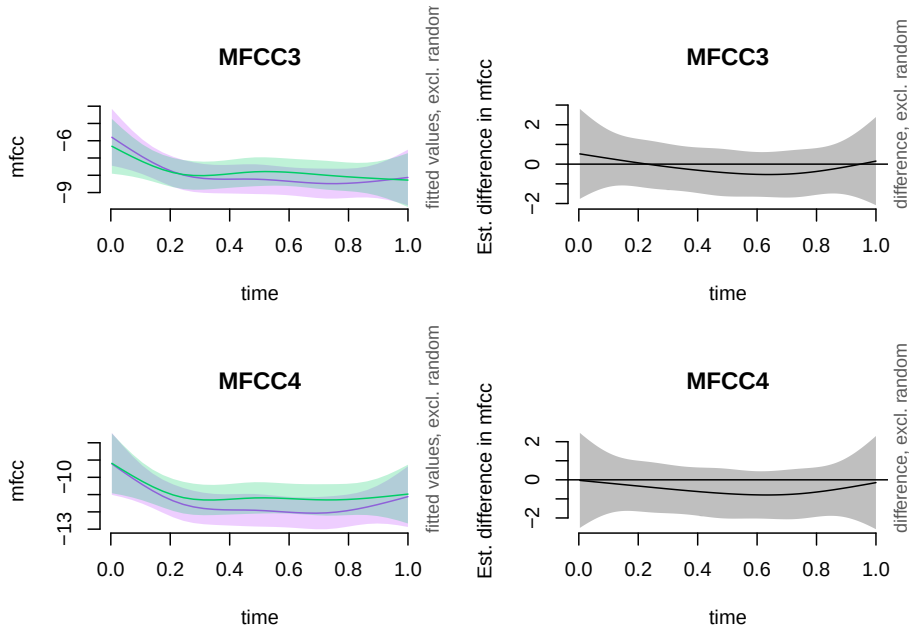
```
par(mfrow=c(1, 1))
par(mar=c(5, 5, 3, 8))
plot_diff2(mGmfcc, view=c("time", "mfccNum"), comp=list(label=c("i", "n")),
           main="Difference by label")
```



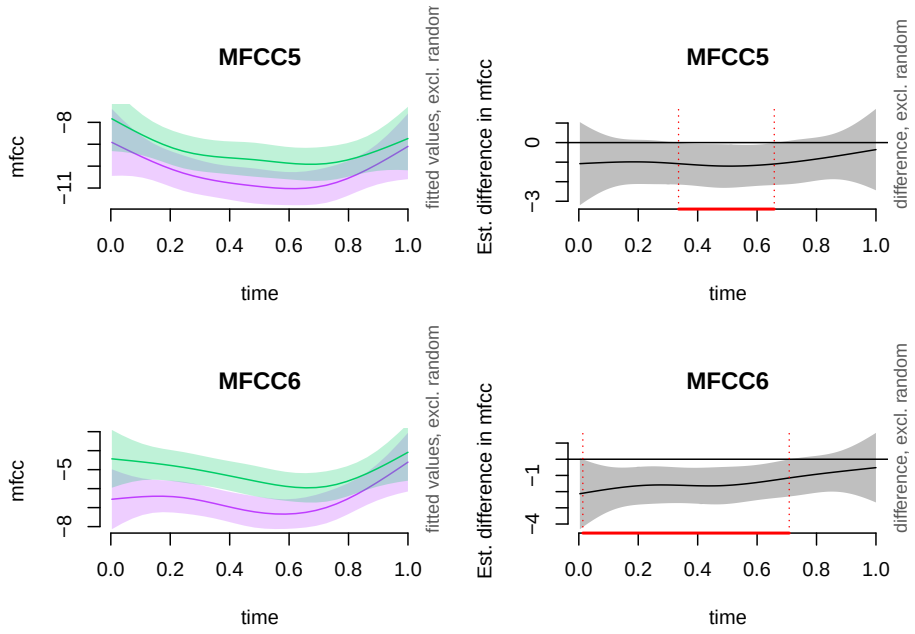

```
par(mfrow=c(2, 2))
plot.new
plot_smooth(mGmfcc, view="time", cond=list("label"="i", mfccNum=1),
            col="darkorchid1", main="MFCC1")
plot_smooth(mGmfcc, view="time", cond=list("label"="n", mfccNum=1),
            col="springgreen3", main="", add=TRUE)
plot_diff(mGmfcc, view="time", shade=TRUE, comp=list(label=c("i", "n")),
          cond=list(mfccNum=1), main="MFCC1")

plot_smooth(mGmfcc, view="time", cond=list("label"="i", mfccNum=2),
            col="darkorchid1", main="MFCC2")
plot_smooth(mGmfcc, view="time", cond=list("label"="n", mfccNum=2),
            col="springgreen3", main="", add=TRUE)
plot_diff(mGmfcc, view="time", shade=TRUE, comp=list(label=c("i", "n")),
          cond=list(mfccNum=2), main="MFCC2")
```



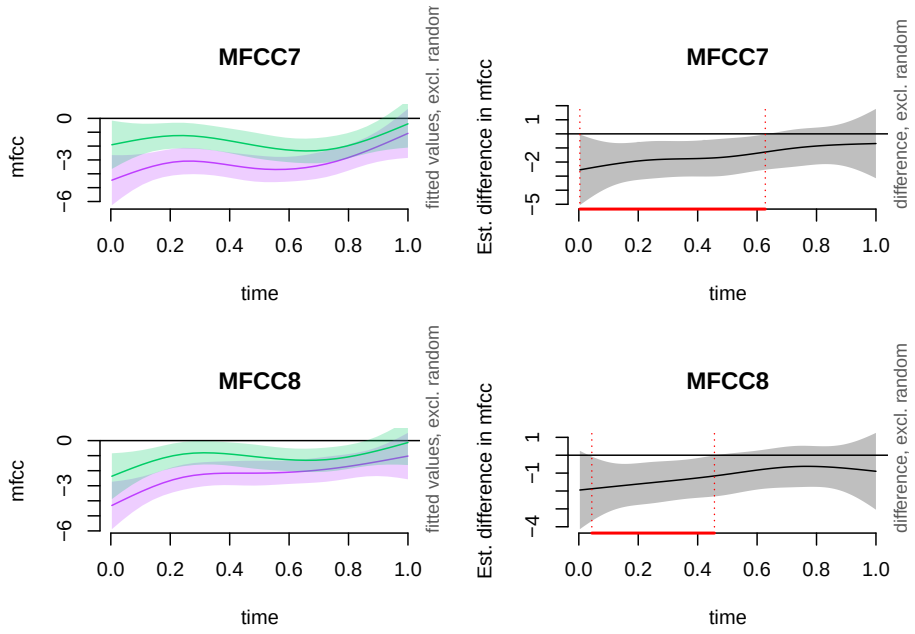

```
plot_smooth(mGmfcc, view="time", cond=list("label"="i", mfccNum=3),
            col="darkorchid1", main="MFCC3")
plot_smooth(mGmfcc, view="time", cond=list("label"="n", mfccNum=3),
            col="springgreen3", main="", add=TRUE)
plot_diff(mGmfcc, view="time", shade=TRUE, comp=list(label=c("i", "n")),
          cond=list(mfccNum=3), main="MFCC3")

plot_smooth(mGmfcc, view="time", cond=list("label"="i", mfccNum=4),
            col="darkorchid1", main="MFCC4")
plot_smooth(mGmfcc, view="time", cond=list("label"="n", mfccNum=4),
            col="springgreen3", main="", add=TRUE)
plot_diff(mGmfcc, view="time", shade=TRUE, comp=list(label=c("i", "n")),
          cond=list(mfccNum=4), main="MFCC4")
```



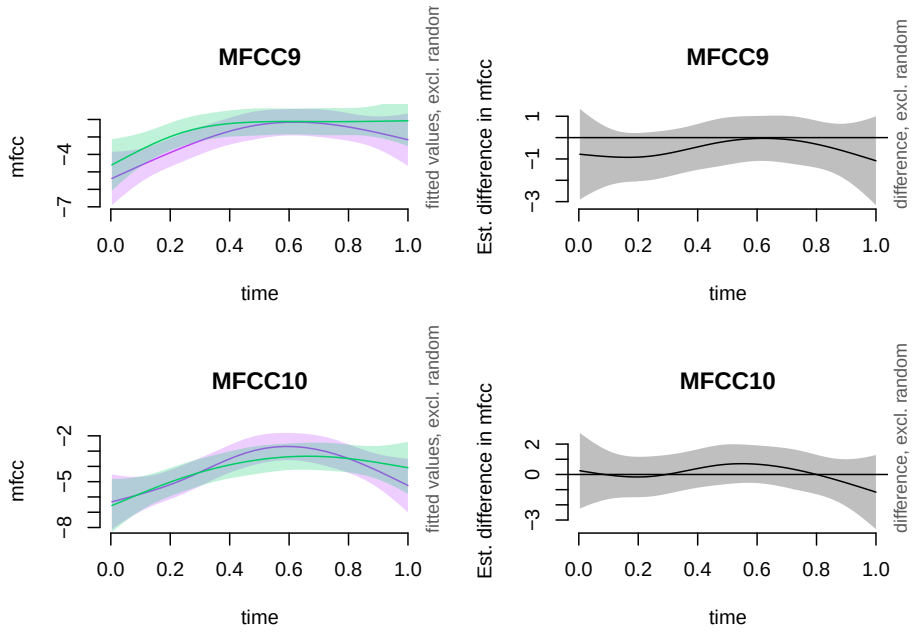

```
plot_smooth(mGmfcc, view="time", cond=list("label"="i", mfccNum=5),
            col="darkorchid1", main="MFCC5")
plot_smooth(mGmfcc, view="time", cond=list("label"="n", mfccNum=5),
            col="springgreen3", main="", add=TRUE)
plot_diff(mGmfcc, view="time", shade=TRUE, comp=list(label=c("i", "n")),
          cond=list(mfccNum=5), main="MFCC5")

plot_smooth(mGmfcc, view="time", cond=list("label"="i", mfccNum=6),
            col="darkorchid1", main="MFCC6")
plot_smooth(mGmfcc, view="time", cond=list("label"="n", mfccNum=6),
            col="springgreen3", main="", add=TRUE)
plot_diff(mGmfcc, view="time", shade=TRUE, comp=list(label=c("i", "n")),
          cond=list(mfccNum=6), main="MFCC6")
```



