Spring 4-25-2017

The Northern Cities Shift: Minnesota's Ever-Changing Vowel Space

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Honors Project in Linguistics

April 26, 2017

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The Northern Cities Shift (NCS) is a vowel chain shift occurring in parts of the North dialect region and only the first changes were reported in Minnesotan English, such as /æ/ raising as in *bat* (Labov et al. 2006). The NCS has shown resistance to the low-back merger (LBM), which is "in transition" in the Twin Cities (Labov). Speech samples from Twin Cities speakers ages 16-18 and 35-55 were recorded, measured and analyzed. The present study finds the shift continuing to advance in some speakers, sometimes co-occurring with the LBM, but full shifting occurring only apart from the LBM.

Honors Project in Linguistics Department
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Acknowledgements

I would like to thank my advisor, Marianne Milligan, for all of the help and guidance that she has given me through my time in the linguistics department, but specifically over the last few months of aid and support through my honors project. I would like to thank my thesis committee members, Christina Esposito and Brooke Lea, for their feedback and support through this process. Over several months I've poured countless hours into this project, but without this group, this project would not have been possible.

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1. Introduction

My interest in dialectology grew after noticing that speakers from my hometown, a northern suburb of the Twin Cities, had vowels that I perceived as noticeably different from speakers that I crossed paths with in St. Paul. I noticed people speaking with stereotypical Minnesotan English, as portrayed in the movie Fargo, something that only months before had sounded neutral to me. As a student at Macalester College, I found myself surrounded by people from all over the country and world who spoke different dialects of English than me. After living in St. Paul for only one year, I could tell that my own vowel space had changed and that I was speaking more like the people around me. I began ordering my dark roast coffee with [ɹum] for cream instead of [ɹʌm] for cream. This fascinated me and motivated me to learn more about social networks and mechanisms of sound change.

Increased access to mass media has not caused dialects of English to become more similar (Wolfram 2000, 2007). Sound change has continued to occur at a fast rate and dialects of English in the US have become more distinct from one another (Wolfram 2007). Vowel chain shifts and vowel mergers are two mechanisms that are currently causing widespread sound changes in English in the US. The Northern Cities Shift (NCS) is a vowel chain shift that occurs in parts of the North dialect region of the US, involving the clockwise rotation of six vowels /æ, ɑ, ɔ, ɛ, ʌ, ɪ/ (Labov, Ash & Boberg 2006). A prominent vowel merger in the United States is the Low Back Merger (LBM), which causes the loss of distinction between the *cot* and *caught* vowels. The LBM is moving east across the US from California. The Twin Cities was shown to be a transition area for both the LBM and the NCS (Labov et al. 2006). This makes the Twin

Cities a particularly interesting place to study, where the westward-moving NCS and the eastern-moving LBM are merging.

In the present study, the six vowels that are involved in the NCS of participants recorded in the summer of 2016 will be compared with the speakers from the Twin Cities in the Atlas of North American English (ANAE). The data in the ANAE was collected from 439 speakers between 1992-1999 (Labov et al. 2006). Based on the four speakers from the Twin Cities represented in the ANAE, Labov et al. (2006) show that the Twin Cities has undergone the first stage of the NCS: the raising of /æ/ as in *cad.* The primary goal of this study is to determine if the NCS has continued to progress this far west into the Twin Cities. The full NCS is yet to be documented in speakers in the Twin Cities, possibly because of the presence of the LBM in some Twin Cities speakers. This study looks to see if the NCS and LBM are co-occurring within participants or if the NCS is acting as a mechanism of resistance to the LBM.

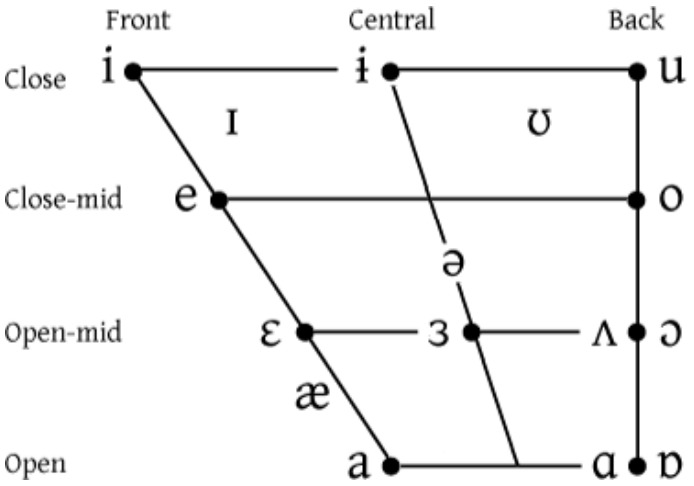
The paper proceeds as follows: Section 2 will give the background information that relates to this study. Section 2.1 discusses how vowels are measured. In section 2.2 the principles of vowel chain shift are discussed. Section 2.3 gives an overview of the Northern Cities Shift (NCS). Section 2.4 examines the process of vowel mergers and section 2.5 discusses the low-back merger (LBM). Previous studies on vowels in Minnesotan English are discussed in section 2.6. Social network density and how it relates to language change are covered in section 2.7, along with previous methods used to quantify a speaker's social network density. Section 3 covers the methodology used in this study. Section 4 displays the results from this study and the conclusion is presented in section 5.

2. Background

2.1 Measuring Vowels

The IPA vowel chart shown in Figure 1 illustrates the position of the tongue in the mouth during the production of each vowel. The vowel /ɑ/ like in *cot* is at the bottom right corner of the vowel chart because the blade of the tongue is low and back when the vowel is produced. The vowel /i/ in *beat* is at the top left corner of the chart because the tongue is high and front when the vowel is produced. Figure 2 depicts the placement of the tongue in one's mouth when producing English vowels.

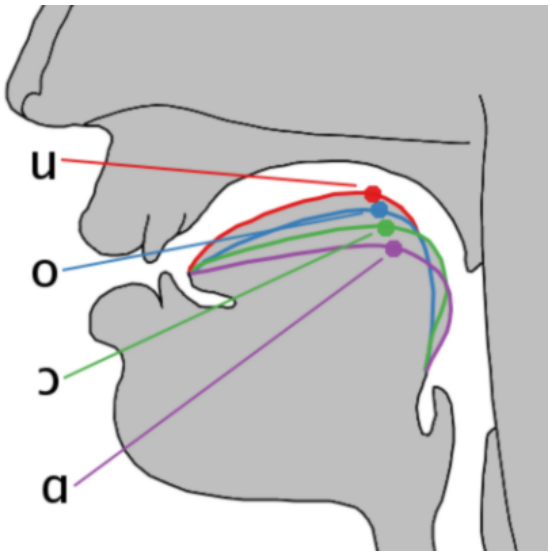
Figure 1: IPA Chart of English Vowels
(https://commons.wikimedia.org/wiki/File:English_vowel_chart.png)



The acoustic measurements of the first (F1) and second (F2) formant frequencies quantify the location of the vowel within the vowel space. The F1 inversely describes the height of the vowel. High vowels have a low F1 and low vowels have a high F1. The F2 shows the front or backness of the vowel. Front vowels have high a high F2 and back vowels have a low F2.

Figure 2: Positions of tongue in mouth when producing vowel

(https://commons.wikimedia.org/wiki/File:Cardinal_vowel_tongue_position-back.png)



2.2 Vowel Chain Shifts

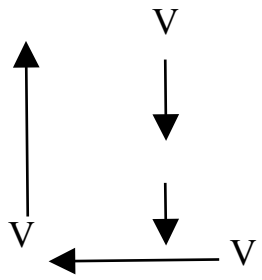
Vowel chain shifts are series of related sound changes (Gordon 2002). The movement of one vowel causes the other phonemes in the vowel space to move. This occurs in order to avoid the merging of vowels and preserve distinction. The chain shifts allow words to continue to be distinguishable to listeners even when vowel movements are occurring (Labov 1994).

A minimal chain shift involves the change in position of two phonemes. The "entering" phoneme moves into the other phoneme's space, causing it to leave and become the "leaving" phoneme. Extended chain shifts involve multiple minimal chain shifts (Labov 1994). The three principles of chain shifts are defined by Labov (1994). Principle 1 states that long vowels tend to rise. The second principle of chain shifts states that short nuclei fall and the nuclei of upgliding diphthongs fall. Principle 3 states that back vowels tend to move forward. It is common for back vowels to move forward, starting chain shifts, because overcrowding occurs more easily in back vowels than in front vowels (Martinet 1952, 1955). This is because there is more space in

the front of one's mouth than the back. There is room for four levels of front vowels, but four levels of back vowels can get too crowded, causing forward shifting or merging to occur.

Three primary patterns of chain shifts were outlined by Labov (1994). Pattern 2 is shown in Figure 3 below. Pattern 2 involves all three of the main principles of chain shifts as described above and can be used to describe the vowel shifting in the NCS. The long front vowel is raised (Principle 1), which makes room for the low back vowel to move forward (Principle 3). The short back vowels then move down into the space formerly occupied by the long low-back vowel (Principle 2).

Figure 3: Pattern 2 Chain Shift:
Source: based on Labov (1994: 125)



A major chain shift in the English language occurred in England during the 15th and 16th centuries. It involved the upward shifting of the long vowel and was named The Great Vowel Shift (Wolfe 1972). The Southern Shift, Canadian Shift and Northern Cities Shift are vowel chain shifts that are currently occurring in English in North America (Labov 2010).

Two different types of chain shifts were defined by Martinet (1952, 1955). In a pull chain shift, the sound moves, creating an opening in the phonological space that another sound is pulled into. Push chain shifts occur when a sound moves close to other sounds in the phonological space, and in doing so pushes the sounds out of the space that they previously

occupied. Labov (1994) supports the idea that push and pull chains can both occur in a phonological space. The ANAE states that the NCS is likely a pull chain shift, started by the raising of the /æ/ vowel, and following pattern 2 of chain shifts, shown in Figure 3.

2.3 The Northern Cities Shift (NCS)

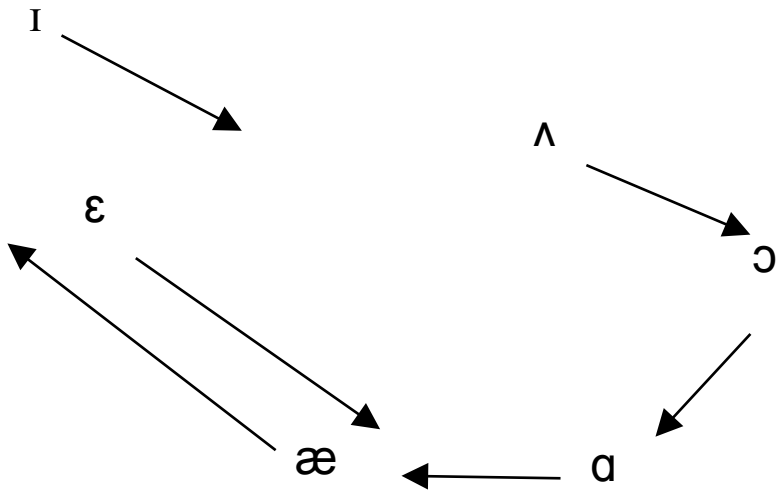
The NCS is a major vowel chain shift that is occurring in the inland North region of the United States. The NCS is characterized by the movement of six vowels: the fronting and raising of /æ/ *bat*, the fronting /ɑ/ *bot*, the lowering and backing of /ɪ/ *bit* and /ɛ/ *bet*, and the backing of /ʌ/ *but* and /ɔ/ *bought* (Labov et al. 2006). The order of the changes involved in the NCS is debated. Labov states that the first step of the shift is the raising and fronting of /æ/, like in 'bat' (Labov 1994). Below in (1) is the proposed order of the NCS (Labov 2010).

