

Musicolinguistic documentation: Tone & tune in Tlahuapa Tù'un Sàví songs

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This study introduces a new methodology for integrating musical and linguistic data in language documentation, using ABC notation and open-source tools like ELAN and MuseScore. Designed for portability and exportability, and to facilitate both linguistic analysis and community-oriented material development, this methodology is used here to explore the link between linguistic tone and musical tune in Tlahuapa Tù'un Sàví, a Mixtec language of Guerrero, Mexico.

Through a multimodal analysis of three Tlahuapa Tù'un Sàví songs, this study illuminates several interactions between tone and tune, including a strong preference for melodic lines to move in parallel with the tone melody of the lyrics and associations between musical ornamentation and specific tonemes. The results of this study not only increase our understanding of the tonal system of Tlahuapa Tù'un Sàví and its interaction with musical style but also help illustrate the rich potential of musical data in linguistic research and documentation. More than simply language data with a melody, the combination of music and language in song offers a unique opportunity for analysis not otherwise possible, and the methodologies demonstrated here aim to make this combination as accessible as possible for researchers, archivists, and community members alike.

1. Introduction¹ Linguists have long turned to songs for linguistic data, from Sapir's (1910) recording of Paiute songs with Tony Tillohash to more recent work that focuses on the lyrical language of different speech communities (Hinton 1984; Hammond 2015). Similarly, ethnomusicologists have been interested in and attentive to the role of language in the musical cultures they study (Charron 1978; Slobin 1985; Fox 2004). One noteworthy trend – particularly in the last few decades – has been an increase in interdisciplinary scholarship which examines not only language, and not only music, but rather the integrated combination of both, through both linguistic and ethnomusicological lenses (Hughes 2000; Barwick 2006; Barwick et al. 2007;

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Marett & Barwick 2003; Tuttle 2012; Tuttle & Lundström 2015), as well as a growing recognition of the importance of music and other verbal arts in language documentation projects (Turpin & Henderson 2015; Fitzgerald 2017; McPherson 2019).

With these approaches in mind, this paper introduces a new methodology for integrating musical and linguistic data in language documentation, using ABC notation (Walshaw 2011) and free and open-source tools such as ELAN (Brugman & Russel 2004) and MuseScore (MuseScore Contributors 2020). Designed to be portable and exportable, and to facilitate both linguistic analysis and the creation of community-oriented materials, this methodology is used here to explore the relationship between linguistic tone and musical tune in Tlahuapa Tù'un Sàví, an indigenous Mixtecan language of Mexico. It begins by describing previous research on tone-tune correspondences and providing a brief sketch of relevant features of Tlahuapa Tù'un Sàví in section 2, before introducing the methodology and data used in sections 3 and 4. In section 5, we present the results of an analysis of the combined musicolinguistic data, and section 6 comprises a discussion of the significance of these results for Tlahuapa Tù'un Sàví and tone-tune typology, as well as applications for community language documentation projects.

2 Background

2.1 Tone-tune correspondences The relationship between tone and tune in song has been a fruitful area of study in many communities around the world. Most previous studies have been empirical investigations which look at both musical transitions (from sung pitch to sung pitch) and linguistic tone transitions (from tone target to tone target, syllable to syllable, or mora to mora) to determine where these two systems move in parallel. Corresponding transitions are then calculated as a percentage of the total number of transitions, to give a measure of tone-tune correspondence. These percentages can be based either on the stricter definition of 'parallel' transitions, where only tone-tune correspondences moving in the same direction are counted (i.e. an ascending musical melody on a LH tone melody), or the more lenient system of 'non-opposing' correspondence, where any transition in which musical melody and lexical tone are not moving in opposing directions is counted as a correspondence.

Previous research in this area has been especially concentrated on languages of Africa and Asia. Table 1 below (adapted from Schellenberg (2012) and McPherson & Ryan (2018)) shows selected results of published studies, including levels of tone-tune correspondence in terms of both parallel and non-opposing systems of analysis:

Table 1. Selected results of published tone-tune correspondence studies

Area	Language	Reference	Parallel	Non-opposing
Asia	Cantonese	Wong & Diehl (2002)	92%	98%
	Kalam Kohistani ²	Baart (2004)	48%	89%
	Thai	List (1961)	76%	(no data)
	Vietnamese	Kirby & Ladd (2016)	77%	99%
	Wu-Ming Tai	Mark & Li (1966)	63%	(no data)
Africa	Ewe	Jones (1959)	68%	95%
	Hausa	Richards (1972)	53%	96%
	Shona	Schellenberg (2009)	53%	67%
	Tommo So ³	McPherson & Ryan (2018)	46%	96%
	Xhosa	Starke (1930), as cited in Schellenberg (2012)	67%	95%
	Zulu	Rycroft (1959, 1979), as cited in Schellenberg (2012)	92%	97%
Papua New Guinea	Duna	Sollis (2010)	66%	92%

Although there is rich work on Asian and African languages, studies on languages and musics of the Americas are far fewer, even though many indigenous languages of North, Central, and South America are tonal. Of North American indigenous languages, the only studied language has been Navajo: Herzog (1934) finds a high degree of correspondence in Navajo gambling songs but a low degree in healing songs, while McAllester (1980: 2) notes that the linguistic tone on the sung lyrics of the ceremonial First Snake Song are “almost always different from their prosodic form”.

There have likewise been very few studies published on the tone-tune relationship in Mesoamerican languages. Pike (1939) presents a brief qualitative analysis

² Kalam Kohistani is an Indo-European (Dardic) language spoken in Upper Swat, Pakistan.

³ These abstracted results for Tommo So apply for fully-specified tonal transitions; the complete analysis in McPherson & Ryan (2018) also includes a nuanced treatment of phonologically-underspecified tones.

of a song called “The Flea” as sung and spoken in an unspecified Mixtec language, and concludes that the song’s melody is “inherent in itself, not caused by text tone interference” (130). More recently, Goldberg (2017) proposes a novel methodology for studying the relationship between tone and tune in Teotitlán del Valle Zapotec – a language in which the tonal system has not yet been fully described – and finds no major correlation between musical melody and linguistic tone. Elliott (2020) provides an in-depth quantitative analysis of tone-tune correspondences in Chichahuaxtla Triqui children’s songs, employing statistical analysis of measures like pitch range, average F_0 , and Hz differences across adjacent tones, and finds that song melody exhibits a greater impact on sung performance than linguistic tones overall.

Across language areas, the majority of tone-tune studies have focused on traditional musics, with a smaller number addressing commercial popular music in tonal languages. In one of these, Kirby & Ladd (2016) examine tone-tune correspondence in a corpus of 20 popular songs in Vietnamese. They find that there is a strong preference for parallel movement of musical melody and lexical tone (at around 77%), that oblique movements (where either music melody or lexical tone stays constant while the other shifts) are allowed in certain cases, and that opposing movement of tone and tune is dispreferred, and they conclude that avoidance of contrary movement between tone and tune is more important in Vietnamese pop music than parallel adherence. Wong & Diehl (2002) similarly examine four Cantonese pop songs popular in the 1990s, and find that the melodic movement generally parallels linguistic tone transitions, in an ordinal rather than ratio scale; i.e. directionality but not magnitude of lexical tone differences is mirrored in the musical melody.

Another subset of the literature examines the relationship between melody and linguistic tone in the formal composition process. Agawu (1984), for instance, presents an in-depth analysis of tone-tune correspondence over the career of Ghanaian composer Ephraim Amu. Amu’s Ewe and Twi compositions displayed progressively stronger correspondences between melody and linguistic tone as his career developed, with particular stylistic considerations allowing for increased parallelisms in his later pieces. Mugovhani (2007) examines the work of six choral composers working in the Bantu language Venda and concludes that linguistic tone melodies play little role in their musical compositions, attributing this to the more Western style of their choral pieces. Rycroft (1970) presents a unique self-analysis by a linguist-ethnomusicologist who was selected to compose the national anthem of Eswatini (formerly known as Swaziland), in which the author details his compositional process of setting the (already composed) Swazi text with careful parallel adherence to tonal patterns.

In broader compositional styles, Yung (1983) details how Cantonese opera singers alter pre-composed melodies as they perform to mirror tone melodies of the lyrics of each particular opera. Liu (1974) shows the importance of ‘even’ (the level tone) and ‘oblique’ (all other tones) tone groups to the traditional composition techniques of Beijing (Peking) Opera, though Stock (1999) analyzes recordings of actual Beijing Opera performances and finds that the expected relationship between musical melody and linguistic tone is often not maintained in practice. Similarly, in their multi-singer analysis of Tommo So women’s folk songs, McPherson & Ryan (2018)

show that the degree of tone-tune correspondence in performance can be sensitive to a number of grammatical and pragmatic factors. They find, for instance, that the strictness of tone-tune mapping varies based on domain (within vs. across word boundaries), position in the musical phrase, function of the tone involved (lexical vs. grammatical), and pre-composed vs. improvised lyrics.

