Khmer Phonetics & Phonology:

Theoretical Implications for ESL Instruction

Alex Donley

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Honors Program of Liberty University.

_____

Jaeshil Kim, Ph.D.
Thesis Chair

_____

Stephanie Blankenship, Ed.D.
Committee Member

_____

David Schweitzer, Ph.D.
Assistant Honors Director

_____

Date

Abstract

This thesis develops an approach to English teaching for Khmer-speaking students that centers on Khmer phonetics and phonology. Cambodia has a strong demand for English instruction, but consistently underperforms next to other nations in terms of proficiency. A significant reason for Cambodia's skill gap is the lack of research into linguistic hurdles Khmer speakers face when learning English. This paper aims to bridge Khmer and English with an understanding of the speech systems that both languages use before turning to the unique challenges Khmer speakers must overcome based on the tenets of L1 Transfer Theory. It closes by outlining strategies for English teachers to build the comprehensibility and confidence of their Khmer-speaking students.

Keywords: Khmer, English, phonetics, phonology, transfer, ESL

Khmer Phonetics and Phonology: Theoretical Implications for ESL Instruction

Introduction

This thesis develops an approach to English teaching for Khmer-speaking students that is grounded in a thorough understanding of Khmer phonetics and phonology. Cambodia, the home of most Khmer speakers, underperforms next to other nations in terms of English proficiency despite the nation's high demand for English instruction ("Cambodia," 2018). A significant reason for the skill gap Cambodia faces is the lack of research on the linguistic hurdles Khmer speakers face when learning English. This paper, then, aims to bridge Khmer and English with an understanding of the speech systems that both languages use. Once Khmer phonetics and phonology have been detailed, the paper turns to the unique challenges Khmer speakers must overcome based on the tenets of L1 Transfer Theory, outlining strategies for English teachers to build the confidence and comprehensibility of their Khmer-speaking students.

Introduction to Khmer

Relevant Literature and Language Description

Khmer is the official language of Cambodia and has between 16 and 20 million speakers who are mainly concentrated in Cambodia, Thailand, Vietnam, and Laos (Eberhand, Simons, & Fennig, 2019). Khmer belongs to the Mon-Khmer sub-branch of the Austro-Asiatic language family and shares several features with Thai, Vietnamese, and Lao: all are syntactically SVO (sentences ordered subject, verb, object) and morphologically isolating (preferring monosyllabic words to polysyllabic ones). Khmer has also borrowed several lexical items specifically from Thai and Lao (Eberhand et al., 2019). While most of its neighbors are tonal, however, Khmer is a stress-based language. (Tikkanen, 2010). Marginal research shows signs of tonogenesis in

Phnom Penh Khmer (Kirby, 2014b), but these findings are debated. Khmer also has a small number of honorific distinctions that mark a speaker's level of familiarity with another (Haiman, 2011). Khmer plays an integral role in the cultural history and identity of Cambodia, but it remains relatively obscure on a global scale.

Khmer has the largest script alphabet of any language, representing a phonetic bank of 33 consonants and over 30 vowels (Huffman, 1970). Khmer consonants fall into two series which change the interpretation of an accompanying vowel (Soky et al., 2016). Vowels, likewise, separate into "dependent" and "independent" categories, combining in a rich array of monophthongs and diphthongs (Soky et al., 2016). A few of Khmer's identifying phonetic features include the use of implosives (such as [ɓ] and [ɗ]), unusual onset consonant clusters (such as [lk-], [kŋ-], and [ʔʊ-]), and its delicate diphthongs and triphthongs (Kirby, 2014a). Due to the difficulty of transcribing Khmer accurately, many words have more than one accepted spelling in Khmer script and in English glosses (Ager, n.d.). Even with several million speakers, Khmer remains far less researched than other languages due to its relatively steep learning curve and the low demand for Khmer speakers abroad.

Most Cambodians speak Standard Khmer, a centrally-located dialect used for instruction in schools (Ager, n.d.). The next largest dialect of the language is Northern or Surin Khmer, which has roughly one million speakers between Cambodia and Thailand. Further dialects include Western Khmer (spoken in the Cardamom region), Southern Khmer or Khmer Krom (spoken in and around southern Vietnam), and Khmer Khe or Kuy (spoken in specific northern provinces) (Ager, n.d.).

Methodology

This thesis evaluates the literature on Khmer phonetics and phonology by documenting spoken Khmer translations of Samarin's (1967) list of over two hundred English words for language elicitation. The spoken translations have been recorded, studied, and transcribed into IPA for analysis throughout the paper. The consultant's Khmer, representing the Phnom Penh dialect, reveals several distinctions between written and spoken pronunciations of certain words. In addition to affirming several well-attested facts of Khmer phonetics and phonology, the recordings also show patterns (especially between written and spoken word pronunciations) that have received little attention in modern literature on Khmer. The section on phonology explores these patterns more thoroughly. Appendix A contains the full list of translated and transcribed words in Table 8.

Phones and Phonemes

Consonants

Consonant inventory. Table 1 maps the consonantal phonemes of Khmer that several sources corroborate. The table represents the consonants in Khmer that are in *contrastive distribution*. Speakers understand them to be distinct, so uttering one in place of another can change the meaning of a word or render speech unintelligible. In addition to the consonants included on the table below, most resources document the use of the voiceless palatal stop /c/, which never appears in the consultant's data. In place of a palatal stop, the consultant uses a sound which is similar but not identical to the English affricate /ʧ/. The following chart revises the consonant inventory by approximating the replacement for the palatal stop to be the alveopalatal affricate /tɕ/.

Table 1

Khmer Consonant Inventory

	Bilabial	Alveolar	Alveo-palatal	Palatal	Velar	Glottal
Stop	p ɓ p^h	t ɗ t^h			k k^h	ʔ
Nasal	m	n		ɲ	ŋ	
Fricative		s				h
Affricate			tɕ $tɕ^h$			
Approximant	ʋ			j		
Trill		r				
Lateral Approximant		l				

Note. Data for Khmer consonants from Sok & Adams (2016) and from Huffman (1970). Some charts include the voiceless labiodental fricative /f/, but /f/ has only come to Cambodia through loanwords and is explicitly non-native to Khmer phonology (Sok & Adams, 2016).

The phonemic inventory of English consonants has some, but not extensive, overlap with that of Khmer. Major exceptions include English's limited nasal range, lack of phonemic distinction between aspirated and unaspirated stops, and the use of plosive /b/ and /d/ rather than implosive /ɓ/ and /ɗ/. While certain Khmer phonemes such as /ʋ/ and /r/ have analogous English counterparts such as /w/ and /ɹ/, English uses several fricatives (/v, θ, ð, z, ʃ, ʒ/) that have no equivalents in Khmer. Comparing the table above to the English Consonant Inventory in Appendix D summarizes the differences between the two inventories. Differences between phonemic bases can cause confusion for English language learners who do not have an explicit

knowledge of how both systems differ. Phones may be complementary allophones in one language while being contrastive phonemes in another language (such as /p^h/ → [p^h, p] in English versus /p^h, p/ in Khmer). The subject of transference and allophonic variation will be further discussed in the sections below.

Allophonic variation in Khmer. Allophonic variation refers to instances in which speakers use different phones to express the same phoneme, often in predictable patterns of speech environments. The example of allophonic variation mentioned above in English is the phoneme /p/, which realizes as [p^h] word-initially (as in *pie*, pronounced [p^hai]) and [p] word-medially (as in *spy*, pronounced [spai]). It is important not only to note what phonemic differences both languages have, but what phonetic difficulties arise out of different allophones in English and Khmer. This section explores Khmer allophones; a later one addresses English.

Word-final consonants. While English and Khmer both have unique branches of allophones based on their original phonemes, one allophonic variation that they have partially in common is that stops and affricates will become unaspirated and unreleased when they are word-final. Table 2 represents this phenomenon as found throughout the Khmer recordings of Appendix A. Aspirated consonants do not appear word-finally in the recordings, and thus do appear on the phonemic side of this chart. A significant deviation in the data is that /k/ may also manifest word-finally as [ʔ] in addition to [kˀ], likely because a glottal stop is close enough to approximate a velar stop, but not a labial or alveolar stop. The distinction between word-final consonants that do not release is subtle, especially between [tˀ] and [tɕˀ].

Table 2

Unaspirated and Unreleased Final Consonants

Underlying phoneme	Allophones	Example
/p/	[p] [pˀ]	[ɾoəpˀ] *count*[1]
/t/	[t] [tˀ]	[satˀ] *animal*
/tɕ/	[tɕ] [tɕˀ]	[kʰlaːtɕˀ] *fear*
/k/	[k] [kˀ] [ʔ]	[tɕikˀ] [tɕiʔ] *dig*

Rhotic variation. A second instance of allophonic variation is the realization of the rhotic /r/ as [r] and [ɾ] in the dataset. (For reference, [r] is a tongue trill while [ɾ] is a tongue tap.) The two form no minimal pairs and have no indication of being in contrastive distribution. Notably, the tap appears far more often than the trill in this dataset. The trill appears in such words as [pram] (*five*) and [rɔluej] (*rotten*), but otherwise, the tap dominates in similar environments such as [pɾo] (*man*) and [ɾoəp] (*count*). As such, the two appear to be in *free variation*, although this may simply reflect a characteristic of the Phnom Penh accent rather than the language as a whole.

Voice Onset Time. Voice Onset Time, or VOT, refers to the length of time that voicing precedes or follows the onset of a consonant. When voicing and the consonant start at the same time, it is called zero VOT; when voicing begins before the consonant, it is called negative VOT; and when voicing begins after the consonant, it is called positive VOT. VOT is especially important to measuring the phonemic distinction between voiced and voiceless stops cross-

[1] While most linguistic sources use single quotation marks to denote glosses and word examples, this paper will use italics to comply with APA formatting standards.

linguistically. In English, for instance, a voiced stop usually has zero VOT while a voiceless stop has positive VOT (since most voiceless stops are aspirated). In French, however, voiced stops use *negative* VOT, while voiceless stops use zero VOT (Caramazza & Yeni-Komshian, 1974). A French language learner, then, may mistake voiceless stops for voiced ones based on the different VOT used in English.

VOT analysis of Khmer stops sheds light on how differently Khmer speakers and English speakers use VOT to differentiate their consonants. Table 3 consolidates data from Praat transcriptions of various Khmer words that can be found in Appendix B. They provide an estimable range of what makes an onset consonant aspirated or not:

Table 3

Aspiration Data for Khmer Stops

	Unaspirated	Aspirated
p	0.013	0.090
	0.028	
t	0.023	0.078
	0.019	
c / tɕ	0.025	0.150
k	0.033	0.131

Unaspirated consonants fall in the 10-40 millisecond range, while aspirated consonants appear to be 70 milliseconds or longer. English uses a similar distinction, not for aspiration, but for voicing: voiced stops range from 15-35 milliseconds, while voiceless stops (particularly word-initial ones) begin voicing at least 70 milliseconds after the onset (Caramazza & Yeni-Komshian,

1974). The difference in VOT provides a hurdle for Khmer ELLs in that they must now think of stops they perceive as voiceless in their L1 to be voiced in their L2. Defining the VOT distinction between phonemic consonants provides greater clarity to the R>H shift and the consonant cluster barriers discussed in the section below on phonology.

Consonant clusters. Huffman (1970) identifies 87 possible onset clusters in Khmer, 85 of which contain two consonants, and 2 of which contain three consonants. Table 4 illustrates the available combinations of clusters in a concise chart.

Table 4

Khmer Onset Clusters (CC-)

	p	**t**	**tʃ**	**k**	**ʔ**	**ɓ**	**ɗ**	**m**	**n**	**ɲ**	**ŋ**	**ʋ**[2]	**j**	**l**	**r**	**s**	**h**
p		pt	ptɕ	pk	pʔ		pɗ		pn	pɲ	pŋ		pj	pl	pr	ps	ph
t	tp			tk	tʔ	tɓ		tm	tn		tŋ	tʋ	tj	tl	tr		th
tɕ	tɕp			tɕk	tɕʔ	tɕɓ	tɕɗ	tɕm	tɕn		tɕŋ	tɕʋ		tɕl			tɕh
k	kp	kt	ktɕ		kʔ	kɓ	kɗ	km	kn	kɲ	kŋ	kʋ	kj	kl	kr	ks	kh
s	sp	st		sk	sʔ	sɓ	sɗ	sm	sn	sɲ	sŋ	sʋ		sl	sr		
m		mt	mtɕ		mʔ		mɗ		mn	mɲ				ml	mr	ms	mh
l	lp			lk	lʔ	lɓ		lm			lŋ	lʋ					lh
ʔ												ʔʋ					

Note. Data for Khmer onset consonant clusters and classes from Kirby (2014a) and from Huffman (1970).

