

A Sociophonetic Analysis of /s/ Variation in Puerto Rican Spanish

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1. Introduction

1.1. Overview of the study

This study addresses how variation in pronunciation interacts with perceptions of speaker social identity. The study utilized an implicit measures timed voice recognition experiment to examine the interaction between realization of syllable-final /s/ and perceived sexual orientation (PSO) in Puerto Rican Spanish. While realization of syllable-final /s/ is linked anecdotally to male PSO, there are no systematically collected data that document the relationship; this study is an exploratory look at the issue. In the experiment, 43 listeners completed an immediately primed timed voice recognition task. A d-prime analysis indicated there was a weaker signal for the deleted variant stimuli when produced by gay sounding talkers, and a three factor mixed model ANOVA found a significant main effect of perceived sexual orientation, $F(1, 41) = 6.47, p < .05$, with responses to gay sounding talkers faster than straight sounding talkers. These results indicate a possible connection between PSO and syllable-final /s/ realization, as well as an overall sensitivity to socially stratified variation.

1.2. Background of the study

The study is organized around the concept of socioindexicality, or the idea that certain patterns of pronunciation index social information (Foulkes & Docherty, 2006; Ochs, 1991). Several studies have shown that by listening to audio-only stimuli, listeners make judgments of sociological variables that contribute to the notion of identity, such as speaker gender, age, country/region of origin, education level, socioeconomic status, ethnicity, and sexual orientation. For example, studies by Baugh (2000) and Purnell, Idsardi, and Baugh (1999) show that listeners make judgments of speaker self-identified ethnicity after listening to speakers say "hello;" data from Carahaly (2000) show that listeners make better-than-chance judgments of a speaker's self-identified sexual orientation after listening to short speech samples. While the ability to categorize speakers based on audio-only stimuli is well documented, the specific phonetic variables that come into play to index social identities are not clearly identified, nor is the process by which evaluations are made fully understood. An important first step for understanding the puzzle of socioindexicality is to identify which cues become relevant in which contexts, and how socioindexical processes vary within and between different languages. There is little data available on sociophonetic variation outside of English, and the lack of data on variables relevant to sociophonetic variation extends to the specific subject of this study: the perception of sexual orientation in Puerto Rican Spanish. This study explores the role that a specific cue, the syllable-final /s/, plays in this process. As we will see, there are few studies that systematically explore the perception of sexual orientation in Spanish, and little systematically collected data that provide clues about what phonetic cues are relevant in its perception.

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There are four areas of study that provide the context for this experiment: speech and sexual orientation; stereotypes and speech processing; phonetic variation and sexual orientation in Spanish; and Spanish /s/ variation. The first area, speech and sexual orientation, is a relatively new field of inquiry, but several studies have shown that listeners make evaluations of speaker sexual orientation based on audio-only stimuli (see Munson & Babel, 2007, for a comprehensive overview). Although the process is documented, the specific phonetic variants, or combination of variants, that trigger these evaluations have thus far proved difficult to isolate. One issue is that phonetic variation and judgments do not necessarily correspond to stereotypical speech profiles that might provide a starting place for analysis. For example, in English there is an association between the stereotype of gay male speech and production of the /s/. The frontally misarticulated [s] (often termed the “lisp”) is a marker of homosexuality in pop culture portrayals of gay men. Nonetheless, systematic studies have failed to document a relationship between self-identified male sexual orientation and a frontally misarticulated [s]. Rather, studies have shown that more careful articulations, rather than misarticulations, correlate with the perception of a speaker as gay sounding (Munson et al., 2006). In addition, there is increasing evidence that shows that there are interactions between judgments of sexual orientation and other speaker characteristics (see Babel & Johnson, 2006), which further clouds the issue. Finally, most of what we know is based on studies examining data from native speakers of American English, so there is little data on speech and sexual orientation in other languages.

The next area of inquiry that is important to the study is stereotypes and speech processing. So far, the most common method for determining the cues relevant to perception of social identity has been to directly elicit judgments of perceived sociological variables. For example, listeners are exposed to a stimulus and then report their evaluation of the speaker’s sexual orientation. This method implies that perception occurs in a straightforward way: a voice is heard and then a judgment is made. This method is useful and its prevalence in recent studies has resulted in a data set that facilitates comparative studies. However, there are some drawbacks that suggest that it may be beneficial to employ different methods that do not require listeners to explicitly comment on a speaker’s social identity. There are two main reasons for this. First, there is evidence from social psychology of the impact of what Fazio and Olson (2003) term “social desirability concerns” on responses. For example, in a study on perceptions of sexual orientation, it is possible that participants possess a variety of reasons for not wishing to explicitly evaluate someone as gay or straight sounding. This may result in self-censorship. In addition, work in psycholinguistics and cognitive psychology shows that perception is more complex, and is influenced by a variety of factors, including social stereotypes. Thus there also exists a potential impact of stereotypes on speech processing. In fact, there is more and more evidence for a more complex model of speech perception that acknowledges the dynamic relationship between stereotypes and bottom-up acoustic processing. For example, Niedzielski (1999) found that when listeners thought they were hearing a Canadian speaker, they identified vowels differently than when they thought they were listening to someone from Detroit, even though the stimuli were the same. In other words, if listeners believe that they are listening to variation associated with a specific stereotype (Canadian English, in the case of Niedzielski’s study), it affects how sounds are processed. This phenomenon presents a challenge to the unidirectional perception process. Instead of hearing a voice and then making an evaluation, it seems that once a stereotype is activated, it changes how listeners “hear” sounds. Because of this, it would be beneficial to try to measure relationships between sounds and social factors without relying on explicit methods.

