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Sounds like a winner: voice pitch influences perception of leadership capacity in both men and women

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It is well known that non-human animals respond to information encoded in vocal signals, and the same can be said of humans. Specifically, human voice pitch affects how speakers are perceived. As such, does voice pitch affect how we perceive and select our leaders? To answer this question, we recorded men and women saying 'I urge you to vote for me this November'. Each recording was manipulated digitally to yield a higher- and lower-pitched version of the original. We then asked men and women to vote for either the lower- or higher-pitched version of each voice. Our results show that both men and women select male and female leaders with lower voices. These findings suggest that men and women with lower-pitched voices may be more successful in obtaining positions of leadership. This might also suggest that because women, on average, have higher-pitched voices than men, voice pitch could be a factor that contributes to fewer women holding leadership roles than men. Additionally, while people are free to choose their leaders, these results clearly demonstrate that these choices cannot be understood in isolation from biological influences.

Keywords: perception; voice pitch; leadership; voting

1. INTRODUCTION

Multiple lines of research show that animal vocalizations contain information about the signaller, and that receivers of vocal signals are influenced by this information. For example, call type signals predator type in monkeys [1], pulse rate signals species identity in frogs [2] and the amplitude of song signals threat of attack in songbirds [3].

More specifically, certain types of vocal signals can inform receivers about a signaller's fighting ability or social dominance because acoustic properties of the signal reliably predict traits, such as size and strength. Because these vocalizations are directly related to physiological or physical properties of the caller, they cannot be faked or exaggerated [4,5]. The 'wahoo' call produced by male baboons (*Papio cynocephalus*), for example, is physiologically costly to produce, and acoustic features of 'wahoos' predict dominance rank, age, and stamina [6]. Vocal characteristics can also predict body size, such as the temporal components of the aggressive song of house crickets (*Acheta domesticus*), the fundamental frequency of male toad calls (*Bufo bufo*) and the formant dispersion of domestic dog growls (*Canis familiaris*). Because larger body size is advantageous in aggressive encounters, male receivers can use information in vocal signals to assess opponents [7–9], and female receivers can use vocal qualities to choose mates that are genetically and physically superior [10–12].

Vocal signals also influence the behaviour of human receivers. More specifically, a growing literature shows that human voice pitch (i.e. 'highness' or 'lowness' as determined predominantly by fundamental frequency) is highly sexually dimorphic (on average twice as high in women compared with men) [13], and strongly influences how speakers are perceived. For example, men with lower-pitched voices are perceived as 'more attractive' [14–18], physically stronger [14,19,20] and 'socially dominant' [17,21–23]. For women, by contrast, higher-pitched voices are perceived as more attractive [24–26], whereas lower-pitched female voices are perceived to be 'socially dominant' [27,28]. Knowing that human voice pitch influences perceptions of the speaker in these myriad ways, we suspect that this signal could influence how humans select their leaders.

(a) *Does voice pitch influence the selection of leaders?*

The selection of leaders is the main mechanism that the members of a society have for affecting how they will be governed. Ideally, this critical choice should be made with great care, by thoughtfully comparing the preferences of those who seek leadership positions with one's own preferences. However, within the context of modern democracies, most citizens are not politically engaged [29]. Consequently, the selection of leaders is often made based on impressionistic judgements. Some of these decisions are quite reasoned, such as simply selecting the candidate of the party one identifies with [30]. However, voters can be also influenced by factors that may or may not be correlated with leadership capacity, such as the physical attractiveness of the candidate [31], or the outcome of a recent local sporting event [32]. Similarly, Todorov *et al.* [33] show that voters make judgements about the competence of candidates after viewing their faces for only 1 s, and Little

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et al. [34] show that vote choices are influenced by perceptions of masculinity and femininity in male faces. While these judgements about faces are shown to predict the outcomes of actual elections at a rate better than chance in both studies [33,34], it is unclear whether facial appearance is an accurate reflection of leadership capacity [33, p. 1625].

Despite evidence that voice pitch influences impressionistic judgements of the speaker, only one study, to our knowledge, has examined whether this vocal signal affects the selection of leaders [17]. In an experiment, recordings of nine United States presidents (five Democrats and four Republicans) were manipulated to yield a higher- and lower-pitched version of the original. Subjects were asked to vote for the higher- or lower-pitched version of each of the nine pairs; they voted for the lower-pitched voices at a rate greater than chance. These vote choices correlated with the perception of the voters that speakers with lower-pitched voices have greater 'integrity' and 'physical prowess'.

