THE PENNSYLVANIA STATE UNIVERSITY
SCHREYER HONORS COLLEGE

DEPARTMENT OF COMMUNICATION SCIENCES AND DISORDERS

# ACOUSTIC CORRELATES OF CHILDHOOD GENDER CONFORMITY/NONCONFORMITY AND SEXUAL ORIENTATION

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# ABSTRACT

Purpose: The purpose of this study is to determine if the cues people use to predict sexual orientation are truly indicative of childhood gender nonconformity.

Methods: 614 individuals participated in the study including 389 females and 225 males. Participants answered questions regarding sexual orientation and childhood gender nonconformity then provided a voice sample for twelve /b/ vowel /t/ words. Measures of fundamental frequency, formant frequency, jitter and shimmer were obtained for each participant. Multiple linear regressions tested the effects of childhood gender nonconformity on these acoustic variables.

Results: Findings suggest that childhood gender nonconformity does not strongly predict acoustic cues. This data was compared with previous research on sexual orientation to determine if childhood gender nonconformity was more predictive of these acoustic cues than sexual orientation.

Conclusion: Listeners are not likely predicting conformity over sexual orientation. Future research should compare listener's perceptions of these recordings rather than the voice productions.

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# Chapter 1

## Introduction

First impressions are an important part of any social interaction. Five hundred milliseconds after meeting someone, judgements are developed on the basis of trustworthiness, dominance, attraction, and competence solely based on the voice of the speaker (McAleer, Todorov & Belin, 2014). Other perceived characteristics are gender, sexual orientation, masculinity and femininity (Munson & Babel, 2007; Munson, 2007). However, assumptions listeners make, about sexual orientation, are not consistent with how the individual actually identifies nor the literature on perceived versus actual sexual orientation (Munson, 2007). Therefore, the cues people associate with homosexuality are not reliably indicative of someone's attraction toward the opposite sex.

The public tends to use voice cues to categorize individuals as androphilic (attracted to men) or gynephilic (attracted to women) and generalize from these categories to sexual orientation (Vasey and VanderLaan, 2014). In other words, the expectation is that gay men will sound more like straight women since they are all attracted to men, and lesbian women will sound more like straight men because of their attraction to females (Munson & Babel, 2007). As noted, voice cues are not an accurate predictor of sexual orientation. Vocal anatomy contributes to the variation in acoustic properties making it unlikely that even among homosexual men, a female pitch range will exist (Baeck, Corthals & Van Borsel, 2011). However, gay men have shown to effeminate their speech to some extent through intonation contour (Gaudio, 1994).

Perception of sexual orientation is not as accurate at determining sexual orientation as the Kinsey Scale. Developed by Alfred Kinsey, this scale, which is used in part for this study, divides sexual orientation into four main categories: fantasy, attraction, behavior and self-identification (Kinsey, Pomeroy, & Martin, 1948). Each category is scaled from 0-6, and an overall score is created by averaging across these main categories. A score of zero represents exclusively heterosexual individuals and six exclusively homosexual (Kinsey Scale, 2015). Arguably, fantasy and attraction are more accurate measures of sexual orientation since behavior and self-identification can be controlled in order to seem more heterosexual. An individual can still have homosexual feelings even if they never act on them.

The Kinsey scale and "gaydar" perceptions do not identify the same people as homosexual, which leads to the question: what cues are people using to determine sexual orientation? The cues that most people use are more predictive of masculinity and femininity rather than androphilia and gynephilia. Gaudio (1994) showed that voices rated as more masculine, having a lower pitch, did not necessarily sound less gay. This suggests that there is a difference between masculine voices and gynephilic voices and people potentially mistake the two as interchangeable when interpreting sexual orientation. Childhood gender nonconformity, or the way an individual exhibits gender atypical behaviors and preferences, is highly correlated with sexual orientation (Reiger, 2008; Bailey, Miller, & Willerman, 1993; Phillips & Over, 1992). Since gender conformity has a high correlation with sexual orientation, listeners may be using voice properties indicative of conformity rather than sexual orientation to predict the latter. The correlation between conformity and sexual orientation would account for high levels of accuracy in guessing sexual orientation.

# Chapter 2

# Literature Review

## Sex Related Voice Differences

Sexual dimorphism, the distinct variation between men and women, accounts for the difference in fundamental frequency. Fundamental frequency, or F0, is the rate at which the vocal folds vibrate in number of times per second (Fant, 1971). It is hypothesized that as a result of sexual selection, specifically contest competitions in which males attract mates through fighting other males, men have developed deeper voices to sound more dominant toward their competitors (Puts, Gaulin, & Verdolini, 2006; Puts, Hodges, Cárdenas, & Gaulin, 2007). Conversely, the variation of larynx size could be sexually dimorphic because men required increased air intake while fighting (Negus & Keith, 1949). Although it is unclear why men have longer and lower vocal folds, numerous studies support that men and women do have different vocal anatomy. (Fant, 1966; Fitch & Geidd, 1999; Negus & Keith, 1949; Ohala, 1984; Terango, 1966)

