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A Phonetic Distance Approach to Intelligibility between Mam Regional Dialects

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A PHONETIC DISTANCE APPROACH TO INTELLIGIBILITY BETWEEN MAM REGIONAL DIALECTS

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ABSTRACT

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by Megan Simon

Mam, an indigenous Mayan language spoken primarily in Guatemala, has considerable internal diversity among its regional dialects. The purpose of this thesis is to estimate their varying degrees of intelligibility and to present groups of dialects whose speakers can be reasonably expected to understand one another. The analysis consists of two parts, the computation of a phonetic distance network and a series of sociocultural interviews. Phonetic distance was measured by Levenshtein distance between cognates in word lists and analyzed with a Neighbor-Net network. Interviews with Mam speakers focused on subjective judgments of intelligibility, contact, and social attitudes. Four main dialect groups were found: Western, Southern, Todos Santos, and Seleguá. Intelligibility is projected to be high within groups and reduced across groups. With the recent wave of immigration from Guatemala to the United States, many monolingual speakers of Mam are interacting with US court, school, and hospital systems by way of an interpreter, but interpreters and clients from different regions do not always understand one another well. Dialect groupings based on intelligibility can inform the interpreter matching process, especially in high-stakes and time-sensitive environments such as the court system.

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LIST OF ABBREVIATIONS

ATI – San Juan Atitán
CAB – Cabricán
CAJ – Cajolá
CHM – Santiago Chimaltenango
CHQ – Concepción Chiquirichapa
COM – Comitancillo
DOJ – US Department of Justice
GAS – San Gaspar Ixchil
IXT – San Ildefonso Ixtahuacán
LEP – Limited English Proficiency
MAR – San Martin Sacatepéquez
NEC – San Pedro Necta
OST – San Juan Ostuncalco
PTZ – San Rafael Pétzal
RTT – Recorded Text Testing
SBA – Santa Bárbara
SIG – San Miguel Sigüilá
SSE – San Sebastián H.
TAC – Tacaná
TAJ – Tajumulco
TEC – Tectitán
TSA – Todos Santos Cuchumatán

1. INTRODUCTION. In 2000, President Clinton signed Executive Order 13166, which requires all federal agencies and agencies receiving federal assistance to develop a plan for providing people with limited English proficiency (LEP) access to their services. All agencies involved in the immigration system, including the Department of Homeland Security and its sub-agencies, the Department of Justice (DOJ), and local law enforcement agencies and courts are bound by this executive order (Gentry 2015:6). A DOJ guidance document recommends that agencies investigate which languages are likely to be encountered in the region that they serve, using census, school system, local and state government, and community organization data to do so. For frequently encountered languages, an agency may need to hire bilingual staff or in-house interpreters. For rarer languages, an agency's plan may be as simple as identifying over-the-phone interpretation services that they are prepared to use (DOJ 2002:41461).

There are a number of challenges in implementing Executive Order 13166, in particular regarding fair access for speakers of indigenous languages and other small language communities. The most easily accessible census data on language use are aggregated into 42 language categories, under which all Central and South American indigenous languages are classified as 'other' (US Census Bureau 2018). Even the most detailed level of analysis, which includes 380 language varieties, does not distinguish between individual languages in the Mayan family (US Census Bureau 2015).

When data and scholarship are available, agencies can develop detailed language access plans that reflect the needs of diverse communities. For example, a 2010 information document prepared by the Administrative Office of the New Jersey Courts lays out guidelines and requirements for becoming an Arabic court interpreter, with an informed and nuanced understanding of the linguistic landscape in mind (Lee, Bergman, & Ismail 2010). It outlines the diglossic nature of Arabic, requiring that prospective

interpreters be fluent in both Modern Standard Arabic and a colloquial variety, and acknowledges that the linguistic differences between colloquial varieties are considerable and should not be assumed to be mutually intelligible. The guidelines include a table dividing Arabic varieties from 20 countries of origin into four dialect groupings, which are used to certify interpreters and match them with clients appropriately. They also include the following caveat:

> The New Jersey Judiciary has invested considerable effort since April 1995 to understand the special needs of Arabic speakers and the linguistic diversity of the Arabic-speaking world so it can develop appropriate approaches for providing equal access to its courts for Arabic speakers who have limited English proficiency. These efforts are based on the expert advice of scholarly linguists and practicing interpreters. The fact that Ethnologue, a preeminent authority on the world's languages, identifies some 40 major varieties of Arabic illustrates the nature of the problem. It is simply not possible to develop court interpreter certification exams in 40 varieties of Arabic or to attempt to match every person needing Arabic interpreting services with an Arabic interpreter from the exact same dialect group. (Lee, Bergman, & Ismail 2010:4)

These guidelines, co-authored by two court interpreters and an Arabic linguist, balance the challenges of adapting to linguistic diversity with the constraints of finding qualified people to provide services. However, the extent of linguistic scholarship available for forming such a recommendation is not widespread across languages; research on dialect clustering and mutual intelligibility is not currently available for many minority indigenous languages. Such an analysis could inform individual language access plans for agencies, in particular those related to the immigration and court systems, and help them fulfill their legal responsibility to ensure 'meaningful access by LEP persons to critical services' without imposing 'undue burdens' (DOJ 2002:41459).

This investigation focuses on the Mayan language Mam. There is a growing population of Mam speakers in the United States, in particular in Alameda County, California, as many people are fleeing violence, poverty, and discrimination in Guatemala. Exact numbers are not available, but *The Mercury News* and *Los Angeles*

Times both report a quickly growing community, where Mam can now be heard regularly in markets, churches, and schools (Carcamo 2016, Sanchez 2018). This rapid growth is reflected in data from the DOJ; in 2013, Mam was not included in the list of the top 25 languages for immigration court cases, but by 2015, it was ranked ninth (US DOJ Executive Office for Immigration Review 2017).

Awareness of Mam and other indigenous languages of Latin America in the US judicial system is limited but growing. According to *The Mercury News*, just a few years ago Alameda County court interpreter Naomi Adelson had to educate county staff on the need for Mam interpreters—not Spanish interpreters—for Mam speakers, dispelling the persistent myth that Mam was a local variant of Spanish instead of a completely unrelated language. Now that there is a stronger presence of Mam speakers in the community and a larger pool of interpreters who work with the courts, she does not need to have that conversation anymore (Sanchez 2018). However, awareness that the language exists is still only a first step. The linguistic scholarship on Mam suggests that speakers from different regions may have difficulty understanding one another, and that perhaps a Mam interpreter who is from a different region than the client would not have the language skills to be qualified to interpret for him or her.

Nora England, in the introduction to her grammar on Mam, notes that despite being spoken in a relatively small geographic region, there is 'considerable variation within ... dialects. Intelligibility between the principal dialect divisions is reduced, although possible with practice' (1983:6). In a later work, she describes Mam as 'the Mayan language with the greatest degree of internal diversity' (2017:500). She attributes this diversity to two main factors, the Mam people's long history in the region, and isolation between towns. The Mam people may have resided in the area since as early as 500 CE, and many of the current towns have existed since before the colonial area.

Geographically, the mountainous terrain makes travel from town to town difficult, and intermarriage between towns is rare (1983:9-10). Over the long history with little contact between towns, the local varieties of Mam had considerable opportunity to grow apart.

Mam has not undergone a standardization process, wherein one variety is socially elevated and promoted across regions. Standardization and a strong written tradition have historically been linked (see Romaine 2000:90), and despite a recent push for bilingual education, literacy in Mam is the exception rather than the norm. Bilingual education is available only (if at all) for the first four years of primary school, after which the instruction is carried out exclusively in Spanish (Patrinos & Velez 2009:594). Native language literacy rates among the Mam community are estimated to be below five percent (Simons & Fennig 2018). Thus, unless speakers have the opportunity to travel throughout the region, their exposure to other varieties of Mam is likely to be limited.

It was only in the span of a few years, when immigration from Guatemala increased dramatically, that understanding the linguistic landscape of Mam and other Mayan languages became relevant to agencies in the US. Traditional linguistic surveys of intelligibility are time- and resource- intensive and may not be able to respond to the urgency of the situation, as people are arriving at immigration hearings and asylum interviews every day.

The primary goal of this investigation is to determine relative degrees of intelligibility between various regional dialects of Mam, and to create groups of regional varieties whose speakers can reasonably be expected to understand each other. The potential application of supporting the work of Mam interpreters shapes the methodological choices throughout. Previously collected word lists and survey results

are reanalyzed using a more recently developed computational method: phonetic distance. This is less time- and resource-intensive than comprehension test-based approaches to intelligibility studies and has been found to have a moderately strong correlation with the results of such tests. Phonetic distance may give a less direct estimation of intelligibility than test-based approaches, but can also be implemented relatively quickly, allowing for more timely recommendations to interpretation services and courts who are encountering indigenous languages for the first time. To contextualize the findings, sociocultural interviews are conducted with Mam speakers, many of whom confront dialectal differences in their professional capacities as teachers and interpreters. An interview with an immigration officer in the United States is also included, to provide a perspective from the immigration system.

The results of the phonetic distance analysis cluster in four main groups; intelligibility is projected to be high between the members of each group but reduced across groups. Municipalities in the Quetzaltenango department, as well as three municipalities in the San Marcos department, together form the Southern group. The Western group includes the Tacaná and Tectitán varieties. The Seleguá group contains municipalities around the Seleguá Valley in Huehuetenango. Finally, Todos Santos, which is just over a ridge from municipalities in the northern group, has its own branch. Opinion surveys and interviews show a large degree of interaction between municipalities within the Seleguá group and the Southern group, and less interaction with speakers of other varieties. Additionally, interviews suggest that a small amount of exposure to another variety has a large effect on a speaker's ability to understand it. This leads to asymmetries in interpretation settings, as the interpreter often has more exposure to other varieties and therefore can understand the client better than the reverse. Recommendations include attempting to match clients with interpreters from

the same dialect group and providing training for interpreters to reproduce the speech patterns of clients from various regions.

The rest of the thesis is organized as follows. Section 2 contains an overview of the relevant previous research in intelligibility studies and phonetic distance algorithms. Section 3 briefly describes the typological profile of Mam and reviews previous investigations of dialect groups. Section 4 details the implementation of the phonetic distance algorithm and clustering analysis using a Neighbor-Net program. The resulting network is compared and contextualized with the results of previously published opinion surveys. In Section 5, sociocultural interviews with Mam speakers, as well as an immigration officer in the United States, are presented. Findings and potential applications are discussed in Section 6.

2. INTELLIGIBILITY STUDIES. This section contains a review of the methods used in intelligibility studies, including comprehension tests, opinion surveys, lexical similarity measures, and phonetic distance. Section 2.1 introduces the factors, both social and structural, that affect intelligibility, and Section 2.2 continues with a discussion of how the term 'dialect' is used in this context. Test- and survey-based methods for measuring intelligibility between regional dialects are discussed in Section 2.3. Section 2.4 traces the development of using the Levenshtein distance algorithm to quantify the distance between language varieties, and its usefulness in predicting both diachronic relationships and synchronic intelligibility. Finally, Section 2.5 discusses the use of a network diagram to represent distances visually.

2.1. FACTORS AFFECTING INTELLIGIBILITY. Intelligibility, or the degree to which speakers of one language variety can comprehend speakers of another, is a notoriously difficult concept to measure and quantify. It is influenced by differences in the structure of the language varieties themselves, such as the phonology, lexicon, and syntax, as

well as the degree of exposure and social attitudes between speakers of different varieties. Intelligibility is not symmetric. Structurally, one variety may be able to use cognates to understand a word in another variety, but the reverse need not be true. For example, Swedish has the words *förvånade* and *förbluffade* to express 'surprised'. Danish has a cognate with the latter example: *forbløffede*. If a Danish speaker uses *forbløffede*, a Swedish speaker would be able to use their cognate to understand the meaning, but a Danish speaker hearing the Swedish word *förvånade* has no helpful cognates and therefore is unlikely to understand it (Gooskens 2006:109). The level of exposure that speakers of one variety have to another is also often asymmetric. To continue with the example of the Scandinavian countries, Danes and Norwegians visit Sweden with more frequency than Swedes visit Denmark and Norway, and over four times as many Danes and Norwegians listen to Swedish radio than Swedes listen to Norwegian or Danish radio (Romaine 2000:13). Sweden is the largest and wealthiest country of the three, and the other countries make more accommodations to understand Swedish than Swedes do to understand speakers from other countries (Gooskens 2006:109).

Degree of exposure to a regional variety has been shown experimentally to have an effect on speech processing. In a study on French regional accents, Floccia et al. find a significant increase in reaction time for a word identification task when a participant is presented with a sentence spoken in an unfamiliar regional accent, as opposed to his or her home accent or an otherwise familiar one (2006:1280). Sumner and Samuel (2009) find that a participant's exposure to an r-dropping New York City dialect, independent of the participant's own production patterns, has an effect on a lexical priming task. Both studies conclude that a lack of familiarity with a variety leads to a higher speech processing cost.

Social hierarchies also affect intelligibility. As summarized by Simons: 'If the social situation is favorable, contact and learning will lead to a boost in intelligibility. If the social situation is not favorable, it will tend to limit intelligibility' (1979:62). In particular, a listener's attitude is biased by factors such as race, ethnicity, and social status (Rickford & King 2016:976). For example, Rubin found that American undergraduates rated a four minute audio sample as harder to comprehend when paired with video of an Asian speaker than when paired with video of a Caucasian speaker (1992:518). This effect has been studied in regard to the justice system previously. Matsuda (1991) discusses the accent discrimination case *Fragante v. City and County of Honolulu*, in which Filipino-American Manuel Fragante sued the city for employment discrimination after the DMV denied him a clerk job because his accent was difficult to understand. A linguist testified at the trial:

> There is a history, in Hawaii and elsewhere, of prejudice against this accent … that will cause some listeners to 'turn off' and not comprehend it. The degree of phonological—or sound-deviation in Fragante's speech was not, however, so far afield from other accents of English-speakers in Hawaii that he would not be understood. (1991:1337)

The testimony and the fact that Fragante lost his case on several appeals demonstrate how social prejudice can supersede structural distance between varieties.

2.2. DEFINITIONS OF DIALECT. Linguists conducting fieldwork have attempted to construct objective tests to measure intelligibility between varieties in order to classify languages and dialects. When varieties are not mutually intelligible, they are classified as separate languages; closer subgroupings are classified as dialects (Simons 1979:5). In practice, popular definitions of language and dialect have as much to do with political boundaries as they do linguistic similarity. Swedish, Danish, and Norwegian are considered separate languages rather than related dialects in large part because of their separate national identities. Many non-mutually intelligible varieties in China are often

considered the same language because of their shared writing system (Romaine 2000:13). As described by Romaine, 'Any variety is part of a continuum in social and geographical space and time. The discontinuities that do occur, however, often reflect geographical and social boundaries and weaknesses in communication networks' (2000:2). In Simons' investigation of mutual intelligibility measures on language varieties in the Solomon Islands, he defines dialect as a 'group of similar idiolects' and states that although social dialects do of course exist, he is focusing on regional or community dialects: 'the local community actually serves as the minimal unit in defining the dialects considered in this thesis. That is, dialect refers to the variety of speech common to a local community or a more inclusive grouping of communities' (1979:3). I adopt his definitions here, as they match the scope of my investigation well.