In a second experiment, Tigue *et al.* manipulated novel male voices rather than those of known leaders. As in the first experiment, subjects were presented with pairs of voices, and asked to vote for either the higher- or lower-pitched voice of each pair. The lower- and higher-pitched voices of each pair were spoken by different men. As in the presidential voices experiment, subjects voted for lower-pitched voices at a rate greater than chance.

Given the lack of research on the link between vote choice and voice pitch, Tigue *et al.* [17] was an important first step in determining how this vocal signal might affect electoral success. However, important questions remain as to how voice pitch might affect the selection of leaders. The most salient of these is whether voters are influenced by the pitch of female voices. It is critical to understand how voters perceive the voices of female candidates; while women have been traditionally under-represented in leadership roles, they are playing an increasingly important role in the democratic governing process. In 2004, Hillary Clinton was arguably the first major political party female candidate in the history of the United States to have a legitimate chance at winning the office of president. Likewise, while in the 1970s women made up less than 5 per cent of the legislative branches on the federal and state level in the United States, as of 2011 women comprise over 15 per cent of the United States Congress and almost 25 per cent of the state-level legislatures [35]. Similar trends are seen in other nations.

A second question not tested previously is whether the particular utterances spoken, and the individuals speaking them, affect how voice pitch influences listener perception of potential leaders. In their first experiment, Tigue *et al.* created stimuli from recordings of United States presidents. This research design could have affected the results in several unexpected ways (i) The speakers were very likely recognized by the subjects. (ii) The study did not account for the political preferences of the subjects. Knowing that vote choice is highly correlated with partisanship [30], those who identify with the Republican Party may have reacted differently to the voices of Democratic presidents than those who identify with the Democratic Party, and vice versa. (iii) While the voices were manipulated experimentally, the content of the utterances varied from president to president (four of which were directly related to foreign policy, whereas the others were not). As such, it is unclear whether the responses to these different voices can be treated as comparable (a test of within-subjects effects was not presented). (iv) The utterances were made by those who successfully won a high-elected office. That is, they may have been perceived to be electable, regardless of voice pitch.

In their second experiment, Tigue *et al.* used voices with which subjects were not familiar. However, subjects were asked to choose between voices spoken by different men. Consequently, subjects' choices could have been driven by myriad characteristics of the vocalizations other than voice pitch. Additionally, the stimuli were devoid of electorally relevant content. More specifically, the speakers recited 'The Rainbow Speech': 'When the sunlight strikes raindrops in the air, they act as a prism and form a rainbow' [36]. Evidence shows that the content of utterances affects how voice pitch influences perceptions of the speaker. For example, Jones *et al.* [26] showed that men respond differently to the voice pitch of female voices if the utterance is positive ('I really like you') rather than negative ('I don't really like you'). This leads us to ask whether manipulating the pitch of an electorally relevant utterance can influence voters.

For the reasons described earlier, we examine the results of experiments in which male and female listeners were asked to vote for male and female voices. The speakers were novel to the listeners, they spoke an electorally relevant utterance, and the pairwise choices made by listeners were between stimuli derived the same speakers with the only variation being the pitch of the two voices of each pair. A series of separate experiments tested whether voting on the basis of voice pitch is influenced by perceptions of strength, competence and trustworthiness.

(b) *Predictions*

We tested the following predictions about how human voice pitch influences perceptions of leaders.

— Because lower-pitched male voices are perceived to be both stronger and more attractive, males with lower-pitched voices will be more likely to be selected as leaders.
— In females, perceptions of attractiveness and dominance are opposed: higher-pitched voices are perceived to be more attractive, but lower-pitched voices are perceived to be more dominant. As such, if humans prefer to select female leaders with lower-pitched voices, then they are influenced by their perception of dominance. Conversely, if humans prefer to select female leaders with higher-pitched voices, then they are influenced by their perception of attractiveness.
— In line with Tigue *et al.* [17], we expect that in an election scenario lower-pitched male voices will be perceived to be stronger, more competent and more trustworthy. While there are no existing studies of perceptions of female voice pitch in the domain of elections, lower-pitched female voices are perceived to be 'socially dominant' [27,28]. As such, we expect that in an election scenario lower-pitched female voices will also be perceived to be stronger, more competent and more trustworthy.

