

# Supplementary materials for: Consonant stability in Portuguese-based creoles

(03 January, 2023)

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## Overview

Supplementary materials for, “Consonant Stability in Portuguese-based creoles”. In this report, we provide code in R (RStudio Team 2020) and we use these R libraries (Wickham et al. 2019; Xie 2021; Slowikowski 2022):

```
library(tidyverse)
library(knitr)
library(ggrepel)

# Set the theme for all figures
theme_set(theme_bw())
```

Load the data set.

```
database <- read_csv('database.csv')
```

The data look like this:

```
database %>% head() %>% kable()
```

Language	Area	Lexifier	First Major Contact	First Major Contact Language	Class	Position	Lexifier	Phone	Place	Stability	Word	Class	Source
Portuguese	Principles of Guinea	Portuguese	1499	1975	Slavery Edo	Stopword- p initial	p	1	1	[ p n ]	feather	Maurer2009[232]	

Language	Macro Area	Lexifier	FirstMajorSettlement	EndOfInfluence	ContactConditions	LanguageClass	GlobalStability	PlaceStability	MannerStability	GlobalStability	Source
Principalities of Guinea	Africa	Gulf of Guinea	Portuguese	1499	1975	Slavery Edo	Stopword- p medial	p	1	1	[t ipa]guts Maurer2009[238]
Principalities of Guinea	Africa	Gulf of Guinea	Portuguese	1499	1975	Slavery Edo	Stopword- b initial	b	1	1	[bw g]elly Maurer2009[216]
Principalities of Guinea	Africa	Gulf of Guinea	Portuguese	1499	1975	Slavery Edo	Stopword- b medial	b	1	1	[ka b]hair Maurer2009[221]
Principalities of Guinea	Africa	Gulf of Guinea	Portuguese	1499	1975	Slavery Edo	Stopword- t initial	t	1	1	[tudu]veryt Maurer2009[237]
Principalities of Guinea	Africa	Gulf of Guinea	Portuguese	1499	1975	Slavery Edo	Stopword- t medial	t	1	1	[mata]lo Maurer2009[227]

We extend the database with some additional variables. First, duration of contact.

```
database$duration <- database$`EndOfInfluence` - database$`FirstMajorSettlement`
```

Next, a variable of global stability.

```
database <- mutate(database, GlobalStability = (PlaceStability + MannerStability)/2)
# table(database$Language, database$GlobalStability)
```

Also, a categorical variable for duration.

```
database <- database %>% mutate(duration_group = ifelse(duration <= 200, 'short', 'long'))
```

And a categorical variable for changes in manner and/or place. Stability in the database is '1' (no change) and '0' (change).

```
database <- database %>% mutate(categorical_stability = ifelse(PlaceStability == 1 & MannerStability == 1, 1, 0))
database <- database %>% mutate(categorical_stability = ifelse(PlaceStability == 1 & MannerStability == 0, 0, 1))
database <- database %>% mutate(categorical_stability = ifelse(PlaceStability == 0 & MannerStability == 1, 0, 1))
database <- database %>% mutate(categorical_stability = ifelse(PlaceStability == 0 & MannerStability == 0, 0, 1))
table(database$categorical_stability)
```

```
##
##      manner/no place      manner/place no manner/no place      no manner/place
##              43              54              517              24
```

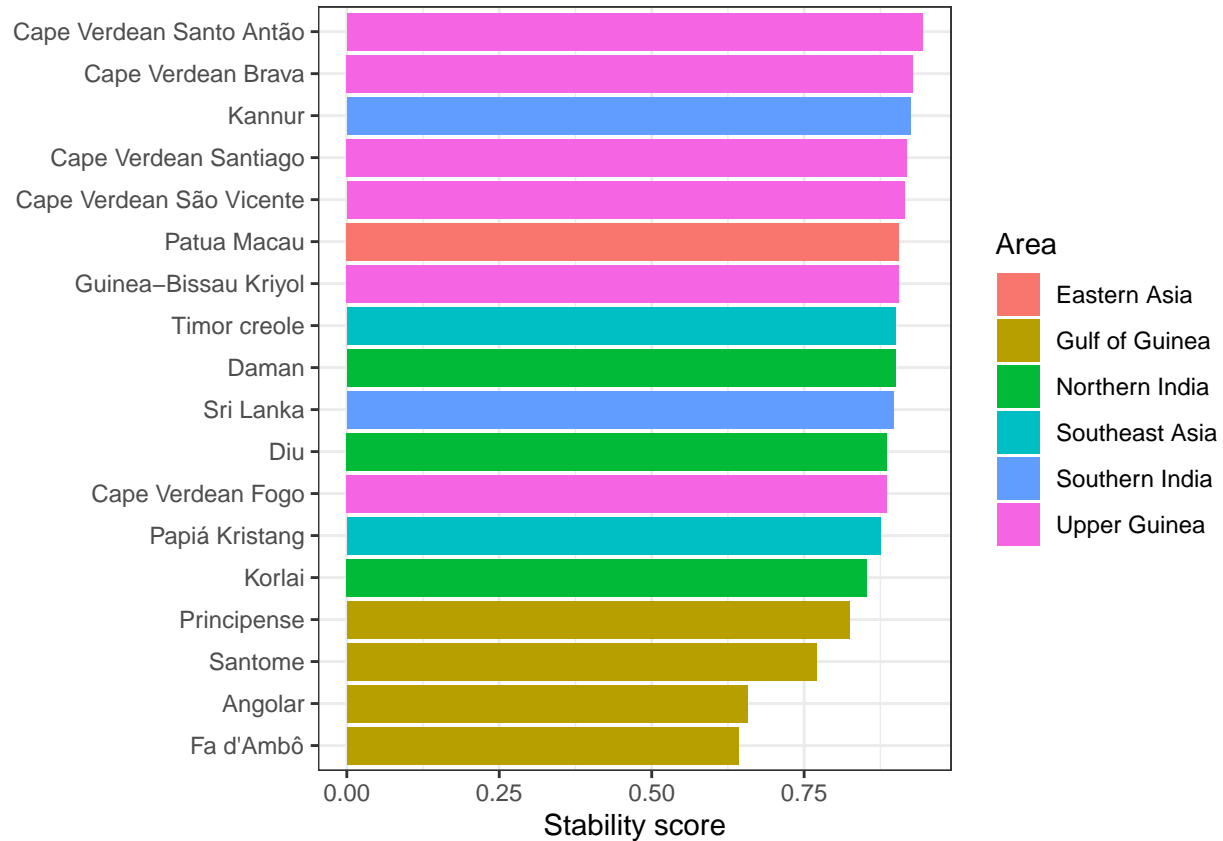
## Creole stability

Which creoles in the sample are more or less stable overall?

```
creole_stability <- database %>% group_by(Language, Area, duration, duration_group, ContactConditions) %>%
```

Plot it by area.

```
ggplot(creole_stability) +
  geom_bar(aes(x = MeanStability, y = reorder(Language, MeanStability), fill = Area),
    stat = "identity", show.legend = TRUE) +
  theme(axis.title.y = element_blank()) +
  labs(x = "Stability score")
```

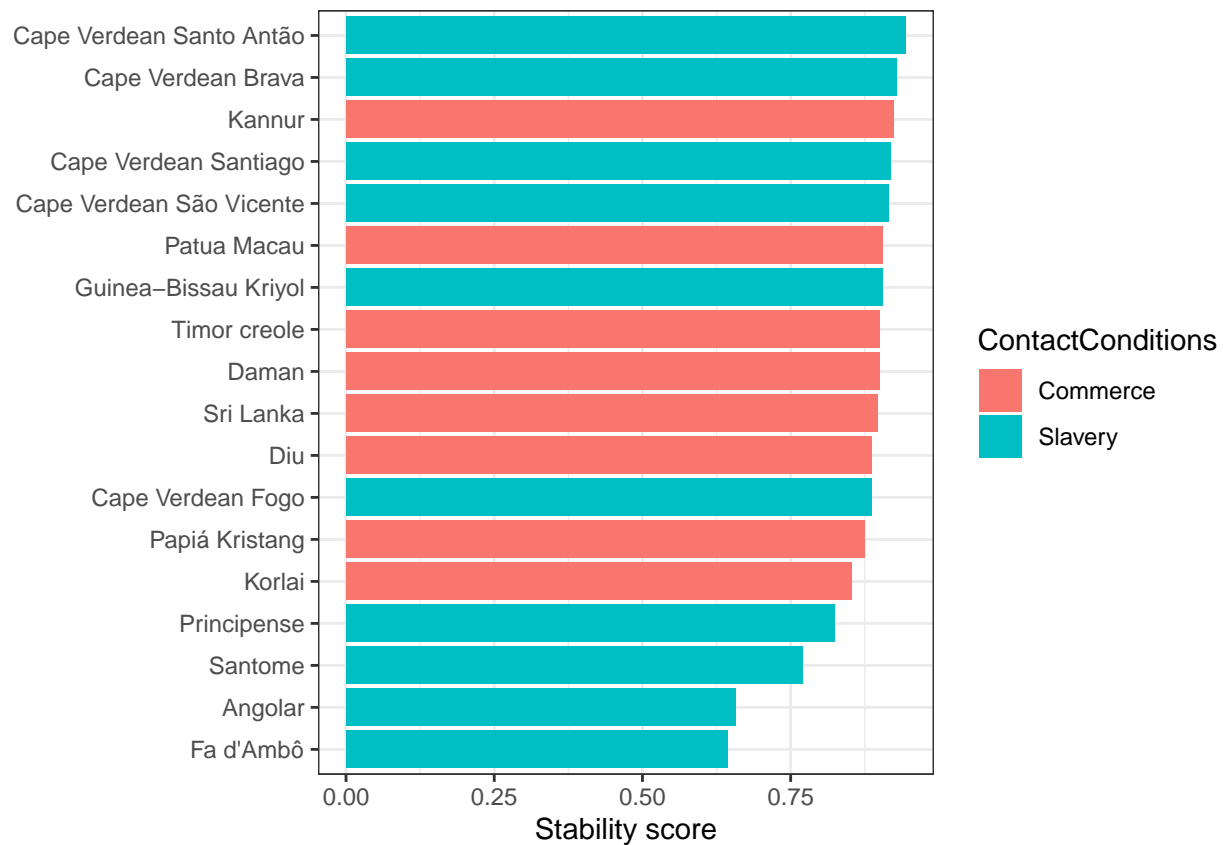


```
table(creole_stability$Area)
```

```
##
##   Eastern Asia Gulf of Guinea Northern India Southeast Asia Southern India
##           1           4           3           2           2
##   Upper Guinea
##           6
```

Plot it by conditions of contact.

```
ggplot(creole_stability) +
  geom_bar(aes(x = MeanStability, y = reorder(Language, MeanStability), fill = ContactConditions),
    stat = "identity", show.legend = TRUE) +
  theme(axis.title.y = element_blank()) +
  labs(x = "Stability score")
```

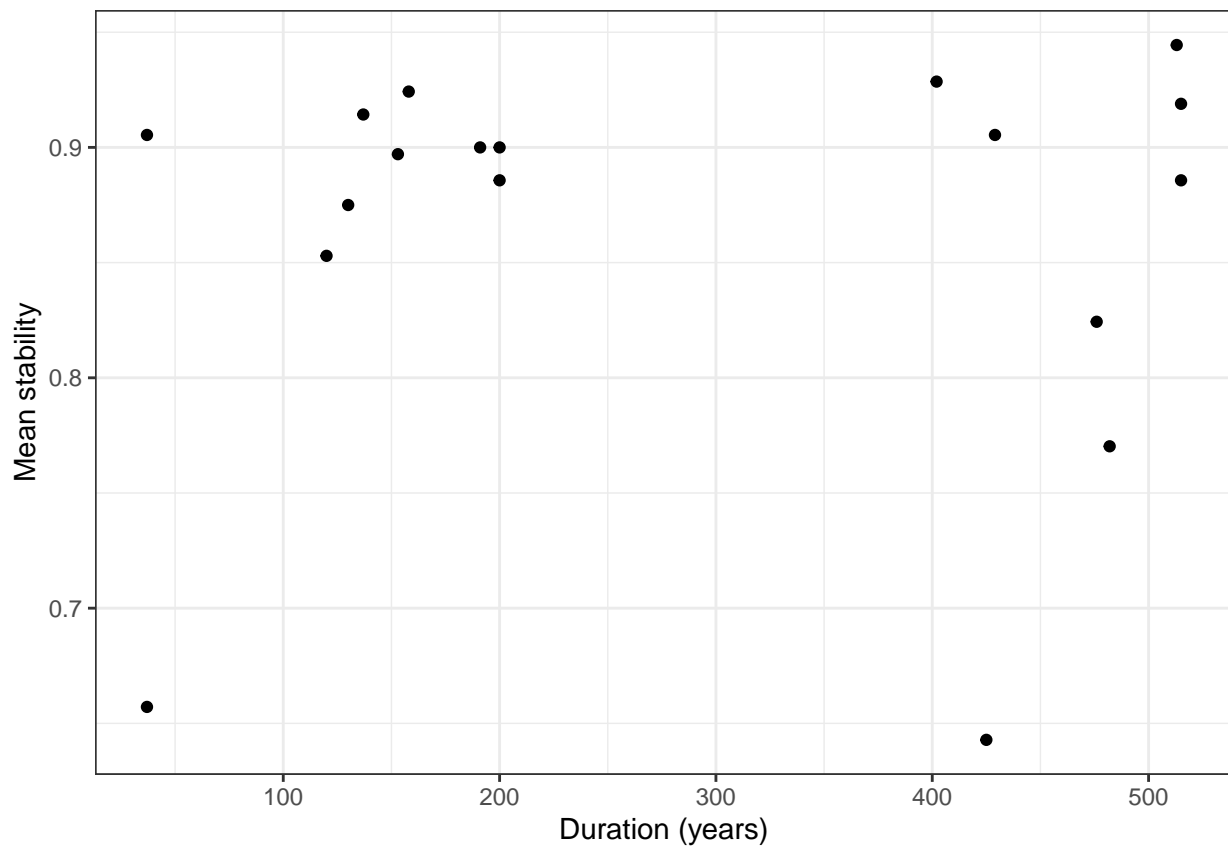


## Duration

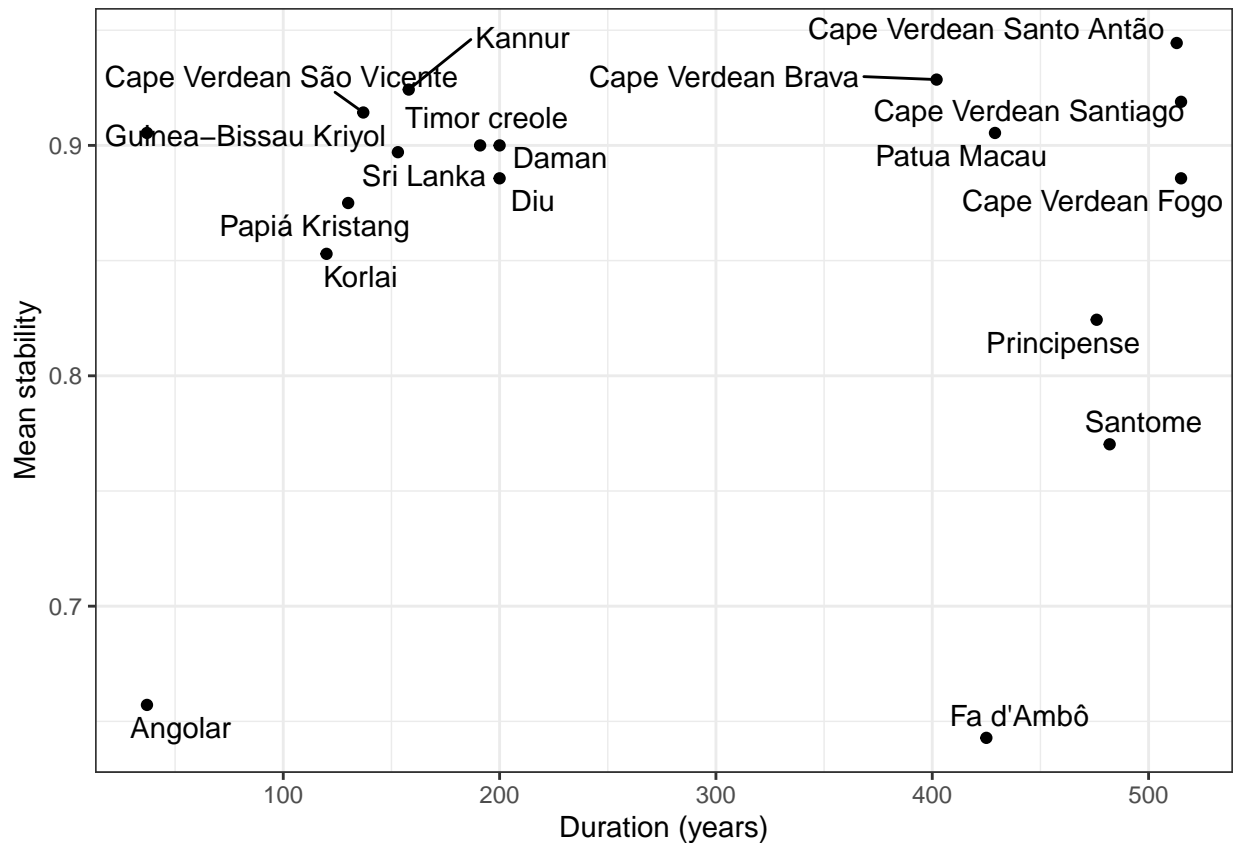
We have the overall stability values. What are these in relation to the duration of contact?

