THE DEVELOPMENT OF GLIDE DELETION IN SEOUL KOREAN: A CORPUS AND ARTICULATORY STUDY.

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ABSTRACT

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This dissertation investigates the pathways and causes of the development of glide deletion in Seoul Korean. Seoul provides fertile ground for studies of linguistic innovation in an urban setting since it has seen rapid historical, social and demographic changes in the twentieth century. The phenomenon under investigation is the variable deletion of the labiovelar glide /w/ found to be on the rise in Seoul Korean (Silva, 1991; Kang, 1997). I present two studies addressing variation and change at two different levels: a corpus study tracking the development of /w/-deletion at the phonological level and an articulatory study examining the phonetic aspect of this change. The corpus data are drawn from the sociolinguistic interviews with 48 native Seoul Koreans between 2015 and 2017. A trend comparison with the data from an earlier study of /w/-deletion (Kang, 1997) reveals that /w/-deletion in postconsonantal position has begun to retreat, while non-postconsonantal /w/-deletion has been rising vigorously. More importantly, the effect of preceding segment that used to be the strongest constraint on /w/-deletion has weakened over time. I conclude that /w/-deletion in Seoul Korean is being reanalyzed with the structural details being diluted over time. I analyze this weakening of the original pattern as the result of linguistic diffusion induced by a great influx of migrants into Seoul after the Korean War (1950-1953). In an articulatory study, ultrasound data of tongue movements and video data of lip rounding for the production of /w/ for three native Seoul Koreans in their 20s, 30s and 50s were analyzed using Optical Flow Analysis. I find that /w/ in Seoul Korean is subject to both gradient reduction and categorical deletion and that younger speakers exhibit a significantly larger articulatory gestures for /w/ after a bilabial than older generation, which is consistent with the pattern of phonological change found in the corpus study. This dissertation demonstrates the importance of using both corpus and articulatory data in the investigation of a change, finding the coexistence of gradient and categorical effects in segmental deletion processes. Finally, it advances our understanding of the outcome of migration-induced dialect contact in contemporary urban settings.

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Chapter 1

Introduction

1.1 Goals of the thesis

One of the key characteristics of human language is that it is dynamic: all languages change over time. Over the past few decades, the field of quantitative sociolinguistics has made a significant contribution toward improving our understanding of the mechanisms of language variation and changes and what underlies them. At the heart of this successful enterprise, the apparent time construct, a research design pioneered by William Labov played a crucial role: in his early studies in Martha's Vineyard and New York City. Labov (1963; 1966) developed a set of methodological innovations by using apparent time differences to infer the progress of linguistic changes. Under the apparent time construct, the linguistic variation, a prerequisite for language change, is quantified by comparing different age groups, and the observed differences among successive generations of the speech community are considered to reflect the diachronic developments in the language at the community level (Labov,

1963; 1972). The idea that a change in progress can be investigated synchronically was groundbreaking because synchronic and diachronic linguistics have been regarded as separate previously (Sankoff, 2013).[1] Indeed, the apparent time construct served as a useful and valid substitute for the real-time examination of data at different points in history which is usually much more costly to the researcher in terms of time and efforts needed for the research. Since then, there followed an avalanche of studies that used the apparent-time construct to make inferences about ongoing changes in different speech communities across the globe.

Although the apparent time study proved a reliable and powerful method in locating changes in progress and greatly improved our knowledge of the mechanism of change, it is widely recognized that the real-time data collected at two different points in time constitute the best resources to investigate diachronic linguistic developments (Sankoff, 2006; Sankoff, 2013). Real-time studies not only allow us to either confirm or reject the hypothesis of linguistic changes posited in previous apparent-time studies, but they can also present other possible developments of the change. Sankoff (2006) presents four possible types of outcomes we may observe in real-time studies. First, if the gradient age distributions originally found in previous studies is repeated at a higher level of the change, we can interpret the result as a continuing change. Second, if the

[1]Chambers defined the synchronic approach to the study of language change as "the most striking single accomplishment of contemporary linguistics" (2009: 160).

gradient age distribution found in the original study is repeated at the same level, the hypothesis about the change in progress can be rejected and the outcome can be interpreted as the effect of static age-grading. Thirdly, if all age groups display the same high level of the variable and there is no significant difference among the age groups, this can be interpreted as the change going to completion, the very last stage of the language change. Lastly, the direction of change can be reversed, usually as a reaction to the stigmatization from above.

Moreover, the results of real-time studies often enrich an apparent time interpretation by identifying new changes or age-grading effect that come into play with the change found in the original studies (Sankoff, 2013). Trudgill's (1988) restudy of Norwich, for example, he verified the continuation of the sound changes he found in his original study. But he also found two new changes that were not present in the community in his original research. Also, Fowler's (1986) replication of Labov's (1966) department store survey of /r/ not only confirmed Labov's hypothesis that there is a change in progress toward a new prestige norm of constricted /r/ in New York City, but the new data also demonstrated that the change is progressing more slowly than before and that the age-grading effect is also involved in the change. The real time panel study[2] of 60 Montreal speakers by Wagner and Sankoff (2011) reveals a more nuanced picture of the the

[2]Panel study is a subtype of real time studies in which the same individuals are followed across time by reinterviewing the same subjects at a later time.

rise of the periphrastic future at the expense of the inflected future by showing two-thirds of their speakers exhibit an age-grading effect in a retrograde direction.

Since 1995, an increasing number of longitudinal research projects returned to speech communities that had been studied in the 1960s and 1970s within the apparent time framework and carried out replications of the previous studies (Bailey, 2002; Sankoff, 2006). They resampled the same age range of speakers and made real-time comparisons based on the reference points set in the previous studies. These real-time projects played a crucial role in tracking the trajectories of ongoing changes in a number of speech communities across the world. The speech communities studied through the real-time construct include New York City (Fowler, 1986), Panama City, Panama (Cedergren, 1987), Norwich, England (Trudgill, 1988), Tsuoraka, Japan (see Chambers, 1995:194–198), Seoul, Korea (Kang and Han, 2013; Kang, 2014), Montreal, Canada (Blondeau, 2001; Sankoff and Blondeau 2007, Sankoff, Blondeau and Charity, 2001), Martha's Vineyard, US (Blake and Josey, 2003; Pope, Meyerhoff and Ladd, 2007), and different regions in Finland (Nahkola & Saanilahti 2004, Nordberg 1975, Nordberg & Sundgren 1998, Paunenen 1996, Kurki, 2004). For more details of these studies, see the discussion of Sankoff (2006; 2013).

Of note is that, compared to a relatively large number of real time studies of Western languages, only a handful of real-time studies have tracked the

diachronic developments of changes in East Asian languages. In this light, this dissertation aims to fill the gap by revisiting the speech community of Seoul, Korea. Seoul is the capital of South Korea with a population of 10 million. The Greater Seoul areas including the cities of Seoul and Incheon, as well as the whole Gyeonggi Province sharing the same dialect are the fifth largest metropolitan areas in the world and houses 25 million. The city of Seoul and its surrounding areas have experienced dramatic changes in many aspects of society over the last century. Due to this dynamic nature of the city, Seoul provides fertile ground for large-scale sociolinguistic research for linguistic innovations in an urban setting. Chapter 3 of this dissertation aims to track the progress one of the ongoing sound changes that had been previously documented in Seoul Korean.

The particular phenomenon chosen to accomplish this goal is the variable deletion of the labiovelar glide /w/ in Seoul Korean. The precise nature of /w/-deletion in Seoul Korean will be elaborated in Chapters 2; the basic gist of the phenomenon is that the labiovelar glide /w/ in rising diphthongs is variably deleted primarily after a consonant and, less frequently, after a vowel. The variable deletion of /w/ occurs both in spontaneous and read speech. This variable deletion has been observed from early on and dubbed as "disappearing *w*" by Martin (1954), but it was the two quantitative variationist studies (Silva, 1991; Kang, 1997) in 1990s that demonstrated that /w/-deletion in Seoul Korean

is not a random process but shows systematic patterns. They show that the variable /w/-deletion is conditioned by various linguistic and external constraints such as preceding segment, following vowel, prosodic position, speech style, speaker age, socioeconomic class, etc. (see Chapter 3 for the detailed discussion of these studies). These previous studies carried out in 1990s showed that there was a change toward more deletion of /w/, with younger speakers deleting /w/ more frequently than older generations and the strongest constraint of the variable deletion process is the preceding segment: /w/ is deleted significantly more after a bilabial (Kang, 1997) and a velar (Silva, 1991).

The variable deletion of /w/ is an ideal linguistic variable for a real-time investigation in Seoul Korean, not only because /w/-deletion is one of the only several variable rules in Seoul Korean that had been examined from the variationist perspective in the past decades[3] but also because it appeared to exhibit different patterns of the change than what was found in the previous apparent time studies. While the previous studies demonstrated that /w/ is much more frequently deleted after a bilabial, in my observation, /w/ seemed to delete as frequently after a segment of other places of articulation (e.g. *twe.ta* 'become') as after a bilabial, especially among younger generations. Based on such an observation, I carried out a preliminary study of /w/-deletion in Seoul

[3]Thus far, only several variable rules have been documented from the variationist approach in Seoul Korean (e.g. the merger of /e/ and /ɛ/ (Hong, 1988), the raising of /o/ to /u/ (Chae, 1995), the deletion of /j/ (Kang, 1997), the monophthongization of /ii/(Kang, 1997), the change in the VOT values (Kang and Han, 2013), etc.).

Korean that revealed a striking picture of the change involving the reversal of the change as well as the change in the effects of constraints governing the deletion. Therefore, /w/-deletion in Seoul Korean is a particularly good example of real time study presenting a more nuanced picture of the development of variable sound patterns that can go beyond providing the real time verification of phonological change.

In Chapter 3 of this dissertation, I present a real time investigation of /w/-deletion in Seoul Korean by extending the research initiated by Silva (1991) and Kang (1997). I also make use of the apparent time construct to compare it with the real time data in evaluating the status of the change. In doing so, I address the following three specific goals. First, I assess the community change of /w/-deletion in postconsonantal position on the basis of the corpus data collected in 1997 and 2017, using real time trend method as well as the apparent time construct. Second, I examine the community shift of /w/-deletion in non-postconsonantal position based on the same corpus data from 1997 and 2017. Third, I investigate the possible change in the effects of constraints governing the deletion, comparing the regression results from 2017 with those from 1997.

Another important issue I aim to address in this dissertation is variation and change at the articulatory level. Research in phonological variation and change has made a great progress as the technologies for acoustic analysis improved and became widely available. In the mid-twentieth century, the use of digital

recording, sound spectrograph,[4] and open-source software for the scientific analysis of speech in phonetics such as Praat (Boersma and Weenink 2007) became increasingly widespread. This enabled researchers to produce phonetically-informed analyses of phonological processes. Also, the works of quantitative sociolinguistics, thanks to the increasing availability of the tools for the acoustic analysis, expanded their scope from the analyses of categorical phonological processes based on auditory analysis to those of gradient variations at the subphonemic level (e.g. phonetic changes of vowels). This allowed the researchers in the field to address questions regarding phonetic aspects of sound patterns and, as a result, we saw an abundance of the analyses of variable sound patterns based on acoustic data in the past decades.

On the other hand, we have a very limited knowledge of variation and change at the articulatory level because articulatory variation and change have been generally inferred from the auditory and acoustic data. An increasing number of linguists, however, point out that variation and change at the articulatory level is covert and we need to use articulatory data to reliably investigate variation and change in sound (Davidson, 2006; Mielke, 2007; Lawson, Scobbie and Stuart-Smith, 2011, *inter alia*). That is, differences in the tongue shapes or variable patterns in the timing and magnitude of gestures are not readily perceived by listeners. Given that articulatory data can provide

[4]Sound spectrograph is an instrument that displays a graphical representation of the distribution of energy as time passes.

additional details about the organization of sound patterns that are unavailable in the acoustic output (Mielke et al., 2016), we can take a more integrated approach to the study of linguistic variation and change, taking into consideration variation and change at a lower and higher level of the grammar altogether.

Studies of variation and change based on the articulatory data, therefore, have a great potential to reveal a more complete picture of variable sound patterns. While the study of speech articulation has a long history (Ladefoged 1957, Fromkin & Ladefoged 1966, *inter alia*), the tools for articulatory studies have not been actively adopted in studies of language variation and change partly due to the practical difficulties (but see Lawson et al. 2011, Mielke, 2013; Mielke et al., 2016, *inter alia*): it is much more expensive and time-consuming to collect and analyze the amount of data needed for carrying out variationist studies. Tools used in the articulatory research such as electropalatography (EPG), electromagnetic midsagittal articulatography (EMMA), magnetic resonance imaging (MRI) are costly and often invasive. For example, in the experiment using EMMA, pellets are placed on the tongue and their positions are measured to obtain the information about tongue shape. Likewise, for EPG, a custom-made artificial palate is fit against a speaker's hard palate by wrapping it around the upper teeth in order to measure the amount of linguopalatal contact.

The development in ultrasound imaging, however, has provided a new avenue in the studies of language variation and change using articulatory data. Since the 1970s, ultrasound became an increasingly useful tool for speech research (Gick, 2002). A number of researchers have used ultrasound to measure tongue shapes and movements with increasing effectiveness (Sonies et al., 1981, Keller and Ostry 1983, Munhall and Ostry 1985, Stone 1990, Stone et al. 1988, 1992, Stone and Lundberg 1996). Ultrasound has become increasingly popular as the only tool for safe, non-invasive and relatively cheap imaging of the movement of the whole tongue, both in the field and the laboratory. In addition, Scobbie, Stuart-Smith and Lawson (2008) convincingly showed the value of using ultrasound imaging for socioarticulatory research by demonstrating that it can be exploited as a tool for eliciting relatively relaxed and vernacular speech. They attempted to show the potential psychosocial impact of ultrasound recording by comparing how subjects behave differently than they would in the presence of a microphone for audio-only recording. They found the use of ultrasound imaging equipment, including a stabilizing headset, did not cause a large or consistent style shift in speech. In this regard, ultrasound is a tool with a great promise for studies of variation and change aiming to collect relaxed and vernacular speech from a larger number of speakers because ultrasound imaging is safe, often portable, and relatively more affordable than other articulatory tools.

In Chapter 4 of this dissertation, I aim to present a study of articulatory variation and change of /w/-deletion in Seoul Korean based on the ultrasound data of tongue movements as well as the video data of lip rounding for the production of /w/. While some previous socioarticulatory studies have used the qualitative approach by analyzing completely different tongue configurations (e.g. Lawson et al. 2011), the current study will examine continuous or quantitative variation and change at the subphonemic level in terms of the magnitude of gestures involved in the production of /w/ in Seoul Korean. Therefore, this dissertation uses corpus data to examine the development of /w/-deletion at phonemic level (Chapter 3), and articulatory data to look into more gradient variation at the articulatory level (Chapter 4).

The articulatory study of /w/-deletion is of importance in a number of ways. First, all studies examining the phenomenon of 'disappearing *w*', restricted themselves to studying the presence versus absence of /w/, the alternation arising in the lexicon or the postlexical phonological component of the grammar. The present articulatory study, on the other hand, seeks to investigate the variation and change of the production and deletion of a glide at the phonetic as well as phonological level. The results of this study will improve our understanding of the categorical and gradient nature of the process and how the magnitude of articulatory gestures involved in the production of /w/ varies and has changed over time at different levels of the grammar. This aligns with a

recent approach that attempts to enrich the account of categorical segmental deletion by considering the gradient component of the phenomenon (Yu 2011; Lin, Beddor, Coetzee, 2014; Solé 2014; Turton, 2014; 2017). Second, the findings of this study can inform the nature of phonological deletion process of any other glides, consonants and vowels and have important implications for a variety of categorical segmental deletion processes in world's languages. Third, this study will address a more fundamental question of the articulatory properties of /w/. Relatively less attention has been paid to the articulatory properties of glides compared to those of vowels and consonants. The current study is, to my knowledge, the first articulatory study of the labiovelar glide /w/ in Korean, utilizing ultrasound imaging (but see Gick 2003 for the articulatory study of English approximants, using EMMA). The findings of this study will improve our understanding of articulatory mechanism by which /w/ is produced and what the primary and secondary articulatory correlates of /w/ are.

1.2 Outline of the dissertation and overview of findings

The dissertation is laid out as follows. In Chapter 2, I provide a detailed description of the phenomenon under study, /w/-deletion in Seoul Korean, by discussing some background of the Korean phonological system and the relevant findings from the previous phonetic and phonological studies on /w/ in Korean.

A remainder of the chapter is spent on providing the sociolinguistic profiles of the speech community of Seoul.

Chapter 3 presents the apparent and real time studies of /w/-deletion in Seoul Korean by extending the research initiated by Kang (1997) who investigated the apparent time data of /w/-deletion some 20 years ago. We shall see that /w/-deletion in postconsonantal position has retreated, beginning with the speakers born in 1970s, while /w/-deletion in non-postconsonantal position that had been identified as a new and vigorous change a decade ago has continued to rise rapidly. We will also see that there has been a simultaneous change of the weakening of the effect of preceding articulation. This is striking because it had been found to be the strongest constraints on /w/-deletion in previous research. As a result, younger speakers are much less subjected to the influence of preceding segment and, therefore, the youngest cohort of the corpus, exhibit similar deletion rates of /w/ in postconsonatal and non-postconsonantal positions. Therefore, I conclude that the observable facts strongly indicates that /w/-deletion in Seoul Korean is being reanalyzed, losing the strong conditioning of preceding segment. As a consequence, /w/-deletion which used to occur mainly after a consonant expanded into non-postconsonantal position.

Chapter 4 presents the articulatory study of /w/-deletion in Seoul Korean, using ultrasound imaging. The chapter investigates the nature of the realization and deletion of /w/ in Seoul Korean and how the articulatory patterns regarding

/w/-deletion changed over time. Based on the ultrasound data of tongue movements and the video data of lip rounding, I will present the following three findings. First, the primary articulatory correlate of /w/ in Seoul Korean is lip rounding while tongue dorsum raising is a secondary articulatory feature. Second, there is evidence for both gradient and categorical effects in the realization of /w/ in Seoul Korean. The gradient reduction of /w/ is evidenced by the significant durational effect on the production of /w/ in Seoul Korean. Simultaneously, the categorical alternation between /w/ and zero is demonstrated by a significant role CATEGORY plays on the magnitude of lip gestures for CV and CwV. Third, the generational difference in the gestural patterns involved in /w/-deletion in Seoul Korean is evidenced, which indicates the diachronic change at the articulatory level. The magnitude of lip gestures is significantly conditioned by a preceding consonant for the older generation but the effect of preceding consonant is not as strong as among younger speakers, which suggests a generational change.

Finally, Chapter 5 reviews the goals of the thesis and summarizes the main findings. The implications of the findings of this dissertation will be discussed next. Lastly, future directions for research and development will be suggested.

Chapter 2

Linguistic variable and the speech community

2.1 Introduction

In Chapter 1, I discussed the two aims of this thesis and why I chose the deletion of labiovelar /w/ and Seoul as the particular linguistic phenomenon and the speech community, respectively, for a real time investigation and an articulatory study of variation and change. In this chapter, I am going to provide a detailed description of the linguistic variable under study and the speech community of Seoul, Korea. In Section 2.2, a description of the variable /w/-deletion in Seoul Korean will be provided along with some discussion of basic notions in Korean phonology relevant to /w/-deletion. We will look into the syllable structures of Korean and then move on to the consonant and vowel systems of Korean (Section 2.2.1). A brief summary of the development of the monophthongal and diphthongal systems of Korean will be provided next (Section 2.2.2). In Section 2.3, the historical development of the speech community of Seoul, Korea over the

last century will be discussed. We will see that the unique historical and social changes of Seoul discussed in this section have important bearing on how /w/-deletion patterns in Seoul Korean have evolved over the last century.

2.2 The linguistic variable under investigation

2.2.1. The variable deletion of the labiovelar glide /w/ in Seoul Korean

The linguistic variable chosen for this thesis is the variable deletion of the labiovelar glide /w/ in Seoul Korean. Both in spontaneous and careful speech in Korean, the labiovelar /w/ in four rising diphthongs (wi, we, wə, wa) is variably deleted primarily after a consonant and, less frequently, after a vowel.

In Korean, a syllable consists of one obligatory vowel and one or more optional consonants or a glide. The one obligatory vowel can be preceded by an onset consonant, a glide, or both, and may be followed by a coda consonant as shown in (1).[5]

(1) Korean syllable structure

[.(C)(G)V(C).]

[5]There is a controversy regarding whether the glide in the CGV sequence belongs to the nucleus of the syllable with the following vowel (GV) or to the syllable onset with the preceding consonant (CG) (see S.C.Ahn, 1988; Y.S. Lee, 1993 for more details). Following a widely accepted view among Korean linguists (e.g. Sohn, 1987; Y.C.Chung, 1991; H.K.Choi, 1991; H.Y.Kim, 1990), I assume that a glide is a part of the nucleus of the syllable with the following vowel, forming diphthongs.

where . is a syllable boundary, C a consonant, G a glide, V a vowel.

The minimal structure of a syllable in Korean is a single vowel (e.g. *i* 'tooth') and the maximal structure of a syllable is CGVC (e.g. *kwis.sok.ma*l 'whisper'). There are four logical possible syllable types where a glide forms a syllable with other segment(s): GV (e.g. *wi* 'up'), CGV (e.g. kwi 'ear'), GVC (e.g. *waŋ* 'king'), CGVC (e.g. *kwan* 'coffin'). Note, however, that /w/ can occur intervocalically as in *ka.wi* 'scissor' because /w/ can occur syllable-initially.

There are nineteen consonants in Korean. The nineteen consonants can be classified in terms of the place and manner of their articulation as shown in (2). All consonants can precede /w/ as an onset consonant except for /ŋ/ (*ŋw).

(2) Consonantal phoneme inventory of Korean (adapted from Sohn, 1999)

place of articulation / articulatory manner			Bi-labial	Alveo-dental	Palatal	Velar	Glottal
stop	lax	voiceless or voiced	p	t	c	k	
	aspirated	voiceless	ph	th	ch	kh	
	tensed	voiceless	p'	t'	c'	k'	
fricative	aspirated	voiceless		s			h
	tensed	voiceless		s'			
nasal		voiced	m	n		ŋ	
liquid	lateral or flap	voiced		l			

Korean has seven monophthongs[6] and /w/ co-occurs with four of them as shown in (3).

(3) Co-occurrence restrictions on glide+vowel sequences

wi	*wɨ	*wu
we[7]	wə	*wo
	wa	

2.2.2 The development of monophthongal and diphthongal systems in Korean

In this subsection, I will provide a brief review of how the diphthongal system of Korean has evolved over time. The history of the Korean language can be divided into four periods (Lee and Ramsey, 2011; Sohn, 2012): Old Korean period

[6]There has been a controversy regarding the number of monophthongs in Korean and the debate centers around the status of three front vowels, /y, ø, e/ (Chang 2017). There are four competing claims. First, some argue for a 10-vowel system consisting of /i, e, ɛ, ə/ʌ, ɑ, u, o, ɨ, ø, y/ (Yang, 1992, 1996; Lee and Ramsey, 2000; Sohn, 2001). Second, Kim (1968) argued for a 9-vowel system /i, e, ɛ, ə, ɑ, u, o, ɨ, ø/where /y/ is diphthongized into / ɨy/. The third position argues for an 8-vowel system /i, e, ɛ, ə, ɑ, u, o, ɨ/: /y/ and /ø/ are diphthongized into /ɨy/and /we/, respectively (Sohn, 1987; Lee, 1993; Kang, 1996). The fourth position argues for a 7-vowel system consisting of /i, e, ə, ɑ, u, o, ɨ/ where a front vowel /ɛ/ has been merged into /e/ and /y/ and /ø/ diphthongized into glides /wi/ and /we/, respectively (Shin, Kiaer, and Cha 2013; Kang, 2014; Shin, 2015). Following the widely accepted view more recently, I posit that Korean has seven underlying vowels.

[7]Although "wae /wɛ/ (왜)" , "we /we/ (웨)" and "oe /we/ (외)" still have different orthographic codes, all three diphthongs are considered homophones with the phonetic realization of [we]. As a result of the merger of a front vowel /e/ and /ɛ/ into /e/(Hong, 1988), "wae /wɛ/ (왜)" and "we /we/ (웨)" do not distinguish each other in pronunciation anymore. A recent finding shows that "wae /we/" and "oe /we/" do not show a significant difference in terms of F1 and F2, even in very careful speech (Chang, 2017). This supports a proposal by Lee and Ramsey (2000) and Sohn (2001) that "oe /we/ (외)" sounds like a glide /we/ rather than a simple vowel /ø/.

(from the first to tenth century), Middle Korean period (from tenth to sixteenth century), Modern Korean period (from seventeenth century to nineteenth century), and Contemporary Korean period (from twentieth century to present). Unfortunately, little documentation of the linguistic system of Korean before the 15th century exists, which makes it almost impossible for linguists to reconstruct the system of diphthongs in the periods before the 15th century (Kang, 1997). Since the new way of the writing system, *hunminjeongeum*[8], known today as *Hangul,* was introduced in 1446, phonological and phonetic information as well as careful commentaries has become available. For this reason, I will discuss the development of the diphthongal system from the 15th century Middle Korean to present.

In the 15th century Middle Korean, there were seven monophthongs (/i, ɨ, u, ə, o, a, ɔ/), seven on-glide (/wə, wa, yu, yə, yo, ya, yɔ/) and six off-glide diphthongs (/ɨy, uy, əy, oy, ay, ɔy/) as laid out in (4).

[8] *Hunminjeongeum* whose literal meaning is "the proper sounds for the instruction of the people" was devised during the reign of King Sejong. This script contains the alphabet letters *(jamo)* and pronunciation rules of their corresponding sounds. The script was created to help the common people illiterate in Chinese characters could easily read and write the Korean language. It was promulgated on October 9, 1446, which remains as *Hangul Day* in Korea (Lee and Ramsey, 2000)

(4) Diphthongal system in the 15th century Middle Korean (adapted from Ahn and Iverson, 2006)

a. On-glides (/y/(IPA [j])

*yi	*yɨ	**yu**
	yə	**yo**
	ya	**yɔ**[9]

b. On-glides (/w/)

*wi	*wɨ	*wu
	wə	*wo
	wa	*wɔ

c. Off-glides (/y/ only)

*iy	ɨy	uy
	əy	oy
	ay	ɔy

The distribution of diphthongs of Middle Korean was highly restricted phonologically (Ahn and Iverson, 2006). That is, of the seven monophthongs in Middle Korean, four formed on-glides with /y/ and only two formed on-glides with /w/. Also, none formed off-glides with /w/ whereas all monophthongs except /i/ formed off-glides with /y/. The central unrounded high vowel /ɨ/ combined only with /y/, forming the off-glide diphthong / ɨy/(*/wɨ/, */yɨ/).

[9]Ahn and Iverson (2006), however, argue that /yɔ/ was marginal.

/ɨy/ lasted into the 20th century before it underwent monophthongization into /i/ or /ɨ/ in most environments.

During the Modern Korean period (from the 17th century to 19th century), the monophthongal and diphthongal system of Korean experienced more drastic changes. The low rounded vowel /ɔ/ had merged with /a/, and /ay/ and /əy/ monophthongized into /ɛ/and /e/, respectively, by the end of the 18th century. Consequently, the Middle Korean system with seven monophthongs (/i, ɨ, u, ə, o, a, ɔ/), seven on-glide (/wə, wa, yu, yə, yo, ya, yɔ[10]/) and six off-glide diphthongs (/ɨy, uy, əy, oy, ay, ɔy/) changed into a new system with eight monophthongs (/i, ɨ, u, e, ə, o, ɛ, a/), six on-glide diphthongs (/wə, wa, yu, yə, yo, ya/) and three offglide diphthongs (/ɨy, uy, oy/) as shown in (5).

