Towards a practical phonology of Korean

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The blue silhouette of the Korean peninsula featured on the front page of this thesis is taken from the Korean Unification Flag (Wikimedia 2009), which is used to represent both North and South Korea.

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Introduction

Learning Korean as a second language is more popular than ever before. Talk To Me In Korean (TTMIK), one of the most popular Korean language learning centres, has attracted 900,000 YouTube subscribers at the time of writing and has published scores of courses and books on the language. The material published by TTMIK is aimed at second-language learners of Korean. Leiden University's Asian Library houses some of the books published by TTMIK, as well as several other resources aimed towards teachers or learners of Korean, such as KJL (2016) and KYL (2017). In addition, the collection contains a number of reference grammars of Korean, handbooks of Korean linguistics, and other academic works on the language, all aimed towards linguists, such as BY (2015), Kim-Renaud (2009), LR (2000), SKC (2012), Sohn (1994; 1999), and YB (2011).

By way of illustration of their difference of approach, let me compare two sources which cover the pronunciation of Korean: a learner-oriented source and a linguist-oriented source. The former, called *Korean pronunciation guide: How to sound like a Korean* (KYL 2017), is published by Darakwon, a Korean publisher specialising in language-learning materials. The book looks colourful and is filled with instructions, exercises, and illustrations. The latter, called *The sounds of Korean* (SKC 2012), is published by Cambridge University Press. This book is much more academic in the way it is structured and provides information.

Both sources introduce the workings of Korean phonetics and phonology in a clear and consistent way. For example, both explain how the speech sounds of Korean can be realised using articulatory terms like *plosive*, *alveolar*, *aspirated*, *diphthong*, *front*, and *rounded*. To get an impression of how the two sources on Korean differ from each other, let us look at the way in which each source covers a specific allophonic variation (§ 2.2.2), namely palatalisation. On the one hand, KYL (2017: 86-91) discuss palatalisation, which they call a *pronunciation rule*, in the following way:

> When the final consonant ㄷ combines with 이, it becomes [지], and when ㄷ combines with 히, it becomes [치]. […] When the final consonant ㅌ combines with 이, it becomes [치].

One of the given examples is visualised like this: "같이 → [가치]". Next to these descriptions, the chapter on palatalisation is filled with illustrative conversations, drawings, and exercises, all accompanied by audio recordings which the reader can access online.

On the other hand, SKC (2012: 207-208) discuss palatalisation, which they call a *phonological rule*, as follows:

> When a lexical morpheme ending with /t, tʰ/ is followed by a grammatical morpheme beginning with /i/, /t, tʰ/ is palatalised into /tɕ, tɕʰ/.

The example which I quoted from KYL (2017: 87) is also mentioned by SKC (2012: 207), albeit formulated in a different way: "같이 /kɑtʰ- + -i/ → [kɑtɕʰi] 'together'". The examples given are again accompanied by online audio recordings.

Even though the implications of both formulations are identical, there are some clear differences between KYL (2017) and SKC (2012) in the way explanations and Korean words, phrases, and sentences are presented and described. Table 1 summarises these differences.

Table 1. Differences of presentation between KYL (2017) and SKC (2012)

	KYL (2017)	**SKC (2012)**
Linguistic terminology	–	✓
In-depth information	–	✓
Illustrations and exercises	✓	–
Official Hangeul spelling	✓	✓
Phonetic Hangeul spelling	✓	–
Full-colour printing	✓	–
Hangeul romanisations	–	–
Phonemic and phonetic transcriptions	–	✓
Meanings of examples	–	✓

The difference between official and phonetic Hangeul spelling mentioned in Table 1 is well-illustrated by the example which I quoted from KYL (2017: 87): "같이 → [가치]". Here, <같이> *gat.i* 'together' is official Hangeul spelling, dictated by the Unified Spelling System of 1933 (NIKL 2017), and <가치> *ga.chi* is make-shift phonetic Hangeul spelling, indicating more unambiguously the actual pronunciation of the same meaning. The discrepancy between official and phonetic Hangeul spelling is caused by the fact that it is not always predictable how a pronunciation is spelled according to the Unified Spelling System. Thus, mentioning both official and phonetic spelling will help the reader in his understanding of the Korean writing system.

Another difference between both sources is the way in which linguistic phenomena such as palatalisation are approached. KYL (2017) discuss them as something which can be deducted from written Korean, while SKC (2012) see them as processes inherent to spoken language without taking its written form into account. In other words: while KYL (2017) attempt to describe the phonology of Korean by reasoning from written language to spoken language, SKC (2012) only consider spoken language. However, it deserves to be mentioned that even SKC (2012: 98-99) discuss Korean phonology in terms of its script in some cases, e.g.: "The best way of finding out whether /ㅟ/ and /ㅚ/ are simple vowels or diphthongs […]" and "Minimal pairs which show ㅖ and ㅒ contrast are given in (3)." This means that both sources deal with Korean phonology in terms of its written form to some extent.

Now, I am not making any claims about which of these two approaches is inherently better. Both appear to serve different audiences in consistent and appropriate ways. I can, however, comment on which approach is linguistically and didactically more responsible. The field of phonology concerns the speech sounds of a particular language and the way in which these sounds interact to represent different meanings. In doing this, it is not at all necessary to take the spelling of this language into account. In other words, languages without a script – meaning most languages spoken today – are susceptible to phonological analysis without any exception. Hence the approach by SKC (2012), who focus on spoken language, is linguistically more responsible. In fact, even second-language learners need not be bothered by the written form om the language at all. After all, one can learn to speak a language without needing to know how to read and write it. Every child learns to speak their first language in this way. This means that even from a didactic perspective, it will make great sense to take the spoken form of a language as a starting point.

Didactically speaking, an advantage of the approach by KYL (2017) is their reliance on illustrations, colours, exercises, and understandable explanations to make their resources accessible to a larger audience. SKC (2012), on the other hand, provide the reader with in-depth information on Korean in a linguistically responsible and concise manner, but not every learner of Korean will feel attracted to dense discussions on linguistics.

Here, I attempt to answer the following research question: How can Korean phonology be taught to second-language learners of Korean in a linguistically responsible yet didactically adequate way? I do this by giving an up-to-date introduction to Korean phonology and by exploring means of valorisation for didactic purposes. In this way, this study aims to serve as a bridge between the linguistic and didactic approaches mentioned earlier, catering to general and Korean linguists as well as second-language learners of Korean by providing an exploration of Korean phonology on the basis of the spoken language. In order to make sure such a work be accessible, it will select only those linguistic terms that are necessary, all of which I will explain. Illustrations will be added to clarify key points. My approach aims to create maximal applicability for a book that teaches second-language learners Korean pronunciation, and maximal adaptability to an introduction to Korean orthography. A good example of a book that teaches second-language learners about pronunciation is Jeroen Wiedenhof's (2015b) *De uitspraak van het Mandarijn in 101 oefeningen* 'Mandarin pronunciation in 101 exercises', which teaches the Mandarin pronunciation of Beijing, guided by accessible linguistic descriptions, exercises, and audio fragments of native speakers, all on the basis of the spoken language.

My experiences with Korean language education at Leiden University inspired me to start this project. Ae Ree Nam (남애리 *nam.ae.li*[1]) used to be my Korean language teacher for over a year. During the time I took her language classes, many of my fellow students, even well beyond their first year of Korean Studies, had trouble mastering Korean phonology. Because not enough class time could be devoted to Korean phonology,

[1] For an overview of the romanisation system and other conventions I adhere to, see § 0.

I offered two presentations on the topic in the autumn of 2019, one to first-year students and one to second-year students. Many of the students who attended these presentations indicated that they found them to be useful. I based these two presentations on the experience with Korean phonology and orthography that I gained while writing my Bachelor's thesis. This was a phonological study of deliberate spelling errors found in Korean web forums. I found that many of these spelling errors reflect common phonological processes.

Coinciding with my work on this study, I am collaborating in a didactic project recording a series of educational videos. Here, I explain the rules which can be used to deduce the pronunciations of Korean Hangeul spellings. These videos will be published online together with six prior videos in which Dr. Nam explains the workings of the Korean alphabet. All future first-year students of Korean Studies at Leiden University will be required to watch these videos even before attending their first Korean class.

Researching the pronunciation of Korean at Leiden University is exciting. Over 60 languages are taught and researched here, both from a linguistic and from a didactic point of view. Each of these languages is approached from its own tradition, partly influenced by the characteristics of the language, such as the script that is used to write it. These differences give rise to dialogue about the way in which languages can best be approached. With this thesis, I hope to contribute to this dialogue.

In the following, I will be first be going over the conventions I adhere to while writing this thesis. Then, I will give an introduction into the Korean language and script, followed by an introduction into the fields of phonetics and phonology. After having introduced these topics, I will discuss the methodology that I use and the results of my research.

0. Conventions

0.1 Romanisation

Nowadays, Korean is written using the native Hangeul alphabet (§ 1.2). All romanisations of Hangeul spellings are based on the Revised Romanisation of Korean (RRK) system (NIKL n.d.). The South Korean government also uses this system, meaning that second-language learners of Korean will be most accustomed to this system. In the context of this study, this system has been adapted in a number of ways. I refer to this adapted version of RRK as *Adapted RRK Transcription* (ART). Often times, there is no difference between the way Hangeul spelling is transcribed in RRK and in ART. All of the changes in ART are intended to unambiguously and consistently reflect the Hangeul spelling of Korean instead of its spoken form, making it easier for the reader to understand the structure of a Korean spelling without having to know the alphabet by heart. The following table illustrates the differences between RRK and ART.

Table 2. Differences of romanisation between RRK and ART

Hangeul spelling	**Meaning**	**RRK**	**ART**
기록	'record'	*girok*	*gi.rog*
원천	'headspring'	*woncheon*	*ueon.cheon*
코끼리	'elephant'	*kokkiri*	*ko.ggi.li*
부산	'Busan city'	*Busan*	*bu.san*
중앙	'centre'	*jung-ang*	*jung.ang*

The first difference between both systems is that in ART, a Hangeul letter is always romanised in the same way, regardless of how it is actually pronounced. For example, the consonant letter ㄱ is always romanised as *g*, even when it is pronounced as [k]. For the most part, romanisations of Hangeul letters as prescribed by RRK are used, with two exceptions. Firstly, in RRK, romanisations of the vowel letter combinations 과, 새, 긔, 겨, 게, 귀, and 늬 are mostly based on their pronunciations: *wa*, *wae*, *oi*, *weo*, *we*, *ui*. However, because ART is based on Hangeul spelling instead of Korean pronunciation, these combinations are romanised as *oa*, *oae*, *oi*, *ueo*, *ue*, *ui*, and *eui* in ART. This makes it clearer what Hangeul vowel letters they are composed of. E.g., 과 [wa] is composed of the vowel letters ㅗ *o* and ㅏ *a*, hence the romanisation *oa* instead of *wa*. Secondly, the double consonant letters ㅃ, ㄸ, and ㄲ are romanised as *bb*, *dd*, *gg* instead of *pp*, *tt*, *kk*. This makes it clear that they are the doubled counterparts of ㅂ *b*, ㄷ *d*,ㄱ *g*, not of ㅍ *p*, ㅌ *t*, ㅋ *k*.

In addition, periods are added in between the romanisations of individual syllable blocks (§ 1.2) within a single word. Here, I define a Korean word as that which is written between two Hangeul spaces. Capital letters are not written in romanisations, in order to only transcribe information present in the original Hangeul spellings. In RRK, when a single romanisation creates ambiguity because it can be used to represent multiple distinct Hangeul spellings, a clarifying hyphen is written: 중앙 'centre' is romanised as *jung-ang* to avoid ambiguity with 준강 *jun-gang* 'semi-strong'. In ART, because the use of periods already takes away any of these ambiguities, these hyphens have not been adopted.

I always romanise Korean names according to the preferences of the people who carry those names. These romanisations divert from ART. For example, the name 임정하 (§ 3.1) is romanised as *im.jeong.ha* in ART, but as *Lim Jeong Ha* by herself. For this reason, I will use the latter instead.

0.2 Glosses

The following abbreviations are used in glosses to indicate the functions of grammatical morphemes. These abbreviations are always given in small capitals. In each gloss definition below, the cursive part is the abbreviated term, e.g. FNP is an abbreviation of *formal non-polite*. The non-cursive parts are further explanations.

ATTR	*attributive* postposition, signalling that an adjective determines a noun
CAUS	*causative* verb form
COR	*coordinative* suffix, connecting two or more elements of a construction
FNP	*formal non-polite* verb form
IND	*indirect* object of a verb
LOC	*locative* suffix
OBJ	direct *object* of a verb
PASS	*passive* voice
PST	*past* tense, indicating a period preceding the moment of speaking
SUB	*subject* of a predicate

All Korean example sentences were provided by me and checked with a native speaker of Korean (Lim Jeong Ha, personal communication, May 5, 2020).

0.3 Symbols

For the purpose of this study, several symbols are used. Here, each of these is explained and exemplified.