There does not seem to be a relationship between overall duration and overall stability.

```
ggplot(creole_stability, aes(x=duration, y=MeanStability)) +
  geom_point() +
  xlab("Duration (years)") +
  ylab("Mean stability")
```



```
ggplot(creole_stability, aes(x=duration, y=MeanStability)) +  
  geom_point() +  
  geom_text_repel(aes(label = creole_stability$Language)) +  
  xlab("Duration (years)") +  
  ylab("Mean stability")
```



Results from the simple regression.

```
msd <- lm(MeanStability ~ duration, data=creole_stability)
summary(msd)

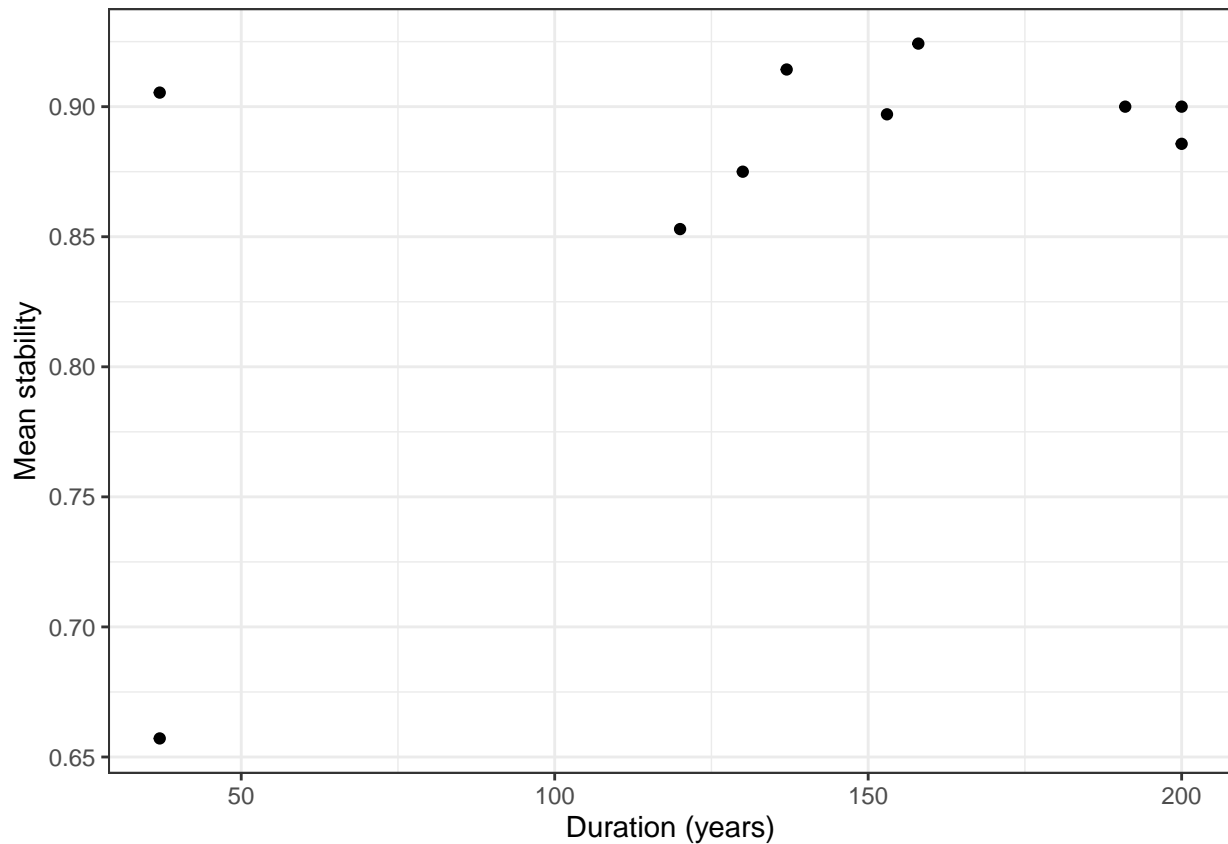
##
## Call:
## lm(formula = MeanStability ~ duration, data = creole_stability)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.221577 -0.002688  0.036798  0.051036  0.079053
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)  8.598e-01  4.086e-02  21.042 4.37e-13 ***
## duration      1.088e-05  1.227e-04   0.089    0.93
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.09017 on 16 degrees of freedom
## Multiple R-squared:  0.0004911, Adjusted R-squared:  -0.06198
## F-statistic: 0.007862 on 1 and 16 DF,  p-value: 0.9304
```

However, there does seem to be two groups of languages – ones that belong to “long duration” ( $\geq 400$  years) and those that below to “short duration” ( $\leq 200$  years).

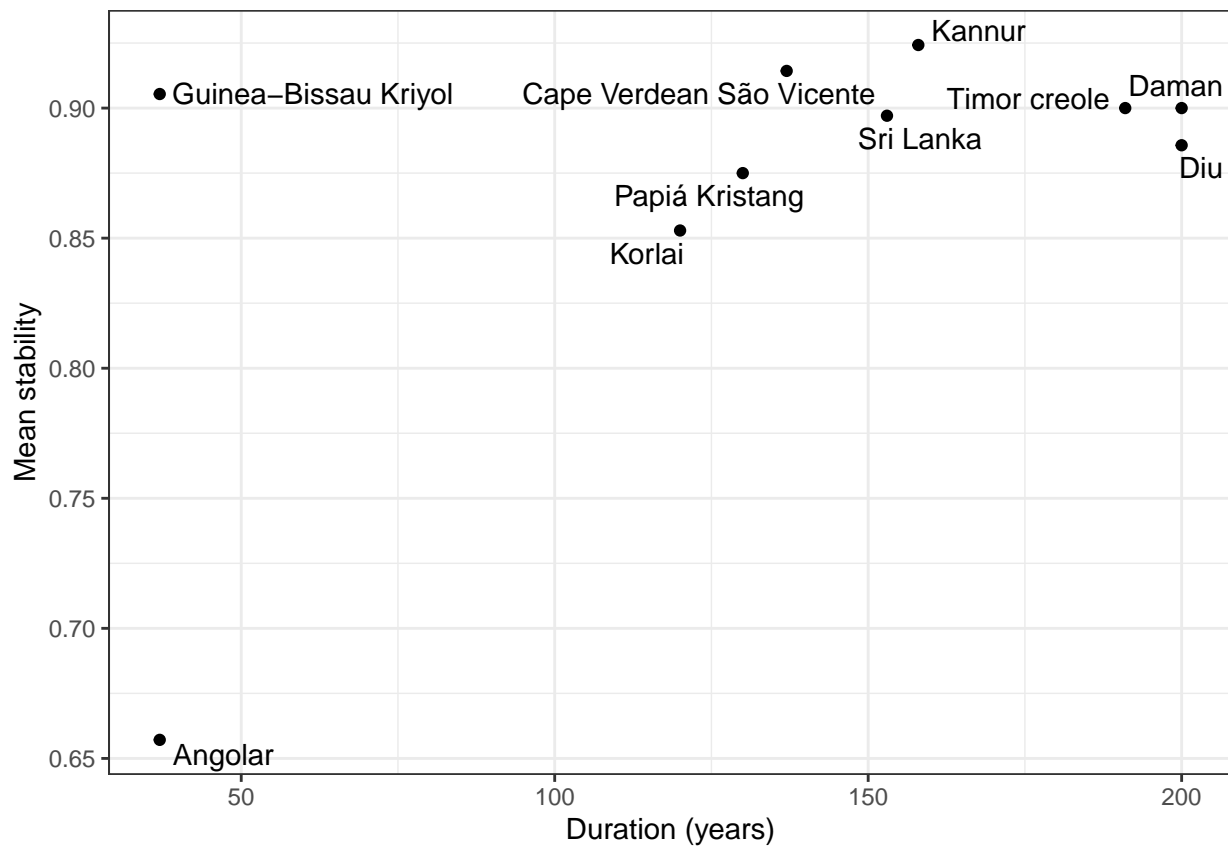
We can try to split the data and rerun the models, but we note that there are very few data points.

```
tmp_short <- creole_stability %>% filter(duration <= 200)
tmp_long <- creole_stability %>% filter(duration > 200)
```

```
ggplot(tmp_short, aes(x=duration, y=MeanStability)) +
  geom_point() +
  xlab("Duration (years)") +
  ylab("Mean stability")
```

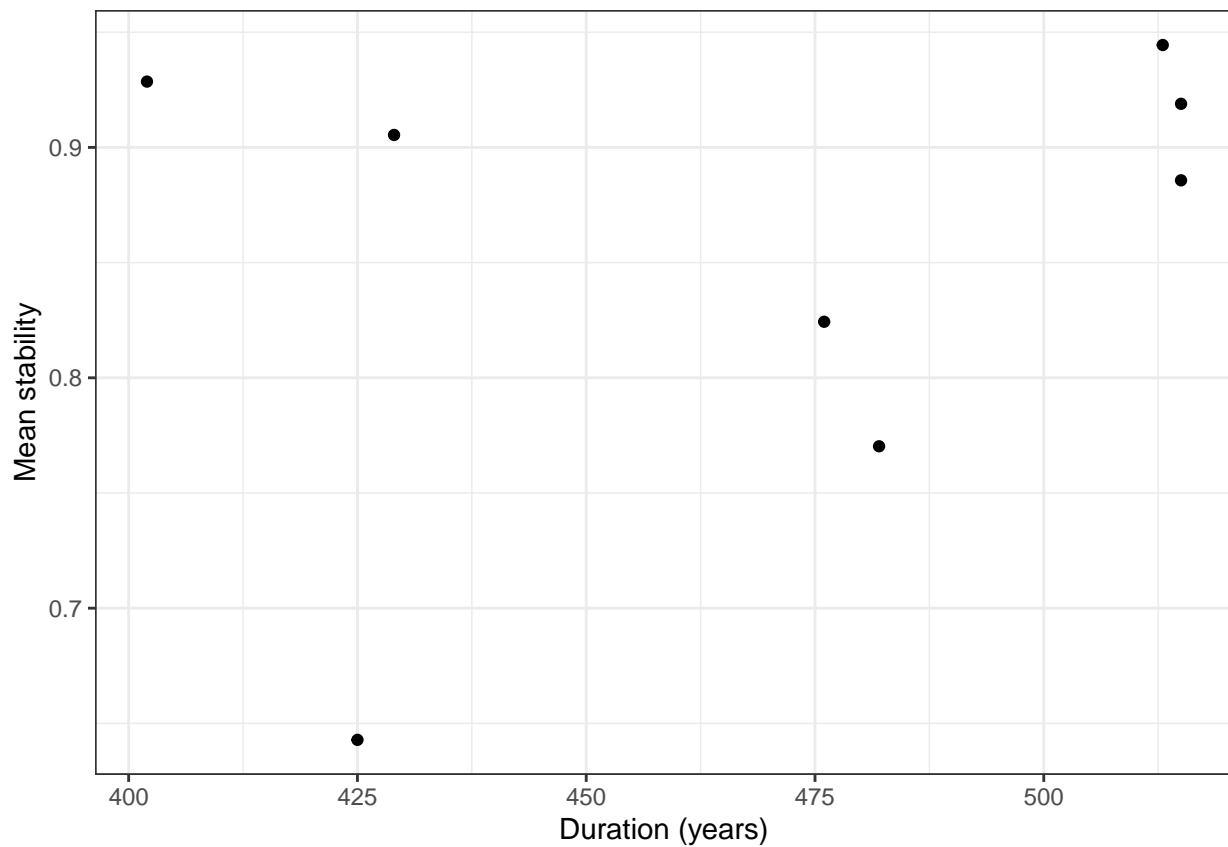


```
ggplot(tmp_short, aes(x=duration, y=MeanStability)) +
  geom_point() +
  geom_text_repel(aes(label = tmp_short$Language)) +
  xlab("Duration (years)") +
  ylab("Mean stability")
```

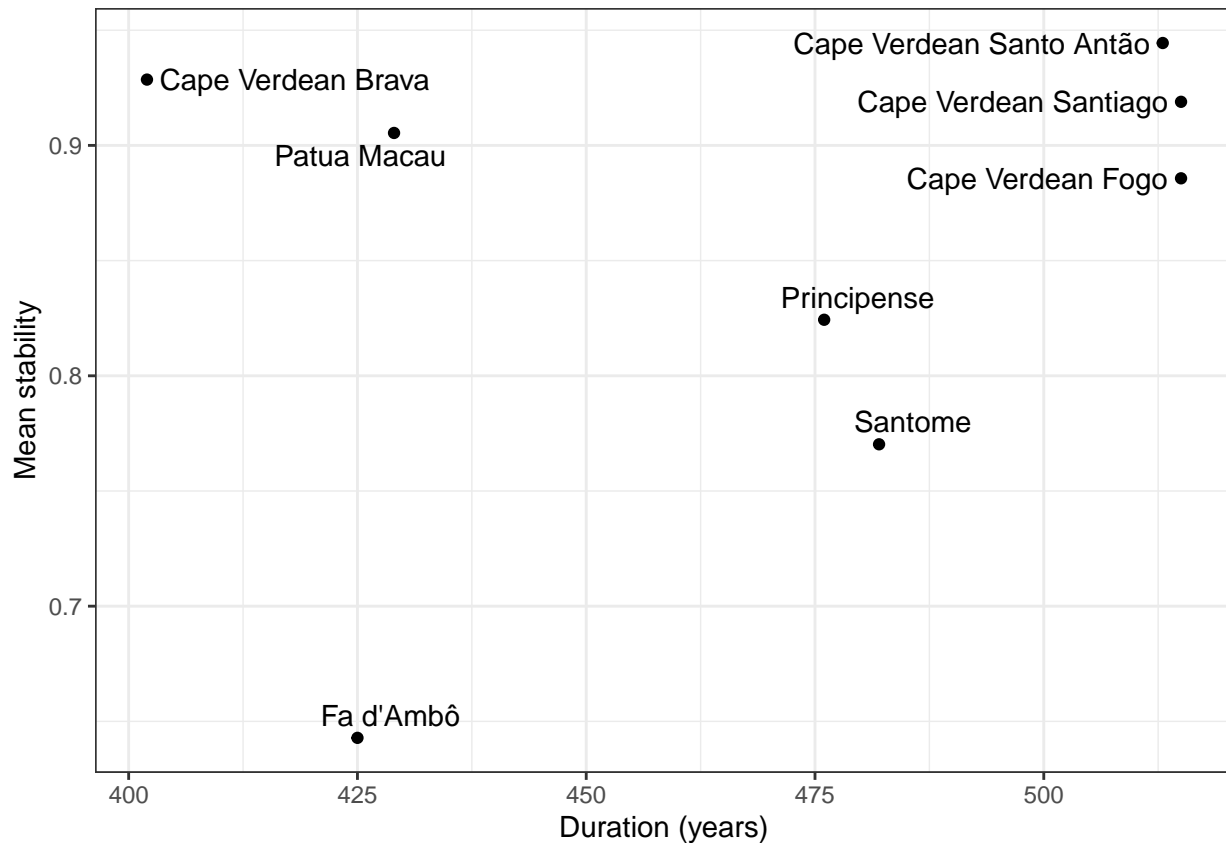


```
ggplot(tmp_long, aes(x=duration, y=MeanStability)) +
  geom_point() +
  xlab("Duration (years)") +
  ylab("Mean stability")
```





```
ggplot(tmp_long, aes(x=duration, y=MeanStability)) +  
  geom_point() +  
  geom_text_repel(aes(label = tmp_long$Language)) +  
  xlab("Duration (years)") +  
  ylab("Mean stability")
```



Or perhaps a single model with an interaction term `MeanSim ~ duration, group * duration`.

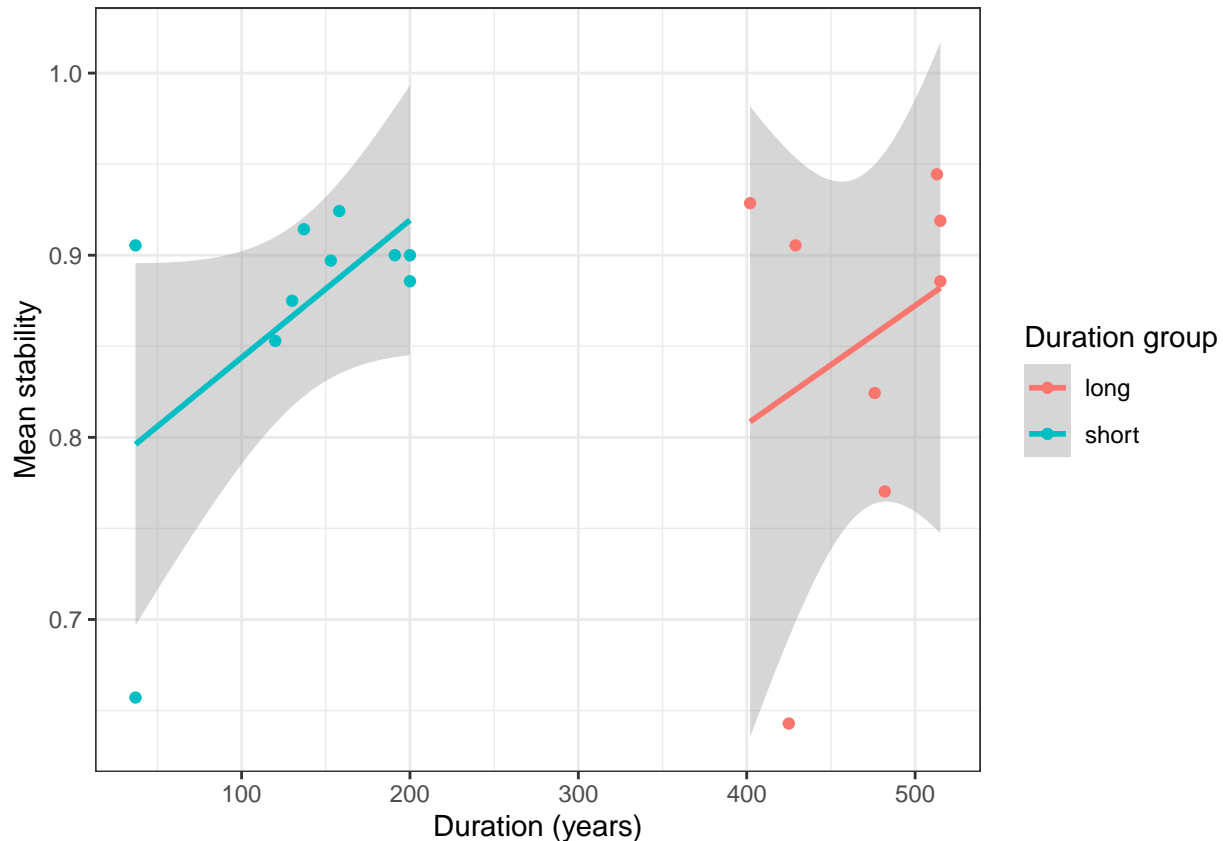
```
msd <- lm(MeanStability ~ duration + duration_group * duration, data=creole_stability)
summary(msd)
```

```
##
## Call:
## lm(formula = MeanStability ~ duration + duration_group * duration,
##     data = creole_stability)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.180674 -0.029112  0.006105  0.041142  0.120003
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)    0.5470360   0.3391096   1.613   0.129
## duration        0.0006506   0.0007192   0.905   0.381
## duration_groupshort 0.2212025   0.3465288   0.638   0.534
## duration:duration_groupshort 0.0001047   0.0008665   0.121   0.906
##
## Residual standard error: 0.08632 on 14 degrees of freedom
## Multiple R-squared:  0.1984, Adjusted R-squared:  0.02667
## F-statistic: 1.155 on 3 and 14 DF,  p-value: 0.3615
```

```
ggplot(creole_stability, aes(x = duration, y = MeanStability, color = duration_group)) +
  geom_smooth(method = "lm") +
  geom_point() +
```

```
xlab("Duration (years)") +
ylab("Mean stability") +
labs(color = "Duration group")
```

```
## `geom_smooth()` using formula 'y ~ x'
```



The variability in the two groups is very different. The direction of the effect is interesting: shorter durations yield more stability more consistently. Over time, the variability in mean stability increases. Time is “destabilizing the pattern of stability”.