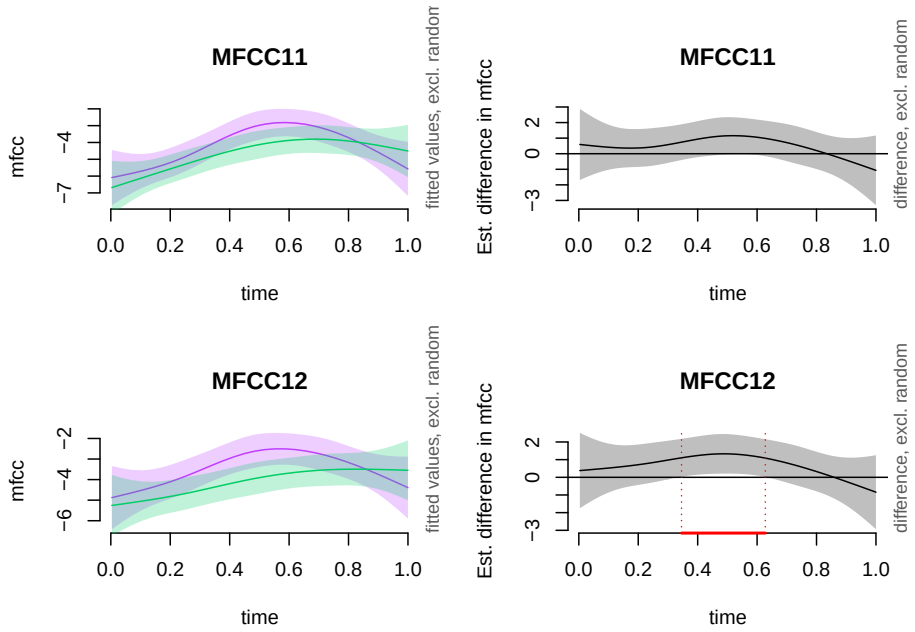

```
plot_smooth(mGmfcc, view="time", cond=list("label"="i", mfccNum=7),
            col="darkorchid1", main="MFCC7")
plot_smooth(mGmfcc, view="time", cond=list("label"="n", mfccNum=7),
            col="springgreen3", main="", add=TRUE)
plot_diff(mGmfcc, view="time", shade=TRUE, comp=list(label=c("i", "n")),
          cond=list(mfccNum=7), main="MFCC7")

plot_smooth(mGmfcc, view="time", cond=list("label"="i", mfccNum=8),
            col="darkorchid1", main="MFCC8")
plot_smooth(mGmfcc, view="time", cond=list("label"="n", mfccNum=8),
            col="springgreen3", main="", add=TRUE)
plot_diff(mGmfcc, view="time", shade=TRUE, comp=list(label=c("i", "n")),
          cond=list(mfccNum=8), main="MFCC8")
```




```
plot_smooth(mGmfcc, view="time", cond=list("label"="i", mfccNum=9),
            col="darkorchid1", main="MFCC9")
plot_smooth(mGmfcc, view="time", cond=list("label"="n", mfccNum=9),
            col="springgreen3", main="", add=TRUE)
plot_diff(mGmfcc, view="time", shade=TRUE, comp=list(label=c("i", "n")),
          cond=list(mfccNum=9), main="MFCC9")

plot_smooth(mGmfcc, view="time", cond=list("label"="i", mfccNum=10),
            col="darkorchid1", main="MFCC10")
plot_smooth(mGmfcc, view="time", cond=list("label"="n", mfccNum=10),
            col="springgreen3", main="", add=TRUE)
plot_diff(mGmfcc, view="time", shade=TRUE, comp=list(label=c("i", "n")),
          cond=list(mfccNum=10), main="MFCC10")
```




```
plot_smooth(mGmfcc, view="time", cond=list("label"="i", mfccNum=11),
            col="darkorchid1", main="MFCC11")
plot_smooth(mGmfcc, view="time", cond=list("label"="n", mfccNum=11),
            col="springgreen3", main="", add=TRUE)
plot_diff(mGmfcc, view="time", shade=TRUE, comp=list(label=c("i", "n")),
          cond=list(mfccNum=11), main="MFCC11")

plot_smooth(mGmfcc, view="time", cond=list("label"="i", mfccNum=12),
            col="darkorchid1", main="MFCC12")
plot_smooth(mGmfcc, view="time", cond=list("label"="n", mfccNum=12),
            col="springgreen3", main="", add=TRUE)
plot_diff(mGmfcc, view="time", shade=TRUE, comp=list(label=c("i", "n")),
          cond=list(mfccNum=12), main="MFCC12")
```




```
plot_smooth(mGmfcc, view="time", cond=list("label"="i", mfccNum=13),
            col="darkorchid1", main="MFCC13")
plot_smooth(mGmfcc, view="time", cond=list("label"="n", mfccNum=13),
            col="springgreen3", main="", add=TRUE)
plot_diff(mGmfcc, view="time", shade=TRUE, comp=list(label=c("i", "n")),
          cond=list(mfccNum=13), main="MFCC13")
```

```
summary(mGmfcc)
```

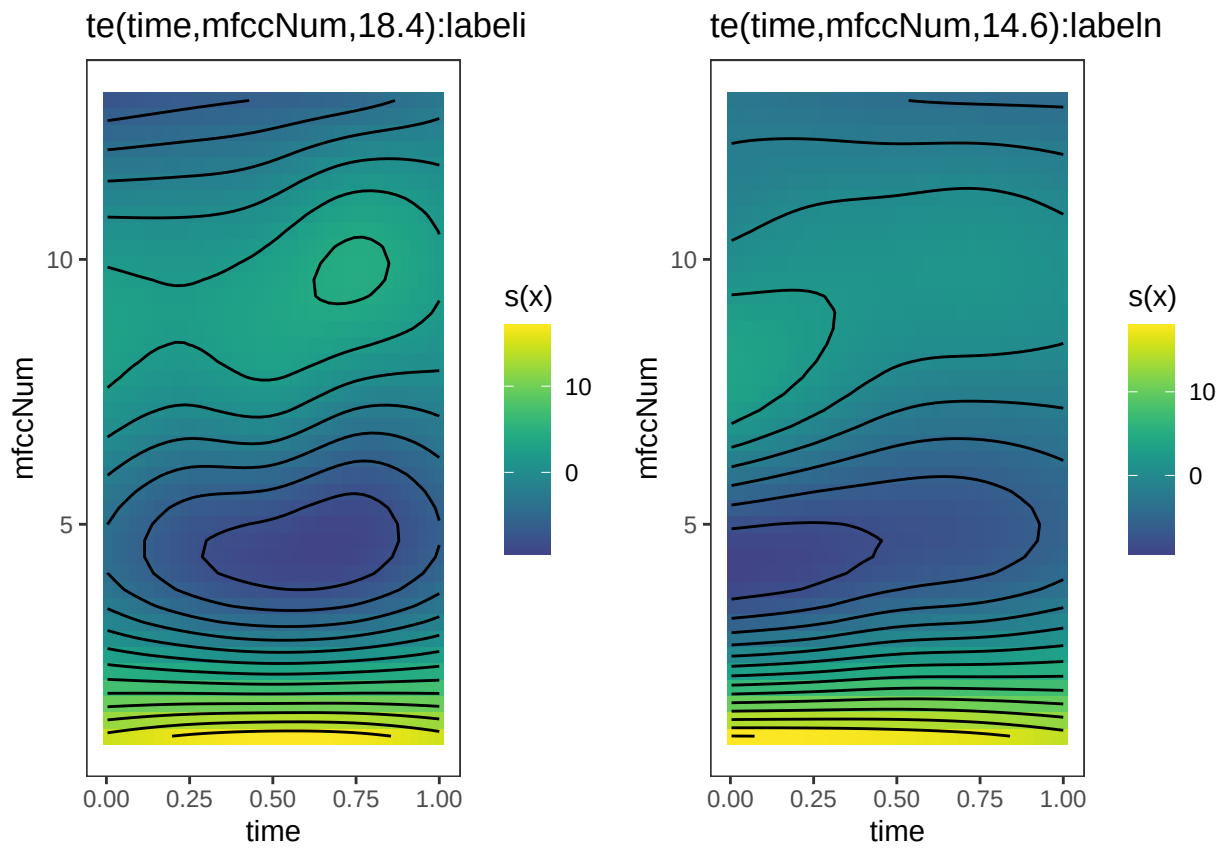
```
##
```

```
## Family: gaussian
## Link function: identity
##
## Formula:
## mfcc ~ label + te(time, mfccNum, by = label)
##
## Parametric coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)  -3.9271     0.1301 -30.182   <2e-16 ***
## labeln        0.3040     0.1840   1.652   0.0985 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Approximate significance of smooth terms:
##                            edf Ref.df     F p-value
## te(time,mfccNum):labeli 16.13  18.67 71.80  <2e-16 ***
## te(time,mfccNum):labeln 15.34  17.81 69.07  <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## R-sq.(adj) =  0.0808   Deviance explained = 8.19%
## fREML = 1.2214e+05  Scale est. = 247.29    n = 29250
```

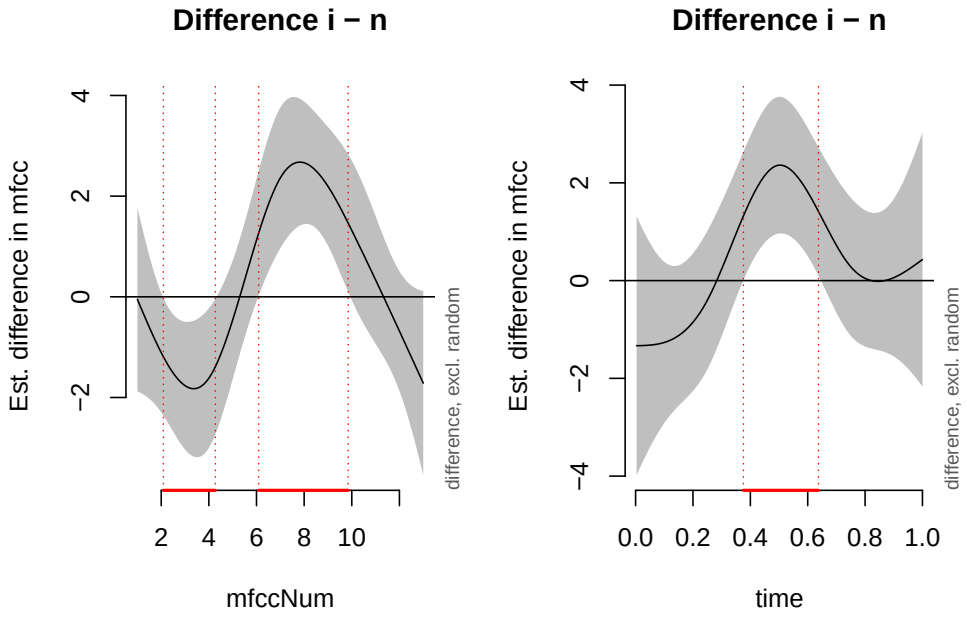
Speaker P

```
mPmfcc=bam(mfcc ~ label + te(time, mfccNum, by=label), data=pmfcc)
mPmfccViz = getViz(mPmfcc)
```

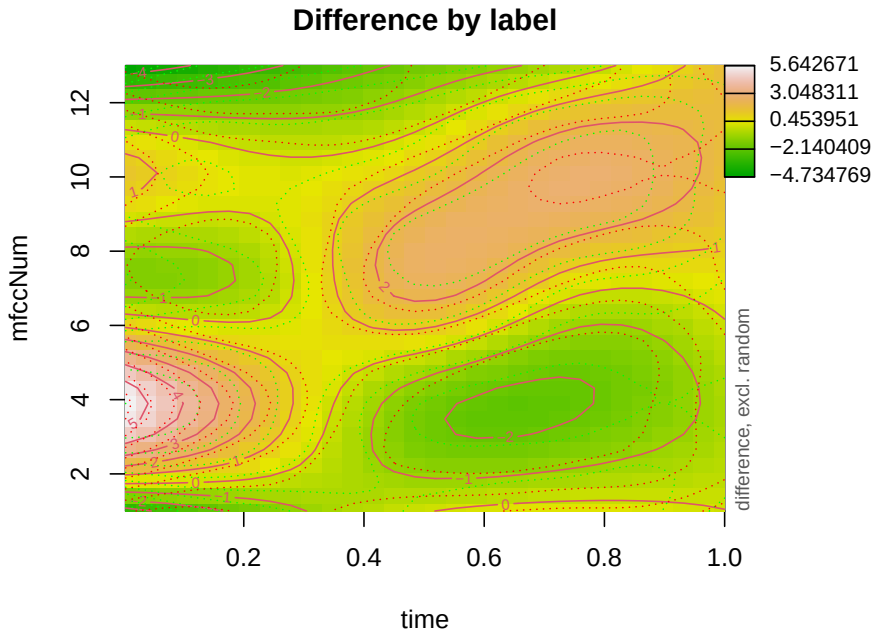
```
print(plot(mPmfccViz, allTerms=T), pages=2)
```