Little work thus far has explored the cognitive side of the relationship between tone and tune, though Wong & Diehl (2002) include a perceptual experiment that shows Cantonese speakers use musical pitch differences to differentiate between ambiguous tone patterns in sung lyrics. As Schellenberg (2012) points out, the experiment relies on a carrier sentence that removes the word in question from the natural musicolinguistic context in which listeners may have other means to disambiguate tonally ambiguous words; but the fact that listeners can use musical information in the absence of linguistic information is still an important finding in the understanding of tone-tune processing.

Finally, while most tone-tune studies address correspondence on a note-to-note level, one recent study by Schellenberg & Gick (2020) investigates microtonal variation – small deviations in pitch that still lie within the range of the same musical note – in sung Cantonese and finds that in certain contexts, singers add rising microtonal contours of less than a semitone to sung notes to reflect rising contour tones in the lyrics.

The present study aims to add to several areas in the literature: it presents a quantitative tone-tune study of a Mixtec language, speaks to the potential of musicolinguistic analysis as part of a wider language documentation project, and considers the relationship between musical ornamentation and linguistic tone, in addition to that between musical melody and linguistic tone.

2.2 Tlahuapa Tù'un Sàví Tlahuapa Tù'un Sàví is a Mixtecan language spoken in the village of Tlahuapa (population: 1,292⁴), in the mountainous eastern region of Guerrero, Mexico. Tlahuapa is situated within the municipality of Alcozauca de Guerrero, close to the border with Oaxaca. Genealogically, Tlahuapa Tù'un Sàví is likely related to Alcozauca Mixtec (cf. Mendoza Ruiz 2016), a Mixtec language in the Mixtecan branch of the Amuzgo-Mixtecan group, which falls within the Eastern-Otomanguean branch of the Otomanguean family (Simons & Fennig 2018). There are no specific figures for speaker numbers of Tlahuapa Tù'un Sàví, but 2010 census data show 87% of Tlahuapan residents (1,126) over three years old speak an indigenous language (INEGI 2010).

Tlahuapa Tù'un Sàví is also spoken alongside other varieties of Mixtec (including San Martín Peras, San Sebastián del Monte, San Juan Mixtepec, and many more) – as well as Triqui, Zapotec, and other indigenous languages of Mexico – in the Oxnard region of Ventura County, California, with an estimated indigenous immigrant Oaxacan/Guerreran community of at least 20,000 (Kresge 2007). Though there is no previously published linguistic research specifically on Tlahuapa Tù'un Sàví, it is being documented (along with other Mixtec varieties spoken in California) as part

⁴ Population figures from INEGI (2010).

of an ongoing collaboration between the University of California, Santa Barbara linguistics department and the indigenous community in Oxnard. This collaboration includes the 2015–2016 and subsequent Field Methods classes (where the present study began), language material creation in partnership with the Mixteco/Indígena Community Organizing Project (MICOP), community-developed orthographies and literacy classes, and a multiyear National Science Foundation-funded project combining methods from linguistic documentation, sociocultural linguistics, and linguistic anthropology to help understand the complex linguistic situation in Oxnard (Campbell & Bucholtz 2017).

Relevant to the study of tone and tune correspondence, Tlahuapa Tù'un Sàví is a tonal language, in which pitch contrasts on morphemes are responsible for different lexical and grammatical realizations (Hyman 2006). Like Mixtec varieties spoken nearby in Alcozauca (Mendoza Ruiz 2016) and Xochapa (Stark et al. 2013), Tlahuapa Tù'un Sàví has four tone levels: low (L), low-mid (m), mid (M), and high (H). The low-mid tone is notably less frequent in Tlahuapa Tù'un Sàví than in closely-related Mixtec varieties (see e.g. Mendoza Ruiz 2016), however, and is most frequently found in inflected verbs (Campbell & Reyes Basurto in progress). In the practical orthography, low tone is indicated by a grave accent <à>, low-mid tone is indicated by a macron <ā>, mid tone is indicated by the lack of an accent <a>, and high tone by an acute accent <á>⁵. Tones can distinguish lexemes from one another, as in the following minimal pair which differs only in tone:

- | | | |
|-----|------|--------|
| (1) | ñu'ù | 'fire' |
| | ñu'ú | 'dirt' |

In addition to lexical differentiation, tones in Tlahuapa Tù'un Sàví also serve grammatical functions, such as marking aspect and mood on verbs. Tonal marking on the stem can differentiate between perfective aspect, imperfective aspect, and potential mood, for example, as in the following minimal triplet (Campbell & Reyes Basurto in progress):

- | | | |
|-----|------------------|------------------------|
| (2) | kàna-ñá | 'she left' (PFV) |
| | PFV.leave=3SG.F | |
| | kána-ñá | 'she leaves' (IPFV) |
| | IPFV.leave=3SG.F | |
| | kana-ñá | 'she will leave' (POT) |
| | POT.leave=3SG.F | |

⁵ In the future, the orthography may shift from accents to superscripted numerals in order to accommodate multiple contour tones that occur especially on inflected verbs, with tone levels marked from lowest to highest as <a¹>, <a²>, <a³>, and <a⁴>, respectively (Eric Campbell p.c. November 2020); however, at the time of this research the accents were still in use.

Prosodically, Tlahuapa Tù'un Sàví words are based around bimoraic couplets (cf. Pike 1948: 79), with most simple words consisting of two moras in either a monosyllabic or bisyllabic arrangement, though there are also a smaller number of trimoraic di- and trisyllabic words (Campbell & Reyes Basurto in progress). In bimoraic words, at least the following basic combinations of Tlahuapa Tù'un Sàví's four tone levels are attested in both monosyllabic and bisyllabic forms, in different distributions (Campbell & Reyes Basurto in progress):

Table 2. Selected attested tonal patterns in Tlahuapa Tù'un Sàví

Tone pattern	Syllable structure	
	Monosyllabic	Bisyllabic
HH	táá 'how'	lílú 'skunk'
HM	kuáan 'yellow'	xáku 'cry (IPFV)'
Hm	–	kuá'a 'like'
HL	xáà 'arrive (IPFV)'	lá'vā 'frog'
MH	iín 'skin'	nduchí 'beans'
MM	iin 'one'	lalu 'bellybutton'
ML	taàn 'tomorrow'	ità 'grass'
mH	ndāá 'where?'	–
mm	sāā 'bird'	–
LH	kóó NEG	tíkú 'louse'
LM	tàa 'man'	ità 'river'
Lm	–	xùxān 'copal'
LL	iìn 'nine'	nūnū 'foam'

There are also a number of bimoraic words with more than two tone targets, as in the following examples (Campbell & Reyes Basurto in progress):

(3) Monosyllabic:	kuĩ	(H.LH)	'green'
	nũu	(LH.M)	'night'
Bisyllabic:	kání	(H.LH)	'long(sg.)'
	kũtu	(LH.M)	'gum'

3. Method: Combining musical and linguistic data in language documentation

The methodology that will be introduced in this section for combining musical and linguistic data in language documentation relies on two main tools: the computer program ELAN (Brugman & Russel 2004) and the ABC system of musical notation (Walshaw 2011).

3.1 ELAN ELAN is a free, open-source software packaged designed for time-aligned transcription and annotation of audio and video data. Developed at the Max Planck Institute for Psycholinguistics, it is available for Mac OS X, Linux, and Windows operating systems. It is widely used in academic research and corpus building, and especially in language documentation (Brugman & Russel 2004), and is the primary tool used by the Field Methods classes and other participants in the collaborative documentation of Tlahuapa Tù'un Sàví to create an annotated, searchable corpus of texts in the language. It uses a multi-tier transcription system, which can be seen in the screenshot in Figure 1:

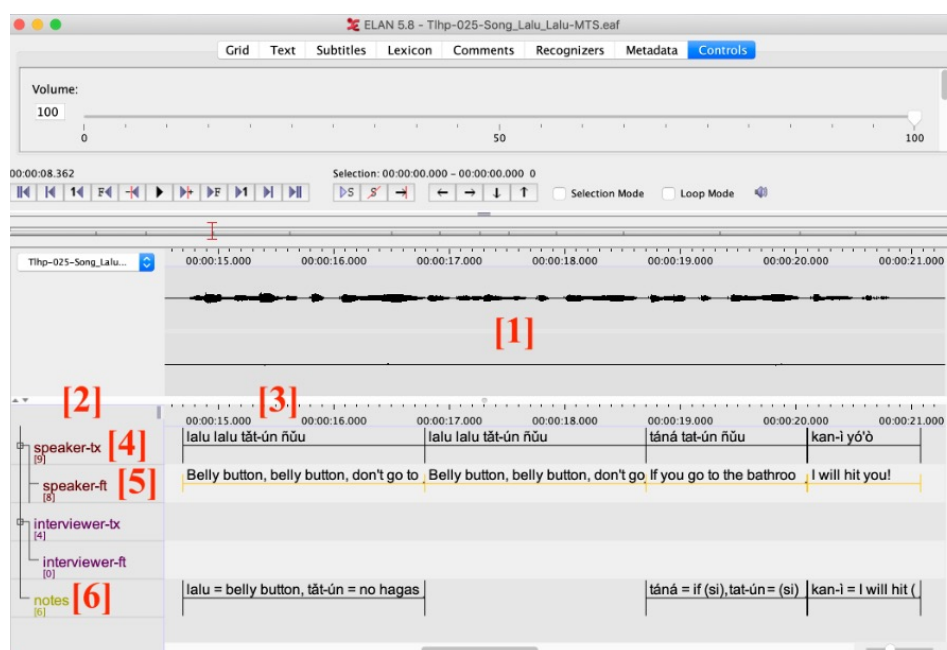


Figure 1. ELAN

Below the waveform of audio data ([1]), there are multiple tiers ([2]) which can each contain time-aligned annotations ([3]) of transcriptions relevant to the delineated section of audio. In this example, each annotation represents an Intonation Unit (IU), a prosodic unit associated with a coherent pitch contour (Chafe 1994).