But it looks like you might have something tastier on your hands. The creoles appear to be bouncing back toward the lexifier over time (based on the duration findings; but perhaps I misunderstand).

And we can also increase the number of observations by running the analysis at the segment level, rather than on mean stability.

Exploratory stuff with GAMs.

```
library(mgcv)
```

```
## Loading required package: nlme
##
## Attaching package: 'nlme'
## The following object is masked from 'package:dplyr':
##
## collapse
## This is mgcv 1.8-40. For overview type 'help("mgcv-package")'.
```

```

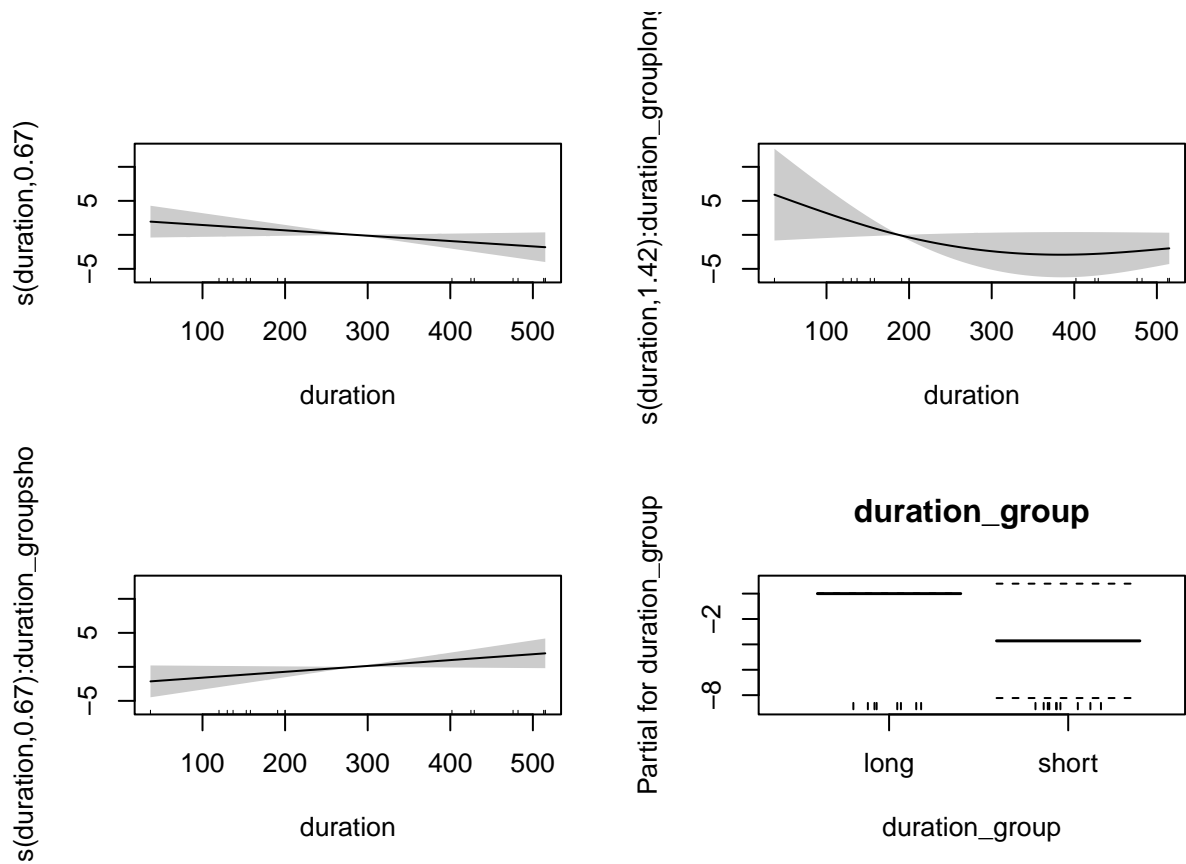
# Factorize duration_group
creole_stability$duration_group = as.factor(creole_stability$duration_group)

# Model with an interaction between duration_group and duration
# (with maximum of cubic-spline fit)
msd.gam <- gam(MeanStability ~ duration_group + s(duration, k=3) + s(duration, by=duration_group, k=3),

summary(msd.gam)

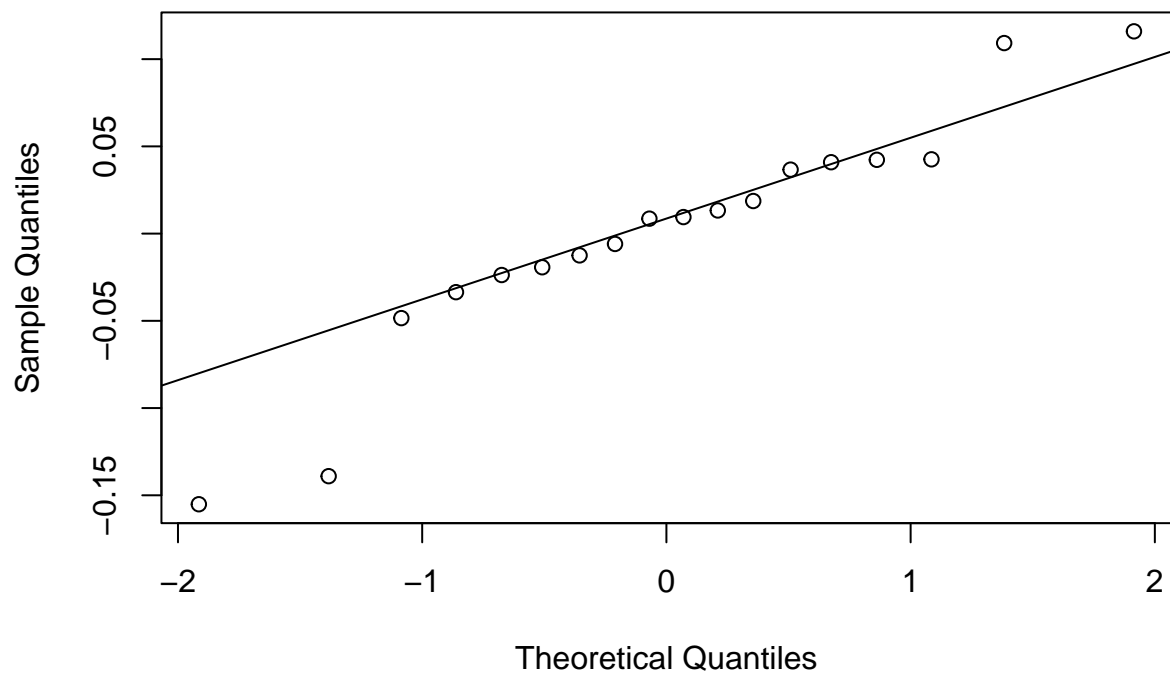
##
## Family: gaussian
## Link function: identity
##
## Formula:
## MeanStability ~ duration_group + s(duration, k = 3) + s(duration,
##      by = duration_group, k = 3)
##
## Parametric coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)      4.705      2.252   2.090  0.0565 .
## duration_groupshort -3.722      2.253  -1.652  0.1219
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Approximate significance of smooth terms:
##              edf Ref.df      F p-value
## s(duration)      0.6667 0.6667 4.160  0.1197
## s(duration):duration_grouplong 1.4242 1.6079 1.606  0.1825
## s(duration):duration_groupshort 0.6667 0.6667 4.984  0.0914 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Rank: 7/8
## R-sq.(adj) =  0.204   Deviance explained =  38%
## GCV = 0.008281   Scale est. = 0.0060923   n = 18
plot(msd.gam, all.terms=T, shade=T, pages=1)

```



```
qqnorm(resid(msd.gam)); qqline(resid(msd.gam))
```

### Normal Q-Q Plot



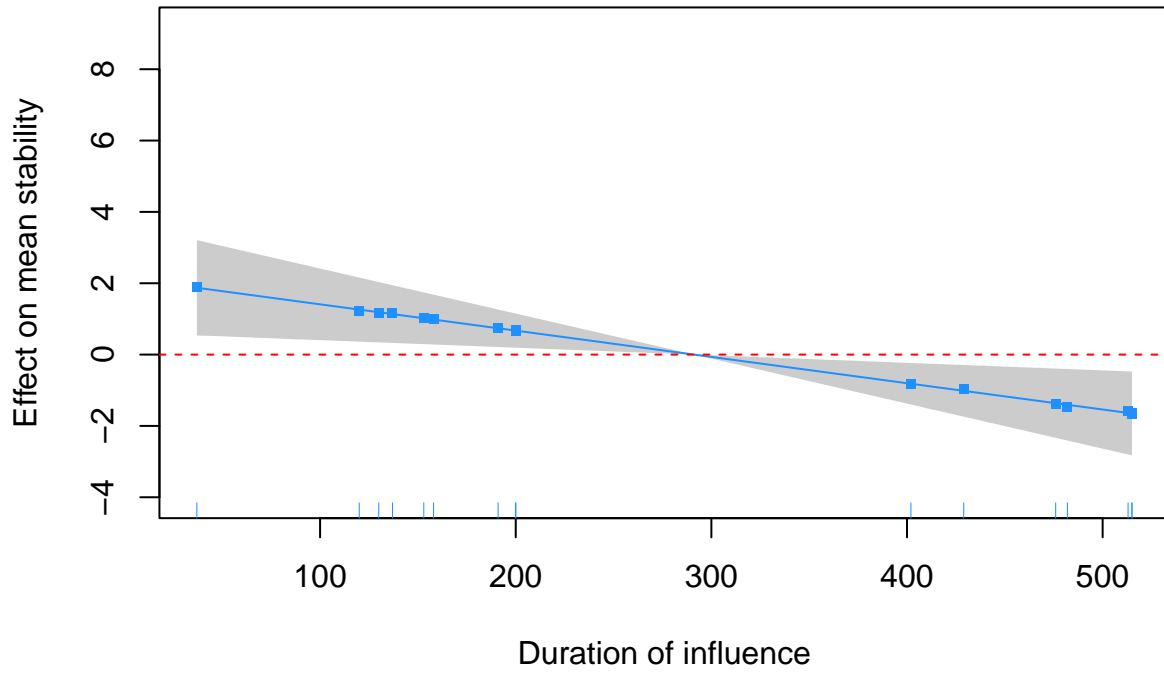
```

msd.gam.trimmed <- gam(MeanStability ~ duration_group + s(duration, k=3) + s(duration, by=duration_group)
summary(msd.gam.trimmed)

##
## Family: gaussian
## Link function: identity
##
## Formula:
## MeanStability ~ duration_group + s(duration, k = 3) + s(duration,
##   by = duration_group, k = 3)
##
## Parametric coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept)      4.110      1.147   3.583 0.00423 **
## duration_groupshort -3.212      1.148  -2.799 0.01716 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Approximate significance of smooth terms:
##               edf Ref.df      F p-value
## s(duration)      0.6667 0.6667 11.824 0.0170 *
## s(duration):duration_grouplong 1.5535 1.6538 4.984 0.0362 *
## s(duration):duration_groupshort 0.6667 0.6667 11.858 0.0169 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Rank: 7/8
## R-sq.(adj) = 0.265   Deviance explained = 45.5%
## GCV = 0.00198   Scale est. = 0.0013752   n = 16
plot(msd.gam.trimmed, sel=1, shade=T, ylab="Effect on mean stability", xlab="Duration of influence", re

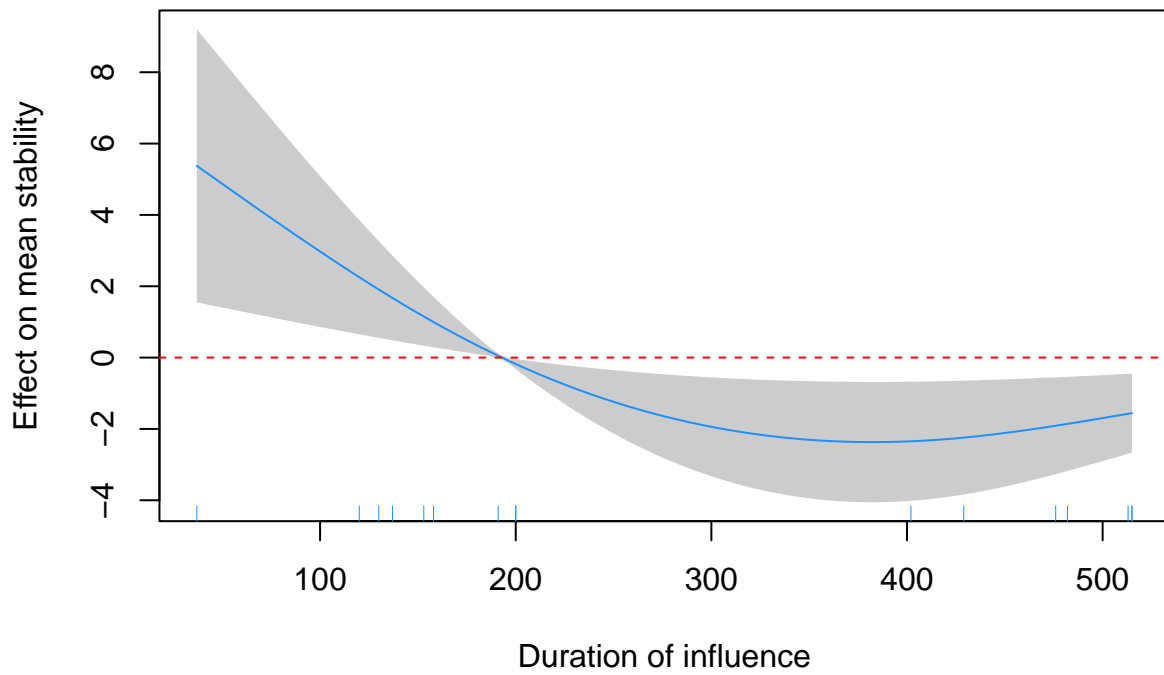
```

### Main effect of duration



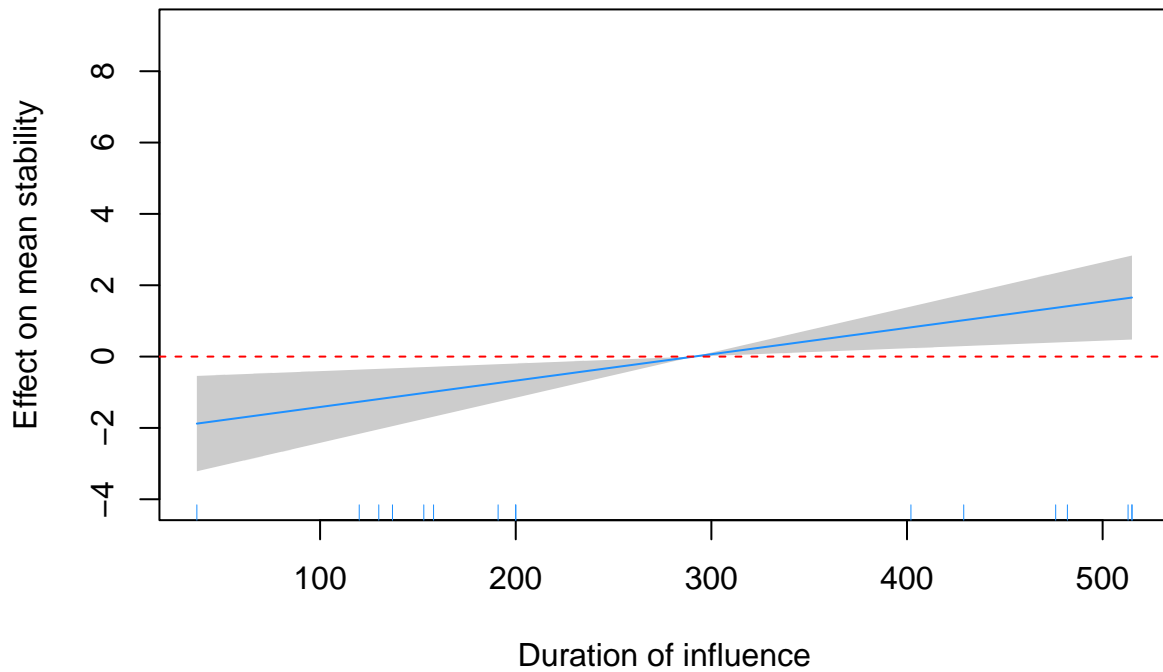
```
plot(msd.gam.trimmed, sel=2, shade=T, ylab="Effect on mean stability", xlab="Duration of influence", ma
```