Symbol	Meaning	Example
.	Hangeul syllable block boundary	*han.gug.mal*
-	1. in romanisation: morpheme boundary	*jib-i*
	2. in glosses: boundary between glosses of different morphemes	house-SUB
~	1. allomorphs of the same morpheme	*–eul* ~ *–leul*
	2. range between two endpoints	[ny] ~ [nœ]
–	in table cells: absence	*N/A*
✓	in table cells: presence	*N/A*
=	realisations with identical meanings	[mul] = [bul] 'water'
≠	realisations with different meanings	[pul] 'horn' ≠ [pʰul] 'grass'
∅	no elicited meaning	[næ] ∅
C	any consonant	[Cul]
V	any vowel	[nV]
' '	meaning	'student'
" "	citation from written source	"같ㅇ → [가치]"
< >	spelling	<k>
( )	1. additional information	(MSDL 2009: 42)
	2. example number	example (4)
[…]	suppressed part of citation	"When the final […]"
[ ]	phonetic transcription in IPA (§ 0.4)	[nɛk̚taɪ]
/ /	phonemic transcription (§ 0.5)	/dʌk/

0.4 Phonetic transcription

In § 0.3, it was mentioned that phonetic transcriptions (as introduced in § 2.1) are given in IPA, which is an abbreviation of *International Phonetic Alphabet*. This alphabet contains the phonetic symbols established by the International Phonetic Association (IPA 2018). Phonetic notations are enclosed in square brackets. For example, [nɛk̚taɪ] indicates the pronunciation of *necktie*. The advantage of using IPA when writing sounds of speech as compared to the regular spellings of written languages is that IPA notations are highly unambiguous and consistent. This does not always hold for regular spellings of languages. For example, the English vowel letter sequence <ea> can be used to write multiple different vowels, as in *dream* and *react*. This ambiguity is resolved by using standard IPA notations. The two words just mentioned are transcribed in IPA as [dɹiːm], and [ɹiækt], respectively. From these two IPA notations, it is instantly clear that these words contain different vowels, namely [iː] and [iæ], respectively. Unless stated differently, phonetic notations in this work are given in the pronunciation of British English, as provided by Cambridge (2020). Appendix A gives the IPA chart revised to 2018.

0.5 Phonemic transcription

Phonemic transcriptions (as introduced in § 2.2) are indicated using slashes. Between two slashes, I maintain a one-to-one correspondence between phonemes and symbols. This is done in order to resolve any ambiguities regarding the number of phonemes at issue. For example, phoneme notations like /tɕ/ (SKC 2012: 57) could lead to the incorrect assumption that this notation

represents two distinct phonemes /t/ and /ɕ/. All phoneme symbols used to represent phonemes are directly taken from the phonetic symbols of IPA (2018). However, one should not confuse notations like /ɛ/ with notations like [ɛ]. Even though both notations make use of the same IPA symbol, the phonemic notation /ɛ/ indicates a vowel phoneme in a specific language, and the phonetic notation [ɛ] indicates the low-mid front unrounded vowel in any language.

1. Korean language and script

1.1 Korean language

The Korean language (Korean: 한국어 *han.gug.eo* or 한국말 *han.gug.mal*) is spoken by almost 80 million speakers worldwide. A large majority of over 48 million speakers lives in South Korea, with another 25 million speakers living in North Korea. Other speakers are spread across the globe, e.g. China (2,7 million), the USA (1,1 million), and Japan (1 million). In both North and South Korea, Korean is the only national language. It is used in all areas of daily life: in school, at the workplace, in the media, by the government, and at home. But Korean is not the only language used in these two countries. Korean Sign Language (Korean: 한국 수화 언어 *han.gug su.hoa eon.eo* or 수화 *su.hoa* 'sign language' for short) is used by a total of 75,000 people, and the small Jeju language (Korean: 제주어 *je.ju.eo*) is spoken by 5,000 people on the South Korean island of Jeju. Additional languages are Mandarin in both North and South Korea, and English in South Korea.

The Korean language is part of the Koreanic language family, of which the only other member is the Jeju language. There has been much debate about the question whether Korean and Japanese are related languages. Some have proposed an Altaic language family, also including the Mongolian, Tungusic, and Turkish languages. For arguments in favour of this hypothesis, see Robbeets (2005).

Example (1) illustrates basic word order in Korean: subject (*so.nyeon.i* 'the boy') – object (*dang.geun.eul* 'a carrot') – verb (*meog.neun.da* 'eats'), which is different from the order in the accompanying English translation.

(1) *so.nyeon-i* *dang.geun-eul* *meog-neun.da*
boy-SUB carrot-OBJ eat-FNP
'The boy eats a carrot.'

In other words, Korean is an SOV language, meaning that the basic word order in unmarked sentences is subject (S) – object (O) – verb (V). English, on the other hand, is an SVO language.

In example (2), we can see that the noun *hag.saeng* 'student', comes last in Korean. Compare this to the English translation, in which *the student* comes first.

(2) *keo.pi-leul* *ma.si-neun* *hag.saeng*
coffee-OBJ drink-ATTR student
'the student that drinks coffee'

In technical terms, the head *hag.saeng* 'student' follows the element by which it is modified, i.e. *keo.pi.leul ma.si.neun* 'that drinks coffee'. Thus, this example illustrates that Korean is a head-final language.

Other grammatical properties of the Korean language which deserve to be mentioned here are its postpositions, tense and aspect markers, passives, causatives, vowel harmony, and multiple social registers (Ethnologue 2020), each of which I will illustrate briefly below.

Two of the many Korean postpositions were shown in examples (1) and (2). While *–i ~ –ga* indicates the subject of a sentence, *–eul ~ –leul* indicates its object. These postpositions, like many other Korean postpositions and suffixes, have two forms. The phonological form of the preceding noun decides which of the two forms occurs.

Tense and aspect, which express how an action, event or state relates to the moment of speaking and extends over time, can be expressed on the verb. Examples (3) and (4) give two examples of tense and aspect marking in Korean.

(3) *eo.je* *pyeon.ji-leul* *bad-ass-da*
yesterday letter-OBJ receive-PST-FNP
'I received a letter yesterday.'

(4) *tae.yang-i* *bich-na-go* *iss-da*
sun-SUB light-sprout-COR be.there-FNP
'The sun is shining.'

In example (3), the verbal suffix *–ass–* indicates the past tense of a verb. And *–go iss–*, a combination of the coordinative suffix *–go* and the verb stem *iss–* 'be there', in example (4) indicates the progressive aspect, meaning that an event is ongoing. Example (3) also illustrates how the subject of a phrase does not have to mentioned explicitly when it can be inferred from context. Here, the implied subject *je.ga* 'I' is not mentioned.

Passives indicate that an action is carried out on the subject, e.g. *The baby is hugged*. Causatives, on the other hand, signal the introduction of a second agentive participant, e.g. *The owner makes his dog eat*. Examples (5) and (6) illustrate a passive and causative in Korean.

(5) *jib-i* *yeo.gi-e* *ji-eo.ji-n.da*
house-SUB here-LOC build-PASS-FNP
'The house is built here.'

(6) *eom.ma-ga* *a.deul-e.ge* *os-eul* *ib-hi-eoss-da*
mother-SUB son-IND clothing-OBJ wear-CAUS-PST-FNP
'The mother made her son put on his clothes.'

Here, the verbal suffix *–eo.ji–* in (5) signals a passive voice, while *–hi–* in (6) signals a causative.

The two verbal suffixes *–ass–* ~ *–eoss–* (past tense) and *–a.ji–* ~ *–eo.ji–* (passive voice) illustrate Korean vowel harmony. Vowel harmony is a phenomenon in which vowels belong to different vowel classes. The properties of these vowel classes are

language-specific. When it comes to Korean, only those verb stems whose last vowels are /a/ or /o/ are conjugated with *–ass–* (past tense) and *–a.ji–* (passive voice). All other verbs are conjugated with *–eoss–* and *–eo.ji–*, respectively. In this way, the final vowel in the verb stem and the vowel(s) in the verbal ending always represent the same class. Apart from verbal inflections, vowel harmony is represented in Korean onomatopoeia and colour terminology. For example, *pa.rah.da* indicates a light shade of blue, while *peo.reoh.da* indicates a darker shade.

The multiple social registers of Korean are visible in honorific vocabulary items, such as *jeo* 'I', *yeon.se* 'age', and *deu.ri.da* 'give', and a number of honorific particles, postpositions, and verbal endings, such as *–nim*, *–gge.seo*, *–si*, and *–yo,* which signal vocatives, subjects, verbs, and complete sentences, respectively. The three honorific vocabulary items mentioned above have non-honorific counterparts, namely *na* 'I', *na.i* 'age', and *ju.da* 'give'.

1.2 Korean script

For my Bachelor's thesis, I studied the phonological aspect of deliberate spelling errors found in Korean web forums. I concluded that many of these spelling errors reflect common phonological processes of Korean, such as the process of palatalisation (see Introduction). Korean is nowadays written using the native Hangeul (Korean: 한글 *han.geul* 'great writing') alphabet, which consists of fourteen consonant letters and ten vowel letters, excluding a number of letter combinations and variant forms. Individual letters are not written next to each other on a single line, as with the Latin alphabet, but are instead arranged into imaginary square-shaped graphic spaces, called *syllabic blocks*. These are then written next to each other on the line, most commonly from left to right, and in horizontal lines from top to bottom. The spelled word 한글 given above is an example of the arrangement of letters into syllabic blocks, since it is composed of the individual letters ㅎ *h*, ㅏ *a*, ㄴ *n*, ㄱ *g*, ㅡ *eu*, and ㄹ *l*. These are arranged into 한 *han* 'great' and 글 *geul* 'writing'. Up to six letters can be arranged into a single syllabic block, e.g. 꿨 *ggueoss*, consisting of ㄱ *g*, ㄱ *g*, ㅜ *u*, ㅓ *eo*, ㅅ *s*, and ㅅ *s*. This block is used to denote the past tense of the verb *ggu.da* 'dream'.

Starting with the introduction of the Unified Spelling System of 1933 (NIKL 2017), Korean spelling is morphophonemic, meaning that the division of letters into syllable blocks is not only based on the pronunciation of the word, but also on its meaning and internal structure (Sohn 1999: 143). Because of this, there are many cases in which a pronunciation is not spelled completely phonetically. For example, even though [kap̚] 'price' is pronounced with only one final consonant, it is spelled with two final consonant letters, namely ㅂ *b* and ㅅ *s* in 값 *gabs*. There are cases in which a single pronunciation can be spelled in multiple ways, e.g. [kɛ], which can mean either 'dog' or 'crab', is spelled as 개 *gae* for 'dog' and as 게 *ge* for 'crab'. Ambiguities like these can make it quite difficult to fully master Korean orthography, especially for second-language learners of Korean.

Hangeul is not only used to write the Korean language, but also Jeju (§ 1.1) and Cia-Cia, an Austronesian language of Indonesia, spoken by over 100,000 people on the island of Buton. Although limited in use, an adapted version of the Hangeul alphabet was developed in 2009 and taught in schools in the city of Baubau (Ethnologue 2020).

2. Phonetics and phonology

In this section, I will introduce a number of basic principles from the linguistic fields of phonetics and phonology. These principles will serve as a framework for my introduction to Korean phonology in § 4.2.

The two fields of phonetics and phonology share one main characteristic: they both deal with the sounds of speech. Before moving on, note that sounds of speech should not be confused with script, e.g. letters. While sounds of speech are part of the spoken form of a language, letters are part of its written form, if any. The two concepts are linked: scripts are used to write down a language's sounds of speech, even though different scripts achieve this goal in sometimes very different ways. In alphabetic writing, broadly speaking, letters represent individual speech sounds or combinations thereof. For instance, the single letter <k> is used to write the final consonant [k] in *oak* [əʊk] and the letter <s> is used to write the final consonant [s] in *grease* [gɹiːs]. However, a single letter can also be used to write multiple sounds, e.g. <x> as in *extra* [ɛkstɹə] is used to write a sequence of the consonants [k] and [s], namely [ks]. And the reverse can also be true, as we saw in *dream* [dɹiːm] and *react* [ɹiækt] in § 0.4.

2.1 Phonetics

Let us first take a look at the field of phonetics. I will base my discussion on the introductory chapter on phonetics by Hayes (2009: 1-17). In phonetics, sounds are studied in the way they are physically produced by the speaker, transmitted through the air, and processed by the hearer. Thus, phonetic analyses deal with the physical aspects of sounds of speech, focusing on their production, acoustics, and recognition. Through these three steps, sound is transmitted from one speaker to another. In phonetic studies, the sounds occurring in speech are typically analysed without taking into account what meanings these sounds can express in individual languages. I will come back to this point in § 2.2 on phonology.

2.1.1 The vocal tract

The human speech organ, also called the *vocal tract*, consists of all cavities through which air can flow while producing sounds of speech, namely the lungs, larynx, pharynx, oral cavity, and nasal cavity. Each has its function: the lungs create the air pressure powering sound production; the vocal folds within the larynx serve as the primary source of air vibrations, i.e. sound; and the upper vocal tract, consisting of the pharynx, oral cavity, and nasal cavity, modifies and filters the produced sound into distinct speech sounds. For the following description of the vocal tract, please refer to Figure 1 below.

