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Candidate Voice Pitch Influences Election Outcomes

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A growing literature in psychology shows that human voice pitch—perceived "highness" or "lowness" as determined by the physiology of the throat—influences how speakers are perceived. This leads to the prediction that candidate voice pitch influences voters. Here this question is addressed with two studies. The first is an experiment conducted with a large national sample of U.S. adults. The results show that men and women prefer to vote for male and female candidates with lower pitched voices. The second study examines the outcomes of the 2012 U.S. House elections. When facing male opponents, candidates with lower voices won a larger vote share. However, when facing female opponents, candidates with higher voices were more successful and particularly so in the case of male candidates. In synthesizing research on the human voice and voter behavior and triangulating evidence from a controlled experiment and a large observational study of actual elections, this article illustrates that candidate voice pitch influences election outcomes.

KEY WORDS: vote choice, voice pitch, perception, elections, leadership

Animal vocal signals contain information about the signaler, such as fighting ability and genetic fitness, and the behavior of the receivers of those signals is influenced by this information (Bradbury & Vehrencamp, 2011; Searcy & Nowicki, 2005). The same can be said of humans. For example, a growing literature in psychology shows that voice pitch—perceived "highness" or "lowness" as determined by the physiology of the throat—influences perceptions of the speaker's strength (Feinberg, Jones, Little, Burt, & Perrett, 2005a; Puts, Apicella, & Cárdenas, 2012; Sell at al., 2010), attractiveness (Collins & Missing, 2003; Feinberg et al., 2005a, 2005b; Puts, Barndt, Welling, Dawood, & Burriss, 2011), dominance (Borkowska & Pawlowski, 2011; Jones, Feinberg, DeBruine, Little, & Vukovic, 2010; Puts, Gaulin, & Verdolini, 2006; Puts, Hodges, Cárdenas, & Gaulin, 2007; Tigue, Borak, O'Connor, Schandl, & Feinberg, 2012), and emotional state (Aronovitch, 1976; Banse & Scherer, 1996; Kuroda, Fujiwara, Okamura, & Utsuki, 1976; Puts et al., 2006; Scherer, 1981; Weeks et al., 2012; Wittels, Johannes, Enne, Kirsch, & Gunga, 2002). Knowing that voice pitch influences perceptions of the speaker leads to the prediction that candidate voice pitch influences voter behavior.

Initial tests of this hypothesis show that voters prefer candidates with lower-pitched voices (Anderson & Klofstad, 2012; Gregory & Gallagher, 2002; Klofstad et al., 2012; Tigue et al., 2012). One of these is an observational study of a small sample of candidates that did not control for alternative explanations of electoral outcomes (Gregory & Gallagher, 2002). The others are based on experiments conducted with college undergraduates (Anderson & Klofstad, 2012; Klofstad et al., 2012; Tigue et al., 2012), that is, individuals who have limited or no experience with voting and whose political preferences are not yet fully formed (Alwin & Krosnick, 1991; Franklin & Jackson, 1983).

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Taken together, whether the influence of candidate voice pitch on voter behavior holds under more realistic conditions is still in question.

Here this question is addressed with two studies. The first is an experiment conducted with a large national sample of adults living in the United States, the first of its kind in the pitch-perception literature. The results show that men and women prefer to vote for male and female candidates with lower-pitched voices. This preference is stronger for female candidates, and among older, well-educated, and politically engaged voters. These findings are novel as previous studies did not test whether the bias in favor of candidates with lower voices varies with voters' demographics. In a second study, the relationship between candidate voice pitch and electoral outcomes in the 2012 U.S. House of Representatives elections is examined. The results show that when facing male opponents, candidates with lower voices won a larger vote share. However, when facing female opponents, candidates with higher voices were more successful and particularly so in the case of male candidates.

Voice Pitch Influences Perceptions of the Speaker

Voice pitch is the perceived "highness" or "lowness" of a voice as influenced by fundamental frequency (F_0), "the number of vibrations per second made by the vocal folds [i.e., vocal cords] to produce a vocalization" (Tusing & Dillard, 2000, p. 150). F_0 is measured in Hertz (Hz), and lower Hz values indicate a lower voice. As with the strings of a guitar, longer and thicker vocal folds produce a lower voice, while shorter and thinner vocal folds produce a higher voice. Vocal-fold size is determined by the size of the larynx (i.e., voice box) in the throat. Taken together, the larger the larynx, the longer and thicker the vocal folds, the lower the pitch of the voice. Voice pitch is on average twice as high in women as in men because the male body contains more testosterone, which in puberty enlarges the male larynx (Titze, 1994). Typical male voices range in pitch between 85 and 180 Hz, and typical female voices range between 165 and 255 Hz (Baken, 1987; Titze, 1994). While voice pitch can be modulated by the speaker, the ability to do so is determined entirely by the physical structure of his or her larynx. Otherwise stated, even with vocal training only some women have the physical ability to sing Soprano, and only some men have the physical ability to sing Bass.