During childhood, young boys' and girls' vocal anatomy is relatively similar, and as they age, their vocal folds grow and change position (Fant, 1966; Fitch & Geidd, 1999). Males' vocal folds become larger compared to the females' vocal folds during puberty and along with body size, sex has an effect on vocal fold length (Fitch & Geidd, 1999). This change during development accounts for the lower pitch produced by men, which is the result of the vocal folds vibrating at a slower rate. (Fant, 1966). Lower pitch is the result of vocal folds vibrating at a

slower rate. Men have longer vocal folds with more mass which causes the folds to vibrate more slowly, creating less vibrations per second when compared to females (Negus & Keith, 1949; Ohala, 1984; Terango, 1966;). The size of female vocal folds is somewhere in between the size of a child's and the average adult male. Females' folds vibrate faster, perceptually correlating to a higher pitch in comparison to men. More specifically, the median F0 is significantly higher for females when compared to males (Terango, 1966). The typical fundamental frequency for male speakers is around 110Hz, while females' is double that (Andrews, 2006). The range of females' F0 tends to be larger when compared to males (Henton, 1989).

In addition to fundamental frequency, formant frequencies are significantly different across the sexes. Formant frequencies are peaks of high energy within the spectrum of sound (Fant, 1971) They are related to the length of the vocal tract rather than vocal folds which is affected by a speaker's sex. Males, on average, have a longer vocal tract compared to females. Fant (1966), showed that formants F1, F2 and F3 were on average 20% higher for female speakers compared to males. Formant frequency variations are noted as a feature of male and female voices that allow listeners to accurately predict sex (Coleman, 1971). Compared to fundamental frequency, formant frequencies are not as helpful at predicting sex, although F1-F3 have been used to make this distinction (Hillenbrand, 2009). When formant and fundamental frequencies were modified, both contributed to the change in the perception of the speaker's gender. However, neither F0 or formants modified without the other influences listeners to change their perception of the speaker (Gelfer & Mikos, 2005; Hillenbrand, 2009). Identifying sex through perception is altered by a change in both fundamental and formant frequencies.

Other acoustic parameters that vary across men and women include jitter and shimmer. Jitter is a measurement of cycle-to-cycle variations of fundamental frequency. It measures the

fundamental frequency perturbation within a given speaker (Brockman et al., 2008). Shimmer measures the cycle-to-cycle variations of amplitude. Much of the research on the effect sex has on jitter and shimmer is inconclusive. Brockman et al. (2008) found that when instructed to speak in a soft voice, men produced a higher jitter and lower shimmer compared to women. At normal and loud volumes, jitter and shimmer measurements had no significant differences between men and women. Teixeira and Fernandes (2014) showed that males have a higher mean for all measures of jitter and lower for all measures of shimmer without instructing a specific volume. Not all findings support that there are gender differences in jitter and shimmer (Hunt 2012). Although the data is inconclusive, studies that do find a pattern tend to show that males havehigher jitter and smaller shimmer.

Along with the measured differences in acoustic parameters, the ways that acoustic correlates are used to identify men and women is different. Males tend to be judged based on the variability of their fundamental frequency, the range of pitches, and the intensity that they use in their speech. Females tend to be judged based on the averages of these same properties as opposed to the ranges used (Aronovitch, 1976). Therefore, not only are differences present in production, the way that they are perceived as masculine and feminine vary depending on the sex of the individual.

## Sexual Orientation Voice Data

According to the Williams Institute (2016), the lesbian, gay, bisexual and transgender (LGBT) community makes up 3.8% of the United States population. While this number is small, the number of people who interact with this population is much larger. The term “gaydar” is

defined as one's ability to predict someone's sexual orientation through subtle cues such as appearance, personality, and voice (Rule & Alaei, 2016). Variability within these cues allows people to interpret sexual orientation. Previous research has supported the idea that one cannot solely use these cues to distinguish someone's sexual orientation (Smith, 1985; Gaudio, 1994).

As noted in the previous section, the variation between homo- and heterosexual speakers is not simply a matter of gay men sounding like female speakers. Homosexual males' pitch, or F0, is slightly higher than heterosexual males pitch, but not within the range of heterosexual female pitch (Baeck, Corthals & Van Borsel, 2011). Anatomical differences between men and women contribute to this process; therefore, it would be unlikely for gay men's pitch to be at the same level as women. Conversely, some research has shown that heterosexual and homosexual females' pitch does not vary to the extent that is seen in men (Waksler, 2001; Kachel, Simpson, & Steffens, 2017). Although, one study shows that lesbian women do have a lower average pitch than heterosexual women. (Van Borsel, Vandaele & Corthals, 2013)

Coates (1986) suggests that gay men try to imitate the intonation contour that women more frequently use. This process of effemination could allow others to perceive them as more homosexual (Gaudio, 1994). Furthermore, differences in F1 and F2 of certain vowels have shown to be affected by sexual orientation. For females, first and second formants for /ɛ/ and /oʊ/ were different for heterosexual and homosexuals. Homosexual males had different first formant for /ɛ/ and /æ/ compared to heterosexuals (Munson, 2006). These differences alone would not allow for others to accurately predict androphilia and gynephilia, similarly to how formants play a role in sex identification, but not without a change in fundamental frequency (Gelfer & Mikos, 2005; Hillenbrand 2009).

