THE IMPACT OF INTERNAL SOCIAL CHANGE ON LOCAL PHONOLOGY

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ABSTRACT

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This dissertation addresses a fundamental question about phonology, i.e. how do we account for the appearance of a phonological rule in a community that had previously never posited one? For example, how could we account for someone who posits a phonological difference between /r/ and /l/, i.e. the two are distinct phonemes in their grammar, when no one in their speech community distinguishes between the two sounds phonologically, i.e. [r] and [l] are simply variants of the same phoneme. The general argument in the literature is that phonological change comes about via re-analysis of some phonetic exaggeration (e.g. Hyman 1975; Ohala 1990; Pierrehumbert 2001; Bermúdez-Otero 2007), but because phonological change is rarely observed, there is a paucity of empirical evidence using production data in a community while a change is underway to support this theory. Recent acoustic analyses of large databases of naturally occurring, ongoing phonological changes show that the role of phonetic variation is minor and in some cases non-existent when a phonological rule is innovated (Fruehwald 2013; 2016; Berkson, Davis & Strickler 2017). Therefore, the available empirical evidence for phonological change stands in contrast to what has been proposed in the theoretical literature.

This dissertation intervenes in the debate through the analysis of a database of naturally occurring speech in Lansing, Michigan where allophonic change is currently underway. In Lansing, /æ/ is being re-organized such that at the turn of the 20th century, speakers in the community did not distinguish between /æ/ in any phonological environments, speakers born in

the 1990s, however, do distinguish between pre-nasal and pre-oral /æ/. I utilize a combination of analyses in this dissertation to account for the initiation and spread of this change throughout the community. First, I conducted an acoustic analysis of /æ/ in F1/F2 space in a corpus of naturally occurring speech by 36 Lansing natives. In particular, I tracked changes in vowel height (F1 at nucleus), backness (F2 at nucleus), diphthongal quality (difference in F1 and F2 at nucleus and offset), and relative distributions of pre-nasal and pre-oral /æ/ token clouds for each speaker (Pillai-Bartlett statistic - see Hay, Warren & Drager 2006; Hall-Lew 2010). I supplemented the acoustic analysis with a sub-phonemic judgement task administered to 107 Lansing natives via an online survey. During the task, respondents were asked to identify whether the vowels in words like *pat* and *pan* are the same.

This dissertation finds that phonological change was gradual in Lansing. The measure of speaker-level distributions with an impressionistic investigation of divergent trajectories, and the results of the sub-phonemic judgement task suggest that there is indeed an intermediate period between no distinction and phonological difference in Lansing whereby the difference between pre-nasal and pre-oral /æ/ was only phonetically implemented. An analysis of the effects of gender and social class on these measures finds that phonetic variation is socially conditioned in Lansing, such that white-collar women are leading the change away from the community norm. I observe that phonetic exaggeration was promoted by social re-organization in the community, which eventually lead to the development and spread of an allophonic rule. In line with the prediction of Baker, Archangeli, and Mielke (2011), I find that the chance alignment of social and phonetic variability in 20th century Lansing accounts for the initiation and spread of this phonological change.

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PHONOLOGICAL CHANGE

1.1 Introduction

One of the challenges faced by phonologists is accounting for change, i.e. how do members of a speech community begin to posit a new phonological rule that has never before existed in that speech community? For example, how could we account for someone who posits a phonological/categorical difference between /r/ and /l/, i.e. the two are distinct phonemes in their grammar, when no one in their speech community distinguishes between the two sounds phonologically, i.e. [r] and [l] are simply variants of the same phoneme. Though the mechanisms of phonological change have been the subject of many articles, dissertations, and chapters, there is still very little that we actually know about what governs phonological change. This is perhaps because as Hockett (1958:456) surmises, phonological change is rare and occurs suddenly—too soon for anyone to detect by direct observation. Because it is so rare, most of what we "know" about phonological change has been deduced from the results of perception studies, simulations, synchronic analysis, and historical data. For example, the Big Bang theory developed by Janda and Joseph (2003) utilizes historical and synchronic data to theorize that phonological change is motivated in the phonetics for a brief amount of time before phonology takes over. Underrepresented in the literature are studies of phonological change *in progress* using language production data. Sociophonologists have made some inroads in this endeavor with the use of large corpora spanning many generations. For example, Fruehwald (2013,2016) investigated Canadian Raising of /aɪ/ in Philadelphia through an analysis of spontaneously produced speech in the Pennsylvania Neighborhood Corpus (PNC) (Labov & Rosenfelder 2011), which is a collection of over 300 hours of recorded interviews with approximately 400

Philadelphia natives, conducted by University of Pennsylvania graduate students as part of their course work.

In *Empirical Foundations for a Theory of Language Change*, Weinreich, Labov & Herzog (1968) describe 5 problems to be addressed when attempting to answer this fundamental question about sound change. One, the Constraints Problem, asks what kinds of innovations are possible and what are not possible. The Transition Problem (or Incrementation Problem) asks how a change progresses in the same direction over multiple generations. The Maintenance Problem concerns why a change does not revert back to its previous linguistic state. The Evaluation Problem asks how the new and old systems are evaluated in the community. The Embedding Problem asks how the innovation is linked to the larger linguistic system and how it is connected to different social groups. The Actuation Problem asks what factors can account for the initiation of change: Why do changes in a structural feature take place in a particular language at a given time, but not in other languages with the same feature, or in the same language at other times (Weinreich et al. 1968:102)? Although many advances have been made in addressing the problems identified by Weinreich et al. in 1968 regarding language change in general, regarding phonological change specifically, some of these problems remain.

The present investigation adds to the growing field of sociophonology and addresses what Weinreich et al. termed the "very heart of the matter" of language change—the Actuation Problem—by focusing on one of these rare changes, namely the development of phonological nasal allophony for /æ/ against the backdrop of socio-historical changes underway in Lansing, MI. Whereas /æ/ was previously raised in all phonological environments for Lansing speakers, e.g. *mat* and *man* were both produced with [$^{\varepsilon}$æ] and similar realizations, recent work has shown that many speakers born after 1984 raise /æ/ only before nasal consonants.

I utilize a combination of analyses, including speaker-level distributions, community level phonetic target analysis, and the results of a judgement task, to investigate this phonological change. The two sources of data for this research are a collection of conversational interviews with natives of Lansing, MI, and responses to a sub-phonemic judgement task. The collection of interviews includes oral histories and sociolinguistic interviews with 36 Lansing natives ranging in date of birth from 1925 to 1984. The sub-phonemic judgement respondents are 107 Lansing natives who range in date of birth from 1925 to 1999.

In addressing the actuation problem of phonological change, I take heed of the following warning in *Empirical Foundations*:

> *Linguistic and social factors are closely interrelated in the development of language change. Explanations which are confined to one or the other aspect, no matter how well constructed, will fail to account for the rich body of regularities that can be observed in empirical studies of language behavior.*
>
> Weinreich, Labov, and Herzog (1968:188)

Therefore, this work is an investigation into both the linguistic/internal and social/external mechanisms by which speakers in a community posit a phonological rule that never before existed. To do this, I focus on 2 aspects of this change, namely:

1. The phonetic changes that /æ/ has undergone on its way towards an allophonic split over 3 generations in Lansing, namely lowering in F1, retraction along F2, and less diphthongal quality.
2. The impact of gender and social class on these measures over generational time

Lansing is an optimal locus for an investigation into phonological change. Lansing is situated in the Inland North, a regional American English dialect area that has received a lot of attention

from sociolinguists over the last few decades. Additionally, the allophonic change under investigation in this dissertation – the development of /æ/ nasal allophony –is fairly well documented in the sociolinguistics literature in varieties of North American English. I discuss both of these aspects of Lansing's suitability for the present project in Chapter 2.

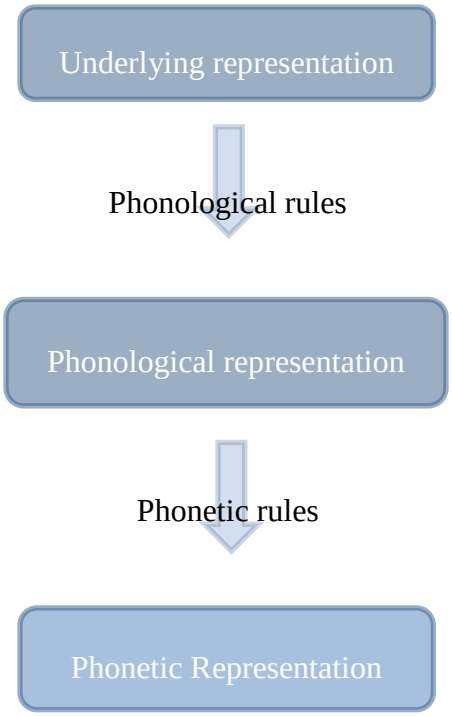
In the rest of this chapter, I will outline and expand upon the theoretical debates in the field concerning the initiation of phonological change. In section 1.2, I discuss the theoretical commitments of this dissertation regarding the distinction between phonetics and phonology. In section0, I review the existing literature on phonological change as it relates to the Actuation Problem described by Weinreich, Labov & Herzog (1968). Section 1.4 is a review of the methodologies for discerning between phonetic vs phonological allophony within speakers. In this section, I also motivate the use of another method: a sub-phonemic judgement task. In section 1.5, I draw on the sociolinguistics literature to provide a framework that will help me to identify the possible actuators of nasal /æ/ allophony in Lansing. Section 1.6 provides a summary of the main and peripheral goals of this dissertation. Section 1.7 includes a summary of the overall findings and section 1.8 provides a layout of each of the chapters in this dissertation.

1.2 Phonetics vs Phonology

In this dissertation, I adopt a modular feedforward framework that is rooted in Generative Phonology (Keating 1990; Pierrehumbert 1990; Bermúdez-Otero 2007). Under this framework, different levels of the grammar occupy different modules. The focus of this dissertation is on the phonetics and phonology modules, which are schematized in (1), below. These modules are arranged serially, as depicted in (1), so that information flows from one module to another in a feedforward fashion. The feedforward nature of this framework is that one module only has

access to the information in the previous module. For example, a phonetic rule will have access to phonological representations but will not have access to underlying representations.

(1) Modular feedforward architecture of the phonetics-phonology interface



Sound change is can include any change that occur in either the phonetic or phonological levels represented in (1). Changes in the phonetic module give rise to phonetically gradient rules which operate over continuous phonetic dimensions (e.g. formant frequency or duration). Many of the changes in the sociolinguistic literature which track change in the phonetic target of a phoneme are examples of this type of change. Changes in the phonology module operate over

discrete phonological dimensions (e.g. features), which manifest phonetically as abrupt changes between separate regions in phonetic space.

Allophonic change, which is the focus of this dissertation, is defined as the emergence of an alternation between two allophones of the same phoneme where previously there had been only one allophone. In line with the framework just described, I will refer to two types of allophony throughout this dissertation– one that is phonetic and one that is phonological. The difference between the two types of allophonic grammars is one of features. Phonetic allophones are those that are distinguished along some phonetic dimension, but in a continuous rather than categorical fashion. Phonological allophones are distinguished by features at the level of phonological representation, the middle level in (1) above. The difference between the two types of allophony is exemplified by examining the realization of /æ/ in different dialects of American English (Dinkin 2011a). The realization of /æ/ as part of the Northern Cities Shift dialect is an example of phonetic allophony. Within this phoneme, tokens of /æ/ in various phonological environments are gradiently different in F1/F2 space, such that by regular phonetic operations, /æ/ tokens before nasal consonants appear at the top of the token cloud while /æ/ tokens before /l/ appear at the bottom of the token cloud. For phonetic allophones, change over time would result in the same phonetic target change (e.g. backing along F2) for both the pre-/l/ and pre-nasal allophones. In other dialects of American English, however, /æ/ before nasal codas is phonologically distinct from /æ/ in other following coda environments. In these dialects, /æ/ before nasal codas are discretely separated in F1/F2 space from the rest of the token cloud, i.e. there is a distinguishable gap in the vowel space between pre-nasal and pre-other tokens of /æ/, whereby the latter tokens are more retracted along F2 than the former. The discrete nature of this difference suggests that /æ/ before nasal consonants has assumed some feature (perhaps

[−peripheral]) that distinguishes it phonologically from the rest of the allophones of this phoneme. Because they have different representations at the phonological level, phonological allophones can be affected independently of each other by changes in phonetic rules and representations. In many dialects of North America, /æ/ before non-nasal consonants is moving backwards in the vowel space, whereas that before nasal consonants appears to be unchanging. Therefore, the fundamental difference between phonetic and phonological allophony, is whether the two allophones are discretely separated by at least one feature (phonological allophony) or by simply phonetic implementation alone (phonetic allophony).

While sound change can occur in any of the modules in (1), this dissertation is concerned with the development of phonological allophony. The primary question to be addressed is whether change in the phonetics gives rise to the development of this phonological rule or whether the rule was developed without a phonetic precursor.

1.3 Gradual vs Abrupt Phonological Change

The prevailing sentiment surrounding phonological change is that it develops gradually, i.e. some exaggerated difference between two phonetic variants is eventually re-analyzed (by speakers and/or hearers) as a phonological rule (Hyman 1975; Ohala 1981; Blevins 2004; Bermudez-Otero 2007; Moreton & Thomas 2007; Baker, Archangeli & Mielke 2011). Others have argued, however, that there is no phonetic precursor to phonological change—change to the grammar is sudden and does not require anything in the phonetics to prompt the change (Fruehwald 2013; Janda and Joseph 2003). In what follows, I discuss the two arguments in turn.

1.3.1 Gradual phonological change

A theory of gradual phonological change posits that phonological change proceeds through the grammar incrementally—first occurring in the phonetic module and then the phonological module. The Life-Cycle of Phonological Processes (henceforward "The Life-Cycle") (Bermúdez-Otero 2007; 2015) is one theory that supports this idea that phonological change is gradual. According to the Life-Cycle, phonological processes first begin as language-independent or mechanical phonetic effects (stage 1, Table 1). Through a process called *phonologization*, these universal phonetic effects become cognitively-controlled language-specific phonetic implementation effects (stage 2). They then become *stabilized* as a phrase-level categorical/phonological rule (stage 3). Over time, the process advances through the grammar by domain narrowing so that it applies at the word level (stage 4), and then the stem-level (stage 5). In its last stage, the phonological process may then advance to the lexicon through morphologization and/or lexicalization (stage 6). To illustrate the Life-Cycle, Bermúdez-Otero & Trousdale (2008) make reference to the historical process of /g/-deletion in British English /ŋg/, captured in Table 1. Under the theory of the Life-Cycle, the process of /g/-deletion went as follows: there was a period in which /g/ was pronounced after the velar /ŋ/ across all environments but perhaps unpredictably deleted in casual conversation on occasion (stage 1). At some point in time, there was a process of gradient lenition of the stop but only at the phrase level (stage 2 in Table 1). At this point, the gradient nature of lenition means that it must be subject to social conditioning. Later, in stage 3, this gradient process develops into a categorical rule whereby lenition at the phrase-level is categorical within and across speakers in the community. This categorical rule then begins to narrow its domain coming under increasing morphological (stage 4), and lexical control (stage 5). The sixth stage of the Life-Cycle is not

included in the table but involves the development of lexical exceptions, which for the /g/-deletion example include words like *younger* and *longer* (Bermúdez-Otero & Trousdale 2012: 10).

Table 1 Process of /g/-deletion (adapted from *Turton 2014: 57)*

	finger	sing-er	sing it	sing
Stage 1	[ŋg]	[ŋg]	[ŋg]	[ŋg]
Stage 2	[ŋg]	[ŋg]	[ŋg]	[ŋg]/ [ŋ]
Stage 3	[ŋg]	[ŋg]	[ŋg]	[ŋ]
Stage 4	[ŋg]	[ŋg]	[ŋ]	[ŋ]
Stage 5	[ŋg]	[ŋ]	[ŋ]	[ŋ]

To explain why phonological change proceeds in this fashion, Bermúdez-Otero & Trousdale (2008) appeal to what they call *input restructuring*. If one thinks about this from the perspective of a language learner, phonological change proceeds in this fashion because the learner's input is mostly made up of the phonology in the stage prior. Thus, the learner simply re-analyzes the rule based on frequency of occurrence in the previous generation's output and applies it at a higher level. For example, if a child is born to parents whose grammars resemble that in stage 3 of Table 1 where the rule only applies at the phrase level, that child is likely to encounter /sɪŋ/

more often than /sɪŋg/ and will then reanalyze /g/-deletion as a word-level process, which will result in them having a stage 4 grammar.

The transition from stage 1 to stage 2 processes forms the basis of what has been termed the *accumulation-of-errors* hypothesis, whereby an epiphenomenal phonetic effect is re-analyzed as a language-dependent speaker-controlled phonetic effect. Most ardently supported by Ohala (1981; 1989; 1990; 1993), the accumulation-of-errors hypothesis posits that a listener (or speaker) hears tokens that are outside of the distribution they are used to and reinterprets the difference in pronunciation as a new phonetic rule. This new phonetic rule can then become a phonological rule. The classic example of this phenomenon is the hypothetical sound change of /ut/-fronting (Ohala 1981). The scenario is as follows. A speaker, intending to produce /ut/, produces [yt], with a fronted realization of /u/, as a result of coarticulation with the following [t]. Being aware of this coarticulation effect, a hearer will mentally reconstruct what they heard as an /ut/. Phonetic change occurs, however, when the listener doesn't take the coarticulation into account and they interpret the [+front] feature as belonging to the vowel rather than the /t/, so they hear the /u/ as a /y/. When that listener speaks, they produce what originally was /u/ as [y]. Crucially, Ohala argues that there has been no phonological rule posited at this point; the phonological rule *can* be posited at some later stage. This scenario is a description of the transition between stages 1 and 2 in the Life-Cycle: a mechanical effect is re-analyzed as a speaker-controlled phonetic effect, and at some later point in time, a phonological rule is posited. Thus, the accumulation of error theory is most in line with a gradual rather than abrupt theory of change. Other research programs subscribe to the same incremental theory of change and push the accumulation-of-errors scenario farther so that re-analysis occurs between stages 1 and 2 and then again between stages 2 and 3, e.g. Hyman (1975; 2013), Evolutionary Phonology (Blevins

2004; 2006), Exemplar Theory (Pierrehumbert 2001; Garrett & Johnson 2011). Though the specific details of each theory are different, they all consider phonetic variability to be a significant catalyst to phonological change.

1.3.2 Abrupt phonological change

In contrast to a theory of gradual phonological change, the Big Bang theory of sound change (Janda & Joseph 2003) argues that phonetic factors guide sound change only very briefly and that phonological conditioning takes over very quickly. To motivate this argument, Janda and Joseph (2003) re-examine two changes, one of which is Swiss German *o*-lowering. Preconsonantal *o*-lowering originally occurred only before /r/, but there many varieties that have generalized this rule in various ways, e.g. some lower before all obstruents except /b/, others lower before nasals and coronal obstruents but not other obstruents, others lower before obstruents except /b/ and nasals, and so on. Crucially, the central city of Schaffhausen used the simpler rule; lowering before /r/, which while diffusing to different villages was generalized in a variety of ways. Crucial for Janda and Joseph (2003) is that the rules in these villages do not phonetically favor a lowered *o;* therefore, though the initial state was lowering before /r/, these villages developed a rule that was not phonetically driven. The authors argue that if phonetic variation did play a role in this change, it must have been very brief and overruled by the phonology in an instant.

1.3.3 Disambiguating abrupt and gradual phonological change

Crucially, as Fruehwald (2013) points out, phonological change is rarely observed while the change is underway. Many theories about the process of phonological change therefore suffer from a paucity of empirical evidence. They rest on completed changes (as is the case with the /ŋg/ example above), on experimental simulations (Garrett & Johnson 2011), perception

studies (Ohala 1981), observations of synchronic data, or prior theories (and see Fruehwald 2016 for an in depth discussion of these methods). Larger databases of naturally occurring, ongoing phonological changes are required to test the theories.

Sociophonologists have been making inroads in this endeavor, compiling large spoken corpora with enough time depth to address questions about phonological change. One such study is Fruehwald's (2013; 2016) investigation into /aɪ/-raising in Philadelphia. The results of his study suggest that, contrary to popular belief, there is no intermediate (phonetic) stage in phonological change – the rule is categorical/phonological from the outset. The literature on change towards a phonemic merger, i.e. the merger of two or more phonemes into one, is also robust in its use of real language data while a change is underway. Though I will not go over the literature in detail here, the general consensus on phonemic mergers is that both types of changes (abrupt and gradual) are possible. Crucially, language/dialect contact predicts which type of change will occur. Changes towards merger in "high contact" areas occur abruptly, while those that are internally motivated (are not triggered by contact with speakers of other phonological systems) progress gradually (see Guy 1990 and Herold 1997). Studies on allophonic change, which is the focus of this dissertation, are underrepresented in the literature. There are in fact, only two studies that I am aware of that attempt to disambiguate gradual from abrupt phonologization of an allophonic split using natural language data. As I summarize below, these studies show conflicting findings, and thus offer no solution to the current theoretical conundrum. It is still unclear if allophonic change is abrupt, gradual, or whether like mergers, its development depends on inter-dialect/language contact.

1.3.3.1 Fruehwald (2013, 2016)

The first investigation of an ongoing phonological split using actual production data is Fruehwald's (2013, 2016) study of Canadian Raising of /aɪ/ in Philadelphia. In North American English, Canadian Raising of /aɪ/ is realized in a variety of ways, but the most common realization is that the diphthong raises when it occurs before voiceless codas but remains low before voiced codas. Therefore, raising of the nucleus is observed in words like *knife* and *write*, but not in words like *knives* and *ride*. Canadian Raising of /aɪ/ has been labeled phonological raising because the raising rule also applies before a flapped /t/ such that the /aɪ/ in *writer* surfaces with the higher variant (Halle 1962; Idsardi 2006; Berkson, Davis & Strickler 2017; Fruehwald 2013; 2016). The rule must be phonological because although the flapped /t/ in *writer* is voiced on the surface, it is underlyingly voiceless; this shows that the rule applies to underlying (phonological) representations, rather than mere surface (phonetic) representations.

In his analysis of /aɪ/-raising in Philadelphia, Fruehwald (2013; 2016) sought to empirically determine whether phonetics played a role in the initial process of phonological change. He asked whether an earlier stage of phonetic variation is what prompts community members to posit a phonological difference between the allophones (gradual phonologization), or if the allophones were phonologically distinguished from the outset (abrupt phonologization). To do this, he conducted an acoustic investigation of /aɪ/ raising in the spontaneous speech of 326 Philadelphia-born speakers whose birthdates range from 1889 to 1998. He compared three measurements of /aɪ/ (nucleus, offset, and duration) over apparent time across four contexts; faithful /t/ (*write*), faithful /d/ (*ride*), flapped /t/ (*writing*), and flapped /d/ (*riding*). His analysis showed that there was no intermediate stage whereby phonetic raising (stage 2 in the Life-Cycle), i.e. the raising of /aɪ/ is determined by surface voicing of the following consonant,

predated phonological raising (stage 3 of the Life-Cycle) in the community. At the community level, the phonetic separation of pre-voiced and pre-voiceless /aɪ/ along F1 has been in progress in Philadelphia since about the 1920s (Labov 2001; Fruehwald 2013; Fruehwald 2016). Fruehwald showed that the difference between pre-voiced and pre-voiceless /aɪ/ was phonological from the very outset of this change, i.e. /aɪ/ began to raise before flapped /t/ at the same time as before faithful /t/, and not at some later time through re-analysis. Fruehwald argues that in Philadelphia there were two phonological categories of /aɪ/ that were phonetically similar and that one of them (the pre-voiceless variant) underwent a phonetically gradual change in height while the other remained low. Therefore, phonological change was abrupt in this speech community, i.e. there was no intermediate stage whereby the allophones were differentiated purely phonetically before a phonological rule was posited. Fruehwald's position is a strong version of the Big Bang theory of sound change proposed by Janda and Joseph (2003) who argue that this intermediate/phonetic stage, if ever observed, would be very brief.

1.3.3.2 Berkson, Davis and Strickler (2017)

In contrast, Berkson, Davis and Strickler (2017) appear to have observed this intermediate stage of Canadian Raising in Fort Wayne, Indiana. Berkson et al. analyzed word-list productions of /aɪ/ before faithful voiceless, faithful voiced, /t/ flap, and /d/ flap consonants in the speech of 27 Fort Wayners. They visually inspected F1 trajectories of each token of /aɪ/ for every speaker and for each speaker compared the difference in F1 at the 30% mark between the four environments. They show that speakers exhibit different patterns of /aɪ/-raising. 15% of the speakers in this sample do not raise in any environment, two-thirds of the speakers in the sample exhibit phonetic raising, i.e. raising before faithful voiceless consonants but not before flapped /t/ or either /d/ variant, and 22% of the speakers exhibit phonological raising whereby /aɪ/ raises before both

faithful and flapped /t/ but not before either /d/ variant. Berkson et al. reconcile this result with Fruehwald's contrary finding by concluding that "phonetic factors guide sound change only for a brief period before phonologization takes place" (Berkson et al 2017:e190).

One unstudied aspect in the Berkson et al. study is change over time. The speakers in this study range in age from 19 to 78. It is unclear if date of birth conditions the patterning of their sample. There are a few possible scenarios that could be borne out of the data if they were to investigate these patterns over time. I'll describe just two here. One such scenario might be that the individuals who have no raising are older speakers, those who exhibit phonetic raising are middle-aged, and the phonological raisers are all younger speakers. This scenario would support a gradual theory of phonologization, because it proceeds generation by generation, with an intermediate stage of phonetic-only conditioning. Alternatively, perhaps those who exhibit no raising are older speakers, middle-aged speakers are a mixture of those who exhibit phonetic raising and those who exhibit phonological raising, and young speakers are phonological raisers. Under this scenario, phonologization would be abrupt because the phonological rule has been posited for some speakers in the middle generation when there was no phonetic raising in the previous generation. Thus, to really tease apart whether phonological change is abrupt or gradual in Fort Wayne, we would benefit from a discussion of how year of birth conditions the patterns reported in their sample. Because there is no information regarding how year of birth conditions the patterns they observe, it is not exactly clear whether Canadian Raising in Fort Wayne can be classified as abrupt or gradual phonological change.

1.3.4 Summary

In sum, Fruehwald (2013, 2016) provides evidence for the strong view that phonological change is abrupt, since there is no transition period between pre- and post-phonologization in his

Philadelphia data. Berkson et al. (2017) support a weak view that phonological change is abrupt but there is a very brief transition period, i.e. the period in which allophony is conditioned phonetically.

The Fruehwald (2013, 2016) and Berkson et al. (2017) studies thus provide a theoretical conundrum for a description of how allophonic change progresses. The results in Fort Wayne suggest that there is indeed a phonetic precursor for phonological change. The Berkson et al. analysis appears to show that both phonological and phonetic stages are active at the beginning of the phonological change, but this remains to be seen as they have yet to show whether Canadian Raising is a new phenomenon in Fort Wayne or if the patterns they observe are distributed among speakers of different age groups. Fruehwald's analysis in Philadelphia, however, suggests that there is no stage at which allophony is phonetically motivated in the community. With this conflicting evidence, and the conflicting theoretical claims in the literature, it is clear that the addition of more studies tracing allophonic development are needed. As discussed previously, there appear to be multiple pathways by which other phonological changes, e.g. change towards phonemic merger, are actuated. Because of this, it would not be completely surprising if multiple pathways for allophonic splits are established. With the analysis of allophonic change in more speech communities, perhaps we can develop a typology of allophonic change.

1.4 Methods for Distinguishing Phonological from Phonetic Distinction

As stated earlier, methods for discerning phonologization from phonetic change are not abundant in the literature, especially since phonological change is so rarely observed. In the case of /aɪ/ raising, acoustic analysis is fairly straightforward because one can readily contrast phonetic (flapped stops) and phonological (faithful stops) raising. Articulatory analyses have also been

employed, e.g. Turton (2014). A method used quite often in the literature on phonemic mergers is a measure of bimodality. This measure is usually a calculation of the distribution of token clouds between two vowel classes. A unimodal distribution is evidence for merger, while a bimodal distribution is taken as evidence of two vowel classes. Lately, conclusions based on distributions have been cautioned against, as studies have shown that while bimodality is often an indication of phonological/categorical difference, the absence of a bimodal distribution does not necessarily entail the absence of a phonological difference (cf. Bermúdez-Otero & Trousdale 2008: 696; Schilling, Watkins & Watkins 2002). Thus measures of bimodality are best interpreted by supplementing with other types of analyses. Here, I motivate the two that will be employed in this dissertation in addition to a measure of bimodality (in this case, the Pillai-Bartlett measure). Further details are given in Chapter 3.

1.4.1 Divergent Trajectories

Fruehwald (2013) noted the utility of examining the rate of change of a vowel phoneme in varying phonological environments to determine whether any of the phonetic differences have been phonologized in the community, and crucially, *when* in apparent time the two environments began to diverge. In his analysis of the phonologization of Canadian Raising in Philadelphia, Fruehwald showed that the difference between /aɪ/ before voiceless and voiced consonants was phonological from the outset of the pre-voiceless phonetic target change by inspecting the rate of change of /aɪ/ in the two phonological environments. He noted that because /aɪ/ in these environments followed different trajectories along F1 from the 1930s onwards, they were two phonological allophones rather than differentiated due solely to phonetics.

This is captured in Figure 1. In the figure, are speaker means of F1 at the nucleus for /aɪ/ across speaker year of birth in the PNC. /aɪ/ means before voiced consonants are indicated with dark circles and those before voiceless are indicated with open circles.

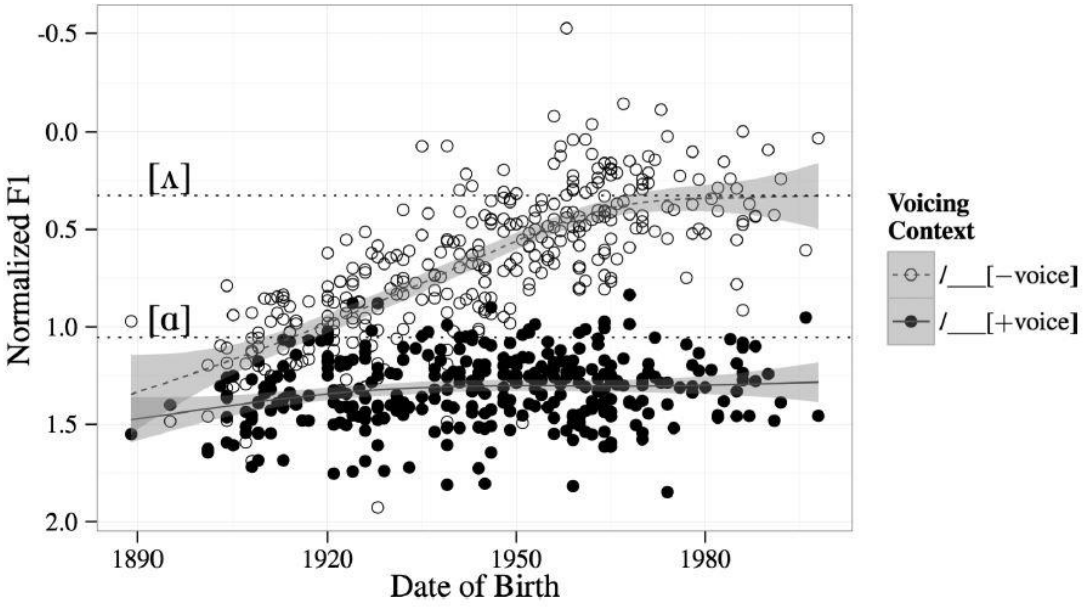


Figure 1 Reproduced from Fruehwald 2016:382. Trajectory of /aɪ/ in Philadelphia in two phonological contexts (before voiced and voiceless consonants) in apparent time.

In Figure 1, we see that /aɪ/ in the two environments proceed along divergent trajectories from the 1930s; that before voiceless consonants moving up the vowel space and that before voiced consonants remaining stable. Thus, he was able to show that phonologization of

Canadian Raising in Philadelphia began in the 1930s. To support this claim, he examined the trajectories of other vowel phonemes in different phonological contexts over time in the same community. One such phoneme was /ɔ/ before fricative, nasal, and other consonants. He noted that unlike pre-voiced and pre-voiceless /aɪ/, the /ɔ/ allophones moved in lockstep over the course of the 20th century and were therefore only phonetically distinguished from one another.

1.4.2 Sub-Phonemic Judgement Task

Another diagnostic utilized in the phonemic merger literature is a *phonemic judgment task* (DiPaolo 1988; Herold 1997; Labov, Ash & Boberg 2006; Johnson & Nycz 2015; Baranowski 2013). Herold (1997) employed this task in her investigation into whether the low-back merger (merger of /ɔ/ and /ɑ/) appeared in eastern Pennsylvania via diffusion from the western part of the state or via an independent innovation. For this study she supplemented production data with a judgement task in which participants were visually presented with pairs of lexical items that differed in incidence of /ɔ/ and /ɑ/ (e.g. *caught* and *cot*) and were asked to indicate whether the vowels in the pairs sounded the same or different to them. Analysis of the judgement data and production data revealed that the merger in eastern Pennsylvania was an independent innovation, rather than the result of diffusion from western Pennsylvania, since speakers in both parts of the state developed the phonemic distinction at about the same time.

Though this judgement task is usually performed to test phonemic merger/distinction, Mellesmoen (2016) has shown that it can be useful for testing whether allophones differ in their phonological representation or whether they merely represent different phonetic implementations of the same phonological features. In her study of /æ/ in British Columbia, Mellesmoen (2016) analyzed speech production and judgement task data to investigate whether there was a phonological distinction between /æ/ before voiced velars (/ŋ/ and /g/) and /æ/ before other

consonants. An analysis of the trajectories in phonetic space of these conditioning environments over apparent time revealed that in BC a three-way allophonic differentiation for /æ/ had developed, such that /æ/ before front nasal consonants, /m/ and /n/, were distinct from /æ/ before voiced velar /g/, and /æ/ before other consonants in F1 x F2 space. The acoustic results for /æ/ before /ŋ/ were unclear, however, as this phonetic environment varied between patterning with /æ/ before /g/ and /æ/ before other nasal consonants. To discern which allophone pre-/ŋ/ belonged to, Mellesmoen (2016) conducted a judgement task. For this, she asked participants to indicate whether pre-/ŋ/ words (e.g. *rang*) sounded more like words with a velar coda (e.g. *rag*) or words with a front nasal coda consonant (e.g. *ran*). She showed that participants classified pre-ŋ /æ/ as part of the pre-/g/ allophone rather than as part of the pre-front nasal allophone. Though this is the only study to utilize the judgement task to determine the phonological status of an allophonic split, the results are convincing because they align with her analysis of trajectory movement.