(1) Six stages of the Northern Cities Shift (Labov 2010)

1. /æ/ is fronted and raised
2. /ɑ/ is fronted
3. /ɔ/ is lowered and fronted
4. /ɛ/ is backed and lowered
5. /ʌ/ is backed
6. /ɪ/ is backed and lowered

The second stage of the NCS involves the fronting of /ɑ/. This fronting allows space for /ɔ/ to be lowered and fronted, the third step. The fourth step of the shift is the backing and lowering of /ɛ/. Next /ʌ/ is backed and /ɪ/ is backed and lowered. The entire shift, as proposed by Labov, is shown in Figure 4. This shifting follows the principles outlined in Labov's pattern 2 for chain shifting, shown in Figure 3.

Figure 4: The Northern Cities Shift
Source: Based on Labov et al. (2006, p. 190)



Eckert was the first to recognize that the /ʌ/ was moving back to the spot where the long "open-o" used to be (Eckert 1988). This /ʌ/ backing is considered a "new stage" of the NCS (Labov 1994). Some research suggests that the NCS is actually two small chain shifts, which is why some studies on the NCS only investigate the movement of the three upper vowels or the three lower vowels, not all six vowels involved in the shift (Benson 2011). Others believe that it may be a combination of unrelated sound changes occurring at the same time (Dinkin 2012, Gordon 2001, Labov 1994, 2001). The current study looks at all six vowels believed to be involved in the NCS. Models of chain shifts can neatly describe the sound changes that co-occur. Gordon (2001) studied the NCS in a small town in Michigan, the goal of the study being to determine if the NCS is in fact a chain shift. The results from the study resulted in a "maybe" from Gordon, after finding some evidence supporting the NCS as a single chain shift and others that challenged that model. Figure 4 neatly shows the NCS, but in reality it is much messier. No one know if the sound changes occurring are one pull chain shift or a combination of unrelated sound changes (Dinkin 2012, Gordon 2001).

2.3.1 Geographic Distribution and Social Factors

The NCS occurs in the Inland North and parts of the North dialect regions, defined by Labov in the ANAE (Labov et al. 2006). It is associated with the cities around the Great Lakes: e.g. Syracuse, Cleveland, Chicago, Detroit, and Milwaukee (Labov 1994, 2012). This chain shift was named the Northern Cities Shift because it was originally discovered as a sound change that was occurring in large cities.

The shift previously found occurring in urban areas has now spread to smaller towns and communities in Michigan and Eastern New York (Dinkin 2011, Gordon 2001). It is common for sound change to spread first from urban area to urban area and then into the surrounding rural areas (Labov 1994). Labov found a correlation between the voting patterns of counties and the amount of vowel shifting, claiming that speakers from more liberal counties exhibited more characteristics of the NCS (Labov 2012). This could be in part because the liberal counties that Labov looked at were more often urban than the conservative counties.

Young female speakers usually lead sound changes that are below conscious awareness, such as vowel shifts (Labov 1990). A study of the NCS in a high school by Eckert (1989) found that the girls had more advanced NCS shifting than the boys and that the "burnouts" had more advanced NCS shifting than the "jocks". Labov (2012) finds that the speakers with the most advanced shift are "upwardly mobile young women...with dense connections within the local neighborhood, and multiple social relations outside the neighborhood". In addition to differences in participation in the NCS by gender, minority ethnicities have not been found to participate in the NCS as much as European Americans (Purnell 2009). This is not always the case, as a study in Lansing, Michigan found the most advanced NCS vowels in both the Mexican American and Anglo young women (Roeder 2010).

2.4 Vowel Mergers

Vowel mergers occur when phonemes lose their distinctive acoustic properties and become pronounced and perceived as the same sound (Gordon 2002). Vowel mergers are more common than vowel chain shifts. *Garde's principle* states that mergers are an irreversible process (Milroy & Harris 1980). Labov (1994) claims that vowel changes in history that were considered mergers and were shown to have unmerged were actually "near-mergers" not complete mergers. Vowels are considered near mergers if speakers distinguish between the two vowels but cannot perceive the distinction (Labov 1994). Unlike vowel chain shifts and other sound changes, vowel mergers have been shown to often occur uniformly in all social classes and genders (Labov 1994). Two main mergers occurring in the US are the pin-pen merger that is occurring in the south and the LBM that is spreading East from the West Coast.

2.5 The Low-Back Merger (LBM)

A major merger occurring in North America is the low-back merger, sometimes called the "The Cot-Caught Merger". The LBM makes "Caught" sound like "Cot" and "Bought" sound like "Bot". The LBM is the unconditioned merging of the vowels /ɑ/ and /ɔ/. Words formerly produced with /ɔ/ are produced with /ɑ/, resulting in the loss of either the /ɑ/ or /ɔ/ vowel. It is an unconditioned phonemic merger. The LBM is moving east across the US from the West (Labov et al. 2006). The Inland North, defined by the presence of the NCS, is resistant to the LBM and has kept the distinction between the two low-back vowels (Labov et al. 2006).

2.6 Previous studies on Vowels in Minnesotan English

Labov (2012) does not identify the Twin Cities as part of the NCS, but as just outside the shift. The first step of the NCS, /æ/ raising and fronting, has been found in Minnesotan English before

velar sounds, for example in 'bag' (Benson et al. 2011, Koffi 2013). The low-back merger was cited as "in transition" in the Twin-Cities in the ANAE (Labov et al. 2006). A study on the Twin Cities dialect by Macalester faculty and students found that only 30% of participants had the LBM (Esposito, Arctander, and Kinney 2009). The Twin Cities is an area in-between the LBM and the area of resistance, where the NCS is prevalent.

A production study by Kaiser (2011) compared the vowel space of Hmong American speakers to that of non-Hmong speakers in the Twin Cities. This study looked at 9 non-Hmong speakers between the ages of 19-25. Of the 9 speakers, 7 were female and 2 were male. This study compared the results from the non-Hmong speakers to the Twin Cities speakers in the ANAE and found evidence that the low-back merger has not changed since the ANAE recordings were made around 1994. The /æ/ vowel was found to be more fronted than recorded in the ANAE when before nasal consonants, but lower before oral consonants. Kaiser states that the results suggest that the LBM and the NCS are "fighting" for control of vowels in Minnesotan English.

A study by Koffi (2014) examined the vowel space of Central Minnesota English, expecting to see aspects of the NCS if the NCS had spread to the Twin Cities. No previous studies in the Twin Cities had looked for the full NCS, so Koffi compared the Central Minnesotan speakers to speakers from the ANAE. The raising of /æ/, the first stage of the NCS, was found to occur only before velars in Central Minnesotan English (Koffi 2014).

2.7 Social Networks and Language Change

Language change is slower for speakers that have more dense social networks (Milroy 1987). People with more dense social networks are those who interact with many people who also

interact with each other. Previous studies have tried to quantify the social network density (SND) of each speaker (Milroy & Margrain 1980, Melancon 2000). Questionnaires from these studies were modified for this current study, to quantify the SND of each speaker.

Dense social networks are most often found to slow and inhibit language change while loose social networks make people more open to language change (Milroy 1987). This is thought to be due to the policing and reinforcement of each other's speech behavior. Language change occurs faster for speakers that have less dense social networks (Milroy 1987).

2.7.1 Quantifying Social Network Density (SND)

A Network Strength Scale (NSS) was developed by Milroy (1980) in a study on three working-class communities in Belfast. The scale quantified the SND and network multiplexity of speakers by assigning each a score, between 0 and 5. The NSS had 5 indicators, shown below (Milroy 1980).

1. Membership of a high density, territorially based cluster.
2. Having substantial ties of kinship in the neighborhood.
3. Working in the same place as at least two others from the same area.
4. The same place of work as at least two others of the same sex from the area.
5. Voluntary association with work mates in leisure hours.

For each indicator that was satisfied, one point was added to the speakers network strength score. The first condition indirectly measured the network density of the speaker, while conditions 2-5 indirectly measured the network multiplexity. The network density refers to the number of connections the people that the speaker is linked to also have with each other. Links between people can be multiplex or uniplex. When people know each other in more than one

context it is considered a multiplex link, for example, neighbors that work for the same company, or cousins that attend the same church.

Milroy (1887) developed a way to measure the SND of a speech community, using the same principles of network density and network multiplexity described above. Milroy developed formulas to measure the density and multiplexity of a social network, shown in (2a) and (2b).

(2) Formulas for Density and Multiplexity of Social Networks

   a. Density = (100 %) (Number of actual links) / (Total number of possible links)
   b. Network Multiplexity = (100%) (Number of multiplex links) / (Number of actual links)

Melancon (2000) modified the scale NSS used in the Belfast study (Milroy 1980) to look at the relationship between the use of Creole in Southern Louisiana and speakers' SND. The scale used by Melancon (2000) is in Figure 5.

Figure 5: Five factors used to assign social network density score to speakers in Melancon's study of Creole in Southern Louisiana (Melancon 2000)

1. How long has the individual lived in the area?
2. Is the individual's spouse a member of a long-time local family in town?
3. Does the individual work in town?
4. How many of the individual's recreational activities take place in town?
5. How many of the individual's friends live in town?

For each of the five questions the participants were assigned a score between 1 and 4. A score of 1 was assigned if the speaker responded "always" or "all" to the question. Scores of 2 indicated the speaker responded "usually" or "most". A score of 3 was assigned if the speaker responded "sometimes" or "some" and 4 was assigned if the speaker responded "never" or "none". Using

this scale, the most dense network score possible was 5 and the most loose network possible score was 20. In her study, the participant with the loosest network had a score of 18. The participant with the most dense network had a score of 5. She found that people with the most dense social networks (scores of 5-7) used Creole more often (Melancon 2000).

2.8 Current Study

In the current study, the F1 and F2 measurements were taken from the participants NCS vowels, /æ, ɑ, ɔ, ɛ, ʌ, ɪ/. If the NCS is in transition in the Twin Cities it is expected we would find that the participants with less dense SND scores would exhibit more characteristics of the NCS than those with denser SND scores. Results from this study will show the extent of the effects of the NCS in Minnesotan English (MNE) and help determine how far west the NCS has spread. Through this research I hope to uncover what processes are the driving the sound change in the vowels of Twin Cities English.

3. Methods

3.1 Speakers

Thirty-six speakers were recorded for this study. Thirty-three of the speakers were used for analysis in this study. Three speakers were excluded because they did not grow up within the designated 7 county Twin-Cities metropolitan area. The speakers were recruited through social networks and offered $5. All speakers in this study were monolingual English speakers. The speakers were between the ages of 16-18 and 35-55 and had spent most of their life in the seven county Twin-City metropolitan area. All speakers were born in the Twin Cities metropolitan area or moved here before the age of 5. Basic demographics of the speakers in the study can be seen in Table 1 below. Nineteen of the speakers in this study identified as female and fourteen

of the speakers identified as male. Fifteen of the speakers were between the ages of 16-18 and eighteen of the speakers were between the ages of 35-55 years old. All of the 16-18 year old speakers were high school students at the time of the recording or had graduated from high school within the past 3 months.

