Phonetic Realization of Vowel Length and Glottalization in Todos Santos Mam

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Language background

Mam is a Mamean-branch Mayan language of Western Guatemala (~600,000 speakers)

- high degree of inter-dialectal variation

Todos Santos Mam is an under-investigated dialect, that is highly divergent along phonetic, lexical, and syntactic dimensions (e.g. England 2017).
Background: vowel length

- Mam has a 5-vowel system (/a i e o u/)
- said to have a **length contrast**, which interacts with vowel quality (England 1983/2011)
- low functional load: few minimal pairs, not referenced in prescriptive grammars (Cristósomo et al. 2015)

<table>
<thead>
<tr>
<th>Examples of vowel length contrast (England 1983)</th>
</tr>
</thead>
<tbody>
<tr>
<td>/a/ vs. /aa/</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>/i/ vs. /ii/</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>/u/ vs. /uu/</td>
</tr>
<tr>
<td></td>
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</tbody>
</table>
Background: Mam /Vʔ/

- Mam also has /Vʔ/ sequences which supposedly interact with vowel length.
  - /Vʔ/ sequences are realized as **glottalized vowels**, with falling pitch, rather than as V-ʔ sequences.
  - Glottalized vowels are also lengthened relative to modal counterparts (England 1983/2011)
  - Vʔ sequences are also active in the phonology: they are heavier than other VC and attract stress
- No phonetic studies of either vowel length or glottalization in Mam.
Background: Mayan /Vʔ/ sequences

- Two views by Mayanists
  - View 1: /Vʔ/ is a ‘glottalized vowel’, where either the vowel is glottalized, or the /ʔ/ occurs in the middle of the vowel (e.g. Attinasi 1973:106, Coon 2004 on Chol; Lois and Vapnarsky 2003 on Yucatec Maya)
  - View 2: /Vʔ/ is a vowel followed by a glottal stop, not a glottalized vowel (Baird 2011).

- Acoustic analyses of glottal stops in Mayan languages are rare, with mixed results (Frazier 2009a, b; Baird 2011)
Goals of current study

**Aim:** to investigate the vowel length contrast and /Vʔ/ realization in Todos Santos Mam, using novel acoustic evidence

- **Vowel Length:** Is there a vowel length contrast supported by duration and/or vowel quality?
- **/Vʔ/:** What is the phonetic realization of /Vʔ/?
- Is there any interaction between vowel length and glottalization?
Method

- Recorded one male speaker of Todos Santos Mam reading a wordlist.
- Speaker was asked to read each word at least three times in isolation.
- Interview was conducted and recorded through Zoom.
  - Note: the use of a compressed file format may skew common vowel quality and phonation measures (Decker 2016; Pena et al. 2021).
- 128 items across the 5 vowel qualities (controlled for stress)

<table>
<thead>
<tr>
<th></th>
<th>short</th>
<th>long</th>
</tr>
</thead>
<tbody>
<tr>
<td>/al/</td>
<td>19</td>
<td>10</td>
</tr>
<tr>
<td>/el/</td>
<td>12</td>
<td>7</td>
</tr>
<tr>
<td>/i/</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>/o/</td>
<td>13</td>
<td>10</td>
</tr>
<tr>
<td>/u/</td>
<td>11</td>
<td>16</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>glottalized</th>
<th>modal</th>
</tr>
</thead>
<tbody>
<tr>
<td>/al/</td>
<td>9</td>
<td>20</td>
</tr>
<tr>
<td>/el/</td>
<td>7</td>
<td>12</td>
</tr>
<tr>
<td>/i/</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>/o/</td>
<td>5</td>
<td>18</td>
</tr>
<tr>
<td>/u/</td>
<td>15</td>
<td>12</td>
</tr>
</tbody>
</table>
Results: vowel length
Results: is vowel length phonemic?

- These results exclude /Vʔ/ tokens.
- linear mixed effects models in R using the lme4 package (Bates et al., 2015)
  - baseline model: duration ~ vowel + OnsetPlace + CodaPlace + (1| stimulus item)
  - Test for effect of length using likelihood ratio tests.
- There is a significant effect of vowel length (long vs. short) (p<2.2e-16)
Results: is vowel length phonemic?

