# (ay) Monophthongization in Deer Park, Texas

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This is to certify that I have examined this copy of a master's thesis by

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and have found that it is complete and satisfactory in all respects, and that any and all revisions required by the final examining committee have been made.

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**Abstract**
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/aɪ/ monophthongization as a marker of Southern speech has been an object of linguistic study for decades (Evans 1935, Johnson 1928, Wise 1933). Recent studies by Fridland (2003), Thomas (2001), and Labov, Ash, and Boberg (2006) have begun to investigate the correlations between /aɪ/ monophthongization and the social features of ethnicity, age, gender, and city size. The following thesis takes up the study of /aɪ/ monophthongization in the city of Deer Park, Texas, a suburb located 20 miles southeast of Houston.

There are two main goals to this study. The first goal is to test the effect of linguistic variables, task variables, and social variables on /aɪ/ monophthongization in Deer Park, Texas, and to compare the findings for these variables to existing research. The second goal of this study is to carry out and compare three different methods for measuring monophthongization. For this study, three measurements have been calculated for each vowel: ΔF1, change in vowel height over time; ΔF2, change in vowel backness over time; and offset F2-F1, the difference between the first and second formants at the vowel offset.

The statistical results indicate that voicing of the following consonant, open versus closed syllable, word list versus map task, map task versus interview, gender, and youngest versus middle age group all have a significant effect on /aɪ/ monophthongization whether it is measured by ΔF1, ΔF2, or offset F2-F1. The difference between the middle and oldest age group is only statistically significant for ΔF1, which suggests that ΔF1 may be a particularly important cue for distinguishing between middle and oldest age group speakers.

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The following thesis would not be possible were it not for the thirty generous members of the Deer Park community who were willing to set aside time to participate in my study.

To my parents, sisters, Beth Hamburg, and Christina Shideler:  thank you for listening, even when you didn't know what “monophthongization” was or why anyone would want to study it.

# 1. Introduction

## 1.1 Thesis Overview

/aɪ/ monophthongization as a marker of Southern speech has been an object of linguistic study for decades (Evans 1935, Johnson 1928, Wise 1933). Recent studies by Fridland (2003), Thomas (2001), and Labov, Ash, and Boberg (2006) have begun to investigate the correlations between /aɪ/ monophthongization (also known as glide weakening) and the social features of ethnicity, age, gender, and city size. The following thesis takes up the study of /aɪ/ monophthongization in the city of Deer Park, Texas, a suburb located 20 miles southeast of Houston. This study seeks to contribute to the body of sociophonetic research on /aɪ/ monophthongization by testing the effect of several social variables on monophthongization, including both speaker and task variables, and by comparing the results for three different methods of measuring monophthongization.

## 1.2 Goals

There are two main goals to this study. The first goal is to test the effect of linguistic environment, task formality, gender, ethnicity, age, education, and residence history on /aɪ/ monophthongization in Deer Park, Texas, and to compare the findings for these variables to existing research.

The second goal of this study is to carry out and compare three different methods for measuring monophthongization. Much of the existing literature on phonological variables in sociolinguistic research has relied upon either auditory coding of data or raw formant values and does not subject the data to statistical analysis. For this study, three measurements have been calculated for each vowel: ΔF1, change in vowel height over time; ΔF2, change in vowel backness over time; and offset F2-F1, the difference between the first and second formants at the vowel offset. The statistical results for sequential linear regressions using each of these measurements as dependent variables are discussed in turn.

This thesis attempts to address the following research questions: Can /aɪ/ monophthongization be predicted by language-internal variables? Can /aɪ/ monophthongization be predicted by task formality? Can /aɪ/ monophthongization be predicted by speaker variables? If so, does the addition of task formality and speaker variables to the statistical model significantly improve the prediction of /aɪ/ monophthongization when compared to a model containing only linguistic variables? This study will also discuss three means of measuring /aɪ/ monophthongization, with the associated research question: Which outcome of /aɪ/ monophthongization (ΔF1, ΔF2, or offset F2-F1) is best predicted by these independent variables?

The thesis is organized as follows. §2 provides an introduction to the background literature on /aɪ/ monophthongization and to the city of Deer Park. §3 describes the methods used in this study. In §4, the results of the study are provided and discussed. §5 draws conclusions about the study and suggests directions for future research.

## 2. Background

### 2.1 Introduction

This purpose of this section is to situate the present work both in terms of the area in which the research was conducted and in terms of the research which preceded this study. §2.2 reviews the dialectological literature on /aɪ/ monophthongization in the Southern United States, including early references to /aɪ/ monophthongization (§2.2.1) and more recent work in the field of sociolinguistics which attempts to correlate monophthongization with social features (§2.2.2). §2.3 describes the history of Deer Park (§2.3.1), provides some more recent information on the city's demographics (§2.3.2), and summarizes some of the content of the interviews related to the subjects' perspectives on their own city (§2.3.3).

### 2.2 Previous Work on /aɪ/ Monophthongization

#### 2.2.1 Early References to /aɪ/ Monophthongization

Since as early as the 1920s and 1930s, dialectologists doing research in the South were publishing descriptions of /aɪ/ monophthongization. /aɪ/ monophthongization is a phonological process in which the diphthong /aɪ/ goes through glide weakening, which Edgerton (1935) describes as retaining a "scarcely perceptible glide towards [ɪ]" (p. 190), or complete loss, in which the vowel is pronounced as simply [a]. Johnson (1928) describes Southerners as "pronouncing *I* and *my* as if they were written *Ah* and *mah*" (p. 381). Wise (1933) notes that "the second element of the diphthong, [ɪ], is often omitted in the pronunciation of the pronoun *I*, so that it is pronounced [ɑ]," and that "*blind* [blaɪnd] may sometimes be heard as *blond* [blɑnd]" (p. 40). Evans (1935) takes the analysis further, noting that /aɪ/ monophthongization does not generally occur before voiceless consonants, such as /p, t, k/. Thus the expected pattern for most of the South would be for monophthongization to occur in open syllables or before voiced consonants but not before voiceless consonants, as exemplified in (1).

| | | |
|---|---|---|
| (1) | high | [ha:] |
| | hide | [ha:d] |
| | height | [haɪt] |

Although tracing the origins of phonological changes which began before modern recording equipment existed is difficult, Bailey (1997) argues on the basis of dialectal records that /aɪ/ monophthongization either did not emerge or did not become widespread in Texas until the last quarter of the nineteenth century.

### 2.2.2 Sociolinguistic Studies of /aɪ/ Monophthongization

In recent years, studies correlating /aɪ/ monophthongization with social variables have become more common. Fridland (2003) investigated the relationship between ethnicity and /aɪ/ monophthongization by comparing Caucasian and African-American speakers in Memphis, Tennessee. The results of her study indicated that neither Caucasians nor African-Americans produced fully monophthongal vowels before voiceless consonants, but African-Americans were more likely to show some amount of glide weakening before voiceless consonants than Caucasians. While African-Americans had glide weakening before voiceless consonants at rates of 44%, Caucasians weakened before voiceless consonants only 25% of the time.

With respect to gender, Fridland found that men and women showed similar overall rates of weakening, but that men in her study were more likely to produce fully monophthongal versions of /aɪ/ than women in all phonetic environments. While African-Americans showed similar rates of glide weakening in all age groups, there was a divide in the Caucasians between the two oldest age groups and the youngest age group, with the youngest age group showing a decrease in glide weakening.

Thomas (2001) examined the vowel spaces of several Southern speakers. He notes that while some speakers who monophthongize /aɪ/ produce the resulting vowel as [ɑː], other speakers front the monophthongal vowel to [æː], and most speakers produce a vowel which is intermediate between the two. Thomas also writes that while young Caucasians from rural areas of Texas still produce monophthongal versions of /aɪ/, the vowel systems of younger speakers from major metropolitan areas like Houston, Dallas-Fort Worth, and Austin no longer show monophthongization.

Labov, Ash, and Boberg (2006) measured /aɪ/ monophthongization in recordings collected via telephone surveys throughout North America for their *Atlas of North American English*. According to Labov et al., /aɪ/

monophthongization is the first step in the Southern Shift (Figure 2.1). The movement of /aɪ/ leaves a void in the system, creating a pull chain which then causes the downward movement of /eɪ/.

Labov et al. found that monophthongization only happened at high rates before voiceless consonants in two small pockets of the South (Figure 2.2). For the rest of the South, including Houston, monophthongization most frequently occurred in the expected environments: before voiced consonants and in open syllables.

In a linear regression with percentage of /aɪ/ monophthongization as the dependent variable, Labov et al. tested the significance of the social factors gender, city size, and age. The results indicated that while gender was not significant, city size and age were. Speakers from smaller cities produced more monophthongized tokens, as did older speakers.

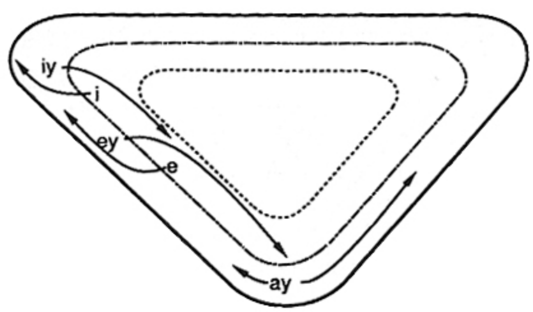


Figure 2.1. The Southern Vowel Shift. (From Labov 1994.)

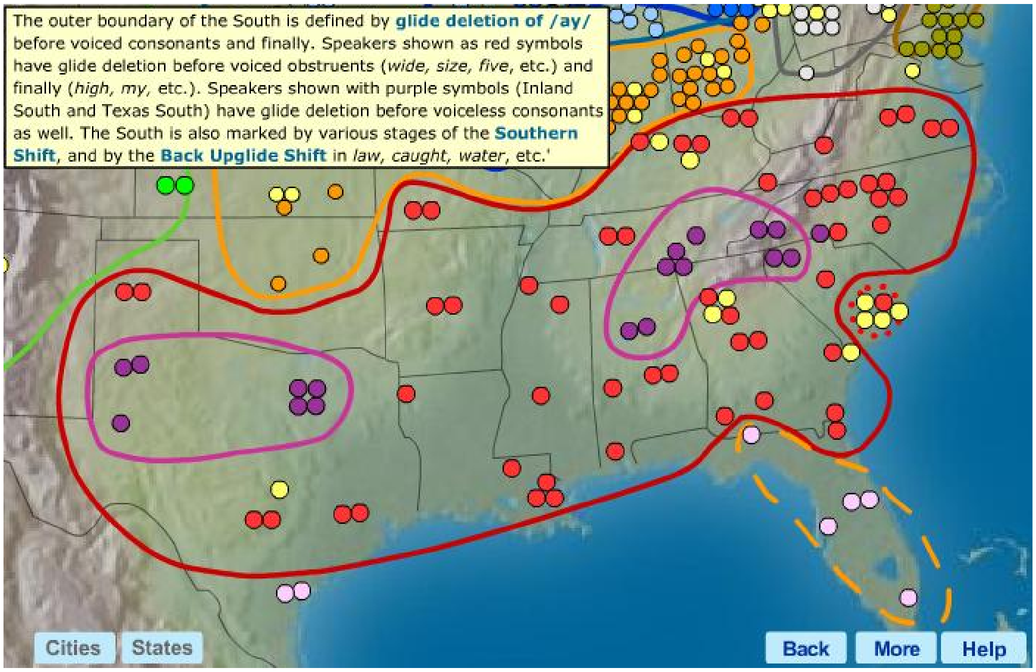

Figure 2.2. Map showing the geographical boundary for /aɪ/ monophthongization in the South. (From Labov, Ash, & Boberg 2006.)

**2.3 Deer Park, Texas**
**2.3.1 Brief History of Deer Park**

Although Deer Park, Texas, was officially founded by Simeon Henry West in 1892-1893, West's original attempts at drawing permanent settlers to the town were thwarted by the unpredictable weather. Deer Park's proximity to the Houston Ship Channel, which leads into the Gulf of Mexico, made it a frequent target for hurricanes. For a period of roughly thirty five years, the city was only sporadically inhabited as a result of recurrent natural disasters (Wells 1985).

That same body of water was what led the Shell Oil Company to begin construction of a refinery in Deer Park in 1928. Shell needed a way to get its oil from West Texas to the East Coast, and the company decided that the Houston Ship Channel would serve as an ideal port for its tankers (Wells 1979). Workers were brought in to aid in the construction of the refinery, many of whom were previously employed by Shell in St. Louis, Missouri, and Alton, Illinois. In 1941, the Shell Chemical Plant was built alongside the Shell Refinery, creating even more jobs in the area. By 1948, another chemical company, Diamond Shamrock, had added a plant along the Ship Channel. The Lubrizol Corporation and Rohm and Haas followed suit in the 1950s (Yeary Weidig 1976). The construction of these plants served as the major impetus for immigration to Deer Park, with an abundance of jobs available to incoming residents.

With an influx of new residents, the demand for city services grew. In 1931, Deer Park's first official school opened. In 1948, the city of Deer Park voted to incorporate. The first Deer Park City Hall was built in 1950, and the Deer Park Public Library opened in 1962. In the 1950s and 1960s, land from surrounding areas was annexed into Deer Park twice, increasing the size of the city to 15.34 miles (Yeary Weidig 1976). By 1973, the city's main thoroughfare, Center Street, had been opened all the way from Highway 225 to Spencer Highway, creating a direct route from the city's many chemical plants to the neighboring city of Pasadena, Texas (Wells 1985). Between 1931 and 1976, the city's population grew from 50 residents to roughly 20,000 (Figure 2.3).

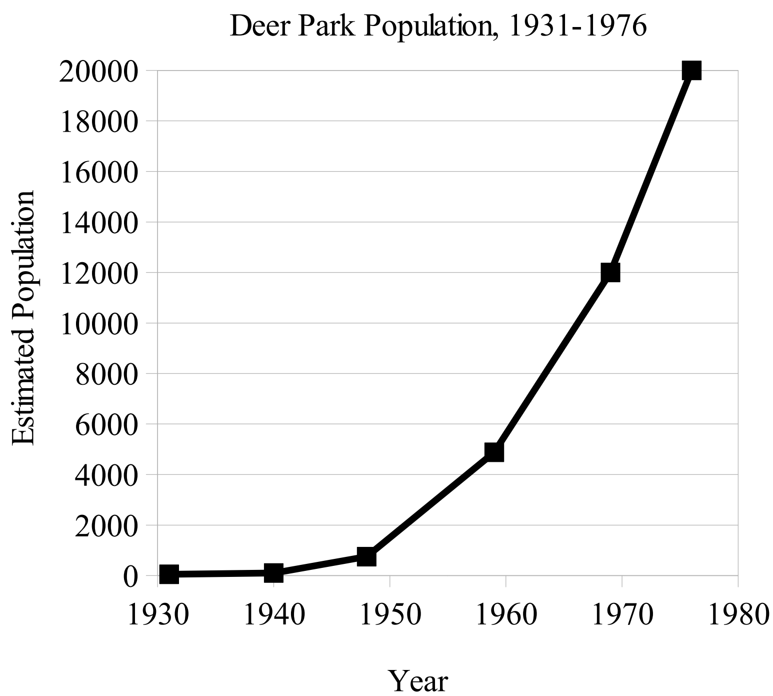

Figure 2.3. Estimated Deer Park population for the years 1931-1976. (Estimates taken from Yeary Weidig 1976).

### 2.3.2 Modern Deer Park

The city of Deer Park is located about 20 miles southeast of downtown Houston (Figure 2.4). As of the 2000 U.S. Census, Deer Park's population had reached 28,520. Immediately east of Deer Park is the city of Pasadena, the largest suburb in the Houston Metropolitan Area, with a population in 2000 of 141,674. Deer Park is 20-30 minutes from downtown Houston by car, 45 minutes from Galveston Island, and 5-6 hours from the Mexican border. In Labov et al.'s map from *The Atlas of North American English* (Figure 2.2), Deer Park, Pasadena, and Houston would all fall within the South (red line) but not within the Inland South or Texas South (purple lines).


Figure 2.4. Map of Deer Park, Texas. (From City of Deer Park 2009.)

At the time of the 2000 U.S. Census, Deer Park was 90% Caucasian and 15.2% Hispanic. Figure 2.5 is a map of Deer Park which is shaded according to the percentage of the population that is Hispanic for a given area, with darker shading indicating a higher Hispanic population. The highest percentages of Hispanics in Deer Park are found along the border with the city of Pasadena, which was 48.2% Hispanic in the year 2000.

The median income for a Pasadena family in 2000 was $38,522 compared to Deer Park's $61,334. In Pasadena, 16% of the population was below the poverty line, whereas only 5.6% of Deer Park fell into this category. 88% of Deer Park citizens over the age of 25 had a Bachelor's Degree or higher, while only 12.7% of Pasadena citizens in the same age group held higher degrees.