Table 1: Demographics of Individual Speakers

Participant Number	Age	Gender	Education	Occupation	SND Score
12	16	M	High School	Student	4
36	17	F	High School	Student	3
2	17	F	High School	Student	4
35	17	F	High School	Student	4
3	17	F	High School	Student	5
34	17	F	High School	Student	5
32	17	M	High School	Student	3
29	17	M	High School	Student	4
31	17	M	High School	Student	5
33	17	M	High School	Student	5
26	17	M	High School	Student	6
6	18	F	High School	Student	4
30	18	F	High School	Student	6
28	18	M	High School	Student	5
27	18	M	High School	Student	6
19	36	F	Bachelor's Degree	Photographer	5
24	36	F	Doctoral Degree	Instructor	6
4	36	M	Master's Degree	Teacher	2
15	37	F	High School	Mom	5
17	38	M	Bachelor’s Degree	Arborist	2
25	40	F	Master's Degree	Librarian	2
16	41	M	Master’s Degree	Engineer	3
23	42	M	Master's Degree	Sales	2

20	45	F	Bachelor's Degree	Mom	3
9	45	M	Doctoral Degree	Radiologist	3
14	46	F	Master's Degree	Teacher	4
1	49	F	Doctoral Degree	Lawyer	3
8	50	F	Master's Degree	Associate Registrar	3
7	51	F	Bachelor's Degree	Accountant	4
21	52	F	Bachelor's Degree	Assistant	4
22	54	F	High School	Homemaker	4
10	54	M	Master's Degree	Director of Budget	4
18	55	F	Bachelor's Degree	MN dept Health	3

3.2 Social Network Density (SND) Score

Each subject completed a demographic questionnaire prior to being recorded for the study. A SND score was calculated for each speaker using their answers from the demographic questionnaire. The demographic questionnaires for both age groups can be found in A.2 and A.3 in the appendix. Questions 11-12, 14-18 and 20 from the questionnaire shown in A.2 in the appendix were used to index the SND of the 35-55 year old speakers. For the 16-18 year old speakers, questions 3 10, 11 and 13-17 from A.3 in the appendix were used to index the SND of each speaker.

The SND scale has 6 questions that are designed to index the density of each speaker's social network. They indirectly measure the SND of each speaker by looking at network characteristics that were identified and used to quantify the density of speaker's social networks in a study done by Melancon (2000). The network characteristics looked at by Melancon (2000) were time, proximity, occupation, activities and in-group. Each participant was given a score

between 0 and 6. High scores indicate more dense networks, while lower scores indicate more loose networks. One point was added to the speaker's score for each of the conditions satisfied.

Table 2: Social Network Characteristics: For speakers 35-55 years old

1. Have lived in the Twin Cities all/most of your life (not out of state > 3 yrs) .
2. Parent(s) grew up in Twin Cities.
3. Partner grew up in the Twin Cities.
4. Work in same neighborhood or suburb that you live in.
5. All/most recreational and social activities within neighborhood/suburb.
6. All/most of friends live within your neighborhood or suburb.

The conditions for the SND scale for the 35-55 year old speakers can be seen in Table 2. The first condition was satisfied if the speaker had lived in the Twin Cities for all or most of their life, and had not lived out of the state for more than 3 years. This excluded most speakers that attended college out of state. Another point was added to the speakers SND score if one or more of their parents grew up in the Twin Cities. Condition three was satisfied if the speaker's partner grew up in the Twin Cities. Three of the adult speakers did not have a partner or spouse, which may have skewed their scores and caused them to be lower. One point was added to the SND score if the speaker's place of work was in the same neighborhood or suburb that they currently live in. Condition five was satisfied if the speaker responded that all or most of their recreational and social activities were within their neighborhood or suburb. Condition six was satisfied if the speaker responded that all or most of their friends live within the neighborhood or suburb that

they live in. Six speakers from the 35-55 year old age group have SND scores of 2. This was the lowest score, indicating the loosest social networks. One speaker had a SND score of 6, indicating the most dense social network. The average SND score for the adults was 3.3.

Table 3: Social Network Characteristics: For speakers 16-18 years old

1. Have lived in the Twin Cities all/most of your life (not out of state > 3 yrs)
2. Parent(s) grew up in Twin Cities.
3. Currently live in your hometown.
4. All/most of people you talked to in the last week live within your neighborhood or suburb.
5. All/most recreational and social activities are within your neighborhood/suburb.
6. All/most of friends live within your neighborhood or suburb.

The SND scale shown in Table 2, which was used for the adults, was modified for the 16-18 year old participants to more encompass their places of social interactions. Questions 3 and 4 from Table 2 were changed because they do not apply to the SND of the speakers in the younger age group as much as they do for the 35-55 year old speakers (Cotterell 2013). The third question was changed because the high school aged speakers do not have long-time partners or spouses. Question 4 was changed because the 16-18 year old participants reported being full-time students. The conditions used to index the SND of the 16-18 year old speakers are shown in Table 3.

Conditions 1, 2, 5 and 6 were the same for the 16-18 year olds as for the 35-55 year olds. The third condition was satisfied if the speaker was currently living in the same place that they

listed as the location they grew up in. Condition 4 was satisfied if the speaker responded that all or most of the people that they talked to in the last week live in the same neighborhood or suburb that they currently live in. No speakers in the 16-18 year old age group scored 2 or lower on the SND scale. Two speakers had scores of 3, the loosest social network score for the age group. Three speakers have SND scores of 6, indicating the most dense social network. The average SND score for the 16-18 year old speakers was 4.625.

Table 4: Social Network Density (SND) Scale

Network Scale	Number of Speakers 16-18 years old	Number of Speakers 35-55 years old	Total Number of Speakers
Close-knit Network (scores of 5-6)	9	3	12
Midrange Network (scores of 3-4)	7	11	18
Open Network (scores of 0-2)	0	6	6

The speakers were placed into three groups based on their SND score, shown in Table 4. Those with a score of 0-2 are classified as having an "open-network". The midrange network is composed of speakers with scores of 3-4, and the close-knit network is speakers with SND scores of 5-6. The number of speakers in each group can be seen in Table 4. No speakers from the younger age group were classified as having open networks. Seven were in the midrange group and 9 were classified as having a close-knit social network. The adult group had 6 speakers with open networks, 11 speakers with midrange network scores and only 3 speakers

with close-knit social networks. When comparing the number of speakers between the age groups in each of the network density groups you need to keep in mind that the index score for each age group are based off of a slightly different network scale.

3.3 Materials

The vowels /æ, ɑ, ɔ, ɛ, ʌ, ɪ/ were of interest in this study. These six vowels are the vowels involved in the NCS, as discussed in section 2.3. The list of word tokens used in this study can be found in A.1 in the appendix. The wordlist was modified from a study used on the NCS in Chicago (McCarthy 2011) and included 52 monosyllabic words. One PowerPoint slide was created for each of the 52 words. Each slide contained the token of interest twice, in the frame "Say X again. X.", resulting in two tokens of each word from the wordlist. The PowerPoint macro Randomize was used to shuffle the order of the slides for each participant.

3.4 Recordings

Each participant was recorded in the sound booth at the Macalester College linguistics lab. Before recording, the participants were told that they were participating in a study on the Twin Cities dialect of English. Participants were instructed to read out loud everything on the screen of the laptop and click the right arrow to go to the next slide after they finished reading the current slide. Recordings were done in Audacity. Reading of the slides and the lack of filler words may have led to hyper articulation of the words of interest. The researcher listened to each track and confirmed that the participants produced the words with natural production. The 52 frames, each containing two occurrences of the token of interest, were labeled by word that is the token of interest and separated into tracks in Audacity. The labeled tracks were then exported from Audacity as multiple files. This process was done for each of the 36 participants.

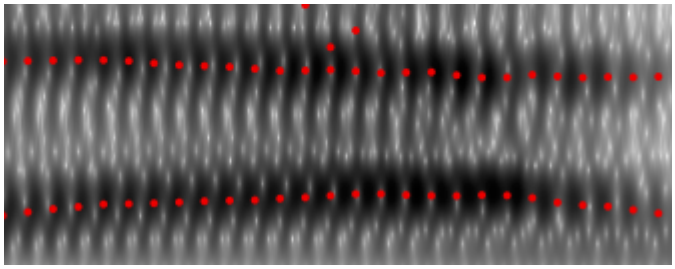
3.5 Acoustic Analysis

VoiceSauce was used for the acoustic analysis in this study (Shue 2011). Before each file was labeled, each track was listened to at least twice to confirm that the speaker read the correct words. VoiceSauce was used to measure the F1 and F2 of every vowel of interest, using the Snack Sound Toolkit with its default settings. A few times VoiceSauce measured the wrong formant. When this occurred, Praat was used to manually find the formant values and the nucleus of the vowel (Boersma, P., & Weenink, D. 2012).

Following the methods recommended by Labov in the ANAE, the measurements of the F1 and F2 were taken at the point of inflection of each vowel of interest, following the "central tendency" of the vowel. The point of inflection is the point in the vowel where the tongue stops moving towards the nucleus and begins moving towards the offglide or the position of the tongue required for the next segment of speech (Labov 2006). The central tendency of a vowel is defined by Labov (2006) as the main movement of one's tongue during the articulation. Measuring this central tendency or point of inflection gives a much more accurate depiction of the vowel than taking the nuclear average (Labov 2006).

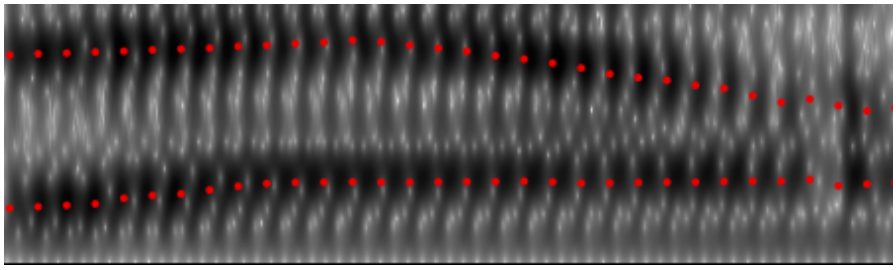
Most vowels in this study had a downward movement of the tongue into the nucleus, followed by a rise out of the nucleus. This was characterized by a slight rise and fall in F1. A visualization of this can be seen in Figure 6 below. The highest F1 value represents the lowest point of the tongue, and the central tendency of the vowel. For vowels with this tendency, the vowels formant values were recorded as the F1 and F2 values at the max F1 value in the vowel of interest.

Figure 6: Upgliding vowel: characterized by slight rise and fall in F1



For ingliding vowels, the tongue moves towards or away from the front or rear periphery of the vowel space. If this was the case, the measurement for the central tendency of the vowel was taken from the nucleus of the F2, at the F2 min or max. This is shown in Figure 7 below.

Figure 7: Ingliding vowel: Characterized by rise and fall of F2



For vowels before velars the max F1 within the first half of the vowel was used for F1 and F2 measurements. This was done to lessen the effects of the velar on the vowel, called the velar pinch, which causes the F2 to rise and F3 to lower before velar sounds.

