The Production and Perception of a Lesbian Speech Style

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1. Introduction

1.1. Language and sexuality

The study of language and sexuality has allowed researchers to probe a style of speech that, unlike differences in region or ethnicity, is learned later in life, and whether consciously or not, is used in constructing a social persona. Work on the production of homosexual speech styles, as well as the perception of such styles, have been insightful in addressing questions of how social identities are constructed through variation in speech. For example, research has shown that variables with strong connections to broad social concepts such as "fun" or "feminine", can be used in connection with other variables to project a more specific persona (Campbell-Kibler 2011, Podesva, 2011b).

Despite being a promising line of research, the relationship between sexual orientation and speech has focused almost entirely on the speech of gay men. Of these I present three primary studies which are particularly relevant to my work in this study. For a review of the literature at large, see Munson and Babel 2007. The first of the studies I want to focus on is by Rudolf Gaudio in 1994, who investigated pitch use as part of a stereotype of gay speech. Gaudio recorded eight men, 4 gay and 4 straight, reading two passages and using natural speech in a short interview. One portion from each of the two readings by each speaker were extracted and played to listeners for rating. Ratings on seven-point scales of four semantic pairs associated with stereotypes of gay speech: "straight/gay", "effeminate/masculine", "reserved/emotional", and "affected/ordinary". Gaudio then analyzed the ratings of "straight/gay" according to multiple pitch variables. Findings showed that listeners

were very accurate in their ratings (different speakers to different degrees), and that the ratings reflected the common stereotype of gay men being effeminate. However, despite analyzing a number of pitch measurements, Gaudio found only one statistically significant difference in pitch according to listener ratings, pitch fluctuation. He concluded that there is clearly some stereotype of gay speech, and that it includes some aspect of pitch, but that there is much more to be uncovered.

In 2003 Ron Smyth, Greg Jacobs, and Henry Rogers conducted a similar study, investigating which phonetic properties serve as markers for listeners to judge the sexual orientation of a man according to his voice. Twenty-five male voices were played for listeners to judge as gay-sounding or straight-sounding in order to assess perceptions of gay men's speech according to discourse type (scientific, dramatic, or spontaneous) and listener group (gay men vs. a mixed group of men and women of unknown sexual orientation). The researchers found that listener judgments were highly consistent at the extremes of the spectrum of gay-sounding to straight-sounding, indicating the existence of certain concrete stereotypes regarding the phonetic quality of gay men's speech. They also found that the discourse type of the reading had a significant effect on the listeners' judgments of the sexual orientation of the speaker, and that gay male listeners were more likely to rate voices as gay-sounding than other listeners, and were also less accurate in their judgments. In general auditory "gaydar", the ability to accurately determine the sexual orientation of an individual by voice alone, is very poor among all participants except in the cases of voices consistently perceived as very gay-sounding or very straight-sounding. There was no significant correlation between

the pitch of a voice and the listeners' ratings of that voice as either straight/gay or masculine/feminine. In keeping with Gaudio's findings, the two constructs of straight/gay and masculine/feminine are highly correlated in listeners' judgments of the voices, with gay sounding voices also sounding more feminine.

In her 2011 study on sociolinguistic style, Kathryn Campbell-Kibler makes use of the notion that specific styles combine linguistic features with broader or less specific indexical meanings. In this case she explores the variables pitch, /s/-fronting, /s/-backing, and ING. Using four speakers in casual interviews, Campbell-Kibler manipulated short recordings to produce different combinations of the features, and used them as stimuli for collecting and testing different styles. In the primary phase of the study, 175 subjects listened to one recording from each of the four speakers, but with different combinations of altered features. They were asked to rate each recording on a nine point scale for nine terms. The terms were , "smart", "knowledgeable", "masculine", "gay", "friendly", "laid-back", "country", "educated", and "confident". The results show interactions between the different traits, most of which were mediated by certain linguistic features. The patterns are complex, indicating support of the hypothesis, that different linguistic features fit together to create different styles. Campbell-Kibler also found a difference in the overall significance of certain features, differences which she compares to the variability of stylistic meaning of different articles of clothing. /s/ fronting, like red stilettos, has a broad meaning of either gay or having a speech impediment, more or less regardless of the other features being used. ING ending, on the other hand, has significant meaning, but these vary according to context; it can sometimes index lower socio-

economic class, or perhaps toughness, or possibly lack of education. The meaning depends on the other linguistic features being used, similar to the blazer.

One of the earliest studies in the area of sexual orientation and speech (Moonwomon-Baird, 1996) investigated lesbian speech patterns and perceptions, but female subjects were not included in other studies until a 2001 study by Rachel Waksler. Work focusing on sexual orientation and speech in women is still very limited. The research is methodically broad, including work in four different languages and five countries, and a mix of production, perception, and representation of lesbian speech in movies. The phonetic variables investigated, on the other hand, are extremely limited, including only measurements of pitch mean and pitch range. Other work has been conducted which includes speech of both male and female speakers. These look at variables beyond pitch, the first and second vowel formants and various aspects of fricative variation. The findings for all of these are mixed, often inconclusive within a study, and even more so when comparing the results between studies. Some studies looking at pitch found no significant difference between sexual orientations, though most have shown a general trend of lesbians having a lower mean pitch and smaller pitch range. When differences in the first and second formants were researched, findings were always significant, for certain vowels, but those vowels differed by study. The direction of difference however did not differ; all studies have found a lower F1 and F2 for lesbian or lesbian-sounding speakers.

The table below shows the previous findings on patterns of speech production and perception based on sexual orientation in women. Findings are

grouped by study, with some studies including both production and perception experiments. Three topics of research are separated according to findings, research showing differences in 1) pitch, 2) fricatives, and 3) vowel formants. A symbol "__" indicates no difference between sexual orientations. An upwards pointing arrow indicates a higher pitch or greater pitch range in lesbian speakers, and a downwards pointing arrow indicates the opposite. When arrows are vertical, the differences are statistically significant. When they are slanted, the differences do not reach the standard measure of significance ($p < 0.05$). "ART" is used for articulation research, "PERC" for perception research, and "FILM" for the study looking at portrayals of lesbians in film. Squares in the table are empty if that phonetic variable was not explored.

Table 1a Results of previous research on lesbian speech looking at pitch

Author	Pitch mean	Pitch range	Vowel	Fricatives	Speakers and Method
Moonwomon-Baird (1997)	Lesbians have lower pitch peaks	↘			2 pairs of speakers, lesbian vs. straight (US) ART
	__	__			Rate speakers on social variables[1] and perceived phonetic variables (US) PERC
Waksler (2001)	__	↗			12 lesbian & 12 straight readers (US)
	__	↘			Actresses playing lesbian and straight (US) FILM

[1] *Social variables* refers to a wide range of descriptive concepts such as "straight", "casual", "feminine", etc. This second experiment of this study includes listeners rating six of these variables based on recordings of speakers. Other work on language and sexuality has made use of such judgment tasks, some including more than the single variable "gay/straight". Different studies have referred to these variables differently (eg: *semantic pairs, affective ratings*, or simple *ratings*). I have chosen *social variable* as it provides a broader term that can be applied to other such descriptive concepts outside of the study. The use of the term *variable* also indicates that these can vary between individuals and correlate with phonetic variables being explored in this study.

Author	Pitch mean	P. range	Vowel	Fricatives	Speakers and Method
Camp (2009)	↘	—			Interviews w/ 12 lesbians and 7 straight (Japan) ART
	↓	↘			Rate speakers on social variables (Japan) PERC
Levon (2011)	Both groups higher for lesbian topics				2 politically opposed groups of lesbians (Israel) ART
Van Borsel et al. (2013)	↓	↓			34 lesbian & 68 straight readers (Brazil) ART
Munson et al. (2006a)				Lesbians have lower center of gravity	Perceived sexual orientation and perception of /s/ or /ʃ/ (US) PERC
Munson et al. (2006b)	—		Lesbians have lower F1 in /ɛ/ and lower F2 in /oʊ/		11 L/B & 11 straight readers (US) ART
	—		Lesbian have low F1 in low-front vowels and low F2 for back vowels		40 listeners judged sexual orientation (US) PERC
Pierrehumbert et al. (2004)			Lesbians and bisexuals have lower F1 in /u/ and lower F1 and F2/ɑ/		16 lesbian, 16 bisexual, and 16 straight readers – lesbian and bisexual combined (US) ART
Rendall et al. (2008)			Lesbians have slightly lower F1 and F2		33 straight & 29 lesbian readers (Canada) ART

Published in 1997 in Livia and Hall's book *Queerly Phrased: Language, Gender, and Sexuality*, Birch Moonwomon-Baird's study is composed of two experiments originally conducted in 1983 and 1984. In the perception experiment, 21 listeners were played a series of recordings of six lesbians and six heterosexual women, and filled out a questionnaire eliciting judgments of the speakers' social identity: class, age, educational background, region of upbringing, ethnicity, and sexual preference as well as phonetic variables: rate of speech, pitch, amplitude, and "forcefulness". Moonwomon-Baird then tested for correlations among perceived

social variables and among perceived phonetic variables, as well as correlations between the two groups of variables. She found no correlations between the perceived sexual orientation and perceived acoustic attributes of the voice or the perceptions of other social aspects of the speaker, with the exception of a positive correlation between listener judgments of "lesbian" and "Jewish". She did find that speakers were much less likely to be judged as lesbian than as straight. This, in addition to comments by listeners, indicate an apparent discomfort making a determination about a speaker's sexual preference and specifically in labeling a speaker as lesbian.

Rachelle Waksler's 2001 study is composed of two parts. The first analyzes pitch in recordings of four film actresses portraying both a lesbian character and a straight character within the same two years. Other requirements were that the two characters be of the same socioeconomic class, and the clips be taken from the similar conversational settings. In comparing the pitch ranges for each actor in her lesbian role and her straight role, Waksler found that for all four women, the straight character had a wider range. She does not note that some of the actors have much larger differences than others. Gina Gershon, for example, has a difference of 281Hz between the pitch ranges in the two roles, but Glenn Close, on the other hand, has a difference of only 2Hz between the roles, which cannot possibly be a significant difference. Waksler concludes from this that the stereotype of lesbians having a smaller pitch range is shown in portrayals of lesbians on film. To test if this stereotype is based in reality, Waksler ran an experiment looking at mean pitch and overall pitch range in clips of 12 lesbian subjects and 12 straight female subjects

recounting the plot of the movie "The Wizard of Oz". She found that differences between the two groups of subjects was not significantly different and did not reflect the stereotype seen in the first part of the study; the average range was slightly smaller for straight subjects. Waksler concludes from these results that while the film portrayals of lesbians make use of the stereotype of a smaller pitch range, this is not upheld in reality; actual speakers do not show significant differences in either pitch range or mean.

In their 2004 study, Janet Pierrehumbert, Tessa Bent, Benjamin Munson, Ann R. Bradlow, and J. Michael Bailey analyzed acoustic measures of 103 speakers reading a series of sentences. Subjects were 26 straight men, 29 gay men, 16 straight women, 16 bisexual women, and 16 lesbians (results of bisexual women and lesbians were combined). Acoustic measurements were made of five vowels /i/, /ɛ/, /æ/, /ɑ/, and /u/) looking at the first and second vowel formants (F1 and F2) , dispersion measured in Bark, and duration. Lesbian women were found to have significantly lower F1 and F2 than straight women, but this appeared mainly to be a result of the difference in the back vowels between the two groups, which were lower and less fronted in lesbian speakers. Men did not differ by average vowel formants, but rather by the formants for particular vowels. These varied in different directions between groups, resulting in a larger overall vowel space for gay men than for straight men. This finding goes against the authors' hypothesis that hetero- and homosexual speakers differ in vowel formants due to a general difference in vocal tract length between sexual orientations, and supports, instead, the idea that lesbian/gay speech styles are learned and used as part of a presentation of identity.