Research on how this physiological characteristic influences vote choice is anchored in experiments on how voice pitch influences perceptions of the speaker. This line of research shows that men with lower-pitched voices are perceived as more attractive (Feinberg et al., 2005a), physically stronger (Feinberg et al., 2005a; Puts et al., 2012; Sell at al., 2010), and more dominant (Puts et al., 2007). Within this literature, a dominant individual is defined as one who "tells other people what to do, is respected, influential, and often a leader" (Puts et al., 2006, p. 287). For women, higher-pitched voices are perceived as more attractive (Collins & Missing, 2003; Feinberg et al., 2005b; Puts et al., 2011), whereas lower-pitched female voices are perceived as more dominant (Borkowska & Pawlowski, 2011; Jones et al., 2010). Voice pitch also conveys information about the emotional state of the speaker. For example, higher-pitched voices are associated with negative emotions such as panic, fear, and stress (Banse & Scherer, 1996; Kuroda et al., 1976; Scherer, 1981; Weeks et al., 2012; Wittels et al., 2002), perhaps due to increased muscle tension in the throat and respiration rate that occur during times of emotional and physical stress (Scherer, 1981).

Knowing that voice pitch influences perceptions of the speaker leads to the prediction that candidate voice pitch could influence voters. The first test of this hypothesis was conducted by Gregory and Gallagher (2002). In examining recordings of 19 presidential debates from eight elections between 1960 and 2000, they find that male candidates with lower voices performed better in pre-election opinion polls and won a higher percentage of the popular vote. Importantly, however, Gregory and Gallagher did not control for other factors that can influence election outcomes. Furthermore, in

examining presidential candidates, this study is only concerned with a small sample of male candidates for a very high-level office.

More recently, Tigue et al. (2012) collected recordings of nine U.S. presidents and manipulated each of them digitally to yield a higher- and lower-pitched version of the original. Male and female voters were asked to listen to and vote for the higher- or lower-pitched version of each pair. Voters preferred the candidates with lower-pitched voices. This preference correlated with voters' perceptions that the speakers of the lower voices have greater integrity and physical prowess. In a second experiment, Tigue et al. (2012) manipulated novel male voices rather than those of known leaders. As in the first experiment, male and female voters were presented with pairs of voices and asked to vote for either the higher- or lower-pitched voice of each pair. Voters again preferred the lower voices.

Tigue et al. (2012) did not address whether voters are influenced by the pitch of female voices. In contrast, Klofstad, Anderson, and Peters (2012) presented male and female voters with pairs of manipulated male and female voices. Voters of both sexes preferred to vote for men and women with lower voices. They perceived lower-pitched female voices to be more competent and stronger. Female voters were not influenced by pitch when asked to judge male competence or strength. Men, however, found lower-pitched male voices to be stronger and more competent. As low voice pitch correlates with physical strength in men (Puts et al., 2012), this result suggests that men are more likely to attend to low voice pitch as a signal of traits that are important in the context of male-male competition, be it physical or political.

In a follow-up study to Klofstad et al. (2012), Anderson and Klofstad (2012) asked whether the preference for leaders with lower-pitched voices shifts to favor candidates with higher-pitched (i.e., feminine) voices within the context of feminine leadership roles. Using the same experimental design as in Klofstad et al. (2012), they found that men and women preferred female candidates with lower (i.e., masculine) voices for feminine leadership roles. Likewise, men preferred men with masculine voices for these roles. Female voters, however, did not discriminate on the pitch of male voices. Consequently, women may not weigh male voice pitch within the context of men seeking feminine leadership roles. It could also be that some women prefer men with feminine voices in feminine leadership roles.

Predictions

Given evidence that voters generally prefer candidates with lower pitched voices (Anderson & Klofstad, 2012; Gregory & Gallagher, 2002; Klofstad et al., 2012; Tigue et al., 2012):

- A more representative sample of adult men and women will prefer to vote for male and female candidates with lower-pitched voices.
- Candidates with lower-pitched voices will have greater success in real elections.

Study 1: 2012 Cooperative Congressional Election Study (CCES) Experiment

Creation of Treatments

Five men and five women were recorded speaking the sentence, "I urge you to vote for me this November," a politically relevant partisan-neutral statement. The women ranged in age from 21 to 38 years ($\bar{x} = 26$ years, SE = 3), and the men 20 to 41 years ($\bar{x} = 28$ years, SE = 4). Voices were recorded as .wav files in an Acoustic Systems soundproof chamber using a Shure SM57 microphone

and a Marantz PMD660 solid state recorder. Each audio file was inspected aurally and visually in Audacity (v. 2.0.1; audacity.sourceforge.net) to ensure that they were free from speech errors and non-speech noise. Engineering Design's Signal acoustics analysis program (v. 4.02.04; engdes.com) was used to normalize the amplitude ("loudness") of the recordings to two volts.

