A18a - SMSL Trial Accuracy and Duration Scoring

In this stage, we will first extract individual files for each GO trial. Then, we use the Praat analysis script for perceptual analysis of accuracy with simultaneous visual comparison to the spectrogram for each file. The script will open each file while simultaneously creating a TextGrid containing tiers to score, 1) Word Accuracy, 2) Onset Error Type, 3) Vowel/Coda Error Type, 4) Comments, 5) Unusable Trial. Last, we use a Matlab script to compile the TextGrid scoring files and check the logical consistency of scoring.

Preconditions
Matlab 2020
Praat (available for download [here](#))
...also the following fonts for Praat: CharisSIL-5.000 and DoulosSIL-5.000 phonetic fonts, from the same Praat download page

…

The following preprocessing steps must have been run:
    A01 - create renamed audio .wav files
    A03 (only if you are doing accuracy scoring from the echo-cancelled audio)
    A04 - create landmarks file (EITHER run full A04 protocol OR see Appendix)
    A04 - create ../annot/…events-sync.tsv (EITHER run full A04 protocol OR see * below)
    [A05](#) - create ../annot/…annot-trials.tsv with the A05 R script

*Syncing generally only changes trigger event times by tens of milliseconds, which isn't that significant for the purposes of this accuracy scoring step. Therefore to create `../annot/events-sync.tsv`, EITHER run A04 properly (getting fully synced event times), OR just copy the following unsynced file into `../annot/` and append '-sync':

`Y:\DBS\sourcedata\sub-DM####\ses-intraop\task\sub-DM####_ses-intraop_task-SMSL_run-##_events.tsv`

Create .wavs for each trial:

Copy the following Matlab script:

    Y:\DBS\derivatives\sub-DM1037\preproc\
    sub_DM1037_ses_intraop_task_smsl_A18_cut_audio_trials_[DATE].m

...into the current subject's preproc directory (after adjusting subject and dates):

    Y:\DBS\derivatives\sub-DM####\preproc\

Open the script in Matlab and change the SUBJECT and RUN variables to match the current subject and the SMSL run containing behavioral data. To find out the proper SMSL run number, refer to the 'intraop smsl' arrow listed in the following text file (look at duration and comment columns):

    Y:\DBS\derivatives\sub-DM####\annot\sub-DM####_runs.tsv

Make sure that the `trials_to_modify_inds` and `trials_to_modify_sec` variables are empty; these can be used later to customize specific trial audio durations if necessary.

Run the Matlab script. It should create the following files within
Y:\DBS\derivatives\sub-DM####\analysis\task-smsl_trial-audio…..

sub-DM####_ses-intraop_task-smsl_audiofiles.tsv
sub-DM####_ses-intraop_task-smsl_audiofiles_gotrials.tsv
sub-DM####_ses-intraop_task-smsl_audiofiles_stoptrials.tsv

It should also create a .wav file for each trial in the following two directories:

Y:\DBS\derivatives\sub-DM####\analysis\task-smsl_trial-audio\ses-intraop_go-trials\
Y:\DBS\derivatives\sub-DM####\analysis\task-smsl_trial-audio\ses-intraop_stop-trials\

If there are trials with unexpected trial durations (negative, NaN, or overly long), the duration used for the trial will be output on the Matlab console and the audio will be opened in Praat.

If some trials need to have their start or stop times manually edited, use the 'trials_to_modify_inds' variable at the top of the Matlab script. This option is to be used on specific trials when sub starts early or trigger was sent at wrong time. (For example, in sub1025, the intraop trial 57 start time ends up being ~700ms later than it should be, and the voice response is cut off.) To use this option, change following variables at the top of the '_A18_cut_audio_trials' Matlab script:

trials_to_modify_inds   %%%%   X-by-1 vector indicating which trials to modify
trials_to_modify_sec   %%%% X-by-2 matrix indicating how much to move start times and stop times