### Long-term influence



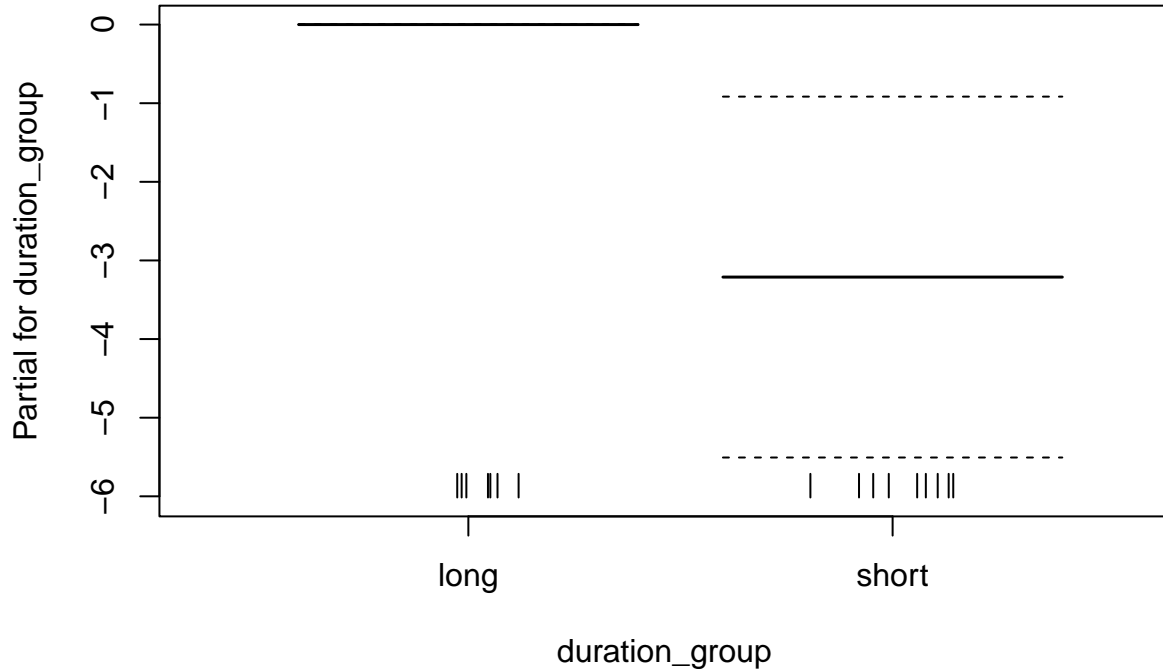
```
plot(msd.gam.trimmed, sel=3, shade=T, ylab="Effect on mean stability", xlab="Duration of influence", ma
```

## Short-term influence



```
# (dotted lines indicate error)
```

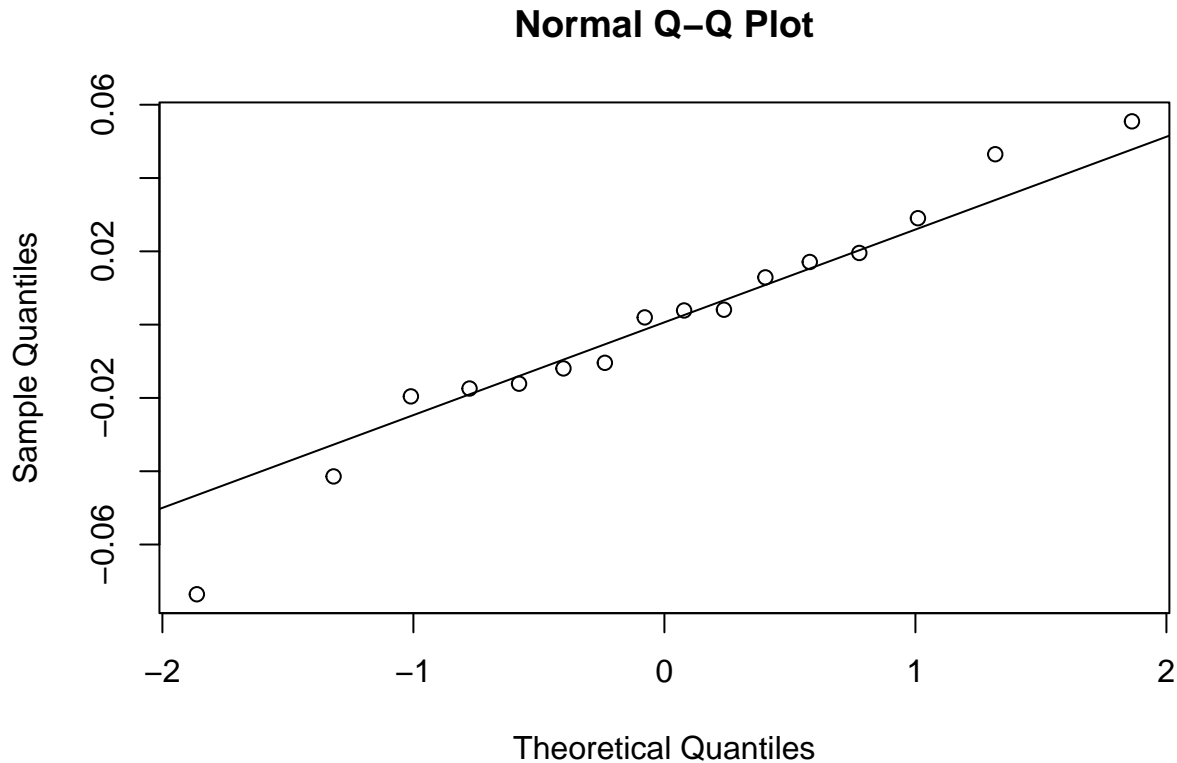
```
plot(msd.gam.trimmed, all.terms=T, sel=4, ylab="Effect on mean stability", xlab="Duration group", main=
```



```
# checking out the model performance
```

```
qqnorm(resid(msd.gam.trimmed)); qqline(resid(msd.gam.trimmed)) # meh
```





Removing the two creoles with the lowest scores produces significant effects. Doesn't seem very reliable, especially given the small sample size. Also, the pattern is strange; a negative trend of duration for long-term influence and a positive one for short-term influence? Also note that the model detected a mean difference between duration groups, with the short group having (slightly) lower mean stability. This appears to be the case but – again – so few observations.

## Duration effects on the segment level

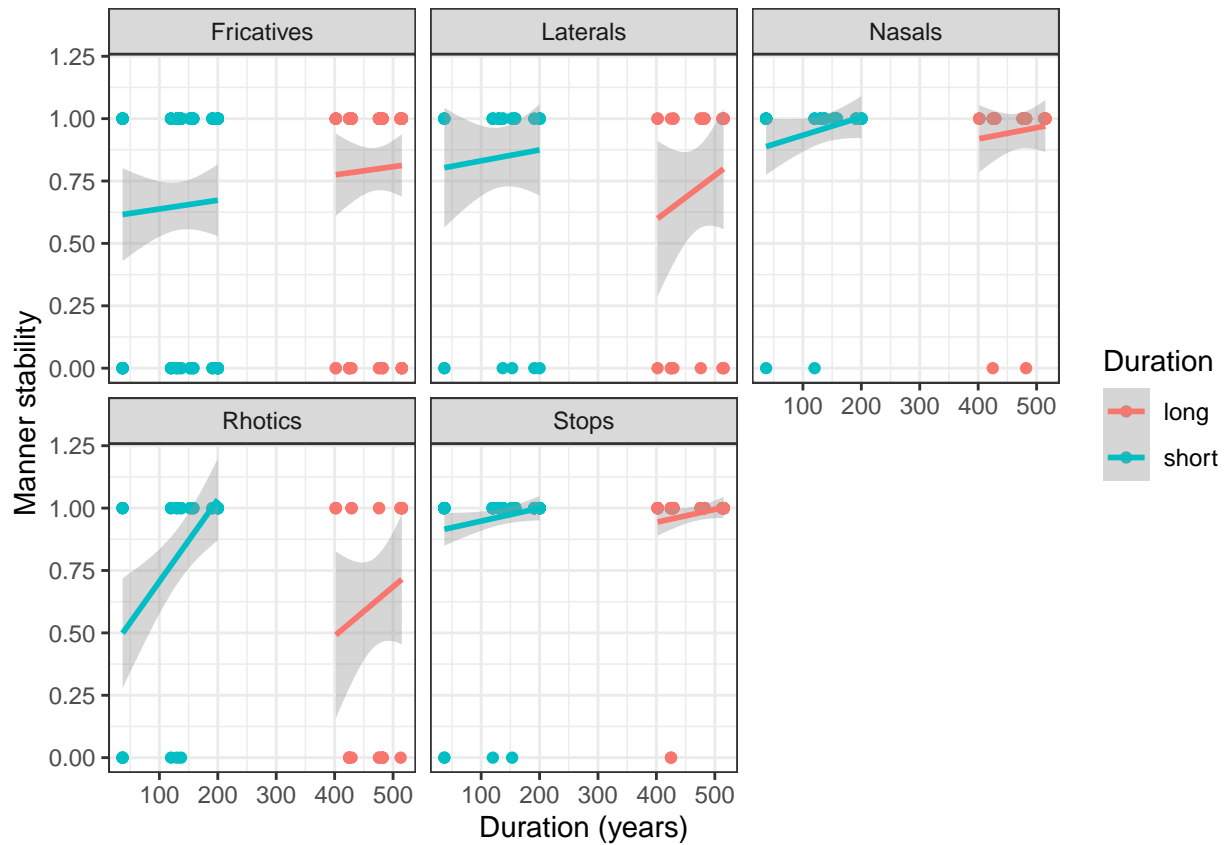
Does duration affect the stability values of specific segments or segment classes?

```
ggplot(database, aes(duration, MannerStability, colour=duration_group)) +
  geom_point() +
  geom_smooth(method = "lm") +
  facet_wrap(~Class) +
  xlab("Duration (years)") +
  ylab("Manner stability") +
  labs(color="Duration")
```

```
## `geom_smooth()` using formula 'y ~ x'
```

```
## Warning: Removed 28 rows containing non-finite values (stat_smooth).
```

```
## Warning: Removed 28 rows containing missing values (geom_point).
```

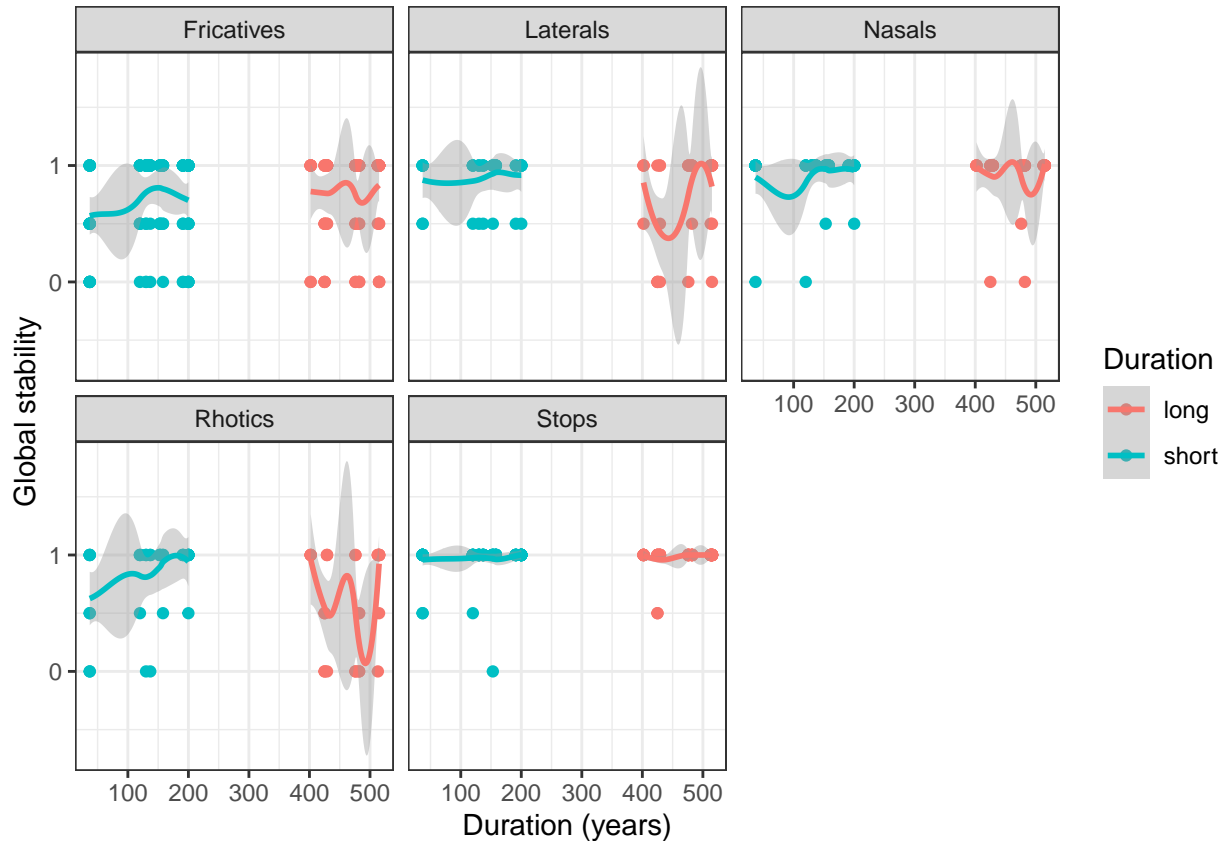


```
ggplot(database, aes(duration, GlobalStability, colour=duration_group)) +
  geom_point() +
  geom_smooth() +
  facet_wrap(~Class) +
  xlab("Duration (years)") +
  ylab("Global stability") +
  labs(color="Duration")
```

```
## `geom_smooth()` using method = 'loess' and formula 'y ~ x'
```

```
## Warning: Removed 28 rows containing non-finite values (stat_smooth).
```

```
## Warning: Removed 28 rows containing missing values (geom_point).
```



```
ggplot(database, aes(duration, PlaceStability, colour=duration_group)) +
  geom_point() +
  geom_smooth(method = "lm") +
  facet_wrap(~LexifierPhoneme) +
  xlab("Duration (years)") +
  ylab("Place stability") +
  labs(color="Duration")
```

```
## `geom_smooth()` using formula 'y ~ x'
## Warning: Removed 28 rows containing non-finite values (stat_smooth).
## Warning: Removed 28 rows containing missing values (geom_point).
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbscsToSbcs': dot substituted for <ca>
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbscsToSbcs': dot substituted for <8e>
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbscsToSbcs': dot substituted for <c9>
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbscsToSbcs': dot substituted for <b2>
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbscsToSbcs': dot substituted for <c9>
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbscsToSbcs': dot substituted for <be>
```

[illegible]

[illegible]

```

## Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 't' in 'mbcsToSbcs': dot substituted for <cc>

## Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 't' in 'mbcsToSbcs': dot substituted for <a0>

## Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 't' in 'mbcsToSbcs': dot substituted for <ca>

## Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 't' in 'mbcsToSbcs': dot substituted for <83>

## Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbcsToSbcs': dot substituted for <ca>

## Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbcsToSbcs': dot substituted for <92>

## Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbcsToSbcs': dot substituted for <c9>

## Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbcsToSbcs': dot substituted for <be>

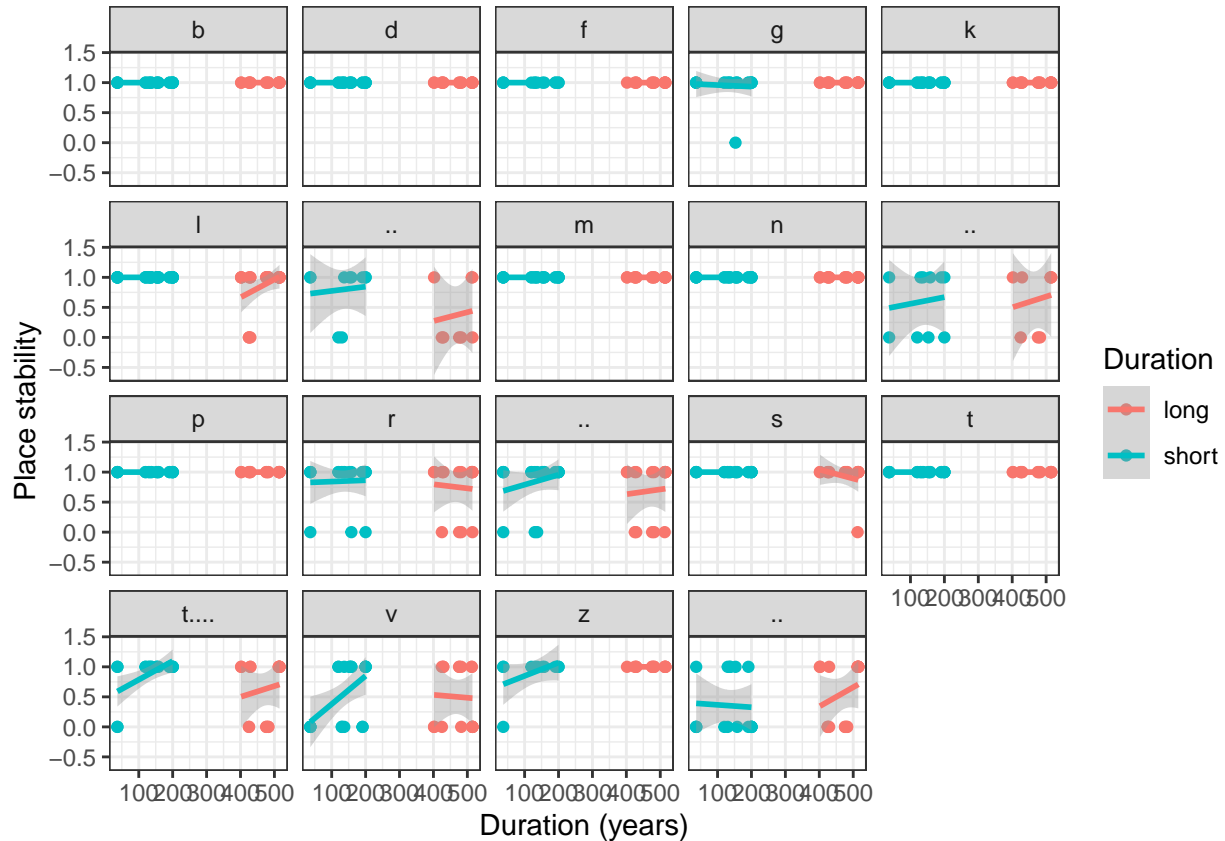
## Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbcsToSbcs': dot substituted for <ca>

## Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbcsToSbcs': dot substituted for <8e>

## Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbcsToSbcs': dot substituted for <c9>

## Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbcsToSbcs': dot substituted for <b2>