2. MATERIAL AND METHODS

(a) *Experimental stimuli*

Seventeen women and 10 men were recorded saying 'I urge you to vote for me this November'. Human voice pitch studies often use recordings of men and women speaking the common English vowels (A, E, I, O and U), or the 'The Rainbow Speech' as in Tigue *et al.* [17], as experimental stimuli in order to measure speech perception in the absence of any context. By contrast, the 'vote for me' utterance adds an electorally relevant, yet partisan neutral, context to the experiment. Women ranged in age from 21 to 60 years ($\bar{x} = 31$ years) and men ranged in age from 20 to 55 years ($\bar{x} = 33$ years). Voices were recorded as .wav files in an acoustic systems anechoic chamber using a Shure SM57 microphone and a Marantz PMD660 solid state recorder. Sampling was at 44.1 kHz. Each audio file was inspected aurally and also visually using the Syrinx acoustic analysis program (v. 2.6h; www.syrinxpc.com) to ensure that all utterances were free from speech errors or non-speech noise. Using Engineering Design's Signal acoustic analysis program (v. 4.02.04), the amplitude of each selected utterance was normalized to 2 V.

We used the PRAAT phonetic analysis program (v. 5.1.43; [37]) to measure the pitch of each recorded voice. The pitch of female and male voices ranged from 162 to 207 Hz ($\bar{x} = 187$ Hz) and 91 to 116 Hz ($\bar{x} = 107$ Hz), respectively. There is no systematic relationship between age and voice pitch among the female ($r_{s15} = -0.27$, $p = 0.15$) or male ($r_{s8} = 0.33$, $p = 0.35$) voices used in this study. Following previous research on voice pitch perception [26], each recording was then altered ± 0.5 equivalent rectangular bandwidths (ERBs) with PRAAT, which uses the pitch synchronous overlap add algorithm to make such alterations [37]. That is, each original recording was converted into a pair of recordings, one of higher pitch and one of lower pitch. The ± 0.5 ERB manipulation is comparable with a perceived shift of ± 20 Hz. ERB was manipulated instead of hertz because the relationship between absolute and perceived pitch in humans is logarithmic. Consequently, a gap of ± 20 Hz will be perceived to be greater or smaller depending on the fundamental frequency of the original recording. Manipulation by ERB accounts for the nonlinear relationship between absolute and perceived pitch, and produces a constant perceivable gap between the higher- and lower-pitched sound files regardless of the fundamental frequency of the original recording.

To verify that participants were able to perceive the difference in pitch between each pair of recordings, two separate groups of listeners were asked to identify which voice out of each pair of male and female voices was higher in pitch. Both men ($t_{17} = 15.29$, $p < 0.01$) and women ($t_{44} = 18.21$, $p < 0.01$) were able to correctly identify the higher-pitched female voices. Men ($t_{14} = 14.09$, $p < 0.01$) and women ($t_{14} = 37.04$, $p < 0.01$) were also able to correctly identify the higher-pitched male voices.

(b) *Procedures*

In one experiment, subjects listened to each pair of female voices through headphones connected to a computer. After listening to each pair, subjects responded to the question, 'If they were running against each other in an election, which voice would you vote for?' The order of the voice pairs—as well as whether the higher- or lower-pitched voice from each pair was heard first—was randomized (an assessment of within-subjects variation is presented in the electronic supplementary material). Subjects marked their responses on a paper questionnaire. A separate sample of subjects used the same procedure to vote for the male voice recordings.

In a separate set of experiments, these same procedures were used to assess subjects' perception of specific characteristics of male and female voices. In each of these experiments, subjects listened to all of the pairs of male and female voices. For each pair of voices, one sample of subjects was asked, 'Which voice is more competent (e.g. capable, experienced, knowledgeable, effective)?' A second sample of subjects was asked, 'Which voice is stronger (e.g. confident, determined, resolute, self-assured)?' A third sample of subjects was asked, 'Which voice is more trustworthy (e.g. honest, straightforward, reliable, believable)?' These three leadership characteristics were chosen after consulting the existing literature on campaigns and elections [33,38–42].

At the end of each experiment, subjects completed a short questionnaire about themselves. These data were used to assess the demographic diversity of the subjects, and to test for between-subjects variation in treatment effects (see the electronic supplementary material).

(c) *Participants*

A sample of 83 undergraduate students (37 men and 46 women) at the University of Miami, Coral Gables, FL, USA was recruited to listen to and vote for the female voices during the spring of 2011. A separate sample of 89 passers-by (49 men and 40 women) in the student union building at Duke University, Durham, NC, USA was recruited to listen to and vote for the male voices during the summer of 2011. At that same time, three separate samples of 70 passers-by (35 men and 35 women in each) in the student union building at Duke University were recruited to listen to and select which voice of each pair was more competent, strong and trustworthy. After participating, listeners recruited at the University of Miami received course credit. Listeners recruited at Duke University received a $5.00 incentive payment after participating.