Trial accuracy scoring:
> Note: audio played from the remote server often skips/misses portions of the recording during playback, making scoring from remote audio files unreliable. For this reason, it is recommended that you download the audio files and Praat scoring code to a local machine, then copy the resulting TextGrids back to the server. If you do so, change the wd$ and outDir$ variables in the Praat script to the local folder where the audio files are stored.
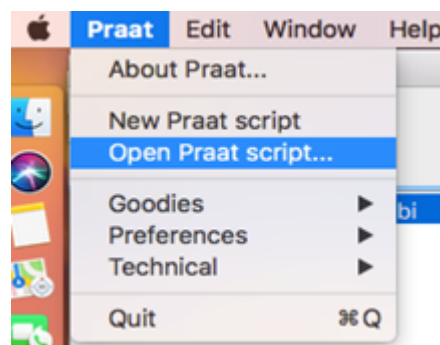
1. Open Praat. On the top menu, select "Praat", and then "Open Praat Script" to open the following code file: Y:\Documents\Code\praat_accuracy_scoring_code
2. Click "Run" to run the script ('Run' from the Praat Script Window top bar, or with Ctrl + R on Windows)
3. In the GUI:
   a. Update the first box with the subject number.
   b. Click OK to run the analysis code.
   c. The waveform and spectrogram will open along with the designated tiers for perceptual analysis.
   d. Score accuracy and error types or trial unusability in the appropriate tiers, detailed below
   e. Click **Continue** when you finish analysing each file to continue to the next file.
   f. If you need to start from a trial other than #1 (for example, to re-score a specific trial), adjust the "Starting file index" filed (note that this is the index within the file list, not the trial number in the filename)
   g. To compare the utterance to the correct pronunciation provided to the subject, see stimulus audio files in this Google Drive folder (double click a file to play it from Google Drive; use Ctrl + F to quickly find a specific word's file)

Tier 1: Accuracy

Tier 1 scores the accuracy of the production. Enter a 1 for accurate productions or a 0 for inaccurate productions. Note that an accurate trial for these purposes includes NO epenthesis or prothesis. Score epenthesis using the Wilson 2014 criteria, where periodic peaks, a visible second (or higher) formant in spectrogram, and drop in intensity prior to second consonant required for scoring of epenthesis. Errors include: disfluencies (restart or omission), unrecognizable from target, phoneme omission, consonant addition, phoneme substitution, incorrect sequencing of phonemes (transposition), and vocoid epenthesis, prothesis.

Tier 2: Onset Error Type

Enter the number representing each of the following error types, considering only the onset consonant cluster:

> 1 - disfluency (restart or prolongation)
> 2 - unrecognizable from target
> 3 - phoneme deletion/omission
> 4 - phoneme insertion (consonants only; enter vowel insertions as epenthesis/prothesis)
> 5 - substitution
> 6 - incorrect ordering/sequencing of phonemes, transposition error
> 7 - vocoid epenthesis (using Wilson 2014 criteria, where periodic peaks, a visible second (or higher) formant in spectrogram, and drop in intensity prior to second consonant required for scoring of epenthesis)
> 8 - vocoid prothesis - insertion of vowel-like sound before consonant onset; Wilson 2014 criteria is "vocoid with visible first and second formants before the obstruent"

If multiple errors are present, enter each error type, comma-separated and then enter a phonemic transcription in the "Comments" tier.

Tier 3: Vowel/Offset Error Type

Score this tier the same as Tier 2 (Onset Error Type), but considering instead the nucleus vowel and the offset consonant.

Tier 4: Speech Epoch

Use this Tier to indicate speech onset, vowel offset, and (if present) coda consonant offset.

> -if the offset is released, mark 4 timepoints: speech onset, voicing onset, voicing offset, and final-consonant offset

> -if the offset is not released, mark 3 timepoints: speech onset, voicing onset, and voicing/syllable offset

> -if there is no voicing, put the 2nd timepoint right before the 3rd timepoint [probably also unusable trial]

Click the 'SpeechEpoch' tier (it should turn yellow). For each timepoint to indicate, click on that timepoint then press Enter. As an alternative to clicking 2 points separately, you can highlight a portion of the spectrogram, then press Enter (two blue/red bars should appear in the SpeechEpoch tier). Ignore any unvoiced sounds like lip smacking that the subject makes before the onset of the intended first consonant. If there does not appear to audible speech preceding the first voicing onset, place these first 2 timepoints as close as possible together. If there is voicing during unusable trials, also indicate those voicing epochs in this tier, as it will be helpful for vibration denoising.

If there is epenthesis between the 2 onset consonants, voicing onset (the second marked timepoint) should be at the beginning of the voicing of the epenthesis, rather than at the 'proper' vowel onset. Below is an example (subject