Gay lisp is a characteristic of gay men's speech that is placed on the consonant /s/ and is usually dentalized by this population (Mack & Munson, 2012; Van Borsel et al., 2009). Although the present study looks at vowel production, gay lisp supports the idea that gay men are using similar patterns in their speech and may also change other aspects of their speech production. Based on this lisp property, listeners were able to interpret sexual orientation for more than half of the gay men in the sample. (Mack & Munson, 2012)This aligns with the idea that anatomy is not the only factor in speech and that sex and sexual orientation may also be factors affecting speech.

### Sexual Orientation and Childhood Gender Nonconformity

Sexual orientation and childhood gender nonconformity are highly correlated (Bailey, Miller, & Willerman ,1993; Phillips & Over 1992; Reiger et al. 2008). In recalling childhood experiences, homosexual men remembered more diverse sex typical and sex atypical behaviors than heterosexual men (Phillips & Over 1992). In other words, more gender nonconforming children were more likely to be homosexual (Bailey, Miller, & Willerman ,1993; Phillips & Over 1992; Reiger et al. 2008). Bailey and colleagues (1993) had mothers recall their adult son's preferences as a child. Mothers of homosexual males reported more nonconforming preferences for their son including being nonathletic and overall less masculine (Bailey, Miller, & Willerman, 1993). This information was compared to the participants' self-reported sexual orientation in adulthood. Similar to self-reporting, mothers are also subjective in how they respond about childhood gender nonconformity. Without the concrete evidence that videos or longitudinal studies offer, participants may alter their answers to sound more gender typical.

Home videos are a more reliable source of analyzing childhood gender conformity as they are more objective. Reiger et al. (2008) took home videos from various recorded events such as birthday parties or play activities of participants to analyze their behaviors, toy preferences, and dress. This more objective data showed that the homosexual population took part in more sex atypical behaviors as well (Reiger et al., 2008). No one method of attaining sex typical behavior has been used, but research generally supports the idea that childhood gender conformity predicts sexual orientation. Since correlations between sexual orientation and childhood gender nonconformity are high, it is anticipated that a variable affected by sexual orientation will also be affected by childhood gender conformity.

## Purpose

Research has already identified acoustic differences between sexes and sexual orientation. However, there is a gap in the research on childhood gender nonconformity and acoustic properties. The purpose of this study is to determine if the cues typically perceived by others as homosexual are actually related to childhood gender nonconformity. Due to the correlations of sexual orientation and conformity, by accurately detecting someone's conformity the listener can predict sexual orientation. Previous literature shows correlations with sex and acoustics as well as sexual orientation and acoustics, but little is known about how acoustics relate to gender conformity. Moreover, the speech differences may be tied more to conformity than it is to sexual orientation. This study looked at the spectrum of childhood gender conformity to see if there are correlations with fundamental frequencies, formant frequencies, jitter and shimmer.

# Chapter 3

## Methods

The participants for this study were drawn from a larger study at Michigan State University looking at the effects of childhood gender conformity on different behaviors. There were 614 individuals that participated in the current study. Of the participants, 389 were females and 225 were males. Participants age ranged from 18 to 27 years old. A total of four participants were homosexual, meaning they were a 5 or 6 on the Kinsey scale for fantasy and attraction. See Figure 1 for details. Conformity varied across participants. See details in Figure 2.