In order to do this, the current experiment utilized a timed voice recognition priming experiment protocol to assess the relationship between /s/ variation and perceptions of sexual orientation. Priming experiments set up an expectation in the priming phase and then measure how a given variable is affected by that expectation in a test phase. Early priming experiments considered semantic associations between lexical items, looking at the latency effect in associated and non-associated objects (Fazio, 2001). For example, listeners primed with the word “doctor” are quicker to identify the word “nurse” as a real word (as opposed to a non-word) than if they are primed with a non-semantically associated term. More recently, priming methods have been extended to investigate the automatic activation of sociocultural identity and sociocultural value judgments, such as racial and gender stereotypes. Priming techniques also have been used to examine low-level speech processing, social stereotypes, and variable phoneme production (see Hay, Nolan, and Drager, 2006; Hay, Warren,

and Drager, 2006; Niedzielski, 1999; Strand, 1999). Congruence (or lack thereof) is the key factor in priming tasks; congruent objects elicit faster response times.

The third area of inquiry important to this study is phonetic variation and sexual orientation specific to Spanish. At this time there are no known production or perception studies on socially stratified variation and its possible relationship to sexual orientation in Spanish. In fact, there is little systematic investigation of phonetic variables and sexual orientation at all.¹ In addition, most anecdotal evidence from academic contexts refers to male effeminacy rather than sexual orientation. For example, Sowards (2007) presents interview data from Mexico that links “a high pitched voice” (p. 146) to effeminate behavior in general, mirroring the connections between fundamental frequency and sexual orientation explored as part of the gay speech stereotype in English by Gaudio (1994) and others.

Important to this study, anecdotal evidence from Spanish points to a possible connection between distinctive patterns of /s/ production related to a specific phonological weakening process that occurs in Caribbean Spanish, aspiration and deletion of the /s/. There are three traditionally recognized variants of /s/ syllable- and word-finally in Caribbean Spanish: the sibilant [s], a fully retained variant; the [h], commonly known as the aspirated variant; and the phonetic zero, also known as the deleted or elided variant (Alba, 1990; Cedergren, 1978; Lafford, 1986; López Morales, 1980 & 1983).² In some speech communities, /s/ weakening has advanced to the stage where /s/ epenthesis occurs; in a discussion of standard and local linguistic norms in Dominican Spanish, Zentella (2003) cites the comic, often mocking phrase “*hablar fisno*,” a play on the expression *hablar fino* (‘to speak fine’), in which hypercorrective /s/-epenthesis occurs at the end of the first syllable in the word *fino*. The phrase *hablar fisno* is known in several dialects, but is seen as an especially apt commentary on Dominican Spanish. Although the weakening process is very advanced in the dialect, speakers realize that the absence of [s] is stigmatized, and insert [s] in the syllable rhyme in places where there is no underlying /s/, as in the case of *abogado* ‘lawyer’ > *asbogado* or *abosgado* (Nuñez-Cedeño, 1994, p. 30). While *hablar fisno* is often equated with formality, higher socioeconomic status, or “posh speech” (Roca, 2005, p. 38), it has come to be associated with male effeminacy in some contexts (Zentella, 2003, p. 60).

One source of data on the link between production of syllable-final /s/ and PSO in Puerto Rican Spanish is from interviews that were part of the larger study protocol of which the current experiment was a part. Full results are reported in Mack (forthcoming). In interviews, 88 participants offered descriptions of the speech stereotype associated with gay males in Puerto Rico. Eight participants (about 9%) mentioned a distinctive /s/ pronunciation as a marker of gay speech. For example, one noted: “*La ‘s’ lo he notado mucho, como que [los hombres gay] tartan de hacer una pronunciación más correcta.*” (‘The ‘s’ I have noticed a lot, it’s like [gay men] try to make a more correct pronunciation of it.’) While only a minority of participants noted this connection, it nonetheless suggests that at least for some individuals in the study community, a more careful pronunciation of the /s/ is part of the gay speech stereotype. More significantly, this trend corresponds to Mendes’ (2007) data from Brazilian Portuguese, in which a similar process occurs with syllable-final /s/.