Tiers can be linked to each other in hierarchical relationships, so that one tier can be the parent of another. In the example above, for instance, the parent tier marked by [4] (speaker-tx) represents transcriptions of the speaker in the practical orthography, while its daughter tier [5] (speaker-ft) is used for free translation (here, into English) of each linked IU in the parent tier. Along with transcription and translation, tiers can also be used to record additional linguistic information, such as individual lexical glosses or usage notes, as in [6].

One of the advantages of using ELAN for language documentation is that its files are designed to be easily exportable to other formats. ELAN files can be exported to work with other corpus management and language documentation software (including CLAN, CHAT, Toolbox/FLEX, and others), and also to video subtitles, transcripts, and various other presentational text formats. A single orthographic tier could be exported to present the text to a story for community use, for instance, or several tiers containing transcription, morpheme-by-morpheme glosses, and free translations could be exported simultaneously to create multilinear formats for use in academic work.

While the default functions of ELAN worked well for transcribing the texts and conversations in our Tlahuapa Tù'un Sàví corpus, once we started to add recorded songs to the database, we began looking for a way to incorporate the musical data into the ELAN files as well. Since annotations in ELAN can only consist of text-based information (rather than images), an alternative to graphical musical notation systems like Western staff notation was needed, and this is the role that ABC notation fills.

3.2 ABC notation A text-based system of musical transcription, ABC notation (Walshaw 2011) was selected as an ideal way to incorporate musical data into ELAN annotations. ABC is a system for notating music in plain text which uses only ASCII characters, and is thus well-suited for formats without graphical capabilities (including, notably, ELAN annotations). Unlike other text-based music notation systems such as MusicXML – a standard commonly used for encoding musical notation on the internet – ABC is designed to be readable by humans as well as computers; it was initially developed as a way for Western folk musicians to quickly and easily share and sight-read melodies.

To give an example of the system in use, the following is an ABC transcription of *Twinkle Twinkle, Little Star*:

```
(4) X: 1
    T: Twinkle, Twinkle, Little Star
    M: 4/4
    L: 1/4
    K: D
    | D D A A | B B A2 |
```

ABC notation begins with a header, which contains a number of informational fields about the notated song. The first field in the example above, 'X', gives the piece a unique numerical identifier. The second, 'T', is for the title. The 'M' field is used to denote the starting meter (here, 4/4 time), while the 'L' field specifies the default note unit length (here '1/4' for a quarter note). The 'K' field specifies the starting key, here D major.

After the header is the music itself, with measures denoted by pipe symbols ('|'). Notes are denoted by the alphabetic characters <A> through <G>, with capitalization and diacritics determining the specific pitches: uppercase <C> represents Middle C⁶, for instance, while lowercase <c> represents the note an octave above, and following commas (<C,>) or apostrophes (<c'>) raise or lower a given note an octave, respectively. The following chart illustrates selected correspondences of ABC pitches to Western staff notation:

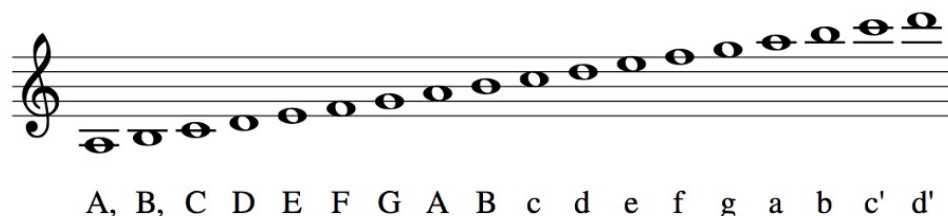


Figure 2. Selected pitches in Western staff notation and ABC

Note length in ABC is specified by numbers immediately following the pitch and is relative to the default value set out in the 'L' field of the header. The 'A2' in the *Twinkle, Twinkle, Little Star* example above, for instance, indicates an A above Middle C that is held for twice as long as the default quarter note – in other words, a half note. Note lengths shorter than the default are indicated by a fraction following the pitch; if the last note of *Twinkle, Twinkle, Little Star* were notated 'A/2', it would be an eighth note, held for half as long as the specified default.

ABC notation has several characteristics that make it well-suited for being integrated with linguistic data in ELAN. First and foremost, because it does not rely on any specific vertical formatting – it can be written in multiple lines, as in the *Twinkle, Twinkle, Little Star* example above, or read in a single line – ABC can be inputted directly into an ELAN annotation, as shown in the following screenshot:

⁶ Corresponding to C4 in scientific pitch notation, MIDI note 60, and a frequency of ~262Hz.

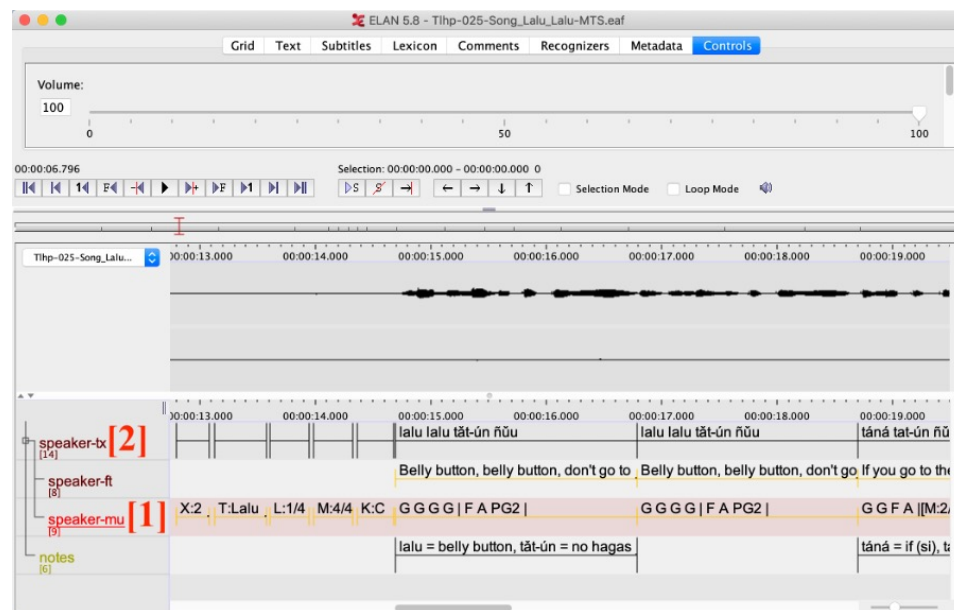


Figure 3. ABC annotation in ELAN

Here, the ABC notation is stored in a daughter tier [1] (speaker-mu) tied to the parent tier [2] of linguistic transcription (speaker-tx), with each annotation corresponding to a line of ABC notation. Adding ABC notation in an annotation tier in ELAN allows researchers access to both the musical and linguistic data in a single file, which can then easily be shared as a cohesive whole with collaborators, making the combined musicological data easily portable⁷.

In addition to portability, another advantage of using ABC for this purpose is that it is inherently exportable. For example, the ABC transcription can easily be exported from ELAN as a text file, using ELAN's "Traditional Transcript Text" export command (with all output options unchecked). From there, the resulting text file can be imported into the free, open-source graphical music editor MuseScore (MuseScore Contributors 2020) as Western staff notation, using the built-in "ABC Import" plugin, as shown below:

⁷ While this study focuses on using ABC to integrate musical data into ELAN, the same method could be applied to any multi-tiered linguistic transcription environment, such as text grids in Praat (Boersma & Weenink 2018) or the Data Format for Digital Linguistics (Hieber 2020).