```



```
ggplot(database, aes(duration, MannerStability, colour=duration_group)) +
  geom_point() +
  geom_smooth() +
  facet_wrap(~LexifierPhoneme) +
  xlab("Duration (years)") +
  ylab("Mean stability") +
  labs(color="Duration")
```

```
## `geom_smooth()` using method = 'loess' and formula 'y ~ x'
## Warning: Removed 28 rows containing non-finite values (stat_smooth).
## Warning: Removed 28 rows containing missing values (geom_point).
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbsToSbcs': dot substituted for <ca>
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbsToSbcs': dot substituted for <8e>
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbsToSbcs': dot substituted for <c9>
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbsToSbcs': dot substituted for <b2>
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbsToSbcs': dot substituted for <c9>
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbsToSbcs': dot substituted for <be>
```

[illegible]



[illegible]

```

## Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 't' in 'mbcsToSbcs': dot substituted for <cc>

## Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 't' in 'mbcsToSbcs': dot substituted for <a0>

## Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 't' in 'mbcsToSbcs': dot substituted for <ca>

## Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 't' in 'mbcsToSbcs': dot substituted for <83>

## Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbcsToSbcs': dot substituted for <ca>

## Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbcsToSbcs': dot substituted for <92>

## Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbcsToSbcs': dot substituted for <c9>

## Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbcsToSbcs': dot substituted for <be>

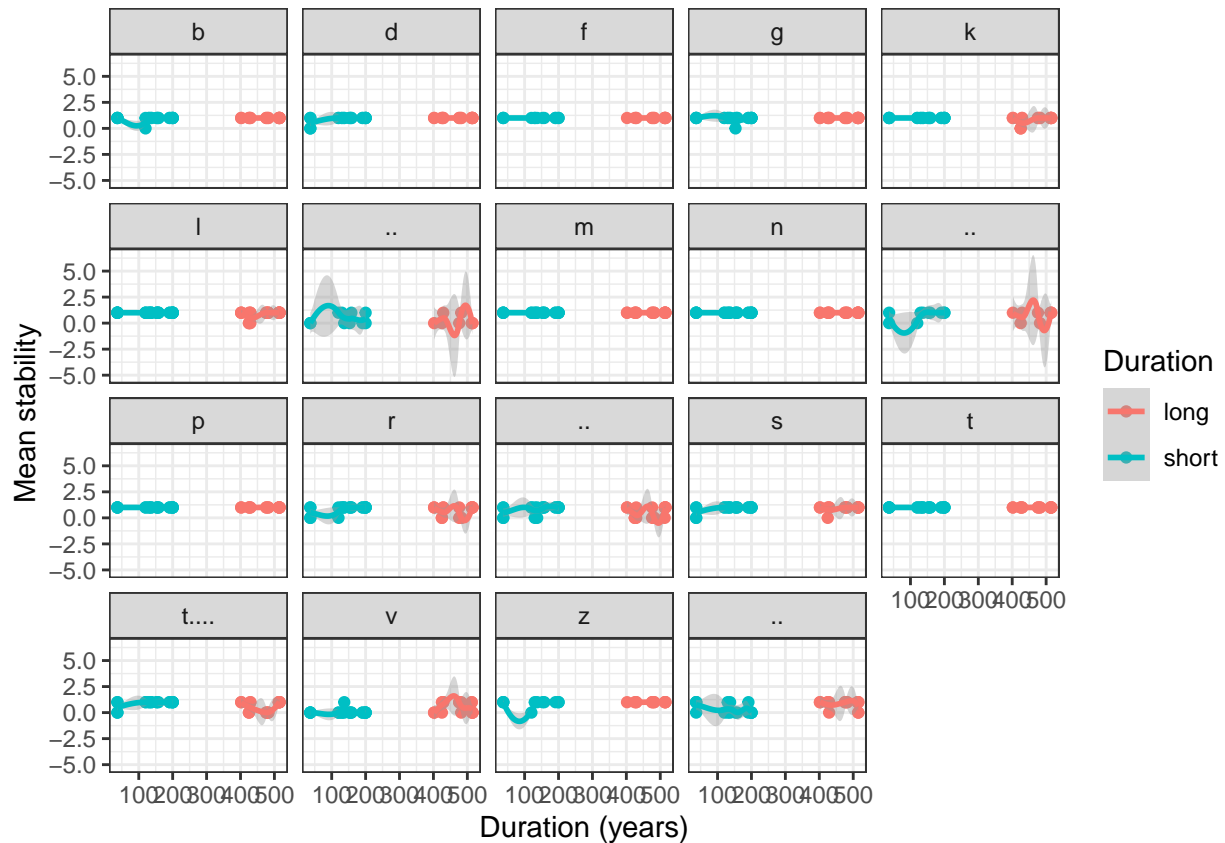
## Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbcsToSbcs': dot substituted for <ca>

## Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbcsToSbcs': dot substituted for <8e>

## Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbcsToSbcs': dot substituted for <c9>

## Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbcsToSbcs': dot substituted for <b2>

```



```
ggplot(database, aes(duration, GlobalStability, colour=duration_group)) +
  geom_point() +
  geom_smooth() +
  facet_wrap(~LexifierPhoneme) +
  xlab("Duration (years)") +
  ylab("Global stability") +
  labs(color="Duration")
```

```
## `geom_smooth()` using method = 'loess' and formula 'y ~ x'
## Warning: Removed 28 rows containing non-finite values (stat_smooth).
## Warning: Removed 28 rows containing missing values (geom_point).
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbscsToSbcs': dot substituted for <ca>
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbscsToSbcs': dot substituted for <8e>
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbscsToSbcs': dot substituted for <c9>
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbscsToSbcs': dot substituted for <b2>
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbscsToSbcs': dot substituted for <c9>
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbscsToSbcs': dot substituted for <be>
```

[illegible]

[illegible]

```

## Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 't' in 'mbcsToSbcs': dot substituted for <cc>

## Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 't' in 'mbcsToSbcs': dot substituted for <a0>

## Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 't' in 'mbcsToSbcs': dot substituted for <ca>

## Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 't' in 'mbcsToSbcs': dot substituted for <83>

## Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbcsToSbcs': dot substituted for <ca>

## Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbcsToSbcs': dot substituted for <92>

## Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbcsToSbcs': dot substituted for <c9>

## Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbcsToSbcs': dot substituted for <be>

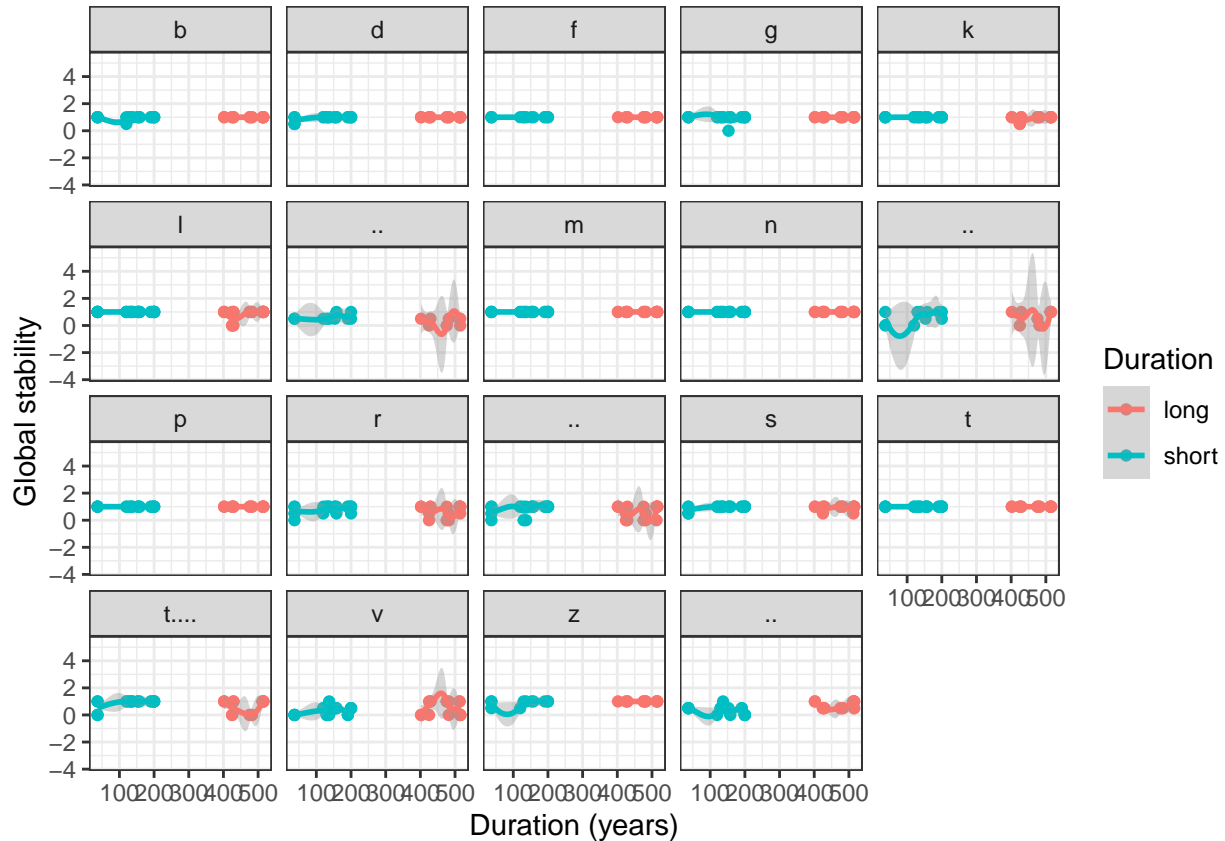
## Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbcsToSbcs': dot substituted for <ca>

## Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbcsToSbcs': dot substituted for <8e>

## Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbcsToSbcs': dot substituted for <c9>

## Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbcsToSbcs': dot substituted for <b2>

```



## Segment stability

Which segments are the most stable across creoles in the language sample?

We calculate stability of place and manner for each phoneme.

```
place_results <- database %>% group_by(LexifierPhoneme) %>% summarize(mplace = mean(PlaceStability, na.rm=T))
manner_results <- database %>% group_by(LexifierPhoneme) %>% summarize(mmanner = mean(MannerStability, na.rm=T))

consonant_stability <- left_join(place_results, manner_results, by = "LexifierPhoneme")

class <- c("nasal", "rhotic", "lateral", "fricative", "stop", "stop", "fricative", "stop", "stop", "lateral")
consonant_stability_class <- cbind(consonant_stability, class)
```

Next, we plot the results.

```
## Warning: Width not defined. Set with `position_dodge(width = ?)`
## Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbscsToSbcs': dot substituted for <ca>
## Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbscsToSbcs': dot substituted for <8e>
## Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbscsToSbcs': dot substituted for <c9>
## Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbscsToSbcs': dot substituted for <b2>
```

```
## Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbcsToSbcs': dot substituted for <c9>

## Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbcsToSbcs': dot substituted for <be>

## Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 't' in 'mbcsToSbcs': dot substituted for <cc>

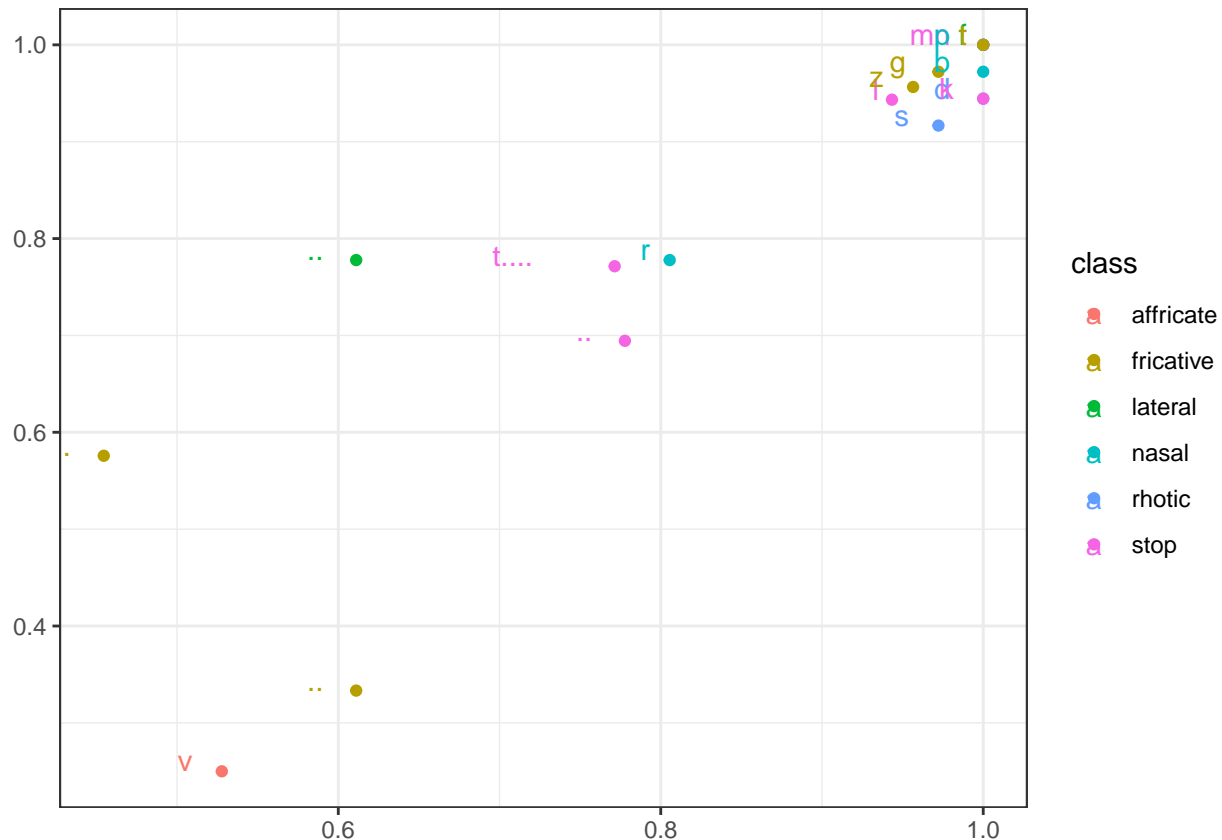
## Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 't' in 'mbcsToSbcs': dot substituted for <a0>

## Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 't' in 'mbcsToSbcs': dot substituted for <ca>

## Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 't' in 'mbcsToSbcs': dot substituted for <83>

## Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbcsToSbcs': dot substituted for <ca>

## Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbcsToSbcs': dot substituted for <92>
```



```
ggplot(consonant_stability, aes(y = mmanner, x = mplace)) +
  geom_point(position = "dodge", aes(color = class)) +
  geom_text_repel(aes(label = LexifierPhoneme)) +
  xlab("Mean stability (place of articulation)") +
  ylab("Mean (manner of articulation)") +
  labs(color = "Segment class")
```



```

## Warning: Width not defined. Set with `position_dodge(width = ?)`
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbcsToSbcs': dot substituted for <ca>
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbcsToSbcs': dot substituted for <8e>
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbcsToSbcs': dot substituted for <ca>
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbcsToSbcs': dot substituted for <8e>
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbcsToSbcs': dot substituted for <ca>
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbcsToSbcs': dot substituted for <8e>
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbcsToSbcs': dot substituted for <ca>
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbcsToSbcs': dot substituted for <8e>
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbcsToSbcs': dot substituted for <ca>
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbcsToSbcs': dot substituted for <8e>
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbcsToSbcs': dot substituted for <ca>
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbcsToSbcs': dot substituted for <8e>
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbcsToSbcs': dot substituted for <c9>
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbcsToSbcs': dot substituted for <b2>
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbcsToSbcs': dot substituted for <c9>
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbcsToSbcs': dot substituted for <b2>
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbcsToSbcs': dot substituted for <c9>

```

[illegible]

[illegible]