The first 2006 study by Benjamin Munson, Elizabeth C. McDonald, Nancy L. DeBoe, and Aubrey R. White consisted of three experiments. The first was an acoustic study of the speech of 44 subjects divided evenly into gay men, heterosexual men, lesbian/bisexual women, and heterosexual women. Subjects were recorded reading a series of single words. The authors found the F1 frequency was higher for gay men in the vowels /i/ and /ɛ/, and /s/ spectra were more negatively skewed. For lesbian/bisexual women, the F1 frequency in /ɛ/, and the F2 frequency in /oʊ/ were lower than for heterosexual women. The second experiment investigated listeners' judgments of the perceived sexual orientation of the speaker as they relate to the actual sexual orientation of the speaker and the acoustic properties of the voice. 40 listeners rated speakers' perceived sexual orientation on a five-point scale. Listeners rated each speaker four times based on four types of words; words with back vowels and no sibilants, words with back vowels and sibilants, words with front vowels and no sibilants, and words with front vowels and no sibilants. Overall, listener ratings corresponded accurately with the sexual orientation of the speakers. The greatest predictors of listener ratings were vowel formant frequencies. For low-front vowels, a high F1 frequency correlated with a higher heterosexual rating for women, and a higher homosexual rating for men. Only the ratings of gay male speakers were affected by word type. Listeners rated gay men as sounding more gay in words with front vowels. Ratings of both female groups did not vary by word type. The third experiment examined perceived height and perceived clarity, testing the extent to how these correlate with judgments of sexual orientation from Experiment 2. The authors found that perceived height and

perceived speech clarity were strongly correlated with perceived sexual orientation, particularly for women. Lower height and lower clarity were positively correlated with a higher straight rating for women and a higher gay rating for men. The results from these experiments demonstrate that sexuality is being expressed phonetically, and that listeners are able to determine with relative accuracy the sexual orientation of the speakers, using primarily the same or related variables which exhibit significant differences in speakers. However, Experiment 3 indicates that listeners may not be rating the sexual orientation directly, but through associations with speech clarity and height of the speaker.

The second 2006 study by Benjamin Munson, Elizabeth C. McDonald, Nancy L. DeBoe, and Aubrey R. White investigates the possibility that the perceived sexual orientation of a speaker can influence how the listener perceives the sounds. It builds off of research by Strand and Johnson (1996) who found that listeners identified ambiguous fricative sounds differently according to the gender of the speaker. Munson et al. hypothesized that if subjects have previously established expectations for differences in the production of fricatives according to sexual orientation, these differences will result in differing results when subjects hear ambiguous fricative sounds from speakers of perceived differing sexual orientation. Similar to Strand and Johnson, Munson et al. created a nine-step sibilant continuum from a clear /s/ to a clear /ʃ/. They used tokens of /æk/ and /ɪp/ taken from 44 speakers whose sexual orientation had been recorded earlier. The simulated fricatives were paired with these tokens to create stimuli of *sack – shack* and *sip – ship* continua for each speaker, which a group of ten listeners, ages 18-35, then heard in a series of two /s/ – /ʃ/ identification tasks. Besides the influence of perceived

sexual orientation, Munson et al. investigated the influence of formant measurements of the following, recognizing that this may have an effect on the fricative identification. Speakers were evenly divided between the two genders, and between the two sexual orientations, which was based, not on the self-identification, but on the judgments made in an earlier study. Using an identical analysis design to that in Strand and Johnson, Munson et al. found that there were significant effects of speaker gender, perceived sexual orientation, and acoustics of the following vowel. Results showed, not surprisingly, that the gender of the speaker had a significant effect on fricative identification, and that women elicited more /ʃ/ perceptions. Both higher F0 and higher F1 in individual speakers elicited more /s/ judgments. These results were slightly different depending on gender. Most central to this study was the role of sexual orientation of the speaker, and the interaction of this with gender. The results showed that female speakers who had previously been identified as sounding homosexual or less feminine, elicited more /s/ percepts than heterosexual or feminine women. Perceived sexual orientation was not a significant predictor of fricative identification in men, an unexpected finding considering findings of earlier studies, and the strong "gay lisp" stereotype.

Drew Rendall, Paul L. Vasey, and Jared McKenzie published a study in 2008 in which 125 subjects (29 lesbians, 33 straight women, 29 gay men, and 34 straight men) were recorded reading a series of isolated single syllable words, which targeted ten vowels in Canadian English. The pitch as well as the first four formants were measured at the central steady state for each vowel. The results were subtle, and for the most part insignificant. The authors found no significant difference in

mean F0 within either gender. Nor did they find significant differences in any formants, with the exceptions of the F1 and F2 in women. Homosexual women had slightly but significantly lower first and second formant frequencies than their heterosexual counterparts. The authors did find significant differences when investigating each vowel individually. In men, the vowels /i/, /æ/, /u/, /ʌ/, /o/, and /ə/ were significantly different between the two groups. The differing formant depended on the vowel, but in every case the given formant was higher in homosexual men, with the exception of schwa, which was higher for heterosexual men. In women, the vowels /i/, /æ/, /e/, /ɪ/, /ʌ/, /o/, and /ɛ/ differed significantly according to different formants. In all but one vowel (the authors don't identify which) the formants in question were lower for the homosexual women. The authors explain this finding by appealing to findings of hormonal differences between homosexual versus heterosexual individuals, and patterns of behavioral differences, which are assumed to be related.

Margaret Camp's 2009 dissertation included two experiments to test the stereotypes and realities of lesbian speech in Japan. She conducted interviews with 12 lesbian/bisexual women and 7 heterosexual women, and compared their speech based on average pitch height and width as well as the maximum and minimum pitch measured in semitones. Beyond the phonetics of speech, Camp also explored the differences in use of gendered morphemes. She found that overall lesbian/bisexual speakers use a lower average pitch, as well as a lower minimum and maximum pitch. Lesbian/bisexual women showed a trend of a smaller average pitch range, but this was not statistically significant. She also found that lesbians use

more neutral morphemes than straight women, and more masculine forms, but not to the same extent as men. In the second part of the study, fifteen participants listened to recordings of one male and one female reading. Pitch in recordings was manipulated to create three different heights: normal, high, and low, and three different widths: natural, wide, and narrow. A total of nine variations per clip. Listeners rated speakers on five seven-point scales: “less attractive/more attractive”, “calm/emotional”, “masculine/feminine”, “unassertive/assertive”, and “heterosexual/homosexual”. Camp analyzed interactions between pitch height, pitch width, score per scale, sex of the speaker, and the sex of the listener. In relation to pitch manipulations, Camp found that for the male voice the perception of homosexuality was higher when the overall pitch was higher; neither the width of the contour nor the sex of the listener was significant. For the female voice, both height and width were significant. A lower pitch was perceived as being more homosexual, as was a narrower range. The interaction between these variables was not significant, nor was the sex of the listener.

Erez Levon’s 2011 study is part of a larger project on language and sexuality in Israel. In this paper, rather than comparing the speech patterns of homosexuals versus heterosexuals, he presents on differences between two different groups of Israeli lesbians. The two groups are contrastive across the political spectrum and in their beliefs about the place of sexuality in the public sphere. The point of difference which Levon focuses is goals of the two groups. The 'mainstream' group, as he labels them, are interested in incorporating homosexuality as an acceptable part of current Israeli culture, an 'accommodationist' approach. The other group, the 'radicals'

argue that the current Israeli structure is in cannot incorporate homosexuality, and instead needs to be reconfigured. Levon investigates the phonetic feature of mean pitch. This is measured in semitones and compared between the two groups of speakers and two contexts, in narratives with gay themes and other contexts. Levon found similar patterns between the two groups; speakers used a significantly higher mean pitch during narratives when discussing gay topics than other topics. However, he analyzes this pattern differently for the two groups. For the mainstream speakers, he argues that the higher pitch is a means of feminizing their speech to accommodate to Israeli notions of femininity. Levon points out that this matches their description of their homosexuality as compatible with Israeli gender norms. Discussing the similarity between the two groups, Levon rejects the idea that a higher pitch for the 'radical' speakers indexes femininity or association with Israeli gender norms, because it is counter to their goals and ideas of the role of homosexuality in the current culture. Unfortunately, he does not provide a clear explanation for the radical groups using the same higher pitch. As he points out, Levon's study is one of only a few that compare variation within members of the same sexual orientation, rather than only looking at differences between straight and gay speakers. This is a potentially useful recognition of the fact the term 'homosexual' or even the more specific 'lesbian' does not apply to a homogenous group.

The 2013 study by John Van Borsel, Jana Vandaele, and Paul Corthals consists of the simple measuring of mean pitch and pitch variation in women by sexual orientation. Subjects were 34 homosexual women and 68 heterosexual women, both

groups ranging in age from 17 to 52 with an average of 32 in both groups. The authors were thorough in taking into account aspects of their subjects such as their job, whether they are in a committed relationship, etc. These were evenly distributed between the groups. They also noted the age of "coming out" for each of the homosexual speakers. The speech samples were readings of the text "The North wind and the sun". Analysis was carried out over the entire text. The authors measured mean pitch, as well as the variation, calculated as the sum of absolute value of all F0 changes divided by the duration of the utterance. Both measurements were in Hertz. The authors found that mean pitch was significantly lower in homosexual women than in heterosexual women. The pitch variation in homosexual women was also significantly smaller than in heterosexual women, though the range in observed levels of variation in homosexual women was contained within the range for heterosexual women, and the mean of two groups was not very high. There was a correlation between pitch average and pitch variation for both groups of speakers, as well as correlation between age and mean pitch in both groups, a "within group" variation of the sort that Levon sought to document. Overall it would appear that the results support the authors' hypothesis that homosexual women would have lower and less variable pitch, in alignment with the general stereotype and findings from some, but not all, other studies on the topic.

The small number of studies published so far shows an unclear picture of the relation between sexual orientation and speech in women. Some show that pitch is significant, but others indicate the difference is only a general tendency. The first and second formants show statistical significance, but only for certain vowels, and

these vowels differ by study. Only one study has explored phonetic variation in fricatives. The paucity of data does not allow for any conclusive picture of what a lesbian speech style is, whether and to what extent listener stereotypes accurately reflect patterns in speech, and what other variables such as perceived femininity or self-identified bisexuality of speakers contribute to a general stereotype of sexual orientation and speech.

1.2. Purpose

The purpose of this study is to uncover the phonetic variables correlated with the perception and/or production of sexual orientation through speech in women. The study is a combination of two experiments. The first of these records and analyzes the speech of women who identify as lesbian, straight, or bisexual. This experiment is designed to collect quality recordings of a large number of speakers and investigate them to reveal a possible speech style based on sexual orientation. Recordings from Experiment 1 were also used in a second experiment for ratings by listeners.

Using these ratings, the second experiment tests for a lesbian speech stereotype. Does such a stereotype exist? And if so, what is it? This experiment also explores the potential accuracy of listeners in their judgments of sexual orientation, as well as possible correlations between associated social variables that work together to create a lesbian persona.

This study differs from previous work in the expansive use of data collected and analyzed. This includes, for one, the number of speakers recorded; most studies researching sexual orientation and speech in women have strikingly small numbers

of speakers (they have been getting larger in recent years). The amount of speech recorded is also much larger than most work to date, with 100 individual words (each recorded twice) and 20 questions and sentences (also recorded twice). This greater amount of testable data allows for a more detailed findings and more robust results than previous research.

In addition to a larger total number of speakers, this research is different from previous research in its inclusion of bisexual speakers as a unique group of participants. Most research on language and sexual orientation has looked only at straight men and women and gay men and lesbians. Work that has incorporated bisexual speakers has grouped them with homosexual speakers as part of a larger LGB participant group. This is the first study to investigate the use of speech by bisexuals separately from lesbians and straight speakers. I also investigate aspects of the speaker beyond sexual orientation alone, looking also at associated variables such as how many friends they have who identify as homosexual or how familiar the speaker is with Queer culture. These have never been explored in previous research, but there is no reason to believe that these variables do not also affect or interact with sexual orientation in influencing differences in phonetic variables in speech.

This study also incorporates more phonetic variables than have previously been examined in relation to the production or perception of speaker sexual orientation. Acoustic analysis in previous literature has been limited to pitch, vowel formants, and fricative variability. This study also measures and analyzes speech rate, word-final /t/ release, and the use of creaky voice (a combination of acoustic features such as low and irregular f0, high H2-H1, and Intra-frame periodicity). With

these additions to and expansions on previous research, this study should give a more complete and in-depth understanding of how women's sexual orientation is perceived and/or produced through the acoustics of speech.

2. Experiment 1

The first experiment of this study was designed to examine differences in the use phonetic variables by women according to self-identified sexual orientation.