3.6 Vowel Normalization

Peterson and Barney (1952) found that the formants of speakers can differ greatly and sound the same to a listener. The formant differences are due to the size differences in speaker's oral cavities and vocal tracts (Wakita 1977). Normalization of formant measurements is done to mimic the normalizing done by the listener's ear, which accounts for differences in F1 and F2

values due to vocal tract differences (Labov 2006). The normalization process allows the vowel spaces of different people to be compared to one another.

An online program called *NORM: The Vowel Normalization and Plotting Suite* was used to normalize the data in this study (Kendall, Thomas 2007). The log-mean normalization attempts to preserve dialect differences while eliminating the variations due to differences in physiology (Thomas 2002). It was found to be the best method for accounting for differences between male and female vocal tract lengths (Thomas 2002). The method used was speaker extrinsic, meaning the formant measurements of each speaker were adjusted using the same G-value. The normalization was done using the same methods and group log-mean value (G-value) used by Labov (2006) in the ANAE, so that the ANAE could be used as a point of comparison to this study. This method of normalization allows for inter-speaker comparability and comparison with the ANAE.

3.7 Northern Cities Shift (NCS) Score

The 3 structural criteria from ANAE were used to quantify each speaker's degree of participation in the NCS and are shown in Figure 8 below (Labov 2006).

Figure 8: Criteria for NCS Participation

1. EQ Measure: /æ/ is both higher and fronter than /ɛ/
2. ED Measure: the distance between the F2 of /ɛ/ and F2 of /ɑ/ is less than 375 hz
3. UD Measure: /ʌ/ is farther back than /ɑ/

Criterion one, the EQ measure, is satisfied if the speaker's mean F1 of /æ/ is lower than the mean F1 of /ɛ/ and the mean F2 of /æ/ is higher than the mean F2 of /ɛ/. The second criterion, the ED measure, is satisfied if the distance between the mean F2 of /ɛ/ and the mean F2 of /ɑ/ is

less than 375 hz, showing that the fronting of /ɑ/ and backing of /ɛ/ brings them closer together. The third criterion, the UD measure, is satisfied if the F2 of /ʌ/ is lower than the mean F2 of /ɑ/.

4. Results

In this section, the six NCS vowels /æ, ɑ, ɔ, ɛ, ʌ, ɪ/ are referred to by words that contain them. The words that will be used to refer to each vowel and their corresponding IPA symbols are as follows: *bat* /æ/, *bet* /ɛ/, *bit* /ɪ/, *but* /ʌ/, *bought* /ɔ/ and *bot* /ɑ/.

4.1 Overview of Twin Cities English Vowel System

The percent of participants satisfying the NCS measures are shown in Table 5. The UD measure, satisfied when the mean *but* vowel is farther back than the mean *bot* vowel, was only satisfied by participants within the 35-55 year old male group.

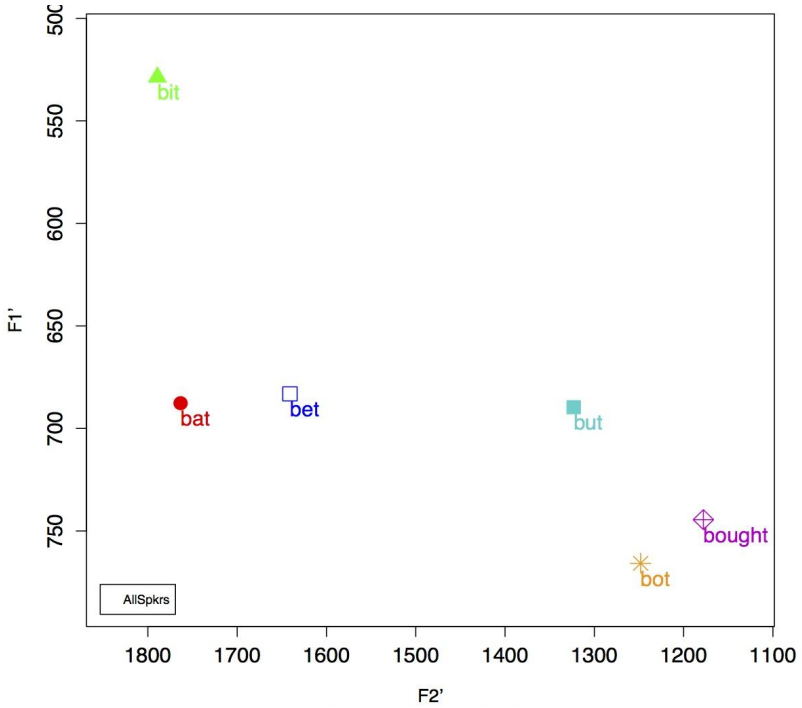
Table 5: Percent of participants satisfying structural Criteria for NCS participation in the current sample

Percent Satisfying	EQ Measure	ED Measure	UD Measure
Young Females	100%	71.42%	0%
Young Males	12.5%	37.5%	0%
Adult Female	33.33%	33.33%	0%
Adult Males	66.66%	83.33%	50%

Of the 16-18 year old female speakers, 100% satisfied the EQ measure, that is they have mean *bat* vowels that are higher and fronter than the mean *bet* vowels. 71% of the young females satisfied the ED measure, showing some degree of *bet* vowel lowering and backing or *bot* vowel

fronting. Greater variability is found within the young male and adult female groups. One third of the 35-55 year old females satisfy the EQ measure and one third satisfy the ED measure.

Figure 9: Normalized Mean F1 and F2 values for all participants



The mean F1 and F2 values across all participants are plotted in Figure 9 and shown in A.4 in the appendix. The normalized means for all participants do not satisfy the UD, ED or EQ measures for the NCS that were set in the ANAE, but the mean *bat* vowel is fronter than the mean *bet* vowel (Labov et al. 2006). This is because some participants are not participating in the NCS. To further investigate what is happening in the vowel spaces of English speakers in the Twin Cities, the normalized means, separated by gender and age group, are plotted and analyzed. Features of the NCS can be seen in the group means plotted below. In addition, the NCS vowels of participants are examined individually.

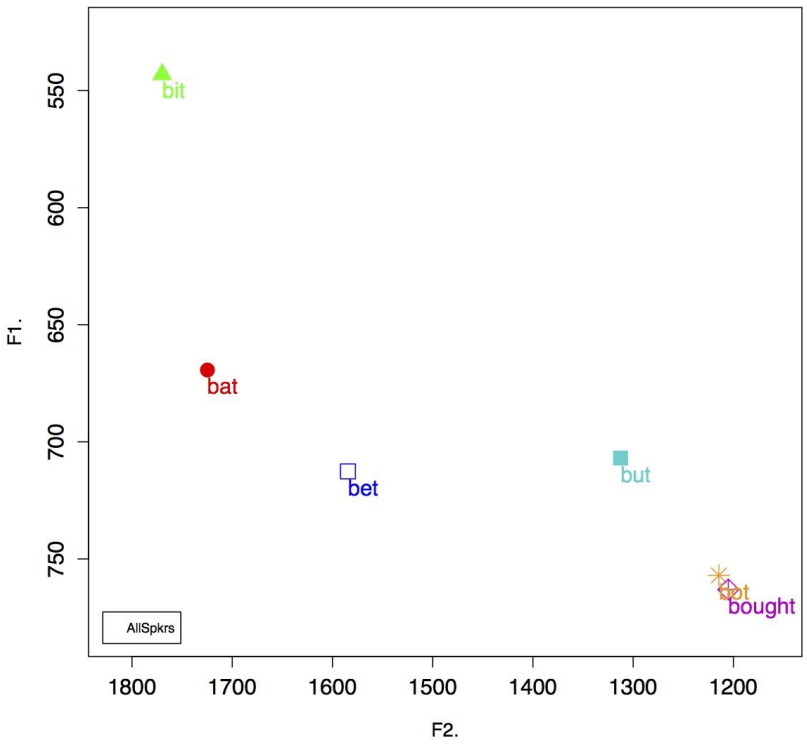
4.2 Vowels of 16-18 Year Old Females in the Twin Cities

Table 6: Patterns seen in young female participants

	EQ	ED	UD	LBM
5 young females	yes	yes	no	yes
2 young females	yes	no	no	yes

Table 6 shows some trends that were seen among the 16-18 year old females. All of the young female participants in this study satisfied the EQ criteria by having mean *bat* vowels that were higher and fronter than their mean *bet* vowels. Five of the young females also satisfied the ED measure. In addition, all young female participants showed participation in the LBM.

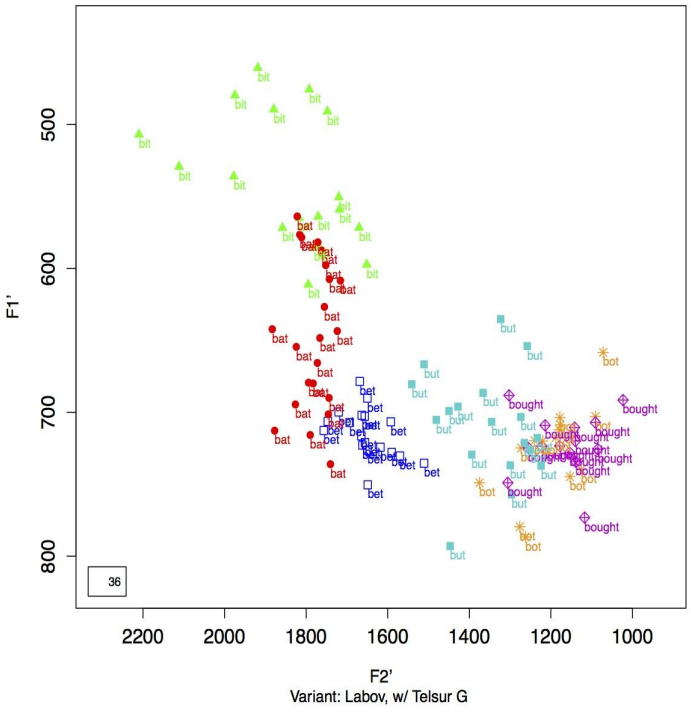
Figure 10: Plot of F1 and F2 means by vowel for 16-18 year old female participants



The mean normalized F1 and F2 of the 16-18 year old female participants are plotted in Figure 10 and shown in A.5 in the appendix. Shown in Figure 10, the mean *bat* vowel for the young females is higher and fronter than the mean *bet* vowel, satisfying the EQ criteria. The ED criteria is also satisfied for the means of the 16-18 year old females, as the distance between the mean F2 of the *bet* vowel and the mean F2 of the *bot* vowel is less than 375 Hz.

All young female participants show some merging of the low-back vowels *bot* and *bought*. This can be seen in Figure 10, where the mean normalized *bot* vowel is overlapping with the mean normalized *bet* vowel for the 16-18 year old female participants.

Figure 11: Speaker 36 - Female, Age 17, from Blaine, MN



A 17 year old female speaker's normalized NCS vowels are plotted in Figure 11. This plot shows the LBM and *bat* vowel raising and fronting co occurring. The NCS vowel plots of most of the young female participants look similar to the plot shown in Figure 11.