1.4.3 Diagnostics of Phonological Change in this dissertation

In the present study, I use the two methods described above to address the actuation and transition problems of phonological change in Lansing. I will investigate phonetic vs phonological allophony within the /æ/ phoneme by examining trajectories of pre-nasal and pre-oral /æ/ in F1/F2 space over time, in conjunction with the results of the phonemic judgment task. According to Fruehwald (2013, 2016), phonological allophones follow disparate trajectories over time while allophones that differ in phonetic implementation proceed in lockstep. Ultimately, we will want to ask whether at the speaker level, the phonological change was abrupt or gradual, i.e. whether individual speakers had a phonological distinction when the vowel in the two environments began to assume different phonetic targets (abrupt) or if speakers developed the

phonological rule sometime after the two allophones began to move in different directions (gradual). The trajectory diagnostic will allow me to determine *when* the phonological allophones began to diverge from the rest of the allophones, i.e. when do the allophones begin to move towards different phonetic targets. Whichever generation in which the relevant allophones begin to differentiate, as determined by this trajectory analysis, is the generation for which the question of abruptness will be asked. If any speakers in this generation have a phonological rule, I will conclude that phonological change was abrupt. If, however, speakers in this generation do not distinguish pre-nasal and pre-oral /æ/ phonologically, then I will conclude that phonological change was a gradual process. To determine whether an individual in Lansing posits a representational difference between pre-nasal and pre-oral /æ/, I will utilize the sub-phonemic judgement task described above.

1.5 Social/External Aspects of Phonological Change

The Berkson et al. (2017) and Fruehwald (2013, 2016) studies provide fodder for debate about the internal conditions that govern allophonic restructuring. Yet neither study provides enough information about the social conditions under which these changes have occurred to make it possible to draw conclusions about the social motivations for change towards a phonological split. Berkson et al. (2017) do not address any aspects of contact, awareness, or social conditioning on /aɪ/ phonologization. Fruehwald (2013, 2016) argues that contact and social evaluation are not crucial components of his findings. He argues through a statistical analysis of his sample that /aɪ/ phonologization in Philadelphia is purely internally motivated; there is no statistical evidence of a sudden increase in speakers with different phonological systems into the community. However, like many other large metropolitan areas, Philadelphia has likely witnessed some in-migration of non-locals. Indeed, there has been a large amount of

immigration over the last two centuries of speakers of Irish, Italian, Spanish, Vietnamese, and Yiddish linguistic background (Katz et al. 2010). I suspect that evidence for the appearance of speakers with non-local /aɪ/ pronunciations in Philadelphia was not captured in Fruehwald's analysis because (1) his sample was specifically made up of "Philadelphia-born" speakers, i.e. only natives of the city (Fruehwald 2016:380), and (2) immigration has been a constant trend rather than a sudden event in the city. This, however remains speculation, as Fruehwald and colleagues *'*do not have a record of population changes in mid- twentieth-century Philadelphia' (Labov, Rosenfelder & Fruehwald 2013: 61). If speakers of /aɪ/ productions that were different from that in the ambient community immigrated to the city at this crucial period of phonetic target change (1930-1940s), then it is possible that contact has played a role in the development of Canadian Raising in Philadelphia, though this remains to be determined. Social evaluation, however, cannot account for Canadian Raising in Philadelphia. Though /aɪ/ raising has recently gained status as a marker of masculinity and toughness in the city (Conn 2005; Wagner 2007), it was not a marker in the earlier half of the 20th century when Canadian Raising initiated (Labov, Rosenfelder & Fruehwald 2013).

Because these are the only two studies that I am aware of to observe allophonic change in an actual speech community, we cannot turn to any other study for examples of the social conditions within which allophonic change is actuated and then propagated throughout a speech community. Baker, Archangeli & Mielke (2011:351) hypothesize that the actuation of allophonic change is the result of a "chance alignment of social and phonetic variation". This is important because as Labov (2001: 322) states, echoing his previous sentiments in Empirical Foundations, "the forces active in qualitatively new changes include social factors, and any effort to account for the initiation of change by purely internal arguments will fail to a significant

degree". The impact of social factors on the spread of language change has been acknowledged by every theory of phonological change, including that of the Life-Cycle of Phonological Processes and proponents of the accumulation-of-errors model. Here I quote Ohala (2013:3): "social and psychological forces induce speakers to copy the pronunciation of the initiator – among the social factors that have been proposed are the prestige of the speaker who was the initiator or how many other speakers s/he comes in contact with". Theorists of allophonic restructuring are, in fact, reasonable to assume that actuation and propagation of this kind of change is subject to the same general sociolinguistic principles that govern other linguistic changes. Studies of language change at every level of the grammar (syntactic, morphological, phonetic, discourse-pragmatic etc.) have demonstrated the generalizability of these principles. In this dissertation, I will likewise demonstrate through the analysis of 36 speakers from the Lansing speech community that the actuation and generational incrementation of nasal /æ/ allophony follows well-attested social pathways.

One relevant and crucial distinction in the sociolinguistic literature is between language changes from 'above' and 'below' (Labov 1972, and see Labov 1990 for an overview of numerous cases). This dichotomy may be strongly associated with whether change towards a phonemic merger is abrupt or gradual, as I will explain below. Changes 'from above' are typically linguistic innovations that are introduced from outside of the speech community (via contact with speakers of another variety/language). People are aware of the linguistic feature ('above' the level of consciousness) and often assign it some social prestige. A notable example is the adoption of post-vocalic /r/ in New York City (Labov 2006 [1966]), which was used proportionally more frequently by speakers when reading aloud than in their spontaneous speech. Changes from above are often led by the highest social status group. In contrast, changes 'from

below' are typically generated within the speech community; they progress rather unconsciously, i.e. the speakers are not aware of the change until late in its diachronic trajectory; and the change is led by 'interior' (upper-working- and lower-middle class) socio-economic status groups. Women, somewhat paradoxically, lead both types of change.

Lansing is situated in the Inland North dialect area, which is defined by a vowel chain shift that has long operated as a change from below: The Northern Cities Shift. Indeed, speakers in this dialect area had been shown to perceive their variety as being identical to standard American English (Preston 1996; Niedzielski 1999, 2002). Yet I write this description in the past tense because, as I describe in Chapter 2, the Northern Cities Shift is being replaced by what might be an externally-generated change from above. A key component of the incoming vowel system is nasal /æ/ allophony. Thus a question I ask in this dissertation is: Did the development of nasal allophony enter Lansing from some external source as a change from above? Or did it proceed as a change from below? To answer this question, ideally the researcher needs evidence from three diagnostics: (i) awareness of the innovation, (ii) socio-economic patterning, and (iii) degree of contact with speakers beyond the speech community. Recent studies of the regional dialect area suggest that the change is one from above (see Becker fc for an overview). Regarding (i) and (ii), speakers have been shown to be aware of nasal allophony, and its incrementation within the region is being led by higher status groups. Regarding (iii), I attempt to address the facts about contact in Chapter 2, section 2.4, where I argue that there is no evidence that Lansing is a high-contact area.

As I mentioned above, the 'change from above'/'change from below' dichotomy conditions whether change towards a phonemic merger is abrupt or gradual. Phonemic mergers from above occur abruptly, while those that are from below occur gradually (Guy 1990; Herold

1997). For example, a well-known phonemic merger in North America is the low-back merger—the phonemic merger of /ɑ/ and /ɔ/. Dinkin (2011b) has shown that the low-back merger in upstate New York is progressing gradually, i.e. there was phonetic movement along F2 of /ɑ/ towards /ɔ/ over time before speakers identified them as the same phoneme. In eastern Pennsylvania, however, Herold (1997) showed that the low-back merger was abrupt, i.e. the generation of speakers who identified /ɔ/ and /ɑ/ as the same phoneme is the first in which phonetic similarity is noted, with no gradual trend toward approximation over prior generations. Crucially, as Dinkin (2011a: 341) points out, the low-back merger in upstate New York is motivated by a gradual backing of /ɑ/ and that when the merger actually occurs, it will be an internally-motivated result of the dialect's existing trends, while that in eastern Pennsylvania is due to immigration of speakers who already had the merger. If allophonic changes are subject to the same conditioning, then we would expect abrupt allophonic changes to be above speaker awareness, to be led by higher social class groups, and to be introduced via contact. Gradual allophonic change, then, should be below awareness, led by lower social class groups, and generated from within the speech community. It is unclear what the social facts are regarding the change towards Canadian Raising in Fort Wayne, but immigration to Philadelphia may account for the abrupt change noted by Fruehwald (2013, 2016), though this remains to be documented. Therefore, the 'from above'/'from below' dichotomy that governs change towards merger (and other linguistic changes) might also govern allophonic change. The awareness and social class facts regarding allophonic change in Lansing lead me to hypothesize that it is a change from above, and that it will therefore have been actuated abruptly. The facts about contact, however, seem to predict that it should be a gradual change. To resolve this apparent conflict, this dissertation will bring to bear both acoustic and experimental analysis of a multi-

generation, socially stratified speaker sample. The investigation of social factors will also elucidate who the leaders of this change are and how the rule spread throughout the community.

1.6 Goals of this Dissertation

Because allophonic change is so rarely observed, there is a wealth of information still to be gained about it that will benefit phonology and sociolinguistics. This dissertation will contribute to the overall knowledge base regarding this kind of language change. Additionally, I will show that despite the fact that allophonic change is rarely observed, many of the general principles of language change that have been established in the last fifty years apply to this linguistic phenomenon as well. The work in this dissertation offers a transdisciplinary approach to age old questions in the field. The goals of the current project are outlined in the next sections.

1.6.1 Main Goals

The main goals of this dissertation are two-fold. The first is to address the actuation problem of phonological change using data produced by speakers in a speech community while the change is still underway. More specifically, I am interested in whether the development of nasal /æ/ allophony was gradual, with an intermediate stage of phonetic variation, or if it was abrupt, with no phonetic precursor. To do this, I must first address the embedding problem. Therefore, the second goal of the dissertation is to determine the acoustics of /æ/ in Lansing over the course of the 20th century, and to examine whether any variants were socially conditioned, i.e. characteristic of particular social groups.

1.6.2 Peripheral Goal

Although this dissertation focuses on the internal and social factors that govern phonological innovation, I will also consider the Transition Problem: How does phonological change propagate throughout the speech community? Because I analyze a speech corpus in which

multiple generations and four social status groups are represented, I aim to generate a hypothesis about how the change spread.

1.7 Findings from this Dissertation

This dissertation finds evidence of gradual phonological change for nasal /æ/ allophony in Lansing, MI. The measure of bimodality within speakers' systems coupled with an impressionistic investigation of divergent trajectories and the results of an allophonic judgement task suggest that there is indeed an intermediate period between mechanical and categorical phonology. With these measures, I show that there are speakers in the community who exhibit the second stage of phonological change in The Life Cycle of Phonological Change, i.e. one that is phonetically motivated. Through an apparent time investigation of these measures, I show that the community has transitioned from a mixture of the first two stages of the Life-Cycle to a mixture of the second and third stages of the Life-Cycle. Therefore, in Lansing, allophonic phonological change has progressed gradually such that there was a point in time when speakers did not distinguish between pre-nasal and pre-oral /æ/. Over time, a phonetic distinction developed between the two allophones, which was then re-analyzed as a phonological distinction. An analysis of the social conditioning of gender and social class on this phonological change finds that it is still spreading throughout the Lansing community, with white-collar women leading the change and blue-collar speakers trailing behind.

1.8 Organization of this Dissertation

This dissertation is organized as follows. The present chapter introduced the theoretical debates about the role of phonetics in phonological change and reviewed the methodologies for teasing the two apart at the speaker level. Chapter 2 provides a socio-historical profile of the Lansing

speech community and a review of the literature on the old and new vowel systems in Lansing in particular and the dialect area in general. Chapter 3 describes the methods employed to determine how this change actuated and spread throughout the community. Chapter 4 describes the results of the acoustic analysis of speech production data from 36 Lansing natives. Chapter 5 describes the development of a phonological rule utilizing an impressionistic analysis of the rate of change to pre-nasal and pre-oral /æ/ in apparent time in conjunction with the results of a sub-phonemic judgement task administered to 107 Lansing natives. Chapter 6 provides a summary of the findings in this dissertation and situates them in the context of the literature on phonological change and North American dialectology.

Chapter 2
ALLOPHONIC CHANGE IN LANSING, MICHIGAN

2.1 Introduction

With respect to the Life-Cycle theory of phonological change described in Chapter 1, Bermúdez-Otero (2015) argues that the theory can be supported via observations of the same phenomenon in multiple dialects of the same language. This is because though various dialects of a language can undergo the same change, they do so at different rates. Turton (2014, 2017) provides evidence for this argument through her investigation into /l/-darkening in speakers of different regional dialects of English. Through an ultrasound analysis, she shows that all stages of the Life-Cycle are represented across the speaker sample, i.e. each stage of the Life-Cycle describes the /l/ grammar of one of the speakers in the sample. Thus, the theory can account for synchronic variability as well as diachronic change. Fruehwald (2013, 2016), however aptly points out that synchronic evidence alone is not enough to support or refute the Life-Cycle theory. The best evidence would come from data that show a diachronic progression through these stages of the Life-Cycle. In Fruehwald's study, as previously discussed, diachronic data did *not* support the Life-Cycle theory. Yet there has been no subsequent diachronic test of the Life-Cycle theory using a dataset of speech production. This dissertation will fill this gap.

In what follows, I provide a description of /æ/ systems that are characteristic of regional dialects in North America, and show that like /l/, regional variation in /æ/ systems provides synchronic evidence for a gradual theory of phonological change. I then argue that the progression of these systems over time in the Inland North dialect area, where Lansing is located, provides diachronic support for the Life-Cycle, seemingly in contradiction to Fruehwald's

finding for /aɪ/ in Philadelphia. The argument is based on measures of bimodality which are currently being debated in the field, therefore the facts here are offered as motivation for further research utilizing additional techniques.

The chapter concludes with a description of the Lansing speech community. The socio-historical facts in Lansing can perhaps put into perspective when and why the current changes under investigation in this dissertation are underway. This will enhance our understanding of why this change happened at this time and in this place (Weinreich, Labov & Herzog 1968).

2.2 Allophonic Variation in North America

One of the most important patterns or isoglossic "pivot points" upon which dialectologists distinguish between regional dialects in North American English is that of /æ/ (Labov 1991; Boberg & Strassel 2000; Labov, Ash & Boberg 2006; Dinkin 2011; inter alia). The *Atlas of North American English* (ANAE) (Labov et al 2006) is the most comprehensive analysis of regional dialects in Canada and the United States. Using recorded telephone interviews with 762 individuals, it divides the continent into major dialect regions based on patterns of phonetic and phonological variation in each area. I begin with brief descriptions of the major /æ/ patterns catalogued in the ANAE, before discussing the degree to which they might support the Life-Cycle theory.

(2) Raised System

> The raised /æ/ system is characteristic of speech in the Inland North dialect area, which includes Chicago and Detroit and encompasses much of the Great Lakes region, including Lansing, MI. This system is described by the ANAE as one in which the /æ/ phoneme sits higher in the vowel space than /ɑ/. There appear to be two flavors of the raised system in the dialect area. In its more common instantiation, pre-nasal tokens sit at the upper front of the distribution of the /æ/ cloud while pre-oral tokens are dispersed to the lower end of a single cloud of /æ/ tokens. In its more advanced realization, it is

described as unconditioned, so that /æ/ with nasal codas are "interspersed with /æ/ before voiced stops and after palatals" and other tokens are at the lower end of the token cloud (Labov et al 2006:177), suggesting that in this system /æ/ tokens before nasals, voiced stops, and after palatals are not distinguished from one another. Therefore, the difference between the 'advanced' and 'more common' realizations of /æ/ in the region is the amount of overlap between pre-nasal and other tokens; pre-nasal tokens are either distributed at the top of the cloud (common) or interspersed with the rest of the conditioning environments (advanced). Crucially, both instantiations of this system are phonetically gradual; the pre-nasal and pre-oral token clouds form an "unbroken phonetic continuum from the least raised to the most raised" (Bermúdez-Otero 2007; Dinkin 2011a).

(3) Continuous System

The phonetically gradual unbroken chain is also observed in continuous systems of North America. In these systems, unlike the raised system, the /æ/ phoneme does not raise above /ɑ/ in the vowel space but remains low. Other than this distinction, the continuous system and the more common raised system are similar; there is some raising and/or fronting depending on phonological environment, however the /æ/ token cloud remains an unbroken phonetic continuum in this system (Labov, Ash & Boberg 2006: 176). According to the ANAE (Labov, Ash & Boberg 2006), the continuous system is traditionally observed in the Midland and Canadian dialect areas.

(4) Nasal system

The most common system in North America is the 'nasal system' (Labov, Ash & Boberg 2006). It has traditionally been observed in Eastern New England, and in parts of the West and Midland dialect areas. In this system, tokens of /æ/ before nasal codas are abruptly separated in F1/F2 space from /æ/ before oral codas.

(5) Split system

Another regional system, the split system, is found principally in Mid-Atlantic cities, e.g. Baltimore, Philadelphia, New York City. The distribution of raised /æ/ tokens is subject to complex phonological (and sometimes morphological and/or lexical) conditions that vary from city to city. In Philadelphia, /æ/ is divided into two separate phonemes; a tense vowel class made up of tokens before voiceless fricatives, voiced stops, and tautosyllabic nasals, and a lax vowel class elsewhere (including function words), and crucially, there are lexical exceptions, e.g. *sad* is lax while *glad, mad, bad*

> are tense (Labov 1994: 429–437). Like the nasal system, the tense and lax vowel classes in the split system are clearly separated in F1/F2 space, whereby the tense class is realized higher and more forward in the vowel space than the lax class.

The regional /æ/ systems described in the ANAE and in many other studies (e.g. Boberg & Strassel 2000; Durian 2012; Dinkin 2009; Dinkin 2011a), resemble the stages of the Life-Cycle of Phonological Processes. Therefore, like /l/, these realizations provide synchronic evidence of the Life-Cycle. I am not the first to suggest this; Dinkin (2009; 2011a) and Bermúdez-Otero (2007) have both pointed out that the second and third stages of the Life-Cycle can be found in some dialects of North American English. I add, though, that there is evidence of more than just those two stages. A description of these systems is important for this dissertation because it will provide a methodological jumping off point for which to investigate diachronic evidence of the Life-Cycle in Lansing; i.e. one of the goals of this dissertation is to provide evidence of a diachronic progression from earlier stages described here to a later stage in the community. Here, I will describe these regional systems as they have been described in the literature and highlight how they are representative of the stages in the Life-Cycle.

When one compares the regional North American /æ/ systems to descriptions of the stages of the Life-Cycle, it becomes clear that these regional realizations of /æ/ are synchronic examples of the Life-Cycle. Recall that the first stage of the Life-Cycle is that of a mechanical/physiological phenomenon. This appears to be close to a description of an unconditioned system, like the one found in more extreme cases of the raised system, whereby pre-nasal and pre-oral differentiation is minimal. The second stage of the Life-Cycle is a phonetic implementation stage whereby a phonetic rule operates in a gradient manner, involving "a continuous shift along one or more dimensions in phonetic space, such as the frequency of the

first formant of a vowel" (Bermúdez-Otero 2007). Bermúdez-Otero (2007) and Dinkin (2011a) cite the continuous /æ/ system as an example of this stage, in which the /æ/ cloud forms an "unbroken phonetic continuum from least to most raised, influenced by numerous features of the vowel's phonetic environments" (Dinkin 2011a:78). The third stage of the Life-Cycle is the categorical/phonological rule stage, and is claimed by Bermúdez-Otero to be "phonetically abrupt" such that the phonological rule creates allophones that have "widely separated targets…and their tokens occupy discrete, largely nonoverlapping regions in phoentic space". Dinkin (2011) notes that this is clearly a description of the nasal system described above. A categorical rule then narrows its domain to the word-level (fourth stage of the Life-Cycle) and then to the stem-level (fifth stage) and by the sixth stage, lexical exceptions are apparent. Bermúdez-Otero (2013) cites the split system of the mid-Atlantic region as exhibiting these last stages on the grounds that the lax and tense classes are phonetically abrupt in F1/F2 space, the rule applies to a stem-level domain (word-level affixes are ignored in determing the phonological environment of tensing), and there are lexical exceptions.

Therefore, synchronic variation in these regional /æ/ systems appears to provide support for the theory of the Life-Cycle of Phonological Processes. A study that can show systematic progression of these stages of /æ/ in a community over time will indeed find diachronic evidence of the Life-Cycle. And most crucially, evidence of gradual phonological change toward /æ/ allophony would have to show a diachronic progression from stage 2 (phonetic distinction) to stage 3 (categorical/phonological distinction) of the Life-Cycle. An abrupt phonological change would not show evidence of stage 2 in the community. Analyses of changes to the phonetic distribution of /æ/ observed in Inland North cities, to be discussed below, suggest (at least at the

community level) that there has been a progression from stage 2 to stage 3 of the Life-Cycle of Phonological Processes.

2.3 Allophonic Change in the Inland North

As mentioned in the previous section, the Inland North dialect area is characterized by the raised /æ/ system. The unconditioned raising of /æ/ is one of the movements in the Northern Cities Shift, a rotation of 6 short vowels in phonetic space (Labov, Yaeger & Steiner 1972; Eckert 1988; Labov 1994; McCarthy 2011; Dinkin 2009b; Gordon & Strelluf 2017), displayed in Figure 2. The arrows display the hypothesized direction of change in phonetic space for each vowel over time. The movement of /æ/ is argued to be the first movements in the NCS chain (although this has been contested more recently, in studies that show /ɑ/-fronting was first (e.g. Gordon & Strelluf 2017)).

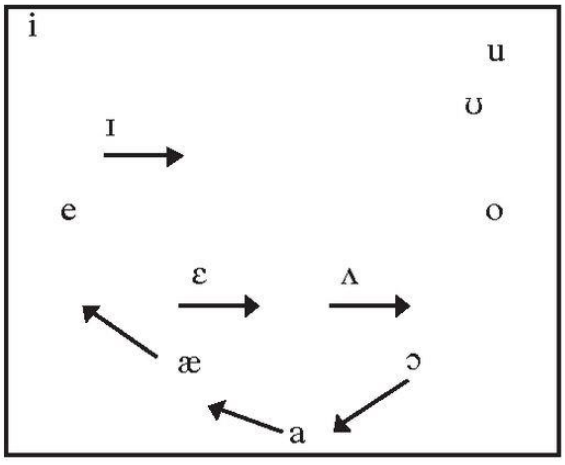


Figure 2 Northern Cities Shift vowel chain shift configuration. (Adapted from Wolfram & Schilling-Estes 1998: 138)

The raising of /æ/ in the Inland North has been so substantial that many NCS speakers have risen /æ/ to mid-front position in the vowel space and often articulate it as a diphthong (Labov 1994; Labov, Ash & Boberg 2006). This acoustic description has led Labov (1994) to conclude that /æ/ in the Inland North behaves as a tense vowel: it is produced with an offglide and diachronically raises along the periphery of the vowel space. Raising and fronting are well documented in the literature on the NCS (see e.g Ito 2001; Gordon 2001; Dinkin 2009; Dinkin 2011a). In this dissertation, I will use them as diagnostic of an 'NCS /æ/' versus other possibilities. Additionally, although it has not often been discussed in the literature on the NCS (although see e.g. Labov 1991 for an exception), I will include diphthongal quality, i.e. change in formant trajectory from the vowel's nucleus to its offset, as a diagnostic of NCS /æ/.

The comparison point for NCS /æ/ is 'LBMS /æ/'. The LBMS or 'Low Back Merger Shift' (LBMS) (Becker fc) is replacing the Northern Cities Shift in the Inland North in what appears to be a supralocal change. As a result, the NCS /æ/ raised system is being replaced with the nasal system. Along with the lowering and retraction of /ɛ/ and /ɪ/ and the progress towards merger of /ɑ/ and /ɔ/, the LBMS involves the lowering and retraction of pre-oral /æ/ such that younger generations of LBMS speakers almost exclusively exhibit a nasal system. The LBMS has been documented with ever greater frequency across North America since the 1990s. First observed in The West and Canada (e.g. Clarke, Elms & Youssef (1995), Hagiwara (1997), Labov (1991), Boberg (2008), and see Becker (forthcoming)), it has more recently been observed in the Midland dialect area (see for example Boberg and Strassel (1995), Bigham (2008), Durian (2012), Strelluf (2014), Holland (2008), Kohn & Stithem (2015)), in New England (Stanford 2019) and surprisingly, in the Inland North: Syracuse, NY (Driscoll & Lape 2015); Ogdensberg, NY (Thiel & Dinkin 2017); Buffalo, NY (Milholland 2018); Rochester, NY (King 2017);

Detroit, MI (Morgan et al. 2017); Grand Rapids, MI (Rankinen, Albin & Neuhaus 2019); Chicago, IL (D'Onofrio & Benheim 2018; Durian & Cameron 2018). Notably for the present study, it has also been recorded in Lansing, MI (Wagner et al. 2016; Nesbitt, Wagner & Mason fc; Nesbitt 2018). Section 2.4.2 below provides more details on the Lansing findings. Movement towards a nasal system has been observed at the community level in each of these analyses. Thus, as Nesbitt & Mason (2016) point out, though the adoption of the nasal system and loss of the NCS is being observed in the Inland North, they appear to be part of a larger trend of regional dialect levelling in North America.

The social circumstances surrounding NCS decline and LBMS adoption in Lansing are as yet unclear. However, social conditioning in the Inland Northern studies cited above, combined with preliminary analyses of social distribution in Lansing, lead to hypotheses that can be tested in this dissertation. I discuss the preliminary findings regarding social conditioning of /æ/ in the Inland North below. The results of preliminary analyses of Lansing speech are presented in section 2.4. Section 2.5 provides a summary and sets up the hypotheses to be tested in Chapter 4.

Labov (1971) suggested a basic three-way taxonomy for distinguishing sociolinguistic variables according to their level of awareness in the community and the social meanings they index. Linguistic *stereotypes* are well above the level of awareness, i.e. speakers use them stylistically and they are often commented on overtly by members of the speech community. One example of a stereotype is *eh* in Canadian English (Gold & Tremblay 2006). Linguistic *markers* are one level down on the awareness continuum. These variables exhibit both interspeaker variation across social groups and style-shifting, but they are not mentioned in metalinguistic discourse. The last type of variable are *indicators*—they may index group affiliation at the

interspeaker level but are not subject to intraspeaker stylistic variation. The entire NCS chain shift appeared to be a classic example of a linguistic indicator (Labov 2001:196) – operating well below the level of awareness (Preston 1996; Niedzielski 2002). Until recently, the NCS showed no signs of style-shifting or social class stratification, i.e. speakers of all social classes were participating in this change. In fact, many studies on the dialect have utilized data from word list speech because its features appeared to be prevalent even when speakers were talking in their more formal speech styles.

The distribution of raised versus nasal /æ/ systems across social class groups in the Inland North has not been subject to much analysis thus far, though three studies note its potential relevance. In Syracuse, NY, Driscoll (2016) found a non-statistically significant association between mean F1 and F2 of /æ/ and speaker education and occupation. She analyzed wordlist data from 50 Syracuse natives aged 18 to 89. In her figures, she shows a slight correlation between higher paying jobs and lower education and /æ/-lowering and /æ/-backing (as well as for /ɛ/-lowering, and /ɑ/-backing), but these relationships were not significant in her statistical modeling. One of the issues with the analysis is that the sample was not evenly balanced for education and occupation, i.e. many of the younger speakers were skewed towards white-collar status. The other issue for this analysis was that social class was analyzed across all speakers in the sample rather than as an interaction with date of birth. Driscoll and Lape (2015) in their preliminary study, and Driscoll (2016), observe that the decline of NCS participation in Syracuse was initiated around speakers born in the 1980s, therefore I speculate that an investigation into social class would benefit from excluding those born prior to 1980. Perhaps with this methodological revisions, the analysis would have resulted in a significant effect of social class on the realization of NCS features in their sample, with the loss of NCS features being led by

speakers with more education and more prestigious occupations. Thiel and Dinkin (2017) find a similar pattern in Ogdensburg, where /æ/-lowering appears to be driven by white-collar speakers, although the education effect does not reach the level of statistical significance. In a larger-scale study of Chicago, there is clear evidence that social class is a factor in NCS recession. In their acoustic analysis of NCS features in the spontaneous speech of 50 Chicago natives born between 1875-1990, Durian and Cameron (2018) show that NCS recession began among speakers born in the 1970s and is thereafter always more advanced in white-collar speech than in blue-collar speech. Thus, in Chicago, it appears to be predominantly white-collar speakers who are reversing NCS features.

Overt negative comments about local speech are reported in Driscoll's (2016) study of Syracuse. Younger Syracusans associate raised /æ/ with older speakers, referencing grandparents or older school teachers as having this *nasally, harsh/hard A accent*. One respondent described the Syracusan accent as "a hard vowel accent that I'd like to think I don't possess" (Driscoll 2016:81).

The qualitative comments in Syracuse are supported elsewhere in the Inland North by quantitative evidence of a shift in the direction of style-shifting over apparent time. In their analysis of /æ/-raising in Ogdensburg, NY, Thiel and Dinkin (2017) compared the means of 43 speakers while reading from a word list and during conversational speech. They showed that older speakers (born before the 1970s) raised /æ/ more in their word list speech than in their conversational speech, suggesting that for them, raised /æ/ is the more prestigious pronunciation, while those born after the 1980s were more likely to *lower* /æ/ while reading from a word list than in their conversational speech.

Thiel and Dinkin (2017) also administered an attitudes survey to their participants. For this, participants listened to a male talker and rated him on Likert scales of localness and educatedness. Crucially, there were multiple talkers who had similar acoustic characteristics but who differed in whether their sound clip was digitally edited to have a raised or unraised /æ/. The researchers compared ratings of the two types of voices (raised and unraised). They found that listeners born before 1960 did not rate raised and unraised /æ/ differently on these affective scales. Listeners born after 1960, however, rated raised /æ/ as more local but less educated than unraised /æ/. Thus, in Ogdensburg, raised /æ/ has apparently risen from an indicator to a marker.

In sum, based on attitudinal, style-shifting, and social class data in the dialect area, there is evidence that the NCS (or at least /æ/) has risen in markedness. As Nesbitt and Mason (2017) argue, this has likely motivated younger, mostly white-collar, speakers to reverse NCS features; a scenario which is expected when an indicator rises to a marker (Labov 2001). Therefore, the change towards the LBMS appears to be one towards a more prestigious form. Considering this, I hypothesize that the propagation of LBMS features throughout the Lansing community will be led by the middle-class and especially by women in that social class, as it appears to be in other Inland North communities and in other changes from above.

2.4 Lansing Speech Community

Lansing, Michigan is a particularly appropriate site for an investigation into allophonic change. Here I provide a sociohistorical description of the Lansing area. A discussion of preliminary findings regarding Lansing speech and its social conditioning is included in section 2.4.2

2.4.1 The Speech Community

Incorporated in 1859, Lansing is the capital of Michigan. It is in the center of the lower part of the state, located approximately ninety minutes' drive west of Detroit, one hour east of

Grand Rapids, and three hours east of Chicago, Illinois. Lansing is in Ingham County, which together with Eaton and Clinton counties comprise the metropolitan area of Greater Lansing or 'Mid-Michigan'. Although it is called a 'metropolitan area', Lansing is situated in the middle of low-population-density farming land (130 to 500 people per square mile), dotted with small towns rarely exceeding 8,000 inhabitants. The closest city to Lansing with a population of more than 50,000 is Battle Creek (pop. 51,286: U.S. Census 2017), which is 50 miles south-west of Lansing. Today, Lansing is a mid-size city of 114,000 inhabitants (US Census 2010), and like many cities in North America, its population is more ethnically diverse than its surrounding neighborhoods and towns; 60% White, 24% Black and 12% Latinx. The population of Ingham County, which includes the college town of East Lansing, is 80% White. Consequently, the city of Lansing, where the speakers in this dissertation were born and raised, is best described as a mid-sized city that is surrounded by less diverse suburban towns which are in turn surrounded by sparsely populated farmland on all four sides.

Lansing, like most other Inland North cities, is part of the *Rust Belt* (see e.g McClelland 2013), a collection of manufacturing communities in the north and northeastern United States that witnessed significant economic and population increases after World War II, but whose economies suffered as the manufacturing industry gave way to the service industry in the 1990s. Lansing is an automotive town. It is where R.E. Olds set up shop and established the Oldsmobile brand, which was a staple brand in Lansing from 1901 to 2004. It is also where General Motors, a world leader in auto manufacturing at the turn of the 20th century, has housed many of its assembly plants, its headquarters from 1965 to 1998, and its body plant—Fisher Body (Coase 2000).

The auto industry boom in Lansing from the early to mid-20th century prompted a rapid increase in population. The city of Lansing was rather small at the turn of the century (pop. 16,485: U.S. Census 1910) but reached its peak in the latter part of the century (pop. 131,403: U.S. Census 1970) due to jobs created by these companies. This boom, however, was followed by general population decline due to the dissolution of auto industry jobs in the city starting in the 1980s.

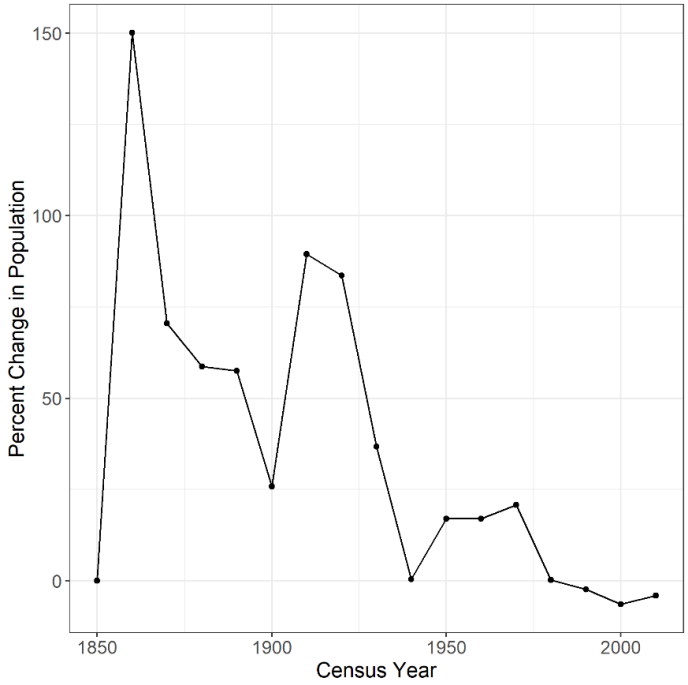


Figure 3 Population rate of change by decade from 1860 to 2010 in Lansing. [Source: US census 1860 – 2010].