The final area of inquiry important to this study is the general sociolinguistic picture of /s/ variation in Spanish. Besides the anecdotal evidence linking /s/ production to effeminacy, another reason for examining /s/ production and evaluations of sexual orientation is the socioindexical power of /s/. Many studies have shown correlations between production of the syllable-final /s/ and speaker gender, social class, and attitudes. Documentation of the variable production of syllable-final /s/ corresponding to social variables is plentiful, and, as Terrell (1979) notes, its variable production has been “shown time after time to be...correlated to social variables.” In general, when we consider the

¹ It bears restating that the question dealt with in this study is phonetic variation and sexual orientation. There are systematic analyses of speech and sexual orientation in Spanish from the perspective of discourse analysis, lexicography, literary studies, and other fields.

² Although the three variants mentioned are traditionally recognized, there is a fourth variant that is possibly coming into more widespread use. This variant is the glottal stop, documented in Spain (Cortés Gómez, 1979), Argentina (Fontanella, 1973), Philippines (Lipski, 2001), and, most significantly for the current study, in Puerto Rico (Valentín-Márquez, 2006).

findings of studies across aspirating and deleting dialects, the findings support the following continuum of socially-stratified variation: on one end of the continuum there is the [s], whose use is correlated with higher socioeconomic status, the speech of women, and with careful speech; on the other end of the continuum there is the deleted variant, correlated with lower socioeconomic status, the speech of men, and casual speech.³ However, there has been no systematic production or perception studies that explore the possible correlation between sexual orientation and /s/ realization.

In summary, there are no studies that systematically explore the perception of sexual orientation in Spanish, and no systematically collected data that provide clues about what phonetic cues are relevant in its perception. In addition, there are no studies that have examined these issues from an implicit processing perspective. With these gaps in mind, the current study was designed as an exploratory look at this issue, concentrating on the following issues: Are response times in a voice recognition task influenced by the type of /s/ in the stimuli and the speaker's perceived sexual orientation? Do these variables interact in a way that suggest that listeners expect different /s/ types for voices having different perceived sexual orientations? And does this interaction emerge in a task in which the listener's attention was drawn explicitly to sexual orientation as a potential source of variation?

2. Study Method

2.1. Overview of method

This study was part of a larger experimental protocol exploring phonetic factors and perception of socially stratified variation. The protocol included three tasks: interviews on speech stereotypes and social categories (described in Mack, forthcoming), an explicit measures of perceived social identity task (described in Mack, 2010), and the task described here (a voice recognition task within a priming experiment).

The stimuli for the current experiment were produced using an adaptation of a matched guise design (Lambert, Hodgson, Gardner, & Fillenbaum, 1960) in which individuals produced three variations of the stimuli containing the variable of interest. The task completed by study participants served as an assessment of the relationship between /s/ production and perceived sexual orientation. Listeners completed one of two conditions: PSO priming or SES priming. The data collection procedure was made up of a series of trials. In each trial, listeners heard a prime phase stimulus made up of six article-noun combinations that did not include any examples of a syllable-final /s/. The listeners were instructed to try to remember the voice. Then there was a short distracter task, followed by a test phase. The test phase stimulus was made up of one phrase that included the syllable-final /s/ in one of its three variations: sibilant [s], aspirated [h], or deleted [0] (phonetic zero). The listeners indicated as quickly as possible if the voice was the same as the voice heard in the priming phase or was a different voice. The listeners' response accuracy and response time were logged; these data were used in the analysis. In the next trial, the sequence began again. The underlying logic of this type of task is that when subjects are exposed to a stimulus, a set of associations related to that stimulus is activated. Thus, when listeners hear a gay sounding voice, it activates a set of beliefs about gay sounding talkers (i.e., stereotypes). The response times gathered in the test phase, then, are a measure of the strength of the association between the variable of interest and those stereotypes. Variants that are more closely associated with (or more congruent to) the speech stereotype will be processed faster than those that are not (or are less congruent).