While the differences between these two cities may seem striking, there is quite a bit of variation within the city of Pasadena, which is more than 4 times the size of Deer Park. Deer Park citizens frequently go to shopping centers, restaurants, and healthcare facilities in Pasadena, and many Deer Park High School students technically live within the city limits of Pasadena; thus, there exists some degree of overlap between the two cities.

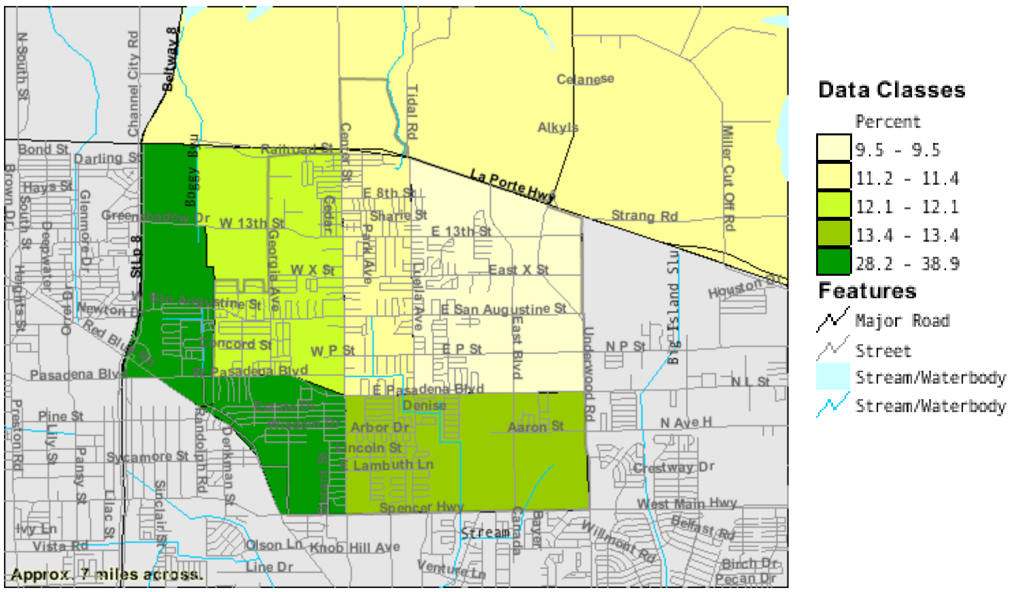

Figure 2.5. Hispanic population in Deer Park. (From the U.S. Census Bureau.)

### 2.3.3 Perspectives on Deer Park from Interviews

A number of themes came up repeatedly in interviewing the 30 subjects from Deer Park who provided data for this study. One common move was for interviewees to characterize Deer Park as a small town as compared to the "big cities" of Pasadena and Houston. One young adult male speaker (CM27) commented that Deer Park was "just one big neighborhood." This theme is further exemplified in the responses of two female speakers from the middle age group (CF33 and CF40) to the question, "Why would you rather live in Deer

Park than Pasadena or Houston?"

> CF33: It just still has that small town feel about it. Growing up here it just seemed like everything was right around my house. I think we took our bike everywhere we went. I just feel like everything was just kind of right here in one little square block area.
>
> CF40: I think just the small town feel of it. You still have parades down the main street. Volunteer fire department speaks volumes. Volunteer EMS men who want to be there. They're just compassionate people in this town.

This characterization of Deer Park is also apparent in the *Deer Park Vistor's Guide*, a pamphlet produced by the City of Deer Park and the Deer Park Chamber of Commerce. The pamphlet describes Deer Park as a "friendly hometown" and a "family-oriented community," "free of congestion, high prices, and big city traffic." A quote from Mayor Wayne Riddle in the guide encourages visitors to "spoil [themselves] with the comforts of our home-away-from-home and warm southern hospitality."

The subject of diversity also came up at many points in the Deer Park interviews despite the fact that the interviewer never raised the issue. Due in part to Texas' relative proximity to Mexico, the largest ethnic population other than Caucasians in Deer Park is the Hispanic population. Despite the fact that the city was still 90% Caucasian as of the last census, many subjects expressed the belief that the Hispanic population in the city was growing. CM53, a male speaker from the oldest age group, gave a fairly typical response.

> CM53: Well when I first moved here it was definitely distinctly Anglo, but now in this period we have turned a lot Hispanic into Deer Park now. So it's a pretty big change over the eighteen, nineteen years I've lived here.

When asked to compare Deer Park to the rest of the South, the majority of subjects agreed with young female speaker CF18B that Deer Park was "not as southern as the rest of the South." Deer Park was described as being less agricultural in nature than other parts of the South, and was said by many subjects to have a less noticeable southern drawl. CM33, a male from the middle age group, noted that in his travels he had been told that his accent was "folksy" but not "comically southern." Most subjects believed that the Texan accent was different from the Southern accent of Southeastern states like Georgia and Alabama. One young female (HF26) contrasted the Deer Park accent with other regions in her interview.

> HF26: I don't think it sounds as twangy, but I guess there's people who do speak like that, but we just don't. I don't think we sound twangy like a country music video or anything like that. Here in Deer Park it doesn't seem like they have it as bad.

When asked, "Do you consider yourself a southerner?" more than one subject responded with, "No. I consider myself to be a Texan." Within Deer Park, then, it seems that there is a crucial distinction between Texas and the rest of the South, a distinction exemplified in the Texas tourism commercial slogan "it's a whole other country." "Texan" and "Southern" are terms that invoke rather different ideas for the subjects I interviewed. Texans were seen as somehow less southern than people from the rest of the South, especially in terms of accent, and subjects were eager to associate themselves with Texas rather than the South at large. The large Hispanic population of Texas was also frequently cited as a distinct feature of the state. CF33B, a female from the middle age group, addressed the contrast between "Texans" and "southerners" directly.

> CF33B: I think it's distinct in that I think Texans are a little more independent, and they think of themselves more as Texans than they do as Americans. And I think that's a characteristic that is unique to Texas more so than it is unique to other states.

While the topics described above represent only a few of the recurrent themes in the interviews that could have been discussed, they were chosen because they occurred most frequently in the interviews and because they seemed relevant to the Deer Park subjects' own beliefs about their city. Although a detailed qualitative study of the interviews was not the goal of the present study, the issues of suburban versus urban settings, ethnic diversity, and regional boundaries are all issues that are worth considering when describing the social life of a community. These comments are intended to better situate the city of Deer Park within the South, providing a more in-depth perspective on the community than what might otherwise be gained from historical facts and demographic data.

Deer Park, as discussed in §2.3.2, is a suburb of Houston. In early historical linguistics, a concern with documenting potentially receding dialectal features led many researchers to seek out NORMs - non-mobile, older, rural males – as representatives of supposedly "pure" dialects (Malmkjaer 2002). More recently, sociolinguistics has drawn on what is called wave theory, where it is assumed that "changes in language spread outwards from centers of influence to the surrounding areas" (Hudson, 1980, p. 41). Working under this theory, Labovian sociolinguistics has focused on urban dialectology, studying the intersection of linguistic and social variables in large urban centers like New York City and Philadelphia.

While there is certainly much to be learned by studying these two extremes – the epicenters of change and the strongholds of relic features – for intermediate areas to be ignored would mean failing to account for the sociolinguistic workings of a large sector of the population. If, as Labov (1994) writes, rural communities are "suffering from the decline in agriculture and a shrinking local population" (p. 23), it could be advantageous for sociolinguists to pay more attention to the thriving suburban areas which surround major urban centers. With that in mind, this thesis takes as its community of interest the suburb of Deer Park, providing some insight into how /aɪ/ monophthongization operates in an area which is neither urban nor rural.

## 2.4 Summary

This section outlined some of the previous research on /aɪ/ monophthongization. The history of the city of Deer Park, Texas, and its modern demographics were also discussed. Finally, the content of the interviews carried out for this study was described. Figure 2.6 summarizes the results of previous research on /aɪ/ monophthongization in the South.

| **Less Monophthongization** | **More Monophthongization** |
|---|---|
| Pre-Voiceless Contexts | Pre-Voiced Contexts and Open Syllables |
| Caucasians | African-Americans |
| Younger Speakers | Older Speakers |
| Cities with >100,000 People | Cities with < 100,000 People |
| Major Metropolitan Areas | Rural Areas |

Figure 2.6. Factors influencing /aɪ/ monophthongization.

Based on the previous research, it would be expected that in Deer Park the highest rates of monophthongization would occur before voiced consonants and in open syllables and that older speakers would monophthongize more than younger speakers. With respect to city size, it is less clear what to expect. Since Deer Park is a suburb of Houston, it can't be classified neatly into the urban or rural category. Previous analyses have chosen to lump suburban areas in with rural areas, as in Labov, Ash, and Boberg's (2006) category of cities with less than 100,000 people, or to treat them as part of urban areas, as in Thomas' (2001) category of major metropolitan areas. This study aims to expand upon previous research by investigating the phenomenon of /aɪ/ monophthongization in the suburb of Deer Park. With that goal in mind, §3 turns to the methods used in this study.

## 3. Methods
### 3.1 Introduction

In this section I describe the methods used in this study. §3.2 provides information on subject recruitment and sample demographics. §3.3 explains the three tasks performed by each speaker, including an interview (§3.3.1), a map task (§3.3.2), and a word list (§3.3.3). §3.4-3.5 describe the acoustic and statistical methods used in analyzing the data.

### 3.2 Subjects

The subjects for this study were recruited primarily by email and through posts requesting volunteers on social networking sites (see recruitment email in Appendix A). Recruitment emails were sent to employees of one school within the Deer Park Independent School System, as well as to some of the employees of a local chemical plant. Additional subjects were recruited among these employees' family members via the snowball ("friend of a friend") method.

In order to participate in the study, subjects had to be native speakers of English from Deer Park who were at least 18 years old. A total of thirty subjects participated in the study, all of whom signed a consent form and completed a demographic questionnaire (Appendix B, C). The questionnaire gathered information on speaker sex, age, ethnicity, occupation, education, and residence history. Participants were also asked whether their parents were from Deer Park and whether they or their parents spoke any languages other than English.

Twenty eight of the thirty subjects self-identified as White or Caucasian while two self-identified as Hispanic. Of these two, both had Spanish speaking parents, but only one spoke Spanish herself. There was also one monolingual English speaker whose mother was bilingual in French and English.

Twenty three of the subjects had never lived outside of Texas, while seven had spent some time in other states. Only two of the thirty subjects had lived outside of Texas before puberty, and these two subjects both spent some of their pre-puberty years as well as the majority of their adult lives in Texas.

Education levels ranged from a junior high education to Master's degrees, and twenty nine of the thirty subjects had completed a high school degree. Fifteen of these subjects had obtained a Bachelor's degree or higher. Breakdowns by sex and age group are provided in Table 3.1.

Table 3.1. Number of subjects by sex and age group. (n = 30)

| | Youngest Group (Age 18-31) | Middle Group (Age 32-47) | Oldest Group (Age 48-66) | Total |
|---|---|---|---|---|
| Male | 5 | 3 | 5 | 13 |
| Female | 6 | 4 | 7 | 17 |
| Total | 11 | 7 | 12 | 30 |

### 3.3 Materials and Data Collection

#### 3.3.1 Interview Task

Subjects first participated in a one-on-one interview lasting about 30 minutes (Appendix D). The interview task was intended to gather a more spontaneous style of speaking by comparison with the more formal and controlled style used in the word list task (§3.3.3), as based on the traditional Labovian model of style as attention paid to speech (Labov 1972). The first section of the interview focused on residence history and language exposure and was primarily intended to gather background information about the subjects and confirm their answers to the demographic questionnaire.

The second section of the interview focused on subjects' impressions of Deer Park as a city and required them to compare Deer Park to the nearby cities of Pasadena and Houston, as well as to the rest of the South. The participants were asked whether they believed that Deer Park had any major problems as a city and whether they thought Deer Park was a good place to live. Subjects were also asked whether they would self-identify as a southerner.

The third and final section of the interview focused on travel and perceptions of the southern accent. The subjects discussed how often they traveled and where they had vacationed in the course of their lifetimes. Participants were asked whether they visited Houston often and whether they felt safe in Houston. The subjects discussed the reasons why they had chosen to live in Deer Park rather than Houston. This section also required subjects to provide features of the southern accent and to reflect on whether they had ever been teased about their accent or faced accent related communication barriers.

### 3.3.2 Map Task

The second task performed by the subjects was a map task. Map tasks were originally developed in speech and hearing sciences to elicit connected speech in a semi-scripted way, allowing for the study of suprasegmental and segmental features. These map tasks were generally carried out by pairs of speakers in scenarios where one speaker was required to duplicate the path on another speaker's map using only verbal cues (Anderson et al. 1991). In current phonetic research, map tasks are used to elicit words containing specific phonetic variables (Ladefoged 2003). The adapted map task used in this study was carried out by single individuals. Since the landmarks were chosen by the researcher but the task was not scripted, the map task was expected to be intermediate between the interview and the word list with respect to formality. The map depicted a fictional zoo with various landmarks indicating the zoo exhibits (Appendix E). The instructions accompanying the map were to describe how to get from the zoo entrance to the sea lion arena as if giving directions to a friend and to note the times when shows take place at the arena. The task was explained to the subjects before the recording began and they were given an opportunity to ask questions if they did not understand the task. The landmarks and show information on the map yielded a possible 18 tokens containing /aɪ/, not including repetitions, the expected use of the direction "right," and any other /aɪ/ tokens produced in the course of giving directions.

### 3.3.3 Word List Task

The final task completed by each subject was a word list (Appendix F). The task was again explained to the subjects before the recording began so that the subjects could ask for clarification if they were in any way confused about the task. The word list included a total of 223 randomized words, 66 of which contained /aɪ/. The words were read the in the carrier phrase, “Say _____ quickly,” to attempt to control for intonation. Dummy words which were not measured were inserted at the beginning and end of each column to decrease list effects.

### 3.3.4 Collection Information and Data Processing

All subjects were recorded in a quiet room in a Deer Park household using a Marantz CDR 300 digital CD recorder and an Audio-Technica AT4041 tabletop microphone. This room was chosen because it contained no computers or other electronic equipment which might lead to noise in the recordings and because it did not border any other rooms which might be in use during recording sessions. Each task was recorded as a separate track in a .wav file with a sampling rate of 44.1 kHz. The recordings were then transferred to a computer and downsampled to 11 kHz before analysis.

The two unscripted tasks were orthographically transcribed and the tokens containing /aɪ/ were extracted from all three tasks for each speaker. Tokens from the first part of the interview in which subjects were asked about their residence history and language experience were excluded from analysis to allow the subjects time to adjust to the interview task, as well as to avoid treating the portion of the interview that was mostly a straightforward question and answer session as identical to the later portion of the interview in which subjects were given more freedom in their answers. To avoid skewing the data in favor of any particular word, no more than three instances of one word were measured from each task for a single speaker. Tokens which were either judged as speech errors or which were pronounced as an unstressed [ə] rather than a diphthongal or monophthongal version of [aɪ] were noted but were not included in the final analysis. After the removal of these tokens, a total of 3,780 tokens remained for acoustic and statistical analysis. The number of tokens analyzed for each subject ranged from 87 to 202, with an average of 126 tokens per speaker.

Each token was coded for speaker, sex, age, ethnicity, education, residence history, task, voicing of following consonant, and open or closed syllable. Age was divided into three groupings: youngest, middle, and oldest, with ranges of 18-31, 32-47, and 48-66 years, respectively. Since regression analyses require discrete independent variables to be converted into dichotomous variables (Tabachnick and Fidell 2007), age was recoded to compare two groups at a time: the youngest group versus the middle group and the oldest group versus the middle group.

Ethnicity was coded as a binary variable indicating that a speaker was either Caucasian or Hispanic. Education was also coded in a binary fashion, with subjects classified according to whether they had or had not received a Bachelor's degree. The distinction between subjects with and without a Bachelor's degree was chosen as the most important educational division because of both the educational significance of attaining a Bachelor's degree and because of the implied mobility involved – while Deer Park citizens could achieve an Associate's degree just outside the Deer Park city limits in Pasadena, earning a Bachelor's degree would mean traveling at least as far as Houston.

Residence history reflected whether a subject had ever lived outside the South before puberty. Task was recoded in a manner similar to the recoding of age, comparing the interview to the map task and the map task to the word list. The linguistic variables were coded to compare /aɪ/ before voiced and voiceless following consonants and in open and closed syllables.

All tokens were also coded as sounding either diphthongal or monophthongal according to the auditory impression of the researcher. If an offglide was heard, the vowel was classified as diphthongal; if an offglide was not heard, the vowel was classified as monophthongal.

