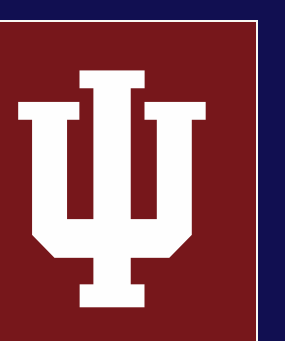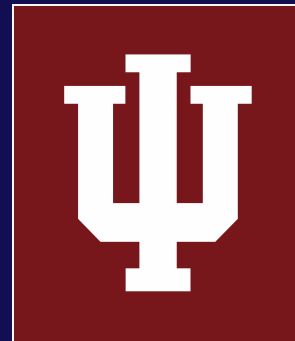# Laminal sounds in San Juan Quiahije Chatino: A phonetic and 3D ultrasound study

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21st Mid-Continental Phonetics & Phonology Conference, Michigan State University, East Lansing, 16-18 September 2016

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Background

Chatino is a group of under-documented, indigenous languages spoken in Oaxaca, Mexico[1]

- Appr. 17 varieties; part of the Otomanguean and Zapotecan language families. [1,2]
- The current focus: San Juan Quiahije (SJQ) Chatino[1,2]
- Chatino languages are generally described as contrasting two series of coronal consonants, oftened described as apicals and laminals.
- SJQ, in particular, is reported to contrast apico-dentals with lamino-alveolars.

We use 3-dimensional ultrasound imaging to better understand the articulations involved in these contrasts.

Methods

Palate Impressions
- Palate impressions were made using dental alginate & digitized with a NextEngine 3D laser scanner; data were saved in binary STL format.

Ultrasound Recordings
- Ultrasound images were recorded with a Philips EpiQ 7G system using an xMatrix x6-1 digital 3D transducer secured under the chin using an Articulate Instruments ultrasound stabilization headset.
- Recording rates varied between about 9 and 16 volumes per second.

Stimuli
- Stimuli included the apico-dental ([t, d, ts, dz, n, r, l]) and lamino-alveolar ([t̠, d̠, tʃ, ʃ, n̠, and l̠]) consonants of SJQ in word initial position before [i] and [a]. Items were either produced in a carrier sentence or repeated three times. In such cases, the middle repetition was analyzed.

