

Analysis of fluency

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Nivja de Jong

LANGSNAP Workshop

Overview

- Introduction
- Acoustic measures of utterance fluency
- How to calculate?
- How to measure? (PRAAT)

L2 fluency:

Broad sense and narrow sense.

Narrow sense:

- Segalowitz (2010). *Cognitive bases of second language fluency*. New York: Routledge.

- Cognitive fluency, utterance fluency, and perceived fluency (Segalowitz, 2010)



Aspects of fluency

- Cognitive fluency: ability of the L2 speaker to smoothly translate thoughts to L2 speech
- Perceived fluency: subjective measure of what listeners perceive – about L2 speaker's cognitive fluency
- Utterance fluency: objective acoustic measures of an utterance

Measuring Utterance Fluency

- Which measures?
- How to measure?

Proposed measures

1. Speech rate (syllables divided per total time)
2. Articulation rate (syllables divided by phonation time)
3. Phonation-time ratio (phonation time divided by total time)
4. Mean length of runs (number of silent pauses divided by number of syllables)
5. Number of silent pauses per minute (number of silent pauses divided by total time)

Proposed measures

6. Mean pause duration (total length of silent pauses divided by total number of silent pauses)
7. Number of filled pauses per minute (number of filled pauses divided by total time)
8. Number of repairs per minute (number of repetitions, restarts and repairs divided by total time)
9. Mean syllable duration (number of syllables divided by phonation time)

Proposed measures

10. All measures that are involved in dialogue:

Length of turns, pauses between turns, overlap, ...

[NOT DISCUSSED IN THIS WORKSHOP]

Proposed measures (2)

1. Speech rate (syllables divided per total time)
2. Articulation rate (syllables divided by phonation time)
3. Phonation-time ratio (phonation time divided by total time)
4. Mean length of runs (number of silent pauses **divided by phonation time**)
5. Number of silent pauses per minute (number of silent pauses **divided by phonation time**)

Proposed measures (2)

6. Mean pause duration (total length of silent pauses divided by total number of silent pauses)
7. Number of filled pauses per minute (number of filled pauses **divided by phonation time**)
8. Number of repairs per minute (number of repetitions, restarts and repairs **divided by phonation time**)
9. Mean syllable duration (number of syllables divided by phonation time)

Question

- Tavakoli & Skehan (2005): three categories of utterance fluency (breakdown, speed, and repair)
- Can we categorize measures of utterance fluency in measures of
 - Breakdown fluency
 - Speed fluency
 - Repair fluency
 - (Other?)

Which measures fall into one category? Which in more than one?

Example of calculations

Sound file with Praat annotations.