## Participants

**Figure 1: Sexual Orientation Participant Data**

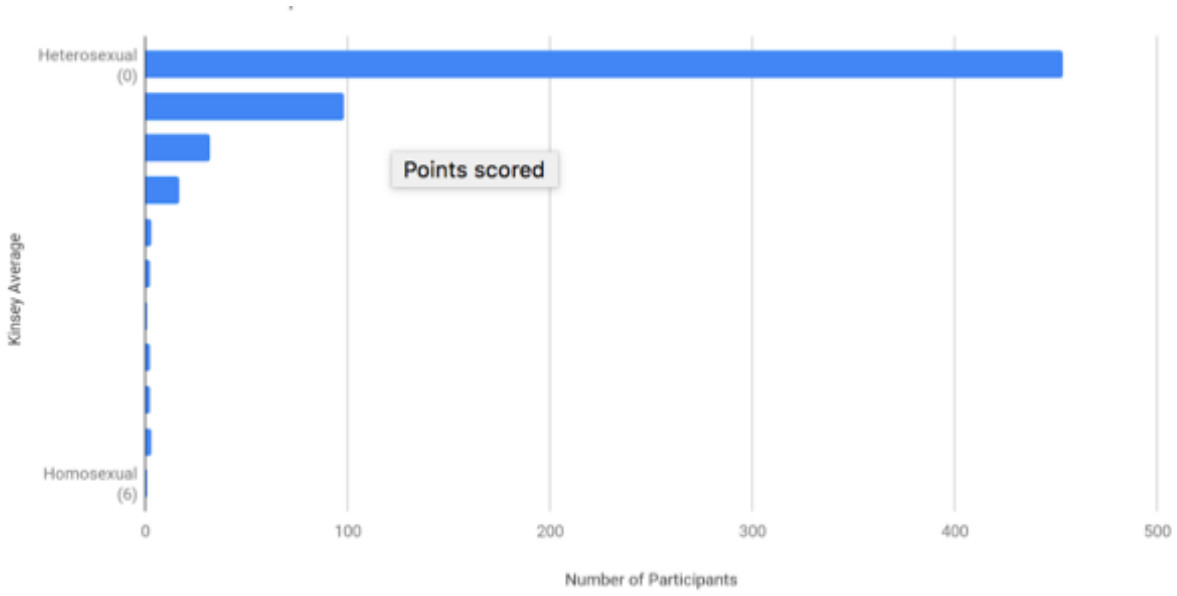
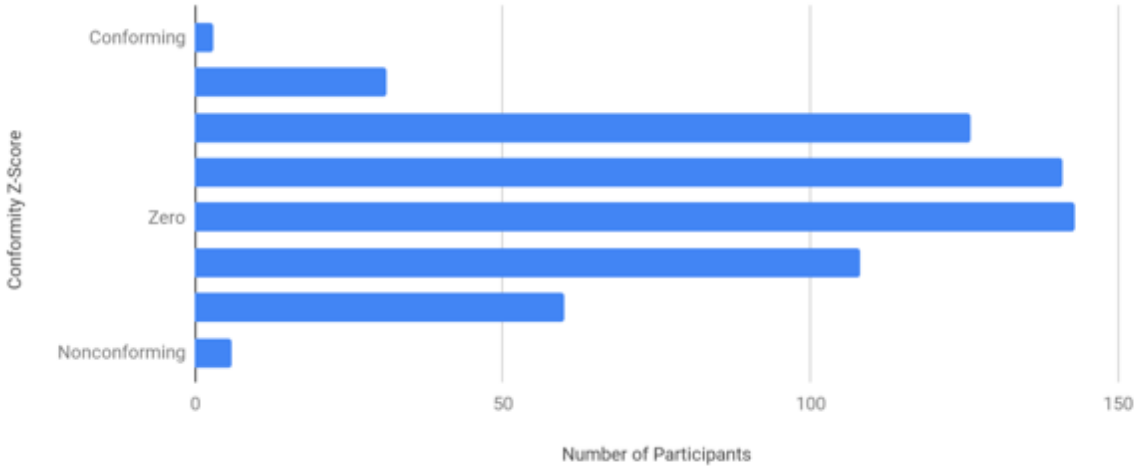


**Figure 2: Childhood Gender Nonconformity Participant Data**




## Procedures

The data were part of a larger study investigating relations of Childhood Gender Nonconformity, or CGN, with empathy, memory, aggression, etc. Participants began by answering questions on empathy by looking at a specific facial expression. Next, they did voice productions for the Rainbow Passage (Fairbanks 1960), counting from 1 to 10, and 12 different /b/ vowel /t/, or /bvt/, productions. Then, they completed memory and other tasks that were not used for this study. The study ended by gaining participant information for childhood recalled behaviors and preferences, as well as sexual orientation questions for fantasy and attraction. Here are two of twenty-four questions for CGN:

1. As a child, which did you like more, romantic stories or adventure stories?
2. As a child, were you interested in playing with dolls?

See Appendix A for full questionnaire. The participants came in to the lab for two sessions, but only the recordings obtained from the first session were used for analysis.

The productions for /bvt/ respectively, are as follows. /bit/, /bɪt/, /bɛt/, /beɪt/, /bæt/, /bʌt/, /baʊt/, /baɪ/, /bʊk/, /but/, /boʊt/, and /bɔt/. They went on further to say other consonants, but due to coarticulation those were not included in the study. The participants' productions for these vowels were then compared to their score for CGN.

## Data Analysis

The first analyses measure correlations of sexual orientation, or SO, with CGN to ensure that the results matched previous research. Next, we examined productions of /b/ vowel /t/, or /bvt/, for measures of mean fundamental frequency (F0), jitter, shimmer and formant frequencies one and two (F1, F2). Since the number of participants rated as homosexual was low, the data were only examined with regard to childhood gender conformity.

In order to correlate SO and CGN data, the questionnaires were manually scored and given an average for both conformity SO and CGN. Within each question there was a gender typical and atypical answer for both sexes. For example, "As a child, did you prefer to play with?" an answer of "girls" for males was atypical and "boys" was typical and vice versa for females. The feminine response was given a score of (-1) and the masculine response was given a score of (1). Answers that were not typical for either gender, such as "don't remember" was given a score of (0). Individual's point value for each was then added up for a raw score then, a z-score was created to determine the conformity level across all participants.

For sexual orientation, the two questions targeted fantasy and attraction on the Kinsey scale. Each question received a score from 0 to 6, similar to the Kinsey scoring system. The two were then averaged to create a new score within the same interval to determine average sexual

orientation. Then a linear regression was created to correlate SO average and CGN Z-score to ensure the data matched previous research.

Measures of mean F0, jitter, and shimmer were measured in Praat (Boersma & Weenink 1997). The script used was developed for a previous study. The script took measurements for harmonics to noise ratio, median F0, minimum F0, maximum F0 and duration. For measures of jitter and shimmer the script obtained three and four measurements respectively. The measurements were then correlated using a correlation matrix to determine if the variables "jitter" and "shimmer" could represent all variables for each. The shimmer measurement was significantly correlated with shimmerapq3 ($r = .89$, $p<.001$), Shimmerapq5( $r=.95$, $p<.001$), shimmerApq11 ($r=.878$, $p<.001$), and shimmerDda ($r=.89$ $p<.001$). The jitter measurement was significantly correlated with jitterRap ($r=.919$, $p<.001$), jitterPPq ($r=.937$, $p<.001$), and jitterddq ($r=.919$, $p<.001$). The measurements within each variable were highly correlated and the first variable was used as a representative measure for all analysis (one for jitter and one for shimmer).