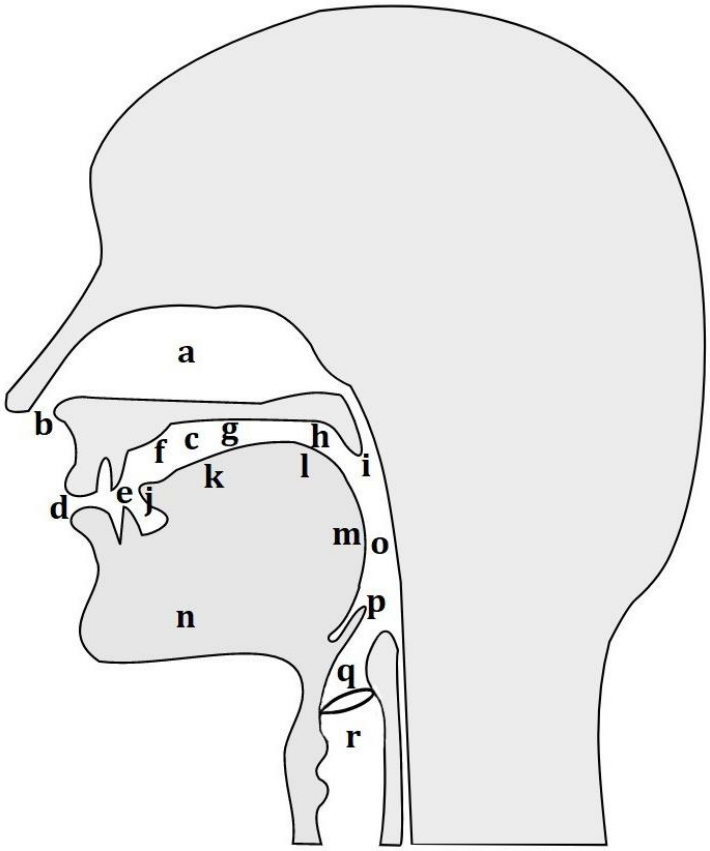
When producing so-called *pulmonary* speech sounds, sound produced by the vocal folds travels past the epiglottis, a flap behind the tongue root, and through the pharynx. Then, it can travel through either the oral cavity or the nasal cavity, or both simultaneously. The nasal cavity ends in the nostrils. The oral cavity, ending in the lips,

consists of multiple parts. When going from the front of the mouth to the back, we come across the following organs which are relevant in speech production:

- the upper and lower *lips*, of which the lower is more flexible
- the upper and lower *teeth*, particularly the incisors
- the *alveolar ridge*, right behind the base of the upper incisors
- the *hard palate*, the part of the roof of the mouth underlain by bone
- the *soft palate*, also called the *velum*, the flap of partly loose-hanging soft tissue near the throat separating the nasal cavity from the oral cavity when raised
- the *uvula* (Latin for 'little grape'), the hanging piece of soft tissue in the back of the throat which can vibrate
- the *tongue*, composed of the tip, front, back, and root
- the *jaw*, which lowers and raises the lower lip, lower teeth, and tongue

All of the organs mentioned above together, including the lungs and larynx, allow humans to produce the sounds which make it possible to convey messages to one another through speech.

Figure 1. Cross section of the human vocal tract (adapted from Wikimedia 2011)



a. nasal cavity
b. nostrils
c. oral cavity
d. lips
e. teeth
f. alveolar ridge
g. hard palate
h. soft palate
i. uvula
j. tip of the tongue
k. front of the tongue
l. back of the tongue
m. root of the tongue
n. jaw
o. pharynx
p. epiglottis
q. vocal folds
r. larynx

2.1.2 Consonants

I will now cover the specific sounds which are created by the vocal tract and used in speech. I first discuss consonant sounds, after which I cover vowel sounds. The difference between consonants and vowels is a matter of constriction. Consonant sounds involve some kind of tight constriction at some place in the vocal tract, obstructing the airflow from the lungs and producing sound. Vowels, on the other hand, involve a less tight constriction. I will now go over two characteristics which can be used to describe consonants. Unless indicated otherwise, I will give examples from the pronunciation of British English, as provided by Cambridge (2020), while focusing on phonetic categories which are relevant in the discussion of spoken Korean.

For the first characteristic, let us start by examining the pronunciation of the sound [k] as in *oak* [əʊk]. When realising this sound, one can feel the back of the tongue moving upward and touching the soft palate near the throat. In other words, the tongue creates a velar constriction blocking the airstream in the vocal tract. This is why this is called a *stop sound*. Next, the lungs create air pressure behind this constriction. The sudden release of the constriction is what makes the popping [k] sound audible. For our purpose, it is highly relevant where exactly in the vocal tract this constriction is located, because the resulting sounds are audibly quite distinct. For [k], this location is the soft palate. Other consonant sounds can be pronounced with a constriction at another place. For example, [t] as in *greet* [gɹiːt] and [p] as in *leap* [liːp] are realised with a constriction at the alveolar ridge and at the lips, respectively. Pronouncing the three sounds [k, t, p] as in *oak* [əʊk], *greet* [gɹiːt], and *leap* [liːp] consecutively allows one to feel the obstruction move from the back to the front of the mouth.

The place at which this obstruction takes place is called the *place of articulation*. I will be testing the following places of articulation for spoken Korean, from the front of the mouth to the back:

- *Bilabial* consonants are pronounced by creating a constriction between the upper and lower lips, e.g. [p] as in *leap* [liːp] and [m] as in *mouse* [maʊs].
- *Labiodental* consonants are pronounced by creating a constriction between the lower lip and the upper teeth, e.g. [f] as in *feel* [fiːl] and [v] as in *veal* [viːl].
- *Dental* consonants are pronounced by creating a constriction between the tip of the tongue and the upper teeth. Some speakers of English pronounce [t̪] as in *time* [t̪aɪm] dentally. If the tip of the tongue is stuck out beyond the teeth, the resulting consonant is called *interdental*, e.g. [θ] as in *thing* [θɪŋ] and [ð] as in *this* [ðɪs].
- *Alveolar* consonants are pronounced by creating a constriction between the front of the tongue and the alveolar ridge, e.g. [t] as in *greet* [gɹiːt] and [s] as in grease [gɹiːs].
- *Post-alveolar* consonants are pronounced by creating a constriction between the front of the tongue and the area right behind the alveolar ridge, e.g. [ʃ] as in *shoe* [ʃuː] and [ʒ] as in *vision* [vɪʒən].

- *Alveolo-palatal* consonants are pronounced by creating a constriction between the front of the tongue and the area ranging from the alveolar ridge to the front part of the hard palate, e.g. [ɕ] as in Korean *sin* [ɕin] 'god'.
- *Retroflex* consonants are pronounced by creating a constriction between the tip of the tongue and the area right behind the alveolar ridge, e.g. [ʈ] as in Indian English *time* [ʈaɪm].
- *Palatal* consonants are pronounced by creating a constriction between the front of the tongue and the hard palate, e.g. [j] as in *you* [juː] and [ç] as in German *nicht* [nɪçt] 'not'.
- *Velar* consonants are pronounced by creating a constriction between the back of the tongue and the soft palate, e.g. [k] as in *oak* [əʊk] and [ŋ] as in *ring* [ɹɪŋ].
- *Uvular* consonants are pronounced by creating a constriction between the back of the tongue and the uvula, e.g. [ʁ] as in French *rester* [ʁɛste] 'stay' and [χ] as in Dutch *acht* [ɑχt] 'eight'.
- *Pharyngeal* consonants are pronounced by moving the root of the tongue back into the pharynx, e.g. [ħ] as in Arabic حلال [ħalaːl] 'allowed'.
- *Glottal* consonants are pronounced by creating a constriction between the vocal folds in the larynx, e.g. [h] as in *hair* [hɛə] and [ʔ] as in *uh-oh* [ɐʔəʊ].

Some consonants are realised by creating a double constriction, i.e. a constriction at two places simultaneously. For example, [w] as in *wit* [wɪt] is labial-velar, i.e. both bilabial and velar. In other words, this sound is pronounced with a constriction between the lips and another simultaneous constriction between the back of the tongue and the soft palate.

A common type of double constriction can be recognised by examining how [v] as in *veal* [viːl] and [f] as in *feel* [fiːl] are pronounced. Placing the hand on the Adam's apple while producing these sounds allows one to feel the difference in pronunciation. While pronouncing [v], one can feel a vibration caused by a constriction between the vocal folds. Thus, [v] can be described as having a double constriction, one between the upper lip and lower teeth, and one between the vocal folds. This is not the case for [f], which only has a constriction between the upper lip and lower teeth. Sounds pronounced with a constriction between the vocal folds, such as [v], are called *voiced* consonants, and sounds pronounced without such a constriction, such as [f], are called *voiceless* consonants. The general term for the presence or absence of this constricting is *voice*. Another example of a voiced – voiceless consonant pair is [d] – [t] as in *doom* [duːm] and *tomb* [tuːm]. Of these two, [d] is voiced and [t] is voiceless.

All of the consonants discussed above are produced with a *pulmonic* airstream mechanism, meaning that they are pressurised by the lungs. Another type of double constriction can be recognised in *implosive* and *ejective* consonants, which are examples of *non-pulmonic* consonants. Both are pronounced with air pressure coming from movements of the closed larynx. For implosive consonants, the larynx moves downwards, and for ejectives, it moves upwards. Besides, another obstruction is made in the oral cavity. The combination of the movement of the larynx and this secondary obstruction

creates either a negative or a positive air pressure within the oral cavity. The sudden release of this pressure creates a distinguishable sound. In this study, I will be testing whether implosives and ejectives occur in Korean.

Next to voiced and voiceless sounds, there are two more groups of sounds that are distinguished by the position of the vocal folds, namely sounds produced with *breathy voice* and *creaky voice*. A sound that is pronounced with breathy voice is realised without the vocal folds touching each other, like with voiceless sounds, although vibration still occurs due to a stronger airflow. This allows more air to pass through the larynx, creating a breathing-like sound. A sound that is pronounced with creaky voice, on the other hand, is realised by drawing the vocal folds tightly together, allowing vibration over a relatively short length when compared to voiced sounds (RH 2013: 73). This creates a cracking sound, also referred to as *vocal fry*. Thus, we can order voiced, voiceless, breathy, and creaky sounds on a scale from biggest to smallest opening between the vocal folds: voiceless – breathy – voiced – creaky.

Voiceless consonants may be pronounced *aspirated*, meaning that they are realised with a delayed closing of the vocal folds in the larynx when compared to non-aspirated voiceless consonants (RH 2013: 237). This creates noise. Examples of aspiratedness are abundant in English, e.g. [t^h] as in *tea* [t^hiː] and [k^h] as in *cow* [k^haʊ]. Aspiratedness typically occurs before a vowel, as in these two examples. Aspirated sounds do not fall on the scale described above, because aspiratedness is caused by a change of position of the vocal folds, not a single position. I will be testing which of these sounds – voiceless, breathy, voiced, creaky, aspirated – occur in Korean speech.

A second group characteristic of consonants can be felt by pronouncing the following two sounds: [t] as in *greet* [gɹiːt] and [s] as in *grease* [gɹiːs]. Both consonants are identical in their places of articulation. They are pronounced by creating one constriction only, namely between the front of the tongue and the alveolar ridge. In other words, they are both alveolar and voiceless. What distinguishes them is not the place, but the kind of constriction created when producing them. The consonant [t] is pronounced by completely blocking off the airflow through the mouth, building up the pressure inside the oral cavity, and then releasing this pressure at once by letting go of the blockage. This pressure release creates a popping sound, in other words, [t] is a stop sound. The consonant [s], on the other hand, is pronounced by creating a tight constriction of the airflow at the same place in the oral cavity, but not a complete blockage. This creates a hissing sound, in other words, [s] is a fricative. This second characteristic of speech sounds is referred to as *manner of articulation*.

I will be testing the following manners of articulation for spoken Korean:

- A *stop* or *plosive* consonant is pronounced with a complete closure of the airflow, followed by a pressure build-up and a sudden release of this pressure, creating a popping sound. Examples are [t] as in *greet* [gɹiːt] and [k] as in *oak* [əʊk]. *Unreleased* stop sounds are pronounced with a more gradual release of the pressure build-up in the oral cavity, preventing a popping sound. Examples are [k̚] as in *necktie* [nɛk̚taɪ] and [p̚] as in *option* [ɒp̚ʃən].

- A *fricative* consonant is pronounced with a tight constriction of the airflow through the oral cavity, resulting in a turbulent airflow, e.g. [s] as in *grease* [gɹiːs] and [f] as in *feel* [fiːl].
- An *affricate* consonant is a stop immediately followed by a fricative, both of which are pronounced at the same place of articulation, e.g. [tʃ] as in *charm* [tʃɑːm] and [dʒ] as in *jump* [dʒʌmp].
- An *approximant* consonant is pronounced with a less tight constriction in the oral cavity, so that less air turbulence occurs. However, the constriction in approximants is still tighter than in vowels. Approximants come in two kinds. In a *lateral approximant*, the air flows around the two sides of the tongue, e.g. [l] as in *low* [ləʊ] and [ʎ] as in *million* [mɪʎən]. And in a *glide*, the air flows over the centre of the tongue, e.g. [j] as in *you* [juː] and [ɹ] as in *red* [ɹʷɛd].
- A *nasal continuant* is pronounced with a complete closure of the airflow through the mouth and with a lowered soft palate, allowing continuous airflow through the nasal cavity, e.g. [n] as in *nose* [nəʊz] and [m] as in *mouse* [maʊs]. A non-nasal sound, produced with a raised soft palate, is called an *oral* sound, e.g. [t] as in *greet* [gɹiːt] and [p] as in *leap* [liːp].
- A *tap* is pronounced with a rapid backwards brush of the tip of the tongue against the roof of the mouth, e.g. [ɾ] in American English *water* [wɔɾɚ] and Spanish *pero* [peɾo] 'but'. A *flap* is pronounced in the same way as a tap, but with a forward brush of the tip of the tongue.
- A *trill* is pronounced by creating a vibration between two parts of the oral cavity caused by a rapid airstream, e.g. [r] in Spanish *perro* [pero] 'dog'.

In this study, I describe consonants phonetically in the following order: place of articulation – manner of articulation. For example, [p] as in *leap* [liːp] is as a *voiceless bilabial stop* and [j] as in *you* [juː] is a *voiced palatal approximant*.

The class of *rhotic* consonants, informally referred to as *r-sounds* or *r-coloured* consonants, is a class that cannot be defined in terms of a single place or manner of articulation. Some examples are the alveolar trill [r], alveolar tap [ɾ], alveolar approximant [ɹ], retroflex flap [ɽ], retroflex approximant [ɻ], uvular trill [ʀ], and uvular fricative [ʁ]. As can be seen, the class consists of consonants that differ in their places and manners of articulation. Technically, rhotic consonants are alike in having a relatively low third formant, which pertains to the acoustic domain (LM 1996: 215-216, 244-245). In this study, I will be testing which rhotic consonants may occur in Korean speech.