2.3. TEST AND SURVEY-BASED APPROACHES TO MEASURING INTELLIGIBILITY. A systematic method for measuring mutual intelligibility of regional dialects was first laid out by Voegelin and Harris in 1951. In this method, a speaker from Community A records a text, the linguist breaks it into small segments, and another speaker from the same community does an 'interpreter translation' of each segment into a common or trade language. The recording is then played for speakers in Community B, who also provide translations of the individual segments. The linguist then compares the translation of A's text from A and B, and judges how many aspects of the text B did not capture. The procedure can be repeated for any number of dialect pairs. Such comprehension tests have since been refined and widely used to measure intelligibility. Casad (1974) lays out a variation on this procedure for language surveys; the major change is that comprehension is measured by scoring a series of comprehension questions about the text, rather than evaluating the quality of a translation, because the previous method was criticized for being just as sensitive to a listener's ability to

translate as his or her ability to comprehend (see Wolff 1959). This method has come to be referred to as Recorded Text Testing (RTT), and certain thresholds have become standard; ten subjects are typically tested from each regional community, and a mean and standard deviation are calculated. A standard deviation higher than 15 percent indicates that there is learned intelligibility of the other variety through contact or exposure; in the cases where there is a larger spread, the higher scores tend to correlate with demographic categories such as age, gender, and mobility. A rough threshold for intelligibility is placed at 85 percent (Pelkey 2011:81).

RTT and similar comprehension methods attempt to directly measure the extent to which one group of speakers understands another. These tests do not discriminate between non-comprehension due to differences in vocabulary, pronunciation, syntax, or social bias. For many language planning applications, a functional comprehension score that aggregates both linguistic and extra-linguistic factors is appropriate. However, it is also a time and resource-extensive process. To obtain intelligibility scores between all pairs for 15 communities, 225 tests must be run, including the control test within each community.

When evaluating large numbers of communities, some researchers opt for opinion surveys rather than comprehension tests (see Gooskens & Heeringa 2004; Tang & van Heuvan 2009). In these experiments, the researcher plays a recording for participants and asks them to judge how well someone from their own dialect community would be able to understand the speaker. Tang and van Heuven (2009:711) state that results from these tests have been found to be reproducible and are used both in language surveys and in the evaluation of speech technology. In their study, they find that judgments of similarity strongly correlate with the results of a comprehension test ($r = 0.818$, p. 723). Judgment tests are an adequate option for evaluating intelligibility between

language variants, but still require extensive perceptual experiments with large numbers of participants.

2.4. Statistical and computational predictors of intelligibility.

Dialectologists have therefore looked to predict intelligibility using more convenient proxies. Chief among these is a measure of lexical similarity, or a ratio of cognates to non-cognates in a word list. Swadesh (1952) introduced the idea of comparing core vocabulary lists of language varieties and using the number of shared items as a metric of distance, drawing conclusions about historical relationships. Lexical similarity has also been seen as a promising method for predicting intelligibility. Simons (1979:78) compiles field studies from unrelated language groups correlating lexical similarity and comprehension tests and concludes that the former can explain 65 percent of the variation in the latter. However, Grimes (1992:32) finds only a weak correlation in a study of dialect pairs in the Philippines, and after a re-analysis of Simons' data, recommends simply that if lexical similarity is below 60 percent, intelligibility is unlikely.

Meanwhile, dialectologists have continued developing computational methods for measuring distance between dialects, hoping to make the tedious process of determining phylogenetic relationships easier and more efficient. Traditional methods involve mapping isoglosses, which are defined as 'the boundary of any linguistic feature or set of features which separate one speech variety from another' (Romaine 2000:136). Isoglosses can be linguistic features at any level, for example, different lexemes to represent a concept or different pronunciations of a particular word. Hundreds or thousands of isoglosses are mapped, and where multiple isogloss boundaries overlap, a dialect region can be defined (Heeringa 2004:10). However, isogloss boundaries are rarely so tidy. As Kessler (1995:60) describes:

> At best, isoglosses for different features approach each other, forming vague bundles; at worst, isoglosses may cut across each other, describing completely contradictory binary divisions of the dialect area. That is, language may vary geographically in many dimensions, but the requirements we usually impose require that a specific site be placed in a unique dialect. Traditional dialectological methodology gives little guidance as to how to perform such reduction to one dimension.

Additionally, dialect continua pose a significant problem for this type of analysis; each adjacent pair of villages may be very similar in their linguistic features, and the choice for where to split up the continua in dialects becomes largely arbitrary (Kessler 1995:60).

Kessler was the first to propose the use of a string edit distance algorithm on a phonetic transcription in the field of dialectology. He considers it a way to 'build accurate distance matrices that minimize editorial decisions without discarding relevant data' (1995:61). He uses Irish Gaelic as a test case, basing his analysis on a dataset of 51 words transcribed in 86 sites in 1956, collected as part of the Linguistic Atlas and Survey of Irish Dialects.

Kessler implements two versions of the Levenshtein distance algorithm. Levenshtein distance is the minimal edit cost of transforming one string into another, using only insertions, deletions, and substitutions, each of which have an associated cost. The simplest version of this, which Kessler terms 'phone string comparison', gives each edit an equal cost of one, and the edits are summed to give a total score to the pair of words. For example, two variants of *eallaigh* 'cattle' in Irish Gaelic are [AL:i] and [aLi]. These have a cost of two, one for the substitution of [a] for [A] and the other for the substitution of [L] for [L:]. Recognizing that some phoneme substitutions are more dramatic than others, and that the previous algorithm assigns the same cost for replacing a [t] with a slightly more palatalized [t] as an [e], he runs another version of the algorithm that breaks each phone into a bundle of twelve features, such as place,

rounding, and stricture, and assigns ordinal values to the features on a scale from 0 to 1. For example, place has a value of 0 for glottal, 1 for bilabial, 0.5 for palatal, et cetera. Instead of assigning all substitutions a cost of 1, he assigns them the difference between the feature values of the two phones, averaged across the twelve features. He terms this method feature string comparison. Under both methods, the scores for each of the individual word-pairs are averaged, resulting in one distance score for the pair of dialects. Using a bottom-up clustering method, he then converts his distance matrix into a tree structure.

Kessler calculates the correlations between both versions of the Levenshtein distance algorithm and the results of a traditional isogloss method and determines that the phone string method has more predictive power ($r = 0.95$, p. 63). He attributes the lack of success of the feature-based model to the arbitrariness with which the distance between phones was determined; under his system, [s] was closer to [g] than to [h], but [s] to [h] is a commonly attested sound change. He proposes that feature system could be made more scientific, but in the meantime declares that simple phone string comparison does quite well. Comparing the Levenshtein distance results to a lexical similarity approach, etymon identity, he writes:

> That phonetic comparison is more precise is not particularly surprising, since etymon identity ignores a wealth of phonetic, phonological, and morphological data, whereas comparing phones has the side effect of also counting higher-level variation: if words differ in morphemes, their phonetic difference is going to be high. (1995:66)

The trees created by his method match established tree relations well on the top levels, but differ on the more granular levels, which he attributes to the small dataset he uses: less than 60 words per dialect. Regardless, the isogloss approach to identifying dialect boundaries is quite a manual and intensive process, and the success of a relatively

simple dynamic programming algorithm in achieving very similar results was an exciting development.

In his widely cited dissertation, Wilbert Heeringa (2004) refines, validates, and applies the Levenshtein distance algorithm to data from Norwegian and Dutch dialects. He tries a simple phone based representation, as well as three systems for weighting costs based on phonetic features. He also tries using acoustic representations, spectra, and formant bundles as input for the algorithm. The acoustic representations are based on only two speakers, and he concludes that 'the use of acoustic representations is useful, but recommend future work to verify the conclusion on the basis of more speakers, and if necessary to refine the acoustic processing' (280). Using a subjective dialect distance judgment experiment to validate the new methodology, he concludes that among transcription-based methods, the best results come from using either simple phones or acoustic representations with logarithmic Levenshtein distance. He speculates that these two methods 'share the property that small segment distances are relatively heavily weighted, which is perhaps also the case in perception' (281).

Heeringa also discusses a length normalization function, which is important so that longer words are not given higher edit costs than shorter words. He proposes that the cost be divided by the length of the alignment. This has the effect of favoring longer alignments when there are multiple possible options with the same edit cost. Longer alignments tend to have more exact matches, which he posits is consistent with human intuition in the comparison of two strings (2004:130-131).

Heeringa et al. (2006) also evaluate various versions of string edit algorithms for the purpose of determining dialect distances. They evaluate algorithms with no linear sensitivity (i.e. ratio of shared segments to all segments) versus the Levenshtein distance algorithm, normalizing by length or not, using n-grams as input, requiring that vowels

align with vowels and consonants align with consonants, and weighting n-gram alignments by degree of match. They apply these to Norwegian and German datasets, with 58 words in 15 dialects for Norwegian and 201 words in 186 dialects for German. They compare their results to the results of a perceived dialect distance experiment done by Gooskens on Norwegian dialects and use geographic consistency (i.e. the idea that geographically contiguous dialects are generally more similar) for German. With the various combinations of the components listed above, the researchers run the data through 40 algorithms to create different distance matrices. They conclude that the various string edit distances account for 43.6 to 53.3 percent of the variance in the matrix created by the judgment experiment, and the correlation coefficients are all significant ($p < 0.001$) but do not differ significantly from one another.

Charlotte Gooskens was the first to deploy this new dialectology method specifically in an intelligibility study. In her 2006 paper, she builds upon an existing investigation into mutual intelligibility between speakers in Denmark, Norway, Sweden and the Swedish-speaking part of Finland. Participants from nine towns had listened to a news segment translated into one of the languages and answered a series of questions about what they heard. Intelligibility was measured by the percentage of questions answered correctly. The results indicated that mutual intelligibility was highest between Norwegians and Swedes, and Danish was the least intelligible to speakers in other countries. Participants had also been asked about their attitude toward the language (e.g. *How beautiful is the language? Would you like to live in that country?*) as well as the amount of contact that they had with it.

Gooskens uses a set of this data, as well as her own adaptation of the experiment, to see if linguistic distance is a significant explanatory factor for the comprehension results. She has a news segment translated and read in the regional dialect of each of the

nine towns, and then aligns the texts and calculates the Levenshtein distance between pairs of related words. She does not publish the number of related words that she uses in the calculation but does note that the mean length of the news segments is 257 words. She uses an edit cost of one for insertions, deletions, and substitutions of vowel for consonant or the reverse. Substituting vowel for vowel or consonant for consonant is an edit cost of 0.5, and a mismatched diacritic (e.g. length) is an extra 0.25. The sum is divided by the length of the alignment for normalization purposes.

Gooskens also calculates the lexical similarity between the languages, looking only at the words that the participants heard during the comprehension test. She aligns the texts and uses the following system to calculate distance:

> A non-cognate was given one point, a compound that is partly cognate was given half a point, and a cognate was given zero points. In some cases a word pair consisted of non-cognates, but still a common synonym cognate existed in the native language of the listeners which would make it possible for them to understand the word in the other language. In such cases the word pair was also given zero points, since what matters is how well the listeners would be able to understand the word. (2006:108)

Unlike Levenshtein distance, this particular linguistic similarity metric is asymmetrical, as a cognate synonym can exist in one language but not the other.

She correlates the intelligibility scores from the original study with her own measures of phonetic and lexical distance, as well as the measures of contact and attitude from the original, to see which has more predictive power. The only two factors that are significant are phonetic distance (r = -0.82) and the judgment of how beautiful the language is (r = 0.56). She says it is unclear whether considering a language beautiful makes it more intelligible or if understanding a language makes it more beautiful, but asserts that phonetic similarity will influence intelligibility but intelligibility will not influence phonetic distance. Overall, she concludes that the high

correlation between phonetic distance and a functional test of intelligibility validates the Levenshtein distance-based method as a predictive tool.

Continuing on the work of Gooskens' 2006 study, Beijering, Gooskens, and Heeringa (2008) conduct an intelligibility study with Danish listeners and Faroese, Swedish, Norwegian, and Danish speakers. The Levenshtein edit costs are weighted by distances determined by spectrograms of the segments, and 58 cognate forms are compared. The distance matrix is compared to the results of a translation-based comprehension test, and the results have a strong negative correlation ($r =$ -0.86). Yang and Castro (2008) correlate phonetic distance and the results of a question-based listening comprehension test on both Bai (Sino-Tibetan) and Hongshuihe Zhuang (Kra-Dai). All edits have a cost of one, and 500 cognates are compared for each. The correlation coefficients are also strongly negative (Bai: $r =$ -0.75, Hongshuihe Zhuang: $r =$ -0.72). Yang (2012) uses the same methodology on 955 cognate pairs between dialects of the Lalo language cluster (Sino-Tibetan), and finds a correlation of $r =$ -0.88. These results provide cross-linguistic evidence supporting Gooskens' initial findings that average Levenshtein distance of cognate pairs is a good predictor of intelligibility between dialects.

A frequent criticism of the use of phonetic distance in dialectology is that the method is not sensitive to whether lexical items are similar because of a shared history or more recent shared innovations (see Campbell 2013:453). This is not an issue in measuring intelligibility, because speakers can use all similarities—not just historically connected ones—to understand each other. Thus, phonetic distance is more suitable as a proxy for intelligibility than it is for mapping historical relationships between dialects. However, there are still limitations that bear mentioning. Levenshtein distance is symmetric and will never capture the asymmetric nature of intelligibility discussed

above. It ignores social factors such as degree of contact and attitudes or bias. At best, it can estimate the theoretical advantage that a speaker of one variety has in learning another variety due to structural elements that they share, a concept sometimes called 'inherent intelligibility' (Simons, 1979:86, Grimes 1992:18, Bouwer 2007:6). Because of the pervasive influence of social factors, inherent intelligibility is never directly isolated in the real world. However, a number of researchers have correlated phonetic distance with functional comprehension tests in unrelated language families, and the correlations are strong enough that the measure can be used as a predictor of real world intelligibility (see Gooskens 2006, Beijering et al. 2008, Yang & Castro 2008, Yang 2012).

2.5. REPRESENTING DISTANCES VISUALLY. As described in Section 2.4, Levenshtein distance returns a distance between two word forms, which when averaged with all of the cognates in a word list, becomes a matrix of distances between dialect pairs. The next stage in the analysis is clustering. Clustering is traditionally approached as a top-down partitioning or bottom-up agglomerating process, resulting in a hierarchical tree (see Kessler 1995). More recently, dialectologists and intelligibility researchers alike are using unrooted networks, rather than trees, to more accurately display relationships between language variants. One such option is a visualization called a Neighbor-Net, developed by Bryant and Moulton (2004) for use in molecular biology. This performs a cluster analysis on a distance matrix:

> The [Neighbor-Net] generates splits graphs from pairwise distances between the taxa (objects under study). A split is a partition of the set of taxa into two non-empty subsets. When all possible splits are computed over a set of taxa, they can either be compatible or incompatible with one another. In the first case, there is a single way of connecting the taxa, which is a perfectly tree-like branching pattern. In the latter case, there are multiple ways of connecting the taxa, resulting locally in a network. The [Neighbor-Net] summarizes the branching parts (edges) and the local networks (boxes) in a single graphical representation. (Hamed 2005:1016)

Hamed uses a Neighbor-Net to cluster the results of a lexical similarity study on Chinese variants and finds that the result is both highly consistent between different word lists and corresponds with existing knowledge of Chinese linguistics, geography, and demic history. Yang (2012) uses the Neighbor-Net approach as well in her work on intelligibility within the Lalo language cluster.

McMahon et al. (2007) uses a Neighbor-Net to analyze the results of a phonetic distance study that includes variants of German, Icelandic, and English. They criticize the traditional tree approach for forcing the data into an incompatible shape.

> The essential problem here is that relationships between varieties are multidimensional, and when such complexity is forced into two dimensions, which are all we are permitted given a binary branching tree structure with no connections between branches, then distortions may occur. (128)

The Neighbor-Net, on the other hand, can clearly display when a variant is intermediate between many other variants—a situation where a binary tree would be forced to make a choice of which cluster to place it in.