Joint Palate-Ultrasound Analysis
- Fully uncompressed DICOM ultrasound files were transferred to a Windows 7 computer and exported to binary FLD file format using Philips QLab software.
- Ultrasound/palate files were analyzed w/ a custom MATLAB toolbox.
- Palates were manually rotated and translated to subjectively align with the tongue data.
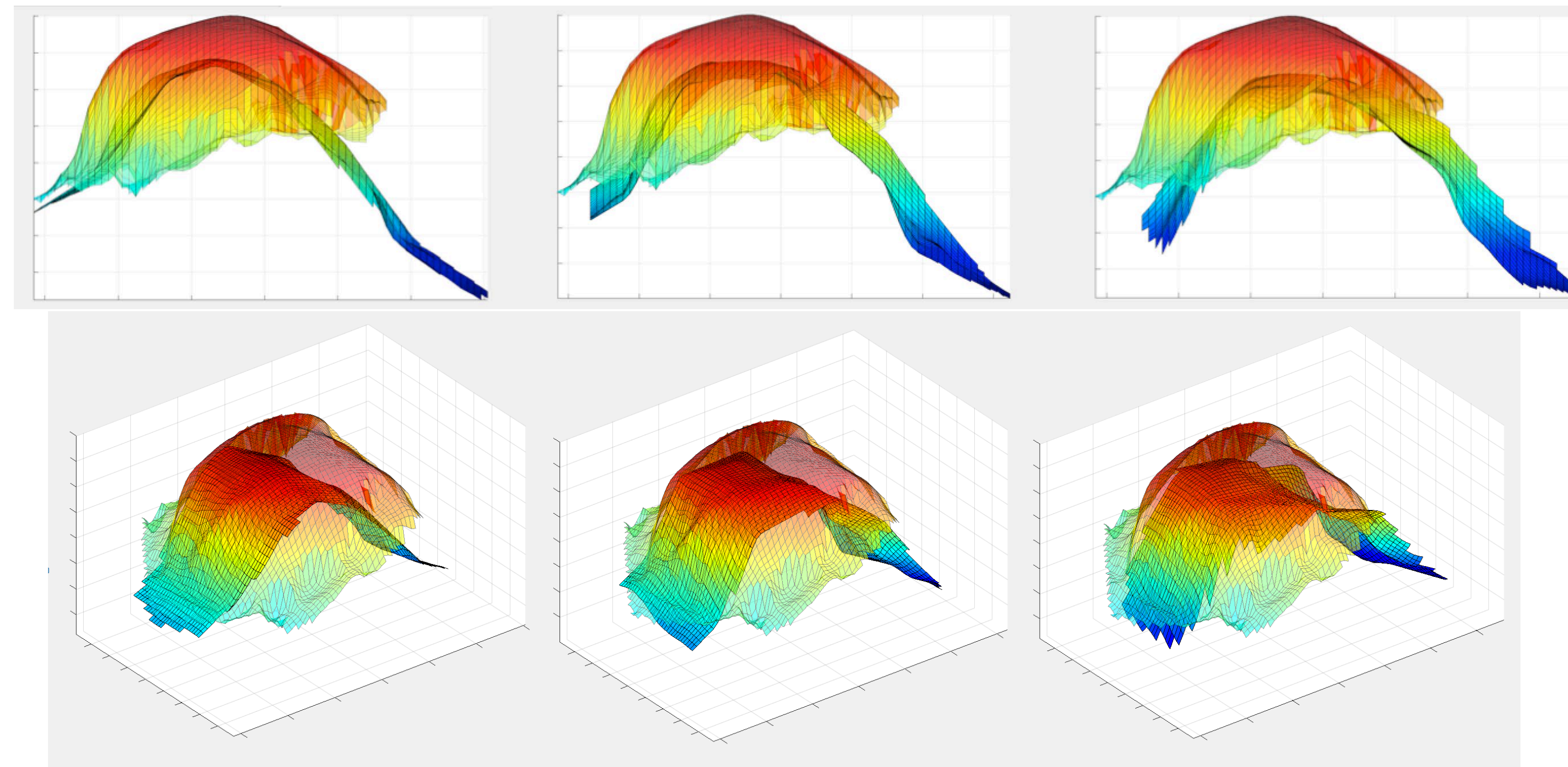
Audio Recordings
- Audio was recorded with a SHURE KSM microphone at 48kHz sampling rate.
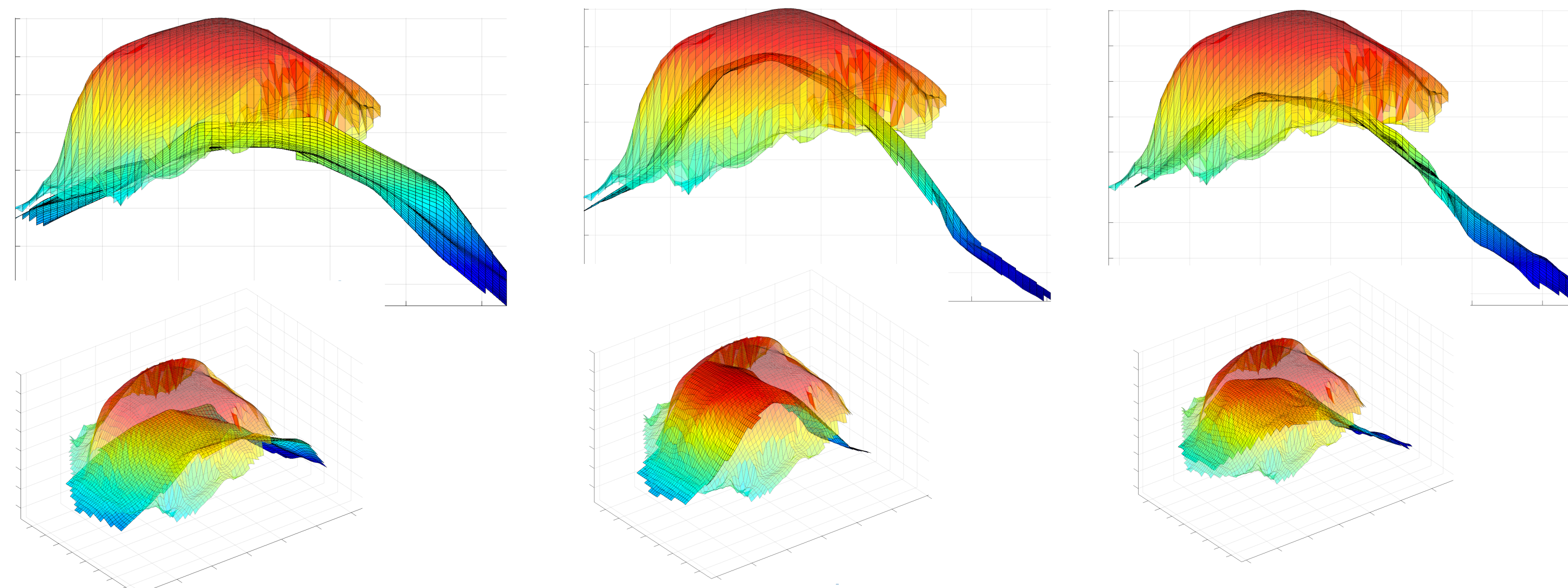
Audio-Ultrasound Synchronization
- Audio and ultrasound recordings were begun and ended by pressing a foot pedal connected to both the ultrasound system and the Windows computer.
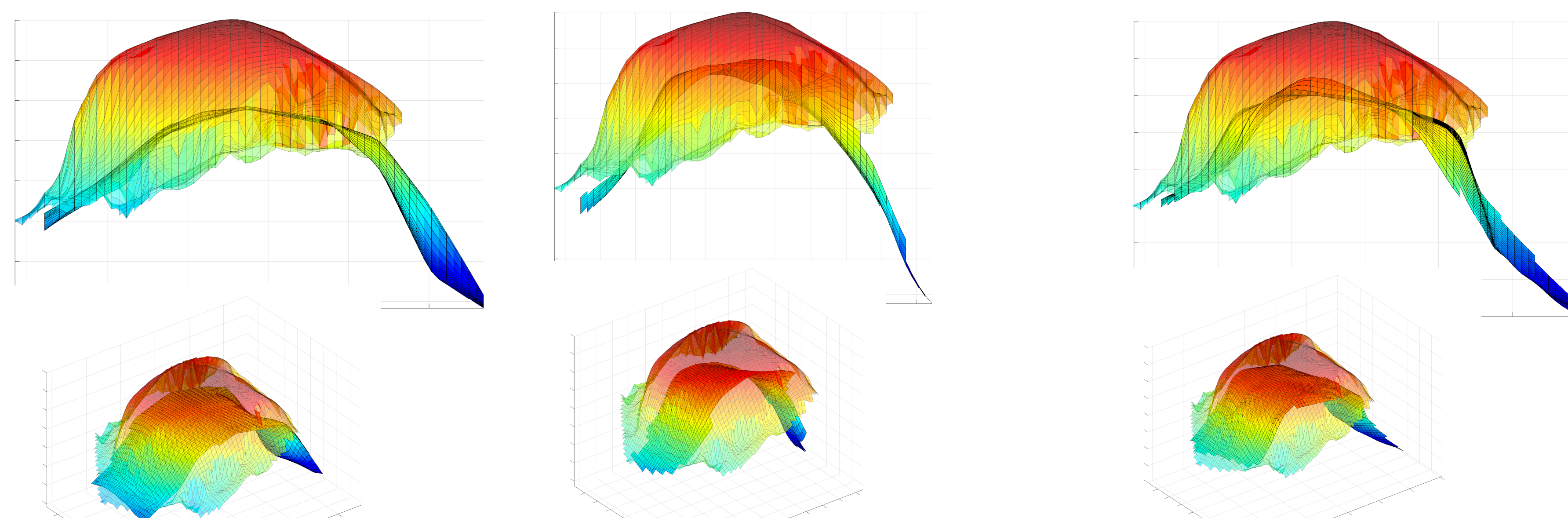
FINDINGS