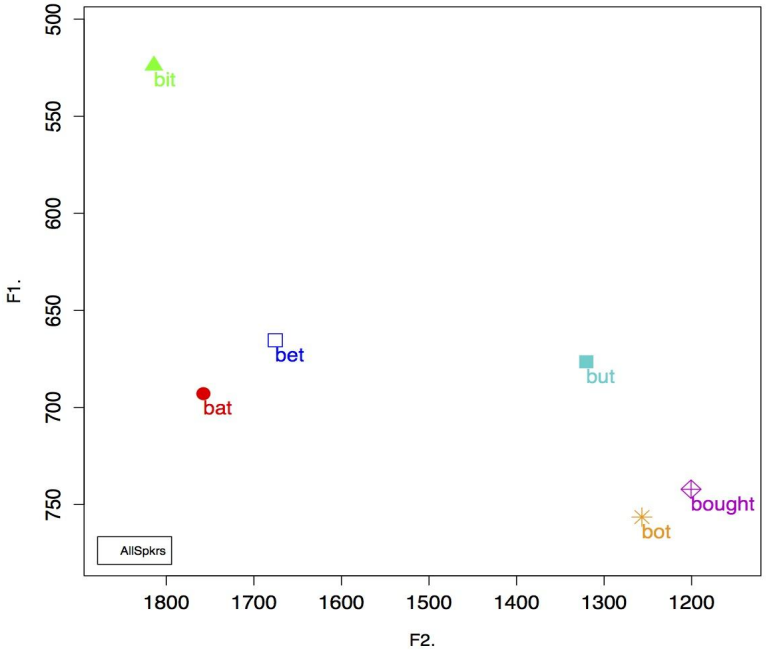
4.3 Vowels of 16-18 Year Old Males in the Twin Cities

Table 7: Patterns seen in young male participants

	EQ	ED	UD	LBM
5 young males	Fronter but not higher	no	no	no
2 young males	Fronter and equal height or higher	no	no	yes
1 young male	no	no	no	yes

Table 7 shows trends seen among the eight young male speakers. Five of the participants in this group had mean *bat* vowels that were fronter than the mean *bet* vowel but not higher. These five participants did not show participation in the LBM and did not satisfy the ED or UD measures. Two of the young males had *bat* vowels that were fronter than the mean *bet* vowel and at an equal height or higher and had the LBM. One male did not show any signs of influence from the NCS and did have the LBM.

Figure 12: Plot of F1 and F2 means by vowel for 16-18 year old male participants



The means of the normalized F1 and F2 measurements of the NCS vowels for the 16-18 year old males are plotted in Figure 12 and shown in A.6 in the appendix. The mean *bat* vowel for the young males is fronter than the mean *bet* vowel, but not higher. The means for the *bot* and *bought* vowel for the young males are similar, suggesting that some of the young males have the LBM. These normalized means differ from those of the young female speaker, who had mean *bat* vowels that were higher than their mean *bet* vowels.

Figure 13: Speaker 33 - Male, Age 17, from St Paul, MN

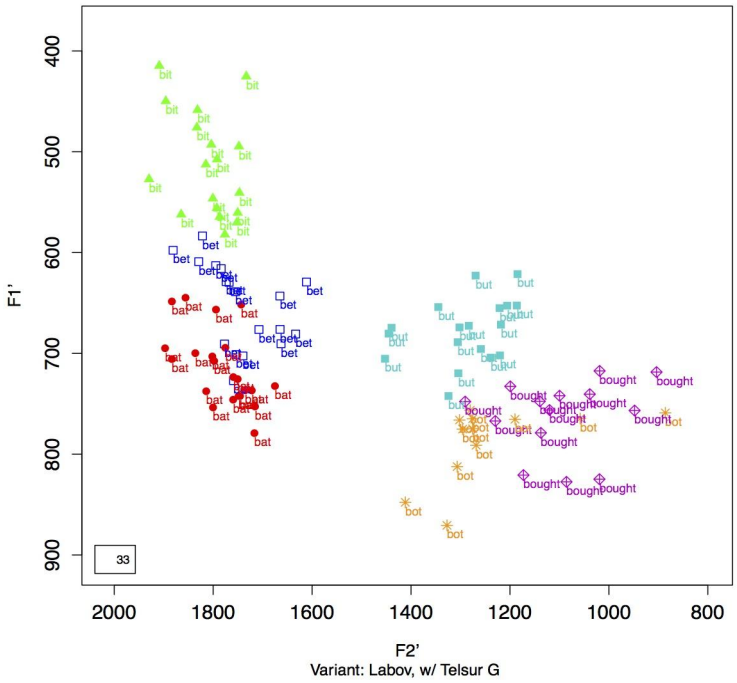
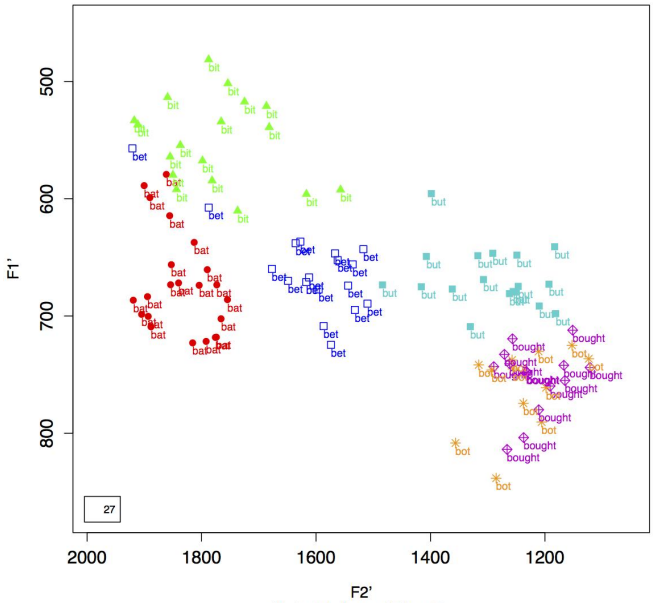


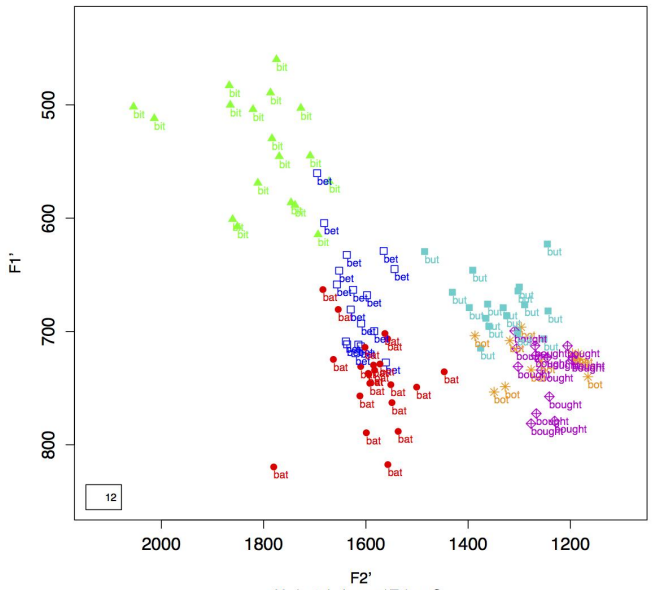
Figure 13 shows the NCS vowels of Speaker 33, who maintains does not show merging of the low-back vowels *bot* and *bought*. Speaker 33's mean *bat* vowel is fronter and lower than the mean *bet* vowel. The young male participants 26, 29, 31 and 32 have NCS vowels similar to speaker 33, with *bat* vowels that are fronter and lower than the *bet* and little overlap of the low-back vowels.

Figure 14: Speaker 27 - Male, Age 18, from Lino Lakes, MN



Shown in Figure 14, speaker 27's *bat* is fronter than *bet* but at a similar height. The LBM looks to be present in this speaker. Figure 14 shows a vowel space that is similar to that of speaker 28, another 18 year old male from Lino Lakes, Minnesota. Speaker 28's NCS vowels are similar to speaker 27's, but the *bat* is higher and fronter than *bet.* Speaker 28 is the only young male speaker that satisfies the EQ measure.

Figure 15: Speaker 12 - Male, Age 16, from Plymouth, MN



Speaker 12's NCS vowels are plotted in Figure 15. The *bet* vowel is higher and fronter than the *bat* vowel. This plot was unique among the young males, as it was the only one that showed no fronting or raising of the *bat* vowel. The participant's parents are not from the Twin Cities. This may explain some of the divergence seen here, with no *bat* vowel fronting or raising occurring and some participation in the LBM.

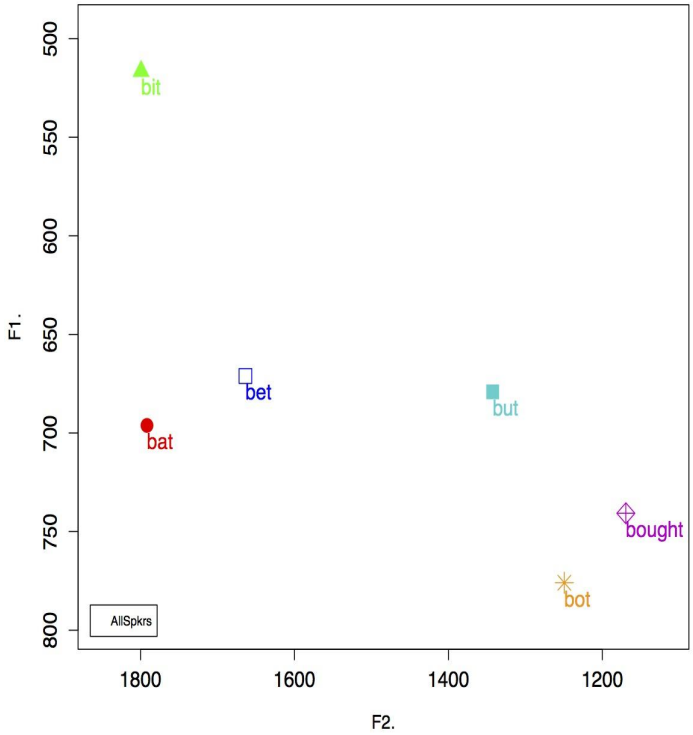
4.4 Vowels of 35-55 Year Old Females in the Twin Cities

Table 8: Patterns seen in adult female participants

	EQ	ED	UD	LBM
2 females	yes	yes or almost	almost	no
2 females	yes	yes or almost	no	no
2 females	no	yes	no	no
3 females	no	no	no	no
3 females	no	no	no	yes

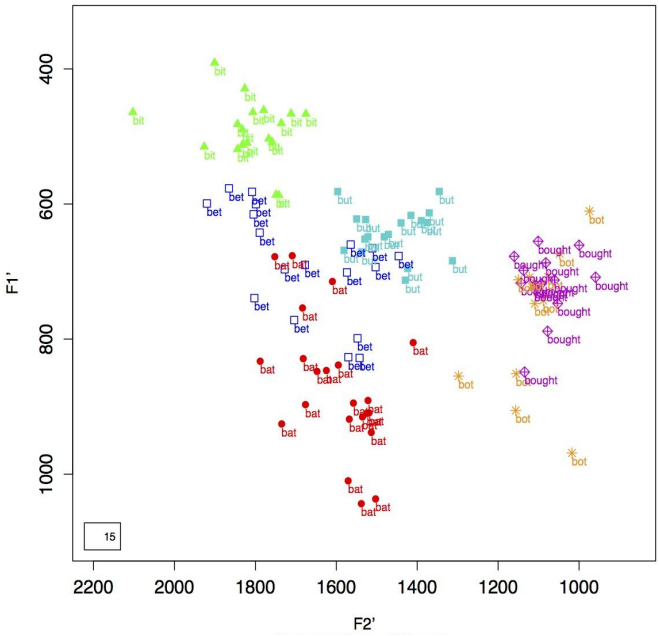
Table 8 shows the number of adult females with similar NCS vowel patterns. Two females satisfied the EQ measure, while almost satisfying the ED and UD measure. These participants did not show signs of participation in the LBM. Influence from the LBM was only seen in the vowels of three of the adult females, all of which did not satisfy the EQ, ED or UD measures.