Figure 3 displays the change in population by decade from 1860 to 2010 in Lansing as reported by the US Census. From 1850 to 1930, the city of Lansing experienced significant

population growth, with an average of 71.55% increase per decade (26.75% more than the state average). From 1930 to 1940, population growth plateaued to .45%, reflecting the large-scale economic stagnation of the national Great Depression that affected areas with prominent manufacturing industries with particular intensity. Population rose during the 1950s, 1960s, and 1970s by 18.26% on average until it fell by 3.18% on average in each of the following decades.

Because one of the aspects of this dissertation is to discern whether allophonic change is externally or internally motivated, it is crucial here to ask: Who contributed to Lansing's population growth and was their speech different from the existing (white) Lansing population? There was no substantial in-migration from outside the Great Lakes area in the 20th century (Fine 2004). Therefore, three other groups with potentially non-local speech patterns must be considered in turn: White rural Michiganders, non-White minorities, Midland dialect speakers, and those moving to the area to attend the local university (Michigan State University).

Much of the population growth in the first half of the 20th century was due to the in-migration of white Michiganders, many of whom came from Lansing's surrounding rural farming towns (Fine 2004). It is conceivable that the concomitant dialect contact between rural and urban speakers actuated the development of the nasal system in Lansing. This, however, is an unlikely scenario since rural and urban speakers in Michigan likely did not have significantly different accents during this time, as sociolinguistic research in Michigan rural towns has shown that rural Michiganders also participate in the NCS (Ito 2001; Gordon 2001). Additionally, it is unclear why nasal system adoption would be led by high socio-economic status community members in the city, since rural speech is not usually positively socially evaluated (Preston 1996; Seale & Mallinson 2018). Another thing to consider is that larger Inland North cities like Detroit

and Chicago, which saw proportionally less rural in-migration in the early 20th century than Lansing (Fine 2004), are also exhibiting this change toward nasal /æ/ allophony.

Additionally, like many northern cities, Lansing received some minority in-migrants—many of whom were African Americans. But unlike in those other cities, the number of non-White residents in Lansing remained relatively low. Figure 4 displays the percentage of non-White Lansingites from 1960 to 2010, as reported by the US census. Though there is a steady incline from 10% to 40% over the course of fifty years, the non-white population stays below 20% up until the 1980s. And although Lansing was a less residentially and educationally segregated city than many others in the 20th century (Fine 2004), it is unlikely that the minority non-White population exerted significant linguistic influence over the White majority.

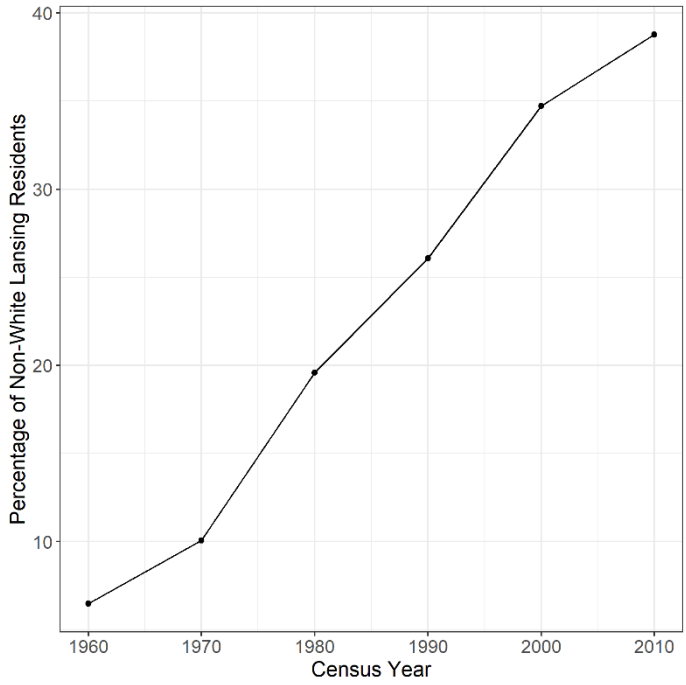


Figure 4 Percentage of Non-White population in Lansing. [Source: US census 1960-2010].

In-migration from Midland states into Lansing is also another possibility, since many Michigan cities experienced in-migration from Ohio, Indiana, and Illinois. According to the US census, the percentage of Lansing residents born in other states rose from around 16 to 18% at the beginning of the 20th century, to 25% in 1950, before slowly declining again to early 20th century levels by the end of the century. In-migration into Lansing from other states was never substantial, however. From 1950 to 2010, less than 10% of Lansing residents per decade reported that they lived in a different state in the previous decade.

Lastly, I consider whether Michigan State University (MSU) might have contributed to a scenario in which large amounts of non-local speakers might interact with the speakers living in neighboring Lansing and therefore provide enough variability to induce change. Two crucial points about the MSU student body raise doubt about this possibility. First, the international student body constitutes a very small proportion of the MSU population (13.7% in 2017) (Michigan State University 2018). These students often reside in East Lansing, which is a neighboring town of Lansing. They leave the area upon finishing their degree and are less likely to interact with speakers born in the actual city of Lansing since East Lansing is not only where they live and where the university is, but it is also a center for social events, shopping, etc. for its residence. Another source of potential contact are non-local college students coming to MSU for school. Crucially, however, 72.7% of the domestic students at MSU are indeed Michigan natives themselves (Michigan State University 2018). Therefore, though Lansing is just miles away from a state university, the university is not a likely locust of large amounts of contact that are needed to promote phonological change.

In summary, Lansing does not appear to have experienced a dialect contact scenario of the type described for linguistic changes from above, whereby supralocal (or simply non-local)

sociolinguistic features are adopted from a dialect with higher overt prestige than the local dialect. Nor does dialect contact appear to have been sufficient to trigger leveling toward a non-prestigious majority norm (cf. Kerswill & Williams 2000).

In the absence of a clear external model for the /æ/ nasal system, therefore, what community-internal social motivation might there have been for its adoption? That is, if we cannot clearly establish that White Lansing speakers were actively adopting the nasal system as an exogenous feature, can we provide some support for the idea that they were at least rejecting the raised /æ/ system as an endogenous feature? There are numerous examples in the sociolinguistic literature of speech communities losing features of their dialects in response to changes in the economy and education system (e.g. Schilling-Estes & Wolfram 1999). Here I trace the major socioeconomic developments in 20th century Lansing, before discussing the likelihood of those changes being motivating forces for the shift from raised to nasal /æ/ patterns in this speech community.

In the United States, although manufacturing industries before the 1930s offered low-paying working-class jobs, the development of labor unions led to relatively high-paying working-class jobs from the 1940s to the 1970s (Knox and Pinch 2006). This is illustrated in interviews with some of the older blue-collar speakers in the current sample (Chapter 3) who discuss how their salaries rose to $70,000 after the 1970s and 1980s labor strikes in Lansing. Accounting for inflation, this equates to $384,687.55 today (see CPI calculator at Bureau of Labor Statistics), which would place one well above working-class blue-collar status even today considering the US median income in 2017 was $60,336 (U.S. Department of Commerce 2017).

During this period of economic growth for factory workers, White residents who were now equipped with higher salaries accelerated "white flight" to the Lansing suburban periphery

that had already begun in the 1960s, to places such as Delta Charter Township ('Delta') and Bath Charter Township ('Bath'). This population movement, which was characteristic of many communities in America at the time (Knox and Pinch 2006), was motivated by White people's desire to raise families away from cities, where crime, drug use, and the in-migration of minority groups was on the rise (or was perceived to be on the rise). According to the US census, the city of Lansing was 93.51% White in 1960 and as of 2010, Lansing's White population is only 61.23%. The largest decrease (9%) in Lansing's White population occurred between 1970 and 1980 (i.e. during the auto manufacturing crisis in Michigan).

Figure 5 shows population change in the city of Lansing compared to Delta and Bath throughout the 20th century. From 1950 to 1980, Delta's population grew an average of 76.82% per decade at a maximum of 127.19% from 1960 to 1970. Although Delta has become less White over time, it is significantly more White than Lansing. In 1980, 94.9% of Delta was White compared to Lansing's 80.42%. Lansing's non-White population, particularly its African American population, has steadily increased since the 1960s. The differential access to capital allowed the White laborers to move away from the urban center when it became less desirable whereas the non-White populace was left to choose from whatever jobs that did not require a college education (mostly in lower paying sectors).

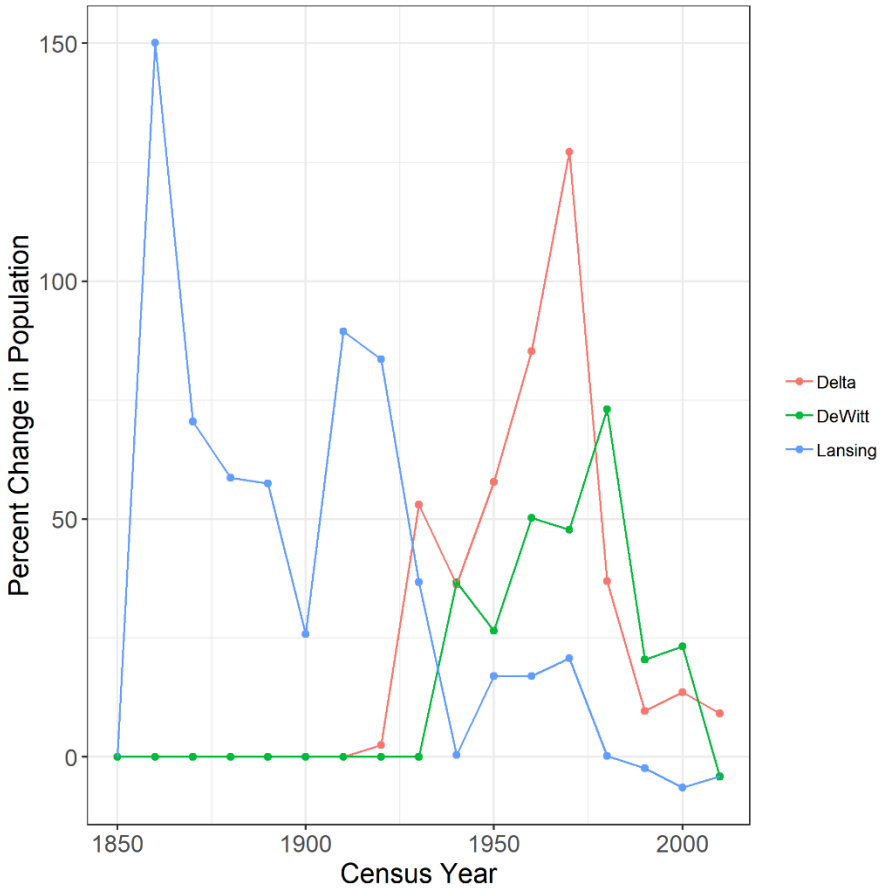


Figure 5 Rate of change in population by decade from 1860 to 2010 in Lansing compared to two Lansing suburbs; Delta Charter Township and Bath Charter Township. [Source: US census 1860 – 2010].

Economic decline began in the 1980s when General Motors, Lansing's largest employer at the time, slowly began to shift its plants and offices to Detroit (Coase 2000; McClelland 2013). The first sign of economic shift was in 1984 when General Motors moved its decision making to Detroit, and eventually moved its headquarters there in 1998 (Coase 2000). In 2000, General Motors announced that the city's staple line, Oldsmobile, would be phased out and that they would be closing many its factories in the city. With the dissolution of many auto-manufacturing plants in the city came an increase in service sector jobs. At the time of writing,

the largest employers in the Lansing are the state government and the hospital system (Lansing Economic Area Partnership). Crucially, the jobs in the service sector require at least some college education (Rosen 2007). Therefore, working-class autoworkers in Lansing have either had to choose from whatever jobs that did not require a college education (mostly in lower paying sectors) or leave the city. Many of these workers were forced to go back to their family farms, while some stayed to navigate this new economy (Fine 2003). The economic impact of this transformation has had many social consequences for these communities and for the manufacturing workers who thrived during America's industrial age. Since 2000, the unemployment rate in Lansing has increased by 8% and as described above, the population has decreased by 15% (U.S. Census 2010).

The Baby Boomer generation (born 1946 – 1960) was most directly affected by this industry transition (McClelland 2013; Knox and Pinch 2006). They would have entered the work force in the 1970s and 1980s, inheriting the traditional manufacturing lifestyle of their parents, but they would have experienced the brunt of economic decline in the 1990s and 2000s when they were in their 40s and 50s. Generation X (born 1964 – 1985) would have in turn inherited dismal socioeconomic circumstances, with less economic opportunity in the city. As I note below, my preliminary analysis finds that many of the linguistic changes that occurred in Lansing took place in this latter half of the 20th century. Therefore, this dissertation is especially interested in the social conditioning of these changes in these two generations.

2.4.2 Preliminary Analyses of /æ/ in Lansing

Even though the White population constitutes the majority ethnic group in Greater Lansing, there has been no substantial investigation of local White phonology. Previous studies have reported on the speech of African American (Jones 2003) and Mexican American speakers

(Roeder 2006, 2010) in Lansing. Only a small number of White speakers were included for purposes of comparison. The studies I've conducted in collaboration with my colleagues at Michigan State University and our advisor, Dr. Suzanne Evans Wagner, and for this dissertation therefore constitute the first large-scale sociolinguistic studies of speech in the White population of Greater Lansing. Here I present the findings from one collaborative and one single-authored analysis of conversational data in Lansing. Both analyses utilize data from contemporary and historical speech as part of the Impact of Higher Education on Local Phonology project (henceforward IHELP), funded by US National Science Foundation grant #BCS-1251437. For this project, we trained undergraduate students who were born and raised in Greater Lansing to conduct sociolinguistic interviews with their Lansing-native friends and family. Sociolinguistic interviews with 30 Lansing natives born 1989 to 1999 were conducted. To get a view of speech in the past, we obtained oral histories (n=21) of Lansing-native auto plant workers recorded in the late 1990s and early 2000s (G. Robert Vincent Voice Library). Speakers in this collection (henceforward 'AutoTown') were born 1907 – 1961. The range of subjects and birth dates allowed us to identify changes in local speech from the NCS to the LBMS pattern over the course of 100 years.

Our preliminary analysis found that /ɛ/ is lowering in apparent time, consistent with both the NCS and the LBMS, while /ɑ/ is retracting from its NCS central position towards merger with /ɔ/, consonant with the LBMS (Wagner, Mason, Nesbitt, Pevan & Savage 2016). Regarding /æ/, we found a progression from an advanced raised continuous system to a common raised continuous system to a nasal system over apparent time. Figure 6 shows three different speakers' /æ/-configurations in conversational speech (sociolinguistic interview or oral history), arranged left to right by year of birth. Red circles represent tokens with /æ/ realized before nasal

consonants; blue triangles represent tokens of /æ/ realized before oral consonants. On the left is the token cloud for Jack Down, born in 1924. He has the expected raised system (Labov, Ash and Boberg 2006, Dinkin 2011a), which shows no phonetic tendency for raising pre-nasal above pre-oral tokens. As we move forward in apparent time, the more common raised continuous /æ/ system become more common, like the configuration of Michelle Baulch, born in 1971, in the center facet of Figure 6. In this system, although there is still a large degree of overlap between pre-nasal and pre-oral token clusters, there is a tendency for pre-nasal tokens to be more raised than pre-oral tokens in the /æ/ cloud. Moving ahead even further in apparent time to speakers born in the 1990s, we encounter the nasal system, exhibited on the right in Figure 6 by the distribution for Ben Langdon, born in 1994. His pre-nasal and pre-oral token clouds barely overlap.

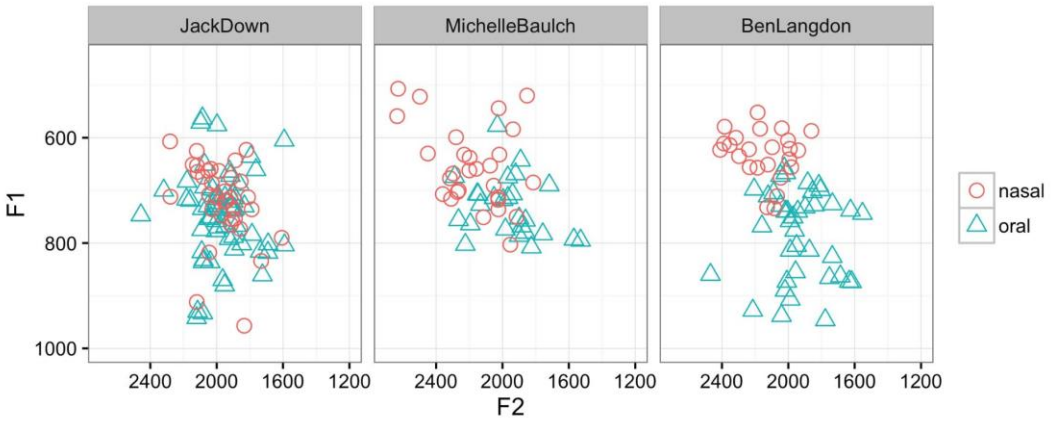


Figure 6 Three distinct /æ/ systems from Greater Lansing: Jack Down, b. 1924, multiple college degrees, advanced raised continuous system; Michelle Baulch, b. 1971, multiple college degrees, common raised continuous system; Ben Langdon, b. 1994, community college student, nasal system.

Figure 7 shows the apparent time shift to this more nasal-like /æ/-system using Pillai-Bartlett scores. The Pillai statistic measures the difference between two clusters of vowels; low scores (approaching zero) indicate a large degree of overlap between two clusters, while higher scores (approaching 1) indicate a very small degree of overlap (see also Chapter 3). Using this statistic, we measured the overlap between pre-nasal and pre-oral token clouds for each speaker.

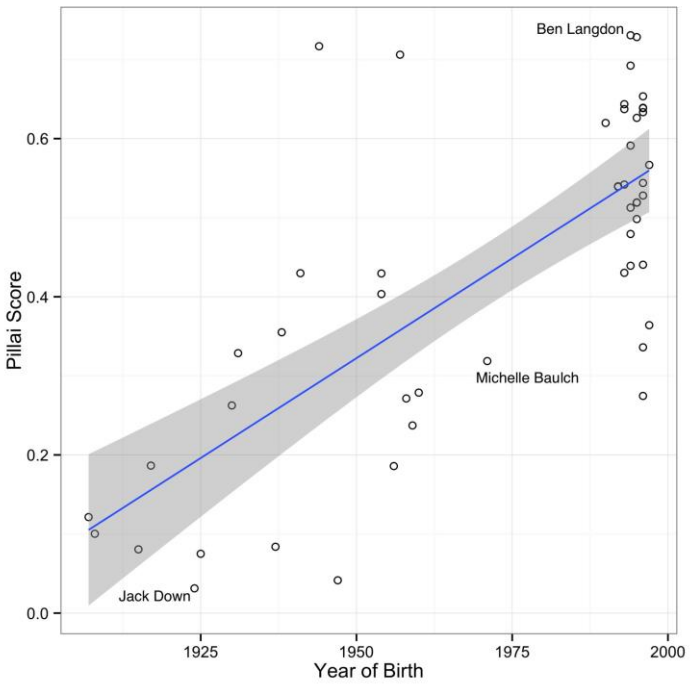


Figure 7 Pillai-Bartlett scores for /æ/ by year of birth for Lansing, MI speakers (from Wagner et al 2016:figure 5)

The degree of overlap between pre-nasal and pre-oral token clouds decreases as year of birth increases, indicating that Greater Lansing speakers have gradually shifted from an

advanced raised (stage 1 of the Life-Cycle) to a common raised continuous (stage 2 of the Life-Cycle) to a nasal (stage 3 of the Life-Cycle) /æ/ system. Recall that Jack Down (Figure 4) showed virtually no difference between pre-oral and pre-nasal TRAP. He has an extremely low Pillai score of 0.07. Ben Langdon, by comparison, has a high Pillai score of 0.73, indicating very little overlap. Judging from the apparent time trends of these vowels and the configurations of the /æ/ systems of white-collar speakers born in the Millennial generation we surmised that Lansing was moving toward the nasal system.

In Nesbitt (2018), I expanded upon the analysis of /æ/ in the Wagner et al (2016) study. First, I wanted to focus on the speakers in the sample who were born and raised in the city of Lansing. This was because the NCS has been found to be less advanced outside of larger cities (see Ito 2001, Gordon 2001). Second, because of the emerging evidence of a change in evaluation of the NCS in other Inland North cities, I wanted to investigate whether the Lansing speech community had begun to assign negative social meaning to NCS /æ/-raising and/or fronting. My third motivation was to provide a more specific time window for NCS adoption and decline in the community. I therefore conducted an analysis of /æ/ on a subset of the Wagner et al (2016) sample which consisted of the 27 speakers who reported that they were born and raised in the city of Lansing rather than in any of the surrounding rural towns (Nesbitt in press). This analysis identified that the change away from the NCS-like raising/fronting of /æ/ and the raised system in the city started with speakers born in the Baby Boomer generation (date of birth 1946–1964). Before this generation, urban Lansingites of all social class backgrounds had /æ/ systems that were more raised than that of their rural peers – each had higher and fronter realizations of /æ/ as compared to /ɑ/ and they displayed no separation between pre-nasal and pre-oral /æ/ in acoustic space. In the Baby Boomer generation, however, only blue-collar

speakers continued advancing the NCS pattern while white-collar speakers did not. Figure 3 displays how /æ/ has moved along the front diagonal over time across social class. The front diagonal measurement captures movement along F1 and F2 simultaneously, with a higher number indicating a higher and more forward realization (normalized F2 – 2*normalized F1, see Labov, Rosenfelder and Fruehwald 2013). In Figure 8, we see that /æ/ remains relatively stable in the white-collar community (red) until it decreases in the Millennial generation. Though there is no data from blue-collar speakers born after 1970, I observed that /æ/ raising and fronting notably peaks only for blue-collar speakers in the Baby Boomer generation where values are outside of the range of any other generation in the community.

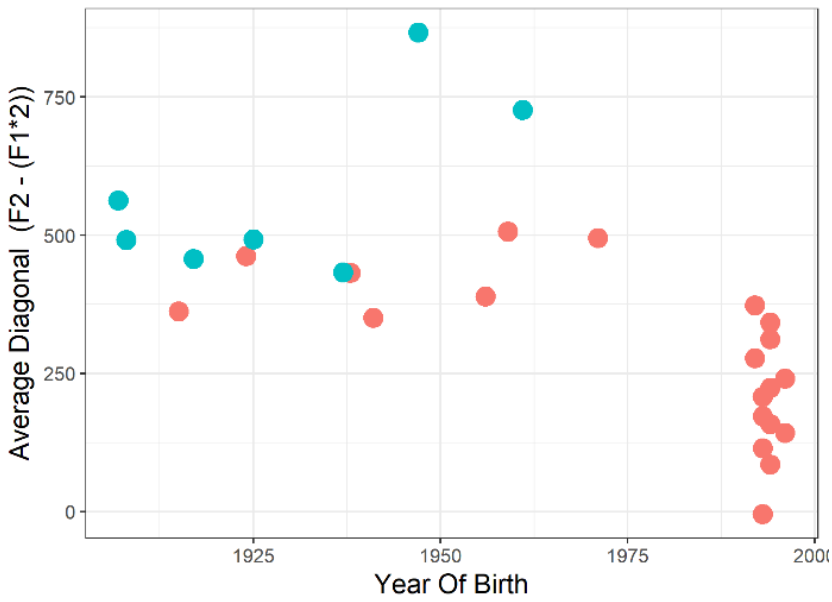


Figure 8 Trajectory of /æ/ diagonal in urban Lansing (blue = blue-collar; red=white collar); dots represent means for individual speakers (n=27).

Phonological contrast as measured by Pillai-Bartlett statistic (Hay, Warren and Drager 2006; Hall-Lew 2010 and see Chapter 3) is displayed in Figure 9 with social class indicated by color (red = white-collar, blue=blue collar). From the figure, it appears that movement toward nasal separation in the white-collar sub-sample occurred in the middle of the 20th century, where we find Pillai scores increase from almost 0 in earlier years to 0.35. Blue-collar speakers, however, appear to remain well below 0.1 over time, save one blue-collar speaker in the Boomer generation who seems to pattern with the white-collar speakers in her generational cohort. Without a more robust and socially stratified sample, however, I was not able to say with confidence whether social class conditions nasal separation in Lansing.

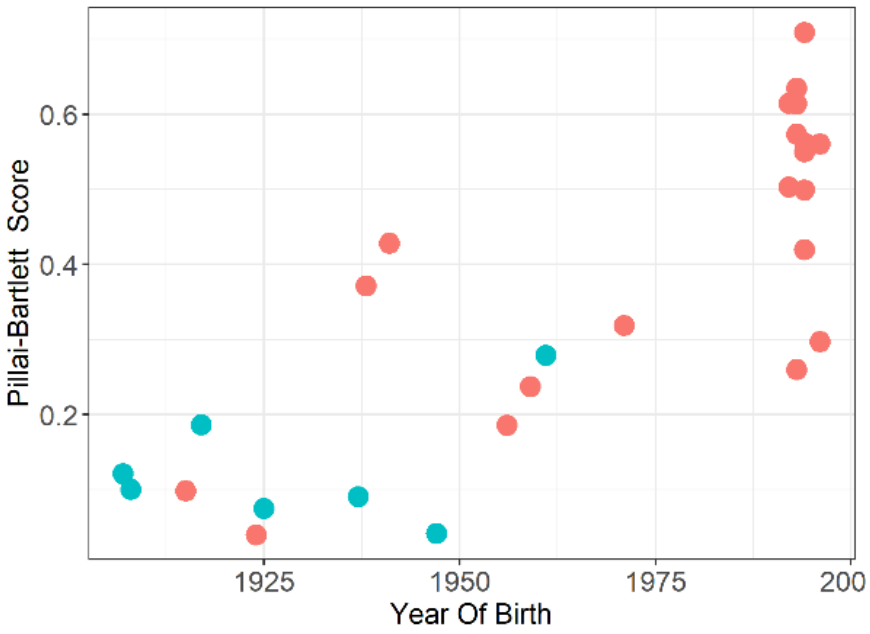


Figure 9 Pillai-Bartlett scores in 20th century Lansing by social class (blue-collar = blue).

More evidence of social motivation comes from a quantitative analysis of style-shifting within the younger white-collar sample of the Wagner et al (2016) participants. In collaboration with Alexander Mason, I reported on a rise in dialect awareness in Michigan (Nesbitt & Mason 2016). As part of that study, we compared speakers' F1 and F2 means of /æ/ in the Wagner et al. (2016) sample while they were speaking spontaneously during their interview to that when they were reading a word list. Since there is no word list data from the speakers in the AutoTown oral histories collection, this analysis included only a subset of 29 speakers who were all born in the 1990s. This style-shifting analysis showed that young speakers in Lansing were more likely to lower and retract pre-oral /æ/ but raise and front pre-nasal /æ/ while reading from a word list than in their conversational speech. Though attitudinal data in Lansing is only really robust for younger speakers, the addition of the social class analysis from Nesbitt (2018) suggests that in Lansing, /æ/ has risen as a linguistic marker as it has in other Inland North communities. These two pieces of information combined with the apparent stratification in /æ/-raising/fronting suggest that the development of nasal allophony will be socially constrained. There is also supporting qualitative evidence from some of the speakers themselves, particularly those aged 20–40. In the IHELP interviews and in additional interviews conducted for this dissertation, young speakers describe the Lansing accent as "nasally" with "hard As" (Nesbitt et al. to appear). One community member born in 1996 reported that she "tones down" her accent when she travels.

2.5 Summary

To summarize, the Wagner et al. (2016), Nesbitt and Mason (2016), and Nesbitt (2018) analyses allow for the generation of hypotheses about the actuation and propagation of allophonic change in Lansing. First, the change has likely occurred gradually. Through the use

of the Pillai-Bartlett analyses, we showed that speakers exhibit the first three stages in the Life-Cycle of Phonological Processes and crucially, there appears to be progression from stage 1 to stage 3 in apparent time. Second, the change appears to be socially motivated, as white-collar speakers almost exclusively exhibit stages 2 and 3, while no blue-collar speakers in the sample exhibit stage 3. Therefore, this dissertation will extend the analyses in these preliminary studies and include social class and gender as conditioning factors in this change.

The Pillai-Bartlett score analysis was a good initial step in exploring /æ/ systems in Lansing. Yet researchers have shown that while bimodality is often an indication of phonological/categorical differences, the absence of a bimodal distribution does not entail the absence of a phonological difference (cf. Bermúdez-Otero & Trousdale 2008: 696; Schilling, Watkins & Watkins 2002). Therefore, for this dissertation, an analysis of Pillai-Bartlett scores over time and across social groups will be supplemented with the impressionistic analysis of rate of change (Chapter 4) and the results of the sub-phonemic judgement task (Chapter 5). The inclusion of these analyses will allow a more definitive answer as to whether phonologization was abrupt or gradual and to address the broader question of *Why changes in a structural feature take place in a particular language at a given time, but not in other languages with the same feature, or in the same language at other times.*

Chapter 3
DATA AND METHODS

3.1 Introduction

The goals of this dissertation are to address the Actuation problem of allophonic change in Lansing, i.e. why does change occur at a particular place in a particular time. In order to do this, I also address the Embedding and Transition Problems, i.e. what are the internal and external conditions surrounding the change and how did the phonological change spread throughout the community. The Embedding Problem is addressed in Chapter 4 where I examine four diagnostics of NCS /æ/ in the spontaneous speech of thirty-six Lansing natives: raising and fronting in F1/F2 space, advanced raised system, and diphthongal quality, against generational time, social class, and gender. I report on the methodology for this component of the dissertation in section 3.2 of this chapter. Along with the Actuation and Transition problems, the Embedding Problem is further addressed in Chapter 5 where I examine phonological change via an analysis of acoustic trajectories of pre-nasal and pre-oral /æ/ allophones and the results of a sub-phonemic judgement task. I report on the methodology for this component of the dissertation in section 3.3. The findings from both of these chapters contribute to a discussion of how and why this change may have occurred, and their implications for our theories of North American dialectology and phonological change will be discussed in Chapter 6.

3.2 Acoustics of /æ/ in 20th century Lansing

My previous research in Lansing suggests that the most significant changes to /æ/ occurred among individuals born in the middle of the 20th century, at which point gender and/or social class condition its acoustic trajectory (Wagner et al. 2016; Nesbitt 2018a; Nesbitt, Wagner &

Mason to appear). In that prior work, the paucity of speakers in the database who were born in the 1970s and 1980s, and the imbalance of gender and social class in the Wagner et al. (2016) sample, made it hard to conclude with certainty when and for whom NCS features have begun to subside. Therefore, the goal of the acoustic analysis in this dissertation is to examine the four selected diagnostics of NCS /æ/ in Lansing with an expanded speaker sample that is balanced for gender, social class, and generational cohort. Throughout, I will refer to this sample of thirty-six speakers as the *Lansing Speech Corpus*. Section 3.2.1 describes how I recruited participants for this study; the demographic distribution of speakers in the Lansing Speech Corpus is detailed in section 3.2.2. Interview methods are described in section 3.2.4. The procedures I followed for processing and transcribing the interviews appear in section 3.2.5, while those for vowel measurement and statistical analysis are in section 3.2.6.

3.2.1 Participant Selection and Recruitment

The data for the Lansing Speech Corpus comes from three sources: oral histories recorded in the late 1990s and early 2000s, sociolinguistic interviews conducted in 2010, and sociolinguistic interviews conducted in the summer of 2018 and spring of 2019. Some (N=12) of the oral histories data in this dissertation come from the Wagner et al. (2016) and Nesbitt (2018) studies and 4 others are newly added; the other sources represent new sociolinguistic information about Lansing speech.

I first sampled from the oral histories collection. Any speaker in that collection who met the demographic criteria described below in section 3.2.2 was included in the corpus (n=16). I then filled in the gaps in the corpus with twenty sociolinguistic interviews, for a total of thirty-six speakers.

The oral histories come from a collection of interviews with Lansing auto industry workers, to be described in more detail in section 3.2.4.1. More information about recruitment methods for this collection can be found on the Michigan State University Vincent Voice Library website where the collection is hosted and in Fine (2004).

The two 2010 sociolinguistic interviews were conducted by an undergraduate student for a senior capstone ethnography project in Lansing's Eastside neighborhood (Fraser 2010). One of these interviewees was recruited at a senior coffee hour in the neighborhood. The second was a friend (and neighbor) of the first, who recommended her as a participant.

For the 2017–2018 interviews, some (n=12) were conducted by a local fieldworker who is a longtime Lansing resident, and some (n=6) were conducted by me. Ten participants were recruited by the fieldworker through personal social networks. The participants are friends, co-workers, children of friends, and neighbors of this interviewer. The remaining eight interviewees responded to my recruitment flyer, which is provided in Appendix 0. I distributed this flyer at local businesses and on social media groups of various Lansing neighborhoods. Because the neighborhood groups on Facebook are "closed" to outsiders, i.e. only those who reside in the neighborhood can post to other members of the group, I contacted the moderator(s) of these groups and asked them to post my flyer on their page. Some ignored my request but others were happy to help. Each participant was compensated $15 for participating in an hour-long sociolinguistic interview.

The demographic profiles of the thirty-six speakers in the Lansing Speech Corpus are provided below. A complete table of speakers in the sample with their demographic information and source of interview is provided in appendix 0.

3.2.2 Speaker Demographic Information

Speakers included in the Lansing Speech Corpus are all natives of Lansing. For this dissertation, Lansing is defined as encompassing all residences located within a 10-mile radius of the state capitol building, which sits at the center of the city. Speakers were classified as 'native' if they had lived in Lansing from at least five years old and had not left the area for more than 3 years. Another requirement of native status is that at least one parent be born and raised in the Lansing metropolitan area and the other parent be from another lower Michigan town[1]. Table 2 provides a summary of the distribution of the social parameters in the Lansing Speech Corpus. A description of how the levels for each demographic category were determined is provided thereafter.