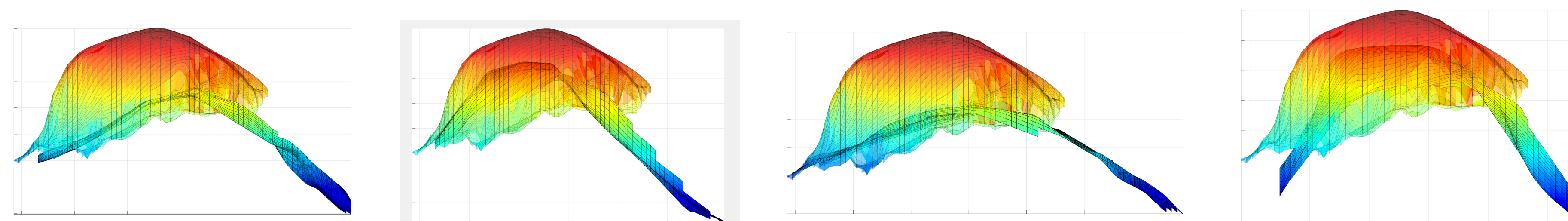**3- and 4D Imaging: laminal voiceless stop before /a/ -**
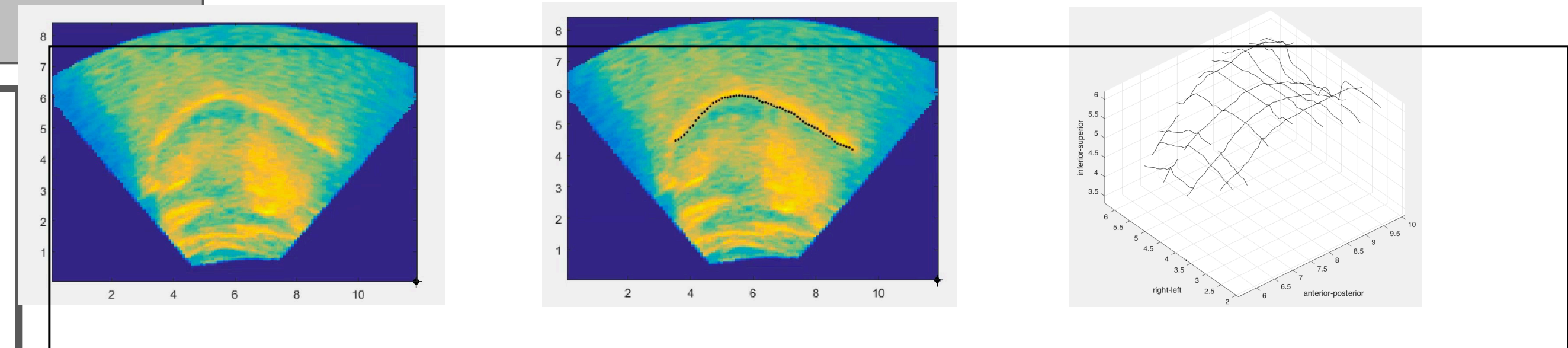