[2] Although English does not share the phoneme /ʋ/ with Khmer, the distinction between /ʋ/ and /w/ is extremely subtle to most listeners. Because of this, Table 4 labels the clusters /tʋ-, kʋ-, sʋ-/ among those shared with English, since most English listeners comprehend them as /tw-, kw-, sw-/. It should be noted, however, that they are not phonetically identical; they are simply similar enough to constitute overlap between the languages.

The table's three shades mark different classes of clusters. The darkest shade represents Class 1 clusters, which have no separation between the first and second consonants. The light shade represents Class 2 clusters, which have slight aspiration after the first consonant. The unshaded boxes represent Class 3 clusters, which have a brief voiced separation (typically using the vowel [ə]) after between the two consonants. The clusters found within double-lined boxes are those that Khmer and English have in common.

The recorded data include 41 of the 85 possible onset clusters, which can be viewed in Table 9 of Appendix C. They also include an unidentified cluster in the form of /mɓ-/ at the start of [mɓai] (*eight*).[3] Khmer's onset clusters are far more numerous and varied than those of English because they frequently violate the hierarchy of sonority that governs English clusters. For comparison, the chart of English onset clusters in Table 11 of Appendix D displays a *long* distribution compared to the *wide* distribution of the Khmer chart. Khmer permits fewer opening consonants in onset clusters than English does, but allows a greater number of second consonants. The Khmer table also has fewer gaps in its distribution, many of which are impossible duplicate clusters such as /pp-/ or /kk-/.

While Huffman (1970) attests to the triple onset clusters of /str-/ and /lkh-/, neither appears in the recorded data. It is uncertain, then, whether a Khmer speaker must stretch to adapt to triple onset clusters in English. English has six triple clusters, all of which begin with *s*-: /spj-, spl-, spr-, str-, skj-, skr-/. Khmer contains double-consonant sets that, when placed together, constitute something like English triple onset clusters (for instance, /sp-/ and /pj-/ together may

[3] A possible explanation for this apparent cluster is that the [m-] is an extended instance of negative Voice Onset Time for the adjacent [ɓ]. The word [mɓai] is also an abbreviation of the full word [pramɓai], implying that the [m-] may be a vestige left over from the original pronunciation.

form /spj-/). Whether this presents an advantage for Khmer ELLs is inconclusive. An area of clear difference between the two languages, however, is Khmer's coda structure. Using C to represent a possible consonant and V to represent a nuclear vowel or diphthong, Khmer syllable structure has a maximum structure of CCCVC (Huffman, 1970). English, on the other hand, may sustain a maximum syllable structure of CCCVCCCC as in a word such as *strengths*, pronounced [stɹɛ̃ŋkθs].[4] The difference in consonant possibilities may provide a significant challenge for speakers who never cluster consonants at the end of a syllable in their first language.

Vowels

Vowel inventory. Huffman (1970) and Sok & Adams (2016) document a rich inventory of vowels and vowel patterns in Khmer. These sources note that a majority of monophthongs (single vowels) have phonemic long and short forms, as depicted in Table 5. The majority of vowels have long and short forms. The phonemes /ɛː/ and /ɔː/ provide an exception because they only appear in a long form. Before approaching Khmer diphthongs, it is important to visualize the distribution of monophthongs in Khmer as it relates to the space of the mouth. Figure 1 is a standard phonetic frame for vowel placement in which the left side represents the front of the mouth and the right side represents the back. Higher placement on the chart stands for a tongue position closer to the roof of the mouth, while lower placement stands for a tongue position farther from the roof of the mouth. Since measuring the exact acoustics of Khmer vowels has not

[4] It should be noted that [stɹɛ̃ŋkθs] has a highly unusual syllable structure for English that even native speakers abbreviate. Oftentimes, English speakers omit [k] so the word is easier to pronounce in quick speech: [stɹɛ̃ŋθs].

been thoroughly documented and lies beyond the scope of this project, the points on the chart represent approximations and not exact locations of each vowel.

Table 5

Khmer Monophthong Inventory

	Front		Central		Back	
High	i	i:	ɨ	ɨ:	u	u:
Mid	e	e:	ə	ə:	o	o:
Mid-Low		ɛ:				ɔ:
Low	a	a:			ɑ	ɑ:

Note. Adapted from *Cambodian system of writing and beginning reader* (p. 8), by F. E. Huffman, 1970, New Haven & London, UK: Yale University Press.

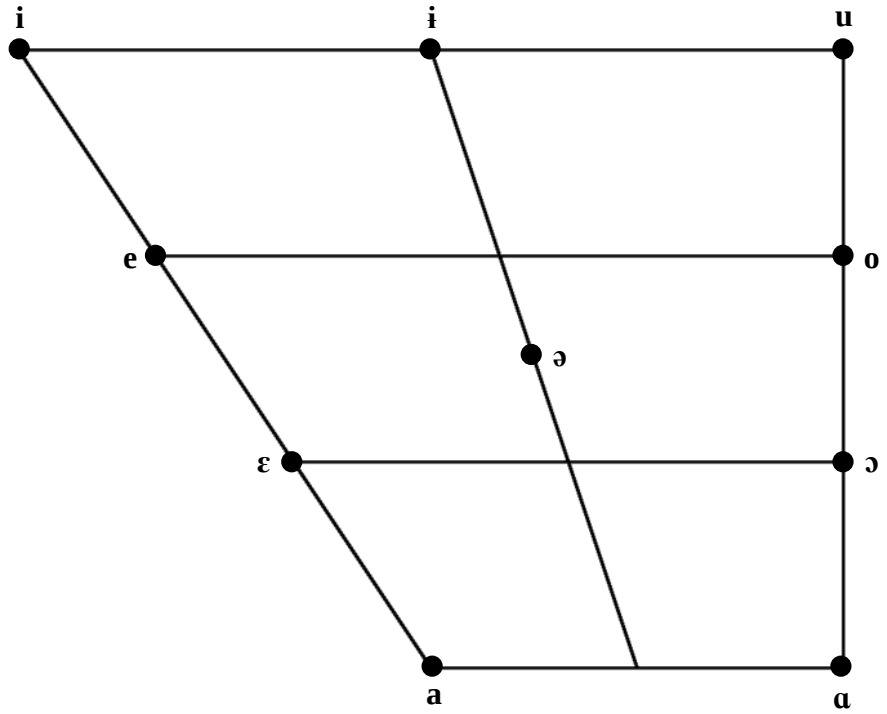

Figure 1. Khmer Monophthong Distribution.

As pictured, Khmer's monophthongs are uniformly spaced.

Diphthongs. Khmer's vowel system includes intricate diphthongs and triphthongs. Sok (2016) reports nine standard diphthongs: /iə, ie, ɨə, uə, ea, oə, ae, aə, ao/. Additionally, there are three short diphthongs reported by Huffman (1970): /eə, oə, uə/. The diphthongs can be separated into categories based on direction. By comparison, English has three diphthongs, all of which move from a low vowel to a high vowel: /aɪ/ as in *pie*, /oʊ/ as in *cow*, and /ɔɪ/ as in *boy*. Khmer has 7 diphthongs that also move from low to high, as illustrated in Figure 2.

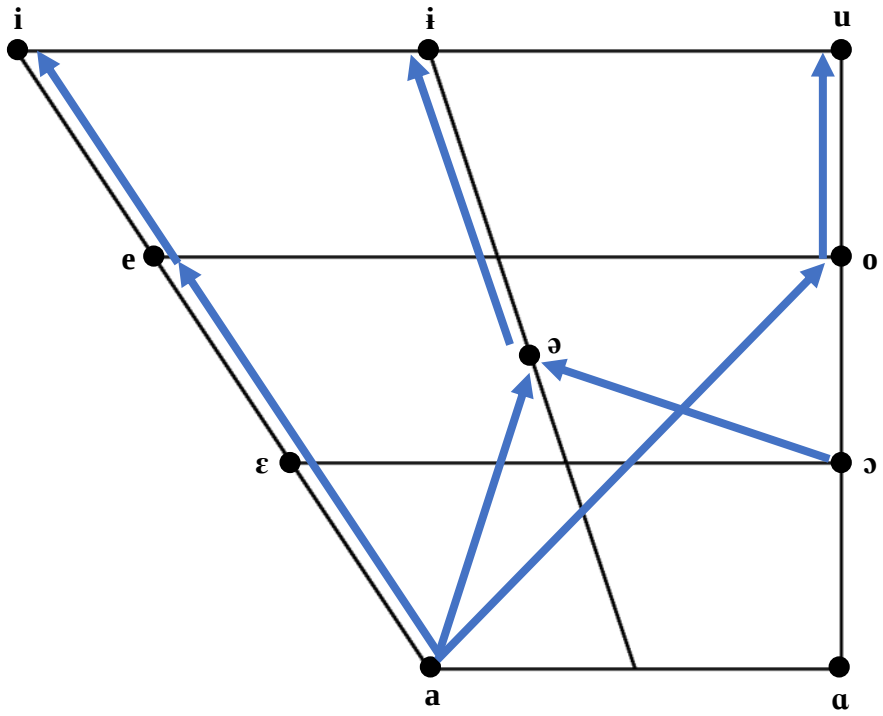

Figure 2. Upward Khmer Diphthongs.

Unlike English, Khmer also has diphthongs that move from higher vowels to lower vowels—three are full-length diphthongs and three are short diphthongs. Figure 3 depicts all downward-moving diphthongs, dividing long and short into separate charts. (An illustration for what a short

diphthong sounds like might be the English word *day*, which Americans pronounce with a soft *-i* sound at the end: [deɪ]. Americans use a similar short diphthong for their *-o* sound in words like *go*: [goʊ].) Altogether, Khmer has seven upward diphthongs and six downward ones. All but five move from the back of the mouth to the front (the exceptions being the upward /aə/ and /ao/ as well as the downward /iə, ɨə, eə/).

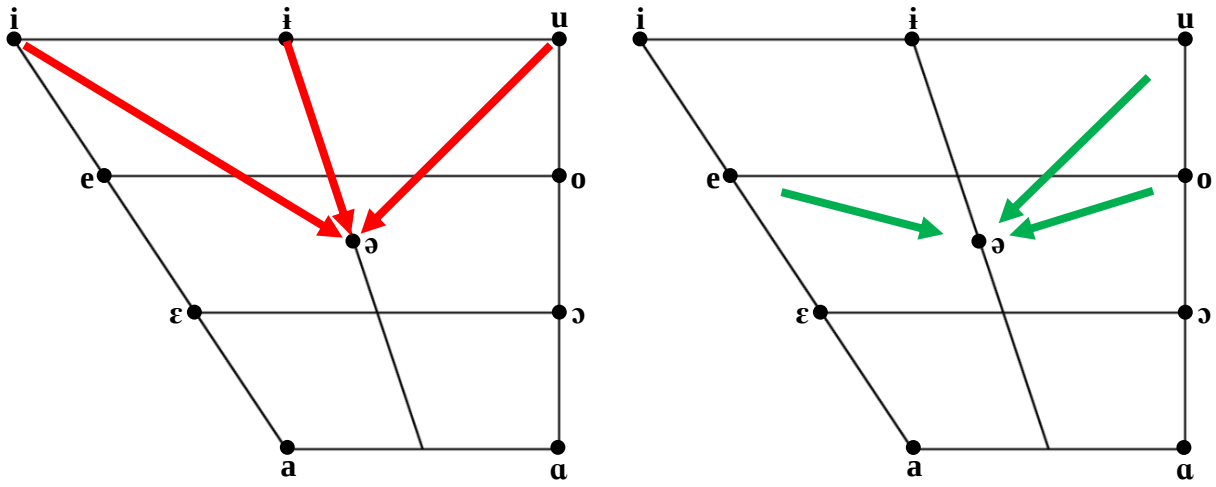

Figure 3. Downward Khmer Diphthongs. Long diphthongs are pictured in red to the left, while short diphthongs are pictured in green to the right.