3. RESEARCH ON MAM. The previous section discussed methods for measuring intelligibility that have been developed throughout the past century on a variety of language groups. In this section, the focus shifts to the work that has been done on the Mam language: its typology, dialectal variation, and available data. Section 3.1 provides a brief outline of the typological background of Mam. Section 3.2 describes some of the documented regional variation and reviews previously proposed dialect groups.

3.1. TYPOLOGICAL PROFILE. Mam is a member of the Mayan language family, categorized under the Eastern, and further, Mamean branch. It is primarily spoken in the Western Guatemalan highlands (England 1983:6). As of the 2003 census, there were 478,000 speakers in Guatemala, many of whom also use Spanish (Simons & Fennig 2018).

In terms of phonemic inventory, Mam has 27 native consonants shared by all dialects, as well as /b d g/, which appear in Spanish loans. Additionally, there are three apico-post-alveolar consonants /t̪ʃ̪ t̪ʃ̪’ ʃ̪/ that are only contrastive in the Todos Santos dialect. There are ten vowels: five cardinal positions with length distinctions (England 2017:501). Tables 1 and 2 list the consonants and vowels in IPA and the practical orthography utilized by B’aayil, Jiménez, and Ajb’ee (2000:29).

TABLE 1. Mam Consonants

		Bilabial		*Alveolar*		*Alveo-palatal*		*Apico-post-alveolar*		*Retroflex*		*Palatal*		*Velar*		*Uvular*		*Glottal*	
Stop	Simple	[p]	p	[t]	t							[kʲ]	ky	[k]	k	[q]	q		
	Glottalized	[ɓ]	b'	[ɗ ~ tˀ]	t'							[kʲˀ]	ky'	[kˀ]	k'	[qˀ]	q'	[ʔ]	'
Affricate	Simple			[t͡s]	tz	[t͡ʃ]	ch	[t̪ʃ̪]	tch	[ʈʂ]	tx								
	Glottalized			[t͡sˀ]	tz'	[t͡ʃˀ]	ch'	[t̪ʃ̪ˀ]	tch'	[ʈʂˀ]	tx'								
Fricative				[s]	s	[ʃ]	xh	[ʃ̪]	sh	[ʂ]	x					[χ]	j		
Nasal		[m]	m	[n]	n														
Flap				[ɾ]	r														
Liquid				[l]	l														
Semi-vowel		[w]	w									[j]	y						
Spanish loan		[b]	b	[d]	d									[g]	g				

TABLE 2. Mam Vowels

	Front		*Central*		*Back*		*Front*		*Central*		*Back*	
High	[ɪ]	i			[ʊ]	u	[iː]	ii			[uː]	uu
Mid	[ɛ]	e			[ɔ]	o	[eː]	ee			[oː]	oo
Low			[a]	a					[aː]	aa		

The parallel series of plain and glottalized consonants are typical of Mayan languages, as is the vowel inventory (Bennett 2015:2-13). Mam has a tendency to drop short, unstressed vowels, a morphophonemic process which often results in large consonant clusters (England 1983:21). In general terms, this is characteristic of all dialects, but the exact rules of how stress assignment and syncope work vary between dialects (England 2000:501-2).

Mam is a synthetic language with a rich morphological system containing both inflectional and derivational morphemes. There are two sets of person markers that

cross-reference noun phrases on the verb, Set A and Set B, which follow an ergative pattern. Verbs can also be inflected for aspect and mood, and nouns can be inflected with Set A markers to indicate their possessors or complements (England 2017:503).

Transitive verbs are almost always accompanied by an auxiliary called a directional, which indicates trajectory, deictic category, or aspect. There are twelve basic directionals that are shared by all dialects (England 2017:509-10). The sentence structure is fairly rigidly verb-initial (VAO and VS). Mam is syntactically as well as morphologically ergative, with a complex voice system (England 1983:22-23). Split ergativity, wherein both subject and object are cross-referenced using Set A markers, is triggered in some circumstances (England 2017:516).

3.2. DIALECTAL VARIATION. Variation between regional dialects exists on all linguistic levels. As mentioned above, there are three apico-post-alveolar consonants that are only contrastive in the Todos Santos dialect. Another example of a phonological variation is in stress assignment; stress falls on the penultimate syllable in Southern Mam, the final syllable in Western Mam, and the last heavy syllable in Northern Mam. In turn, these stress differences interact with various syncope rules that tend to shorten or drop unstressed vowels (England 2017:501). Person enclitics vary from region to region. For example, the Set A 1SG enclitic following a vowel tends to be /-ye'/ in the south, /-∅/ in the west, and /-a/ or /-a'/ in the north and central regions (B'aayil et al. 2000:58-60). There are syntactic differences as well; an adjective typically precedes the noun in all dialects, but in the west and north it can follow the noun if the noun is preceded by a demonstrative or quantifier. However, in the south, an adjective that follows a noun is interpreted as the base of a relative clause (England 2017:506-7). Contact with bordering Mayan languages has introduced variations in both the lexicon and syntax. Northern Mam has acquired a system of noun classifiers from the

Q'anjob'alan languages, which it borders, but these have not entered usage in Western Mam (England 2017:508). In general, Northern Mam dialects have more borrowings from Q'anjob'al, Southern Mam dialects have borrowings from K'iche', and Western Mam dialects have retained the most from Proto-Mam (B'aayil et al. 2000:129).

In her widely cited grammar of San Ildefonso Ixtahuacán Mam, Nora England mentions 'at least 15 distinct dialects which can be divided into three major divisions' (1983:6), shown on a map as Northern, Southern, and Western Mam. These divisions are based on the work of Terrence Kaufman (1976) in creating an orthography for Mayan languages. She notes that the dialect of Todos Santos, while grouped with the north, is 'quite different from other Northern Mam dialects' (1983:20). Her more recently published grammar sketch mentions two central subgroups in addition to the three aforementioned major areas, but unfortunately the analysis she cites is unpublished (see England 2017:500). Nevertheless, she uses the three principal divisions throughout the grammar sketch, generally giving an example from a variety from each region for each linguistic pattern she describes.

There is one work specifically investigating intelligibility between Mam dialects, completed by Godfrey and Collins in 1987 as part of a Summer Institute of Linguistics (SIL) survey. Their investigation includes lexical comparisons for 53 communities, opinion surveys from 86 communities, and a comprehension test conducted between eight municipalities (1987:8). They conclude that although dialect boundaries are certainly not clear-cut nor easy to define, dialects can be broken into three large groups (Southern, Western, and Northern) or six small groups (Huehueteco, Quetzalteco, Central, Tacaneco, Todosantero, and Tajumulteco). Within each group, they claim, varieties can be considered mutually intelligible, depending on the context of the conversation or text (107-112). However, as detailed below, their classifications rely

heavily on the lexical similarity scores, and as mentioned in Section 2.4, using lexical similarity to predict the results of comprehension tests has had mixed results in previous research (see Grimes 1992, Gooskens 2006).

In their particular implementation of a lexical comparison analysis, Godfrey and Collins elicit a Swadesh list and other key vocabulary by having bilingual consultants translate full sentences from Spanish, thus avoiding some of the ambiguity that comes from eliciting words in isolation. From the 80 sentences, they extract a list of 294 words and morphemes (Godfrey & Collins 1987:9-10). Word lists are compared by computer, and only exact matches are considered matches. In order to allow their program to capture near matches, they do the comparison with two levels of pre-processing of the words. 'Complete' forms are phonological transcriptions that only disregard stress and vowel length distinctions. 'Reduced' forms delete all vowels and collapse some of the consonants. As would be expected, the overall ratio of shared forms between lists is higher for the reduced forms than the complete forms (22). Unfortunately, they do not publish glossed transcriptions that include vowel length, which is phonemic in Mam, making it difficult to utilize their collection for future investigations.

Godfrey and Collins also carry out a Recorded Text Testing-style comprehension test between all combinations of eight large municipalities throughout the Mam-speaking region (1987:37). They use Mam texts that had been originally written as bilingual education resources, and have representatives from each municipality translate and record them in their own dialect. At least eight participants from each municipality then listen to and answer questions about the recordings. The researchers judge comprehension on two scales; they first directly ask the participant how well they understand the recording, and then count the number of pre-specified elements captured correctly during a structured translation task (38-51). The complete matrices of the

comprehension scores and lexical comparisons have only a weak positive correlation ($r = 0.34$ for complete forms, $r = 0.15$ for reduced forms, p. 409), and while the researchers are able to select subsets of the data that show a stronger correlation, the significance level is not high (e.g. $r = 0.72$, $p = 0.1$ for reduced form similarity between 75 and 84 percent, p. 61). Godfrey and Collins note that the correlations are far from perfect and only provide very rough estimates of intelligibility, but nevertheless utilize them to draw conclusions about municipalities that are not included in the comprehension test portion (55-56).

While there are concerns regarding the validity of the results based on the lexical comparison, the opinion survey results have proven to be a valuable resource. Godfrey and Collins visit 86 communities in and around the Mam-speaking region and interview a group of native speakers in each. They are prepared with a list of all the municipalities and regions where Mam is spoken. They first ask the participants where the 'true' Mam was spoken, in an attempt to ascertain which varieties are considered more or less prestigious. They then work through the list of communities, asking first where Mam is spoken exactly the same or where there are only minor differences that do not impede communication, second where Mam is very different and it is very difficult to understand, and finally going through the remaining communities and ranking them in descending order of how easy it is to understand someone from that community. They do not publish the raw responses from the surveys, but use the results in combination with census data, a geographic survey, and personal observations to write a short description of the linguistic attitudes and patterns of contact in 55 communities (1987:13-17). These results are also taken into account when the authors propose the six dialect groups.

An extensive work by B'aayil, Jiménez, and Ajb'ee (2000) describes dialectal variation in Mam on phonological, morphological, lexical, and syntactic levels. The purpose of the work is to describe and document variation, so that a standard form can be developed for wider communication between communities, as well as for the expansion of written works and bilingual education. The authors do not attempt to cluster the varieties into dialect groups, though they occasionally organize patterns of linguistic features into North, West, Central, and South throughout the work (see pages 135, 234-235 for examples). The work does not include information on intelligibility between varieties.

In the course of their research, the authors collected 26 word lists from communities in the Mam-speaking region. These include a Swadesh list with 112 items and a 'special list' with an additional 133 items, many of which are regional plant or animal names or terms specific to Mayan culture. The words are phonemically transcribed using the orthography listed in Tables 1 and 2 in Section 3.1. Stress is not marked, but vowel length, which interacts with stress in Mam, is included. This is a valuable source of data, though a few drawbacks must be noted. Firstly, the researchers do not include any information about how the lists were elicited and transcribed, including how many speakers were consulted in each community. Secondly, there are two municipalities, Tacaná and Todos Santos Cuchumatán, that have three separate lists each. The authors do not specify if the lists were collected in different communities within and around the municipalities, or if they differ in some other way. Finally, there are gaps in the word lists; in particular, there are several varieties that have roughly half of the words as the other varieties. Despite these omissions, this resource is the most complete published source of parallel word lists between communities.

4. PHONETIC DISTANCE ANALYSIS. This chapter details the process of calculating, visualizing, and interpreting phonetic distances between each of the varieties. Section 4.1 begins with an outline of the methodological choices. Section 4.2 contains details regarding data preparation, and Section 4.3 continues with the process of calculating Levenshtein distance and measuring internal consistency with Cronbach's alpha. Section 4.4 covers the creation of a Neighbor-Net network and the use of statistical bootstrapping to determine confidence. Section 4.5 contextualizes the distances and branches produced by the computational method with results of the opinion surveys published by Godfrey and Collins (1987).

4.1. METHODS. The present work uses previously collected data, in conjunction with updated methodological tools, to estimate intelligibility between regional varieties of Mam. Phonemic transcriptions of word lists published in B'aayil et al. (2000) are used as input for a Levenshtein-based phonetic distance algorithm. The simple version of the algorithm, in which each edit has an equal cost, is chosen because Heeringa et al. (2006) tests more complex implementations, including using more gradient phonetic details and weighted edit costs, and does not find that those algorithms correlate to perceived dialect distance more closely than the simple version. Following Heeringa (2004:130-131), the raw edit cost is normalized by dividing by the length of the longest alignment, which counteracts the tendency of longer word pairs to have more edits. The Neighbor-Net method is used to cluster and visually represent the distances, as in McMahon et al. (2007) and Yang (2012).

In order to contextualize the distances represented in the Neighbor-Net, the results of the opinion surveys conducted by Godfrey and Collins (1987) are incorporated into the analysis. This allows for an interpretation of the network in terms of which towns and regions Mam speakers consider to be exactly like their own, different but highly

intelligible, or very different and difficult to understand. Godfrey and Collins also provide information about geography and commercial centers, which is used to compare the results of the phonetic distance measure with patterns of contact.

4.2. DATA PREPARATION. As mentioned in Section 3.2, the appendices in B'aayil et al. (2000) include word lists for 26 regional varieties. Five of these lists are incomplete, with less than half the data of the others. Many of the missing lexical items for two varieties (Comitancillo and Tajumulco) were found in the chapter on lexical variation and incorporated into their respective word lists. However, three varieties (Génova, San Miguel Ixtahuacán, and Concepción Tutuapa) had so few words that their average phonetic distances were calculated using fewer than 58 cognates, the smallest number used in a previously validated study of this type (Beijering, Gooskens, and Heeringa 2008). Therefore, these three lists were excluded from the present analysis, leaving 23 varieties in total. The varieties and their abbreviations are listed in Table 3. B'aayil et al. unfortunately do not provide information on the distinction between TAC1, TAC2, and TAC3, which were all collected in or near Tacaná, nor the distinction between TSA1, TSA2, and TSA3 from Todos Santos Cuchumatán. Figure 1 shows the locations of the municipalities on a map of western Guatemala.