2.1. Methods

2.1.1. Participants

Recordings were made of 64 women in the Berkeley community. Due to technical issues and experimenter error, only 54 participants were used as speakers in the analysis. Participants were solicited through various forms of advertisements/announcements (around the campus and surrounding area, online, in class, and by word-of-mouth). The participants self-identified as either homosexual (N=12), bisexual (N=18), or heterosexual (N=24). All were native speakers of American English, from varying areas in the US. Participants' ages ranged from 18-54, but since most participants were students of the University of California Berkeley, the numbers were skewed towards ages between 18-21, with only six participants above the age of 30. Participant ethnicities were self-identified as Asian, Black, Hispanic, and White, as well as combinations of any of those four. All were native speakers of Standard American English.

2.1.2. Stimuli

The recording procedure was split into two blocks. This first was a word reading block, in which 100 words were read one at a time in random order, twice.

These words were 1-3 syllable English words chosen for phonetic balance. They provide multiple examples of a range of phonemes, consonant clusters, and a variety of spoken word frequencies (all frequent enough to be familiar to speakers)

The second block of the experiment showed sentences and questions in random order, also twice each. Collection of these longer utterances served multiple purposes such as comparison of intonation structure, but for this study, the recordings were used to analyze phonetic variables in the more natural context of continued speech. Sentences were ten simple structured utterances ranging from seven to nine words in length. Questions were five polar question (yes/no) and five content questions (wh-) ranging from seven to ten words.

2.1.3. Procedure

The experiment was run in a sound attenuated recording booth. Participants sat at a desk in front a screen with word and sentence prompts being displayed using OpenSesame. Audio recording was conducted using an AKG 535 EB microphone positioned approximately 8 inches from the speakers, slightly to the right to avoid problems with aspiration. Recordings were made at a 48Hz sampling rate and digitized with a Steinberg UR22 USB audio interface. A Canon FX100 video camera, positioned behind the screen of the teleprompter on which the prompts were being displayed, simultaneously recorded video and audio with an internal microphone for use in future video-based research. Recordings were processed on the Phonology Laboratory Dell desktop computer.

In the first two blocks, speakers were given the choice of being joined in the sound booth by the researcher. Most expressed no preference, in which case the researcher remained in the booth in case any issues or questions came up.

The optional third part of the experiment was a discussion/interview regarding views of a lesbian speech style. This was recorded with the researcher to elicit a more natural speech style for use in future research. The data was not analyzed in this study.

2.2. Analysis

2.2.1. General

Transcripts were made of the recorded speech. The words and utterances were presented in a different random order for each speaker, but this order was save in the experiment program OpenSesame and used as the transcript for each individual speaker. Transcripts were aligned with recordings using the python script 'pyalign', an implementation of the Penn forced aligner, which is based on the HTK speech recognition toolkit (Yuan and Liberman, 2009).

The automatic alignments were visually checked in Praat Boersma, 2001), and misalignments were hand corrected. Minor misalignments were not corrected, the large amount of data to evening out any effect of the errors. Measurements were made of phonetic variables using python scripts, with more detail extracted in R.

2.2.2. Pitch mean and range

The mean pitch and pitch range were extracted from the primary and secondary stressed vowels in all recorded speech. Each vowel was divided into 7 equal time points, using the middle point for the pitch value. The median pitch was

taken for each vowel quality (/i/, /ɪ/, /e/, /ɛ/, /ə/, /ɚ/, /æ/, /ɑ/, /o/, and /u/) from which the overall mean was calculated. Pitch range was measured as the interquartile range for all values. This, rather than the total range, was used to avoid extreme values not representing speakers' normal range.

2.2.3. Vowel formants and vowel space

Measuring vowel formants used steps 1-3 from above, using the same middle time point for each vowel. For this calculation, diphthongs /aʊ/, /ɔɪ/, and /aɪ/. Rather than using the Hertz values, which do not reflect the auditory representation of vowel formants, I converted the measurements to the Equivalent Rectangular Bandwidth (ERB) rate. This auditory frequency scale is similar to Bark or other functions that allow researchers to measure a variable more similar to how vowels are processed through the auditory system. I used the function:

ERB = 21.4*log(4.37*(f/1000)+1)

As with the pitch, the median F1 and F2 were taken for each vowel quality. Then, to get the overall F1 and F2, I calculated the mean of these medians. I calculated the vowel space for each speaker using the R function "convexhull.xy" (authors: Adrian Baddeley and Rolf Turner) Given a set of points with x and y values (F1 and F2) the function calculates the convex hull, providing a measure of the overall size of the vowel space.

2.2.4. Rate of speech

The rate of speech was measured through vowel length. For each vowel, the first time point was subtracted from the last. The median length was measured for

each vowel quality and then the mean of all medians indicated the overall rate of speech.

2.2.5. Fricative spectral balance

To get the spectral balance, spectra were calculated for each fricative at the midpoint of the fricative. Spectra were then divided into halves based on the frequency of the sound. Sums were taken of the amplitudes in the top half, as well as the bottom half. The spectral balance is the ratio of amplitudes of the higher to lower frequencies.

2.2.6. Word-final /t/ release

I extracted from the recordings for each speaker all words with final /t/. These were extracted including the following 50 milliseconds to avoid issues with alignment errors. The words were then played and determined by ear to either be released or unreleased. Finally, the proportion for each speaker was calculated as the proportion of unreleased /t/s to released /t/s.

2.2.7. Creak

Using an artificial neural network, trained on a wide range of speech, Thomas Drugman, John Kane, and Christer Gobl (2012) have recently developed a software for detecting creak in recorded speech. This algorithm uses as input a number of new and existing acoustic features that have been determined to be relevant to creak. For this experiment, I used the software, which they make available online at https://github.com/jckane/Voice_Analysis_Toolkit/tree/master/creak_fcns.

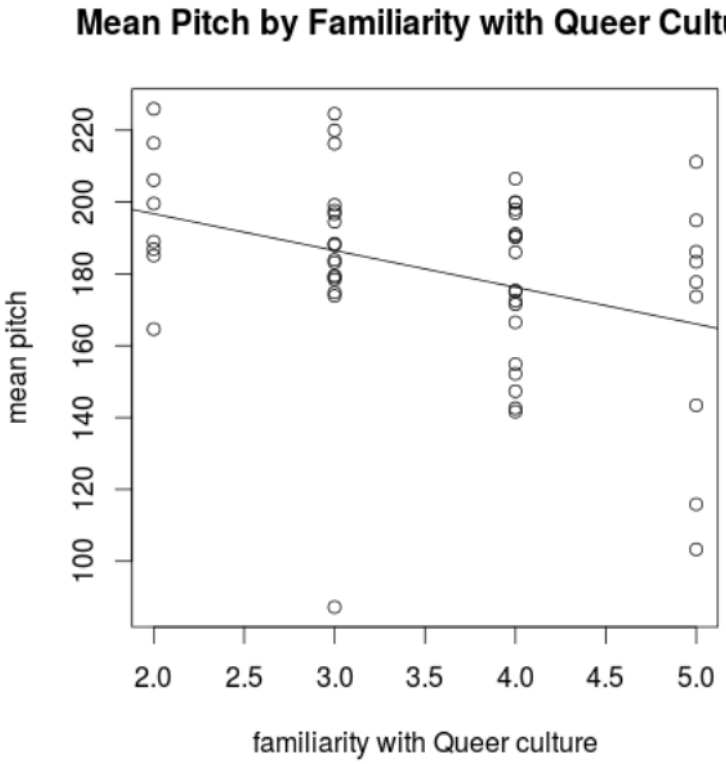
2.3. Results

2.3.1. Sexual orientation

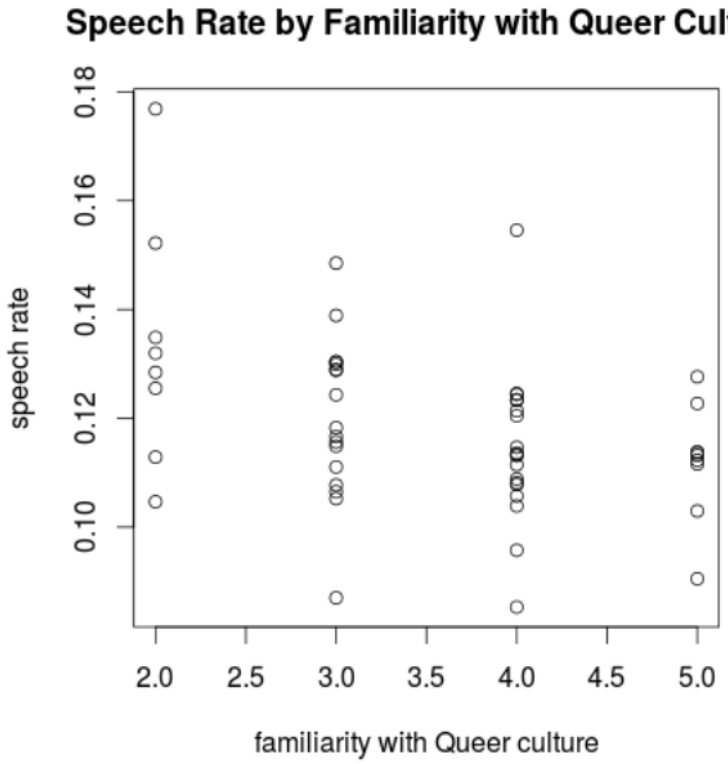
ANOVAs were run testing the correlation of speaker sexual orientation and the different phonetic variables. The sexual orientation of the speaker showed no direct correlation with her use of any of the phonetic variables measured in the study. Even the variables of average pitch and pitch range, which have been found in some previous studies (Van Borsel et al. 2013, Moonwomon-Baird 1996, Camp (2009), and Waksler (2001) to be associated with a lesbian identity, do not correlate with sexual orientation of speakers in this study.

2.3.2. Other speaker features

Prior to recording, participants completed a questionnaire asking for information about their sexual orientation, as well as questions regarding their interaction with LGB individuals and Queer culture. One of these questions asked speakers directly to rate their "familiarity with Queer culture". The interpretation of this was left open to speakers. Of the various information collected from the speaker, this self-stated familiarity was the only one to show direct correlation with phonetic variation of the individual's speech. This was tested using a linear regression model with familiarity as the dependent variable and the different phonetic measurements as independent variables. A higher familiarity with Queer culture is correlated with a lower median pitch ($p < 0.005$), as well as a faster rate of speech ($p < 0.005$). These are illustrated in figures 1 and 2 respectively.


Mean Pitch by Familiarity with Queer Culture
mean pitch
100
120
140
160
180
200
220
2.0
2.5
3.0
3.5
4.0
4.5
5.0
familiarity with Queer culture

(a)


Speech Rate by Familiarity with Queer Culture
speech rate
0.10
0.12
0.14
0.16
0.18
2.0
2.5
3.0
3.5
4.0
4.5
5.0
familiarity with Queer culture

(b)

Figure 1 (a,b) Scatterplots showing the relationship between speaker familiarity with Queer culture and mean pitch (Fig. 1a) and rate of speech (Fig. 1b).

A multiple linear regression model testing including sexual orientation of the speaker as one of the independent variables revealed that the familiarity of the speaker with Queer culture also showed an interaction with the sexual orientation for both these variables. As seen in figures 3 and 4, the mean pitch and duration of vowels respectively is smaller as the familiarity of the speaker increases. The pattern is somewhat different when speakers are analyzed separately by sexual orientation. The straight speakers pattern more clearly and for both variables (median pitch $p=0.0785$, speech rate $p=0.0428$) than other speaker, particularly lesbian speakers, who show no correlation between phonetic variables and familiarity with Queer culture.

