



# An Acoustic Analysis of /æ/ Variation and its Relationship with Perceived Sexual Orientation

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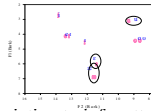
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## Speech Sound Variation Indexes Social Categories

- Acoustic variation in speech indexes social categories. For example, Stuart-Smith (2007) showed that sex differentiation in /s/ in Glaswegian English varies systematically as a function of talkers' age and social class. Purnell, Baugh, and Idsardi (1999) showed that people can identify a talkers' race from single words
- Munson, McDonald, DeBoe, and White (2006) showed that /æ/ differs as a function of men's sexual orientation (Figure 1). Measurements of formant frequencies at vowel midpoint showed that gay men produced a lower, backer /æ/ than straight men. The formants of /e/ and /u/ also differ as a function of men's sexual orientation (Figure 1), as does the spectral skewness of /s/.

Figure 1  
Pink: Gay Men  
Blue: Heterosexual Men  
(Taken from Munson et al., 2006)



- In perception experiments, listeners use phonetic variation to infer attributes about talkers. Munson et al. (2006) showed that listeners infer men's sexual orientation based on the F1 frequencies of low-front vowels, the F2 frequency of back vowels, and the spectral skewness of /s/.
- Impressionistically, the heterosexual men's /æ/ productions sounded more like the 'tense' tokens of /æ/ that are characteristic of speakers who are engaging in the Northern Cities Chain Shift, while the gay men's /æ/ productions sounded more like the tokens of /æ/ characteristic of the Northern California Chain Shift.
- This poster is part of a larger project examining the nature of the social meanings of phonetic variants, including the association between /æ/ variation and perceived sexual orientation

## Purposes of the Study

### To Examine the Semantics of Social Meaning

- Our first experiment applied tests from the field of formal semantics to examine the nature of the social meaning "tense /æ/ = gay"

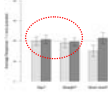
### To Better Understand the Influence of Acoustic Variation in /æ/ on Judgments of Sexual Orientation

- The results of a series of perception experiments showed a less-straightforward relationship between /æ/ variants and perceived sexual orientation than previous research suggested. This poster reports on detailed acoustic analyses of the stimuli used in this experiment in order to resolve some apparently contradictory findings

## Surprising Finding 1: We Failed to Replicate Munson et al.

- Smith, Munson, and Hall (2008) examined the perception of tense and retracted /æ/ in sentences. Participants were presented with spoken sentences and indicated how surprised they would be to find out the talker was gay or straight (among other attributes).
- Sentences were constructed to test different hypotheses about the nature of the social meanings associated with /æ/. Sentences were produced by 10 trained talkers producing prototypical tense and retracted /æ/ variants.
- No relationship between /æ/ variant and perceived sexual orientation was found. (Figure 2).

Figure 2  
Data from Smith, Hall and Munson (2008)



## Surprising Finding 2: Perception of Single Words Excised from Sentences Gave Opposite-than-Predicted Effects

- We speculated that Smith et al.'s failure to replicate Munson et al. was because the tokens of /æ/ in those words were unlike those used in Munson et al. To examine this, we did a perception experiment with single words excised from the sentences used by Smith et al., using procedures identical to those in Munson et al.
- Surprisingly, an opposite-than expected relationship was found between variant and perceived sexual orientation: tense /æ/ words were rated as gayer sounding than straight /æ/ words (Figure 3). This was not true for non-/æ/-bearing words from the same sentences.

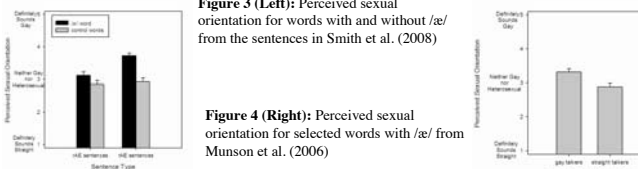


Figure 3 (Left): Perceived sexual orientation for words with and without /æ/ from the sentences in Smith et al. (2008)

Figure 4 (Right): Perceived sexual orientation for selected words with /æ/ from Munson et al. (2006)

## Surprising Finding 3: Perception of the Munson et al. Single Words Still Shows the Same Pattern as Before

- One possibility is that the association between /æ/ types and perceived sexual orientation had changed between the time when Munson et al. collected their data and when Smith et al. did.
- To examine this with did an additional experiment with the subset of the perception stimuli from Munson et al. that contained /æ/. The results of this experiment replicated Munson et al.'s earlier finding (Figure 4)

## Acoustic Measures

- To resolve the apparently contradictory findings of Smith et al. (2008) and Munson et al. (2006) we made detailed acoustic measures of all of the /æ/ tokens from Smith et al. and Munson et al. This included measures of the overall spacing of formants, as well as acoustic indices of tenseness / retraction. These were measures of the trajectories of F1 and F2 in the first half of the vowel

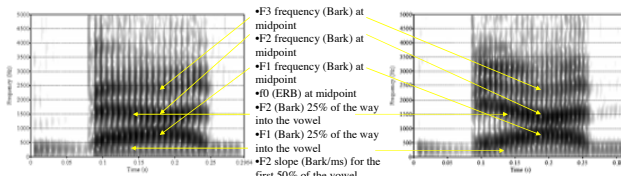


Figure 5: A token of 'bad' with a retracted /æ/ produced by a trained talker from Smith et al.