TABLE 3. List of Regional Varieties Included in the Analysis

Abbreviation	*Municipality*	*Department*
ATI	San Juan Atitán	Huehuetenango
CAB	Cabricán	Quetzaltenango
CAJ	Cajolá	Quetzaltenango
COM	Comitancillo	San Marcos
CHM	Santiago Chimaltenango	Huehuetenango
CHQ	Concepción Chiquirichapa	Quetzaltenango
GAS	San Gaspar Ixchil	Huehuetenango
IXT	San Ildefonso Ixtahuacán	Huehuetenango
MAR	San Martín Sacatepéquez	Quetzaltenango
NEC	San Pedro Necta	Huehuetenango
OST	San Juan Ostuncalco	Quetzaltenango
PTZ	San Rafael Pétzal	Huehuetenango
SBA	Santa Bárbara	Huehuetenango
SIG	San Miguel Siguilá	Quetzaltenango
SSE	San Sebastián H.	Huehuetenango
TAC1	Tacaná	San Marcos
TAC2	Tacaná	San Marcos
TAC3	Tacaná	San Marcos
TAJ	Tajumulco	San Marcos
TEC	Tectitán	Huehuetenango
TSA1	Todos Santos Cuchumatán	Huehuetenango
TSA2	Todos Santos Cuchumatán	Huehuetenango
TSA3	Todos Santos Cuchumatán	Huehuetenango

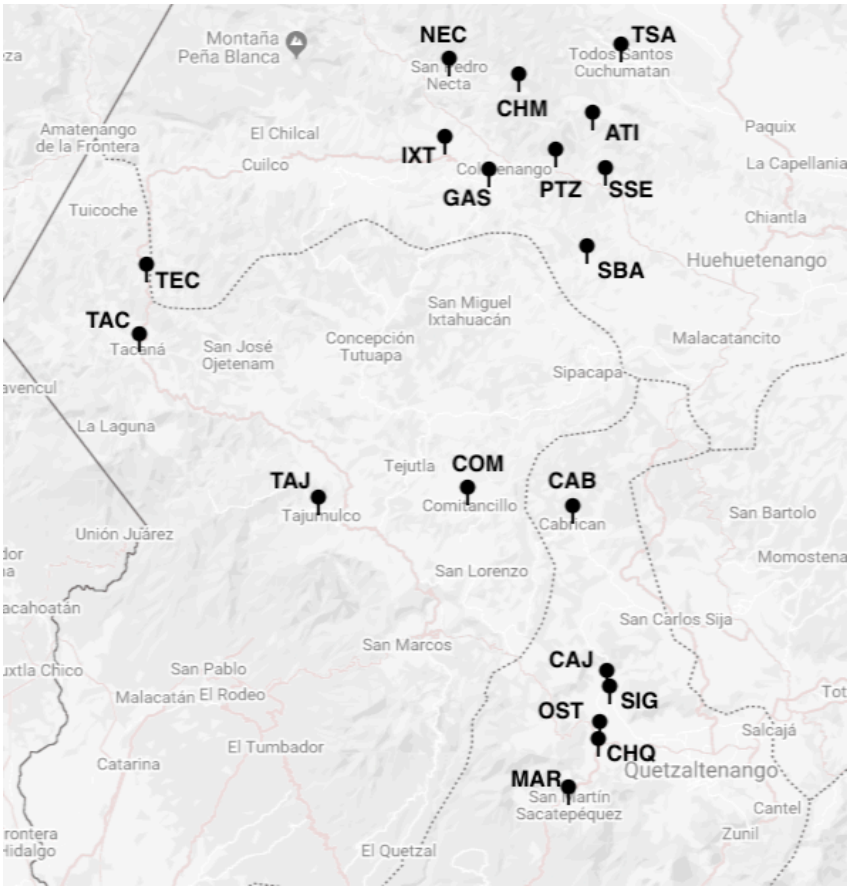

FIGURE 1. Map of included municipalities in western Guatemala.

The original word lists included 245 semantic items, but there was a significant amount of pruning and cleaning necessary. Twenty semantic items were duplicates and had to be combined. Additionally, a number of the Spanish translations of the semantic items, which were presumably used for elicitation, are ambiguous in Mam. For example, the entries for body parts were often inflected with Set A markers for possession, but word lists differed on which person was chosen. The entries for 'nose' include /**n**txaan**e**/ in Santiago Chimaltenango, /**q**txa'n/ in Todos Santos 3, and /**t**txa'n/ in Tacaná 3. The prefix /n-/ and enclitic /-e/ in the first indicate 1SG, the /q-/ and /-∅/ in the second indicate 1PL inclusive, and the /t-/ and /-∅/ in the last indicate 3SG (B'aayil et al. 2000:58-60). Were these forms to be incorporated into the phonetic distance

algorithm, the distance between the varieties would be falsely inflated. Similarly, many verbs in Mam include a directional which is not specified in the Spanish prompt. The entries for the phrase ‘he did it’ include /ma **txi’** tb’incha’n/ in Concepción Chiquirichapa, /ma **kub’** tb’inchan/ in San Juan Ostuncalco, and /**b’aj** tb’iinchina/ in Todos Santos 1. The directionals /xi’/, /kub’/, and /b’aj/ have cognates in all dialect groups and indicate ‘here to there’, ‘downward’, and ‘complete’ respectively (England 2017:509-10). As there was not enough information to separate dialectal variation from morphophonemic variation, all body parts and verb phrases from the word lists were removed.

This left 183 semantic items to be included in the analysis. However, there was not always precisely one word for each semantic item in each list. The most complete lists, Cajolá and San Ildefonso Ixtahuacán, had 181 items, and the list with the most gaps, Tajumulco, had 122 items. The median number of items per list was 174, and the mean 167. Additionally, many lists included more than one variant for a particular semantic item. When that was the case, the phonetic distance was calculated for each of the variants, and the smallest of those distances was incorporated in the average between the two dialects.

Phonetic distance was only calculated between cognate pairs, which were determined using lexical variation information provided by B’aayil et al. in combination with similarity judgments. It is important to exclude non-cognates to control for the possibility of ambiguous elicitation prompts and unlisted synonyms. For example, the word /maq’maj/ is listed for ‘hot’ in San Juan Ostuncalco, while /kyaq/ is listed in Cabricán. However, in San Juan, /maq’maj/ is used to describe hot weather, and /kyaq/ is used to describe hot objects. Comparing the phonetic distance between /maq’maj/ and /kyaq/ would erroneously inflate the difference between the two varieties. Likewise, the

word lists are not comprehensive, and we cannot assume that they includes all synonyms available in each variety. For ‘teacher’, many varieties include a variation of the native Mam word /xnaq’tzaal/ while other varieties include a variation of the Spanish loan /maestro/. It is unclear whether these speakers exclusively use the one term or understand both, and therefore it is considered best to remove the potential source of variation entirely.

4.3. CALCULATION OF THE PHONETIC DISTANCE MATRIX. Table 4 shows an example of how the Levenshtein distance algorithm optimally aligns two words and calculates the edit cost. The alignment is found using the process detailed in Martin and Jurafsky (2009:73). The word for ‘eagle’ is /q’aanjel/ in Santiago Chimaltenango (CHM) and /q’njil/ in San Juan Ostuncalco (OST). The alignment in Table 4 allows the former to be transformed into the latter with the least number of edits. Permitted edits include insertions, deletions, and substitutions. The long vowel /aa/ is deleted and the vowel /e/ is substituted for the vowel /i/. The rest of the segments match and therefore have zero cost.

TABLE 4. The Optimal Alignment between /q’aanjel/ and /q’njil/

CHM:	q’	aa	n	j	e	l
OST:	q’	-	n	j	i	l
		Deletion			*Substitution*	
Cost:	0	1	0	0	1	0

Longer words are likely to have more edits, and thus have higher edit costs. This is avoided by applying a normalization function. The sum of the edits is divided by the length of the longest alignment to return a normalized cost. Specifying ‘longest’ is necessary because in some cases, there is more than one alignment that achieves the minimal cost. For example, there are two possible alignments that have four edits for /chmojxhen/ and /chemjxiin/, the words for ‘spider’ in Tacaná 2 and San Juan Atitán.

The two alignments are illustrated in Table 5 and Table 6. Both have a total of four edits, giving a simple cost of 4. However, the length of their alignments differ and would return different results if normalized by dividing by their own length. The longer alignment is preferred because it has a tendency to align more of the common segments, which mimics human perception in the comparison of two words (Heeringa 2004:131). In this case, the length of the longest alignment is 8, and therefore the normalized cost is 0.5. For the 'eagle' example in Table 4 above, the length of the longest alignment was 6, and the normalized cost 0.33.

TABLE 5. Shorter Alignment for /chmojxhen/ and /chemjxiin/

TAC2:	ch	m	o	j	xh	e	n
ATI:	ch	e	m	j	x	ii	n
		Substitution	*Substitution*		*Substitution*	*Substitution*	
Cost:	0	1	1	0	1	1	0

TABLE 6. Longer Alignment for /chmojxhen/ and /chemjxiin/

TAC2:	ch	-	m	o	j	xh	e	n
ATI:	ch	e	m	-	j	x	ii	n
		Insertion		*Deletion*		*Substitution*	*Substitution*	
Cost:	0	1	0	1	0	1	1	0

For each pair of word lists, the normalized phonetic distance was calculated between all possible cognate pairs. These were then averaged to return a single aggregate distance score between the two varieties. The resulting distance matrix can be found in Appendix A, and Appendix B shows a corresponding matrix with the number of cognate comparisons included in each aggregate. The latter range from 82 to 181, with a median of 120 and a mean of 122.2.

Following Heeringa (2004:170), internal consistency was measured using Cronbach's alpha, a measure that involves the average inter-correlation between cognates and the number of cognates compared. In the distance matrix created above, each cell contains an average of many individual distances, each based on one cognate

pair. It is also possible to create a whole matrix based solely on the phonetic distances between cognates meaning 'mother', another for the cognates meaning 'cloud', and yet another for the cognates meaning 'red'. The first step in finding the inter-average correlation is to do this for all sets of cognates. Then, Pearson's correlation coefficient, *r*, is found for each pair of matrices: the correlation between the 'mother' and the 'cloud' matrices, between the 'cloud' and 'red' matrices, et cetera. The mean of these correlations is the average inter-correlation, and it indicates the degree of consistency between the individual components. Cronbach's alpha then is calculated as follows, in which n is the number of cognates, and $\bar{r}$ is the average inter-correlation.

$$\alpha = \frac{n \times \bar{r}}{1 + (n - 1) \times \bar{r}}$$

An acceptable lower bound for alpha when calculating phonetic distance is 0.7 (Heeringa 2004:173). As each cell in the phonetic distance matrix is comprised of a different number of comparisons, and varies in which cognates are included, the alpha value is different for each pairwise language comparison. In the present analysis, the values range from 0.81 to 0.92, all well above the 0.7 threshold. A matrix with the results is in Appendix C.

4.4. CLUSTERING DIALECTS. The distance matrix was transformed into a network diagram using the equal angle Neighbor-Net method available in the SplitsTree 4 package (Huson and Bryant 2006). This method takes the matrix of distances between varieties, draws weighted splits—or binary partitions between the varieties—and represents them in a network figure (Bryant and Moulton 2004:255).

The advantage of the network approach is its ability to represent ambiguity in the data. For example, take two subsets of the present data, shown in Figure 2. Subset A contains SSE, NEC, GAS, and ATI, all municipalities clustered together near the Seleguá river valley in Huehuetenango (Godfrey and Collins 1987:80). Referring to the

distance matrix, the phonetic distance between all pairs of varieties is roughly equal. Subset B contains IXT, GAS, TSA1 and TSA2. In this matrix, the distance between IXT and GAS is notably smaller, as is the distance between TSA1 and TSA2. A binary tree could represent the relationships between varieties in Subset B well by connecting IXT and GAS in one pair, TSA1 and TSA2 in another pair, and then connecting the two pairs. It could not represent the data from Subset A as well; the shortest distance is between NEC and GAS, but the distance between GAS and ATI is only marginally longer. The networks visually represent that ambiguity.

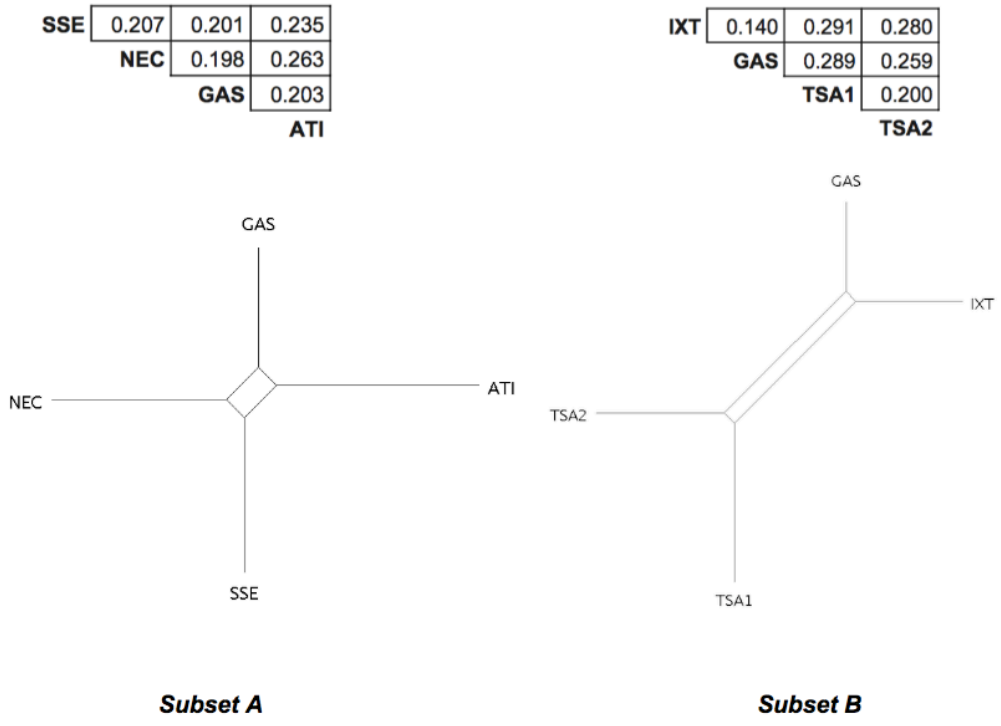

FIGURE 2. Distance matrices and Neighbor-Nets for two subsets of the data.

The box connecting the varieties in Subset B is long and thin; the long edges represent the strength of the partition between TSA1 & TSA2 and IXT & GAS, and the short edges represent the weakness of the partition between IXT & TSA1 and GAS &

TSA2. In contrast, the box connecting the varieties of Subset A is relatively square, indicating that the possible partitions are of somewhat comparable strength. The length of the line connecting the inner box to a variety label represents the split between that individual variety and the rest of the varieties. Subset B shows that TSA1, for example, is more distinct from the rest of the varieties than GAS is. The length of the shortest path from one variety to another is the distance between those varieties (Bryant and Moulton 2004:256-258, Yang 2012:124).

The network diagram that includes all varieties, and all of the possible partitions between them, is more complex. Figure 3 shows the output of the tree with the 23 varieties included. Branches formed with long, narrow boxes in the inner portion represent clusters of varieties, and varieties connected with shorter lines are less divergent than those connected with longer lines. Four main branches are visible: one with NEC through SSE at the top of the figure, another with CAB through SIG on the right, a third with TEC through TAC1 on the bottom left, and a fourth with the TSA varieties on the left. The members of each of the four branches are circled for visual clarity.