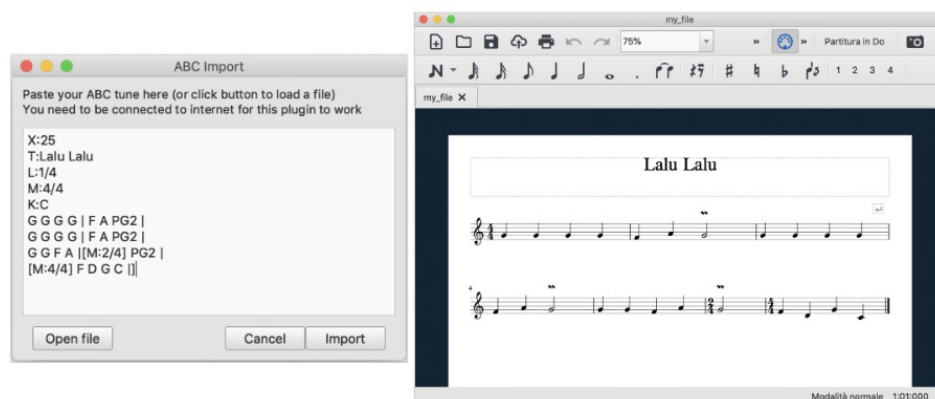


Figure 4. Importing ABC annotation into MuseScore as staff notation

Once in MuseScore, this musical data can then be easily converted into other types of musical notation that may be more useful for a given situation or community context, including solfège, shape notes, tablature, and 简谱 (*jiǎnpǔ*)⁸, with support for braille music notation forthcoming. This ease of conversion means that anyone with access to the ELAN file will have both the linguistic and musical data, with that musical data able to be rendered in whatever notation format is most useful for them.

Likewise, it is also possible to first transcribe music in a more familiar graphical notation system using MuseScore and then convert that transcription to ABC for inclusion in an ELAN file. This can be done by exporting a transcription from MuseScore into the intermediary MusicXML format, which can then be opened and converted to ABC in free, open-source conversion tools like EasyABC⁹ (Liberg 2012):

⁸ Through the plugin Jianpu Numbered Notation (Tachibana 2020).

⁹ EasyABC acts as a graphical frontend for the command line utilities *abc2xml* (Vree 2020a) and *xml2abc* (Vree 2020b), which can also be used on their own as Python scripts.

The screenshot shows the EasyABC 1.3.5 application window. The title bar reads 'EasyABC 1.3.5 - Senza titolo 1'. The interface includes a toolbar with play, stop, and other controls. On the left, a sidebar lists 'No. 1' and 'Titolo 1 Lalu Lalu'. The main area is divided into two sections: 'Spartito' (Musical Score) and 'Codice ABC' (ABC Code). The 'Spartito' section displays a musical score for 'Lalu Lalu' on four staves. The 'Codice ABC' section shows the following code:

```
X:1
T:Lalu Lalu
L:1/4
M:4/4
K:C
G G G G | F A PG2 |
G G G G | F A PG2 |
G G F A | [M:2/4] PG2 |
[M:4/4] F D G C |
```

Figure 5. Converting MusicXML to ABC in EasyABC

A further advantage of ABC notation in language documentation is that it is inherently extensible to be able to serve the needs of specific communities. The package *microABC* (Lacerda 2010), for instance, allows for the transcription of microtonal music¹⁰ through ABC, and even before this formalized package became available, community members developed conventions for notating non-even-tempered tones in ABC. In transcribing Middle Eastern music, for example, ‘^/’ and ‘_/’ have been used to denote half-sharp and half-flat accidentals, respectively, so that ‘_/C’ represents a note a quarter-tone below Middle C. Finally, since the beta release of ABC 2.2 (Walshaw 2015), it is possible to define specific pitch values for individual notes in Hz using the “instructions” header field (‘I’), allowing users to transcribe natively in any microtonal scale.

Transcribers can also make use of the optional “notes” header field (‘N’) to further specify how the ABC notation should be interpreted. Not only does this field

¹⁰ Music using notes that are not included in the Western 12-tone scale; many Middle Eastern and Asian musics (among others) make use of microtones.

allow for user-defined symbols (one could specify that a '@' after a note indicates ingressive airflow, or that a following '?' indicates creaky phonation, for instance), it also lets transcribers incorporate culturally relevant musical concepts; ABC transcriptions of Indian classical music, for instance, use the 'N' field to indicate which *tāla* (rhythmic mode) a piece should be played in.

4. Data Over the course of a 2015–2016 Field Methods class, in which the second author was the language consultant, we recorded three songs which serve as the data for this analysis: *Lalu Lahu* and *Konējò là kò'nchí*, both sung by the second author, and *Ñà lo'o kué'e*, sung by the second author's mother, Benita Basurto Olivera. *Lalu Lahu* and *Konējò là kò'nchí* were recorded digitally with a Shure SM10A head-worn cardioid, dynamic microphone, using a Tascam DR100-mkII digital recorder. *Ñà lo'o kué'e* was sung on a Skype call from Oaxaca, and the audio was recorded digitally via internally-routed audio from the computer making the call. We worked together to transcribe the text to each song in ELAN, with the second author providing translations into Spanish and English as we went. Texts were transcribed with reference to their spoken form; as we listened, the second author would write down what she (or her mother) had sung, speak it, and then we would transcribe the spoken tones from there. While this methodology is common in studies of tone-tune alignment, Konoshenko & Kuznetsova (2015) point out that it can be difficult for speakers to fully dissociate known musical melodies from words when speaking lyrics, and so to help ensure the accuracy of the tones of the spoken forms, transcriptions were cross-checked wherever possible with other independently-transcribed instances of the words in the larger corpus of Tlahuapa Tù'un Sàví texts created as part of the collaborative documentation project.

After the linguistic transcription was complete, the first author transcribed the sung melody for each song using ABC (or staff notation later converted to ABC, in the case of *Ñà lo'o kué'e*), checking with the second author by singing and playing back the transcribed melodies together. The ABC notation for each song was then added into the time-aligned ELAN file. Sheet music for each song was created by importing the ABC source into MuseScore, where the linguistic data (transcription and free translation into English and Spanish, exported from ELAN tiers) were added below the staves, as seen in Figures 6–8 below.

This section will introduce and provide a brief overview of each of the three recorded songs, as well as general observation on some of their musical features.

Lalu Lahu

This is a nursery rhyme-style song, sung to remind children not to wet the bed at night. It is sung addressing the belly button (*lalu*) because it is seen as the locus of conscious decision making.

La - lu la - lu tăt - ún ñũu
belly - button belly - button, don't go to - the bathroom at night
ombligo ombligo no - hagas del baño por la noche

3
la - lu la - lu tăt - ún ñũu
belly button belly button don't go to - the bathroom at night
ombligo ombligo no - hagas del baño por la noche

5
tá - ná tat - ún ñũu kan - ì yó - 'ò
if you go to - the bathroom at night I'll - hit you!
sì haces - del baño por la noche voy a - pegarte!

Figure 6. *Lalu Lalu*¹¹

Konējò là kò'nchí

This song is a musical component of a larger narrative, in which children are told by their parents to catch a rabbit. The rabbit, once caught, promises the children that if they let him out, he will dance for them and then return. The children let him out, and instead of dancing and returning to them, he runs away while singing this song.

Ko - né - jò là kò - 'n - chí aa ka - ndi - ta! Ko -
rabbit rabbit ragged now jump!
conejo pequeño ahora brinca!

4
né - jò là kò - 'n - chí aa ka - ndee!
rabbit rabbit ragged now get down!
conejo pequeño ahora agáchate!

6
Co - ne - jo? Co - ne - jo fi - no! Vá - mo - nos ching - au!
rabbit? rabbit dapper! let's go, damn it!
conejo fino! vámonos chingau!

Figure 7. *Konējò là kò'nchí*

¹¹ In these and all following musical examples, the English and Spanish are free translations rather than morpheme-by-morpheme glosses and do not necessarily follow the same morpheme order as the Tlahuapa Tù'un Sàví; full morpheme-by-morpheme glosses are provided in the Appendix.

Ñá lo'o kué'e

This is a stand-alone song which tells the story of a lost love. It is sung from the perspective of a man waiting for his lover, Lucila, who does not return.

Ndá'-vì kú - ì xá - ku-ì Táá tá - ká
 poor me I - cry how like
 pobre-de me estoy llorando como igual

6
 nùú xí - ka-urí ká - -ya Ndá'-vì kú - ì
 when you - were around everything continues poor me
 cuando estabas - tú todo - sigue pobre-de me

9
 Táá táá tá - ká - ví tù' - un ndì - kà - -ún xí' - in ká-ya
 how like the-words you said to - me continue
 como eran las - palabras dijiste a - mi sigue

12
 Yó' - ò ñá kué'e kòó ñú'un ini - -ún xà'-á-ya
 you ungrateful one don't remember inside about-this
 tú malagradecida no te acuerdas dentro de - esto

15
 ini - -rà vi - ti taàn - va kòó
 about - this man every - day don't
 de - este hombre todos los - días no

17
 nd - gá - ní - ni-ún kú-sú - chí in-ì xá - ku-ì xà'-ún
 remember sad I feel I - cry for-you
 te acuerdas triste mi siento estoy llorando por - ti

20 ñá lo'o kué'e Rrí rrí ká-chi yó'ò
ungrateful small one [sound of - leaving] said you
malagradecida [sonido de - irse] dijiste tú

24 nùú t - káá - -i xà'á tù - ndí - kǎ
where I hang at the base of the banana grove
donde estoy columpiándome al pie del platanar

26 sì - sì - kí Lu - cí - la Á kòó ndá - kú'ū ini - -ún xà' -
playing Lucila don't remember inside about-
jugando Lucila no te acuerdas dentro de -

30 -i t - káá - -i xà'á tù - ndí - kǎ sǐsǐ - kí
me hanging at the base of the banana grove playing
mi columpiándome al pie del platanar jugando

33 Lu - cí - la
Lucila
Lucila

35 Ñà - ká ndó' - -i xá - ku-i ñá lo'o kué'e
this - is what I - experience I - cry ungrateful small one
es - lo que me - pasa estoy - llorando malagradecida

Figure 8. *Ñá lo'o kué'e*

Musical features

Structurally, these three songs share a common theme and variation form, with each section building on the last and the end of the piece signaled by a new, unrelated theme. *Lalu Lalu* and *Konéjò là kò'nchí* both show an [A A_i B] form: they open with a theme (A), repeat that theme verbatim once, and follow up with a variation of the same before ending with a new section (B). In *Ñá lo'o kué'e* – the longest of the three songs – the melodic and rhythmic motifs of the opening A section are carried forward through a series of increasingly longer, denser variations that shift through several time signature changes, before ending with a key change and accompanying B theme: [A A_i A_{ii} A_{iii} A_{iv} A_v A_{vi} A_{vii} B].