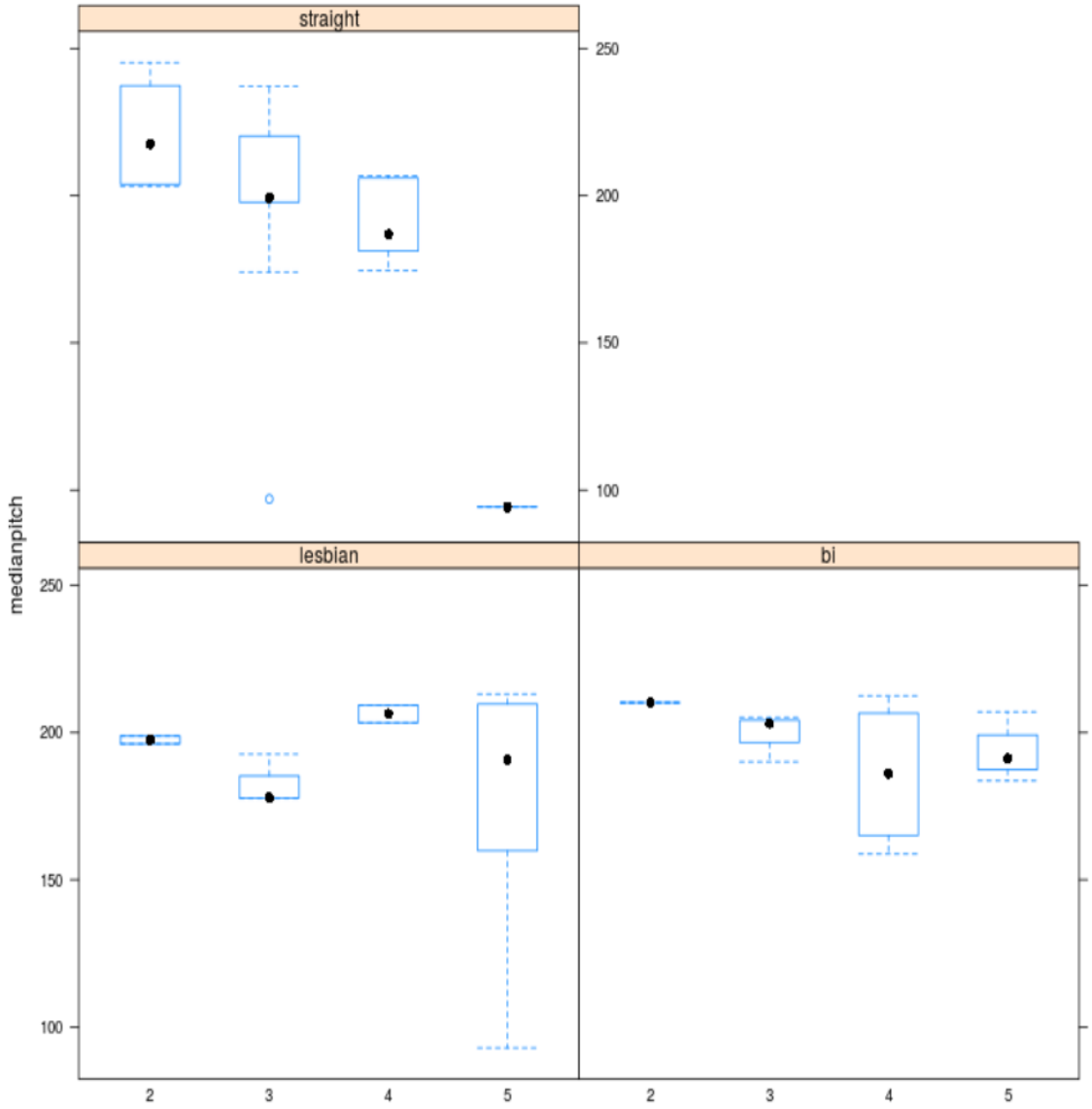


Figure 2 Box and whiskers plots showing the relationship between speaker familiarity with Queer culture and mean pitch divided according to speaker sexual orientation.

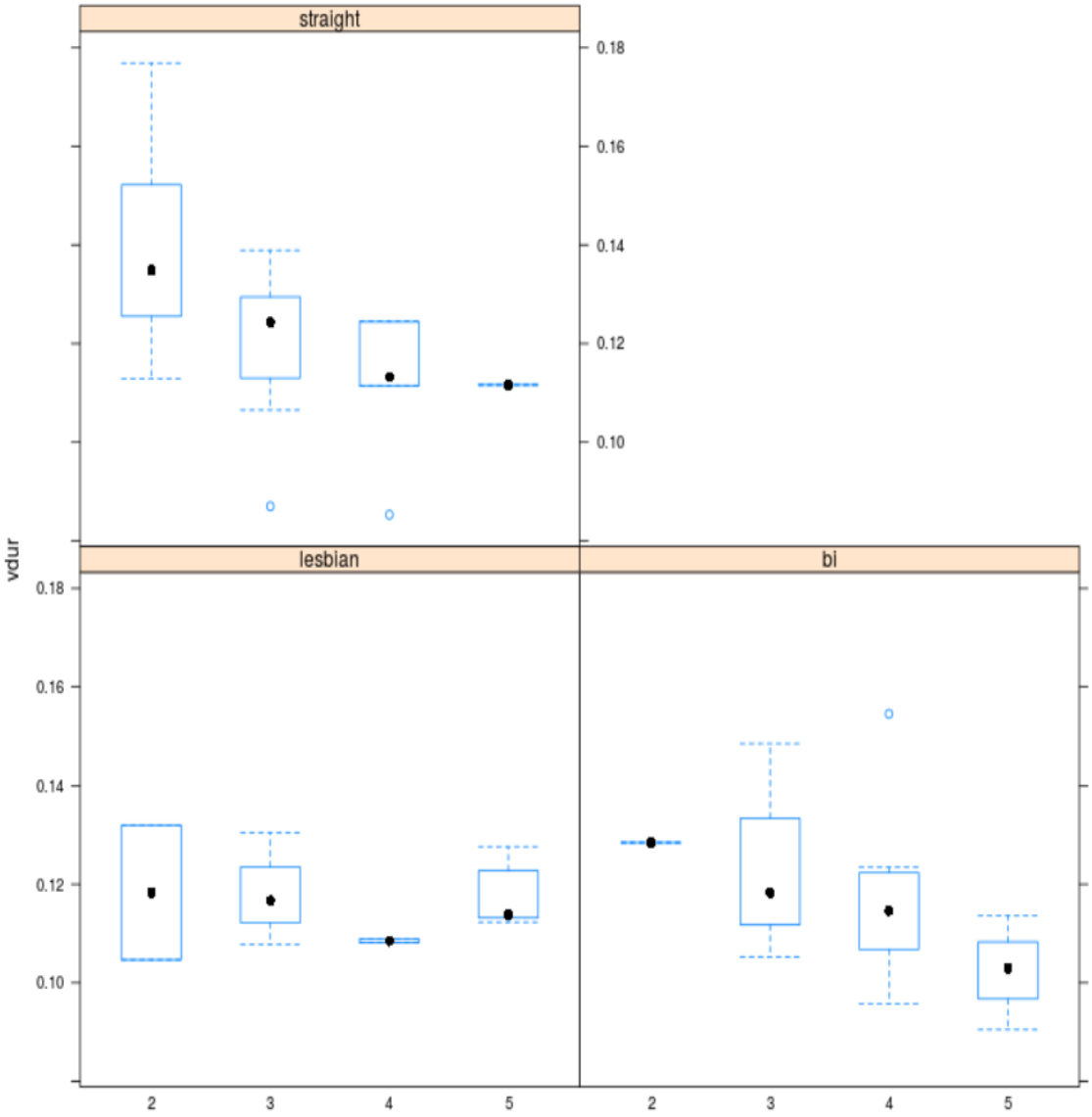


Figure 3 Box and whiskers plots showing the relationship between speaker familiarity with Queer culture and rate of speech divided according to speaker sexual orientation.

2.4. Discussion of Experiment 1

Sexual orientation of the speaker is not directly correlated with any of the variables I measured. However, certain phonetic variables do correlate the familiarity of a speaker with Queer culture. A higher familiarity generally means a

lower median pitch and faster speech. This familiarity correlation is only true for straight speakers for either variable. It would seem that sounding familiar with Queer culture is less of a concern for lesbian and bisexual speakers. Straight speakers who are more familiar with Queer culture are using phonetic variables to express this through speech. Low mean pitch has been shown in other studies, and expressed by participants, to be a feature of a lesbian speech stereotype. While "familiarity with Queer culture" is a general and abstract concept, open to interpretation by participants, it almost certainly involves affinity with that larger group and interactions with people who identify as Queer. For people who do not identify as Queer but associate with that group, taking on aspects of the speech stereotype may be a useful way of expressing that association.

I made no attempt to hide the purpose of the study from participants. The questionnaire including the self-rating of familiarity with Queer culture, as well as sexual orientation and other related questions was filled out by participants before recording began as. This awareness most likely had an effect on the participants expression of familiarity with Queer culture through pitch and speech rate in the experiment. If the interpretation of the results is correct, that straight speakers are using aspects of a lesbian speech stereotype to express familiarity with Queer culture, it would be reasonable to speculate that this social variable is not expressed through speech when speakers are not actively thinking about it. Most theories of sociolinguistics hold that variation within individuals is based on many factors, including interlocutor, stance, and topic. In the case of this study, while the "topic" of the speech analyzed was limited to a list of words and sentences, the topic of the

interaction at large involved questions of sexuality, a topic which may incline straight speakers with high familiarity with Queer culture to make an attempt to express that aspect of their identity. This hypothesis could be tested easily by running the same experiment but without any mention of sexuality until after recording was finished.

3. Experiment 2

The second experiment of this study was designed to collect and measure listener perception of social variables based on phonetic variation.

The self-identified sexual orientation of the speakers was not reflected in any phonetic variables, but the results of previous literature show that, while women may not use these variables to project their sexuality, they are used by listeners in interpreting the sexuality of speakers. The focus of this study was on the phonetic variables associated with judgments of sexuality, trying to determine a phonetic stereotype of lesbian speech. It also investigated associations with other social variables that listeners were asked to rate. Part 1 presents correlations between various ratings and the speakers' actually orientations. Part 2 presents the phonetic predictors of "lesbian" rating. Part 3 presents phonetic variable correlations with other social variables. Part 4 discusses the "personae" revealed in a Principal Components Analysis of the production experiment results.

3.1. Methods

3.1.1. Participants

This perception experiment was run on Amazon Mechanical Turk. Participants were limited to MTurk "masters", users that have been rated highly for

their participation in other experiments. A total of 58 individuals participated in this experiment. They ranged in age from 21 to 69 years with an average of 37.4, and included 23 women and 35 men. All were native speakers of English, coming from a wide range of locations around the US, with one from British Columbia, Canada.

3.1.2. Stimuli

Stimuli for this perception experiment were taken from recordings of the speakers in the earlier production experiment. The experiment used the same five words from each of the 54 speakers that were analyzed in the first experiment. They were *absent*, *dose*, *locate*, *museum*, and *popular*. These particular words were chosen to get a range of phonetic variables, but simultaneously target a few more specific variables that have been found to be relevant in previous research on topics of sexuality and gender expression. Specifically, these are voiced and voiceless sibilants/z/ & /s/, word-final /t/, vowels /i/, /ʌ/, /æ/, /e/, /o/, /u/, /a/, /ɚ/, and a range in the of number of syllables). Rather than being played separately, words were combined into sets of five to avoid an uncomfortably long experiment time for participants.

3.1.3. Procedure

This experiment was divided into two nearly identical MTurk Human Intelligence Tasks (HITs). Participants in each HIT heard recordings from the 54 speakers analyzed in the first part of the study. Each recording had the same five words, in alphabetic order, with one speaker per recording. For each of these, participants gave a 1-5 rating for three social variables. These variables targeted aspects of perceived speaker personality, background, presentation, and

orientation. The experiment was broken into two HITs so that each listener only judged three of the six variables. In one HIT (HIT 1), listeners rated subjects on a scale from 'very educated' to 'very uneducated', a second scale from 'very formal' to 'very casual', and a third scale from 'very masculine' to 'very feminine'. In the other HIT (HIT 2), listeners rated speakers from 'very shy' to 'very outgoing', 'not at all likely to be a lesbian' to 'very likely to be a lesbian', and 'very compassionate' to 'very uncaring'. This division was done for two reasons, 1) to shorten the total time of the experiment, avoiding tedium for the participants and 2) to separate judgments for 'feminine' and 'lesbian', the expected correlation of which was expected to become stronger if every listener were asked to judge both.

3.2. Analysis

3.2.1. Phonetic variables

The acoustic data analyzed in this experiment are a subset of the data collected in Experiment 1. Only the five words that listeners heard when making their judgments were examined in analyzing the results for the second experiment. These are assumed to show the same phonetic variation seen in the complete recordings for each speaker, and following similar testing used in Experiment 1 analysis, the results showed the same patterns: no significant correlations with sexual orientation, and correlations between a high familiarity with Queer culture and lower average pitch as well as familiarity and faster rate of speech.

3.2.2. Listener ratings

Each speaker was rated by listeners on scales of the six social variables listed above. Recordings were rated by 30 participants in HIT1 and 28 participants in

HIT2. Because I was not analyzing differences in ratings by listener, the mean rating was taken for each speaker, resulting in an individual score for each variable. This number was used in analyzing the correlation with ratings and the various phonetic variables examined in Experiment 2. Speakers mean ratings were also used in conducting a principal components analysis of the social variables.