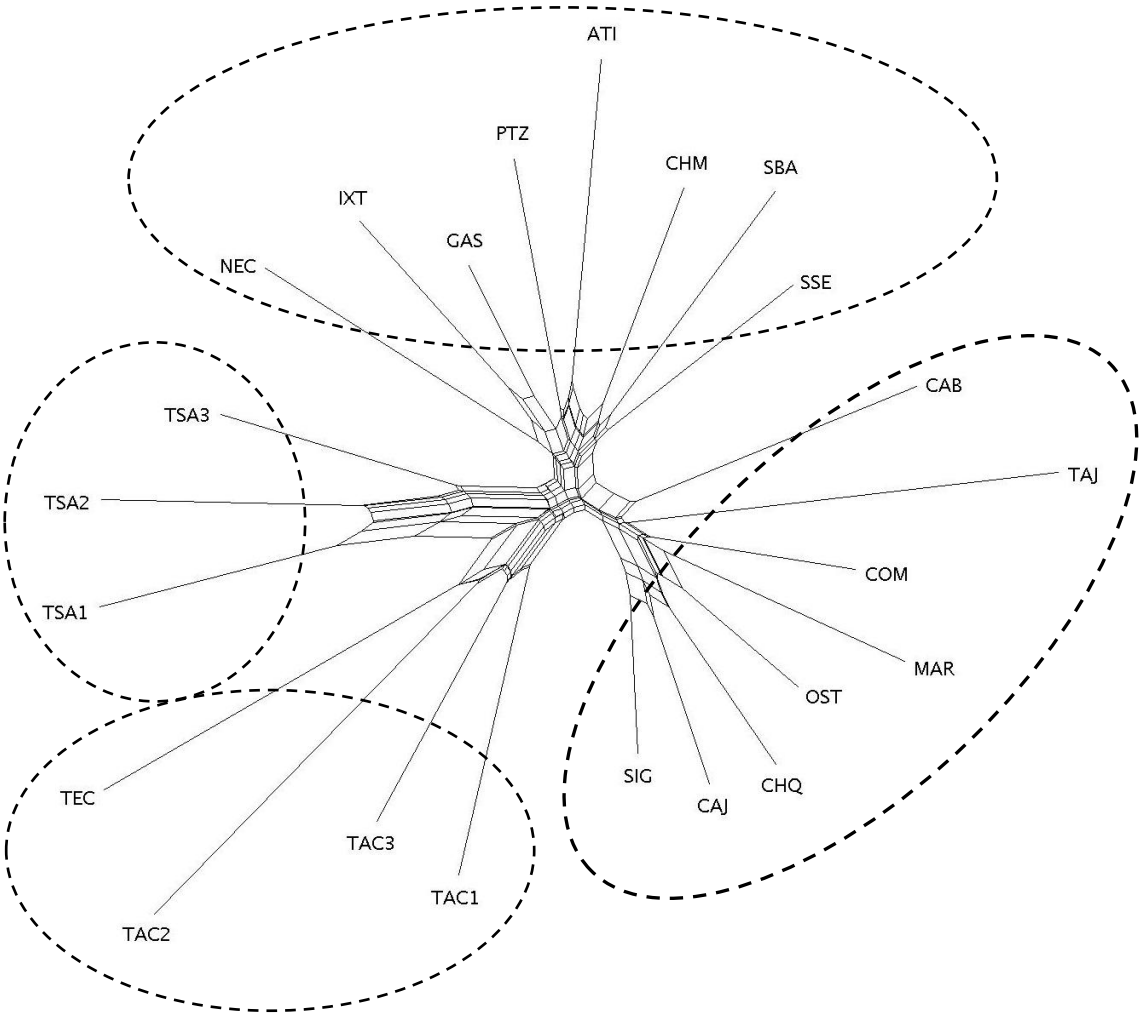

FIGURE 3. Neighbor-Net diagram of the phonetic distances between all varieties.

Following McMahon et al. (2007), the confidence of the splits and the shape of the network was checked with bootstrapping, a resampling method typically used for determining standard error for a sample mean (Johnson 2001:49). In this application, it allows us to estimate which aspects of the network are highly likely to be representative of the distances between the varieties as wholes, and which are specific to the particular sample of cognates in the dataset. The analysis was repeated 35 times, and in each trial, a random 10 percent of lexical items were excluded. Differences between the resulting networks were noted and quantified.

In 33 of 35 bootstrapped trials, the four main branches seen in Figure 3 appear in the same order with the same members. In one trial, the TSA and TEC/TAC branches are reversed, and in another, TAJ is intermediate between the right and bottom left branches. There is high confidence that the varieties cluster into four main groups.

The internal structure of each group, however, is less stable under bootstrapping. The top branch, NEC through SSE, maintains the same internal order of varieties in only 5 of 35 trials. The bottom left branch, with TEC and the TAC varieties, has an identical inner structure in 28 of 35 trials. The TSA branch is the most stable; it has the same structure in all 35 trials. The right branch has a smaller, inner cluster of varieties that are adjacent in 34 trials: SIG, CAJ, CHQ, OST, and MAR. The exact order of this sub-cluster, however, always changes. The other three varieties in the right branch (CAB, TAJ, and COM), appear on the outer edge of the sub-cluster in 33 trials. The most frequent structure is the one that appears in Figure 3, with CAB, TAJ, and COM appearing on the upper edge of the branch, and COM the closest neighbor to the sub-cluster. This structure appears in 20 trials. The second-most frequent structure, appearing in 9 trials, has CAB on the upper edge of the branch, and COM and TAJ on the lower edge. Two examples of bootstrapped trials are shown in Figure 4.

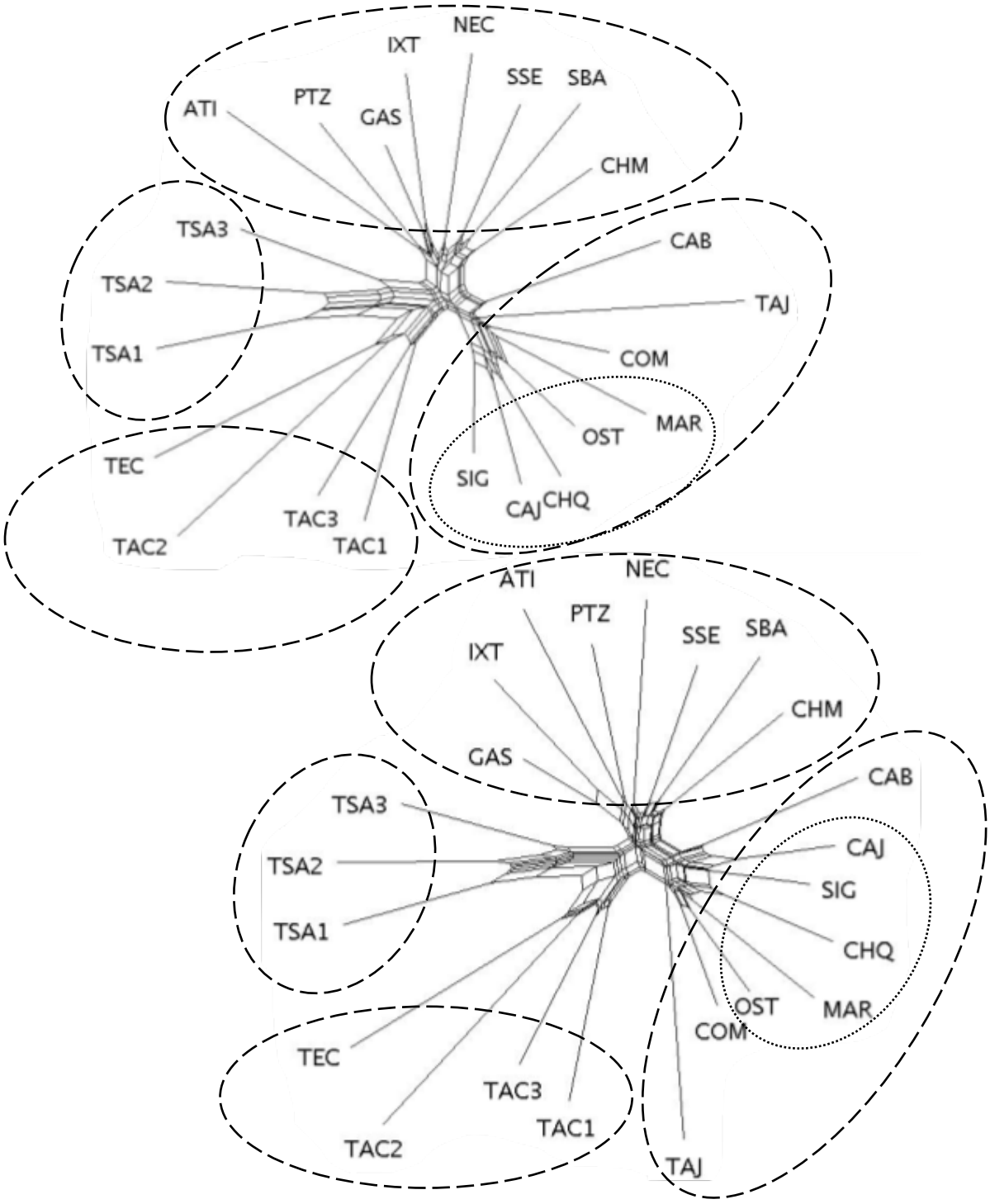

FIGURE 4. Two bootstrapped trials of the phonetic distance network. The four main branches in each are circled with dashed lines. Note how the internal structure of the top and right branches change. The sub-group in the right branch, enclosed by a dotted circle, is a core group of five varieties that consistently appear together in bootstrapped trials.

From this process, it is reasonable to conclude that there are four main dialect groups. The upper branch includes NEC, IXT, GAS, PTZ, ATI, CHM, SBA, and SSE, all municipalities in the Huehuetenango department, clustered near the Seleguá river valley (Godfrey & Collins 1987:80). These are henceforth referred to as the Seleguá group. The right branch includes a core group of five municipalities, SIG, CAJ, CHQ, OST, and MAR, which are clustered together geographically in the Quetzaltenango department. CAB, TAJ, and COM, the former in Quetzaltenango and the latter two in San Marcos, are part of this group but more divergent. This branch is now referred to as the Southern group. The bottom left branch, consisting of TEC and the three TAC varieties, is the Western group. Finally, the left branch, consisting of the three TSA varieties, is the Todos Santos group. The groups are summarized in Table 7.

TABLE 7. Four Main Dialect Groups Generated by Phonetic Distance

Group	*Municipality*	*Abbrev.*
Seleguá	San Juan Atitán	ATI
	Santiago Chimaltenango	CHM
	San Gaspar Ixchil	GAS
	San Ildefonso Ixtahuacán	IXT
	San Pedro Necta	NEC
	San Rafael Pétzal	PTZ
	Santa Bárbara	SBA
	San Sebastián H.	SSE
Southern	*Core:*	
	Concepción Chiquirichapa	CHQ
	San Martin Sacatepéquez	MAR
	San Juan Ostuncalco	OST
	San Miguel Sigüilá	SIG
	Cajolá	CAJ
	Edge:	
	Cabricán	CAB
	Comitancillo	COM
	Tajumulco	TAJ
Western	Tacaná	TAC
	Tectitán	TEC
Todos Santos	Todos Santos Cuchumatán	TSA

4.5. CONTEXTUALIZING DISTANCES AND CLUSTERS. As suggested above, the four main branches of the network correspond roughly to geographic regions. The core cluster of the Southern group is geographically very compact; the route from San Martín Sacatepéquez to Cajolá is only 11 miles long, and one would pass through Concepción Chiquirichapa, San Juan Ostuncalco, and San Miguel Sigüilá along the way. The other, more phonetically distant members of this group—Cabricán, Comitancillo, and Tajumulco—all sit further north and west. Cabricán is the closest, 22 miles from San Juan Ostuncalco, and Tajumulco is the furthest, 38 miles away. The Western group contains Tacaná and Tectitán, two municipalities that are six miles apart, near the border with Mexico. The nearest municipality from a different group is Tajumulco, 29 miles away.

While all of the groups have members that are geographically adjacent, physical distances alone cannot explain the divisions in the network. The varieties from Todos Santos Cuchumatán have their own distinct branch but appear to be very close to the municipalities of the Seleguá group on a map. In fact, the distance between Todos Santos and San Juan Atitán is only five miles as the crow flies. However, the two municipalities are on opposite sides of a mountain range, and the actual journey between them is 43 miles of winding mountain road. Additionally, the centrally located Tajumulco is ten miles closer to Tacaná than San Juan Ostuncalco but appears in the Southern group.

The network shares some structure with the classification previously proposed by Godfrey and Collins (1987:141). Table 8 lists the six groupings detailed in their work and the corresponding groups generated by the phonetic distance network. *Mam huehueteco* is exactly equivalent to the Seleguá group, as is *Mam todosantero* and the Todos Santos group. *Mam quetzalteco* is a subsection of the Southern group; Godfrey

and Collins classify COM as *Mam central* and TAJ as *Mam tajumulco.* Also included in *Mam central* are Concepción Tutuapa and San Miguel Ixtahuacán, two municipalities that were excluded from the present analysis for lack of data.

TABLE 8. Comparison of the Groups Generated by Phonetic Distance with a Previous Classification System

Municipalities	*Godfrey and Collin's Classification*	*Proposed Classification*
ATI, PTZ, GAS, IXT, NEC, SSE, SBA, CHM	Mam huehueteco	Seleguá group
TSA1, TSA2, TSA3	Mam todosantero	Todos Santos group
TAC1, TAC2, TAC3	Mam tacaneco	Western group
TEC	Tektitek	Western group
MAR, OST, SIG, CAJ, CHQ, CAB	Mam quetzalteco	Southern group
COM	Mam central	Southern group
TAJ	Mam tajumulteco	Southern group

Godfrey and Collins stated that the language spoken in Tectitán was 'very divergent' and did not include it as a variety of Mam (1987:112). Kaufman (1969) considered the variety spoken in Tectitán to be a different language, Teco (now Tektitek), a classification which is now generally accepted. However, Tektitek is sometimes considered to be mutually intelligible with Western Mam (see England 1983:6), and therefore it is not wholly surprising that it appears in the same branch in the phonetic distance network. Overall, the two classification systems are compatible, but the phonetic distance network combines several of Godfrey and Collins's groups into one.

The results of the opinion surveys conducted by Godfrey and Collins also provide context for interpreting the network. The researchers asked participants in each municipality if the way of speaking in other Mam communities was exactly the same, slightly different but understandable, or difficult to understand. They also note commercial centers, historical connections between municipalities, and attitudes about which dialects are more or less prestigious.

The Seleguá group (ATI, PTZ, GAS, IXT, NEC, SSE, SBA, CHM) contains eight municipalities that are geographically close together and connected by good highways and commercial relationships (Godfrey & Collins 1987:80). Some of the smaller municipalities were historically *aldeas*, small villages associated with a larger municipality, of other communities in the analysis. Until the late 1940s, San Rafael Pétzal and San Gaspar Ixchil were aldeas of Colotenango, another Mam-speaking town in the area, and Santiago Chimaltenango was an aldea of San Pedro Necta. Speakers from Colotenango considered the speech of all eight municipalities to be very similar to their own, if not exactly identical, and maintained they had no problems understanding anyone from that area. San Ildefonso Ixtahuacán is the commercial center for San Pedro Necta, San Gaspar Ixchil, San Rafael Pétzal, Santa Bárbara, and San Sebastián H. (Godfrey & Collins 1987:80-85). Statistically speaking, the inner structure of this branch of the network is not stable when bootstrapped, and the smaller, internal clusters cannot be considered significant. This mirrors the situation portrayed by the opinion surveys, in which there are differences between municipalities, but they do not have a significant effect on intelligibility.

The Todos Santos varieties appear in their own branch on the network, quite separate from the cluster of other northern municipalities. Godfrey and Collins comment on aspects of the linguistic variation that makes this dialect unique, but unfortunately do not report the results of the opinion survey. Todos Santos has three phonemes that do not appear in other dialects, there are a number of unique lexical variants, and many words have an extra or missing vowel compared to cognate forms in other regions (1987:88).

The Western group contains the varieties from Tacaná and Tectitán. According to Godfrey and Collins, only a small percentage of people under 20 years old speak Mam

in Tacaná (1987:111). The language of Tectitán is considered Tektitek, a language that is closely related to Mam (Kaufman 1969). In the opinion surveys, Tectitán participants said that the speech in Tacaná is very different from their own. However, many people in Tectitán, particularly men, understood and spoke the Tacaná variety. The people of Tectitán considered the variety in Tacaná to have more prestige, and therefore were accustomed to adopting it. This is an example of non-symmetric intelligibility; the people of Tacaná did not typically use the Tectitán variety (Godfrey & Collins 1987:87). Overall, the shape of the network, in particular the long length of the lines connecting these four varieties to the center, is consistent with Godfrey and Collin's conclusion that Tacaná has the variety that is closest to Tektitek and most distant from all other dialects of Mam (1987:99).

B'aayil et al. observed that the western varieties of Mam have the least amount of influence from Q'anjobal and K'iche', and in terms of lexicon, are the most similar to Proto-Mam (2000:129). The tight connection between the Todos Santos and Western branches in the network suggests that the Todos Santos varieties could also have a high number of retentions, because geographically speaking, the populations in these two branches are unlikely to have much contact. B'aayil et al. do not directly address the question of retention specifically in Todos Santos, but another piece of evidence in favor of this hypothesis comes from Godfrey and Collins's observation that in Todos Santos, both men and women have retained their traditional dress (1987:88). In most Mayan communities, the men have switched to wearing Western clothing, and only the women wear Mayan clothing (England 1983:11). It may be possible that Todos Santos has remained both culturally and linguistically more conservative, and therefore has a closer phonetic distance to the conservative western varieties. However, this is simply a hypothesis and more investigation should be done on this point.