Table 2 Distribution of the Lansing Speech Corpus by generational cohort, social class, and gender.

Generational cohort	Blue Collar		White Collar	
Silent (birth years 1925–1945)	3f	3m	3f	3m
Baby Boomer (birth years 1946–1964)	3f	3m	3f	3m
Generation X (birth years 1965–1984)	3f	3m	3f	3m

[1] I would have ideally liked to limit the pool of speakers to those for whom both parents were born and raised in Lansing. This was impossible because of (1) the limited demographic information provided by oral history interviewees, and (2) the fluctuation in residency due to the in-migration of Michiganders into Lansing in the first half of the 20th century followed by mass exodus in the latter half (Fine 2004). I do not think the absence of two Lansing native parents is an issue for my current analysis because recent analyses in lower Michigan show similar trends of NCS participation (followed by recession) to that in Lansing (Morgan et al. 2017; Rankinen, Albin & Neuhaus 2019). Therefore, the parents of my interviewees would probably have had similar /æ/ productions.

Generational cohort was determined by the participant's year of birth. For this dissertation, I use cultural generations rather than birth year or decade of birth, as is common in sociolinguistics research, so as to capture how cultural change in the US (which as discussed in Chapter 2 also applies to Lansing) has impacted language use. Though this is a less common technique, many sociolinguists have used cultural generations to divide their sample (cf. Dubois & Horvath 2000; Durian 2012; Dodsworth & Kohn 2012; Dodsworth & Forrest 2016). There is no consensus in social science research or in public discourse about the precise limits on popular generational labels, however (indeed, generational groupings are "imprecise but culturally useful" (Pew Research Center)). I have employed the date range for Baby Boomers in Knox and Pinch (2006) and made the generations on either side uniform 20-year periods. The three generational cohorts in this dissertation are the Silent generation (born 1925–1945), the Baby Boomer generation (born 1946–1964), and Generation X (born 1965–1985). In this dissertation, I also use data from the 21 Millennial generation speakers (born 1985–1999) in Wagner et al (2016) as a temporal reference. I do not include them in the statistical analyses below because, as discussed in Chapter 2, this group is not balanced for social class or gender. The majority of Millennial speakers here are women (N=18), and they are all middle-class. I include them in the figures below to provide a trajectory of (female) white-collar speech after generation X and as a comparison point to the white-collar female women who participated in the sub-phonemic judgement task.

Working- and middle-class Lansingites were targeted for this dissertation. I made the decision to focus on these two groups because (1) Lansing does not have a traditional 'old money' upper class (cf Kroch 1996 for the speech of the Philadelphia upper class) and (2) these groups, as opposed to the upper and under class, are often the innovators of linguistic change in

urban areas (Labov 2001; Baranowski 2013). Classification of social class has been and still is highly debated in sociolinguistics and sociology more generally. Because there is no unifying methodology, studies using social class as a variable have utilized metrics that include some combination of median income of a neighborhood, occupation, education level, income, median price of homes in a person's neighborhood, parents' occupation and/or education level, or job sector to determine an individual's socio-economic status. Occupation appears to be the most predictive measure of an individual's socio-economic status in more recent work (Labov 2001; Forrest & Dodsworth 2016; Baranowski & Turton 2018). Furthermore, Holley, Dodsworth & Wagner (to appear) argue that occupation is predictive because of the way it tends to capture social prestige and linguistic market pressures, and is reflective of the speaker's social network. Lastly, occupation seems to be the most salient indicator of social class in the Lansing community, as sociolinguistic interviewees were more likely to discuss occupation than education or material wealth when topics of social class came up. As such, I use occupation as my measure of social class for this dissertation. Speakers in manual labor occupations (e.g. car body assembly, construction worker, machine operator), or in low-level service and care jobs (e.g. wait staff, daycare worker, receptionist) that require less than 2 years of training after high school were classified as *blue-collar*. Those in managerial positions and in occupations that require at least 2 years of technical training outside of high school (e.g. chemical engineer, financial manager, information technology supervisor, plant manager) were classified as *white-collar*. Two speakers in the sample were stay-at-home parents, so I classified them according to their spouse's occupation, which for both was white-collar. It is worth mentioning here that the social class status of most of the participants in this study matched that of their parents, i.e. those

who grew up blue-collar were themselves blue-collar. The one exception is a female Generation X speaker whose parents were blue-collar but who is themselves white-collar.

Participants were classified as either male or female. Though I recognize that gender is a gradient variable rather than dichotomous, I classified gender here as binary in line with how participants referred to themselves in the demographic part of the interview. Speakers in the sample were often interviewed by a stranger, so it may very well be the case that some did not feel comfortable enough to disclose intimate details of their identity. So, I cannot say definitively that there was indeed a binary split of gender in the sample, but the categories reflect what participants reported during their interview.

The choice to limit the corpus to just thirty-six speakers is the result of various methodological limitations related to recruitment and speaker classification. First, the oral histories speakers in general provided very little demographic information during their interviews. The only consistent information gathered by the interviewers was hiring date, ethnicity, marital status, current address, education level, and job title. Because other demographic information was not readily reported for each speaker, I did my best to gain this information from the interview recording; oftentimes doing some calculation, e.g. discerning year of birth from reported year of high school graduation and age at graduation. So, eliminated from the sample were speakers for whom age, education, gender, residency background of their parents, and their own residency status were not readily available in the interview. Also excluded from the pool of speakers were those who reported that they were born and/or raised in a neighboring rural town outside of the Lansing metropolitan area. A third major complication in sampling was a very common issue in linguistics research – the recruitment of men. The fieldworker and I recruited all eleven female participants and conducted sociolinguistic

interviews with them in less than two months. By contrast, it took nine months to recruit and interview the seven men. While this dissertation would benefit from the inclusion of more speakers in each demographic group, time constraints did not permit a larger demographically balanced sample. Future researchers working on Lansing speech are encouraged to increase the size of the corpus.

Table 3 Number of participants from each data source

	Year Recorded	Silent	Boomer	Gen X	Total
Oral History	90s/00s	10	6	0	16
Sociolinguistic Interview	2010	2	0	0	2
Sociolinguistic Interview	2018/9	0	6	12	18
Total		12	12	12	36

The second thing to consider is how change over time can be interpreted, since the speakers were recorded during three different time periods of data collection. Table 3 displays the distribution of speakers in the Lansing Speech Corpus by the interview collection method (sociolinguistic interview or oral history). Recall that the sixteen oral histories interviews were recorded in the late 1990s and early 2000s, the two ethnographic interviews were conducted in 2010, and the eighteen sociolinguistic interviews were conducted in 2018 and 2019. All of the oral histories speakers are in the Silent and Baby Boomer generations, while the sociolinguistic interview speakers are in the Baby Boomer and Generation X cohorts. Crucially, the oral

histories interviews were conducted almost 20 years before the sociolinguistic interviews were conducted in 2018 and 2019.

There are two avenues for exploring language change in this sample, and any sample in which speakers differ in both year of birth and year of recording. An Apparent Time analysis compares data by date of birth to show change over generational time. A Real Time analysis would compare data by date of recording and thus display change in the community's language. In the Lansing Speech Corpus, a real time analysis would compare data from the speakers interviewed in the early 2000s to those interviewed in 2018/2019 to show change over the last 20 years. It could very well be the case that most of the changes explored in this chapter have taken place in the last 20 years rather than over the course of multiple generations. I use the apparent time construct in this dissertation because while there is some evidence that speakers exhibit slight variations in their speech after adolescence (cf Labov 2001; Tagliamonte & D'Arcy 2009),changes in (phonological) representation have not been established as changes that occur in adulthood (Labov 1994: 102–107)[2].[3]

[2] If we look at Table 3, it appears that I can investigate real versus apparent time change in this sample. There is indeed an even split in the Baby Boomer generation between the sociolinguistic interviews conducted in 2018 and 2019 and the oral histories conducted almost twenty years prior. I will not do this, however, because much of the social conditioning on these changes occurs in this Baby Boomer generation. Though the interview sources are evenly distributed in this generation, social class and gender are unevenly distributed within these two groups. Therefore, I would not be able to conclude whether any differences between the groups is indeed evidence of real time change or simply an imbalance in the social makeup of these groups. I recognize that I have not convincingly ruled out a real time conflation in this analysis and I leave it for future research to consider how recent these changes are.

[3] Fruehwald (2017) offers a solution for disambiguating between apparent and real time in a sample using Generalized Additive Models and Tensor Product Smooths to model the data. I do not use these methods here because the Lansing Speech Corpus is relatively small. However, any analysis with a potential real and apparent time confound and a good amount of speakers would benefit from using this technique.

3.2.3 Interviewers

Most of the sociolinguistic interviews (n = 13) utilized in this dissertation were conducted by a Lansing community member. I conducted five of them. This interviewer, who I will refer to throughout this dissertation as the *Lansing interviewer,* was born and raised 4 hours north of Lansing and has resided in Lansing since they were 20 years old. They identify as white, female, and are in their mid-40s. I selected this interviewer because they were a longtime Lansing resident and they have a socioeconomically diverse social network. I recruited this interviewer through the social networks of a Michigan State University professor. They were tasked with recruiting, scheduling, and interviewing the participants that they recruited. They were paid $20 per speaker that they interviewed, and I trained them for two hours before they carried out any interviews. During this training session, I introduced them to the study and my objectives regarding speaker demographics. I also trained them to use the recording equipment and introduced them to best practices for conducting a sociolinguistic interview (to be described in 3.2.4). I provided this interviewer with all the materials necessary to conduct the interview, including consent forms, the script for introducing the formal tasks, the list of interview questions, an interview flow-chart, the recording equipment, and the money for participant payment. After the interviewer conducted three interviews in the field, I listened to the interviews and had a second thirty-minute session where I provided feedback and offered some suggestions for answering/deflecting questions that were aimed at learning more about the study's focus. In two of these initial interviews, the participant had inquired about the purpose of the study and the interviewer had revealed that we were interested in "the way that people pronounce vowels in Michigan". Disclosure of this information would almost certainly guarantee that a participant would monitor their speech and likely produce more careful speech, which is not the objective of these interviews. This was not an issue in this particular case, since

this exchange occurred towards the end of the interview. Neither this part of the conversation nor any following parts were included in the current analysis, in any case. For subsequent interviews, I trained the interviewer to deflect conversations about the purpose of the study until after the formal tasks were administered.

The Lansing interviewer conducted all their interviews between July and September of 2018. After their interviews were over, she and I had a three-hour debriefing session during which I gathered some valuable information not readily apparent in the interviews themselves. From this discussion, I was able to get a better sense of interviewees' socio-economic background by asking more questions about the occupations of family members and the neighborhoods that they grew up in.

The two sociolinguistic interviews from 2010 were conducted separately by a Michigan State University undergraduate student for a senior capstone ethnographic project on the NCS in the speech of older women (aged 65+) in the Eastside neighborhood of Lansing. This interviewer was white, female and aged between 19 and 21 at the time of the project. She was from Florida, and did not have a distinctive regional accent of any kind (as indicated by an interviewee and impressionistically determined by me).

3.2.4 Interview Methods

Because the goals of the oral histories projects, senior capstone project, and the new sociolinguistic interview projects were different, the procedures for conducting interviews were also somewhat different. The most important difference is that the aim of the oral histories project was to discuss factory life with former auto plant employees in Lansing, whereas the goal of the sociolinguistic interviews was to obtain speech for acoustic analysis. Thus, the topics of conversation were a bit different. While the oral histories interviewers focused much of their

time on topics related to factory life with little time spent on topics outside of that, the other interviewers were interested in learning about all phases of the interviewees' life. So, while there is some discussion about work-life in the sociolinguistic interviews, topics in these interview are broader and cover the entire lifespan, including childhood and adulthood. I do not think this is a problem for the current analysis as the interviewers of all types of interviews tended to let the interviewee discuss whatever topic they wanted to. For transparency, I describe the methods used for each of the three sources of data in what follows.

3.2.4.1 Oral Histories

The sixteen oral histories recordings analyzed for this dissertation were gathered from a collection of audio recordings housed at the Michigan State University library. This collection, *G. Robert Vincent Voice Library*[4] includes spoken word recordings dating back to 1888. I utilized recordings from the *Lansing Auto Town Gallery,* which features audio-recorded oral histories of members of the United Auto Workers Local 602 and workers from Lansing's Fisher Body and Diamond REO automobile assembly plants. The oral histories with REO workers were recorded in the late 1990s by Dr. Lisa Fine, Professor of History at Michigan State University (Fine 2004), and the Fisher Body oral histories were recored in the early 2000s by historians of the United Auto Workers Local 602.

Though these interviews took place in a variety of locations, the interviews analyzed for this dissertation were restricted to those conducted either in an interviewee's home or in the local union conference room. Likewise, though some plant workers were interviewed in groups, interviews analyzed for this dissertation include only those in which a single person was

[4] The archive of G. Robert Vincent Voice Library Collection is available to the public through the Michigan State University library (https://vvl.lib.msu.edu/).

interviewed. Some interviewees were interviewed by a panel of UAW historians (usually 2–3) and others were interviewed one-on-one by a Lansing area native.

Each interview lasted about 1 hour. Topics ranged from tensions between laborers and managers in the plants to racism, sexism, community building, and union activism. Though the purpose of these interviews was to talk about life in the plant, many interviews included lengthy discussions about the speaker's family, upbringing, and friendship groups which were valuable in painting the picture of Lansing in the middle of the 20th century that I included in my description of the speech community in Chapter 2. Though oral histories do not follow the pattern of sociolinguistic interviews, and oral historians are not concerned with the preoccupations of sociolinguists, e.g. whether a speaker is monitoring their speech, these interviewers did a good job of asking questions that would prompt the interviewee to speak for at least a few minutes at a time, so that much of the interview was the interviewee speaking freely about a topic that interested them. This provided a good amount of natural language data from each participant in the sample for which to conduct an acoustic analysis.

3.2.4.2 Sociolinguistic Interviews

The 2017–2018 sociolinguistic interviews were recorded using a Zoom H4N Handy Recorder. They were recorded as uncompressed WAV files at a 44.10 Hz sampling rate in 16-bit resolution. We used a Sony ECM-CS10 Tie-Clip Omnidirectional Business microphone rather than the microphone on the recorder. The microphone was clipped to the lapel or the upper neckline of the participant's shirt, and the recorder stayed connected to the microphone during the interview. The recorder often sat on a surface (usually a table) next to the interviewee, whenever possible out of their line of vision. During the interviews that I conducted, I had my computer opened with a map of Michigan showing. Whenever the interviewee talked about

geography or geographical mobility, I would indicate the map on the computer and have them identify various places throughout the interview, e.g. where their neighborhood was, where the good and bad parts of town were, where people vacationed in the summer, etc. My main motivation for including the computer as a prop – under the guise of assisting in showing a non-native Michigander the lay of the land—was to help the interviewee be more comfortable around the recording equipment. I can't be sure that this helped but I did learn more about Michigan geography as a result. It also ensured that the participant's attention was on the project's cultural goals (Lansing and Michigan life, local practices) rather than on its linguistic goals, thus reducing the likelihood of highly self-monitored speech. Other materials employed during interview sessions were the consent form, word list and sub-phonemic judgement task items, which we kept out of view until they were needed.

Interviews were conducted in various places throughout the Lansing area: most were conducted in an interviewee's home and others were either conducted in the conference room of a Lansing community center, in the Michigan State University Sociolinguistics Lab, or in my home. Though none of the interviews were conducted in a sound attenuated space, interviews were conducted in quiet rooms and there was no discernable background noise in any of the resulting audio files. Two interviews were interrupted by a child or spouse who briefly asked for something. Another interviewee answered their phone in the middle of an interview. These interruptions only lasted a few minutes after which the interview resumed. Other than these minor interruptions, each interview ran continuously in one sitting.

Each conversation began with the participant reading the consent form, consenting to be recorded, choosing a pseudonym, and attaching the microphone to their clothing. The recording device was then switched on. None of the recruited individuals declined to consent to a recorded

interview. The recording began with the interviewer asking the participant to say their pseudonym. The interviewer then proceeded to ask the interviewee questions about themselves. The full list of possible questions is included in the Appendix 0. Following the usual practice in sociolinguistic interviews (Labov 1984), the interview questions in this list were a guide rather than a fixed list, and interview topics were mostly determined by the participant. They were encouraged to discuss in detail any topic that was of interest to them. So, while not every question in the list was asked during each interview, the interviewers made it a point to ask at least one question within a given topic in the list. Topics ranged from family history to formative school years, work history, current and past neighborhood demographics, Lansing, and winter in Michigan. This portion of the interview lasted between 30 and 45 minutes.

After the conversational portion of the interview, interviewees participated in two formal tasks which were aimed at testing two phonological phenomena related to NCS recession in Michigan. The first was not analyzed for this dissertation but required participants to judge syllable boundaries (Nesbitt 2018b). The second formal task was the phonological judgement task which will be described in detail in Chapter 5. After these tasks, participants were asked to read aloud from a list of 100 words adapted from Evans, Ito, Jones, and Preston (2000), Ito (2001); Jones (2003), Roeder (2006), inter alia. For all words, the nucleus of the primary stressed syllable was one of the six Northern Cities Shift vowels in various phonetic environments.

Following these three formal tasks, the interview concluded with a discussion of attitudes toward Lansing as a place compared to other metropolitan areas, and attitudes to the local dialect. Because I am interested in speech that is as close to unmonitored as possible to provide a description of everyday speech in Lansing, only the speech produced during the casual conversation portion of each interview was included in the quantitative analysis for this

dissertation. The qualitative content of the post-task discussion of Lansing and local speech is discussed where relevant. Speech produced during the word-list reading, the syllable boundary task and sub-phonemic judgement tasks, and the discussion of attitudes is not included in the analysis for this dissertation, though I intend to include it in future work.

The two 2010 sociolinguistic interviews were conducted in the same manner as described above for the conversational portion of the sociolinguistic interview. Participants were audio-recorded in their homes in quiet rooms while wearing a lavalier microphone. Though the specific interview questions were a little different, they covered the same range of topics. Because these interviews were conducted as part of a different project, they did not include the formal tasks mentioned above.

3.2.5 Audio Processing, Transcription, and FAVE suite

Twelve of the oral history recordings were obtained from the Michigan State University library in .wav format. The remaining 4 were obtained from the library website in .mp3 format and converted to .wav in Praat (Boersma 2001). Three of these recordings[5] were conducted in a room with considerable low frequency noise – perhaps produced by a fan or because of the recording equipment. These three recordings were passed through a high-pass filter in Praat to reduce the low-frequency noise. Frequencies above 2000 Hz were removed from the audio.

The entirety of each recording was transcribed in ELAN (Max Planck Institute for Psycholinguistics 2018), a linguistic annotation software provided by the Max Planck Institute. Four annotation tiers were included in the transcription; one for the interviewee, one for the interviewer, one to indicate interview tasks, and the final tier for background noise. Speech was

[5] These speakers were Mabel McQueen, Marvin Grinstern, and Vernon Cook in Appendices 0 and 0.

transcribed in breath groups, so that segments were about four seconds each and roughly corresponded to when a speaker took a breath or paused. All sounds produced were transcribed using US English orthography and special symbols for non-linguistic sounds (e.g. coughs) were employed according to the transcription guidelines put forth by the Linguistic Data Consortium at the University of Pennsylvania (Linguistic Data Consortium 2013).

After transcription, each interview was passed through the Forced Alignment and Vowel Extraction (FAVE) suite (Rosenfelder et al. 2014) for forced alignment and vowel measurement. FAVE is available as downloadable scripts which can be run locally.[6] I will provide a brief description of the two stages of FAVE below but see Evanini (2009) and Fruehwald (2013) for a more thorough description of the mechanics of FAVE.

FAVE uses the Carnegie-Mellon (CMU) pronouncing dictionary to align orthographic transcriptions with sound files at the level of the phoneme. The CMU dictionary is an open-access dictionary of over 134,000 North American English words and their pronunciations. To do the alignment, FAVE must first review a transcription to ensure that every word in it is an actual word in the CMU dictionary. This is the "dictionary-check" stage of FAVE. If any word in a given file is not found in the CMU dictionary, FAVE requires the user to provide an ARPAbet transcription – pronunciation symbols utilized by the CMU dictionary – of that word and temporarily add it to the dictionary. Once a file has been dictionary checked, FAVE aligns the orthographic transcription with the acoustic signal in the corresponding sound file.

[6] The FAVE scripts are currently being maintained by Josef Fruehwald on GitHub (https://github.com/JoFrhwld/FAVE)

The FAVE-extract stage measures and normalizes all the vowel phonemes in the recording. FAVE measures vowel phonemes according to the parameters set by the user. I used the default settings specified by the FAVE creators, which are based on best practices established by the ANAE (Labov, Ash & Boberg 2006). The first default setting was to set the maximum formant measurements for each gender at 5000 Hz for males and 5500 Hz for females. The second was to model formant predictions after those from the ANAE. With this setting, when FAVE encounters a phoneme, it will generate a few possible measurements by changing some parameters (e.g. the number of formants it identifies) and compare this pool of measurements to the distribution of measurements of that phoneme in the ANAE. Based on the ANAE distribution of that phoneme, FAVE will determine which measurement is most likely valid and discard all other measurements for that phoneme. After going through the entire file, FAVE then eliminates outliers. For this, FAVE looks at each measurement and compares it to the speaker's overall distribution of that vowel class. If a given token is found to be extreme for that speaker, i.e. sits outside of the distribution of that vowel class, the token is discarded.

The resulting measurements in the output are vowel duration, and formant measurements (F1, F2, F3) at the 20%, 50%, and 80% time points along the vowel for every vowel in the file. Other valuable information provided by FAVE includes stress (stressed or unstressed) and phonetic environment of each phoneme (following manner, following place, following voicing, preceding segment, and number of syllables occurring after the vowel).

FAVE outputs a raw data file and a file with normalized data. This dissertation analyzes the normalized data. Normalization is meant to eliminate differences in measurements that arise due to physiological factors (e.g. age) while maintaining differences that are the result of sociolinguistic variation (Adank, Smits & van Hout 2004; Labov, Ash & Boberg 2006; Thomas

2011). Though there are various normalization methods, the Lobanov (1971) normalization method is preferred by sociophoneticians (for a discussion, see Thomas & Kendall 2007 and Adank, Smits & van Hout 2004) over the other methods and it is the one FAVE utilizes. The Lobanov method is a vowel-extrinsic method of normalization, meaning that it uses measurements of multiple vowels spoken by an individual to calculate a grand mean by which each vowel may be normalized. FAVE then rescales the Lobanov normalized values back to Hertz (Hz).

3.2.6 Measurements and Analysis

The thirty-six interviews in the Lansing Speech Corpus produced 76,723 FAVE-measured vowels. I report in this dissertation on the /æ/ tokens alone.[7] To avoid measuring vowels that are commonly reduced in casual speech, I eliminated any token that did not occur in a primary stressed syllable and any that were in a 'stop word'. The list of 'stop words' with /æ/ excluded from the analysis were the following: *a, am, an, an, and, as, at, had, has, have, than, that, that's*. Tokens of /æ/ preceding /r/ were excluded from the analysis, as /æ/ is merged with /eɪ/, and /ɛ/ when it occurs before /r/ (MARRY, MARY, and MERRY, respectively) in most American English dialects, including the NCS (see Labov, Ash & Boberg 2006:56). Finally, I omitted tokens that were not produced in the casual speech portion of the interview, i.e. any tokens that were produced during the formal tasks or the subsequent attitudes portion of the sociolinguistic interview. The final token count for /æ/ analyzed in this dissertation is 4,158. Throughout this dissertation I will refer to two allophonic environments; *pre-nasal* and *pre-oral*. Pre-nasal /æ/ tokens are those that precede the three nasal consonants in American English; /m/,

[7] I will include speaker mean values of /ɛ/ and /ei/ in a visualization of /æ/'s diphthongal quality.

/n/, and /ŋ/. Those that precede a non-nasal consonant are pre-oral. Of the token count, 1,590 tokens are pre-nasal and 2,568 are in pre-oral position.

The ggplot2 (Wickham 2009), dplyr (Wickham and Francois 2016), gridExtra (Wickham 2017), and tidyr (Augie 2016) packages in R (R core team) were used for all data manipulation and visualizations.

To employ the four diagnostics of NCS /æ/ mentioned in section 3.2 at the start of this chapter, four acoustic measures of /æ/ were used: F1, F2, and diphthongal quality of pre-oral /æ/, and Pillai-Bartlett score. The first (F1) and second (F2) vowel formant measures were taken at the mid-point of the vowel in Hertz (Hz), as supplied in the FAVE output. F1 measurements correspond to tongue height during the articulation of the vowel; a higher F1 value indicates a lowered tongue position and a lower F1 value indicates a higher tongue position. F2 measurements correspond to tongue back-ness; a higher number indicates a further forward articulation and a lower number indicates a farther back articulation. Diphthongal quality (DQ) is assessed by a measurement of trajectory length (Fox & Jacewicz 2009; Jacewicz, Fox & Salmons 2011) which captures changes in F1 and F2 between points along the vowel's duration. As noted in previous studies on /æ/, the two points for diphthongal quality of this phoneme are at 50% and 80% of the vowel (Labov, Ash & Boberg 2006; Mielke, Carignan & Thomas 2017). DQ is operationalized (see below) as the square root of the sum of the squares of the differences in F1 and F2 of the relevant time points in the vowel. A higher DQ value indicates more of a difference in F1/F2 space between the vowel's midpoint (50%) and its offset (80%).

(6) DQ = $\sqrt{(F1_{50\%} - F1_{80\%})^2 + (F2_{50\%} - F2_{80\%})^2}$

Separation between pre-nasal and pre-oral tokens was measured using the Pillai-Bartlett statistic (Hay, Warren & Drager 2006; Hall-Lew 2010). In measuring separation, the statistic utilizes MANOVA to evaluate the distance between two distributions and their variance. Pillai-Bartlett scores range from 0 to 1, where 0 indicates no difference between distributions and 1 indicates complete separation of the distributions. Thus, in the discussion of /æ/ systems in section 4.6, speakers with an NCS unconditioned system should have a Pillai-Bartlett score closer to 0, those with a normal raised continuous system would have a score closer to .5, and those with a nasal system should have Pillai-Bartlett scores closer to 1.

Linear mixed-effects regression models were utilized to determine the effects of social class, gender, and generational cohort on the four dependent acoustic measures (Pillai-Bartlett score, F1, F2, duration, and DQ). The fixed effects were operationalized as follows: Social Class (blue collar, white collar), Gender (female, male), and Generation (Silent, Boomer, Gen X). The linear models included random intercepts for *speaker* and *word* to account for any variability caused by any individual speaker producing a large amount of speech or a lexical item occurring disproportionately more often than others in the corpus. An ANOVA analysis was performed on Pillai-Bartlett scores, as each speaker in the sample only had one score. This analysis included a random intercept of *speaker* as a random effect. For all four analyses, all possible interactions between the fixed effects were included with the fixed effects in a full model. Fixed effects and any interactions that were not significant in the full model were removed. Throughout the discussion of results, I will indicate when an effect or interaction was not included in the resulting model. Results of the models are provided for reference in each section, below. I conducted all linear mixed-effects regression modeling with the lme4 package in R (Bates et al. 2015). Welch two-sample follow-up t-tests were performed whenever there was a significant

three-way interaction and whenever an effect with more than two levels came out as significant. These statistical analyses will test the hypothesis that generational cohort, gender, and social class condition movement in F1 and F2, diphthongization, and nasal allophony in 20th century Lansing.

3.3 Phonological Change

As briefly summarized at the start of this chapter (section 3.1), the goals of this dissertation are to address the Actuation, Embedding, and Transition Problems of phonological change, i.e. how did it begin, what are the internal and external conditions surrounding the change, and how did it spread throughout the community? The Embedding problem is first addressed in Chapter 4 where I investigate the acoustic changes to /æ/ and the social factors that condition them. To further address the Embedding problem and to address the Actuation and Transition problems, I will investigate in Chapter 5 the temporal and social mechanisms by which /æ/ nasal allophony developed and spread in Lansing. I ask when speakers in Lansing developed an allophonic distinction between pre-nasal and pre-oral /æ/ and who the leaders and laggards of this change are. To do this, I utilize two techniques; (1) an impressionistic examination of pre-nasal and pre-oral trajectories in the vowel space over time, a la Fruehwald (2013, 2016), and (2) a sub-phonemic judgement task, a la Mellesmoen (2016). The trajectories analysis includes the conversational speech data from the Lansing Speech Corpus described above and the results are provided in Chapter 5 (section 5.2.1). The judgement task includes participants of the 2017–2018 sociolinguistic interviews in the Lansing Speech Corpus, and other Lansing natives who completed the task online. Those results are presented in Chapter 5 (section 5.2.2). In what follows, I describe the methods for conducting both analyses.

3.3.1 Divergent Trajectories

According to Fruehwald (2013, 2016), phonological allophones follow disparate trajectories over time while allophones that differ only in phonetic realization, not phonological representation, proceed in lockstep with one another. Therefore, I will investigate phonetic vs phonological allophony within the /æ/ phoneme by examining trajectories of pre-nasal and pre-oral /æ/ in F1/F2 space over apparent time.

As a point of comparison with /æ/, I include a visual inspection of phonetic trajectories for two other short-front vowel classes in the same phonological environments: /ɛ/ and /ɪ/. Here I will determine whether the phonological profile of these classes is similar to that of /æ/. The hypothesis is that they are different, as the analysis in Nesbitt (2018) suggests that no allophones within these classes are phonologically distinct from the others. Therefore, the allophones within these phonemes must only be phonetically distinguished and should move in lockstep over time. If the allophones within these phonemes are indeed phonetically distinguished then I would expect participants to be more likely to judge them as the same during the judgement task because acoustic difference may not be enough to prompt a *different* response. If this hypothesis is correct, I can leverage this difference between /æ/ and these other classes to ascertain whether respondents are making judgements based on acoustic (dis)similarity or on differences in representation. I discuss this in further detail in 5.2.1.

The second purpose of the trajectory diagnostic is to determine when the phonological allophone(s) of /æ/ began to diverge from the rest of the allophones. This latter question is important for the subsequent analysis of the actuation (initiation) and propagation (spread) of phonological change. For the actuation question, we will want to ask whether at the speaker level, the phonological change was abrupt or gradual, i.e. whether individual speakers posited a

representational difference between pre-nasal and pre-oral /æ/ at the time the vowel in the two environments began to assume different phonetic targets (abrupt) or if speakers developed the phonological rule sometime after the two allophones began to move in different directions (gradual). To determine this, I must first discern when the relevant allophones began to move towards different targets. Whichever generation in which the relevant allophones begin to differentiate, as determined by this trajectory analysis, is the generation for which the question of abrupt phonologization will be relevant. If any speakers in this generation posits a phonological rule, I will conclude that phonologization was abrupt. If, however, no speakers in this generation posit a phonological difference between pre-nasal and pre-oral /æ/ but speakers in subsequent generations do then I will conclude that phonologization was a gradual process, occurring only after a phonetically implemented distinction.

3.3.2 Sub-Phonemic Judgement Task

Though the investigation into trajectories of conditioning environments can tell us whether and when phonologization has occurred at the community level, it cannot tell us whether individual speakers exhibit phonological or phonetic allophony. Likewise, Pillai-Bartlett scores are not useful for teasing the two apart on their own, as studies have shown that while bimodality is often an indication of phonological/categorical differences, the absence of a bimodal distribution does not entail the absence of a phonological difference (cf. Schilling, Watkins & Watkins 2002; Bermúdez-Otero & Trousdale 2008: 696). Therefore, I supplement the Pillai-Bartlett analysis with a sub-phonemic judgement task (Mellesmoen 2016) to discern whether for each respondent, phonetics alone is what distinguishes pre-nasal from pre-oral /æ/ or if the two allophones are phonologically distinct. A comparison of responses between generations will address an aspect of the Actuation Problem of phonological change: was phonologization

gradual or abrupt in Lansing, i.e. at the beginning of the acoustic change, are there any speakers that consider pre-nasal and pre-oral /æ/ to have different phonological representations? An investigation into the interaction of change over time against social class will address the Transition Problem of phonological change; how has nasal allophony spread throughout the community, i.e. who are the leaders and laggards of the change?

3.3.2.1 Experimental Stimuli

The judgement task for this dissertation required participants to judge whether the vowels in thirty pairs of CVC lexical items were the same or different. The complete list of lexical pairs is included in Appendix 0. These pairs were grouped into six conditions of five pairs. The differences between the conditions are illustrated in Table 4 and described in detail below.

Pairs in Condition 1, which I will refer to throughout this chapter as the *target condition*, were CVC lexical items in American English that had the same onset and vowel /æ/ but differed in whether their coda consonant was nasal or oral. One of the target pairs in this study was *fan* and *fat*; these words share the same onset /f/ and nucleus /æ/ but differ in whether their coda consonant is nasal /n/ or oral /t/. CVC pairs in Condition 2 shared the same onset and vowel /æ/ but had different oral coda consonants. An example of this type of pair is *pass* and *pack*; they both have an onset /p/ followed by an /æ/ but they differ in that one has a coda stop /k/ and the other a fricative /s/. I included this type of pair to be able to test whether phonetically implemented differences might prompt an individual to judge these pairs to be different, thus making this methodology unsuitable for drawing conclusions about phonologization

Table 4 Conditions of Lexical Pairs in the sub-phonemic judgement task

CONDITION	Vowel Phoneme	Final Consonant Nasality	Example Pair
1	/æ/	nasal-oral	FAN-FAT
2	/æ/	oral-oral	PASS-PAT
3	/ɛ/	nasal-oral	PEN-PET
4	/ɛ/	oral-oral	PET-PECK
5	/ɑ/ and /ɔ/	nasal-nasal or oral-oral	BOT-BOUGHT
6	mix	Mix	BIT-BOMB

. As is the case in other studies on /æ/ in the dialect area, speakers in Lansing show clear conditioning within the pre-oral token cloud such that there is a gradient difference in vowel space. For example, many speakers produced /æ/ before fricatives lower than the rest of the pre-oral tokens, others produced /æ/ before affricates higher than the rest of the conditioning environments in the pre-oral cloud, and often /æ/ before /l/ was produced lower than the rest of the pre-oral tokens. Crucially, in the analysis of trajectory, the difference between /æ/ before these various consonant types is the result of low-level co-articulation rather than any phonological difference, i.e. they moved in lockstep with each other towards a separate phonetic target than pre-nasal /æ/. Thus, in the present judgement task, if phonologization is what is driving *different* responses, respondents should judge pairs of different pre-oral tokens as the same – whether they produce them with different acoustics or not. Take for example one of the

Condition 2 pairs – *pack* and *pass*. Although /æ/ before /k/ is gradiently different than /æ/ before /s/ in the vowel space, this difference is not expected to be meaningful to respondents and thus the expectation is that they will be less likely to judge /æ/ in these two words to be different. This is the expectation for responses to all lexical pairs in this condition. If a respondent judges the pairs in this condition to be different, then this is an indication that phonetic implementation differences are what the respondent is relying on. In this case, a claim that Condition 1 (target pairs) judgements are an indication of phonological representations would be unsubstantiated. If a respondent judges Condition 1 pairs (target pairs) to be different but Condition 2 pairs to be the same, it is more likely that their judgements about Condition 1 pairs are representative of a perceived phonological difference rather than phonetic differences. If a respondent were to judge both condition one and two pairs to be the same then this might suggest that they are relying on some other cue, i.e. orthography.