2.2. Participants

The study was carried out at a large public university in the San Juan, Puerto Rico, metropolitan area. The choice of location was based on the prevalence of aspiration and deletion in the linguistic

³ Although these are the general trends between /s/ realization and social variables, it should be noted that the weakening process is at different stages in different regions, which necessarily effects the relative positions of variants on the continuum. In addition, the dynamic nature of language variation means that variants' socioindexical properties change according to local context.

profile of the community, as well as the availability of local linguists who served as consultants and university-level students who could serve as study participants. Male participants who recorded the study stimuli (henceforth ‘talkers’) were recruited by fliers, bulletin board postings (both on paper and online), and word-of-mouth. No reference to sexual orientation was made in the fliers or postings. The specific purpose of the study was referred to as “an experiment on speech perception” on the informed consent form. All talkers completed a demographic questionnaire that included questions about their age, region of origin within Puerto Rico, level of education, and linguistic background. The talkers’ mean age was 23 years. All were native speakers of Puerto Rican Spanish. Recording sessions for the talkers lasted from 20 to 40 minutes, and each talker was paid \$10.00 for his participation.

The talkers were not asked to report their sexual orientation for several reasons. First, because this experiment centered on speech stereotypes, and there is not a strict correspondence between self-reported sexual orientation and “sounding gay” or “sounding straight,” the data is of limited use to this study. Clearly, it is a generalization to assume that all gay men speak with the kind of stereotypical gay characteristics upon which the task depended, and/or that all straight men speak without these traits. Indeed, Smyth, Jacobs, and Rogers (2003) reported that the voice that had been rated as straightest sounding in their study was, in fact, the voice of a gay man. Second, asking talkers to self-report sexual orientation assumes not only that all talkers have classified themselves using the dominant society’s categories of sexual orientation, but also that they are comfortable sharing information about their sexual orientation with a complete stranger. As an outsider to the community, I elected not to put talkers in this potentially uncomfortable position, nor did I wish to rely on data that was gathered in this way.

Twenty talkers were initially recruited. Local informants helped to identify and recruit several stereotypically gay sounding talkers, but it was assumed that the variation occurring in a group of 20 talkers would provide enough natural variation for two subsets, one of more stereotypically gay sounding talkers, and one of more stereotypically straight sounding talkers, to be identified. In other words, the recruitment depended on a convenience sample of willing and available talkers, followed by a systematic rating task, reported in Mack (2010). This approach differs from several of the previous studies on speech and sexual orientation that either used a more targeted approach in recruiting gay sounding speakers or entrusted the identification of gay sounding and straight sounding men to the investigator(s) or to local informants. The drawback of that practice is that the selection of the talkers (in other words, how closely their voices fit the gay stereotype, or the heterosexual stereotype) is dependent upon the investigators’ or a select group of local informants’ judgments. An unintended consequence is that the resulting speech samples may reflect the investigator’s preexisting view of which speakers are gay sounding and which are straight sounding that may or may not correspond with that of the larger study community. In the current study, identification of which talkers were gay sounding and which were straight sounding was based on evaluations made by 23 listeners who were from the same community as those who completed the voice recognition study. Using the listener ratings of talker perceived sexual orientation, the seven talkers evaluated as the most stereotypically gay sounding and the seven talkers evaluated as the most stereotypically straight sounding talkers were identified by calculating their mean ratings score. These talkers’ stimuli were used as the test items in the voice recognition experiment; the stimuli that had been recorded by talkers who were not in either one of the groups were used as practice items and distracter items.

There were 54 listener participants who completed the experimental protocol. Because of technical issues, 11 of these participants’ results had to be discarded, resulting in 43 participants whose data was used in the final analysis; this included 21 participants in Condition One and 22 participants in Condition Two. This group was made up of 33 female and 10 male participants, 14 females and 7 males in Condition One, and 19 females and three males in Condition Two. All listeners completed a demographic questionnaire that included questions about their age, level of formal education, region of origin, the amount of time they have spent in the San Juan metropolitan area, and their linguistic background. The mean age of listeners was 22.8 years. All were native speakers of Puerto Rican Spanish, and all were undergraduate or Masters degree students at the university. Listeners were recruited by fliers, bulletin board postings (both on paper and online), and word-of-mouth. No reference to sexual orientation was made in the fliers or postings. The specific purpose of the study

was referred to as "an experiment on speech perception" on the informed-consent form. The listeners were paid \$10 for their participation.

2.3. Stimuli

The talkers were recorded saying the priming phase stimuli and the test phase stimuli. The priming phase stimuli were six article-word combinations. All article-noun combinations included nouns that are among the top 175 highest frequency words in Spanish (Davies, 2006). The list was designed to include equal numbers of masculine and feminine article-noun combinations. It included three of the five vowels present in the Spanish vowel system in stressed position: /e/, /i/, and /u/, and included /a/ in pretonic position. The fifth vowel, /o/, occurred only in posttonic, phrase-final position. The article-noun combinations were the following (frequency ratings appear in parentheses):

el día 'the day' (71)
 la vida 'the life' (88)
 el tiempo 'the weather' or 'the time' (68)
 la gente 'the people' (158)
 el mundo 'the world' (118)
 la manera 'the manner' (152)

The decision to use short duration stimuli was partially based on the success of similar methods in Munson, McDonald et al. (2006). That study, along with subsequent studies using the same stimuli (Munson, Jefferson et al., 2006; Munson, 2007) illustrates that short, single word stimuli are sufficient to establish speaker social identity in the minds of listeners. The decision to include article-noun combinations rather than single words was made in order to lend a more natural sounding element to the stimuli set, as article-noun combinations are more common in Spanish than are single nouns.