The recordings were manipulated to yield a higher- and lower-pitched version of each. Following previous studies on voice-pitch perception (Jones, Feinberg, DeBruine, Little, & Vukovic, 2008), each recording was altered +/−.5 equivalent rectangular bandwidths (ERB) with Praat (v. 5.1.43; Boersma & Weenink, 2013), which uses the Pitch Synchronous Overlap Add Method (PSOLA) algorithm to alter F_0 (Boersma & Weenink, 2013; Moulines & Charpentier, 1990). PSOLA alters voice pitch without altering other aspects of the recorded voices (Feinberg et al., 2005a; Feinberg, DeBruine, Jones, & Perrett, 2008; Jones et al., 2008). The relationship between absolute and perceived pitch in humans is logarithmic (Stevens, 1998). Manipulation by ERB accounts for this and produces a constant perceivable gap between the manipulated sound files regardless of the F_0 of the original recording (Stevens, 1998). A +/−.5 ERB shift is roughly comparable to a perceived shift of +/−20 Hz. On a guitar, this shift is equivalent to the difference between open string G and D notes, and on a piano the difference is between C4 ("Middle C") and A3.

Praat (v. 5.1.43; Boersma & Weenink, 2013) was used to measure the pitch of the recorded voices using the "Get Pitch" command. In line with recommended settings for pitch analysis in Praat (Boersma & Weenink, 2013), the pitch of the female voices was measured within a range of 100–600 Hz, and for male voices within a range of 75–500 Hz. All other system settings were set to their defaults. The pitch of the unaltered female and male voices range from 189 to 207 Hz ($\bar{x}$ = 199 Hz, SE = 3 Hz) and 91 to 116 Hz ($\bar{x}$ = 107 Hz, SE = 4 Hz) respectively. The pitch of the higher- and lower-pitched female sound files range from 214 to 233 Hz ($\bar{x}$ = 224 Hz, SE = 3 Hz) and 170 to 190 Hz ($\bar{x}$ = 181 Hz, SE = 3 Hz) respectively. The pitch of the higher- and lower-pitched male sound files range from 110 to 136 Hz ($\bar{x}$ = 127 Hz, SE = 4 Hz) and 81 to 98 Hz ($\bar{x}$ = 91 Hz, SE = 3 Hz) respectively. A previous study verified that voters can perceive which voice of each pair is higher in pitch (Klofstad, Anderson, & Peters, 2012).

Procedure

A total of 393 men and 411 women in the 2012 Cooperative Congressional Election Study (CCES) pre-election survey (Ansolabehere, 2012; Mann, 2012), conducted online by YouGov between October 1 and November 5, 2012, participated in the experiment. YouGov maintains panels of individuals who volunteer to complete surveys over the Internet. More individuals participated in the study than were included in the data set. The subset of participants included in the data set was selected using YouGov's matched random sample methodology. This method entailed two steps. First, a representative target sampling frame of U.S. Citizens was created using demographic data from a variety of sources, including the 2010 American Community Survey, the 2008 and 2010 Current Population Surveys, and the 2007 Pew U.S. Religious Landscape Survey. Second, for each member of the target sample at least one member from the pool of opt-in participants was selected for inclusion in the data set. This matching process was based on the following variables: sex, age, race, years of education, interest in politics, employment status, Evangelical or born again Christian status, marital status, partisanship, and ideology. The result is a data set comprised of participants who have the same measured characteristics as the target sample. More details on the matched sampling process are provided in the online supplement.

As space was limited on the CCES questionnaire, study participants were assigned randomly to listen to either the five pairs of male voices (N = 198 male and 224 female voters) or the five pairs of female voices (N = 195 male and 187 female voters). Before participating, voters completed a sound check task to insure that they could hear audio played by the online survey instrument. Voters chose

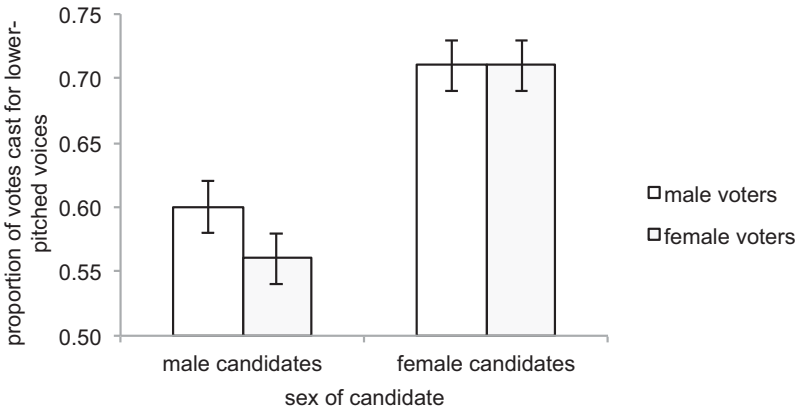

Figure 1. Election experiment results. Proportion of votes (+/- SE) cast for the lower-pitched version of male and female candidate voices. A value of .50 indicates no discernible preference for either higher- or lower-pitched voices. Male and female voters preferred to vote for male and female candidates with lower-pitched voices.

whether to use computer speakers (N = 717) or headphones (N = 87). After listening to each pair of voices, voters were asked which candidate they would vote for. The order of the pairs of voices, and whether the higher-or lower-pitched version of each voice was presented first, were randomized. Online voice-pitch experiments have been shown to produce results that are comparable to laboratory experiments (Feinberg et al., 2008).