3.2.3. Principal components analysis

A principal components analysis was run comparing the six different social variables. Strong correlations between certain variables indicated redundancy in the measurements. A PCA of social ratings highlights certain perceived personae such as straight women who are very feminine, or highly educated women who use very formal speech. The PCA was run on the six social variables using the *prcomp* function in the 'stats' package of R (R Core Team, 2013) scaled to unit variance.

3.2.4. Statistical analysis

Significance was tested using linear regression models similar to those used to test significance between variables in Experiment 1, with listener ratings as the dependent variables and acoustic variables as the independent variables.

3.3. Results

3.3.1. Listener ratings and speaker information

3.3.1.1. Lesbian ratings

Analysis showed that listeners are in general successful in rating a speaker's self-identified sexual orientation. Straight speakers were significantly less likely to be judged as sounding like a lesbian than lesbian speakers ($p<0.005$). Bisexuality was not a variable which listeners were given to judge; the variable was a range

from “very likely to be a lesbian” to “not at all likely to be a lesbian”. Listener lesbian ratings of bisexual speakers patterned more closely to listener ratings of lesbian speakers, but there was a difference that approached significance (p=0.08).

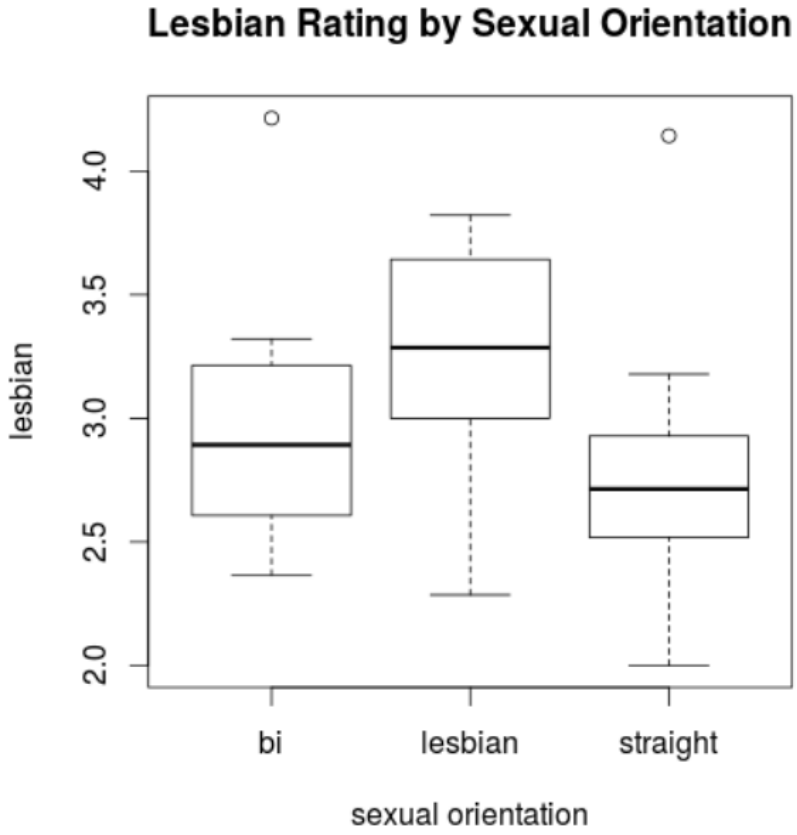
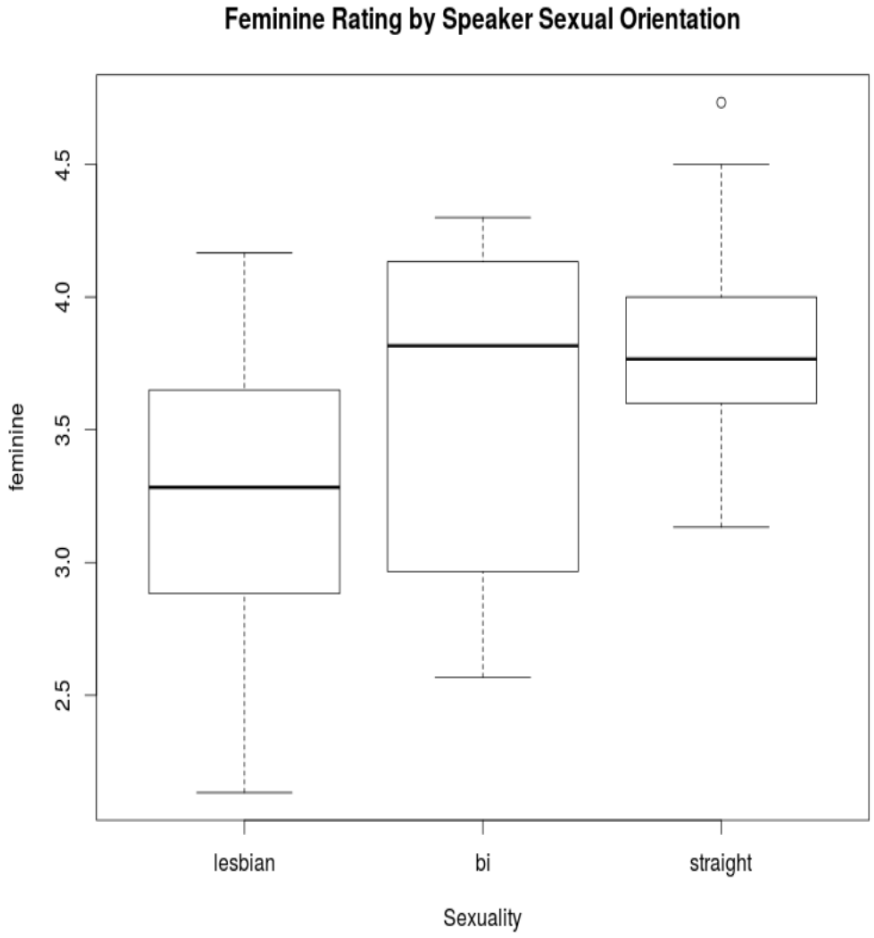


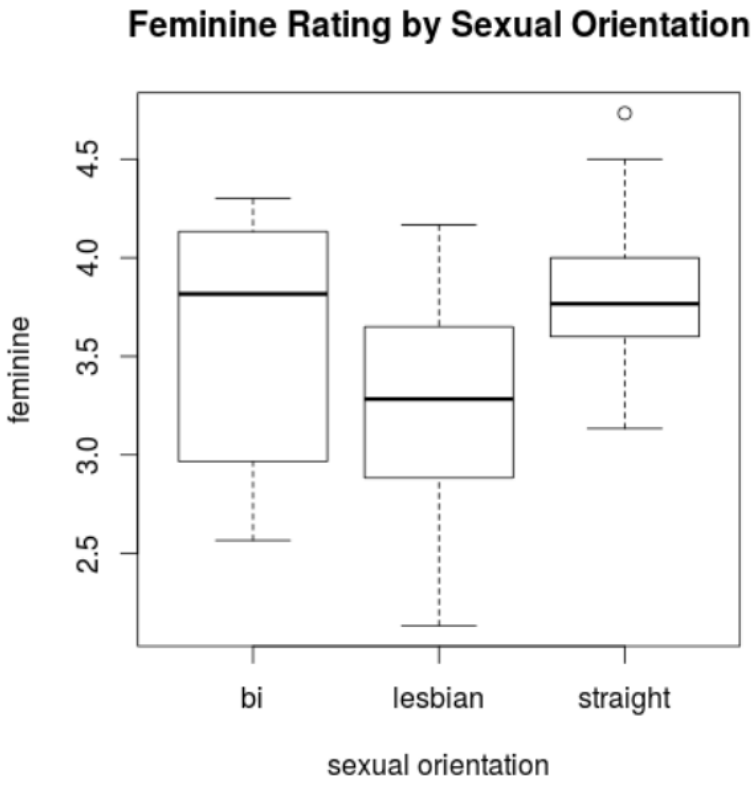
Figure 4 Box and whiskers plot showing the relationship between listener ratings of likelihood of being a lesbian and speaker sexual orientation.

3.3.1.2. Other listener ratings

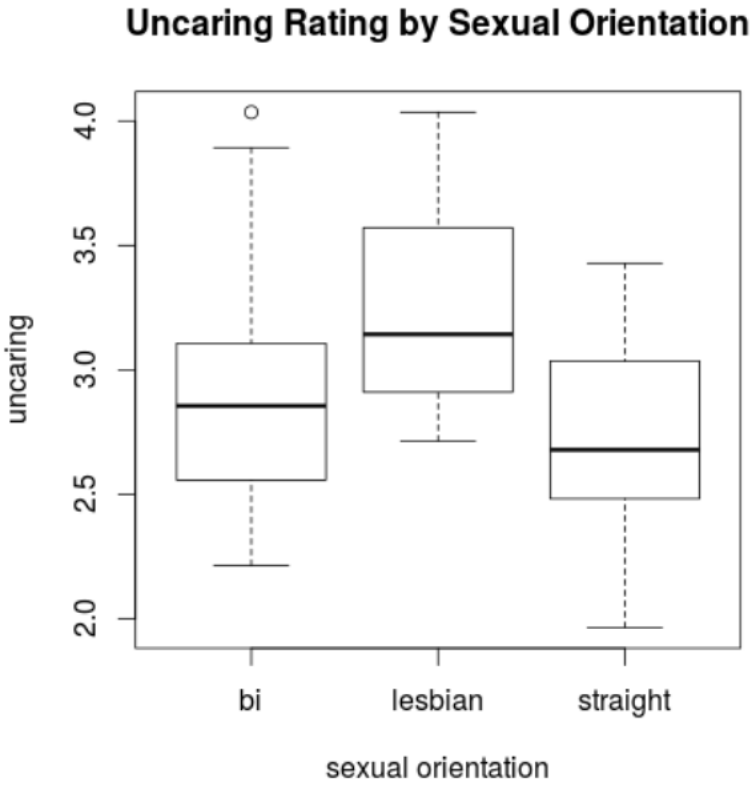
Sexual orientation of speakers was also correlated with the feminine-masculine rating and the compassionate-uncaring rating. Straight women were significantly more likely to be rated as being more feminine than lesbians (p< 0.005), and bisexuals were somewhat more so (p= 0.06). Lesbian speakers were

also more likely to be rated as sounding uncaring than straight speakers and bisexual speakers. This was statistically significant for straight women ($p < 0.005$), and approached significance with bisexual women ($p = 0.057$).




Feminine Rating by Sexual Orientation
feminine
2.5
3.0
3.5
4.0
4.5
bi
lesbian
straight
sexual orientation

(a)



(b)

Figure 5 (a,b) Box and whiskers plot showing the relationship between listener ratings of likelihood of being a lesbian and speaker sexual orientation.