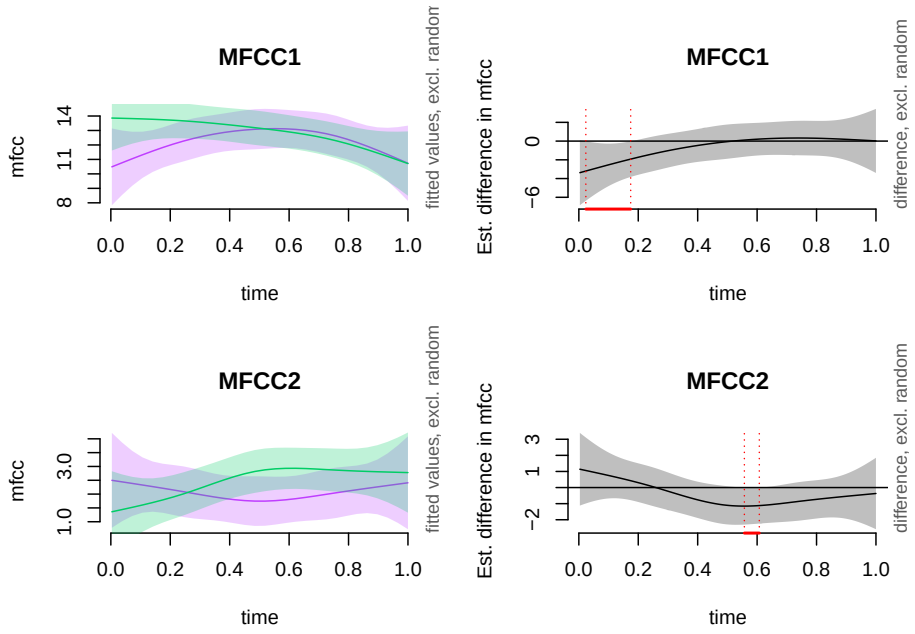

```
par(mfrow=c(1, 2))
plot_diff(mPmfcc, view="mfccNum", shade=TRUE, comp=list(label=c("i", "n")))
plot_diff(mPmfcc, view="time", shade=TRUE, comp=list(label=c("i", "n")))
```



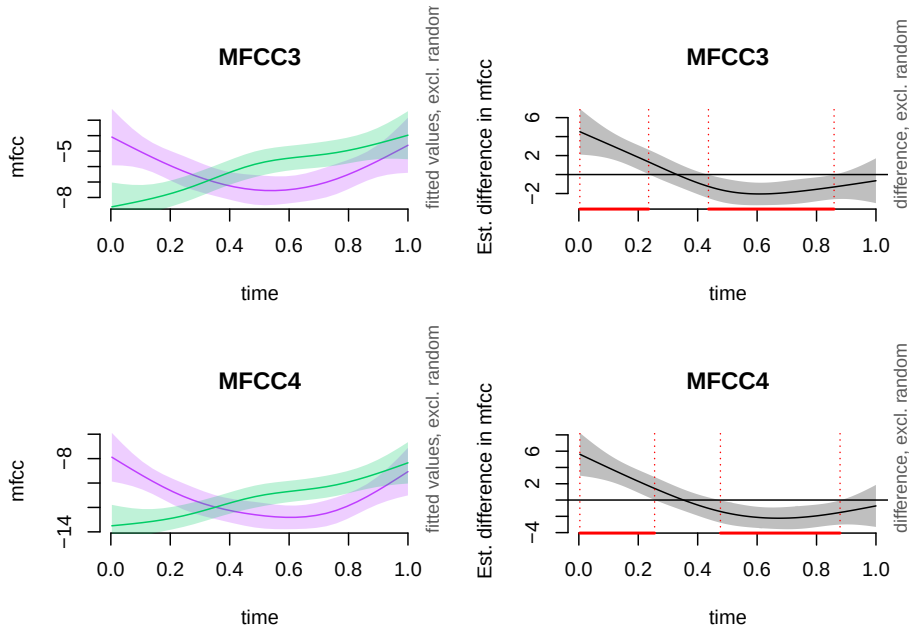
```
par(mfrow=c(1, 1))
par(mar=c(5, 5, 3, 8))
plot_diff2(mPmfcc, view=c("time", "mfccNum"), comp=list(label=c("i", "n")),
           main="Difference by label")
```



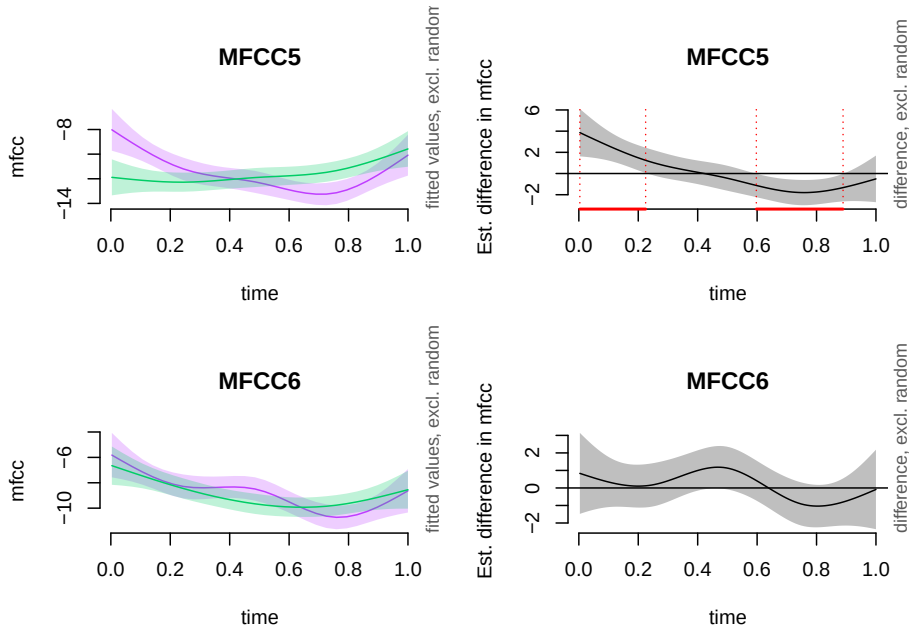

```
par(mfrow=c(2, 2))
plot.new
plot_smooth(mPmfcc, view="time", cond=list("label"="i", mfccNum=1),
            col="darkorchid1", main="MFCC1")
plot_smooth(mPmfcc, view="time", cond=list("label"="n", mfccNum=1),
            col="springgreen3", main="", add=TRUE)
plot_diff(mPmfcc, view="time", shade=TRUE, comp=list(label=c("i", "n")),
          cond=list(mfccNum=1), main="MFCC1")

plot_smooth(mPmfcc, view="time", cond=list("label"="i", mfccNum=2),
            col="darkorchid1", main="MFCC2")
plot_smooth(mPmfcc, view="time", cond=list("label"="n", mfccNum=2),
            col="springgreen3", main="", add=TRUE)
plot_diff(mPmfcc, view="time", shade=TRUE, comp=list(label=c("i", "n")),
          cond=list(mfccNum=2), main="MFCC2")
```



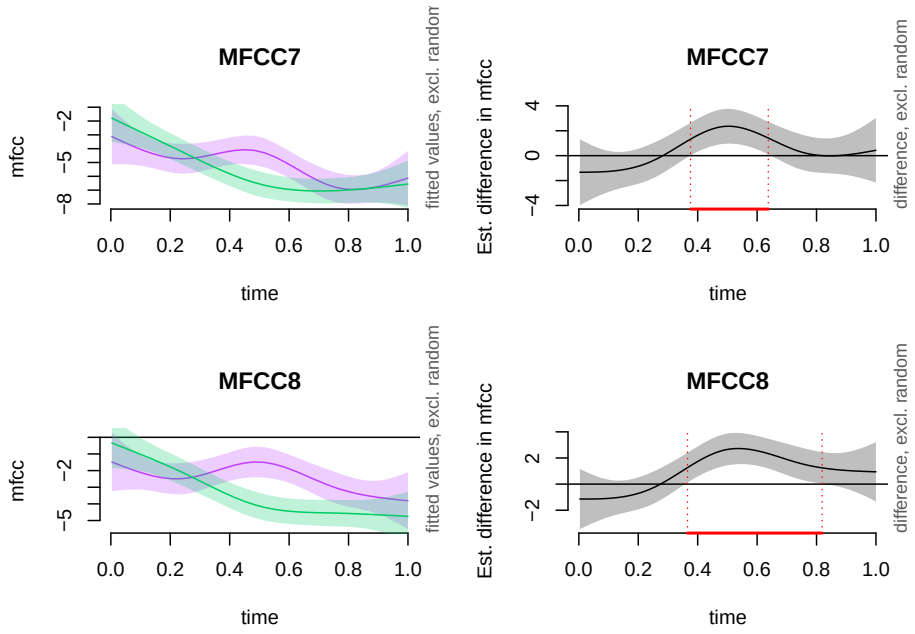

```
plot_smooth(mPmfcc, view="time", cond=list("label"="i", mfccNum=3),
            col="darkorchid1", main="MFCC3")
plot_smooth(mPmfcc, view="time", cond=list("label"="n", mfccNum=3),
            col="springgreen3", main="", add=TRUE)
plot_diff(mPmfcc, view="time", shade=TRUE, comp=list(label=c("i", "n")),
          cond=list(mfccNum=3), main="MFCC3")

plot_smooth(mPmfcc, view="time", cond=list("label"="i", mfccNum=4),
            col="darkorchid1", main="MFCC4")
plot_smooth(mPmfcc, view="time", cond=list("label"="n", mfccNum=4),
            col="springgreen3", main="", add=TRUE)
plot_diff(mPmfcc, view="time", shade=TRUE, comp=list(label=c("i", "n")),
          cond=list(mfccNum=4), main="MFCC4")
```



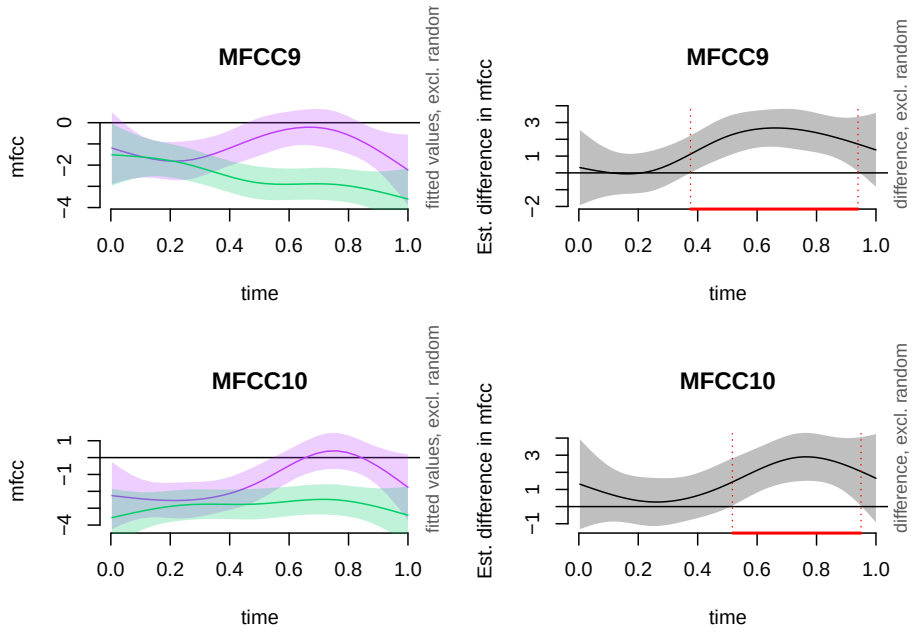

```
plot_smooth(mPmfcc, view="time", cond=list("label"="i", mfccNum=5),
            col="darkorchid1", main="MFCC5")
plot_smooth(mPmfcc, view="time", cond=list("label"="n", mfccNum=5),
            col="springgreen3", main="", add=TRUE)
plot_diff(mPmfcc, view="time", shade=TRUE, comp=list(label=c("i", "n")),
          cond=list(mfccNum=5), main="MFCC5")

plot_smooth(mPmfcc, view="time", cond=list("label"="i", mfccNum=6),
            col="darkorchid1", main="MFCC6")
plot_smooth(mPmfcc, view="time", cond=list("label"="n", mfccNum=6),
            col="springgreen3", main="", add=TRUE)
plot_diff(mPmfcc, view="time", shade=TRUE, comp=list(label=c("i", "n")),
          cond=list(mfccNum=6), main="MFCC6")
```