Finally, among the municipalities of Southern group (MAR, OST, SIG, CAJ, CHQ, COM, CAB, TAJ), the opinion surveys found that speakers have a very clear awareness of the differences between municipalities, but minimal trouble understanding their speech. Participants in Cajolá considered their dialect to be exactly equal to San Miguel Sigüilá and San Juan Ostuncalco, and similar enough to Concepción Chiquirichapa to be understood. The participants in San Juan Ostuncalco, on the other hand, maintained that their variety of Mam was different from the surrounding municipalities. Godfrey and Collins noted significant phonological differences between San Martín Sacatepéquez and San Juan Ostuncalco, such as a tendency to place stress word-finally. The biggest commercial center of this region, however, is San Juan Ostuncalco, and many from San Martín Sacatepéquez visit regularly for the market. This high degree of exposure explains why intelligibility is high, despite phonological differences (1987:89-92). Additionally, the prestige that San Juan Ostuncalco gains from being the largest commercial center helps explain why their survey responses emphasize more difference between themselves and the surrounding municipalities than vice versa. Godfrey and Collins do not report on the details of the survey responses from Cabricán, Comitancillo, or Tajumulco, which are geographically more central in the Mam-speaking region. However, they report that Tajumulco, despite having its own group in their classification system, shares many features with southern varieties; Comitancillo shares features with both the southern and northern varieties; and Cabricán, though classified with the south, might need more support in adopting a proposed standard based off of the San Juan Ostuncalco variety (1987:93-110). In the phonetic distance network, these three municipalities are consistently in the Southern branch, but on the edge of it. In the majority of the bootstrapped versions, they appear on the edge closest to the Seleguá branch.

Overall, we can see that the results of the phonetic distance algorithm, clustered in a Neighbor-Net, are not at odds with previous dialect groupings and geographic features. However, the varieties from Todos Santos, which are sometimes grouped with the other northern municipalities, are shown to be quite distinct from their neighbors. Opinion survey results and other social and economic information published in Godfrey and Collins (1987) help contextualize the groups and distances seen in the network. From their results, we can conclude that intelligibility within branches is fairly high; differences exist but can be superseded, and there is fairly high exposure between same-branch municipalities through commercial relationships. This is mirrored by the results from the bootstrapping process; the four main branches remain consistent with resampled data, but the internal clusters within branches are unstable.

While the opinion surveys conducted by Godfrey and Collins were a valuable source of contextualizing information, a number of questions remain. Firstly, while the researchers report which regional varieties are judged mutually intelligible by the speakers, they do not specifically report on which varieties are *not*. Secondly, they exclude participants with unusual amounts of experience or exposure to other varieties of Mam from their analysis. While this is appropriate for estimating an 'average' or 'typical' degree of intelligibility between speakers of dialects, it does not lend itself to the investigation of how readily structural differences between regional varieties can be overcome with practice. The next chapter aims to fill these gaps.

5. SOCIOCULTURAL INTERVIEWS. Interviews were conducted to elicit more nuanced and contemporaneous sociocultural information about language attitudes and patterns of contact. These also provided the opportunity to gauge participants' reactions to recordings of Mam from dialects that they may not have previously encountered in Guatemala. The scope of this section is quite limited, as it includes only eight

interviews with Mam speakers, most of whom are highly educated and from the same region. It should not be seen as a comprehensive account of the sociocultural landscape. However, it provides a valuable look at the perspectives of a certain demographic of Mam speakers in Guatemala, in particular, how they perceive and adjust to dialectal differences that they encounter in their professional careers. Additionally, a Mam interpreter and an immigration officer in the United States are asked directly how they handle differences between regional dialects in their work. Section 5.1 briefly lays out the methodology, Section 5.2 introduces the demographics of the participants, and Sections 5.3 through 5.6 discuss common themes and key observations from their interviews. The terms 'inter-' and 'intra-regional' in this section refer to the four dialect groups proposed in Section 4: Seleguá, Todos Santos, Western, and Southern.

5.1. METHODS. Interviews were conducted orally and audio recorded. All interviews with Mam speakers were conducted in Spanish, with one exception (P8) that was conducted in English. For interviews with Mam speakers, the participants were first asked about their demographics and linguistic histories, and more general questions about language exposure. In order to elicit opinions about Mam dialects spoken in regions that they may not have visited or encountered, three audio samples of Mam speech were taken from YouTube. The first was a recording of a middle-aged female teacher in Comitancillo, telling a story to a group of children. The second was a recording of two older women from Todos Santos who were prompted to 'speak in Mam' by a Spanish-speaker at the beginning of the video. The third recording was of a young man from Huitán, a town three miles south of Cabricán, speaking about Mam language and culture directly to the camera. These three clips were not intended to be used comparatively; simplicity of language, background noise, rate of speech, and individual speaker effects were not controlled for. While the participants were asked to

rate each video on how well they understood it, how well the speaker spoke Mam, how beautiful their dialect was, and how much they would like to travel or live in the place where it was spoken, these scale ratings were simply intended to elicit qualitative responses. For each recording, the participant listened to 30 seconds of audio. He or she then answered questions about that recording, and the process was repeated for the next sample. The full set of interview questions is included in Appendix D.

Individual interviews with Mam speakers were numbered and transcribed. Results were qualitatively analyzed, and common themes were identified using emergent coding. As there was only one interview with an immigration officer in the US, key points from this interview were extracted and included. The excerpts discussed below were translated by the author. Anonymized participant numbers follow each quoted excerpt.

5.2. PARTICIPANTS. There was a total of eight participants who were native Mam speakers. They ranged in age from 21 to 78, and the average age was 48. Seven participants (P1-7) were born and continued to live in Concepción Chiquirichapa, San Juan Ostuncalco, and surrounding aldeas. These two towns are very close by, only one mile apart, in the department of Quetzaltenango. The eighth participant (P8) was born in Santiago Chimaltenango, near the Seleguá river valley in Huehuetenango, and lived there until she moved to the United States as a young adult. Six of the participants were women. With the exception of one older woman who had no formal schooling (P1), all of the participants had experience in higher education and professional careers. Six were teachers with bilingual classrooms (P2-7). In addition to that career, two of these six worked for the Guatemalan Academy of Mayan Languages (P3, P7), one worked for the General Management of Bilingual and Intercultural Education (P3), one worked as a cartographer (P6), and one worked as a tourist hiking guide (P2). One was a nurse and

adult literacy coach in Guatemala who has since become a Mam interpreter for a school district in California (P8). The immigration officer was a white male who did not speak Mam.

All Guatemalan participants considered Mam to be their native language, and all spoke Spanish fluently. Six reported that they first learned to speak Spanish when they began going to school at age five or six. One exception (P6) was a man whose father spoke Mam and whose mother spoke Kaqchikel and K'iche'. Since the parents typically communicated in Spanish at home, he learned it as a native language as well. The other exception was the 78-year-old woman with no formal schooling (P1), who started to learn Spanish when her own children entered school.

5.3. PATTERNS OF INTRA- AND INTER-REGIONAL CONTACT. Within regions, inter-town marriages and migrations are common. The participants who live and work around San Juan Ostuncalco and Concepción Chiquirichapa described fairly consistent communication with people from other nearby Mam-speaking communities in the Quetzaltenango department, including San Martín Sacatepéquez, San Miguel Sigüilá, Cajolá, and Cabricán. Three have a spouse or parent from another municipality in that group, and six have either attended school or worked in another nearby town. Five said that they visit another municipality in the group at least once per week.

Intra-region contact is also high due to shared access to cultural and commercial resources. While the participants interviewed here were educated professionals who likely traveled more than the average person in the community, they also describe ample opportunity to hear the Mam of other nearby towns without leaving their own community. Three said that they listen to radio programs broadcast in Mam from nearby municipalities. One woman, an elementary school teacher, described having schoolmates from San Martín Sacatepéquez, San Miguel, Cajolá, Huitán, and Cabricán

when she studied for her teaching degree in San Juan Ostuncalco. They also have contact with people from other communities through the central market:

(1) Well, what happens is that San Juan is a very commercial municipality … Sundays and other important days people from other municipalities come to sell. They come from Comitancillo. It's very frequent that people from other municipalities come, to do, say, commercial transactions. (P7)

The woman from Santiago Chimaltenango described having frequent contact with other people from other towns around the Seleguá Valley, including San Pedro Necta, San Juan Atitán, Santa Bárbara, San Sebastián H., and Colotenango. She was part of a church group which had members from all of those towns. She also traveled around these areas as a community health worker. She never traveled to Todos Santos Cuchumatán, but her father had a coffee farm in that region, with many Todosantero workers.

Exposure across dialect regions, on the other hand, is largely limited to higher prestige educational or professional pursuits. Participants from Quetzaltenango have significantly less frequent contact with communities in Huehuetenango than other municipalities in their local region. They only reported traveling this far for professional reasons; one woman went monthly to develop literacy materials with a bilingual education leader who lived in San Sebastián H., and another woman went to Huehuetenango a few times a year connected to her work in tourism. Two of the teachers described having professional development meetings a few times a year in either San Marcos or Huehuetenango. Only one participant mentioned Tacaná, on the far western edge of the country; he was sent there as part of a cartography contract. In response to the question 'Would you like to travel or live where they speak Mam like this?' after a recording from a different department, two of the eight participants said no specifically because they did not have any family to visit there. Travel appears to be

limited to business or visiting family, and none of the participants had family in a Mam-speaking town in a different department.

Participants reported that radio programs are limited to nearby towns, and that national and departmental television and radio is broadcast exclusively in Spanish. However, children do have some exposure to varieties from other departments through the literacy materials used in the schools. Four participants reported teaching from books written in Huehuetenango or San Marcos in their classrooms or using them when they were first learning to read themselves.

(2) But the books in the schools … are written in another version of Mam, so also you learn the Mam of other regions. Almost all of the books are from other parts, some from San Marcos, some from Huehue - it's whoever they contracted to write the book. (P7)

(3) Some books are the dialect from here [San Juan Ostuncalco] There are others that are from Huehue, others from San Marcos. (P6)

(4) There in Huehue [they say] /wa'/ - it's 'toad'. And here [San Juan Ostuncalco] is /xta'/, so they are different. We had a book that we started to read, and this word came up. 'What is this?' we asked the teacher. Then he told us that it was the same, that they are dialectal differences. (P5)

With one exception, all of the participants interviewed here were literate in Mam. This is not the norm in Guatemala, as L1 literacy is estimated to be less than five percent (Simons & Fennig 2018). Other individuals who lived in San Juan Ostuncalco and San Martín Sacatepéquez, and did not fluently read and write in Mam, commented anecdotally that reading in Mam was more difficult than reading in Spanish, because, like English, the letters did not match the pronunciation. Given that the orthography for Mam is designed to be phonetic, one can speculate that the difficulty arose from using materials developed in a different dialect. The Mam interpreter living in California expressed a similar challenge, regarding translation work for the local library.

(5) Sometimes they ask [me] to make flyers in Mam. But it's a little bit confuse [sic.] because the people from Todos Santos they can ... some of them can

read but ... if I'm writing something in my Mam, my language, they will not understand. That's the problem. (P8)

Even if primary school students are given some exposure to other dialects of Mam during their first few years of learning how to read, secondary education is generally conducted in Spanish, and students are unlikely to have significant exposure to those more distant dialects thereafter.

5.4. PERCEPTIONS OF DIALECTAL DIFFERENCES. All participants commented on specific dialectal differences between the speech of their hometown and those of nearby communities. They mentioned both pronunciation and lexical differences.

(6) It's different. They have a pronunciation that is stronger, or weaker, say, or maybe some are slower. (P5)

(7) Here in San Juan, for 'man', here we say /iichin/, but in Conce [Concepción Chiquirichapa] they say /chan/, so it's a little different. (P2)

(8) Here [San Juan Ostuncalco] when something is good we say /b'a'n/. There [Cajolá] they say /ween/. (P3)

Almost all participants from the Southern group insisted that, despite those differences, they understood each other well.

(9) There are dialectal differences but yes it's the same Mam, it's Mam they speak, because although some words are not the same we still understand each other. (P3)

(10) Sometimes it's more difficult to understand the words from other municipalities because there are words that are very unique to that municipality. For example … in Concepción Chiquirichapa, which is nearby- Here in San Juan we say 'no' as /mixti/. They say /kla/, but the people understand each other. They don't talk like that but they understand. (P7)

(11) San Marcos? Yes, we understand each other. We always have some variations ... it's not the same, then, but yes we understand each other, the message. (P4)

There was only one exception, the woman who did not have a formal education or a profession outside of the home, and who mainly stayed in her aldea of San Juan Ostuncalco. She said that sometimes she did not understand people from San Miguel

Sigüilá, Cajolá, or Concepción Chiquirichapa because the words and pronunciation were different.

Even across regions, where structural differences between varieties are more pronounced and contact is reduced, the majority of the participants emphasized that it is still the same language and difficulty can be overcome.

(12) It's different, different words. Sometimes you understand, sometimes you don't. If you don't understand, you ask the person what they meant by what they said. (P6)

The participant recognizes differences and acknowledges challenges in comprehension, but does not view these as insurmountable challenges.

5.5. POSITIVE ATTITUDES AND SOLIDARITY WITHIN THE MAM COMMUNITY. The majority of the participants made positive comments towards varieties of Mam that were different from their own. Four participants made positive comments after listening to the audio recordings, in their responses to the questions 'How well does this person speak?' and 'How beautiful do you think their dialect is?'

(13) In my opinion they speak well ... I understood like five words, but the rest I didn't understand. I'm sure it's a beautiful language if you understand. (P8)

(14) Beautiful for them where they are, but for us we don't understand so four out of five. (P4).

(15) They speak this way, they understand well. This is how they speak. (P1)

One of the participants, an administrator in the government's bilingual education program, directly rejected the idea of a standard.

(16) Each region has its accent, so we cannot say this is the correct one. We say that all are correct, one only has to learn the different forms. There isn't one that is better than another. (P7)

There was only one negative comment about other varieties of Mam:

(17) It always feels odd because it's not the true Mam, one's own true Mam, but yes, yes we understand each other. (P4)

None of the participants directly criticized a speaker for using a Mam word that was different than his or her own, but two participants reported that a speaker in a recording spoke less well and less beautifully because she used Spanish words. Collins (2005) also finds that highly educated Mam speakers have negative attitudes towards Mam-Spanish codeswitching. Mam teachers, in particular, often consider the act of codeswitching to support the erroneous and discriminatory view in Guatemala that indigenous languages are 'inferior' and 'unable to articulate complex ideas' (255). They avoid the practice as part of a wider sociopolitical ideology oriented against oppression from the Spanish-speaking majority (240). Although the present interviews did not directly investigate attitudes towards non-indigenous communities, the broader sociopolitical context and the two negative responses to codeswitching suggest that an anti-Spanish orientation might heighten participants' solidarity in their use of Mam. Collins' work suggests that this ideology is more pronounced among the highly educated, such as the majority of participants interviewed here. It should be noted, however, that the participant without formal education (P1) also demonstrated a pluralistic acceptance of other dialects, even when she could not understand them.

ROLES OF EXPOSURE AND ACCOMMODATION. Four participants acknowledged the role that practice played in their ability to understand people from different Mam speaking regions well.