Method of Analysis

The voter is the unit of analysis. Analyses were conducted using SPSS (v. 19; ibm.com). Vote choices were coded 1 if the voter selected the lower voice and 0 if the higher voice was selected. The average of these choices for each of the five votes that voters cast yields a summary preference ratio ranging from 0 to 1, whereby higher values indicate a stronger preference for lower-pitched voices. A preference ratio of .5 indicates that the voter had no preference for either the higher or lower voices. Analysis of variance (ANOVA) was used to assess voters' preferences.

Results

The Influence of Candidate Voice Pitch on Vote Choice. An ANOVA of vote choices was conducted with voter sex, candidate sex, and the interaction of the two. Type of playback device (headphones or computer speakers) was included as a covariate. As shown in Figure 1, voters preferred to vote for male and female candidates with lower-pitched voices, and this preference is stronger when voters judged female candidates ($F_{1,799} = 51.20$, $p < .001$). Vote choice did not vary with voter sex ($F_{1,799} = 1.45$, $p = .23$) or the interaction between voter sex and candidate sex ($F_{1,799} = 1.98$, $p = .16$).

Variation in the Relationship Between Candidate Voice Pitch and Vote Choice. Previous studies conducted with college undergraduates did not test whether the bias in favor of candidates with lower voices varies with voters' demographics. The large and diverse national sample of subjects included in the current study allows for this. As prior experiments on candidate voice pitch and vote choice were conducted with college undergraduates (Anderson & Klofstad, 2012; Klofstad et al., 2012; Tigue et al., 2012), perceptions of candidates' voices may vary by the age of the voter. To test this prediction, a post hoc ANOVA of heterogeneity in vote choice was conducted with candidate sex, voter age (whether the voter was 40 years of age or younger), and the interaction of the two. Type of

playback device was included as a covariate. Voters over the age of 40 cast more votes for candidates with lower-pitched voices ($F_{1,799} = 10.03$, $p = .002$; 40 years of age or older: 66%, under 40 years of age: 60%). The interaction between candidate sex and voter age was not statistically significant ($F_{1,799} = .54$, $p = .46$).

As previous studies only used college undergraduates as voters (Anderson & Klofstad, 2012; Klofstad et al., 2012; Tigue et al., 2012), perceptions of candidates' voices may also vary by the educational background of the voter. To test this prediction, a post hoc ANOVA of heterogeneity in vote choice was conducted with candidate sex, voter education (whether the voter had at least a four-year degree), and the interaction of the two. Type of playback device was included as a covariate. Voters with a four-year degree or higher cast more votes for candidates with lower voices ($F_{1,799} = 5.72$, $p = .017$; four-year degree or better: 67%, less than four-year degree: 62%). The interaction between candidate sex and voter education was not statistically significant ($F_{1,799} = 1.65$, $p = .20$).

A post hoc analysis of heterogeneity in vote choice was also conducted to test whether responses to candidate voice pitch varied by political engagement. Voters were asked, "Would you say you follow what's going on in government and public affairs: 'most of the time,' 'some of the time,' 'only now and then,' 'hardly at all,' or 'don't know'?" In total, 26 voters did not provide an answer to this question. An ANOVA of vote choice was conducted with candidate sex, an indicator of high political engagement (whether voters reported that they follow government and public affairs "most of the time"), and the interaction of the two. Type of playback device was included as a covariate. Highly engaged voters cast more votes for candidates with lower voices ($F_{1,773} = 7.46$, $p = .006$; engaged: 67%, not engaged: 61%). The interaction between candidate sex and voter engagement was not statistically significant ($F_{1,773} = .04$, $p = .84$).

Study 2: Influence of Candidate Voice Pitch on 2012 U.S. House Elections

Data

Data were gathered about the two candidates with the largest vote share in each 2012 U.S. House of Representatives general election. In total, 13 candidates had no opponent, leaving 857 candidates to include in the study. Recordings of candidate voices were taken from YouTube videos. Each video was played while being recorded as a .wav file with Audacity (v. 2.0.1; audacity.sourceforge.net). The highest-quality three seconds of audio from each recording, based on aural and visual inspection with Audacity, was selected for analysis. Videos were available for 796 candidates (160 women, 636 men).

The "Quantify Source" command in GSU Praat Tools (Owren, 2008), a script package that allows for automated analysis of sound files in batches in Praat (v. 5.1.43; Boersma & Weenink, 2013), was used to measure the pitch of the recorded voices. In line with recommended settings for pitch analysis in Praat (Boersma & Weenink, 2013), the pitch of the female voices was measured within a range of 100–600 Hz and for male voices within a range of 75–500 Hz. All other system settings were set to their defaults. The pitch of each candidate's voice was measured as the mean in Hz across the audio file. Female candidates had higher pitched voices than male candidates (female candidates: $\bar{x} = 199$ Hz, SE = 3 Hz; male candidates: $\bar{x} = 130$ Hz, SE = 1 Hz; $t_{794} = -26.74$, $p < .01$). If an audio file was available for both candidates in a district (N = 722), pitch was also measured as whether the candidate's voice was lower than his or her opponent's. Female candidates were less likely to have lower voices than their opponents (female candidates: $\bar{x} = 13\%$, male candidates: $\bar{x} = 59\%$; $t_{720} = 10.89$, $p < .01$).