(5) Diphthongal system in the 18th century Modern Korean (adapted from Ahn and Iverson, 2006)

a. On-glides (/y/(IPA [j])

*yi	*yɨ	**yu**
ye	**yə**	**yo**
yɛ	**ya**	

b. On-glides (/w/)

*wi	*wɨ	*wu
we	wə	*wo
wɛ	wa	

[10]It is widely established that /yɔ/ was marginal (Ahn and Iverson, 2006).

c. Off-glides (/y/ only)

	ɨy	(uy)
		(oy)

In the 19th century, the two off-glides /uy/ and /oy/ were monophthongized into /ü/ and /ö/, respectively. These typologically marked monophthongs, /ü/ and /ö/, however, soon became diphthongized into /wi/ and /we/, respectively, by the early 20th century.[11] Meanwhile, /ɨy/ began to be monophthongized to /i/or /ɨ/, depending on the dialect (Ahn and Cho 2003). By the end of 20th century, another change in the monophthongal system that impacted the diphthongal system has taken place: the merger of /e/ and /ɛ/. As a result of the merger of the front vowel /e/ and /ɛ/ into /e/ (Hong, 1988), wɛ and yɛ disappeared.

The resultant monophthongal and diphthongal system for the Contemporary Korean today is that there are seven monophthongs (/i, ɨ, u, e, ə, o, a/) along with nine diphthongs, four labial and five palatal (/wi, we, wə, wa; yu, yo, ye, yə,

[11]Ahn and Iverson (2006) term the developments of /uy/ > /ü/ > /wi/ and /oy/ > /ö/ > /we/ from the 18th to century to 20th century as a "phonological inversion". That is, off-glide diphthong in the 18th century became complex monophthong in the 19th century and then turned into on-glide diphthong in the 20th century.

ya and ɯi[12]/) as shown in (6). As seen in (6), all glides are on-glides where a glide precedes the following monophthong (C.S.Lee 1994, Martin 1992). All historical off-glide diphthongs have disappeared and do not exist in Contemporary Korean.

(6) Diphthongal system in Contemporary Korean today (adapted from Ahn and Iverson, 2006)

a. On-glides (/y/(IPA [j])

*yi	*yɨ	yu
ye	yə	yo
	ya	

b. On-glides (/w/)

wi	*wɨ	*wu
we	**wə**	*wo
	wa	

c. Onglides (/ɯ/)

ɯi		

d. Off-glides: None

The gaps in the chart in (6) show that not all glides can combine with all

[12] /ɯi/with a central unrounded onset, a remnant of histocial /ɨy/, is marginal in that it occurs in word-initial position for only some speakers (Ahn and Iverson, 2006).

monophthongs. /j/ cannot combine with /i/ and /w/ does not combine with /u/ and /o/. /ɨ/ combines with /i/ only. Ahn and Iverson (2006) argues that this is due to a rigorous constraint banning diphthongal configurations in which a glide cannot occur with a vowel sharing the same features; for example, the labial glide cannot occur with rounded vowels (e.g. */wo/, */wɔ/) and the palatal glide and labial glide cannot occur with the vowels sharing the same place of articulation (e.g. */yi/, */iy/, */wu/).

2.3 The speech community of Seoul, Korea

This section presents the sociolinguistic profiles of Seoul to provide a perspective on the community itself. The current status of the city and its historical changes in terms of demographic, economic and educational aspects will be discussed in order to take into consideration important societal changes that could have had an impact on how the /w/-deletion patterns have changed over time.

2.3.1 Sociolinguistic profile of Seoul

Seoul is the capital and largest metropolis of South Korea. Seoul is one of the leading global cities, ranking fourth in the world among major metropolitan areas in terms of the size of economy and first in technology readiness by PwC's Cities of Opportunity report in 2015. South Korea, an affluent, technologically advanced country with an impressive record of innovation today, however, was

one of the poorest countries in the world in 1950s, receiving foreign aid or official development assistance (ODA) from the Organization for Economic Cooperation and Development (OECD). What happened to this country and how has the city of Seoul evolved over the last century?

Seoul has been the capital of Korea since Joseon Dynasty was built in 1392. During the 500 years of the Joseon period, little contact with other countries was made. At the end of 19th century, however, Seoul eventually opened its gates to foreigners and began to modernize. Unfortunately, the dynasty could not control influences from outside very well and failed to protect itself against imperialism, which resulted the colonization by Japan from 1910 to 1945. At the end of the Second World War, Japan surrendered to Soviet and U.S. forces who occupied the northern and southern halves of Korea, respectively. This eventually led to the establishment of separate governments with conflicting ideologies, leading to the division of Korea into North Korea and South Korea in 1948.[13] This conflict of ideologies resulted in the Korean War that broke out on June 25, 1950, which continued until 1953. The Korean War ended in an armistice, and, since then on, North and South Korea has remained technically at war even till now.

[13]Since the liberation of Korea from Japanese colonial rule in 1945, North Korea has remained under the communist regime, while South Korea has been established as a democratic country.

Figure 2.1: Seoul in 1930

Although the whole country was left devastated by the Korean War, South Korea achieved extremely rapid economic growth and industrialization after the Korean War, ranking the 11th largest economy in the world today. South Korea's economic prosperity as measured in Gross Domestic Product (GDP) per capita rose from 158 USD in 1960 to 2,457 USD in 1985 and then to 27,539 USD in 2017. In the 1990s, Korea came to reverse its position from a recipient to a donor of official development assistance (ODA) from OECD. The Greater Seoul areas including the cities of Seoul and Incheon, as well as the whole Gyeonggi Province grew into the world's fourth largest metropolitan economy[14] today and have served as the business and financial hub of South Korea. Although it

[14] The Greater Seoul areas' GDP in 2014 was US $845.9 billion, the fourth largest economy in the world after Tokyo, New York City and Los Angeles.

accounts for only 0.6 percent of the nation's land area, the city generated 23 percent of the country's GDP overall in 2012.

Figure 2.2: Seoul in 2000s.

The population of Seoul as of 2017 is estimated at 9.9 million, housing about 20% of the total population of South Korea.[15] The population of Seoul is made up of approximately 97.3% Korean and 2.7% foreigners, which makes Seoul a very homogeneous society in terms of ethnicity. The composition of the population is more diverse with regard to regional dialects the inhabitants speak, however. According to the reports published by the Seoul Institute in 2004, *Seoul thobagi,* true Seoul natives whose parents were also born and raised in Seoul, accounts for

[15]The Greater Seoul areas sharing the same dialect of the Seoul dialect or Gyeonggi dialect houses over 25.6 million, which is almost half of all the residents in the country (UN World Urbanization Prospects).

less than 4.9% as of 2004. This is due to a great influx of people from all around the countries into Seoul in search of greater economic and educational opportunities after the Korean War. The population of Seoul has skyrocketed throughout the second half of the twentieth century (see Figure 2.3), from 1.4 million in 1948 to 11 million in 1992.[16]

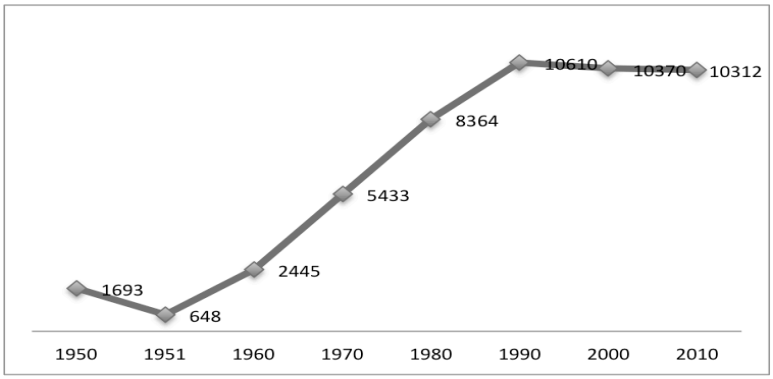

Figure 2.3: Change in the Population of Seoul (unit:K).

South Korea has one of the most highly educated and skilled workforces in the world and is constantly ranks among the top education systems in the world. South Korea ranked second globally on the OECD's Program for International Student Assessment, or PISA, measuring student performance in mathematics, reading, and science in 2014. The number of students in higher education had risen from 101,014 in 1960 to 647,505 in 1980 and to 3,383,293 in 2000.[17] Sixty-five

[16]The population of Seoul within the city limit has been decreasing since the early 1990s, largely due to the high costs of living in the city, resulting in 9.9 million in 2017.
[17]The statistics is from Korean Educational Development Institute (KEDI) and Korean National Statistical Office.

percent of Korean 25-34-year-olds have attained tertiary education. Seoul is home to the majority of South Korea's most prestigious universities. Among the 10 top universities in Korea, 7 are located in the Greater Seoul area, according to the annual U.S. News Best Global Universities ranking in 2017.

2.3.2 The Seoul dialect and its status

The Seoul dialect is another name for Gyeonggi dialect, a sub-type of the Central dialect and differs little linguistically from Gyeonggi dialect. The Seoul dialect or Gyeonggi dialect is recognized as the prestige variety. It is the basis of the standardized form used in South Korea. *Pyojun-eo* or the standard version of the Korean language is defined by the National Institute of the Korean Language as "the modern speech of Seoul widely used by the well-cultivated." It is noteworthy that the standard Korean is stipulated to be based on the Seoul dialect.

Few systematic studies have been carried out on what social prestige or meaning the features of the Seoul dialect bear, but any native speakers of Korean would acknowledge that the Seoul dialect tends to be associated with positive traits such as prestige, intelligence, etc., while some features of other regional dialects are stigmatized or become an object of ridicule. There is interesting anecdotal evidence showing the relative prestige of the Seoul dialect compared

to another regional dialect, Kyungsang dialect. One of the former presidents of South Korea, Kim Young-sam, during his office between 1993 and 1998, often became an object of ridicule when it comes to his pronunciation of words containing /w/. He is a native speaker of the South Kyungsang dialect with only a small number of *w*-diphthongs is reported to have existed. Even though he seemed to make tremendous efforts to adopt the pronunciation of Seoul Korean, he dropped /w/ quite frequently even in a public speech. For example, he once pronounced *kwankangtosi* 'the city of tourism' as *kankangtosi* 'the city of rape' in a public speech. People gossiped about it not only because he made a fatal error in pronouncing an important word in his public speech, but also because people thought that he dropped *w* much more frequently than what other educated men would do. Kang (1997) argues that President Kim's frequent dropping of /w/ contributed to the increased awareness of /w/-deletion at national level.

Chapter 3

A real-time trend study of /w/-deletion in Seoul Korean

3.1 Introduction

In Chapter 2, I provided a description of the linguistic variable under study and discussed the current status and historical development of the speech community of Seoul, Korea. In this chapter, I examine two paired changes in progress involving /w/ in Seoul Korean, postconsonantal and non-postconsonantal /w/-deletion, using the real time as well as apparent time data to account for the mechanism(s) that underlies the development of /w/-deletion in the speech community of Seoul, Korea.

I begin by reviewing previous studies on /w/-deletion in Seoul Korean (Section 3.2). In Section 3.3, the methodology of the study is described: Section 3.3.1 outlines the two most widely used methodology in studying language change: apparent and real time studies. In Section 3.3.2 and 3.3.3, I provide a detailed description of how I carried out the sociolinguistic fieldwork in Seoul, Korea, and how the data were coded and analyzed using statistical tests. Next,

the synchronic variation and diachronic change of postconsonantal/w/-deletion is documented in Section 3.4: I analyze the apparent time distribution of postconsonantal /w/-deletion (Section 3.4.1) and the real time changes observed between 1997 and 2017 (Section 3.4.2). I find that /w/-deletion in postconsonantal position has begun to retreat, beginning with the speakers born in 1970s. In Section 3.4.3, I investigate whether the effects of any of the constraints operating on /w/-deletion in postconsonantal position have changed over time and find that, surprisingly, the effect of preceding consonant that used to be the strongest constraint on postconsonantal /w/-deletion has significantly weakened. In the subsequent section (Section 3.5), the change and current status of /w/-deletion in non-postconsonantal position is analyzed and compared to the status of postconsonantal deletion. I find that non-postconsonantal /w/-deletion has been rising vigorously and that the effect of preceding phonology has weakened for non-postconsonantal deletion as well. Meanwhile, the effect of following vowel and speech style has grown stronger. Consequently, two paired changes involving /w/ in Seoul Korean, postconsonantal and non-postconsonantal /w/-deletion that used to show different patterns not only show similar deletion rates among the younger speakers but they also came to have the same set of the constraints in the same order of significance. In Section 3.6, I argue that the weakening of the original patterns and restructuring of /w/-deletion in Seoul Korean can be seen as the consequence of linguistic diffusion. I

discuss the relevant social and historical background of Seoul that created the right environment for the linguistic diffusion within a community (Section 3.6.1). In Section 3.6.2, I discuss how can we link the change at the community level to the inception of sound change in an individual's grammar, by discussing how these changes can be implemented at the individual speaker level.

3.2 Previous studies on /w/-deletion in Seoul Korean

Early on, Martin (1954:10) captures the essentials of the phenomenon of /w/-deletion as follows: "the phoneme /w/ freely drops after *p, ph, pp, m, wu([u]),* or *o*…in sloppy speech, /w/ disappears after other voiced sounds such as *l, n, ŋ*". H.K. Choi (1982) also observes that the deletion of *w* is one of the prominent features of Seoul Korean. Although the variable deletion of /w/ in Korean was observed from early on, the systematic nature of the deletion was noted in work in the variationist tradition.

Silva (1991), based on 17 participants' read speech, shows that postconsonantal /w/-deletion in Korean is conditioned by various linguistic and extralinguistic constraints as shown in the GoldVarb output in Table 1.[18] The strongest conditioning factor on postconsonantal /w/-deletion Silva found was place of articulation for the preceding consonant: deletion is significantly favored

[18]In the output from GoldVarb analysis, each factor influencing the dependent variable is given a weight indicating the relative strength of each factor group on /w/-deletion. Factors with a weight above 0.5 favor the application of the rule, those with a weight below 0.5 disfavor the rule, and factors with the value 0.5 had no effect on the rule (Tagliamonte, 2006).

after a nondorsal consonant, while it is sharply inhibited after a dorsal consonant. The second most significant constraint was speech style. Silva elicited four different speech styles in reading which forms a continuum in which the formality decreases: minimal pairs, word lists, sentences and running text. He found that the glide deletion is less likely to occur in more formal speech styles than in informal styles. The third most significant constraint Silva (1991) found was manner feature of the preceding consonant. He found that a preceding aspirated stop favors deletion while a preceding fortis (or reinforced)[19] consonant inhibits deletion. The fourth most significant factor was speaker's father's occupational prestige. Speakers whose fathers had more prestigious occupations were less likely to delete /w/. Following vowel was the fifth most significant factor: front vowels tend to promote deletion, whereas less deletion occurs when /w/ is followed by a nonfront vowel. Speaker sex also had a small but significant effect. His female informants were less likely to delete the labiovelar glide than male informants.

[19]Reinforced and fortis stops are used interchangeably and both refer to one of the three stop categories with the shortest Voice Onset Time (VOT) values.

Factor groups	Factors	Weight	% Applications	Total *N*
1. Preceding C—place	dorsal	0.274	23	744
	nondorsal	0.678	63	970
2. Speech style	minimal pairs	0.093	13	136
	word list	0.358	34	782
	sentences/text	0.650	49	1234
3. Preceding C—manner	reinforced	0.294	19	104
	lax	0.486	29	657
	aspirated	0.716	48	137
4. Father's occupational prestige	higher	0.434	36	1261
	lower	0.592	49	891
5. Following vowel	nonfront	0.437	35	1109
	front	0.567	48	1043
6. Gender	female	0.452	38	1160
	male	0.556	46	992

[a]Number of cells = 136; fit: χ^2 (128) = 287.485; $p < .0001$; log likelihood = −1086.199.
[b]Input probability = 0.304.

Table 3.1: GoldVarb probabilities for the factors for /w/-deletion. From Silva (1991).[20]

Silva paid a special attention to the fact that place of articulation of a preceding consonant strongly conditions postconsonantal /w/-deletion, emphasizing the nature of /w/-deletion as an articulation of the CwV sequence with reduction of the number of gestures performed by the body of the tongue. He argues that, when a nondorsal (labial or coronal) segment precedes /w/, speakers are more likely to delete /w/ in the CwV sequence because the deletion of /w/ in this context has advantages in articulatory economy: the tongue body needs to retract and re-front. By contrast, when a dorsal segment precedes /w/, speakers are less likely to delete /w/ because the tongue needs to be retracted

[20]The factor groups are listed in the order of significance.

for the preceding [+back] segment and then fronted for the following vowel anyway, with no advantage to deleting the glide. As such, Silva focused on the articulatory motivation of /w/-deletion.

A subsequent study on /w/-deletion provided more intricate details of the phenomena. Kang (1997), based on the naturalistic as well as read speech from the sociolinguistic interviews with 56 speakers, examined the change of /w/-deletion both in postconsonantal and non-postconsonantal position and showed that /w/-deletion is systematically conditioned by a number of linguistic and social factors as shown in Table 3.2 and 3.3. As in Silva's (1991), place of the preceding segment was found to be the strongest conditioning factor on postconsonantal /w/-deletion. He categorized place of preceding consonant into five levels (bilabial, alveolar, palatal, velar and glottal) and showed that a preceding bilabial highly favored deletion while all others disfavored deletion.

Factor groups	Factors	Weight	% Applications	Total N
*Preceding C (place)	bilabial	0.955	81	886
	alveolar	0.454	23	1860
	palatal	0.298	11	836
	velar	0.354	16	1774
	glottal	0.346	12	894
*Preceding C (manner)	lax	0.509	30	2718
	aspirated	0.475	14	600
	reinforced	0.488	19	810
*Following vowel	[-bk]	0.531	22	3205
	[+bk]	0.468	31	3045
*Syllable position	initial	0.421	24	3721
	noninitial	0.615	29	2529
Morph. boundary	zero	0.504	25	5661
	present	0.459	38	589
*Presence of coda	zero	0.522	26	4049
	present	0.459	27	2201
*Speech Style	ingroup	0.667	39	850
	interview	0.631	30	1421
	sentence R	0.427	22	2230
	word R	0.402	21	1749
*Gender	male	0.476	24	3188
	female	0.525	28	3062
*Social Status	upper	0.414	22	2103
	middle	0.498	25	2087
	lower	0.590	32	2060
*Age	16-25	0.545	30	2111
	26-45	0.524	27	2099
	46+	0.429	21	2040

number of cells: 2585 total chi-square = 3004.0572
chi-square/cell = 1.1621 loglikelihood = – 2654.210 Input = 0.235
overall deletion rate = 26.1%

Table 3.2: GoldVarb probabilities for the factors conditioning postconsonantal /w/-deletion. From Kang (1997).[21]

[21]The order of predictors is not in the order of statistical significance.

The second most significant factor was speech style as in Silva's: speakers delete /w/ significantly more in the interview setting than in the reading task. The deletion was clearly favored in a more informal speech style. The third significant constraint which Silva (1991) did not examine was the prosodic position where /w/ occurs. /w/ was less likely to be deleted when it was in the domain-initial syllable , while deletion was more likely when it was in non-initial position. The fourth significant factor Kang found was social status of the speaker: the lower the social class of the speakers, the more deletion of /w/. The fifth significant constraint was manner of the preceding stops: lax (lenis) segments favor deletion, while aspirated and reinforced (fortis) segments disfavor deletion of /w/. Age was the sixth significant factor selected to be significant: the younger generation was more likely to delete /w/ than the older generation. The following vowel was the seventh most significant constraint. There was more deletion when a front vowel follows /w/ and less deletion when a nonfront vowel does. Lastly, speaker gender was significant: female speakers were more likely to delete compared to their male counterparts.

Kang (1997) also noted that /w/ can be deleted even when there was no preceding consonant and examined the status of /w/-deletion in non-postconsonantal position. Although the rate of deletion was less than 10 percent in all age groups, he found that there was a significant increase in deletion rates:

3% for the speakers older than 45, 4% for the speakers aged 26-45 and 7% for the youngest speakers aged 16-25. For non-postconsonantal /w/- deletion,

Factor groups	Factors	Weight	% Applications	Total N
Following vowel	[-bk]	0.504	4	657
	[+bk]	0.497	5	1095
*Syllable position	initial	0.303	1	1090
	noninitial	0.797	10	662
Presence of coda	zero	0.520	5	861
	present	0.480	4	891
*Preceding vowel	[+rnd]	0.738	19	200
	[-rnd]	0.389	6	462
Speech Style	in-group	0.578	5	277
	interview	0.549	5	465
	sentence R	0.477	4	501
	word R	0.436	5	509
Gender	male	0.524	5	869
	female	0.476	4	883
*Social Status	upper	0.385	3	584
	middle	0.501	4	585
	lower	0.614	7	583
*Age	16-25	0.608	7	601
	26-45	0.486	4	553
	46+	0.404	3	598

number of cells: 523 total chi-square = 516.0708
chi-square/cell = 0.9868 loglikelihood = – 272.459 Input = 0.022
overall deletion rate = 4.7%

Table 3.3: GoldVarb probabilities for the factors conditioning non-postconsonantal /w/-deletion. From Kang (1997).[22]

[22]The order of predictors is not in the order of statistical significance here either.

prosodic position (non-initial position favoring the deletion), preceding vowel (rounded vowel favoring deletion), social class (lower class favoring deletion), and speaker sex (women favoring deletion) were found to be significant conditioning factors.

Like Silva (1991), Kang (1997) paid a special attention to the strong conditioning of preceding phonology on postconsonantal /w/-deletion. Rather than the articulatory motivation Silva (1991) highlighted, Kang (1997) underscored the perceptual motivation for /w/-deletion. When /w/ is preceded by a labial consonant, the acoustic cues for /w/ is obscured because both a labial consonant and /w/ provide the same acoustic cue: the lip rounding. It is therefore difficult for listeners to parse the cue for /w/. In contrast, when a nonlabial consonant precedes /w/, listeners do not have such difficulties. This acoustic ambiguity between the 'labial consonant+w+V' sequence and the 'labial consonant+V' sequence results in perceptual confusion for listeners. This consequently leads them to attribute the acoustic cue of /w/ to the preceding labial consonant. In this light, Kang (ibid.) argues that /w/-deletion is one instance of "sound changes by listeners" as proposed by Ohala (1981:187) where listeners fail to recognize the phonetic environment causing perturbations on a neighboring segment and misinterpret the sequence of sounds.

Even though Silva (1991) viewed /w/-deletion as a process to reduce the articulatory efforts and Kang (1997) accounted for the deletion as a perceptually

motivated sound change, both Silva (1991) and Kang (1997) concluded that preceding segment phonology was overwhelmingly the most influential factor on the deletion of /w/ in Seoul Korean.

In a later study on /w/-deletion by Lee (2004), however, she analyzed the speech of six young native speakers of Korean aged between 20 and 35 and showed that following vowel and prosodic position exert a stronger influence on /w/-deletion compared to preceding segment phonology. The results replicate previous findings that deletion is promoted after a bilabial and before a front vowel in a non-initial position but her findings differed from those from the previous studies in that the effect of preceding consonant was not stronger than that of following vowel or prosodic position.

3.3 Methodology

3.3.1 Investigating the change at the community level: apparent-time and real-time trend studies

In studying language change in progress at the community level, two different methods have provided the primary sources: the apparent time and the real time study.

The use of apparent-time differences allows linguists to infer the progress of linguistic changes using the synchronic data. It was introduced by William Labov in his early studies of Martha's Vineyard (1963) and New York City (1966)

and has been the most widely used analytic construct in quantitative sociolinguistics for over 50 years[23]. An underlying premise of the apparent time construct is that an individual's language largely remains stable over the course of lifespan after the critical period of language acquisition. It follows that an individual's language largely reflects the state of the language they acquired in their childhood. With this premise, the speech of different age groups are compared at the same point in time to make inferences about language change. When each age cohort registers an increasing use of the variant, the differences among successive generations of the speech community are considered to reflect the diachronic developments in the language at the community level (the apparent-time interpretation, Labov 1963; 1972).

Although the apparent-time construct is a very useful analytical tool for exploring language change in progress, the real-time trend study is considered the most reliable method in studying language change at the community level (Trudgill, 1988; Labov, 1994; Sankoff and Blondeau, 2007).[24] In contrast to the synchronic nature of the apparent-time method, the real-time construct tracks

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[23]An earlier use of the apparent time approach can be found in Gauchat (1905) that studied phonological change in the Swiss village of Charmey. However, it was Labov's groundbreaking works in Martha's Vineyard and New York City in 1960s that led to the widespread use of apparent time method in sociolinguistic research.

[24]Another subtype of real time study is panel study which tracks the language change at the individual level. In real time panel study, the same individuals are followed across time to elucidate the relationship bewteen the development of the grammars of individual speakers an the language change of the speech community as a whole (e.g. Baugh 1995, Cukor-Avila 2002, Hernandez-Campoy 2003, Nahkola & Saanilahti 2004).

language change in progress using the longitudinal data. In real time trend study, follow-up studies return to a community that was surveyed previously and resample the same age range of speakers, using the same sampling criteria of the previous study they are making a comparison with (Bailey 2002, Sankoff 2006). This allows for comparisons of the speakers of the same age range of the same community at two different points in time. Although the real time trend study has been relatively rare compared to the widespread use of the apparent time studies,[25] interest in longitudinal sociolinguistic research has grown considerably over the past decade (Sankoff, 2013).

The evidence from the real time study lends valuable insights into language change that corroborate or enrich apparent-time interpretations. Fowler's (1986) replication of Labov's department store survey of /r/, for example, not only supports Labov's hypothesis that there is a change in progress toward a new prestige norm of constricted /r/ in New York City, but the new data provide a more refined explanation of the change by demonstrating that the change is progressing more slowly than before and that the age-grading effect come into play with the change. The real time panel study of 60 Montreal speakers by

[25]However, the speech communities that have been investigated through the real time trend study include New York City (Fowler, 1986), Panama City, Panama (Cedergren, 1987), Norwich, England (Trudgill, 1988), Tsuoraka, Japan (see Chambers, 1995:194–198), Montreal, Canada (Blondeau, 2001; Sankoff and Blondeau 2007, Sankoff, Blondeau and Charity, 2001), Martha's Vineyard, US (Blake and Josey, 2003; Pope, Meyerhoff and Ladd, 2007), and different regions in Finland (Nahkola & Saanilahti 2004, Nordberg 1975, Nordberg & Sundgren 1998, Paunenen 1996, Kurki, 2004).

Wagner and Sankoff (2011) also reveals a more nuanced picture of the change of the rise of the periphrastic future at the expense of the inflected future by showing two-thirds of their speakers exhibit an age-grading effect in a retrograde direction. In a real-time study of Virrat, a small rural town in southern Finland, Nahkola and Saanilahti (2004) compared the speech of 46 informants in 1986 and 24 out of the total 30 panel speakers in 1996 including 10 additional youngest speakers in terms of the use of 14 different variables. While the panel sample in 1996 exhibited the pattern predicted by the 1986 corpus for 10 out of 14 variables, the apparent time prediction failed for the other four variables: the changes have reversed its direction of the change. The evidence from trend studies, especially in such cases involving an unexpected reversal of the change or the reinterpretation of the data from an earlier study, are crucial for accounting for presenting a more accurate picture of the diachronic change (Cukor-Avila and Bailey, 2007; Johnson, 1996).

In this study, I draw on both the apparent and real-time trend method to investigate the synchronic variation as well as diachronic change of the /w/-deletion in Seoul Korean. I analyze the synchronic data collected in 2017 and use this apparent-time evidence to infer a change of /w/-deletion at the community level. Then I compare the 2017 corpus data with the data from Kang (1997) to examine whether the real-time comparison corroborates the apparent-time interpretation inferred based on the 2017 data. We will see that, as Boberg (2004)

emphasized, an accurate view of language change emerges only when both synchronic and diachronic data are considered.