3.3.2. Listener ratings and phonetic variables

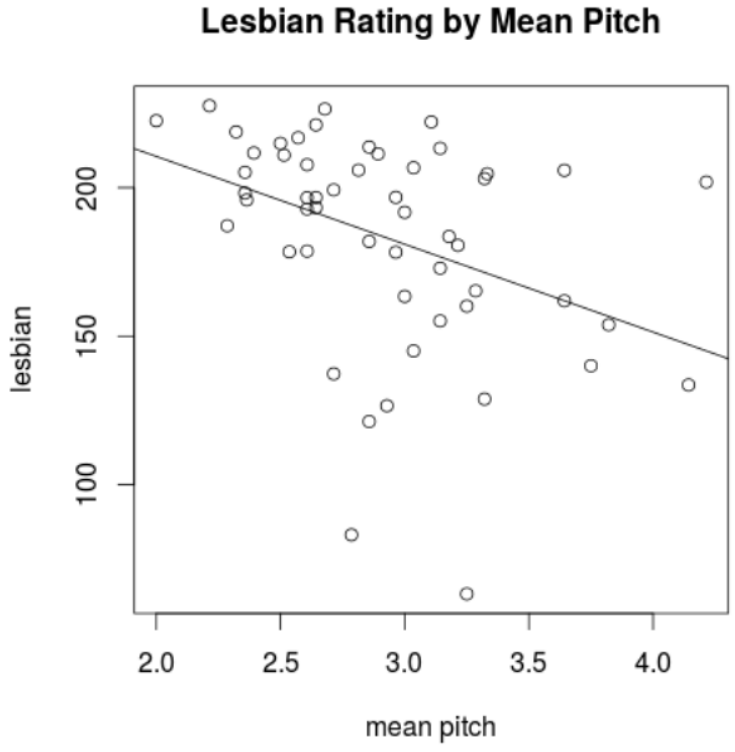
Table 2 Pearson's correlations – R between listener ratings and selected phonetic variables

	Listener ratings of social variables					
	casual	educated	feminine	lesbian	outgoing	uncaring
mean pitch	-0.002	-0.12	0.19	-0.39**	-0.14	-0.44**
pitch range	0.19	-0.11	-0.08	0.35*	0.36**	0.21
mean F1	-0.1	-0.04	0.27*	0.03	0.53***	-0.24 .
mean F2	-.015	0.07	0.5***	-0.43**	-0.002	-0.42**
creak	-0.04	0.04	-0.32*	-0.38*	-0.05	0.26 .
speech rate	0.23	-0.31*	-0.26 .	0.19	0.004	0.24 .
/t/ release	-0.44**	0.26 .	0.01	0.1	-0.01	-0.001

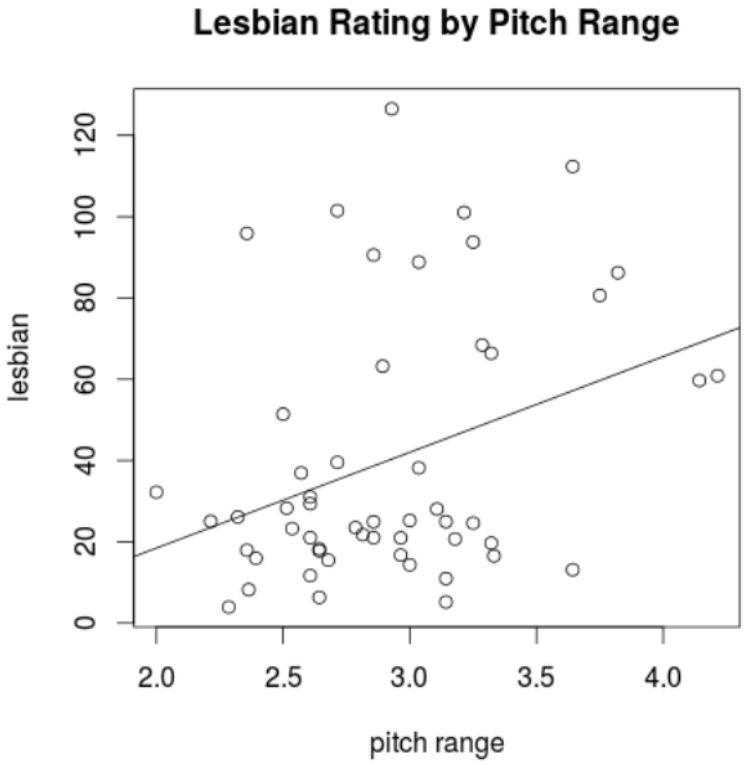
'***' $p < 0.001$, '**' $p < 0.01$, '*' $p < 0.05$, '.' $p < 0.08$

3.3.2.1. Lesbian ratings

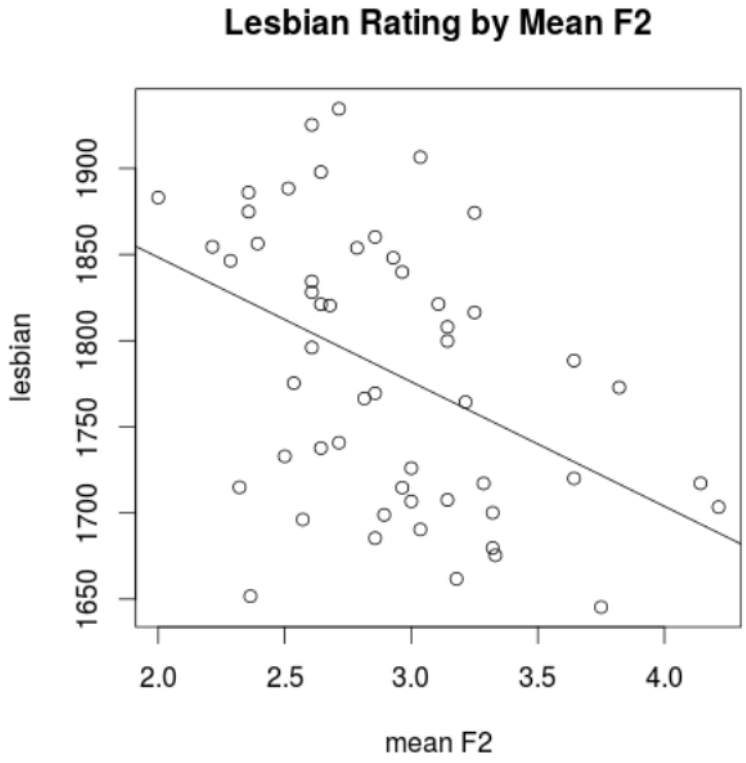
Average lesbian ratings by listeners correlated with a number of phonetic variables in the speakers production. These were median pitch, pitch range, median F2, and creak. Median pitch shows a strong negative correlation with lesbian ratings. Speakers with a higher median pitch were rated and less likely to be a lesbian ($p<0.005$). Like median pitch, the range of a speaker's pitch was correlated with her average lesbian rating ($p<0.05$). Women with wider pitch ranges tended to rated by listeners as more likely to sound like a lesbian. The second formant patterns in the same way as pitch; a higher F2 is correlated with a lower lesbian rating ($p<0.005$). Speakers with a higher lesbian rating also tended to have a higher proportion of creaky voice ($p<0.05$).



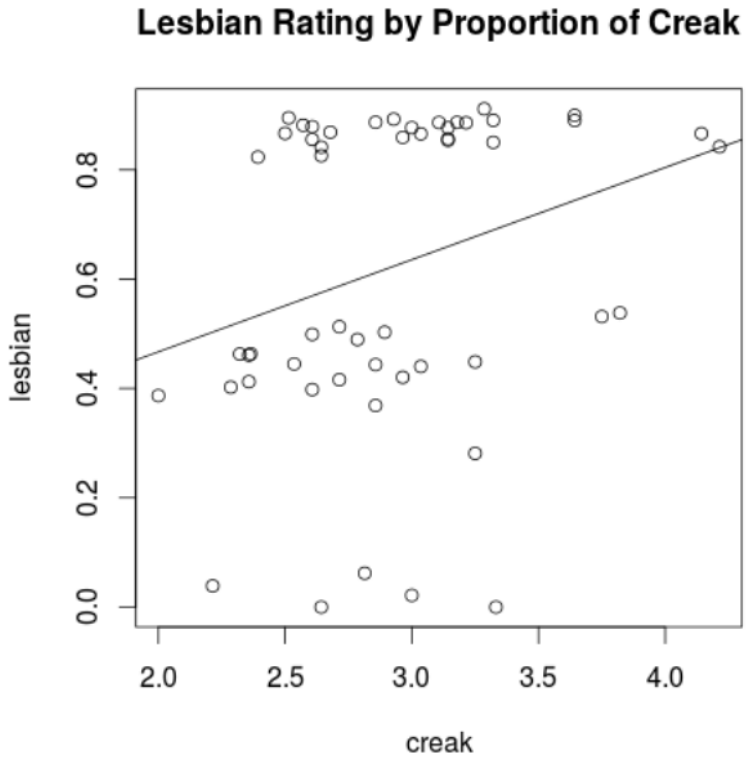
(a)


Lesbian Rating by Pitch Range
lesbian
0
20
40
60
80
100
120
2.0
2.5
3.0
3.5
4.0
pitch range

(b)


Lesbian Rating by Mean F2
lesbian
1650
1700
1750
1800
1850
1900
2.0
2.5
3.0
3.5
4.0
mean F2

(c)



(d)

Figure 6 (a,b,c,d) Scatterplots showing the relationship between listener ratings of lesbian likelihood and mean pitch (Fig. 6a), pitch range (Fig. 6b), mean F2 (Fig. 6c), and creak (Fig. 6d).

3.3.2.2. Other listener ratings

Ratings on the scale from "very casual" to "very formal" are correlated with the word-final /t/ release ($p<0.005$). Speakers with a higher proportion of unreleased /t/s were more likely to be rated as sounding more casual.

Ratings on the scale from "very educated" to "very uneducated" showed correlation with two phonetic variables. A slower speech rate is correlated with sounding more educated ($p<0.05$). The proportion of unreleased to released /t/s in word-final position shows correlation with 'educated' ratings, though it did not

reach significance (p=0.059). Speakers with more released /t/s tend to be rated as sounding more educated.

Ratings on the scale from "very feminine" to "very masculine" correlated with speech rate, median f1, median f2, and creak. The speech rate, measured as the vowel duration for primary stress syllables was positively correlated, though it does not quite reach significance (p=0.059). Speakers with longer vowel durations tended to be rated as sounding more feminine. Also correlated with femininity are median values for F1 ($p<0.05$) and F2 ($p<0.001$). Creak is negatively correlated with femininity ratings ($p<0.05$). Women with a higher proportion of creaky voice tended to be rated as sounding more masculine.

Ratings on the scale from "very outgoing" to "very shy" show strong correlations with median F1 ($p<0.001$) and pitch range ($p<0.01$). A higher F1 and a wider pitch range both make a speaker more likely to be rated as more outgoing.

Ratings on the scale from "very compassionate" to "very uncaring" show a strong correlation with median pitch (p=0.001) and median F2 (p=0.002). Speakers with higher median values for these pitch and F2 were more likely to be rated as sounding more compassionate. Creak, median F1, and speech rate also show correlations with 'compassionate' ratings, though none reached significance. More creak (p=0.0575), median F1 (p=0.0792), and speech rate (p=0.0834) all correlate with a higher 'compassionate' rating.

3.3.3. Principal components analysis

A principal components analysis was run on the six social variables as rated by listeners. The first four principal components account for over 95% of the

variance. These PCs can be understood as representing certain social personae. They are more complex, and give a more complete and realistic understanding of social variables than the six basic variables given to listeners to rate. Penelope Eckert gives a concise definition of this concept of personae in her 2012 paper Three waves of variation study: The emergence of meaning in the study of variation,

> "the meanings of variables are basic and underspecified, gaining more specific meanings in the context of styles (personae)." – Eckert 2012 p. 87

3.3.3.1. Personae

Table 3 Principal component rotations. Rotations in gray indicate social variables that make up a given persona.

	Principal component (PC)			
	PC 1	PC 2	PC 3	PC 4
casual	-0.3	-0.57	0.23	-0.38
educated	0.25	0.59	-0.35	-0.26
feminine	0.56	-0.15	0.25	0.01
lesbian	-0.49	0.28	0.24	0.65
outgoing	-0.01	0.45	0.79	-0.37
uncaring	-0.54	0.17	-0.27	-0.48

The first principal component, accounting for 43.27% of the variance, is most notably very feminine, very compassionate, and not at all likely to be a lesbian. The second, accounting for an additional 32.02% of the variance, is primarily educated, formal, and outgoing. The third, accounting for an additional 14.98% of the variance, is primarily very outgoing, and also somewhat uneducated. The fourth, accounts for only a further 5.15% of the variance (perhaps not strong enough to be considered a

socially recognizable persona) and is defined primarily as likely to be a lesbian and compassionate, as well as somewhat formal and shy.

3.3.3.2. Phonetic variable correlations

Table 4 Correlations between persona and selected phonetic variables

	Principal components			
	PC 1	PC 2	PC 3	PC 4
mean pitch	0.31*	-0.25 .	0.004	0.07
pitch range	-0.26 .	0.1	0.39**	-0.1
mean F1	0.18	0.15	0.58***	-0.02
mean F2	0.48***	-0.1	0.08	-0.07
creak	-0.26 .	0.14	-0.14	0.14
speech rate	-0.32*	-0.13	0.09	-0.0003
/t/ release	0.1	0.31*	-0.19	0.3*

'***' $p < 0.001$, '**' $p < 0.01$, '*' $p < 0.05$, '.' $p < 0.08$

Persona 1 – the straight, compassionate, and feminine persona – is strongly correlated with median F2 ($p<0.001$), speech rate ($p<0.05$), and median pitch ($p<0.05$). Persona 2 – the formal, educated, and outgoing persona – shows correlation with /t/ release ($p<0.05$), median pitch ($p = 0.05$). Persona 3 – the outgoing and uneducated persona – is correlated with median F1 ($p < 0.0001$), pitch range ($p<0.001$), median pitch ($p<0.005$). Persona 4 – the compassionate and lesbian-like persona – is correlated with word-final /t/ release ($p<0.05$).