The test phase stimuli included two phrases:

Estos chicos no vienen. 'These boys aren't coming.'
Estos coches no van. 'These cars don't run.'

The talkers were instructed to read the phrase several times pronouncing each /s/ as [s], several times pronouncing each /s/ as [h], and several times not pronouncing any of the possible /s/ tokens. This method resulted in more natural sounding tokens as compared to digitally manipulated stimuli.

Since the main source of data for this experiment was response times, an analysis of duration differences in the test phase stimuli was conducted. The first one-way ANOVA showed a non-significant effect of stimulus /s/ type on stimulus duration, $F(2, 81) = 2.95, p = .058$. The second one-way ANOVA that showed that there was a significant effect of the perceived sexual orientation on stimuli duration, $F(2, 82) = 3.98, p = .049$, with stimuli recorded by the gay sounding talkers shorter than stimuli recorded by the straight sounding talkers.

2.4. Procedure

The experiment was designed and delivered to the participants via E-Prime experiment management software (Schneider, Eschman, & Zuccolotto, 2002). Listener responses were collected via the number keypad and the PST serial response box. Paper stickers on the button box and keyboard marked the appropriate buttons as same, middle, and different. The experiment began with instructions that the listeners read through at their own pace, pressing any key on the keyboard to advance. In order to facilitate evaluations of the talkers according to social categories, the listeners were told that they would listen to a group of individual talkers who varied in how stereotypically gay sounding or straight sounding they were (PSO priming, Condition One) or how stereotypically upper, middle, or lower class sounding they were (SES priming, Condition Two). The choice to prime listeners for socioeconomic status (SES) was made based on the strong associations between /s/ production and

social class. The benefit of including this condition was that it would provide comparison data that would verify that the priming in Condition One had an effect on listener responses.

When listeners were ready to begin, there was a practice block of ten trials to provide an opportunity for them to become accustomed to the task. At the end of the practice block, listeners were instructed to inform the investigator of any doubts or questions they had about the task. After the practice block, the experimental trials began. Upon completion of all the trials, listeners saw a screen telling them that the experiment was complete and thanking them for their participation.

In the priming phase, listeners were instructed that they were to listen to the talker and attempt to remember his voice. Listeners heard the six priming phase noun-article combinations, all produced by the same talker. An orthographic display of the words was presented on the computer monitor at the same time the recording was heard. These stimuli did not include the variable of interest, the syllable-final /s/. The goal of the priming phase was to activate stereotypical notions of social identity in the mind of the listener, and, ideally, establish a speaker's social identity for the listeners.

In the distracter task, listeners were presented with mental math problems or counting exercise. After the distracter task was completed, the listeners begin the test phase, in which they were instructed to press the middle button as soon as the screen turned from red to green. This action activated a short beep that corresponded to the start of the stimulus recording for the test phase. The stimulus for the test phase was auditory only; it was not accompanied by an orthographic display of the word. The listeners were then instructed to press the leftmost button (labeled “same”) if the talker was the same talker as in the prime phase, and press the rightmost button (labeled “different”) if the talker was a different talker than in the prime phase. The listeners were instructed to press the appropriate button as quickly as possible without compromising accuracy. The study's variable of interest, syllable-final /s/, appeared in this phase.

All trials appeared in random order. Each listener heard each of the 14 talkers during six trials throughout the experiment: with each of the three /s/ types ([s], [h], phonetic zero) in two different test phrases. This resulted in 84 responses made by each listener, plus the practice block of 10 trials and 14 distracter trials. The complete experiment protocol took approximately one hour to complete.

The response times were logged, and served as a measure of the relationship of /s/ production and the perception of sexual orientation. This technique follows methods successful in Banaji and Hardin (1996), Blair and Banaji (1996), Fazio, Sanbonmatsu, Powell, and Kardes (1986), and Kawakami, Young, and Dovidio (1998) that document the pervasiveness of automatic stereotyping, the influence of priming on response time to stimuli, and the lack of conscious control over evaluative judgments.