### 3.4 Acoustic Analysis

The vowel analysis was performed using Praat signal analysis software (version 5.0.47 for Windows). A Praat script was used which automatically calculated values for the first and second formants (F1 and F2) at points 20%, 50%, and 80% into the selected vowel, producing a total of six formant measurements per vowel. These points were intended to represent the vowel onset, midpoint, and offset. Figures 3.1 and 3.2 show these three measurement points for a typical monophthongal production of *bye* and a typical diphthongal production of *height* from a female in the middle age group (CF40). Figure 3.3 shows these measurement points in a more complex token, a production of *time* from a male in the middle age group (CM33) which is auditorily diphthongal but has less extreme formant movement in the spectrogram. Measurements were taken within each vowel at points based on percentages of the total duration rather than simply measuring at points a certain number of milliseconds into the vowel in an attempt to make the measurements of vowels of varying durations more comparable. The onset and offset measurements were taken at 20% and 80% rather than at the extreme endpoints of the vowel selection to avoid formant changes related to the effect of neighboring consonants. Vowel duration (from actual onset to offset) was also measured.

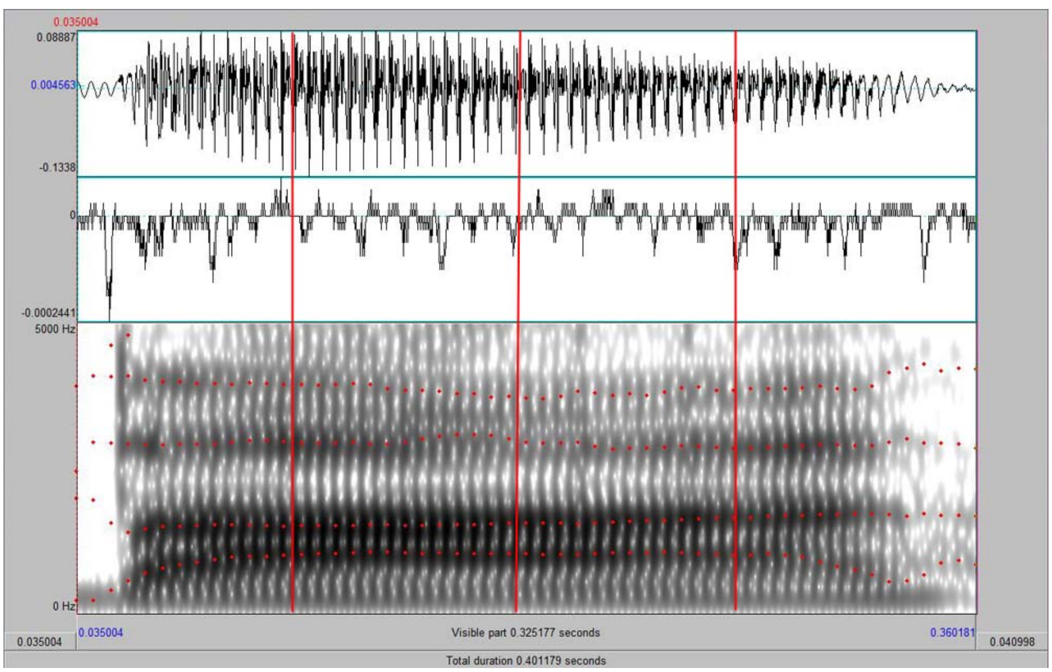


Figure 3.1. Waveform and spectrogram for a monophthongal production of *bye* [ba:] from a female speaker in the middle age group (CF40). Red lines represent measurement points at 20%, 50%, and 80% into the vowel.

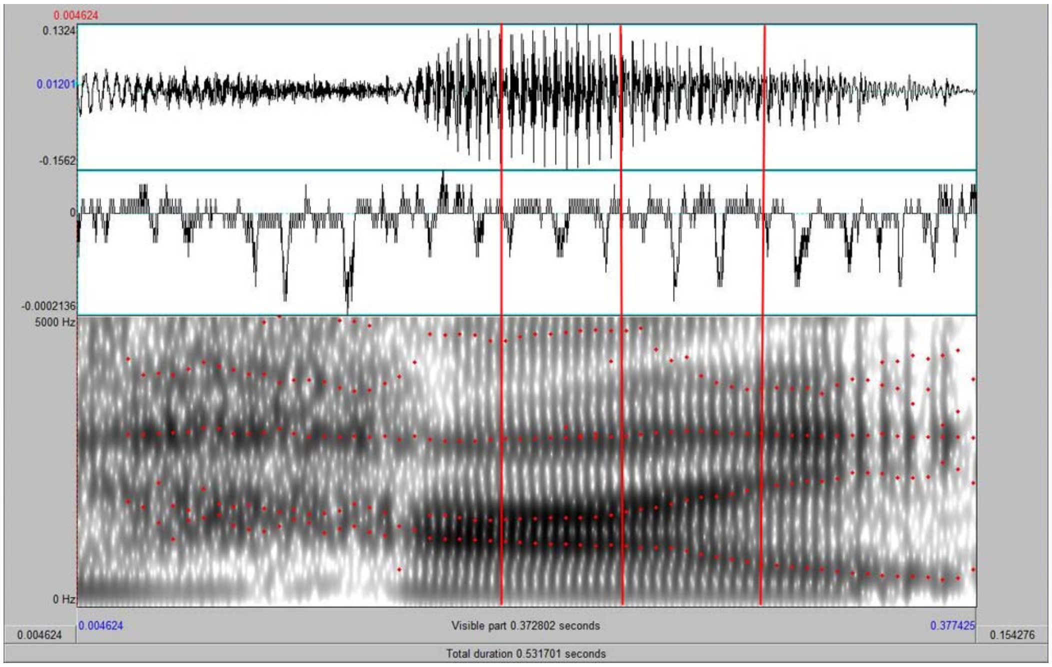


Figure 3.2. Waveform and spectrogram for a diphthongal production of *height* [haɪt] from a female speaker in the middle age group (CF40). Red lines represent measurement points at 20%, 50%, and 80% into the vowel.

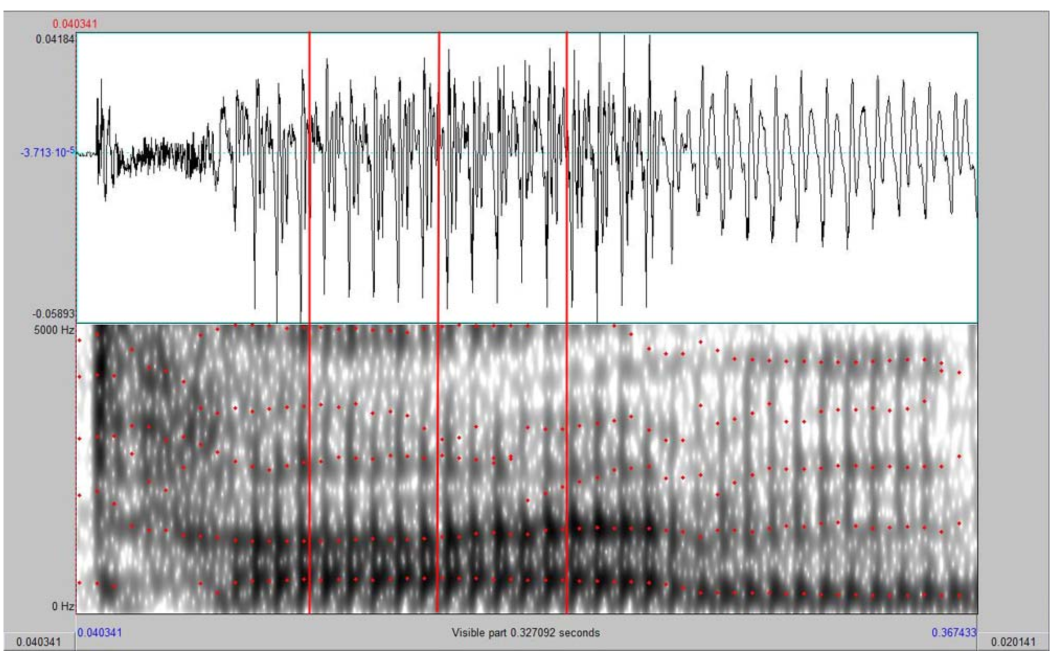


Figure 3.3. Waveform and spectrogram for a diphthongal production of *time* [taɪm] from a male speaker in the middle age group (CM33). Red lines represent measurement points at 20%, 50%, and 80% into the vowel.

Boxplots for both F1 and F2 were generated using SPSS statistical software (version 16.0.1 for Windows). Formant values which were classified by SPSS as outliers were remeasured by hand to correct for possible formant tracking errors.

To represent spectral change in the vowels over time, two measurements were taken. These measurements capture information about the trajectories of the first and second vowel formants (F1 and F2, respectively).

$\Delta$F1 = [End F1 (80%) - Beginning F1 (20%)] / Duration (ms)

$\Delta$F2 = [End F2 (80%) - Beginning F2 (20%)] / Duration (ms)

It would be expected in an upgliding vowel like /aɪ/ that over time the value of F1 in Hertz would decrease and that the value of F2 in Hertz would increase, indicating the presence of the /ɪ/ glide. Change in F1 and F2 are measures which make it possible to track gliding in the vowel. A vowel with a lower $\Delta$F1 would be showing more movement over time. Lower $\Delta$F1 values would therefore be expected in more diphthongal vowels, while higher $\Delta$F1 values would be expected in more monophthongal vowels. A vowel with a lower $\Delta$F2 would be showing less movement over time. Lower $\Delta$F2 values would therefore be expected in more monophthongal vowels, while higher $\Delta$F2 values would expected in more diphthongal vowels. This method of vowel measurement corresponds to what Morrison (2007) calls the "slope hypothesis." Morrison writes that under this hypothesis, the most important cues for the perception of vowel quality are "whether the change in the frequency of each formant is positive or negative and the rate of change in time” (p. 4).

A third value, offset F2-F1, was also calculated. This value represents the distance between the second and first formants at a point 80% into the vowel duration. For offset F2-F1, when the /aɪ/ data are rank-ordered so that F2-F1 values are correlated with temporal variables, a higher value will again tend to represent a more diphthongal vowel, while a lower value will tend to represent a more monophthongal vowel.

While ΔF1 and ΔF2 are both measurements of vowel inherent spectral change (i.e., trajectory) which are scaled by duration, offset F2-F1reflects only the distance between the first and second formants at one point in time and therefore does not take duration information into account. It is not clear what effect biological differences between males and females may have on these measurements as compared to the traditional raw Hertz values used in sociophonetic studies. For the purpose of this study, the F1 and F2 values which were used in calculating ΔF1, ΔF2, and offset F2-F1 were not normalized. While using the unnormalized values allows a closer comparison to previous research which did not use normalization techniques, it should be noted that the decision not to normalize the vowels could potentially affect the results for monophthongization by gender.

Histograms for all three dependent variables, ΔF1, ΔF2 , and offset F2-F1, were examined in SPSS to confirm that the assumption of normality had been met.

### 3.5 Statistical Analysis

To assess the relationship between each of the dependent variables and several independent variables simultaneously, multiple linear regression was used. The independent variables, as discussed above in §3.3.4, included both language-internal and language-external factors. The language internal factors tested included voicing of the following consonant and open or closed syllable. Two types of language-external factors were tested: factors relating to task formality and speaker variables. For task formality, the interview task was compared to the map task and the map task was compared to the word list. The speaker variables tested included gender, ethnicity, age (oldest group versus middle group and youngest group versus middle group), education, and residence history. Three separate linear regressions were carried out with these same independent variables but with $\Delta$F1, $\Delta$F2, or offset F2-F1 as dependent variables.

In each case, sequential (also known as hierarchical) regression was used. Sequential regression allows the researcher to assess the significance of adding each set of independent variables to the regression equation (Tabachnick and Fidell 2007). For the purposes of this study, three blocks of independent variables were used. The first block of independent variables included the linguistic variables of voicing of the following consonant and open or closed syllable. The second block of independent variables included the task variables interview versus map task and word list versus map task. The final block of independent variables included the social variables gender, ethnicity, age, education, and residence history. Using sequential regression rather than standard regression makes it possible to evaluate the model including linguistic variables alone and then to add task and social variables to the equation, determining whether the addition of these sets of variables significantly improves the model or not at each step in the process.

One issue to consider in analyzing the data collected for this study is that the tokens, which were labeled according to linguistic, task, and speaker factors, are nested within speakers. It therefore cannot necessarily be assumed that any two tokens are fully independent of one another, since they may have been spoken by the same person. To address the problem that there may be some additional influence of individual differences on monophthongization, a random effects model was used. This model allows the intercept to vary by individual, accounting for the fact that there could be individual characteristics which are unmeasured but which may influence monophthongization for a particular speaker.

All statistical results were generated using SPSS statistical software (version 16.0.1 for Windows).

## 4. Results
### 4.1 Introduction

In this section I present the results of the data analysis. Descriptive tables for the dependent and independent variables and token counts by independent variable are provided in Appendices G and H. The results are organized according to the independent variables to facilitate a comparison of the hypotheses with the results. In each section, results based on auditory coding of the data as either monophthongal or diphthongal are first discussed. This is followed by the results for the acoustic measures, which were subjected to inferential statistical analysis to enable the simultaneous testing of all of the independent variables. §4.2 describes the results for the linguistic variables voicing of the following consonant and open versus closed syllable. §4.3 takes up the discussion of the results for the task variables (map task versus interview and map task versus word list). §4.4 addresses the results for the speaker variables gender, ethnicity, age, education, and residence history. §4.5 concludes the results section by summarizing the main findings for all of the variables tested.

### 4.2 Linguistic Variables
#### 4.2.1 Voicing of the Following Consonant

The hypotheses for voicing of the following consonant, in which syllables of /aɪ/ which end in a voiced consonant are compared to those which end in a voiceless consonant, are as follows:

H1: /aɪ/ monophthongization will occur more before voiced consonants than before voiceless consonants.

H0: There will be no significant difference in /aɪ/ monophthongization before voiced and voiceless consonants.

Table 4.1. Frequency of /aɪ/ monophthongization by following consonant.

| | Voiced | Open | Voiceless | Total |
|---|---|---|---|---|
| Percentage Auditory Monophthongization | 531 (14.1%) | 189 (5%) | 60 (1.6%) | 780 (20.6%) |

The frequencies of /aɪ/ monophthongization by following consonant are given in Table 4.1. Figure 4.1 shows the percentage of auditory monophthongization before voiced and voiceless consonants only. Monophthongization occurs before a voiced consonant in 14.1% of the data, whereas monophthongization before a voiceless consonant occurs in only 1.6% of the data. This lends support to the hypothesis that monophthongization occurs more frequently before voiced consonants than before voiceless consonants.

The statistical results for ΔF1, ΔF2, and offset F2-F1 are given in Appendices I, J, and K, respectively. The results indicate that for a typical individual, the ΔF1 for /aɪ/ with a voiced following consonant is estimated to be 0.606 Hz/ms higher than the ΔF1 for /aɪ/ with a voiceless following consonant; this association is statistically significant ($p < .05$). The ΔF2 for a typical individual for /aɪ/ with a voiced following consonant is estimated to be 2.165 Hz/ms lower than the ΔF2 for /aɪ/ with a voiceless following consonant; this association is statistically significant ($p < .05$). The offset F2-F1 for a typical individual for /aɪ/ with a voiced following consonant is estimated to be 302.416 Hz lower than the offset F2-F1 for /aɪ/ with a voiceless following consonant; this association is statistically significant ($p < .05$).

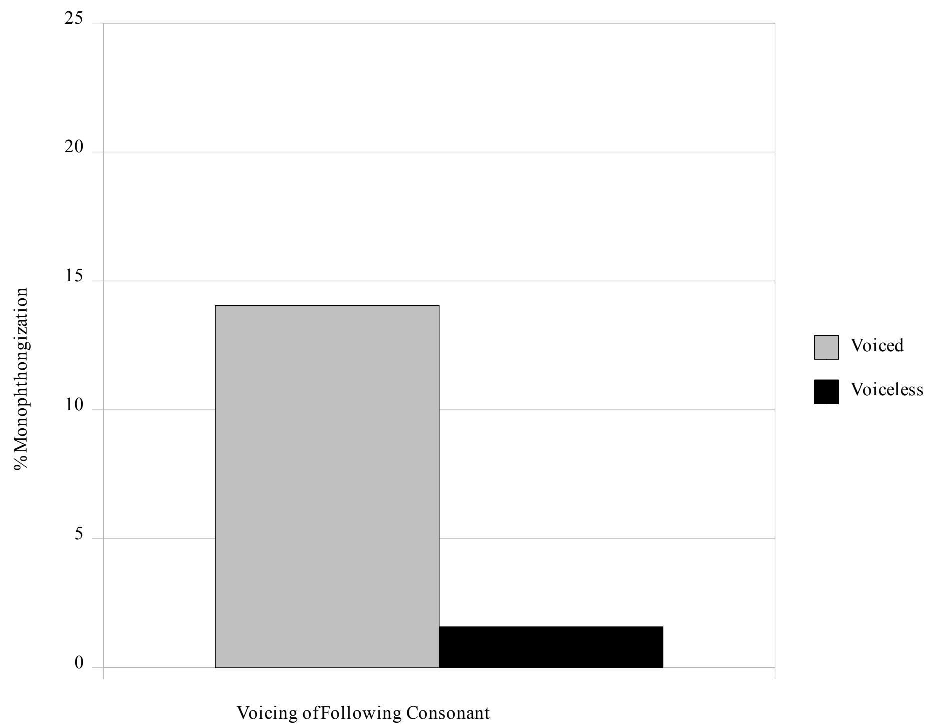


Figure 4.1. Percentage auditory monophthongization by voicing of the following consonant.