Figure 6: A token of 'bad' with a tense /æ/ produced by the same talker.

References: Munson, B., McDonald, E.C., DeBoe, N.L., & White, A.R. (2006). The acoustic and perceptual bases of judgments of women and men's sexual orientation from read speech. *Journal of Phonetics*, 34, 202-240; Purnell, T., Idsardi, W., & Baugh, J. (1999). Perceptual and phonetic experimentation on American English dialect identification. *Journal of Language and Social Psychology*, 18, 10-30; Smith, E.A., Munson, B., & Hall, K.C. (2008). *Rethinking the meaning of Munsonian [æ]: sexual orientation or personal will being?* Oral presentation at the conference on New Ways of Analyzing Variation (NWAV), Houston, TX; Stuart-Smith, J. (2007). Empirical evidence for gendered speech: /s/ in Glaswegian. In J. Cole and J. Hualde (Eds.), *Laboratory Phonology 9*. New York: Mouton de Gruyter.

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This poster is available on-line at <http://www.ic.umn.edu/~munson05>

## Stimulus Acoustics

- MANOVA showed that the stimuli differed in all of the parameters that were measured except F1 slope. These are summarized in Table 1. Figures 7 and 8 show average formant trajectories for the /æ/ tokens for the gay and straight men's productions, and the tense and retracted /æ/ used as Stimuli in Smith et al.
- The findings shows that the gay men's stimuli from Munson et al. were more similar to the tense /æ/ stimuli from Smith et al. than they were to the retracted /æ/ stimuli, but the heterosexual men's stimuli were unlike either.

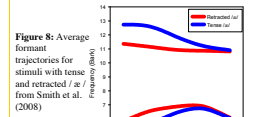
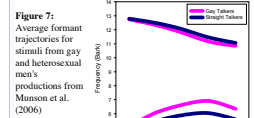


Figure 8: Average formant trajectories for stimuli with tense and retracted /æ/ from Smith et al. (2008)

Variable	Tense /æ/ average (SD)	Retracted /æ/ average (SD)	Gay Talkers average (SD)	Heterosexual Talkers average (SD)	Significant Pairwise Comparisons
Midpoint F0 (ERB)	3.96 (0.12)	3.56 (0.12)	3.52 (0.12)	3.42 (0.12)	(Heterosexual vs. tense /æ/)
Midpoint F1 (Bark)	6.44 (0.42)	6.88 (0.48)	6.65 (0.66)	5.90 (0.54)	(Heterosexual vs. gay), (retracted /æ/ vs. tense /æ/), (retracted /æ/ vs. heterosexual)
Midpoint F2 (Bark)	11.86 (0.73)	10.93 (0.54)	11.79 (0.43)	12.03 (0.78)	(retracted /æ/ vs. all others),
Midpoint F3 (Bark)	14.35 (0.48)	14.34 (0.48)	14.35 (0.54)	14.73 (0.42)	(Heterosexual vs. all others)
25% F1 (Bark)	5.67 (0.64)	6.56 (0.50)	6.08 (0.91)	5.46 (0.50)	(Heterosexual vs. gay), (retracted /æ/ vs. tense /æ/), (retracted /æ/ vs. heterosexual)
25% F2 (Bark)	12.59 (0.73)	11.14 (0.66)	12.33 (0.47)	12.48 (0.75)	(retracted /æ/ vs. all others),
F1 Slope (Bark/ms)	-0.0109 (0.0111)	-0.0047 (0.0095)	-0.0093 (0.0079)	-0.0087 (0.0094)	None
F2 Slope (Bark/ms)	-0.0165 (0.0125)	-0.0041 (0.0074)	-0.0088 (0.0060)	-0.0084 (0.0107)	(retracted /æ/ vs. heterosexual), (retracted /æ/ vs. tense /æ/)
Perceived Sexual Orientation	3.94 (0.33)	3.20 (0.50)	3.32 (0.47)	2.76 (0.62)	(Heterosexual vs. all others), (tense /æ/ vs. all others)

## Regression Analyses

- Regression analyses showed that 26% of the variance in the mean ratings of perceived sexual orientation for the entire set of stimuli were predicted by three measures: midpoint F0, midpoint F1, and F2 at the 25% point in the vowel.
- A regression for the ratings for just the Smith et al. words found 22% of the variance to be predicted by midpoint F0 and F2 at the 25% point in the vowel. A regression on just the ratings for the Munson et al. words found 32% of the variance to be predicted by midpoint F0, midpoint F1, and midpoint F2. This is broadly comparable with the findings of Munson et al. (2006)

## Conclusion: It's Not That Surprising After All

- The apparently contradictory findings of Smith et al. and Munson et al. weren't really contradictory at all. The parametric phonetic characteristics of the /æ/ tokens in the two studies were different enough to elicit different patterns of performance. Talkers were rated as gayer-sounding if they had higher formant frequencies (including a high F2 frequency associated with tense /æ/) and a high fundamental frequency
- This analysis underscores the importance of using detailed acoustic-phonetic measurements rather than impressionistic categories like 'tense' and 'retracted' /æ/ when characterizing socially relevant distinctions in speech sounds.