Along with these broad structural similarities, these three Tlahuapa Tù'un Sàví songs show other shared musical elements. *Lalu Lalu* and *Konéjò là kò'nchí* both make use of spoken speech rhythms (similar to *recitativo*) to some extent in their finales, for instance. In fact, *Konéjò là kò'nchí*'s A₁ and B sections are performed entirely in this spoken style, indicated by percussive noteheads (signaling relative as opposed to absolute intervals) in the example below:

(5)



Co - ne - jo? rabbit? conejo? Co - ne - jo rabbit conejo fi - no! dapper! fino! Vá - mo - nos ching - au! let's go, damn it! vámonos chingau!

(*Konéjò là kò'nchí*: 6–8)¹²

This musical style seems to tie into the song's function; *Konéjò là kò'nchí* is part of a longer, spoken narrative where a rabbit tricks children into letting him out of his cage so that he can dance for them, and then runs away. The melodic opening to the song (measures 1–5) represents the rabbit mocking the children singing to him earlier, and the last three measures in this *recitativo* style represent the rabbit's (spoken) reply, transitioning both thematically and stylistically into the spoken closing and moral of the story.

Rhythmically, the songs diverge in that while *Lalu Lalu* and *Konéjò là kò'nchí* both map straightforwardly onto Western time signatures (*Lalu Lalu* in 4/4 and 2/4, and *Konéjò là kò'nchí* in 6/8), *Ñá lo'o kué'e* is much more complex, and, when transcribed in ABC and Western staff notation as it is here, reveals the limits of Eurocentric conceptualizations of meter to elegantly (or fully) characterize its rhythmic structure. In our transcription it is chiefly set in 6/8, with alternating excursions to 2/4, 5/8, and 7/8, as shown below:

(6)



Táá táá tá - ká - ví how like como eran tú - un ndi - kà - ún the-words you said las - palabras dijiste xí - in ká-ya to - me continue a - mi sigue

Yó' - ò ñá kué'e you ungrateful one kòó ñú'un don't remember ini - ún xà'-á-ya inside about-this

(*Ñá lo'o kué'e*: 9–14)

¹² Numbers following the song name indicate which measures each example represents.

Rather than necessarily implying that *Ná lo'o kue'e* is organized in any sort of 'mixed-meter' in the Western conception, however, we simply see this as evidence that it represents a less Western-influenced, and potentially older, form of Tlahuapa Tù'un Sàví song than either *Lalu Lalu* or *Konéjò là kò'nchí*.

With the music and linguistic data combined, we can now turn to examining the relationship between musical tune and lexical tone in these three Tlahuapa Tù'un Sàví songs.

5. Results

5.1 Melody Examining the relationship between musical tune and lexical tone reveals that in all three songs, there is a strong preference for the melody line to move in parallel with the lexical tone melody of the lyrics; i.e. for a two-word, four-syllable phrase with a lexical tone pattern of LH MM, the sung musical pitch will rise between the first and second syllables (L → H), fall between the second and third syllables (H → M), and stay the same between the third and fourth syllables (M → M).

This pattern can be seen in the combination of linguistic transcription and musical notation, and examples (7)–(9) show a simplified schematic for each song. The lexical tone is shown orthographically on the first line, while the arrows below indicate the relative change of musical (sung) pitch from the preceding segment. An upward arrow indicates a rise, a level arrow indicates no change, and a downward arrow indicates a fall. Bolded segments indicate where the pattern of parallel correspondence holds.

(7) *Lalu Lalu*

la-lu la-lu	tăt-ún	ñũu
→→→→	↘↗	↘↗↘
la-lu la-lu	tăt-ún	ñũu
→→→→	↘↗	↘↗↘
tá-ná tat-ún	ñũu	
→→ ↘↗	↘↗↘	
ka-nì yó'ò		
↘↘ ↗↘		

(8) *Konéjò là kò'nchí*¹³

ko-né-jò ↗↘	là →	kò-'n-chí ↘↗↗	aa ↘	ka-ndi-ta →→→
ko-né-jò →↗↘	là →	kò-'n-chí ↘↗↗	aa ↘	ka-ndee →→

(9) *Ñá lo'o kué'e*

ndá'-vì	kú-ì	xá-ku-ì	táá	tá-ká	nùú	xí-ka-ún	ká-ya
↘ ↗↘		↗↘↘ ↗		↗↗	↘	↗↘↗	→↘
ndá'-vì	kú-ì	táá	táá	tá-ká-ví	tù'-un	ndì-kà-ún	xí'-in ká-ya
↗↘ ↗↘		↗ ↘		↗↗→	↘→	→→↗	→↘ ↗↘
yó'-ò	ñá ¹⁴	kué'e	kòó	ñú'un	ini-ún	xà'-á-ya	
↗↘ ↘		↗ ↘		↗ ↘↗		↘↗↘	
ini-rà	vi-ti	taàn-va	kòó	ndgá-ní-ni		kú-sú-chí	in-ì
↗↗ →→		↘ ↗ ↘↗		→→↘↘		↗→↘	↘
xá-ku-ì		xà'-ún	ñá	lo'o	kué'e		
↗↘		→↗ ↘		→	↗↘		
rrú	rrú	ká-chi	yó'-ò	nùú		tká-á-ì	xà'-á
↗ →		→↘ ↗↘		→		↗↘↗	↘↗
tù-ndí-kă		sì-sì-kí		Lu-cí-la			
↘↗→		↘→↗		↘↗↘			
á	kòó	nda-kú'ũ		ini-ún		xà'-ì	tkáá-ì
↗ ↘		↗↘		↗↘↗		↘↗	↗↘ ↗↗
tù-ndí-kă		sìsì-kí		Lu-cí-la			
↘↗→		↘↗		↘↗↘			
ñà-ká	ndó'-ì	xá-ku-ì	ñá	lo'o	kué'e		
↗→ →↘		↗↘ →		↗	↗↘		

¹³ Only the first four measures of *Konéjò là kò'nchí* are included, as the last three measures are in Spanish (a non-tonal language).

¹⁴ In this schematic, the written feminine singular classifier *Ñá* is treated as a low tone, as it is sung as the masculine singular classifier *tà* on the recording.

Examining this correspondence in aggregate, the pattern of musical melody and lexical tone moving in parallel holds over 90% of *Lalu Lahu*, 90% of *Konéjò là kò'nchí*, and 83% of *Ñá lo'o kué'e*:

Table 3. Parallel tone-tune correspondences by song

	Segments with pattern	Total segments	% correspondence
<i>Lalu Lahu</i>	19	21	90%
<i>Konéjò là kò'nchí</i>	18	20	90%
<i>Ñá lo'o kué'e</i>	95	115	83%

Notably, these results are for the strictest criteria for tone-tune correspondence, where both musical tune and lexical tone move in parallel. As mentioned above, other tone-tune studies have also considered a less strict form of correspondence when musical melody and lexical tone simply do not move in opposite directions, called ‘non-opposing’ (cf. Schellenberg 2012) correspondence. In this system, a descending musical tune on a MM lexical tone melody would still count as a correspondence, while a descending musical tune on a MH tone melody would not; likewise, a HL lexical tone melody sung with a level musical tune would count as correspondence, while the same HL tone pattern sung with an ascending musical melody would not. If we consider these three Tlahuapa Tù'un Sàví songs within the more lenient framework of non-opposing correspondence, the results are even stronger:

Table 4. Non-opposing tone-tune correspondences by song

	Segments with pattern	Total segments	% correspondence
<i>Lalu Lahu</i>	21	21	100%
<i>Konéjò là kò'nchí</i>	20	20	100%
<i>Ñá lo'o kué'e</i>	112	115	97%

In addition, there is evidence that this pattern is based specifically on individual tone targets rather than syllables. One example is the musical and tonal melody on the word *ñũu* ‘night’ in *Lalu Lahu*. *Ñũu* is a monosyllabic, bimoraic word with three tone targets and a LHM melody, and its prall ornament (described in detail in section 5.2 below) means that its single syllable is realized with a three-note alternation from the primary note (L) to a note a half-step above (H) and back to the primary note (M):

(10)

tăt - ún nǎuu
don't go to - the bathroom at night
no - hagas del baño por la noche

(Lalu Lalu: 2)

Similarly, in *Ñá lo'o kué'e*, the monosyllabic negation marker *kòó* preserves its LH lexical tone melody by being sung across two notes: a rapid lower grace note (L) and the higher primary note (H):

(11)

ini - -rà vi - ti taàn - va kòó
about - this man every - day don't
de - este hombre todos los - días no


(Ñá lo'o kué'e: 15–16)

5.2 Ornamentation In addition to this correspondence between musical tune and lexical tone in the melodies of these three songs, there are also patterns linking various musical ornamentation types to specific lexical tones. Ornaments are musical flourishes or embellishments added to melody notes, and include techniques such as trills on a piano, hammer-ons and pull-offs on guitar strings, and *meend* glides in North Indian classical music.