3.3.2 Sociolinguistic fieldwork

3.3.2.1 Sampling the speech community

There were two important considerations in sampling the speech community of Seoul for the current project. First of all, special attention was paid to select a sample of speakers representative of the population of Seoul. In order to draw a robust generalization about the entire population from the results obtained from the sample, it is important to achieve the sample representing the target population. Following most sociolinguistic studies as well as for a comparison with Kang (1997), an initial study to make comparison with, the sample was stratified by traditional social characteristics such as age, sex, social class and education and I tried to have a balanced number of informants in each social categories.

Also, it was crucial to construct matched samples with those of Kang (1997) because the data from the current corpus are to be compared with the results from Kang (1997). Therefore, efforts were made to include speakers whose social characteristics are comparable with those of Kang (1997).

In order to satisfy the above criteria, I relied on both random and judgment sampling[26] in recruiting native speakers of Seoul Korean who were born and raised in Seoul or arrived before five and lived in Seoul till the age of 18 without relocating to another region for more than six months. To ensure representativeness of the sample, an unbiased random selection of individuals is crucial. Relying purely on random sampling, however, is not always the best way to sample population in sociolinguistic research because a very large number of samples are generally needed to ensure the complete unskewedness in the sample. It is realistically infeasible to analyze the data from the number of samples that measure up to the statistical standards required. Also, the true random sampling was somewhat difficult due to people's relunctance to have a long conversation with a stranger in Korea.[27] For this reason, judgment sampling was used along with random sampling.

In the initial stage of the fieldwork, I used the network procedure (Horvath, 1985), in which speakers are selected within the fieldworkers' network. Because I already knew social characteristics of the interviewees, this corresponded to the

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[26]Under random sampling, each individual is chosen entirely by chance, while judgment sampling is a method in which the investigator identifies the social characteristics of the speakers to be studied and then recruit speakers who fill preselected social categories (e.g., working-class, female speakers in the 41-65 age group).

[27] Hibiya (1987) also made minor adjustments when carrying out a sociolinguistic fieldwork in suburban Tokyo. She also found it to difficult to recruit informants only based on random sampling because Japanese people tend to avoid speaking to strangers. Thus, she relied on key speakers who could introduce her to other people in the community.

judgment sampling. I also asked those who I interviewed to introduce someone within their networks ("friend of a friend" technique) (Milroy, 1987). Through this technique, I often met the speaker without knowing any social characteristics of the speaker, which corresponded to the random sampling. At times, however, I asked the informants to introduce someone who belongs to a specific social category such as a male speaker in his early 20s who did not go on to college[28], which corresponded to judgment sampling.

When some parts of the target population are not included in the sample population, one can face with selection bias or undercoverage, which prevents the sample from being representative of the target population. To avoid this, I relied on various other means to make sure that no demographic group is underrepresented in the sample. In order to fill certain social categories whose members were hard to locate, I visited institutions or neighborhoods where I could easily meet such groups of speakers. To interview lower class elderly speakers, I visited a nursing home in *Chungwoon-dong* in Seoul and interviewed two female Seoul natives in their 80s. To recruit middle-aged female speakers, I asked for help from the owner of a Henna Café where many middle-aged women dye their hair with Henna, natural hair dyes. Unlike fancy and spacious hair salons in which loud music is played and the hair stylists greet you in polite and formal languages, Henna Café is a very cozy place with no background

[28] Since more than 70% of the population attend college as of 2010 in Korea, it is very likely youngsters who do not go on to college belong to a lower social class.

music and is usually run by a middle-aged woman who uses very friendly and casual languages. Henna Café was ideal for the recording of sociolinguistic interviews, because ladies need to wait for at least two hours to dye their hair and many of the ladies were willing to chat with me and get paid while they were waiting. To recruit younger lower social class speakers, I contacted the nun who works for *Kooryongmaeul* 'Kooryong village', the very poor neighborhood in the middle of the affluent southeasten part of Seoul. I volunteered to teach English to high school students in the neighborhood and I was able to interview three young speakers from the neighborhood.

Social class	Working Class		Middle Class		Upper Class		Total
Age	M	F	M	F	M	F	
16-25	3	3	2	4	2	2	16
26-45	2	3	3	5	2	2	17
46+	2	5	2	2	2	2	15
Total	18		18		12		48

Table 3.4: Structure of the 2017 corpus by age, sex and social class.[29]

The final sample for this study consists of 48 Koreans, born in Seoul or arrived before the age of five and lived in Seoul till the age of 18 without

[29] I basically followed Kang's (1997) breakdown of age groups because one of the primary aims of this study is to assess the real-time change by comparing the same age groups at two different points in time.

relocating to another region for more than six months. Table 3.4 represents the social structure of the sample. The informants ranged in age from 15 to 87 years (1930 to 2002 of speaker YOB) and were stratified by age, sex and social class (see Appendix A for the full demographic information of the participants).

3.3.2.2 Sociolinguistic interview

For data collection, I mainly relied on sociolinguistic interviews, the classic method of sociolinguistic research of the one-on-one recorded conversational interview, which is followed by a reading task desinged to elicit more formal speech for comparions (Labov 1972a, 1984; Wolfram and Fasold, 1974).[30] The primary goal of sociolinguistic interview is to obtain large quantities of casual and naturalistic speech or "vernacular". The questions asked during the interview are designed to steer speaker's attention away from their speech itself toward the topics of interest to interviewees. An interview is considered successful when the participants forget they are being recorded and produce truly vernacular speech.

There are two types of sociolinguistic interviews (Feagin, 2013). The traditional interview type modeled on Labov's early works employs a set of questions to elicit naturalistic speech of speakers. In this type of interview, the

[30] Most interviews were one-on-one interviews, but I had group interviews with several informants when they wanted to have an interview in pair or in group. Group interviews are variations on the one-on-one sociolinguistic interview approach and was used in Labov's work with Harlem street gangs (Labov et al., 1969).

protocols appropriate for the interviews are designed beforehand for structured interviews. Another type of sociolinguistic interview is to simply let the conversation flow (Briggs, 1986; Hazen, 2000). This more open-ended type of interview has advantages of making interviewees feel more comfortable by reducing the distance between the researcher and the informants. Without protocols prepared, however, the interview may go astray. For the fieldwork in Seoul for the current dissertation research, I combined both interview types depending on the characteristics of each informant. For those that are talkative or easily get animated when telling their own life stories, I tried not to interrupt with the prepared protocols and let them continue to elaborate on what they wish to talk about. For those who remained self-conscious throughout the interview and were not willing to share their narratives, I tried to elicit as much casual speech as possible from them with the prepared protocols.

I told people that I am a graduate student studying how the lives of people in Seoul have changed over time. I was careful to dress suitably according to the social characteristics of each informant. For example, when interviewing older people, I dressed to look neat and tidy, which helps me show respect to the elders. I wore something casual when interviewing teenagers to show friendliness and solidarity with the younger group. I often took some beverages or chocolates to the interview, which helped make informants feel more comfortable.

I usually began the interview by asking them about themselves - year and place of birth, parents' birthplace, places they lived in the past, etc. and then moved on to the topics of general interest. I usually asked them about their hobbies, family, friends, school, from which I obtained many clues about what the participants are particularly interested in or excited about, so I was able to use additional questions that can evoke their animated narratives.[31]

I undertook meticulous planning to make speakers feel comfortable in order to elicit the maximally naturalistic speech of the participants. Throughout the interviews, I tried to give interviewees plenty of space to elaborate on topics of interest, not interrupting the flow of the speaker's speech. But I tried to respond to their story by nodding, backchanelling or, sometimes, agreeing verbally and sharing my own story too. When there was some awkward silence, I often changed the topic that would lighten the atmosphere, such as, family or hobby, etc. Most of the interviewees seemed to feel more comfortable and tend to speak more at length as the interview progressed.[32]

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[31]It has been long established in variationist sociolinguistics that narratives are prime sites for obtaining natural, vernacular speech (Schilling-Este, 2013).

[32]When I noticed the informants felt more comfortable telling their stories and switched to a more casual style of speech than the beginning of the interview, I tried to obtain some information about their socioeconomic status, naturally eliciting speaker's (or their parents' or spouse's) schooling, occupation, social networks (who they interact with the most), etc.

After the conversational interview, the informants participated in the reading tasks, where they read aloud the list of sentences and words including /w/. When informants misread the tokens, they were asked to reread the sentence.

The sociolinguistic interview was followed by a brief debriefing session. I elaborated on the purpose of the study and told them their data will be used for research purposes only and securely stored. The informants signed an Informed Consent Form, indicating their understanding of the purpose of the study and recording, and their permission for their recording to be used for the research. They were paid for their time.[33] In saving their speech data, pseudonyms were used for the protection of identities of speakers.

3.3.3 Data analysis

3.3.3.1 Coding the dependent variable

The coding was performed based on the auditory and acoustic analyses by three phonetically-trained coders: one main coder, the author, who coded all the tokens and two other coders who coded 800 different tokens each. For each speaker, the dependent variable was coded as either "*w*-present (1)", or "w-deleted (0)" beginning about ten minutes into the interview and continuing to code each /w/ that occurred. The coders listened to the sound files, and when it

[33]Many older people refused to be paid. In Korea, it is often considered rude for a younger person to provide an older person with monetary compensation. I brought some cookies or a cake as a gift when interviewing older people in case they refuse to be paid.

was straightforward to identify /w/ with an auditory signal the token was coded as "*w*-present" without spectrographic examination. When /w/ is not clearly heard, however, the spectrogram of the token was examined to double check whether we can identify any partial acoustic correlates in the spectrogram. Because /w/ is known to lower F2 and F3 of adjacent vowels (Lieberman, Delattre, Gerstman and Cooper, 1956; Kent and Read, 1992), a slight lowering of F2 and F3 at the onset of the following vowel was used to judge the acoustic presence of /w/. There were some indistinct tokens, however. Tokens with very weak auditory and acoustic signals, especially in very fast speech, were heard as ambiguous. These cases were resolved by relistening to the tokens with other coders and closely examining the spectrogram. The tokens that still remain indistinct (6% of the entire tokens) were coded as ambiguous and excluded from the analysis.[34] The final dataset includes 5497 tokens of the words containing /w/ from 48 native Seoul Koreans.

3.3.3.2 Modeling and significance testing

To test the significance of the potential predictors, generalized mixed-effects regression models were used. Models were fit to the 2017 apparent-time sample, using the *lmer* function from the lme4.0 package (Bates, Maechler, Bolker, Walker, Christensen, Singamann, Dai and Grothendieck, 2015) in R (R Development Core

[34] Exclusion of these ambiguous tokens prevents us from the analysis of fuller understanding of the phenomena. Chapter 4 of this thesis addresses this issue.

Team, 2015), with SPEAKER and WORD as potential random effects. All fixed-effect predictors were analyzed using sum-contrast, by which the mean of each level is compared with the grand mean of the dependent variable.[35]

Model selection was primarily guided by log likelihood tests but reference was made to Akaike Information Criterion (Akaike, 1974) and Bayesian Information Criterion (Schwarz, 1978) values as well. The models that provided the best fit to the data are reported. Significance levels or p-values were calculated based on Satterthwaite's (1946) approximations for the degrees of freedom using the lmerTest package (Kuznetsova, Brockhoff, & Christensen, 2013).

3.3.3.3 Predictors

In this subsection, I justify the selection of the linguistic and extralinguistic predictors included in the mixed-effects logistic models. In selecting possible constraints of /w/-deletion, I was guided by earlier research on /w/-deletion (e.g. Silva, 1991; Kang, 1997; Lee, 2002), but I excluded some predictors that failed to reach statistical significance repeatedly in the preliminary analyses. Below are

[35] Contrast (or deviation) coding differs from treatment or (dummy) coding, an alternative used as a default in regression modeling in R, by which the effect of each level of a predictor is contrasted against an arbitrary reference level. For different coding schemes for categorical variables in R, see UCLA Statistical Consulting Group (2011)(https://stats.idre.ucla.edu/r/library/r-library-contrast-coding-systems-for-categorical-variables/).

the descriptions of the final set of linguistic and extralinguistic predictors that each token was coded for.

3.3.3.3.1 Linguistic predictors

Preceding articulation: For postconsonantal /w/-deletion, preceding articulation was coded as bilabial (e.g. *mwe* 'what'), alveolar(e.g. *swip.ta* 'easy'), palatal (e.g. *chal.yeng* 'photo shooting'), velar (e.g. *sa.kwa* 'apple') or glottal (e.g. *ceng.hwak* 'accurate'), following Kang (1997). For non-postconsonantal /w/-deletion, preceding articulation was coded as rounded vowel, unrounded vowel or pause.

Following vowel: There are four possible vowels that follow /w/ in Korean: *i*, *e*, *ə*, *a*. Following vowel was initially coded as these four levels, but later collapsed into two levels (front (*i*,*e*) vs. nonfront (*ə*, *a*)) because the preliminary analyses of the data revealed that the model with the collapse did not differ significantly in log likelihood from the model without the collapse.[36]

Prosodic position: In Korean, elements at the beginning of the prosodic domains tend to be strengthened or lengthened, thus it resists lenition or deletion (Cho and Keating, 2001; Cho, 2005). As a result, a number of historical sound changes in Korean were affected by whether the segment occurs in the initial position of these domains or not. For example, the raising of /o/ to /u/ that initiated as

[36]This indicates that the collapsed predictor did not worsen the fit of the model significantly.

early as the 16th century occurred mainly in a non-initial position of the word (Chae, 1995). Another example is the now lost vowel ʌ that turned into *a* in a word-initial position and to ɨ in a non-initial position (Choi, 1991). Similarly, it has been reported that /w/ in a word-initial position is far less likely to be deleted than that in a non-initial position (Kang, 1997; Lee, 2004). In order to examine whether this effect is replicated in the current dataset, each token was coded as to whether /w/ occurs in a word-initial or non-initial position.

3.3.3.3.2 Extralinguistic predictors

Speaker age: Following the established practice in sociolinguistic research, speaker age was coded as the year of birth (YOB), as a proxy for tracking the progress of the change (see Bailey, 2008). YOB was centered by subtracting the mean of YOB from each speaker's YOB.[37] In order to examine potential nonlinear effects of speaker's YOB, I included the quadratic term for YOB by computed orthogonal polynomials using the *poly ()* function in R.

[37] Centering a predictor on the mean decreases multicollinearity between a multiplicative term (interaction or polynomial term) and its corresponding main effects.

SEC	Occupational characteristics	Educational characteristics	Percentage
Upper	higher government or business officials, professionals	college graduation or higher	4.9%
Middle	semi-professionals small businessmen white collar workers	college, junior college or highschool	39.3%
Lower	blue collar workers peddlers, laborers lowest employees of service industry	high school, middle school or lower	55.7%

Table 3.5: Social class stratification of the Seoul population in Kang (1997).

Social class: Although social class is the primary social variable in sociolinguistics (Chambers, 1995:66), it is not an easy task to stratify social class in contemporary society. Generally, more than one indicators are used in sociolinguistic studies to determine the socioeconomic standing of speakers. Labov (1966) assessed an informant's social class based on the composite index of his/her occupation, education and income, and divided the informants into five different social class groups. Trudgill (1974) used as many as six indicators of social class - occupation, income, education, housing, locality, and the father's occupation. Since the comparison with Kang's (1997) results is crucial for the current study, I mainly followed Kang's practice of classifying speakers into three different social class groups in terms of an occupational and educational scale (see Table 3.5 for Kang's (1997) classification of speakers in terms of social

class). Following Wagner and Sankoff (2011), those not in the labor force were classified according to the occupation of the head of household and those who retired from their work were classified according to their previous occupational level. In the case of the young students, their parents' occupation and their aspiration for higher education and occupation was reflected to determine their social class.

Speech style: Speech style was coded as conversational or read speech.

Speaker gender: Gender of the speaker was coded as male or female.

3.3.3.3.3 Interactions

I also included the following explanatory interaction terms that proved significant repeatedly in the preliminary analyses:

Preceding articulation by speaker birthyear (YOB): This interaction term tests the prediction that the effect of preceding segment has changed over time.

Following vowel by speaker birthyear(YOB): This interaction term tests the possibility that the effect of following vowel has changed over time.

Style by speaker birthyear(YOB): This interaction term tests the possibility that the effect of speech style has changed over time.

Table 3.6 lists all potential predictors and their interaction terms along with their levels included in the analysis.

	Predictor	Postconsonantal /w/-deletion	Non-postconsonantal /w/-deletion
External	*YOB (Year of Birth)*	year of birth (continuous)	
	CLASS (Social class)	working, middle, upper	
	STYLE (Speech style)	conversational, read	
	SEX (Speaker sex)	male, female	
Internal	*PROSODIC* POSITION	initial, non-initial	
	FOLVOWEL(Following Vowel)	front, non-front	
	PRESEG (Preceding Articulation)	bilabial, alveolar, palatal, velar, glottal	rounded vowel, unrounded vowel, pause

Table 3.6: Summary of the potential fixed-effects predictors and their levels.

3.4 Postconsonantal /w/-deletion in Seoul Korean

This section shows how the patterns of postconsonantal /w/-deletion in Seoul Korean changed over time and whether there is any change in the effects of conditioning factors. In Section 3.4.1, I analyze the synchronic corpus data from 2017 and use the apparent-time evidence to infer a generational change. When older and younger speakers in the 2017 dataset are compared, I find that /w/-deletion is retreating with the younger generations trending towards less deletion. In Section 3.4.2, I compare the 2017 data with the data from Kang (1997) and examine whether the apparent-time inference based on the 2017 data is

confirmed by the real-time comparison. In Section 3.4.3, I investigate the effects of various linguistic and extralinguistic factors on /w/-deletion as well as their interaction terms with speaker birthyear to see if there has been any change in the effects of these factors. The results indicate that /w/-deletion is not merely retreating but being reanalyzed as a general deletion rule, while the strong phonological conditioning of preceding segment weakens.

3.4.1 Apparent-time evidence: A retreat of the /w/-deletion?

Let us first inspect the 2017 dataset by speaker YOB to see what they tell us about the synchronic variation of /w/-deletion in Seoul Korean according to speaker age. Figure 3.1 illustrates /w/-deletion rates by speaker YOB in two different speech styles (conversational and read speech). In conversational speech, the deletion rate appears to increase over time between the years of 1930 and 1970, but starting around 1970, the trend reversed its direction.[38] The same pattern of the rise and decline of /w/-deletion is in evidence in read speech as well.

[38] The decrease in /w/-deletion rate in the speech of people born after 1970, however, is surprising given Kang's (1997) finding that /w/- deletion advanced toward more deletion some 20 years ago. However, it is not hard to find cases where the direction of sound changes reverses in the development of change. For example, Labov et al. (2013) demonstrated that the fronting of /aw/ and /ow/ in Philadelphia began to retreat sometime in the 1950s and has trended toward backing since then. Zellou and Tamminga (2014) showed that the degree of nasal coarticulation in Philadelphia English increased between 1950 and 1965, but starting around 1965, the degree of coarticulatory vowel nasality was found to decrease. But again around 1980, the degree of nasality increased again sharply. Strassel and Boberg (1996) found that short-a tensing in Cincinnati retreated in spite of the general trend toward tense short-a in the nation as a

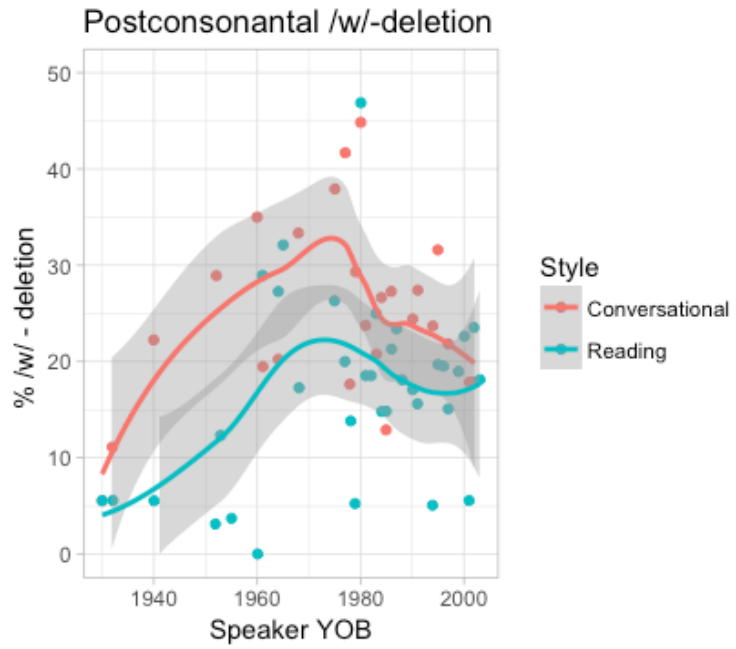

Figure 3.1: Mean /w/-deletion rate by speaker YOB in two different speech styles, fit with a loess curve.

3.4.2 Real-time evidence: Perhaps the reversal of the change

Let us now turn to the real-time construct and compare /w/-deletion rates found in the 2017 dataset with those from Kang (1997).

Age	1997	2017	Sig. of the change
15-25	.39	.23	t(550)=8.886, p<0.001**
26-45	.33	.28	t(347)=2.004, p=0.046*
46+	.29	.27	t(432)=0.597, p=0.551

Table 3.7: /w/-deletion rates in 1997 and 2017 in conversational speech.[39]

whole. Therefore, we may, at this point, conclude that the innovation in /w/- deletion can be regarded one of those changes whose direction has been reversed.

[39]The significance of the change was tested using one-sample t-tests.

Table 3.7 displays /w/-deletion rates in 1997 and 2017 in conversational speech. In conversational speech, speakers age 45 and under show a significant decrease in /w/-deletion rates in 2017, compared to deletion rates in 1997: for the speakers age 15 to 25, the mean deletion rates dropped by sixteen percentage points (39% in 1997 and 23% in 2017); for the speakers age between 26 and 45, the mean deletion rates dropped by five percentage points (33% in 1997 and 28% in 2017). For the group of older speakers age 46 and above, however, there was no significant change between the 1997 and 2017 sample.

Age	1997	2017	Sig. of the change
15-25	25	19	$t(941)=5.066, p<0.001$
26-45	24	20	$t(904)=3.367, p<0.001$
46+	17	17	$t(616)=-0.118, p=0.906$

Table 3.8: /w/-deletion rate in 1997 and 2017 in the read speech.

Table 3.8 presents /w/-deletion rates in 1997 and 2017 in read speech. There is a significant decrease in the deletion rates for speakers age 45 and under in read speech as well: for the speakers age 15 to 25, the mean deletion rates dropped by nine percentage points; for speakers age 26 to 45, the mean deletion

rates decreased by four percentage points. For the speakers age 46 and above, however, there was no significant change in the deletion rate over the 20 years.

These trend comparisons, representing a real-time reassessment of the community after a 20-year interval, reveal a significant decline of /w/-deletion among speakers age 45 and under. This observed change appears to represent a nontrivial generational change in the community and, this corroborates the apparent-time pattern that younger speakers have been deleting /w/ less beginning with those born after 1970.

3.4.3 The constraints governing /w/-deletion

This subsection assesses the significance and relative contribution of external and internal factors governing /w/-deletion in the 2017 dataset. The results reveal that the quadratic term of YOB (YOB^2) is statistically significant, confirming the reversal of the change found in apparent time and real-time comparisons. Another remarkable finding that emerged was that the effect of preceding articulation that used to be the strongest conditioning factor has substantially weakened over time and is not so strong for younger generations any longer. Therefore, I suggest that the observed patterns might not merely reflect a retreat of /w/-deletion but a phonological restructuring of /w/-deletion as a general deletion rule. In what follows, I will first lay out the output of a generalized

linear mixed effects model and provide the discussion of the effect of each fixed-effect predictor.

Table 3.9 presents the significant fixed effects that were retained in the final model for postconsonantal /w/-deletion that provided the best fit to the data. First of all, the quadratic term of speaker year of birth (YOB^2) turned out significant, which confirms the apparent time pattern presented in Section 3.4.1. that /w/-deletion advanced toward more deletion till around 1970 but then declined ever since. SOCIAL CLASS turned out significant. Working class speakers are far more likely to delete /w/, which is consonant with Kang's (1997) finding that the lower the social standing of the speaker, the more likely they were likely to delete /w/. Also, there is significantly less deletion in read speech compared to conversational speech, which is consonant with Kang (1997) that found sharp patterns of stylistic differentiation as well. On the other hand, SPEAKER GENDER did not reach statistical significance, which suggests that

	Estimate	SE	Pr(>|z|)	Sig.	N	% Retention	
						2017	1997
(Intercept)	-0.52	0.369	0.159				
External constraints							
YOB (centered)	14.184	6.382	0.026	*	N/A		
YOB^2(centered)	19.869	6.316	0.002	**	N/A		
SOCIOECON CLASS							
(vs. working)					1481	76	68
Middle	0.258	0.139	0.064	.	2020	80	75
Upper	0.732	0.266	0.006	**	296	86	78
STYLE							
(vs. conversational)					1332	74	70
Read speech	0.45	0.133	<0.001	***	2465	82	78
Internal constraints							

PROSODIC POSITION (vs. non-initial)							
Initial	0.55	0.121	<0.001	***	1290 2507	77 83	71 76
FOLLOWING VOWEL (vs. front)							
Non-front	0.607	0.174	<0.001	***	1590 2207	77 81	69 78
PRECEDING ARTICULATION (vs. bilabial)					(bilabial)613	67	29
Alveolar	1.302	0.362	<0.001	***	1045	80	77
Palatal	0.994	0.404	0.014	*	330	86	89
Velar	0.935	0.338	0.006	**	1200	81	84
Glottal	0.121	0.358	<0.001	***	609	84	88
Interaction terms							
PRECEDING ARTICULATION YOB* (vs.Bilabial*YOB)					(bilabial)613	67	29
Alveolar*YOB	-37.774	8.305	<0.001	***	1045	80	77
Palatal*YOB	-36.769	18.424	0.046	*	330	86	89
Velar*YOB	-24.907	8.049	0.002	**	1200	81	84
Glottal*YOB	-34.274	12.011	0.004	**	609	84	88

Table 3.9: Regression results for best-fitting model predicting retention of /w/ in postconsonantal position.

there is very little gendered differentiation in terms of /w/-deletion and that both men and women are advancing toward less deletion of /w/ potstconsonantally in a similar manner.