There are three limitations to this approach to studying candidates' voices. One is that there are characteristics of the human voice other than pitch that can influence how speakers are perceived (Hodges-Simeon, Gaulin, & Puts, 2010). However, given the well-developed psychology literature on voice-pitch perception and the lack of political science studies on nonverbal vocal signals, examining

the influence of candidate voice pitch on voters is a logical starting point. A second limitation is that all of the 61 candidates (7% of those running) who were unable to be recorded lost their elections. Consequently, the results from these data are somewhat more representative of winning candidates. A third limitation is that the content of the recordings was not constant across candidates. Voice pitch can modulate with the emotional state of the speaker (Aronovitch, 1976; Banse & Scherer, 1996; Kuroda et al., 1976; Scherer, 1981; Wittels et al., 2002), and different topics and audiences might evoke different emotions from the speaker (though this proposition has not been tested). Regardless of the emotional state of the speaker, however, voice pitch and the degree to which it can be modulated are still determined entirely by the physiology of the throat. Thus, the measure used here is an accurate proxy for each candidate's average voice pitch.

Method of Analysis

The candidate is the unit of analysis. Analyses were conducted using Stata/MP (v. 11.2; stata.com). The bivariate relationship between candidate voice pitch and electoral outcomes is tested with two-tailed two-sample t-tests for whether the election was won or lost and Pearson correlation for vote share. Multiple regression analysis, logistic for whether the election was won or lost and linear for vote share (Canes-Wrone, Brady, & Cogan, 2002; Carson, Koger, Lebo, & Young, 2010), is used to assess the relationship between candidate voice pitch and electoral outcomes controlling for other factors:

$$E_i = P_i + F_i + P_i * F_i + D_i + V_i + S_i + Q_i \quad (1)$$

Here, $_i$ indicates the candidate. E is the outcome of the election. P is the pitch of the candidate's voice. F indicates whether the candidate is female. $P*F$ is included to account for the fact that men have lower voices than women on average (Titze, 1994) and to test whether voice pitch has different effects on the success of male and female candidates. D indicates whether the candidate is a Democrat. V is President Barack Obama's vote share in the candidate's district for Democratic candidates and Governor Mitt Romney's vote share for Republican candidates (the analysis excludes 15 candidates who did not identify with either party). Including V accounts for the district's political preferences (e.g., Republican candidates were likely to perform better in districts where Romney was popular and Democrats where Obama was popular). To account for the diminishing marginal returns of campaign spending, S is the natural log of the candidate's total disbursements during the 2011–12 election cycle (Jacobson, 1980). Knowing that prior experience in elected office is a strong predictor of electoral success, Q is an indicator of whether the candidate has held elected office in the past and/or is currently an incumbent (Jacobson, 1989). Robust standard errors for regression coefficients are clustered by congressional district. The model in Equation 1 is run separately on candidates who faced male opponents and candidates who faced female opponents to account for possible sex of opponent effects.

As logistic regression coefficients are not readily interpretable, their substantive meaning was assessed using Clarify, a procedure in Stata that can be used to estimate the predicted probability of winning office based on the parameters of the regression model (King, Tomz, & Wittenberg, 2000; Tomz, Wittenberg, & King, 2003). Predicted probabilities were calculated by varying the value of candidate voice pitch while holding all other variables in the model at their means.

Results

Candidate Mean Voice Pitch. As shown in Figure 2, the mean voice pitch of winning candidates is lower than that of losing candidates among both male and female candidates (male candidates: $t_{634} = 3.15$, $p = .002$; female candidates: $t_{158} = 2.14$, $p = .03$). There is also a negative correlation between mean voice pitch and vote share for both male and female candidates (male