Triphthongs. Triphthongs in Khmer generally consist of two vowels connected by a semivowel or a diphthong that closes with a semivowel. Six triphthongs are attested to by literature on Khmer: /iəj, iəʊ, ɨəj aoj, aəj, uəj/. While few of these combinations appeared in the recorded data, the diagrams found in Figure 14 of Appendix C depict the movement of these articulations. All Khmer triphthongs end toward the top of the mouth and close with a semivowel. Most of them have a high-low-high movement pattern (the exceptions being /aoj/ and /aəj/), and all of them have back-to-front movement except for /iəʊ/.

These triphthongs give Khmer speakers a richer base set of vowel articulations in their L1 than most English speakers have. Although General American English has no triphthongs, British English uses a few for pronunciation of such words as *hour* (as [aʊə]) and *fire* (as [faɪə]). Khmer speakers, then, should face no obstacles related to triple vowels in American English.

Phonology

R>H Shift

The most significant phenomenon attested by the recorded data is realization of /r/ as [h] as written Khmer becomes spoken. Often, words that contain [r] or [ɾ] in their formal pronunciation drop the tap in spoken form and replace it with [h], typically by aspirating the preceding consonant. Table 6 contains several examples from the recorded data.

Table 6

Examples of the R>H Shift

English word	Written form	Spoken form
root	[ɾəuʔtɕʰəː]	[həuʔtɕʰəː]
bad	[akɾɑkˀ]	[akʰoəkˀ]
because	[ɓipɾoə]	[pʰoə]
fish	[tɾəi]	[tʰəi]
right (correct)	[tɾouʊ]	[tʰou]
squeeze	[tɾoʔɓɑtˀ]	[tʰəɓɑtˀ]
straight	[tɾɑŋ]	[tʰoəŋ]
thick	[kɾa]	[kʰejə]
woods	[pɾəitɕʰəː]	[pʰai]

Aside from the first entry, all instances of R>H shift occur (1) in an onset consonant cluster and (2) after a voiceless stop: /p, t, k/. Other onset clusters that include /r/, such as /sr-/ and /mr-/, do not follow this pattern of adaptation. This correlation cements the relationship between the R>H shift and consonant aspiration, which has also been observed in certain Thai words (J. Kim, personal communication, March 5, 2020). The consultant reports that the spoken words do not drop /r/ altogether, but use a "soft r," upholding the idea that all of the aspirated consonants above use /r/ underlyingly.

Literature outside the study attests to the prevalence of the R>H shift not only in Phnom Penh Khmer but also in sections of Standard Khmer and a dialect called Kien Giang Khmer (Kirby & Giang, 2017). Some hypothesize that the movement toward aspiration owes itself to physiological implications of devoicing [r] or [ɾ], which creates additional breathiness on the previous consonant. Others claim that the relationship has more to do with the historical correlation between alveolar [r] and uvular [ʁ], which pushes the place of articulation back toward the glottis and the manner of articular toward a fricative (Kirby & Giang, 2017).

Realization of /ŋ/ as [ɲ]

The consultant noted that in the word for *play*, which in its written form is /leːŋ/, realizes as [leːɲ] in its spoken form. To identify what rule might govern why this occurs, Table 7 records several other words whose /ŋ/ was word-final. Among these data entries, a clear pattern emerged: a syllable-final /ŋ/ after a front vowel consistently appeared as [ɲ]. The reason for this adaptation may have to do with an association between vowel frontness and pushing the nasal's place of articulation forward. After front vowels such as [ɛː], [eː], or [iː], the final nasal is more naturally

articulated as a palatal than as a velar. After [əː] or [ɔː], however, the velar nasal remains the same.

Table 7

Examples of the Realization of /ŋ/ as [ɲ]

	Written (phonemic)	Spoken (phonetic)
knee	[tɕkɔŋ]	[tɕkɔŋ]
straight	[trɑŋ]	[tʰoəŋ]
thin	[sɗaəŋ]	[sɗàəŋ]
spear	[lɔmpɛːŋ]	[lɔmpɛːɲ]
smoke	[pʰsaeŋ]	[pʰsaeɲ]
horn	[snaeŋ]	[snaeɲ]
long	[ʋeiŋ]	[ʋeiɲ]

Application for English Language Learners

L1 Transfer Theory

One of the longest-standing observations in linguistic theory is that language learners tend to realize their new language or L2 in ways that resemble principles or parameters of their native language or L1. Simply put, elements of a speaker's first language *transfer* into his or her second language. When an L1 shares a linguistic feature with its L2, the resulting similarity results in *positive* transfer; when it differs from its L2, the dissimilarity results in *negative* transfer (Pienemann, Kawaguchi, DeBiase, & Hakensson, 2005). While transfer may occur in any realm of linguistics—syntax, morphology, etc.—this study investigates the possibilities for positive and negative transfer in the fields of phonetics (individual speech sounds) and

phonology (speech sound patterns). These fields separate two levels of possible transference: phonology primarily covers the differences in *phonemes* mentioned above, while phonetics covers the differences in particular allophones of the same phonemes.

A proper approach to interlanguage transfer in the classroom benefits from an understanding of what language theorist Bill VanPatten (2015) terms "input processing" (p. 113). Input processing is a theory that centers around the linguistic forms that students innately prioritize when learning a new language. Before they can produce output, students must listen to and interpret their L2 to find connections between form and meaning (VanPatten, 2015). Students naturally prioritize content words and lexical meaning over function words and grammatical meaning (VanPatten, 2015). With this in mind, an effective classroom must associate unfamiliar forms (such as new phonemes and allophones) with clear differences in meaning to make input comprehensible to students. Since minimal pairs give students very clear form-meaning connections in the realm of phonology, upcoming suggestions for pedagogy often involve exercises that build from individual word differentiation toward integration of those words in natural discourse. Input processing thus bridges the negative transfer gap witnessed between Khmer and English.

Transference in Khmer Pronunciation

Phonemic transfer and English. Comparing the phonemic systems of English and Khmer can help identify the speech sound distinctions that the two languages have in common, marking the underlying structures that will and will not transfer easily. Khmer shares salient consonant phonemes such as /p, t, k, s, h/ and vowels such as /i, e, o, u, a/ with English. English, however, has a sizable inventory of phonemic fricatives that Khmer does not use and shows a

greater tendency toward voicing. The English approximant /ɹ/ is adjacent but not identical to the Khmer rhotic trill /r/. Fortunately, both English and Khmer share the phonemic distinction between close vowels such as /ɔ/ and /ɑ/ as well as /e/ and /ɛ/. But where Khmer has an extensive inventory of diphthongs and triphthongs, English has a more diverse set of monophthongs that often trip up students, especially in stress / lax vowel distinctions. Thus, while Khmer has some features which transfer positively into English, there are several possible areas for negative transfer that Cambodians face while acquiring English. The following sections hypothesize, based on linguistic estimates, what specific hurdles English language instruction should address to encourage comprehensibility and confidence in Khmer-speaking students.

***Consonant transfer*.** A comparison of the English consonants of Table 10 in Appendix D to the Khmer consonants of Table 1 shows that Khmer actually has finer phonemic distinctions in than English. Khmer differentiates aspirated /p^h/, /t^h/, and /k^h/ versus unaspirated /p/, /t/, and /k/, but the larger store of phonemic stops does not necessarily imply that all English consonant distinctions will come easily to a Khmer language learner. Besides the common phonemes mentioned above, a Khmer speaker should also be able to articulate English nasals fairly well, since all of them transfer positively between the two languages: /m, n, ŋ/. Several other English sounds like the *ch*- sound /ʧ/ may be approximated by nearby sounds such as /tɕ/. English /b/ and /d/ are trickier phonemes for Khmer students depending on the context of learning. A Khmer student who hears English /b/ and /d/ may perceive them as their native /p/ and /t/ based on the difference of VOT mentioned above. A Khmer student reading English letters *b* and *d* may instead realize them as implosive /ɓ/ and /ɗ/, which are more analogous. Thus, it is important that

if Khmer students pronounce /b/ and /d/ as English speakers do, they understand them to be slightly different phonemes than the ones they have in their L1.

Negative transfer arises as phonemic English consonants use places and manners of articulation that Khmer consonants do not. English contains labiodental fricatives *f-* and *v-* (/f, v/), interdental fricatives *th-* and *th-* (/θ, ð/), and postalveolar fricatives *sh-* and soft *j-* (/ʃ, ʒ/). These are intermediate compared to standard Khmer places of articulation (labial, alveolar, palatal, velar, glottal), thus encouraging Khmer speakers to adapt them into native or near-native phonemes. An example substitute might be such as /s/, /t/, or /f/ in place of /θ/, depending on whether the speaker prioritizes manner or place of articulation. A second challenge lies in the differences between English and Khmer voicing: English has a greater number of voiced phonemes than Khmer does. Part of the list of unique voiced phonemes overlaps with the list of fricatives: /v, ð, ʒ, ʤ, g/. While not all of these are of equal weight for lexical meaning (/ð/ nearly never forms a minimal pair), the phoneme that Khmer language learners struggle the most with is /v/. Most Khmer speakers approximate /v/ with /ʊ/, which English listeners perceive as /w/.

Onset clusters. Despite—or perhaps due to—the array of onset clusters in their L1, Khmer speakers often struggle to articulate non-native consonant clusters and tend to adapt them using native phonology. Several obscure clusters in English such as /θr-/ (in *through*) and /ʃr-/ (in *shrug*). Khmer speakers use their native /sr-/ in place of both of these, which greatly impacts the intelligibility of students to other English speakers. In addition, the difference of VOT for stops between languages impacts not only single consonants, but consonant clusters as well. A Khmer ELL will often pronounce a voiceless stop that comes before /ɹ/ as a voiced stop, adapting a word

such as *try* (/tɹaɪ/) into *dry* (/draɪ/) or *practice* (/pɹæktɪs/) into *bractice* (/bra:ktɛs/). This is likely due to the fact that Khmer C*r*- clusters use unaspirated stops and have a completely smooth, unarticulated transition between consonants; phonemically, the Khmer /pr/ sounds to an English speaker like /br-/.

***Vowel transfer*.** Khmer also has a fair amount of positive transference to English based on a comparison of the English vowel chart in Figure 15 of Appendix D to the Khmer vowel chart of Figure 1. the vowels /i, e, a, o, u, ɔ, ə/ are common to both languages. Tricky English vowels might include English /æ/ as in *bat* (approximated by Khmer /a/) as well as unstressed vowels /ɪ/ as in *bit* and /ʊ/ as in *good* (adapted by most learners as /i/ and /u/, respectively). Negative transfer may also reflect the abundance of diphthongs and triphthongs in Khmer compared to English. To differentiate /i/ and /ɪ/ sounds, a learner may use a Khmer diphthong such as /iə/ to replace English /ɪ/, since such a contrast is more natural based on the Khmer-speaker's L1. A similar shift may occur from /ʊ/ to /uə/ or other nearby diphthong. It is uncertain how such adaptations would impact comprehensibility for English speaking listeners. Noting these kinds of adaptations, however, is important to developing an effective pedagogy for Khmer students.

Phonetic transfer and English. Besides the observations about different phoneme patterns in the two languages, it is also important to note the differences in allophonic variation (that is, realization of individual phones) that can create negative transfer from Khmer to English. While the range of allophonic variation in English is too wide to be addressed in its entirety, the following sections approach a few prominent examples of when allophonic variation might impact comprehensibility for Khmer language learners.

***English consonant allophones*.** One area of clear positive transference for Khmer students is the trend of unaspirated, unreleased consonants in the word-final position. English speakers often leave stops unreleased in quick speech for words such as *stop* ([stapˀ]) or *kick* ([kɪkˀ]), especially at the end of a sentence. Another example of unreleased consonant allophones comes in the word *looked*, which is underlyingly /lʊkd/ but manifests as [lʊkˀt] due to the rules for coda consonant clusters in English. A Khmer speaker may attempt to pronounce this as either [kˢd] or [k^{h}t] depending on the circumstances, since both are possible clusters in his or her L1. An instructor may then guide the student toward a greater understanding of niche instances in which English leaves its consonants unreleased, using the instances in which Khmer leaves consonants unreleased as a base upon which to teach and practice the articulation in English.