1024 intraop) with visible epenthesis: "FPUB" is pronounced as Fuh-PUB":
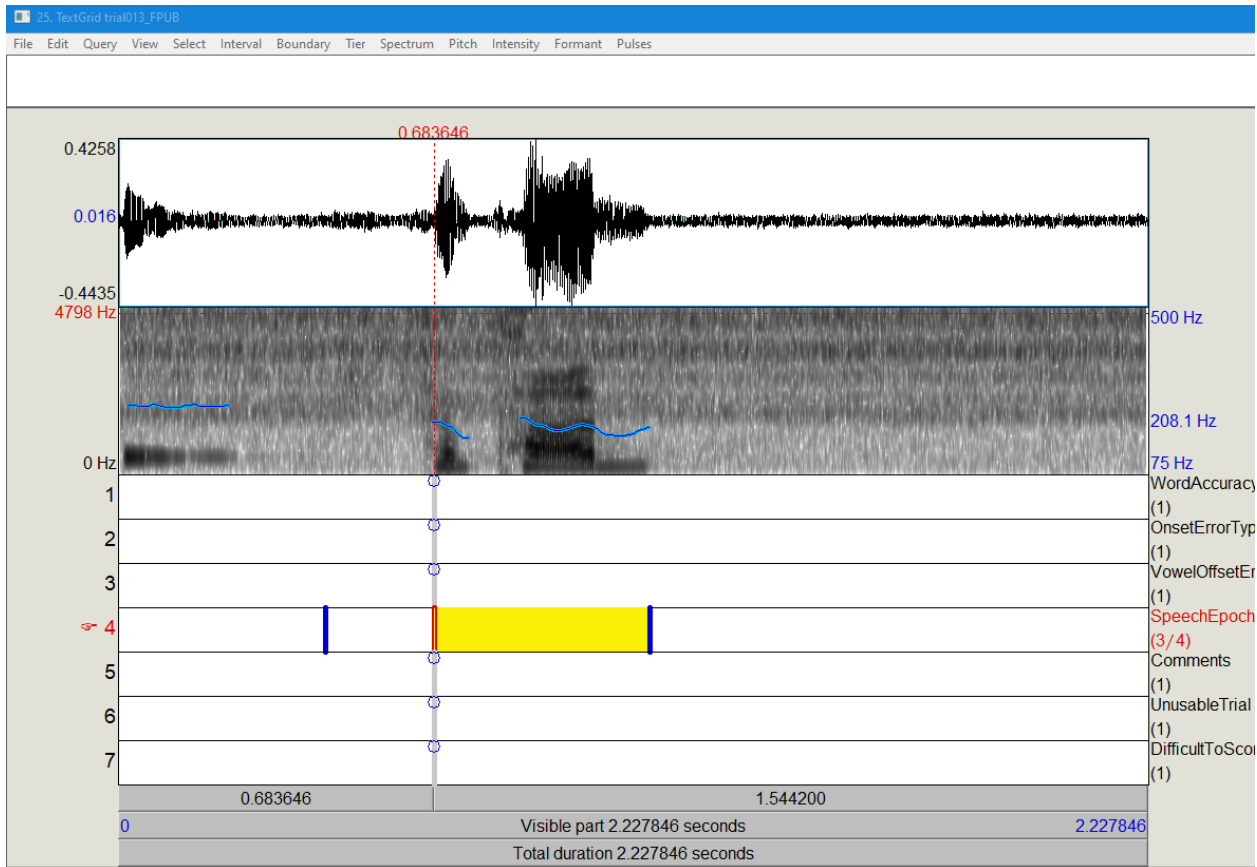
Tier 5: Comments

Enter a phonemic transcription for inaccurate productions. You do not need to provide a phonemic transcription if the production is accurate. Record any other unusual occurrences that should be noted. For IPA characters, click the IPA symbol to insert characters, rather than using keyboard shortcuts (e.g. enter ʃ rather than \sh), as these are easier to import into Matlab.

Tier 6: Unusable Trial

If a trial does not contain an utterance or the audio quality/background noise makes it impossible to score the utterance, mark this tier with a 1. Also mark this tier with a 1 if the subject started but did not finish attempting to complete the utterance, which may occur due to drowsiness from intraoperative anesthesia. Do not mark this tier with a 1 if you judge that the subject completed their attempt at the utterance, but dropped phonemes from the end due to a speech error; in this case, mark the error in the preceding tiers. Trials marked as unusable in this tier do not need to be scored in any other tiers. These trials will not be counted as accurate or inaccurate and will be excluded from all further analysis.

Tier 7: Difficult To Score

Mark this tier as a 1 if you had a hard time deciding whether to mark this trial as an error or not, due to background noise or ambiguity of the utterance. Leave this tier empty if the trial was not difficult to score. In Tier 4 (Comments), describe why the trial was difficult to score (e.g. "hard to tell if the first consonant was ʃ or S"). The purpose of this tier is to mark trials which should be reviewed later, after either cleaning the audio or getting a second opinion about how to score them. After these ambiguous trials are resolved, it may be helpful to go back and change corresponding scores in this tier from 1 to 0.

Duration can also be scored separately from accuracy (for GO and STOP trials), using the praat_duration.praat script.