2.1.3 Vowels

As we have seen, consonants are pronounced with a tight constriction of some kind at some place along the vocal tract. The place(s) and manner(s) of this constriction make a consonant distinguishable from other consonants. Vowels, on the other hand, are pronounced with a relatively open vocal tract. They are primarily distinguishable by the position of highest part of the tongue and the shape of the lips while realising them. It is

the highest part of the tongue which turns out to be decisive in recognition, according to acoustic and articulatory studies. One can visualise the position of the highest part of the tongue using the IPA vowel table in Appendix A. Here, the trapezoid shape of the table represents a side-view of the oral cavity, with the lips facing left. The place of a vowel symbol within the table represents the vowel that is produced when the highest part of the tongue is in that position. For instance, positioning the highest part of the tongue in the upper front part of the oral cavity while the lips are relaxed creates the vowel [iː] as in *dream* [dɹiːm], which is positioned in the upper left part of the vocal chart.

Let us start by examining the pronunciation of the vowel [uː] as in *do* [duː]. When pronouncing this vowel, or any vowel, there is no heavy constriction in the oral cavity like we saw with consonants. The jaw is raised, also raising the highest part of the tongue, and the lips form a round shape. In producing this sound, the highest part of the tongue is the back. Now, compare the pronunciation of [uː] to that of another vowel, like [yː] as in German *Bühne* [byːnə] 'stage'. The position of the jaw and the lips are the same for both vowels, but for this vowel, the highest part of the tongue is the front. And for the vowel [iː] as in *dream* [dɹiːm], the position of the jaw and tongue is the same as for the previous vowel, but the lips are relaxed. From these three examples, we can see that vowels can be described according to three characteristics: the vertical and horizontal position of the highest part of the tongue and the shape of the lips. These three characteristics are referred to as *height*, *backness*, and *rounding*.

Let us see how each of these characteristics can function. When it comes to height, the vowel [uː] as in *do* [duː] is referred to as a *high vowel*, because the jaw and highest part of the tongue are raised. The vowel [ɑː] as in *spa* [spɑː] is referred to as a *low vowel*, because the jaw and highest part of the tongue are lowered. Some vowels fall in between the height of high and low vowels, such as [ʌ] as in *but* [bʌt]. These are referred to as *mid vowels*. When pronouncing the vowels [uː, ʌ, ɑː] as in *do* [duː], *but* [bʌt], and *spa* [spɑː] consecutively, one can feel the highest part of the tongue moving downward and the oral cavity opening up wider.

In terms of backness, the long vowel [iː] as in *dream* [dɹiːm] is referred to as a *front vowel*, since the highest part of the tongue is the front. The vowel [uː] in *do* [duː], on the other hand, is an example of a *back vowel*, since the highest part of the tongue is the back. Again, there is middle ground, some vowels falling in between front and back vowels when it comes to their backness. These are called *central vowels*. An example is the schwa vowel [ə] as in *tak<u>e</u>n* [tʰeɪkʰən] or *<u>a</u>bout* [əbaʊt]. Pronouncing the vowels [iː, ə, uː] as in *dream* [dɹiːm], *tak<u>e</u>n* [tʰeɪkʰən] and *do* [duː] consecutively allows one to feel the highest part of the tongue moving from the tip to the back of the tongue.

And finally, rounding. As already mentioned, the vowel [yː] as in *Bühne* [byːnə] 'stage' is pronounced with rounded lips, narrowing the passage at the end of the vocal tract. For this reason, this vowel is a *rounded vowel*. Vowels that are pronounced with relaxed lips, such as [ɑː] as in *spa* [spɑː], are called *unrounded vowel*. There is no term for vowels that are pronounced with intermediate roundedness.

For my purpose, I describe vowels phonetically in the following order: height – backness – rounding. For example, [y] is a *high front rounded vowel* and [ʌ] is a *mid back unrounded vowel*.

All of the vowels discussed so far are monophthongs, meaning that they consist of a single vowel. Two of these vowels can be sequenced into a diphthong, involving a transition of the position of the lips, jaw, and tongue. Diphthongs are transcribed using two vowel symbols, e.g. [aɪ] as in *ride* [ɹaɪd] and [oʊ] as in *glow* [gləʊ]. Combinations of three vowels, called *triphthongs*, also occur, such as [aɪə] in *fire* [faɪə] and [aʊə] as in *sour* [saʊə].

Just like consonants, vowels can be pronounced nasally, again by lowering the soft palate, allowing airflow through the nasal cavity as well as the oral cavity. Examples of nasal vowels can be found in French, e.g. *Mont Blanc* [mɔ̃blɑ̃]. And just like there is a class of rhotic consonants, vowels can also be pronounced rhotically. Rhotic vowels are also alike in having a lowered third formant (LM 1996: 313), and they are often pronounced with the root of the tongue retracted. They occur in American English before [ɹ], such as in [ɔˠ] *north* [nɔˠɹθ] and [ɜˠ] in *nurse* [nɜˠɹs].

Some languages have different vowel lengths, i.e. the time duration during which a vowel is pronounced. An example of such a language is Classical Latin, which has a contrast between the five short vowels [i, e, a, o, u] and their long counterparts [iː, eː, aː, oː, uː] (Hayes 2009: 83).

And lastly, a phenomenon that is applicable to both consonants and vowels is *tone*, i.e. distinguishing different meanings from each other using differences of pitch. Well-known examples of this occur in Mandarin, e.g. [á] in *fēng* [fáŋ] 'wind' vs. [ǎ] in *féng* [fǎŋ] 'sew'. There are two kinds of tone contours. On the one hand, level tones, such as the high tone in [á], maintain one pitch. On the other hand, contour tones, such as the rising tone in [ǎ], shift from one pitch to another.

2.2 Phonology

As we saw in the previous section, phonetic analyses deal with the production, acoustics, and recognition of sounds of speech without paying attention to the meanings that these sounds express in specific languages. Phonological analyses, on the other hand, deal with the ways in which the speech sounds of individual languages are organised to convey meaning. In this section, I will introduce some basic phonological concepts.

2.2.1 Phonemes

As mentioned above, phonology deals with the organisation of speech sounds in individual languages, and how these sounds represent meaning. Let us look at an example. English *duck* is commonly pronounced as [dʌk]. In English, this specific sequence of the sounds [d], [ʌ], and [k] refers to the bird which can be found swimming around in ponds. However, none of these three individual sounds refer to ducks. They only create this meaning in combination with each other. Changing the individual sounds can create

drastically different meanings. Swapping [d] for [l] creates the sound sequence [lʌk], which does not refer anymore to the water bird, but to the concept of good fortune, i.e. *luck*. In other words, the sounds [d] and [l] have the power of distinguishing meaning in English. Speech sounds serving to distinguish meanings within a single language are called *phonemes*. In other words, /d/ and /l/ are two phonemes of English. This is indicated by the use of slashes, identifying phonemes. On average, each individual language has about 30 phonemes (Hayes 2009: 20), but there is much variation between languages. *Minimal pairs* are sets of two or more meanings whose phonemic make-ups differ in only one phoneme, such as *duck* /dʌk/ and *luck* /lʌk/ mentioned above.

This close connection between phonemes and meanings was already noticed over a hundred years ago in Ferdinand de Saussure's (1916) *Cours de linguistique générale* 'Course in general linguistics'. His concept of the *arbitrariness of the sign*, as mentioned in MSDL (2009: 1-2), refers to the discovery that there is no inherent reason why a particular sequence of phonemes and a specific meaning should be connected to each other. The water bird mentioned earlier can be referred to as a *duck*, but just as well as an *eend* (in Dutch), *canard* (in French) or *bebek* (in Indonesian). The choice for either of these phonemic forms is a matter of social convention. Exceptions to this fundamental arbitrariness of language are rare, e.g. in onomatopoeia, i.e. phonetically mimicking the sound of a referent, such as *buzz* for the sound of a bee flying or Mandarin *māo* for 'cat'.

2.2.2 Allophones

As we saw, phonemes have the power to distinguish meaning in a specific language. However, not all individual sounds occurring in a language have this power. In other words, not all of a language's distinguishable sounds have phonemic status in that language. Examples of two of such non-phonemic sounds in English are the alveolar nasal [n] and dental nasal [n̪]. Both sounds may occur in *nap*, which can be realised as either [næp] or [n̪æp] without a change in meaning (Alison Buck, personal communication, April 5, 2020; § 3.1). Both realisations refer to sleeping for a brief period. So, while changing [dʌk] into [lʌk] distinguishes meanings, changing [næp] into [n̪æp] does not. We thus conclude that [n] and [n̪] are not two separate phonemes of English. Instead, they are two different realisations of the same English phoneme /n/. Different realisations of the same phoneme are called *allophones*. In other words, [n] and [n̪] are two different allophones of English. Note the use of square brackets when indicating allophones, since these are actual realisations, i.e. phonetic entities, rather than different phonemes. These two realisations are referred to as the *allophonic variants* of a phoneme. Some allophonic variants, such as [n] and [n̪], are in *free variation*, meaning that they occur in shared environments. The choice between free variants is determined by factors such as setting, style, regional variety or mood. This means that even within the idiolect of a single person, multiple free variants of the same phoneme will occur.

Let us look at an example of two phonemes in Dutch, namely /p/ and /b/. Their phonemic status is evident from minimal pairs such as *pot* [pɔt] 'jar' and *bot* [bɔt] 'bone'. However, /p/ and /b/ do not have this contrastive power in each and every phonological

environment. For example, in *krap* ‘narrow’ and *krab* ‘crab’, both phonemes are pronounced in the same way, namely [p]. Thus, the pronunciation [kɾɑp] can refer to both meanings. In this environment, /p/ and /b/ lose their power to contrast different meanings. This is an example of a *contextually limited contrast*. We know that *krab* [kɾɑp] ‘crab’ contains the phoneme /b/ because the pronunciation [b] occurs in other environments, such as in the plural form *krabben* [kɾɑbə] ‘crabs’. Korean phonology can also be described in terms of phonemes, free variants, and contextually limited contrast, as we will see in § 4.2.

In the following, I will treat phonological processes such as palatalisation as instances of allophonic variation instead of phoneme changes, like SKC (2012: 207-208) do (see Introduction). For example, instead of describing the process of palatalisation as a change of the phoneme /t/ into the phoneme /tɕ/, it can also be described in the following way: the phoneme /t/ has the allophonic realisations [t] and [t̠ɕ], of which only [t̠ɕ] occurs before /i/ and only [t] elsewhere. The practical implications of this approach are identical to those of SKC (2012), the main difference being that I discuss processes like these in terms of surface phonetic realisations and underlying analytic phonological units of analysis, instead of underlying phonemes and surface phonemes. I do this on the basis of the law of parsimony, stating that any unnecessary units of analysis can be discarded. The benefit of this approach is a higher level of transparency to the reader.

3. Methodology

3.1 Theoretical background

For the purpose of this study, I discuss the phonology of Korean according to the methodology described in the two phonological chapters in Carl Lodewijk Ebeling's (1960: 15-82) *Linguistic units*. Let me first give a practical example of Ebeling's approach. Imagine that we hypothesised the English phoneme /n/ as in *nap* to be alveolar. We can test this hypothesis by shifting the place of articulation when realising this phoneme in *nap*. This shifting takes place along a single dimension with two end points. At one end, we pronounce /n/ as a bilabial nasal, i.e. by creating a constriction between the upper and lower lips. And at the other end, we pronounce it as a uvular nasal, i.e. by creating a constriction between the back of the tongue and the uvula. In between these two end points, we pronounce it at intermediary places, such as the alveolar ridge and the soft palate.

Then, we can ask a native speaker of English what the meaning is of each of these realisations, if any. From this, we can draw conclusions on the phoneme boundaries of the idiolect of this specific speaker. The term *idiolect* refers to "an individual's distinctive way of speaking" (MSDL 2009: 42). By means of illustration, I consulted with Alison Buck, a 24-year-old female native speaker of English who grew up in Bala Cynwyd, a community near Philadelphia, USA. I presented her with the following pronunciations and asked her if they meant anything, and if so, what: [mæp], [ɱæp], [n̪æp], [næp], [ɳæp], [ɲæp], [ŋæp], and [ɴæp]. In order, these are bilabial, labiodental, dental, alveolar, retroflex, palatal, velar, and uvular nasal realisations. I chose these specific stimuli because of a suspected meaning difference between the bilabial realisation [mæp] and the alveolar realisation [næp]. As it turns out, this contrast was indeed present in Buck's idiolect. The dental, alveolar, retroflex, palatal, and velar relations – [n̪æp], [næp], [ɳæp], [ɲæp], [ŋæp] – all referred to the concept of sleeping for a brief period, i.e. a nap. The bilabial realisation – [mæp] – on the other hand carried another meaning, namely a small-scale representation of an area, i.e. a map. And finally the labiodental and uvular realisations – [ɱæp] and [ɴæp] – did not refer to anything. From this, we can conclude that the phoneme /n/ in the idiolect of this speaker reaches from the dental to the velar nasal. The phoneme /m/, on the other hand, only covers the bilabial nasal. The labiodental and uvular nasals are no realisations of any phoneme. The labiodental nasal, being located in between two distinct phonemes while not contributing to any meaning, is a good example of what Ebeling (1960: 46) refers to as a *phonemic non liquet* (Latin for 'it is not clear'), in other words: "[…] the listener is not certain what form he has heard, he will assume that he has missed a nuance or that the speaker has not sufficiently carefully articulated." This does not mean that this realisation is located on the overlap between the ranges of two phonemes. Instead, it means that this realisation is not located in the range of any phoneme at all. It fills up an empty space.