Two more conditions, Condition 3 and Condition 4, were included in this experiment to (1) determine whether speakers are making judgements based on phonological representation rather than acoustic differences, and (2) to distract the participant from focusing on /æ/. Condition 3 CVC pairs were like the target pairs but had a vowel other than /æ/ - either /ɛ/ or /ɪ/. An example of this type of pair is *pen* and *pet*; they share the same onset /p/ and vowel /ɛ/ but differ in whether the final consonant is nasal /n/ or oral /t/. Aside from distracting the respondent from the focus of the study (/æ/), the primary reason for adding these pairs was to determine whether judgements for the target pairs – those with /æ/ in oral and nasal contexts – are indeed based on phonological representation and not just acoustic difference. The logic here is the same as that for condition two pairs (e.g. *pass-pat*); because the difference between /ɛ/ and /ɪ/ in pre-nasal and pre-oral environments in Lansing is not due to a phonological representation difference

but rather a low-level co-articulatory effect, respondents are not expected to judge pre-nasal and pre-oral pairs as different. Participants are also not expected to judge various combinations of pre-oral /ɛ/ as different because as is the case with pairs of pre-oral /æ/, the difference between them are only the result of phonetic implementation rather than an inherent difference in phonological representation. The same is true for /ɪ/. Thus, I balanced the pool of stimuli to include a fourth condition, Condition 4, similar to Condition 2 pairs. These pairs had the same onset, and nucleus /ɛ/ or /ɪ/ and differed in their following oral consonant. An example Condition 3 pair is *pet* and *pen*, and Condition 4 pair is *pet* and *peck.*

A fifth condition of CVC pairs was included as filler pairs in the experiment. These Condition 5 pairs tested another on-going change in Lansing – the merger of /ɔ/ and /ɑ/. The five pairs in this condition shared the same onset and coda consonant but differed in whether the vowel was /ɔ/ or /ɑ/. An example pair of lexical items in this 5th condition is *bot* and *bought*. Judgements for these pairs were not included in the analysis for this dissertation.

The final condition, Condition 6, was composed of filler CVC pairs. Some of these pairs had vowels and final consonants that did not match orthographically or phonemically and should have been judged to be different by every participant in the study. An example pair is *bit* and *bomb*, where /ɪ/ and /ɑ/ are different phonemes and are represented with different orthographic symbols, as are /t/ and /m/. The vowels and consonants of other pairs matched orthographically but differed in phonemic representation, .e.g. *make* and *mack.* A subset of the pairs in this condition had different vowel phonemes that were represented with the same grapheme, <a>, e.g. *make* and *mack*. While the vowels in these words are represented with the same orthographic symbol they map onto different phonemes, /eɪ/ and /æ/, respectively. These were included to ensure that participants were not making judgements based on orthography alone. One of the

purposes of including this condition was to further distract the participant from focusing on /æ/ pairs by including lexical items with other vowel phonemes in them. The other motivation for including these pairs was to eliminate participants who were not paying attention to the task or who were making judgements based on orthography alone. If a participant judged *make* and *mack* to be the same then it is likely that they were making judgements based on orthography alone. If, however, a participant judged the pairs in Conditions 1 through 4 (pan-pass, pass-pack, pen-pet, pet-peck) to be the same but those in Condition 6 to be different, it is more likely the case that they are taking into consideration their own pronunciation of these phonemes rather than relying on orthography alone.

3.3.2.2 Experimental Task

This experiment was presented via two methods; an online survey and on a piece of paper. The online survey was disseminated via Qualtrics (Qualtrics 2005). Fourteen of the 2017/8 sociolinguistic interview participants did the task on a piece of paper, while four completed the survey online. Because of technical difficulties during some of the sociolinguistic interviews, ten participants completed a paper version of this survey. The paper version was identical to that of the Qualtrics survey.

Upon entering the survey on Qualtrics, participants read a consent form, which is provided in Appendix 0. Consent to having their data used for analysis was granted by clicking a button at the bottom of the screen which took the participant to the first block of questions. For those who did the paper version, consent was given at the beginning of the sociolinguistic interview. The first block of questions in the survey was a set of demographic questions. These questions were used to ensure that respondents fit the demographic criteria of this project. Sociolinguistic Interview participants did not have to respond to this block of questions, as their

demographic information was already provided. A discussion of participant demographics is provided below in section 3.3.2.4. A second block of questions in the survey was part of an experiment for another study (Nesbitt 2018b). For this task, participants were presented with CVCVC American English words and asked to indicate which syllable the medial consonant belonged to – the second or first. Analysis of the data from this block is not included in this dissertation.

The third block of questions made up the judgement task, which is the focus of this dissertation. In this block, participants were visually presented with pairs of words and were instructed to judge whether the vowels in the pairs sounded the same or different to them. The following instructions were positioned at the top of their screen/paper throughout this block of the experiment, so that every time a pair of words was presented on the screen/paper, so too were the instructions.

> *For each pair of words, read aloud each word and indicate whether the vowels in those two words sound the same or different to you. Try not to think too hard about your response. Provide the first response that comes to mind. There are no right or wrong answers.*

Participants indicated whether the vowels in a given pair sounded the same or different by clicking (or circling on their piece of paper) *same* or *different*. After judging one pair of words, they went on to the next pair of words, and so on. About five pairs appeared on the same page before a participant had to press a button to navigate to the next page. Pairs were presented

in random order for each participant. To ensure more statistical power, each pair of words was presented twice. In total, participants judged whether the vowels in sixty pairs (6 conditions x 5 pairs x 2 trials) of CVC lexical items were the same or different to them.

Upon completing the survey, participants were asked if they were taking the survey for credit towards a class. Those who responded "no" were directed to a message that thanked them for participating and notified them that they were finished with the survey. Those who responded "yes" were directed to a page where they were prompted to insert their experimental nickname in order to receive the class credit. Upon entering their name, they were informed that they could receive more credit for forwarding the survey to an older family member. They were then thanked for participating and notified that they were finished with the survey.

3.3.2.3 Participant Recruitment and Selection

This experiment was disseminated on Qualtrics at various times between April 2018 and February 2019. The first group of participants were undergraduate students at Michigan State University who agreed to participate in exchange for class credit, along with any family members to whom they forwarded the survey. Other participants were those who did the sociolinguistic interview discussed in the previous chapter. I also disseminated the survey via social media and email. From these various recruitment methods, 252 people participated in this experiment.

Many participants were eliminated from the study because they did not meet the demographic criteria for this dissertation; they either were not a native of Lansing, MI, did not identify as white/Caucasian, answered "stay-at-home parent" in the question about occupation, or had considerable experience speaking a language other than English. For the latter criterion, I eliminated anyone who indicated that they had more than five years' experience speaking a

language other than English. Native Lansing status was defined as: (1) having been born and lived in the Lansing area until at least age 15, (2) hadn't left the Lansing area for longer than two years, and (3) still reside in Lansing. I determined each respondent's hometown by asking them to enter the zip code of the place they were raised. I identified them as native if this zip code was within 10 miles of the Lansing city center (the capitol). Participants in this study were required to have been born in Lansing, which is a different criterion than that defined for the Lansing Speech Corpus. Recall that rather than requiring that the Lansing Speech Corpus speakers be born in Lansing, I set the cutoff at age 5. This was merely a methodological decision because many of the oral histories speakers did not explicitly state that they were born in Lansing but did make reference to living there since before age 5. I also eliminated anyone who did not respond to the questions about education, occupation, and/or year of birth, and anyone who reported that they were not 18 or older because I was not approved to test minors.

Sixty-five participants were excluded from the analysis due to various performance related issues. First, participants were eliminated if they did not answer at least 90% of the experimental questions. Participants were also eliminated from the analysis if they provided the same response (either *same* or *different*) to 75% or more of the pairs in the survey. Participants were also excluded from the analysis if they judged more than one of the *make/mack* or *bit/bomb* type pairs in Condition 6 to be the same. In theory, every participant should have judged Condition 6 pairs to be different but because I know that the survey is repetitive and perhaps some participants could have misread one of these pairs, I was more conservative with this elimination criterion. Rather than eliminating everyone who responded *same* for any Condition 6 pairs, I eliminated anyone who responded *same* to more than one of these pairs.

3.3.2.4 Demographic distribution

After the above demographic and performance eliminations, the resulting pool of participants for this experiment was 107 white monolingual English-speaking Lansing natives. The demographic distribution of these participants is given below.

The distribution of participants according to generational cohort is provided below in Table 5. Generational cohort was classified according to a participant's reported age range. Participants were given the following age ranges to choose from: 17 or younger, 18–34, 35–54, 55–74, and 75 and older. Those who responded *17 or younger* were eliminated from the analysis because they are considered minors.

Table 5 Distribution of experimental participants by Generational Cohort

Silent	Baby Boomer	Generation X	Millennial	Total
16	35	28	28	107

The remaining respondents were classified according to the generational cohorts employed for the Lansing Speech Corpus construction: the Millennial generation is made up of those who responded 18–34 , those who responded 35–54 are Generation X, those who responded 55–74 made up the Baby Boomer generation, and those 75 and older are the Silent generation respondents. As with the sociolinguistic interview participants, socio-economic status for this experiment was determined by occupation and education level. In the survey, participants were able to provide a free entry for "What were your two longest held jobs?". Participants were also asked, "What level of education is necessary to do your type of job?*"* and were given five

choices; *some high school, high school, some college/vocational, bachelor's degree,* or *post bachelor's degree*. I followed the same procedure for classifying these participants as I did for the sociolinguistic interview participants. Those in manual labor, low-level service, and care jobs that require less than 2 years of training after high-school were classified as *blue-collar*. Those in managerial and professional positions whose occupations required at least 2 years of technical training outside of high-school were classified as *white-collar*. For participants who indicated that they were a student or retired, I classified them according to their response to the question about education; those who chose *some college/vocational* or above were classified as *white-collar*. The distribution of participants according to generational cohort and social class is provided below in Table 6.

Table 6 Distribution of experimental participants by Generational Cohort and Socio-Economic Status

Generation	Blue-Collar	White-Collar	Total
Silent	9	7	16
Boomer	17	18	35
Gen X	14	14	28
Millennial	13	15	28
Total	53	54	107

The effect of gender on this change in progress was not explored in this analysis. Though it would have been ideal to consider this social factor, especially because many of the acoustic changes to /æ/ in Lansing are conditioned by gender (Chapter 4), gender was not evenly

distributed across generational cohorts and social class groups. In Table 7, I display the distribution of gender in this sample for transparency and because, as I note in Chapter 4, gender might be an important factor for the propagation of this change.

Table 7 Distribution of experimental participants by Generational Cohort, Socio-Economic Status, and Gender

	Blue Collar		White Collar	
Silent	6f	3m	5f	2m
Baby Boomer	14f	3m	10f	8m
Gen X	11f	3m	11f	3m
Millennial	10f	3m	9f	6m

3.3.2.5 Statistical Analysis

For this task, phonological allophony between pre-nasal and pre-oral /æ/ will be identified if Condition 1 pairs elicit significantly more *different* responses than Condition 2 pairs, e.g. if participants judge pre-nasal and pre-oral /æ/ to be different but pre-oral and pre-oral pairs to be the same. The primary goal of this experiment was to ascertain whether phonologization was abrupt or gradual in Lansing, i.e. is it the case that the generation of speakers in which pre-nasal and pre-oral /æ/ begin to diverge in phonetic space are the same generation of participants to judge /æ/ to be different allophones? As such, abruptness will be investigated by comparing responses between Conditions 1 and 2 in whichever generation pre-nasal and pre-oral /æ/ diverge from one another in F1/F2 space, as determined by the trajectories analysis. Phonologization

will be interpreted as abrupt if this generation of participants judge /æ/ before nasal consonants to be different from /æ/ before oral consonants but pre-oral /æ/ pairs to be the same. Phonologization, however, will be identified as gradual in Lansing if only subsequent generations judge /æ/ before nasal consonants to be different from /æ/ before oral consonants.

As with the production data, I will examine social class as it conditions same/different judgements in each condition. This analysis will be utilized to continue the discussion regarding who the linguistic innovators are and who are the likely retainers of the old mechanical/co-articulatory allophonic system.

Responses to this task were analyzed using a binomial mixed-effects logistic regression model in R (R Core Team 2013). Response was entered as the dependent variable, while Condition, Generational Cohort, Social Class, and their interactions were entered as predictor/independent variables, and Participant and Pair as random intercepts. Response had two levels (same, different), Condition had two levels (one, two), Generational Cohort had four levels (Silent, Boomer, Gen X, Millennial), and Social Class had two levels (Blue-collar, White-collar).

To conclude, this dissertation will examine the phonetics and phonology of /æ/ over generational time in 20th century Lansing. Chapter 4 will address the embedding problem of phonological change by examining the NCS diagnostics: fronting, raising, diphthongal quality, and /æ/ system as they are related to generational time, social class, and gender in the community. Chapter 5 will examine the actuation, social embedding, and propagation of nasal allophony through the apparent time analysis of allophone trajectory and sub-phonemic judgement task responses.

Chapter 4
/æ/ IN 20TH CENTURY LANSING

4.1 Introduction

This chapter is concerned with the influence of generational time, gender, and social class on the realization of /æ/ in 20th century Lansing. I will examine these factors with respect to 4 of the 5 NCS diagnostics which were preliminarily examined in Wagner et al. (2016) and Nesbitt (2018), and described in Chapter 2. that have been described in the literature. These diagnostics include (i) movement along F1 of pre-oral /æ/, (ii) movement along F2 of pre-oral /æ/, (iii) diphthongal quality of pre-oral /æ/, and (iv) the separation of pre-nasal and pre-oral allophones in F1/F2 space. The diagnostic being left out of the analysis is the position of /æ/ relative to /ɛ/ in the vowel space. Because /ɛ/ lowers as part of both the NCS and LBMS, the relative position of these phonemes is less informative of NCS participation (or rejection) in the current sample.

By examining how these diagnostics change over time, we can get a more thorough view of the time window for the adoption and rejection of the NCS in Lansing. The inclusion of social class and gender will allow for a more nuanced picture of which community members are on the leading end of the change, which can in turn allow us to determine whether the movements of /æ/ are changes from above or below in the community. The analysis of Pillai-Bartlett scores will either confirm or deny the preliminary findings in Wagner et al. (2016) and Nesbitt (2018) that there is a diachronic progression from systems that are advanced raised to those that are common raised (or less advanced) to nasal systems. This will contribute to the discussion in Chapter 5 about whether phonologization of the nasal split occurred gradually or

abruptly in the community. I investigate these measures against the hypothesis that the emergence of non-NCS features is driven by social aspiration.

4.2 Results

The methods for creating the Lansing Speech Corpus (selecting speakers from existing corpora, and interviewing additional speakers to fill demographic gaps) are provided in Chapter 3 (section 3.2), along with details of the coding and statistical analysis procedures. The following is an analysis of the four diagnostics with respect to generational time, social class, and gender in the Lansing Speech Corpus. Below, results of the mixed effects regression and ANOVA analyses of the social patterning of /æ/ in Lansing across the 20th century are presented for each of the four dependent diagnostic variables (see 3.2.6 for full details of statistical methods). Section 4.3 reports on the height of the nucleus (measured by F1 at the midpoint); section 4.4 reports on the backness of the nucleus (measured by F2 at the midpoint); diphthongal quality (trajectory length measurement) is examined in section 4.5; and in section 4.6, the relative conditioning of pre-nasal and pre-oral allophones (measured by Pillai-Bartlett score) is modeled. Section 4.7 provides a summary of this study's findings, and a discussion of implications for our theories of language change, chain shifting, the NCS, and North American dialectology are provided in Chapter 6.

For consistency across sections, I report the generational change (or lack thereof) for the dependent variable, followed by an analysis of other main effects and interactions that came out as significant in the analyses. In all of the figures below, dots represent speaker means accompanied by a loess curve with a 95% confidence interval. For ease of reference, the generational cohort groups used for the present study are as follows: Silent generation (born 1925–1945), the Baby Boomer generation (born 1946–1964), and Generation X (born 1965–

1985). I also note that data from the Millennial generation speakers (born 1985–1999) in Wagner et al. (2016) are utilized in the figures as a temporal reference but are excluded from the statistical analyses and general discussion of the changes described.

4.3 F1 of Pre-Oral /æ/

Figure 10 displays average F1 values across generational time in the sample. Looking at the trend line, it appears that F1 values remain stable from speakers born in the 1920s to the 1960s that this is followed by an increase (decline in the vowel space) in the 1990s.

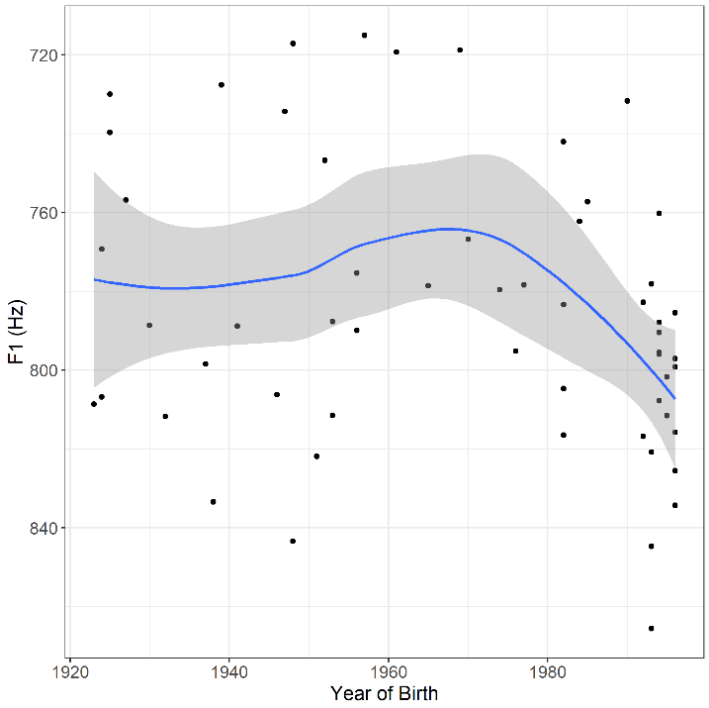


Figure 10 Average F1(Hz) values of pre-oral /æ/ by speaker year of birth in 20th century Lansing. Lansing Speech Corpus (n=36), plus Millennial speakers (n=21) for reference.

This visual interpretation is supported by follow-up t-tests where there is no significant effect of generational time in the transition from Silent (*M* = 781 Hz, *SD* = 37 Hz) to Baby

Boomer generation speakers (M = 793.7 Hz, SD = 43.56 Hz), $t(20.8) = -0.47$, $p > 0.05$, nor in the transition into Generation X (M = 777.4 Hz, SD = 26.8 Hz), $t(18) = -0.08$, $p > 0.05$. Looking at the distribution of mean values over time in Figure 10, however, there is a clearer apparent time picture: From the Silent to Baby Boomer generation, the range of F1 values increases such that some Baby Boomer speakers have higher means in the vowel space than Silent generation speakers and others have much lower means. In Generation X, mean F1 values converge at the midpoint of the Baby Boomer range and subsequently increase (lower in the vowel space as shown in Figure 10). So, although the trend line and follow-up t-tests appear to show stability in the first half of the 20th century, there is movement along F1 in the Baby Boomer generation, albeit in different directions for different speakers. This is confirmed by the regression analysis. Table 8 displays the results of the mixed effects regression analysis on F1 of pre-oral /æ/.

According to the mixed effects regression analysis (Table 8), the apparent time picture of Lansing's pre-oral /æ/ in the height dimension is one of raising in the vowel space (decreasing F1) from Silent to Baby Boomer generation, followed by lowering (increasing F1) into Generation X. Below, I show that raising from Silent to Baby Boomer generation is conditioned by gender. The main effect of gender is significant in the model (see Table 8). There is also a significant interaction of gender with generational cohort, such that the direction of the difference depends on generational cohort. I will explore this change via follow-up Welch two sample t-tests in 4.3.1. Though social class is not significant in the model, it does contribute to a significant three-way interaction with generational cohort and gender such that social class is only significant for men. The results of the follow-up t-tests for this interaction are investigated in 0.

Table 8 Best fit mixed-effects model of pre-oral /æ/ F1

Predictor	Value(s)	Estimate	Std. Error	df	t-value	Significance
		747.46	13.5	45.12	55.369	***
GEN	GenX	46.69	18.94	41.46	2.465	**
GEN	Silent	45.78	18.86	39.72	2.428	**
GENDER	male	78.41	17.46	31.48	4.491	***
SES	WhiteCollar	30.59	17.5	31.86	1.748	[0.090]
GEN × GENDER	GenX × male	-90.69	25.08	32.69	-3.616	***
GEN × GENDER	Silent × male	-96.57	25.14	32.42	-3.841	***
GEN × GENDER × SES	Boomer × female × WhiteCollar	-27.74	25.83	37.18	-1.074	[0.290]
GEN: GENDER:SES	GenX × female × WhiteCollar	-38.82	25.3	33.65	-1.534	[0.134]
GEN × GENDER × SES	Silent × female × WhiteCollar	-45.72	25.61	35.23	-1.785	[0.083]
GEN × GENDER × SES	Boomer × male × WhiteCollar	-64.84	23.45	25.83	-2.765	**
GEN × GENDER × SES	GenX × male × WhiteCollar	-52.1	24.75	31.14	-2.105	*

Significant difference ($p < 0.001$) is reported as ***; significant difference ($p < 0.01$) is reported as **; significant difference ($p < 0.05$) is reported as *, and non-significant appears as [].

4.3.1 F1, Generational Time and Gender

Figure 11 displays the interacting effect of generational cohort and gender on F1 values. As can be seen from the different trajectories for female speakers (red line) and male speakers (blue line), the F1 target is different for each gender group. This gender difference is especially evident for speakers born in the Boomer generation, 1940s–1960s . The wide range of F1 values exhibited in Figure 10 is due to a gender split in this generation, whereby women have lower F1 values (higher in the vowel space) and men have higher F1 values (lower in the vowel space) than any other speakers in the sample.

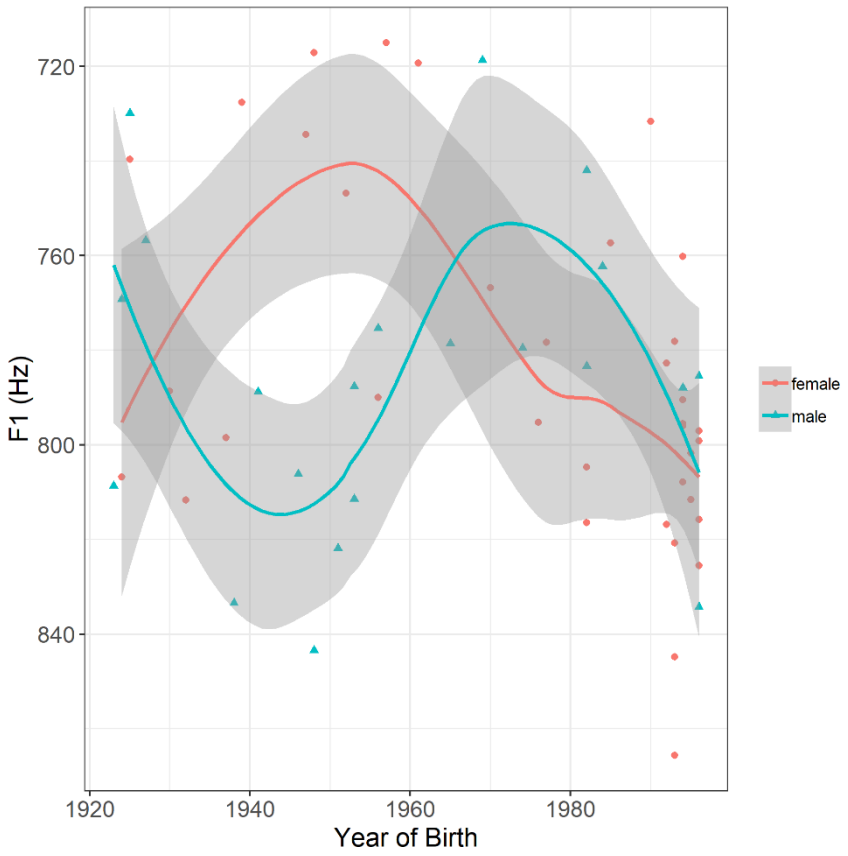


Figure 11 Average F1(Hz) values of pre-oral /æ/ by speaker year of birth and gender in 20th century Lansing. Lansing Speech Corpus (n=36), plus Millennial speakers (n=21) for reference.

Let us examine women and men separately first. Figure 11 shows and follow-up Welch two sample t-tests confirm that within the female group, there are on average higher realizations (lower F1 values) of pre-oral /æ/ in the Baby Boomer generation (M = 741.3 Hz, SD = 30 Hz) compared to the Silent generation (M = 777.2 Hz, SD = 38.3 Hz), $t(9.5) = -2.22$, $p<0.05$. This is followed by a significant *decrease* in realizations (higher F1 values) in Generation X (M = 786 Hz, SD = 23.1 Hz) compared with Baby Boomer women, $t(9.5) = -3.3$, $p<0.01$. Thus, for women in Lansing, the nucleus of pre-oral /æ/ rose in the first half of the 20th century, and fell in

Generation X. Recall from Table 8 that social class did not have a significant effect on F1 for women.

In the male group, however, there is a different temporal pattern, as well as an effect of social class. Overall, as shown in Figure 11, men's mean realization of /æ/ falls from the Silent (*M* = 785.2 Hz, *SD* = 39.4) to the Boomer generation (*M* = 808 Hz, *SD* = 24.5) (higher F1 values), before rising in Generation X (*M* = 760.8 Hz, *SD* = 25.7) (lower F1 values). This is the opposite of the pattern for women, as illustrated previously in Figure 11, whose mean /æ/ nucleus rose and then fell.

These different trajectories have led to the following effect of gender across generational time: No significant effect of gender in the Silent generation; women (*M* = 777 Hz, *SD* = 38.3 Hz) and men (*M* = 785.2 Hz, *SD* = 39 Hz) exhibit similar F1 values, $t(9.99) = -0.11$, $p > 0.05$. In the Baby Boomer generation, there is a significant effect of gender such that women (*M* = 741.3 Hz, *SD* = 30 Hz) exhibit higher realizations of /æ/ (lower F1) than men (*M* = 808 Hz, *SD* = 24.5 Hz), $t(9.74) = -4.61$, $p<0.001$. Finally, in Generation X, men (*M* = 760.8 Hz, *SD* = 25.7 Hz) exhibit higher realizations of /æ/ (lower F1) than women (*M* = 786 Hz, *SD* = 23.1 Hz), $t(9.87)= 1.83$, $p<0.05$. In sum, there was no gender effect at the turn of the 20th century on raising, women then had higher realizations in the middle of the 20th century, which was followed by male speakers exhibiting higher realizations later.

4.3.2 Summary of F1 Results

At the community level there was stability of the nucleus of pre-oral /æ/ in the F1 dimension in the beginning and middle of the 20th century, which was followed by a rise in F1 values in the 1990s. This is mitigated by the fact that change was gender-conditioned, i.e. each gender exhibited opposite changes over time. In the Silent to Baby Boomer generational

transition, women raised /æ/ while men lowered. In Generation X, women lowered /æ/ and men raised /æ/. In the subsequent Millennial generation, women continued to lower /æ/ and men proceeded to do so also. Therefore, while at the community level there appeared to be stability in the first half of the twentieth century, change over time is evident when gender is taken into account.

4.4 F2 of Pre-Oral /æ/

Table 9 displays the results of the mixed effects regression analysis for F2. The reference/intercept group are Baby Boomers, as before. As shown in the table, there is a main effect of generational cohort, with Generation X speakers having significantly more backed /æ/ (lower F2 values) than the cohort reference group, Baby Boomers.

Table 9 Best fit mixed-effects model of pre-oral /æ/ F2

Predictor	Value(s)	Estimate	Std. Error	df	t-value	Significance
		1979.902	38.966	37.454	50.812	***
GEN	GenX	-236.107	54.828	36.567	-4.306	***
GEN	Silent	-12.144	54.893	36.727	-0.221	[0.826]
GENDER	male	-88.613	53.633	33.645	-1.652	[0.108]
GEN × GENDER	GenX × male	198.338	76.378	34.509	2.597	*
GEN × GENDER	Silent × male	6.431	76.521	34.737	0.084	[0.934]

Significant difference ($p < 0.001$) is reported as ***; significant difference ($p < 0.01$) is reported as **; significant difference ($p < 0.05$) is reported as *, and non-significant appears as [].

Unlike for F1, there is no significant difference in F2 realization between Boomers and Generation X in the regression, and there is no main effect of gender. There is, however, a significant interaction between generation and gender. Social class and its interaction with the

other main effects did not come out as significant in the model and will not be explored in what follows

Figure 12 displays average F2 values across apparent time in the sample. This, along with the regression output in Table 9, shows that in Lansing, the general picture is one of stability in the transition from Silent to Baby Boomer generation, which is followed by significant backing (lower F2 values) in Generation X. This is the same trend that was observed for F1 values in the follow-up t-tests.

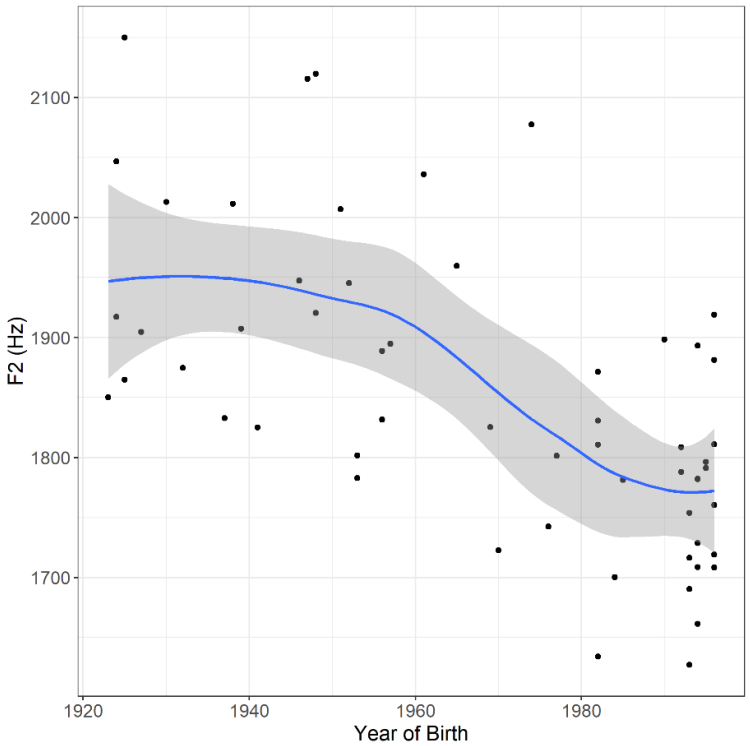


Figure 12 Average F2 (Hz) values of pre-oral /æ/ by speaker year of birth in 20th century Lansing. Lansing Speech Corpus (n=36), plus Millennial speakers (n=21) for reference.

Since neither the main effect of social class or its interaction with other social variables was significant in the model, I will not explore the effects of social class on F2 values in what follows. Gender was not a significant main effect on F2, but as we saw for F1, its interaction with generational cohort was significant, whereby the effect of gender changes over generational time.

4.4.1 F2, Generational Time and Gender

Figure 13 displays the interacting effect of generational cohort and gender (red = female) on F2 values in the corpus.

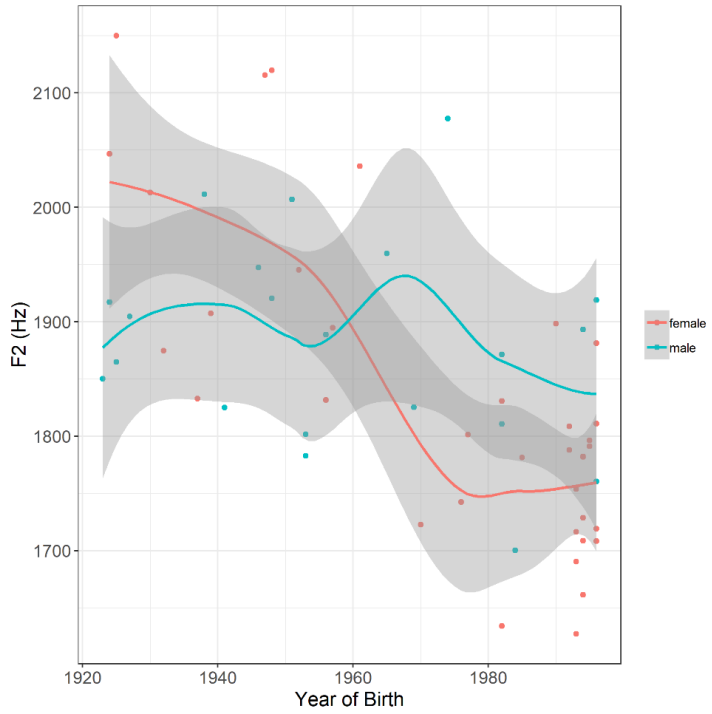


Figure 13 Average F2(Hz) values of pre-oral /æ/ by speaker year of birth and gender in 20th century Lansing. Lansing Speech Corpus (n=36), plus Millennial speakers (n=21) for reference.