3. Analysis and Results

3.1. *d*-prime Analysis

Before analyzing the response time data, a *d*-prime (d') analysis was conducted to examine listeners' overall discrimination in the task. *D*-prime analyses measure the detection of whether a voice changed between the priming phase and the test phase. *D*-prime (Macmillan & Creelman, 2005) has the advantage over conventional percent correct analyses in that it accounts for both hits (cases where the prime voice and the test voice were the same and were correctly identified as such) and false alarms (cases where the voices were not the same, but where the listener identified the test talker as the same as the prime talker). The d' value indicates whether the listener exceeded a threshold of detection, and whether she or he was biased to providing a particular response. For example, if a listener was unsure of an answer, he or she might tend to respond with “same” more often than he or she responded with “different.” In that case, the percentage values may not be an accurate reflection of how well listeners performed in the detection task. In other words, if the listener replied “same” for every item, his or her percentage correct for the items where the prime talker is the same as the test talker would be 100%, because he or she correctly identified the test talker as the priming phase talker in all situations in which that was the case. However, this would mean that the percentage correct for the cases where the prime talker and test talker are different is zero; the 100% statistic doesn't give a true picture of the listener's sensitivity to the signal. Therefore, it is important to contextualize the

percentage scores and interpret them in an analysis that takes into account potential response biases. Signal detection theory provides a way to take this into account.

To calculate d' , each data point is coded into four possible response types: 1) hits (those cases in which the listener correctly identified the test talker as the same as the priming phase talker); 2) false alarms (those cases in which the listener identified the test talker as the same as the priming phase talker, when in fact he wasn't); 3) misses (those cases in which the listener identified the test talker as different than the priming phase talker, when in fact he wasn't); or 4) correct rejections (those cases in which the listener correctly identified the test talker as different than the priming phase talker). The formula for signal detection analysis compares the hit rate (the number of hits as a proportion of the number of possible hits) to the false alarm rate (the number of false alarms as a proportion of the number of possible false alarms). The z score for the false alarm is subtracted from the z score of the hit rate. A higher absolute d' value means that there is more sensitivity to the difference between the when the talker is the same and when the talker is different, which translates to a subject's higher sensitivity, while a d' value near zero is a reflection of chance performance (Claremont, 2009; Macmillan & Creelman, 2005). In terms of this experiment, if we observe similar d' values for all stimuli types across both gay and straight sounding talkers, it would indicate that listener sensitivity is relatively stable and is not influenced by differences in the type of /s/ listeners hear or by perceived sexual orientation. If we observe d' prime values close to zero, it indicates that the listeners are performing at about chance level and that the signal is not strong. Higher d' prime values (typically around 2.0) will mean that the signal is stronger, and that listeners are more sensitive to it.

In this experiment, d' analysis was conducted for the [s] and deleted variants. (Aspirated tokens were not used for the stimuli in which the test talker did not match the prime talker, so it was not possible to calculate d' .) The mean d' values were highest for cases where gay sounding talkers produced the [s] variant and lowest for cases where gay sounding talkers produced the deleted variant. This information is summarized in Figure 1. In order to assess the statistical significance of these results, the d' data was analyzed in a two factor repeated-measures ANOVA. The two factors were PSO (gay sounding or straight sounding) and /s/ type (sibilant [s], aspirated [h], or the deleted variant). There was a significant main effect of PSO, $F(1, 42) = 7.15, p < .005$. There was also a significant main effect of /s/ type, $F(1, 42) = 42.61, p < .005$, and a significant combined effect $F(1,42) = 10.91, p < .005$. A paired-sample T-test showed a significant difference between both deleted variants as well as between the deleted variants and [s] variants, but not between the two [s] variants ([s] + gay sounding voice and [s] + straight sounding voice). These results indicate that there was a difference in listeners' sensitivity based on PSO and /s/ type. The signal was strongest and listeners were most sensitive to differences in the case of talkers producing the [s] variant. When listeners heard the deleted variant produced by speakers who were stereotypically gay sounding, their sensitivity to the signal was lower than in any other combination, suggesting a mismatch between PSO and the type of /s/ produced.