Compile and check manual scorings:

Copy the following Matlab script:

> Y:\DBS\derivatives\sub-DM1007\preproc\sub_DM1007_ses_intraop_task_SMSL_A18_compile_scorings_20210901.m

...into the current subject's preproc directory (after adjusting subject and dates):

> Y:\DBS\derivatives\sub-DM####\preproc

Open the script in Matlab and change the SUBJECT variable to match the current subject. Run this script. It will compile all of the manual scorings you performed (which were saved as .TextGrid files) into a single table variable in Matlab. If any inconsistencies or incomplete scorings are found (such as word_accuracy==1 while onset_accuracy==0, or word_accuracy==0 without any listed error_type), it will produce an error. Use the error message to re-score the problematic trial by calling the Praat script again and skipping to the trial in question with the field "Starting file index." Once all errors are corrected, the results will be saved as a .tsv file.

Appendix: creating the landmarks .tsv file

If A04 has not been run yet, you will need to create the landmarks file for associating a time within the audio file with the global time coordinates used by task data files. Create a .tsv file with the following columns and values (filling in the appropriate subject, session, run, and audiofile numbers/names):

task	run	filetype	name	ftc	dtc	landmark_descr
smsl	#	audio_wav	sub-DM####_ses-#SESSION#_task-smsl_run-##_recording-directionalmic_physio.wav			

(If using AEC audio or a different session, use that filename in the 'name' field instead.)

Fill in the 'ftc' and 'dtc' fields using the steps below.

Open the main audiofile for the session in Praat. For intraop, it will probably be:
Y:\DBS\sourcedata\sub-DM####\ses-intraop\task\sub-DM####\sub-DM####_ses-intraop_task-smsl_run-##_recording-directionalmic_physio.wav

For preop, it will probably be:
Y:\DBS\sourcedata\sub-DM####\ses-preop\task\sub-DM####\sub-DM####_ses-preop_recording-computermic_physio.wav

Select and use ctrl+N to zoom into the first set of pulses in the signal, which should look like this:

Zoom into the first detectable moment of the first pulse and place the cursor there:
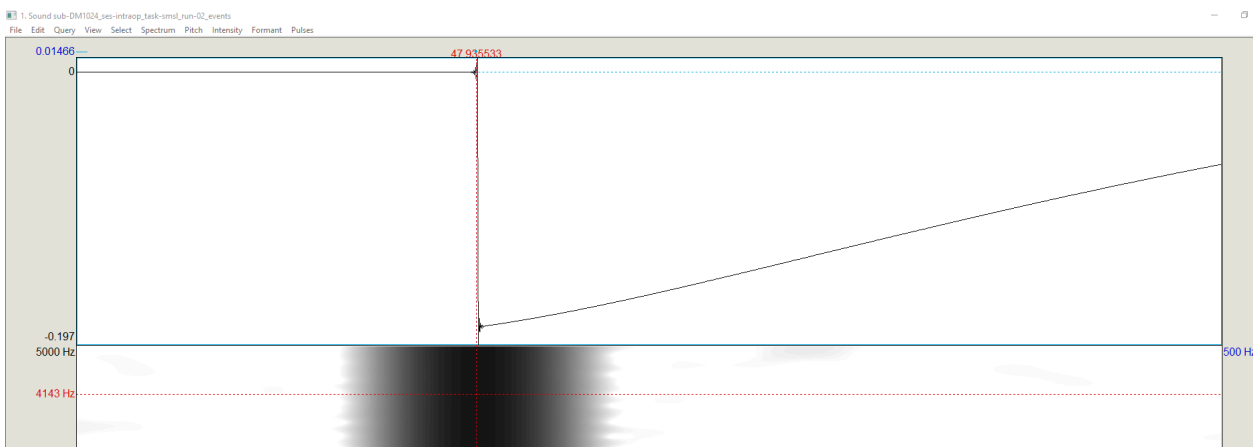
(You may want to compare to directional mic audio in order to confirm that these are the beeps which occurred just before the experimental trials began.) Enter the time listed in seconds in red at the top of the waveform window into the 'ftc' column of your .tsv table.

Open the following table:
Y:\DBS\sourcedata\sub-DM####\ses-#SESSION#\task\sub-DM####_ses-#SESSION#_task-SMSL_run-##_events.tsv

Find the first row where the 'event_code' column value is "Trigger test":

Copy the 'onset' value from this row into your table in the 'dtc' column.

Optionally, add a note in the 'landmark_descr' field about the event that is indicated by ftc and dtc, such as 'onset of first trigger beep' or 'onset of first audio stimulus.'

Save this landmarks table .tsv file as:
Y:\DBS\derivatives\sub-DM####\sub-DM####_ses-#SESSION#_annot-audio-landmarks.tsv

NB: in some recordings, the 'Trigger test' beeps were not played as audio. In this case, use the first 'Audio Stim Onset' event in the _events.tsv table and the corresponding audio trigger, which will be the onset of the cue stimulus (e.g. when you can detect the first sound of "GVUD" or whatever the stimulus for that trial was).