The English phoneme /p/ often manifests as aspirated [p^{h}], most notably at the beginning of words such as *pain*: [p^{h}en]. When /p/ follows /s/ in a cluster, however, it manifests as [p] as in *Spain*: [spen]. All voiceless stops and affricates in English (/t, ʧ, k/) experience similar allophonic variation in terms of aspiration. Khmer students, then, may interpret all voiceless stops to be underlyingly aspirated since they appear most often. Words such as *spy* and *sky* may be overenunciated as [sp^{h}ai] or [sk^{h}ai], which would lead to confusion among listeners. Language instructors, then, must be careful to distinguish between when the English phoneme /p/ should be pronounced [p^{h}] and when it should be pronounced [p], especially with regard to onset clusters that begin with /s/.

Another instance of tricky allophonic variation in English deals with the consonant cluster /tr-/ which, while it is technically common to both languages, manifests as [tɾ-] in Khmer and [ʧɹ-] in English. Due to English spelling, a Khmer speaker may attempt to pronounce both /t/

and /r/ as they articulate the English consonant cluster. In reality, English speakers adapt their underlying /t/ sound into [ʧ] to adjust to the alveolar approximate [ɹ] that immediately follows. A native English speaker would pronounce *tree* identically to *chree*. Practicing this articulation must be backgrounded by experience pronouncing the alveolar approximate on its own, as it is often a difficult articulation for non-English speakers to distinguish from [l]. Once students have mastered [ɹ], they will be able to practice [ʧɹ-] as a cluster in words such as *trite* or *true*. Note also that a parallel allophonic variation occurs for voiced forms of these clusters: /dr-/ becomes [ʤɹ-].

English vowel allophones. The most important instance of allophonic variation in English is that several vowels may manifest as [ə], especially if there is a shift in stress. The word *address*, for instance, should be pronounced as [ædʒɹɛs] if the stress falls on the first syllable and [ədʒɹɛs] if the stress falls on the second, which can change the meaning of the word from noun to verb. Similar phenomena occur for many words: *because* at certain times starts with [bi-] and at other times starts with [bə-], but *bean* and *bun* will always be separately [bin] and [bən]. Teaching students these distinctions, especially the more rigid nature of vowels in monosyllabic content words, is key to providing them structured input and uplifting their comprehensibility.

Strategies for ESL Instruction

Emphasize positive transfer. ESL instruction for Khmer-speaking students ought to uplift the strengths of positive transfer while targeting the comprehension-centered detriments of negative transfer. When learning English words that begin with consonant clusters, the teacher should begin with shared clusters such as /sp-/, /sn-/, and /sm-/ before moving on to more

difficult combinations. Likewise, it would be useful to create a correspondence chart for English and Khmer vowel sets so that language learners can know what speech sounds both languages have in common. Placing similar Khmer and English words next to each other, such as English *caught* (pronounced [kɔtˈ]) and Khmer *stone* (pronounced [kɔʔ]) will make English pronunciation seem more accessible to students. Starting with positive transfer builds student confidence & motivation.

Phonetic exercises. After showing students what aspects of Khmer are similar to those of English, it is also be useful to allow the students to explore the features in which they differ. The examples mentioned in the sections above are a good place to start: a few minutes of class time might go to practicing the /f-/ and /v-/ sounds by having the students move their lips and modulate voicing. The class may begin with explicit teaching that encourages students to pay attention to the shape of their lips, the position of their lips relative to their teeth, and whether they are humming through their articulation. Once students explicitly understand of the mechanics of an articulation, the teacher may introduce exercises to ease them into more organic use of both sounds, such as the sentence "I *f*ound a *v*acuum."

A similar exercise for vowels might encourage students to distinguish the /i/ and /ɪ/ distinction by moving their tongue around the high-front position slightly to understand that the two vowels are close but separated. The teacher may also present listening challenges that require students to hear the different between stressed and unstressed *i*, helping them to recognize patterns and correct their own speech. More involved exercises might allow students to say minimal pairs such as *beat* and *bit* in quick succession. Over the course of several exercises,

the key would be to move from explicit and mechanical to implicit and organic, giving students the tools to improve without bogging them down with minute tasks.

Tongue twisters and speed challenges. Consonant clusters and difficult phonology may come later in the form of tongue twister challenges—if a student can say, "Buy *thr*ee *tr*ees, get one *fr*ee," at a normal pace, he has achieved conversational comprehensibility. Once students show competency in the way of phonetic accuracy, the teacher can introduce speed challenges that will push students toward fluency. Incentivizing and rewarding these efforts will not only push the class in general toward excellence, but will also reward those students who go above and beyond with particular challenges that will give them a strong presence in their L2.

Discourse & task-oriented speech. On top of the individuated attention to different phonetic and phonemic aspects of English, it is important for teachers to build up to discourse-level exercises that emphasize the usefulness of phonetic work to real-world tasks. A workable segue from phonetics and phonology to syntax might be songs or karaoke, in which students may imitate the speech patterns of English singers and songwriters with their newfound knowledge. (A song such as "I Believe I Can Fly" could, for instance, test a student's ability to pronounce the /fl-/ cluster in *fly* or correctly articulate *believe* as [bəliv].) Depending on the level of proficiency among students, a teacher may then explore exercises in storytelling, skits, artwork, or interviews that indirectly test students' articulatory abilities. A range of tests involving different stress patterns and intonations will give the teacher the best opportunity for helpful correction throughout the process.

The following is an original story that a student might practice and read aloud to demonstrate mastery of distinguishing voiceless and voiced stops in English onset clusters:

> Once, when I was a professional sailor, I saw a storm brewing out at sea. It wasn't prudent to leave, but the crew groaned about waiting. They said gray skies weren't a problem. Not true. We packed our trout and fresh water, drew up our sails, and left the port. The sky grew darker and darker. Then the storm hit. We braced ourselves on the rails and prayed for safety, but the waves drove us into a rock and broke the hull. Several crew members drowned and the rest of us clung to crates in the water. We washed up on a tropical island.

The excerpt tests the students' use of /pr-, tr-, kr-/ with words such as *prudent*, *true*, and *crew*. It couches these phonemes within the context of a narrative, allowing students to focus more on articulating English speech within the meaning of the story rather than in disconnected speech. Exercises such as these apply theories of transfer and input processing to help Khmer students learn difficult English speech sounds naturally and effectively.

Conclusion

Khmer is an important and under-researched language whose phonetic and phonologic commonalities with English have been examined here, but invite further research in the future. Cambodia's English proficiency lies behind several of its neighbors, offering an opportunity for close investigation of what difficulties Khmer-speaking English language learners face based on their first language. A cursory overview of the phonemes in Khmer shows that it shares several features with English that provide opportunities for positive transfer. Instruction should start by supporting phonologic forms that both languages have in common before exploring more difficult differences between the languages. The charts above and in the following appendices highlight the consonants, vowels, clusters, and diphthongs that both languages possess.

The additional differences between both languages—specifically, the phonemes, clusters, and structures that are unique to English—may be challenging but not insurmountable if they are addressed incrementally throughout a teaching period. Khmer has a richer store of consonant clusters, diphthongs, and triphthongs than English does. While this does not mean that Khmer-speaking students will acquire English more easily than those whose consonant and vowel combinations are less varied, it does mean that Khmer-speaking students may need to focus on reduction or simplification where other English language learners need to acquire several new speech sounds and patterns. Khmer-speaking students will also benefit especially from an explicit explanation of how aspiration works in English as opposed to Khmer. Since aspiration in Khmer is phonemic and in English is simply allophonic, demonstration of how the pronunciation of *pie* and *spy* differ will increase students' self-awareness, comprehensibility, and confidence in speaking. A similar principle applies to voiced English onset clusters such as /br-, dr-, gr-/, which Khmer-speaking English language learners are often unaware they mispronounce.

With an increased understanding of how Khmer and English phonologies interact, Khmer-speaking students will be able to achieve higher levels of proficiency than they are at the present. Future research may investigate several subjects that this paper had time to address only briefly. Measurement of the frequency and the environments of certain errors (such as mispronounced onset clusters, coda clusters, diphthongs, etc.) would be quite useful. Coda clusters in particular, which are far more intricate in English than in Khmer, invite further research. Higher aspects of phonology—namely suprasegmental details such as stress and tonal patterns—are minimally addressed in this paper and also invite deeper study. At the practical level, research could examine which teaching techniques present Khmer-speaking students with

comprehensible input that, in turn, demonstrably supports comprehensible output. This paper serves as a basis and impetus for such research possibilities in the future.

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Appendix A: Transcription of Khmer Words

The language consultant interviewed for this paper was a native speaker of Khmer from the Kandal province of Cambodia, which surrounds the capital city of Phnom Penh. Over the course of several weeks, the consultant provided Khmer translations of Samarin's (1967) list of over two hundred English words for language elicitation. All words were recorded in audio files and in writing for the purpose of studying the speech sounds and patterns of Khmer. Shortly after sessions began, the consultant noted that several Khmer words have different written and spoken pronunciations. The research then adjusted to record transcriptions for both conversational and written Khmer separately to see if any linguistic trends arose from comparison between the two. Table 8 contains the full list of translated and transcribed words.

Table 8

Phonetic Transcriptions of Khmer Words

English	**Orthog. estimate**	**Phonetic 1: Written (Broad)**	**Phonetic 2: Spoken (Narrow)**	**Phonetic 3: Spoken variants**
all	ទាំងអ	[teŋɔ]	[t̪eiŋɔ]	[t̪eiŋɔh]
and	និង	[nəŋ]	[nəŋ]	
animal	សត្វ	[sat]	[satˀ]	
ashes	ផេះ	[pʰeh]	[pʰɛh]	
at	នៅ	[nɨʊ]	[nɨʊ]	
back	ខ្នង	[knɔŋ]	[kn̪ɔŋ]	
bad	អាក្រក់	[akrɑkˀ]	[akʰoəkˀ]	
bark	សំបកឈើ	[səmɓɔtɕʰəː]	[sɓɔkˀtɕʰɨː]	
because		[ɓipɾoə]	[pʰoə]	
belly	ពោះ	[kɓalpoəh]	[kɓalpoəh]	
big	ធំ	[tʰom]	[tʰom]	
bird	ចាប	[tɕaːp]	[tɕãːpˀ]	
bite	ខាំ	[kʰam]	[kʰam]	
black	ខ្មៅ	[kʰmaʊ]	[kmɑu]	
blood	ឈាម	[tɕʰiːm]	[tɕʰim]	[tɕʰiəm]
blow	ផ្លុំ	[pʰlɔm]	[pʰl̪ɔm]	

bone	ឆ្អឹង	[tɕʰɨʔəŋ]	[tɕʰəʔɑŋ]	
breast	ដោះ	[ɗɑh]	[ɗɑh]	
breathe	ដកដង្ហើម	[ɗɔɗɔŋhɑm]	[ɗoʔtʰham]	
brother	បង/ប្អូនប្រុស	[ɓɔŋ.prou]	[ɓɔŋ.pɾou]	
burn	ដុត	[ɗot]	[ɗoʈ̚]	[ɗoʔ]
child	កូន	[koun]	[koun]	[koən]
claw		[ɗam]	[ɗam]	
clothing		[kʰɑoʔɑi]	[kɑʔɑi]	
cloud	ពពក	[popok]	[popokˀ]	
cold	ត្រជាក់	[tɾotɕeə]	[tɛtɕeəkˀ]	
come		[moː]	[moː]	
cook	ចំអិន	[tvɛmhou]	[tɛmho]	
count	រាប់	[ɾiəp]	[ɾoəpˀ]	
cut	កាត់	[kat]	[kaʈ̚]	
dance	រាំ	[ɾoəm]	[ɾoəm]	
day	ថ្ងៃ	[tŋai]	[ŋai]	
die	ស្លាប់	[slap]	[slapˀ]	
dig	ជីក	[tɕik]	[tɕikˀ]	[tɕiʔ]
dirty	មុត	[koːʔkɾi]	[kəʔkɾi]	
dog	ឆ្កែ	[tɕʰkai]	[tɕʰkai]	[tɕʰkaə]
drink	ជីក	[pʰək]	[pʰəkˀ]	
dry	ស្ងួត	[sŋuət]	[sŋuəʈ̚]	
dull	រឹល	[rəl̪]	[rəl̪]	
dust	ដី	[kam.tɛkˀ.ɗəi]	[ɗəi]	
ear	ត្រចៀក	[tɔʔtɕiək]	[ʈɔʔtɕiəkˀ]	
earth	ផែនដី	[pʰandəi]	[pʰan̪ɗəi]	[pʰaen̪ɗəi]
eat	ញុំ	[ɲam]	[ɲam]	
egg	ពង	[pɔːŋ]	[pɔːŋ]	[poːŋ]
eight	ប្រាំបី	[mɓai]	[mɓai]	
eye	ភ្នែក	[pʰnɛːk]	[pʰnɛːkˀ]	
fall	ធ្លាក់	[tʰliət]	[ʈʰliətˀ]	
far*	ឆ្ងាយ	[tɕʰŋaj]	[tɕʰŋaj]	
fat / grease	ខ្លាញ់	[kʰlaːŋ]	[kʰlaːŋ]	
father	ឪពុក	[poʔ]	[pokˀ]	
fear	ខ្លាច	[kʰlaːtɕˀ]	[kʰleəʔ]	
feather	ស្លាប	[slaːp]	[sl̪aːpˀ]	
few	ពីរបី	[piɓəi]	[piɓəi]	
fight		[tɕʰloəknijə]	[tɕʰloəknijə]	
fire	ភ្លើង	[pʰlaəŋ]	[pʰlaəŋ]	[pʰləːŋ]
fish	ត្រី	[tɾəi]	[tʰəi]	
five	ប្រាំ	[pʰrɑm]	[prɑm]	
float	អណ្តែត	[ɑn̪ɗaeʈ̚]	[n̪ɗaeʈ̚]	