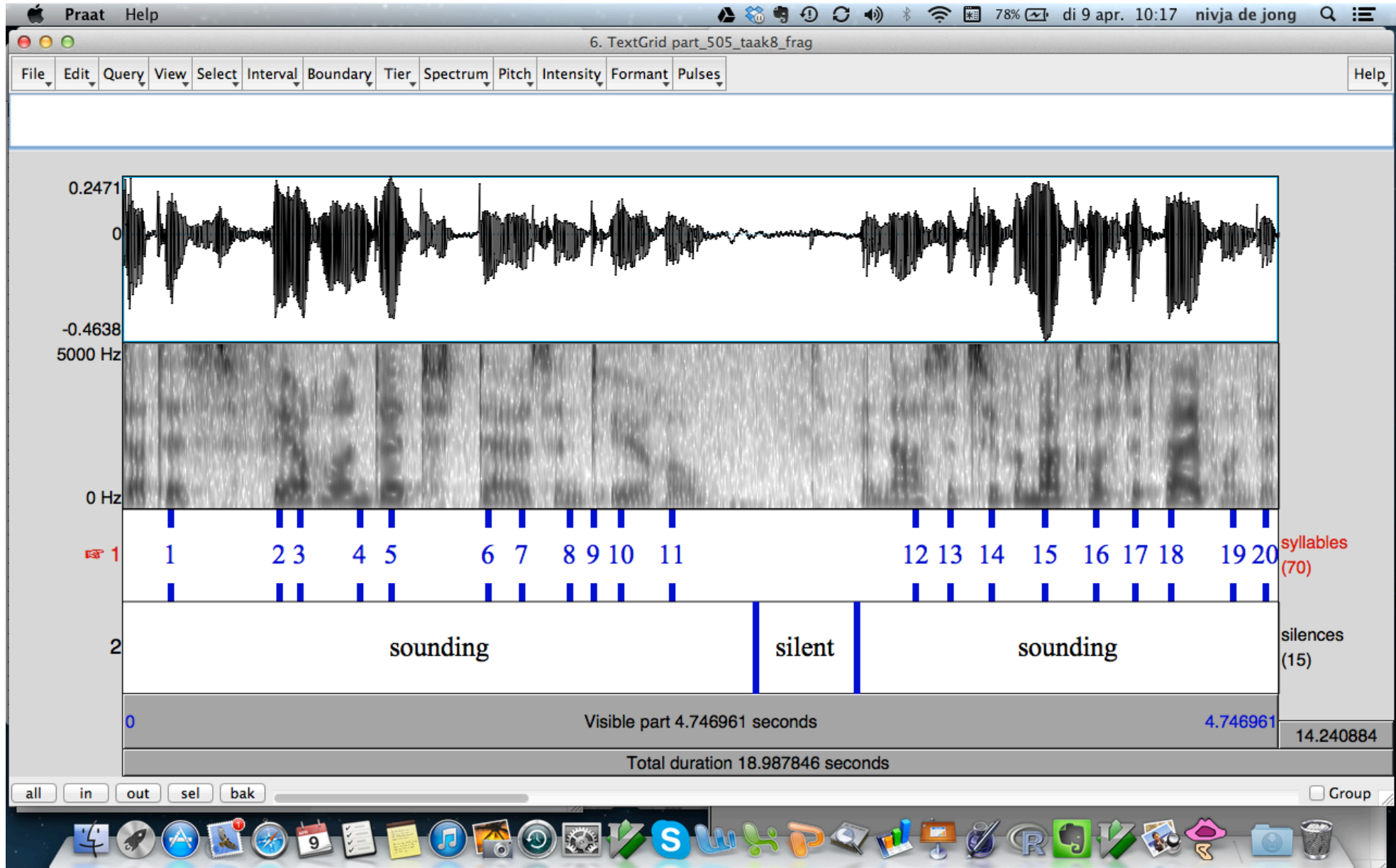
Total time =

Phonation time =

Number of syllables =

Number of silent pauses =

Example of calculations



Example of calculations

Sound file with Praat annotations.

Total time = 18.99s

Phonation time = 14.32s

Number of syllables = 70

Number of silent pauses = 7

Calculate the following measures (see handout):

Speech rate, articulation rate, Mean length of utterance (in syllables), Mean length of utterance (in seconds), Number of pauses per minute (total time), number of pauses per minute (phonation time), mean pause duration, mean syllable duration, phonation time ratio

Example of calculations

Speech rate: = $70 / 18.99$

Articulation rate = $70 / 14.32$

Mean length of utterance (in syllables) = $70 / (7+1)$

Mean length of utterance (in seconds) = $14.32 / (7+1)$

Number of pauses per minute (total time) = $7 / 18.99$

Number of pauses per minute (speaking time) = $7 / 14.32$

Mean pause duration = $(18.99 - 14.32) / 7$

Mean syllable duration = $14.32 / 70$

Phonation time ratio = $14.32 / 18.99$

Measures of breakdown fluency

Speech rate: = $70 / 18.99$

Articulation rate = $70 / 14.32$

Mean length of utterance (in syllables) = $70 / (7+1)$

Mean length of utterance (in seconds) = $14.32 / (7+1)$

Number of pauses per minute (total time) = $7 / 18.99$

Number of pauses per minute (speaking time) = $7 / 14.32$

Mean pause duration = $(18.99 - 14.32) / 7$

Mean syllable duration = $14.32 / 70$

Phonation time ratio = $14.32 / 18.99$

Measures of breakdown fluency

Speech rate: = $70 / 18.99$

Articulation rate = $70 / 14.32$

Mean length of utterance (in syllables) = $70 / (7+1)$

Mean length of utterance (in seconds) = $14.32 / (7+1)$

Number of pauses per minute (total time) = $7 / 18.99$

Number of pauses per minute (speaking time) = $7 / 14.32$

Mean pause duration = $(18.99 - 14.32) / 7$

Mean syllable duration = $14.32 / 70$

Phonation time ratio = $14.32 / 18.99$

Not calculated:

Number of filled pauses per minute, Pruned speech rate

Measures of speed fluency

Speech rate: = $70 / 18.99$

Articulation rate = $70 / 14.32$

Mean length of utterance (in syllables) = $70 / (7+1)$

Mean length of utterance (in seconds) = $14.32 / (7+1)$

Number of pauses per minute (total time) = $7 / 18.99$

Number of pauses per minute (speaking time) = $7 / 14.32$

Mean pause duration = $(18.99 - 14.32) / 7$

Mean syllable duration = $14.32 / 70$

Phonation time ratio = $14.32 / 18.99$

More on silent pauses

Silent pauses

- Micropause (silence of .2s or less)
- Hesitation (silence of .3 to .4s)
- Unfilled pause (silence of .5s or more)

Minimum duration of silent pauses

Occlusives such as “p”, “t”, “k”, etc: include short silences.
These are ‘articulation’ pauses, and not ‘hesitation’ pauses.

Thresholds in literature between 100ms – 1000ms: ???

De Jong & Bosker (submitted) advice to use a threshold of 250 – 300ms:

- Choosing a higher or lower threshold leads to a lower correlation between measures of fluency with L2 proficiency
- Choosing a higher threshold leads to more problems with intercollinearity (between number of pauses and duration of pauses)

Breakdown fluency

Distinguish between

- Number of pauses
- Duration of pauses

Breakdown fluency: number or duration of silent pauses?