Figure 16: Plot of F1 and F2 means by vowel for 35-55 year old female participants



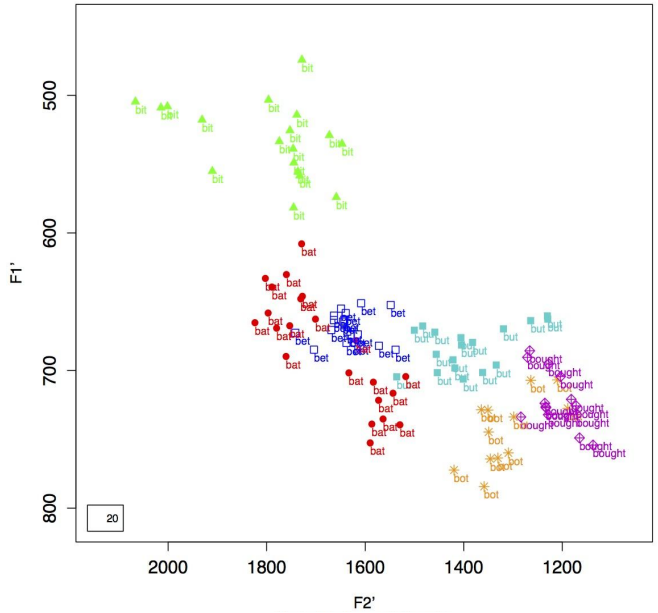
The means of the normalized vowels of the 35-55 year old females are plotted in Figure 16 and shown in A.7 in the appendix. Figure 16 looks similar to Figure 12, which showed plotted the mean normalized formant measurements for the young male participants. The mean *bat* vowel is fronter than the *bet* vowel, but it is not higher. The LBM does not look to be as present in the adult female participants as the 16-18 year old females. This can be seen when comparing Figure 16 to Figure 10, which plotted the mean formant measurements for the young females.

Figure 17: Speaker 15 - Female, Age 37, from St. Paul, Minnesota



The vowels of speaker 15 are plotted in Figure 17. The speaker's *bat* vowel is more low and back than the *bet* vowel. This speaker shows evidence of some low-back vowel merging. Speaker 14 is a 46 year old female for St. Paul, MN and has similar vowels to speaker 15, with some low-back vowel merging and lack of expected NCS shifting.

Figure 18: Speaker 20 - Female, Age 45, from St. Paul, MN



Shown in Figure 18, speaker 20 raises and fronts some but not all *bat* vowels to higher and fronter than the *bet* vowel. The speaker also looks to have distinct low-back vowels.

Figure 19: Mean normalized NCS vowels of Speakers 18 (red) and 19 (blue):

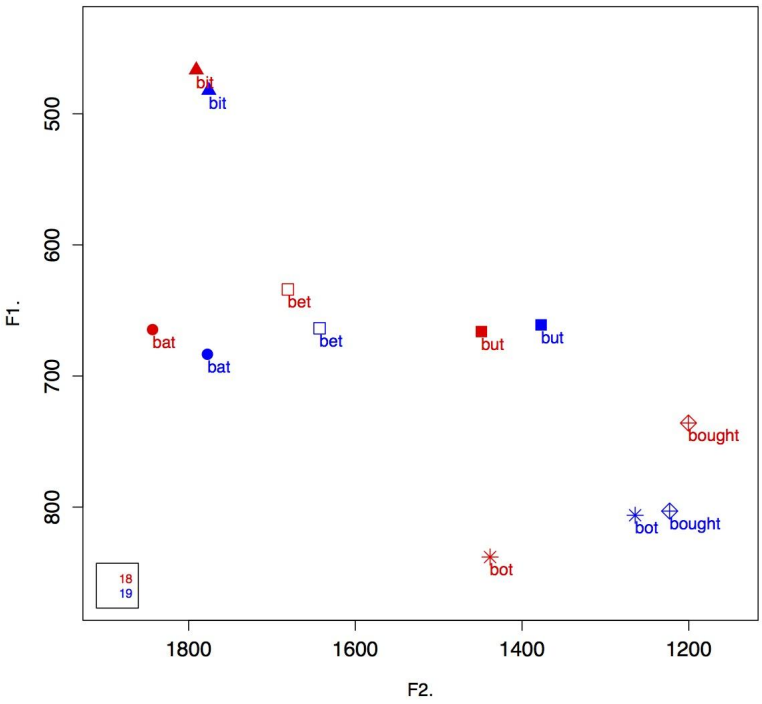


Figure 19 shows the normalized means of two female speakers. Speaker 18, plotted in red, is a 55 year old female from St. Paul. This speaker's mean *bot* vowel is over 200 Hz more forward than their mean *bought* vowel, showing no signs of influence from the LBM. Speaker 19, plotted in blue, is a 36 year old female from St. Paul. This speaker participates in the LBM. Apart from the low-back vowels *bot* and *bought*, speakers 18 and 19 have very similar NCS vowels. Both speakers show *bat* vowel fronting and some *bat* vowel rising, but not to a height exceeding that of the *bet* vowel. Figure 19 shows that the LBM may not have much of an effect on the other four vowels that are involved in the NCS.

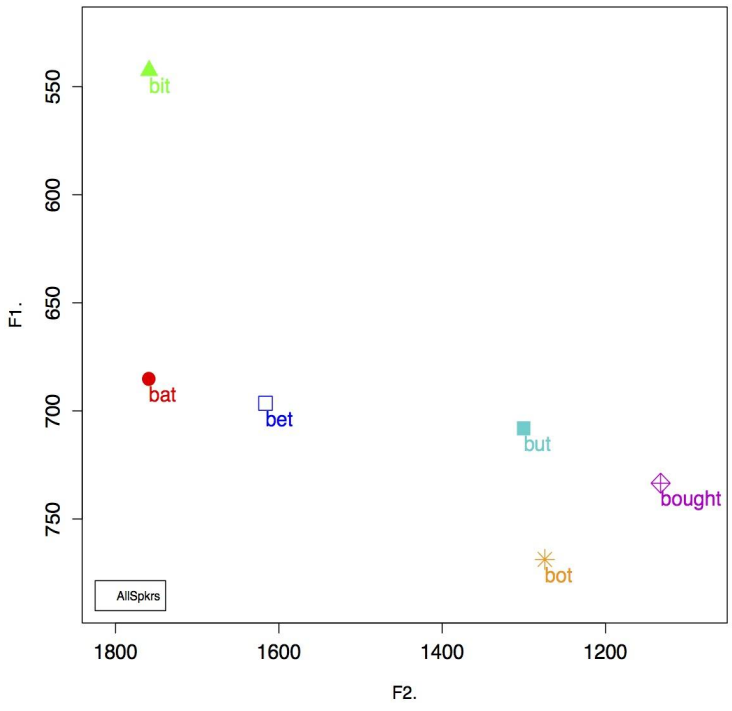
4.5 Vowels of 35-55 Year Old Males in the Twin Cities

Table 9: Patterns seen within adult male participants

	EQ	ED	UD	LBM
3 males	yes	yes	yes	no
1 males	yes	yes	almost	no
2 males	no	no	no	no

Table 9 shows trends within the adult male participants. Three adult males satisfied all three NCS measures for full participation in the NCS. These three men did not show signs of the LBM. One male satisfied the EQ and ED measure and almost satisfied the UD measure, also showing no signs of the LBM. Two males did not participate in the NCS or have the LBM.

Figure 20: Plot of F1 and F2 means by vowel for 35-55 year old male participants



The means of the normalized F1 and F2 of the six vowels involved in the NCS for the 35-55 year old male participants are plotted in Figure 20 and seen in A.8 in the appendix. The means for the 35-55 year old males satisfy the EQ and ED criteria for the NCS. The UD criteria is nearly satisfied, with the mean F2 of the *but* vowel only 25 Hz higher than the mean F2 of the *bot* vowel. Four out of the six 35-55 year old male participants show full or nearly full participation in the NCS. Two of the men show no participation in the NCS.

Figure 21: Speaker 23 - Male, Age 42, from St. Paul, MN

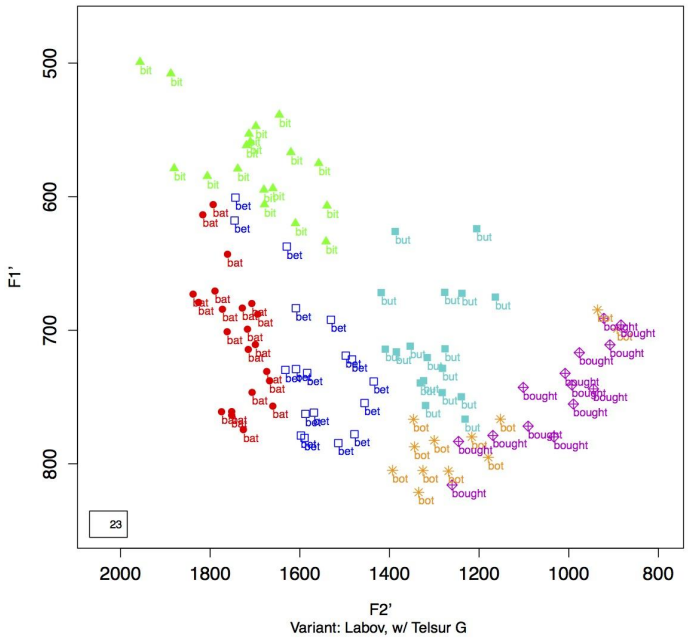


Figure 21 shows the NCS vowels of speaker 23. The speaker's mean *bat* vowel is fronter and slightly higher than the *bet* vowel, satisfying the EQ criteria. The distance between the mean F2 of *bet* and mean F2 of *bot* is less than 375 Hz, satisfying ED criteria. The UD criteria is not satisfied, as mean *bot* vowel is slightly more back than the mean *but* vowel. This speaker shows a nearly full NCS and no evidence of participation in the LBM.