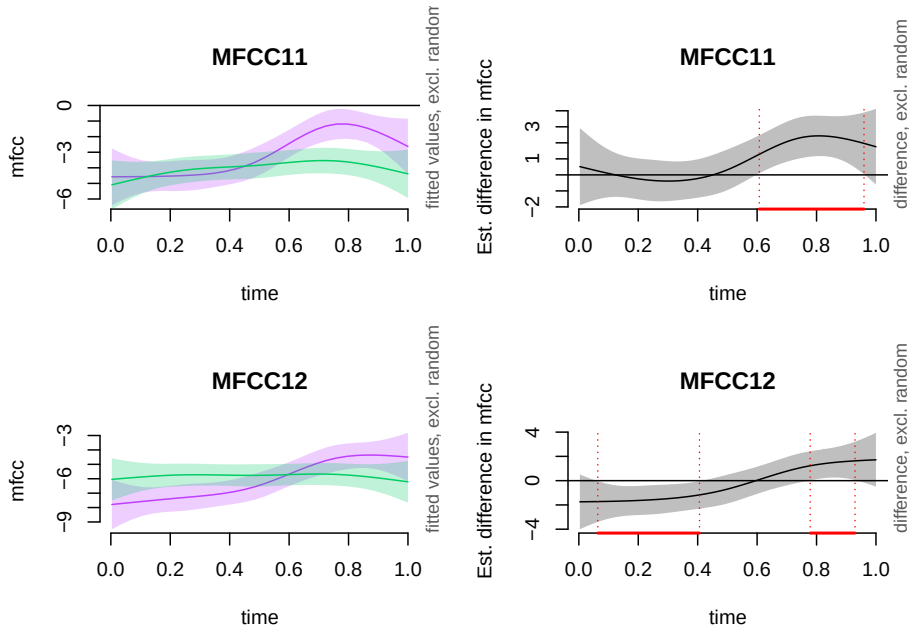

```
plot_smooth(mPmfcc, view="time", cond=list("label"="i", mfccNum=7),
            col="darkorchid1", main="MFCC7")
plot_smooth(mPmfcc, view="time", cond=list("label"="n", mfccNum=7),
            col="springgreen3", main="", add=TRUE)
plot_diff(mPmfcc, view="time", shade=TRUE, comp=list(label=c("i", "n")),
          cond=list(mfccNum=7), main="MFCC7")

plot_smooth(mPmfcc, view="time", cond=list("label"="i", mfccNum=8),
            col="darkorchid1", main="MFCC8")
plot_smooth(mPmfcc, view="time", cond=list("label"="n", mfccNum=8),
            col="springgreen3", main="", add=TRUE)
plot_diff(mPmfcc, view="time", shade=TRUE, comp=list(label=c("i", "n")),
          cond=list(mfccNum=8), main="MFCC8")
```



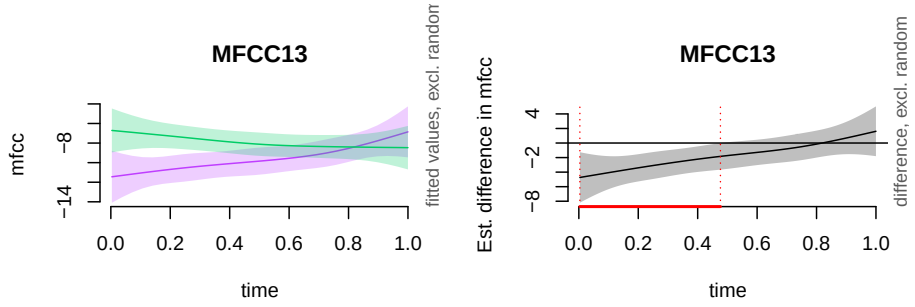

```
plot_smooth(mPmfcc, view="time", cond=list("label"="i", mfccNum=9),
            col="darkorchid1", main="MFCC9")
plot_smooth(mPmfcc, view="time", cond=list("label"="n", mfccNum=9),
            col="springgreen3", main="", add=TRUE)
plot_diff(mPmfcc, view="time", shade=TRUE, comp=list(label=c("i", "n")),
          cond=list(mfccNum=9), main="MFCC9")

plot_smooth(mPmfcc, view="time", cond=list("label"="i", mfccNum=10),
            col="darkorchid1", main="MFCC10")
plot_smooth(mPmfcc, view="time", cond=list("label"="n", mfccNum=10),
            col="springgreen3", main="", add=TRUE)
plot_diff(mPmfcc, view="time", shade=TRUE, comp=list(label=c("i", "n")),
          cond=list(mfccNum=10), main="MFCC10")
```




```
plot_smooth(mPmfcc, view="time", cond=list("label"="i", mfccNum=11),
            col="darkorchid1", main="MFCC11")
plot_smooth(mPmfcc, view="time", cond=list("label"="n", mfccNum=11),
            col="springgreen3", main="", add=TRUE)
plot_diff(mPmfcc, view="time", shade=TRUE, comp=list(label=c("i", "n")),
          cond=list(mfccNum=11), main="MFCC11")

plot_smooth(mPmfcc, view="time", cond=list("label"="i", mfccNum=12),
            col="darkorchid1", main="MFCC12")
plot_smooth(mPmfcc, view="time", cond=list("label"="n", mfccNum=12),
            col="springgreen3", main="", add=TRUE)
plot_diff(mPmfcc, view="time", shade=TRUE, comp=list(label=c("i", "n")),
          cond=list(mfccNum=12), main="MFCC12")
```




```
plot_smooth(mPmfcc, view="time", cond=list("label"="i", mfccNum=13),
            col="darkorchid1", main="MFCC13")
plot_smooth(mPmfcc, view="time", cond=list("label"="n", mfccNum=13),
            col="springgreen3", main="", add=TRUE)
plot_diff(mPmfcc, view="time", shade=TRUE, comp=list(label=c("i", "n")),
          cond=list(mfccNum=13), main="MFCC13")
```




```
summary(mPmfcc)
```

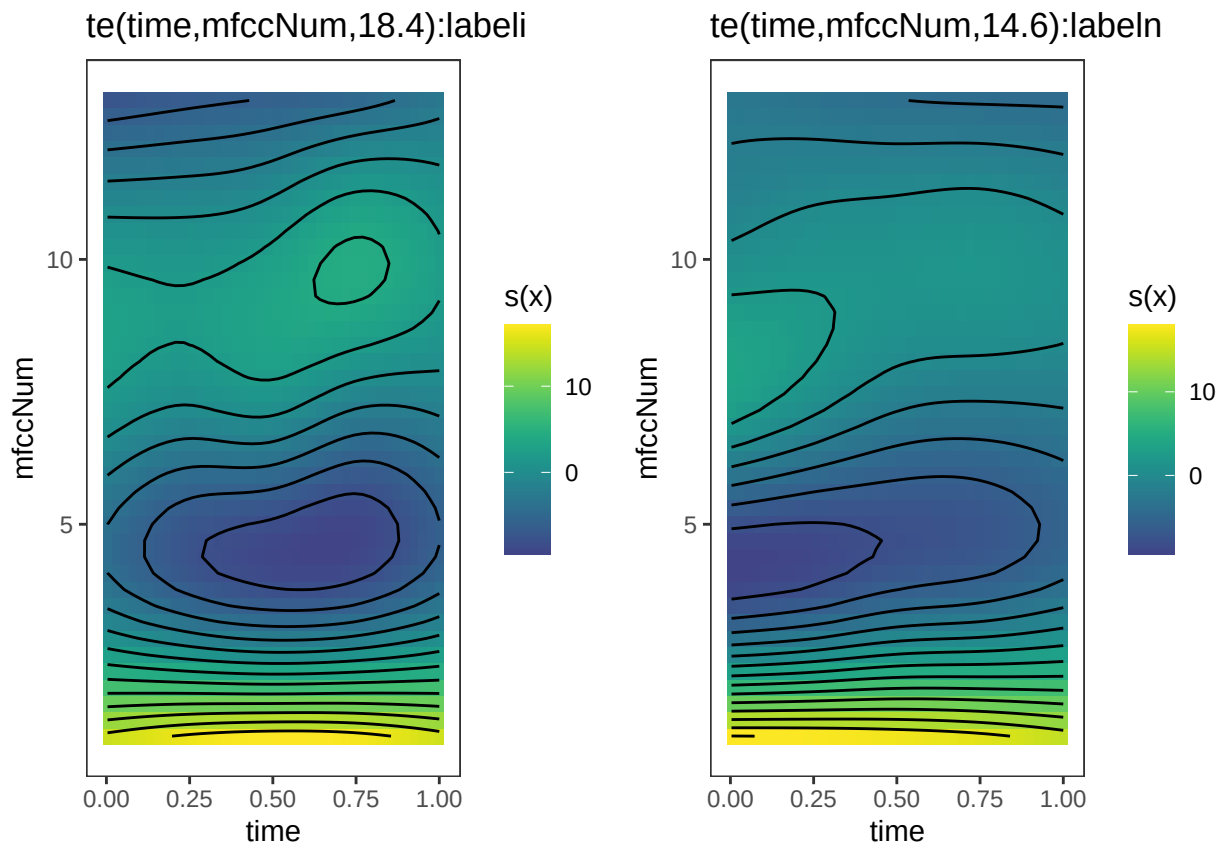
```
##
```

```
## Family: gaussian
## Link function: identity
##
## Formula:
## mfcc ~ label + te(time, mfccNum, by = label)
##
## Parametric coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)  -4.0270     0.1333 -30.206   <2e-16 ***
## labeln       -0.1523     0.1885  -0.808    0.419
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Approximate significance of smooth terms:
##                           edf Ref.df     F p-value
## te(time,mfccNum):labeli 18.4  20.97 106.2  <2e-16 ***
## te(time,mfccNum):labeln 14.6  16.99 128.6  <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## R-sq.(adj) =  0.131   Deviance explained = 13.2%
## fREML = 1.2285e+05  Scale est. = 259.6     n = 29250
```

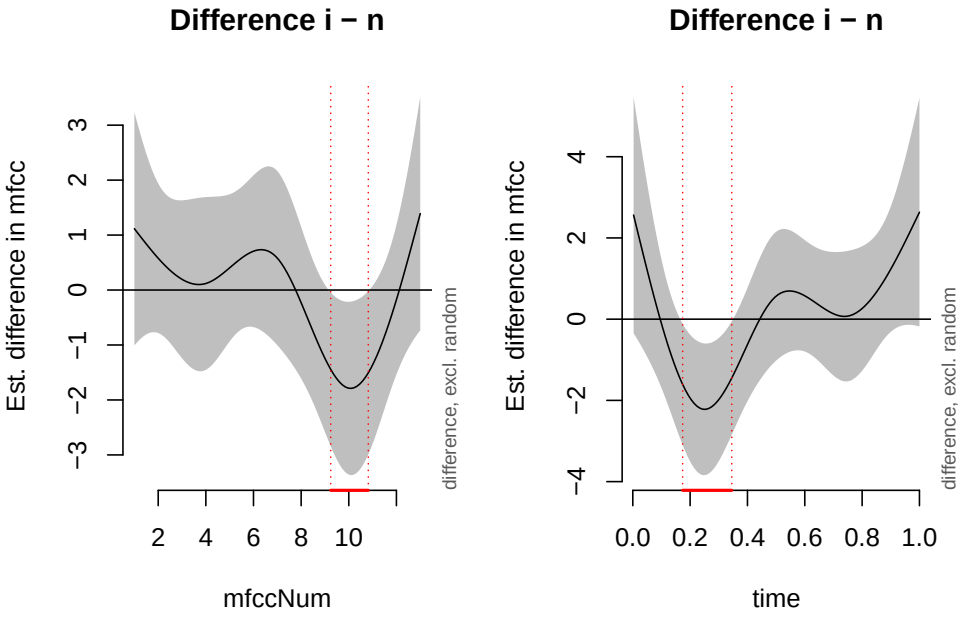
Speaker R

```
mRmfcc=bam(mfcc ~ label + te(time, mfccNum, by=label), data=rmfcc)
mRmfccViz = getViz(mPmfcc)
```