Among the internal constraints, PROSODIC POSITION was one of the strongest predictors of postconsonantal /w/-deletion: the deletion is inhibited significantly more when /w/ occurs in a domain-initial position than in a non-initial position. The robust effect of prosodic position found in Kang (1997) is

replicated in the current dataset. Korean has the primary stress on the initial syllable of the word and is a duration accent language. Since the initial syllable tends to be lengthened in a duration accent language, a number of lenitive phenomena are inhibited in the domain-initial position in Korean (Kang, 2014).[40] In a similar manner, the chance of /w/-deletion is found to be significantly lowered in a domain-initial position. Next, FOLLOWING VOWEL also shows a significant effect on postconsonantal /w/-deletion. Deletion is favored before a front vowel while it was disfavored before a nonfront vowel, which aligns with the findings of previous research (Silva, 1991; Kang, 1997; Lee, 2004). This is likely to result from the coarticulatory effects of following vowels. Since all front vowels that co-occur with /w/(/i/ and /e/) are unrounded, the articulatory movement involved in these vowels is lip spreading, which conflicts with the lip rounding of /w/. Due to such coarticulatory effects, the articulatory gestures of lip rounding for /w/ may be greatly interfered or reduced. Lastly, the main effect of PRECEDING ARTICULATION turned out significant: /w/ is more likely to be deleted after a bilabial than a segment of other places of articulation. This is consistent with previous literature: Kang (1997) showed far greater deletion rates when /w/ is preceded by a bilabial (.81) compared to an alveolar (.23), a palatal (.11), a velar (.16) and a glottal (.12). Similarly, Silva (1991) found that deletion of /w/ is favored after a nondorsal consonant than a dorsal. Of

[40]Meanwhile, segments in unstressed syllables are more likely to be subject to lenitive processes such as gestural overlap, blending, deletion, etc. (de Jong et al., 1993).

note, however, is that the 2017 data exhibited a significant interaction between speaker YOB and PRECEDING ARTICULATION, indicating that the effect of PRECEDING ARTICULATION operating on /w/-deletion was not consistent over time: the effect of PRECEDING ARTICULATION is significantly larger for older speakers than for younger generations. That is, older speakers are likely to delete /w/ much more often when /w/ is preceded by a bilabial than by a consonant of other places of articulation whereas younger speakers do not exhibit such a pattern. The negative estimates for each level of this interaction term indicate that while the rate of /w/-deletion after a preceding bilabial decreased significantly more over time, the deletion rate when /w/ is preceded by a consonant of other places of articulation did not drop as much. To illustrate this effect more intuitively, the informants were divided into three different age groups (speakers born before 1970, those born between 1970 and 1990 and those born after 1990. As Figure 3.2 displays, speakers born before 1970 show the strong conditioning of preceding bilabials as in Kang (1997), while speakers born after 1970 are not subject to such strong effect of preceding bilabials as their older counterparts. This is again strongly suggestive /w/-deletion has not simply retreated since 1970s but it has gone through a phonological restructuring.

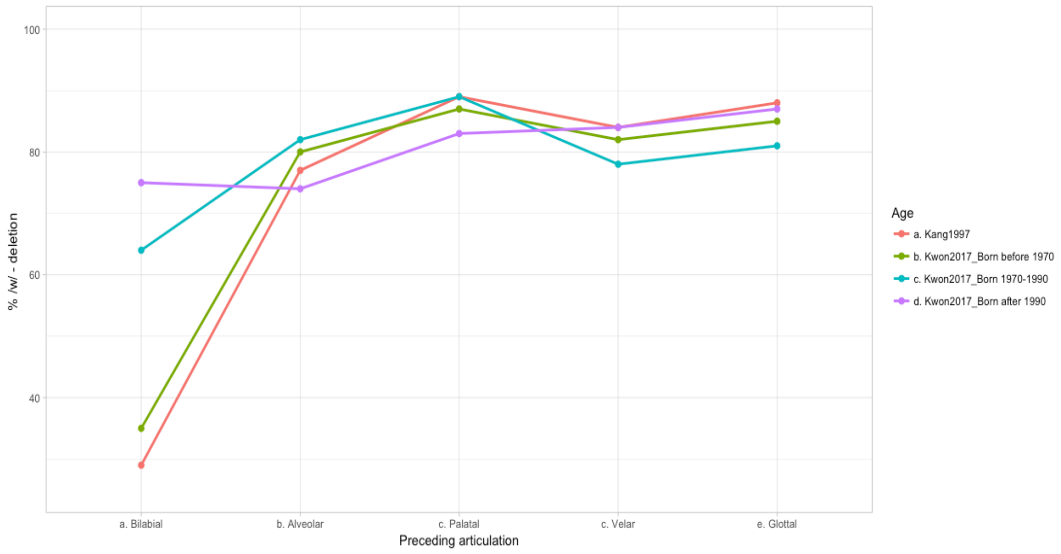

Figure 3.2: The weakening of the effects of preceding articulation.

3.4.4 Section summary

The apparent time and real time comparisons as well as the results of the generalized mixed-effects model presented in this section provide ample evidence for the ongoing change of postconsonantal /w/-deletion. That is, /w/-deletion has not only been retreating but also the effect of preceding consonants has weakened. From this, I conclude that postconsonantal /w/-deletion has been reanalyzed, losing the phonological conditioning of preceding consonants. To examine whether this conclusion is robust enough, I investigate how non-postconsonantal /w/-deletion changed over time and whether non-postconsonantal /w/-deletion patterns similarly with postconsonantal deletion in the next section.

3.5 Non-postconsonantal /w/-deletion

In this section, I examine the diachronic development of non-postconsonantal /w/-deletion in Seoul Korean and what constraints govern non-postconsonantal /w/-deletion in comparison to postconsonantal /w/-deletion. In Section 3.5.1, I use the apparent-time evidence to infer a generational change regarding non-postconsonatal /w/-deletion. I show that non-postconsonantal /w/-deletion has been vigorously rising with the younger generations deleting /w/ much more than older speakers. In Section 3.5.2, I use the longitudinal approach to test whether the pattern found in the apparent-time study is verified by the real-time evidence. In Section 3.5.3, I examine the effects of various linguistic and external factors governing non-postconsonantal /w/-deletion in Seoul Korean and compare them with those governing postconsonantal /w/-deletion. In Section 3.5.4, I draw a final conclusion that /w/-deletion in Seoul Korean which used to be restricted mostly to the postconsonantal position has extended to the non-postconsonantal position and younger generations might be treating these two rules as the same rules.

3.5.1 Apparent time evidence: a rise of non-postconsonantal /w/-deletion

Figure 3.3 displays the rates of /w/-deletion against speaker YOB in two different speech styles. For conversational style, the deletion rate has consistently risen throughout 1900s although it shows a little hump at the end. The same

trend is found in read speech, but the deletion rate is always lower than in the conversational speech. These results support the findings of Kang (1997): deletion of /w/ in non-postconsonantal position rose gradually at the time is now sharply rising.[41]

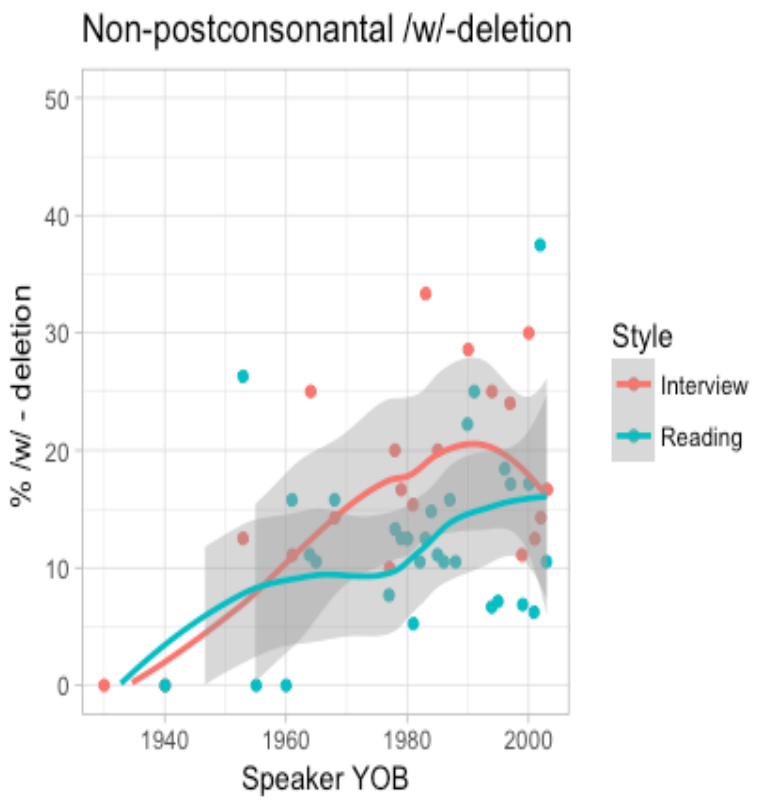

Figure 3.3: Non-postconsonantal /w/-deletion
by speaker age and speech style.

[41]This aligns well with the well-known S-curve for the sound change (Chen, 1972; Wardhaugh, 2002;210).

3.5.2 Real time evidence: Verifying the vigorous rise of non-postconsonantal /w/-deletion

Age	1997	2017	Sig. of the change
15-25	.07	.19	t(549)=-7.126, p<0.0001***
26-45	.04	.12	t(575)=-5.892, p<0.0001***
46+	.03	.09	t(537)=-4.814, p<0.0001***

Table 3.10: Rates of deletion of non-postconsonantal /w/ in 1997 and 2017.

Table 3.10 provides /w/- deletion rates in non-postconsonantal position by speaker age from the 1997 and 2017 corpus. In all age groups, the deletion rates have increased sharply over the past twenty years and the increase is highly significant, as indicated by extremely low p-values of <0.0001. These trend comparisons of the non-postconsonantal /w/-deletion reinforces the apparent time inference put forward above that /w/-deletion is vigorously rising in non-postconsonantal position.

3.5.3 Constraints governing non-postconsonantal /w/-deletion

Table 3.11 shows the effects of significant fixed effects predictors retained in the final model for non-postconsonantal /w/-deletion. Among the external constraints, speaker YOB (centered) is the most significant constraint with a negative coefficient, corroborating the apparent time and real time patterns shown in Section 3.5.1 and 3.5.2 that /w/-deletion in non-postconsonantal position has been rising rapidly.

	Estimate	SE	Pr(>|z|)	Sig.	N	% Retention	
						2017	1997
(Intercept)	0.058	0.752	0.939				
External constraints							
YOB (centered)	-0.119	0.019	<0.001	***	NA	NA	NA
SOCIOECON CLASS (vs. working)					714	83	93
Middle	1.053	0.316	<.001	***	820	89	96
Upper	1.286	0.538	0.017	*	134	87	97
STYLE (vs. conversational)					490	85	95
Read speech	1.291	0.352	<0.001	**	1178	87	95
Internal constraints							
PROSODIC POSITION (vs. initial)					450	97	99
Non-initial	1.681	0.685	0.014	*	1218	83	90
FOLLOWING VOWEL (vs. front)					728	84	96
Nonfront	1.696	0.562	0.003	**	940	89	97
PRECEDING ARTICULATION (vs. rounded)					(rnd) 298	81	81
Unrounded	0.004	0.526	0.994		936	82	94
Pause	1.768	0.902	0.050	.	436	97	NA
Interaction terms							
*STYLE*YOB* (vs. conversational)					490	85	95
Read speech	0.054	0.016	<0.001	***	1178	87	95
*FOLVOWEL*YOB* (vs. front*YOB)					728	84	96
Nonfront*YOB	0.029	0.012	0.019	*	940	89	97
PRECEDING ARTICULATION YOB* (vs. rounded*YOB)					298	81	81
Unrounded *YOB	0.055	0.017	<.001	***	936	82	94
Pause*YOB	0.003	0.041	0.944		436	97	NA

Notes: *: p<0.05, **: p<0.01, ***: p<0.001

Table 3.11: Regression results for best-fitting model predicting retention of /w/ in non-postconsonantal position.

This indicates that /w/-deletion in non-postconsonantal position that was found to be an incipient change then by Kang (1997) not only continued but accelerated. STYLE turned out a significant factor with deletion promoted in conversational speech than in read speech as in postconsonantal /w/-deletion. This is interesting because STYLE was not chosen as a significant factor for non-postconsonantal /w/-deletion in the 1997 corpus (Kang 1997). The significant interaction between STYLE and YOB, however, indicates that the effect of STYLE grew significant over time. It is not surprising STYLE emerged as a significant constraint over the past 20 years considering that as the linguistic change advances, the level of social awareness of the change increases, which occasionally creates social stereotypes regarding the variable (Derwing, 1973).

SOCIAL CLASS also proved significant for non-postconsonantal /w/-deletion as in postconsonantal /w/-deletion: working class speakers exhibit a significantly higher deletion rate of /w/ than middle and upper class speakers. This is consistent with Kang's (1997) finding and suggests that low social class speakers are on the forefront of the rise of /w/-deletion in non-postconsonantal position. In contrast, no influence of SPEAKER GENDER was observed. There

seems to be no gendered differentiation in terms of non-postconsonantal /w/-deletion as it was the case for postconsonantal /w/-deletion.[42]

Among linguistic constraints, PROSODIC POSITION has the strongest effect on non-postconsonantal /w/-deletion as it does for postconsonantal /w/-deletion: the deletion is significantly inhibited when /w/ occurs in a domain-initial position than in a non-initial position. The pattern found in previous studies (Kang, 1997; Lee, 2004) that the deletion rate is lower in a domain-initial position is replicated. FOLLOWING VOWEL also has a significant effect on non-postconsonantal /w/-deletion as in postconsonantal /w/-deletion: deletion rate of /w/ is much higher when /w/ is followed by a front vowel than a nonfront vowel. It is interesting that the effect of a following front vowel did not come out as significant in Kang (1997) but it emerged as a significant factor after 20 years. In the 2017 data, a significant interaction between FOLLOWING VOWEL and YOB was found, which indicates that the effect of FOLLOWING VOWEL on non-postconsonantal /w/-deletion has waxed. Figure 3.4 demonstrates that the effect of FOLLOWING VOWEL was much weaker in 1997 than in 2017.

[42] It is somewhat surprising that there is no gendered differentiation in the retreat of postconsonantal /w/-deletion as well as the rise of non-postconsonantal /w/-deletion in that women, regardless of social characteristics such as class, age, etc., tend to use more standard variants than men and women further introduce and lead changes towards both prestige and vernacular forms (Romaine, 2003).

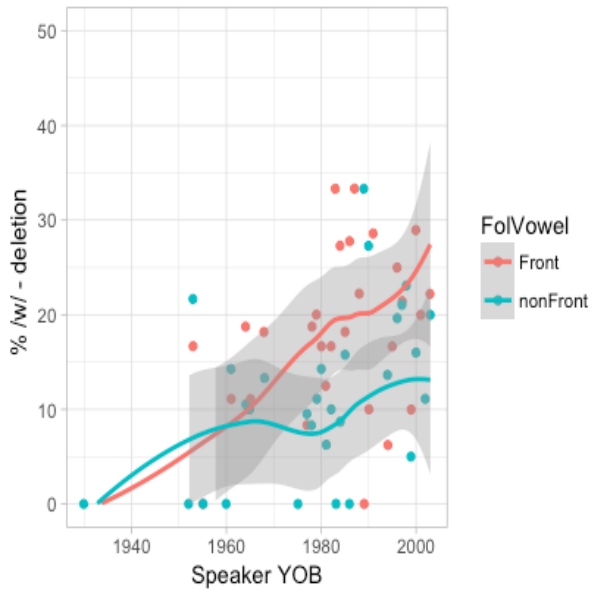

Figure 3.4: The change in the effects of following vowels on non-postconsonantal /w/-deletion

The main effect of PPRECEDING ARTICULATION also came out significant, but its significance is due to the significant difference between the rounded vowels and pause as can be seen in Table 3.11. There is no significant difference between the deletion rates of /w/ when /w/ is preceded by rounded and unrounded vowels in constraining /w/-deletion. This is unexpected considering Kang's (1997) finding that /w/ was deleted significantly more when preceded by a rounded vowel than an unrounded vowel. It is suggestive that the effect of PRECEDING ARTICULATION on non-postconsonantal /w/-deletion has also weakened just as the effect of preceding consonant on postconsonantal /w/-deletion weakened. This is supported by the significant interaction between

PRECEDING ARTICULATION and YOB, which is illustrated in Figure 3.5. The effect of PRECEDING ARTICULATION was substantial in the 1997 corpus but it is not so in the 2017 corpus. These results suggest that the effects of PRECEDING ARTICULATION on non-postconsonantal deletion have dwindled while the effect of FOLLOWING VOWEL became stronger over time.

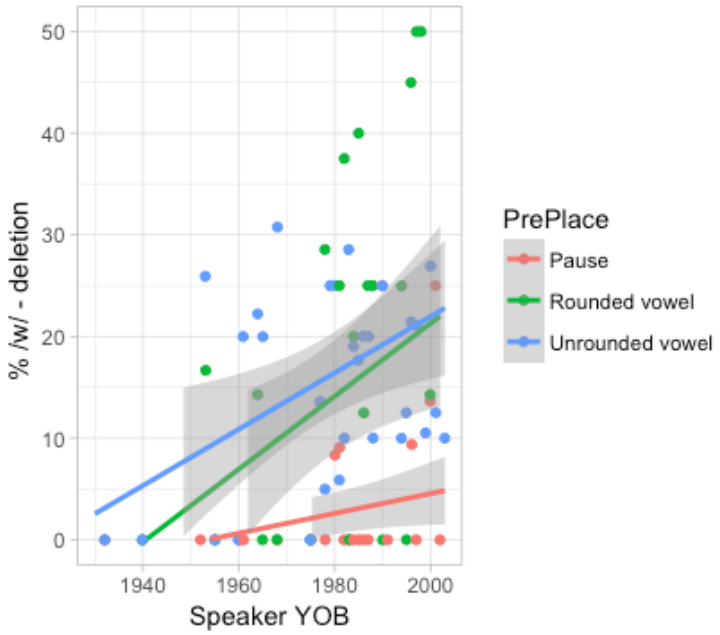

Figure 3.5: The change of the effects of preceding segments.

3.5.4 Section summary

In this section, I demonstrated that /w/-deletion in non-postconsonantal position has been vigorously rising continuously. It is also shown /w/-deletion in non-postconsonantal position is significantly constrained by SOCIAL CLASS

and STYLE, with lower social class speakers deleting more in informal speech than formal speech, the same patterns found for postconsonantal /w/-deletion. PROSODIC POSITION and FOLLOWING VOWEL were significant constraints for non-postconsonantal /w/-deletion just as they had the robust effects on postconsonantal /w/-deletion. What is interesting is that the effect of PRECEDING ARTICULATION which used to have the strong effect has significantly weakened while those of FOLLOWING VOWEL and STYLE that did not have significant effect on non-postconsonantal deletion back in 1990s have significantly waxed and emerged as significant predictors.

Since /w/-deletion in postconsonantal position has retreated while /w/-deletion in non-postconsonantal position has risen, the younger speakers, as a consequence, exhibit similar deletion rates of /w/ in postconsonatal and non-postconsonantal positions. Simultaneously, the effect of preceding articulation on both postconsonantal and non-postconsonantal /w/-deletion has weakened, while they are conditioned by the same set of other linguistic and external constraints: PROSODIC POSITION, FOLLOWING VOWEL, STYLE, SOCIAL CLASS. Therefore, I argue that all these results point to the conclusion that postconsonantal /w/-deletion has been reanalyzed, largely losing the strong phonological conditioning of preceding segments.

3.6 Discussion

In this section, I summarize the main findings of the chapter and discuss how they were involved in two mechanisms of language change: transmission and diffusion. I provide possible explanation(s) of the observed changes as regard to the interplay of transmission and diffusion of linguistic change within a single speech community, a dramatic increase in the literacy and the social meanings associated with /w/-deletion (Section 3.6.1). I also discuss how the changes could have been implemented at the individual speaker level in Section 3.6.2.

3.6.1 The weakening of the original pattern: outcome of diffusion?

The examination of the apparent time and real time data in Seoul Korean revealed that /w/-deletion in postconsonantal position has retreated, beginning with the speakers born in 1970s, while /w/-deletion in non-postconsonantal position has been rising rapidly. A closer examination of the data revealed also that the effect of preceding articulation that used to be the strongest constraints on both postconsonantal and non-postconsonantal /w/-deletion has significantly weakened, while the effect of the following vowel and speech style on non-postconsonantal /w/-deletion grew stronger. This led postconsonantal and non-postconsonantal /w/-deletion to have the same set of the constraints in the same order of significance. As a result, the youngest cohort are much less subjected to the influence of preceding segment and, therefore, the youngest

cohort of the corpus, appear to treat the deletion of /w/ in postconsonatal and non-postconsonantal positions as the same rule. Therefore, we may interpret observable facts as the outcome of the restructuring of /w/-deletion rule: /w/-deletion in Seoul Korean is being reanalyzed and simplified.

The profiles of change of /w/-deletion in Seoul Korean, however, are unusual in that the effects of constraints governing the deletion pattern were not consistent over time. Since Weiner and Labov (1983) demonstrated that linguistic constraints on the passive/active alternation to be consistent across speaker sex, class, age, and ethnicity, the finding of the consistent effects of internal constraints across social factors in the conditioning linguistic variation has continued to resurface (e.g. Braga, 1982; Labov, 2010).[43]

However, the linguistic change that involved a loss or weakening of the structural constraints is often attested when linguistic innovation is diffused across the communities. Labov (2007) demonstrates that, unlike a process of linguistic transmission whereby changes are faithfully transmitted across generations within the speech community, a process of diffusion usually results in weakening of the original pattern and a loss of structural features. He further argues that the crucial difference between these two processes of language change is that transmission happens through adult-to-adult interaction while diffusion takes place through adult-to-adult interaction. It has been now

[43]Labov (2001:29) termed this as "relative segregation of social and structural elements in language."

established that adult speakers are capable of making changes to their language across their lifespan (Sankoff 2004; Sankoff and Blondeau 2007, *inter alia*). The language learning of adult speakers, however, is much more coarse in that it loses much of the details of the original system being transmitted, while children learn even very complex patterns flawlessly. Due to this difference in learning ability between adult and child language learners, the diffusion of linguistic structures or features often results in a loss of the structural details constraining variation and it occasionally leads to reanalysis or simplification of the rule (Labov, 2007).

One of the representative cases exhibiting a weakening of the rule's structural details is the short-a tensing rule in American English. The rule started in New York City (cf. Babbitt, 1896) and the NYC system has very complex grammatical and lexical conditioning. In the New York City system, short-a is raised before voiceless fricatives (*half*), voiced stops (*bag*), and front nasals (*ham*, *hand*), and lax /æ/ elsewhere (*halve, back, hang*) (Cohen, 1970; Labov, 1966; 2007; Labov, Ash, and Boberg, 2006; Labov, Yaeger, and Steiner, 1972). This complex conditioning, as the rule spread into other regions including New England, northern New Jersey, Albany, Cincinnati and New Orleans lost most of its complex constraints (Labov, 2007; 2010) and was simplified.

The development of the short-a system within a speech community can exhibit the weakening of the original patterns and simplification. Becker and

Wong (2009) provide apparent-time evidence that the complex short-a pattern in the New York City is changing over time. They show that the traditional NYC split system is maintained by older white speakers, but the system is losing its complex conditioning among young white speakers. They further demonstrate that young native New Yorkers of ethnic minorities (Chinese, Puerto Rican, and African American) do not produce the traditional NYC split system, but instead change toward the nasal system (Labov, 2007). A recent study led by Labov and his colleagues (Labov, Fisher, Gylfadottir, Henderson and Sneller, 2016) also demonstrated that the Philadelphia speech community is experiencing a similar change. Philadelphia used to maintain its traditional Philadelphia system that is slightly different from the system of New York City but equally or more complex than the New York system. This pattern was found to be uniform across all social classes and stable till 2000s (Kroch, 1996; Labov, 2001; Conn, 2005). Labov et al. (2016) show that younger Philadelphians with higher education are retreating from the traditional "split" system and turning toward the nasal short-a system, a simpler short-a system that prevails across the country.

The weakening of the original patterns of /w/-deletion and the reanalysis of /w/-deletion in Seoul Korean resembles the development of short-a system in NYC and Philadelphia in that it arises as a result of diffusion where adult-to-adult contact plays a primary role in triggering the linguistic innovation. As discussed at length in Chapter 2, Korea has experienced dramatic demographic

changes after the Korean War. The population of Seoul was only 1.4 million in 1948 but it has skyrocketed to 11 million by 1992, approximately 8 times greater in a 50-year period. Recall that *Seoul thobagi,* true Seoul natives whose parents were also born and raised in Seoul, is estimated to account for less than 4.9%, according to the reports published by the Seoul Institute in 2004. This indicates that a majority of the population of Seoul has been made up of people who themselves are from other dialect regions and those whose parents are the speakers of other regional dialects. It follows that the speech community of Seoul must have had a very complex dialect contact situations during the second half of the twentieth century. Under this circumstance, numerous contacts must have been made between adult speakers with a variety of regional dialects including the Seoul dialect. In this process, the patterns of /w/-deletion are diffused from the native speakers of Seoul to other adult speakers from other dialect regions. If this is the case, dilution of the original pattern can be attributed to the very nature of the diffusion process that usually fails to replicate the original system.

All the speakers of this study, however, are not the second dialect speakers but the native speakers of Seoul Korean who were born and raised in Seoul. It may appear odd how children known to have the ability to acquire languages with astonishing accuracy could not learn the pattern correctly. Most of the informants in this study, however, report that their parents are originally from the dialect regions other than Seoul. Payne (1976) showed that among 34 children

who moved to King of Prussia, a suburban area of Philadelphia, those arrived in the city under the age 9 acquired the local norms almost perfectly while the majority of children between 10 and 14 years of age failed to learn the precise patterns of the local norms. Given this, child learners of parents from other dialect regions may have learn the overall pattern of /w/-deletion but failed to assign a correct probabilistic distribution (Yang, 2000; 2002).

A question arises at this point. Was it not possible for child learners to correct the imperfect system they learned from their parent(s) through vernacular reorganization? It is well-established that children acquire the grammar of their primary caretakers in the beginning but, at some point, adopt the system of their peers (Labov, 2001:415). Most of their peers, however, are also the children of the parents from other dialect regions after all. Consequently, they may have ended up failing to preserve the original patterns and constraints of /w/-deletion and further reinterpreted the rule.

Before drawing the final conclusion, however, I need to admit that little is known about the patterns and constraints of /w/-deletion in other regional dialects of Korea. Researchers have observed the deletion of *w* in other dialects including Kangwon (B.K. Lee 1977), Chungchung (Y.M. Han 1992) and Chunla dialects (H.K. Choi 1991). Unfortunately, however, there is few systematic studies that investigated what constraints govern /w/-deletion in other dialects.

Therefore, it should be remained as a future project, which will be further discussed in Chapter 5.

Thus far, I have provided a possible account of how the constraints on /w/-deletion has been lost and the rule has simplified through the transmission and diffusion of the patterns of /w/-deletion. How can we account for the retreat of postconsonantal /w/-deletion then? Here again, I want to propose that some external factors gave rise to the change of /w/-deletion. In the first half of the twentieth century, the Korean language faced a crisis since Korea was occupied by Japan between 1910 and 1945, and the use of Korean was strictly prohibited in public. Korean people were forced to surrender their Korean family names and adopt Japanese surnames and they were taught in Japanese in school. It was only at home or in confidential gatherings among Koreans that they could talk to each other in Korean. Children acquired Korean, their mother tongue, at home, but many were deprived of the opportunities to learn to read and write in Korean. Also, educational opportunities were severely limited. Elementary schools, for example, accommodated only 30 percent of all school-age children; only one out of 20 or so enrolled in secondary schools, and very few Koreans attended college then. The adult literacy rate in 1945 was only 22 percent. Not long after the Japanese colonial occupation of Korea ended, the Korean war broke out in 1950 and lasted for three years. Given these historical facts, it is not hard to imagine how seriously the development of modern education was disrupted in the first

half of the twentieth century in Korea (Suh, 1978; Song, 1997; Yoon 2007; Caprio, 2009).

In the second half of the twentieth century, however, Korea has made spectacular progress in modernization and economic growth after the Korean War ended. An ensuing change was a great amount of investment in the education system. The percentage of students going on to optional middle school[44] in 1985 was more than 99 percent. Approximately 34 percent of high school graduates attended institutions of higher education in 1987, and this was one of the world's highest rates. By 1970 adult literacy had reached 87.6 percent and by the late 1980s it increased to 93 percent. As of 2002, Korea's literacy rate had reached 99.9 percent.