Figure 22: Speaker 9 - Male, Age 45, from St. Louis Park, MN

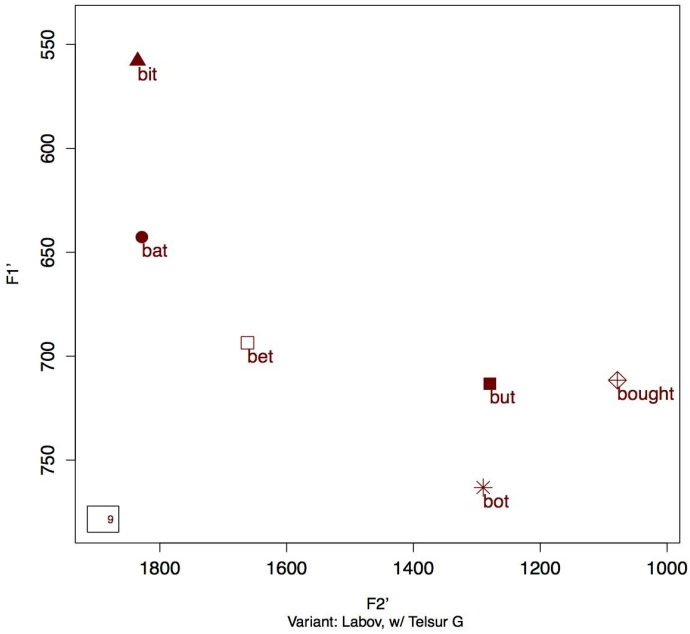


Figure 23: Speaker 10 - Male, Age 54, from Minneapolis, MN

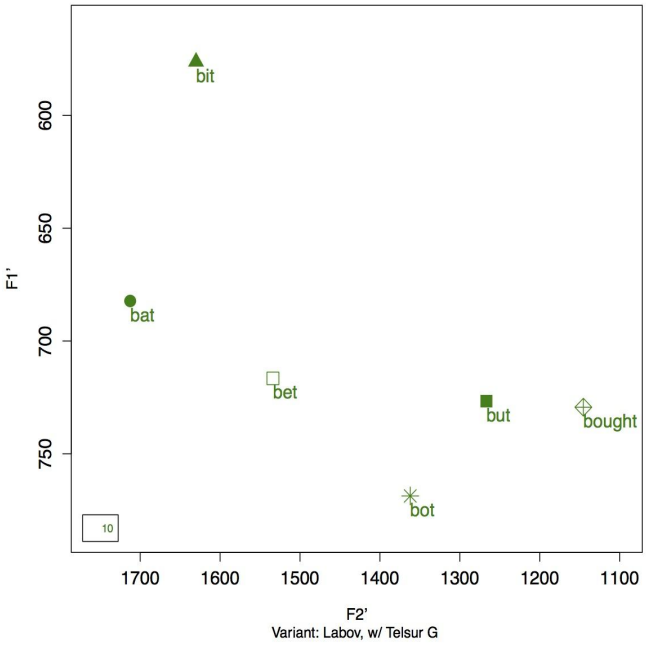
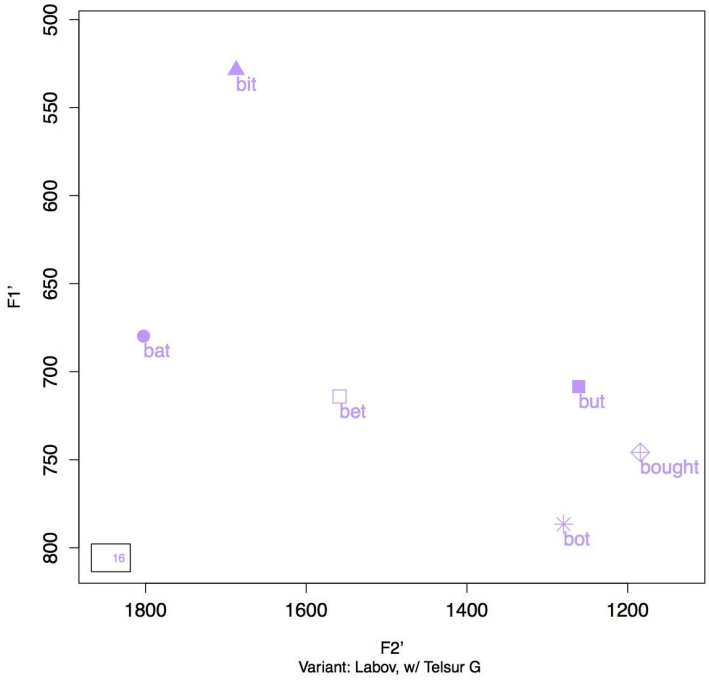


Figure 24: Speaker 16 - Male, Age 41, from St. Paul, MN



Figures 22-24 show the speakers who satisfy the EQ measure, ED measure and UD measures. All of the participants from this study whose means were found to satisfy the three structural criteria for the NCS are middle-aged males. The participants with the full NCS did not show merging of the low-back vowels, as predicted by previous research. The fronting of the *bot* vowel /ɑ/ which satisfies the UD measure prevents the LBM. No participants that satisfied the UD measure showed merging or near-merging of the low-back vowels. The male participants showing full participation in the NCS had stronger city ties than those not participating in the NCS, that is they did not live in outer suburbs. They also had higher degrees than those not participating in the NCS.

4.6 Comparison of participants in current study to ANAE Twin Cities speakers

None of the four ANAE speakers from the Twin Cities participated fully in the NCS, that is none of them satisfied all three of the structural criteria for participation in the NCS (Labov et al. 2006). The demographics of the four Twin Cities speakers from the ANAE are shown in Table 10.

Figure 25: The NCS vowels from the 4 ANAE speakers from the Twin Cities
Source: Based on Labov et al. (2006)

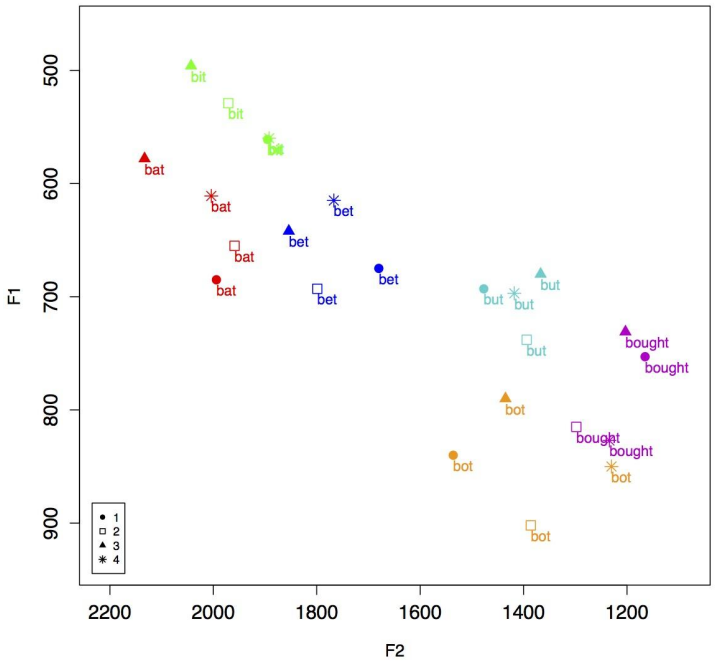


Table 10: The Demographics and NCS measures of the 4 ANAE speakers from the Twin Cities Metro Area (Labov et al. 2006)

Speaker	Age	Gender	City	EQ	ED	UD
1	31	M	Minneapolis		X	X
2	24	F	Minneapolis	X		
3	57	F	St. Paul	X		X
4	26	F	Stillwater	X		

All three of the women from the Twin Cities in the ANAE satisfy the EQ measure, with mean *bat* vowels higher and fronter than mean *bet* vowels. The ANAE recorded only one male from the Twin Cities. The male speaker satisfied the ED and UD measures, but not the EQ measure. Three males in the current study satisfied all three NCS measures, evidence for some advancement in the NCS in the Twin Cities since speakers from the ANAE were recorded . The results from the current study shows the variation that is found across participants from the Twin Cities. Four speakers is too few to truly be representative of what was happening in vowels in the Twin Cities when speakers were recorded for the ANAE in the 1990's. The means of the ANAE Twin Cities speakers are shown in Figure 25. In the current study only 4 of the adult females satisfied the EQ measure, and in the ANAE all three female speakers satisfied the EQ. The oldest Twin Cities female speaker from the ANAE is also the only female to satisfy the UD measure. In the current study, the females that nearly satisfied the UD measure were 49 and 52 years old, suggesting that this is an older feature that is not present among young speakers.

4.7 *BIT* vowel backing and lowering

The sixth step of the NCS as defined by Labov (2010) is the backing and lowering of the vowel /ɪ/. This step is not required for speakers to be fully participating in the NCS. The backing and lowering of the *bit* vowel is the one vowel involved in the NCS that is not looked at in the EQ, ED or UD measures. When comparing the mean *bit* vowel from the current study (F1 = 528.67 Hz, F2 = 1789.31Hz) to that of the speakers from the ANAE (F1= 536.5 Hz, F2= 1950.25 Hz) there is evidence that backing of the *bit* vowel may have occurred.

4.8 SND Score and the NCS Score

There was no relationship between the NCS score and the SND score of participant. It was expected that participants with lower SND scores (less dense social networks) would have higher NCS scores (more aspects of the NCS) if the NCS was spreading into Twin Cities English. Given that the full NCS was found only in the 35-55 year old male participants, there was not enough diversity within NCS scores to see any overall trends. Among the 35-55 year old male participants, the three participants with the highest SND scores were also the three participant that had the highest NCS score (full NCS), shown in Table 11. This was the opposite finding as expected.

Table 11: The SND score and NCS score of the 35-55 year old male participants

Participant	SND Score	NCS Score
4	2	0
17	2	1
23	2	2
9	3	3
16	3	3
10	4	3

4.9 Education Level and the NCS Score

The three males with NCS scores of 3, the full NCS, were the males with the highest degree levels. The women with the most advanced *bot* vowel fronting, which nearly satisfied the UD

measure, had doctoral degree. It may be that in the Twin Cities, participation in the NCS is related to the education level. Two participants in the present study did not have any college education. These two participants also had NCS scores of zero and showed no signs of participation in the NCS. This is further evidence suggesting that speakers with higher education levels may be the ones participating in the NCS in the Twin Cities. It may be that the participants with the highest levels of education interact with and are influenced by professionals from other cities where the NCS is prevalent.

5. Conclusion

The purpose of the present study was to determine whether the full NCS has spread into Twin Cities English. Speakers with NCS vowel means that satisfy the EQ, ED and UD measures have the full NCS. The satisfaction of the three NCS measures was found only in the 35-55 year old male speakers. The three male speakers fully participating in the NCS had high levels of education and strong ties to the city. In the current study 48% of participants show advanced bat vowel raising and fronting, with a mean /æ/ higher and fronter than the mean /ɛ/, satisfying the EQ criteria 48% of the participants satisfy the ED measure, showing that /æ/ fronting is not the only thing occurring, but some degree of /ɛ/ backing or /ɑ/ fronting is also occurring in English in the Twin Cities. In the present study it was expected that the participants would be either participating in the NCS or the LBM. Some participants were found to not be participating in the NCS or the LBM.

All of the 16-18 year old female speakers had *bat* vowel raising and fronting and also looked to have the LBM or near-merger. The vowels of the young male participants in the

current study patterned very differently from the young females, as most did not raise the *bat* vowel or show merging of the low-back vowels. The presence of both the *bat* vowel raising and the LBM in participants was not expected because the *bat* vowel raising has been cited as the first stage of the NCS and the NCS is a mechanism that prevents the LBM. It may be that the *bat* vowel raising and fronting in the young participants is not the first stage of the NCS, but a separate process that occurs with the LBM.