After testing the possible places of articulation of /n/, I tested the value of voicing for this phoneme. For this, I confronted Buck with the voiceless nasal realisation [n̥æp]. According to her, this still referred to the concept of a nap. This means that in her idiolect,

the feature of voicing, in contrast to the feature of articulation place, is irrelevant to the realisation of the phoneme /n/. Thus, it would be incorrect to describe the phoneme /n/ as having a voiced quality.

As we saw from this example, the starting point of any phonemic analysis in Ebeling's approach should be the phonetic dimensions along which features of sounds are shifted. These dimensions are continuums with two end points at each side. The goal of the phonologist is then to assign feature boundaries along these continuums and to assign phonemes to specific areas in between these boundaries, as well as to assign those parts of the continuums not taken in by any phoneme. These boundaries can be drawn by first forming hypotheses about what distinctive features are relevant to a specific phoneme, and then shifting the value of this feature. Doing this for one feature at a time can result in another realisation of the same phoneme (e.g. for [n̪æp]), a new phoneme (e.g. for [mæp]) or a pronunciation which is not recognised at all (e.g. for [ŋæp]). In the first case, one can expand the part of the continuum representing the same phoneme. By listening to native speakers while unaware that they are being observed, one can determine the most common realisation of each phoneme. By repeating this process for all features, one can make claims about which phonemes and allophones are present in a particular language. If one finds that a particular phoneme does not at all change when shifting the value of a specific feature, one must conclude that this feature is irrelevant for this phoneme. By eliminating all of these irrelevant features, one can present a phonemic analysis in terms of relevant distinctive features. A good example of such an analysis is Wiedenhof (2015a: 53-67), in which a feature-based phonology of Beijing Mandarin is presented.

I will use the phonological analyses by SKC (2012) to form hypotheses about what features are distinctive in Korean. This study, which is only eight years old at the time of writing, has the benefit that Korean sounds are discussed extensively, both from a phonological perspective and from a phonetic perspective. The authors present a number of Korean phonemes and their allophonic realisations, which they support by presenting minimal pairs.

Because only native speakers are able to accurately judge whether shifting the value of a specific feature forms a new meaning, I will also be consulting with two native speakers of Korean. The first of these is Lim Jeong Ha (임정하 *im.jeong.ha*), a 24-year-old female speaker who grew up in the city of Daegu, but moved to Seoul in 2016. I will refer to her as *Lim*. The second is Jaeyeong Yang (양재영 *yang.jae.yeong*), a 21-year-old male speaker who grew up in the city of Ulsan, but moved to Seoul in 2017. I will refer to him as *Yang*. I already knew both of these people before starting writing my thesis. I consult with both a male and a female speaker in order to maximise representativeness even with just two speakers. In addition, judgments given by speakers who are in their twenties reflect modern usage, making analysis of Korean phonology maximally up-to-date. This contemporary account is most useful to second-language learners of Korean. On top of that, an up-to-date analysis will maximise the relevance of my account for the field of Korean linguistics, and it offers linguists an opportunity to analyse Korean phonology diachronically. What distinguishes this study from SKC (2012) is that I present a

phonology which is true for at least two speakers at this point in time, while SKC (2012) present the phonology of an undefined standard form of Korean (§ 3.3).

I will conduct the interviews in English, combined with Korean where necessary. Conducting the interviews in English comes with an advantage. Speaking in a second language forces the native speakers to indicate the meanings of Korean utterances clearly, which benefits my understanding of meaning distinctions.

3.2 Stimuli

The stimuli I present to the two native speakers of Korean are given in appendix B. I begin by presenting vowel stimuli. I do this in the environment [nV]. Cross-linguistically, this environment occurs frequently, making it a safe starting point. After having tested the vowel stimuli, I continue to consonant stimuli. I present these on the basis of expected lexical contrasts, much like the English-language stimuli that I discussed in the previous section. This is because stimuli with expected lexical contrast are most likely to reveal phoneme boundaries. For example, I test aspiratedness in bilabial stops in the environment [Cul] because of an expected contrast between [pul] and [p^hul]. However, if these environments turn out to not reveal any phonemic contrast, I continue to test the same feature in other environments. I base expectations of lexical contrasts on my experiences with the Korean language.

During the process, I present stimuli by testing one feature at a time, as mentioned in § 3.1. In other words, I test one feature by keeping the values of all other features maximally constant. For example, I test vowel height by keeping backness and roundedness constant, e.g. in front rounded vowels, resulting in stimuli ranging from the high realisation [ny] to the low realisation [nœ]. And I test place of articulation by keeping voice and manner of articulation constant, e.g. in voiceless stops. This means that I present stimuli ranging from the bilabial realisation [pam] to the glottal realisation [ʔam].

On the continuum in between these two endpoints, I will need to adjust the points I present to the native speakers on the basis of their responses. I begin with presenting points on opposite sides of the continuum, since these are maximally contrastive, followed by points along the continuum. If there is no difference in meaning between any of these points, I consider this feature to be irrelevant. But if there is a difference in meaning between them, presenting the native speakers with further intermediate points allows one to decide where to draw phoneme boundaries and endpoints along the continuum. Intermediate points should be tested until no further meaning distinctions can be found. In doing this, I alternate the direction in which I move along the continuum to obtain the most reliable results.

I test features in a largely systematic order, which allows the native speakers and me to keep track of the progress. But to prevent the native speakers from responding on autopilot once they figure out the pattern in the stimuli, I break up the pattern by presenting earlier stimuli again from time to time. Comparing the answers to these repeated stimuli allows me to check how reliable the given answers are.

3.3 Features

In this section, I will discuss the consonant and vowel features that I test with my stimuli. Most of these are taken from the phoneme features that are recognised by SKC (2012), although I also test some additional features.

In their chapters on Korean consonants, SKC (2012: 57) present a phoneme inventory of Korean, containing nineteen consonant phonemes. The authors recognise a total of thirteen phonemic features, which can be divided into two groups:

- place features: bilabial, alveolar, alveolo-palatal, velar, glottal
- manner features: stop, fricative, affricate, nasal, lateral approximant, lax, tense, aspirated

The only two of these features which have not been discussed in § 2.1 are *lax* and *tense*. SKC (2012: 32-34) define the difference between both features in terms of *tension*, which is present in tense sounds, but absent in lax sounds. In their words, tense sounds are "strong sounds with lengthy articulation" and are "produced with tension in the vocal folds". The authors do not provide any further articulatory explanations on the exact pronunciation of tense sounds. For this reason, I am unable to test these two features. Instead, I will be testing the feature of voice, including breathy and creaky voice (§ 2.1.2), which is also defined by the position of the vocal folds. BY (2015: 11) claim that Korean vowels are realised more breathy following a lax or aspirated stop, and more creaky following a tense stop. LM (1996: 55-57) claim that the Korean consonants that are referred to as *tense* are actually pronounced with *stiff voice*, i.e. in between voiced and creaky consonants in terms of the size of the opening between the vocal folds. LR (2000), SKC (2012), Sohn (1994; 1999), and YB (2011) do not discuss breathy and creaky voice in Korean.

When it comes to vowels, SKC (2012: 98, 102) present two different Korean vowel inventories. The first one contains ten vowel phonemes /i/, /y/, /ɯ/, /u/, /e/, /ø/, /ʌ/, /o/, /æ/, and /ɑ/. The second inventory only contains the seven vowel phonemes /i/, /ɯ/, /u/, /ɛ/, /ʌ/, /o/, and /ɑ/. In this second inventory, /e/ and /æ/ merged into /ɛ/. Additionally, /y/ and /ø/ were diphthongised into /wi/ and /wɛ/. Then, what is the status of these two inventories? The authors mention that the larger inventory is based on "Standard Korean Pronunciation (SKP)" and the smaller one on "Seoul speakers' real speech (or pronunciation)". Strikingly, the authors do not clearly define this standard form of the language. They do mention that they concentrate on "the Standard Seoul Korean dialect" and that "Standard Korean" is based on the Seoul dialect, but they also mention that SKP is "slightly different from Seoul speakers' real speech" (SKC 2012: 15, 97). BY (2015: 4-6) also mention both inventories and label them as "traditional ten-vowel system (orthography)" and "real speech", respectively. They claim that both inventories are based on "the Seoul dialect, which is more commonly known as Standard Korean".

A clearer image of the status of both inventories comes from the surveys that BY (2015: 4) report on, claiming that /y/ is realised by 5% of 350 speakers between the ages of 20 and 70; /ø/ is realised by only 3.37% of 210 speakers between the ages of 21 and 79; and /e/ and /æ/ "tend to merge together in all age groups". Besides, EKC (n.d.) mentions that the ten-vowel inventory is only used by elder people in the central part of South Korea, including the provinces of Gyeonggi, Gangwon, and Chungcheong. Most other speakers use the seven-vowel inventory. Thus, the distinction between both inventories is a matter of age and dialect. This view is underlined by an account from Dr. Nam, who told me how her grandmother, who was born in the province of Chungcheong in 1922, referred to Korean melons as [t̪ɕʰamø], whereas speakers from later generations refer to them as [t̪ɕʰamwɛ] (Ae Ree Nam, personal communication, May 11, 2020).

In a video (YouTube 2013) recorded in 2007 by EBSCulture, a channel featuring educational videos, 이현복 *i.hyeon.bog*, professor at the Department of Linguistics at Seoul National University, discusses the merger of /e/ and /æ/ in modern Korean. He notes that speakers should still distinguish between /e/ and /æ/ because this prevents a vowel from disappearing from the Korean vowel system. Thus, there seems to be prescriptivist pressure to retain the distinction between these two vowel phonemes.

In the discussion of vowel phoneme features by SKC (2012), both inventories are equal. The authors recognise the same seven features for the SKP and Seoul phonemes, which can be divided into three groups:

- backness features: front, back
- roundedness features: unrounded, rounded
- height features: high, mid, low

In a later section about diphthongs (SKC 2012: 109-116), the authors mention three additional glide phonemes. Since they regard glides as vowels, they describe these glides according to the vowel phoneme features mentioned above. They distinguish vowels from glides with the feature *syllabic*. This feature indicates whether a sound is able to constitute its own syllable, which they define as the smallest abstract unit formed by a phoneme or a sequence of phonemes (SKC 2012: 47). According to the authors, vowels are syllabic but glides are not. However, because I regard glides as consonants, I do not test the feature of syllabicity.

Next to the thirteen consonant features and seven vowel features, I also test four additional features that are mentioned in the literature. The first of these is tone, which is not phonemic in Korean according to SKC (2012: 152) and BY (2015: 24). According to Sohn (1994: 455-456) and LR (2000: 288-289), Middle Korean, which was spoken until the 16th century, had three distinctive tones: high, rising, and low. An example is /son/, which could mean 'guest', 'hand' or 'grandchild' depending on which of the three tones it carried. Only the Gyeongsang and Hamgyeong dialects of Korean still distinguish tones. With my stimuli, I test two level tones, high and low, and two contour tones, rising and falling. These tonal patterns are phonetically most contrastive.

The second feature is vowel length, which is stated to not be phonemic in "everyday language usage" (SKC 2012: 152-153). Sohn (1994: 189, 452) mentions that speakers below approximately 40 years old as of 1992 are less sensitive to phonemic vowel length, although vowels may be lengthened for emphatic purposes. This means that at the time of writing, speakers below approximately 70 years old are less sensitive to phonemic length. This constitutes the vast majority of Korean speakers. L&R (2000: 66) also recognise a loss of vowel length distinctions in the Seoul dialect. BY (2015: 24) even claim a "near extinction of long vowels in contemporary Korean".

The third feature is nasality. According to SKC (2012: 81), vowels are hardly pronounced nasally when preceding nasal consonants. Sohn (1994: 436) claims the opposite, namely that vowels becomes nasalised when surrounded by nasal consonants, as in [nũːn] 'snow', and when in the neighbourhood of a nasal consonants in emotional expressions, such as [ãnĩ] 'No!'. LR (2000: 64) mention that the nasal consonants [m] and [n] can have a "slightly oral release", examples of which they transcribe as [mᵇu] 'white radish' and [nᵈe] 'yes'. This oral release never occurs with [ŋ].

And the fourth feature is plosive release. Several authors, including SKC (2012: 65), Sohn (1994: 438, 473), and L&R (2000: 12), mention that plosive consonants are pronounced unreleased in word-final position.

Additionally, I test two features do not occur in the literature to explore the limits of Korean phonology. These features are consonant and vowel rhoticity and, type of airstream mechanism (pulmonic, implosive, ejective).

And finally, SKC (2012) discuss several phonological processes of Korean, which govern allophonic variations. With my stimuli, I will be testing the occurrence of some consonant sequences which are the targets and outcomes of four of these processes, namely nasalisation, lateral assimilation, aspiratisation, and palatalisation. According to my own judgments, these processes are most relevant to spoken Korean. I will now be going over each of these according to the authors' features as described above.

Nasalisation (SKC 2012: 189) can be illustrated by the presence of consonant sequences like [mn] and [ŋm] in spoken Korean, but the absence of [p̚n] or [k̚m]. More generally, stop, fricative, and affricate phonemes are pronounced as nasal consonants when occurring before nasal phonemes. In this allophonic variation, their places of articulation do not change.

Lateral assimilation (SKC 2012: 190-191) can be illustrated by the presence of [mn] and [ŋn] in spoken Korean, but the absence of [ml] or [k̚l]. Generally, the lateral approximant phoneme /l/ is pronounced as an alveolar nasal consonant [n] when following a bilabial or velar phoneme. When this bilabial or velar phoneme is a stop, it is pronounced as a nasal consonant because of nasalisation.