Formants were also measured using a Praat script developed for a previous study. To accurately measure each vowel, each word was separated as an individual sound file. Boundaries were placed in between each word and then segmented and separated by vowel (GNU General Public License 2002). Each vowel was analyzed separately. Reliability was performed on a random sampling across participants and vowels using TF32. Six participants (3 male and 3 female) for each of the twelve vowels and three formants were measured for a total of 216 formant measurements. For formant one values, or F1, the script and manually coded formants were 90% correlated. For measures of formant two, or F2, the script and manually retrieved formants were 97% correlated. The other formants were all measured using the Praat script.

# Chapter 4

# Results

Results for the study were analyzed according the following independent variables: Sex, Female CGN and Male CGN. Dependent variables were tested in the order of fundamental frequency (F0), formant frequencies (F1 and F2), jitter and shimmer. The discussion will compare the results to the sexual orientation data seen in previous studies.

## Results for Sex

### Fundamental Frequency

Median fundamental frequency for males and females significantly varied for men and women. A linear regression testing the effect of sex on median F0 for each participant was conducted. Results reveal that sex is a significant predictor of F0, $F(1,622) = 4102.347$, $p<.001$ accounting for 88% of the variance. More specifically women had a median F0 that is 88.583 Hz higher than males.

### Formant Frequencies (F1, F2)

Along with F0, F1 and F2 were also predicted by a participants sex. A linear regression testing the effect of sex on F1 and F2 for each vowel was conducted. Results revealed that sex impact formant frequency for all of the vowel formant pairs; $p<.001$ for all vowel formants.

**Jitter and Shimmer**

Jitter is predicted by an individual's sex. Using the jitter variable that was shown to be representative by all measures of jitter, a linear regression was created for jitter and sex. Results revealed that sex significantly predicted jitter across participants, $F(1,622) = 259.585$, $p<.001$. Sex accounted for 29% of the variation in jitter with an increase in .008 for males. Shimmer was also reduced to one variable that represented all shimmer measurements. Using this variable, results support that sex significantly predicted shimmer across participants. For shimmer, sex was a significant predictor, $F(1,622) = 4102.347$, $p<.001$ accounting for 22% of the variation with males having an average of .016 above females.

## Results for Female Childhood Gender Nonconformity

A linear regression tested the effects of CGN on SO. Since the coding for CGN and SO were opposite for men and women, the two were tested separately. A linear regression testing the effects of CGN on SO for females showed that the two variables were significantly correlated, $F(1,386)=23.646$ $p<.001$ accounting for 5.7% of the variation. Therefore, female sexual orientation was significantly predicted by childhood gender nonconformity. As females increase one point on the conformity scale, on average they increase on the Kinsey scale by .502. In other words, when females increase on the conformity scale, or become more nonconforming, they are also higher on the Kinsey scale, or more homosexual.

**Fundamental Frequency**

A linear regression testing the effects of CGN for females on median fundamental frequency for each participant was conducted. Results revealed that CGN for females was not a significant predictor of fundamental frequency, $F(1,386)= .017$, $p=.895$. For women, nonconformity does not predict median fundamental frequency.

**Formant Frequencies (F1, F2)**

Multiple linear regressions were conducted testing the effect of CGN scores on F1 and F2 for each vowel across females was conducted. Results revealed that CGN scores impact formant frequency for some, but not all, of the vowel-formant pairs (See Table 1).

**Table 1: Formant Frequencies for Female Childhood Gender Nonconformity**

| Vowel | Formant 1 | | Formant 2 | |
|---|---|---|---|---|
| | F | Sig | F | Sig |
| /i/ | F(1,384)= .387 | p>.001 | F(1,384)=6.459 | p>.001 |
| /ɪ/ | F(1,386)=11.083 | p=.001* | F(1,386)=1.668 | p>.001 |
| /ɛ/ | F(1,386)=18.896 | p<.001* | F(1,386)=.826 | p>.001 |
| /eɪ/ | F(1,386)= .341 | p>.001 | F(1,386)=4.139 | p=.043** |
| /æ/ | F(1,386)= 13.650 | p<.001* | F(1,386)= .185 | p>.001 |
| /ʌ/ | F(1,386)= 13.740 | p<.001* | F(1,386)=1.012 | p=.046** |
| /aʊ/ | F(1,386)=5.269 | p=.022** | F(1,386)= .082 | p>.001 |
| /aɪ/ | F(1,385)= .608 | p>.001 | F(1,385)= 5.261 | p=.022** |
| /ʊ/ | F(1,386)= 3.555 | p>.001 | F(1,386)= .233 | p>.001 |
| /u/ | F(1,386)=.686 | p>.001 | F(1,386)=4.843 | p=.028** |
| /oʊ/ | F(1,386)= 6.310 | p=.012** | F(1,386)=.012 | p>.001 |
| /ɔ/ | F(1,386)= 22.111 | p<.001* | F(1,386)= 5.744 | p=.017** |

* Significant
** Marginally Significant

**Jitter and Shimmer**

A linear regression analyzed the effects of female CGN data with jitter and shimmer. Neither jitter nor shimmer were predicted by female nonconformity. A linear regression testing the effects of CGN on jitter for female participants was conducted. Results revealed that CGN for females was not a significant predictor of jitter, $F(1,386)= .129$, $p=.719$. Another linear

regression testing the effects of CGN on shimmer for female participants was conducted. Results revealed that CGN for females was not a significant predictor of shimmer, $F(1,386)= .507$, $p=.477$.