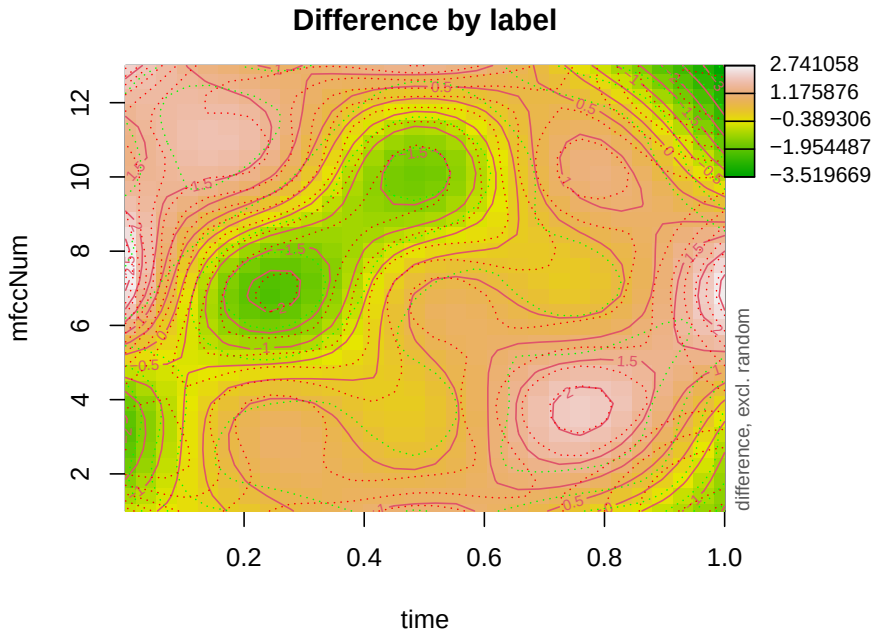
```
print(plot(mRmfccViz, allTerms=T), pages=2)
```



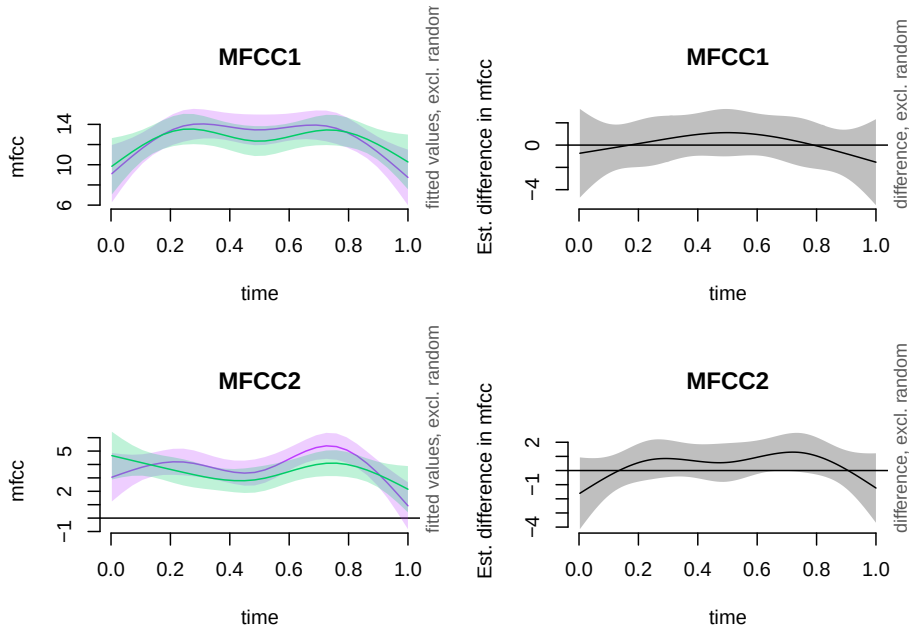

```
par(mfrow=c(1, 2))
plot_diff(mRmfcc, view="mfccNum", shade=TRUE, comp=list(label=c("i", "n")))
plot_diff(mRmfcc, view="time", shade=TRUE, comp=list(label=c("i", "n")))
```



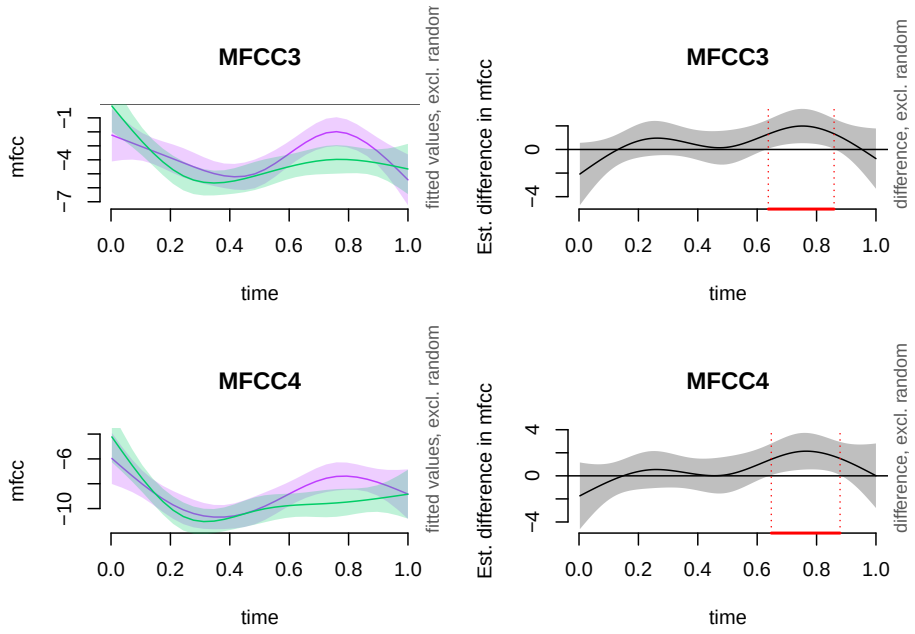
```
par(mfrow=c(1, 1))
par(mar=c(5, 5, 3, 8))
plot_diff2(mRmfcc, view=c("time", "mfccNum"), comp=list(label=c("i", "n")),
           main="Difference by label")
```



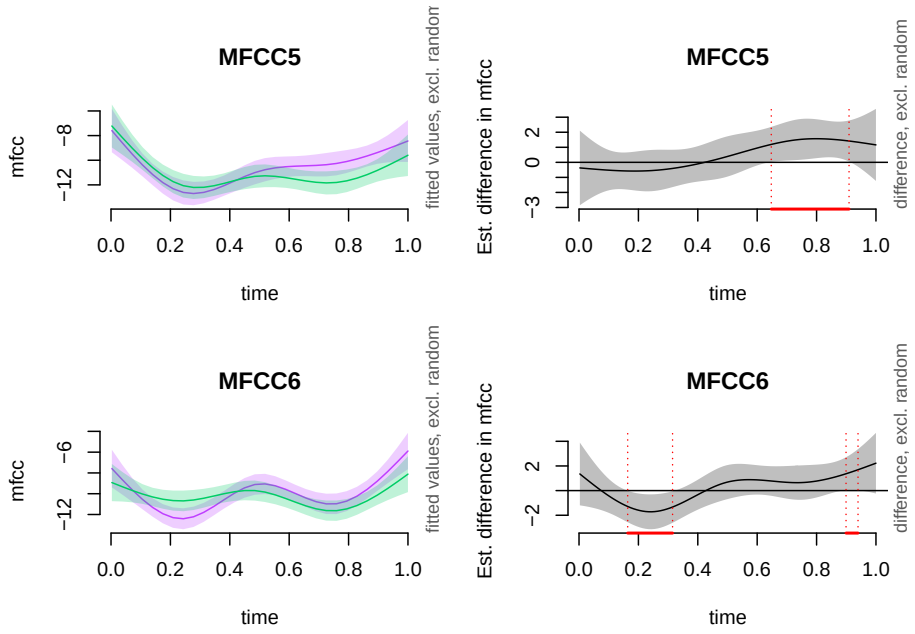

```
par(mfrow=c(2, 2))
plot.new
plot_smooth(mRmfcc, view="time", cond=list("label"="i", mfccNum=1),
            col="darkorchid1", main="MFCC1")
plot_smooth(mRmfcc, view="time", cond=list("label"="n", mfccNum=1),
            col="springgreen3", main="", add=TRUE)
plot_diff(mRmfcc, view="time", shade=TRUE, comp=list(label=c("i", "n")),
          cond=list(mfccNum=1), main="MFCC1")

plot_smooth(mRmfcc, view="time", cond=list("label"="i", mfccNum=2),
            col="darkorchid1", main="MFCC2")
plot_smooth(mRmfcc, view="time", cond=list("label"="n", mfccNum=2),
            col="springgreen3", main="", add=TRUE)
plot_diff(mRmfcc, view="time", shade=TRUE, comp=list(label=c("i", "n")),
          cond=list(mfccNum=2), main="MFCC2")
```



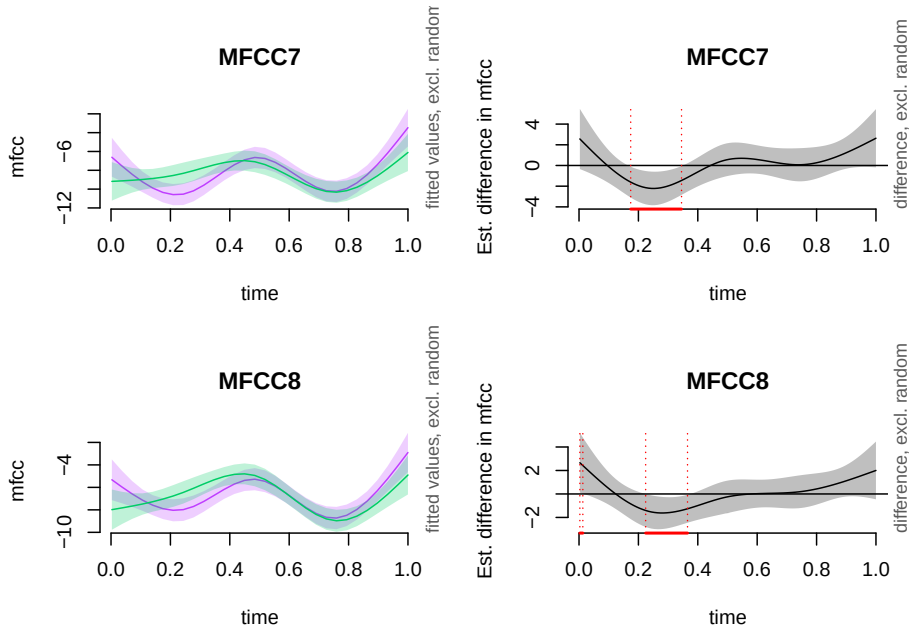

```
plot_smooth(mRmfcc, view="time", cond=list("label"="i", mfccNum=3),
            col="darkorchid1", main="MFCC3")
plot_smooth(mRmfcc, view="time", cond=list("label"="n", mfccNum=3),
            col="springgreen3", main="", add=TRUE)
plot_diff(mRmfcc, view="time", shade=TRUE, comp=list(label=c("i", "n")),
          cond=list(mfccNum=3), main="MFCC3")

plot_smooth(mRmfcc, view="time", cond=list("label"="i", mfccNum=4),
            col="darkorchid1", main="MFCC4")
plot_smooth(mRmfcc, view="time", cond=list("label"="n", mfccNum=4),
            col="springgreen3", main="", add=TRUE)
plot_diff(mRmfcc, view="time", shade=TRUE, comp=list(label=c("i", "n")),
          cond=list(mfccNum=4), main="MFCC4")
```