Considering the historical facts described above, it is conceivable the retreat of postconsonantal /w/-deletion was triggered by substantial social changes in the speech community whereby there was a dramatic increase in literacy and, therefore, more exposure to orthography. The crucial role of orthography in constraining speech production has been recognized in a number of psycholinguistic studies (Seidenberg and Tanenhaus, 1979; Donnenwerth-Nolan, Tanenhaus, and Seidenberg, 1981; Dijkstra, Roelofs, and Fieuws, 1995; Halle, Chereau, and Segui, 2000; Damian and Bowers, 2003, *inter alia*). Dijkstra, Roelofs, and Fieuws (1995) show that not only phonemic and phonological codes, but also orthographic codes, exert an influence on our perception of phonemes. Halle,

[44] Only primary school education was compulsory at the time.

Chereau, and Segui (2000) demonstrate that subjects tended to choose the correct orthography even if what they heard was phonetically different from the phoneme typically represented in the orthography. This suggests a robust influence of orthographic codes on phonetic perception. Damian and Bowers (2003) further show that orthographic information influences performance in tasks even without visual orthographic codes. This suggests that orthographic codes can be activated in speech production even without visual cues. These studies show that our speech perception and production as well as phonological system are heavily influenced by orthographic codes. Given these findings, it seems plausible that a dramatic increase in the literacy and the increased exposure to orthography in a short period of time could have result in the retreat of postconsonantal /w/-deletion. That is, people may have stayed away from the forms deviating from the spelling and move toward a more standard form, which agrees with the written form.[45]

Similar cases whereby the change moved toward the direction of written forms have been identified in Contemporary Seoul Korean. In Korean, stem-final coronal obstruents of nouns varies with [s] in the prevocalic position as in /pat^{h}-ɨl/ [pat^{h}-ɨl] ~ [pas-ɨl] 'field, accusative'. While a wide set of obstruents (*s, ch, th, c, t*) may occur as variants, it has been reported *s* occurs most frequently, followed

[45]Such changes toward more standard forms can be found in the history of other languages as well. Sundgren (2009), for example, demonstrated that five out of seven morphological and morphophonological variables in Eskilstuna Swedish changed towards more standard forms over time.

by *ch, th,* and *c, t* were the least frequently occurring variants (Ko, 1989; Martin, 1992; Hayes, 1998; Kang, 2003; Jun, 2010, *inter alia*). According to the report on the language changes of Korean by the National Institute of the Korean Language, however, the variant of the underlying form that conforms to the orthography, is used increasingly more frequently rather than [s]. Another instance of a sound change toward a variant that agrees with written forms is the preservation of a syllable-initial /l/ in Seoul Korean. Yun and Kang (2017) report that an underlying syllable-initial /l/ that used to delete obligatorily is increasingly preserved to agree with the written form. Although more extensive studies are certainly needed before a final ruling can be made, these changes toward the written or standard forms could have been influenced by the rapid increase in the literacy in Korea.

Related factors that could have made an impact on the retreat of postconsonantal /w/-deletion is the social meaning associated with /w/-deletion. Recall that /w/ was deleted more frequently among the speakers of the lowest social class and in conversational style compared to formal style. The strong association of /w/-deletion with the speech of working-class speakers as well as casual speech style suggests that people recognize the overt stigma of /w/-deletion and tend to retain /w/ in a more formal style.[46] Therefore, it is possible the withdrawal from /w/-deletion was led by the higher social class in

[46]Although more extensive research is necessary to probe what social meanings postconsonantal /w/-deletion bears, the results of this study suggest that /w/-deletion is likely to be linked to low-prestige, uneducatedness, sloppiness, etc.

response to the stigma attached to /w/-deletion.[47] Some recent studies show that the stigma or negative social evaluations associated with a variant may spur phonological change at a higher level. Labov and colleagues have discovered that, in Philadelphia English, younger speakers with higher education have been leading a withdrawal from tense /oh/ and /aeh/, the two stereotypical features of the Philadelphia that are highly stigmatized (Labov, Rosenfelder and Fruehwald, 2013; Labov, Fisher, Gylfadottir, Henderson and Sneller, 2016). In a similar manner, younger speakers belonging to the highest social class may have driven the retreat and reanalysis of /w/-deletion, with a motivation to avoid /w/-deletion that carries social stigma.

3.6.2 The implementation of the change at the individual speaker level

Provided that the innovation at the community level was initiated this way, how can we link the change at the community level to the inception of sound change in an individual's grammar? Even though we are studying the changes of the larger speech community, a sound change is actuated in the mind of individual speakers after all.[48] That is, it is the changes of the production targets of individual speakers making up speech communities that eventually bring about sound changes at the community level (Stevens and Harrington, 2011).

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[47]The retreat of /w/-deletion in postconsonantal position appears to be a change from above in that it is led by the highest social class group and favored in a formal style.

[48]A similar observation was made earlier by Milroy and Milroy (1985:347) who noted "linguistic change must presumably originate in speakers rather than in languages."

Browman and Goldstein (1991; 1992) were pioneering exponents of the view that articulatory factors play an important role in sound change at its origins by describing a possible mechanism of how gestural reduction and overlap can bring about permanent sound changes. According to this scenario, some speakers become attuned to particular instances of casual speech variation (e.g. changes in the magnitude of some gestures) and make a slight shift of the value of the constriction degree parameter for that gesture. For example, in the case of lenition of stops in English, where stop consonants weakens to corresponding fricative: *must be* pronounced as [mʌsβɪ], the changes involve reductions in the magnitude of individual stop gestures such that there is incomplete closure or reduction in the movement amplitude. Reducing the constriction degree of a stop gesture will increase the likelihood for listeners to categorize a stop as a fricative. The preponderance of the fricative output over the stop output could result in a further reduction whereby there is a systematic drift in the parameters of individual gestures or the amount of gestural overlap with adjacent segments, until the recategorization into fricative is achieved. The development of a number of phonological alternations and sound changes, as they further argued, can be seen as resulting from the changes in the magnitude of the gestures or the overlap of gestures.

Some recent studies have provided the articulatory evidence that lends support to the idea that the systematic variation in the articulation may spur a

sound change by demonstrating that subtle articulatory changes can cause listeners to reinterpret the sound category and make changes at a higher level of abstraction. Yu (2011), for example, has developed a means to measure the likelihood of a phonetic precursor being phonologized as a sound pattern and attempted to explain why the patterns of vowel height harmony (henceforth HH-interaction) are more frequently attested than the patterns involving the interaction between voicing and vowel height (HV-interaction), using this notion of relative robustness of phonetic precursors. He showed that the phonetic precursors to vowel height harmony were more robust than the precursor to obstruent voicing-induced vowel raising based on the finding that the magnitude of HH-coarticulation is stronger than the magnitude of HV-coarticulation both in terms of the range of targets and the temporal extent of its influence. In a study of /l/-vocalization in American English, Lin, Beddor and Coetzee (2014) measured the magnitude of anterior and dorsal constrictions for laterals in/(C)(C)VlC/ words and showed that the degree of anterior constriction was correlated with the frequency separation between F1 and F2. They argue that a quantitative change in the magnitude of the alveolar constriction for /l/ contributed to the initiation and lexical diffusion of historical /l/ lenition as well as /l/ loss. Solé (2014) examined whether listeners can detect the nasal leak that may accompany utterance-initial voiced stops in Spanish, using oral and nasal airflow measurements in order to examine how variation in production is

perceived and reinterpreted by listeners. The results showed that listeners can hear the nasal airflow leakage in the production of voiced stops /b d g/ and reinterpret them as nasal segments, failing to relate it to voicing initiation. Solé further argues that the nasal airflow leakage serves as an implementational feature in a number of sound changes involving emergent nasals adjacent to voiced stops in oral contexts.

All these studies discussed thus far demonstrate that the fine-grained quantitative variations in the articulatory production may play an important role in providing the input to permanent historical sound change. One thing we can predict about /w/-deletion in Seoul Korean based on these findings is that there could have been some articulatory forces that provided the pre-conditions for the change of /w/-deletion. There could have been the systematic variation and change in the amount of coarticulatory gestural overlap between /w/ and a preceding segment, which gave rise to the weakening of the effect of preceding segment.[49] That is, while older generations show a significantly larger amount of coarticulatory gestural overlap between /w/ and a preceding bilabial or velar compared to a preceding alveolar or palatal, younger generations may have produced /w/ with increasingly smaller coarticulatory gestural overlap between /w/ and a preceding segment, regardless of the place of the articulation. This

[49] Although most cases of this type of sound changes are regarded as the phonologization of phonetically grounded constraints (Ohala, 1993; 2005; Hale and Reiss, 2000; Barnes, 2002; Blevins, 2004), we may think of expanding this idea into the changes going in the opposite direction.

significant quantitative decrease in the magnitude of anticipatory consonant-to-/w/ coarticulation may have served as a precursor to the reanalysis of /w/-deletion. If we find systematic variation in the amount of coarticulation between /w/ and a preceding segment according to speaker age, it would suggest not only that the lenition or deletion processes of /w/ are not automatic but planned,[50] but also that such systematic variation according to speaker age provided an input to sound change. This line of prediction regarding the implementation of the changes at the individual speaker level will be tested using the articulatory data in the next chapter.

[50]Otherwise every speaker should produce the same amount of coarticulatory effects and show similar place-governed patterns.

Chapter 4

Articulatory Variation and change of /w/-deletion

4.1 Introduction

The previous chapter demonstrated that the effect of place of preceding segment, the strongest conditioning factor on /w/-deletion, has weakened over time and the variable deletion of /w/ in Seoul Korean is being reanalyzed, losing the strong phonological conditioning of preceding segment. In accounting for the nature of /w/-deletion in Seoul Korean and its development over time, I discussed a possibility that variability in the gradient reduction or overlap of articulatory gestures may have played an important role in the initiation of the change at the level of individual speakers (Yu, 2011; Lin et al., 2014; Solé, 2014). I argued that the development of this rule was preceded or accompanied by the changes in the patterns of gestural reduction and overlap of gestures. That is, the gestural strategies Seoul Korean speakers employ for producing CwV may have changed qualitatively and perhaps quantitatively over generations. While older

speakers make greater amount of gestural overlap between /w/ and a preceding bilabial, younger generations may have developed a strategy of articulating /w/ more carefully, which may have affected the weakening of the effect of preceding segment. This chapter aims to test this hypothesis using articulatory data.

There was a previous attempt to explain the mechanism of /w/-deletion in Seoul Korean from articulatory perspective. Silva (1991) viewed /w/-deletion as a process that simplifies articulation of the CwV sequence by reducing the number of gestures performed by the body of the tongue. He predicted that when a nondorsal (labial or coronal) segment precedes /w/, speakers are more likely to delete /w/ in the CwV sequence because the tongue body needs to retract for /w/ and re-front for the following vowel. The deletion of /w/ in these contexts has advantages in articulatory economy. By contrast, when a dorsal (velar) segment precedes /w/, the tongue needs to be retracted for the preceding back segment and then fronted for the following vowel anyway, therefore, in this context, there is no advantage to deleting the glide and speakers are more likely to retain /w/. Silva's emphasis was on how preceding segments made different impact on the reduction of the gestures of tongue body rather than lip gestures. In Chapter 3, however, I questioned Silva's (1991) view, arguing that the nature of /w/-deletion in Seoul Korean can be better accounted for by the overlap of lip gestures rather than tongue gestures considering that deletion rate is considerably higher when /w/ is preceded by a bilabial.

Without articulatory data, what happens at the articulatory level has been only inferred from acoustic or auditory data in the sociolinguistic research. As an increasing number of linguists point out that variable articulatory patterns are often elusive in the auditory or acoustic analysis, there has been some movement toward using articulatory data in order to reliably investigate variation and change at the articulatory level (Davidson, 2006; Mielke 2007; Lawson et al., 2011, *inter alia*). This study aims to contribute to this enterprise by taking account of variation and change of /w/-deletion patterns in Seoul Korean at the articulatory level, using ultrasound.

This chapter is organized as follows. I first briefly discuss the literature on the use of ultrasound in the studies of language variation and change (Section 4.2). Then I seek to provide an articulatory account of /w/-deletion in Seoul Korean by addressing three sub-questions. In Section 4.3, I first define /w/ in Seoul Korean in an articulatory perspective. Although lip protrusion and rounding and tongue dorsum raising and backing have generally been considered the major articulatory correlates of glide /w/, the results show that the magnitude of lip gestures contributing to the production of /w/ is far greater than that of tongue gestures, from which I conclude that lip rounding is the primary articulatory correlate for /w/ in Seoul Korean and the tongue makes a secondary contribution to it. Once the articulatory correlates for /w/ in Seoul Korean are defined, I examine the categorical and gradient nature of the realization of /w/

(Section 4.4). It has been increasingly recognized that categorical and gradient effects of related phonological processes can coexist within the same grammar and gradient phonetic details play an important role in shaping the variable sound patterns (Robinson, 1976; Bermúdez-Otero, 2010; 2015; Burki et al. 2011; Erker 2012; Turton 2014, *inter alia*). I examine whether fine phonetic details play a role in explaining the variation and change of /w/-deletion in Seoul Korean and demonstrate that gradient phonetic conditions, along with the effect of category, play an important role in shaping the variable patterns of /w/-deletion. Having established this, I finally seek to account for the synchronic variation and diachronic change of the /w/-deletion process in Seoul Korean from the articulatory perspective (Section 4.5). The gestural patterns involved in /w/-deletion are examined first and it will be examined whether there is a generational difference in the magnitude of articulatory gestures depending on the adjacent segments, which suggests a generational change at the articulatory level. We will see that the articulatory pattern is consistent with the pattern of /w/-deletion at the phonological level shown in Chapter 3. The general discussion of the main findings of this chapter will be provided in Section 4.6. The chapter concludes by summarizing the findings and discussing implications of the study in Section 4.7.

4.2 Ultrasound Tongue Imaging in the Studies of Language Variation and Change

Since the 1970s, advances in technology have made ultrasound a useful tool for speech research as ultrasound can measure tongue shapes and movements with increasing effectiveness. Imaging tongues using ultrasound is becoming increasingly popular in linguistics studies since it is a tool for safe, non-invasive imaging of the dynamic movements of the entire tongue.

Scobbie et al. (2008) emphasized the value of using ultrasound for vernacular articulatory research, demonstrating that it can be exploited as a tool capable of eliciting relatively relaxed and vernacular speech. They attempted to show the potential psychosocial impact of ultrasound recording by comparing how subjects behave differently than they would in the presence of a microphone for audio-only recording. They found that the use of ultrasound imaging equipment, including a stabilizing headset, did not cause a large or consistent style shift in speech (two informants talking to each other in Scobbie et al. (2008) are seen in Figure 4.1). A comparison was made of socially salient variables (*th*-fronting, *t*-glottalling, and *l*-vocalisation) and there was no clear pattern of variation between the control group (audio-recording only) and the group recorded using ultrasound. Although there were individual variations, there was no overall average decrease in vernacular variants in the ultrasound condition.

Figure 4.1: Two informants wearing a stabilizing headset for ultrasound tongue imaging during spontaneous discourse. From Scobbie et al. (2008).

Lawson et al. (2008; 2011), using ultrasound, successfully identified socially-stratified articulatory variation in the realization of the postvocalic /r/ in Scottish English. Based on the ultrasound data analysis of naturalistic speech data, they found that middle class informants used greater proportions of bunched variants than working class informants, and females use greater proportions of bunched variants than males.[51] They concluded that articulatory variation in /r/ is perceptible and can be exploited by speakers to index socio-economic class in Scottish English. This study was one of the pioneering studies that showed a great potential for socioarticulatory studies to capture the covert variations at the articulatory level that have been largely unidentifiable in the auditory and acoustic approach to the analysis of variation.

[51]This gender difference was mainly found among the working class speakers.

In a similar manner, ultrasound can be particularly useful in the sociolinguistic study of the Korean glide /w/ in that it enables us to capture the variations in the articulatory details observed in the vernacular speech of speakers as well as their careful speech. The use of vernaculars is crucial to the socioarticulatory analysis of /w/-deletion because the synchronic variations and diachronic change with regard to /w/-deletion are far more evident in the casual speech than in the formal speech as we witnessed in Chapter 3. This study therefore aims to investigate the variable patterns of /w/-deletion in Seoul Korean at the articulatory level by analyzing the magnitude of articulators' movements involved the production of /w/ in naturalistic speech as well as careful speech.

4.3 Experiment 1: The articulatory definition of /w/-deletion in Seoul Korean

4.3.1 Research questions

Before embarking on an analysis of the variation and change of /w/-deletion process in Seoul Korean, it is necessary to define /w/ in an articulatory perspective. Lip protrusion as well as dorsum raising and backing have generally been considered the major articulatory correlates of glide /w/. Anderson (1976), however, reports that, cross-linguistically, the 'primary' articulation of labiovelars is labial in some languages, while it is velar in other languages. Lisker (1995), for example, found that the primary articulation of /w/ in American

English is lip rounding. Little attention has been paid to articulatory correlates of /w/ in Korean, thus a question remains as to which articulator makes the primary contribution to the production of the Korean glide /w/ and which one is the secondary articulator.

4.3.2 Method[52]

4.3.2.1 Participants

Five native speakers of Seoul Korean participated in the study, although the data from two speakers were not included in the analysis due to the importing errors in the ultrasound software Articulate Assistant Advanced (AAA). The remaining three speakers are all female and the data from these three speakers are presented here. Participant 1 (EDA) was in her 50s, participant 2 (JKJ) in her 30s and participant 3 (SHJ) in her 20s. None reported any history of speech or hearing impairments. All subjects were phonetically untrained and were unaware of the nature of the study at the time of data collection. They were paid for their time.

[52]The methods described in this section are applied to Experiment 2 and 3 as well. However, different stimuli sets are used in each experiment and different statistical models were built according to the questions addressed in each experiment. The details of differences will be described in the method sections of each experiment (Section 4.4.2 and 4.5.2).

4.3.2.2. Materials

To address the first issue of providing the articulatory definition of /w/ in Seoul Korean, /w/-realization in very careful read speech (Stimuli Part I) are analyzed. Items in Part I include 27 monosyllabic words of the syllable type CwV and CV (e.g. *pwi* and *pi*, *twa* and *ta, kwe* and *ke*) and they were designed to elicit clearly articulated CwV and CV tokens in very careful speech. No CwV token in this part was realized with /w/ deleted.

In all items, /w/ is preceded by a labial, alveolar, or velar segment and followed by one of the four different vowels (i, e, ə, a) that co-occur with /w/ in Korean. These words were chosen to yield tokens of /w/ produced in a number of contexts. Twelve additional filler words were added to the stimuli set and the order of items was randomized. The target items were repeated three times. The full set of stimuli used in the current study is provided in Appendix C.

4.3.2.3 Procedures

Recordings were made inside a sound-attenuated booth at the Phonetics Lab at the University of Pennsylvania. Midsagittal images of the tongue from the speakers were recorded using the EchoB portable ultrasound machine. A 5-8 MHz convex-curved transducer that produced up to 87 scans per second across a 70 degrees field of view was used. Focal depth was 70mm. The probe stabilization headset (see Figure 4.2), designed by Articulate Instruments, was

used to stabilize the speakers' head. This lightweight and portable headset fixes the transducer midsagitally under the speaker's chin. This ensures that there is little lateral movement of the probe and no probe rotation. Nevertheless, the speakers could move freely during the recording because the headset had adjustable parts to help securely fit to the speaker's head.

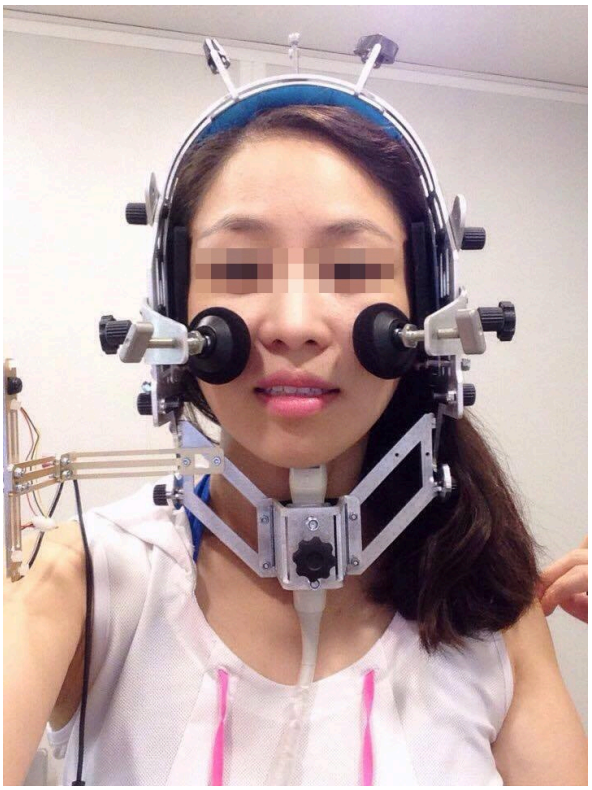

Figure 4.2: Probe stabilization headset to hold the probe steady but allow natural head movement during speech.

Once the subjects are seated in the chair, a SONY Shure SM58 microphone was attached to the subjects, which enabled the simultaneous audio recording. Also, the side-view video of the participant's face was videotaped to record the lip rounding. An audio signal from a microphone and the incoming video signal

from the ultrasound machine was synchronized, using a SyncBrightUp unit (Articulate Instruments Ltd 2010).

The stimuli were presented to the speaker using Articulate Assistant Advanced (AAA) software which recorded participants' ultrasound images as well as acoustic data. The speaker read aloud the sentence corresponding to the stimuli number[53] from written lists at a comfortable pace. Sample ultrasound image of tongue and camera image of lips are illustrated in Figure 4.3.

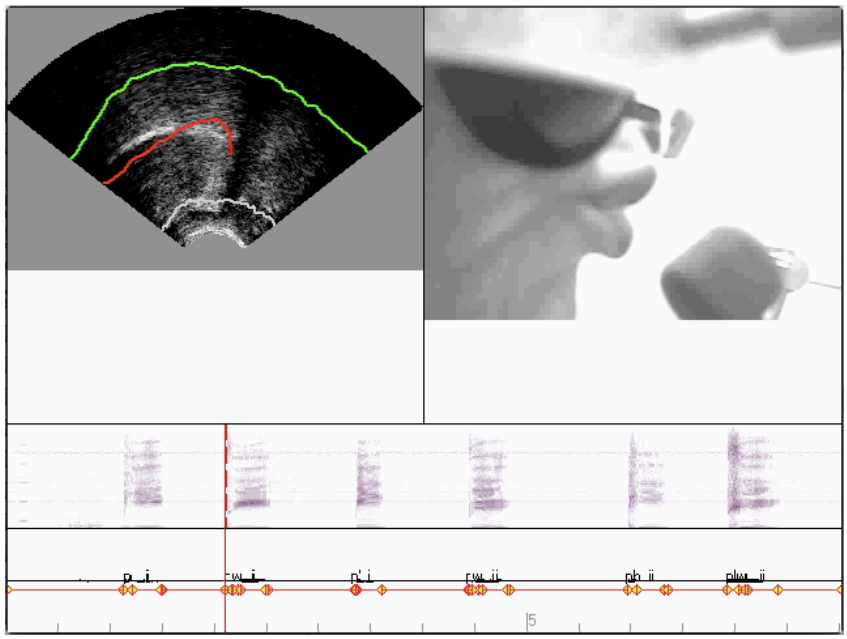

Figure 4.3: Sample image of a tongue surface (ultrasound) and lip shape. The right side is the tongue tip and the left side is the tongue root. The green line in the ultrasound image is the palate trace, the highest possible point of the tongue, and the red line indicates the average tongue position.

[53]Because presenting sentences in Korean was not supported in AAA, the stimuli number was presented in AAA and the speakers read aloud the sentence corresponding to the stimuli number once the stimuli number appeared on the screen.

4.3.2.4 Data analysis

4.3.2.4.1 Segmentation and Synchronization

First, the sound files were exported from Articulate Assistant Advanced (AAA). Acoustic segmentation was made mainly through the Korean Forced Aligner (Yoon and Kang, 2013), but textgrid files were manually inspected and, if necessary, corrected in Praat (Boersma and Weenink 2010). These sound files were imported back into AAA along with their textgrid files. The ultrasound and side-view videos of CV and CwV sequences were exported as avi files.

4.3.2.4.2 Optical Flow Analysis (OFA)

The qualitative analysis of ultrasound data can be quite effective when the variable involves variants with qualitatively different tongue shapes. Lawson et al. (2008; 2011), for example, provide a qualitative analysis for their ultrasound data of Scottish /r/ realizations by developing categorical possibilities for tongue shapes (e.g. bunched /r/, tip up etc.). When tongue shapes are similar and exhibit subtle variations, however, we need to employ the quantitative analysis that can help us capture small but significant differences.

In this study, the quantitative analysis technique called Optical Flow Analysis (OFA; Horn and Schunck, 1981; Fleet and Weiss, 2006) was used to measure the amount of articulatory gestures involved in the production of /w/. Optical Flow Analysis (OFA) is a video-based motion analysis tool that measures

the apparent magnitude of movement (MM) of objects in a video (Barbosa et al. 2008). The method's utility has been demonstrated for the data from a number of languages including Plains Cree, English, Shona (Barbosa et al. 2008). Recent ultrasound studies have introduced OFA as a relatively easy but powerful tool for extracting articulatory information from ultrasound video (Hall et al. 2015, *inter alia*).

OFA is a particularly appropriate analysis method for the current study. First, OFA is capable of extracting reliable kinematics in any type of video. For the current articulatory study of the production of /w/ involving two articulators, lips and tongue, OFA can capture the movement of tongue in the ultrasound videos and that of lips in the side-view videos. This enables the unified measurement of the motions of tongue and lips, which allows the direct comparison between two articulators in terms of the magnitude of gestures. Second, OFA extracts the data from all frames, rather than single frames as is common with static postural analyses widely used in the ultrasound analysis (Barbosa and Vatikiotis-Bateson, 2014; Hall et al., 2015; Moisik et al., 2014). Since /w/ is heavily coarticulated with surrounding segments, extracting the movement of articulators from a series of time sequences can be more advantageous in seizing the global movements of articulators before and after the production of /w/.

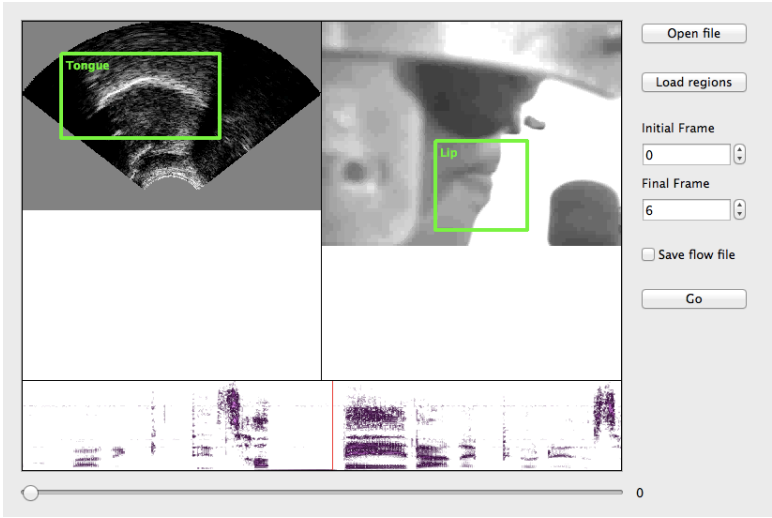

Figure 4.4: Defining regions of interest in the optical flow domain.