flow	ហូរ	[houɾ]	[hou]	
flower	ផ្កា	[pʰka:]	[pkã:]	
fog	អ័ព្ទ	[ap]	[apˀ]	
foot	ជើង	[cəiəŋ]	[cəiəŋ]	[cʲə:ŋ]
four	បួន	[ɓuən]	[ɓuən]	[ɓoən]
freeze	កក	[kɔʔ]	[kɔʔ]	
fruit	ផ្លែឈើ	[pʰlaecʰi:]	[plaicʰi:]	
full	ពេញ	[peiŋ]	[pĕiŋ]	
give	ឱ្យ	[ʔao:j]	[ʔao:i]	[ʔavi]
good	ល្អ	[lɔʔɔ:]	[l̪ɔʔɔ:]	[lɔʔɔə]
grass	ស្មៅ	[smau]	[smau]	
green	បៃតង	[ɓajtɑŋ]	[ɓaitaŋ]	
guts	ពោះវៀន	[povɨən]	[povɨən]	[pɔvɨən]
hair	សក់	[sɑk]	[sɑkˀ]	
hand	ដៃ	[ɗai]	[ɗai]	
he	គាត់	[ko:t]	[koətˀ.niəŋ]	
head	ក្បាល	[kɓʱa:l̪]	[kɓʱa:l̪]	
hear	លឺ	[l̪əɨ]	[l̪əɨ]	
heart	បេះដូង	[ɓahɗouŋ]	[ɓahɗouŋ] [ɓɑhɛɗouŋ]	
heavy	ធ្ងន់	[tʰŋon]	[tʰmon]	
here	ទីនេះ	[nih]	[nih]	[ti:nih]
hit	វាយ	[vai]	[vi]	
hold (take)		[tro]	[tʰou]	
horn	ស្នែង	[snaeŋ]	[snaeɲ]	
how?	របៀបណា	[ɗo:tˀməɗətˀ]	[tʰɨ:mətˀ]	
hundred	រយ	[mɾoj]	[mɾoi]	
hunt	បរបាញ់	[ɓaiɲsat]	[ɓaiɲsatˀ]	
husband	ប្ដី	[ɓɗəj]	[pɗəi]	
I	ខ្ញុំ	[kʰɲom]	[ɲom]	
ice	ទឹក	[təʔkɔ]	[təkɔ]	[tɨkɔ]
if	ប្រសិនបើ	[pɾosɛnɓael]	[pəsɛnɓael]	
in	ក្នុង	[knoŋ]	[knɔŋ]	
kill	សម្លាប់	[sɑmlapˀ]	[səla:pˀ]	
knee	ជង្គង់	[cɑkɔŋ]	[cɑkɔŋ]	
know	ដឹង	[ɗəŋ]	[ɗɑŋ]	
lake	បឹង	[ɓəŋ]	[ɓɑŋ]	
laugh	សើច	[saəc]	[savəcˀ]	[saəcˀ]
leaf	ស្លឹកឈើ	[slakcʰɨ:]	[slapcʰɨ:]	
left	ឆ្វេង	[cʰvɛ:ŋ]	[cʰvɛ:ɲ]	
leg	ជើង	[cəə:ŋ]	[cəə:ŋ]	

lie	ភ្ញៀ	[pʰou]	[pʰou]	
live	រស់នៅ	[ɾsoəna:v]	[ɾoənɑv]	
liver	ថ្លើម	[kʰlaəm]	[kʰlaəm]	
long	វែង	[vei:ŋ]	[vei:ŋ]	
louse	ចៃ	[caj]	[caj]	[cai]
man	បុរស	[manɪʔpɾo]	[pɾo]	
many	ច្រើន	[craən]	[craən]	
meat (flesh)	សាច់	[sac]	[sacˀ]	
moon	ព្រះច័ន	[pɾeacan]	[pcan]	
mother	ម្តាយ	[maʔ]	[mɗai:]	
mountain	ភ្នំ	[pʰno:m]	[pʰno:m]	
mouth	មាត់	[moəʈˀ]	[moəʈˀ]	
name	ឈ្មោះ	[cʰmuəh]	[cʰmoə]	
narrow	ចង្អៀត	[cɑŋiət]	[cəʔiətˀ]	
near	ជិត	[cət]	[cətˀ]	
neck	ក	[kɑ]	[kɑ]	
new*	ថ្មី	[tʰmai]	[tʰmae]	
night	យប់	[jɔp]	[jɔpˀ]	
nose	ច្រមុះ	[cɾɪmɔ]	[cɾɪmɔ]	
not	មិនមែនទេ	[mənmaenatʰei]	[mənmaen]	
old	ចាស់	[ca]	[ca]	
one	មួយ	[moəj]	[moəj]	
other	ផ្សេងទៀត	[neakˀ.ɗo.təi]	[neakˀ.ɗo.təi]	
person	មនុស្ស	[manu]	[manu]	
pierce		[ɗɑmlo]	[ɗɑmlo]	
play	លេង	[le:ŋ]	[leiŋ]	
pull	ទាញ	[tiəɲ]	[tiəɲ]	
push	រុញ	[əɾoəɲ]	[əɾoəɲ]	
rain	ភ្លៀង	[pʰliəŋ]	[pliəŋ]	
red	ក្រហម	[kɾəhom]	[kɾahɑm]	
right	ស្តាំ	[sɗam]	[sɗam]	
right (correct)	ត្រូវ	[tɾouv]	[tʰou]	
river	ទន្លេ	[tənlei]	[təlei]	
road	ផ្លូវ	[pʰlouv]	[plov]	
root		[ɾəuʔcʰəː]	[həuʔcʰəː]	
rope		[ksaj]	[ksai]	
rotten	រលួយ	[rəluej]	[ʔɑluei]	
rub	ដុស	[mɓal]	[ɗɔh]	
salt	អំបិល	[ʔəmbɑl]	[mɓal]	
sand	ខ្សាច់	[kʰsac]	[kʰsacˀ]	

say	និយាយ	[ənjaj]	[ɲjai]	[ənjai]
scratch	អេះ	[ʔeh]	[ʔeh]	[ʔɛh]
sea	សមុទ្រ	[sɑʔmot˺]	[sɑmot˺]	
see	ឃើញ	[kʰəːɲ]	[kʰəːɲ]	
seed		[kɾoəp˺]	[kʰoəp˺]	
seven	*ប្រាំពីរ	[mpal]	[mpal]	
sew	ដេរ	[ɗeː]	[ɗeː]	[ɗei]
sharp	*មុត	[sɾoət]	[sɾoət˺]	
shoot	បាញ់	[ɓaɲ]	[ɓaɲ]	
short	ខ្លី	[kʰləj]	[kʰləi]	
sing	ច្រៀង	[tɕrijəŋ]	[tɕɾijəŋ]	
sister	បង/ប្អូនស្រី	[ɓaŋ.srəj]	[ɓaŋ.sɾəi]	
sit	អង្គុយ	[ʔankoj]	[ŋkoi]	
skin	ស្បែក	[sɓaek]	[sɓaek˺]	
sky	មេឃ	[meikʰ]	[meːk˺]	[meɨk˺]
sleep	គេង	[keːŋ]	[keːŋ]	[keɨŋ]
small	តូច	[toutɕ]	[toutɕ˺]	
smell		[həʈ]	[həʈ˺]	
smoke	ផ្សែង	[pʰsaeŋ]	[pʰsaeŋ]	
smooth	*រលោង	[rolouᵕ]	[ʔəlouᵕ]	
snake	*ពស់	[poə]	[poə]	
snow	ព្រិល	[prəːl]	[pɾəːl]	
some	ខ្លះ	[kʰlah]	[kʰlah]	
spear	លំពែង	[lɔmpɛːŋ]	[lɔmpɛːɲ]	
spit		[sɗɑ.tɑʔ.moət]	[sɗɑ.tɑʔ.moət˺]	
split		[tɕəɾu]	[tɕəɾu]	
squeeze	ច្របាច់	[tɾoʔɓɑt˺]	[tʰəɓɑt˺]	
stand	ឈរ	[tɕʰou]	[tɕʰou]	
star	ផ្កាយ	[pʰkaːj]	[pkaiː]	[pʰkaiː]
stick		[kəmteitɕəʊ]	[kəʔteʔtɕʰɨː]	
stone	ថ្ម	[tmɔː]	[tmɔː]	
straight	ត្រង់	[trɑŋ]	[tʰoəŋ]	
suck	បឺត	[ɓət]	[ɓə̃t˺]	
sun	ព្រះអាទិត្យ	[prejatet˺]	[tŋai]	
swell	ហើម	[haəm]	[haəm]	
swim	ហែល(ទឹក)	[hael]	[hael]	
tail	កន្ទុយ	[kɑntoj]	[ktoi]	
ten	ដប់	[dɑp]	[dɑp˺]	
that	នោះ	[nu]	[nu]	
there	ទីនោះ	[nu]	[nu]	[tiːnu]
they	ពួកគេ	[puəkʰei]	[puəkkʰei] [puəkkʰeː]	

thick	ក្រាស់	[kɾa]	[kʰejə]	
thin	ស្តើង	[sɗəəŋ]	[sɗəəŋ]	
think	គិត	[kət]	[kətˀ]	[katˀ]
this	នេះ	[ni]	[nih]	
thou	អ្នក	[neak]	[neakˀ]	[neaʔ]
three	បី	[ɓəj]	[ɓəj]	
throw	បោះ	[ɓɑh]	[ɓɑh]	
tie	ចង	[cɔ:]	[cɔ:]	
tongue	អណ្តាត	[nda:t]	[nda:tˀ]	
tooth	ធ្មេញ	[tʰme:ɲ]	[tʰmẽ:ɲ]	
tree	ដើមឈើ	[ɗəmcʰɨ]	[ɗəmcʰɨ]	
turn	បត់	[ɓɔtˀ]	[ɓɔtˀ]	
twenty	ម្ភៃ	[mpʰaj]	[məpʰai]	[mpʰai]
two	ពីរ	[pi:]	[pi:]	
vomit	ក្អួត	[kʔuət]	[kʔuətˀ]	
walk	ដើរ	[ɗəə]	[ɗəə]	
warm	កក់ក្តៅ	[kɗɑʊ.ən.ən]	[kɗɑu.lə.mom]	
wash	លាង	[liəŋ]	[liəŋ]	
water	ទឹក	[tək]	[ʈəkˀ]	
we	យើង	[jɨəŋ]	[jɨəŋ]	
wet	សើម	[sɑəm]	[sɑəm]	
what?	អ្វី	[ʔəʊəj]	[ʔəi]	
when?		[nəɨʔɑnɑ]	[nənə]	[nəonɑ]
where?		[belnɛ]	[belnɛ]	
white	ស	[sɑ:]	[ɓoə.sɑ:]	
who	អ្នកណា	[nɛ̰ʔna]	[nɑke:]	
wide	ទូលាយ	[tu:liəj]	[təliəi]	
wife	ប្រពន្ធ	[ɓɾapontʰ]	[pəpon]	
wind	ខ្យល់	[kʰcal]	[kʰcal]	
wing	ស្លាប	[sla:ɓ]	[slã:ɓ]	
wipe	ជូត	[cu:t]	[cu:tˀ]	
with	ជាមួយ	[cəiəmuəj]	[cəəmuəi]	
woman	ស្ត្រី	[manu.sɾaj]	[manu.sɾai]	
woods	ព្រៃ	[pɾəicʰə:]	[pʰai]	
work	ធ្វើការ	[tvə:kəh]	[tə:kə]	
worm	ដង្កូវ	[ɗɔŋkaʊ]	[pɔkaʊ]	
ye		[pok.neak]	[pokˀ.neakˀ]	
year	ឆ្នាំ	[cʰnam]	[cʰnam]	
yellow	លឿង	[liəŋ]	[ɓoə.liəŋ]	