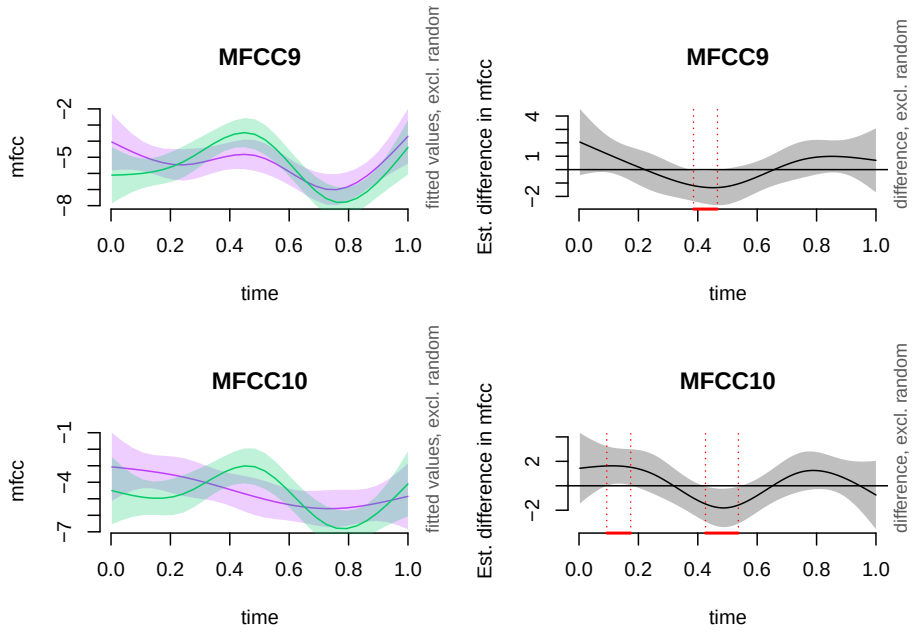

```
plot_smooth(mRmfcc, view="time", cond=list("label"="i", mfccNum=5),
            col="darkorchid1", main="MFCC5")
plot_smooth(mRmfcc, view="time", cond=list("label"="n", mfccNum=5),
            col="springgreen3", main="", add=TRUE)
plot_diff(mRmfcc, view="time", shade=TRUE, comp=list(label=c("i", "n")),
          cond=list(mfccNum=5), main="MFCC5")

plot_smooth(mRmfcc, view="time", cond=list("label"="i", mfccNum=6),
            col="darkorchid1", main="MFCC6")
plot_smooth(mRmfcc, view="time", cond=list("label"="n", mfccNum=6),
            col="springgreen3", main="", add=TRUE)
plot_diff(mRmfcc, view="time", shade=TRUE, comp=list(label=c("i", "n")),
          cond=list(mfccNum=6), main="MFCC6")
```



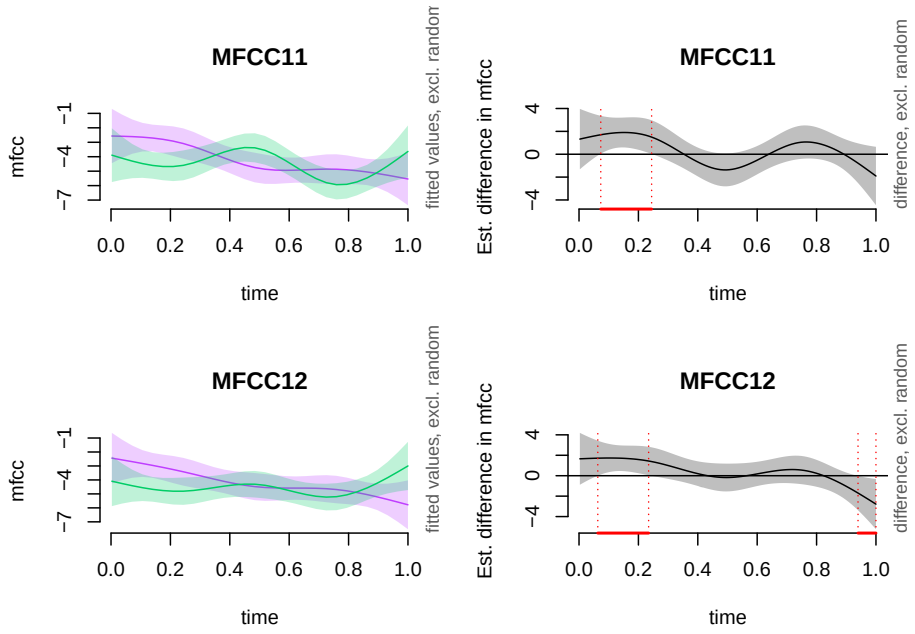

```
plot_smooth(mRmfcc, view="time", cond=list("label"="i", mfccNum=7),
            col="darkorchid1", main="MFCC7")
plot_smooth(mRmfcc, view="time", cond=list("label"="n", mfccNum=7),
            col="springgreen3", main="", add=TRUE)
plot_diff(mRmfcc, view="time", shade=TRUE, comp=list(label=c("i", "n")),
          cond=list(mfccNum=7), main="MFCC7")

plot_smooth(mRmfcc, view="time", cond=list("label"="i", mfccNum=8),
            col="darkorchid1", main="MFCC8")
plot_smooth(mRmfcc, view="time", cond=list("label"="n", mfccNum=8),
            col="springgreen3", main="", add=TRUE)
plot_diff(mRmfcc, view="time", shade=TRUE, comp=list(label=c("i", "n")),
          cond=list(mfccNum=8), main="MFCC8")
```



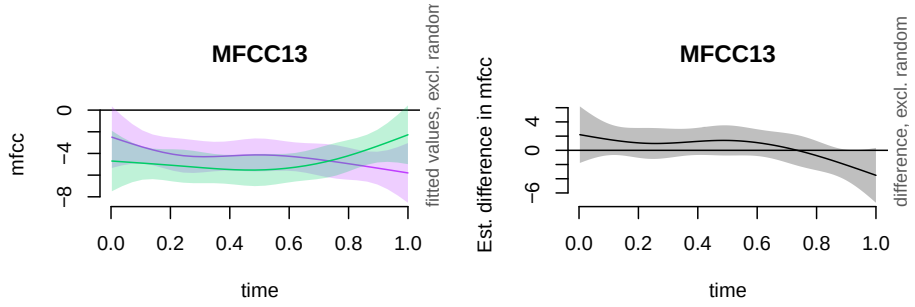

```
plot_smooth(mRmfcc, view="time", cond=list("label"="i", mfccNum=9),
            col="darkorchid1", main="MFCC9")
plot_smooth(mRmfcc, view="time", cond=list("label"="n", mfccNum=9),
            col="springgreen3", main="", add=TRUE)
plot_diff(mRmfcc, view="time", shade=TRUE, comp=list(label=c("i", "n")),
          cond=list(mfccNum=9), main="MFCC9")

plot_smooth(mRmfcc, view="time", cond=list("label"="i", mfccNum=10),
            col="darkorchid1", main="MFCC10")
plot_smooth(mRmfcc, view="time", cond=list("label"="n", mfccNum=10),
            col="springgreen3", main="", add=TRUE)
plot_diff(mRmfcc, view="time", shade=TRUE, comp=list(label=c("i", "n")),
          cond=list(mfccNum=10), main="MFCC10")
```




```
plot_smooth(mRmfcc, view="time", cond=list("label"="i", mfccNum=11),
            col="darkorchid1", main="MFCC11")
plot_smooth(mRmfcc, view="time", cond=list("label"="n", mfccNum=11),
            col="springgreen3", main="", add=TRUE)
plot_diff(mRmfcc, view="time", shade=TRUE, comp=list(label=c("i", "n")),
          cond=list(mfccNum=11), main="MFCC11")

plot_smooth(mRmfcc, view="time", cond=list("label"="i", mfccNum=12),
            col="darkorchid1", main="MFCC12")
plot_smooth(mRmfcc, view="time", cond=list("label"="n", mfccNum=12),
            col="springgreen3", main="", add=TRUE)
plot_diff(mRmfcc, view="time", shade=TRUE, comp=list(label=c("i", "n")),
          cond=list(mfccNum=12), main="MFCC12")
```




```
plot_smooth(mRmfcc, view="time", cond=list("label"="i", mfccNum=13),
            col="darkorchid1", main="MFCC13")
plot_smooth(mRmfcc, view="time", cond=list("label"="n", mfccNum=13),
            col="springgreen3", main="", add=TRUE)
plot_diff(mRmfcc, view="time", shade=TRUE, comp=list(label=c("i", "n")),
          cond=list(mfccNum=13), main="MFCC13")
```




```
summary(mRmfcc)
```

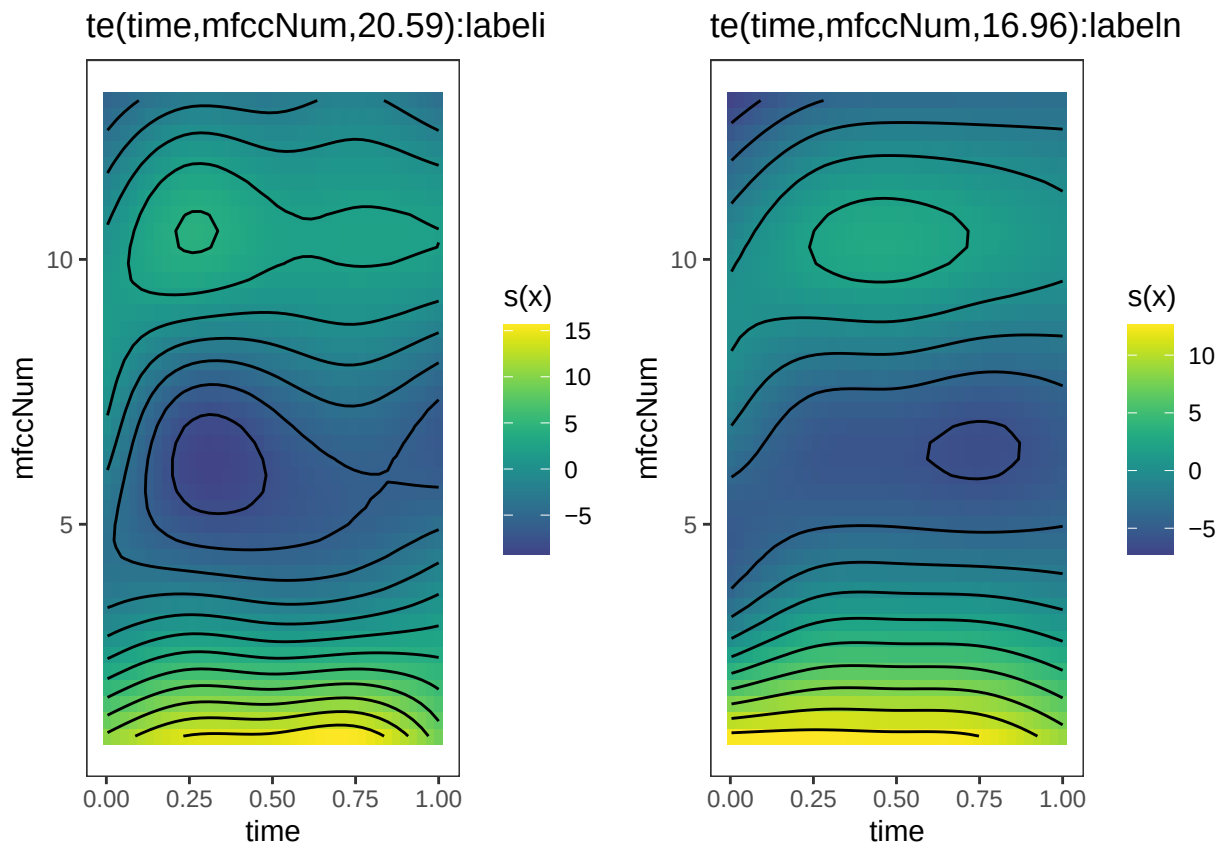
```
##
```

```
## Family: gaussian
## Link function: identity
##
## Formula:
## mfcc ~ label + te(time, mfccNum, by = label)
##
## Parametric coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)  -4.1470     0.1257 -32.979   <2e-16 ***
## labeln       -0.3129     0.1778  -1.759   0.0785 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Approximate significance of smooth terms:
##                            edf Ref.df     F p-value
## te(time,mfccNum):labeli 21.78  23.46 103.2  <2e-16 ***
## te(time,mfccNum):labeln 21.27  23.20 103.8  <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## R-sq.(adj) =  0.142   Deviance explained = 14.3%
## fREML = 1.2115e+05  Scale est. = 230.92    n = 29250
```