Speech rate: = $70 / 18.99$

Mean length of utterance (in syllables) = $70 / (7+1)$

Mean length of utterance (in seconds) = $14.32 / (7+1)$

Number of pauses per minute (total time) = $7 / 18.99$

Number of pauses per minute (speaking time) = $7 / 14.32$

Mean pause duration = $(18.99 - 14.32) / 7$

Phonation time ratio = $14.32 / 18.99$

Breakdown fluency: number of silent pauses

Speech rate: = $70 / 18.99$

Mean length of utterance (in syllables) = $70 / (7+1)$

Mean length of utterance (in seconds) = $14.32 / (7+1)$

Number of pauses per minute (total time) = $7 / 18.99$

Number of pauses per minute (speaking time) = $7 / 14.32$

Mean pause duration = $(18.99 - 14.32) / 7$

Phonation time ratio = $14.32 / 18.99$

Breakdown fluency: duration of silent pauses

Speech rate: = $70 / 18.99$

Mean length of utterance (in syllables) = $70 / (7+1)$

Mean length of utterance (in seconds) = $14.32 / (7+1)$

Number of pauses per minute (total time) = $7 / 18.99$

Number of pauses per minute (speaking time) = $7 / 14.32$

Mean pause duration = $(18.99 - 14.32) / 7$

Phonation time ratio = $14.32 / 18.99$

Choosing unconfounded measures

Breakdown fluency:

Number of silent pauses / phonation time

Mean duration of silent pauses

Number of filled pauses / phonation time

Mean duration of filled pauses

Speed fluency:

Articulation rate or mean syllable duration

Repair fluency:

Number of repairs and or repetitions / phonation time

(Mean duration of repairs / repetitions)

Measuring utterance fluency

- Record L2 speech-data
 - Annotate by hand (e.g.: PRAAT, CLAN)
 - For monologic speech (excerpts): use automatically obtained measures (De Jong & Wempe, 2009: script in PRAAT)
 - Use a combination of these two methods

Choosing unconfounded measures

Breakdown fluency:

Number of silent pauses / phonation time

Mean duration of silent pauses

Number of filled pauses / phonation time

Mean duration of filled pauses

Speed fluency:

Articulation rate or mean syllable duration

Repair fluency:

Number of repairs and or repetitions / phonation time

(Mean duration of repairs / repetitions)

Praat script

- For each .wav-file in a directory, it will give you
 - nsyll
 - npause
 - dur (s)
 - phonationtime (s)
 - speechrate (nsyll/dur)
 - articulation rate (nsyll / phonationtime)
 - ASD (speakingtime/nsyll)

Praat script HOWTO

- Open praat

- Go to

<http://sites.google.com/site/speechrate>

(e.g., google speech rate praat)

On the site, click on Praat script v2:
as found in bottom left



Navigation
Speech Rate: Praat script that detects syllable nuclei
How does the script work?
▼ Praat Script Syllable Nuclei
tutorial
Praat Script Syllable Nuclei v2

Copy the script:
starting from “####” to “endfor” (bottom of page):

g

[Speech Rate: Praat script that detects syllable nuclei](#) >

Praat Script Syllable Nuclei v2

```
#####  
#  
# Praat Script Syllable Nuclei  
# Copyright (C) 2008 Nivja de Jong and Ton Wempe  
#  
# This program is free software: you can redistribute it and/or modify  
# it under the terms of the GNU General Public License as published by  
# the Free Software Foundation, either version 3 of the License, or  
# (at your option) any later version.  
#  
# This program is distributed in the hope that it will be useful,  
# but WITHOUT ANY WARRANTY; without even the implied warranty of  
# MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE. See the  
# GNU General Public License for more details.  
#  
# You should have received a copy of the GNU General Public License  
# along with this program. If not, see http://www.gnu.org/licenses/  
#  
#####  
#  
# modified 2010.09.17 by Hugo Quené, Ingrid Persoon, & Nivja de Jong  
# Overview of changes:  
# + change threshold-calculator: rather than using median, use the almost maximum  
#   minus 25dB. (25 dB is in line with the standard setting to detect silence  
#   in the "To TextGrid (silences)" function.  
#   Almost maximum (.99 quantile) is used rather than maximum to avoid using  
#   irrelevant non-speech sound-bursts
```