3.4. Discussion of Experiment 2

The results of Experiment 2 are revealing in a number of ways. They demonstrate a stereotype of lesbian speech composed of a number of phonetic variables, supporting findings of earlier studies as well as incorporating differences not uncovered before. The results also indicate the existence of a particular set of

social personae that listeners are cuing into, and show that, as with some, but not all, previous studies, listeners are generally able to make accurate judgments about the speakers' sexual orientations.

3.4.1. Lesbian speech stereotype

The results of the second experiment demonstrate that, while many may not be aware of a style of speech associated with lesbians, a stereotype exists to the extent that different listeners rated the same speakers as sounding more likely to be a lesbian. Listener ratings of a speaker's likelihood of being a lesbian was correlated with mean pitch, pitch range, median F2, and creaky voice.

3.4.1.1. Pitch mean and range

Most research on female speech and sexuality has focused on pitch. Findings vary and are not consistent, but where pitch is found to correlate with either the self-identified sexual orientation of the speaker or the speaker's rating as sounding like a lesbian, it is always in the same direction (with the exception of subjects Waksler, 2001). Lesbian and/or lesbian-sounding speakers use a lower average pitch and a smaller pitch range. The results of Experiment 2 support this. Speakers with a lower median pitch and smaller pitch range were rated as sounding more likely to be a lesbian.

3.4.1.2. Creak

Creak is a relatively new variable being explored in sociophonetic research. Creaky voice is generally perceived in popular culture as being used predominantly by young women, but recent research has shown that young men may use it just as much, if not more, and that the perception of what it marks socially is quite complex

(Yuasa, 2010). It is strongly associated with use by young women, while simultaneously being a marker of masculinity (a primary reason for its stigmatization of use by young women).

Though this phonetic variable has been tied directly to perceptions of gender, the relationship to sexual orientation has not been explored or even considered. Because the tie to gender is so complex, the expectation for its role in a lesbian speech stereotype was uncertain. It was hypothesized that the association with masculinity means that it may be used more in a style that also includes lower pitch and smaller pitch range, phonetic variables strongly associated with masculinity. The experiment confirmed this hypothesis. While creak was not directly correlated with the self-identified sexual orientation of the speaker, it is correlated with the perceived sexual orientation by listeners. A high proportion of creak was also correlated with a higher lesbian rating.

3.4.1.3. Second formant

For listeners in Experiment 2, the most significant phonetic variable in rating the sexual orientation of a speaker was her F2 mean. Speakers with a lower F2 were significantly more likely to be rated as sounding like a lesbian. Pierrehumbert et al. (2004), Munson et al. (2006b), and Rendall et al. (2008) also found that the second formant is a significant cue used by listeners in evaluating speaker sexual orientation, as well as being used differently by speakers according to sexual orientation. Pierrehumbert et al. and Munson et al. found significant differences in F2 in only certain vowels, though these specific vowels differed between studies and between experiments of perception versus production.

In investigating which vowels in particular showed F2 correlations with listener ratings, I found that only /ɚ/ significantly influenced ratings of the likelihood of a speaker to be a lesbian ($p < 0.001$). Other vowels showed no correlation with this rating, though all but /o/ and /u/ had negative coefficients (contributing to the general trend of lower F2 sounding more lesbian-like).

3.4.2. Lesbian rating accuracy

The ratings were not only consistent, demonstrating that listeners are cuing into a common stereotype of lesbian speech, they were also strongly correlated with the actual sexual orientation of the speaker, indicating that this lesbian speech style is in fact used more often by lesbian speakers.

As discussed in Experiment 1, the self-identified sexual orientation of the speakers did not correlate directly with any of the phonetic variables that were measured. Nonetheless, listeners' judgments of a speaker's likelihood of being a lesbian were significantly higher for self-identified lesbians. Post-hoc analyses were run to determine what phonetic variables accurately function as predictors of the speaker orientation. The variables that were correlated with listeners' judgments of speaker sexual orientation, median F2, median pitch, pitch range, and creak, were not correlated with self-identified sexual orientation when tested using linear models. Two possible (and potentially overlapping) situations could explain these results. The variables may be interacting in more complex ways than were originally tested, and/or the listeners may be using phonetic variables that were not measured in this study but are part of a real lesbian speech style. In addition to the linear models of Experiment 1, post-hoc analyses were run on the original data. A Linear

Discriminant Analysis was used in the aim of providing dimension reduction and testing for potential combinations of phonetic variables. I tested all of the phonetic variables measured in the study with the aim of finding a linear combination of features and thus a categories of phonetic variables that serve as better predictors of speaker sexual orientation. LDA was unsuccessful. Regression models were also run stepwise with combinations of the variables but, like LDA, this stepwise regression testing was unsuccessful in predicting the sexual orientation of the speaker.

Evidently, listeners are using some other phonetic variables in judging speaker orientation, phonetic variables that are in fact used by speakers as part of a lesbian speech style. These variables go beyond those that are also considered by listeners to sound lesbian-like, and used by straight speakers to indicate familiarity with Queer culture. This study has shown that listeners are able to rate a speaker sexual orientation with a significant degree of accuracy. It has also demonstrated a number of variables that compose a perceived lesbian speech stereotype that is not used consistently by lesbian speakers. However, although this study has analyzed more phonetic variables than any previous work on lesbian speech combined, it has not uncovered the variables that are used by self-identified lesbian speakers to allow listeners to accurately predict their sexual orientation. What this study has made especially clear, is that the interaction of language and sexuality in women is more complex than what has already been explored and requires more research to uncover the whole picture.

3.4.3. Social personae

In most studies investigating the perception of gay and/or lesbian speech, listeners are asked to judge only the sexual orientation of the speaker, using either a binary of straight or gay or a scale between the two. Some studies have also included the variable of femininity or masculinity, recognizing that the perception of sexual orientation is often associated closely with gender representation. This study included judgments of variables beyond these two for a multiple reasons. The primary reason was to understand what other associations listeners have with female sexual orientation and how strong those associations are. For example, it was expressed in some interviews from Experiment 1 that lesbians tend to use more casual speech. Additionally, these ratings were included as a distraction for listeners to avoid them focusing entirely on sexual orientation and gender representation and consequently overthinking their judgments. I found that a number of these variables did, indeed, show strong correlations with one another. To provide a more complete picture of the listener perceptions, I combined them in a principal component analysis.

The results of the principal component analysis revealed a number of what I have termed personae. These personae, particularly the first three, are common and recognizable clusterings of social variables. These include a compassionate, straight, and feminine persona (P1), an educated, formal, and outgoing persona (P2), and a very outgoing and somewhat uneducated persona (P3). The fourth (P4) is less recognizable, a compassionate lesbian persona, but it may be that this is a representation of the 'femme' lesbian in contrast to the 'butch' lesbian represented by the P1. Note that these principal components do show the overall clusterings of

social variables; when using formal speech, a woman sounding outgoing is considered to be more educated, as demonstrated by P2. However, without this formal speech, that same outgoing attitude is associated with a lower level of education, as shown in P3. While the first of these is a stronger stereotype, both are recognizable personae.

With each speaker consequently having a score for each personae, it is possible to see the phonetic variables used by or associated with each one. Sociophonetic representations of these multidimensional perception gives us as linguists a better understanding of what listeners are really judging when they hear certain variables, such as a lower average pitch or smaller pitch range. Listeners are less likely to be assigning each speaker a scale for separate variables, as they are to be classing them into a certain socially established personae.

4. General discussion

4.1. Interpretation of results

This study had two primary goals, to determine whether sexual orientation is reflected in speech by women and if so how, and to examine the existence and nature of the lesbian speech stereotype. The study revealed that sexual orientation is reflected by women in speech, though I was not able to uncover how. I was successful in demonstrating the existence and nature of the stereotype, and also uncovered a number of other findings regarding speech and sexuality.

4.1.1. Familiarity influencing speech

I found that female speakers are not using the multiple phonetic variables I measured in differently to reflect their sexual orientation, but that certain other

aspects of the speakers' identities as the interact with sexual orientation do correlate with some of these phonetic variables. Familiarity with Queer culture, or related variables, has not been analyzed in any previous research. This study shows that it is significant in determining certain phonetic variables of participant speech. The significance turns out to only be true for speakers who do not identify as lesbian or bisexual (sexual identities included in this study which would be defined as Queer). I propose that this difference is based on a inclination for women who are not themselves Queer but identify with Queer culture, to demonstrate this familiarity through speech. Women who self-identify as bisexual or lesbian, may not feeling this inclination as their sexual orientation alone places them, at least in some ways, within Queer culture. It is likely that the context (a recording experiment known by speakers to related to sexual orientation) increased this inclination, and I would expect the effect to be weaker if not nonexistent in contexts where sexual orientation was not being considered. Levon 2011 demonstrated that mean pitch changes for speakers when discussing issues of sexuality. While my study is different in many ways, and the speech analyzed here does not involve discussion of sexual orientation, it is a topic at the front of speakers minds during recordings, and I anticipate an influence in the effect of familiarity on speech patterns like pitch and rate.

4.1.2. Lesbian speech stereotypes

One goal of this study was uncover the phonetic variables that compose a common stereotype of lesbian speech. Regardless of whether and how sexual orientation is expressed by speakers, there has been shown in previous research to

be exist some cluster of phonetic variables that are expected of lesbian speech or that make a woman sound like a lesbian when she uses them. This study has added support to this idea, has uncovered a further variable not examined in previous literature, and has added support to certain findings of phonetic variation that have previously showed mixed results. In all three previous studies looking at vowel formants, results have shown that lesbian women have lower values in the first two formants, though the significance varies between different vowels in different studies, and that this difference is true in both the production and perception of lesbian speech. While my research showed no difference in these variables in the production experiment, F2 was significantly lower in correlation with a higher lesbian rating, in keeping with previous findings. However, unlike previous studies, this study shows no correlation between F1 and lesbian rating. Previous research is not as consistent in findings of pitch mean and pitch range. Only two of the five studies investigating pitch in female sexual orientation found statistically significant differences. In one case it was in listener ratings based on pitch mean (Camp 2009); in the other it was the pitch mean and pitch range of read speech (Van Borsel et al., 2013). The listener ratings in my own experiment showed significantly lower pitch means for speakers with a higher lesbian rating. Of the four studies investigating differences in pitch range, three showed that regularly, if not significantly, lesbians used a smaller pitch range than straight women.[2] One study (Waksler 2001) found that actresses playing lesbians also tended to use a smaller range when playing

[2] Research for my undergraduate thesis supports this finding of a smaller pitch range correlating with a higher lesbian rating.

lesbians, but that the lesbian speaker she recorded generally used a wider pitch range, as seen in the listener ratings in my own Experiment 2.

4.1.3. Lesbian stereotypes and femininity

It has been brought up in a number of studies, mostly looking at men, that homosexuals are often associated with heterosexual members of the opposite sex. Gay men are often considered to sound more feminine, and lesbians are often considered to sound more masculine. As an example, Munson et al. (2006b) discussed the possibility that a lower F2 is perceived to sound more lesbian-like, not because it is part of a lesbian stereotype per se, but that it reflects associations between lesbians and masculinity. Men, having longer vocal tracts, also have lower F1 and F2, and this may explain why these variables are predictors of lesbian ratings. This same pattern could be argued to be true for many of the phonetic variables explored in this study. A lower average pitch, demonstrated in this and other studies to be part of a lesbian speech stereotype, can be seen as marking masculinity, as men generally have lower pitches than women. It is also true that ratings of femininity and lesbian ratings show a strong negative correlation. However, this study showed that not all phonetic variables associated with lesbian ratings were associated with feminine ratings. In fact, only two phonetic variable, mean F2 and creak, had strong correlations in opposite directions with lesbian and feminine ratings. Other phonetic variables that were predictors of one rating, were not for the other.