- clear length contrast across all five vowels
- more pronounced in peripheral vowels (/a/, /i/, /u/), although no significant interaction of vowel quality and length was found.
Results: is vowel quality predictable from length?

- **Mixed effects models**
  - 2 models (for F1 and F2 respectively)
  - DV: F1 and F2 (Hz; standard measure of vowel quality)
  - main effects of:
    - **duration** (gradient)
    - **length** (categorical, long vs. short)
    - vowel quality (categorical, /a, i, e, o, u/)
    - (Onset place, coda place)
  - interaction of vowel quality with duration and length.

- **Results**
  - For both F1 and F2, duration and length are non-significant
  - interaction of **length and vowel quality** is strongly significant.
  - suggests that vowel quality is predictable from **length**, and seems to be phonologized.
Results: is vowel quality predictable from length?

- Uniform lowering/centralization across all vowels except /a/
- Note: /a/ not raising is unusual for a purely phonetic vowel reduction process.
Results: realization of /Vʔ/
Realization of /Vʔ/

- Post-vocalic /ʔ/ seems to be realized primarily as a pitch contrast
  - /Vʔ/ is falling, while /V/ is level/rising
  - /Vʔ/ also seems to be variably realized with creaky voice.
Realization of /Vʔ/

- **Measures of F0**
  - across 10 normalized time points
  - T1 & T10 were omitted from analysis to minimize coarticulation and pitch tracking errors.
  - all data points where f0>300 were automatically excluded

- **Voice quality**
  - H1-H2 and H1-A2, at midpoint of vowel
  - Measured in Praat
F0 of /V/ vs. /Vʔ/

Pitch tracks of /V/ vs. /Vʔ/, by vowel

- contrast in pitch contour across all five vowels
- This difference was also confirmed to be significant via SSANOVA.
Phonation measures /V/ vs. /Vʔ/

- Presence of post-vocalic /ʔ/ (/Vʔ/ vs /V/) was a significant predictor of both H1-H2 (p < 0.001) and H1-A2 (p < 2.23e-09)

tested using mixed effects models, with vowel, onset place, & coda place as baseline predictors, and stimulus as a random intercept
Results: do glottalized vowels lengthen?

- Recall: glottalized vowels are described as being lengthened.
- Seems to be true for short glottalized vowels.
  - Difficult to tell for long glottalized vowels because there are very few words with long glottalized vowels.
Conclusion & Discussion

● Mam has a phonemic vowel length contrast, reflected in both vowel duration and quality
● Phonetic realization of /Vʔ/ is consistent with England’s description:
  ○ lengthened
  ○ falling pitch, and glottalized
● Typologically unusual
  ○ /Vʔ/ sequences are commonly realized as short checked vowels, opposite of the lengthening effect found in Mam.
  ○ Checked /Vʔ/: Hupa (Gordon & Luna 2004), Min (Pan 2017), Ngalakgan (Baker 2008), Capanahua (Loos 1967)
  ○ Lengthened /Vʔ/: Cahuilla (Seiler 1965) and Huehuelta Tepehua (Kung 2007)
Acknowledgements

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References


Cristósomo, Mario Roberto Aguilón, Apolinario Miranda Mauricio & Ana Elizabeth López Ramírez (2015). *Nuk’b’il Yol Mam: Gramática Normativa del Idioma Maya Mam*. San Marcos, ALMG.


F1/F2 model results (LENGTH * vowel)
Results: is vowel quality predictable from length?

- vowel F1/F2 seems to be clustered by length category, and not just predictable by duration
Realization of /Vʔ/

- SSANOVA
- dotted lines show confidence interval
Phonation measures with vowel length included
/ʔ/ as glottalized vowel vs. full glottal stop

- /ʔ/ sequences are only realized with falling pitch if non-final.
  - e.g. /tsiʔɓ/ ‘writing’
- final /ʔ/ is realized as a modal vowel followed by a full glottal stop ([ʔ] is sometimes deleted in fast speech)
  - e.g. /siʔ/ ‘bug’
- suggests that glottalization is an allophonic realization of /ʔ/.