(18) In my case, I'm used to it, so I understand. (P2)

(19) Because of the practice that I've had ... how I've learned other words in other places - that makes it easier. Now when people only speak in [their] region there, sometimes it is difficult [for them] to understand the words from other municipalities. (P7)

In contrast, the one woman who had very limited contact with other varieties of Mam (P1) spoke more about differences and difficulties in comprehension and was one of the only participants who did not emphasize shared understanding in her interview.

This woman was one of two participants who admitted having trouble understanding a different variety of Mam. After listening to the recording from Todos Santos, she reported not understanding much at all. The interpreter from Santiago Chimaltenango (P8), likewise, reported only understanding 'maybe four words' of the recording from Comitancillo. The latter participant traveled and had exposure to Mam-speaking towns in Huehuetenango, but not in San Marcos, where Comitancillo is. She also described an experience with another Mam woman in California, who was from San Martín Sacatepéquez.

(20) I went to help someone from San Martín Quetzaltenango but it's different. We didn't understand each other. I think it's different Mam ... She said 'Oh, your Mam - it's different. I speak Mam but it's different.' And I said okay. But she speak [sic.] Spanish, so I didn't work with her. (P8)

This participant reported changing her own speech patterns when speaking to people from Todos Santos, so that they would understand her better.

(21) People from Todos Santos, some of them understand a little bit more my dialect, but some of them, nothing. Not nothing, but they say 'Oh I don't understand, what do you say?' But I'm trying to talk a little bit like them because ... I learn a little bit the sounds, the names of things, and all those things. It's helping me a lot to communicate. (P8)

As described previously, this participant had exposure to the Todos Santos dialect when she was growing up. In general, however, there is less contact between Todos Santos and other Mam-speaking municipalities in Huehuetenango, so Todosanteros often do not have the same degree of exposure to a dialect like her own. As an interpreter, she adjusts her accent and lexicon when working with clients from Todos Santos so that they will understand her better. A teacher from San Juan Ostuncalco described doing something similar when she taught in Cajolá.

(22) I had to adopt how it is there ... When I said words that were from San Juan the children would laugh because they didn't understand well. Then I had to talk like they talked there. (P3)

Speakers who have had sufficient exposure and are highly motivated in their communications with speakers from other dialect regions may be able to rely on accommodation strategies to improve comprehension (see Giles 2016). Both participants here adjusted their speech patterns in production in order to be successful in their professional pursuits.

5.6. DIALECTAL DIFFERENCES IN INTERPRETATION SETTINGS IN THE UNITED STATES. According to an immigration officer in the United States, the majority of Mam monolinguals encountered in the immigration system have not traveled outside of their own town, and it is rare that they have a formal education. The primary language of instruction in Guatemalan secondary schools is Spanish, so if an immigrant arriving in the US is monolingual in Mam, they most likely did not attend many years of school.

The officer reported that many times, the Mam interpreters tell him that they understand the client, but the client does not understand them. The interpreters are professionals, and have considerable practice listening to many different forms of Mam. The client, on the other hand, typically does not. The officer concluded that 'it all comes down to exposure.' Comparing the situation with Arabic, he said that a Yemeni client will usually be able to understand an Egyptian interpreter because they often have experience with Egyptian media. This is rarely the situation for indigenous languages in Central America; he sees few monolingual Mam immigrants with any exposure to other varieties.

If an interpreter and client do not understand each other, the interpreter informs the immigration officer of the difficulty and he asks the translation service to provide another interpreter. Before doing so, he will find out where the person is from, so that they can find someone from a similar region. He has found that sometimes they could both be from the San Marcos department, but not from the same town, and they will not

understand each other. He considers the variety in Todos Santos to be 'completely different' from the other varieties in Huehuetenango and mentioned that he usually needs someone who is also from Todos Santos to interpret.

The interviews with the immigration officer and the Mam interpreter both demonstrated that regional varieties and reduced comprehension are major concerns for them during interpreted conversations. Both make sure to ask clients where they are from and if they understand the interpreter. They both report that geography alone is not sufficient for predicting if a client and interpreter will be able to understand one another. The fact that both parties come from the same department in Guatemala does not mean that they will be able to understand one another well. The interpreter and the officer are also both very aware of the role that exposure plays in a client's ability to understand the interpreter. Because clients often have less experience hearing other regional varieties than the interpreter does, an asymmetrical situation results, in which the interpreter can understand the client much better than the reverse.

In general, Mam-speaking participants took great pride in their language, across all of its dialects, and reported positive attitudes towards speakers of other varieties. The majority of participants here were well-educated and had professional careers, mostly as teachers, that occasionally brought them in contact with people from other Mam-speaking regions. In eight interviews, only two participants reported very low comprehension of a recording from a different region. A participant from the Southern group was unable to understand a speaker from Todos Santos, and a participant from the Seleguá group was unable to understand a speaker from the Southern group. In both cases, the participant had little or no contact with the people from the region in question. Degree of exposure plays a large role in a speaker's ability to understand a variety of Mam that is not in the same group as their own, and interpreters and teachers

who accommodate the speech patterns of other dialects have successfully improved comprehension with their clients and students.

6. DISCUSSION. The current analysis of Mam regional dialects was proposed in response to a dramatic increase in the number of Mam speakers in the United States, who are often interacting with immigration authorities, courts, schools, and hospitals with the aid of an interpreter. Given previous observations of a high degree of variation between dialects, it is of interest to investigate how well speakers from different regions are able to understand each other and whether dialectal differences prevent an interpreter from being able to successfully work with a client.

Section 6.1 summarizes the results of both the computational and sociocultural analyses presented in this paper and discusses how they interact to build a fuller understanding of intelligibility between dialects. Section 6.2 directly addresses some of the criticisms of Levenshtein distance as a method in dialectology and argues that it is an appropriate and effective tool for the present purpose. Finally, Section 6.3 contains recommendations regarding the matching and professional development of Mam interpreters in the United States.

6.1. SUMMARY. The results of the phonetic distance analysis show four main dialect groups: Western, Southern, Seleguá, and Todos Santos. These groups are partially predictable geographically, but not completely. For example, Todos Santos appears very close to the Seleguá group on a map but has its own distinct branch in the network.

A distance matrix or network figure is meaningless without qualitative observations that allow us to interpret and scale the quantitative information. The results of previously published dialect opinion surveys (Godfrey & Collins 1987) indicate that intelligibility is high between members of each of the four groups, but do not include information about the degree of intelligibility across groups. The second part of the

current analysis, the sociocultural interviews with Mam speakers, addresses this question. Participants with no exposure to an across-group dialect reported low comprehension, but a small amount of personal experience with that dialect improved comprehension greatly. To continue with the example from the previous paragraph, interviews confirmed that speakers from the Todos Santos and Seleguá groups are not easily able to understand one another unless they have had exposure to the other dialect.

The phonetic distance network is a proxy for 'inherent intelligibility', how similarity between two linguistic forms can help speakers of different varieties to understand one another. However, patterns of contact and social attitudes also play large roles in intelligibility. High levels of contact among communities across regions would indicate that real-world intelligibility tends to be higher than the phonetic distance network suggests. Likewise, negative attitudes towards other Mam communities and their language varieties would indicate that intelligibility tends to be lower than the network suggests, i.e., that functional intelligibility could be quite low even between varieties that are phonetically very similar. The sociocultural interviews examine the roles of these two factors. The findings, low inter-group contact and overall positive attitudes, suggest that intelligibility predictions based on phonetic distance will not be radically affected by community-level social factors.

With regard to Mam interpretation in the United States, interviews with an immigration officer and a Mam interpreter revealed that dialectal differences are a real challenge in this setting. It is not infrequent that an interpreter and a client find that they cannot understand each other well, and that a new interpreter from a different region must be found. Often, the interpreter will understand the client better than the reverse, because the interpreter has more exposure to a variety of Mam dialects.

6.2. USE OF LEVENSHTEIN DISTANCE IN DIALECTOLOGY. The present investigation of intelligibility between language varieties relies on an algorithm, Levenshtein distance, that is insensitive to many linguistic features and complexities. In Section 2.4, the method was justified by pointing to a number of studies across language families that correlate Levenshtein distance between cognates with results of comprehension tests. Here, I discuss some of the criticisms of computational approaches and why Levenshtein distance might be a more appropriate proxy for intelligibility than is immediately apparent.

First, an algorithm that treats all edits between two words equally has been criticized as blunt or reductionist in this application (see McMahon et al. 2007). Indeed, many dialectology researchers have worked to refine the method by incorporating more fine-grained articulatory or acoustic distances between particular sounds (see Heeringa 2004, Kessler 2005, Heeringa et al. 2006). However, even complex systems of weighted edit costs based on distances between spectrogram images have not improved the predictive power of the algorithm (Heeringa et al. 2006).

In retrospect, these results are not surprising. A model of intelligibility should model perceptual distances, not production ones. Linguists have a convenient proxy for perceptual distances in the form of phonemic transcriptions. Phonemes are perceptual categories; differences within categories are minimized and differences across categories are amplified. An implementation of Levenshtein distance that uses phonemic transcriptions as input is already sensitive to changes that the listener deems meaningful. Judging from comments in the interview portion of the study, a Levenshtein distance approach based on phonemes may even have parallels with folk perceptions of how Mam dialects differ: ‘they have this accent, this pronunciation .... sometimes they insert in more [sounds], and sometimes they get rid of some’ (P2). The

participant is describing insertions and deletions, two of the edits quantified by the Levenshtein distance algorithm.

Second, phonetic distance algorithms are sometimes tainted by their association with lexical similarity measures, as they are both methods that distill complex linguistic relationships into numbers. However, as discussed in Section 2.4, researchers have found phonetic distance to be a more consistently strong proxy for modeling intelligibility than lexical similarity. Conceptually speaking, there are a number of advantages. Phonetic distance captures both phonological and morphological differences. If a morpheme is different from one variety to the next, it will lead to more edits and increase the overall distance. Lexical similarity is limited to the lexical level. Additionally, it can reasonably be hypothesized that phonetic distance is less sensitive to the subjective choice of which words belong in the comparison list than lexical similarity is. With a sufficient number of cognates, the algorithm should be able to account for a large cross-section of different sound changes. One could further test this hypothesis by comparing the stability of lexical similarity and phonetic distance results with resampled word lists.

Finally, the fact that phonetic distance-based trees and networks of dialect relationships are accurate on a broad level but not a fine-grained one is sometimes seen as a liability, especially in applications that involve mapping historical relationships (see Kessler 1995). However, this is largely inconsequential when determining intelligibility. In the present analysis, the network consistently produced four main groups under resampling, but the inner structures of some of those groups were random. From the results of opinion surveys and interviews, the dialectal differences within those branches were not found to be an impediment to intelligibility. Intelligibility is a multi-faceted concept that is dependent on an individual's background, the topic and medium of

conversation, attitudes and bias at both individual and social levels, and many other factors in addition to the structural similarities between language varieties. One cannot make strong and detailed claims about intelligibility between linguistic communities as wholes; one can only estimate how language structure and social factors influence comprehension in a theoretical average interaction. A blunt tool, such as a network that shows general tendencies, is not so much limiting as it is appropriate for the application.

6.3. RECOMMENDATIONS FOR MAM INTERPRETERS IN THE UNITED STATES. Regional dialectal variation is a challenge for Mam interpreters and those working with them in the United States. It is not uncommon for an interpreter or client to say that they do not understand the other party well, and for a new interpreter to be sought out. Whether or not people from two different Mam-speaking municipalities can be reasonably expected to understand one another is not fully predictable from geography. In interviews, both the Mam interpreter and the immigration officer mentioned that they had noticed dramatic differences or reduced comprehension between dialects in municipalities that are both in the San Marcos department. Likewise, they both commented on comprehension difficulties between speakers from Todos Santos and speakers from the other nearby municipalities within the Huehuetenango department. Both observations are consistent with the groupings presented in the phonetic distance analysis, which split San Marcos into Western and Southern branches, and Huehuetenango into Seleguá and Todos Santos branches.

Since department boundaries do not offer an adequate predictor of how well speakers will understand one another, the officer sometimes specifically requests an interpreter from the same hometown as the client. However, there is a shortage of Mam interpreters working in the US and finding a professional in the first place can be a lengthy process (Sanchez 2018). Initially assigning interpreters based on the four groups

outlined in Table 7 can limit the number of times that a new interpreter must be found, and can facilitate the search for an interpreter by expanding the options to people beyond the client's hometown.

Both the immigration officer and Mam interpreter also commented on asymmetries in comprehension when the interpreter and client are from different regions. The interpreter, as a professional, tends to have exposure to and practice understanding diverse dialects, but the client typically does not. The interpreter will understand the client much better than the reverse. The interpreter interviewed in the present work combats that asymmetry by adopting the words and accent of clients from another municipality. Professional development that includes exposure to a variety of Mam dialects, as well as coaching on reproducing non-native accents, would help interpreters to work successfully with a wider variety of clients.

7. CONCLUSION. This investigation estimated the degree of intelligibility between regional dialects of Mam. Using the Levenshtein distance algorithm to compare words in previously collected word lists, a phonetic distance matrix was calculated for 23 municipalities. This was clustered and visualized in a network figure, using the Neighbor-Net method. Four main groups emerged; the Western group included Tectitán and Tacaná, the Southern group included municipalities in the Quetzaltenango department as well as Comitancillo and Tajumulco, the Seleguá group included municipalities near the Seleguá Valley in Huehuetenango, and the Todos Santos varieties were a group by themselves. These groups can be used to make informed decisions about matching interpreters and clients in courts, schools, and hospitals in the US.

A Levenshtein distance-based analysis has previously been published only for languages of the Indo-European, Sino-Tibetan, and Kra-Dai families. The method's

successful implementation on Mam dialects is a promising sign that it can also provide good results for other Mayan languages, as well as other indigenous languages of Mesoamerica. There are populations of indigenous language speakers from many parts of Mexico, Central, and South America living in the US, and many of these language communities could benefit from intelligibility studies in order to make recommendations around interpreter matching. The present method takes advantage of Swadesh and other word lists, which exist for many language varieties already, and uses computational tools to glean new information from them, making the possibility of a comprehensive intelligibility study for many languages much more immediately attainable.