Appendix B: VOT Transcriptions

Aspirated Consonants

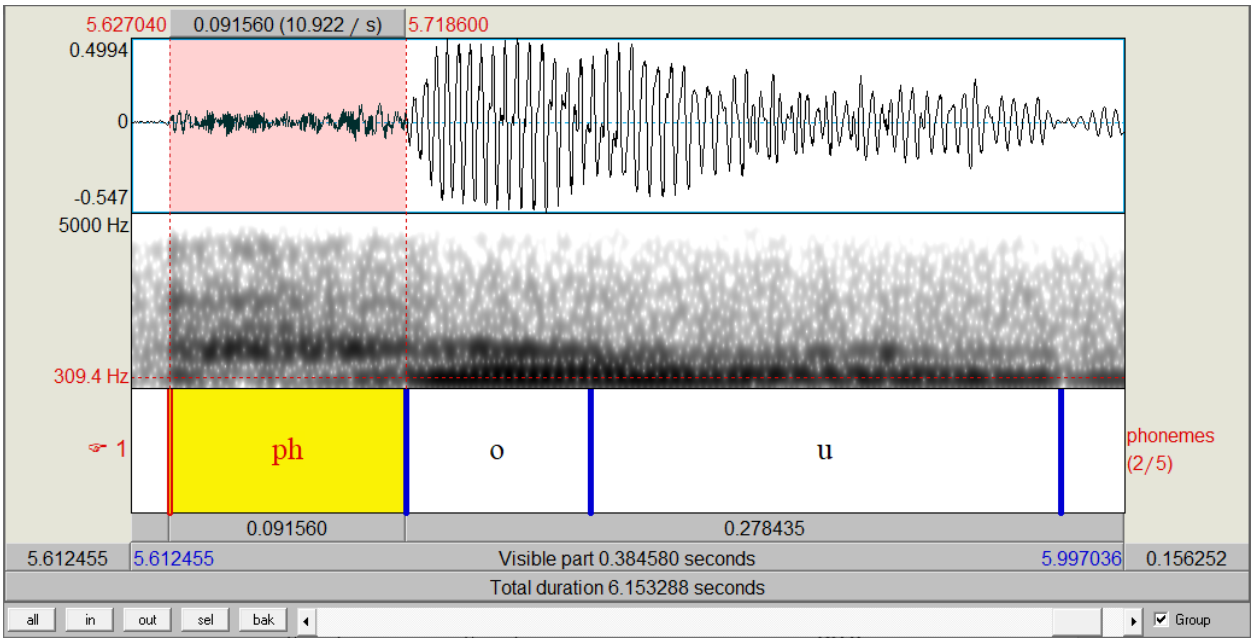

Figure 4. Audacity transcription of [p^{h}ou] (*lie*). The opening consonant lasts ~0.092 seconds.

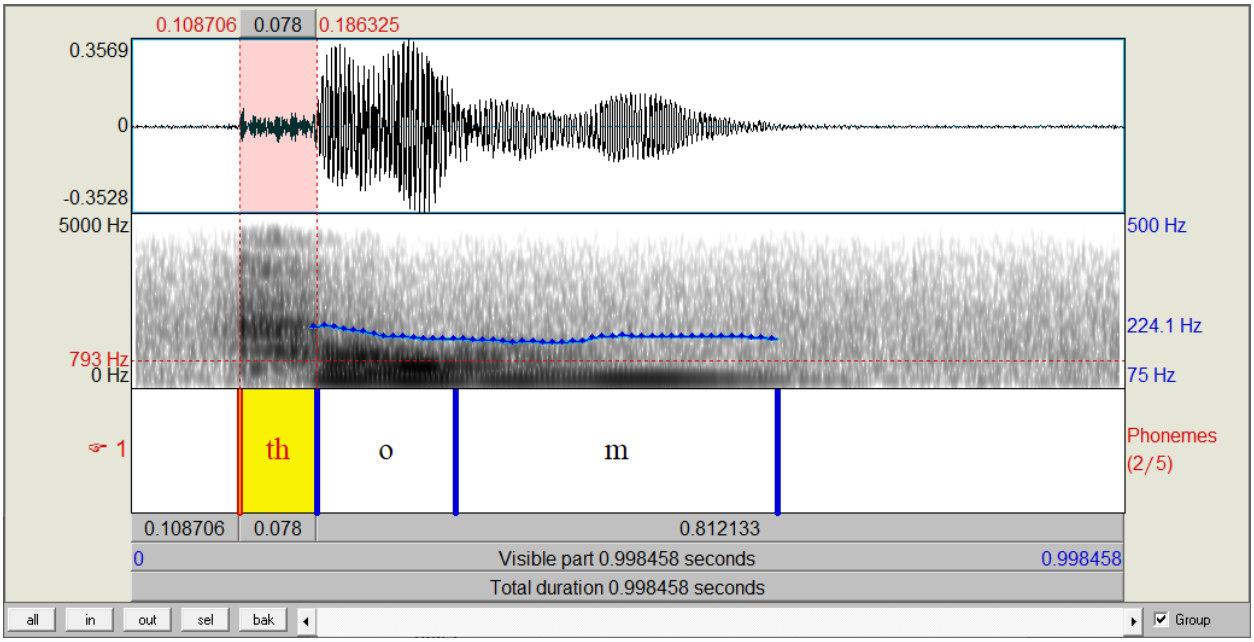

Figure 5. Audacity transcription of [t^{h}om] (*big*). The opening consonant lasts ~0.078 seconds.

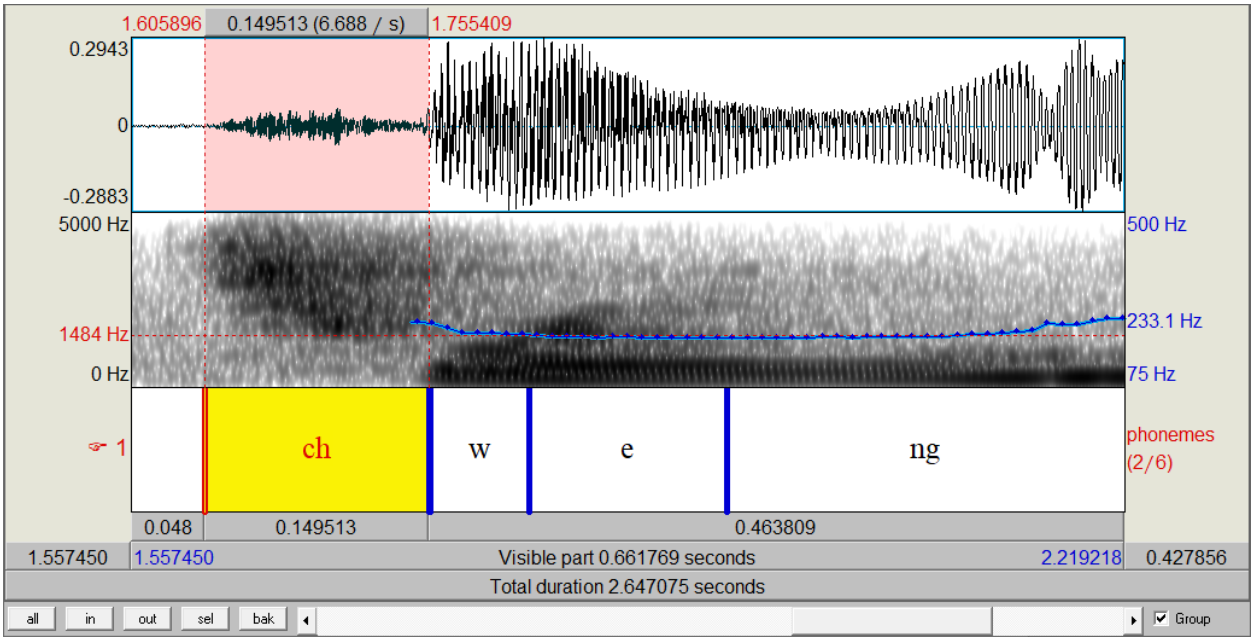

Figure 6. Audacity transcription of [tɕʰʊeːŋ] (*left*). The opening consonant lasts ~0.150 seconds.

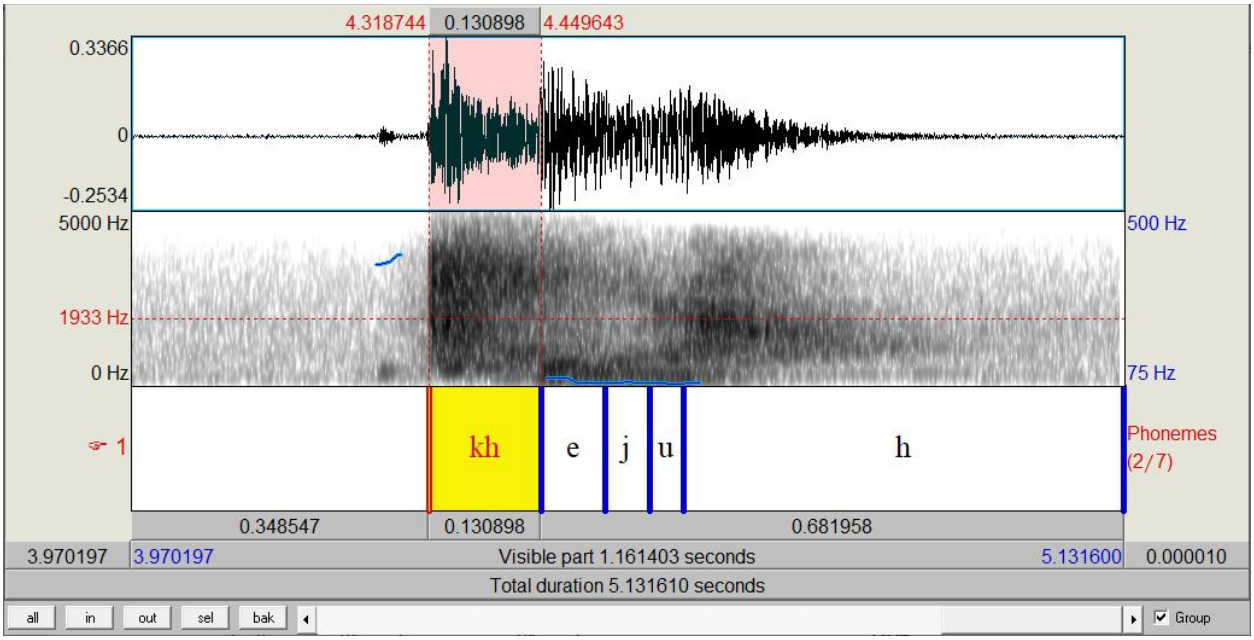

Figure 7. Audacity transcription of [kʰejə] (*thick*). The opening consonant lasts ~0.131 seconds.