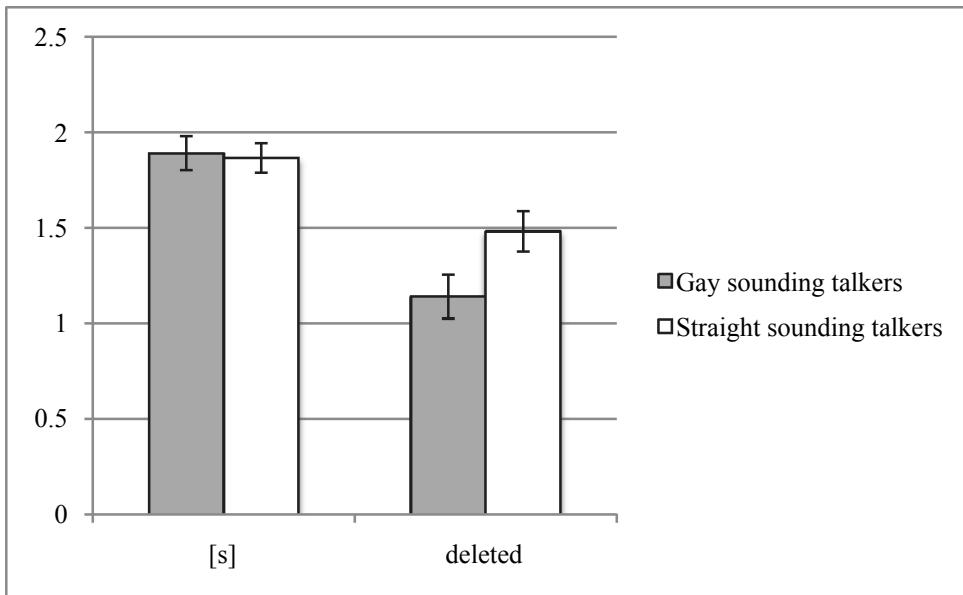


Figure 1. D-prime values of responses for [s] and deleted variants as produced by gay sounding and straight sounding talkers. Error bars represent the standard error.

3.2. Response time analyses

For the response time analyses, responses longer than six seconds were not considered in the data analysis, as they were assumed to be the result of listener distraction or inattention. Approximately 3.4% of the data fell into this category. In addition, each listener's hits' mean response time and standard deviation was calculated; responses more than three standard deviations from the mean were discarded. This accounted for less than 3% of the data. This convention of data trimming is often used in studies utilizing reaction times (Cohen and Lea, 2004), and is considered the most robust method as it limits the potential effect of outliers, non-normal distributions, and differences in variance (Wilcox, 1998).

The response time data were analyzed in a three factor mixed model ANOVA. There were two within-subjects' factors, PSO (gay sounding or straight sounding) and /s/ type (sibilant [s], aspirated [h], or the deleted variant), and one between-subjects factor, condition (Condition One, PSO priming, or Condition Two, SES priming). There was a significant main effect of perceived sexual orientation, $F(1, 41) = 6.47, p < .05$, with responses to gay sounding talkers faster than straight sounding talkers. This was the only statistically significant main effect, and there were no statistically significant interactions. In other words, listeners responded quicker to the talkers who had been previously rated as gay sounding, slower to the talkers who had previously been rated as straight sounding, and this difference was statistically significant. Since the earlier statistical analysis had shown that stimuli recorded by the gay sounding talkers were shorter in duration, a linear mixed effects model analysis was carried out to examine whether stimuli length was a significant factor in response times; no significant effect was found.

Since this was an exploratory investigation, a separate analysis of the data by condition was conducted in order to assess if there were distinct trends in the data depending on the priming condition (Condition One, PSO priming; Condition Two, SES priming). For each condition, a two factor within-subjects ANOVA was carried out, with PSO and /s/ type as the two factors. In Condition One, the analysis showed a non-significant main effect of /s/ type, $F(2, 21) = .430, p = .65$. It also showed a non-significant main effect of PSO $F(1, 21) = 1.57, p = .22$, as well as a non-significant interaction effect between PSO and /s/ type on response times, $F(2, 42) = .098, p = .91$.

In contrast to Condition One, the two factor within-subjects ANOVA for Condition Two did show a significant main effect of PSO, $F(1, 21) = 5.25, p < .05, \eta^2 = .2$, with faster responses for gay sounding talkers. There was not a statistically significant main effect of /s/ type, but the result was

suggestive, $F(2, 21) = 2.86$, $p = 0.068$, $\eta^2 = .12$, with faster responses for the [s] variant. There was no significant combined effect $F(2, 42) = .056$, $p = .945$, $\eta^2 = .003$. In other words, when listeners were led to believe that the talkers varied in terms of their social class, there was an observable effect of perceived sexual orientation on response times.

4. Discussion and Conclusions

There were two statistically significant results found in this experiment. First, the d' data showed a significant main effect of PSO and /s/ type, as well as a significant combined effect. Sensitivity to the signal was lowest when listeners heard the deleted variant produced by speakers who were stereotypically gay sounding. A possible interpretation is that there was a lack of congruency in those cases; listeners did not expect to hear deletion after receiving the prime of a gay sounding talker. In addition, the signal was strongest and listeners were most sensitive to differences in the case of talkers producing the [s] variant. The most likely interpretation of this finding is that [s] tokens were more easily processed than deleted tokens. There are numerous studies that document that ease of processing is influenced by speech clarity (see Tucker and Warner, 2007; Ernestus, Baayen and Schreuder, 2002). With [s] tokens, there was more phonetic information available to process the signal than with the deleted variants. Therefore, ease of processing could translate to a stronger signal and more sensitivity to [s] tokens. This could account for the statistically significant differences between the [s] and deleted variants, but there is also a statistically significant difference between gay sounding talkers and straight sounding talkers, as well as a significant combined effect. A possible interpretation of this is that there is an interaction between speech clarity and prototypical gender. Studies have shown that processing is affected by gender prototypicality (Strand, 1999 & 2000). In the d' data, there are four possible combinations of perceived sexual orientation and /s/ type:

- A) [s] + straight sounding voice
- B) deleted + straight sounding voice
- C) [s] + gay sounding voice
- D) deleted + gay sounding voice

From what is known about the effects of gender prototypicality and speech clarity on speech processing, we would expect the strongest signal to appear in case A ([s] + straight sounding voice), since this combination is the strongest both in terms of gender prototypicality and speech clarity. This prediction is not contradicted by the data. Next, we would expect case D (deleted + gay sounding voice) to have the weakest signal, since it is weakest both in terms of gender prototypicality and speech clarity. The data are consistent with this prediction as well. We would expect case B (deleted + straight sounding voice) to be an intermediate case, since it is made stronger by its gender prototypicality but weaker by its lower speech clarity. This is indeed the case. Finally, we would expect case C ([s] + gay sounding voice) to also be intermediate, as it is weaker in terms of gender prototypicality but stronger in terms of speech clarity. This, however, is not the case. In fact, it is the as strong as the other [s] variant. I hypothesize that the strength is a reflection of the strength of association between the sibilant [s] variant and the perception of the speakers as gay sounding. Accuracy in the task, as measured by d' , is affected not only by gender prototypicality and speech clarity, but also by relationships between the variants and perceived sexual orientation.

The second statistically significant finding was that there was an effect of perceived sexual orientation on response times, with voices perceived as gay sounding eliciting faster responses than voices that are perceived as straight sounding. This finding is problematic in light of the proposed explanation for the d' results. I proposed that gender prototypicality had an influence on accuracy, and assigned straight sounding talkers as those with most prototypically male voices. If we follow the same line of reasoning, we would expect quicker responses for the more prototypically male voices (again, the straight sounding talkers). One possible explanation is that measures of accuracy and speed of voice recognition are not necessarily comparable measures. The question is complicated by the results of a pilot test of the same methods in English (reported in Mack & Munson, 2008) that found the

reverse: listeners responded quicker to straight sounding talkers than to gay sounding talkers, and the difference was statistically significant level. These results, taken together, have implications for speech processing, as they suggest that socially stratified variation affects processing in different ways in different languages. Certainly, more quantitative and qualitative data is needed regarding this question.

Although the differences in response times by condition were not statistically significant, it is nonetheless notable that perceived sexual orientation had a significant relationship with response times in the condition in which perceived sexual orientation was not mentioned at all (in which listeners were instead led to believe that the variation in voices was due to differences in social class). One possible explanation is that the differences in talker sexual orientation were interpreted in Condition Two as differences in social class. However, this explanation is not supported by the available data from the second part of the larger experimental protocol, the explicit measures perceived social identity task (reported in Mack, 2010). In that task, ratings of perceived social class and perceived sexual orientation were not correlated. An analysis of the rankings of the 20 original talkers' perceived social class showed that perceived sexual orientation groups and perceived social class groups did not align. Among the talkers rated as from a higher social class, six were from the gay sounding group and four were from the straight sounding group (and the inverse, four gay sounding and six straight sounding in the lower social class group). In addition, data from the explicit measures task indicates that listeners responded to different cues when evaluating social class and sexual orientation, so it seems unlikely that there was a wholesale attribution of the differences in perceived sexual orientation as differences in social class by the listeners in Condition Two of the voice recognition experiment. More investigation is needed to assess the role of social category priming in experiments such as this one.

Since this is the first study of its kind, there is a need for studies that examine this issue, especially the relationship between speech stereotypes and real-world production, as well as the impact of social information on speech perception. Future research should also attempt to better integrate the local context of lexical frequency in priming tasks. While the stimuli for this study were taken from the 175 most-frequent words in worldwide Spanish according to Davies' (2006) corpus, it would be beneficial to obtain and utilize frequency data gathered from the community of study in explorations such as this one. In addition, studies using digitally manipulated stimuli are needed. In this study, each /s/ type stimulus was a naturally produced; it is likely there were slight differences in vowels, intonation, and duration. While statistical tests showed that duration was not a significant factor in response times, differences in vowels and intonation were not analyzed. Using digitally manipulated stimuli would provide a way to keep these variables constant, allowing for greater isolation of the variable of interest. Finally, more investigation of the relevant socioindexical cues that interact with perception of sexual orientation is needed. While this experiment focused on quantitative methods, there is a need for data acquired using both qualitative and quantitative methods. These investigations should address how these cues come together in perception of social identity in different varieties Spanish as well as how they compare with other languages.

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