As shown in the figure (and see Table 1), for women, stability in F2 between the Silent (M = 1977 Hz, SD = 131.5) and Boomer generations (M = 1996.5 Hz, SD = 127.5), $t(9.99) = 0.285$, $p > 0.05$) is followed by a significant decrease in F2 values into Generation X (M = 1753.4 Hz, SD = 70.9), who exhibit lower F2 values than their predecessors, $t(8.07) = 4.23$, $p<0.01$. In Figure 13, F2 values remain stable for men. There are no significant differences in F2 values in the male group from Silent (M = 1900 Hz, SD = 61.3) to Boomer generation (M = 189.3 Hz, SD = 87), $t(9.38) = -0.09$, $p > 0.05$ nor in the transition to Generation X (M = 1874.2 Hz, SD = 130.6), $t(8.66) = 0.27$, $p > 0.05$).

4.4.2 Summary of F2 Results

In sum, I observe that pre-oral /æ/ has moved farther back in the vowel space from the beginning to the end of the 20th century, with the significant change occurring in the transition from Baby Boomer to Generation X speakers, at least for women. In the Silent and Baby Boomer generations, women exhibited fronter realizations than men. With the retraction of pre-oral /æ/ exhibited by women in the middle of the 20th century, the pattern switched such that men exhibit fronter realizations than women.

4.5 Diphthongal Quality of Pre-Oral /æ/

In this section, I examine diphthongal quality of pre-oral /æ/ by measuring the change in F1/F2 from the midpoint of the vowel to its offset. Diphthongal quality (DQ) is this dissertation's third diagnostic of NCS /æ/. As discussed earlier in Chapter 2, pre-oral /æ/ is more diphthongal in the Inland North than it is in other regions of North America, which have more monophthongal realizations of pre-oral /æ/ (Boberg & Strassel 2000; Labov, Ash & Boberg 2006). In what follows, I test whether diphthongal quality of pre-oral /æ/ has changed over time for Lansing

speakers. The results of a mixed effects regression analysis are in Table 10; a visual plot of DQ over apparent time is in Figure 14.

Table 10 Best fit mixed-effects model of pre-oral /æ/ Diphthongal Quality (DQ)

Predictor	Value(s)	Estimate	Std. Error	df	t-value	Significance
	(Intercept: boomer female)	253.42	17.83	37.95	14.217	***
GEN	GenX	-62.01	25.12	36.76	-2.469	**
GEN	Silent	-12.46	25.17	37.06	-0.495	[0.624]
GENDER	male	-63.14	23.9	30.78	-2.642	**
GEN × GENDER	GenX × male	65.64	34.4	32.58	1.908	[0.065]
GEN × GENDER	Silent × male	-22.99	34.37	32.59	-0.669	[0.508]

Significant difference ($p < 0.001$) is reported as ***; significant difference ($p < 0.01$) is reported as **; significant difference ($p < 0.05$) is reported as *, and non-significant appears as [].

Figure 14, below, traces the diphthongal quality of pre-oral /æ/ (in red) across year of birth in the Lansing sample. For comparison, I have included mean DQ values of /ɛ/ (in blue) as a reference for a front monophthong. Higher diphthongal quality values on the y-axis indicates more movement in F1/F2 space between the vowel's midpoint and its offset. In the figure, average DQ values higher than 300 represent a large amount of transition between the vowel's midpoint and its offset, whereas values around 150 represent a difference commensurate with that of a monophthongal realization.

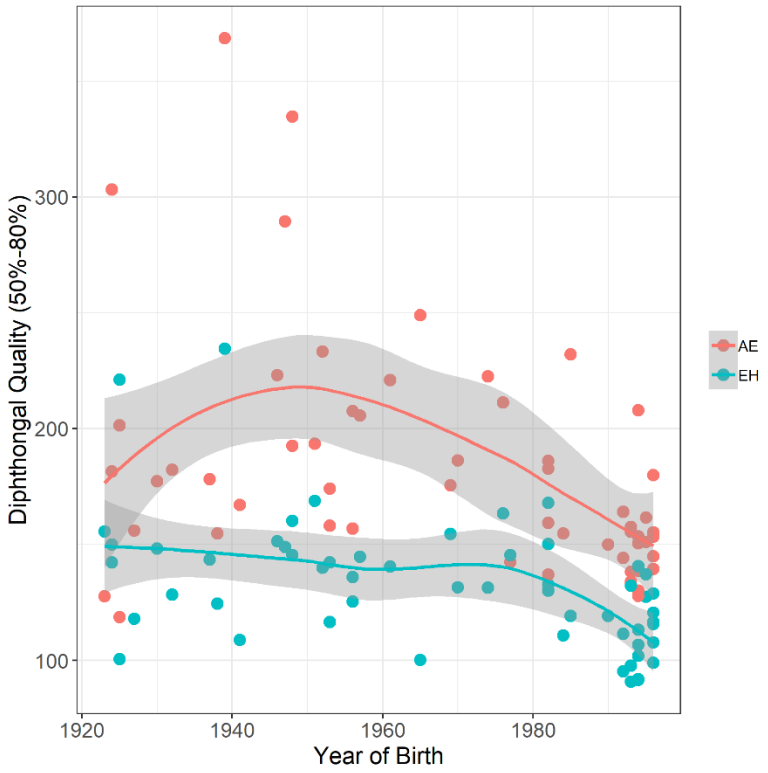


Figure 14 Average Diphthongal Quality (Hz) values of pre-oral /æ/, /eɪ/, and /ɛ/ by speaker year of birth in 20th century Lansing. Lansing Speech Corpus (n=36), plus Millennial speakers (n=21) for reference.

As displayed in Table 10 and visible in Figure 14, there is a main effect of generational cohort but only in the transition from Baby Boomer to Generation X speakers, where diphthongal quality values fall, i.e. pre-oral /æ/ becomes more monophthongal. Neither social class nor its interaction with the other fixed effects come out as significant and they were thus excluded from the final model. There is a significant main effect of gender in the model, but this effect disappears in Generation X, and the interaction is not significant in the model.

4.5.1 Diphthongal Quality and Gender

Figure 15 displays DQ measure over time partitioned by gender. In this figure (and follow-up t-tests confirm it), there is an effect of gender in the first two generations, where women have higher DQ values than men.

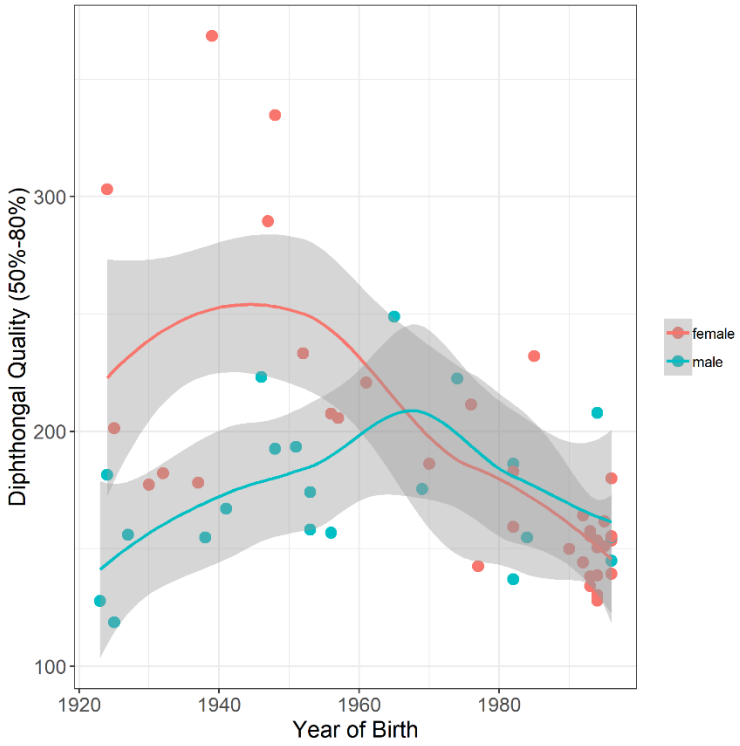


Figure 15 Average Diphthongal Quality (Hz) values of pre-oral /æ/ by speaker year of birth and gender in 20th century Lansing. Lansing Speech Corpus (n=36), plus Millennial speakers (n=21) for reference.

In the Silent generation, women exhibit larger DQ values (M = 234.28 Hz, SD = 81.5) than men (M = 152.39 Hz, SD = 25.1), $t(5.85) = 2.44$, $p<0.05$; and in the Baby Boomer generation, women (M = 253.28 Hz, SD = 57.64) exhibit larger DQ values than men (M = 183.1

Hz, *SD* = 25.2), *t*(7.22) = 2.77, p<0.05. This gender effect disappears in Generation X, however, where women (women *M* = 186.93) and men (*M* = 187.44) have similar DQ values, *t*(9.38) = −0.05,p > 0.05. In other words, men's and women's diphthongal quality for /æ/ seems to move in opposite directions over time until converging in Generation X. Within the female group, there is no statistically significant effect of generational cohort on DQ values between silent generation (*M* = 234.28 Hz, *SD* = 81.5) and Baby Boomer generation speakers (*M* = 253.28 Hz, *SD* = 57.64), *t*(8.53) = 0.34, p > 0.05. There is an effect in the subsequent generational transition whereby Generation X women (*M* = 186.93, *SD* = 31.3) have lower DQ values than their predecessors, *t*(8.32) = 2.48, p<0.05. Within the male group there is a statistically significant effect of generational cohort in the first half of the 20th century. Silent generation men (*M* = 152.39 Hz, *SD* = 25.1) exhibit smaller DQ values than Baby Boomer generation men (*M* = 183.1 Hz, *SD* = 25.2), *t*(9.96) = 2.27, p<0.05. Subsequently, there is non-significant of generational cohort on DQ values; Generation X men exhibit similar DQ values (*M* = 187.44, *SD* = 41.8) as their predecessors *t*(8.21) = −0.22, p > 0.05. Thus, for women, there was stability and then a decrease in diphthongal quality from the baby boomer to Generation X speakers. This is in contrast to the male group where DQ values rose and then remain stable. The interaction between generational cohort and gender was likely insignificant in the regression model because though there was an interaction of gender and generational cohort in the transition from Silent to Baby Boomer generation, the gender effect disappeared in Generation X.

4.5.2 Summary of Diphthongal Quality Results

In sum, diphthongal quality of pre-oral /æ/ in Lansing has have shifted toward monophthongization. Diphthongal quality peaked for women in the 1920s – 1940s and then declined, while that for men peaked in the 1960s and then declined. The transition from a female

lead in previous generations to no gender difference in Generation X is reminiscent of the social change we have previously seen for the F1 and F2 of /æ/ in sections 4.3 and 4.4. Clearly, the post-Boomer period is a critical one for /æ/ in the Lansing speech community.

4.6 Nasal Allophony

The last diagnostic of NCS participation to be considered in this dissertation is that of pre-nasal and pre-oral token distribution at the level of the speaker. We know from previous studies that Inland Northern speech is characterized by unconditioned and continuous /æ/ systems, though more recent studies have noted the appearance of the supra-local nasal system (Chapter 2). In what follows, I examine the effect of generational time on these systems as measured by Pillai-Bartlett score in twentieth century Lansing (see 2.2.2.6 for details on Pillai-Bartlett). Table 11 displays the output of an ANOVA analysis on Pillai-Bartlett scores in Lansing. The only significant effect on these scores is of speaker year of birth; gender and social class had non-significant on Pillai-Bartlett scores.

Table 11 ANOVA results of Pillai-Bartlett score analysis

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
YOB	1	25.13	25.13	21.85	$4.53e^{-05}$ ***
Residuals	34	39.11	1.15		

Figure 16 displays the Pillai-Bartlett scores for each speaker in the sample across year of birth. The higher the Pillai-Bartlett measurement (from 0 to 1), the greater the separation between pre-oral and pre-nasal token clouds for that speaker.

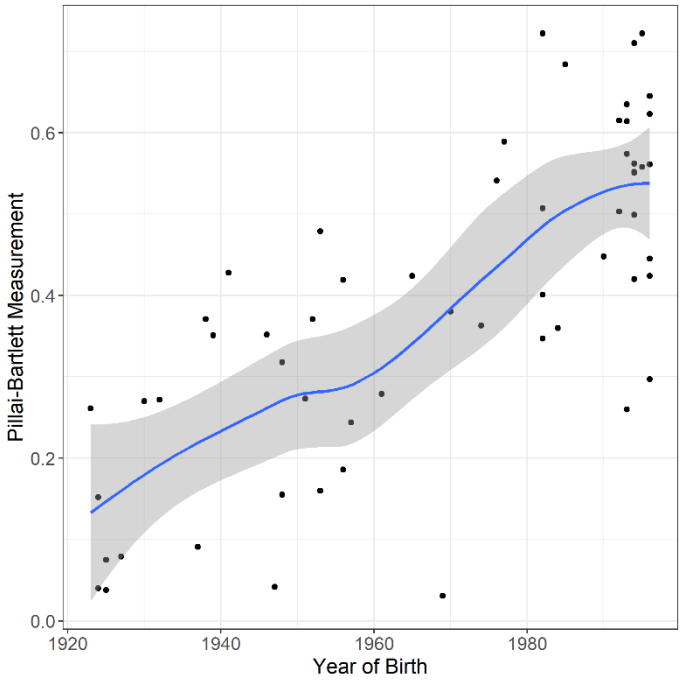


Figure 16 Per speaker Pillai-Bartlett score of pre-nasal and pre-oral /æ/ distribution by speaker year of birth in 20th century Lansing. Lansing Speech Corpus (n=36), plus Millennial speakers (n=21) for reference.

In the figure, we see that the proportion of speakers with Pillai-Bartlett scores close to 1 continuously increases from the earliest birth dates onward. This is confirmed by the ANOVA analysis (Table 11). Social class, gender, and their interactions with year of birth were not significant in the model. The general picture of the relationship between pre-nasal and pre-oral token cloud overlap in Lansing is one of increasing separation over the 20th century.

4.6.1 Summary of Nasal Allophony Results

In sum, there has been a change in the relationship between pre-nasal and pre-oral allophones of /æ/ in 20th century Lansing. The community has increased the distance between /æ/ in these two environments over time. Many speakers born in the 1920s had Pillai-Bartlett scores close to 0 indicating an advanced raised /æ/ system. Speakers born in the 1950s and 1960s have larger

Pillai-Bartlett scores indicating nasal conditioning, where their /æ/ systems resembled that of a more common (less advanced) raised /æ/ system. Speakers born in the 1990s have Pillai-Bartlett scores ever closer to zero. The general trend, then, is that the advanced raised system is gradually giving way to a nasal system. I note that this change is ongoing, however. Though speakers born in the 1990s have higher Pillai-Bartlett scores than their predecessors, none of them have scores of 1, which would indicate a true gap in phonetic space between pre-nasal and pre-oral token clouds.

4.7 Summary: /æ/ in 20th Century Lansing

The above analysis of the impact of external and internal factors on the realization of /æ/ in 20th century Lansing has shown linguistic and social reorganization, as summarized in Table 12 and Table 13. Linguistically, the community has moved from an unconditioned /æ/ system to a nasal system. In opposition to pre-nasal /æ/, the pre-oral allophone has lowered and retracted in the vowel space and has decreased in diphthongal quality. This general trend is mediated by the fact that there was relative stability between the Silent and Baby Boomer generations that was followed by a significant downward trajectory in each of these measures in the transition to Generation X. I also note that what looks like stability between Silent and Baby Boomer generation means is actually the result of gender conditioning such women advanced NCS features during this period while men did not participate in the change. In short, all four of the diagnostic measures of NCS /æ/ collectively demonstrate that the Lansing speech community has shifted away from the NCS toward a higher mean F1 (lower in the vowel space), lower mean F2 (farther back in the vowel space), lower mean DQ (more monophthongal), and higher Pillai-Bartlett scores (more separation between pre-nasal and pre-oral allophones).

Table 12 Distribution of /æ/ features across generational time in 20th century Lansing

	Silent to Boomer	**Boomer to Generation X**
F1	Gender conditioned change	Stability
F2	Stability	Retraction
Diphthongal Quality	Stability	Less diphthongal
Nasal conditioning	More nasal conditioning	More nasal conditioning

With regard to the social re-organization of NCS /æ/ characteristics in Lansing, Table 13 summarizes which gender group was most advanced for three of the four acoustic measures explored in this dissertation across each generation; in the table, the NCS version of the feature is more indicative of the specified gender group in that generation. Nasal conditioning, as measured by Pillai-Bartlett score is not included, as the only social dimension relevant for this measure is generational cohort. I observe that social conditioning with respect to the other three features has changed in the community.

Table 13 Summary of social conditions on acoustically salient NCS features in 20th century Lansing

	Silent	**Baby Boomer**	**Generation X**
NCS Raising (F1)		Female	Male
NCS Fronting (F2)	Female	Female	Male
Diphthongization	Female	Female	

From the Silent and Baby Boomer generations, women were most advanced in NCS /æ/ raising, fronting and diphthongization. In Generation X, however, as women reversed course and retreated from the NCS, it was men who exhibited more NCS features. In Lansing, women led men in advancing NCS features (unconditioned raising, fronting, diphthongization) in the beginning of the 20th century. In Generation X, men advanced NCS features while women began to diverge from the range of these measures in prior generations – thus leading the community change towards NCS reversal/rejection. These findings are unsurprising, given the fact that women are often the leaders of community change (Labov 1990). The large amount of inter-speaker variation in the Baby Boomer generation followed by a switch in social conditioning in Generation X further support the claims in Nesbitt (2018) and Nesbitt, Wagner & Mason (in press) which argue that NCS features were at their height for speakers born in the middle of the 20th century and that they began to decline thereafter. In Chapter 5, I explore the development and spread of nasal allophony for /æ/ at the level of the speaker. In Chapter 6, I discuss the implications of the results of the phonetic and phonological analyses in this dissertation with a view to some future potential lines of investigation.

Chapter 5
PHONOLOGIZATION OF /æ/ NASAL ALLOPHONY IN LANSING

5.1 Introduction

I now return to the main research question of this dissertation: What has been the impact of these changes in phonetic target and social conditioning of /æ/ on the phonological systems of Lansing speakers? This chapter addresses two questions regarding the development of a phonological distinction between pre-nasal and pre-oral /æ/ in Lansing, MI. The first concerns the Actuation Problem which asks why the change was initiated. For this, we will ask whether phonological /æ/-nasal allophony developed gradually from a phonetic precursor or was abruptly posited in the community? The second concerns the Transition Problem: how did the change spread throughout the community?

I utilize a combination of methods to answer these questions in this chapter, including impressionistic visualizations of phonetic differentiation between allophones of /æ/ and the analysis of a sub-phonemic judgement task. The methodology for both has been provided in Chapter 3 (section 3.3). As a reminder, the data for the trajectory visualizations come from the Lansing Speech Corpus plus the Millennial speakers in Wagner et al (2016) and Nesbitt (2018), while the data for the judgement task come from Lansing Speech Corpus speakers plus others recruited through supplemental methods.

As I will show, the results of these analyses suggest that phonologization is gradual in Lansing. The trajectory analysis finds that the pre-nasal allophone is phonologically distinct from the rest of the allophones and that it began to distinguish itself in F1/F2 space among speakers born in the 1930s. Subsequently, the sub-phonemic judgement task shows that no

speakers born at that time (or even a decade later) posit a phonological distinction between the allophones. This finding that phonologization was gradual supports the analysis in Chapter 2 of Pillai-Bartlett scores in Lansing over time, which showed the progression of systems from NCS raised to continuous to nasal. The analysis of social factors in this chapter suggests that white-collar (women) respondents are the leaders of this change and that blue-collar respondents are on the trailing end.

In what follows, I present the results of the trajectory analysis (section 5.2.1). I analyze the responses to the sub-phonemic judgement task in section 5.2.2. Section 5.3 concludes this chapter with a discussion of the methodological implications of the sub-phonemic judgement task. I consider the implications of these results for our theories of allophonic phonologization specifically and phonological change more generally. As a reminder, this dissertation distinguishes between allophones that are phonologically distinct and those that are distinguished only phonetically. Phonological allophones are distinguished from one another by means of a phonological rule acting on abstract phonological representations and thus have different phonological features. Phonetic allophones have the same phonological features and differ only in phonetic realization.

5.2 Results

5.2.1 Phonetic and Phonological Allophony

To determine whether any allophone of /æ/ has become phonologically distinguished from the rest of the allophones, I begin with a discussion of trajectories over time for each allophone. To determine whether sub-phonemic conditioning of /æ/ in Lansing is phonological, I compare the analysis of /æ/ with the same for two other short-front vowels; /ɛ/ and /ɪ/. I follow this analysis with a determination of *when* in the apparent time trajectory divergence is evident for /æ/. For

these comparisons, I utilize the production data from the Lansing Speech Corpus plus that from Millennials in the Wagner et al (2016) study. For reference, birth years in the sample are as follows: 1925–1945 = Silent generation, 1946 –1964 = Baby Boomer, 1965–1984 = Generation X, 1985–1999 = Millennial.

In Figure 17, I show the trajectory of /æ/ in three following phonological environments; before fricatives (in red), nasals (in green), and stops (in blue). Each dot on the plot represents a token. I set aside the trajectories of the pre-/l/ and pre-affricate allophones because of their low token counts in the sample, N=174 and N=166, respectively. These two allophones are produced on average only 3 times per speaker, which makes any conclusions about conditioning less robust. For transparency, I have included a figure of the trajectories of all five phonological environments in appendix 0.

For now, I focus on a comparison of the trajectories for the pre-nasal (in green), pre-fricative (in red), and pre-stop (in blue) allophones because token counts for these are robust in the sample, N=2235, N=1382, and N=2332, respectively. In Figure 17, we see a clear distinction between the trajectories of the pre-nasal and pre-oral allophones. The pre-fricative (in red) and pre-stop (in blue) allophones fluctuate in diagonal measurement into Generation X and then decline into the Millennial generation; they move down and backwards in the vowel space over time. This is in contrast to the pre-nasal allophone (in green) which remains relatively stable from the 1920s onward.

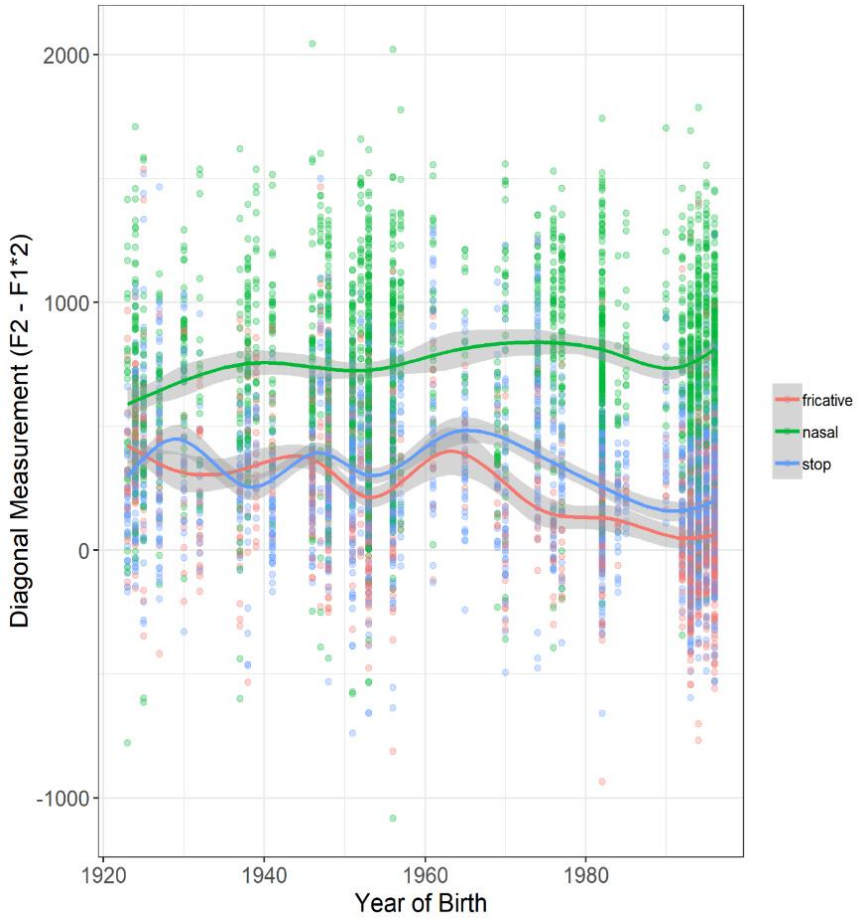


Figure 17 Per token diagonal measurement of /æ/ in three following phonological contexts by speaker year of birth in 20th century Lansing.

We can compare the allophonic trajectories of /æ/ with those of /ɛ/ and /ɪ/. In Figure 18, I show the trajectory of /ɛ/ (left facet) and /ɪ/ (right) in the same three following phonological environments; before fricatives (in red), nasals (in green), and stops (in blue). We again ignore the other following environments, as token counts for them are relatively low.

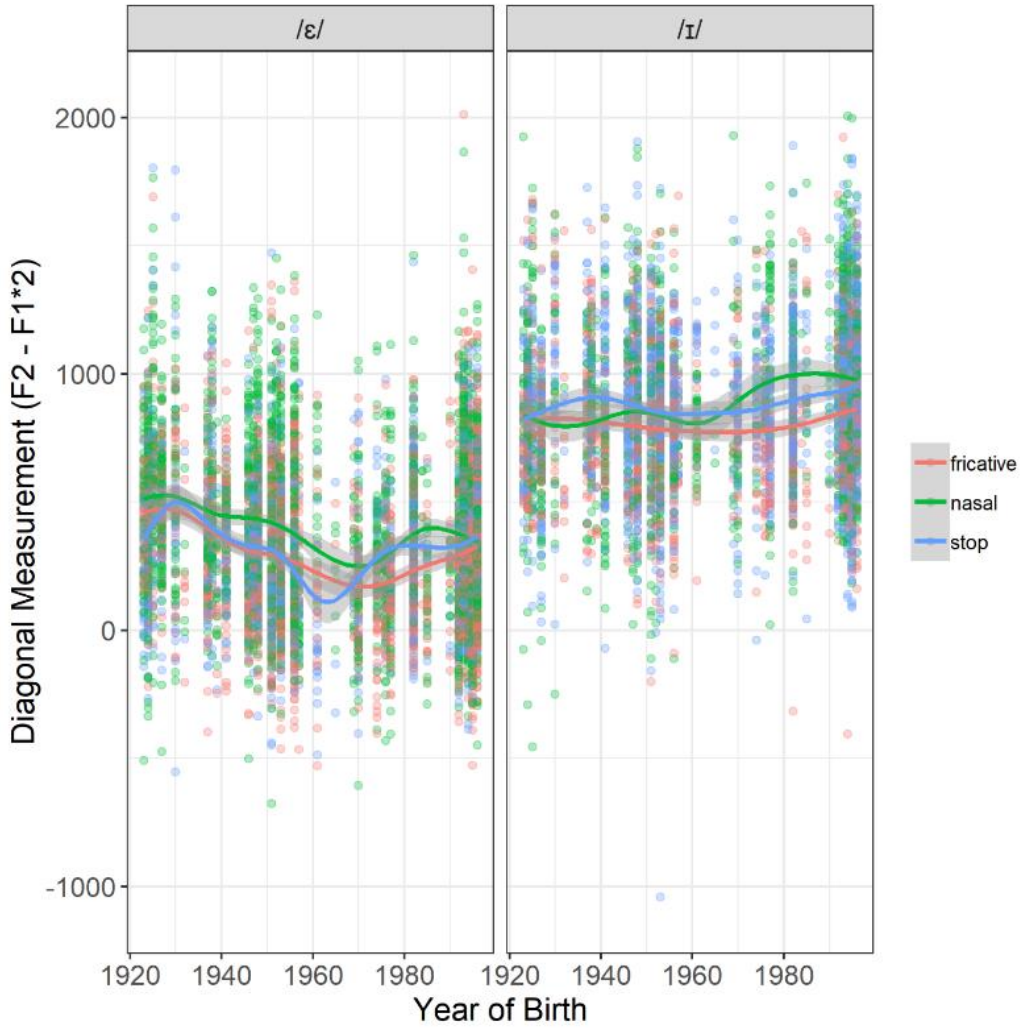


Figure 18 Per token diagonal measurement of /ɛ/ (left facet) and /ɪ/ (right facet) in three following phonological contexts by speaker year of birth in 20th century Lansing.

For both of these vowel classes, we find that the pre-nasal allophone moves in lockstep with the pre-stop and pre-fricative allophones. Therefore, I argue that unlike for /æ/, the pre-nasal allophones of /ɛ/ and /ɪ/ are phonetically rather than phonologically distinguished from the rest of the allophones. These vowel classes have a different phonological make-up than /æ/ in terms of nasal conditioning; the latter moving towards a phonological distinction and the former

only phonetically distinct. I will utilize this distinction (phonetic vs phonological allophony) in the analysis of the judgement data to follow. If the sub-phonemic judgement task is indeed capturing the difference between phonological and phonetic allophony, respondents should react differently when presented with /ɛ/ and /ɪ/ words than when they are presented with /æ/ words.

As for a more precise estimation of when in apparent time the pre-nasal and pre-oral allophones of /æ/ began to diverge, we focus on the trend lines in the 1920 to 1940 birth year range in Figure 17 (approximately the Silent generation). Focusing on the period between 1920 and 1930, the pre-nasal (green line) and pre-fricative allophone (in red) already show distinct trajectories; pre-nasal increasing and pre-fricative slightly decreasing. In this same time window, the pre-nasal (green line) and pre-stop allophone (blue line) are moving in lockstep; both upward. In the 1930s, the pre-stop allophone diverges from that upward trajectory. From the 1940s onward, the pre-stop and pre-fricative allophones move in lockstep.

In conclusion, visual inspection of the F1/F2 diagonal trajectory of /æ/ in multiple following phonological environments indicates that at the community level, pre-nasal /æ/ and pre-oral /æ/ have distinct phonological features, whereas pre-nasal and pre-oral /ɛ/ and /ɪ/ are distinguished via phonetic implementation rules. Additionally, we have seen that the nasal allophone diverged from the rest close to 1930 which is in the Silent generation, (birth year 1925–1945). Therefore, in the analysis of whether phonologization of allophonic splits occur abruptly or gradually in a community, I will focus on Silent generation speakers.

5.2.2 Sub-Phonemic Judgement Task: Actuation and Transition of Phonologization

In the previous section, I showed that pre-nasal /æ/ began to move along a different trajectory from the rest of the allophones in F1/F2 space in the Silent generation (1925–1945). As such, the actuation question will be addressed by examining phonologization in this generation. If

phonologization was abrupt in Lansing, the difference between pre-nasal and pre-oral /æ/ should be phonological for at least some Silent generation respondents. If, however, phonologization was gradual in Lansing, the difference between pre-nasal and pre-oral /æ/ should not be phonological for any of the Silent generation respondents but should appear in subsequent generations. Under the gradual hypothesis, Silent generation respondents will only distinguish the two allophones phonetically.

A complete description of the methodology for this task is provided in Chapter 3 (section 3.3), which includes a description of the statistical analyses employed below. I include a brief description of the methods here as a reminder to the reader. During the sub-phonemic judgement task, participants were presented with two CVC lexical items and were asked to indicate whether the vowels in the two words sound the same or different to them. Responses from 107 white monolingual English-speaking Lansing natives are analyzed here. In this task, Condition 1 was composed of 5 pairs of CVC words that had the same onset and nucleus /æ/ but differed in whether the coda consonant was nasal or oral, e.g. *pat* and *pan.* Condition 2 was composed of 5 pairs of CVC words that had the same onset and nucleus /æ/ but had different oral coda consonants, e.g. *pat* and *pass.* The hypothesis for this experiment is that participants who distinguish pre-nasal and pre-oral /æ/ phonologically will be more likely to respond DIFFERENT to Condition 1 pairs than they are to Condition 2 pairs because the latter compare /æ/ tokens that differ only phonetically while the former compare /æ/ tokens that have different phonological representations. Those who do not have a phonological distinction between pre-nasal and pre-oral /æ/, however, should respond DIFFERENT to Condition 1 and Condition 2 pairs at the same rate. To determine when the phonological change occurred, I ask in which generation do we observe that Condition 1 pairs garner more DIFFERENT responses than Condition 2 pairs.

Additionally, the trajectory analysis in section 5.2.1 showed that the two allophones began to differentiate in their acoustics in the Silent Generation (date of birth 1920–1945). Therefore, if this change occurred abruptly, responses between Condition 1 and Condition 2 must be different in this generation. If difference is not noted in this generation but observed in subsequent generations, allophonic reorganization must have occurred gradually in Lansing. In addition to generation, this analysis includes social class as a factor, as the spread of phonological change appears to be conditioned by social class. Gender was not included as an external factor due to the small number of males across generations in the sample. The binomial mixed-effects logistic regression model included Response (same, different) as the dependent variable, and Condition (1,2), Generational Cohort (Silent, Boomer, Gen X, Millennial), and Social Class (Blue-collar, White-collar) as predictor variables, and Participant and Pair as random intercepts.

Table 14 Mixed-effects regression model for responses to CæC pairs.

Predictor	Values	Estimate	Std. Error	df	t-value
	(Intercept: BlueCollar, Cond 1, Boomer)	-2.783	0.37604	*-7.401*	***
Cond	Cond2	0.232	0.55423	0.419	[0.675]
GEN	GenX	1.079	0.36434	2.961	**
GEN	Millennial	2.075	0.35692	5.812	***
GEN	Silent	0.096	0.89294	0.107	[0.914]
SocialClass	WhiteCollar	1.039	0.19922	5.216	***
Cond × GEN	Cond2 × GenX	-0.862	0.68858	-1.253	[0.210]
Cond × GEN	Cond2 × Millennial	-2.358	0.72244	-3.264	**
Cond × GEN	Cond2 × Silent	NA	NA	NA	NA

Significant change ($p < 0.001$) is reported as ***, significant change ($p < 0.01$) is reported as **, slightly significant change ($p < 0.05$) is reported as *, and non-significant appears as [].

The best fit model for the data is provided below in Table 14. Blue-collar, Condition 1, and the Baby Boomer generation are set as the reference level. This model included the significant two-way interaction between Generational Cohort and Condition, and significant main effects of Generational Cohort and Social Class. In what follows, I will report on the interaction results and then the social class effect. Figure 19 displays the distribution of the percentage of responses to lexical pairs over time. In the figure, generational cohort appears on the x-axis and response percentage appears on the y-axis. Condition 1 responses appear on the left and Condition 2 responses are on the right. *Different* responses are shown in yellow and *same* responses are in blue.