Aspiratisation (SKC 2012: 193-194) can be illustrated by the presence of [t̚ɕʰ] and [pʰ], but the absence of [ht̚ɕ] or [p̚h]. Generally, lax stops, fricatives, and affricate phonemes are pronounced with aspiratisation when occurring before or after the glottal fricative phoneme /h/. Terminologically, I distinguish between the processes of aspiratedness mentioned above and aspiratisation: while aspiratisation is triggered by the presence of /h/, aspiratedness can also occur without /h/.

And lastly, palatalisation (SKC 2012: 207-208) can be illustrated by the presence of [t̠ɕi] and [t̠ɕʰi], but the near-absence of [ti] or [tʰi]. Generally, alveolar stop phonemes are pronounced as alveolo-palatal affricate phonemes when occurring before the high front unrounded vowel phoneme /i/. However, this is only the case of this vowel phoneme belongs to a grammatical element such as *–i*, which indicates a causative (§ 1.1), and not a lexical element such as *ip* 'leaf'.

This leaves us with the following fourteen groups of stimuli features:

- height (high ~ low)
- backness (front ~ back)
- roundedness (unrounded ~ rounded)
- length (short ~ long)
- tone (high, low, falling, rising)
- place of articulation (bilabial ~ glottal)
- manner of articulation (stop, fricative, affricate, approximant)
- voice (voiceless ~ creaky)
- aspiratedness (unaspirated ~ aspirated)
- airstream mechanism (pulmonic, implosive, ejective)
- plosive release (released, unreleased)
- nasality (oral ~ nasal)
- rhoticity (non-rhotic ~ rhotic)
- phonological processes (nasalisation, assimilation, aspiratisation, palatalisation)

Here, the values given in between brackets can be either on a continuous scale, in which case both endpoints are separated by a tilde (e.g. *high ~ low*), or discrete, in which case each individual value is separated by a comma (e.g. *released, unreleased*). A full list of stimuli is presented in Appendix B.

3.4 Practical constraints

I am writing this thesis in unprecedented times. The global health situation is being threatened by the COVID-19 disease, caused by the SARS-CoV-2 virus. The Dutch government has responded to the spread of this disease by implementing a nationwide partial lockdown, a ban on public meetings for groups consisting of more than three people, and a mandatory interpersonal distance of 1.5 metres. Leiden University has responded by cancelling all physical classes, seminars, exams, and other activities, and by closing all university buildings for students and most staff members. On May 25, 2020, an article by Corine Hendriks was posted on the Leiden University website, in which she discusses how multiple researches at the Leiden University Centre for Linguistics (LUCL) have come to a halt during the corona crisis. Mainly researches that require personal contact or traveling abroad, such as laboratory work and fieldwork, are heavily affected (Hendriks 2020).

The execution of the current study is also challenged by the pandemic. Meeting up with native speakers of Korean in person is not feasible at this moment, so I have to resort to online communication tools. That is why I approach them through social media and have sessions with them through Zoom, a free videotelephony and online chat service. However, the audio quality of this platform makes it difficult to accurately convey speech sounds, even though it is crucial that they are heard and understood well. After all, I am working with fine distinctions between speech sounds which can be hard to distinguish, even in person. On top of that, a natural interaction between the native speakers and me can make it easier to ask follow-up questions, and again, online communication makes this harder. In order to make sure the native speakers are at ease throughout the data gathering sessions, I decided to not record the sessions. The existence of all of these constraints does not mean that I should not continue working on Korean phonology in times like this. Instead, one should look for the most ideal way of conducting research given the limitations.

The allotted time for writing a graduation thesis at Leiden University is one semester, equal to a period of five months. With my thesis supervisor, Jeroen Wiedenhof, I agreed upon a final deadline one month before the end of the semester, resulting in a writing period of four months. Within this relatively short period and despite limited resources, I have gained confidence that Ebeling's (1960) methodology described here allows one to describe a complete phonology of contemporary Korean which is linguistically responsible yet didactically adequate. In this thesis, I explain theoretical background information, methodological considerations, some promising results, and how these results can be implemented and expanded upon. Because a total of two hours of data gathering will suffice for a first exploration of the current status of Korean phonology, I arrange a one-hour-session with both native speakers.

4. Results

In § 3, I explained the methodology according to which I am exploring the phonology of Korean. In this section, I will discuss the results of this, starting with some general comments on my experiences with both data gathering sessions.

4.1 Data gathering experiences

My data gathering sessions with Lim Jeong Ha on May 3, 2020 and with Jaeyeong Yang on May 13, 2020 turned out to be surprising in some ways and as expected in others. Expectedly, the limited audio quality made it quite difficult to convey some of the more intricate pronunciation differences in a clear and consistent manner, although repeating each stimulus at least twice resolved this problem. Besides, having the conversations in English proved to be convenient while talking about meaning distinctions. Surprisingly, the estimated time slots of one hour turned out to be not nearly enough for me to map the entire phonology of Korean. I did, however, find some unexpected phenomena, sometimes even while looking for the answer to an entirely different question. I will get back to this in § 4.2. Because the goal of this study is to explore the feasibility of my methodology, and not to produce a complete Korean phonology, I decided not to plan second sessions with both native speakers.

4.2 Korean phonology

I will now discuss my findings of both data gathering sessions, relating them to the fourteen groups of stimuli features mentioned in § 3.3, except for roundedness. I found conclusive results for the features tone, plosive release, vowel nasality, nasalisation, aspiratisation, and palatalisation. The features height, backness, roundedness, length, place of articulation, manner of articulation, voice, aspiratedness, airstream mechanism, consonant nasality, rhoticity, and lateral assimilation need further research.

4.2.1 Vowel stimuli

Height and roundedness

For Lim, I found that [ne] = [nɛ] ‘yes’, but [næ] Ø. For Yang, on the other hand, [ne] ‘you’ and [nɛ] = [næ] ‘yes’. So, for both speakers, there is a difference in meaning between [ne] and [næ]. This tells us that the documented merger of /e/ and /æ/ into /ɛ/ (§ 3.3) is not complete.

For Yang, I found [nø] = [nwɛ] ‘brain’, although the second is more common. This observation shows us that realising /wɛ/ instead of /ø/, mentioned in § 3.3, is most common, although not ubiquitous.

While [nʌ] = [nɑ] ‘I’ for Yang, they both mean ‘you’ for Lim. And for Yang, [nɔ] can carry both meanings. So, the same stimuli can have very different meanings to both

speakers. The realisations [ʌ] and [ɑ] are examples of free variants, explained in § 2.2.2, since they occur in a shared environment, but do not distinguish meaning.

Length

For Yang, I found [nu] ≠ [nuː], and [na] ≠ [naː]. While the short realisation [nu] refers to either 'eye' or 'snow', the long realisation [nuː] only refers to 'snow'. And while [na] refers to either 'horse' or 'word', [naː] only refers to 'word'. This means that distinctions in vowel length are not completely lost in modern Korean, contrarily to what is said in some grammars (§ 3.3). For Lim, I did not find any lexical contrast caused by vowel length.

Tone

For Lim, I found [ná] = [nà] = [nă] = [nâ] 'I'. And for Yang, I found [ní] = [nì] = [nǐ] = [nî] 'you', although he mentioned that [ní] is reminiscent of the Seoul dialect, [nî] is reminiscent of the Gyeongsang dialect, and [nǐ] can be used as a vocative form. So, vowel tone is not phonemic, but seems to have discourse functions.

Nasality

For Yang, [ni] = [nĩ] 'you', [nu] = [nũ] 'gnu', and [na] = [nã] 'I'. And for Lim, [na] = [nã] 'I' and [nʌ] = [nʌ̃] 'you'. For both speakers, the oral realisations are more common. So, vowel nasality is not phonemic for both speakers. The alternation between oral vowels and their nasal counterparts is another example of free variation.

Vowel rhoticity

For both speakers, I found meaning distinctions between rhotic and non-rhotic vowels in all tested stimuli: [ni] 'you' ≠ [nɨ˞] Ø; [nu] 'gnu' ≠ [nʊ˞] 'defecate'; [na] 'I' ≠ [nɑ˞] 'day' or Ø; [nʌ] 'you' ≠ [nʌ˞] Ø. The fact that [nɑ˞] = [nal] 'day' leads to a connection between rhoticity and laterality. I will get back to this below, under Consonant rhoticity.

4.2.2 Consonant stimuli

Place of articulation

For Yang, [χam] = [ħam] = [ham] 'box'. Besides, [zam] = [ʒam] = [ʐam] = [ʝam] 'sleep', although all of these realisations are uncommon, with [d̠ʑam] being the most common pronunciation. Additionally, [mal] = [ɱal] 'horse', and [nal] = [ɳal] 'day'. And for both speakers, [mal] = [maɭ] 'horse'. So, the place of articulation may vary for some realisations. All of these alternations, such as [χ], [ħ], and [h], are again examples of free variation.

Manner of articulation

For Yang, [tam] = [θam] 'sweat'; [dam] = [ðam] 'wall'; [pul] = [pɸul] 'horn'; and [bul] = [βul] = [bβul] 'fire'. This tells us that the contrast between stops, fricatives, and affricates is weak in some contexts. Again, these are examples of free variation. Although [am] and [ʔam] both mean 'cancer', only the first of these is considered common by both speakers.

This means that Korean words beginning with a vowel are pronounced without an initial glottal stop [ʔ].

Voice

I found that [pam] = [bam] 'night'; [m̥al] = [mal] 'horse'; and [hada] = [ɦada] 'do'. Besides, [pul] = [b̰ul] 'horn', and [t̪ɕok̚] = [d̪ʑok̚] 'page'. Also, [bul] = [b̰ul] 'fire', and [dal] = [d̰al] 'moon'. And finally, for Yang, [d̰al] = [d̰al] 'moon', and [g̈i] = [g̰i] 'energy'. In other words, there is a strong connection between voiceless, breathy, voiced, and creaky realisations, although I did not find any voiceless and breathy counterparts nor any voiced and creaky counterparts carrying the same meaning. This is strange, because voiceless and breathy sounds are alike in having a relatively large opening between the vocal folds, while with voiced and creaky sounds, this opening is relatively small (§ 2.1.2). This tells us that acoustic similarities do not always coincide with phonological contrasts.

Aspiratedness

For both speakers, [pul] 'horn' ≠ [pʰul] 'grass'; [sal] 'rice' ≠ [sʰal] 'flesh'; [m̥al] 'horse' ≠ [m̥ʰal] 'arm'. Overall, I found no cases of aspirated and unaspirated counterparts carrying the same meaning, so aspiratedness is always contrastive. For Yang, I found [b̰ul] = [pʰul] 'grass'; [ʑ̈i] = [ɕʰi] 'poem'; and [g̈i] = [kʰi] 'height'. So, there seems to be a connection between breathy voice and aspiratedness, which can be explained by the fact that both are characterised by a relatively large opening between the vocal folds.

Airstream mechanism

I found that [d̪ʑok̚] = [t̪ɕʼok̚] 'page'; [b̰ul] = [pʼul] 'horn'; [ʑ̰i] = [ɕʼi] 'seed'; [d̰al] = [tʼal] 'daughter'; and [g̰i] = [kʼi] 'talent', of which the second is shared by both speakers. So, there is a close connection between creaky and ejective realisations, both being characterised by a relatively high tension on the vocal folds. Additionally, for both speakers, [mul] = [ɓul] 'water', and [nal] = [ɗal] 'day', although these implosive realisations are judged "too strong" by Yang. This means that there is a connection between nasal and implosive realisations.

Plosive release

For both speakers, I found unreleased [ap̚] 'front', [mat̚] 'flavour', and [mok̚] 'neck', while their released counterparts [ap], [mat], [mok] carry no meaning. In other words, the absence of plosive release is ubiquitous after vowels.

Nasality

The feature of nasality gave rise to some surprising results. According to Lim, [mul] = [bul] 'water', and according to Yang, [m̥ʰal] = [pʰal] 'arm', and [n̥ʰal] = [tʰal] 'mask'. As mentioned in § 3.3, LR (2000: 64) claim that the nasal consonants [m] and [n], but not [ŋ], can have a "slightly oral release", i.e. [mᵇ] and [nᵈ]. The case of 'water' tells us that this slightly oral release may even be completely oral, i.e. [b]. This means that the feature of nasality is irrelevant here. The fact that [maŋ] means 'net' but [mag] is meaningless confirms the statement by the authors that [ŋ] is always completely nasalised. It should

be noted that there is a difference between [mul] 'water' on the one hand, and [m̥ʰal] 'arm' and [n̥ʰal] 'mask' on the other hand. The nasal realisation [mul] is most common, but it may also be pronounced orally as [bul]. On the other hand, the oral realisations [pʰal] 'arm' and [tʰal] 'mask' are most common, but they may also be pronounced nasally as [m̥ʰal] and [n̥ʰal], respectively. In other words, their oral and nasal qualities work in opposite directions.

Consonant rhoticity

For both speakers, [ɾaŋ] = [laŋ] = [raŋ] 'with', of which the realisation with [ɾ] is most common. According to Yang, the realisations with [r] is "too long". All other rhotic realisations, such as [ɹaŋ] and [ʁaŋ], are meaningless. Furthermore, [mal] = [maɭ] = [maɬ] 'word' or 'horse', with the second being most common and the latter sounding "too English" according to Yang. The other lateral realisations [maʎ] and [maʟ] do not carry meaning. In other words, both the alveolar tap [ɾ] and the retroflex lateral [ɭ] may also be realised as the alveolar lateral [l] as a form of free variation. This leads to a connection between rhoticity and laterality, just like the case of [naˑ] = [nal] 'day' mentioned under Vowel rhoticity.