A recent study on vowel changes in Ohio found that participants that had the LBM also had backing of the *bat* vowel (Durian 2010). This nicely follows the principles of chain shifting, as the merging of the low-back vowels allowed space for the *bat* vowel to be "pulled" into the space formerly occupied by the low-back vowel. In the present study the LBM most often co-occurred with *bat* vowel fronting and raising, opposite to the shifting found by Durian (2010). The *bat* vowel fronting and raising was seen in all of the 16-18 year old females in the current study, co-occurring with the merging of the low-back vowels. The *bat* fronting occurring with the LBM may be due to the influence of the NCS on English in the Twin Cities.

The NCS is present in English in the Twin Cities among 35-55 year old educated males with strong ties to the city. This finding was surprising because it is not common for males to lead sound changes. As predicted by prior research, full participation in the NCS was never found occurring with the LBM. Labov noted that women and young people tend to lead sound language change and have the most advanced vowel systems (Labov 1994, 2001). Following that assumption, it is expected that the speakers of Twin Cities' English will follow trends set by the 16-18 year old females, shown in Figure 10, and participate in *bat* vowel fronting and raising and the LBM in the future.

Most speakers in this study were from the upper or middle class. Different results may be found if participants were from more diverse demographic groups. The participation in the NCS by those with higher degree levels may be reflecting participation differences by social class. A study with greater ethnic and social class diversity in the Twin Cities would be good follow up research.

References

Arctander, Kaitlyn, Hannah Kinney, and Christina M. Esposito (2009). "Low-back vowel merger in Minnesotan English." *The Journal of the Acoustical Society of America* 126.4: 2162-2162.

Benson, E. J., Fox, M. J., & Balkman, J. (2011). The bag that Scott bought: The low vowels in northwest Wisconsin. *American Speech*, *86*(3), 271-311.

Boersma, P., & Weenink, D. Praat: doing phonetics by computer. 2012 [Computer program].

Cotterell, J. (2013). *Social Networks in Youth and Adolescence* (Adolescence and Society). Florence: Taylor and Francis.

Dinkin, A. J. (2011). Nasal short-a systems vs. the Shift. *University of Pennsylvania Working Papers in Linguistics*, *17*(2), 9.

Dinkin, A. J. (2012). Toward a unified theory of chain shifting.

Eckert, P. (1988). Adolescent social structure and the spread of linguistic change. *Language in society*, *17*(02), 183-207.

Eckert, P. (1989). *Jocks and burnouts: Social categories and identity in the high school*. Teachers College Press.

Durian, D. (2010). A new perspective on vowel variation across the 20th century in Columbus, OH. *Unpublished manuscript, Department of Linguistics, The Ohio State University, Columbus*.

Gordon, M. J. (2001). *Small-town values and big-city vowels: A study of the Northern Cities Shift in Michigan*. Durham, NC: Duke University Press.

Gordon, M. J. (2002). Investigating chain shifts and mergers. *The handbook of language variation and change*, *11*, 244-266.

Kaiser, E. A. (2011). *Sociophonetics of Hmong American English in Minnesota* (Doctoral dissertation, University of Minnesota).

Koffi, E. (2013). The Acoustic Vowel Space of Central Minnesota English: Focus on Female Vowels. *Linguistic Portfolios, 2*.

Koffi, E. (2014) "The Acoustic Vowel Space of Central Minnesota English in Light of the Northern Cities Shift," *Linguistic Portfolios*: Vol. 3 , Article 2.

Labov, W. (1990). The intersection of sex and social class in the course of linguistic change. *Language variation and change*, *2*(02), 205-254.

Labov, William. "Principles of language change: Internal factors." (1994).

Labov, W. (2001). *Principles of linguistic change. Vol. 2, Social factors* /(Language in society, v. 29; Language in society, v. 29). Oxford: Blackwell.

Labov, W., Ash, S., & Boberg, C. (2006). *The atlas of North American English: Phonetics, phonology and sound change ; a multimedia reference tool.*Berlin u.a.: Mouton de Gruyter.

Labov, W. (2010). *Principles of linguistic change* (Pbk. ed.). (Language in society, 20, 29, 39; Language in society (Oxford, England), 20, 29, 39). Chichester, West Sussex, UK: Wiley-Blackwell.

Labov, W. (2012). Dialect diversity in America : The politics of language change(Page-Barbour lectures for 2009; Page-Barbour lectures, 2009). Charlottesville: University of Virginia Press.

Martinet, A. (1952). Function, structure, and sound change. Word8. 1-32.

Martinet, A. (1955). Economie des changements phonétiques. Berne: Francke.

McCarthy, C. (2011). The Northern Cities Shift in Chicago. *Journal Of English Linguistics*, *39*(2), 166-187.

Melancon, M. E. (2000). The sociolinguistic situation of Creoles in South Louisiana : Identity, characteristics, attitudes.

Milroy, J., & Harris, J. (1980). When is a merger not a merger?: the MEAT/MATE problem in a present-day English vernacular. *English World-Wide*, *1*(2), 199-210.

Milroy, L., & Sue Margrain. (1980). Vernacular Language Loyalty and Social Network. Language In Society, 9(1), 43-70.

Milroy, L. (1987). *Language and social networks* (2nd ed.). (Language in society, 2; Language in society (Oxford, England), 2). Oxford, UK: B. Blackwell. http://www.gbv.de/dms/bowker/toc/9780631153146.pdf

Peterson, G. E., & Barney, H. L. (1952). Control methods used in a study of the vowels. *The Journal of the acoustical society of America*, *24*(2), 175-184.

Purnell, T. C. (2009). The vowel phonology of urban southeastern Wisconsin. *Publication of the American Dialect Society*, *94*(1), 191-217.

Roeder, R. V. (2010). Northern Cities Mexican American English: Vowel production and perception. *American Speech*, *85*(2), 163-184.

Shue, Y. L., Keating, P., Vicenik, C., & Yu, K. (2010). VoiceSauce: A program for voice analysis. *Energy*, *1*(H2), H1-A1.

Thomas, E. R. (2002). Instrumental phonetics. *The handbook of language variation and change*, 168-200.

Wakita, H. (1977). Normalization of vowels by vocal-tract length and its application to vowel identification. *IEEE Transactions on Acoustics, Speech, and Signal Processing*, *25*(2), 183-192.

Thomas, E. R., & Kendall, T. (2007). NORM: The vowel normalization and plotting suite. *Online Resource: http://ncslaap. lib. ncsu. edu/tools/norm*.

Wolfe, P. M. (1972). *Linguistic change and the great vowel shift in English* (Vol. 42). Univ of California Press.

Wolfram, W. (2000). Linguistic Diversity and the Public Interest. *American Speech*, *75*(3), 278-280.

Wolfram, W., & Ward, B. (2007). *American voices : How dialects differ from coast to coast.* Malden, Mass.: Blackwell.

7. Appendix

A.1 Word tokens included in analysis

/æ/: bat, bad, cast, sack, sad, sat, stab, staff, tap, bag, tag
/ɑ/: cot, dot, sob, stock, top, bog, bot
/ɔ/: caught, paw, saw, soft, stalk, toss, bought
/ɛ/: bed, dead, deaf, deck, set, step, test, beg, bet
/ʌ/: but, cup, cut, duck, dust, stud, tough, tub, bug
/ɪ/: bit, did, kiss, rib, sick, sit, stiff, tip, big

A.2 Demographic questionnaire for speakers ages 35-55

1. Age: _____
2. Gender: _____
3. Where did you grow up? _____
4. Years of Education: _____
5. Occupation: _____
6. Are you a native English speaker? _____
7. What languages are spoken in your home?_____
8. What languages do you speak? _____
9. Were you born in the Twin Cities metropolitan area? _____
10. If not, at what age did you move to the Twin Cities?_____
11. How long have you lived in the Twin Cities metropolitan area?
    a. All of my life
    b. Most of life (e.g. college out of state)
    c. Some of my life
12. Where else have you lived and for how long? _____
13. Did you attend college or graduate school out of state?
    a. Yes
    b. No
    c. Other _____

14. Did your parents grow up in the Twin Cities?
    a. Yes
    b. No
    c. Only 1
15. Did your partner grow up in the Twin Cities?
    a. Yes
    b. No
    c. N/A
16. What neighborhood or suburb is your work located in? _____
17. How many recreational or social activities do you do in your neighborhood or suburb?
    a. All
    b. Most
    c. Some
    d. None
18. How many of your friends live in your neighborhood or suburb?
    a. All
    b. Most
    c. Some
    d. None
19. How many people that you talked to in the last week live in your neighborhood or suburb?
    a. All
    b. Most
    c. Some
    d. None
20. Where do you currently live? _____

A.3 Demographic questionnaire for speakers ages 16-18

1. Age: _____
2. Gender: _____
3. Where did you grow up? _____

4. Education (e.g. year in HS or college): _____

5. Are you a native English speaker? _____

6. What languages are spoken in your home? _____

7. What languages do you speak? _____

8. Were you born in the Twin Cities metropolitan area? _____

9. If not, at what age did you move to the Twin Cities? _____

10. How long have you lived in the Twin Cities metropolitan area?
    a. All of my life
    b. Most of life
    c. Some of my life

11. Where else have you lived and for how long? _____ _____

12. Have you attended college out of state?
    a. Yes
    b. No
    c. Other _____

13. Did your parents grow up in the Twin Cities?
    a. Yes
    b. No
    c. Only 1
    d. Other _____

14. How many recreational or social activities do you do in your neighborhood or suburb?
    a. All
    b. Most
    c. Some
    d. None

15. How many of your friends live in your neighborhood or suburb?
    a. All

b. Most
c. Some
d. None

16. How many people that you talked to in the last week live in your neighborhood or suburb?
    a. All
    b. Most
    c. Some
    d. None

17. Where do you currently live? _____

A.4: Normalized F1 and F2 means by vowel class for all participants

Vowel	Mean F1	Mean F2
bat	687.668	1763.361
bet	683.138	1640.899
bit	528.667	1789.31
bot	765.775	1248.099
bought	744.472	1177.867
but	689.634	1323.103

A.5: F1 and F2 Means by vowel for 16-18 year old Female Participants

Vowel	Mean F1	Mean F2
bat	669.332	1724.785
bet	712.621	1584.554
bit	543.091	1769.937

bot	757.027	1214.468
bought	763.086	1205.081
but	706.918	1312.543

A.6 : F1 and F2 Means by vowel for 16-18 year old male participants

Vowel	Mean F1	Mean F2
bat	692.893	1757.737
bet	665.383	1675.558
bit	523.889	1814.186
bot	756.464	1256.833
bought	742.113	1200.719
but	676.463	1320.404

A.7: F1 and F2 Means by vowel for 35-55 year old female participants

Vowel	Mean F1	Mean F2
bat	696.13	1791.658
bet	671.112	1663.749
bit	516.516	1799.274
bot	775.951	1249.408
bought	740.713	1169.475
but	679.126	1342.524

A.8: F1 and F2 Means by vowel for 35-55 year old male participants

Vowel	Mean F1	Mean F2

bat	685.191	1759.323
bet	696.483	1616.392
bit	542.528	1758.868
bot	768.721	1274.317
bought	733.443	1132.465
but	708.069	1300.216