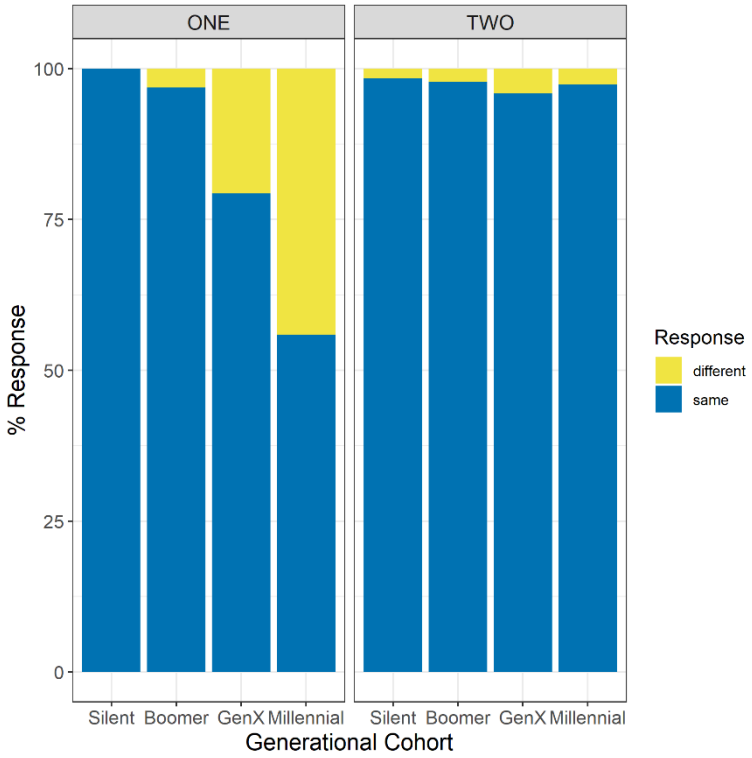


Figure 19 Distribution of responses to pre-nasal and pre-oral pairs (left = condition one) compared to pre-oral and pre-oral pairs (right = condition two) of /æ/ over generational time.

The first observation to be made about the figure is that respondents judge pairs in Condition 2 to be different at least 95% of the time no matter their age. We compare this to the general increase in the amount of *different* (indicated in blue) over apparent time. The regression analysis did not compare the two conditions in the Silent generation because no Silent generation participants responded *different* to Condition 1 pairs and the dependent variable (response) required two levels (same, different). Since *different* responses for Condition 1 are at zero for this group and those for Condition 2 are at 2%, we would not expect to find a significant effect of condition on responses in this generation – this group behaves the same under each condition. In the Baby Boomer generation, though *different* responses to Condition 1 increase to 3%, this is not significant in the model. Although in Generation X, *different* responses increase to 20.7%, this is also not significant in the model. The only combination of condition and generation that is significantly different from the baseline is found in the Millennial generation. Millennial respondents are significantly more likely to judge pre-nasal and pre-oral /æ/ as different from one another than pre-oral pairs. *Different* responses in the Millennial group reach 44% under Condition 1 in this experiment. Thus, while respondents do not judge pre-oral /æ/ pairs to be different, the community is moving towards distinguishing between pre-nasal and pre-oral /æ/. The initiation of this move appears to have occurred in Generation X with the significant increase occurring in the subsequent Millennial generation.

To provide a clearer view of the social/external conditions on this change, I turn to an investigation into the impact of social class in each generation on responses in this task, which is displayed in Figure 20. In the figure, as above, generational cohort appears on the x-axis and response percentage appears on the y-axis. Condition 1 responses appear on the left and Condition 2 responses are on the right. *Different* responses are shown in yellow and *same*

responses are in blue. White-collar respondents are at the top and blue-collar respondents are on the bottom facet.

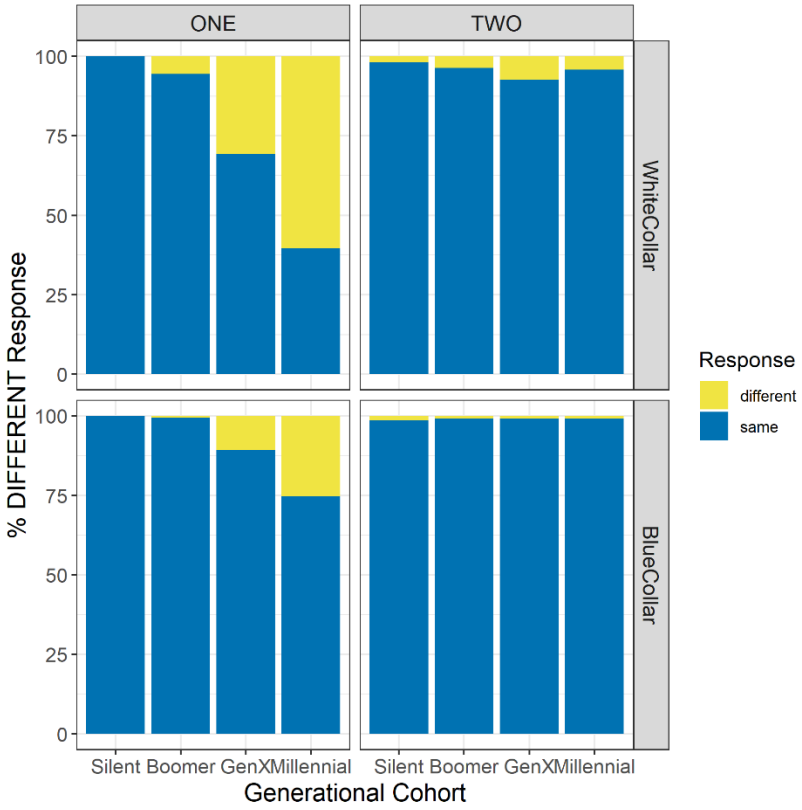


Figure 20 Distribution of responses to pre-nasal and pre-oral pairs (left = condition one) compared to pre-oral and pre-oral pairs (right = condition two) of /æ/ over generational time and by Social Class (White Collar respondents at the top).

In what follows, I will only report on responses to Condition 1 pairs (left facet), since as we can observe in Figure 20, *different* responses to Condition 2 pairs remain below 10% across all generations and social class groups. In the Silent generation, no respondent indicated that Condition 1 pairs were different, regardless of their social class. In the Baby Boomer blue-collar sample, *different* responses remain at 1%. White-collar Baby Boomer respondents judge

Condition 1 pairs to be different 6% of the time. This suggests an increase in perception of a difference, but I note that these respondents also judge Condition 2 pairs to be different 4% of the time. In Generation X, blue-collar respondents judge Condition 1 pairs to be different 10.7% of the time while white-collar respondents judge them to be different 30.7% of the time. And finally, in the Millennial generation, blue-collar respondents increase in the amount of different responses to Condition 1 pairs to 25.4%. White-collar Millennials also increase the amount of different responses to Condition 1 pairs to 60.4%.

In sum, I note that while *different* responses to Condition 2 pairs remain at 1% in each generation and across social groups, there is a general increase in the amount of *different* responses to Condition 1 pairs across time in both social class groups. In the Silent and Baby Boomer generations, respondents consider all tokens of /æ/ to be the same, no matter the conditioning environment. There is an increase in perceived difference between pre-nasal and pre-oral tokens in Generation X. This increase is really only evident in the white-collar sample and the difference between conditions is not statistically significant for them at any rate. There is a larger increase in distinction between the two conditions in the Millennial generation. In this Millennial generation, respondents are significantly more likely to consider pre-nasal and pre-oral pairs to be different than in any other generation.

Another crucial finding is that the aforementioned pattern is more prominent in the white-collar as compared to the blue-collar Millennial sample. Significance in the Millennial generation is only observed in the white-collar group, as opposed to the blue-collar group. Therefore, white-collar respondents appear to be leading in the development of a phonological distinction between pre-nasal and pre-oral /æ/; they are not only the first to judge /æ/ as different in the two phonetic environments, but younger white-collar Lansingites are significantly more

likely than blue-collar Lansingites to judge the two allophones as different during this task. These findings indicate that while nasal allophony is phonological for some speakers in the Millennial generation, the spread of this change is a more recent development.

5.2.2.1 Phonetic Conditioning

One tool for distinguishing phonetic from phonological allophony in this chapter was to compare responses to Condition 1 versus Condition 2 pairs. If a participant judged pre-oral pairs (Condition 2) alone to be different in this task, then it must be the case that co-articulatory/acoustic coupling is what is being captured by this experiment rather than any representational difference. The results above indicate that this is not the case – respondents do not judge allophones that are not differentiated phonologically to be distinguishable enough to prompt a *different* response. Another tool utilized here is an analysis of responses of pairs whose conditioning environments are not differentiated due to a phonological rule – /ɛ/ and /ɪ/ in various environments. For this, I consider responses to lexical pairs in Conditions 3 (*pen-pet*) and 4 (*pet-peck*). Figure 21 displays the distribution of responses to the lexical pairs with /ɛ/ or /ɪ/ as their relevant vowel across generational time. Condition 3 pairs are in the left-hand facet and Condition 4 pairs are on the right. *Different* responses are represented in yellow and *same* responses are represented in blue. The results for these conditions are unsurprising, given the trajectory analysis in section 5.2.1. Respondents in every generation judge /ɛ/ and /ɪ/ phonemes before oral and nasal consonants to be the same – almost categorically; 2% of respondents in the Millennial generation judge them to be different.

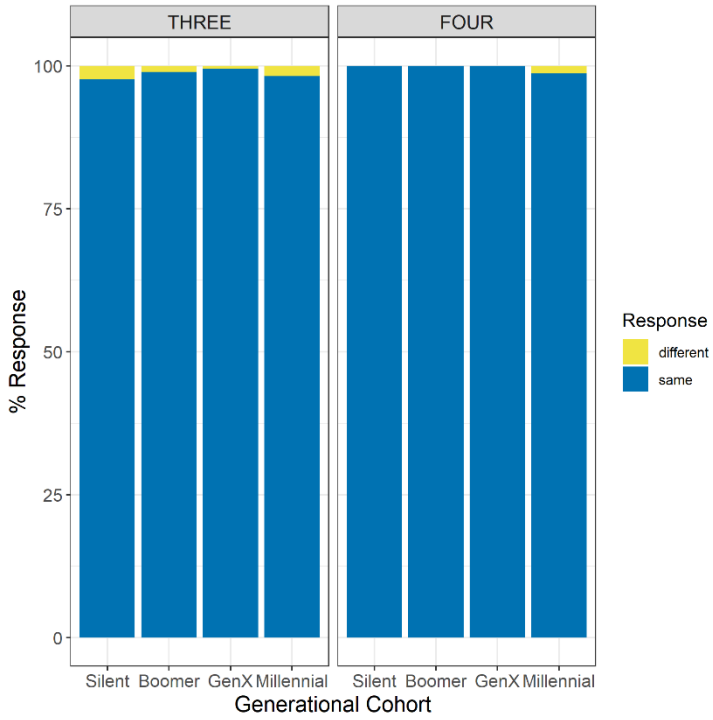


Figure 21 Distribution of responses to pre-nasal and pre-oral pairs (left = condition one) compared to pre-oral and pre-oral pairs (right = condition two) of /ɛ/ and /ɪ/ over generational time.

As with the judgements for pre-oral pairs of /æ/, respondents in Lansing do not distinguish between pre-nasal and pre-oral /ɛ/ phonologically. The same is true of Condition 4 – participants do not consider /ɛ/ and /ɪ/ before various oral consonants to be different from one another. Thus, the difference between /ɛ/ in any of these environments is merely phonetic rather than part of the phonological make-up of the vowel. The comparison of the results for these vowel classes to those for /æ/ suggests that performance on this task can capture sub-phonemic representation at the level of the individual.

5.3 Conclusion

The results of these analyses suggest that /æ/ nasal allophony in Lansing developed gradually. Respondents at the beginning of the separation of pre-oral from pre-nasal /æ/ in phonetic space — Silent generation respondents — do not judge this vowel to be different in the two environments. It is one generation later, in the Baby Boomer generation, that we observe some participants in the community judging /æ/ in these two environments to be different, and three generations later, in the Millennial generation, that these judgements are statistically different from judgements to pre-oral pairs. Thus, the phonological rule was not already present in the community before/as the two allophones began to diverge in acoustic space, in opposition to the prediction of the Big Bang Theory (Janda & Joseph 2003) and Baker, Archangeli & Mielke (2011), and as exemplified by Fruehwald (2016). The findings in this dissertation suggest that the allophonic rule in Lansing developed only after pre-nasal and pre-oral /æ/ were assuming different phonetic targets, in line with theories of gradual phonologization supported by The Life-Cycle of Phonological Processes (Bermúdez-Otero 2003, 2013; Bermúdez-Otero & Trousdale 2008; Ramsammy 2015), Hyman (1975; 2013), Evolutionary Phonology (Blevins 2004, 2006), and Exemplar Theory (Pierrehumbert 2001; Garrett & Johnson 2011).

The analysis of social factors provides a picture of how this change spread throughout the community. The results suggest that the spread of nasal allophony is being led by white-collar community members. While there is a general increase in *different* responses over apparent time in both the blue- and white-collar community, these judgements first appear in the white-collar Generation X group, and it is only in the white-collar group in the Millennial generation that *different* judgements are statistically significant between the two conditions. In line with the sociolinguistic literature on supra-local change, phonologization appears to have actuated in the

white-collar community first and then spread to the blue-collar community. Though the impact of participant gender on responses was not investigated in this chapter, I will offer some insights about gender based on impressionistic observations in section 6.1.

Chapter 6
CONCLUSIONS AND DISCUSSION

The goals of this dissertation were to address the Actuation problem of allophonic change in Lansing, i.e. why does change occur at a particular place in a particular time. In order to do this, I also addressed the Embedding and Transition Problems—what are the internal and external conditions surrounding the change and how did the change spread throughout the community. To address these problems, I utilized a combination of analyses. First, using a corpus of natural language data from 36 Lansing natives, I conducted an acoustic analysis of /æ/ in F1/F2 space. In particular, I measured changes in F1, F2, diphthongal quality, and relative distributions of pre-nasal and pre-oral /æ/ within each speaker in the sample. I supplemented this with the results of a sub-phonemic judgement task administered to 107 Lansing natives via an online survey. Below, I summarize my findings. The results of this dissertation provide some evidence for previous claims in the literature that address these problems but run counter to others. Additionally, these results offer some important new avenues for investigation. Below, I discuss each of these in turn.

First, the results of this dissertation confirm that both social/external and linguistic/internal factors are involved in phonological change. Commonplace in the phonological change literature is to assert that phonologization of coarticulation occurs when a mechanical effect is so strong that it is interpreted by a hearer as a distinct phonetic target. Baker et al. (2011) argue that this is too simple and in fact overpredicts the occurrence of this type of sound change because mis-articulations are so common. They claim that inter-speaker variability in the degree of the phonetic effect is what promotes this change, i.e. the range of the effect must be so great for some speakers that those speakers produce a sound that others

perceive as a distinct target. They also argue that the likelihood of the hearer adopting the novel target in their speech depends on social factors. These two points have allowed them to update our theory of the actuation of phonologization: "the ability of a phonetically motivated coarticulation to lead to sound change depends on the chance alignment of extreme coarticulation with extreme influence" (Baker et al 2011: 351). The results of this dissertation provide clear support for this hypothesis. In Chapter 4 (Figure 7), I showed that at the turn of the 20th century, there was minimal inter-speaker variation with respect to conditioning of pre-nasal /æ/, such that all speakers exhibited very low Pillai-Bartlett scores. In the Baby Boomer generation, however, there is considerable inter-speaker variation – some speakers show no conditioning of the pre-nasal environment while others do, and crucially, there is considerable variation with respect to pre-oral productions which can be accounted for by gender - women exhibit much higher and more forward realizations in this generation than men. Respondents born one generation later then begin to distinguish between the allophones in the sub-phonemic judgement task. It appears that these circumstances are what have driven this phonological change; considerable variability in conditioning combined with considerable social conditioning. Thus, the chance alignment of inter-speaker variation and social influence is what appears to have motivated allophonic change in Lansing.

Second, through the analysis of Pillai-Bartlett scores, and judgement task results, I have shown that there are three types of allophony operating in the Lansing speech community with respect to pre-nasal and pre-oral conditioning environments. The first is phonetically motivated but not controlled, the second is a speaker controlled phonetic effect, and the third is the result of a phonological rule. In the vowel space, speakers who exhibit phonetically implemented but not controlled allophony have overlapping pre-nasal and pre-oral token clouds, and they do not judge

/æ/ in these environments to be different. Those who exhibit controlled phonetic allophony exhibit some conditioning of the pre-nasal environment but no clear distinction from the pre-oral cloud. They also do not report that the vowels in these two environments sound different from one another. Speakers with a phonological rule, on the contrary, have discretely separated pre-nasal and pre-oral token clouds and are more likely to report that /æ/ is different in these environments. This type of allophony is characteristic of speakers in Lansing born in the latter half of the 20th century, who had a clear distinction between pre-nasal and pre-oral /æ/. I therefore provide evidence of the first three stages of the Life-Cycle of Phonological Processes operating in Lansing: epiphenomenal/absence of conditioning, controlled phonetic implementation, and phonological distinction.

Crucially, I show that there is a diachronic progression through these stages in the Lansing community. In the Silent generation (birth dates 1925–1945) there is a mixture of the first two types of allophony in the community. In the Baby Boomer generation (birth dates 1946–1964), Pillai-Bartlett scores increase, suggesting a shift towards more pre-nasal conditioning. In Generation X (birth date 1965–1985), the first type decreases even more as Pillai-Bartlett scores rise. By the Millennial generation (birth date 1985–1999), no speaker exhibits the first type, though there is an increase in pre-nasal conditioning. This generational progression reflects exactly what is predicted in the Life-Cycle of Phonological Processes (Bermúdez-Otero 2007; Bermúdez-Otero & Trousdale 2012)—the diachronic progression from phonetically motivated but not controlled allophony (stage 1 of the Life-Cycle), to a speaker controlled phonetic effect (stage 2 of the Life-Cycle), to a phonological rule (stage 3 of the Life-Cycle)—but runs counter to the theory of abrupt phonological change (Fruehwald 2013, 2016; Janda & Joseph 2003).

With regard to the Embedding problem, the results of the acoustic analyses in Chapter 4 show that Lansing participated in the NCS in the earlier half of the 20th century but began to adopt features characteristic of the supralocal Low Back Merger Shift after the 1960s. During this time, pre-oral /æ/ begins to lower and retract in the vowel space and show less diphthongal movement from the nucleus to the offset of the vowel. I also show that women led both the advancement of the NCS and the adoption of the LBMS. Social class was not significant in these analyses, though it has been in other analyses in the dialect area. I suspect that this is because of the small sample size combined with the change in trajectory in the middle of the 20th century for all of these measures. The sub-phonemic judgement experiment (Chapter 5) did reveal a social class effect, though as I note below, this sample was imbalanced for gender, such that women made up much of the sample. Thus, it may very well be the case that social class conditioning is only relevant for women, as would be expected given that "men appear to be less invested in the social value of linguistic variation" (Labov 2001: 321).

6.1 Gender and Allophonic Change in Lansing

It is worth specifying here that it is likely the case that the specific leaders of this change are white-collar women. I was not able to control for gender in the sub-phonemic judgement task, since the respondent count in the earlier generations is too low for a statistical analysis and male Lansingites are underrepresented in the sample (see Table 7). Gender, however, is an important conditioning factor in the acoustic distribution of /æ/ (see Chapter 4 for details). A visual inspection of the distribution of responses during the sub-phonemic judgement task appears to point to this same finding. Figure 22 displays the distribution of responses to Condition 1 pairs only, by generational cohort (x-axis), social class (side facet; white-collar on top), and gender (top facet; female respondents on left).

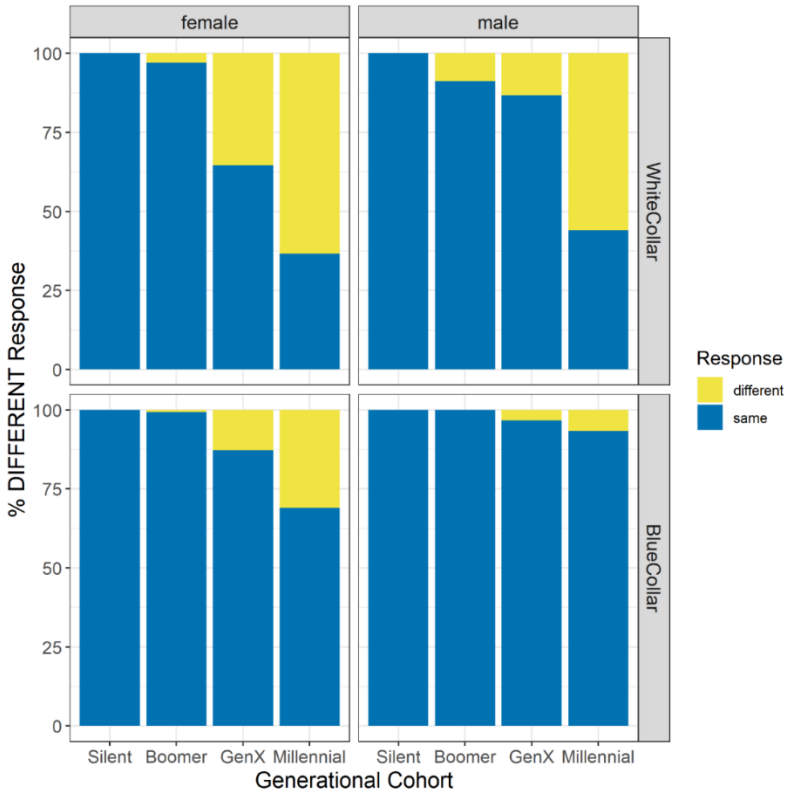


Figure 22 Distribution of responses to pre-nasal and pre-oral pairs of /æ/ over generational time, by social class (White Collar respondents at the top), and gender (women on the left).

The crucial thing to note here is that in Generation X, men of both social class groups and blue-collar women pattern the same: although some respond that pre-nasal and pre-oral /æ/ are different, this only occurs 20% of the time for these groups. Generation X white-collar women seem to distinguish between pre-nasal and pre-oral /æ/, with *different* responses almost at 40%. From this, it appears that white-collar women are driving this change. In the subsequent, Millennial generation, *different* responses increase for white-collar men and women and for blue-collar women, although the proportion of responses is more substantial for the white-collar respondents than the blue-collar respondents. Again, these observations are based on a small

number of respondents in each group and should be interpreted with caution. It suggests, though, that any study examining this change in this community would find that white-collar women were the first in Lansing to posit this rule, while other community members are on the trailing end of this change. And, in line with the acoustic analysis in Chapter 4, blue-collar men are not yet participating. This provides an avenue for future studies examining the Actuation, Embedding, and Transition problems of this and perhaps any other allophonic change.

6.2 Internally Motivated Change from Above

Given the results of the sub-phonemic judgement task (Chapter 5), allophonic change in Lansing appears to be a change from above; with white-collar women leading. There are two findings that give me pause in this conclusion, however. First, in Chapter 2, I showed that in-migration from other dialect/language areas and non-White groups was limited in Lansing; therefore nasal allophony is likely an internally motivated change, which seems to go against the description of a change from above. This may not be a problem, as some studies have shown that changes from above can be internally motivated (Schilling-Estes & Wolfram 1999). Another issue for the account that this is a change from above is that the acoustic analyses of spontaneous speech in the Lansing Speech Corpus (Chapter 4) did not reveal an effect of social class—this includes the analysis of per-speaker token distributions. This latter issue may be accounted for if we consider that the Lansing Speech Corpus was composed of only 36 speakers. Perhaps with more speakers in the sample, social class might prove significant. What is clear from this discrepancy in results, however, is that contact (or lack thereof) is perhaps more important than social conditioning in differentiating abrupt versus gradual changes.

6.3 Contact as a Conditioning Factor

The departure of the results of the current analysis from those of the few studies supporting a theory of abrupt phonologization bring up what I suspect is a crucial fact about the mechanisms of allophonic phonologization – perhaps both abrupt and gradual phonologization are possible (as is the case in the literature on phonemic mergers) and the likelihood of either one occurring in a community is dependent upon some external/social conditioning factor(s). I put forth a conditioning factor here: the presence of inter-dialect contact and the impact of awareness on the change. We know from previous studies on allophonic change that variable realizations lead to reallocation of phonetic environments whereby a phoneme assumes one target in one environment and another target in another environment (Britain 2002; Baker, Archangeli & Mielke 2011; Mielke, Baker & Archangeli 2016; Trudgill & Foxcroft 1978). The crucial difference between contact-induced phonological changes and those that are internally motivated is the difference in magnitude of the difference between realizations, and relative awareness of the change. In changes from above, variable pronunciations are prominent upon contact, and thus phonologization is expected to occur abruptly, given the right social circumstances. In internally motivated changes, however, variable realizations are less likely to gain social awareness and occur so rapidly. As discussed in Chapter 1, we know that in the literature on changes towards phonemic mergers, inter-dialect/language contact and awareness condition whether a change is abrupt or gradual. Mergers that are abrupt are characteristic of communities undergoing change via contact, while mergers that progress gradually and under the level of awareness occur in communities where inter-dialect/language contact is low (Guy 1990). There is no reason why allophonic changes wouldn't be subject to the same conditioning. Fruehwald (2013, 2016) finds that allophonic change in Philadelphia was abrupt, and though there is no

evidence of in-migration in the statistical analysis he performed on his sample of Philadelphia-born residents, it is still likely that contact can account for abruptness in his data, as Philadelphia is a large city that like other cities in the US have experienced in-migration throughout the 20th century. The results of the analysis of nasal allophony in this dissertation finds that the allophonic rule developed gradually, i.e. after the phonetic changes were occurring. Crucially, Lansing is not a contact city and allophony appears to be operating below the level of awareness. Although there was considerable in-migration from other Michigan towns into Lansing until the middle of the 20th century, there is no indication that large numbers of speakers from other dialects or languages have migrated here. If contact and awareness are indeed relevant for allophonic phonologization – and I believe they are – it is unsurprising then that phonological change was gradual in Lansing but abrupt in Philadelphia. Berkson et al. (2017) do not address any aspects of contact or social conditioning on /aɪ/ phonologization, so I am not sure if this distinction holds. However, given the apparent differences between the Philadelphia and Lansing results, my position is that there is a relevant component to our theory of allophonic phonologization that can be tested in the future, and that has been attested in the literature on phonemic mergers in progress (see Guy 1990; Herold 1997) namely that there are two mechanisms by which allophony can arise—abrupt and gradual—and the incidence of each is dependent on when variable realizations and social conditioning are introduced into the community. To be more explicit: I hypothesize that allophonic change is abrupt in communities where there is contact between dialects/languages with different realizations of the target phoneme and perhaps some social evaluation but gradual in non-contact communities where the change is relatively unnoticed. This statement can thus account for all phonological changes – including changes toward phonemic mergers and allophonic splits.

6.4 Methodological Considerations

There are a few aspects of this research that I might consider if I were to conduct this research again. I address some of them below and hope that future studies will take them into account.

6.4.1 Awareness of Variable Phonologies

We know from previous studies that sociolinguistic awareness of a phonological change can impact behavior on judgement tasks. An explicit example of the effect of awareness on phonological change is Baranowski's (2013) examination of two mergers in progress in Charleston, South Carolina. Baranowski showed that while the community was moving towards both the *cot-caught* and *pin-pen* mergers, participants behaved differently during the judgement tasks that involved these vowels. While participants were willing to judge *cot*-type and *caught*-type words to be the same, they were unwilling to judge *pin*-type and *pen*-type words to be the same even though many of the speakers displayed a clear merger of the two sounds. Unlike the *cot-caught* merger, the *pin-pen* merger is a marked feature of the South and thus socially undesirable in Charleston. The *cot-caught* merger, however, is progressing well below the level of awareness in the community. As such, in Charleston, judgements matched the production data for the *cot-caught* merger but not for the *pin-pen* merger. Participants negatively evaluated *pin-pen* and were thus less likely to say they were the same sound. What this shows is that the use of a judgement task on phonological changes that operate above the level of awareness in a community is not useful. While, as I speculated earlier, raised /æ/ has possibly risen to the status of a marker in the Inland North, in contrast, nasal allophony does not appear to be operating above the level of awareness in Lansing or anywhere else in North America. So, it is assumed here that the issue of awareness is not relevant for this change in progress. Future research on

phonological change will do well to ensure that the variable in question is operating under the level of awareness when utilizing a same-different judgement task.

6.4.2 Acoustic Salience vs Representation

One potential confound of this study is that participants may be judging different productions of pre-oral /æ/, since each generation has been exposed to different relevant exemplars across individual lifespans. From the trajectory analysis in the previous chapter, we saw that Silent generation speakers produce pre-nasal and pre-oral /æ/ in the same way, with the tongue higher and more forward in the mouth. Generation X speakers, however, produce pre-oral /æ/ with a slightly lower and much farther back realization than pre-nasal /æ/. So, for Silent generation respondents in the judgment task, the two conditioning environments produce similar acoustics, while for Generation X respondents, the two sounds are acoustically different from one another. Thus, though we find differences between these generations for the judgement task, it is unclear whether the results do indeed reflect a difference in phonological representation or phonetic realization. What this appears to suggest is that the current analysis falls short of discerning whether for a given respondent, their *different* judgements are the result of a phonetic difference between pre-nasal and pre-oral /æ/ or if that difference is indeed phonological. I argue, however, that the current analysis is indeed indicative of representational knowledge.

If these judgements were about phonetic (rather than phonological) opposition between environments, we'd expect participants to judge at least some pairs in conditions 2 (*pass* and *pack*), 3 (*pen* and *peck*), and 4 (*pet* and *peck*) to be different. We do not see this in the data. Respondents consistently judge the pairs in these conditions to be the same even though some of these are realized acoustically different from one another. I would argue that this is because the distinction between two separate realizations of the same phoneme is merely the result of

phonetic implementation, but for those who report a difference, pre-nasal /æ/ is phonologically distinct from that in these other environments. This suggests to me that though the phonetic distinction between pre-nasal and pre-oral /æ/ is indeed much sharper for Millennial generation respondents than for Silent generation respondents, acoustic salience alone within a phoneme cannot account for the difference in responses by the two groups in this task. If indeed this task is only indicative of phonetic opposition, perhaps the other diagnostics utilized in this dissertation to tease apart phonological from phonetic allophony (bimodality, and divergent vs lockstep trajectories) are better suited for questions regarding phonologization.

6.4.3 Orthography in American English

Another potential confound in this study involves the issue of orthography. One of the problems with presenting words in American English to a participant is the grapheme-phoneme mismatch. It is likely that many of the participants in this study would have taken orthography as a cue and made their judgements of lexical pairs accordingly; they would have judged Condition 1 pairs (*pan* and *pat*) to be the same because they share the same character <a> regardless of whether the corresponding pronunciation of that character in the two words was indeed the same sound to them. This is a common issue with presenting visual stimuli in studies examining phenomena at the phonetics/phonology level. As discussed in Chapter 3 (section 3.3.2.1), I attempted to reduce the likelihood that this would happen by including words whose vowel character, <a>, could correspond to a different phoneme in American English (compare *make* and *mack*), and by including pairs of lexical items whose graphemes did not match but whose pronunciations may be similar in the community, e.g. *lot* and *thought.* I excluded from the analysis any participant who judged pairs like *make* and *mack* to be the same. I cannot definitively say, however, that those who judged pairs with words like *make* in them to be different, were not relying on

orthography while they were judging the target pairs. So, orthography remains a possible confound in this study, the effects of which might be eliminated with the replacement of visual stimuli with auditory stimuli.

One might argue that an auditory perception task might also resolve the issue of Millennial and Silent generation respondents making judgements for different pronunciations. For this, participants might be presented with a raised/fronted pre-nasal and a lowered/retracted pre-oral /æ/. Upon asking them to judge whether these sounds are the same or different, a Silent generation respondent who does not posit an allophonic rule should judge these as the same while a respondent who posits an allophonic rule should judge them as different. The presentation of auditory stimuli would eliminate the two possible confounds in the current study but is likely to introduce another confound. I purposefully chose not to present participants with auditory stimuli because I wanted to avoid judgements based on the speaker's pronunciation and focus on respondents' own phonological knowledge. Therefore, I am not sure that the presentation of auditory stimuli would be a sound solution for the current analysis. I leave this for future research.

6.5 Inland North Dialectology

While the results of this dissertation further confirm some previous findings regarding the linguistic patterning of /æ/ as part of the NCS (raising, fronting, diphthongization, unconditioned system), the generational change and social conditioning results offer some confirmation of some existing claims in the literature, and some new information for our knowledge base about the NCS.

/æ/-raising is a rather new phenomenon in Lansing, MI: The results of this dissertation show that NCS /æ/-raising was adopted in the middle of the 20th century, which is well after the period identified in the account of Inland North /æ/-raising proposed by Labov (2010). Labov's hypothesis is that /æ/-raising developed in upstate New York in the early 1800s due to leveling across multiple /æ/ systems and spread westward to other Inland North locales. As Gordon and Strelluf (2017) point out, if this scenario held, raised /æ/ would be evident in western locales at least by the turn of the 20th century, since by Labov's own account it would take three generations for /æ/ to raise (also see Kerswill & Williams (2000) for a discussion of leveling taking two generations). This dissertation finds that the raising pattern occurred in Lansing at least two generations after that purported by Labov's account. This is in line with recent studies in Chicago, Buffalo, and Grand Rapids (Gordon and Strelluf 2017) where /æ/-raising is not well attested in speakers born at the turn of the 20th century. One caveat here is that Lansing is a mid-sized city. If the NCS spread to Lansing via a cascade model of diffusion from larger cities to smaller towns, we would expect Lansing to have adopted NCS features later than larger cities (Callary 1975). Yet, if it was the size of Lansing that accounted for its "late adoption" of /æ/-raising, then the larger cities of Chicago, Buffalo, and Grand Rapids should have acquired /æ/-raising much earlier than is reported in the literature. Thus, I conclude that /æ/-raising is a more recent phenomenon in the Inland North than suggested by Labov (2010). It is still unclear whether Lansing acquired /æ/-raising from these larger cities. If it did, this was a recent phenomenon, likely happening at the turn of the 20th century.