[illegible]

```
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :  
## conversion failure on ' ' in 'mbscsToSbcs': dot substituted for <ca>  
  
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :  
## conversion failure on ' ' in 'mbscsToSbcs': dot substituted for <92>  
  
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :  
## conversion failure on ' ' in 'mbscsToSbcs': dot substituted for <ca>  
  
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :  
## conversion failure on ' ' in 'mbscsToSbcs': dot substituted for <92>  
  
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :  
## conversion failure on ' ' in 'mbscsToSbcs': dot substituted for <ca>  
  
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :  
## conversion failure on ' ' in 'mbscsToSbcs': dot substituted for <92>  
  
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :  
## conversion failure on ' ' in 'mbscsToSbcs': dot substituted for <ca>  
  
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :  
## conversion failure on ' ' in 'mbscsToSbcs': dot substituted for <92>  
  
## Warning in grid.Call(C_convert, x, as.integer(whatfrom), as.integer(whatto), :  
## conversion failure on ' ' in 'mbscsToSbcs': dot substituted for <ca>  
  
## Warning in grid.Call(C_convert, x, as.integer(whatfrom), as.integer(whatto), :  
## conversion failure on ' ' in 'mbscsToSbcs': dot substituted for <8e>  
  
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :  
## conversion failure on ' ' in 'mbscsToSbcs': dot substituted for <ca>  
  
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :  
## conversion failure on ' ' in 'mbscsToSbcs': dot substituted for <8e>  
  
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :  
## conversion failure on ' ' in 'mbscsToSbcs': dot substituted for <ca>  
  
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :  
## conversion failure on ' ' in 'mbscsToSbcs': dot substituted for <8e>  
  
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :  
## conversion failure on ' ' in 'mbscsToSbcs': dot substituted for <ca>  
  
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :  
## conversion failure on ' ' in 'mbscsToSbcs': dot substituted for <8e>
```

```
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :  
## conversion failure on ' ' in 'mbscsToSbcs': dot substituted for <8e>  
  
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :  
## conversion failure on ' ' in 'mbscsToSbcs': dot substituted for <ca>  
  
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :  
## conversion failure on ' ' in 'mbscsToSbcs': dot substituted for <8e>  
  
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :  
## conversion failure on ' ' in 'mbscsToSbcs': dot substituted for <ca>  
  
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :  
## conversion failure on ' ' in 'mbscsToSbcs': dot substituted for <8e>  
  
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :  
## conversion failure on ' ' in 'mbscsToSbcs': dot substituted for <ca>  
  
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :  
## conversion failure on ' ' in 'mbscsToSbcs': dot substituted for <8e>  
  
## Warning in grid.Call(C_convert, x, as.integer(whatfrom), as.integer(whatto), :  
## conversion failure on ' ' in 'mbscsToSbcs': dot substituted for <c9>  
  
## Warning in grid.Call(C_convert, x, as.integer(whatfrom), as.integer(whatto), :  
## conversion failure on ' ' in 'mbscsToSbcs': dot substituted for <b2>  
  
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :  
## conversion failure on ' ' in 'mbscsToSbcs': dot substituted for <c9>  
  
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :  
## conversion failure on ' ' in 'mbscsToSbcs': dot substituted for <b2>  
  
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :  
## conversion failure on ' ' in 'mbscsToSbcs': dot substituted for <c9>  
  
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :  
## conversion failure on ' ' in 'mbscsToSbcs': dot substituted for <b2>  
  
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :  
## conversion failure on ' ' in 'mbscsToSbcs': dot substituted for <c9>  
  
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :  
## conversion failure on ' ' in 'mbscsToSbcs': dot substituted for <b2>  
  
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :  
## conversion failure on ' ' in 'mbscsToSbcs': dot substituted for <c9>  
  
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :  
## conversion failure on ' ' in 'mbscsToSbcs': dot substituted for <b2>
```

```
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :  
## conversion failure on ' ' in 'mbscsToSbcs': dot substituted for <c9>  
  
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :  
## conversion failure on ' ' in 'mbscsToSbcs': dot substituted for <b2>  
  
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :  
## conversion failure on ' ' in 'mbscsToSbcs': dot substituted for <c9>  
  
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :  
## conversion failure on ' ' in 'mbscsToSbcs': dot substituted for <b2>  
  
## Warning in grid.Call(C_convert, x, as.integer(whatfrom), as.integer(whatto), :  
## conversion failure on ' ' in 'mbscsToSbcs': dot substituted for <c9>  
  
## Warning in grid.Call(C_convert, x, as.integer(whatfrom), as.integer(whatto), :  
## conversion failure on ' ' in 'mbscsToSbcs': dot substituted for <be>  
  
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :  
## conversion failure on ' ' in 'mbscsToSbcs': dot substituted for <c9>  
  
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :  
## conversion failure on ' ' in 'mbscsToSbcs': dot substituted for <be>  
  
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :  
## conversion failure on ' ' in 'mbscsToSbcs': dot substituted for <c9>  
  
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :  
## conversion failure on ' ' in 'mbscsToSbcs': dot substituted for <be>  
  
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :  
## conversion failure on ' ' in 'mbscsToSbcs': dot substituted for <c9>  
  
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :  
## conversion failure on ' ' in 'mbscsToSbcs': dot substituted for <be>  
  
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :  
## conversion failure on ' ' in 'mbscsToSbcs': dot substituted for <c9>  
  
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :  
## conversion failure on ' ' in 'mbscsToSbcs': dot substituted for <be>  
  
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :  
## conversion failure on ' ' in 'mbscsToSbcs': dot substituted for <c9>  
  
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :  
## conversion failure on ' ' in 'mbscsToSbcs': dot substituted for <be>
```

```

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbcsToSbcs': dot substituted for <be>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbcsToSbcs': dot substituted for <c9>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbcsToSbcs': dot substituted for <be>

## Warning in grid.Call(C_convert, x, as.integer(whatfrom), as.integer(whatto), :
## conversion failure on 't ' in 'mbcsToSbcs': dot substituted for <cc>

## Warning in grid.Call(C_convert, x, as.integer(whatfrom), as.integer(whatto), :
## conversion failure on 't ' in 'mbcsToSbcs': dot substituted for <a0>

## Warning in grid.Call(C_convert, x, as.integer(whatfrom), as.integer(whatto), :
## conversion failure on 't ' in 'mbcsToSbcs': dot substituted for <ca>

## Warning in grid.Call(C_convert, x, as.integer(whatfrom), as.integer(whatto), :
## conversion failure on 't ' in 'mbcsToSbcs': dot substituted for <83>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 't ' in 'mbcsToSbcs': dot substituted for <cc>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 't ' in 'mbcsToSbcs': dot substituted for <a0>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 't ' in 'mbcsToSbcs': dot substituted for <ca>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 't ' in 'mbcsToSbcs': dot substituted for <83>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 't ' in 'mbcsToSbcs': dot substituted for <cc>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 't ' in 'mbcsToSbcs': dot substituted for <a0>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 't ' in 'mbcsToSbcs': dot substituted for <ca>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 't ' in 'mbcsToSbcs': dot substituted for <83>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 't ' in 'mbcsToSbcs': dot substituted for <cc>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 't ' in 'mbcsToSbcs': dot substituted for <a0>

```



```

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 't ' in 'mbsToSbcs': dot substituted for <ca>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 't ' in 'mbsToSbcs': dot substituted for <83>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 't ' in 'mbsToSbcs': dot substituted for <cc>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 't ' in 'mbsToSbcs': dot substituted for <a0>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 't ' in 'mbsToSbcs': dot substituted for <ca>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 't ' in 'mbsToSbcs': dot substituted for <83>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 't ' in 'mbsToSbcs': dot substituted for <cc>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 't ' in 'mbsToSbcs': dot substituted for <a0>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 't ' in 'mbsToSbcs': dot substituted for <ca>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 't ' in 'mbsToSbcs': dot substituted for <83>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 't ' in 'mbsToSbcs': dot substituted for <cc>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 't ' in 'mbsToSbcs': dot substituted for <a0>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 't ' in 'mbsToSbcs': dot substituted for <ca>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 't ' in 'mbsToSbcs': dot substituted for <83>

## Warning in grid.Call(C_convert, x, as.integer(whatfrom), as.integer(whatto), :
## conversion failure on ' ' in 'mbsToSbcs': dot substituted for <ca>

## Warning in grid.Call(C_convert, x, as.integer(whatfrom), as.integer(whatto), :
## conversion failure on ' ' in 'mbsToSbcs': dot substituted for <92>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbsToSbcs': dot substituted for <ca>

```

[illegible]

```
## Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 't ' in 'mbsToSbcs': dot substituted for <cc>

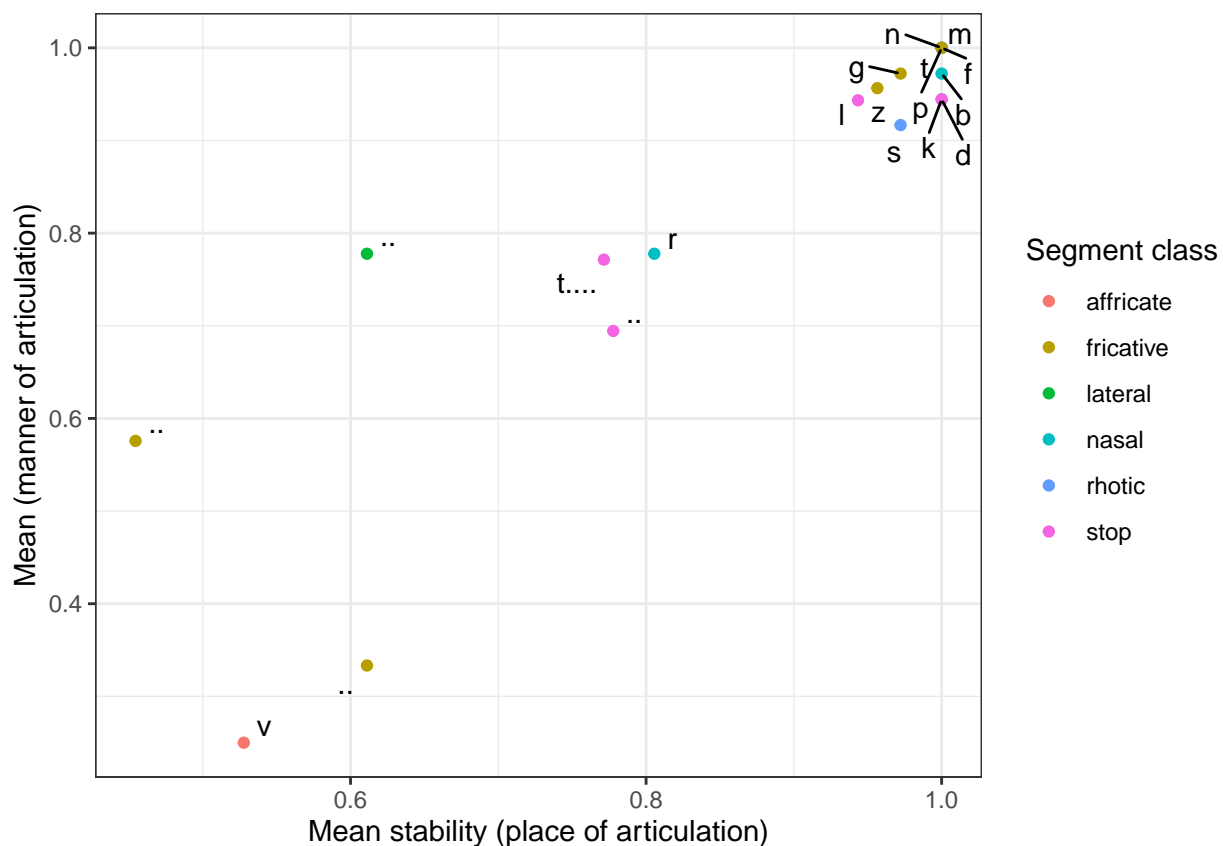
## Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 't ' in 'mbsToSbcs': dot substituted for <a0>

## Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 't ' in 'mbsToSbcs': dot substituted for <ca>

## Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 't ' in 'mbsToSbcs': dot substituted for <83>

## Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbsToSbcs': dot substituted for <ca>

## Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbsToSbcs': dot substituted for <92>
```



Here is an alternative view for the global results.

```
consonant_global_stability <- mutate(consonant_stability_class, mglobal = (mmanner + mplace)/2)

ggplot(consonant_global_stability) +
  geom_bar(aes(x = mglobal,
               y = reorder(LexifierPhoneme, mglobal),
               fill = class), stat = "identity", show.legend = TRUE) +
  labs(x = "Stability score", y = "Phoneme", fill = "Manner")
```

```
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbsToSbcs': dot substituted for <ca>
```

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]



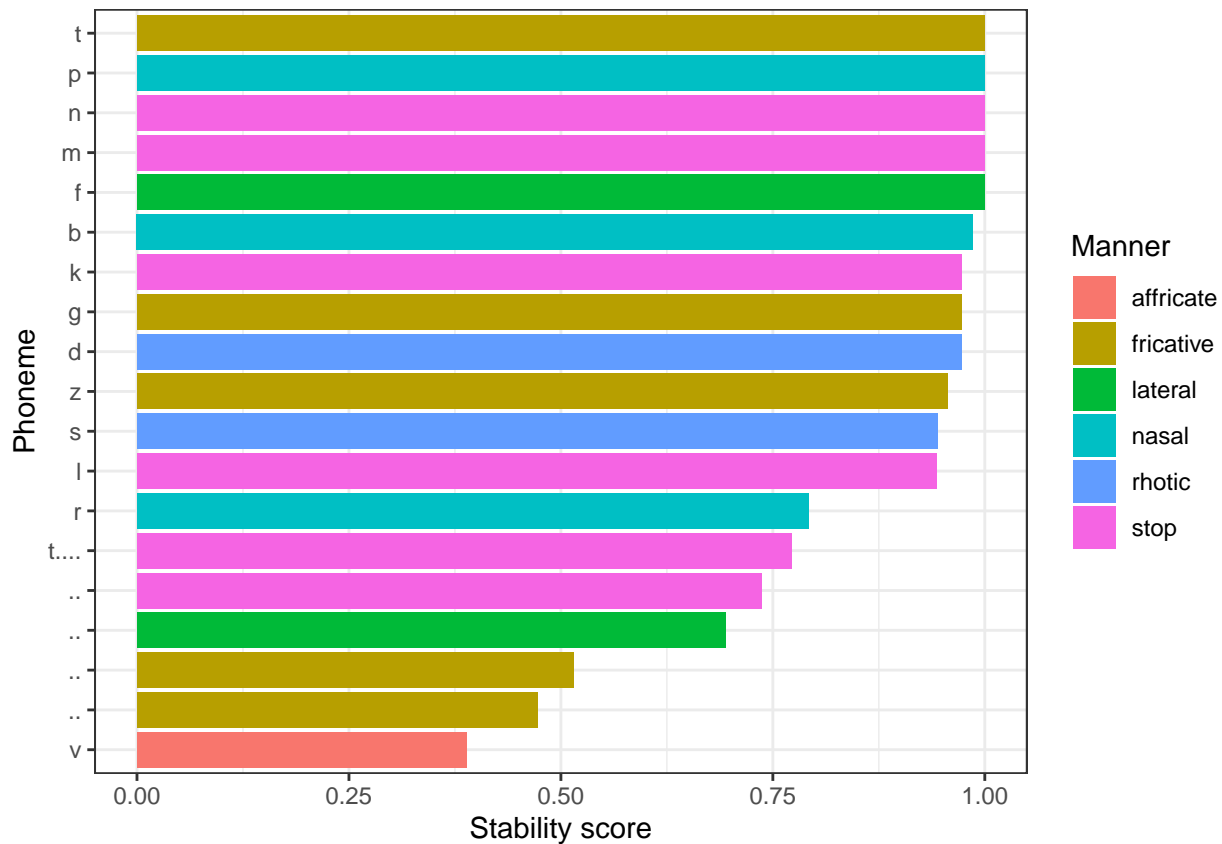
[illegible]

[illegible]

[illegible]

[illegible]

```
## Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 't' in 'mbsToSbcs': dot substituted for <ca>
## Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 't' in 'mbsToSbcs': dot substituted for <83>
```



Calculate the stability of the segments.

```
# qplot(x = duration, y = MeanStability, data = consonant_global_stability, color = duration_group) +
# geom_smooth(method = "lm")
```

And we can also increase the number of observations in duration regression by running the analysis at the segment level, rather than on mean stability.

```
library(lmerTest)
```

```
## Loading required package: lme4
## Loading required package: Matrix
##
## Attaching package: 'Matrix'
## The following objects are masked from 'package:tidyr':
##
##   expand, pack, unpack
##
## Attaching package: 'lme4'
## The following object is masked from 'package:nlme':
##
```

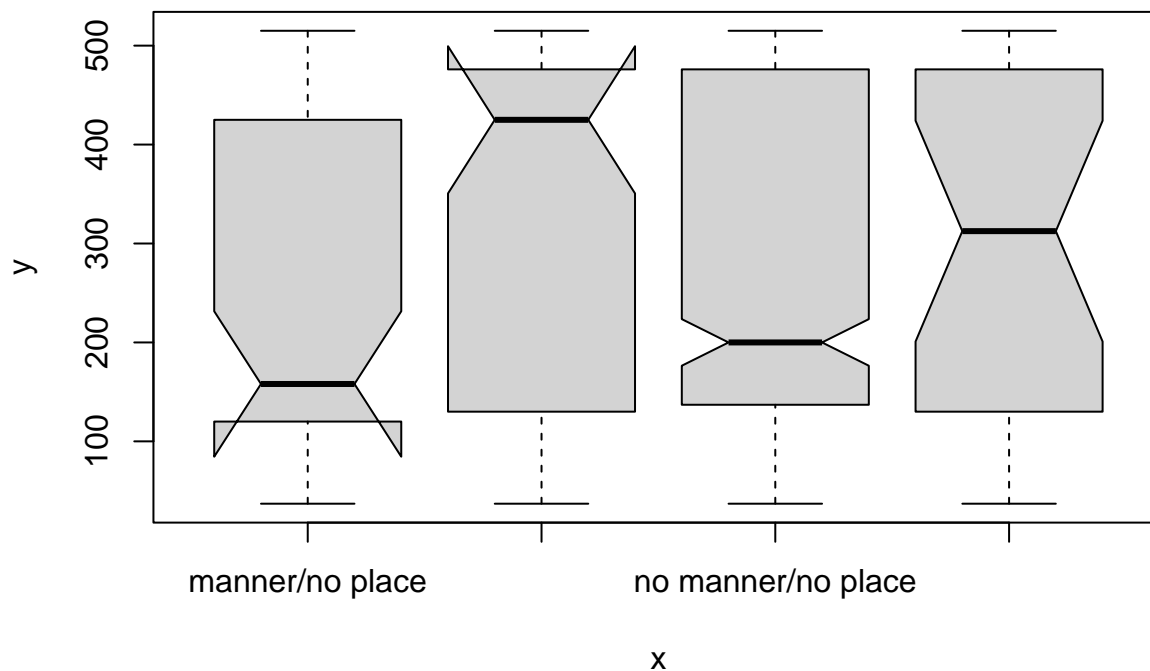
```
##      lmList
##
## Attaching package: 'lmerTest'
## The following object is masked from 'package:lme4':
##
##      lmer
## The following object is masked from 'package:stats':
##
##      step
# Factorizing
mod.db = database %>%
  as.data.frame() %>%
  mutate(categorical_stability = as.factor(categorical_stability),
         Lexifier = as.factor(Lexifier),
         CreolePhoneme = as.factor(CreolePhoneme),
         Language = as.factor(Language))

# Remove singletons/doubletons
#goodies = names(table(mod.db$CreolePhoneme)>2)

#mod.db = mod.db %>%
#  filter(CreolePhoneme %in% goodies)

plot(mod.db$categorical_stability, mod.db$duration, notch=T)

## Warning in (function (z, notch = FALSE, width = NULL, varwidth = FALSE, : some
## notches went outside hinges ('box'): maybe set notch=FALSE
```