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Syllable

Syllable

Praat script HOWTO

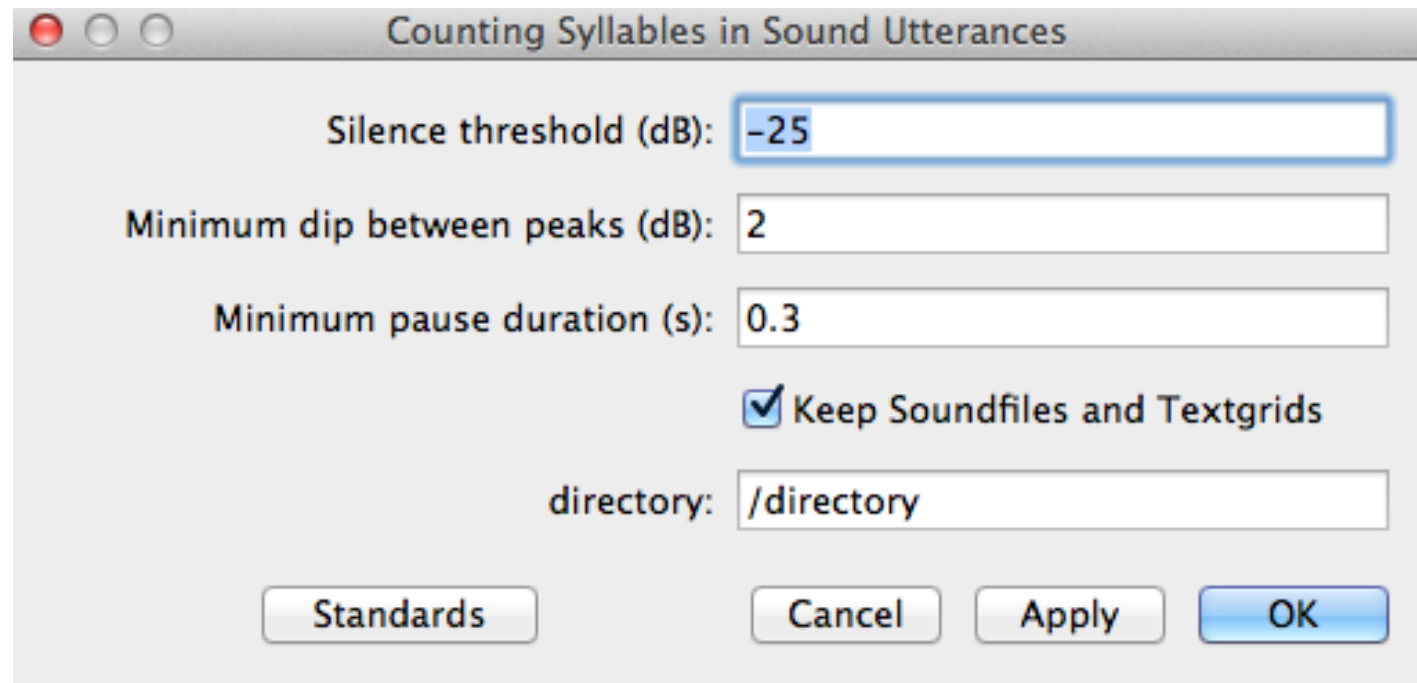
- In PRAAT, choose “New praat script”
- Paste the script into this window
 - NB on a mac, sometimes you need to paste it first into a text editor and then into PRAAT
- Download from the “Langsnap”-page of the praat script some soundfiles, and save them into a folder that is easily accessible

[http://sites.google.com/site/speechrate/
langsnap](http://sites.google.com/site/speechrate/langsnap)