### 4.2.2 Open Versus Closed Syllables

The hypotheses for syllable type, in which closed syllables containing /aɪ/ are compared to open syllables containing /aɪ/, are as follows:

H1: /aɪ/ monophthongization will occur more in open syllables than in closed syllables.

H0: There will be no significant difference in /aɪ/ monophthongization in open and closed syllables.

Figure 4.2 shows the percentage of auditory monophthongization in open and closed syllables. Tokens where monophthongization occurs in an closed syllable make up 15.6% of the data, whereas tokens where monophthongization occurs in open syllables make up 5% of the data.

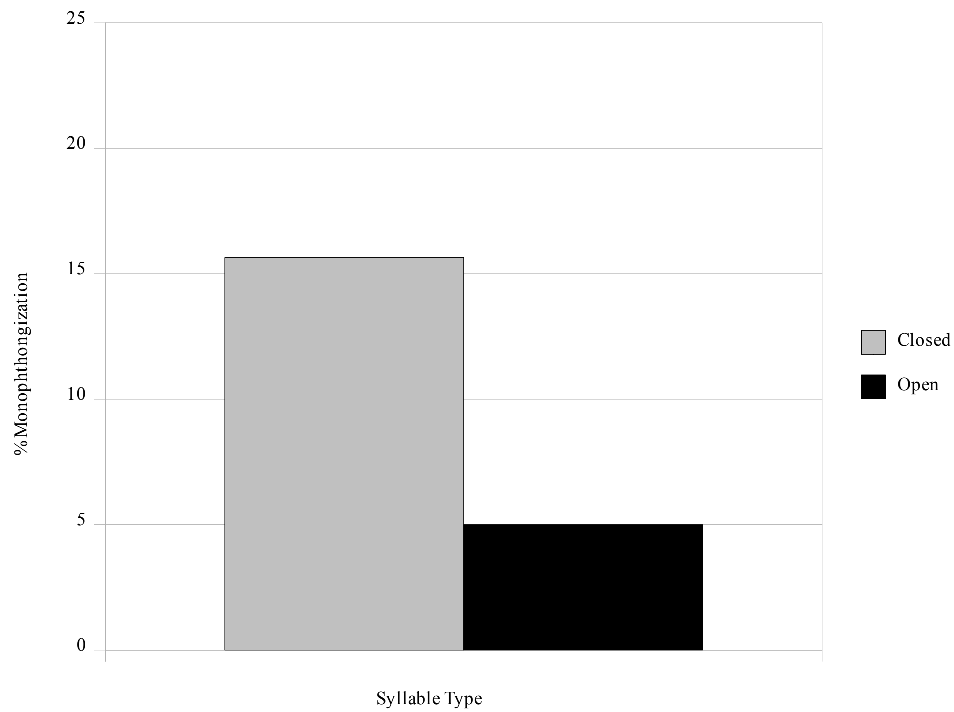


Figure 4.2. Percentage auditory monophthongization by syllable type.

The initial hypothesis was that monophthongization would occur more in open syllables than in closed syllables because the closed condition included syllables ending in voiceless consonants, which disfavor monophthongization. However, Figure 4.2 shows that monophthongization occurs more in closed syllables than in open syllables. This could be due to the inclusion of syllables ending in voiced consonants in the closed condition. Since monophthongization occurs before voiced consonants in 14.1% of the data (Figure 2.10), these syllables inflate the percentage for closed syllables.

By comparison to the 14.1% monophthongization in syllables ending in voiced consonants, open syllables have a relatively low percentage of monophthongization at 5%. This could be due to the higher number of syllables ending in voiced consonants than open syllables overall, which would result in more opportunities for monophthongization to occur before voiced consonants.

The statistical results indicate that for a typical individual, the $\Delta F1$ for /aɪ/ in a closed syllable is 0.138 Hz/ms lower than the $\Delta F1$ for /aɪ/ in an open syllable; this association is statistically significant ($p < .05$). The $\Delta F2$ for a typical individual for /aɪ/ in a closed syllable is 0.413 Hz/ms higher than the $\Delta F2$ for /aɪ/ in an open syllable; this association is statistically significant ($p < .05$). The offset F2-F1 for a typical individual for /aɪ/ in a closed syllable is 63.555 Hz higher than the offset F2-F1 for /aɪ/ in an open syllable; this association is statistically significant ($p < .05$).

## 4.3 Task Variables

### 4.3.1 Interview Versus Map Task

The hypotheses for interview versus map task are as follows:

H1: /aɪ/ monophthongization will occur more in the interview than the map task.

H0: /aɪ/ monophthongization will occur at equal rates in the interview and the map task.

Figure 4.3 shows the percentage of auditory monophthongization in the interviews and map tasks. Monophthongization occurs in interviews in 9.8% of the data, whereas monophthongization occurs in map tasks in only 3.2% of the data. This is in line with the hypothesis that monophthongization would be more common in the interview task.

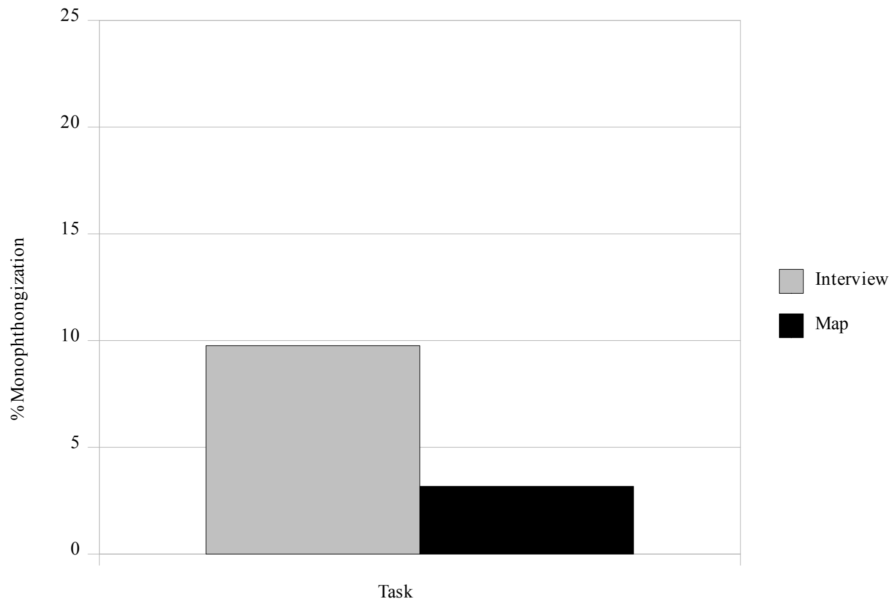


Figure 4.3. Percentage auditory monophthongization in the interviews and map tasks.

The statistical results indicate that for a typical individual, the ΔF1 for /aɪ/ in the map task is estimated to be 0.23 Hz/ms lower than in the interview task while holding linguistic variables constant; this association is statistically significant ($p < .05$). The ΔF2 for a typical individual for /aɪ/ in the map task is estimated to be 0.871 Hz/ms higher than in the interview task while holding linguistic variables constant; this association is statistically significant ($p < .05$). The offset F2- F1 for a typical individual for /aɪ/ in the map task is estimated to be 152.823 Hz higher than in the interview task while holding linguistic variables constant; this association is statistically significant ($p < .05$).

### 4.3.2 Word List Versus Map Task

The hypotheses for word list versus map task are as follows:

H1: /aɪ/ monophthongization will occur more in the map task than the word list.

H0: /aɪ/ monophthongization will occur at equal rates in the map task and the word list.

Figure 4.4 shows the percentage of auditory monophthongization in the word lists and map tasks. Monophthongization occurs in word lists in 7.7% of the data, whereas monophthongization occurs in map tasks in 3.2% of the data.

This finding is not what was predicted by the hypothesis. It is possible that the map task is a more formal task than what was expected. While the subjects seemed to be less focused on pronunciation in the map task than the word list, it could be the case that the task of giving directions encourages subjects to hyperarticulate key words. It is also possible that the uneven number of tokens in the tasks contributed to the higher percentage of monophthongization in the word list. Since there are more tokens from the word lists than the map tasks overall, subjects may have simply had more opportunities

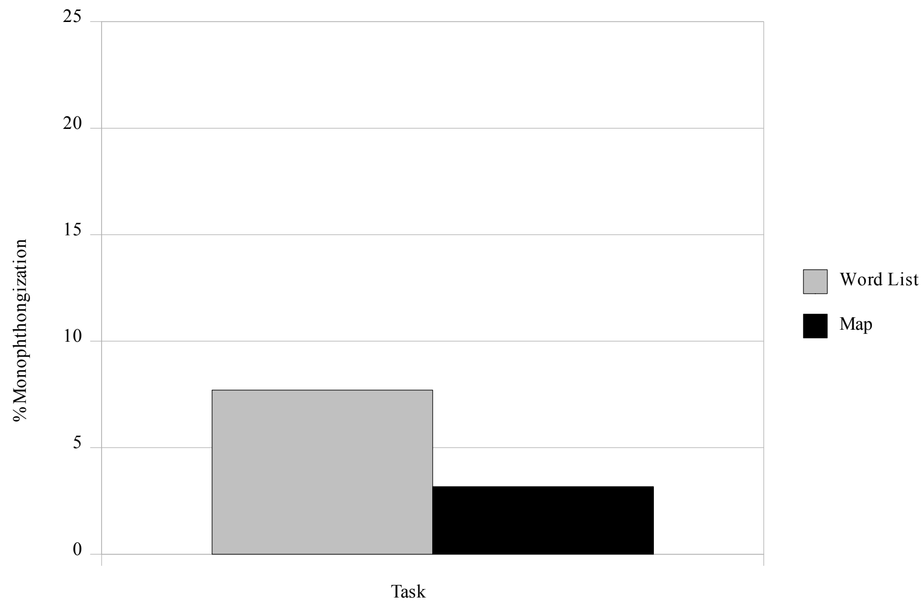


Figure 4.4. Percentage auditory monophthongization in the word lists and map tasks.

to monophthongize in the word lists than in the map tasks.

The statistical results indicate that for a typical individual, the ΔF1 for /aɪ/ in the map task is estimated to be 0.175 Hz/ms higher than in the word list task while holding linguistic variables constant; this association is statistically significant ($p < .05$). The ΔF2 for a typical individual for /aɪ/ in the map task is estimated to be 0.758 Hz/ms lower than in the word list task while holding linguistic variables constant; this association is statistically significant ($p < .05$). The offset F2-F1 for a typical individual for /aɪ/ in the map task is estimated to be 139.011 Hz lower than in the word list task while holding linguistic variables constant; this association is statistically significant ($p < .05$).

### 4.4 Speaker Variables
#### 4.4.1 Youngest Versus Middle Age Group

The hypotheses for youngest versus middle age group are as follows:

H1: /aɪ/ monophthongization will occur more in the middle age group than in the youngest age group.

H0: /aɪ/ monophthongization will occur at equal rates in the middle and youngest age groups.

Table 4.2. Frequency of /aɪ/ monophthongization by age group.

| | Youngest | Middle | Oldest | Total |
|---|---|---|---|---|
| Percentage Auditory Monophthongization | 58 (1.5%) | 287 (7.6%) | 435 (11.5%) | 780 (20.6%) |

The frequencies of /aɪ/ monophthongization by age group are given in Table 4.2. Figure 4.5 shows the percentage of monophthongized tokens from the youngest and middle age groups only. Monophthongization occurs in tokens from the youngest age group in 1.5% of the data and in tokens from the middle age group in 7.6% of the data. This supports the hypothesis that monophthongization occurs more frequently in the middle age group than in the youngest age group.

The statistical results indicate that the ΔF1 for /aɪ/ for a typical middle age group speaker is 0.785 Hz/ms higher than the ΔF1 for /aɪ/ for a typical youngest age group speaker while holding all other variables constant; this association is statistically significant ($p < .05$). The ΔF2 for /aɪ/ for a typical middle age group speaker is 0.795 Hz/ms lower than the ΔF2 for /aɪ/ for a typical youngest age group speaker while holding all other variables constant; this

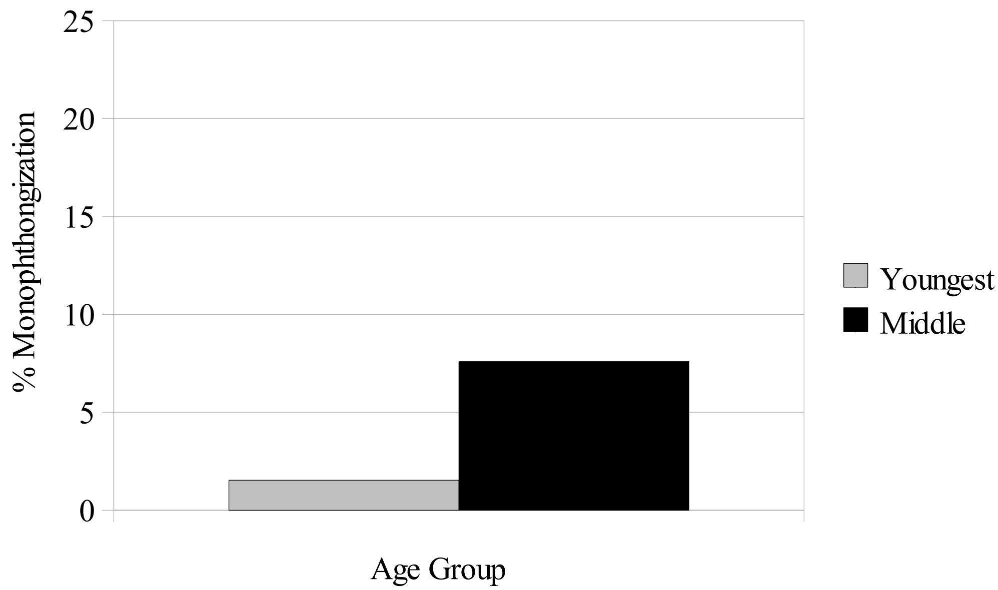


Figure 4.5. Percentage auditory monophthongization in the youngest and middle age groups.

association is statistically significant ($p < .05$). The offset F2-F1 for /aɪ/ for a typical middle age group speaker is 189.803 Hz lower than the offset F2-F1 for /aɪ/ for a typical youngest age group speaker while holding all other variables constant; this association is statistically significant ($p < .05$).

### 4.4.2 Middle Versus Oldest Age Group

The hypotheses for middle versus oldest age group are as follows:

H1: /aɪ/ monophthongization will occur more in the oldest age group than in the middle age group.

H0: /aɪ/ monophthongization will occur at equal rates in the oldest and middle age groups.

Figure 4.6 shows the percentage of monophthongized tokens from the middle and oldest age groups. Monophthongization occurs in tokens from the middle age group in 7.6% of the data and in tokens from the oldest age group in 11.5% of the data. This supports the hypothesis that monophthongization occurs more frequently in the oldest age group than in the middle age group.

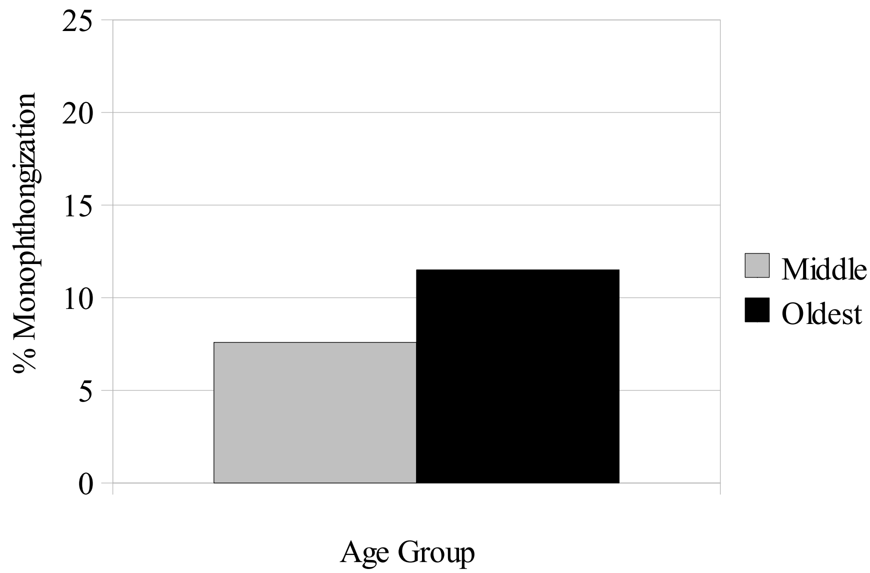


Figure 4.6. Percentage auditory monophthongization in the middle and oldest age groups.