Hugely skewed in favor of no manner/place (10X as frequent as the next most frequent level; this could cause problems for the models).

```
table(mod.db$categorical_stability)
```

```
##
##   manner/no place      manner/place no manner/no place      no manner/place
##               43                54                517                24
```

```
# Place stability
```

```
cat.mod.place = glmer(PlaceStability ~ log(duration) + (1|CreolePhoneme), data=mod.db, family="binomial")
```

```
summary(cat.mod.place)
```

```
## Generalized linear mixed model fit by maximum likelihood (Laplace
```

```
##   Approximation) [glmerMod]
```

```
##   Family: binomial ( logit )
```

```
## Formula: PlaceStability ~ log(duration) + (1 | CreolePhoneme)
```

```
##   Data: mod.db
```

```
##
```

```
##      AIC      BIC    logLik deviance df.resid
```

```
##    296.8    310.2   -145.4    290.8      635
```

```
##
```

```
## Scaled residuals:
```

```
##      Min      1Q   Median      3Q      Max
```

```
## -6.2517  0.0388  0.0432  0.1725  2.1540
```

```
##
```

```
## Random effects:
```

```
##   Groups      Name      Variance Std.Dev.
```

```
## CreolePhoneme (Intercept) 31.32    5.597
```

```
## Number of obs: 638, groups: CreolePhoneme, 34
```

```
##
```

```
## Fixed effects:
```

```
##      Estimate Std. Error z value Pr(>|z|)
```

```
## (Intercept)    5.3041    2.5433   2.086   0.037 *
```

```
## log(duration) -0.1279    0.2215  -0.577   0.564
```

```
## ---
```

```
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
##
```

```
## Correlation of Fixed Effects:
```

```
##      (Intr)
```

```
## log(duratn) -0.511
```

```
# Manner stability
```

```
cat.mod.manner = glmer(MannerStability ~ log(duration) + (1|CreolePhoneme), data=mod.db, family="binomial")
```

```
summary(cat.mod.manner)
```

```
## Generalized linear mixed model fit by maximum likelihood (Laplace
```

```
##   Approximation) [glmerMod]
```

```
##   Family: binomial ( logit )
```

```
## Formula: MannerStability ~ log(duration) + (1 | CreolePhoneme)
```

```
##   Data: mod.db
```

```
##
```

```
##      AIC      BIC    logLik deviance df.resid
```

```
##    251.1    264.4   -122.5    245.1      635
```

```
##
```

```
## Scaled residuals:
```

```

##      Min      1Q  Median      3Q      Max
## -6.2224  0.0043  0.0046  0.1928  0.7464
##
## Random effects:
##   Groups      Name      Variance Std.Dev.
## CreolePhoneme (Intercept) 396.3    19.91
## Number of obs: 638, groups: CreolePhoneme, 34
##
## Fixed effects:
##              Estimate Std. Error z value Pr(>|z|)
## (Intercept)  10.11364    2.42778   4.166  3.1e-05 ***
## log(duration) 0.08086    0.22973   0.352   0.725
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##              (Intr)
## log(duratr) -0.517
# Duration group
cat.mod.group = glmer(as.factor(duration_group) ~ PlaceStability + MannerStability + (1|CreolePhoneme),

## boundary (singular) fit: see help('isSingular')

summary(cat.mod.group)

## Generalized linear mixed model fit by maximum likelihood (Adaptive
## Gauss-Hermite Quadrature, nAGQ = 0) [glmerMod]
## Family: binomial ( logit )
## Formula: as.factor(duration_group) ~ PlaceStability + MannerStability +
##          (1 | CreolePhoneme)
## Data: mod.db
##
##      AIC      BIC    logLik deviance df.resid
##    882.3    900.2   -437.2    874.3     634
##
## Scaled residuals:
##      Min      1Q  Median      3Q      Max
## -1.3362 -1.1102  0.8246  0.9007  1.2288
##
## Random effects:
##   Groups      Name      Variance Std.Dev.
## CreolePhoneme (Intercept) 0         0
## Number of obs: 638, groups: CreolePhoneme, 34
##
## Fixed effects:
##              Estimate Std. Error z value Pr(>|z|)
## (Intercept)  -0.04164    0.24231  -0.172   0.8636
## PlaceStability 0.62124    0.29861   2.080   0.0375 *
## MannerStability -0.37043    0.27504  -1.347   0.1780
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##              (Intr) PlcStb

```



```
## PlaceStblty -0.521
## MannrStblty -0.339 -0.580
## optimizer (bobyqa) convergence code: 0 (OK)
## boundary (singular) fit: see help('isSingular')
```

Some indication that place stability is more often associated with shorter periods of influence.

Numerically, the manner/place category has 50% of its observations in the longest duration from the sample. At the same time, no manner/no place is associated with the shortest duration.

## Word position

Next we ask, does word position influence stability?

First, data preparation.

```
data_by_position <- database %>% select(Position, LexifierPhoneme, PlaceStability, MannerStability) %>%
data_by_position$PlaceStability <- as.numeric(data_by_position$PlaceStability)
data_by_position$MannerStability <- as.numeric(data_by_position$MannerStability)
```

Next, calculate stability for each segment according to its word position.

```
position_stability <- mutate(data_by_position, GlobalStability = (PlaceStability + MannerStability)/2)
position_results <- position_stability %>% group_by(LexifierPhoneme, Position) %>% summarize(m = mean(G
```

```
## `summarise()` has grouped output by 'LexifierPhoneme'. You can override using
## the `.groups` argument.
```

And plot the results for all segments.

```
position_results$Position <- factor(position_results$Position, levels = c('word-initial', 'word-medial'
ggplot(position_results, aes(x = LexifierPhoneme, y = m, fill = Position)) +
  geom_col(position = position_dodge2(width = 0.9, preserve = "single")) +
  theme(axis.title.x = element_blank(),
        axis.title.y = element_blank()) +
  labs(x = "Lexifier phoneme", y = "Mean stability", fill = "Word position")
```

```
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbsToSbcs': dot substituted for <ca>
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbsToSbcs': dot substituted for <8e>
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbsToSbcs': dot substituted for <c9>
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbsToSbcs': dot substituted for <b2>
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbsToSbcs': dot substituted for <c9>
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbsToSbcs': dot substituted for <be>
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 't' in 'mbsToSbcs': dot substituted for <cc>
```

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]



```

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbcsToSbcs': dot substituted for <ca>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbcsToSbcs': dot substituted for <92>

## Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbcsToSbcs': dot substituted for <ca>

## Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbcsToSbcs': dot substituted for <8e>

## Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbcsToSbcs': dot substituted for <c9>

## Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbcsToSbcs': dot substituted for <b2>

## Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbcsToSbcs': dot substituted for <c9>

## Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbcsToSbcs': dot substituted for <be>

## Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 't ' in 'mbcsToSbcs': dot substituted for <cc>

## Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 't ' in 'mbcsToSbcs': dot substituted for <a0>

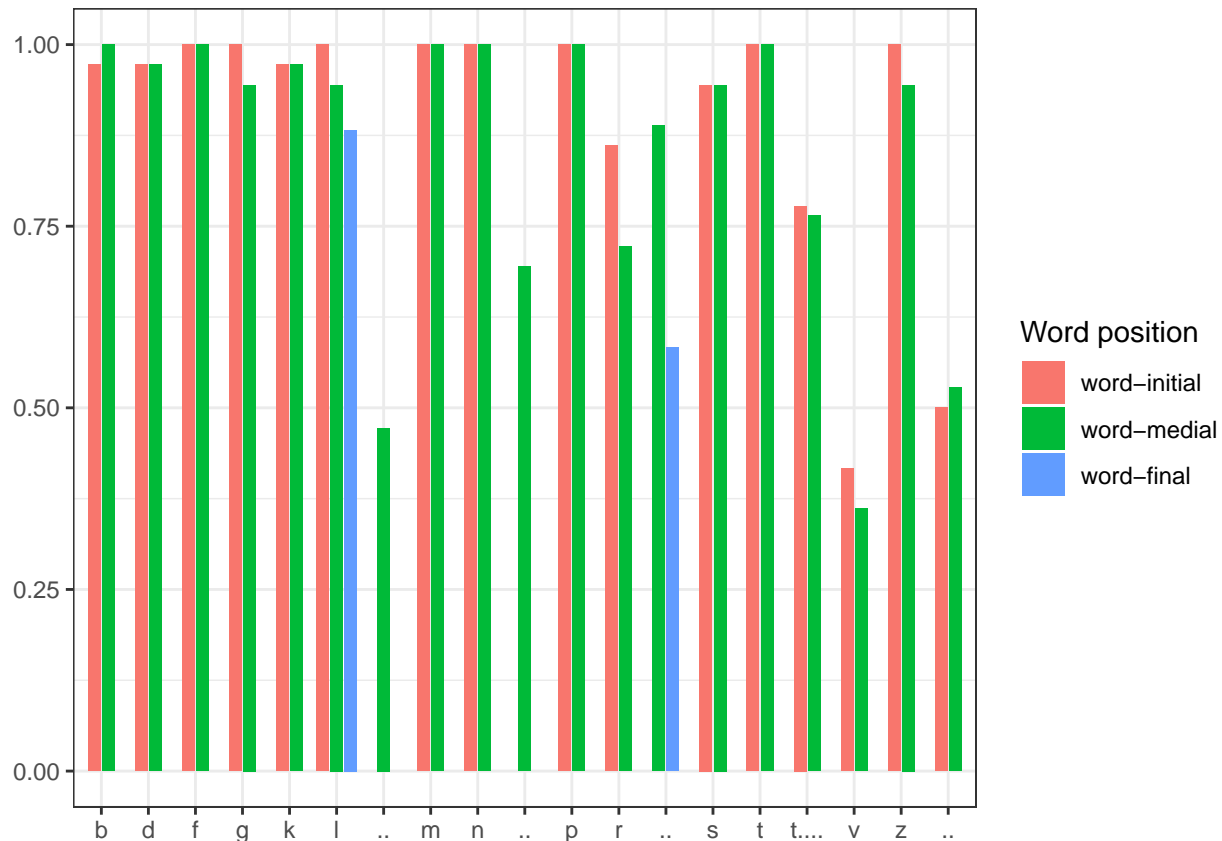
## Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 't ' in 'mbcsToSbcs': dot substituted for <ca>

## Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 't ' in 'mbcsToSbcs': dot substituted for <83>

## Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbcsToSbcs': dot substituted for <ca>

## Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbcsToSbcs': dot substituted for <92>

```



Flip horizontally.

```
ggplot(position_results) +
  geom_bar(aes(x = m,
               y = reorder(LexifierPhoneme, m),
               fill = Position),
           stat = "identity",
           show.legend = TRUE,
           position = "dodge2") +
  labs(x = "Stability score", y = "Phoneme", fill = "Word position")

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbcsToSbcs': dot substituted for <ca>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbcsToSbcs': dot substituted for <8e>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbcsToSbcs': dot substituted for <ca>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbcsToSbcs': dot substituted for <92>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbcsToSbcs': dot substituted for <c9>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbcsToSbcs': dot substituted for <b2>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbcsToSbcs': dot substituted for <c9>
```

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]



[illegible]

[illegible]

```

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbcsToSbcs': dot substituted for <be>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 't ' in 'mbcsToSbcs': dot substituted for <cc>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 't ' in 'mbcsToSbcs': dot substituted for <a0>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 't ' in 'mbcsToSbcs': dot substituted for <ca>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 't ' in 'mbcsToSbcs': dot substituted for <83>

## Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbcsToSbcs': dot substituted for <ca>

## Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbcsToSbcs': dot substituted for <8e>

## Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbcsToSbcs': dot substituted for <ca>

## Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbcsToSbcs': dot substituted for <92>

## Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbcsToSbcs': dot substituted for <c9>

## Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbcsToSbcs': dot substituted for <b2>

## Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbcsToSbcs': dot substituted for <c9>

## Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbcsToSbcs': dot substituted for <be>

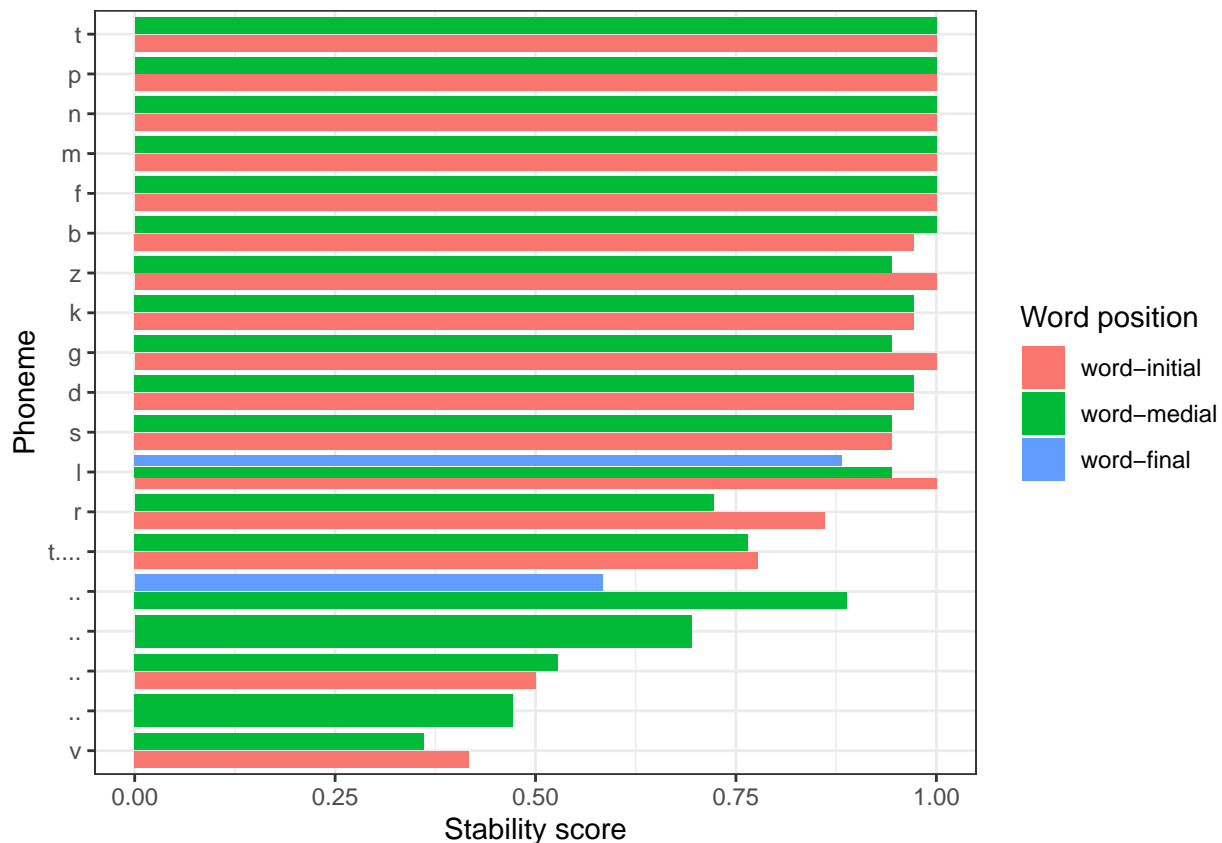
## Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 't ' in 'mbcsToSbcs': dot substituted for <cc>

## Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 't ' in 'mbcsToSbcs': dot substituted for <a0>

## Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 't ' in 'mbcsToSbcs': dot substituted for <ca>

## Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 't ' in 'mbcsToSbcs': dot substituted for <83>

```



Plot the results for segments that show differences.

```
position_results1 <- position_results %>% pivot_wider(names_from = Position, values_from = m)

different_position <- subset(position_results1, position_results1$`word-initial` != position_results1$`word-medial`)

different_position_results <- different_position %>% pivot_longer(c(`word-initial`, `word-medial`, `word-final`))

different_position_results$Position <- factor(different_position_results$Position, levels = c('word-initial', 'word-medial', 'word-final'))

ggplot(different_position_results,
       aes(x = LexifierPhoneme, y = m, fill = Position)) +
  geom_col(position = position_dodge2(width = 0.9, preserve = "single")) +
  labs(x = "Lexifier phoneme", y = "Mean stability", fill = "Word position")

## Warning: Removed 8 rows containing missing values (geom_col).
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbcsToSbcs': dot substituted for <c9>
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbcsToSbcs': dot substituted for <be>
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 't ' in 'mbcsToSbcs': dot substituted for <cc>
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 't ' in 'mbcsToSbcs': dot substituted for <a0>
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
```

[illegible]

[illegible]

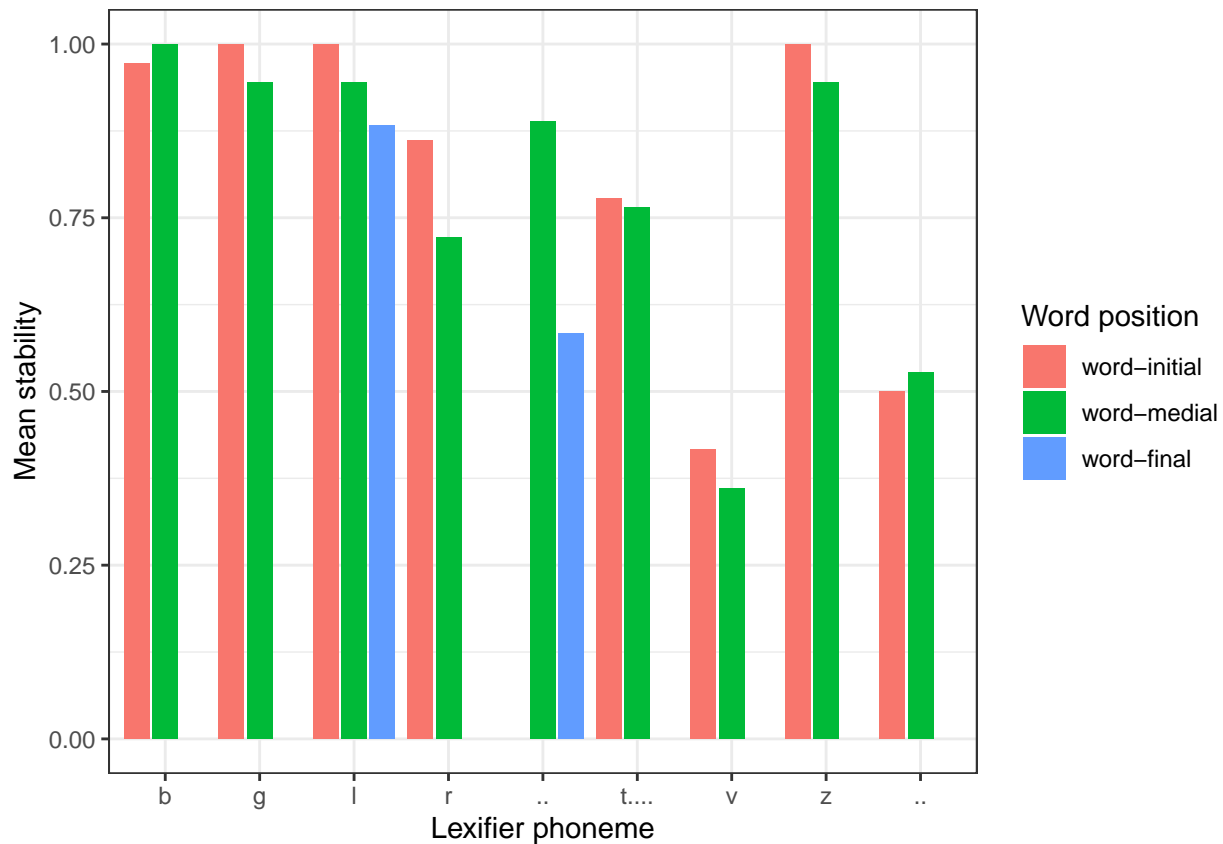
[illegible]