Unaspirated Consonants

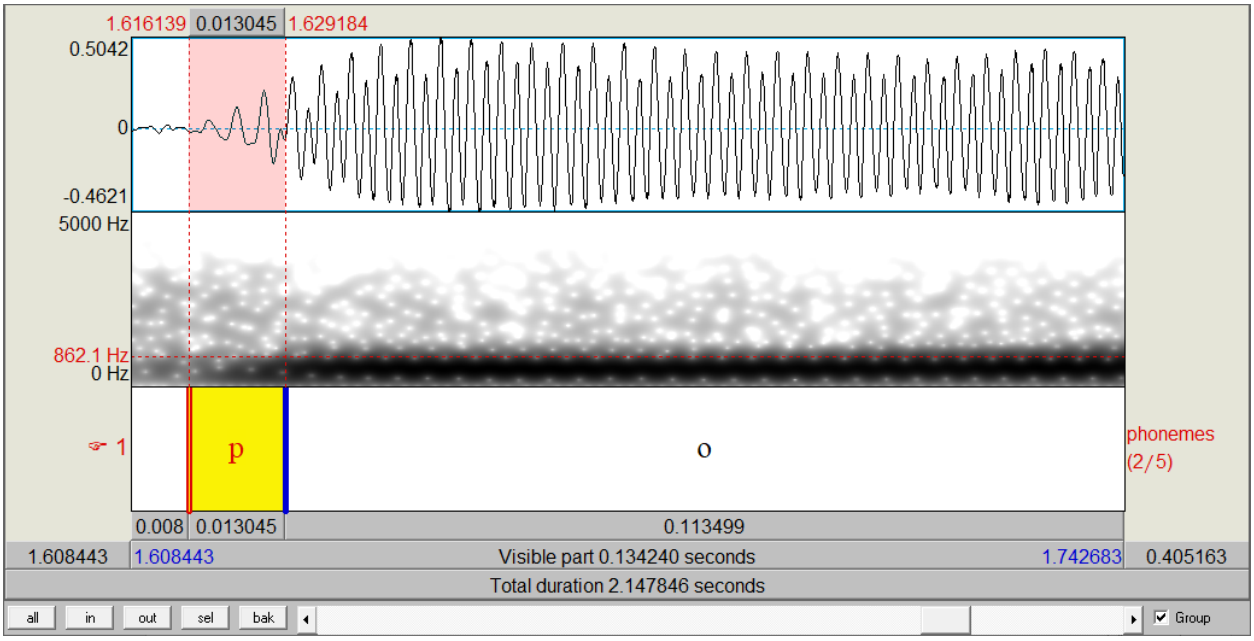

Figure 8. Audacity transcription of [poə] (*snake*). The opening consonant lasts ~0.013 seconds.

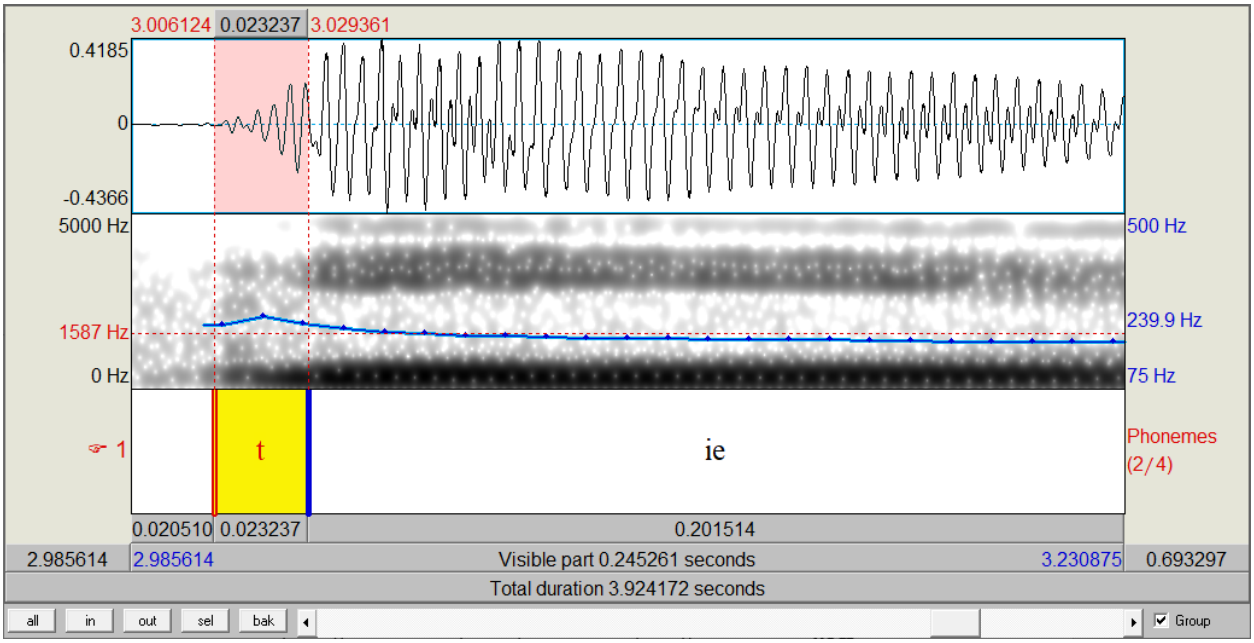

Figure 9. Audacity transcription of [tiəŋ] (*pull*). The opening consonant lasts ~0.023 seconds.

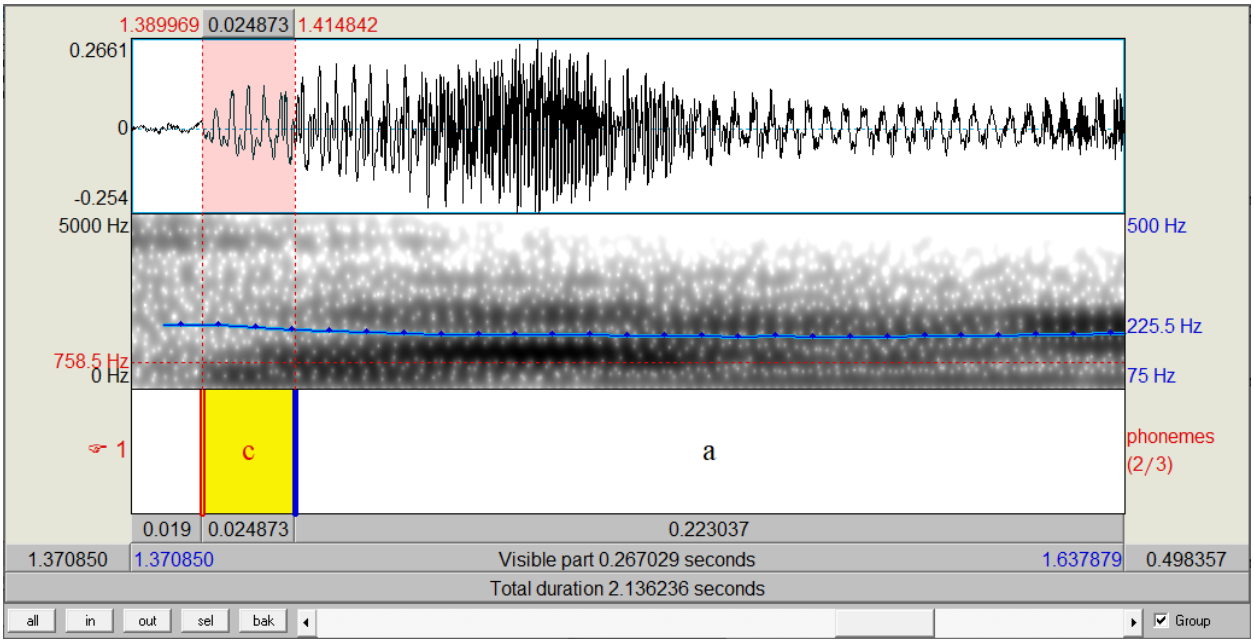

Figure 10. Audacity transcription of [tɕãːpˀ] (*bird*). The opening consonant lasts ~0.025 seconds.

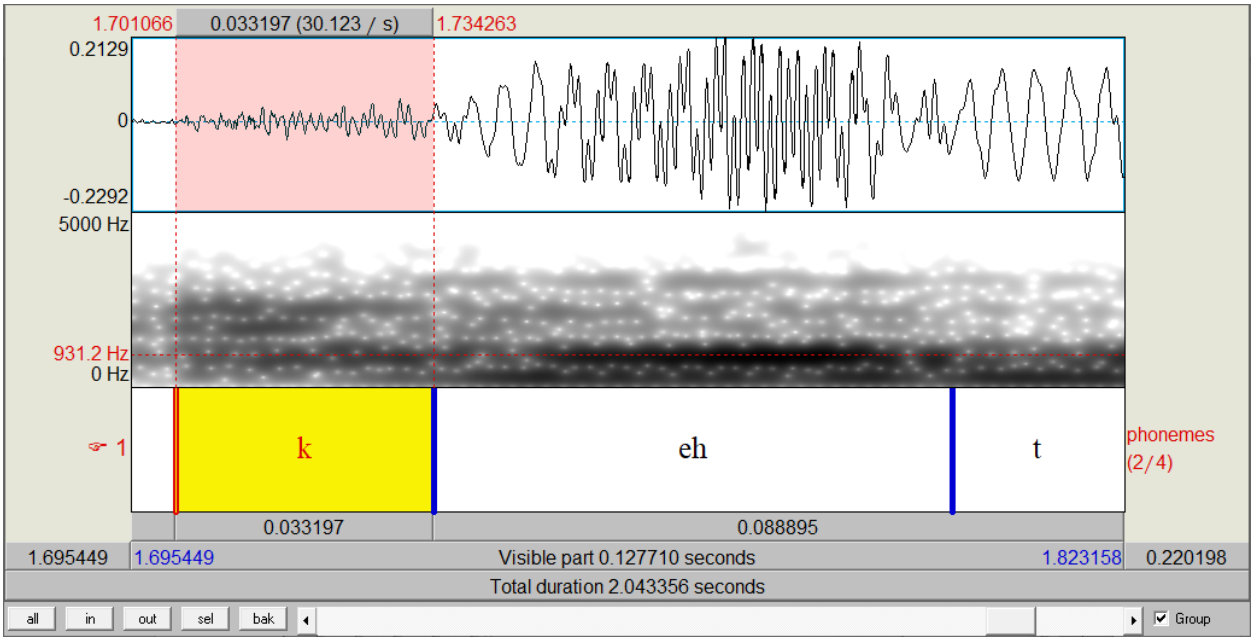

Figure 11. Audacity transcription of [kətˀ] (*think*). The opening consonant lasts ~0.033 seconds.

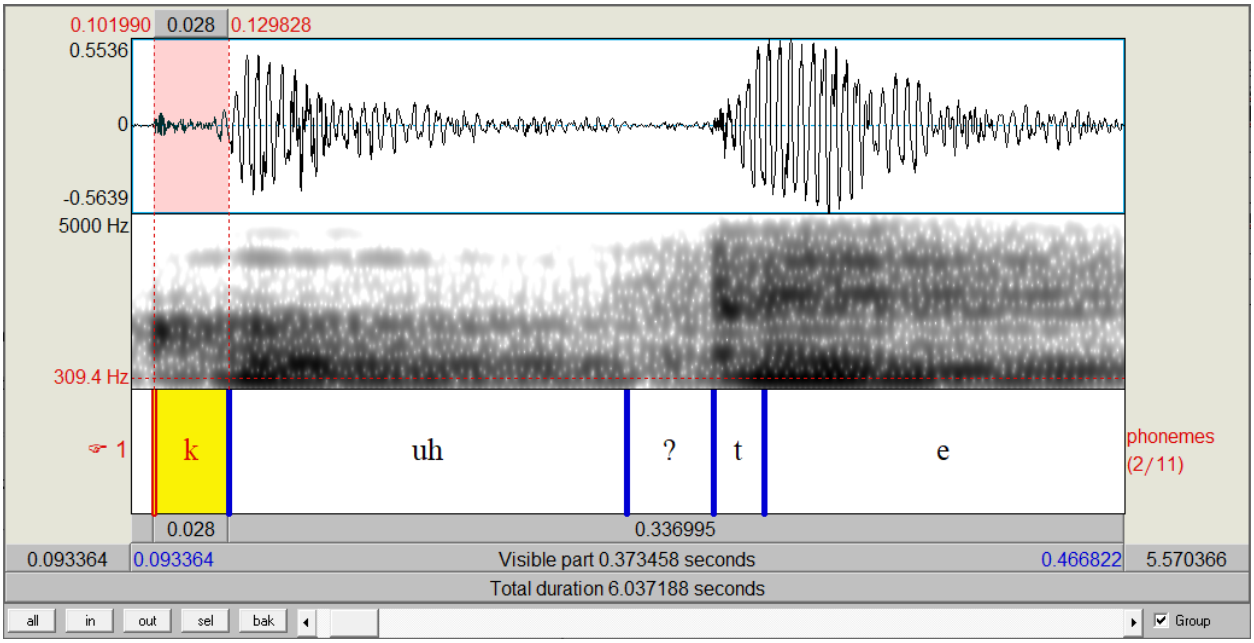

Figure 12. Audacity transcription of [kəʔteʔtɕʰiː] (*stick*). The opening consonant lasts ~0.028 seconds.