The statistical results indicate that the ΔF1 for /aɪ/ for a typical middle age group speaker is 0.619 Hz/ms lower than the ΔF1 for /aɪ/ for a typical oldest age group speaker while holding all other variables constant; this association is statistically significant ($p < .05$). The ΔF2 values for /aɪ/ for typical middle age group and oldest age group speakers are not statistically different ($p > .05$). The offset F2-F1 values for /aɪ/ for typical middle age group and oldest age group speakers are also not statistically different ($p > .05$).

Table 4.3. Age group range, mean, and standard deviation by dependent variable and p-values for age group comparisons by dependent variable. * $p < .05$, ** $p < .01$, *** $p < .001$.

| | Δ F1 | | | Δ F2 | | | Offset F2-F1 | | |
|---|---|---|---|---|---|---|---|---|---|
| | [End F1 (Hz) - Beginning F1 (Hz)] / Duration (ms) | | | [End F2 (Hz) - Beginning F2 (Hz)] / Duration (ms) | | | Offset F2 (Hz) – Offset F1 (Hz) | | |
| Age Group | Range | Mean | Std Dev | Range | Mean | Std Dev | Range | Mean | Std Dev |
| Oldest | -7.51 to 5.72 | -0.61 | 1.12 | -9.53 to 11.2 | 1.9 | 2.09 | 240.7 to 2297.82 | 1189.71 | 344.96 |
| Middle | -6.83 to 5.7 | -0.86 | 1.2 | -4.68 to 8.78 | 1.82 | 1.95 | 137.54 to 2289.06 | 1094.81 | 356.18 |
| Youngest | -8 to 7.52 | -1.21 | 1.29 | -7.82 to 10.89 | 2.25 | 1.84 | 91.4 to 2287.44 | 1278.5 | 339.14 |
| Age Group Comparison | p-Value | | | p-Value | | | p-Value | | |
| Oldest vs Middle | .000*** | | | .103 | | | .830 | | |
| Middle vs Youngest | .000*** | | | .013* | | | .040* | | |

Table 4.3 provides the range, mean, and standard deviation for all three age groups for ΔF1, ΔF2, and offset F2-F1. The p-values for the comparison of oldest age group to middle age group and middle age group to youngest age group are also provided. For ΔF1, both age group comparisons are highly significant. For ΔF2 and offset F2-F1, the comparison of middle age group to youngest age group is significant but the comparison of oldest age group to middle age group is not significant. ΔF1 is the only dependent variable for which the comparison of the oldest age group to the middle age group is significant. This suggests that the oldest age group and middle age group may behave similarly with respect to ΔF2 and offset F2-F1 in /aɪ/

monophthongization while differing in their $\Delta$F1 values. Change in vowel height over time would therefore be predicted to be the most important measurement of /aɪ/ monophthongization for distinguishing middle age group speakers from oldest age group speakers. The higher significance of the age group comparisons for $\Delta$F1 and $\Delta$F2 as compared to offset F2-F1 also suggests that including temporal information in the dependent variable improves the model.

### 4.4.3 Gender

The hypotheses for gender are as follows:

H1: /aɪ/ monophthongization will occur more in males than females.

H0: /aɪ/ monophthongization will occur at equal rates in males and females.

Figure 4.7 shows the percentage of monophthongized tokens from males and females. Monophthongization occurs in tokens from males in 11.5% of the data and in tokens from females in 9.1% of the data. This supports the hypothesis that monophthongization occurs more frequently in this sample in males than in females.

However, when the data is partitioned by age and gender simultaneously, a more complicated pattern emerges, as in Figure 4.8.

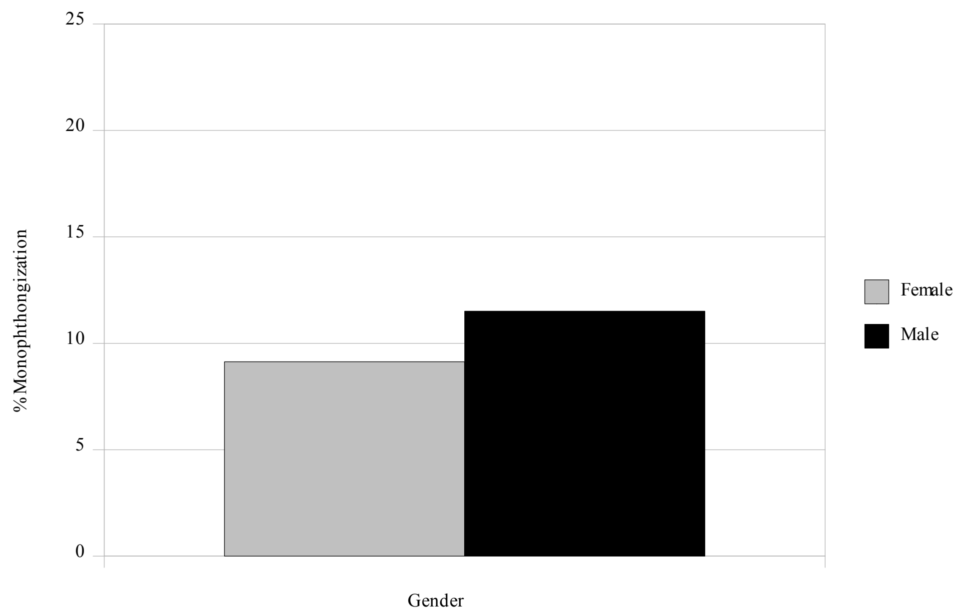


Figure 4.7.  Percentage auditory monophthongization by gender.

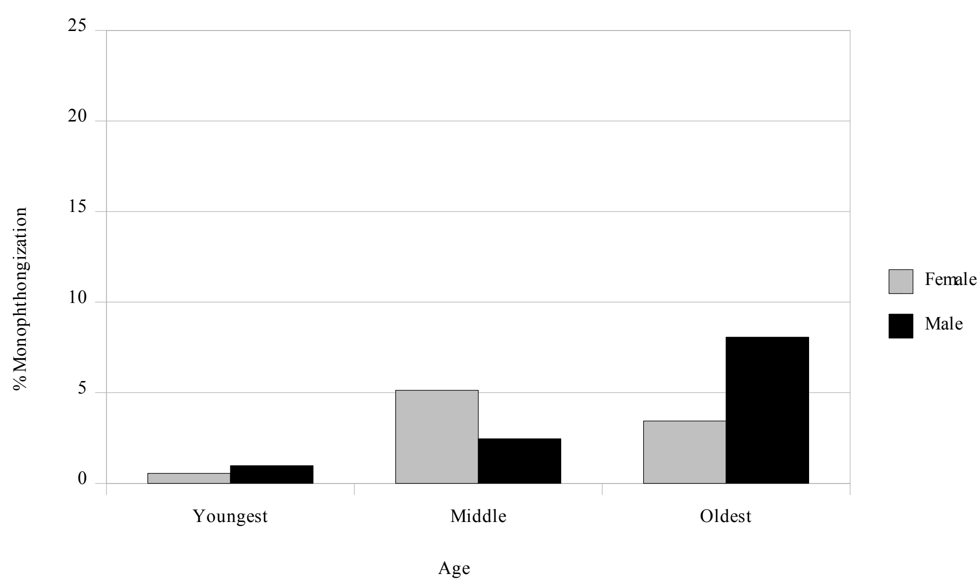


Figure 4.8.  Percentage auditory monophthongization by gender and age.

In the combined chart, males follow the expected pattern of increasing their use of monophthongization with each increase in age grouping (from 1% in the youngest group to 2.5% in the middle age group to 8.1% in the oldest age group). Females, on the other hand, have a peak of 5.1% monophthongization in the middle age group, where they actually exceed the males. Three of the four middle age group females (CF33, CF37, and CF40) have the highest amount of monophthongization of any females in the sample.

The exact reason for this pattern is unclear. One possibility is that attitudes could be playing a role. Tillery (1997) found that subjects' ratings of Texas a place to live were highly correlated with their amount of /aɪ/ monophthongization. The three middle age group females who showed the highest rates of monophthongization were also among the subjects who most enthusiastically praised the city of Deer Park during their interviews. Attitudes toward their locale could possibly be related to their higher use of monophthongization, but since attitudinal ratings were not collected in this study, it is not possible to evaluate this hypothesis further.

The statistical results indicate that the ΔF1 for /aɪ/ for a typical male is estimated to be 0.517 Hz/ms higher than the ΔF1 for /aɪ/ for a typical female while holding all other variables constant; this association is statistically significant ($p < .05$). The ΔF2 for /aɪ/ for a typical male is estimated to be 0.519 Hz/ms lower than the ΔF2 for /aɪ/ for a typical female while holding all other variables constant; this association is statistically significant ($p < .05$). The offset F2-F1 for /aɪ/ for a typical male is estimated to be 162.526 Hz lower than the offset F2-F1 for /aɪ/ for a typical female while holding all other variables constant; this association is statistically significant ($p < .05$).

### 4.4.4 Ethnicity

The hypotheses for ethnicity, in which Caucasians were compared to Hispanics, are as follows:

H1: /aɪ/ monophthongization will occur more in Caucasian speakers than Hispanic speakers.

H0: /aɪ/ monophthongization will occur at equal rates in Caucasian and Hispanic speakers.

Figure 4.9 shows the percentage of auditory monophthongization in Caucasian and Hispanic speakers. Monophthongization occurs in tokens from Caucasian speakers in 20.6% of the data, whereas monophthongization occurs in tokens from Hispanic speakers in only 0.1% of the data. While these numbers are certainly influenced by the fact that only two of the thirty speakers were Hispanic, the drastic difference between the two groups supports the hypothesis that monophthongization would be more common in the Caucasian speakers than in the Hispanic speakers.

The statistical results indicate that the $\Delta F1$ values for /aɪ/ for typical Hispanic and Caucasian speakers are not statistically different ($p > .05$). The $\Delta F2$ values for /aɪ/ for typical Hispanic and Caucasian speakers are not statistically different ($p > .05$). The offset F2-F1 values for /aɪ/ for typical Hispanic and Caucasian speakers are also not statistically different ($p > .05$).

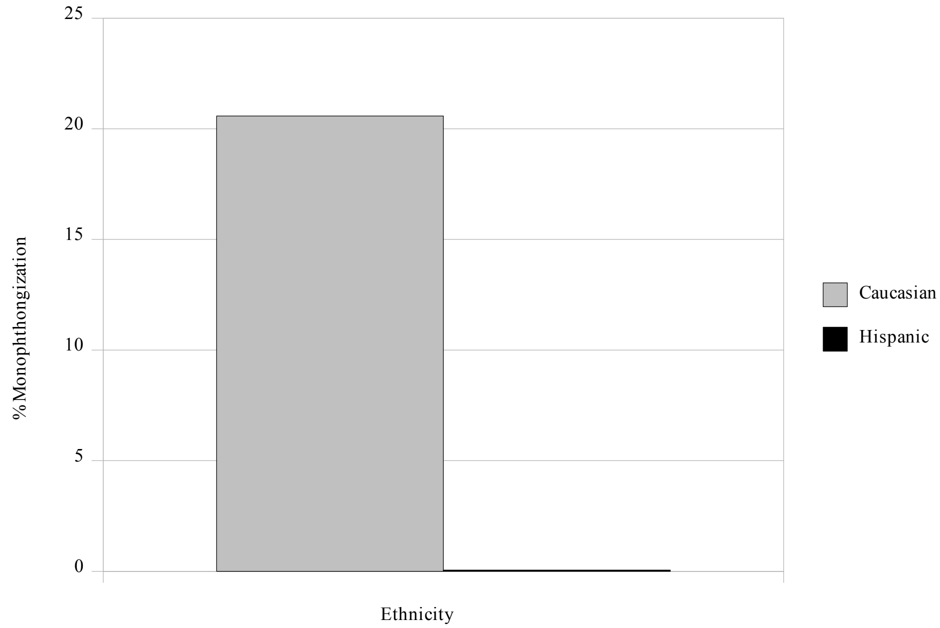


Figure 4.9. Percentage auditory monophthongization by ethnicity.

### 4.4.5 Education

The hypotheses for education, in which tokens from subjects without a Bachelor's degree were compared to tokens from subjects with a Bachelor's degree or higher degree, are as follows:

H1: /aɪ/ monophthongization will occur more in speakers who do not have a Bachelor's degree.

H0: /aɪ/ monophthongization will occur at equal rates in subjects with and without a Bachelor's degree.

Figure 4.10 shows the percentage of auditory monophthongization in speakers with and without Bachelor's degrees. Monophthongization occurs in tokens from speakers with Bachelor's degrees in 13.7% of the data, whereas monophthongization occurs in tokens from speakers without a Bachelor's degree in 7% of the data.

This finding is not what was predicted by the hypothesis, and the differences are not likely to be due to discrepancies in token counts since the amount of data for subjects with and without a Bachelor's degree is quite close. It is not clear from the available data why speakers with a Bachelor's degree would be monophthongizing more than speakers without a Bachelor's degree.

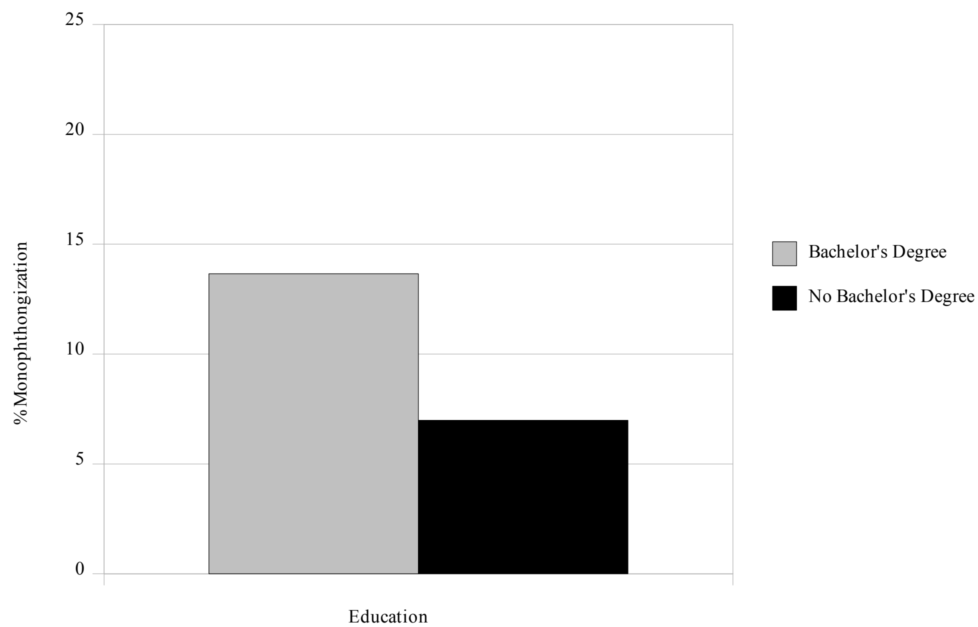


Figure 4.10. Percentage auditory monophthongization by education.

The statistical results indicate that the ΔF1 values for /aɪ/ for typical speakers with and without a Bachelor's degree are not statistically different ($p > .05$). The ΔF2 values for /aɪ/ for typical speakers with and without a Bachelor's degree are not statistically different ($p > .05$). The offset F2-F1 values for /aɪ/ for typical speakers with and without a Bachelor's degree are also not statistically different ($p > .05$).

### 4.4.6 Residence History

The hypotheses for residence history, in which tokens from subjects who lived outside the South pre-puberty were compared to tokens from subjects who did not live outside the South pre-puberty, are as follows:

H1: /aɪ/ monophthongization will occur more in speakers who never lived outside the South before puberty.

H0: /aɪ/ monophthongization will occur at equal rates in speakers who have and have not lived outside the South before puberty.

Figure 4.11 shows the percentage of auditory monophthongization in speakers who did and did not live outside the South pre-puberty. Monophthongization occurs in tokens from speakers who lived outside the South prior to puberty in 0.5% of the data, whereas monophthongization occurs in tokens from speakers who did not live outside the South prior to puberty in 20.2% of the data. This is in line with the hypothesis that monophthongization would be more frequent in subjects who did not live outside the South pre-puberty.