(d) *Method of analysis*

For each analysis, the listener is the unit of analysis. Each sample of listeners was analysed independently. Forced choices were coded 0 if the listener selected the lower-pitched voice, and 1 if the higher-pitched voice was selected. The average of each forced choice yields a summary preference ratio ranging from 0 to 1, whereby higher values indicate a stronger preference for the higher-pitched voices, and lower values indicate a stronger preference for the lower-pitched voices. To assess listener preferences, two-tailed one-sample *t*-tests were used to compare the average of the sample's preference ratio with 0.50 (i.e. no preference for higher- or lower-pitched voices). These tests were conducted in the R statistical computing environment (v. 2.12.2).

3. RESULTS AND DISCUSSION

(a) *Do listeners prefer female leaders with lower-pitched voices?*

The results of the female candidate election (figure 1) show that both men ($t_{36} = -3.44$, $p < 0.01$) and women ($t_{45} = -2.87$, $p < 0.01$) voted more frequently for lower-pitched female voices.

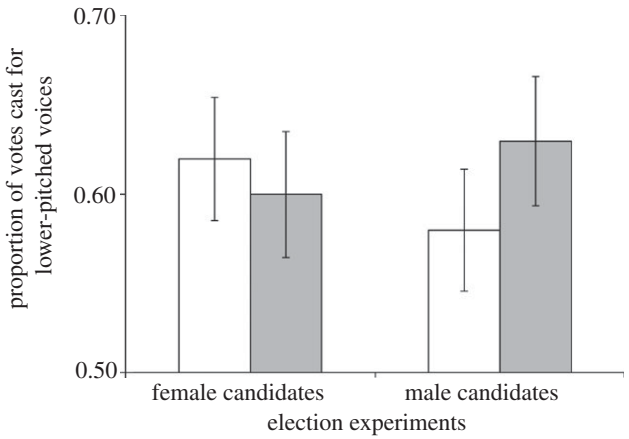

Figure 1. Election experiment results. Proportion of votes (±standard error) cast for the lower-pitched version of male and female voices. A value of 0.50 represents no discernible preference for either higher- or lower-pitched voices. Male (white bar) and female (grey bar) listeners voted for the lower-pitched male and female voices more frequently ($p < 0.05$).

Table 1. Proportion of lower-pitched voices judged as competent, strong and trustworthy. (A value of 0.50 represents no discernible preference for either higher- or lower-pitched voices. Male and female listeners found the lower-pitched female voices to be more competent, stronger and more trustworthy. Male (but not female) listeners found lower-pitched male voices to be more competent and stronger. Neither men nor women found the lower- or higher-pitched male voices to be more trustworthy). *$p <$ 0.05 (one-sample *t*-test); **$p < 0.01$ (one-sample *t*-test).

	female voices		male voices	
	male listeners	female listeners	male listeners	female listeners
competent	0.70**	0.72**	0.58*	0.55
strong	0.73**	0.69**	0.62*	0.56
trustworthy	0.68**	0.73**	0.56	0.50

These findings raise an important question: if higher-pitched female speakers are perceived as more attractive [24–26], why are lower-pitched female speakers perceived to be better leaders? The results of the second set of experiments offer an answer (table 1). Both men and women find lower-pitched female voices to be more competent (male listeners: $t_{34} = -6.36$, $p < 0.01$; female listeners: $t_{34} = -6.52$, $p < 0.01$), stronger (male listeners: $t_{34} = -7.20$, $p < 0.01$; female listeners: $t_{34} = -4.57$, $p < 0.01$) and more trustworthy (male listeners: $t_{34} = -5.00$, $p < 0.01$; female listeners: $t_{34} = -6.49$, $p < 0.01$). This last finding is novel, given that feminized women's faces are perceived to be more trustworthy [43]. By contrast, in the context of this experiment masculinized (i.e. lower-pitched) female voices are perceived to be more trustworthy. These differences in the judgement of the trustworthiness of women's faces and voices might reflect a genuine difference in how humans perceive conspecific faces and voices. However, they could also be a product of the specific context generated by the 'vote for me' stimulus. That is, when it comes to the specific case of an election, we may perceive masculinized female voices to be more trustworthy. Whether the same is true of masculinized female faces remains to be tested.