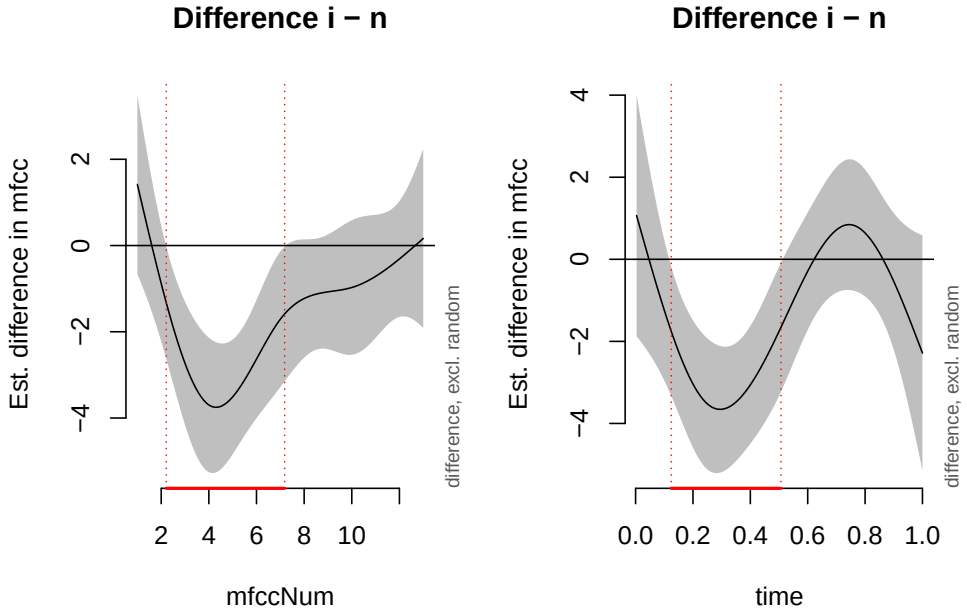
Speaker Y

```
mYmfcc=bam(mfcc ~ label + te(time, mfccNum, by=label), data=ymfcc)
mYmfccViz = getViz(mYmfcc)
```

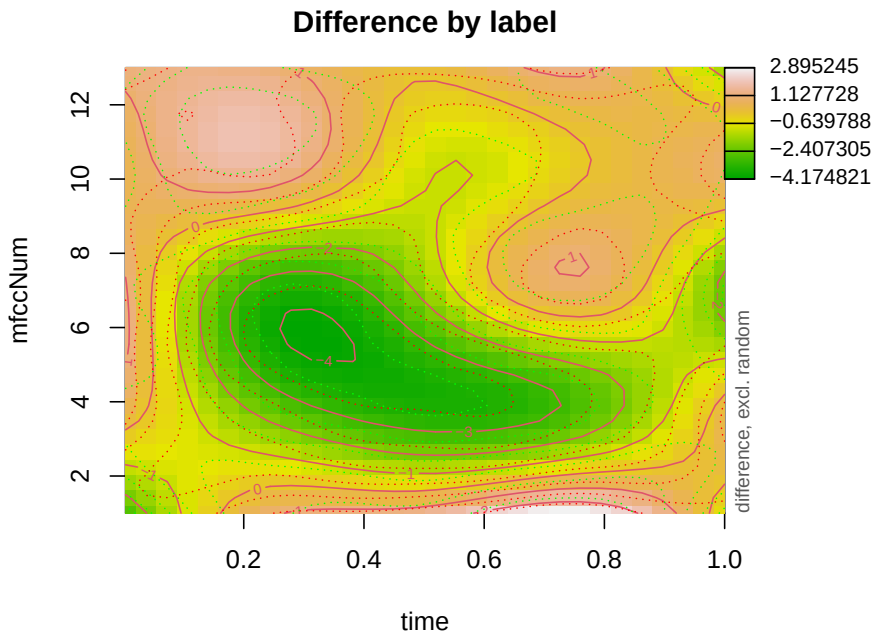
```
print(plot(mYmfccViz, allTerms=T), pages=2)
```



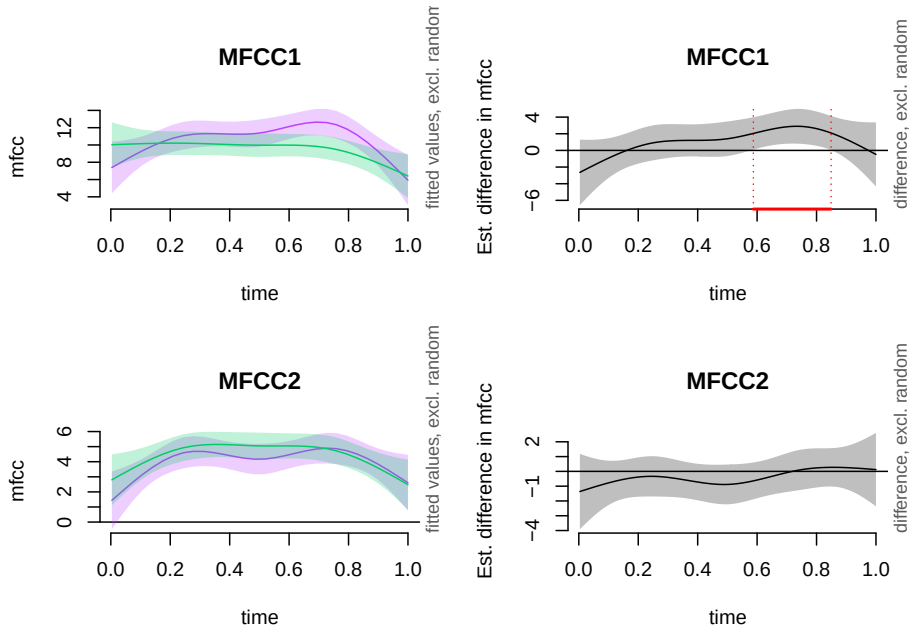

```
par(mfrow=c(1, 2))
plot_diff(mYmfcc, view="mfccNum", shade=TRUE, comp=list(label=c("i", "n")))
plot_diff(mYmfcc, view="time", shade=TRUE, comp=list(label=c("i", "n")))
```



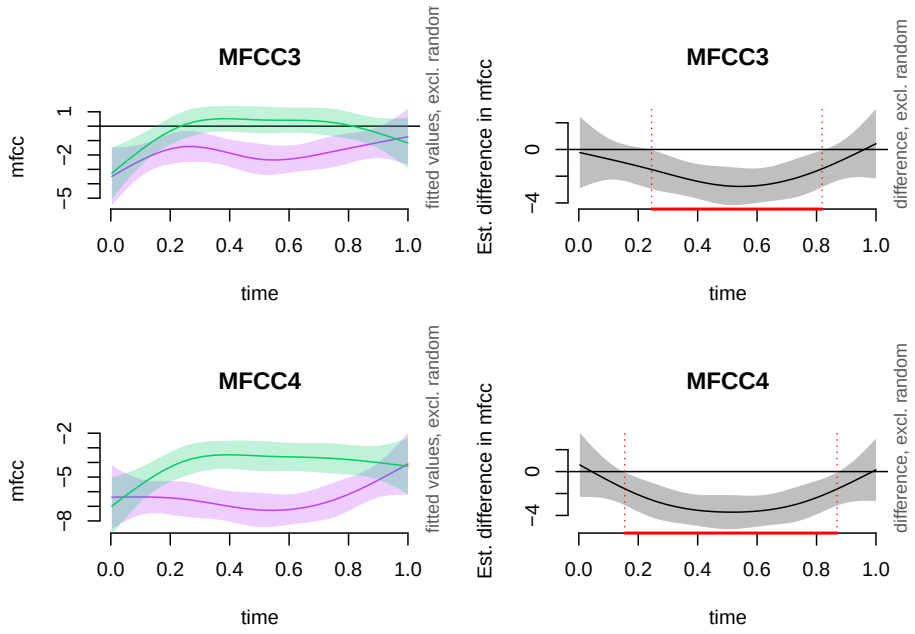
```
par(mfrow=c(1, 1))
par(mar=c(5, 5, 3, 8))
plot_diff2(mYmfcc, view=c("time", "mfccNum"), comp=list(label=c("i", "n")), main="Difference by label")
```



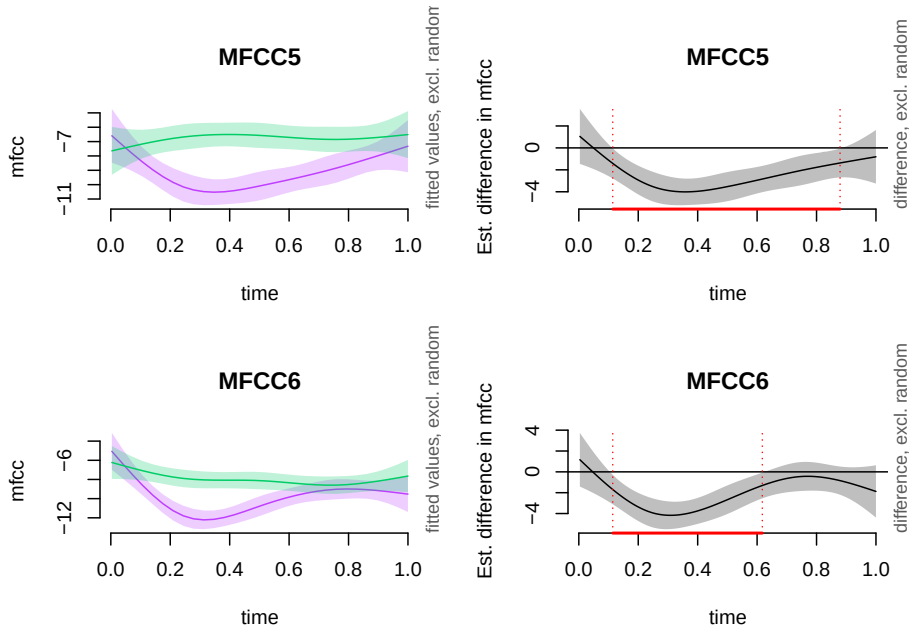

```
par(mfrow=c(2, 2))
plot.new
plot_smooth(mYmfcc, view="time", cond=list("label"="i", mfccNum=1),
            col="darkorchid1", main="MFCC1")
plot_smooth(mYmfcc, view="time", cond=list("label"="n", mfccNum=1),
            col="springgreen3", main="", add=TRUE)
plot_diff(mYmfcc, view="time", shade=TRUE, comp=list(label=c("i", "n")),
          cond=list(mfccNum=1), main="MFCC1")

plot_smooth(mYmfcc, view="time", cond=list("label"="i", mfccNum=2),
            col="darkorchid1", main="MFCC2")
plot_smooth(mYmfcc, view="time", cond=list("label"="n", mfccNum=2),
            col="springgreen3", main="", add=TRUE)
plot_diff(mYmfcc, view="time", shade=TRUE, comp=list(label=c("i", "n")),
          cond=list(mfccNum=2), main="MFCC2")
```