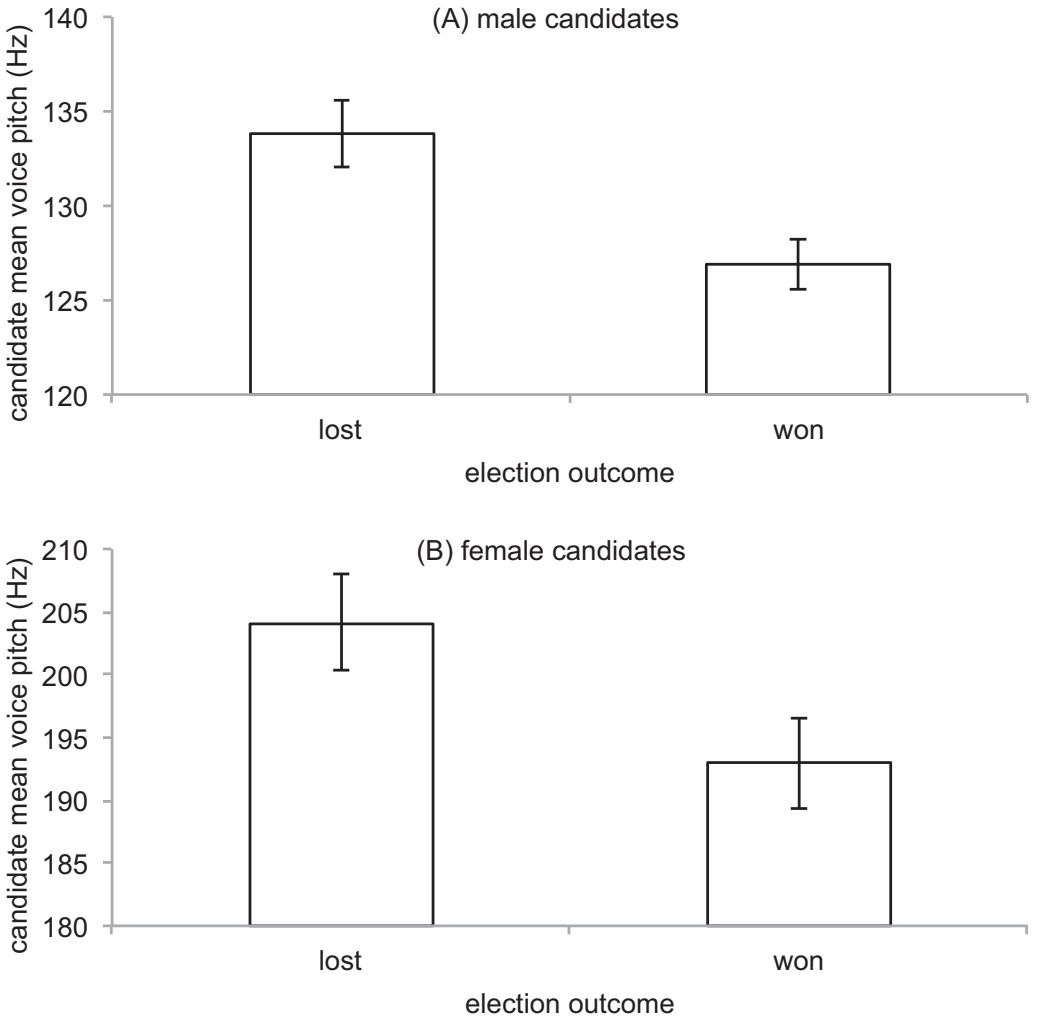

Figure 2. Mean voice pitch of winners and losers of 2012 U.S. House elections (+/− SE). Male and female candidates with lower voices were more likely to win election.

candidates: $r_p = -.15$, $p < .001$; female candidates: $r_p = -.18$, $p = .02$), indicating that candidates with lower-pitched voices won a larger share of the vote.

Table 1 presents the results of the regression analysis of the relationship between candidate mean voice pitch and electoral outcomes. The negative *Candidate mean voice pitch* coefficients in the first two columns of Table 1 indicate that candidates with lower voices were more likely to win ($p = .038$) and won a larger vote share ($p = .025$) against male opponents. Using the standard +/−20 Hz used in experiments where voters are asked to vote for candidates with lower and higher voices (Anderson & Klofstad, 2012; Klofstad et al., 2012; Tigue et al., 2012), a shift in voice pitch from 164 Hz to 124 Hz (+/−20 Hz the sample mean of 144 Hz) increases the likelihood of the candidate winning over a male opponent by 13.9 percentage points. Likewise, a decrease of 40 Hz in mean pitch is correlated with an increase in vote share of 1.2 percentage points over a male opponent. The insignificant *Candidate sex* Candidate mean voice pitch* and *Candidate sex* coefficients in the first and second columns of Table 1 indicate that these results did not vary significantly by the sex of the candidate.

Table 1. Relationship between candidate mean voice pitch and outcomes of 2012 U.S. House elections

	Opponent is Male		Opponent is Female	
	Candidate Won[a]	Candidate Vote Share[b]	Candidate Won[a]	Candidate Vote Share[b]
Candidate mean voice pitch	-.01*	-.03*	.03*	-.005
	(.007)	(.01)	(.01)	(.02)
Candidate sex (female)	−2.97	−6.56	8.90**	2.84
	(2.63)	(4.13)	(3.30)	(10.25)
Candidate sex* Candidate mean voice pitch	.02	.04	-.06***	-.02
	(.02)	(.02)	(.02)	(.06)
Candidate party affiliation (Democrat)	-.38	-.04	-.75	−1.19
	(.35)	(.70)	(1.08)	(1.34)
Copartisan presidential candidate district vote share	.21***	.82***	.23***	.75***
	(.03)	(.04)	(.07)	(.09)
Natural log of campaign spending	.84***	.48***	1.37**	1.06***
	(.17)	(.10)	(.44)	(.32)
Quality candidate (has held elected office in past)	1.77***	7.13***	-.03	4.14*
	(.30)	(.93)	(1.00)	(1.68)
Constant	−21.08***	2.70	−33.48***	−2.85
	(3.25)	(2.17)	(6.46)	(4.66)
χ^2	90.55***	—	50.10***	—
F	—	524.06***	—	112.70***
Pseudo R^2	.68	.83	.66	.82
N	616	616	152	152

Note. Cell entries are regression coefficients. Cases with missing data were omitted from the analysis using listwise deletion. Model type: [a]logistic regression; [b]linear regression.
*$p \leq .05$; **$p \leq .01$; ***$p \leq .001$ (robust standard errors, clustered by House district, in parentheses).