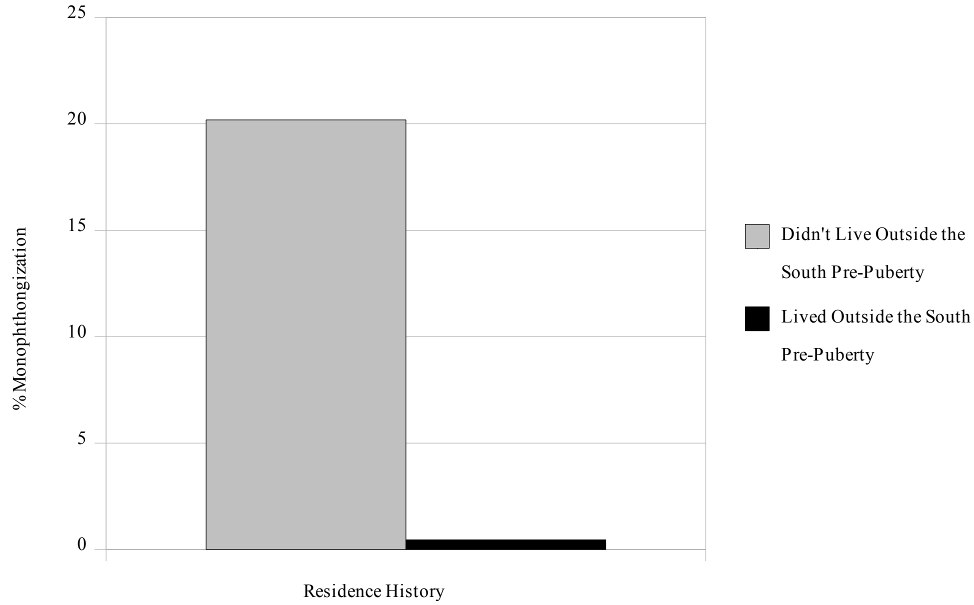


Figure 4.11. Percentage auditory monophthongization by residence history.

The statistical results indicate that the ΔF1 values for /aɪ/ for typical speakers who did and did not live outside Texas prior to puberty are not statistically different ($p > .05$). The ΔF2 values for /aɪ/ for typical speakers who did and did not live outside Texas prior to puberty are not statistically different ($p > .05$). The offset F2-F1 values for /aɪ/ for typical speakers who did and did not live outside Texas pre-puberty are also not statistically different ($p > .05$).

### 4.5 Comparison of Blocks

As discussed in §3.5, sequential regression was used in this study with the linguistic, task, and social variables entered into the statistical model separately. The sequential approach makes it possible to compare the results for the model containing linguistic variables only (block 1) to the results for the model when the task variables have been added (block 2) and to then compare those results to the model when linguistic, task, and social variables are all included (block 3). The three blocks were compared to one another with a likelihood ratio test using the -2 restricted log likelihood values. This test compares block 1 to block 2 and block 2 to block 3 to assess whether adding the sets of variables in blocks 2 and 3 significantly improves the model. A significant p-value for the likelihood ratio test indicates that the model with more variables included is better than the model with fewer variables.

For ΔF1, the comparison of block 1 to block 2 was significant ($p < .05$), indicating that adding the task variables led to an improvement over the model with linguistic variables alone. The comparison of block 2 to block 3 was also significant ($p < .05$), indicating that adding the social variables resulted in an improvement over the model with linguistic and task variables.

For ΔF2, the comparison of block 1 to block 2 was significant ($p < .05$), indicating that adding the task variables led to an improvement over the model with linguistic variables alone. However, the comparison of block 2 to block 3 was not significant for ΔF2, ($p > .05$), indicating that adding the social variables did not result in an improvement over the model with linguistic and task variables.

For offset F2-F1, the comparison of block 1 to block 2 was significant ($p < .05$), indicating that adding the task variables led to an improvement over the model with linguistic variables alone. The comparison of block 2 to block 3 was also significant ($p < .05$), indicating that adding the social variables resulted in an improvement over the model with linguistic and task variables.

### 4.6 Summary

This section presented the descriptive and inferential results by independent variable. Each independent variable was first assessed in terms of auditory monophthongization. Following a discussion of the auditory results, the statistical results for ΔF1, ΔF2, and offset F2-F1 were provided. Both of the linguistic variables (voiceless versus voiced following consonant and open versus closed syllable) were statistically significant predictors of /aɪ/ monophthongization as measured by ΔF1, ΔF2, and offset F2-F1. Both of the task variables (interview versus map task and map task versus word list) were also statistically significant predictors of /aɪ/ monophthongization as measured by ΔF1, ΔF2, and offset F2-F1. The social variables of gender and youngest versus middle age group were statistically significant predictors of /aɪ/ monophthongization as measured by ΔF1, ΔF2, and offset F2-F1. Middle age group versus oldest age group was significant for ΔF1 but not for ΔF2 or offset F2-F1. Ethnicity, education, and residence history were not significant predictors of /aɪ/ monophthongization for ΔF1, ΔF2, or offset F2-F1. §5 presents a more detailed interpretation of these results and suggests directions for future research.

## 5. Discussion
### 5.1 Interpretation of Results

For ΔF1, ΔF2, and offset F2-F1, the statistical results indicate that /aɪ/ is more monophthongal before voiced consonants than before voiceless consonants. This is in line with the hypothesis that /aɪ/ monophthongization will occur more before voiced consonants than before voiceless consonants. Figure 4.1, which compares the percentage of auditory monophthongization before voiced consonants to the percentage of auditory monophthongization before voiceless consonants, also indicates higher rates of monophthongization before voiced consonants.

For the statistical comparison of open syllables to closed syllables, /aɪ/ was found to be more monophthongal in open syllables than in closed syllables for ΔF1, ΔF2, and offset F2-F1. This is in line with the hypothesis that /aɪ/ monophthongization will occur more in open syllables than in closed syllables. Figure 4.2, which compares the percentage of auditory monophthongization in open syllables to the percentage of auditory monophthongization in closed syllables, does not support the hypothesis. As discussed in §4.2.2, the fact that Figure 4.2 shows higher rates of monophthongization in closed syllables could be due to the fact that the closed condition includes syllables where /aɪ/ occurs before a voiced consonant, which favor monophthongization. The results in Figure 4.2 also reflect the fact that there were fewer tokens where /aɪ/ occurred in an open syllable than where /aɪ/ occurred in a closed syllable, which skews the percentage data in favor of the category with the most tokens (i.e., the closed syllables). The estimates from the statistical results, which test all of the independent variables simultaneously and which are better suited to unbalanced data, are therefore more likely to be reliable.

For the statistical comparison of the interview task to the map task, /aɪ/ was found to be more monophthongal in the interview task than in the map task for ΔF1, ΔF2, and offset F2-F1. This supports the hypothesis that /aɪ/ monophthongization will occur more in the interview than the map task. Figure 4.3, which compares the percentage of auditory monophthongization in the interview task to the percentage of auditory monophthongization in the map task, also supports this conclusion.

For ΔF1, ΔF2, and offset F2-F1, the statistical results indicate that /aɪ/ is more monophthongal in the map task than in the word list. This supports the hypothesis that /aɪ/ monophthongization will occur more in the map task than the word list. Figure 4.4, which compares the percentage of auditory monophthongization in the map task to the percentage of auditory monophthongization in the word list, does not support the hypothesis. As discussed in §4.3.2, it could be the case that the speakers were performing in a more formal manner than what was predicted for the map task. However, there were also fewer tokens where /aɪ/ occurred in a map task than where /aɪ/ occurred in a word list, which skews the percentage data in favor of the category with the most tokens (i.e., the word list). Because the statistical method is better suited to unbalanced data than the comparison of raw percentages and the statistics assess all of the independent variables simultaneously, the statistical results are more likely to be accurate than the percentage data.

For the statistical comparison of the youngest age group to the middle age group, /aɪ/ was found to be more monophthongal in the middle age group than in the youngest age group for ΔF1, ΔF2, and offset F2-F1. This supports the hypothesis that /aɪ/ monophthongization will occur more in the middle age group than in the youngest age group. Figure 4.5, which compares the percentage of auditory monophthongization in the youngest age group to the percentage of auditory monophthongization in the middle age group, also indicates that /aɪ/ was more monophthongal in the middle age group than in the youngest age group.

The comparison of the middle age group to the oldest age group is the only comparison where the statistical results are significant for one dependent variable but not for the other two dependent variables. When the middle age group was compared to the oldest age group, ΔF1 was found to be significant, while ΔF2 and offset F2-F1 were not. For ΔF1, /aɪ/ was found to be more monophthongal in the oldest age group than in the middle age group. This supports the hypothesis that /aɪ/ monophthongization will occur more in the oldest age group than in the middle age group. Figure 4.6, which compares the percentage of auditory monophthongization in the middle age group to the percentage of auditory monophthongization in the oldest age group, also supports this hypothesis.

For ΔF1, ΔF2, and offset F2-F1, the statistical results indicate that /aɪ/ is more monophthongal in males than in females. This supports the hypothesis that /aɪ/ monophthongization will occur more in males than in females. Figure 4.7, which compares the percentage of auditory monophthongization in males to the percentage of auditory monophthongization in females, also indicates that /aɪ/ was more monophthongal in males than in females.

For the statistical comparison of the Hispanic speakers to the Caucasian speakers, there was no significant difference for ΔF1, ΔF2, or offset F2-F1. This does not support the hypothesis that /aɪ/ monophthongization will occur more in Caucasian speakers than Hispanic speakers. Figure 4.9, which compares the percentage of auditory monophthongization in Hispanic speakers to the percentage of auditory monophthongization in Caucasian speakers, shows a higher percentage of auditory monophthongization for Caucasian speakers. However, this finding was based on data from only two Hispanic speakers. With such a small sample of Hispanic speakers, it is possible that the lack of statistical significance for the comparison of Hispanic speakers to Caucasian speakers is because there was simply not enough power to detect a significant difference.

For the statistical comparison of the speakers with a Bachelor's degree to the speakers without a Bachelor's degree, there was no significant difference for ΔF1, ΔF2, or offset F2-F1. This does not support the hypothesis that /aɪ/ monophthongization will occur more in speakers who do not have a Bachelor's degree. Figure 4.10, which compares the percentage of auditory monophthongization in speakers with a Bachelor's degree to the percentage of auditory monophthongization in speakers without a Bachelor's degree, shows a higher percentage of auditory monophthongization for speakers with a Bachelor's degree. While this finding is unexpected, it does not emerge as a significant difference in the statistical model.

For the statistical comparison of the speakers who had lived outside the South pre-puberty to the speakers who had not lived outside the South pre-puberty, there was no significant difference for $\Delta$F1, $\Delta$F2, or offset F2-F1. This does not support the hypothesis that /aɪ/ monophthongization will occur more in speakers who never lived outside the South before puberty. Figure 4.11, which compares the percentage of auditory monophthongization in speakers who lived outside the South pre-puberty to the percentage of auditory monophthongization in speakers who did not live outside the South pre-puberty, shows a higher percentage of auditory monophthongization for speakers who did not live outside the South pre-puberty. However, there were only two speakers in the entire sample who had lived outside the South pre-puberty. As a result, the percentage data was most likely skewed in favor of the category of speakers who had not lived outside the South pre-puberty, which had more tokens. With data for only two speakers who had lived outside the South pre-puberty available, it is possible that the lack of statistical significance for the residence history comparison is because there was simply not enough power to detect a significant difference.

### 5.2 Directions for Future Research

The results of this study indicate that voicing of the following consonant, open versus closed syllable, word list versus map task, map task versus interview, gender, and youngest versus middle age group all have a significant effect on /aɪ/ monophthongization whether it is measured by $\Delta F1$, $\Delta F2$, or offset F2-F1. The difference between the middle and oldest age group is only statistically significant for $\Delta F1$. This suggests that the middle and oldest age group speakers may be behaving similarly with respect to $\Delta F2$ and offset F2-F1 but differently with respect to $\Delta F1$. More research is needed to determine whether this finding holds for other communities.

The results of this study support the work of previous researchers that indicates that monophthongization is more common before voiced consonants and in open syllables. This study also finds that older speakers monophthongize more than younger speakers, as expected from previous research, but adds to this generalization the suggestion that /aɪ/ monophthongization may be realized differently by the middle and oldest age groups with respect to $\Delta F1$. For both comparisons of age groups, the significance is also higher for $\Delta F1$ and $\Delta F2$ than for offset F2-F1, which suggests that temporal information may improve the model.

The finding that $\Delta F1$ is the only dependent variable that distinguishes the middle age group from the oldest age group suggests that F1 should continue to be measured in studies of /aɪ/ monophthongization and that studies which use only F2 to assess monophthongization may fail to capture an important aspect of this dialectal feature. Measuring both ΔF1 and ΔF2 in this study made it possible to compare how the different independent variables under investigation related to both of these outcomes of monophthongization. The results suggest that future studies of /aɪ/ monophthongization would benefit from a careful investigation of both F1 and F2 to determine whether vowel height and vowel backness might be used differently by different social groups.

Three tasks were used in this study to represent three levels of formality. The results contribute to our understanding of /aɪ/ monophthongization, indicating that task formality does have a significant effect on /aɪ/ monophthongization. As expected, more formal tasks show less /aɪ/ monophthongization than less formal tasks.

In contrast to the findings of Labov, Ash, and Boberg (2006), gender was a significant predictor of /aɪ/ monophthongization in this study. Ethnicity and residence history, on the other hand, were not predictive of /aɪ/ monophthongization, which is possibly the result of a small amount of data for Hispanic speakers and for speakers who had lived outside the South before puberty. Education also was not predictive of /aɪ/ monophthongization.

Throughout this study, the results that have been presented have included auditory categorization of the data, acoustic measurements, and statistical analysis of the acoustic measurements. A comparison of the auditory and acoustic methods has made it possible to demonstrate the potential pitfalls of relying on the auditory data alone. While the auditory categorization of the data as either monophthongal or diphthongal was useful for initial exploration of the data, the results based on the auditory information alone were at times either unclear or at odds with the hypotheses. The statistical analysis of the acoustic data, which was not as heavily influenced by the unequal numbers of tokens for certain categories, was more reliable and clarified the data in the cases where the auditory information was difficult to interpret. Furthermore, the statistical analysis demonstrated that some of the auditory data that seemed to support the hypotheses, such as the ethnicity data, was not statistically significant and should therefore be interpreted with caution.

This study also seeks to expand the literature on /aɪ/ monophthongization by demonstrating methods for measuring monophthongization that include temporal information as captured by change in vowel height and vowel backness over time ($\Delta F1$ and $\Delta F2$, respectively). Much of the previous work on /aɪ/ monophthongization has used only auditory analysis or has relied upon raw formant values taken at a single point in the vowel's trajectory. Morrison (2007) argues that vowel perception is sensitive to spectral change and not based on a single point of time in the vowel's duration. If the goal of our research is to explain how linguistic features are used and interpreted from a social perspective, then sociolinguistic studies should take into account how those linguistic features are perceived by humans and model the linguistic features appropriately. More research in a wide variety of communities and dialects is needed to assess how well these measurements of vowel change over time compare to traditional methods of vowel measurement.

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## Appendix A: Sample Recruitment Email

A Study of the Deer Park Dialect

Researcher: Meghan Oxley, Graduate Student, University of Washington Department of Linguistics

Subject Line: Adult Deer Park speakers needed for dialect research

Native speakers of English from Deer Park, Texas who are at least 18 years old and have no known speech or hearing difficulties are needed for a dialect study. You will participate in an audio recorded interview consisting of 3 parts:
1. An interview in which you are asked for background information and about your opinions of Deer Park
2. A map task in which you describe how to get from one point to another on a map
3. A reading task in which you read a series of sentences out loud

All information gathered in this study will remain confidential. Your name will not be published in the results of this study.

Please forward to friends, family, and coworkers where relevant.

**Appendix B: Consent Form**

## UNIVERSITY OF WASHINGTON CONSENT FORM
## A Study of the Deer Park Dialect

Investigator:

Meghan Oxley, Graduate Student, Dept. of Linguistics, Univ. of Washington

Investigators' statement
I am asking you to be in a research study. The purpose of this consent form is to give you the information you will need to help you decide whether or not to be in the study. Please read the form carefully. You may ask questions about the purpose of the research, what I would ask you to do, the possible risks and benefits, your rights as a volunteer, and anything else about the research or this form that is not clear. When all your questions have been answered, you can decide if you want to be in the study or not. This process is called "informed consent."

### PURPOSE OF THE STUDY

The purpose of this study is to better understand the linguistic features of the Deer Park dialect by interviewing native speakers of American English from Deer Park who do not have any known speech or hearing difficulties.

### PROCEDURES

If you choose to be in this study, I will ask you to do three things:

***Interview:*** First, would like to interview you about your experiences in Deer Park. The entire interview will last about 40 minutes and will focus on your experiences as a member of the Deer Park community. For example, I will ask you, "How long have you lived in Deer Park?" "Do you think Deer Park is a good place to live?" and "Do you consider yourself a Southerner?" You do not have to answer every question.

***Map Task:*** I will give you a map of a fictional location and asked to describe how to get from one point on the map to another, making reference to landmarks.

***Reading:*** I will ask you to read a list of sentences aloud.

I will record the entire session. I will store the recordings in a locked file cabinet.

### RISKS, STRESS, OR DISCOMFORT

Some people feel that providing information for research is an invasion of privacy. I have addressed concerns for your privacy in the OTHER INFORMATION section. Some people feel self-conscious when they are audiorecorded.