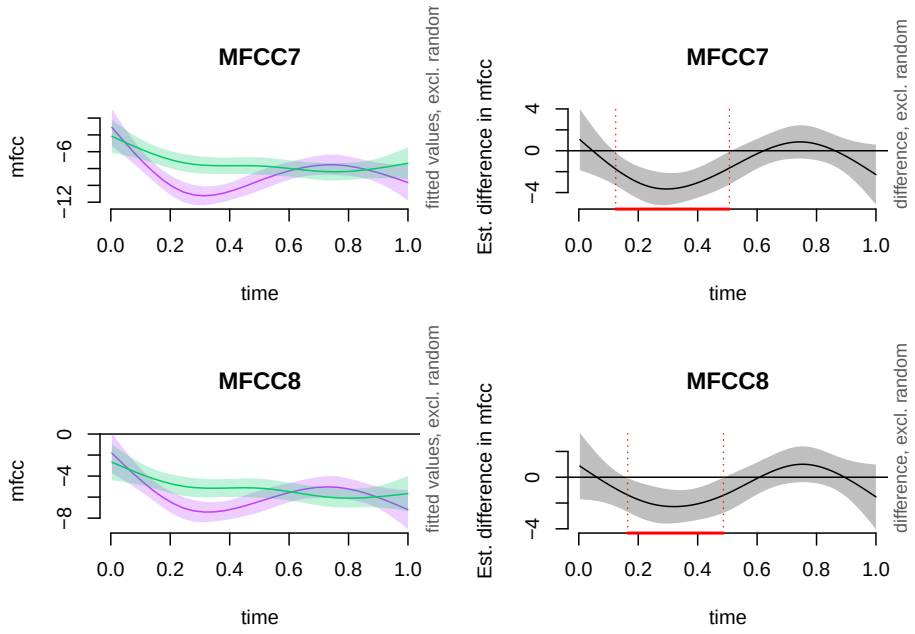

```
plot_smooth(mYmfcc, view="time", cond=list("label"="i", mfccNum=3),
            col="darkorchid1", main="MFCC3")
plot_smooth(mYmfcc, view="time", cond=list("label"="n", mfccNum=3),
            col="springgreen3", main="", add=TRUE)
plot_diff(mYmfcc, view="time", shade=TRUE, comp=list(label=c("i", "n")),
          cond=list(mfccNum=3), main="MFCC3")

plot_smooth(mYmfcc, view="time", cond=list("label"="i", mfccNum=4),
            col="darkorchid1", main="MFCC4")
plot_smooth(mYmfcc, view="time", cond=list("label"="n", mfccNum=4),
            col="springgreen3", main="", add=TRUE)
plot_diff(mYmfcc, view="time", shade=TRUE, comp=list(label=c("i", "n")),
          cond=list(mfccNum=4), main="MFCC4")
```



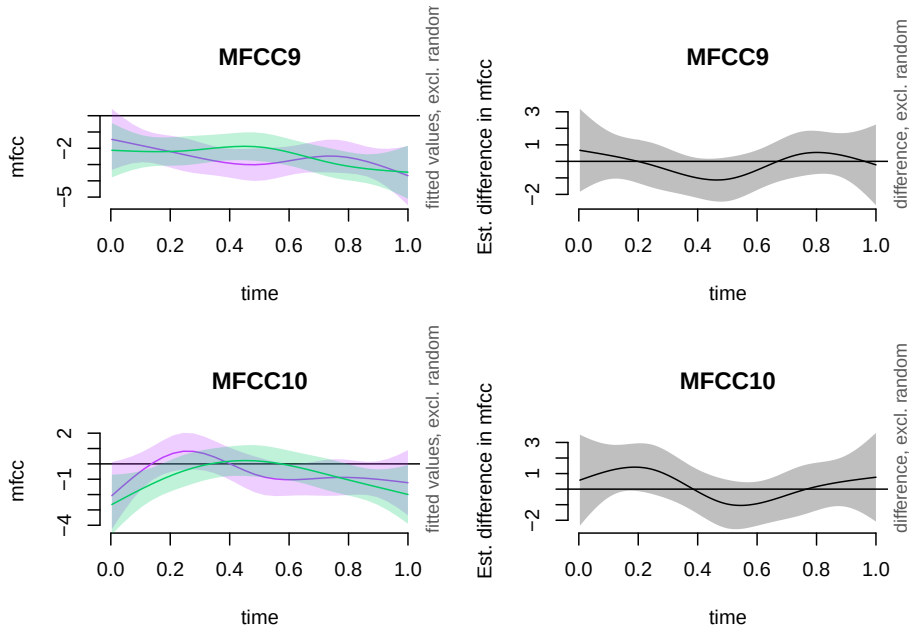

```
plot_smooth(mYmfcc, view="time", cond=list("label"="i", mfccNum=5),
            col="darkorchid1", main="MFCC5")
plot_smooth(mYmfcc, view="time", cond=list("label"="n", mfccNum=5),
            col="springgreen3", main="", add=TRUE)
plot_diff(mYmfcc, view="time", shade=TRUE, comp=list(label=c("i", "n")),
          cond=list(mfccNum=5), main="MFCC5")

plot_smooth(mYmfcc, view="time", cond=list("label"="i", mfccNum=6),
            col="darkorchid1", main="MFCC6")
plot_smooth(mYmfcc, view="time", cond=list("label"="n", mfccNum=6),
            col="springgreen3", main="", add=TRUE)
plot_diff(mYmfcc, view="time", shade=TRUE, comp=list(label=c("i", "n")),
          cond=list(mfccNum=6), main="MFCC6")
```



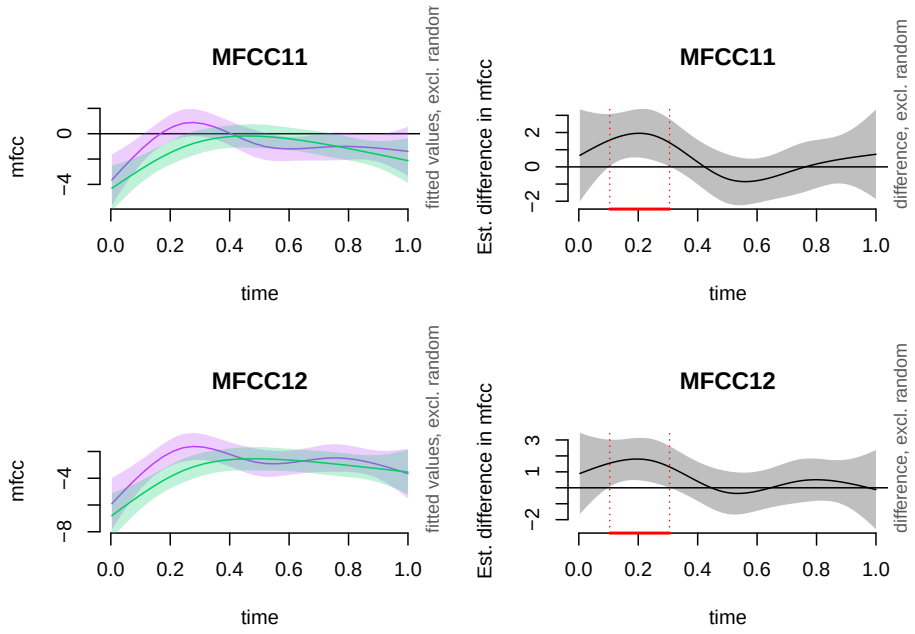

```
plot_smooth(mYmfcc, view="time", cond=list("label"="i", mfccNum=7),
            col="darkorchid1", main="MFCC7")
plot_smooth(mYmfcc, view="time", cond=list("label"="n", mfccNum=7),
            col="springgreen3", main="", add=TRUE)
plot_diff(mYmfcc, view="time", shade=TRUE, comp=list(label=c("i", "n")),
          cond=list(mfccNum=7), main="MFCC7")

plot_smooth(mYmfcc, view="time", cond=list("label"="i", mfccNum=8),
            col="darkorchid1", main="MFCC8")
plot_smooth(mYmfcc, view="time", cond=list("label"="n", mfccNum=8),
            col="springgreen3", main="", add=TRUE)
plot_diff(mYmfcc, view="time", shade=TRUE, comp=list(label=c("i", "n")),
          cond=list(mfccNum=8), main="MFCC8")
```




```
plot_smooth(mYmfcc, view="time", cond=list("label"="i", mfccNum=9),
            col="darkorchid1", main="MFCC9")
plot_smooth(mYmfcc, view="time", cond=list("label"="n", mfccNum=9),
            col="springgreen3", main="", add=TRUE)
plot_diff(mYmfcc, view="time", shade=TRUE, comp=list(label=c("i", "n")),
          cond=list(mfccNum=9), main="MFCC9")

plot_smooth(mYmfcc, view="time", cond=list("label"="i", mfccNum=10),
            col="darkorchid1", main="MFCC10")
plot_smooth(mYmfcc, view="time", cond=list("label"="n", mfccNum=10),
            col="springgreen3", main="", add=TRUE)
plot_diff(mYmfcc, view="time", shade=TRUE, comp=list(label=c("i", "n")),
          cond=list(mfccNum=10), main="MFCC10")
```




```
plot_smooth(mYmfcc, view="time", cond=list("label"="i", mfccNum=11),
            col="darkorchid1", main="MFCC11")
plot_smooth(mYmfcc, view="time", cond=list("label"="n", mfccNum=11),
            col="springgreen3", main="", add=TRUE)
plot_diff(mYmfcc, view="time", shade=TRUE, comp=list(label=c("i", "n")),
          cond=list(mfccNum=11), main="MFCC11")

plot_smooth(mYmfcc, view="time", cond=list("label"="i", mfccNum=12),
            col="darkorchid1", main="MFCC12")
plot_smooth(mYmfcc, view="time", cond=list("label"="n", mfccNum=12),
            col="springgreen3", main="", add=TRUE)
plot_diff(mYmfcc, view="time", shade=TRUE, comp=list(label=c("i", "n")),
          cond=list(mfccNum=12), main="MFCC12")
```




```
plot_smooth(mYmfcc, view="time", cond=list("label"="i", mfccNum=13),
            col="darkorchid1", main="MFCC13")
plot_smooth(mYmfcc, view="time", cond=list("label"="n", mfccNum=13),
            col="springgreen3", main="", add=TRUE)
plot_diff(mYmfcc, view="time", shade=TRUE, comp=list(label=c("i", "n")),
          cond=list(mfccNum=13), main="MFCC13")
```

```
summary(mYmfcc)
```

```
##
```

```
## Family: gaussian
## Link function: identity
##
## Formula:
## mfcc ~ label + te(time, mfccNum, by = label)
##
## Parametric coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)  -3.0151     0.1371 -21.985  < 2e-16 ***
## labeln        0.5766     0.1940   2.973  0.00295 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Approximate significance of smooth terms:
##                            edf Ref.df     F p-value
## te(time,mfccNum):labeli 20.59  22.79 74.29  <2e-16 ***
## te(time,mfccNum):labeln 16.96  19.66 65.20  <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## R-sq.(adj) =  0.0926   Deviance explained = 9.38%
## fREML = 1.2368e+05  Scale est. = 274.69    n = 29250
```