In these Tlahuapa Tù'un Sàví songs, three notable types of ornamentation can be seen. The first of these is a prall, or upper mordent, which consists of a single alternation between a principal note, the note a half-step above, and the principal note again. It is represented by the (♯) symbol (or in ABC, a 'P' before the note being ornamented), and is used in the excerpt from *Lalu Lalu* below:


(12)

*(Lalu Lalu: 2)*

Another type of ornament used in the Tlahuapa Tù'un Sàví songs is the upper acciaccatura – a rapid move from the note a half-step above to the principal note. It is represented by a grace note with a strike through the stem () (or in ABC, '{/x}' before the principal note, where 'x' represents the pitch of the ornament note), and can be seen in the following example from *Ñá lo'o kué'e*:

(13)

*(Ñá lo'o kué'e: 20)*

Finally, the third ornamentation type used is a fall, a prolonged descent to a non-specified pitch target. It is represented by a fall line following the ornamented note () (or in ABC, by a user-defined ';' following the note), and is used throughout *Ñá lo'o kué'e*:

(14)

26

sì - sì - kí Lu - cí - la
 playing Lucila
 jugando Lucila

(Ñá lo'o kué'e: 26–27)

Using the combined musical and linguistic data, we can examine how these ornaments co-occur with various lexical tones by searching for their ABC symbols in the ELAN corpus. From this analysis, two interesting patterns emerge. First, both the prall and the upper acciaccatura – ornaments which involve an accent tone situated above the principal note – only occur on notes where the sung lyric has a high tone. Second, in 12 out of the 13 cases in which the fall ornament is used, it occurs either 1.) on a note with a lower lyrical tone than the preceding note (i.e. a low tone following a mid tone), as in both *kú-ì* 'me' and *xáku-ì* 'I cry' in (15):

(15)

Ndá'-vì kú - -ì xá - ku-ì
 poor me I - cry
 pobre-de me estoyllorando

(Ñá lo'o kué'e: 1–3)

Or 2.) on a note which itself encompasses a falling tone melody in a single syllable (i.e. a HM tone melody on a single note), as in (16), where the final *ká-ya* is pronounced [káa]:

(16)

9

Táá táá tá - ká - ví tù' - un ndì - kà - -ún xí' - in ká-ya [káa]
 how like the-words you said to - me continue
 como eran las - palabras dijiste a - mí sigue

(Ñá lo'o kué'e: 9–11)

The only use of the fall which does not fit into one of these categories is on a level tonal melody (*ini* ‘inside’, measure 15); in other words, the fall ornament never co-occurs with a rising tonal melody.

Taken together, the patterns of use of these ornamentation types show the two ornaments which utilize a pitch above the principal note (the prall and upper acciaccatura) to be linked to lexical high tones, and the fall to be linked to falling lexical tone melodies. As with musical melody, then, the use of these ornamentations in Tlahuapa Tù'un Sàví songs seems to be linked to lexical tone, with specific tones or tone melodies licensing the use of certain ornamentation types.

6. Discussion

Correspondence of tone and tune

Observing the relationship of tone and tune in these Tlahuapa Tù'un Sàví songs reveals a strong correlation between the two; lexical tone and musical melody move in parallel at rates of 83%–90%, depending on the song, for an average of 88%. If we take correspondence to mean non-opposing movement, those rates increase to 97%–100%, for an average of 99%. Situating these results within the previous literature on tone-tune relationships reveals that Tlahuapa Tù'un Sàví sits on the higher end of the typology of correspondences, as seen in Figure 9 and Table 5 below:

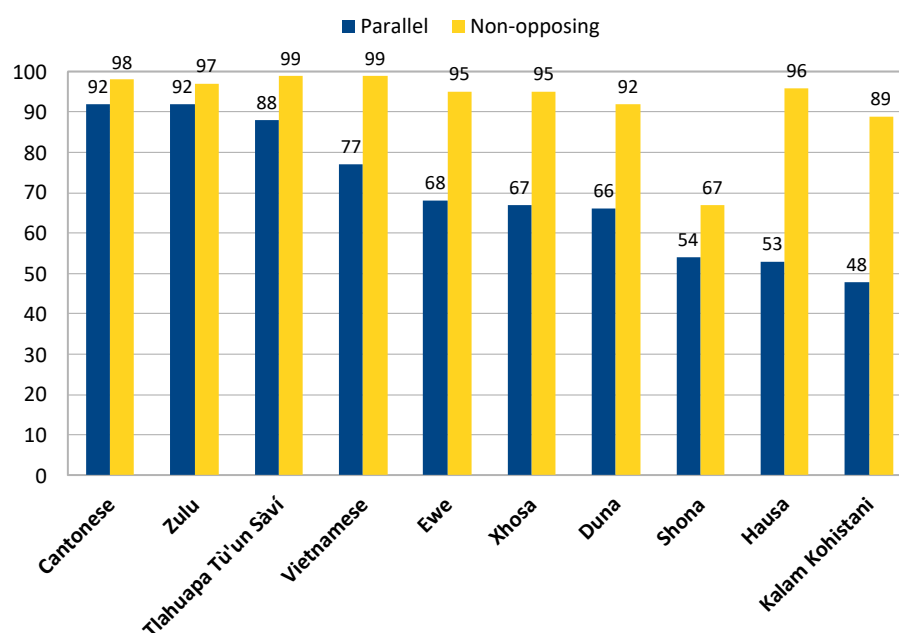


Figure 9. Comparative cross-linguistic results for tone-tune correspondence

Table 5. Comparative cross-linguistic results for tone-tune correspondence

Language	Reference	Parallel	Non-opposing
Cantonese	Wong & Diehl (2002)	92%	98%
Zulu	Rycroft (1959, 1979), cited in Schellenberg (2012)	92%	97%
Tlahuapa Tù'un Sàví	(present study)	88%	99%
Vietnamese	Kirby & Ladd (2016)	77%	99%
Ewe	Jones (1959)	68%	95%
Xhosa	Starke (1930), cited in Schellenberg (2012)	67%	95%
Duna	Sollis (2010)	66%	92%
Shona	Schellenberg (2009)	54%	67%
Hausa	Richards (1972)	53%	96%
Kalam Kohistani	Baart (2004)	48%	89%

These results help place Tlahuapa Tù'un Sàví in the typological picture for how musical melody and lexical tone interact in tonal languages around the world.

Of course, within these average percentage of 88% parallel and 99% non-opposing correspondences in Tlahuapa Tù'un Sàví, there are also individual differences among the three songs examined. While the range of difference (7% for parallel and 3% for non-opposing) is not as great as in many other tone-tune studies, the more fine-grained results for individual songs do reflect a specific trend seen in the tone-tune typology, where musical genres closer to speech on a speech-song continuum (e.g. List 1963) tend to show relatively higher degrees of correspondence, and genres closer to 'pure song' tend to show relatively lower correspondence (Schellenberg 2012). All three Tlahuapa Tù'un Sàví songs in this study are situated relatively further towards the 'song' end of the continuum, but there are still slight differences in their use that could order them along the speech-song cline. *Lalu Lalu* (which exhibits 90% parallel correspondence) is a children's nursery rhyme, for instance, and *Konéjò là kò'nchí* (also 90% parallel correspondence) is a sung interlude connected to a longer prosaic, non-musical story; these could both be thought of as further towards the "speech" side of the cline than *Ná lo'o kué'e*, a self-contained adult love song with the lowest percentage of correspondence. Situating these songs alongside other work on tone-tune relationships that examines genre in Table 6 (adapted from Schellenberg (2012)) shows that the relationship between genre (in terms of the speech-song continuum) and relative tone-tune correspondence in Tlahuapa Tù'un Sàví mirrors those seen in other languages:

Table 6. Language-specific continua of tone-tune correspondence (Schellenberg 2012)

Language	Higher correspondence			Lower correspondence	
Nguni (Rycroft 1979)	War cries; praise-poetry	Personal solo songs	Traditional dance-songs	Modern church, school, and popular music	
Chinese (Chao 1956)	Children's songs; street vendors' cries	Chanting: traditional (learned) reading style	Recitative in traditional Chinese drama	Traditional, "stereotyped" melodies	Modern songs
Thai (List 1961)	Mnemonic recitation (multiplication tables)	Traditional literary recitation	Classical songs	Popular songs	
Tlahuapa Tù'un Sàví (present study)	Children's nursery rhyme (<i>Lalu Lala</i>); song within a story (<i>Konéjò là kò'nchí</i>)			Traditional self-contained song (<i>Ñá lo'o kué'e</i>)	

This is not necessarily to imply that there is a consistent cross-linguistic relationship between specific genres and tone-tune correspondence (i.e. “nursery rhymes have higher levels of tone-tune correspondence”) – though with more data this may prove to be the case – but rather to support the idea that genre can play a role in within-language tone-tune correspondence. Diachronic change could also provide another explanation for the pattern observed in the Tlahuapa Tù'un Sàví songs; as evidenced by its non-Western rhythmic organization, *Ñá lo'o kué'e* is likely to be the oldest of the three songs in the data, and it could be that its relatively lower level of correspondence is a result of certain lexical tones shifting over time while the musical tune has remained the same.