The positive *Candidate mean voice pitch* coefficient in the third column of Table 1 indicates that candidates with higher voices had an increased likelihood of winning office when facing a female opponent ($p = .023$). That is, in contrast to when the opponent is male, when the opponent is female candidates with lower voices performed more poorly. However, the positive *Candidate sex (female)* coefficient ($p = .007$) and negative *Candidate sex* Candidate mean voice pitch* coefficient ($p = .001$) indicate that the relationship between voice pitch and electoral success against female opponents varies by the sex of the candidate. Accounting simultaneously for the effects of *Candidate mean voice pitch*, *Candidate sex (female)*, and the interaction of the two, a shift in voice pitch from 110 Hz to 150 Hz (+/− 20 Hz the male candidate mean of 130 Hz) decreases the likelihood of a male candidate wining over a female opponent by 25.8 percentage points. In comparison, a shift in voice pitch from 219 Hz to 179 Hz (+/− 20 Hz the female candidate mean of 199 Hz) decreases the likelihood of a female candidate winning over a female opponent by only .5 percentage points, a statistically significant but substantively marginal effect.

Candidate Has Lower Voice than Opponent. Male candidates with lower voices than their opponents were more likely to win (lower-voice win rate: 57%, higher-voice win rate: 43%; $t_{572} = -3.31$, $p = .001$). The same can be said of female candidates, but the difference is not statistically significant (lower-voice win rate: 53%, higher-voice win rate: 44%; $t_{146} = -.69$, $p = .49$), perhaps due to lower statistical power in the pool of female candidates compared to the much larger pool of male candidates. Male candidates with lower voices than their opponents also won a larger share of the vote (lower-voice vote share: 51%, higher-voice vote share: 46%; $t_{572} = -3.63$, $p < .001$). The same can be said of female candidates, but the difference is not statistically significant (lower-voice vote share: 51%, higher-voice vote share: 48%; $t_{146} = -.71$, $p = .48$), again perhaps due to lower statistical power.

Table 2. Relationship between Candidate Having a Lower Voice than Opponent and Outcomes of 2012 U.S. House Elections

	Opponent Is Male		Opponent Is Female	
	Candidate Won[a]	Candidate Vote Share[b]	Candidate Won[a]	Candidate Vote Share[b]
Candidate has lower voice	.16	1.19	.32	−1.32
	(.41)	(.72)	(.78)	(1.53)
Candidate sex (female)	-.01	.53	−1.56	−3.50
	(.46)	(.80)	(1.15)	(3.43)
Candidate sex* Candidate has lower voice	.69	.02	1.28	2.11
	(.82)	(2.68)	(1.41)	(2.90)
Candidate party affiliation (Democrat)	-.44	-.64	-.41	−1.44
	(.37)	(.72)	(1.12)	(1.41)
Copartisan presidential candidate district vote share	.23***	.81***	.21**	.74***
	(.03)	(.04)	(.07)	(.09)
Natural log of campaign spending	.89***	.51***	1.32**	1.09***
	(.20)	(.10)	(.47)	(.33)
Quality candidate (has held elected office in past)	1.62***	6.43***	.08	4.21*
	(.31)	(.91)	(.91)	(1.78)
Constant	−24.76***	−1.24	−28.74***	−2.02
	(3.82)	(1.24)	(6.16)	(4.11)
χ^2	65.19***	—	39.84***	—
F	—	391.20***	—	98.99***
Pseudo R^2	.68	.67	.63	.81
N	561	561	146	146

Note. Cell entries are regression coefficients. Cases with missing data were omitted from the analysis using listwise deletion. Model type: [a]logistic regression; [b]linear regression.
*$p \leq .05$; **$p \leq .01$; ***$p \leq .001$ (robust standard errors, clustered by House district, in parentheses).

Table 2 presents the results of the multivariate regression analysis of the relationship between a candidate having a lower voice than his or her opponent and electoral outcomes. The positive *Candidate has lower voice* coefficient in the second column of Table 2 suggests a trend ($p = .101$) whereby candidates who had a lower voice than their opponent won 1.19 percentage points more of the share of votes when facing a male opponent. No other systematic relationships between having a lower voice and electoral outcomes were detected. The insignificant *Candidate sex* Candidate has lower voice* coefficients in Table 2 indicate that these results did not vary by the sex of the candidate.

Discussion

In synthesizing research on the human voice and voter behavior and triangulating evidence from a controlled experiment and a large observational study of actual electoral outcomes, this article illustrates that candidate voice pitch, a physiologically determined characteristic, can influence electoral outcomes. The experiment shows that men and women prefer to vote for male and female candidates with lower-pitched voices. This preference is stronger for female candidates, and among older, well-educated, and politically engaged voters. In line with the results of the experiment, the observational study shows that House candidates with lower voices were more successful at the polls when facing male opponents. In contrast, candidates with higher voices performed better against female opponents, and particularly so in the case of male candidates.