**BENEFITS OF THE STUDY**

You may not directly benefit from taking part in this study. However, I hope the results of the study will allow me to learn more about the Southern United States and how the dialect spoken in this region compares to those spoken in other regions.

**OTHER INFORMATION**

Taking part in this study is voluntary. You can stop at any time.

Information about you is confidential. I will code the study information. I will keep the link between your name and the code in a separate, secured location until January 2008. Then I will destroy the link.

I would like to keep your recordings indefinitely for my research and to share with other researchers. I would also like to be able to use your recordings in presentations and for educational purposes. Even though your name will not be associated with the data, it is possible that someone who knows you might recognize your voice. If the results of this study are published or presented, I will not use your name.

Although I will make every effort to keep your information confidential, no system for protecting your confidentiality can be completely secure. It is possible that unauthorized persons might discover that you are in this study, or might obtain information about you. Government or university staff sometimes review studies such as this one to make sure they are being done safely and legally. If a review of this study takes place, your records may be examined. The reviewers will protect your privacy. The study records will not be used to put you at legal risk of harm.

---

Signature of investigator Printed Name Date

Subject's statement:

This study has been explained to me. I volunteer to take part in this research. I have had a chance to ask questions. If I have questions later on about the research I can ask the investigator listed above. If I have questions about my rights as a research subject, I can call the University of Washington Human Subjects Division at (206) 543-0098. I will receive a copy of this consent form.

☐ I give my permission for the researcher to re-contact me to clarify information. Giving your permission to re-contact you does not obligate you in any way.

☐ I do NOT give my permission for the researcher to re-contact me to clarify information

**The researcher may use my recordings and data in the following ways:**

☐ The researcher may use my data in any way that she feels is appropriate.

**-Or-** to limit the use of your data, check as many as apply:

☐ My data may be made available to researchers **within** the University of Washington.

☐ My data may be made available to the **larger** academic research community.

☐ My data may be used as part of **teaching** materials.

☐ My data may be published in **online** research databases.

______________________________________________________________________

Signature of subject Printed name Date

Copies to: Investigator's file, Subject

**Appendix C:  Demographic Questionnaire**

**SPEAKER SURVEY**

**Sex**:    M    F    **Age**: ______

**Ethnicity**: __________________    **Occupation**: ____________________

Highest Level of **Education** Completed:

| | | | |
|---|---|---|---|
| Elementary | Junior High | High School | Bachelor's |
| MA | PhD | Other: ___________ | |

Where were you **born**?  (city and state)

Have you **lived** anywhere other than Deer Park?  If so, please list the city, state, and country of all places you have lived below along with your ages while living there.

Are your **parents/primary caregivers** from Deer Park?    Yes    No

If not, please provide the cities and states where your parents/primary caregivers grew up.

Mother/Primary Caregiver: ____________________

Father/Primary Caregiver: _____________________

Are you a native speaker of any **languages** other than English?  If so, please list these languages.

Are your **parents/primary caregivers** native speakers of any **languages** other than English?  If so, please list these languages.

Mother/Primary Caregiver: ____________________

Father/Primary Caregiver: _____________________

**Appendix D: Interview Questions**

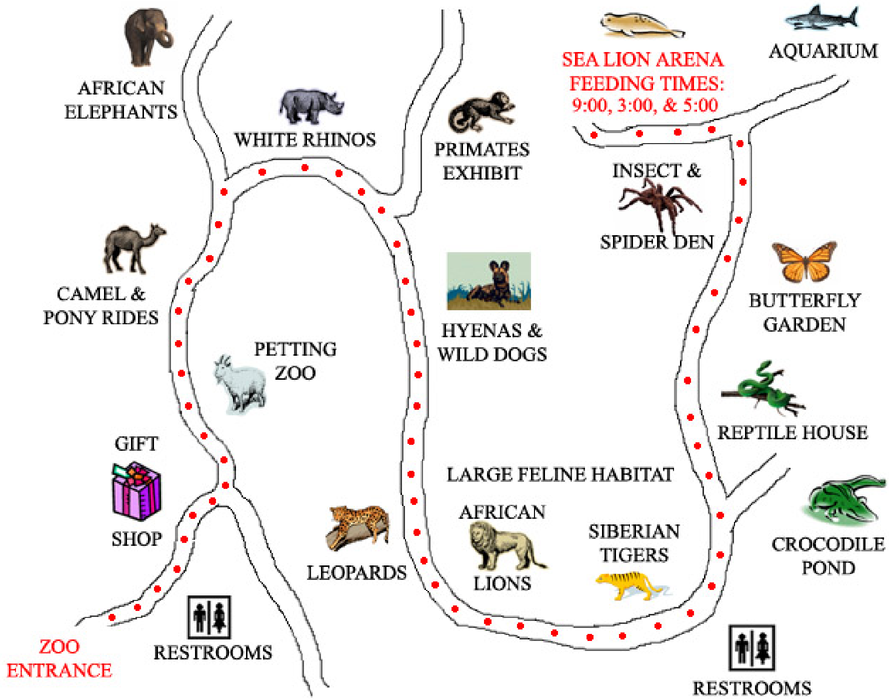
I. Background
1. Where were you born?
2. How long have you lived in Deer Park?
3. What about your parents? Where were they born? Have they ever lived in Deer Park? Do they live in Deer Park now?
4. Do you speak any languages other than English? Were there other languages spoken in your household growing up?
5. Have you learned any other languages in school?

II. Deer Park/The South
6. Do you think Deer Park is a good place to live? Compared to Pasadena? Houston? Why or why not?
7. Do you think Deer Park is part of Houston? Part of the South?
8. How do you think Deer Park compares to the rest of the South?
9. Do you consider yourself a Southerner?
10. Do you think most of the people in Deer Park are from the South?
11. What types of jobs do people have here?
12. What do you do in your free time?
13. Do you think you can get pretty much whatever you need in Deer Park, or do you have to go to other cities often?
14. What nearby cities do you go to?
15. Do you think Deer Park has any major problems as a city? What kinds of problems? Pollution? Education? Development?

III. Travel
16. Do you go to Houston often? Downtown? Westheimer? Kirby?
17. What do you do in Houston? Where have you been? Museum of Fine Arts? Zoo? Galleria?
18. Do you think Houston is safe?
19. Why do you think you live in Deer Park rather than Houston? Cost? Safety? Parking? Friendliness? Schools? Jobs?
20. Do you travel much?
21. Where have you traveled?
22. Have you ever had trouble communicating with someone from another part of the country because of their accent?
23. Have you ever been criticized because of your accent or because you use a different word for something than someone else?
24. Do you think there is a unique Deer Park accent? Different from Pasadena/Houston/the rest of Texas/the rest of the South? How is it different? Examples?
25. What do you think are some features of a "Southern" accent? Do you think that the typical Deer Parkian has those features? Do you?

## Appendix E: Map Task

A friend of yours is interested in going to the sea lion show at the local zoo. Describe how to get from the entrance to the sea lion arena based on the path given in red dots, making reference to landmarks and noting the times of the show.



**Appendix F: Word List**

I.

Say **neck** quickly.
Say **child** quickly.
Say **wood** quickly.
Say **dog** quickly.
Say **tube** quickly.
Say **god** quickly.
Say **hide** quickly.
Say **back** quickly.
Say **top** quickly.
Say **whine** quickly.
Say **saw** quickly.
Say **fly** quickly.
Say **coop** quickly.
Say **dime** quickly.
Say **pen** quickly.
Say **file** quickly.
Say **robe** quickly.
Say **mile** quickly.
Say **flaw** quickly.
Say **guide** quickly.
Say **bee** quickly.
Say **fried** quickly.
Say **wise** quickly.
Say **tar** quickly.
Say **bag** quickly.
Say **die** quickly.
Say **sing** quickly.
Say **word** quickly.
Say **clean** quickly.

II.

Say **watch** quickly.
Say **hole** quickly.
Say **green** quickly.
Say **pawn** quickly.
Say **fire** quickly.
Say **duke** quickly.
Say **pipe** quickly.
Say **raw** quickly.
Say **light** quickly.
Say **prime** quickly.
Say **void** quickly.
Say **cup** quickly.
Say **tile** quickly.
Say **step** quickly.
Say **blind** quickly.
Say **wife** quickly.
Say **ten** quickly.
Say **cap** quickly.
Say **line** quickly.
Say **bake** quickly.
Say **time** quickly.
Say **pop** quickly.
Say **spa** quickly.
Say **pie** quickly.
Say **heed** quickly.
Say **not** quickly.
Say **chick** quickly.
Say **brush** quickly.
Say **rock** quickly.

III.

Say **proud** quickly.
Say **page** quickly.
Say **run** quickly.
Say **tall** quickly.
Say **mom** quickly.
Say **night** quickly.
Say **prize** quickly.
Say **loud** quickly.
Say **bit** quickly.
Say **book** quickly.
Say **cow** quickly.
Say **fine** quickly.
Say **liar** quickly.
Say **hot** quickly.
Say **saw** quickly.
Say **nine** quickly.
Say **swap** quickly.
Say **wall** quickly.
Say **bib** quickly.
Say **do** quickly.
Say **right** quickly.
Say **poke** quickly.
Say **smile** quickly.
Say **beg** quickly.
Say **dope** quickly.
Say **rice** quickly.
Say **lamp** quickly.
Say **nose** quickly.
Say **lace** quickly.

IV.

Say **tooth** quickly.
Say **guess** quickly.
Say **cave** quickly.
Say **crow** quickly.
Say **lock** quickly.
Say **pine** quickly.
Say **rise** quickly.
Say **bride** quickly.
Say **taught** quickly.
Say **small** quickly.
Say **knife** quickly.
Say **tub** quickly.
Say **bind** quickly.
Say **hike** quickly.
Say **rye** quickly.
Say **gauze** quickly.
Say **ride** quickly.
Say **full** quickly.
Say **bet** quickly.
Say **tick** quickly.
Say **wine** quickly.
Say **mice** quickly.
Say **paid** quickly.
Say **web** quickly.
Say **fool** quickly.
Say **fawn** quickly.
Say **play** quickly.
Say **comb** quickly.
Say **stripe** quickly.

V.

Say **bus** quickly.
Say **fin** quickly.
Say **tan** quickly.
Say **hid** quickly.
Say **tide** quickly.
Say **lot** quickly.
Say **bug** quickly.
Say **guy** quickly.
Say **moss** quickly.
Say **caught** quickly.
Say **boy** quickly.
Say **type** quickly.
Say **dip** quickly.
Say **dive** quickly.
Say **fraud** quickly.
Say **while** quickly.
Say **bay** quickly.
Say **foot** quickly.
Say **dry** quickly.
Say **hood** quickly.
Say **wire** quickly.
Say **boot** quickly.
Say **deep** quickly.
Say **mime** quickly.
Say **bond** quickly.
Say **fill** quickly.
Say **pig** quickly.
Say **gold** quickly.
Say **short** quickly.

VI.

Say **daze** quickly.
Say **pool** quickly.
Say **jump** quickly.
Say **buy** quickly.
Say **five** quickly.
Say **law** quickly.
Say **bye** quickly.
Say **doubt** quickly.
Say **tied** quickly.
Say **fall** quickly.
Say **like** quickly.
Say **prom** quickly.
Say **feel** quickly.
Say **write** quickly.
Say **broad** quickly.
Say **big** quickly.
Say **dye** quickly.
Say **swipe** quickly.
Say **but** quickly.
Say **hawk** quickly.
Say **far** quickly.
Say **bribe** quickly.
Say **cab** quickly.
Say **height** quickly.
Say **fell** quickly.
Say **sand** quickly.
Say **grease** quickly.
Say **ball** quickly.
Say **girl** quickly.

VII.

Say **jazz** quickly.
Say **bell** quickly.
Say **both** quickly.
Say **cat** quickly.
Say **draw** quickly.
Say **bait** quickly.
Say **tribe** quickly.
Say **pin** quickly.
Say **deck** quickly.
Say **tie** quickly.
Say **babe** quickly.
Say **buck** quickly.
Say **died** quickly.
Say **head** quickly.
Say **tire** quickly.
Say **sigh** quickly.
Say **blonde** quickly.
Say **doe** quickly.
Say **guys** quickly.
Say **cot** quickly.
Say **dude** quickly.
Say **paint** quickly.
Say **golf** quickly.
Say **start** quickly.

VIII.

Say **dull** quickly.
Say **goose** quickly.
Say **blue** quickly.
Say **code** quickly.
Say **lie** quickly.
Say **boat** quickly.
Say **spy** quickly.
Say **cape** quickly.
Say **lawn** quickly.
Say **find** quickly.
Say **beat** quickly.
Say **kite** quickly.
Say **bud** quickly.
Say **beak** quickly.
Say **fail** quickly.
Say **tin** quickly.
Say **rod** quickly.
Say **tight** quickly.
Say **bat** quickly.
Say **mall** quickly.
Say **owl** quickly.
Say **clock** quickly.
Say **three** quickly.
Say **fan** quickly.

**Appendix G: Descriptives for Dependent and Independent Variables**

| Variable | N | Minimum | Maximum | Mean | Standard Deviation |
|---|---|---|---|---|---|
| ΔF1 | 3780 | -8 | 7.52 | -0.89 | 1.23 |
| ΔF2 | 3780 | -9.53 | 11.2 | 2.01 | 1.97 |
| Offset F2-F1 | 3780 | 91.4 | 2297.82 | 1198.77 | 352.77 |
| Gender | 3780 | 0 | 1 | 0.44 | 0.5 |
| Ethnicity | 3780 | 0 | 1 | 0.94 | 0.24 |
| Oldest Versus Middle Age Group | 3780 | -1 | 1 | -0.14 | 0.78 |
| Young Versus Middle Age Group | 3780 | -1 | 1 | -0.12 | 0.77 |
| Education | 3780 | 0 | 1 | 0.47 | 0.5 |
| Residence History Pre-Puberty | 3780 | 0 | 1 | 0.94 | 0.24 |
| Word List Versus Map Task | 3780 | -1 | 1 | -0.35 | 0.75 |
| Map Task Versus Interview | 3780 | -1 | 1 | -0.14 | 0.68 |
| Voiceless Versus Voiced Following Consonant | 3780 | -1 | 1 | 0.28 | 0.81 |
| Open Versus Closed Syllable | 3780 | -2 | 1 | 0.2 | 1.33 |

## Appendix H:  Token Counts by Linguistic, Task, and Speaker Variables

| Males (n = 1677) | Voiceless | Voiced | Open | Total |
|---|---|---|---|---|
| Youngest | 155 (4.1%) | 363 (9.6%) | 176 (4.7%) | 694 (18.4%) |
| Middle | 89 (2.4%) | 185 (5%) | 94 (2.5%) | 368 (9.7%) |
| Oldest | 147 (3.9%) | 292 (7.7%) | 176 (4.7%) | 615 (16.3%) |
| Females (n = 2103) | Voiceless | Voiced | Open | Total |
| Youngest | 156 (4.1%) | 358 (9.5%) | 175 (4.6%) | 689 (18.2%) |
| Middle | 119 (3.2%) | 294 (7.8%) | 152 (4%) | 565 (15%) |
| Oldest | 185 (4.9%) | 427 (11.3%) | 237 (6.3%) | 849 (22.5%) |

| Ethnicity | Voiceless | Voiced | Open | Total |
|---|---|---|---|---|
| Caucasian | 801 (21.2%) | 1805 (47.8%) | 946 (25%) | 3552 (94%) |
| Hispanic | 50 (1.3%) | 114 (3%) | 64 (1.7%) | 228 (6%) |

| Education | Voiceless | Voiced | Open | Total |
|---|---|---|---|---|
| Bachelor's | 451 (11.9%) | 996 (26.4%) | 549 (14.5%) | 1996 (52.8%) |
| No Bachelor's | 400 (10.6%) | 923 (24.4%) | 461 (12.2%) | 1784 (47.2%) |

| Residence History: Lived Outside Texas Pre-Puberty | Voiceless | Voiced | Open | Total |
|---|---|---|---|---|
| Yes | 52 (1.4%) | 118 (3.1%) | 69 (1.8%) | 239 (6.3%) |
| No | 799 (21.1%) | 1801 (47.7%) | 941 (24.9%) | 3541 (93.7%) |

| Task | Voiceless | Voiced | Open | Total |
|---|---|---|---|---|
| Interview | 450 (11.9%) | 1136 (30%) | 388 (10.3%) | 1974 (52.2%) |
| Map Task | 131 (3.5%) | 223 (5.9%) | 280 (7.4%) | 634 (16.8%) |
| Word List | 270 (7.1%) | 560 (14.8%) | 340 (9%) | 1170 (31%) |

## Appendix I: Statistical Results for ΔF1

### Block 1

**Information Criteria[a]**

| | |
|---|---|
| -2 Restricted Log Likelihood | 11786.486 |
| Akaike's Information Criterion (AIC) | 11790.486 |
| Hurvich and Tsai's Criterion (AICC) | 11790.489 |
| Bozdogan's Criterion (CAIC) | 11804.960 |
| Schwarz's Bayesian Criterion (BIC) | 11802.960 |

The information criteria are displayed in smaller-is-better forms.

a. Dependent Variable: Delta_F1_No_Abs.