Non-correspondence

Because the correspondence of musical tune and lexical tone is so high in Tlahuapa Tù'un Sàví, it is also worthwhile to examine those places where tune and tone do not correspond. Of course, not all instances of non-correspondence need be motivated, but there are two specific examples which warrant particular consideration from a functional perspective.

First is the last line of *Ñá lo'o kué'e*, reproduced with the previous measure for context below in both staff notation and the schematic for examining tone-tune correspondences:

(17)

33
Lu - cí - la
Lucila
Lucila

35
Ñà - ká ndó' - i xá - ku-i ñá lo'o kué'e
this - is what I-experience I - cry ungrateful small one
es - lo que me - pasa estoy - llorando malagradecida

Lu-cí-la

↘ ↗ ↘

ñà-ká ndó'-i xá-ku-i ñá lo'o kué'e
↗ → → ↘ ↗ ↘ → ↗ ↘

(Ñá lo'o kué'e: 33–36)

The opening segment of this last line – the inanimate classifier *ñà* in *ñà-ká* ‘this is’ – represents one of the relatively few instances of oppositional alignment between tone and tune in these songs: the musical melody ascends from the preceding pitch, while the lexical tone descends, from the previous M to an L. Crucially, however, this transition occurs at a significant musical juncture – not only is this a new musical phrase (which in itself may provide an opportunity for the relative relations for melody and lexical tones to ‘reset’), it is also the point where the song modulates from Ab-minor to A-major for the final phrase. This key change on a final phrase represents a departure from the previous musical melody, and thus a point at which the tone-tune relationship could plausibly be reset – on analogy with the ‘pitch reset’ of a new Intonation Unit in linguistic discourse (Du Bois et al. 1993) – and where we might expect non-correspondence with respect to the previous musical pitch and lexical tone.

The second instance in which tone-tune non-correspondence may be functionally motivated is in measure 5 of *Ñá lo'o kué'e*, the last measure of the first line shown here in staff notation and in schematic form:

(18)

Ndá'-vi	kú - -i	xá - ku-i	Táá	tá - ká
poor	me	I - cry	how	like
pobre-de	me	estoyllorando	como	igual

ndá'	-vi	kú-i	xá-ku-i	táá	tá-ká
	↘	↗↘	↗↘↘	↗	↗↗

(Ñá lo'o kué'e: 1-5)

While the tone-tune relationship on *táká* 'similar' represents a correspondence in the non-opposing system (the lexical tone stays the same, while the musical melody rises), it is not a parallel correspondence, and there is a particular process of tone sandhi in Tlahuapa Tù'un Sàví phonology which may help to explain why.

Tone sandhi refers to any process through which the linguistic tone for a given lexeme changes, often due to surrounding words or tonemes (Yip 2002). Preliminary investigation indicates that Tlahuapa Tù'un Sàví may have a tone sandhi process involving upstep – the phonetic raising of a phonological tone – which can occur when two H tones come into contact across word boundaries (Sims 2016). For example, in (19), when the H tone at the end of *komí* 'four' occurs directly before the H tone on the first syllable of *skóva* 'broom', the H tone in *skóva* is realized phonetically higher ([ǽ]) than the H tone before it:

(19)	komí		'four'
	skóva		'broom'
	komí skóva	[komí skǽva]	'four brooms'

This same process could account for the tone-tune relationship here; if upstep were applied in this situation, for instance, it would be realized with the following lexical tones, and a parallel tone-tune correspondence:

(20)	táá	tá-ká
	↗	↗↗

Upstep does not appear to be an obligatory process in Tlahuapa Tù'un Sàví – it does not occur every time two H tones meet across word boundaries, and the same speaker may produce the same H-#H sequences both with or without upstep – but it could potentially account for the realization of the particular tone-tune correspondence in this instance.

Other considerations

Examining music and language data together in these three songs also illuminates other features of the interaction between music and language in Tlahuapa Tù'un Sàví, including temporal correspondences and phonetic processes involved in their performance.

In terms of temporal correspondence, the data show a correlation between vowel length and note length in *Lalu Lalu* and *Konéjò là kò'nchí*. In both these songs, (C) VV sequences are categorically realized on longer notes than (C)V sequences. In *Lalu Lalu*, (C)V sequences are on quarter notes, and (C)VV sequences (*ñúu* 'night') are on half notes, which are twice as long. In *Konéjò là kò'nchí*, (C)V sequences are sung as eighth notes, while (C)VV sequences (*aa* 'now', *kandee* 'get down') take either quarter (twice as long) or dotted quarter (three times as long) notes. This correlation is especially interesting in light of differing analyses of vowel length in Mixtec languages more broadly as either phonemic, lexically specified, or otherwise predictable (e.g. Carroll 2015: 105; León Vázquez 2017: 49). These findings on their own do not necessarily lead to any definitive conclusions – they could point to phonemic length contrasts being preserved in musical text-setting, but they could equally be reflective of the same predictable processes involved in non-musical speech, especially since both *Lalu Lalu* and *Konéjò là kò'nchí* fall further towards the 'speech' side of the speech-song continuum than *Ñá lo'o kué'e*, which does not show this link between vowel length and note length. The correspondence seen here does, however, point towards the potential of further research specifically examining the treatment of vowel length in Mixtec songs to contribute to our understanding of its phonemic status.

While this temporal correspondence between vowel length and note length is limited to *Lalu Lalu* and *Konéjò là kò'nchí*, *Ñá lo'o kué'e* shows interesting phonetic processes in the interaction of music and language. One of these is the collapsing of (C)V?V sequences to (C)VV on phrase-final long notes. In example (21), for instance, *kué'e*¹⁵ 'ungrateful (one)' in measure 12 is realized as [kuée], and *ñú'un* 'memory' in measure 13 as [ñúun]:

(21)

Yó' - ò ñá kué'e [kuée] kòó ñú'un [ñúun]
 you ungrateful one don't remember
 tú malagradecida no te acuerdas

(*Ñá lo'o kué'e*: 12–13)

¹⁵ <'> is used in the orthography to represent the glottal stop.

Both of the (C)V?V to (C)V?V sequences above occur on relatively long notes (half notes here), and this is true of all four cases of this phenomenon. It also appears to be categorical in this song; all musical phrase-final (C)V?V sequences in *Ná lo'o kué'e* are realized as (C)V?V, and no non-final (C)V?V sequences are.

A similar process in *Ná lo'o kué'e* sees some CVCV sequences ending in the inanimate classifier =*ya* realized as C?V, with the clitic's initial consonant elided. In example (22), *xà'á-ya* 'about this' in measure 14 is pronounced [xà'áa]:

(22)

Yó' - ò ná kué'e kòó ñú'un ini - -ún xà'-á-ya [xà'áa]
 you ungrateful one don't remember inside about-this
 tú malagradecida no te acuerdas dentro de - esto

(*Ná lo'o kué'e*: 12–14)

And in example (23), *ká-ya* 'it continues' in measure 11 is pronounced [káa]:

(23)

Táá táá tá-ká - ví tò' - un ndi - kà - -ún xí' - in ká-ya [káa]
 how like the-words you said to - me continue
 como eran las - palabras dijiste a - mi sigue

(*Ná lo'o kué'e*: 9–11)

This is not always the case, however; in example (24), *ká-ya* 'it continues' in measure 7 realized as [káya], with the classifier's full form intact:

(24)

núú xí - ka-ún ká - -ya [káya]
 when you - were around everything continues
 cuando estabas - tú todo - sigue

(*Ná lo'o kué'e*: 6–7)

Though more data would be needed to draw substantive conclusions, it's possible that this difference could be related to rhythmic weight. In examples (22) and (23), where the clitic is reduced, the C \check{V} V sequences are on relatively longer notes (half or dotted half) following runs of relatively shorter notes (eighth notes or eighth note triplets). In example (24), however, where the clitic is not reduced, the C \check{V} CV sequence falls on shorter notes (eighth and quarter notes) than the preceding note (a dotted quarter). Given the other interactions between note length and position and vowel realization in Tlahuapa Tù'un Sàví songs, it could be that this distinction in rhythmic context affects the realization of these sequences as either C \check{V} CV or C \check{V} V.