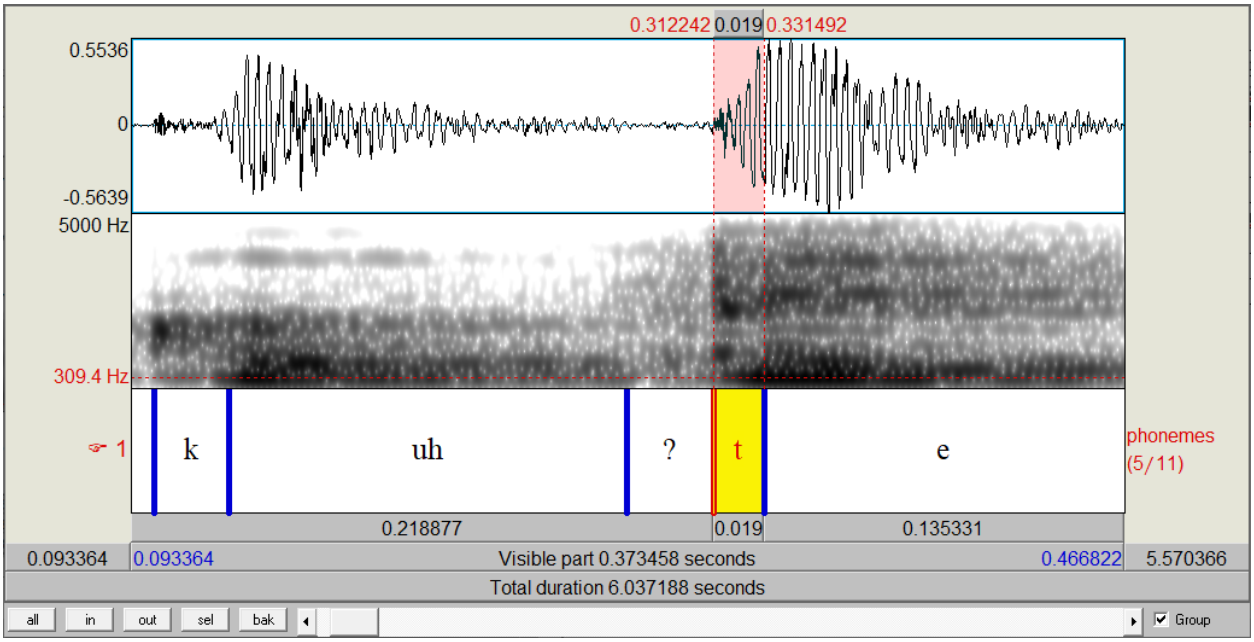

Figure 13. Audacity transcription of [kəʔteʔtɕʰiː] (*stick*). The medial consonant lasts ~0.019 seconds.

Appendix C: Additional Khmer Phonetic References

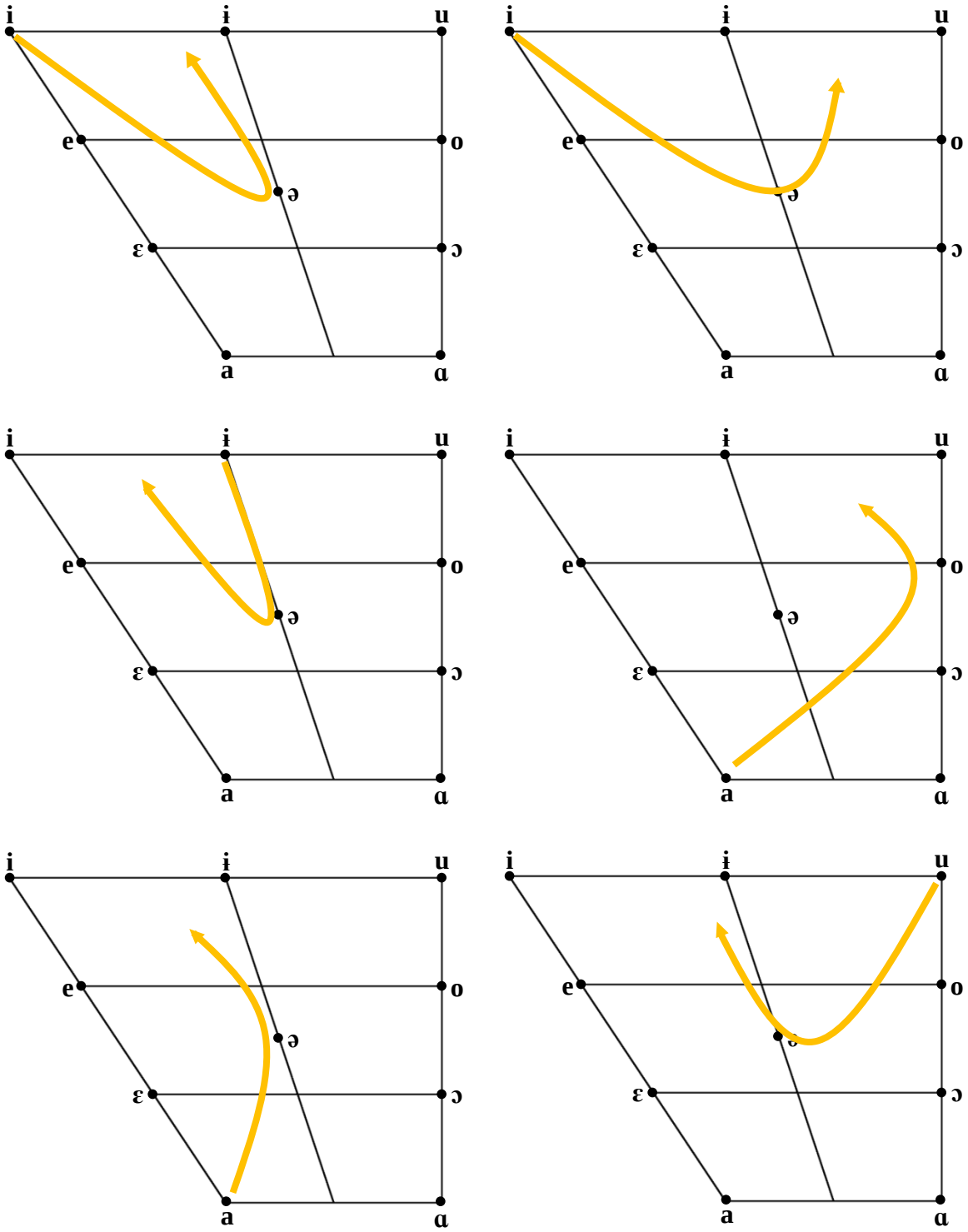

Figure 14. Khmer Triphthongs (in the order of /iəj, iəw, ɨəj, aoj, aəj, uəj/)

Table 9

Example Words for Khmer Onset Clusters

C1	C2																
	p	t	tɕ	k	ʔ	ɓ	ɗ	m	n	ɲ	ŋ	l	r	s	h	ʋ	j
p		pt	ptɕ	pk	pʔ		pɗ		pn	pɲ	pŋ	pl	pr	ps	ph		pj
			[ptɛan] *moon*	[pkaː] *flower*			[pɗaːj] *husband*		[pʰnoːm] *mountain*			[pliəŋ] *rain*	[prəːl] *snow*	[psaɛŋ] *smoke*	[pʰɛh] *ashes*		
t	tp			tk	tʔ	tɓ		tm	tn		tŋ	tl	tr		th	tʋ	tj
								[tmɔː] *stone*			[tŋai] *day*	[tliət] *fall*			[tʰəi] *fish*	[tʋəːkəh] *work*	
tɕ	tɕp			tɕk	tɕʔ	tɕɓ	tɕɗ	tɕm	tɕn		tɕŋ	tɕl			tɕh	tɕʋ	
				[tɕkɔŋ] *knee*				[tɕmoə] *name*	[tɕnam] *year*		[tɕŋaj] *far*	[tɕloəknijə] *fight*			[tɕʰiːm] *blood*	[tɕʋɛŋ] *left*	

k	kp	kt	kʨ		kʔ	kɓ	kɗ	km	kn	kɲ	kŋ	kl	kr	ks	kh	kʋ	kj
		[ktoi] *tail*	[kʰʨal] *wind*		[kʔuət] *vomit*	[kɓalpoəh] *belly*	[kɗɑu] *warm*	[kmau] *black*	[knɔŋ] *in*	[kɲom] *I*		[klaəm] *liver*	[kra] *thick*	[ksai] *rope*	[kʰam] *bite*		
s	sp	st		sk	sʔ	sɓ	sɗ	sm	sn	sɲ	sŋ	sl	sr			sʋ	
						[sɓɔkʨʰɨ:] *bark*	[sɗaəŋ] *thin*	[smau] *grass*	[snaeŋ] *horn*		[sŋuət] *dry*	[sla:ɓ] *wing*	[sroət] *sharp*				
m		mt	mʨ		mʔ	mɓ	mɗ		mn	mɲ		ml	mr	ms	mh		
						[mɓai] *eight*	[mɗai:] *mother*						[mroi] *hundred*				
l	lp			lk	lʔ			lm			lŋ				lh	lʋ	

Appendix D: English Phonetic References

Table 10

Phonemic English Consonant Inventory

	Bilabial		Labio-dental		Dental		Alveolar		Post-alveolar		Palatal		Velar		Glottal	
Stop	p	b					t	d					k	g	ʔ	
Nasal		m						n						ŋ		
Fricative			f	v	θ	ð	s	z	ʃ	ʒ					h	
Affricate									ʧ	ʤ						
Approximant		w						ɹ				j		w		
Lateral Approximant								l								

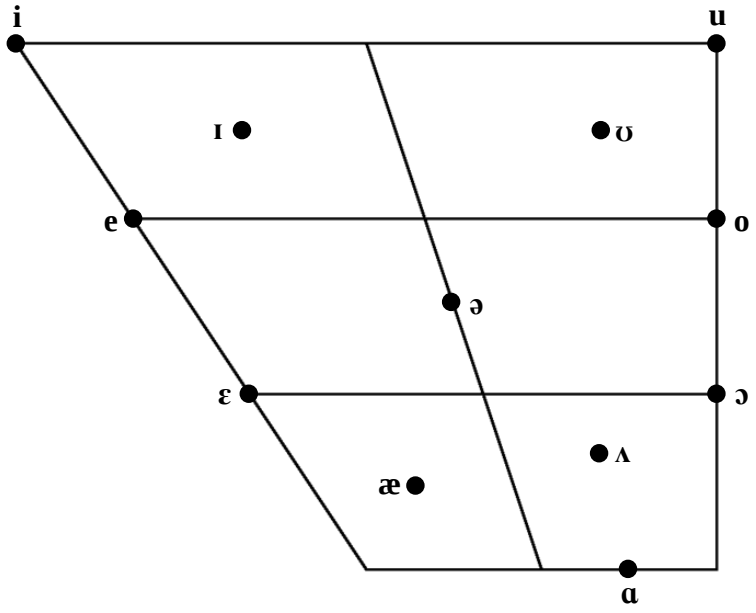

Figure 15. English Vowel Distribution

Table 11

English Onset Clusters (CC-)

	p	**t**	**k**	**m**	**n**	**w**	**j**	**l**	**r**
p							pj	pl	pr
t						tw	tj		tr
k						kw	kj	kl	kr
b							bj	bl	br
d						dw			dr
g						gw		gl	gr
f							fj	fl	fr
θ						θw			θr
ʃ									ʃr
s	sp	st	sk	sm	sn	sw		sl	
h							hj		
v							vj		
m							mj		
l							lj		