The data acquisition and processing procedures for OFA were as follows. First, the video data acquired in the ultrasound recording were exported from AAA and saved in avi files on the computer. I applied the optical flow analysis to these movies files that consist of image sequences, using *FlowAnalyzer*, the tool which is part of a larger Matlab toolbox for multimodal data analysis. The regions of interest (lips and tongue in this case) were first selected as in Figure 4.4. The optical flow algorithm then compares the difference in brightness of individual pixels from frame to frame, then calculates how much and in which direction each pixel in the defined regions of interest in the image moved from one frame to the next. The summed optical flow for the n-th region of interest at the discrete time k is computed as in (1) where $\| . \|$ denotes the vector magnitude, and x_i, x_f, y_i, y_f are the initial and final boundary positions of the

region of interest in the horizontal and vertical directions, respectively. This results in frame-by-frame measures of Magnitudes of Movements (MMs) and the sum of the magnitudes of all pixels inside each region of interest can be calculated (Barbosa et al. 2008).

(1) $$v_n(k) = \sum_{x=x_i}^{x_f} \sum_{y=y_i}^{y_f} \|\overrightarrow{v}(x, y, k)\|$$

For the comparison across speakers, MMs for each speaker were normalized to zero mean and unit variance within speaker to eliminate gestural variation due to physiological differences among speakers.

4.3.2.4.3 Statistical testing

In order to examine various questions in this chapter, the mixed-effects modeling is used as the primary statistical method since the data come from multiple speakers. To answer our first question of investigating which articulator serves as the primary articulator for the production of /w/, the fixed-effect of ARTICULATOR (lips, tongue) is tested by fitting mixed-effects linear regression models to the magnitude of gestures, with the SPEAKER and WORD as potential random effects that account for different behavior by individual speakers and words. The interactions of ARTICULATOR with PRECEDING CONSONANT or FOLLOWING VOWEL were also tested. All fixed-effect predictors were

analyzed using sum contrasts.

The dependent variable was the magnitude of gestures for /w/. The difference between the magnitude of movement (MM) for CwV and mean MM of CV (MM of each CwV tokean - mean MM of all CV tokens of the same phonological contexts) was used instead of the magnitude of /w/ itself, for the following two reasons. First, determining the boundary between /w/ and the following vowel was not always straightforward because the transition from /w/ to the following vowel is quite smooth. Another reason for using the delta value is that since /w/ heavily coarticulates with surrounding gestures, considering the whole sequence is more advantageous in seizing the global movements of articulators. The magnitude of /w/ in /pwi/, for example, was measured by subtracting the mean magnitude of all tokens of/pi/ from the magnitude of a token of /pwi/. Quantitative analysis is performed on these delta values as a proxy for the amount of gestures left purely for /w/ after the gestural reduction or overlap with neighboring segments. It is assumed that the larger this difference is, the more robust and salient the acoustic and perceptual cues for /w/ are.

Models were stepped down from full models and model selection was guided by log likelihood tests as well as Akaike Information Criterion (Akaike, 1974) and Bayesian Information Criterion (Schwarz, 1978) values. Significance levels or p-values were calculated based on Satterthwaite's (1946)

approximations for the degrees of freedom using the lmerTest package (Kuznetsova, Brockhoff and Christensen, 2013). Tukey's Honest Significant Difference (HSD) test (with alpha set at 0.05) was used for post-hoc comparisons between levels.

4.3.3 Results

All the ultrasound and side-view videos were closely examined to confirm that the major articulatory correlates of /w/ in Seoul Korean are lip protrusion and dorsum raising and backing as suggested in the literature and determine which articulatory feature demonstrates more salient manifestation. There are substantially larger additional gestures for lips when producing *twa* in comparison to *ta* whereas the additional gestures for tongue appear almost minimal.

The quantitative analysis using Optical Flow Analysis (OFA) confirms that the magnitude of lip gestures is far greater than that of tongue gestures. As shown in Figure 4.5, every speaker exhibits significantly larger lip gestures than tongue gestures. This is upheld in a mixed-effects linear regression model, with TONGUE significantly lowering the magnitude of gestures compared to LIPS ($\chi^2(1)= 11.322$, p= 0.0007661 ***).

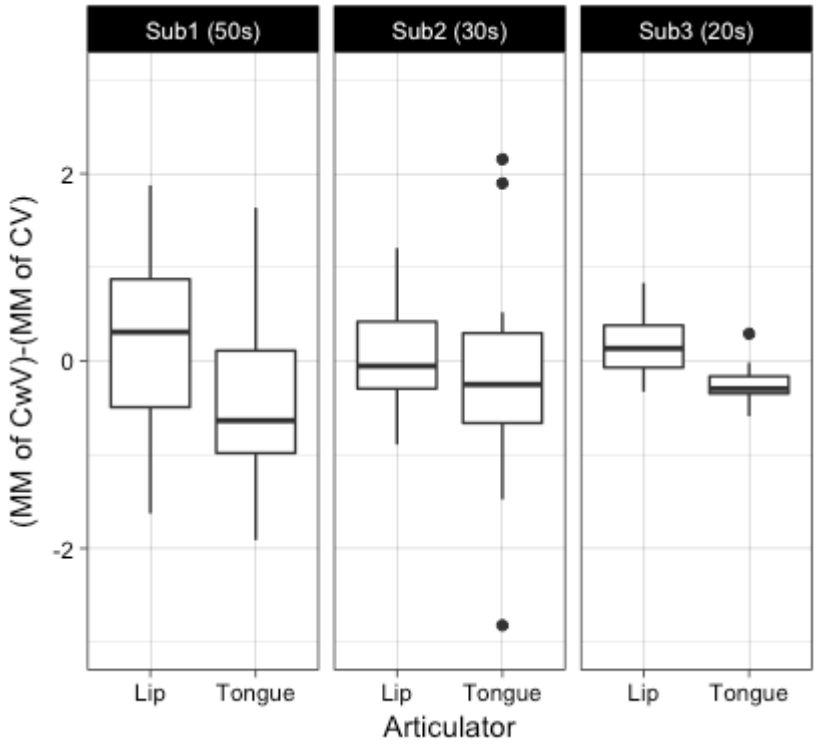

Figure 4.5: Magnitude of gestures for lips and tongue for (CwV-CV).

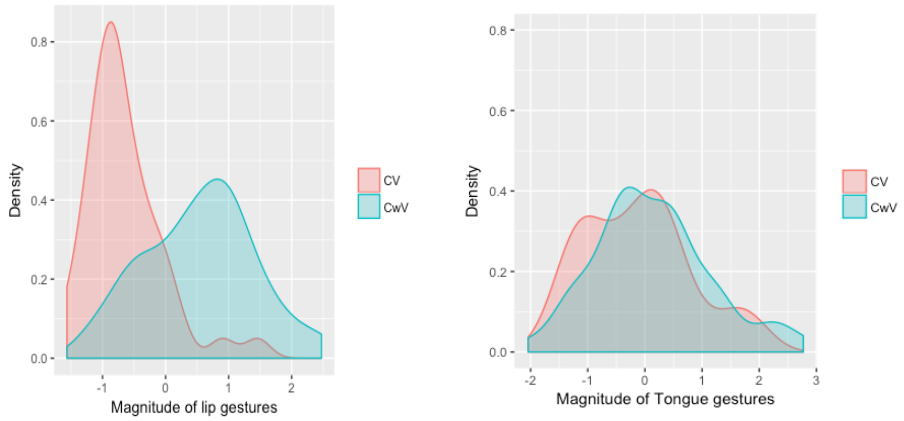

Figure 4.6: Density plot for the amount of lips and tongue gestures for CV and CwV.

Figure 4.6 shows the distribution of the magnitude of lip and tongue gestures, respectively, of CV and CwV sequences. The distribution of the lip gestures shows the evidence of bimodality, showing two totally different distributions for CwV and CV. However, no evidence of bimodality is found in the distribution of the tongue gestures. This indicates that lips certainly make a substantial contribution to the production of /w/ while it is not clear whether tongue makes significantly different gestures for CwV from CV. Therefore, we conclude that lip is the primary articulator for the production of /w/ in Seoul Korean, while tongue makes a secondary contribution. Based on this finding along with the findings that will be presented in the subsequent sections, I argue that the nature of /w/-deletion in Seoul Korean can be better accounted for by the quantitative changes in the amount of overlap of lip gestures, refuting Silva's (1991) claim that /w/-deletion is the process that simplifies articulation of the CwV sequence through the reduction of tongue gestures (Silva 1991).

4.4 Experiment 2: Gradient reduction vs. categorical deletion of /w/

4.4.1 The questions

Now that the articulatory correlates for /w/ in Seoul Korean are established, I seek to probe the gradient and/or categorical nature of /w/-deletion in Seoul Korean. A majority of sociolinguistic studies dealing with the occurrence or deletion rate of a particular segment and the factors governing its production

(e.g. /t, d/-deletion, /g/-dropping, etc.) have generally coded variants in terms of discrete outputs: the retention or deletion of a segment, the alternation arising in the phonological or lexical component of the production system.

Over the decades, however, it has been widely recognized that there are considerable gradient deviations in the pronunciation of words from their assumed canonical form and an increasing number of linguists attempted to take such gradient effects into consideration in accounting for the sound patterns. Some argued that a number of processes of deletion or lenition traditionally assumed to be categorical in nature can be accounted for by gradual phonetic reduction processes (e.g., Browman and Goldstein, 1990, 1992; Fokes and Bond, 1993; Fougeron and Steriade, 1997). In the framework of Articulatory Phonology (Browman and Goldstein, 1990; 1992), in particular, the disappearance of a segment in the speech signal is considered the end point of a gradient phonetic process, by which the segment is obscured by extreme overlap with gestures of adjacent segments. Under this view, a phonetic reduction presents a continuum of realizations ranging from weakly reduced forms with partial acoustic cues to extremely reduced forms with total disappearance of cues in the acoustic signal (Davidson 2006; Helgason & Kohler, 1996; Manuel et al., 1992, *inter alia*).

Yet another position of accounting for these gradient effects distinguishes gradual phonetic reduction from categorical phonological deletion, but posits that the categorical and gradient effects of related phonological processes can

coexist within the same grammar (Robinson, 1976; Kiparsky 1985; Bermúdez-Otero, 2010; 2015, *inter alia*). An increasing number of studies in phonetics, phonology and sociolinguistics have evidenced for the categorical and gradient effects of the related phonological processes. Bermúdez-Otero (2010) argues that /t/ or /d/-deletion in English exhibits both categorical deletion and gradient phonetic reduction. That is, /t/ or /d/ alternates with zero by morphological constraints and, at the same time, /t/ or /d/ exhibits gradient reduction based on gestural overlap with adjacent segments. Burki et al. (2011) also argues that the schwa deletion in French is subject to gradient lenition as well as categorical deletion, by showing that while the disappearance of schwa is conditioned by the duration of the segment, it cannot be accounted for as a pure fast speech or casual speech phenomenon because it may disappear at slow rates and in careful pronunciations as well. Turton (2014) also demonstrates that /l/-darkening in a few varieties of English (e.g. Received Pronunciation, London, Liverpool English) exhibits both the categorical allophony and gradient phonetic effect of darkening. In Erker's (2012) sociophonetic study of Spanish coda /s/, he found that both categorical and gradient effects related to the production of /s/ in Spanish are exhibited depending on the origins of speakers (the Caribbean or Latin America) and whether they recently arrived at or were raised in the city. First, he analyzed the data from a categorical approach by measuring the frication of /s/ by presence or absence and found that the Caribbeans are more

likely to delete /s/ than those from Latin America and among Caribbeans, those who had recently arrived in NYC exhibited a higher deletion of /s/, while those from Mainland did not show any difference in deletion rates regardless of whether they arrived the city recently or not. Secondly, he took a gradient approach by measuring /s/-frication in terms of the center of gravity and found that the NYC-raised speakers showed longer duration and higher center of gravity in their production of /s/. The studies discussed thus far suggest that gradient phonetic details play an important role in shaping the variable sound patterns and that analyzing variable patterns considering the gradient effects along with the categorical effects provides a more complete understanding of the phenomena.

In this light, I aim to provide insight into this debate by investigating the articulatory variability of /w/-deletion in Seoul Korean. Specifically, this study investigates the contribution of phonetic factor, duration, and categorical phonological factor, category, to the magnitude of two articulators, lips and tongue, involved in the production of /w/.

4.4.2 Method

4.4.2.1 Materials

To address the second question of the gradient and categorical nature of /w/-deletion in Seoul Korean, the articulatory data of semi-spontaneous speech data

were elicited. The speakers were asked to freely produce several sentences using each of 28 words (Stimuli Part II), comprising 14 pairs that contrasted CV and CwV (e.g. *twɛji* 'pig' vs. *tɛji* 'earth'). This elicited 523 tokens of semi-spontaneous productions, with multiple tokens per word per talker. As in Stimuli Part I, in all items, /w/ is preceded by a labial, alveolar, or velar segment and followed by a front or nonfront vowel. The full set of stimuli used in the current study is provided in Appendix C.

4.4.2.2 Model construction and statistical testing

Mixed-effects linear regression models were used to examine the effects of DURATION[54] and CATEGORY (CwV and CV) on the magnitude of gestures of each CV and CwV tokens. Using the lmer function from the lme4.0 package in R (R Development Core Team 2014), models were fit separately to the magnitude of lip and tongue gestures, with the SPEAKER and WORD as potential random effects that account for different behavior by individual speakers and words. All fixed-effect predictors were analyzed using sum contrasts.

Models were stepped down from full models and model selection was guided by log likelihood tests as well as Akaike Information Criterion (Akaike, 1974) and Bayesian Information Criterion (Schwarz, 1978) values. Significance levels or p-values were calculated based on Satterthwaite's (1946)

[54]Durational measures were log-transformed from the original raw values to reduce the influence of atypical outliers.

approximations for the degrees of freedom using the lmerTest package (Kuznetsova, Brockhoff, & Christensen, 2013). Tukey's Honest Significant Difference (HSD) test (with alpha set at 0.05) was used for post-hoc comparisons between levels.

4.4.3 Results

Figure 4.8 displays the amount of lip gestures plotted as a function of log duration of CwV and CV sequence.[55] Correlation lines between the amount of gestures and duration are fit separately to each sequence type (CV and CwV) and Pearson's *r*[56] is used to measure the strength of correlation between the amount of gestures and log duration and added to smoothing lines. Correlations are measured using R's basic *cor.test* function, which provides the values of

[55]As discussed in the methods (Section 4.3.2.4.2), log duration of the entire syllable (CwV or CV) is used instead of /w/ itself not only because finding the boundary between /w/ and the following vowel was not always straightforward but also because /w/ tends to coarticulate with surrounding segments, which should be reflected in measuring the amount of articulatory gestures.

[56]Pearson Product Moment Correlation Coefficient, *r*, was used to calculate and measure the strength of a linear association between the amount of gestures and log duration. Drawing a line of best fit through the data of two variables, the Pearson correlation coefficient, *r*, indicates how far away all data points are from the line of best fit. It can take a range of values from +1 to -1. A value of 0 indicates that there is no correlation between the two variables. A value greater than 0 indicates a positive association while a value less than 0 indicates a negative association. The following guidelines have been proposed as to interpreting Pearson's correlation coefficient.

	Coefficient, *r*	
Strength of Association	Positive	Negative
Small	.1 to .3	-0.1 to -0.3
Medium	.3 to .5	-0.3 to -0.5
Large	.5 to 1.0	-0.5 to -1.0

Pearson's *r* as well as p-values (R Core Team 2014). We can see from Figure 4.7 that CwV shows a strong positive correlation between the magnitude of lip gestures and log duration, with a Pearson's value of *r*=0.699 (p=1.235e-05), as opposed to CV which have a much weaker but significant value of *r*=0.375 (p=0.01438). The fact that the lip gesture in CwV is much more strongly correlated with duration than CV strongly suggests that /w/ exhibits a wide range of temporal and gestural variability. In other words, /w/-deletion can be viewed as a gradient process whereby the magnitude of gestures of /w/ is gradiently reduced as a function of duration.

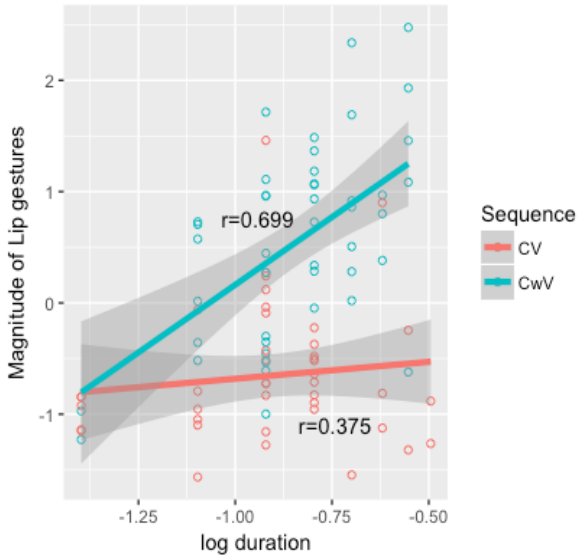

Figure 4.7: The magnitude of lip gestures against log duration. Correlation lines calculated separately for each sequence type and show Pearson's *r* value.

By contrast, the relation between log duration and the magnitude of tongue gestures is somewhat unclear. As Figure 4.8 shows, both CwV and CV show a strong correlation with duration: CwV shows a strong correlation with duration, with a Pearson's value of *r*=0.642 (p=8.513e-07). CV also exhibits a strong correlation with duration, with a Pearson's value of *r*=0.729 (p=2.99e-08). Since CwV and CV exhibit a gradient covariation between the magnitude of tongue gestures and log duration, it is hard to conclude that the phonetic variability in the amount of tongue gestures for CwV is attributable to /w/. Rather, it seems more plausible the durational effects shown here is epiphenomenal. It is notable, for tongue gestures, category does not appear to play a crucial role. Tongue's contribution to making the acoustic and perceptual cues for /w/ in Seoul Korean appears minimal since the amount of tongue gestures is similar for CwV and CV.

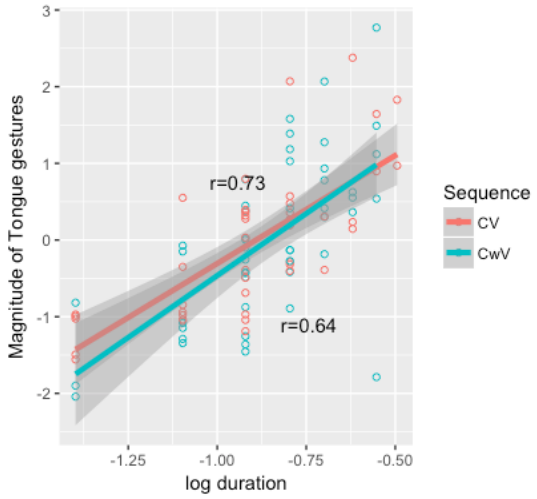

Figure 4.8: The magnitude of tongue gestures against log duration. Correlation lines calculated separately for each sequence type and show Pearson's *r* value.

In order to examine the role of gradience and categoricity through statistical modeling, several linear mixed effects models were constructed and compared in terms of their goodness-of-fit. The log-likelihood test was used for nested models. For non-nested models, the AIC or BIC values were used: a model with a lower AIC or BIC value was considered to have a better fit to the data.

Model	AIC	BIC
M1: Lip gestures ~ log(DURATION)+(1|SPEAKER)	234.50	244.36
M2: Lip gestures ~ CATEGORY+(1|SPEAKER)	204.16	214.02
M3: Lip gestures ~ CATEGORY +log(DURATION) +(1|SPEAKER)	193.39	205.72
M4: Lip gestures ~ CATEGORY *log(DURATION) +(1|SPEAKER)	**184.86**	**199.66**
M5: Lip gestures ~ CATEGORY *log(DURATION)+(1|SPEAKER) +(CATEGORY|SPEAKER)	190.86	213.05
M6: Lip gestures ~ CATEGORY *log(DURATION)+(1|SPEAKER) +(DURATION|SPEAKER)	190.36	212.55

Table 4.1: Comparison of models using AIC and BIC values.

Table 4.1 shows that DURATION alone provides the weakest fit, and CATEGORY does not perform well on its own either. Including DURATION and CATEGORY together provides a better fit but adding the interaction between DURATION and CATEGORY improves on a model even further, suggesting that DURATION behaves differently for the two sequence types. Although a random slope of SPEAKER was also fitted which allowed the model to specify separate intercepts for CATEGORY for each SPEAKER, the model did not create the better fit in terms of AIC and BIC.

	Estimate	SE	t value	Pr(>|t|)
(Intercept)	-0.2038	0.4255	-0.479	0.63398
CATEGORY_CwV	2.9739	0.5808	5.120	2e-06 ***
Duration	0.4896	0.4365	1.122	0.26524
CATEGORY_CwV:Duration	2.1164	0.6454	3.279	0.00153 **

Table 4.2: Summary of the best mixed-effects linear regression model on the magnitude of lip gestures (model 4).

The best model, model 4, is shown in Table 4.2. This demonstrates that, once the interaction between DURATION and CATEGORY is added, the sole effect of DURATION generates a non-significant p-value, highlighting how duration plays a bigger role in the conditioning CwV than CV, as we witnessed in Figure 4.7. The best model indicates that the production of CwV involves significantly larger lip gestures than that of CV, which suggests that the categoricity certainly plays an important role in the realization of /w/. It also reveals that CwV is much more strongly driven by gradient effects than CV, indicating that the production of /w/ is strongly modulated by duration.

To summarize, the findings in this section indicate that the realization of /w/-deletion in Seoul Korean is subject to gradient phonetic effects as well as effects of category. First, there is gradient phonetic effects of duration, with which the model improves significantly. The amount of articulatory gestures for /w/ significantly increases as the duration of CwV increases whereas there is no such strong durational effect for the CV tokens. At the same time, category plays

an important role in accounting for the majority of the variation in this model, producing a much better fit of the data.

4.5 Quantitative changes in the gestural overlap and the development of /w/-deletion in Seoul Korean

4.5.1 Questions

Now that the articulatory correlates for /w/ in Seoul Korean are defined (Section 4.3) and the categorical and gradient nature of the realization of /w/ is established (Section 4.4), I seek to investigate the synchronic variation and diachronic change of the /w/-deletion patterns in Seoul Korean in terms of gradient articulatory gestures. Specifically, I examine whether there is a generational difference in the gestural patterns indicating a diachronic change at the articulatory level. In Chapter 3, I demonstrated that there is an ongoing change where younger speakers are subject to weaker influence of preceding segments on /w/-deletion at a higher level. Speakers born before 1970 deleted /w/ after a bilabial much more often while speakers born after 1970 did not delete /w/ in the post-bilabial context as much often. In this regard, it will be tested whether the gestural coordination patterns between /w/ and a preceding segment in Seoul Korean have changed quantitatively in tandem with the weakening of the influence of preceding phonology at a higher level. The prediction is that speakers above 45 years of age will show the patterns sensitive

to preceding segment while speakers age 45 and under will not show such an articulatory pattern.

To this end, the speakers from different generations are compared in terms of the amount of lip and tongue gestures involved in the production of /w/ (Section 4.5.3.1 and 4.5.3.2). In addition, a possible change in the effect of duration is investigated in relation to this change in Section 4.5.3.3. It will be shown that the changes of /w/-deletion in Seoul Korean are better accounted for in terms of the changes in the amount of lip gestures involved in the production of /w/ rather than those of tongue gestures. That is, older speakers exhibit a smaller amount of lip gestures for /w/ when /w/ is preceded by a bilabial, while younger speakers show similar amount of lip gestures regardless of what precedes /w/, which aligns well with the generational changes demonstrated in Chapter 3. The results show that older speakers exhibit strong durational effects while younger speakers do not show such strong gradient phonetic effects in /w/-deletion. All these findings point to the conclusion that /w/-deletion in Seoul Korean is going through the phonological and phonetic change whereby it dephonologizes into a categorical deletion process, losing the phonological conditioning as well as much of gradient phonetic effects.

4.5.2 Method

4.5.2.1 Materials

To investigate the diachronic change in the articulatory patterns across speech styles, both careful speech (Stimuli Part I) and casual speech (Stimuli Part II) were analyzed. Details of these stimuli sets are described in Section 4.3.2.1 and 4.4.2.1.

4.5.2.2 Model construction and significance testing

Mixed-effects linear regression models were used to model the relationship between the magnitude of gestures for /w/ and two explanatory predictors governing /w/-deletion process: PRECEDING SEGMENT (labial, alveolar, velar) and FOLLOWING VOWEL (front, nonfront). In quantifying the magnitude of gestures for *w*, the difference between the magnitude of movement (MM) for CwV and mean MM of CV (MM of each CwV tokean - mean MM of CV) was used instead of the magnitude of /w/ itself, for the following two reasons. First, determining the boundary between /w/ and the following vowel was not always straightforward because the transition from /w/ to the following vowel is quite smooth. Another reason for using the delta value is that since /w/ heavily coarticulates with surrounding gestures, considering the whole sequence is more advantageous in seizing the global movements of articulators. The magnitude of /w/ in /pwi/, for example, was measured by subtracting the

mean magnitude of all tokens of/pi/ from the magnitude of a token of /pwi/. Quantitative analysis is performed on these delta values as a proxy for the amount of gestures left purely for /w/ after the gestural reduction or overlap with neighboring segments. It is assumed that the larger this difference is, the more robust and salient the acoustic and perceptual cues for /w/ are.

The fixed-effects of PRECEDING SEGMENT (labial, alveolar, velar) and FOLLOWING VOWEL (front, nonfront) on the difference between the magnitude of CwV and mean MM of CV (MM of CwV - mean MM of CV) were tested as well as their interactions with SPEAKER AGE in order to examine the changes in the gestural patterns over time. Using the *lmer* function from the lme4.0 package in R (R Development Core Team 2014), models were fit separately to the magnitude of lip and tongue gestures, with the SPEAKER and WORD as potential random effects that account for different behavior by individual speakers and words. All fixed-effect predictors were analyzed using sum contrasts.

Models were stepped down from full models and model selection was guided by log likelihood tests as well as Akaike Information Criterion (Akaike, 1974) and Bayesian Information Criterion (Schwarz, 1978) values. Significance levels or p-values were calculated based on Satterthwaite's (1946) approximations for the degrees of freedom using the lmerTest package (Kuznetsova, Brockhoff, & Christensen, 2013). Tukey's Honest Significant

Difference (HSD) test (with alpha set at 0.05) was used for post-hoc comparisons between levels.

4.5.3 Results

4.5.3.1 Lip gestures

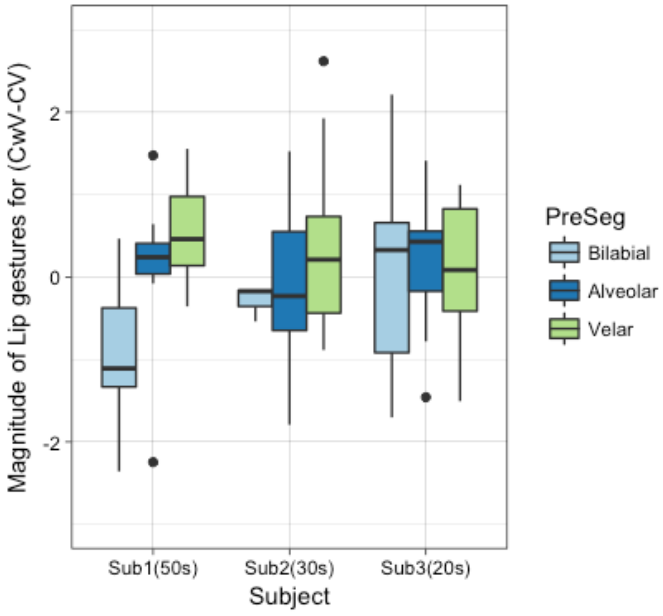

Figure 4.9: Magnitude of lip gestures by Preceding consonant and Speaker.