Applications

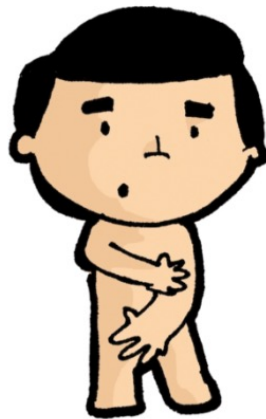
Finally, while the methodology used to combine musical and linguistic data here is useful for academic linguistic research, such as studying the relationship between tone and tune, it is also equally well-suited for the creation of community materials. In the case of these three Tlahuapa Tù'un Sàví songs, for instance, we were able to use the data already present in the ELAN corpus files to easily create a songbook for community use. This involved exporting the tier with ABC notation into a plain text file using ELAN's built-in "Traditional Transcript Text" export function, which could then be imported and converted into staff notation using the built-in "ABC Import" plugin in MuseScore. Once the music was imported into MuseScore, the Tlahuapa Tù'un Sàví transcription, English free translation, and Spanish free translation tiers were exported to text files from ELAN, and then the contents of each were copied and pasted into MuseScore as individual lyrics tiers. Finally, we included a short explanatory text about each song in Tlahuapa Tù'un Sàví, English, and Spanish – these were recorded and transcribed in the same ELAN files, and exported to plain text to be added to the score page in MuseScore. The result of this process can be seen in the example page for *Lalu Lalu* below:

Lalu Lalu

La - lu la - lu tăt - ún ñũu
belly - button belly - button, don't go to - the bathroom at night
ombligo ombligo no - hagas del baño por la noche

3 la - lu la - lu tăt - ún ñũu
belly button belly button don't go to - the bathroom at night
ombligo ombligo no - hagas del baño por la noche

5 tá - ná tat - ún ñũu kan - ì yó - 'ò
if you go to - the bathroom at night I'll - hit you!
si haces - del baño por la noche voy a - pegarte!



Ñà yaa yó'o xà'á-nà vâlí ku'àn-yà ná
chindeé ñà'á-yà-nà ná tàtakà-nà ñũu.

*This song is for the children, to help
them not go to the bathroom at night.*

*Esta canción es dedicada para los niños,
para que no hagan del baño por la noche.*

Figure 10. Lalu Lalu songbook page

Integrating musical and linguistic data, then, not only allows for the kinds of musicolinguistic analysis seen above, but also for the streamlined creation of community materials like this songbook – materials which ensure the data collected in documentation can be useful for the communities from which it emerges as well as for academic linguists.

7. Conclusion This study has presented a new methodology for integrating musical and linguistic data in language documentation, through the use of ELAN and ABC notation, and demonstrated the application of this method to the study of tone-tune

correspondence in Tlahuapa Tù'un Sàví. The results add to our understanding of the typology of tone-tune relationships by situating Tlahuapa Tù'un Sàví as a language with high correspondence between musical melody and lexical tone in both parallel and non-opposing systems, as well as by showing the importance of ornamentation in studies of tone-tune correspondence. Finally, this study has aimed to highlight the potential and value of integrating musical data into language documentation projects more broadly. Much more than simply language data with a melody, the combination of music and language in song represents a unique opportunity for both musicolinguistic analyses and community material development alike.

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Appendix¹⁶

Lalu Lalu

- (1) Lalu lalu tăť-ún ñũu
 Lalu lalu tăť=ún ñũu
 belly.button belly.button NEG.POT.go.to.the.bathroom=2s night
 ‘Belly button, belly button, don’t go to the bathroom at night’
 ‘Ombligo, ombligo, no hagas del baño por la noche’
- (2) Lalu lalu tăť-ún ñũu
 Lalu lalu tăť=ún ñũu
 belly.button belly.button NEG.POT.go.to.the.bathroom=2s night
 ‘Belly button, belly button, don’t go to the bathroom at night’
 ‘Ombligo, ombligo, no hagas del baño por la noche’
- (3) Táná tat-ún ñũu
 Táná tat=ún ñũu
 if POT.go.to.the.bathroom=2s night
 ‘If you go to the bathroom at night’
 ‘Si haces del baño por la noche’
- (4) kan-ì yó’ò!
 Kan=ì yó’ò!
 POT.hit=1s 2s
 ‘I will hit you’
 ‘Voy a pegarte’

Konéjò là kò'nchí

- (1) Konéjò là kò'nchí aa kandita
 Konéjò la kò'nchí¹⁷ aa kandita
 rabbit the ragged now POT.jump
 ‘Ragged rabbit, jump now’
 ‘Conejo pequeño, brinca ahora’
- (2) Konéjò là kò'nchí aa kandee
 Konéjò la kò'nchí aa kandee
 rabbit the ragged now POT.get.down
 ‘Ragged rabbit, get down now’
 ‘Conejo pequeño, agáchate ahora’

¹⁶ The first line of glossing is in the practical orthography, in which hyphens are used to separate person enclitics from the verb roots.

¹⁷ The word *kò'nchí* broadly carries the meaning of ‘small’, but with a pejorative connotation.


Ñá lo'o kué'e

- (1) Ndá'vì kú-ì xáku-ì
Ndá'vì kú=ì xáku=ì
poor COP=1s IPFV.cry=1s
'Poor me, crying'
'Pobre de me, que estoy llorando'
- (2) Táá táká nùú xíka-ún ká-ya
Táá tá=ká nùú xíka=ún ká=ya
how similar=DIST where IPFV.walk=2s remain=CLS.INAN
'Everything remains the same as when you were around'
'Todo sigue igual como cuando tú estabas'
- (3) Ndá'vì kú-ì
Ndá'vì kú=ì
poor COP=1s
'Poor me'
'Pobre de me'
- (4) Táá táá tákávì tù'un ndikà-ún xí'in ká-ya
Táá táá tá=ká=ví tù'un ndikà=ún xí'in ká=ya
how how similar=DIST=EMPH words PFV.say=2s with remain=CLS.INAN
'As the words you told me remain'
'Como eran las palabras que me dijiste sigue'
- (5) Yo'ò ñá kué'e kòó ñú'un ini-ún xà'á-ya
Yó'ò ñá kué'e kòó ñú'un ini=ún xà'á=ya
2s 3SF ungrateful NEG memory inside=2s about=CLS.INAN
'You, ungrateful one, who doesn't remember'
'Tú, malagradecida que no te acuerdas'
- (6) Ini-rà viti taàn-va kòó ndgánini-ún
ini=rà viti taàn=va kòó ndgánini=ún
inside-3SM today tomorrow=DM NEG IPFV.think=2s
'About this man, every day, you don't remember'
'De este hombre, todos los días, no te acuerdas'
- (7) kúsúchí in-ì xáku-ì xà'-ún ñá lo'o kué'e
kúsúchí in=ì xáku=ì xà'á=ún ñá lo'o kué'e
sadness inside=1s IPFV.cry=1s about=2s 3SF small ungrateful
'I feel sad and cry for you, ungrateful one'
'mi siento triste y lloro por ti, malagradecida'

- (8) Rrú rrú káchi yó'ò
 Rrú rrú káchi yó'ò
 sound.of.car.driving IPFV.say 2s
 'You went *rrú rrú*, and left'
 'Rrú rrú dijiste, y fuiste'
- (9) nùú tkáá-ì xà'á tùndíkă sîsîkî Lucíla
 nùú tkáá=ì xà'á tùndíkă sîsîkî Lucíla
 where IPFV.be.hanging=1s foot banana.tree.grove PFV.play Lucila
 'where I'm swinging at the base of the banana tree grove, Lucila'
 'donde estoy columpiándome al pie del platanar, Lucila'
- (10) Á kòó ndákú'ũ ini-ún xà'á-ì
 Á kòó ndákú'ũ ini=ún xà'á=ì
 DUB NEG IPFV.remember inside=2s about=1s
 'You don't remember me'
 'No te acuerdas de mi'
- (11) tkáá-ì xà'á tùndíkă sîsîkî Lucíla
 tkáá=ì xà'á tùndíkă sîsîkî Lucíla
 IPFV.be.hanging=1s foot banana.tree.grove PFV.play Lucila
 'swinging at the base of the banana tree grove, Lucila'
 'columpiándome al pie del platanar, Lucila'
- (12) Nàkà ndó'-ì xáku-ì ñá lo'o kué'e
 Nà-ká ndó'=ì xáku=ì ñá lo'o kuée
 CLS.INAN-DIST IPFV.experience=1s IPFV.cry=1s 3SF small ungrateful
 'This is what I'm going through, and why I cry for you, ungrateful one'
 'Es lo que me pasa, que estoy llorando por ti, malagradecida'

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