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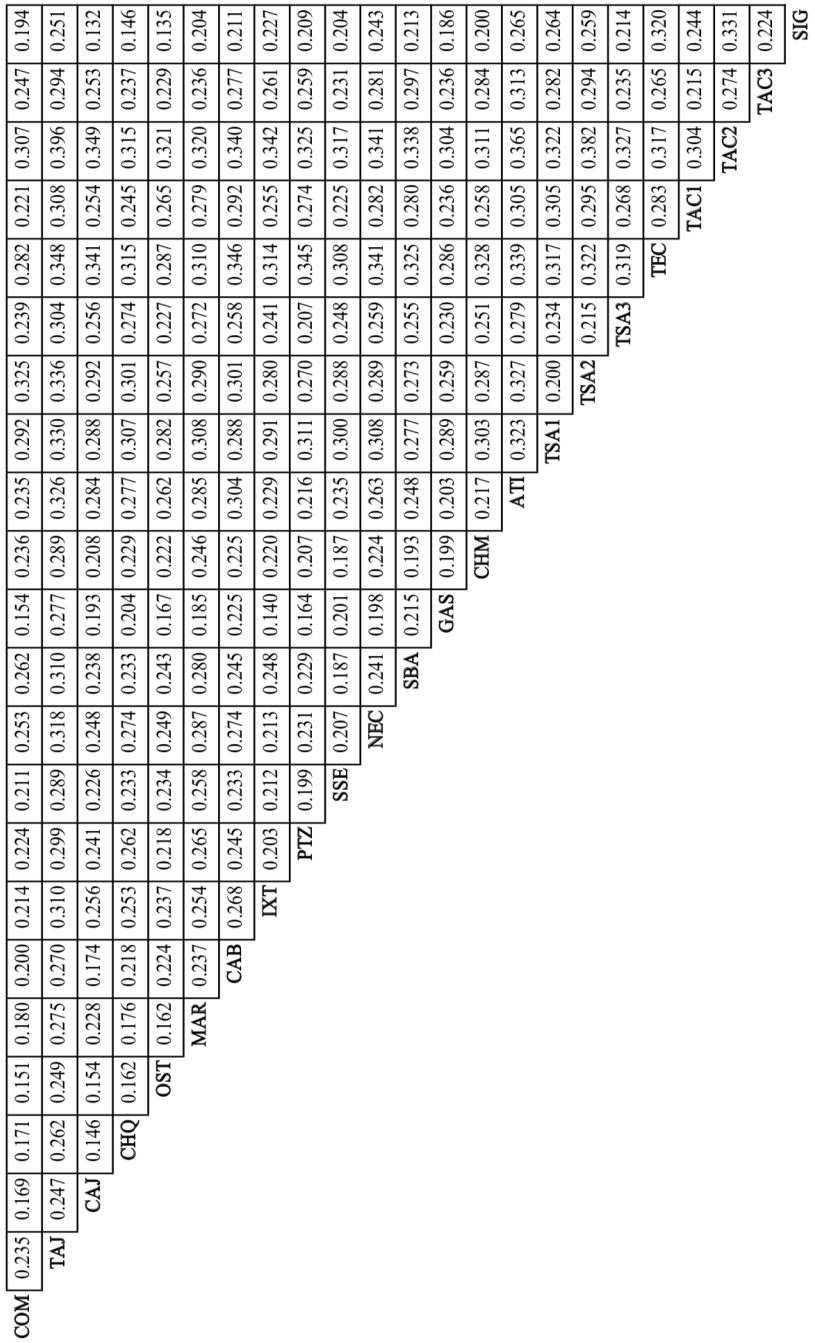
APPENDIX A.

Phonetic distance matrix

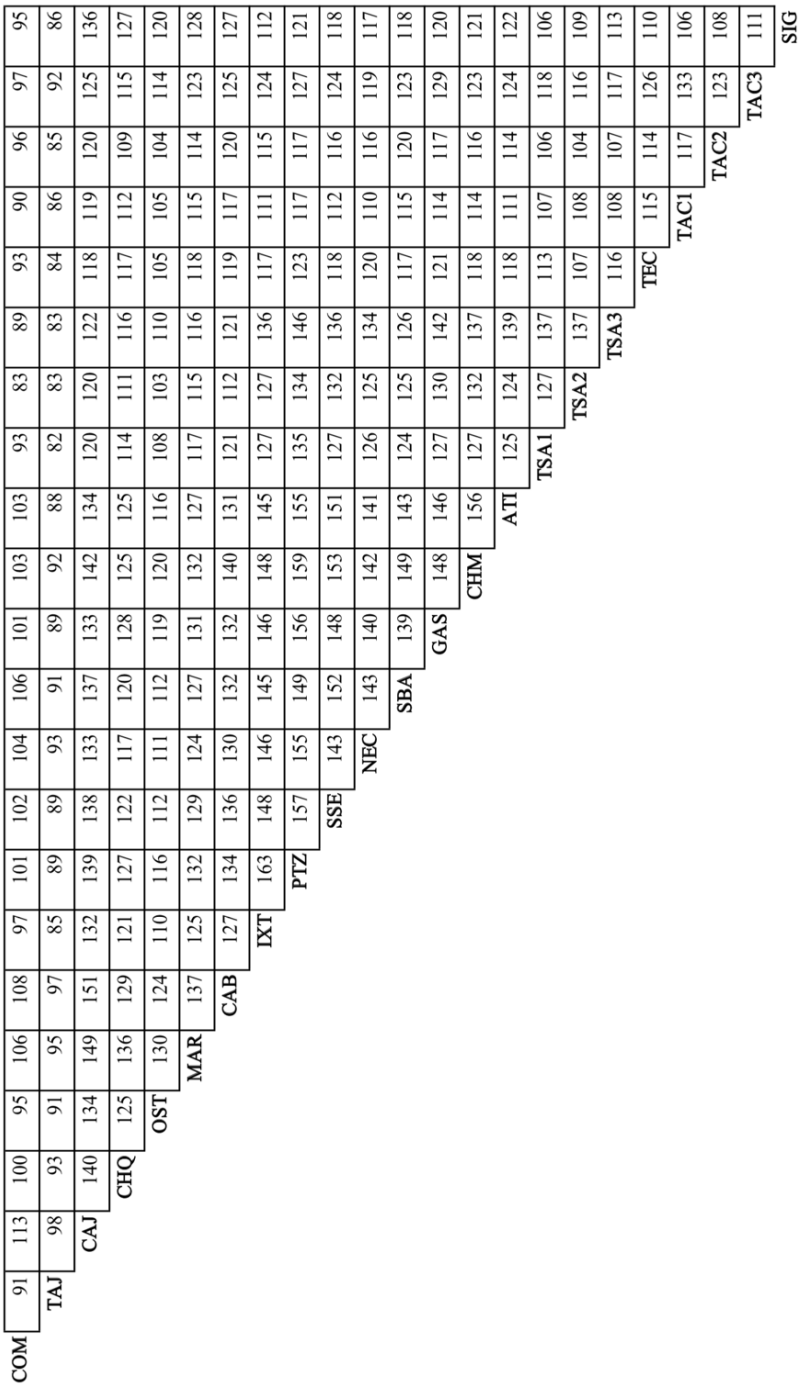


	COM	TAJ	CAJ	CHQ	OST	MAR	CAB	IXT	PTZ	SSE	NEC	SBA	GAS	CHM	ATI	TSA1	TSA2	TSA3	TEC	TAC1	TAC2	TAC3	SIG
COM	0.235	0.169	0.171	0.151	0.180	0.200	0.214	0.224	0.211	0.253	0.262	0.154	0.236	0.235	0.292	0.325	0.239	0.282	0.221	0.307	0.247	0.194	
TAJ	0.247	0.262	0.249	0.275	0.270	0.310	0.299	0.289	0.318	0.310	0.277	0.289	0.326	0.330	0.336	0.304	0.348	0.308	0.396	0.294	0.251		
CAJ	0.146	0.154	0.228	0.174	0.256	0.241	0.226	0.248	0.238	0.193	0.208	0.284	0.288	0.292	0.256	0.341	0.254	0.349	0.253	0.132			
CHQ	0.162	0.176	0.218	0.253	0.262	0.233	0.233	0.274	0.233	0.204	0.229	0.277	0.307	0.301	0.274	0.315	0.245	0.315	0.237	0.146			
OST	0.162	0.224	0.174	0.237	0.218	0.234	0.237	0.249	0.243	0.167	0.222	0.262	0.282	0.257	0.227	0.287	0.265	0.321	0.229	0.135			
MAR	0.237	0.254	0.265	0.258	0.234	0.287	0.280	0.246	0.185	0.308	0.290	0.272	0.310	0.279	0.320	0.236	0.204						
CAB	0.233	0.245	0.262	0.233	0.274	0.245	0.225	0.225	0.204	0.288	0.301	0.258	0.346	0.292	0.340	0.277	0.211						
IXT	0.212	0.203	0.241	0.226	0.248	0.213	0.274	0.304	0.229	0.291	0.280	0.241	0.314	0.255	0.342	0.261	0.227						
PTZ	0.199	0.231	0.229	0.164	0.140	0.220	0.207	0.216	0.311	0.270	0.207	0.345	0.274	0.325	0.259	0.209							
SSE	0.207	0.187	0.201	0.187	0.235	0.288	0.248	0.308	0.225	0.317	0.231	0.204											
NEC	0.241	0.198	0.224	0.263	0.308	0.289	0.259	0.341	0.282	0.341	0.281	0.243											
SBA	0.215	0.193	0.248	0.277	0.273	0.255	0.325	0.280	0.338	0.297	0.213												
GAS	0.199	0.203	0.289	0.259	0.230	0.286	0.236	0.304	0.236	0.186													
CHM	0.217	0.303	0.287	0.251	0.328	0.258	0.311	0.284	0.200														
ATI	0.323	0.327	0.279	0.339	0.305	0.365	0.313	0.265															
TSA1	0.200	0.234	0.317	0.305	0.322	0.282	0.264																
TSA2	0.215	0.322	0.295	0.382	0.294	0.259																	
TSA3	0.319	0.268	0.327	0.235	0.214																		
TEC	0.283	0.317	0.265	0.320																			
TAC1	0.304	0.215	0.244																				
TAC2	0.274	0.331																					
TAC3	0.224																						
SIG																							

Source code and data available at https://github.com/m-c-simon/mam-phonetic-distance

APPENDIX B.

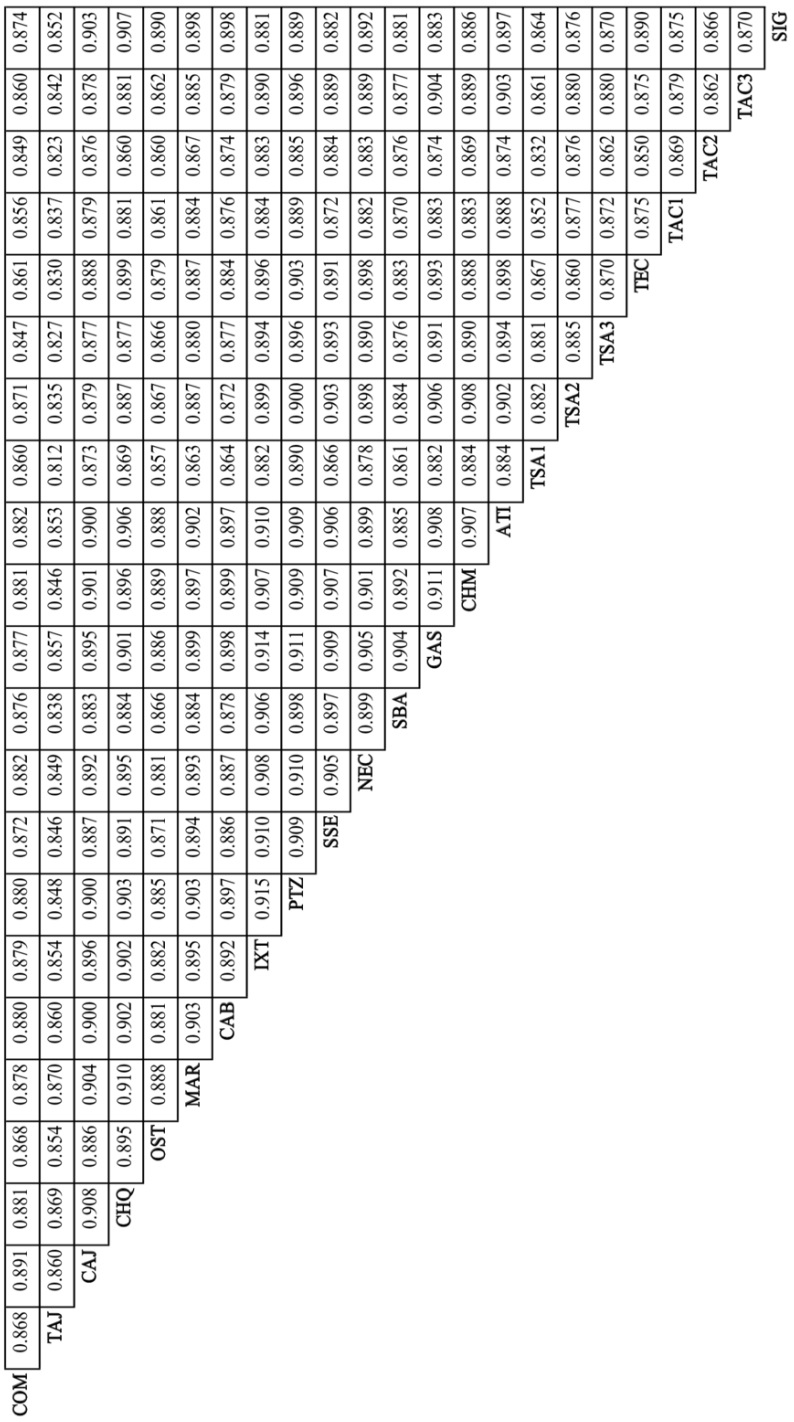
Number of cognate pairs compared in each distance score



Source code and data available at https://github.com/m-c-simon/mam-phonetic-distance

APPENDIX C.

Matrix of Cronbach alpha values



Source code and data available at https://github.com/m-c-simon/mam-phonetic-distance

APPENDIX D.

Sociocultural interview questions and audio clip prompts

MAM SPEAKERS IN GUATEMALA

Do you identify as male or female?
How old are you?
Where were you born and where did you grow up?
Where were your parents born? Your grandparents? Your partner/spouse?
What is your native language?
Do you speak any other languages? On a scale of 1-5, how fluent are you?
Do your parents speak any other languages?
How big is your hometown?
Did you ever move from one town to another in Guatemala?
How often do you travel to different towns?
How often do you speak to someone who is not from your hometown?
What is your occupation or livelihood?
What languages do you speak at school?
What languages do you read?
What languages do you hear on the radio or television?
Do the people in neighboring towns speak the same as you?
How well do you understand people from the neighboring towns?
In response to audio clips from three regions:
- Do you know where this person is from?
- How do you know?
- On a scale of 1-5, how well does this person speak Mam? Why?
- On a scale of 1-5, how beautiful do you think their dialect is? Why?
- On a scale of 1-5, how much would you like to live where they speak that dialect? Why?
- On a scale of 1-5, how well do you understand their dialect? Why?

MAM INTERPRETERS IN THE UNITED STATES

Do you identify as male or female?
How old are you?
Where were you born and where did you grow up?
How old were you when you left Guatemala? When you came to the US?
Where were your parents born? Your grandparents? Your partner/spouse?
What is your native language?
Do you speak any other languages? On a scale of 1-5, how fluent are you?
Do your parents speak any other languages?
How big was your hometown?
Did you ever move from one town to another in Guatemala?
How often did you travel to different towns?
How often did you speak to someone who was not from your hometown?
What was your occupation or livelihood?
What languages and dialects did you speak at school?
What languages and dialects did you read?
What languages and dialects did you hear on the radio or television?
Did the people in neighboring towns speak the same as you?
How well did you understand people from the neighboring towns?
In response to audio clips from three regions:

Do you know where this person is from?
How do you know?
On a scale of 1-5, how well does this person speak Mam? Why?
On a scale of 1-5, how beautiful do you think their dialect is? Why?
On a scale of 1-5, how much would you like to live where they speak that dialect? Why?
On a scale of 1-5, how well do you understand their dialect? Why?

How do people who need interpreting services find you?
What are some challenges of interpreting?
Do you ever interpret for Mam speakers who are from a different town or region than you? Is that more difficult or about the same?

IMMIGRATION OFFICERS

Do you work with people who speak Mam?
What languages do you use to communicate with them?
Do you use an interpreter?
What is the process for finding an interpreter?
On a scale of 1-5, how well do you think you're able to understand someone through an interpreter? Can you elaborate on your answer?
Do interpreters and clients ever have difficulty communicating? Why do you think that is?

AUDIO CLIP PROMPTS

Todos Santos Cuchumatán, Huehuetenango: https://www.youtube.com/watch?v=j2WZsDB2LHM
Comitancillo, San Marcos: https://youtu.be/BS3DALbt31g?t=111
Huitán, Quetzaltenango: https://www.youtube.com/watch?v=XeSvsaFGr6g&index=2