Phonological processes

- Nasalisation

For both speakers, [amːun] = [ap̚mun] 'front door'; [amni] = [ap̚ni] 'front teeth'; [nanmal] = [nat̚mal] 'word'; [hunːal] = [hut̚nal] 'future'; [aŋma] = [ak̚ma] 'devil'; and [haŋnɛ] = [hak̚nɛ], referring to a location on campus. However, all of the latter realisations containing an unreleased stop are judged "too stiff" by Yang. In other words, nasalisation is most common, but not ubiquitous in all environments in which the process applies. All of these alternations are examples of free variation.

- Lateral assimilation

For both speakers, [hap̚li] = [hap̚ni] = [hamni] 'rationality', although only the latter is common. On the other hand, only [pak̚lam] and [paŋnam] can mean 'exhibition', while [pak̚nam] is judged meaningless by both speakers. This leads to the suggestion that lateral assimilation is also most common, but not ubiquitous, although more research is needed to confirm this.

Furthermore, for both speakers [kɯmli] = [kɯmni] 'interest', while [kɯmni] also carries the meaning of 'gold tooth'. Here, the alternation between [l] and [n] is an example of a contextually limited contrast, mentioned in § 2.2.2. While these two realisations are in contrast in environments such as [mal] 'horse' ≠ [man] 'ten thousand', they may lose their contrastive power in the environment [kumni], where both meanings 'interest' and 'gold tooth' apply due to the optional lateral assimilation of [l] into [n].

- Aspiratisation

For both speakers, [ip̚hak̚] = [ip̚ʰak̚] 'school entrance'; and [puk̚han] = [pukʰan] 'North-Korea', although the latter realisations with [pʰ] and [kʰ] are judged more common.

However, [d̪ʑohda] Ø ≠ [d̪ʑot^{h}a] ‘be good’; and [hajahgɛ] Ø ≠ [hajak^{h}ɛ] ‘whitely’. To understand the difference between the first and last two pairs, let us take a look at the structures of the four meanings. The first meaning ‘school entrance’ is composed of [ip̚] ‘enter’ and [hak̚] ‘learn’. Combining them creates the sequence [p̚h], which may be aspiratised into [p^{h}]. The same goes for the second meaning ‘North-Korea’, which is composed of [puk̚] ‘north’ and [han] ‘Korea’. Again, combining them may lead to the aspiratisation of [k̚h] into [k^{h}]. By contrast, the third meaning ‘be good’ is composed of the verb stem [d̪ʑoh] ‘be good’ and the infinitival suffix [da]. The sequence [hd] is aspiratised into [t^{h}], but this time, the change is ubiquitous. The same goes for the fourth meaning ‘whitely’, composed of the verb stem [hajah] ‘be white’ and the adverbial suffix [gɛ]. The resulting sequence [hg] is aspiratised into [k^{h}] and again, the change is ubiquitous. From these four examples, we can conclude that in sequences of the form [hC] – e.g. [hd] and [hg] – aspiratisation is ubiquitous, while sequences of the opposite form [Ch] – e.g. [p̚h] and [k̚h] – may also be left unaspiratised. The optional alternation between [Ch] and [C^{h}], such as between [p̚h] and [p^{h}] is an example of a free variation.

Let us get back to the example of the verb stem [d̪ʑoh] ‘be good’. As we saw, if this stem is followed by a verbal inflection beginning with a stop consonant, such as the adverbial suffix [gɛ], the final [h] triggers aspiratisation, but is not pronounced itself. Interestingly, if the stem is followed by a verbal inflection beginning with a vowel, it is not pronounced either (SKC 2012: 210). Their example is [d̪ʑoh] followed by the connective [asʌ], which is pronounced as [d̪ʑoasʌ]. Additionally, if the stem is isolated without any sound following it, the final [h] is pronounced as [t̚] (SKC 2012: 182). So, [d̪ʑoh] is realised as [d̪ʑot̚] in isolation. This means that the [h] in [d̪ʑoh] is not pronounced under any circumstance. But if it is it is only visible by its effect on its environment, such as in triggering aspiratisation, how do we know [h] is actually part of the stem, and not some other consonant, e.g. [t̚]? I recognise a phoneme /h/ as the final consonant of this verb stem to account for the fact that it triggers aspiratisation. This phonological process also occurs when [h] follows a stop, such as in the example of [puk^{h}an] ‘North-Korea’ mentioned above. So, I extend the tight connection between the occurrence of [h] and aspiratisation to circumstances in which [h] itself is never realised.

Interestingly, when [h] occurs before the approximant [w] or [j], the combination of both consonants may also be aspiratised into [ʍ^{h}] and [j̥^{h}] as a form of free variation. For example, according to both speakers, [hwaŋ] = [ʍ^{h}aŋ] ‘sulfur’, and [hjaŋ] = [j̥^{h}aŋ] ‘smell’. This goes against what I just mentioned about aspiratisation being ubiquitous in sequences of the form [hC]. Because of these two examples, we have to conclude that aspiration is only ubiquitous in [hC] sequences resulting from compounding, such as the compounding of the verb stem [d̪ʑoh] ‘be good’ and the infinitival suffix [da] into [d̪ʑot^{h}a] ‘be good’. In all other cases, including [Ch] sequences, aspiratisation is optional.

- Palatalisation

For both speakers, [midad̪ʑi] and [kat̪ɕ^{h}i] mean ‘sliding door’ and ‘together’, respectively, but [midadi] and [kat^{h}i] do not carry meaning. So, applying palatalisation is ubiquitous in all environments in which the process applies.

On the basis of the discussion above, we have to postulate three groups of phonological processes of Korean, based on how ubiquitous their application is:

1. ubiquitous:
   - palatalisation
2. optional, but most common:
   - nasalisation
   - lateral assimilation
3. ubiquitous in some cases and optional, but most common in other cases:
   - aspiratisation

4.3 Further implementation

This thesis is an attempt at valorisation, making expert information about the Korean language available for wider societal use. My efforts aim at maximal applicability for a book that teaches second-language learners Korean pronunciation, and at maximal adaptability to an introduction to Korean orthography. This book can be used in Korean language classes or for self-study. The phonological explorations of Korean presented in this thesis can serve as the basis for the contents of this book, and the methodological considerations described here aid in writing about Korean pronunciation in a clear and linguistically responsible manner, with an audience of non-linguist second-language learners in mind. The methodology I adhered to can be used to further the phonological exploration of contemporary spoken Korean.

In order to make the implementation of phonetic and phonological concepts of Korean understandable to any learner, making a link to the workings of Korean orthography can be useful. For example, the verb stem [d̥ʑoh] 'be good' mentioned in § 4.2 will be more recognisable to a second-language learner of Korean if it is also given spelled in Hangeul, i.e. 좋 *joh*. Besides, the phonetic concept of aspiratedness can be exemplified by the difference in pronunciation between the aspirated consonant letter ㅌ *t* and its non-aspirated counterparts ㄷ *d* and ㄸ *dd*. Note that the pronunciation of Korean and not its orthography should be taken as the basis of this course, as extensively argued for in this work. After all, a reliance on the spoken language is what sets this approach apart from existing didactic approaches.

Furthermore, a didactic work on the pronunciation of Korean cannot do without audio fragments of native speakers pronouncing key examples. Pronunciations simply cannot be accurately and consistently transmitted in written form, especially if they are unknown to the reader, even with the aid of IPA. These audio fragments can be combined with passive and active exercises, just like in Wiedenhof (2015b), in order to familiarise students with Korean pronunciation.

Conclusion

In this thesis, I have attempted to answer the following research question: How can Korean phonology be taught to second-language learners of Korean in a linguistically responsible yet didactically adequate way? I have done this by providing methodological considerations for didactic purposes. I have exemplified this methodology with an accessible exploration of contemporary Korean phonology, solely based on spoken language. This study has multiple goals. First of all, it aims to serve as a bridge between existing linguistic and didactic works on Korean phonology. Secondly, it explores means of valorisation of expert knowledge on the language. Thirdly, it ensures maximal applicability in a book that teaches Korean pronunciation to an audience of second-language learners, potentially in combination with an introduction to Korean orthography. And lastly, I hope to contribute to the dialogue about language research and education at Leiden University with this study.

In the process, I have accomplished a number of things. Firstly, I developed a functionally superior romanisation system of the Korean Hangeul alphabet, which I refer to as *ART*. The system is recognisable and intuitive to any second-language learner of Korean, because it is based on the Revised Romanisation of Korean (NIKL n.d.), which is also used by the South Korean government. On top of that, it is purely based on the written form of the language, contrarily to existing romanisation systems. Secondly, I have shown the feasibility of introducing the reader to a number of topics for the purpose of second-language acquisition, such as the structure of the Korean language and script, and the fields of phonetics and phonology. I did this in a linguistically responsible manner, without the need for prior knowledge on linguistic. And thirdly, I have proved the possibility of successfully applying Ebeling's (1960) approach to explore the phonology of a language solely based on its spoken form. The results turned out most promising, as a number of discoveries were made despite the limitations imposed on this study by the global health crisis. For example, I have shown that tone and vowel nasality are not phonemic in Korean and that the absence of plosive release is ubiquitous after vowels. I have also shown that there are three groups of phonological processes in Korean, based on how ubiquitous their application is, and that an unpronounced phoneme /h/ should be postulated at the end of any verb stem which triggers aspiratisation in verbal inflections.

Hopefully, my Bachelor's thesis, Master's thesis, and educational videos on the pronunciation of Korean will all contribute to the valorisation of expert information on the Korean language for wider use by the ever-growing group of second-language learners of Korean.

Acknowledgement

Writing this thesis has been a period of new insights for me. Not only did I learn to apply a new method for exploring the phonology of a language, I also learnt significant things about the pronunciation of modern Korean. Besides, I learnt to always separate spoken and written language in a linguistic study. Of course, I have received the help of other people during my thesis writing process. I want to thank Ae Ree Nam, Jaeyeong Yang, Lim Jeong Ha, and Suyeon Lee for sharing their native speaker insights on the Korean language, and Alison Buck for sharing her insights on American English. But foremost, I want to thank Jeroen Wiedenhof for the many pieces of advice and his attentive suggestions for improvement of my work. I hope I have taught him as much about the Korean language as he has taught me about conducting proper research and writing in a consistent and accessible manner.

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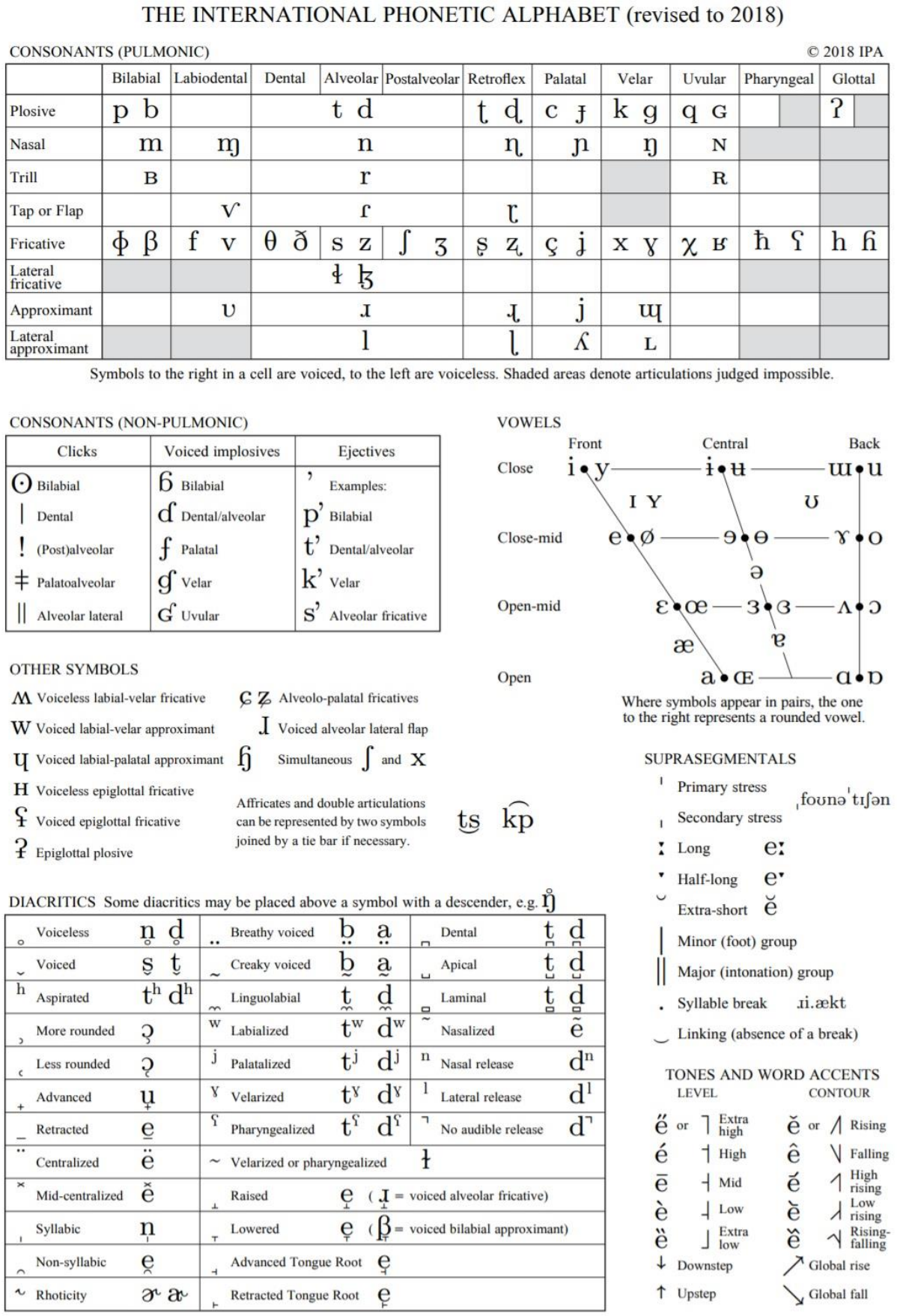
Appendix A. IPA chart (IPA 2018)



THE INTERNATIONAL PHONETIC ALPHABET (revised to 2018)

CONSONANTS (PULMONIC) © 2018 IPA

	Bilabial	Labiodental	Dental	Alveolar	Postalveolar	Retroflex	Palatal	Velar	Uvular	Pharyngeal	Glottal
Plosive	p b			t d		ʈ ɖ	c ɟ	k g	q ɢ		ʔ
Nasal	m	ɱ		n		ɳ	ɲ	ŋ	ɴ		
Trill	ʙ			r					ʀ		
Tap or Flap		ⱱ		ɾ		ɽ					
Fricative	ɸ β	f v	θ ð	s z	ʃ ʒ	ʂ ʐ	ç ʝ	x ɣ	χ ʁ	ħ ʕ	h ɦ
Lateral fricative				ɬ ɮ							
Approximant		ʋ		ɹ		ɻ	j	ɰ			
Lateral approximant				l		ɭ	ʎ	ʟ			

Symbols to the right in a cell are voiced, to the left are voiceless. Shaded areas denote articulations judged impossible.