**Estimates of Fixed Effects[a]**

| Parameter | Estimate | Std. Error | df | t | Sig. | 95% Confidence Interval Lower Bound | 95% Confidence Interval Upper Bound |
|---|---|---|---|---|---|---|---|
| Intercept | -.958086 | .080680 | 29.278 | -11.875 | .000 | -1.123027 | -.793145 |
| Voiceless_vs_Voiced | .298857 | .023414 | 3749.120 | 12.764 | .000 | .252952 | .344763 |
| Closed_vs_Open | -.051291 | .014250 | 3749.068 | -3.599 | .000 | -.079231 | -.023352 |

a. Dependent Variable: Delta_F1_No_Abs.

**Estimates of Covariance Parameters[a]**

| Parameter | | Estimate | Std. Error |
|---|---|---|---|
| Residual | | 1.288761 | .029771 |
| Intercept [subject = Speaker] | Variance | .183433 | .051035 |

a. Dependent Variable: Delta_F1_No_Abs.

### Block 2

**Information Criteria[a]**

| | |
|---|---|
| -2 Restricted Log Likelihood | 11774.355 |
| Akaike's Information Criterion (AIC) | 11778.355 |
| Hurvich and Tsai's Criterion (AICC) | 11778.359 |
| Bozdogan's Criterion (CAIC) | 11792.828 |
| Schwarz's Bayesian Criterion (BIC) | 11790.828 |

The information criteria are displayed in smaller-is-better forms.

a. Dependent Variable: Delta_F1_No_Abs.

**Estimates of Fixed Effects[a]**

| Parameter | Estimate | Std. Error | df | t | Sig. | 95% Confidence Interval Lower Bound | 95% Confidence Interval Upper Bound |
|---|---|---|---|---|---|---|---|
| Intercept | -.942233 | .081184 | 29.961 | -11.606 | .000 | -1.108042 | -.776424 |
| Voiceless_vs_Voiced | .302520 | .023383 | 3747.128 | 12.938 | .000 | .256676 | .348364 |
| Closed_vs_Open | -.046005 | .014467 | 3747.268 | -3.180 | .001 | -.074368 | -.017641 |
| WL_vs_Map | .088711 | .026016 | 3755.726 | 3.410 | .001 | .037703 | .139718 |
| Map_vs_Int | -.116159 | .028431 | 3756.766 | -4.086 | .000 | -.171900 | -.060417 |

a. Dependent Variable: Delta_F1_No_Abs.

**Estimates of Covariance Parameters[a]**

| Parameter | | Estimate | Std. Error |
|---|---|---|---|
| Residual | | 1.281570 | .029613 |
| Intercept [subject = Speaker] | Variance | .183746 | .051079 |

a. Dependent Variable: Delta_F1_No_Abs.

## Block 3

**Information Criteria[a]**

| | |
|---|---|
| -2 Restricted Log Likelihood | 11753.645 |
| Akaike's Information Criterion (AIC) | 11757.645 |
| Hurvich and Tsai's Criterion (AICC) | 11757.648 |
| Bozdogan's Criterion (CAIC) | 11772.114 |
| Schwarz's Bayesian Criterion (BIC) | 11770.114 |

The information criteria are displayed in smaller-is-better forms.

a. Dependent Variable: Delta_F1_No_Abs.

**Estimates of Fixed Effects[a]**

| Parameter | Estimate | Std. Error | df | t | Sig. | 95% Confidence Interval | |
|---|---|---|---|---|---|---|---|
| | | | | | | Lower Bound | Upper Bound |
| Intercept | -1.257691 | .283375 | 22.930 | -4.438 | .000 | -1.843997 | -.671386 |
| Voiceless_vs_Voiced | .303183 | .023381 | 3748.387 | 12.967 | .000 | .257342 | .349023 |
| Closed_vs_Open | -.045944 | .014466 | 3748.142 | -3.176 | .002 | -.074306 | -.017582 |
| WL_vs_Map | .087497 | .025989 | 3764.937 | 3.367 | .001 | .036544 | .138450 |
| Map_vs_Int | -.115232 | .028404 | 3764.879 | -4.057 | .000 | -.170920 | -.059544 |
| Gender | .516841 | .107268 | 22.584 | 4.818 | .000 | .294713 | .738968 |
| Ethnicity | -.085910 | .218515 | 23.006 | -.393 | .698 | -.537937 | .366118 |
| Old_vs_Mid | -.309572 | .071121 | 22.484 | -4.353 | .000 | -.456884 | -.162260 |
| Young_vs_Mid | .392535 | .079901 | 22.693 | 4.913 | .000 | .227123 | .557947 |
| Educ_Bi | .122432 | .107830 | 22.682 | 1.135 | .268 | -.100804 | .345668 |
| Residence_Hist_PrePub | .117605 | .209535 | 22.693 | .561 | .580 | -.316176 | .551386 |

a. Dependent Variable: Delta_F1_No_Abs.

**Estimates of Covariance Parameters[a]**

| Parameter | | Estimate | Std. Error |
|---|---|---|---|
| Residual | | 1.281642 | .029616 |
| Intercept [subject = Speaker] | Variance | .058000 | .020396 |

a. Dependent Variable: Delta_F1_No_Abs.

# Appendix J: Statistical Results for ΔF2

## Block 1

**Information Criteria[a]**

| | |
|---|---|
| -2 Restricted Log Likelihood | 14844.261 |
| Akaike's Information Criterion (AIC) | 14848.261 |
| Hurvich and Tsai's Criterion (AICC) | 14848.264 |
| Bozdogan's Criterion (CAIC) | 14862.735 |
| Schwarz's Bayesian Criterion (BIC) | 14860.735 |

The information criteria are displayed in smaller-is-better forms.

a. Dependent Variable: Delta_F2_No_Abs.

**Estimates of Fixed Effects[a]**

| Parameter | Estimate | Std. Error | df | t | Sig. | 95% Confidence Interval Lower Bound | 95% Confidence Interval Upper Bound |
|---|---|---|---|---|---|---|---|
| Intercept | 2.299449 | .108035 | 29.390 | 21.284 | .000 | 2.078620 | 2.520279 |
| Voiceless_vs_Voiced | -1.066347 | .035128 | 3749.449 | -30.356 | .000 | -1.135218 | -.997476 |
| Closed_vs_Open | .162523 | .021379 | 3749.380 | 7.602 | .000 | .120606 | .204439 |

a. Dependent Variable: Delta_F2_No_Abs.

**Estimates of Covariance Parameters[a]**

| Parameter | | Estimate | Std. Error |
|---|---|---|---|
| Residual | | 2.900890 | .067012 |
| Intercept [subject = Speaker] | Variance | .323497 | .091331 |

a. Dependent Variable: Delta_F2_No_Abs.

## Block 2

**Information Criteria[a]**

| | |
|---|---|
| -2 Restricted Log Likelihood | 14690.624 |
| Akaike's Information Criterion (AIC) | 14694.624 |
| Hurvich and Tsai's Criterion (AICC) | 14694.627 |
| Bozdogan's Criterion (CAIC) | 14709.096 |
| Schwarz's Bayesian Criterion (BIC) | 14707.096 |

The information criteria are displayed in smaller-is-better forms.

a. Dependent Variable: Delta_F2_No_Abs.

**Estimates of Fixed Effects[a]**

| Parameter | Estimate | Std. Error | df | t | Sig. | 95% Confidence Interval Lower Bound | 95% Confidence Interval Upper Bound |
|---|---|---|---|---|---|---|---|
| Intercept | 2.224693 | .105918 | 30.287 | 21.004 | .000 | 2.008466 | 2.440921 |
| Voiceless_vs_Voiced | -1.082355 | .034439 | 3747.497 | -31.428 | .000 | -1.149876 | -1.014834 |
| Closed_vs_Open | .137791 | .021307 | 3747.672 | 6.467 | .000 | .096016 | .179566 |
| WL_vs_Map | -.378726 | .038311 | 3758.126 | -9.886 | .000 | -.453838 | -.303614 |
| Map_vs_Int | .435305 | .041865 | 3759.399 | 10.398 | .000 | .353223 | .517386 |

a. Dependent Variable: Delta_F2_No_Abs.

**Estimates of Covariance Parameters**[a]

| Parameter | | Estimate | Std. Error |
|---|---|---|---|
| Residual | | 2.780159 | .064240 |
| Intercept [subject = Speaker] | Variance | .306250 | .086468 |

a. Dependent Variable: Delta_F2_No_Abs.

# Block 3

**Information Criteria**[a]

| | |
|---|---|
| -2 Restricted Log Likelihood | 14682.609 |
| Akaike's Information Criterion (AIC) | 14686.609 |
| Hurvich and Tsai's Criterion (AICC) | 14686.612 |
| Bozdogan's Criterion (CAIC) | 14701.078 |
| Schwarz's Bayesian Criterion (BIC) | 14699.078 |

The information criteria are displayed in smaller-is-better forms.

a. Dependent Variable: Delta_F2_No_Abs.

**Estimates of Fixed Effects**[a]

| Parameter | Estimate | Std. Error | df | t | Sig. | 95% Confidence Interval | |
|---|---|---|---|---|---|---|---|
| | | | | | | Lower Bound | Upper Bound |
| Intercept | 2.985114 | .522632 | 23.310 | 5.712 | .000 | 1.904763 | 4.065466 |
| Voiceless_vs_Voiced | -1.082738 | .034438 | 3747.842 | -31.440 | .000 | -1.150257 | -1.015218 |
| Closed_vs_Open | .137676 | .021307 | 3747.701 | 6.461 | .000 | .095901 | .179451 |
| WL_vs_Map | -.378816 | .038302 | 3760.006 | -9.890 | .000 | -.453910 | -.303722 |
| Map_vs_Int | .435276 | .041861 | 3759.875 | 10.398 | .000 | .353204 | .517348 |
| Gender | -.518836 | .198103 | 23.095 | -2.619 | .015 | -.928551 | -.109121 |
| Ethnicity | .157486 | .402884 | 23.364 | .391 | .699 | -.675225 | .990198 |
| Old_vs_Mid | .222902 | .131399 | 23.031 | 1.696 | .103 | -.048898 | .494702 |
| Young_vs_Mid | -.397293 | .147492 | 23.178 | -2.694 | .013 | -.702273 | -.092313 |
| Educ_Bi | -.198549 | .199060 | 23.161 | -.997 | .329 | -.610179 | .213080 |
| Residence_Hist_PrePub | -.641912 | .386812 | 23.157 | -1.659 | .111 | -1.441793 | .157969 |

a. Dependent Variable: Delta_F2_No_Abs.

**Estimates of Covariance Parameters**[a]

| Parameter | | Estimate | Std. Error |
|---|---|---|---|
| Residual | | 2.780126 | .064238 |
| Intercept [subject = Speaker] | Variance | .210910 | .068806 |

a. Dependent Variable: Delta_F2_No_Abs.

## Appendix K: Statistical Results for Offset F2-F1

## Block 1

**Information Criteria[a]**

| | |
|---|---|
| -2 Restricted Log Likelihood | 53563.820 |
| Akaike's Information Criterion (AIC) | 53567.820 |
| Hurvich and Tsai's Criterion (AICC) | 53567.823 |
| Bozdogan's Criterion (CAIC) | 53582.293 |
| Schwarz's Bayesian Criterion (BIC) | 53580.293 |

The information criteria are displayed in smaller-is-better forms.

a. Dependent Variable: Offset_F2-F1.

**Estimates of Fixed Effects[a]**

| Parameter | Estimate | Std. Error | df | t | Sig. | 95% Confidence Interval Lower Bound | 95% Confidence Interval Upper Bound |
|---|---|---|---|---|---|---|---|
| Intercept | 1243.724159 | 33.023643 | 29.099 | 37.662 | .000 | 1176.193158 | 1311.255160 |
| Voiceless_vs_Voiced | -148.193760 | 5.884759 | 3748.413 | -25.183 | .000 | -159.731401 | -136.656120 |
| Closed_vs_Open | 25.842174 | 3.581567 | 3748.396 | 7.215 | .000 | 18.820164 | 32.864183 |

a. Dependent Variable: Offset_F2-F1.

**Estimates of Covariance Parameters[a]**

| Parameter | | Estimate | Std. Error |
|---|---|---|---|
| Residual | | 8.1400E4 | 1880.387560 |
| Intercept [subject = Speaker] | Variance | 3.1968E4 | 8577.214045 |

a. Dependent Variable: Offset_F2-F1.

## Block 2

**Information Criteria[a]**

| | |
|---|---|
| -2 Restricted Log Likelihood | 53365.402 |
| Akaike's Information Criterion (AIC) | 53369.402 |
| Hurvich and Tsai's Criterion (AICC) | 53369.406 |
| Bozdogan's Criterion (CAIC) | 53383.875 |
| Schwarz's Bayesian Criterion (BIC) | 53381.875 |

The information criteria are displayed in smaller-is-better forms.

a. Dependent Variable: Offset_F2-F1.

**Estimates of Fixed Effects[a]**

| Parameter | Estimate | Std. Error | df | t | Sig. | 95% Confidence Interval Lower Bound | 95% Confidence Interval Upper Bound |
|---|---|---|---|---|---|---|---|
| Intercept | 1229.480549 | 32.335696 | 29.351 | 38.022 | .000 | 1163.380980 | 1295.580117 |
| Voiceless_vs_Voiced | -151.155277 | 5.750546 | 3746.413 | -26.285 | .000 | -162.429782 | -139.880771 |
| Closed_vs_Open | 21.175252 | 3.557884 | 3746.468 | 5.952 | .000 | 14.199675 | 28.150830 |
| WL_vs_Map | -69.554212 | 6.400745 | 3749.895 | -10.867 | .000 | -82.103492 | -57.004931 |
| Map_vs_Int | 76.461406 | 6.995174 | 3750.318 | 10.931 | .000 | 62.746691 | 90.176121 |

a. Dependent Variable: Offset_F2-F1.

**Estimates of Covariance Parameters[a]**

| Parameter | | Estimate | Std. Error |
|---|---|---|---|
| Residual | | 7.7504E4 | 1790.850121 |
| Intercept [subject = Speaker] | Variance | 3.0521E4 | 8188.036764 |

a. Dependent Variable: Offset_F2-F1.

## Block 3

**Information Criteria[a]**

| | |
|---|---|
| -2 Restricted Log Likelihood | 53286.859 |
| Akaike's Information Criterion (AIC) | 53290.859 |
| Hurvich and Tsai's Criterion (AICC) | 53290.862 |
| Bozdogan's Criterion (CAIC) | 53305.328 |
| Schwarz's Bayesian Criterion (BIC) | 53303.328 |

The information criteria are displayed in smaller-is-better forms.

a. Dependent Variable: Offset_F2-F1.

**Estimates of Fixed Effects[a]**

| Parameter | Estimate | Std. Error | df | t | Sig. | 95% Confidence Interval Lower Bound | 95% Confidence Interval Upper Bound |
|---|---|---|---|---|---|---|---|
| Intercept | 1437.177510 | 154.268199 | 23.033 | 9.316 | .000 | 1118.074735 | 1756.280285 |
| Voiceless_vs_Voiced | -151.208120 | 5.750501 | 3746.528 | -26.295 | .000 | -162.482538 | -139.933702 |
| Closed_vs_Open | 21.185133 | 3.557879 | 3746.487 | 5.954 | .000 | 14.209565 | 28.160702 |
| WL_vs_Map | -69.505279 | 6.400122 | 3751.163 | -10.860 | .000 | -82.053336 | -56.957222 |
| Map_vs_Int | 76.411512 | 6.994759 | 3751.062 | 10.924 | .000 | 62.697611 | 90.125412 |
| Gender | -162.526185 | 58.565181 | 22.968 | -2.775 | .011 | -283.686699 | -41.365672 |
| Ethnicity | -134.376956 | 118.872362 | 23.052 | -1.130 | .270 | -380.252578 | 111.498666 |
| Old_vs_Mid | 8.418192 | 38.863585 | 22.949 | .217 | .830 | -71.987232 | 88.823616 |
| Young_vs_Mid | -94.901558 | 43.573729 | 23.000 | -2.178 | .040 | -185.040773 | -4.762344 |
| Educ_Bi | -17.903171 | 58.818945 | 22.990 | -.304 | .764 | -139.582306 | 103.775963 |
| Residence_Hist_PrePub | -15.103581 | 114.305435 | 22.985 | -.132 | .896 | -251.571174 | 221.364013 |

a. Dependent Variable: Offset_F2-F1.

**Estimates of Covariance Parameters[a]**

| Parameter | | Estimate | Std. Error |
|---|---|---|---|
| Residual | | 7.7504E4 | 1790.853593 |
| Intercept [subject = Speaker] | Variance | 1.9797E4 | 6031.028693 |

a. Dependent Variable: Offset_F2-F1.