Praat script HOWTO

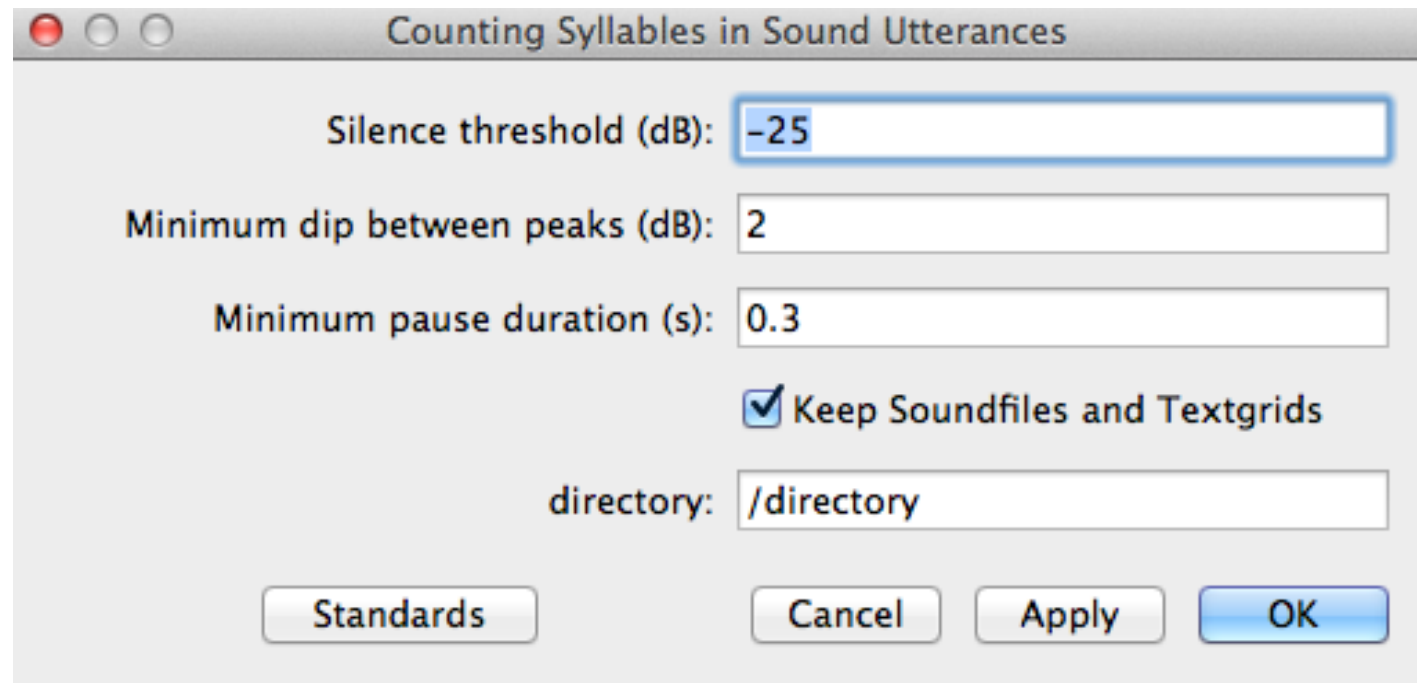
Run the script

- Ctrl-r or choose 'run script'



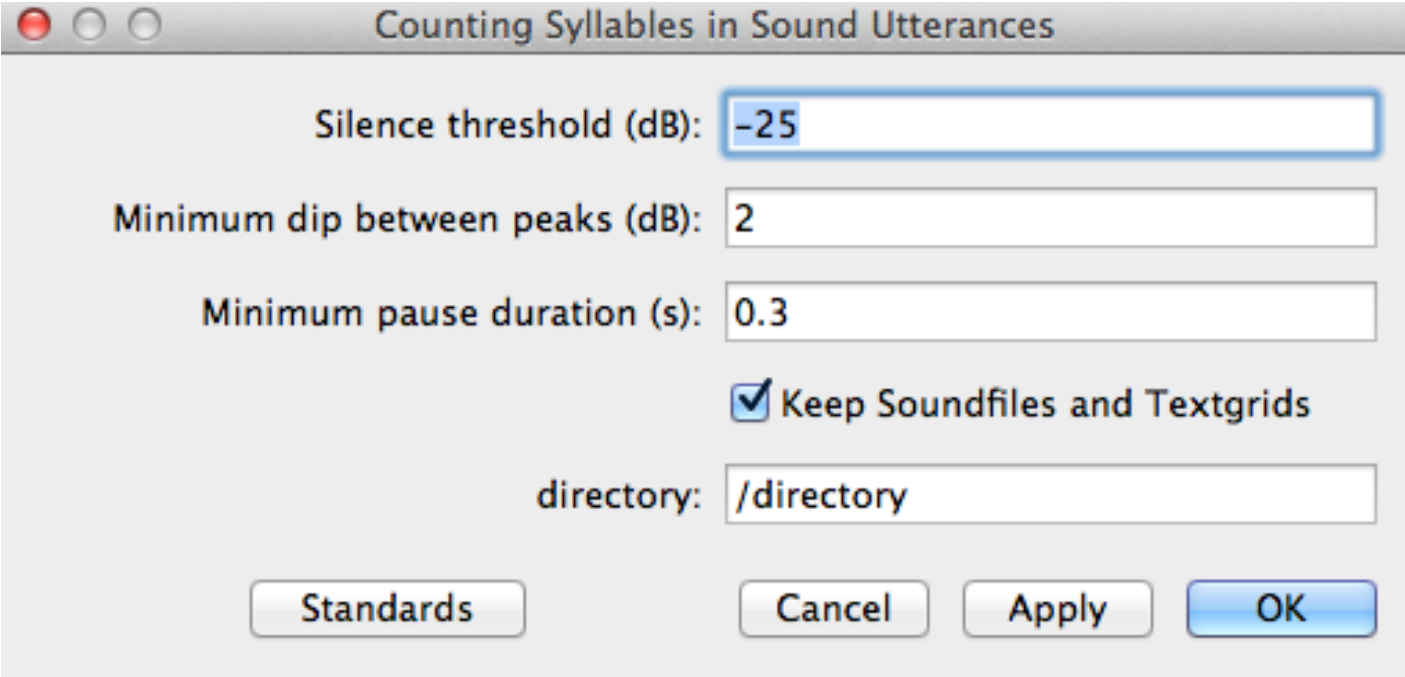
Praat script HOWTO

Change default values, at least “/directory”



Silence threshold (dB): from the 99% loudest peak, how much dB below should be counted as silence?