The reason F1 is not correlated in my own research when it is in previous research is unclear, as is the difference in pitch range in different studies. A wider

pitch range may provide evidence that speech styles of lesbians are not based entirely off of concepts of masculine speech. A lower mean pitch may generally be considered to sound masculine, but a wider pitch range and greater proportion of creak are not. The stereotype of lesbian speech is more complex, demonstrated also in the differences between PC1, in which sexual orientation is closely correlated with gender representation, and PC3, in which it is not remotely so. This is an important point to keep in mind in future research and explorations of different phonetic variables. Phonetic variables likely reflect social variables and identities beyond simply sexual orientation, and others of these affective variables may be utilized as an expression of sexuality and sexual orientation, such as the concept of "fun" as it is used to project a homosexual persona in Podesva (2011b).

4.1.4. Accuracy of lesbian rating

The purpose of Experiment 2 was primarily to understand the nature of a lesbian speech stereotypes. However, it explored other topics and uncovered a number of interesting findings. While analysis of variables in Experiment 1 indicated that speech is not used as a tool by women in expressing their sexual orientation, a comparison of listener ratings and the sexual orientation of speakers showed that listeners are able to accurately determine the sexual orientation of speakers with greater than chance accuracy. Post-hoc analyses of the findings from Experiment 1 confirmed that listeners were not making this accurate judgment based on any combination of the variables that I measured. It must be the case that some other phonetic variable is acting as a cue, if not multiple variables. My work in this study have been the most phonetically comprehensive so far, but there is clearly

more to be uncovered. The lesbian speech style being investigated is, like other styles and stereotypes, complex and not to be expected as a single variable like pitch or F2.

4.1.5. Personae

Some previous research examining lesbian speech styles have included a comparison of lesbian ratings with ratings of femininity. This study investigated these ratings as well as four others, "formal/casual", "educated/uneducated", "shy/outgoing", and "compassionate/uncaring". Using a principal components analysis, I uncovered three strong and recognizable social personae. As discussed by Penelope Eckert, Kathryn Campbell-Kibler, and others in research on language and identity, judgments people make, and they way people present themselves are not single dimensions such as feminine or straight, but complex combinations of these. My research showed that the most prominent of these personae is a combination of straight, feminine, and compassionate (which also indicates an opposite persona of lesbian, masculine, and uncaring).

This study provides a simple way of extracting social personae through statistical analysis. My findings also include a stereotypical personae that is outgoing, formal, and educated, unrelated to the questions of gender and sexual orientation that were the focus of this study. Other sociolinguistic researchers can make use of this method to better understand the complexity of the social identities that are their focus.

4.2. Future research

4.2.1. Further phonetic analysis

Analysis of speech production, showed no correlation between sexual orientation and any of the phonetic variables I measured. However, listener ratings of how likely a speaker is to be a lesbian correlated with speaker sexual orientation, showing a better than chance accuracy. The study observed the existence of what is referred to as "gaydar", the ability to detect the sexual orientation of others based on speech (and sometimes other modes of identity presentation). Whatever listeners are using to make this judgment has to be a phonetic variable that they can only detect in recorded speech of five words per speaker. While this study clearly demonstrates certain variables that compose a larger lesbian speech stereotype, it has not uncovered what phonetic variable or variables lesbian and bisexual speakers tend to use more than straight ones that allow listeners to accurately rate their sexual orientation.

This study has measured and analyzed all phonetic variables that have been researched in other work on lesbian speech, as well as variables which have not, but there are many others that have not yet been studied in this context. These include voice onset time, F3, nasality, and amplitude, among others. Amplitude in particular was mentioned multiple times by speakers in the interview question on stereotypes of lesbian speech. Because the speakers were not positioned at precisely the same distance from the microphone, I decided that measuring amplitude would not show a reliably accurate analysis of differences between sexual orientations. In future research, amplitude should be included among the analyzed variables.

4.2.2. Participant variables

In my own previous research for my undergraduate thesis, as well as the work of others, aspects of the listeners identity, such as gender and sexual orientation have been included in the analysis. For the sake of time, these variables were excluded, but the information was collected and has yet to be explored. Various aspects of the listener may certainly affect overall ratings. In my own previous research, for example, male listeners were significantly less likely than women to judge speakers as sounding like lesbians.[3] This may be the case in the current study, which could be determined using existing data. Other variables, such as age, sexual orientation, or area of residence/origin of the listener may have an effect on how they tend to rate speakers.

Age did not show the same variability in speakers as in listeners (participants in Experiment 1 were predominantly college undergraduates). However, other variables, such as where the speaker was from, may show interaction with sexual orientation in determining patterns in different phonetic variables. As shown with the influence of speaker familiarity with Queer culture, other variables besides sexual orientation are reflected in speech in this context.

4.2.3. Types of lesbians and other sexual orientations

[3] In discussions with listeners following the task, multiple male participants expressed to me they felt uncomfortable judging someone as being a member of a stigmatized minority unless they had been informed overtly, or had very strong evidence that it was the case. This reservation was not expressed by any female listeners, and based on the results of the experiment, they appear overall not to share this discomfort. It should be noted that the task asked participants to judge "the voice, not the speaker". That is, regardless of the actual orientation of the speaker, do they think the speaker "sounds like a lesbian". This is different from the task which would make listeners feel uncomfortable as they expressed to me, so the difference between the genders may have been in their understanding of the task.

To say that all lesbians sound alike is undeniably false, but besides this reflecting all the many reasons individuals speak differently, it may reflect a difference in desire by lesbians to sound "like a lesbian". Additionally, there are within the larger group of homosexual women, subdivisions such as the common "butch" and "femme". While the stereotype revealed by listener ratings in Experiment 2 apparently target a more masculine stereotype, others lesbian identities also exist and have the potential to be expressed through speech. In fact, the fourth principal component that is composed of a high lesbian rating and a high compassionate rating could be a representation of a lesbian stereotype other than the more dominant "butch" associated with masculine features.

In addition to variation within a single sexual orientation, there are other sexual orientations that have not been investigated in any linguistic research. This study is the first to include bisexual as a separate orientation for participants. Previous research has either grouped these participants with homosexual participants, creating and LB or GB category, or excluding them from the study. This study, still, only includes three of a wide range of recognized sexual orientations. Most are so much of a minority, that finding members of that group would be extremely difficult, and stereotypes/patterns regarding their speech likely do not exist (particularly considering results from Experiment 1 showing that bisexual speakers pattern with lesbians and not as a separate group. Nonetheless, it should be recognized that this study is incomplete in that it does not incorporate all possible female identities as potentially expressed through speech.

4.2.4. Video and visual lesbian stereotypes

Many people are not consciously aware of a lesbian speech stereotype, but stereotypes of appearance are much stronger. The interview involved questions of how speakers think lesbians generally present their sexual identity through appearance, or stereotypes they are aware of. Most speakers had a much easier time describing (stereo)typical lesbian hairstyles, clothing, and even ways of holding themselves, than they had describing lesbian speech. The question of how these stereotypes interact has not been addressed or even considered in previous research on language and sexuality. Individuals are more aware of stereotypes of lesbian appearance than speech, but how different is their influence on listener judgments? If participants are presented with video of women who are stereotypically lesbian sounding, but appear stereotypically straight, are they more likely to judge her as sounding like a lesbian or sounding straight? What about the reverse? An upcoming study will explore these differences using video recordings made in Experiment 1 with similar structure to Experiment 2, but testing first, how speakers are rated without speech, and second, combining video recordings of certain speakers with audio recordings of others.

4.2.5. Context and recording type

The context of recordings, such as where and with whom the participants are speaking, can influence how speech is produced. I believe that even the awareness of the speakers of the intent of the study caused them to alter their speech slightly, making variables such as mean pitch different to what it would have been in a similar context with no awareness of the intent. If participants were not considering the topic of speech and sexual orientation, I probably would not have found the

inclination of straight women to use pitch and speech rate differently according to their familiarity with Queer culture. This experiment can be replicated so that participants are not aware of the intent of the study going into it. Without this awareness, I hypothesis that speakers will not show this same pattern and that familiarity with Queer culture will not be a significant factor in predicting differences in phonetic variables.

Along these same lines of context influencing speech, the type of recording is likely to affect how participants use speech as a social variable. The analysis of recordings from Experiment 1 included recordings of subjects reading a series of single words and short sentences. This did not reveal any correlations of phonetic variables and sexual orientation, but it does not reflect the type of natural speech found in recordings of free speech and open discussions. It is this natural speech in which individuals are most likely to express sexual orientation through speech, and I have recordings of precisely this. Recordings were made of interviews with individual participants. For the sake of time, they were not analyzed for the current study, but the next step in my research is to analyze the free speech recording in the interviews in the same way that I have analyzed the reading of words and sentences. I anticipate finding stronger correlations with certain variables, and perhaps finding lesbians and bisexual speakers making use of speech styles reflected in the phonetic variation based on familiarity with Queer culture and in the ratings by listeners of what sounds like lesbian speech. For example, mean pitch is more likely to show a correlation with speaker sexual orientation in interview recordings. It is also possible that sexual orientation or related speaker variables correlate with

variability between recording types. Perhaps one group is more likely to have a greater difference between read and interview speech.

In addition to using recorded interview speech for production analysis, I will run a similar experiment to Experiment 2, investigating similar questions, but using short clips of natural speech from interviews. This type of speech is a more accurate representation of what listeners hear when making judgments about a woman's sexual orientation outside of an experiment environment. The two experiments in this study reveal the type and direction of variability in speech between women of different sexual orientations, and a basic understanding of the linguistic stereotype listeners are using, but for a more complete understanding, natural speech should be used.

Other recording types include conversations between participants as in the study by Moonwomon-Baird (1997). Interspeaker conversations are otherwise not found in research on sexual orientation and speech in women. This is due primarily to the fact that high quality recordings are much more easily made in sound booths with participants sitting in front of a microphone, rather than in a comfortable setting where speakers can face each other with little or no awareness of recording material. Future research may be able to more easily uncover patterns of speech based on sexual orientation that were not revealed in the current study. Such patterns clearly exist, as they were used by listeners in determining the sexual orientation of speakers with better than chance accuracy, and a more natural speech environment of this kind is likely to make these patterns more clear and measurable. Another example of collection of naturalistic speech is the work

conducted by Podesva (2007, 2011a, and 2011b). Podesva analyzed speech from homosexual men in social and professional environments and found that they were more likely to use certain phonetic variables in social environments than in professional environments, perhaps as a means of expressing their sexual orientation. This is the only work of its kind in the study of language and sexuality, and the method could be well applied to research of female sexual orientation and speech.

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Appendix: Phonetic variable principal component analysis

Similar to the principal components analysis run on the social variables, a PCA was run on the phonetic variables measured. The first seven principal components account for over 92% of the variance. Table 5 demonstrates the composition of the different phonetic principal components. It lists the correlations between the different phonetic principal components and various phonetic variables.

Table 5 Correlations between phonetic PCs and selected phonetic variables

	Phonetic principal components						
	PC 1	PC 2	PC 3	PC 4	PC 5	PC 6	PC 7
mean pitch	0.02	0.26	0.04	-0.09	0.04	0.03	0.35
pitch range	-0.82	-0.63	-0.39	0.41	-0.4	-0.2	-0.07
mean F1	-0.64	-0.26	0.38	-0.007	-0.33	0.36	-0.3
mean F2	-0.45	-0.45	0.62	0.02	-0.12	-0.3	0.22
vowel space	-0.1	0.28	0.26	0.84	0.29	0.2	-0.03
speech rate	-0.33	-0.62	-0.44	-0.03	0.25	0.42	0.21
/t/ release	-0.28	0.59	-0.3	0.16	-0.61	0.09	0.15
/s/ spec. bal.	0.77	-0.2	0.17	0.27	-0.14	0.06	0.31
/ʃ/ spec. bal.	0.7	-0.01	0.32	-0.24	-0.26	0.37	0.1

'***' $p < 0.001$, '**' $p < 0.01$, '*' $p < 0.05$, '.' $p < 0.08$

The principal components demonstrate ways in which phonetic variables are used together in the American English dialect of the speakers in this study. This data does not relate directly to the focus of this research (lesbian speech styles), and are in fact, not necessarily sociolinguistic in nature. However, these findings may be of interest to any phonetician who is interested in certain phonetic variables and how

their use interacts with others. It is important in any phonetic analysis to acknowledge and incorporate the complexity of phonetic patterns. Variables are not used in isolation; speakers using a certain variation, such as sibilant skew, are more or less likely to a certain variation of another variable, such as mean F1, which may not regularly be considered. This use of PCA, can even extend in use beyond phonetic variation to explore variation in morphology, syntax, or any other level of linguistics. None exist in isolation and PCA helps to understand in what ways they are used together.