## Results for Male Childhood Gender Nonconformity

A linear regression testing the effects of CGN on SO for males showed that the CGN predicted SO, $F(1,224)=38.995$ $p<.001$ accounting for 14.8% of the variation. On average, as males increase on conformity by one point, they also decrease in the Kinsey scale. More specifically, less conforming males have lower levels on the Kinsey scale, which is contradictory of previous studies. This indicates that male childhood gender nonconformity significantly predicted male sexual orientation, but not in the anticipated direction.

### Fundamental Frequency

For males, CGN was not a significant predictor of fundamental frequency. A regression testing the effects of CGN on median fundamental frequency for male participants was conducted. Results reveal that CGN for males was not a significant predictor of fundamental frequency, $F(1,224)=1.620$, $p=.204$.

**Formant Frequencies (F1, F2)**

A linear regression testing the effect of CGN scores on F1 and F2 for each vowel across males was conducted. Results reveal that CGN scores did not significantly impact any formant frequencies, although few were marginally significant. (See Table 2).

**Table 2: Formant Frequencies for Male Childhood Gender Nonconformity**

| Vowel | Formant 1 | | Formant 2 | |
|---|---|---|---|---|
| | F | Sig | F | Sig |
| /i/ | F(1, 222)=5.540 | p=.019** | F(1, 222)=.995 | p>.001 |
| /ɪ/ | F(1, 223)=2.782 | p>.001 | F(1, 223)=4.031 | p=.046** |
| /ɛ/ | F(1, 223)=.295 | p>.001 | F(1, 223)=1.991 | p>.001 |
| /eɪ/ | F(1, 223)=.993 | p>.001 | F(1, 223)=.120 | p>.001 |
| /æ/ | F(1, 223)=.718 | p>.001 | F(1, 223)=.049 | p>.001 |
| /ʌ/ | F(1, 223)=.426 | p>.001 | F(1, 223)=.157 | p>.001 |
| /aʊ/ | F(1, 223)=.255 | p>.001 | F(1, 223)=.371 | p>.001 |
| /aɪ/ | F(1, 223)=.013 | p>.001 | F(1, 223)=3.434 | p>.001 |
| /ʊ/ | F(1, 223)=.098 | p>.001 | F(1, 223)=.020 | p>.001 |
| /u/ | F(1, 223)=3.772 | p=.053** | F(1, 223)=.000 | p>.001 |
| /oʊ/ | F(1, 223)=.475 | p>.001 | F(1, 223)=2.008 | p>.001 |
| /ɔ/ | F(1, 223)=.227 | p>.001 | F(1, 223)=.377 | p>.001 |

* Significant
**Marginally Significant

**Jitter and Shimmer**

A linear regression testing the effects of CGN on jitter for male participants was conducted. Results revealed that CGN for males was not a significant predictor of jitter, $F(1,224)=.997$, $p=.324$. Conversely, a linear regression testing the effects of CGN on shimmer for male participants was conducted. Results revealed that CGN for males was marginally significant predictor of shimmer, $F(1,224)=6.009$, $p=.015$ with one point on the conformity scale decreasing shimmer by .009.

# Chapter 5

## Discussion

Sex, sexual orientation, and childhood gender nonconformity, all affect the acoustics produced by varying speakers. Sex is the most predictive of acoustic measures varying most drastically for men and women. Previous research has supported that sex predicts fundamental frequency and formant frequencies but is inconsistent for jitter and shimmer (Fant 1966; Fitch & Geidd 1999; Brockman et al. 2008; Hunt 2012). This research aligns with previous research on these measures and provides more data to support that jitter and shimmer are predicted by sex.

For fundamental and formant frequencies, the results showed that females were higher than males for both variables. Median fundamental frequency was, on average, 108.834 Hz higher for females. This is similar to the results of Andrews (2006) that shows that females had 220 Hz average while males had 100Hz. For formant frequencies one and two, every vowel appeared to be affected by sex. Since vocal fold and vocal tract size affect the production of fundamental and formant frequencies respectively, it was anticipated that sex would have the strongest relationship for these variables.

Jitter and shimmer here showed different results when compared to previous studies. While jitter is usually higher for males and lower for females, results of this study showed that both variables were lower for females. This indicated that both fundamental frequency and intensity perturbation for male speakers were higher.