Figure 4.9 plots the magnitude of lip gestures by PLACE OF PRECEDING CONSONANT and SPEAKER. The strikingly different patterns are found between two age groups. The older speaker in her 50s (Sub1) exhibits much smaller lip gestures when /w/ is preceded by a bilabial compared to an alveolar or a velar. This can be interpreted as there exists a substantially larger reduction or overlap of lip gestures when a bilabial precedes /w/. By contrast, the amount

of lip gestures for /w/ is similar across contexts for younger speakers in her 20s and 30s (Sub2 and 3), which suggests that younger generations show similar amount of gestural reduction for /w/. This generational difference in the gestural pattern suggests that the gestural strategies Seoul Korean speakers employ in producing CwV have changed over generations. Among older speakers, there is a greater amount of gestural overlap between /w/ and a preceding bilabial that share the same articulator set, lips. It is well-established that the magnitude of gestures for a segment is greatly reduced when a segment is adjacent to homorganic segment(s). Over time, however, younger generations appear to have developed a new strategy of coordinating among gestures, which resulted in a smaller amount of gestural overlap between /w/ and a preceding bilabial.

The results from the linear mixed effects model fitted on the magnitude of lip gestures (see Table 4.3) confirm this, showing a significant interaction between PLACE OF PRECEDING SEGMENT and SPEAKER AGE ($\chi^2(2)= 6.5646$, $p=0.03754$*). The results show that younger speakers, compared to older generations, exhibit significantly smaller lip gestures for /w/ when /w/ is preceded by an alveolar or a velar compared to a bilabial.

	Estimate	SE	t value	Pr(>|t|)	
(Intercept)	-0.9950	0.2852	-3.488	0.000769	***
PreSeg_Alveolar	-1.0108	0.4234	2.387	0.019165	*
PreSeg_Velar	1.3017	0.3631	3.585	0.000558	***
Age_Young(20s-30s)	0.8514	0.3830	2.223	0.028832	*
FolVowel_Nonfront	0.5539	0.2119	2.614	0.010572	*
PreSeg_Alveolar* Age_Young	-0.9567	0.5294	-1.807	0.074229	.
PreSeg_Velar* Age_Young	-1.0897	0.4809	-2.266	0.025979	*

Table 4.3: Estimated coefficients for the magnitude of lip gestures of (CwV − CV).

Still, PLACE OF PRECEDING CONSONANT remains highly significant ($\chi^2(2)=9.0651$, p=0.01075*): the amount of lip gestures is significantly reduced when a bilabial precedes /w/. FOLLOWING VOWEL also proves to condition the amount of lip gestures significantly ($\chi^2(1)=7.1088$, p=0.00767*): the magnitude of lip gestures is significantly smaller when /w/ is followed by a front vowel (Figure 4.10). This can be attributable to the coarticulation between /w/ and a following vowel. The lip spreading gestures for the front vowels /i/ and /e/ can significantly interfere with the lip rounding gestures for the production of /w/.

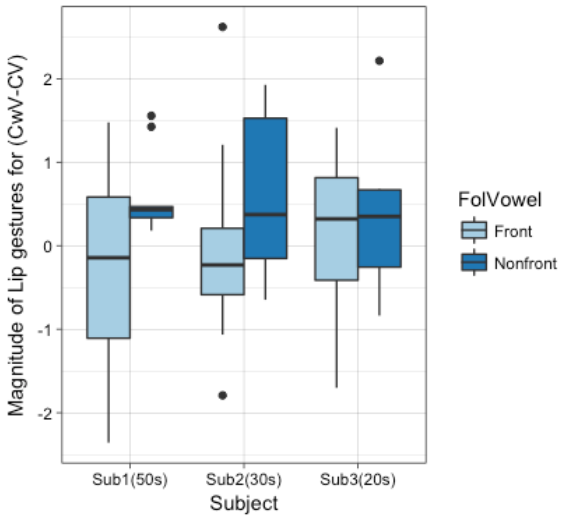

Figure 4.10: Magnitude of lip gestures by following vowel.

4.5.3.2 Tongue gestures

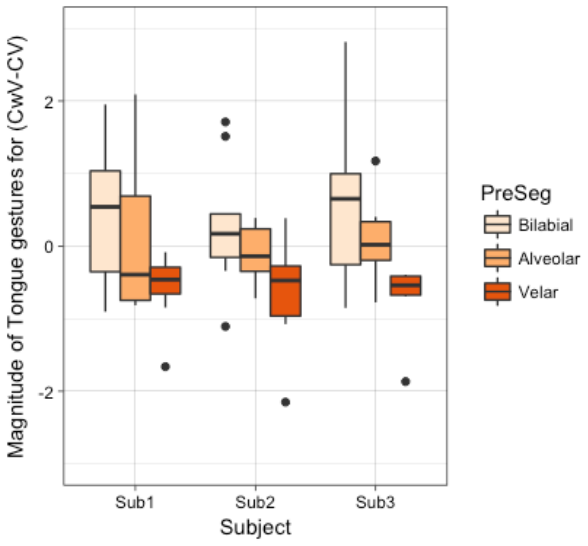

Figure 4.11: Magnitude of tongue gestures by place of preceding consonant.

Thus far, it has not been very clear whether the tongue is involved in the production of /w/ in Seoul Korean at all, because the amount of tongue gestures for CwV was not significantly different from that of CV. The linear mixed effects model fitted on the magnitude of tongue gestures for /w/ (Table 4.4), however, reveals that the magnitude of tongue gestures is conditioned by place of preceding consonant ($\chi^2(2)=9.18$, p=0.01018 *): the magnitude of tongue gestures is significantly smaller when /w/ is preceded by a velar compared to when /w/ is preceded by a bilabial across all subjects (Figure 4.11). This can be attributable to gestural overlap between /w/ and a preceding velar consonant sharing the same articulator, the tongue dorsum. I argue that this can taken as evidence showing that tongue still makes significant contribution to the production of /w/. If Korean /w/ does not involve any tongue gesture at all, the amount of tongue gestures should be more or less similar across different preceding segments. Therefore, I conclude that tongue dorsum movement can be considered a secondary but still important articulatory correlate for the production of /w/ in Seoul Korean.

	Estimate	SE	t value	Pr(>|t|)	
(Intercept)	0.4304	0.2031	2.12	0.03798	*
PreSeg_Alveolar	-0.4076	0.284	-1.435	0.15621	
PreSeg_Velar	-0.9064	0.2906	-3.119	0.00273	**

Table 4.4: Estimated coefficients for
the magnitude of tongue gesturesfor (CwV − CV).

4.6 Discussion

This chapter has investigated the nature of realization and deletion of /w/ in Seoul Korean and how the articulatory patterns regarding /w/-deletion changed over time. The three main findings of this chapter can be summarized as follows. First, the primary articulatory correlate of /w/ in Seoul Korean is lip rounding while tongue dorsum raising serves as a secondary articulatory feature. Second, there is evidence for both gradient and categorical effects in the realization and deletion of /w/ in Seoul Korean. The gradient reduction of /w/ is evidenced by the significant durational effect on the production of /w/ in Seoul Korean. Simultaneously, the categorical alternation between /w/ and zero is demonstrated by a significant role CATEGORY plays on the magnitude of lip gestures for CV and CwV. Third, the generational difference in the gestural patterns involved in /w/-deletion in Seoul Korean is evidenced, which can indicate the diachronic change at the articulatory level. The magnitude of lip gestures is significantly conditioned by a preceding consonant for the older generation but the effect of preceding consonant is not as much strong among younger speakers, which suggests a generational change. These findings are discussed more in depth in the following subsections.

4.6.1 Phonological and phonetic representation of glides

The finding that /w/ in Seoul Korean involves the primary articulation of lips while tongue makes a secondary contribution has an important implication for the controversy regarding the phonological and phonetic representation of glides that has not been resolved for decades. Halle et al. (2000) and Halle (2005) argue against the existence of dorsal glide, claiming that the crucial distinction between vowels and glides is place of articulation and the designated articulator of all vowels is [Dorsal]. Nevins and Chitoran (2008) refute this claim, arguing instead that glides have two designated articulators and /w/ is both [Dorsal] and [Labial]. They further hypothesized that the cross-linguistic distinction between vocalic and consonantal behavior of glides is reflected phonetically in the relative magnitude of one or the other of the two gestures. They predicted that the glides with a relatively larger dorsal gesture would alternate with dorsals, and the glides with a relatively larger non-dorsal gesture would alternate with non-dorsal consonants. It indeed is the case that Seoul Korean /w/ proves to have larger bilabial gesture than tongue gestures in this study and it alternates with a bilabial consonant as in (2).

(2)

/nup+ə/ > [nuwə] ‘lie down’

/kup+ə/> [kuwə] ‘bake’

(cf. /kup+ko/> [kup. ko] 'to bake and')

Therefore, I concur with Nevins and Chitoran (2008) and conclude that /w/ in Seoul Korean involves both the gestures of lips and tongue dorsum but the more consonantal nature of /w/ is reflected in the larger magnitude of lip gestures.

4.6.2 The coexistence of gradient and categorical effects of /w/-deletion

The results of this study indicate that categorical deletion and gradient reduction of /w/ coexist in Seoul Korean. That is, the disappearance of /w/ in the speech signal may have originated both from a gradient phonetic reduction and a categorical phonological deletion process. These findings carry important theoretical implications regarding the nature of segmental deletion.

The nature of segmental deletion has been subject to debate. Deletion has been described in many sociolinguistic studies as a categorical alternation between one and zero in a majority of sociolinguistic studies (e.g. /t, d/-deletion, /g/-dropping, etc.), while other studies have considered it to be the end point of a gradient phonetic process, by which the segment is obscured by extreme overlap with gestures of adjacent segments (e.g., Browman and Goldstein, 1990, 1992; Fokes and Bond, 1993; Fougeron and Steriade, 1997). Yet another approach argues that categorical and gradient effects of related phonological processes can coexist within the same grammar (Robinson, 1976; Kiparsky 1985; Cohn, 1990; 1998; Zsiga, 1995, Bermúdez-Otero, 2010; 2015, *inter alia*). This study provides

insight into this debate by demonstrating the coexistence of categorical deletion and gradient reduction contributing to shaping the surface variations of /w/-deletion. The findings of this study reaches beyond /w/-deletion in Seoul Korean, since they can be applied to any phenomena involving segmental deletion.

4.6.3 Articulatory and gestural approach in language variation and change

The articulatory and gestural changes with regard to /w/-deletion demonstrated in this chapter are not only consistent with the sociolinguistic patterns found based on the auditory and acoustic analyses for the diachronic change of /w/-deletion (Chapter 3) but present a fuller picture of the phenomena by demonstrating the variable patterns found at the articulatory level, which hints at what happens at the lower level of our grammar when sound changes take place at a higher level. While the variable deletion of /w/ is being reanalyzed as a general deletion rule at a community level, the changes took place in the gestural coordination between /w/ and a preceding segment: the amount of overlap between two decreased over time, which led to the enhancement of the perceptual cues of /w/.

This articulatorily-informed variationist study shed light on the fundamental question of how the changes at the articulatory level are manifested. The findings of this study demonstrate how the difference between two successive

generations is reflected in articulatory gestures when a sound change takes place in the community. This apparent time change at the articulatory level is an important demonstration of how the gestural coordination can be reorganized across generations, which in turn makes an impact on the changes at a higher level.

While I can only speculate at this point about how the patterns of /w/-deletion have evolved over time, the following is one possible scenario I would like to entertain based on all the pieces of evidence found in this dissertation. It is highly probable /w/-deletion originated as intrinsic phonetic effects as two subsequent gestures sharing the same articulator sets, /w/ and a preceding bilabial, overlap more frequently. Once speakers reanalyzed this as a phonological effect and the innovation was set in motion, /w/-deletion trended towards more deletion and expanded its contexts, even to the non-postconsonantal position (Silva, 1991; Kang, 1997). While the deletion of /w/ rose in the Seoul speech community, a very large number of migrants from other dialect regions were absorbed into the population of Seoul, which made the original population of Seoul in an absolute minority which is less than ten percent of the entire city population. It justly resulted in numerous dialect contacts among adult speakers, which created the right environment for the diffusion of the original /w/-deletion system of Seoul Korean. The diffusion process, by its nature, led to the failure of replicating the structural details of the

system: the effect of preceding phonology has weakened both on postconsonantal and non-postconsonantal /w/-deletion and the effects of following vowel and speech style on non-postconsonantal /w/-deletion have grown stronger. In the meantime, /w/-deletion in postconsonantal position has retreated perhaps due to the orthographic influence and the negative social evaluation towards /w/-deletion. In contrast, /w/-deletion in non-postconsonantal position rose vigorously throughout the time. As a consequence, the youngest cohort exhibit the similar rate of /w/-deletion in postconsonantal and non-postconsonantal position that now share the same set of the constraints in the same order of significance. This indicates that the subsequent generations of children have reinterpreted the rule and treated the two rules as if they were the same. Before the innovation took place at the phonological level, individual speakers may have made changes in the gestural coordination between /w/ and a preceding segment by reducing the amount of overlap between the two.[57] It is plausible the gradient reduction of the articulatory gestures for /w/ served as a precursor to the sound change of /w/-deletion. That is, the articulatory changes of individual speakers may have play an important role in the diachronic change of /w/-deletion. As an increasing number of Seoul Koreans made gestural

[57] This can perhaps be seen as a case of the dephonologization process whereby phonetic naturalness of the rule is lost. Kirby (2013) demonstrates that there is another dephonologization process underway in Seoul Korean: the dephonologization of voicing that used to be a primary cue in signaling the three-way laryngeal contrast. Instead, F0 difference is enhanced and phonologized to replace the original voicing contrast of consonants.

adjustments between /w/ and its preceding segment, the subsequent generations of children as well as other members of the speech community are more likely to heed to the difference and choose to reproduce the modified gestural coordination (Lindblom et al. 1995). In the case of /w/-deletion in Seoul Korean, this kind of mini-sound changes within an individual's grammar appears to have eventually proceeded to become a sound change at the community level.

Chapter 5

Conclusion

5.1 Review of the goals and the summary of the findings

This dissertation had two aims. The first was to track the progress of the ongoing sound changes involved in /w/-deletion in Seoul Korean using a real-time as well as the apparent time data. In Chapter 3, using the real-time trend method, I re-studied the speech community of Seoul where /w/-deletion has been studied previously (Kang, 1997), and provided the answers to three specific questions on the basis of the corpus data collected in 1997 and 2017. First, I assessed the community change of /w/-deletion in postconsonantal position and demonstrated that /w/-deletion in postconsonantal position that trended toward more deletion in the past (Kang, 1997) has begun to retreat, beginning with the speakers born in 1970s. Second, I examined the trajectories of the change of /w/-deletion in non-postconsonantal position and showed that the deletion of /w/ in non-postconsonantal position has been rising vigorously throughout the time. As a result, I find that the youngest group in the corpus show similar deletion rates of /w/ in postconsonantal and non-postconsonantal position. Third, I investigated the possible change(s) in the effects of constraints governing

the deletion, comparing the results from the generalized mixed-effects model on the 2017 dataset with the results of the multivariate analyses on the 1997 dataset. The results revealed that the effect of preceding phonology has weakened both on postconsonantal and non-postconsonantal /w/-deletion. Place of preceding segments that used to exert the strongest influence on /w/-deletion in the past appears to have lost much of its effect on /w/-deletion. Concomitantly, for non-postconsonantal /w/-deletion, the effects of following vowel and speech style that did not have a significant impact in the past, grew stronger, which led postconsonantal and non-postconsonantal /w/-deletion to have the same set of the constraints in the same order of significance. Therefore, I concluded that /w/-deletion in Seoul Korean is being reanalyzed with the structural details being diluted over time. I argued that the weakening of the original patterns of /w/-deletion in Seoul Korean and the reorganization of the rule can be seen as the outcomes of the diffusion process which usually results in the loss of structural constraints in the process due to the imperfect nature of adult language learning. A great influx of migrants into Seoul from other dialect regions in the second half of the century after the Korean War, I argued, is attributable to creating the right environment for the linguistic diffusion within a community. Lastly, I discussed how can we link the change at the community level to the inception of sound change in an individual's grammar, by discussing how these changes are manifested at the articulatory level.

The second goal of this dissertation was to address the variation and change at the articulatory level. In Chapter 4 of this dissertation, I presented a study of articulatory variation and change of /w/-deletion in Seoul Korean based on the ultrasound data of tongue movements as well as the video data of lip rounding for the production of /w/. Before proceeding to provide an articulatory account of variation and change of /w/-deletion in Seoul Korean, I addressed the two important issues regarding the nature of /w/-deletion process in Seoul Korean that laid a foundation for answering the question I eventually aim to get at. The first was to define the articulatory correlates of /w/ in Seoul Korean. The data revealed that lip rounding is the primary articulatory correlate of /w/, while the raising of tongue dorsum is the secondary articulatory feature for /w/ in Seoul Korean, the finding that has an important implication for the controversy regarding the phonological and phonetic representation of glides. The second issue I addressed was the gradient and/or categorical nature of /w/-deletion. I demonstrated that /w/ in Seoul Korean is subject to both gradient phonetic reduction and categorical phonological deletion: the gradient reduction of /w/ was evidenced by the significant durational effect on the production of /w/ in Seoul Korean while the role of category is demonstrated by a significant effect of category on the magnitude of lip gestures for CV and CwV, the finding that carry important theoretical implications for the nature of deletion process of any segments in world's languages. Finally, I aimed to provide the articulatory

account of the variation and change of /w/-deletion in Seoul Korean and showed that there is a generational difference in the magnitude of articulatory gestures involved in /w/-deletion in Seoul Korean, which suggests the diachronic change at the articulatory level. The effect of preceding consonants for the older generation is substantial for older generation, whereas it is not so strong for younger speakers. Also, younger speakers showed a significantly smaller amount of overlap or reduction of bilabial gestures for /w/ and a preceding bilabial compared to their older counterparts. These articulatory or gestural changes with regard to /w/-deletion are not only consistent with the weakening of the effect of preceding articulation found in the variationist analyses based on the auditory and acoustic analyses for the diachronic change of /w/-deletion in Chapter 3 but also present a fuller picture of the phenomena by demonstrating the variable patterns found at the articulatory level.

5.2 Implications

The findings of this thesis have substantial implications for a wide range of important issues including the mechanism of transmission and diffusion of linguistic innovations, articulatory variation and change and language change more generally.

First, the findings of this thesis inform the process of diffusion, one of the two different mechanisms of language change. I demonstrated that the patterns of

/w/-deletion observed today are the outcomes of diffusion. Although the diffusion of linguistic innovations usually takes place across communities, I showed that a similar process of diffusion could have taken place under unusual historical and social circumstances where a majority of the population of the city is composed of migrants from other dialect regions (see Section 3.6.1 in Chapter 3 for more details). I also argued that the faithful transmission was also involved although the child learners of the Seoul Korean appears to have failed to replicate the original system since more than 90% of the parent generation could not provide the accurate input for them. Also, they may have missed the last chance to replicate the original patterns by vernacular reorganization because most of their peers are also the children of migrants who are not likely to have the Seoul system. Therefore, the results of this study serve as an important demonstration of how a combination of transmission and diffusion can shape an unusual trajectory of a phonological change over time under unusual social contexts. This dissertation further demonstrates that sound patterns are not just determined by our cognitive faculty but rather they are the contingent products of the interaction of a wide range of linguistic and language-external factors over time (Anderson, 2006; Mielke et al., 2013).

This thesis is important also because it provides one of a handful real-time trend studies tracking the diachronic changes of Seoul Korean based on the speech of speakers from a wide range of social characteristics in terms of age,

gender, social class, etc. Rather than merely confirming the apparent-time interpretation in the previous studies, the real-time trend study presented in Chapter 3 provides a fuller understanding of the historical development of /w/-deletion in Seoul Korean. This study, therefore, provides a vivid illustration of a sound change currently in progress in Seoul Korean, still largely under- studied variety in the studies of variation and change (Brown and Yeon, 2015).

The findings of the articulatory study of variation and change of /w/-deletion presented in Chapter 4, the first articulatory study carried out within a variationist approach in Seoul Korean, offer explanations extending into diverse realms as the phonological and phonetic representation of glides, the categorical and gradient nature of segmental deletion and the nature of articulatory variation and change. The findings here adds to the growing body of literature highlighting the importance of fine articulatory details in understanding language variation and change, by demonstrating the generational change at the articulatory level in Seoul Korean. This study calls attention to the importance of articulatory insight in understanding the mechanism of language variation and change. I hope the data presented in this study fit a small but significant piece into the puzzle of investigating the role of articulatory details in language variation and change and that this study will provide stimulus and inspiration for more research examining fine articulatory details of various sociolinguistic patterns.

5.3 Directions for future work

This dissertation suggests many important avenues for future research that should provide a clearer understanding of the phonological and phonetic change of /w/-deletion in Seoul Korean, articulatory variation and change invovled in /w/-deletion in Seoul Korean and sound changes in Seoul Korean more generally.

First of all, further investigation into the pattterns of /w/-deletion in other dialect areas are required in order to better understand how /w/-deletion patterns of native Seoul Koreans have diffused into speakers of other dialects and how the Seoul system was influenced by other dialects as well. The examination of each dialect regions' older speakers who lived in their hometowns throughout their lives will reveal the original system of /w/-deletion in each dialect region. Comparing these original systems with the /w/-deletion patterns of those who have relocated to Seoul from other dialect regions will demonstrate how the diffusion process diluted the original pattern of Seoul Korean and resulted in the loss or weakening of the structural details. Besides, comparing the two groups of Seoul-born speakers with parents who are native to Seoul and those whose parents are from other dialect regions will also elucidate how differently the original patterns of /w/-deletion of Seoul Korean have been

transmitted to successive generations. This will shed light on the interaction of the processes of second dialect acquisition and transmission as well.

Another important question this thesis has not tackled is how much lifespan change and age-grading contributed to the overall change of /w/-deletion.[58] Even though the apparent time construct traditionally posits that individuals' language largely remains stable after the critical period, recent studies of language change across the lifespan demonstrate that adult speakers can make a modest but significant change in their language in the direction of ongoing changes in the community measured by apparent time or a real-time trend study (Yaeger-Dror, 1994; Harrington, 2006; Sankoff and Blondeau 2007; Kwon, to appear, *inter alia*). Another possible effect that can also be involved in the real-time community change is that of age-grading. Labov (1994: 86-98) reviewed several real time studies including Trudgill's (1988) restudy of Norwich, Cedergren's (1987) restudy of Panama City and Fowler's restudy of (r) in New York City and concluded that age-grading can be observed in the process of real-time change for certain types of linguistic change. The retreat of postconsonantal /w/-deletion, in particular, is highly likely to show the effects of lifespan change or age-grading because it is change from above influenced by standard language

[58]The lifespan change and age-grading at the individual speaker level are not mutually exclusive with community level change, but rather, both can be involved in the mechanism of real-time change. Chambers (2009) show that the age-grading effect can be superimposed on the pattern of phonological change. Sankoff and Blondeau (2007) demonstrated that some groups of speakers make significant lifespan changes by participating in the change in progress of the speech community.

features. Considering that the deletion of /w/ in one's speech is often an object of stigmatization and ridicule, speakers more implicated in the "linguistic market" (D. Sankoff and Laberge 1978) are likely to retain /w/ more than other age-groups, especially the youngest and oldest cohorts. This will certainly produce some age-grading pattern. The stigma associated /w/-deletion in Seoul Korean may have led the adult speakers, especially those in upper social class, to avoid deleting /w/, which may eventually led many adult speakers to move toward the direction of the ongoing change in the community during their lifetime. In this light, comparing the same informants over an extended period of time through a real-time panel study will shed light on how age-grading or lifespan change of individual speakers contributed to the historical change of /w/-deletion at the community level. As Sankoff and Blondeau (2007) pointed out, although real-time trend studies provide the best use of resources when it comes to tracking language change in progress, a combination of trend and panel components is crucial in building more informed models of the relationship between language change in the historical sense and language change as experienced by individual speakers.

For a more nuanced understanding of how social meaning has influenced the trajectory of change of /w/-deletion, further investigation into the socio-indexicality of /w/-deletion in Seoul Korean will be necessary. Although we have a rough understanding that /w/-deletion is associated with negative traits

such as 'uneducatedness, sloppiness, etc.', no systematic study has been carried out to scrutinize what socio-indexical properties are attached to the *w*-deleted variant depending on contexts, social characteristics of speakers and hearers.[59] This line of research will unveil how the social meaning contributed to trajectories of the change of /w/-deletion in Seoul Korean.

There are a number of open questions that I plan to pursue in future work of articulatory variation and change as well. It remains to be seen whether we can obtain further evidence of categorical deletion and gradient reduction of /w/-deletion. The immediate next step would be to examine whether /w/ exhibits categorical and gradient effects according to the various phonological contexts (post-bilaibal, alveolar, velar, etc.), prosodic positions (utterance-initial position, phrase-initial position, word-initial position, etc.) and different levels of the grammar (stem, word and phrase level). Further work with larger number of speakers is certainly required in order to test whether the speakers in this study are representative of each age group.

[59]Garrett and Johnson (2013) demonstrate that certain groups of individuals are more likely to attach social meaning to the different realizations of phonological variables than others, which eventually drive the sound change.

Appendix A

Demographic Information of the Speakers

Speaker	YOB	Sex	Social Class	Educ[60]	Occupation
Sub01_GH	2002	M	Working	High school	High school student
Sub02_KH	2001	M	Upper	National Uni.	High school student
Sub03_YS	1964	M	Upper	Regional U.	Professor
Sub04_HS	1975	F	Working	Community college	Assistant at a hospital
Sub05_HB	1987	F	Middle	National Uni.	Governmental official
Sub06_HJ	1986	F	Working	National Uni.	Governmental official
Sub07_DS	1997	W	Working	High school	High school student
Sub08_JEK	1988	F	Middle	Regional Uni.	Works for IT company
Sub09_JW	1979	M	Middle	National Uni.	Works for IT company
Sub10_DP	1958	M	Working	High school	Unemployed
Sub11_JY	1979	F	Upper	National Uni.	Housewife
Sub12_SY	1981	F	Upper	National Uni.	Designer
Sub13_NF	1955	M	Upper	National Uni.	Former CEO
Sub14_HYJ	2000	F	Upper	National Uni.	College student

[60] For the youngest speakers in our dataset, the education level they have attained thus far does not represent their education level accurately; one of the two 15-year-old male speakers had an aspiration to go on to a prestigious university and he was doing very well in school, while the other 15-year-old had no such aspiration and wanted to be a carpenter right after he graduated from a vocational high school. For speakers such as these, the projected education level was used.