Where are the NCS speakers?: The third contribution of this dissertation is a suggestion for future Inland North researchers. For contemporary scholars looking to investigate the NCS, this study and other recent studies show that the available subject pool is waning. The NCS is no

longer prevalent in Inland Northern cities. The more likely carriers of the NCS in the Inland North are speakers born prior to the 1980s, young blue-collar speakers, and perhaps rural speakers (cf Gordon 2001). Though the latter two groups may also be participating in the supra-local changes, no recent studies have ruled these speakers out as possible NCS torchbearers. Indeed, Durian and Cameron (2018) find that the NCS has remained among blue-collar speakers in Chicago.

Michiganders are not as peculiar as we once thought: The loss of NCS features in the middle of the 20th century suggests that we need to update our previous notions of Inland Northerners' sociolinguistic awareness. The social conditioning observed in this chapter, accompanied by the commentary and style-shifting discussed in Chapter 1, suggest that Inland Northerners are somewhat aware of NCS /æ/ and that they assign it indexical social meaning. This can lead us to re-interpret some earlier studies of sociolinguistic attitudes to /æ/ in the Inland North. For example, Niedzielski (1999) found that when asked whether a fellow Detroiter had produced a lower or higher variant of /æ/, Detroit natives picked out the low variant from a provided range. Although to our knowledge, most white Detroiters at that time exhibit advanced NCS features themselves, including raised /æ/, participants' belief that they spoke standard American English led them to pick out the standard, unraised variant as representative of a fellow Detroiter's speech. Therefore, their social evaluation of their dialect as correct/standard overrode their performance on this task. For Niedzielski, this was evidence that the NCS was well under the level of awareness. Considering more recent studies like the current one and others in the dialect area which show that the NCS version of /æ/ has been retreating for some time, it seems more likely that Niedzielski's participants were simply aware at some level that a community lowering of /æ/ had begun. These perception studies were conducted on college students born in the

1960s and 1970s, the same generation in which NCS features began to decline in Michigan. This suggests that it may not have been entirely the case that social evaluation was overriding performance on the perception task. It appears to be likely that exposure to within-generational social reality – more lowered variants available in the community – was affecting performance on the task.

From an indicator to a marker: Changes in the social conditioning over time for /æ/ suggest that NCS realizations have come to be negatively evaluated in Lansing, which points to a possible social motivation for these changes, as discussed in 4.7. Given the available evidence in the literature, the NCS was progressing well below the level of awareness in the earlier half of the 20th century. Women led in the advancement of NCS /æ/ characteristics. The subsequent decline in NCS /æ/ realization by women (while men continued to advance) in the transition from the Baby Boomer generation to Generation X suggests that NCS /æ/ in Lansing might have gained social salience as a local *marker*. Labov (1972) defines a marker as a sociolinguistic variable that not only has an interspeaker social distribution (e.g. across social class, neighborhoods or ethnic groups), but is also subject to intraspeaker variation. To confirm that NCS /æ/ has become a marker in Lansing, we would therefore need to conduct an analysis of style-shifting. If the hypothesis is accurate, I would expect speakers born in the middle of the 20th century to exhibit less NCS-like /æ/ features in their more formal speech, e.g. when reading a word list, as compared to in their conversational speech. Thiel and Dinkin (2017) show that while older speakers in Ogdensburg do not style-shift, younger speakers shift away from NCS features in their more formal speaking style. I suspect the same pattern to emerge in Lansing. I leave examination of style-shifting in my data for a future project.

Another possible avenue for investigating social motivations for these changes is an implicit attitudes test. Labov (2001:229), citing Sturtevant (1947), suggests that the social motivation of linguistic change is that the form becomes associated arbitrarily with social traits of the originating group. If this is the case, then we might expect the NCS version of /æ/ to be a marker of older local Lansing identity. If one were to conduct an attitudinal study, I would expect Michiganders to rate NCS /æ/ in the speech of an older local more favorably than if heard in the speech of a younger (maybe even middle-class) local.

6.6 Phonological Representations in the Inland North (more questions)

Structural account of the LBMS in Lansing: I noted earlier that two components of the LBMS shift are underway in Lansing – pre-oral /æ/ lowering and retraction, and the low-back merger. The structural account of the LBMS is one of a pull chain whereby /ɑ/ moves in the direction of merger with /ɔ/ which pulls /æ/ and the other short front vowels, /ɛ/ and /ɪ/. Though there is evidence of these components occurring in Lansing (Nesbitt, Wagner & Mason under revision), it remains to be seen if the LBMS in the Inland North is a pull or push chain. The absence of Generation X speakers made it difficult for us to speculate. The present analysis shows that /æ/ retracted in Generation X. I look forward to examining movement of /ɑ/ towards /ɔ/ to better address this question.

Tense/Lax distinction: The Inland North version of /æ/ is described as [tense] because it moves upward along the periphery of the vowel space and is described as diphthongal (Labov 1994). In Lansing, and in other Inland Northern cities, /æ/ is either no longer moving along the periphery of the vowel space and/or is no longer diphthongal. This leads to the hypothesis that there has been a shift in this phoneme from tense to lax. I test this hypothesis in Nesbitt (2018b) by examining whether Inland Northerners treat /æ/ as they do traditionally tense vowels or lax

vowels in a syllable parsing task. For this, I asked whether Inland Northerners parse a consonant that followed /æ/ as they would one that followed a tense vowel or a lax vowel. The logic behind this is that intervocalic consonants in American English are conditioned by the tenseness of the preceding vowel, i.e. when preceded by a long/tense vowel, English speakers will parse them as onsets of the following syllable. The hypothesis was that older Inland Northerners would treat /æ/ as they do tense vowels, but younger Inland Northerners would treat it as a lax vowel. The preliminary results of this analysis suggest that indeed, older Inland Northerners treat /æ/ as they do tense vowels, while younger Inland Northerners treat it as a lax vowel. This analysis is preliminary, though, because results are based on a comparison of just 10 lexical items. In any case, there appears to be a trend towards a change overtime in tense vs lax associations for /æ/ in the dialect area. I therefore look forward to exploring this question in a future project.

6.7 North American Dialectology

This dissertation joins the growing literature on the decline of regional speech patterns in North America. One of the most substantial contributions of this analysis to the field is that one of the 'pivot points' upon which North American dialectologists draw the Inland North isogloss—the unconditioned raising of /æ/—is being lost. As I've stated previously in Chapter 1, the loss of a regional /æ/ configuration in place of the nasal system is not confined to the Inland North. We see this trend in various locations across North America, in for example, Kansas City (Strelluf 2014), Cincinnati (Boberg & Strassel 2000), New Orleans, LA (Labov 2007), New York city (Becker & Wong 2009; Becker 2010), various cities along the east coast between Philadelphia and New York city (Ash 2002), Philadelphia (Labov, Rosenfelder & Fruehwald 2013; Sneller 2017; Sneller 2019), and New England (Stanford 2019), inter alia. Thus, short /æ/ appears to no longer be a reliable metric for distinguishing regional dialects in North America, at least for

speakers born since about 1990. I also noted in Chapter 1 that the second pivot point—low-back merger vs distinction—appears to be diminishing as more regional varieties move towards merger. Therefore, dialectologists must either look to other features that distinguish regional varieties of North American English, or entertain the idea that rather than divergence, we are witnessing dialect levelling. The movement towards the supralocal patterns of low-back merger and the nasal system in various regions suggest the latter.

6.8 Mid-20th century and Loss of Regional North American Features

The transition from the Baby Boomer generation to Generation X appears to have been a crucial period for changes to regional varieties in North America. Researchers elsewhere in Michigan have observed the same decline in NCS features over the same period of time (Morgan et al. 2017; Rankinen, Albin & Neuhaus 2019). Loss of local speech features in the mid-20th century is not restricted to the Inland North dialect area. It has been reported in various locations across North America, in for example, Ohio (Durian 2012), Philadelphia (Labov, Rosenfelder & Fruehwald 2013), New England (Stanford 2019), Raleigh, NC (Dodsworth & Kohn 2012), inter alia. One wonders what similar social conditions were in place in such disparate areas to have motivated the apparent leveling of dialects at about the same time. A few possible explanations include (1) a rise in face-to-face contact between speakers of different varieties brought on by increased mobility, (2) the spread of Western regional phonology through increased exposure to television, (3) the shift to an economy increasingly dominated by service jobs that would require more "standard American" speech during the commission of a job, or perhaps some combination of all three. I leave it for future work to investigate the social motivations behind this broader trend.

APPENDICES

APPENDIX A
Recruitment Flyer for 2018/2019 Sociolinguistic Interviews

Attention Lansing natives!

Earn $15 for Talking to a Linguist for 1 Hour.

My name is Monica Nesbitt. I am a PhD student and researcher in the Michigan State University Sociolinguistics Lab. Our research team is currently interviewing Lansing natives as part of our Lansing Speech project and would like you to participate!

The Lansing Speech project aims to better understand Lansing speech and culture by interviewing those who were born and raised here. The recordings from this project will contribute to our growing collection of oral histories of native Lansingites.

Each interview lasts about 1 hour, during which we will discuss with you your experiences growing up in Lansing and have you play a few short language games. Though our interviewers will come prepared with topics to discuss, we are also interested in hearing about whatever interests you.

Interviews will be scheduled until the end of August 2018.

If you are interested in participating, please make sure you satisfy the below qualifications and then contact me via email nesbit17@msu.edu, a private message on Facebook Messenger, or by cell (909) 997-2375 so that we can schedule an interview.

Please help us spread the word and share this with as many native Lansingites that you know. We are especially interested in hearing from multiple generations of the same family!

Compensation $15

Qualifications
a) +17 years old
b) From within 15 miles of the MI state capitol
- Lived there from around age 2 to at least around age 17
- Left the area for no more than 4 years
c) Self-identify as white (we will interview non-white residents later in the year!)
d) Native speaker of American English
e) No history of a hearing or speech disorder

APPENDIX B

Consent Form for 2018/2019 Sociolinguistic Interviews

Thank you for contributing to this research project. Our research team at Michigan State is interested to hear about life and language in Lansing. I can tell you more about the project once we've completed the interview. I will be happy to answer any questions that you might have at the end of this session.

This session consists of three parts. First, I'd like to hear about your life and experiences growing up, how your community has changed in your lifetime, how you think it compares to other areas of Lansing specifically and Michigan in general. I have topics and questions prepared, but we're most interested in the aspects of your life and the perspectives that *you* think are most important to share with us. After the interview, I'll have you do 2 simple language tasks and then ask you to read aloud a short list of words that have distinctive pronunciations across the U.S. Altogether, the interview will take no more than one hour.

Because it will be difficult for me to write down everything you say, I would like to audio-record our conversation if that's okay with you. If it is not okay, for any reason, just let me know before we start.

Before you begin, I would like to inform you that participation in this research project is voluntary. You have the right to stop participating in this study at any time, and you also have a right to not answer specific questions. You may change your mind at any time and withdraw. There will be no penalty or disadvantage to you under any of these circumstances. You must be 18 or older to participate.

Please email me at nesbit17@msu.edu if you have any questions regarding the procedure.

If you have concerns or questions about this study, such as how the data will be used, how to do any part of it, or to report an injury, please contact my supervisor, Dr. Suzanne Evans Wagner, at (517) 355-9739, or e-mail wagnersu@msu.edu or regular mail at B-401 Wells Hall, 619 Red Cedar Rd, East Lansing, MI 48824.

If you have questions or concerns about your role and rights as a research participant, would like to obtain information or offer input, or would like to register a complaint about this study, you may contact, anonymously if you wish, the Michigan State University's Human Research Protection Program at 517-355-2180, Fax 517-432-4503, or e-mail irb@msu.edu or regular mail at 4000 Collins Rd, Suite 136, Lansing, MI 48910.

APPENDIX C
Interview Questions for 2018/2019 Sociolinguistic Interviews

General

What is your pseudonym?

What is your birth year?

What is your gender identity?

What ethnic group (race) would you say you belong to?

Have you ever spoken any language besides English? Do you at home?

Where were you born and raised?

Family

Who do you live with at home?

Do you have children?

How old are they?

Where are do they live now?

Where did they go to school?

Are you married?

Where is your spouse from?

What do they do for a living?

How did you meet your spouse?

How about your parents?

Did you live with them growing up?

Where are they from?

What did they do for a living?

How did they meet?

School and Work

What high school did you go to?

What middle school did you go to?

What elementary school did you go to?

Were you involved in any activities when you were in school? Sports, clubs, etc?

What sorts of things did you and your friends do outside of class?

What do you think was the racial make-up of your schools?

Were inter-racial friendships normal?

What about social class? Were the students from blue-collar or white-collar families?

What about training after high school? Did you attend college or anything?

What university did you go to ?

What do you do for work?

How long have you worked in your current position?

How did you get into this line of work that you do now?

What other kinds of jobs have you had?

Neighborhood

Where were you born?

What neighborhood did you grow up in?

Did you go to your neighborhood schools? Did your friends?

Describe your childhood neighborhood. What kinds of families lived there? Were they blue-collar or white-collar? What was the racial make-up of your neighborhood? Was it a close-knit community? What sorts of activities did the neighborhood do? Did all the kids attend the same schools? Was your neighborhood the same or different from other neighborhoods in the area?

Would you describe it as your typical Michigan neighborhood?

What neighborhood do you live in now? Why did you move?

Where do your friends and family live now? Why did they move?

Have you noticed any changes to the neighborhood that you grew up in?

How about Lansing? Has it changed at all?

Localness

What do you think of Lansing as a place to live? Would you recommend it?

Which Lansing neighborhoods do you think are the best and which ones are the worst?

What sorts of things are there to do in Lansing?

Are there any other places in Michigan worth checking out?

Are they better than Lansing?

Did you or did any of your friends and family work for any of the auto plants in town? What did they do? How long did they work there? What do they do now?

If you could live anywhere, where would it be?

Would you rather live in a big city or a small town? Why?

Would you describe Lansing as a big city?

Do you get out of Lansing much? Ever go to Detroit or Chicago? Anywhere else?

When you travel abroad and/or out of the state, where do you tell people you're from?

Narrative Prompts

Do you think the winters in Michigan are getting worse or better?

Do you think the roads in Michigan are worse than anywhere else?

Why do you think roads are such an ongoing issue here?

What's the worst trouble you ever got in at home?

Did you ever get blamed for something you didn't do?

Is there anything else you would like to share about your experiences related to living in Lansing or otherwise?

Post-interview questions:

When you travel, has any one picked you out as being from Lansing or Michigan by the way you talk?

What do they notice?

Do you take it a plus or minus from their point of view? Form your own?

What do you think makes a Lansing accent?

Is that different from a Detroit accent?

Is that different from anywhere else in Michigan?

Is there any part of your accent that you've tried to change?

APPENDIX D

Table 15 Speaker Demographics – Lansing Speech Corpus plus 21 Millennials from Wagner et al. (2016)

*(Millennials were not included in statistical analyses due to demographic imbalance)

Subj #	Name	Sample	Birth Year	Generation	Gender	Social Class
1	MarvinGrinstern	Oral Histories Collection	1923	Silent	male	blue-collar
2	JackDown	Oral Histories Collection	1924	Silent	male	white-collar
3	MarilynShadduck	Oral Histories Collection	1924	Silent	female	blue-collar
4	LeslieMitchell	Oral Histories Collection	1925	Silent	male	blue-collar
5	MabelMcQueen	Oral Histories Collection	1925	Silent	female	blue-collar
6	VernonCook	Oral Histories Collection	1927	Silent	male	blue-collar
7	ShirleySanborn	Oral Histories Collection	1930	Silent	female	white-collar
8	FrancesWest	2010 Sociolinguistic Interview	1932	Silent	female	white-collar
9	GayleGooslin	Oral Histories Collection	1937	Silent	female	blue-collar
10	JohnDean	Oral Histories Collection	1938	Silent	male	white-collar
11	MaudeRobinson	2010 Sociolinguistic Interview	1939	Silent	female	white-collar
12	RichardBudd	Oral Histories Collection	1941	Silent	male	white-collar
13	DeanPotter	2018/19 Sociolinguistic Interview	1946	Boomer	male	white-collar
14	LindaMaxon	Oral Histories Collection	1947	Boomer	female	blue-collar
15	AnnePotter	2018/19 Sociolinguistic Interview	1948	Boomer	female	white-collar
16	KarelTaborsky	Oral Histories Collection	1948	Boomer	male	blue-collar
17	JosephAbraham	Oral Histories Collection	1951	Boomer	male	blue-collar
18	CherryBomb	2018/19 Sociolinguistic Interview	1952	Boomer	female	blue-collar
19	GeneralEisenhower	2018/19 Sociolinguistic Interview	1953	Boomer	male	white-collar

Table 15 cont'd

20	MikelLienhart	Oral Histories Collection	1953	Boomer	male	blue-collar
21	JuneLowe	2018/19 Sociolinguistic Interview	1956	Boomer	female	white-collar
22	RandyThayer	Oral Histories Collection	1956	Boomer	male	white-collar
23	ConnieStevens	2018/19 Sociolinguistic Interview	1957	Boomer	female	white-collar
24	SharonDecker	Oral Histories Collection	1961	Boomer	female	blue-collar
25	AaronPeters	2018/19 Sociolinguistic Interview	1965	Generation X	male	blue-collar
26	BillMummy	2018/19 Sociolinguistic Interview	1969	Generation X	male	white-collar
27	ViolaMatt	2018/19 Sociolinguistic Interview	1970	Generation X	female	white-collar
28	JackPierce	2018/19 Sociolinguistic Interview	1974	Generation X	male	blue-collar
29	SarahMary	2018/19 Sociolinguistic Interview	1976	Generation X	female	blue-collar
30	Serendipity Miller	2018/19 Sociolinguistic Interview	1977	Generation X	female	blue-collar
31	AmandaNelson	2018/19 Sociolinguistic Interview	1982	Generation X	female	white-collar
32	KingLlama	2018/19 Sociolinguistic Interview	1982	Generation X	male	white-collar
33	SamHill	2018/19 Sociolinguistic Interview	1982	Generation X	male	white-collar
34	StaceyMiller	2018/19 Sociolinguistic Interview	1982	Generation X	female	blue-collar
35	KenWinters	2018/19 Sociolinguistic Interview	1984	Generation X	male	blue-collar
36	BunnyLlama	2018/19 Sociolinguistic Interview	1984	Generation X	female	white-collar
37	VickyPine	2014/15 Sociolinguistic Interview	1990	Milllennial	female	white-collar

Table 15 cont'd

38	ChelseaWalsh	2014/15 Sociolinguistic Interview	1992	Milllennial	female	white-collar
39	EllenBordner	2014/15 Sociolinguistic Interview	1992	Milllennial	female	white-collar
40	EmmaAllen	2014/15 Sociolinguistic Interview	1993	Milllennial	female	white-collar
41	MelodyWilliams	2014/15 Sociolinguistic Interview	1993	Milllennial	female	white-collar
42	MichelleRaggle	2014/15 Sociolinguistic Interview	1993	Milllennial	female	blue-collar
43	SarahStone	2014/15 Sociolinguistic Interview	1993	Milllennial	female	white-collar
44	BenLangdon	2014/15 Sociolinguistic Interview	1994	Milllennial	male	white-collar
45	JenniferMason	2014/15 Sociolinguistic Interview	1994	Milllennial	female	blue-collar
46	JessicaTawnee	2014/15 Sociolinguistic Interview	1994	Milllennial	female	white-collar
47	KarenPeterson	2014/15 Sociolinguistic Interview	1994	Milllennial	female	white-collar
48	KarenTimmons	2014/15 Sociolinguistic Interview	1994	Milllennial	female	blue-collar
49	LucyGarth	2014/15 Sociolinguistic Interview	1994	Milllennial	female	blue-collar
50	BriDixon	2014/15 Sociolinguistic Interview	1995	Milllennial	female	white-collar
51	KatherineShort	2014/15 Sociolinguistic Interview	1995	Milllennial	female	white-collar
52	CarolineTonks	2014/15 Sociolinguistic Interview	1996	Milllennial	female	white-collar
53	EdBrand	2014/15 Sociolinguistic Interview	1996	Milllennial	male	white-collar
54	HelenSmith	2014/15 Sociolinguistic Interview	1996	Milllennial	female	white-collar

Table 15 cont'd

55	MegPaxton	2014/15 Sociolinguistic Interview	1996	Milllennial	female	white-collar
56	PeteShaw	2014/15 Sociolinguistic Interview	1996	Milllennial	male	white-collar
57	StephanieWilson	2014/15 Sociolinguistic Interview	1996	Milllennial	female	white-collar

APPENDIX E
Consent Form for Sub-Phonemic Judgement Task

Research Participant Information and Consent Form

Thank you for contributing to this research project. My name is Monica Nesbitt. I am a Ph.D. student at Michigan State University working on my dissertation. I am investigating people's impressions of a speaker. I cannot tell you more about exactly what I'm interested in, but if you contact me at the email provided below, I will be happy to answer any questions that you might have.

For this experiment, there are two short tasks. For these tasks, you will answer questions about the words that appear on your computer screen.

Before you begin, I would like to inform you that participation in this research project is voluntary. You have the right to stop participating in this study at any time, and you also have a right to not answer specific questions. You may change your mind at any time and withdraw. There will be no penalty or disadvantage to you under any of these circumstances. You must be 18 or older to participate.

If you are taking this for extra credit, you will receive 1% extra credit towards your final course grade for participating in this experiment. You will receive another percentage point if you have a family member that is your grandparent's age complete this survey. If you wish not to participate in this study, your instructor has an equivalent non-research assignment which may be done in place of research participation.

Please email me at nesbit17@msu.edu if you have any questions regarding the procedure.

If you have concerns or questions about this study, such as how the data will be used, how to do any part of it, or to report an injury, please contact my supervisor, Dr. Suzanne Evans Wagner, at (517) 355-9739, or e-mail wagnersu@msu.edu or regular mail at B-401 Wells Hall, 619 Red Cedar Rd, East Lansing, MI 48824.

If you have questions or concerns about your role and rights as a research participant, would like to obtain information or offer input, or would like to register a complaint about this study, you may contact, anonymously if you wish, the Michigan State University's Human Research Protection Program at 517-355-2180, Fax 517-432-4503, or e-mail irb@msu.edu or regular mail at 4000 Collins Rd, Suite 136, Lansing, MI 48910.

You indicate your voluntary agreement to participate by navigating to the next page.

APPENDIX F

Social Media and Email Recruitment Script for Sub-phonemic Judgement Task

Do the vowels in BOT and BOUGHT sound the same to you? Whatever the answer, the Sociolinguistics Lab at Michigan State wants to hear from you! Please take this survey. It takes 4 minutes! We're trying to reach as many people from as many places, generations, and ethnic backgrounds. When you're done, please share with all of your friends and family.

APPENDIX G

Table 16 Pairs of Lexical Items for Sub-Phonemic Judgement Task

Condition	Lexical Items		Vowel	Final Cons Nasality
1	FAN	FAT	æ	nasal-oral
1	TRAM	TRACK	æ	nasal-oral
1	RAN	RAG	æ	nasal-oral
1	PAM	PASS	æ	nasal-oral
1	BAN	BAT	æ	nasal-oral
2	PASS	PACK	æ	oral-oral
2	RASH	RAT	æ	oral-oral
2	PACK	PAT	æ	oral-oral
2	RAT	RAG	æ	oral-oral
2	SAP	SACK	æ	oral-oral
3	RENT	REST	ɛ	nasal-oral
3	PEN	PET	ɛ	nasal-oral
3	TEN	TECH	ɛ	nasal-oral
3	KIM	KIT	ɪ	nasal-oral
3	BIN	BIT	ɪ	nasal-oral
4	REST	LET	ɛ	oral-oral
4	PECK	PET	ɛ	oral-oral
4	FETCH	FED	ɛ	oral-oral
4	KISS	KIT	ɪ	oral-oral
4	BIT	BIG	ɪ	oral-oral

Table 16 (cont'd)

5	BOSS	BOUGHT	ɑ/ɔ	oral-oral
5	TOT	TAUGHT	ɑ/ɔ	oral-oral
5	STALK	STOCK	ɔ/ɑ	oral-oral
5	CAUGHT	COT	ɔ/ɑ	oral-oral
5	DAWN	DON	ɔ/ɑ	nasal-nasal
6	REST	COT	ɛ/ɑ	oral-oral
6	PIN	PEN	ɪ /ɛ	nasal-nasal
6	BOMB	BIT	ɑ/ɪ	nasal-oral
6	SAT	SAW	æ/ɔ	oral-oral
6	MAKE	MACK	eɪ/æ	oral-oral

APPENDIX H

Table 17 Pillai-Bartlett and Mean F1, F2, and DQ Values for Each Speaker in the Lansing Speech Corpus plus 21 Millennials from Wagner et al. (2016)

*(Millennials were not included in statistical analyses due to demographic imbalance)

Name	Allophone	F1 (Hz)	F2 (Hz)	DQ (Hz)	Pillai-Bartlett
MarvinGrinstern	pre-nasal	727	1995	236	0.261
MarvinGrinstern	pre-oral	809	1850	128	0.261
JackDown	pre-nasal	736	1982	141	0.04
JackDown	pre-oral	769	1917	182	0.04
MarilynShadduck	pre-nasal	712	2204	450	0.152
MarilynShadduck	pre-oral	807	2047	303	0.152
LeslieMitchell	pre-nasal	742	1996	108	0.075
LeslieMitchell	pre-oral	730	1865	119	0.075
MabelMcQueen	pre-nasal	722	2009	198	0.038
MabelMcQueen	pre-oral	740	2150	201	0.038
VernonCook	pre-nasal	697	1972	191	0.079
VernonCook	pre-oral	757	1905	156	0.079
ShirleySanborn	pre-nasal	646	2059	176	0.27
ShirleySanborn	pre-oral	789	2013	177	0.27
FrancesWest	pre-nasal	666	2080	326	0.272
FrancesWest	pre-oral	812	1875	182	0.272
GayleGooslin	pre-nasal	712	1938	320	0.091
GayleGooslin	pre-oral	798	1833	178	0.091
JohnDean	pre-nasal	678	2111	134	0.371
JohnDean	pre-oral	833	2012	155	0.371
MaudeRobinson	pre-nasal	605	2179	692	0.351

Table 17 (cont'd)

MaudeRobinson	pre-oral	728	1907	368	0.351
RichardBudd	pre-nasal	609	2050	177	0.428
RichardBudd	pre-oral	789	1825	167	0.428
DeanPotter	pre-nasal	703	2108	346	0.352
DeanPotter	pre-oral	806	1948	223	0.352
LindaMaxon	pre-nasal	654	2223	269	0.042
LindaMaxon	pre-oral	734	2115	289	0.042
AnnePotter	pre-nasal	690	2334	564	0.155
AnnePotter	pre-oral	717	2120	335	0.155
KarelTaborsky	pre-nasal	729	2062	231	0.318
KarelTaborsky	pre-oral	843	1920	193	0.318
JosephAbraham	pre-nasal	679	2030	212	0.273
JosephAbraham	pre-oral	822	2007	193	0.273
CherryBomb	pre-nasal	642	2294	350	0.371
CherryBomb	pre-oral	747	1945	233	0.371
GeneralEisenhower	pre-nasal	652	2165	320	0.479
GeneralEisenhower	pre-oral	788	1783	174	0.479
MikelLienhart	pre-nasal	771	1957	205	0.16
MikelLienhart	pre-oral	811	1802	158	0.16
JuneLowe	pre-nasal	651	2115	318	0.419
JuneLowe	pre-oral	790	1831	208	0.419
RandyThayer	pre-nasal	651	1986	131	0.186
RandyThayer	pre-oral	775	1889	157	0.186
ConnieStevens	pre-nasal	646	2194	433	0.244
ConnieStevens	pre-oral	715	1895	206	0.244

Table 17 (cont'd)

SharonDecker	pre-nasal	591	2109	217	0.279
SharonDecker	pre-oral	719	2036	221	0.279
AaronPeters	pre-nasal	578	2080	261	0.424
AaronPeters	pre-oral	779	1960	249	0.424
BillMummy	pre-nasal	735	1927	151	0.031
BillMummy	pre-oral	719	1825	175	0.031
ViolaMatt	pre-nasal	667	2175	453	0.38
ViolaMatt	pre-oral	767	1723	186	0.38
JackPierce	pre-nasal	649	2199	376	0.363
JackPierce	pre-oral	780	2078	222	0.363
SarahMary	pre-nasal	628	2150	332	0.541
SarahMary	pre-oral	795	1742	211	0.541
Serendipity Miller	pre-nasal	607	2094	428	0.589
Serendipity Miller	pre-oral	778	1801	142	0.589
AmandaNelson	pre-nasal	616	2226	474	0.722
AmandaNelson	pre-oral	816	1634	163	0.722
KingLlama	pre-nasal	617	2086	210	0.507
KingLlama	pre-oral	742	1871	137	0.507
SamHill	pre-nasal	679	2001	160	0.347
SamHill	pre-oral	783	1811	186	0.347
StaceyMiller	pre-nasal	716	2159	363	0.401
StaceyMiller	pre-oral	805	1831	183	0.401
BunnyLlama	pre-nasal	633	2152	255	0.684
BunnyLlama	pre-oral	757	1781	232	0.684
KenWinters	pre-nasal	689	1967	153	0.36

Table 17 (cont'd)

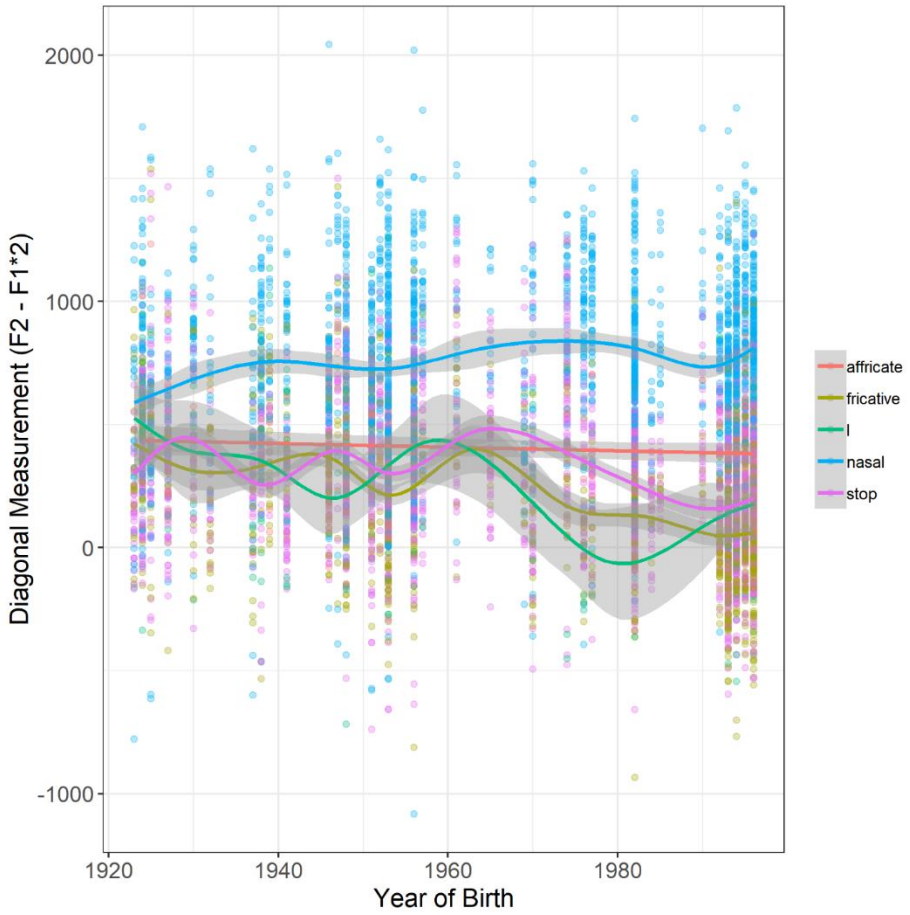
KenWinters	pre-oral	762	1700	155	0.36
VickyPine	pre-nasal	599	2144	281	0.448
VickyPine	pre-oral	732	1898	150	0.448
ChelseaWalsh	pre-nasal	703	2132	325	0.503
ChelseaWalsh	pre-oral	817	1808	164	0.503
EllenBordner	pre-nasal	648	2114	244	0.615
EllenBordner	pre-oral	783	1788	144	0.615
EmmaAllen	pre-nasal	709	1941	297	0.614
EmmaAllen	pre-oral	866	1627	138	0.614
MelodyWilliams	pre-nasal	703	2050	193	0.574
MelodyWilliams	pre-oral	845	1717	133	0.574
MichelleRaggle	pre-nasal	666	1928	195	0.26
MichelleRaggle	pre-oral	778	1690	157	0.26
SarahStone	pre-nasal	597	2145	233	0.635
SarahStone	pre-oral	821	1754	155	0.635
BenLangdon	pre-nasal	627	2170	114	0.552
BenLangdon	pre-oral	788	1893	208	0.552
JenniferMason	pre-nasal	644	2174	218	0.71
JenniferMason	pre-oral	796	1709	150	0.71
JessicaTawnee	pre-nasal	634	2024	292	0.562
JessicaTawnee	pre-oral	790	1782	139	0.562
KarenPeterson	pre-nasal	681	2088	232	0.551
KarenPeterson	pre-oral	760	1782	128	0.551
KarenTimmons	pre-nasal	661	2101	178	0.499
KarenTimmons	pre-oral	796	1729	153	0.499

Table 17 (cont'd)

LucyGarth	pre-nasal	693	1912	212	0.42
LucyGarth	pre-oral	808	1661	130	0.42
BriDixon	pre-nasal	585	2165	240	0.722
BriDixon	pre-oral	812	1791	151	0.722
KatherineShort	pre-nasal	620	2091	358	0.558
KatherineShort	pre-oral	802	1796	162	0.558
CarolineTonks	pre-nasal	622	2037	172	0.445
CarolineTonks	pre-oral	825	1811	180	0.445
EdBrand	pre-nasal	746	2069	116	0.297
EdBrand	pre-oral	785	1761	145	0.297
HelenSmith	pre-nasal	660	2150	186	0.561
HelenSmith	pre-oral	799	1719	139	0.561
MegPaxton	pre-nasal	653	2145	270	0.623
MegPaxton	pre-oral	816	1708	153	0.623
PeteShaw	pre-nasal	590	2066	103	0.645
PeteShaw	pre-oral	834	1919	155	0.645
StephanieWilson	pre-nasal	690	2200	221	0.424
StephanieWilson	pre-oral	797	1881	155	0.424

APPENDIX I

Figure 23 Per Token Diagonal Measurement of /æ/ in Five Following Phonological Contexts by Speaker Birth Year in the Lansing Speech Corpus (plus 21 Millennials from Wagner et al. (2016))



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