The purpose of this study though was not to obtain data on sex and acoustic, but to contrast the impacts of childhood gender nonconformity and sexual orientation on acoustic

properties. These results on sex and acoustic properties were used to ensure that the participant acoustics matched previous studies before analyses on gender nonconformity were analyzed. Since the acoustic properties for sex matched previous research, with the exception of jitter and shimmer, further analyses were thought to be accurate. In other words, participants were performing similar to previous research and therefore the data recorded from Praat and TF32 were most likely correct.

## Childhood Gender Nonconformity and Sexual Orientation

Female sexual orientation was significantly predicted by childhood gender nonconformity; therefore, it was expected that acoustic properties affected by SO would be affected by CGN. According to the results of this study, the hypothesis was not supported. Different variables were affected in previous studies of lesbian and straight women compared to the effects of conforming and nonconforming women in this study. See Table 3.

**Table 3: Female Sexual Orientation and Childhood Gender Nonconformity Comparison**

| Previous Research on Sexual Orientation | CGN Findings |
|---|---|
| • F0<br>  ○ Women do not have a variation in F0. (Waksler 2001; Kachel, Simpson, & Steffens 2017)<br>  ○ Women do have a variation in F0. (Van Borsel, Vandaele & Corthals 2013)<br>• Formants (Munson 2006)<br>  ○ 1st /ɛ/<br>  ○ 2nd /ɛ/<br>  ○ 1st /oʊ/<br>  ○ 2nd /oʊ/ | • F0<br>  ○ Not significantly predicted<br>• Formants<br>  ○ 1st /ɪ/<br>  ○ 1st /ɛ/<br>  ○ 2nd /eɪ/ **<br>  ○ 1st /æ/<br>  ○ 1st /ʌ/<br>  ○ 2nd /ʌ/ **<br>  ○ 1st /aʊ/ **<br>  ○ 2nd /aɪ/ **<br>  ○ 2nd /u/ **<br>  ○ 1st /oʊ/ **<br>  ○ 1st /ɔ/<br>  ○ 2nd /ɔ/ **<br>• Jitter<br>  ○ Not significantly predicted<br>• Shimmer<br>  ○ Not significantly predicted |

**Marginally Significant

Previous data was inconclusive on whether lesbian women have a lower pitch than heterosexual women. Although CGN and SO are not always the same, they are highly correlated. In this study, the CGN data is more closely related to the Waksler 2001 and Kachel, Simpson, & Steffens 2017 studies in which these groups of participants do not show a variation in fundamental frequency. Female speakers did not vary in their pitch based on who they were attracted to nor their childhood preferences. Jitter and shimmer also showed no effect based on these factors. However, formant frequencies were more often significantly predicted by childhood gender nonconformity than sexual orientation (Munson 2006). Although previous

research has supported that formant frequencies alone do not change listeners perception of a speaker (Hillenbrand 2009; Gelfer & Mikos 2015). Overall for females, the research does not support that one can use acoustic cues to determine sexual orientation or childhood gender nonconformity.

Male sexual orientation was also significantly predicted by childhood gender nonconformity. Therefore the hypothesis for the study was that CGN acoustics would be similar to results of sexual orientation acoustics. However, the data obtained did not support this hypothesis either. See Table 4.

**Table 4: Male Sexual Orientation and Childhood Gender Nonconformity Comparison**

| Previous Research on Sexual Orientation | CGN Findings |
|---|---|
| • F0<br>  ○ Males pitch is higher ((Baeck, Corthals & Van Borsel 2011)<br>• Formants (Munson 2006)<br>  ○ 1st /ɛ/<br>  ○ 1st /æ/ | • F0<br>  ○ No significantly predicted<br>• Formants<br>  ○ 1st /i/ marginal<br>  ○ 1st /u/ marginal<br>  ○ 2nd /ɪ/ marginal<br>• Jitter<br>  ○ Not significant<br>• Shimmer<br>  ○ Nonconforming men have lower shimmer ** |

**Marginally Significant

Similar to the female analyses, acoustics for males were not significantly different for most variables. Previous research has shown that gay men have different acoustic properties including a higher pitch, but this was not observed when differentiating by CGN. For males, no variable significantly differed across CGN, but some formants and shimmer were marginally

significant. Formants that were different across SO from the Munson (2006) study did not vary for CGN. Shimmer was marginally lower for nonconforming men. To compare, the data on sex showed that females had a lower shimmer which was the trend seen with nonconforming males.

## Conclusion

In summary, SO and CGN are highly correlated, but the acoustic correlates of homosexual and nonconforming individuals does not match. The data do not support that (1) acoustics can help predict CGN nor (2) that CGN has more acoustic differences than sexual orientation allowing people to anticipate sexual orientation. Moreover, it is not likely that individuals are guessing childhood gender nonconformity through perception and "gaydar". Although the data does not give enough differences to allow listeners to predict sexual orientation and conformity, there are still acoustic variations.

This study lacked homosexual participants with a total of 4 participants rated high enough to be considered homosexual on the Kinsey scale. To gain a better understanding of how CGN and SO overlap, more homosexual participants would need to be added to the sample. Future research should focus on perceptions of CGN speakers and if listeners predict nonconforming participants are homosexual. One approach to this would include finding nonconforming individuals who are heterosexual and play speech samples to see if people assume they are homosexual since this study did not show that the acoustics were drastically different. The acoustic data does not support that listeners can predict CGN or SO from a speech

sample, but this process still occurs. There is still no clear understanding of which cues are used to predict sexual orientation.