Sub15_IS	1940	F	Middle	High school	Housewife
Sub16_YK	1964	M	Middle	Regional college	Tennis coach
Sub17_YD	1981	M	Middle	National Uni.	Banker
Sub18_RJ	1968	F	Middle	Regional U.	Cooking lady
Sub19_HK	1995	M	Middle	National Uni.	College student
Sub20_YJ	1994	F	Middle	National Uni.	Student
Sub21_YS	1996	M	Working	High school	Recreational instructor
Sub22_YO	1930	F	Working	Middle school	Unemployed
Sub23_SJ	2000	F	Working	High school	Factory worker
Sub24_YR	1990	F	Middle	National Uni.	College student
Sub25_Joon	1983	M	Working	Regional U.	Bartender
Sub26_Min	1991	F	Working	Community college	Student
Sub27_SH	1932	F	Working	No schooling	Unemployed
Sub28_JY	1977	F	Working	Community college	Housewife
Sub29_SY	1980	M	Working	Regional U.	Self-employed
Sub30_JM	1960	F	Middle	Regional U.	Housewife
Sub31_JF	1952	M	Middle	Regional U.	Retired (former high school teacher)
Sub32_YE	1989	M	Middle	National Uni.	Graduate student
Sub33_MS	1961	F	Working	High school	Nanny
Sub34_YHJ	1999	M	Middle	National Uni.	High school student
Sub35_HJY	2000	F	Working	Regional U.	High school student
Sub36_CJY	1998	F	Middle	Regional U.	High school student
Sub37_CMJ	1996	F	Middle	Regional U.	High school student
Sub38_HJH	1997	F	Middle	Regional Uni.	High school student
Sub39_GI	1985	F	Upper	National Uni.	Works for IT company
Sub40_HR	1984	F	Middle	National Uni.	Housewife
Sub41_AOK	1953	F	Working	High School	Cooking lady
Sub42_IR	2003	F	Working	High School	High school student
Sub43_HW	1995	M	Upper	National Uni.	College student

Sub44_HJ	1997	F	Upper	National Uni.	College student
Sub45_NH	1965	M	Working	High School	Unemployed
Sub46_HH	1979	M	Middle	National Uni.	High school teacher
Sub47_HY	1950	F	Upper	Regional Uni.	Housewife
Sub48_WS	1953	F	Upper	National Uni.	Housewife

Appendix B

Sociolinguistic Interviews

I. Examples of interview modules (for 40s-60s)

- Hometown
- The cities you have lived more than 6 months
- Who are the three people whom you interact with the most frequently?
- What are the things you are most interested these days?
- Can you tell me about your family? Do you spend a lot of time with your family?
- 선생님의 일에 대해서 조금 들어볼 수 있을까요? 어떤 일을 하시고 일하시는 것에 행복을 느끼시나요?
- 배우자를 어떻게 만나셨나요? 결혼에 골인하기 까지 러브스토리를 조금만 들어볼 수 있을까요?
- 대학시절 가장 기억에 남는 추억이 있으신가요?
- 젊을 때 가장 잘했다고 생각하시는 것과 하지 않아서 가장 후회스러운 부분은 무엇인가요?
- 자녀교육에 가장 신경 쓰시는 부분이 어떤 부분인지 여쭤봐도 될까요?
- 친구와의 추억중에 가장 생각나는 일이 있으신가요? 같이 여행 간 적은요?
- 부모님께 가장 자랑스러웠던 순간과 가장 죄송했던 순간은 언제이신가요?

II. Reading task

1. 예컨대, 왜구가 대나무로 공격한 것을 의미해.
2. 시간 외 근무수당이 늦게 지급되어 진희를 애태웠었어.
3. 외숙모댁에 데릴사위가 와 있더라구.
4. 그는 해괴망측한 점괘로 속임수를 쓰고 있었어.
5. 아무리 더 의뢰해보아도 더 이상의 에누리는 업대.
6. 게딱지를 집게로 들어 봐.
7. 카메라를 네모진 가방안에 넣어 놔.
8. 모레 태권도 시합이 예정되어 있대.
9. 계속 꾀병을 부리면 팀에서 제외될 위기에 처한 거지.
10. 빨간펜으로 내천 위치와 배의 궤적을 표시해봐.
11. 일례로, 파리채를 가위로 잘라버린 사건이 있지.
12. 의사선생님과 약속이 있대.
13. 주희는 의상학과를 가고 싶어해.
14. 수연이는 부모님과 상의하지 않았대.
15. 보원이는 사과를 들고 있었어.
16. 형의 소원은 그곳에 가보는 것이다.
17. 파란 이 잎과 예쁜 꽃이 어울려요.
18. 아버지를 학교 입구에서 봤어요.
19. 사과가 잘 익고 있어요.
20. 어제 이익과 손실을 계산해 봤어요.
21. 밥과 국이 식고 있어요.
22. 진원이 회사는 한화그룹의 자회사니까.
23. 삼월에는 뭔가를 해보겠어.
24. 그의 계산은 아주 정확했다.
25. 참외를 먹고 아버님을 뵙다가 야단 맞았다.
26. 관둬라. 그냥 둬.
27. 지원이는 의예과에 다니고 있어.
28. 그 마을은 이제 폐허가 됐다.
29. 폐기가 된 것들은 여기다 버려.
30. 뒷산에 귀신이 나타났다는 소문이 퍼졌다.

31. 튀는 공을 꼭 잡기는 힘들다.
32. 그 죄수는 족쇄를 찬 기분으로 쉬어도 쉰 것 같지 않았다.
33. 내 실수를 넓은 마음과 이해로 예쁘게 봐 줘.
34. 석좌교수님은 좌석에서 일어났다.
35. 위험하게 추월하려 하지마.
36. 그해에 도량형 통일과 화폐개혁이 있었다.
37. 그는 죄인의 수의를 입고 있었다.
38. 저 기와집을 계단에서 촬영해 보자.
39. 간통죄는 존폐 위기에 몰려잇어.
40. 좌석버스에서 사과를 먹었다.
41. 기왕 관광왔는데 영화를 볼 수는 없지.
42. 의심하지 말고 믿어줘
43. 자연분만과 재왕절개 사이에서 고민중이야.
44. 거지도 요즘은 십원은 안 받아.
45. 잘 모르는 사람에게 결례를 하면 안 돼.
46. 청와대 경호실의 호위를 받을 때 그는 굉장한 성취감을 느꼈다.
47. 그 동사의 변형규칙과 용례를 잘 공부해 봐.
48. 그것 봐, 내가 뭐랬어.
49. 그는 죽는 그 순간에도 괜찮다고 이야기했다.
50. 재권이가 화분과 편지를 보내오다니 이거 웬일이야.
51. 위문가는 것은 항상 유쾌한 일은 아니야.
52. 문화부 장관은 자원봉사자와 군인을 대거 동원했다.
53. 이 곳이 옛날 혜화문 자리야.
54. 음악회에서 기획부 차관과 사모님을 뵈었다.

Appendix C

Stimuli for the Ultrasound experiment

Preceding segment & Following vowel	Labial	Alveolar	Dorsal (velar)
/i/	pwi-pi p'wi-p'i p^{h}wi-p^{h}i	twi-ti t'wi'-t'i t^{h}wi-t^{h}i	kwi-ki k'wi-k'i k^{h}wi-k^{h}i
/e/	pwe-pe p'we-p'e p^{h}we-p^{h}e	twe-te t'we-t'e t^{h}we-t^{h}e	kwe-ke k'we-k'e k^{h}we-k^{h}e
/a/	pwa-pa p'wa-p'a p^{h}wa-p^{h}a	twa-ta t'wa-t'a t^{h}wa-t^{h}a	kwa-ka k'wa-k'a k^{h}wa-k^{h}a
/ə/	pwə-pə p'wə-p'ə p^{h}wə-p^{h}ə	twə-tə t'wə-t'ə t^{h}wə-t^{h}ə	kwə-kə k'wə-k'ə k^{h}wə-k^{h}ə
Nonce words with /w/ in non-initial position	ka.ta.**pwi**.ta ka.ta.**p^{h}we**.ta ka.ta.**p'wa**.ta ka.ta.**p'wə**.ta	ka.pa.**twi.**pa k a.pa.**t^{h}we**.pa ka.pa.**t'wa.**pa ka.pa.**t'wə**.pa	pa.ta.**kwi**.ta pa.ta.**kwe.**ta pa.ta.**kwa.**ta pa.ta.**kwə.**ta
Minimal pairs	i) **pwe**.eoss.neun.te 'greet (honorific)' **pe**.eoss.neun.te 'be cut' ii) seon.**pwe**.ta 'display' seon.**pe**.ta 'is a senior'	i) **twe**.ge 'very' **te**.ge 'usually' ii) **twe**ss. ta 'became' **te**ss.ta 'put, approach' iii) twe.gi 'pig	1) **kwi.**in 'important person' **ki.**in 'eccentric person' 2) **kwa**.chang 'exaggeration' **ka.**chang 'the most' 3) ne.kwa 'internal medicine'

		te.gi 'it's okay' iv) twel.su. iss.eu.myeon 'if possible' tel.su.iss.eu.myeon 'if you can pull over'	ne.ka 'a small stream' 4) kwa.in 'me' ka.in 'a beautiful person' 5) kwa.sin 'overtrust' ka.sin 'servant' 6) kwan.cheong 'government office' kan.cheong 'plea' 7) kwa.ja 'snack' ka.ja 'let's go' 8)seong.kwak 'castle' seong.ka 'hymn'
Real words with /w/ at different levels	▪ te.**pwi** 'debut' (stem) ▪ **pwi**.p^{h}e 'buffet' (stem) ▪ keu. keos. **pwa** 'look at that' (word) ▪ **pwa**t.seum.ni.ta 'saw' (word) ▪ ceo.eum. **pwe**ss. eul.t'ae 'when first met' (word) ▪ ke.jip wi.e 'on the top of doghouse' (phrase) ▪ si.jip wa.seo	▪ **twi**t.san (stem) 'the mountain in the back' ▪ hak.kyo.**twi** (stem) 'the back of the school' ▪ **twə**t. ta 'put' (word) ▪ jal.**twe**n. il. i.ta 'it is good' (word) ▪ mut **wi**.e.seo 'on the ground' (phrase) ▪ seo.ye.pu**t wa**n.seong. hu.e 'after making the	▪ **kwi**.yeop. ta 'cute' (stem) ▪ sa.**kwi**.ta 'date with' (stem) ▪ **kwə**n.wi 'authority' (stem) ▪ cham.jeong.**kwə**n 'suffrage' (stem) ▪ hak.**kwa** 'department' (stem) ▪ byeon**g. w≜**n 'hospital' (word) ▪ chun**k.w≜**n 'pray' (word) ▪ pang.song.ku**k wa**n.kong 'construction of the broadcasting company' (phrase) ▪ u. ce.ku**k wi**.ceung.e.neun 'on the loft of the post office'

	'after she got married' (phrase) ▪ ka.mum wass.eul.t'ae 'when we had a draught'	caligraphy brush' (phrase) ▪ pung.seong.han meo.ri.su**t** **w≜**n.han.da.my eon 'if you want the thick hair' (phrase)	(phrase)
Various prosodic positions	**(1) Higher levels above word for /w/ in /a# k_a/ (#=a prosodic boundary)** **Ui:** igosɨn patakka. [U kwajangnimi jəgisə sanda.] This place seashore the manager here lives 'This place is the seashore. The manager lives here'. **IPi:** igosɨn patakka, [IP kwajangnime kohjaŋida.] This place seashore the manager's hometown 'This place is the seashore, which is the manager's hometown'. **APi:** igosɨn patakka [AP kwailgagejjok] ita. This place seashore near the fruit store be 'This place is located near the fruit store'. **Wi:** igosɨn [AP patakka (W gwaəga)] sanɨn goʃida. This place seashore man-Nom live-REL place-Dec 'This place is where the seashore man lives'. (2) Word and syllable levels for /w/ in /n# C_a/ (#= a prosodic boundary) **Wi:** kɨjədʒanɨn [AP marɨn (W kwajangnimɨl)] siləhassta. the woman-Top. skinny manager-acc. not care for 'She didn't like the skinny manager.' **Si:** kɨjədʒanɨn [AP marɨn (W oh (S kwajangnimɨl)] siləhassta. the woman-Top. skinny manager Oh-acc. not care for 'She didn't like the skinny manager Oh.		

Bibliography

Ahn, Sang-Cheol. 1985. The Interplay of Phonology and Morphology in Korean. Ph.D. dissertation, University of Illinois, Urbana-Champaign.

Anderson, S.R. 1976. On the description of multiply-articulated consonants. Journal of Phonetics. 4. 17-27.

Articulate Instruments Ltd. 2010. Syncbrightup users manual: Revision 1.10. Edinburgh, UK.

Barbosa, A.V. p.c., 2013. FlowAnalyzer. [ComputerProgram].

Barbosa, A.V., Yehia, H.C., Vatikiotis-Bateson, E. 2008. Linguistically valid movement behavior measured non-invasively. In: Göcke, R., Lucey, P., Lucey, S. (eds), *Auditory and visual speech processing - AVSP08*. Moreton Island, Australia: Caual Productions, 173-77.

Barbosa, A.V. and Vatikiotis-Bateson, E., 2014. Optical flow analysis for measuring tongue-motion. *The Journal of the Acoustical Society of America*,*136*(4), pp.2105-2105.

Bates, D., Maechler, M., Bolker, B., and Walker, S. 2013. lme4: linear mixedeffects models using Eigen and S4. R package version 1.0-5. Available from http://CRAN.R-project.org/package=lme4.

Bermúdez-Otero, R. 2015. Amphichronic explanation and the life cycle of phonological processes. In: Honeybone, P. and Salmons, J. C. (Eds.), *The Oxford handbook of historical phonology (p. 374–399). Oxford: Oxford University Press.*

Browman, Catherine. P., & Goldstein, Louis. (1992). Gestural structures:Distinctiveness, phonological processes and historical change. In Ignatius Mattingly and Michael Studdert-Kennedy (eds.), Modularity and the

Motor Theory of Speech Perception, pp. 313-39. Hillsdale, NJ: Lawrence Erlbaum.

Browman, Catherine. P., & Goldstein, Louis. (1991). Articulatory Phonology: An Overview.*Phonetica,49*(3-4), 155-180. doi:10.1159/000261913

Bermúdez-Otero, Ricardo. 1999. Constraint interaction in language change: quantity in English and Germanic [opacity and globality in phonological change].: University of Manchester and Universidad de Santiago de Compostela Doctoral dissertation.

_____ 2007. 'Diachronic phonology', in Paul de Lacy (ed.), *The Cambridge handbook of phonology*. Cambridge: Cambridge University Press, 497-517.

_____. 2011. Cyclicity. In Marc van Oostendorp, Colin J. Ewen, Elizabeth Hume & Keren Rice (eds.), *The Blackwell companion to phonology*, vol. 4, 2019–2048. Malden, MA: Wiley-Blackwell.

Caprio, Mark E (2009). "Radical Assimilation under Wartime Conditions". Japanese Assimilation Policies in Colonial Korea, 1910–1945. University of Washington Press. p. 155. ISBN 978-0-295-98900-6.

Cheshire, Jenny. 2005. Age and generation-specific use of language. In U. Ammon, N. Dittmar, K. Mattheier and P. Trudgill (eds.) *Sociolinguistics: An Introductory Handbook of the Science of Language and Society*. Berlin: Mouton de Gruyter, pp. 1552-1563.

Cohn, A. C. 1998. The phonetics-phonology interface revisited: Where's phonetics?. In *Texas Linguistic Forum* (Vol. 41, pp. 25-40). Austin; University of Texas; 1998.

Cukor-Avila, P. and Bailey, G. 2013. Real Time and Apparent Time. *The Handbook of Language Variation and Change*, pp.237-262.

Davidson, Lisa. 2006. Comparing tongue shapes from ultrasound imaging using smoothing spline analysis of variance. *Journal of the Acoustical Society of America* 120:1, 407-415.

Davidson, Lisa. 2006. Schwa Elision In Fast Speech: Segmental Deletion Or Gestural Overlap?. *Phonetica* 63 (2-3): 79-112. doi:10.1159/000095304.

Dijkstra, T., Roelofs, A., & Fieuws, S. 1995. Orthographic effects on phoneme monitoring. *Canadian Journal of Experimental Psychology*, 49, 264–271.

Donnenwerth-Nolan, S., Tanenhaus, M. K., & Seidenberg, M. S. 1981. Multiple code activation in word recognition: Evidence from rhyme monitoring. *Journal of Experimental Psychology: Human Learning and Memory*, 7, 170–180.

Eckert, Penelope. 1997. Age as a sociolinguistic variable, in*: The Handbook of Sociolinguistics*, Coulmas, Florian, ed., Oxford, 151-167.

Feagin, Crawford. Feagin, C., 2002. Entering the community: Fieldwork. *The handbook of language variation and change*, 20-39.

Fleet, D.J. and Weiss, Y. 2006. Optical Flow Estimation. Handbook of Mathematical Models in Computer Vision, ed. N. Paradgios, N., Chen, Y., & Faugeras, O.D. Secaucus, NJ: Springer, 239-57.

Fokes, J. and Bond, Z.S., 1993. The elusive/illusive syllable. *Phonetica,50*(2), pp.102-123.

Fougeron, C. and Steriade, D., 1997. Does deletion of French schwa lead to neutralization of lexical distinctions?. In *EUROSPEECH* (Vol. 2, pp. 943-946).

Fruehwald, Josef, Jonathan Gress-Wright, and Joel Wallenberg. 2009. Phonological rule change: the constant rate effect. Paper presented at North-Eastern Linguistic Society (NELS) 40, MIT.

Gick, B., 2002, The use of ultrasound for linguistic phonetic fieldwork. Journal of the International Phonetic Association. 32:2, 113-122.

Gick, Bryan. 2003. Articulatory correlates of ambisyllabicity in English glides and liquids. In John Local, Richard Ogden & Rosalind Temple (eds), Phonetic interpretation: papers in laboratory phonology VI. Cambridge: Cambridge University Press

Guy, Gregory R. 1991a. Contextual conditioning in variable Lexical Phonology. Language Variation and Change 3(2), 223–239.

Guy, Gregory R. 1991b. Explanation in variable phonology: an exponential model of morphological constraints. Language Variation and Change 3(1), 1–22.

Hall, K.C., Allen, C., McMullin, K., Letawsky, V. and Turner, A., 2015. Measuring Magnitude of Tongue Movement for Vowel Height and Backness. In *Proceedings of the 18th International Congress of Phonetic Sciences*.

Halle, P. A., Chereau, C., & Segui, J. 2000. Where is the /b/ in ''absurde'' [apsyrd]? It is in French listeners' minds. Journal of Memory and Language, 43, 618–639.

Halle, M. 1978. Formal versus Functional Considerations in Phonology, Bloomington, Indiana University Linguistics Club.

Halle, M., 2005. Palatalization/Velar softening: what it is and what it tells us about the nature of language. Linguistic Inquiry 36.1, 23–41.

Halle, M., Vaux, B., Wolfe, A., 2000. On feature spreading and the representation of place of articulation. Linguistic Inquiry 31.3, 387–444.

Harrington, Jonathan. 2010. Acoustic phonetics. In W.J. Hardcastle and J.Laver (eds.) The Handbook of Phonetic Sciences. Blackwell: Oxford.

Horn, B.K.P. and Schunck, B.G. 1981. Determining optical flow. *Artificial Intelligence* 17, 185-203.

Hulbert, H. B. 2014. *The history of Korea*. Routledge.

Horvath, B. 1985. Variation in Australian English. Cambridge: Cambridge University Press.

Hwang, K. M. 2010. *A history of Korea*. Palgrave Macmillan.

Hyman, Larry M. 1976. Phonologization. In A. Juilland (ed.), *Linguistic studies presented to Joseph H. Greenberg*, 407-418. Saratoga.

KAIST. KAIST Concordance Program. URL http://csfive.kaist.ac.kr/kcp/.

Kang, Hyeon-Seok 1997. *Phonological variation in glides and diphthongs of Seoul Korean: its synchrony and diachrony*. PhD dissertation, Ohio State University.

Keller, E. and Ostry, D. 1983. Computer measurement of tongue dorsum movement with pulsed echo ultrasound. *Journal of the Acoustical Society of America* 73, 1309-1315.

Kent, R. D. and C. Read. 1992. The acoustic analysis of speech. San Diego, California:Singular Publishing Group, Inc.

Kenstowicz, M. J. 1994. *Phonology in Generative Grammar*. Oxford ; Cambridge, MA, Blackwell.

Kim, D. K. 2005. *The history of Korea*. ABC-CLIO.

Kiparsky, Paul. 1982. Lexical morphology and phonology. In In-Seok Yang for the Linguistic Society of Korea (ed.), *Linguistics in the morning calm: selected papers from SICOL* 1981, vol. 1, 3–91. Seoul: Hanshin Publishing Company.

Kiparsky, P. 1985. *Some Consequences of Lexical Phonology,* in: Hulst, H. van der and N. Smith (eds.) The Structure of Phonological Representations, vol 1, Foris, Dordrecht, pp. 131-175

Kiparsky, Paul. 2000. Analogy as optimization: 'exceptions' to Sievers' Law in Gothic. In Aditi Lahiri (ed.), Analogy, levelling, markedness: principles of change in phonology and morphology, 15–46. Berlin: Mouton de Gruyter.

Kroch, Anthony S. 1989. Reflexes of grammar in patterns of language change. *Language Variation and Change* 1:199–244.

Labov, William. 1972. Some principles of linguistic methodology. Language in Society 1:97-120.

Labov, William. 1994. *Principles of linguistic change, vol. 1: Internal factors*. Oxford: Blackwell.

Labov, William. 2001. Principles of Linguistic Change: Social Factors. Malden, MA:Blackwell.

Lawson, Eleanor; Stuart-Smith, Jane; and Scobbie, James. 2008. "Articulatory Insights into Language Variation and Change: Preliminary Findings from an Ultrasound Study of Derhoticization in Scottish English," University of Pennsylvania Working Papers in Linguistics: Vol. 14: Iss. 2, Article 13.

Lawson, Eleanor, James M. Scobbie, and Jane Stuart-Smith. 2011. "The Social Stratification Of Tongue Shape For Postvocalic /R/ In Scottish English1". *Journal Of Sociolinguistics* 15 (2): 256-268. doi:10.1111/j.1467-9841.2011.00464.x.

Lawson, E., Scobbie, J. and Stuart-Smith, J. (2011). The social stratification of tongue shape for postvocalic /r/ in Scottish English1. *Journal of Sociolinguistics*, 15(2), pp.256-268.

Lieberman, A. M., P. C. Delattre, L. J. Gerstman and F. S. Cooper. 1956. Tempo of frequency change as a cue for distinguishing classes of speech sounds. Journal of Experimental psychology 52. 127-137.

Lisker, Leigh. 1995. English /w, j/: Frictionless approximants or vowels out of place? In Fredericka Bell-Berti and Lawrence J. Raphael (eds.), Producing Speech: Contemporary Issues. For Katherine Safford Harris (pp. 129–142). Woodbury, NY: American Institute of Physics Press.

Lundberg, A. and Stone, M. 1999. Three-dimensional tongue surface reconstruction: Practical considerations for ultrasound data. *Journal of the Acoustical Society of America* 106, 2858-2867.

Martin, Samuel. 1954. *Korean morphophonemics*. Baltimore, MD: Linguistic Society of America.

Mascaró, J. 1976. *Catalan Phonology and the Phonological Cycle,* PhD dissertation MIT, Cambridge, Mass. Distr. by IULC, Bloomington Indiana,1978.

McMahon, April M. S. 2000. Lexical Phonology and the history of English. Cambridge: Cambridge University Press.

Mielke, Jeff. 2012. Ultrasound and corpus study of a change from below: vowel rhoticity in Canadian French. New Ways of Analyzing Variation (NWAV) 41, Bloomington.

Scott R. Moisik, Hua Lin and John H. Esling (2014). A study of laryngeal gestures in Mandarin tones using simultaneous laryngoscopy and laryngeal ultrasound (SLLUS) . Journal of the International Phonetic Association, 44, pp 21-58 doi:10.1017/S0025100313000327

Munhall, K. G. & Ostry, D. J. 1985. Ultrasonic measurement oflaryngeal kinematics. In Titze, I. R. & Scherer, R. C. (eds.), *Vocal Fold PhYSiology:*

Biomechanics, Acoustics and Phonatory Conh' Vl, 145-162. Denver, CO: Denver Center for the Performing Arts.

Schilling, Natalie. 2013. Sociolinguistic fieldwork. Cambridge: Cambridge University Press.

Nevins, A., and Chitoran, I. 2008. Phonological representations and the variable patterning of glides. *Lingua*, 118, 1979-1997

Ogura, S.(1940) The Outline of the Korean Dialects, *Memoirs of the Research Department of the Tokyo Bunko* No. 12, Tokyo: Toyo Bunko

Ohala, J. 1981. The listener as a source of sound change. CLS 18. 178–203.

Pope, J., Meyerhoff, M. and Ladd, D.R., 2007. Forty years of language change on Martha's Vineyard. Language, 83(3), pp.615-627.

Robinson, Orrin Warner (1976). 'A 'scattered' rule in Swiss German', Language 52 (1): 148-62.

Rubach, J. 1984. Cyclic and Lexical Phonology: The Structure of Polish. Dordrecht, Foris.

Sankoff, G., Blondeau, H. and Charity, A., 2001. Individual roles in a real-time change. Montreal (r--> R) 1947-1995. H. van de Velde, R. van Hout et coll.,'r-atics': Sociolinguistic, phonetic and phonological characteristics of/r/, Bruxelles, ILVP.

Sankoff, Gillian, and Hélène Blondeau. 2007. Longitudinal Change across the lifespan: /r/ in Montreal French. *Language* 83 (3). 560–588

Scobbie, J.M., Stuart-Smith, J., and Lawson, E. 2008. Final report on ESRC Grant RES000222032: *Looking variation and Change in the Mouth: Developing the Sociolinguisitic Potential of Ultrasound Tongue Imaging*.

Seidenberg, M. S., & Tanenhaus, M. K. 1979. Orthographic effects on rhyme monitoring. *Journal of Experimental Psychology: Human Learning and Memory*, 5, 546–554.

Silva, D. J. 1991. Phonological variation in Korean: The case of the "disappearing *w*". *Language Variation and Change* 3. 153–170.

Sohn, Ho-Min (1994). Korean: Descriptive Grammar. Descriptive Grammars. London: Routledge.

Sonies, B. C., Shawker, T. H., Hall, T. E., Gerber, L. H. & Leighton, S. B. (*1981)*. Ultrasonic visualization of tongue motion during speech. *Journal of the Acoustical Society of America* 70, 683-686.

Sproat, Richard and Osamu Fujimura. 1993. Allophonic variation in English /l/ and its implications for phonetic implementation. *Journal of Phonetics* 21, 291–311.

Stevens, M. and Harrington, J., 2014. The individual and the actuation of sound change. *Loquens*, *1*(1), p.003.

Stone, M. 1990. A three-dimensional model of tongue movement based on ultrasound and X-ray microbeam data. *Journal of the Acoustical Society of America* 87, 2207-2217.

Stone, M., Shawker, T. H., Talbot, T. & Rich, A. 1988. Cross-sectional tongue shape during vowel production. *Journal of the Acoustical Society of America* 83,1586-1596.

Stone, M., Faber, A., Raphael, L. J. and Shawker, T. H. 1992. Cross-sectional tongue shape and linguopalatal contact patterns in [s], [ʃ] and [l]. *Joumal of Phonetics* 20, 253-270.

Stone, M. & Lundberg, A. 1996. Three-dimensional tongue surface shapes of English consonants and vowels. *Joumal of the Acoustical Society of America* 99, 3728-3737.

Tae-Jin Yoon & Yoonjung Kang. 2013. The Korean Phonetic Aligner Program Suite.
http://korean.utsc.utoronto.ca/kpa/

Tagliamonte, Sali A. 2006. *Analysing Sociolinguistic Variation*. Cambridge: Cambridge University Press.

Team, R.C., 2010. R Development Core Team, 2014. *R: A Language and Environment for Statistical Computing*.

Trudgill, Peter. 1988. Norwich revisited: Recent linguistic changes in an English urban dialect. *English World Wide* 9.33–49.

Yun, Suyeon and Yoonjung Kang (2017). Allophonic variation of the word-initial liquid in North and South Korean dialects. Presented at the 2017 Annual Meeting on Phonology (AMP 2017).

Wrench, A. & Scobbie, J.M. 2008. High-speed Cineloop Ultrasound vs. Video Ultrasound Tongue Imaging: Comparison of Front and Back Lingual Gesture Location and Relative Timing. *Proceedings of the International Seminar on Speech Production.*

Suh, Sang-Chul (1978), Growth and Structural Changes in the Korean Economy, 1910–1940: The Korean. Economy under the Japanese Occupation, Harvard University Press, ISBN 0-674-36439-2

Song, Byung-Nak (1997) The Rise of the Korean Economy. 2nd ed. Hong Kong; Oxford University Press. ISBN 0-19-590049-9