[ta]-[tya]-[cha]

[ti]-[tyi]-[chi]

[na-nya-la-lya]

Ultrasound Imaging

Discussion

- Many, if not all, Chatino languages seem to distinguish between two coronal places of articulation described in the literature as the contrast between apicals and laminals.
- E. Cruz (201X): SJQ Chatino apico-dental /t, d, ts, dz, s, n, r, l/ are produced by touching the tip of the tongue against the back of the teeth and the alveolar ridge. "The lamino-alveolars / t̠, d̠, tʃ, ʃ, n̠, and l̠ / are produced "by placing the blade of the tongue against the alveolar ridge." (E.Cruz, 2011X:66).
- The current study indicates that apicals are dental.
- Laminal t,d are secondarily palatalized alveolars and they systematically differ in the level of tongue raising from the laminal fricatives and affricates. Palatalization is concomittant with the dental articulation.
- The place of articulation of laminals is alveolar or post-alveolar.
- There is a systematic coarticulatory effect of of front vowels on both apicals and laminals.

Future Directions

- The laminal sounds in Chatino languages result from the old progressive palatalization process. Vowel syncope processes leading to the rise of mono-syllabic stems resulted also in the deletion of the surface trigger of palatalization and phonemization of the palatalization contrast.
- Future studies will show if the place distinction in the laminal series have phonological consequences.

References