## Appendix A

## Childhood Gender Nonconformity Questionnaire

1) As a child, did you prefer to play:
   a) with boys
   b) with girls
   c) didn't make any difference
   d) alone
   e) don't remember
2) As a child, did you like inside chores such as cooking, sewing, and cleaning house, or outside chores such as working on automobiles and house painting?
   a) Inside chores
   b) Outside chores
   c) Liked or disliked them equally
   d) Don't remember
3) As a child, were you interested in playing with dolls?
   a) Yes
   b) No
   c) Don't remember
4) In childhood (between ages 3 and 12), were you very interested in the work of a garage mechanic?
   a) Yes
   b) No
   c) Don't remember
5) As a child, which did you like more, romantic stories or adventure stories?
   a) Romantic stories
   b) Adventure stories
   c) It didn't make any difference
6) Before age 13, when you read a story, did you imagine you were the male in the story or the female in the story?
   a) The male in the story
   b) The female in the story
   c) Sometimes the male, sometimes the female
   d) Neither one
   e) Didn't read stories
7) As a child, did you sometimes imagine yourself as being the courageous leader of others?
   a) Yes
   b) No
   c) Don't remember
8) As a child, did you ever wish you had been born a [For women] boy instead of a girl [For men] girl instead of a boy?
   a) Often
   b) Occasionally
   c) Never

9) As a child, did you sometimes imagine or fantasize about physically defending someone against a monster, a dangerous animal, or "evil" people?
   a) Yes
   b) No
   c) Don't remember
10) In childhood fantasies, did you sometimes wish you could go hunting big game?
   a) Yes
   b) No
   c) Don't remember
11) In childhood, did you wish you would become very strong physically?
   a) Yes
   b) No
   c) Don't remember
12) In childhood, was there ever a period in which you wished you would, when adult, become a dressmaker or dress designer?
   a) Yes
   b) No
   c) Don't remember
13) In childhood fantasies, did you sometimes imagine yourself driving a racecar?
   a) Yes
   b) No
   c) Don't remember
14) In childhood, did you ever wish to become a dancer?
   a) Yes
   b) No
   c) Don't remember
15) In childhood, did you ever wish to become a pilot, or did you fantasize about being a pilot?
   a) Yes
   b) No
   c) Don't remember
16) As a child, did you have the reputation of being a [For men] "sissy boy" [For women]"tomboy"?
   a) Often
   b) Occasionally
   c) Never
17) As a child, compared to other [For men] boys your age [For women] girls your age, did you feel
   a) Much more masculine
   b) Somewhat more masculine
   c) Equally masculine
   d) Somewhat less masculine
   e) Much less masculine
18) As a child, compared to other [For men] boys your age [For women] girls your age, did you feel
   a) Much more feminine
   b) Somewhat more feminine

c) Equally feminine
d) Somewhat less feminine
e) Much less feminine

19) As a child, did you
20) [For men]
a) Always feel good about being a boy (or never thought about how you felt)
b) Usually feel good about being a boy
c) Rarely feel good about being a boy
d) Never feel good about being a boy
21) [For women]
a) Always feel good about being a girl (or never thought about how you felt)
b) Usually good about being a girl
c) Rarely feel good about being a girl
d) Never feel good about being a girl
22) As a child, did you enjoy wearing dresses and "feminine" clothes?
a) Yes, I enjoyed them.
b) I did not particularly enjoy it, but I didn't mind it either.
c) I disliked wearing such clothes.
d) I don't remember.
23) 21. As a child, did you ever have the secret desire to be a [For women] boy [For men] girl?
a) Frequently
b) Occasionally
c) Rarely
d) Never
24) As a child, did you ever tell anyone that you wanted to be a [For women] boy [For men] girl?
a) Frequently
b) Occasionally
c) Rarely
d) Never
25) As a child, did you enjoy experimenting with cosmetics and jewelry?
a) Yes
b) No
c) I never did this.
d) I don't remember.
26) Mark each activity that you often enjoyed at the specified ages:
27) When you were 5-8:
a) Baseball
b) Marbles
c) Dolls
d) Football
28) When you were 9-13:
a) Baseball
b) Marbles
c) Dolls
d) Football

## Appendix B

## Sexual Orientation Questionnaire

1) Which of the following best describes your sexual feelings at present?
   a) I am attracted to men only, never to women
   b) I am almost always attracted to men, but on rare occasions I am attracted to women.
   c) I am more often attracted to men, but I frequently find women attractive
   d) I am equally attracted to women and men
   e) I am more often attracted to women, but I frequently find women attractive
   f) I am almost always attracted to women, but on rare occasion I am attracted to men
   g) I am attracted to women only, never to men

2) Which of the following best describes your sexual fantasies at present?
   a) Always a man, never a woman
   b) Almost always a man, but on rare occasions, I imagine sex with a woman
   c) More often a man, but I frequently fantasize about having sex with a woman
   d) Equally often a man or a woman
   e) More often a woman, but I frequently fantasize about having sex with a man
   f) Almost always a woman, but on rare occasions, I imagine sex with a man
   g) Always a woman, never man

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