The higher this number (e.g. -30, -40), the lower the chance of finding silent pauses



Counting Syllables in Sound Utterances

Silence threshold (dB):

Minimum dip between peaks (dB):

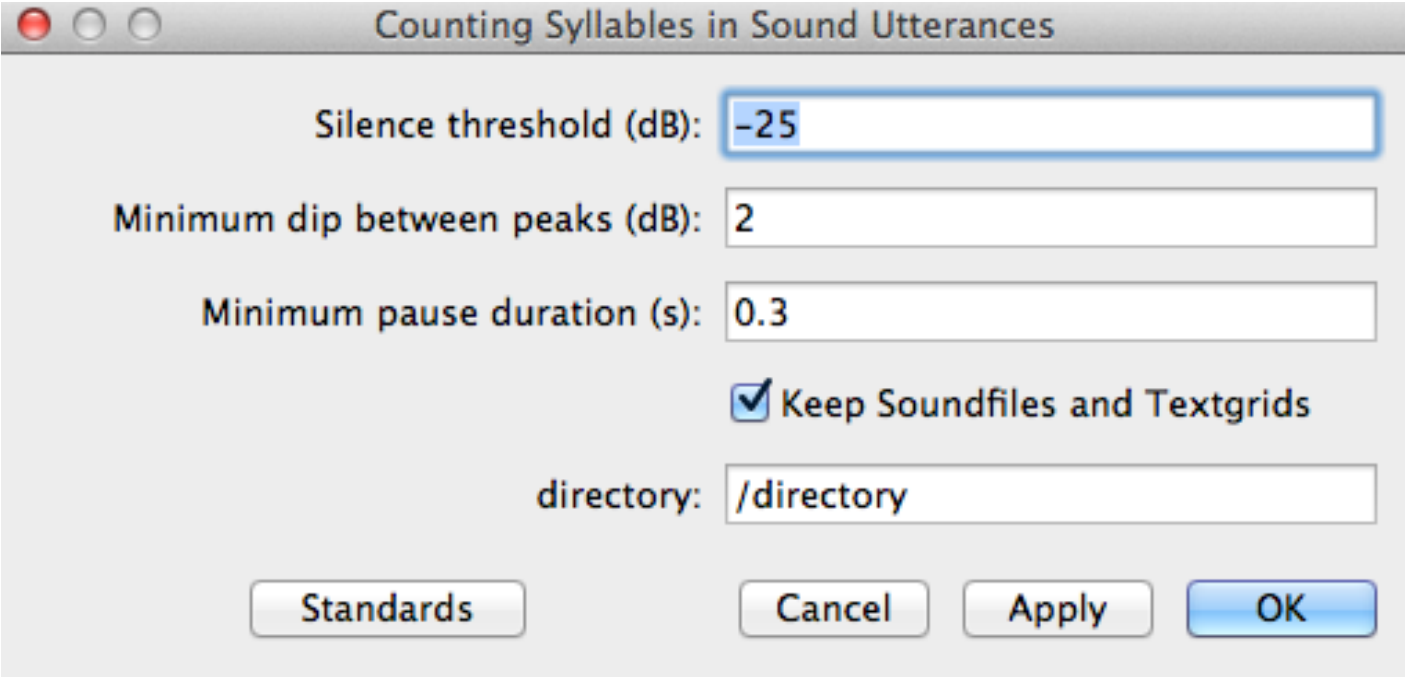
Minimum pause duration (s):

Keep Soundfiles and Textgrids

directory:

In between two consecutive peaks in loudness (“potential syllable nuclei”): how deep should the dip in intensity be?

The higher this number, the fewer syllables will be found



Counting Syllables in Sound Utterances

Silence threshold (dB):

Minimum dip between peaks (dB):

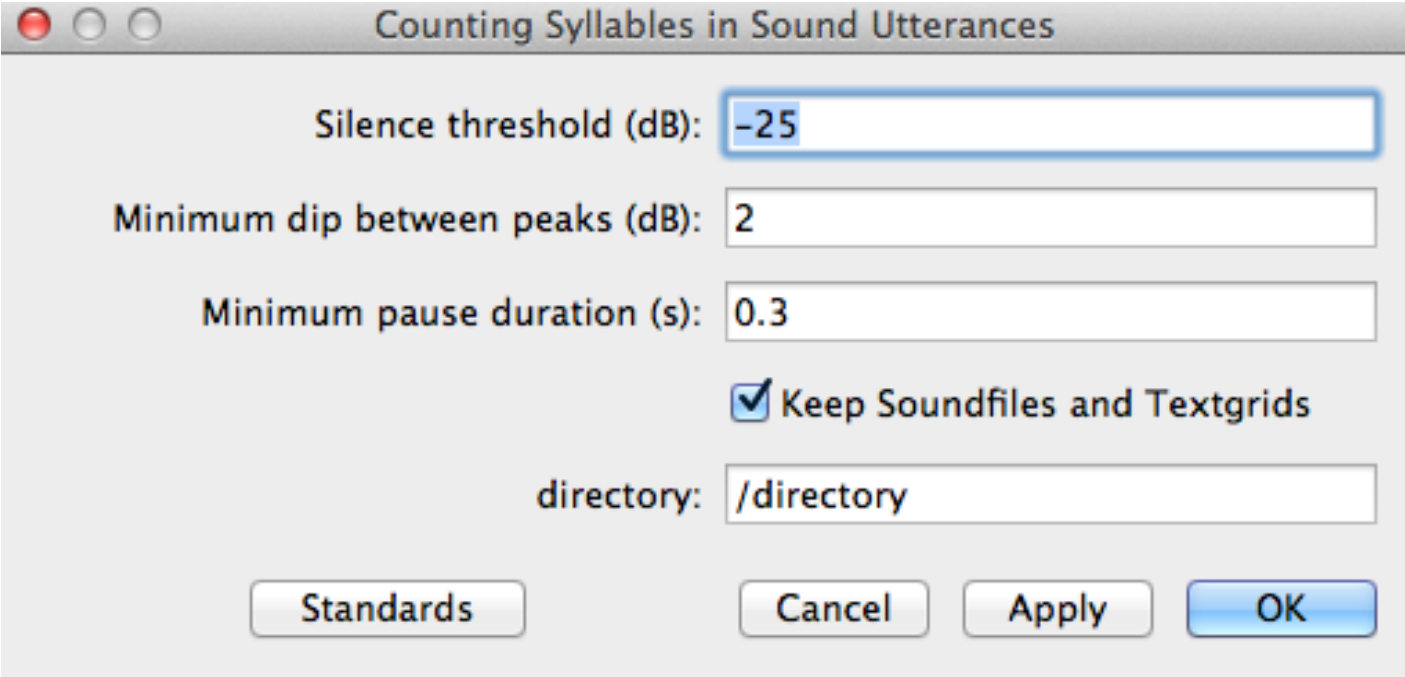
Minimum pause duration (s):