[illegible]



[illegible]

```
## Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbcsToSbcs': dot substituted for <ca>
## Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbcsToSbcs': dot substituted for <92>
```



Flip horizontally.

```
# TODO: reorder doesn't work here
ggplot(different_position_results) +
  geom_bar(aes(x = m,
               y = reorder(LexifierPhoneme, m),
               fill = Position),
           stat = "identity",
           show.legend = TRUE,
           position = "dodge2") +
  labs(x = "Stability score", y = "Phoneme", fill = "Word position")
```

```
## Warning: Removed 8 rows containing missing values (geom_bar).
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbcsToSbcs': dot substituted for <c9>
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on ' ' in 'mbcsToSbcs': dot substituted for <be>
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 't' in 'mbcsToSbcs': dot substituted for <cc>
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 't' in 'mbcsToSbcs': dot substituted for <a0>
```

```
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :  
## conversion failure on 't' in 'mbsToSbcs': dot substituted for <ca>  
  
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :  
## conversion failure on 't' in 'mbsToSbcs': dot substituted for <83>  
  
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :  
## conversion failure on ' ' in 'mbsToSbcs': dot substituted for <ca>  
  
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :  
## conversion failure on ' ' in 'mbsToSbcs': dot substituted for <92>  
  
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :  
## conversion failure on ' ' in 'mbsToSbcs': dot substituted for <c9>  
  
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :  
## conversion failure on ' ' in 'mbsToSbcs': dot substituted for <be>  
  
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :  
## conversion failure on 't' in 'mbsToSbcs': dot substituted for <cc>  
  
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :  
## conversion failure on 't' in 'mbsToSbcs': dot substituted for <a0>  
  
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :  
## conversion failure on 't' in 'mbsToSbcs': dot substituted for <ca>  
  
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :  
## conversion failure on 't' in 'mbsToSbcs': dot substituted for <83>  
  
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :  
## conversion failure on ' ' in 'mbsToSbcs': dot substituted for <ca>  
  
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :  
## conversion failure on ' ' in 'mbsToSbcs': dot substituted for <92>  
  
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :  
## conversion failure on ' ' in 'mbsToSbcs': dot substituted for <c9>
```

[illegible]

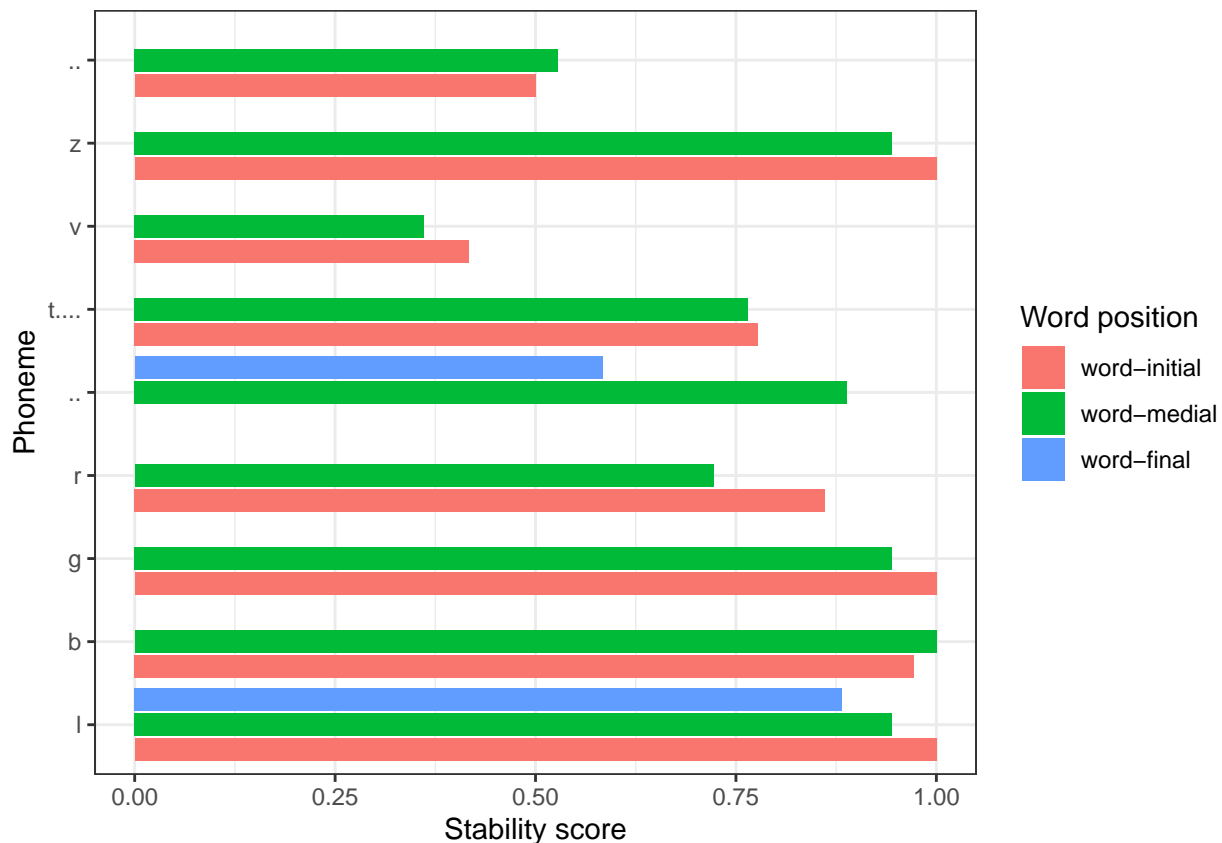
```
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :  
## conversion failure on ' ' in 'mbcsToSbcs': dot substituted for <ca>  
  
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :  
## conversion failure on ' ' in 'mbcsToSbcs': dot substituted for <92>  
  
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :  
## conversion failure on ' ' in 'mbcsToSbcs': dot substituted for <c9>  
  
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :  
## conversion failure on ' ' in 'mbcsToSbcs': dot substituted for <be>  
  
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :  
## conversion failure on 't' in 'mbcsToSbcs': dot substituted for <cc>  
  
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :  
## conversion failure on 't' in 'mbcsToSbcs': dot substituted for <a0>  
  
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :  
## conversion failure on 't' in 'mbcsToSbcs': dot substituted for <ca>  
  
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :  
## conversion failure on 't' in 'mbcsToSbcs': dot substituted for <83>  
  
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :  
## conversion failure on ' ' in 'mbcsToSbcs': dot substituted for <ca>  
  
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :  
## conversion failure on ' ' in 'mbcsToSbcs': dot substituted for <92>  
  
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :  
## conversion failure on ' ' in 'mbcsToSbcs': dot substituted for <c9>  
  
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :  
## conversion failure on 't' in 'mbcsToSbcs': dot substituted for <cc>
```

[illegible]

[illegible]

[illegible]





## Conditions of contact

The finding that “slavery has a negative impact on stability” was mainly observational and also literature-based (e.g. Faraclas et al. (2007); Carvalho and Lucchesi (2016); Upper Guinea light creoles = slavery but with lighter contact conditions versus Gulf of Guinea hard creole = slavery and harder contact conditions).

Test whether there’s a relation between type of contact situation and overall mean stability.

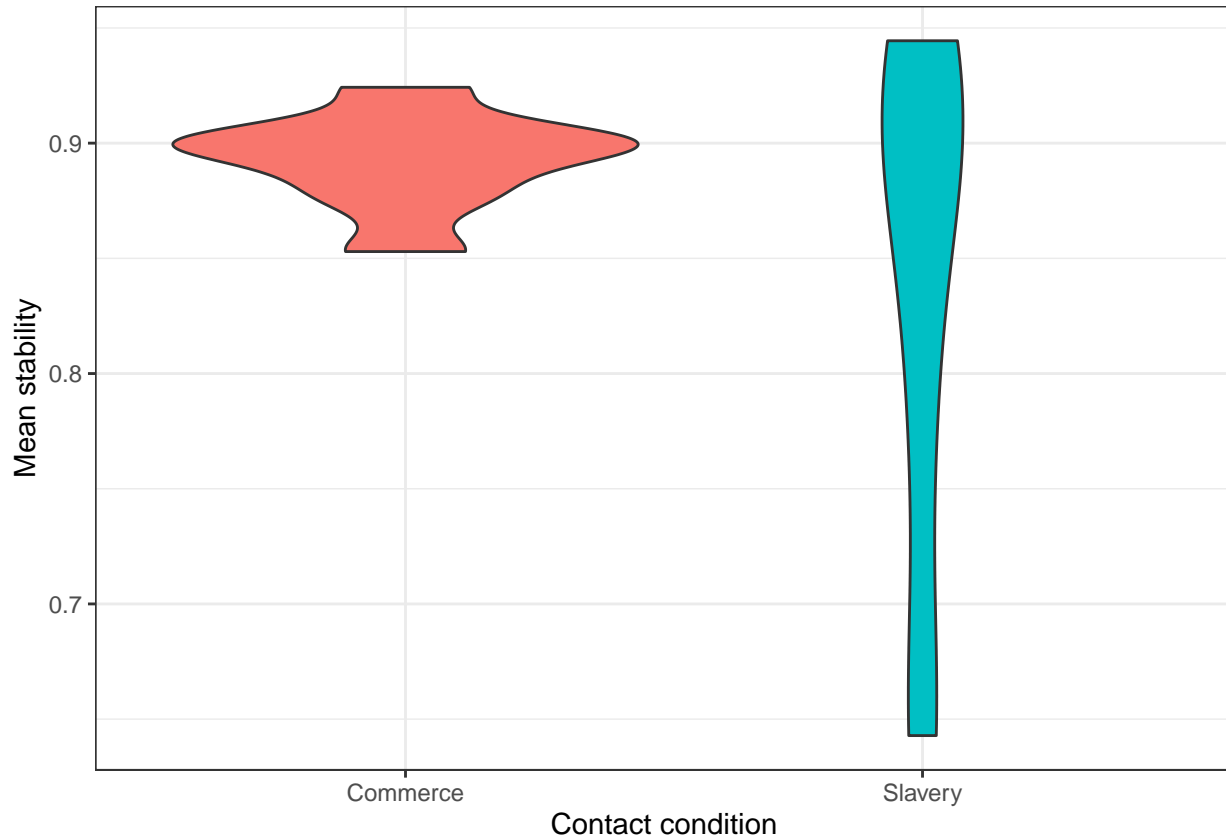
```
m <- lm(MeanStability ~ ContactConditions, data=creole_stability)
summary(m)
```

```
##
## Call:
## lm(formula = MeanStability ~ ContactConditions, data = creole_stability)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.196336 -0.016876  0.007455  0.061289  0.105251
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)      0.89255     0.03030   29.459 2.28e-15 ***
## ContactConditionsSlavery -0.05335     0.04065   -1.313   0.208
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.08569 on 16 degrees of freedom
```

```
## Multiple R-squared:  0.0972, Adjusted R-squared:  0.04078
## F-statistic: 1.723 on 1 and 16 DF,  p-value: 0.2079
```

```
ggplot(creole_stability, aes(x = ContactConditions, y = MeanStability, fill = ContactConditions)) +
  geom_smooth(method = "lm") +
  geom_violin() +
  xlab("Contact condition") +
  ylab("Mean stability") +
  guides(fill="none")
```

```
## `geom_smooth()` using formula 'y ~ x'
```



```
m <- lm(MeanStability ~ duration + ContactConditions * duration, data=creole_stability)
summary(m)
```

```
##
## Call:
## lm(formula = MeanStability ~ duration + ContactConditions * duration,
##     data = creole_stability)
##
## Residuals:
```

	Min	1Q	Median	3Q	Max
##	-0.203607	-0.023472	0.007634	0.056201	0.098616

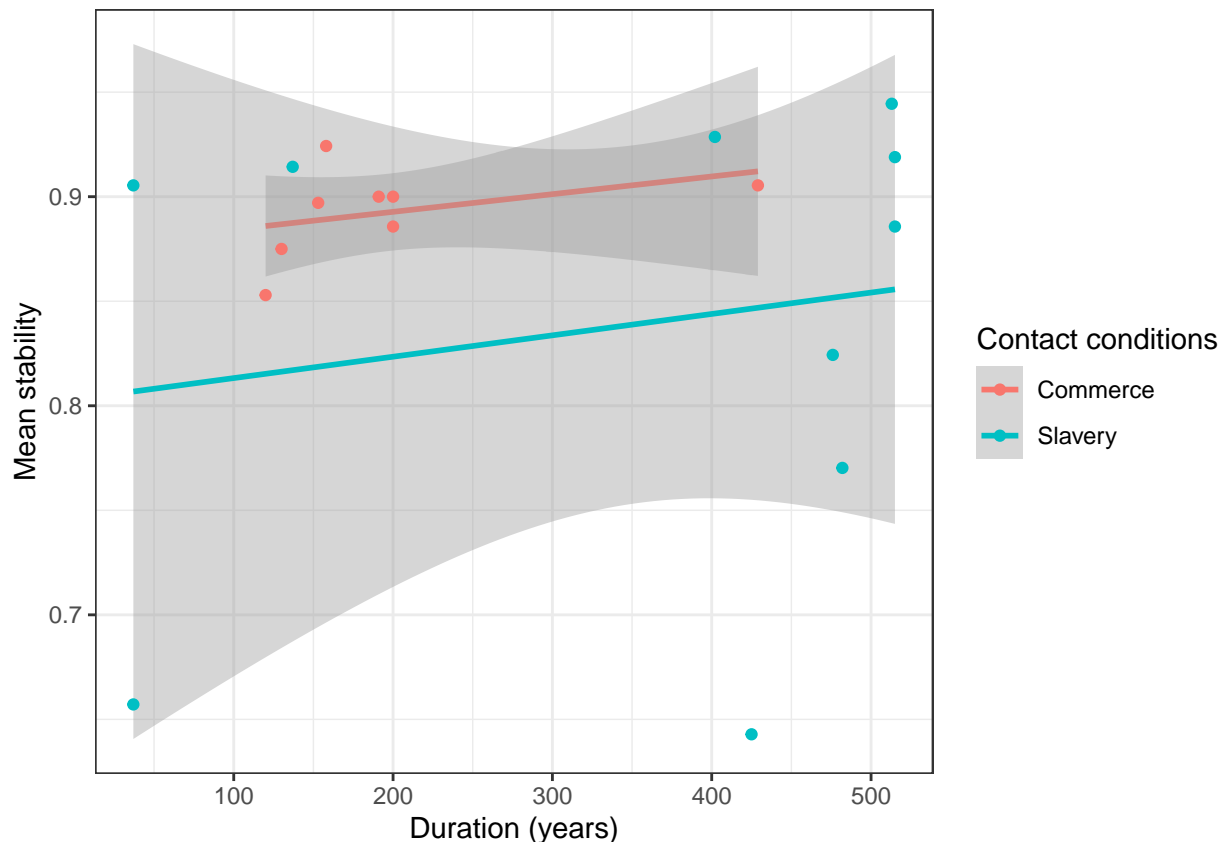
```
##
## Coefficients:
```

	Estimate	Std. Error	t value	Pr(> t )
## (Intercept)	8.758e-01	7.531e-02	11.629	1.4e-08 ***
## duration	8.459e-05	3.455e-04	0.245	0.810

```
## ContactConditionsSlavery          -7.282e-02  9.625e-02  -0.757    0.462
## duration:ContactConditionsSlavery  1.766e-05  3.763e-04   0.047    0.963
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.08992 on 14 degrees of freedom
## Multiple R-squared:  0.1302, Adjusted R-squared:  -0.05624
## F-statistic: 0.6983 on 3 and 14 DF,  p-value: 0.5685
```

```
ggplot(creole_stability, aes(x = duration, y = MeanStability, color = ContactConditions)) +
  geom_smooth(method = "lm") +
  geom_point() +
  xlab("Duration (years)") +
  ylab("Mean stability") +
  labs(color="Contact conditions")
```

```
## `geom_smooth()` using formula 'y ~ x'
```



## References

- Carvalho, Ana Maria, and Dante Lucchesi. 2016. "Portuguese in Contact." In *The Handbook of Portuguese Linguistics*, 41–55. Wiley Blackwell. <https://doi.org/10.1002/9781118791844.ch3>.
- Faraclos, Nicholas, Don Walicek, Mervyn Alleyne, Wilfredo Geigel, and Luis Ortiz. 2007. "The Complexity That Really Matters: The Role of Political Economy in Creole Genesis." In *Deconstructing Creole: New Horizons in Language Creation*, edited by U. Ansaldi, S. J. Matthews, and L. Lim, 227–64. John Benjamins. <https://doi.org/10.1075/tsl.73.12far>.
- RStudio Team. 2020. *RStudio: Integrated Development Environment for r*. Boston, MA: RStudio, PBC. <http://www.rstudio.com/>.

- Slowikowski, Kamil. 2022. *Ggrepel: Automatically Position Non-Overlapping Text Labels with 'Ggplot2'*. <https://CRAN.R-project.org/package=ggrepel>.
- Wickham, Hadley, Mara Averick, Jennifer Bryan, Winston Chang, Lucy D'Agostino McGowan, Romain François, Garrett Golemund, et al. 2019. "Welcome to the tidyverse." *Journal of Open Source Software* 4 (43): 1686. <https://doi.org/10.21105/joss.01686>.
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