These findings lead to five conclusions. First, while candidate voice pitch had a large and uniform effect in the experiment, the results of the observational study were less conclusive. In real elections voters are influenced by many factors in addition to the acoustic qualities of candidates' voices. Thus, it is not surprising that the relationship between candidate voice pitch and electoral outcomes was

subtler in the observational data when alternative explanations of electoral outcomes were accounted for in the multivariate analysis. This in mind, future experiments should test whether the influence of candidate voice pitch can be modulated by additional information, such as a profile of the candidate's demographic background, information on their policy views, or a picture of their face. The content of the vocal stimuli could also be varied to test whether different types of vocal messages modulate the effect of voice pitch on electoral success. For example, as leaders with masculine facial features are preferred during times of conflict (Little, Burriss, Jones, & Roberts, 2007; Spisak, Dekker, Kruger, & van Vugt, 2012), leaders with lower pitched (i.e., more masculine) voices may be preferred more strongly when discussing foreign policy compared to domestic policy.

Second, the observational study is the first to show a case where candidates with higher-pitched voices were more successful: male candidates running against female opponents. What explains this anomaly given that prior studies have demonstrated that men with lower voices are perceived positively on myriad dimensions, including attractiveness (Feinberg et al., 2005a), strength (Feinberg et al., 2005a; Klofstad et al., 2012; Puts et al., 2012; Sell at al., 2010), competence (Klofstad et al., 2012), dominance (Puts et al., 2007), integrity (Tigue et al., 2012), and physical prowess (Tigue et al., 2012)? As individuals with lower voices have higher levels of testosterone (Dabbs & Mallinger, 2001; Puts et al., 2012), and as testosterone correlates with physical and social aggressiveness (Archer, 1991; Mazur & Booth, 1998; Puts et al., 2012), it could be that male candidates with lower voices are perceived as too aggressive when paired against a female opponent. Future experiments on voice pitch and elections will require voters to participate in elections where male and female candidates compete against each other to test this theory.

Third, the results of the experiment show that older, well-educated, and politically engaged voters are the most biased in favor of candidates with lower voices. Voters with these characteristics are also the most likely to turn out to vote (Verba, Schlozman, & Brady, 1995) and from the perspective of classic democratic theory are also expected to make the most reasoned choices at the polls (Lau & Redlawsk, 1997). As individuals with lower voices have higher levels of testosterone (Dabbs & Mallinger, 2001; Puts et al., 2012), are physically stronger (Feinberg et al., 2005a; Puts et al., 2012), and more aggressive physically and socially (Archer, 1991; Mazur & Booth, 1998; Puts et al., 2012), using voice pitch as a signal of leadership might be useful if more aggressive individuals are more forceful at pursuing the interests of constituents. On the other hand, modern political conflict is a competition between complex ideologies as opposed to brute force. More specifically, it is unclear whether voice pitch is a credible signal of political leadership quality. Consequently, because they are biased more strongly in favor of candidates with lower voices, it is unclear whether older, well-educated, and politically engaged voters are actually better at making reasoned choices. Additional research is needed to examine the connection between voice pitch and objective measures of leadership ability to answer this question.

Fourth, the experiment also showed that the bias in favor of candidates with lower voices is the strongest for female candidates. Notwithstanding countries that use gender quotas (Davidson-Schmich, 2006), women are also vastly underrepresented in leadership positions across the globe. Taken together, given that women, on average, have higher-pitched voices than men (Titze, 1994), voice pitch may play a role in the underrepresentation of women in leadership roles. At the very least, voice pitch is a physiologically determined characteristic that does not counterbalance patriarchal social norms that contribute to gender inequality. In this same vein, voters' bias in favor of candidates with lower voices will benefit a specific subset of female candidates who are more likely to have lower voices, those who are physically larger (Puts et al., 2012), between the ages of 40 and 60 (Baken, 2005; Stathopoulos, Huber, & Sussman, 2011; Titze, 1994), and who have higher levels of testosterone (Dabs & Mallinger, 2001; Puts et al., 2012). As with the relationship between voice pitch and leadership quality, further study is needed to determine whether women with these characteristics are actually better political leaders.

Finally, the findings presented here are part of a wider transformation of political science scholarship. Traditionally, political opinions and behavior have been explained with individual-level demographics, such as partisan identification and socioeconomic status (Campbell, Converse, Miller, & Stokes, 1960; Verba et al., 1995). More recently, this paradigm has expanded to include environmental factors, such as exposure to political dialogue in one's social network (Klofstad, 2011; Rolfe, 2013; Sinclair, 2012; Zuckerman, 2004). Others have begun addressing genes (Fowler, Baker, & Dawes, 2008; Hatemi et al., in press; Hatemi et al., 2011; Settle, Dawes, & Fowler, 2009), the neurological system (Oxley et al., 2008), and hormones (Apicella & Cesarini, 2011; McDermott, 2011). Still others focus on how the physical appearance of candidates can influence voter's perceptions (Atkinson, Enos, & Hill, 2009; Little et al., 2007; Spisak, Homan, & van Vugt, 2011; Todorov, Mandisodza, Goren, & Hall, 2005). The current study expands upon these innovations by showing with multiple sources of evidence that a physiological characteristic—candidate voice pitch—can affect electoral outcomes. To wit, while voters consciously consider their own political preferences and those of the candidates when casting their ballots, the results presented here demonstrate that the electorate also makes thin impressionistic judgments based on far more subtle factors of which they may not be aware. Importantly, these factors may not be relevant to a candidate's leadership ability, an unexplored question that calls into question whether voters are capable of making reasoned choices at the polls.

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