CONSONANTS (NON-PULMONIC)

Clicks	Voiced implosives	Ejectives
ʘ Bilabial	ɓ Bilabial	’ Examples:
| Dental	ɗ Dental/alveolar	pʼ Bilabial
! (Post)alveolar	ʄ Palatal	tʼ Dental/alveolar
ǂ Palatoalveolar	ɠ Velar	kʼ Velar
‖ Alveolar lateral	ʛ Uvular	sʼ Alveolar fricative

OTHER SYMBOLS

ʍ Voiceless labial-velar fricative
w Voiced labial-velar approximant
ɥ Voiced labial-palatal approximant
ʜ Voiceless epiglottal fricative
ʢ Voiced epiglottal fricative
ʡ Epiglottal plosive

ʗ ʖ Alveolo-palatal fricatives
ɺ Voiced alveolar lateral flap
ʧ Simultaneous ʃ and x

Affricates and double articulations can be represented by two symbols joined by a tie bar if necessary.

t͡s k͡p

VOWELS

Where symbols appear in pairs, the one to the right represents a rounded vowel.

SUPRASEGMENTALS

ˈ Primary stress ˌfoʊnəˈtɪʃən
ˌ Secondary stress
ː Long eː
ˑ Half-long eˑ
˘ Extra-short ĕ
| Minor (foot) group
‖ Major (intonation) group
. Syllable break ɹi.ækt
‿ Linking (absence of a break)

TONES AND WORD ACCENTS

LEVEL		CONTOUR	
e̋ or e᷅	Extra high	ě or e᷄	Rising
é e᷄	High	ê e᷈	Falling
ē e᷅	Mid	ě e᷄	High rising
è e᷈	Low	ȅ e᷅	Low rising
ȅ e᷈	Extra low	ȇ e᷈	Rising-falling
↓	Downstep	↗	Global rise
↑	Upstep	↘	Global fall

DIACRITICS Some diacritics may be placed above a symbol with a descender, e.g. ŋ̊

◌̥ Voiceless	n̥ d̥	◌̤ Breathy voiced	b̤ a̤	◌̪ Dental	t̪ d̪
◌̬ Voiced	s̬ t̬	◌̰ Creaky voiced	b̰ a̰	◌̺ Apical	t̺ d̺
◌ʰ Aspirated	tʰ dʰ	◌̼ Linguolabial	t̼ d̼	◌̻ Laminal	t̻ d̻
◌̹ More rounded	ɔ̹	◌ʷ Labialized	tʷ dʷ	◌̃ Nasalized	ẽ
◌̜ Less rounded	ɔ̜	◌ʲ Palatalized	tʲ dʲ	◌ⁿ Nasal release	dⁿ
◌̟ Advanced	u̟	◌ˠ Velarized	tˠ dˠ	◌ˡ Lateral release	dˡ
◌̠ Retracted	e̠	◌ˤ Pharyngealized	tˤ dˤ	◌̚ No audible release	d̚
◌̈ Centralized	ë	~ Velarized or pharyngealized	ɫ		
◌̽ Mid-centralized	e̽	◌̝ Raised	e̝ (ɪ̝ = voiced alveolar fricative)		
◌̩ Syllabic	n̩	◌̞ Lowered	e̞ (β̞ = voiced bilabial approximant)		
◌̯ Non-syllabic	e̯	◌̙ Advanced Tongue Root	e̙		
◌˞ Rhoticity	ɚ a˞	◌̘ Retracted Tongue Root	e̘		

Appendix B. Stimuli

1. Height (high ~ low)

- *Front rounded*: [ny] ~ [nœ]
- *Front unrounded*: [ni] ~ [na]
- *Back rounded*: [nu] ~ [nɒ]
- *Back unrounded*: [nɯ] ~ [nɑ]

2. Backness (front ~ back)

- *High rounded*: [ny] ~ [nu]
- *High unrounded*: [ni] ~ [nɯ]
- *Mid rounded*: [nø] ~ [no]
- *Mid unrounded*: [nɛ] ~ [nʌ]
- *Low rounded*: [nœ] ~ [nɒ]
- *Low unrounded*: [næ] ~ [nɑ]

3. Roundedness (unrounded ~ rounded)

- *High front*: [ni] ~ [ny]
- *High back*: [nɯ] ~ [nu]
- *Mid front*: [ne] ~ [nø]
- *Mid back*: [nʌ] ~ [no]
- *Low front*: [na] ~ [nœ]
- *Low back*: [nɑ] ~ [nɒ]

4. Length (short ~ long)

- *High front unrounded*: [kil] ~ [kiːl]
- *High back rounded*: [nun] ~ [nuːn]
- *Low front unrounded*: [mal] ~ [maːl]

5. Tone (high, low, falling, rising)

- *High front unrounded*: [ní], [nì], [nî], [nǐ]
- *High back rounded*: [nú], [nù], [nû], [nǔ]
- *Low front unrounded*: [ná], [nà], [nâ], [nă]

6. Place of articulation (bilabial ~ glottal)

- *Voiceless stop*: [pam] ~ [ʔam]
- *Voiced stop*: [bam] ~ [ɢam]
- *Voiceless fricative*: [ɸam] ~ [ham]
- *Voiced fricative*: [βam] ~ [ɦam]
- *Voiceless sibilant affricate*: [t̪s̪am] ~ [ʈʂam]
- *Voiced sibilant affricate*: [d̪z̪am] ~ [ɖʐam]

- *Voiceless nasal*: [m̥al] ~ [n̥al]
- *Voiced nasal*: [mal] ~ [nal]
- *Voiceless approximant*: [ɯiʤa] ~ [ɯ̥iʤa]
- *Voiced approximant*: [wiʤa] ~ [ɯiʤa]
- *Voiceless lateral*: [maɭ̥] ~ [maɹ̥], [maɬ̥]
- *Voiced lateral*: [mal] ~ [maɹ], [maɬ]

7. Manner of articulation (stop, fricative, affricate, approximant)

- Voiceless bilabial: [pul], [ɸul], [pɸul], [ʍul]
- Voiced bilabial: [bul], [βul], [bβul], [wul]
- Voiceless alveolar: [tal], [sal], [tsal], [ɹ̥al]
- Voiced alveolar: [dal], [zal], [dzal], [ɹal]
- Voiceless palatal: [caŋ], [ç̥aŋ], [cç̥aŋ], [j̊aŋ]
- Voiced palatal: [ɟaŋ], [ɟ̊aŋ], [ɟɟ̊aŋ], [jaŋ]
- Voiceless velar: [kan], [xan], [kxan], [ɯ̥an]
- Voiced velar: [gan], [ɣan], [gɣan], [ɯan]
- Voiceless glottal: [ʔan], [han], [ʔhan]

8. Voice (voiceless ~ creaky)

- *Bilabial stop*: [pul] ~ [p̰ul]
- *Alveolar stop*: [tal] ~ [t̰al]
- *Alveolar sibilant*: [sal] ~ [s̰al]
- *Alveolo-palatal sibilant*: [ɕi] ~ [ʑ̰i]
- *Alveolo-palatal affricate*: [t̠ɕo̰k] ~ [dʑ̰o̰k]
- *Velar stop*: [ki] ~ [g̰i]
- *Glottal fricative*: [hada] ~ [ɦ̰ada]
- *Bilabial nasal*: [m̥al] ~ [m̰al]
- *Alveolar nasal*: [n̥al] ~ [n̰al]
- *Velar nasal*: [maŋ̊] ~ [maŋ̰]
- *Labio-velar approximant*: [ʍaŋ] ~ [w̰aŋ]
- *Palatal approximant*: [j̊aŋ] ~ [j̰aŋ]
- *Velar approximant*: [ɯ̥isa] ~ [ɯ̰isa]
- *Alveolar lateral*: [maɭ̥] ~ [maɭ̰]
- *Alveolar tap*: [mʌɾ̥i] ~ [mʌɾ̰i]

9. Aspiratedness (unaspirated ~ aspirated)

- *Bilabial stop*: [pul] ~ [pʰul]
- *Alveolar stop*: [tal] ~ [tʰal]
- *Alveolar sibilant*: [sal] ~ [sʰal]
- *Alveolo-palatal sibilant*: [ɕi] ~ [ɕʰi]
- *Alveolo-palatal affricate*: [t̠ɕo̰k] ~ [t̠ɕʰo̰k]

- *Velar stop*: [ki] ~ [kʰi]
- *Bilabial nasal*: [m̥al] ~ [m̥ʰal]
- *Alveolar nasal*: [n̥al] ~ [n̥ʰal]
- *Velar nasal*: [maŋ̊] ~ [maŋ̊ʰ]
- *Labio-velar approximant*: [ʍaŋ] ~ [ʍʰaŋ]
- *Palatal approximant*: [j̊aŋ] ~ [j̊ʰaŋ]
- *Velar approximant*: [ɰ̊isa] ~ [ɰ̊ʲʰisa]
- *Alveolar lateral*: [ma̰l̥] ~ [ma̰l̥ʰ]
- *Alveolar tap*: [mʌɾ̥i] ~ [mʌɾ̥ʰi]

10. Airstream mechanism (pulmonic, implosive, ejective)

- *Bilabial*: [pul], [ɓul], [pʼul]
- *Alveolar*: [dal], [ɗal], [tʼal]
- *Alveolar sibilant*: [sal], [sʼal]
- *Alveolo-palatal fricative*: [ɕi], [ɕʼi]
- *Alveolo-palatal affricate*: [t̪ɕo̰k], [t̪ɕʼo̰k]
- *Velar*: [ki], [ɠi], [kʼi]

11. Plosive release (released, unreleased)

- *Bilabial*: [ap], [ap̚]
- *Alveolar*: [mat], [mat̚]
- *Velar*: [mok], [mok̚]

12. Nasality (oral ~ nasal)

- *Bilabial*: [bul] ~ [mul]
- *Alveolar*: [dal] ~ [nal]
- *Palatal*: [d̪ʑal] ~ [ɲal]
- *Velar*: [bag] ~ [baŋ]
- *High front unrounded*: [ni] ~ [nĩ]
- *High back rounded*: [nu] ~ [nũ]
- *Low front unrounded*: [na] ~ [nã]

13. Rhoticity (non-rhotic ~ rhotic)

- *Consonant*: [ɾaŋ], [raŋ], [ɽaŋ], [ɻaŋ], [ɻ̊aŋ], [ʀaŋ], [ʁaŋ], [laŋ]
- *High front unrounded*: [ni] ~ [niˠ]
- *High back rounded*: [nu] ~ [nuˠ]
- *Low front unrounded*: [na] ~ [naˠ]

14. Phonological processes (nasalisation, assimilation, aspiratisation, palatalisation)

- *Nasalisation, bilabial*: [ap̃mun], [amːun], [ap̃ni], [amni]
- *Nasalisation, alveolar*: [nat̃mal], [nanmal], [hut̃nal], [hunːal]
- *Nasalisation, velar*: [ak̃ma], [aŋma], [hak̃nɛ], [haŋnɛ]

- *Lateral assimilation, bilabial nasal*: [gɯmli], [gɯmni]
- *Lateral assimilation, bilabial stop*: [hap̃li], [hap̃ni], [hamni]
- *Lateral assimilation, velar nasal*: [haŋlo], [haŋno]
- *Lateral assimilation, velar stop*: [bak̃lam], [bak̃nam], [baŋnam]

- *Aspiratisation, bilabial*: [ip̃hak̃], [ip^{h}ak̃]
- *Aspiratisation, alveolar*: [hat̃hɛ], [hat^{h}ɛ], [d̪ʑohda], [d̪ʑot^{h}a]
- *Aspiratisation, alveolo-palatal*: [d̪ʑohd̪ʑo], [d̪ʑot̪ɕ^{h}o]
- *Aspiratisation, velar*: [buk̃han], [buk^{h}an], [hajahgɛ], [hajak^{h}ɛ]

- *Palatalisation, voiced*: [midadi], [midad̪ʑi]
- *Palatalisation, aspirated*: [gat^{h}i], [gat̪ɕ^{h}i]