Keep Soundfiles and Textgrids

directory:

Minimum pause duration (s): How long should a pause be to be counted as a silent pause?

The higher this number, the fewer pauses will be found



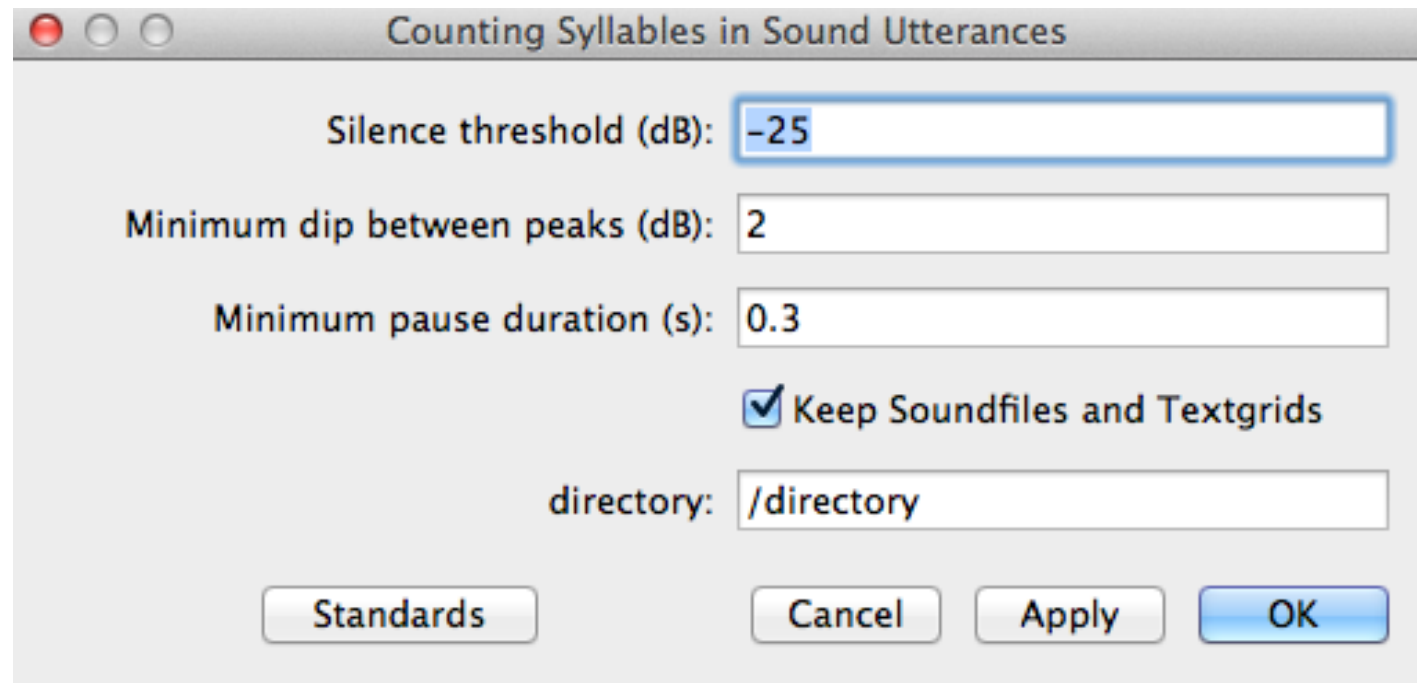
The image shows a dialog box titled "Counting Syllables in Sound Utterances". It contains several input fields and a checkbox. The "Silence threshold (dB)" field is highlighted with a blue border and contains the value "-25". The "Minimum dip between peaks (dB)" field contains "2". The "Minimum pause duration (s)" field contains "0.3". There is a checked checkbox labeled "Keep Soundfiles and Textgrids". The "directory:" field contains "/directory". At the bottom, there are four buttons: "Standards", "Cancel", "Apply", and "OK".

Silence threshold (dB):	-25
Minimum dip between peaks (dB):	2
Minimum pause duration (s):	0.3
<input checked="" type="checkbox"/> Keep Soundfiles and Textgrids	
directory:	/directory

Buttons: Standards, Cancel, Apply, OK

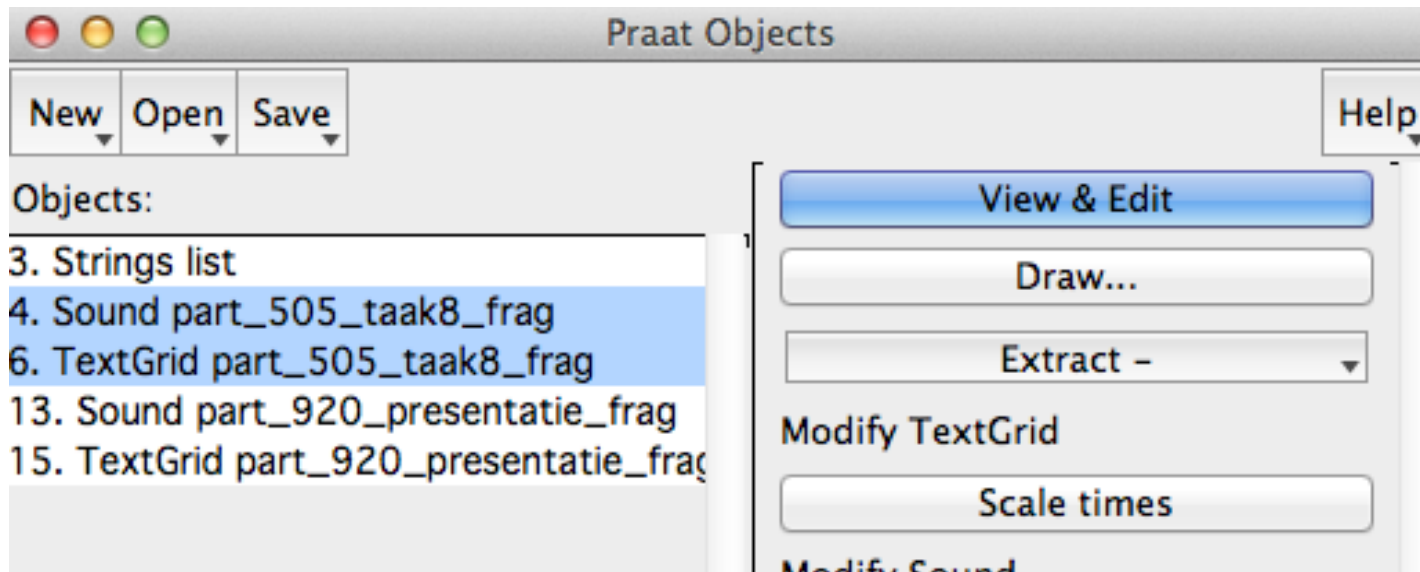
Praat script HOWTO

Check “Keep Soundfiles and TextGrids” to inspect performance of the script.



Praat script HOWTO

Checking the TextGrids for performance:



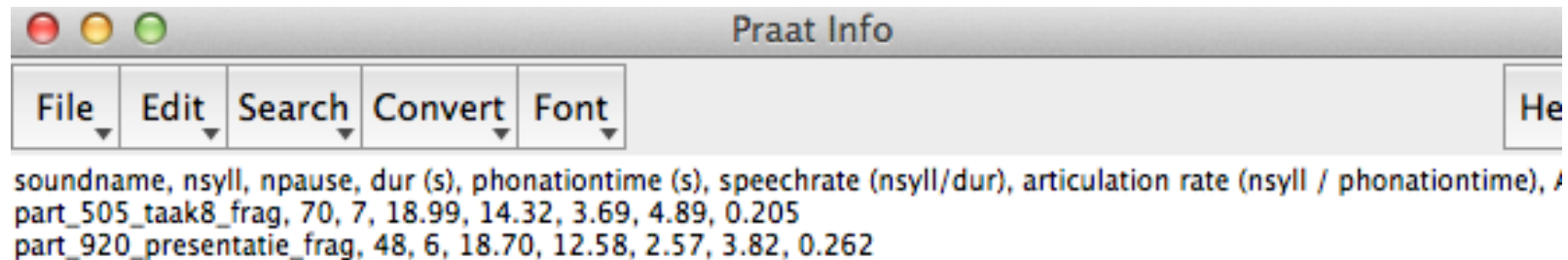
In the PRAAT objects window, select the Soundfile and the corresponding TextGrid together, then click “View and Edit”

Praat script 'disclaimer'

- The script will only work if the soundfile does not have too much background noise (otherwise: perform a filter first)
- The script can only detect syllables that are actually there; many unstressed/reduced syllables not picked up
- Long syllables can be counted as two (if there are two peaks with a sufficient dip...)

Praat script HOWTO

Results are written in an “Info”-window:



You can save this file, and open it in a spreadsheet program: indicate comma is a delimiter.

Questions?

n.dejong@uu.nl