(b) *Do listeners prefer male leaders with lower-pitched voices?*

In line with Tigue *et al.* [17], the results of the male candidate election (figure 1) show that both men ($t_{48} = -2.29$, $p = 0.03$) and women ($t_{39} = -3.46$, $p < 0.01$) voted more frequently for lower-pitched male candidates.

The results of the candidate characteristic experiments show that while men and women find lower-pitched female voices to be more trustworthy, the same cannot be said of male voices (male listeners: $t_{34} = -1.35$, $p =$ 0.19; female listeners: $t_{34} = 0$, $p = 1$; table 1). Vukovic *et al.* [44] also found that women do not judge the trustworthiness of male voices based on voice pitch. Tigue *et al.* [17], however, found that lower-pitched voices of former United States presidents are perceived to be more trustworthy. One explanation for this difference between our study and Tigue *et al.* [17] is the vocal stimuli presented to the listeners. Our 'vote for me' stimulus frames the forced choices within the context of an election. The recordings used by Tigue *et al.* [17] were general statements about the current state of the country, not electioneering. As such, perceptions of the trustworthiness of male voices could be context-dependent. Vukovic *et al.* [44] lend credence to this hypothesis, showing that women's perceptions of the trustworthiness of male voices vary with perceptions of how suitable men with lower-pitched voices are for long-term, relative to short-term, relationships. An additional explanation for the difference we find in perceptions of trustworthiness of male and female voices is that men have lower-pitched voices than women, on average [13]. Consequently, even a higher-pitched male voice could still be relatively low enough to convey trustworthiness, at least to the degree that our listeners did not discriminate between the higher- and lower-pitched versions of each pair of voices within the context of an election.

Our data also show that women are not influenced by pitch when asked to judge the competence ($t_{34} = -1.42$, $p = 0.17$) or strength ($t_{34} = -1.45$, $p = 0.16$) of men's voices. The latter seemingly contradicts evidence that lower-pitched voices are perceived to be physically stronger [14,19,20], and that perceptions of masculinity in facial appearance reliably predict hand-grip strength [45]. However, a woman's assessment of a man's strength within the specific electoral context created by the 'vote for me' stimuli could differ from how she would assess physical strength. More specifically, subjects were asked: 'which voice is stronger (e.g. confident, determined, resolute, self-assured)?' This question is framed around 'intellectual' strength rather than physical prowess. In a similar vein, women may just attend to other cues, vocal or otherwise, to assess the strength and competence of men within the context of an election. A final possibility is that from the perceptive of a female listener, any male voice with a fundamental frequency that is within the normal range is low enough to be perceived as competent and strong in the context of an election. This hypothesis

makes the testable prediction that women will discriminate between high and low pitch voices if the pitch of the original voice recording falls outside the range of the average male.

Unlike women, men find lower-pitched male voices to be stronger ($t_{34} = -2.46$, $p = 0.02$) and more competent ($t_{34} = -2.04$, $p = 0.05$). Why was male voice pitch salient in the context of strength and competence among men, but not women? A probable answer is that low-voice pitch indicates male threat potential. Men with more masculine voices (i.e. lower pitch and structure of formant frequencies) are larger, physically stronger and more physically aggressive [46]. In this same vein, substantial evidence shows that higher levels of endogenous androgens (e.g. testosterone) affect vocal anatomy, resulting in lower voice pitch [46,47]. Increased androgen levels predict aggressiveness in both humans [48] and non-human animals [49]. While modern political conflict is not physical in nature, testosterone also 'encourages dominant behaviour intended to achieve or maintain high status (implying power, influence and valued prerogatives)' [50, p. 362]. Thus, it is perhaps not surprising that men are more attentive to low-voice pitch as a signal of strength and competence, traits that are likely to be highly salient in the context of male–male competition, be it physical or political.

4. CONCLUSION

Political commentators are well aware of how the qualities of human voice affect perceptions of leaders, even if their impressions are not based on scientific evidence. To examine this folk wisdom empirically, and to integrate the literatures on voice perception and leadership choice, we asked whether voters are influenced by candidate voice pitch. Our results show that men and women select female leaders with lower voices, probably because both men and women perceive lower-pitched female voices to be more competent, stronger and more trustworthy, attributes that are probably correlated with perceptions of leadership capacity. In line with Tigue *et al.* [17], our results also show that women and men vote more frequently for lower-pitched male voices. Among women, the preference for lower-pitched male voices could be because women find men with lower voices to be more attractive, a perception that can enhance a candidate's electability [31]. Among men, lower-pitched male voices are perceived to be stronger and more competent, attributes that are probably correlated with perceptions of leadership capacity (and especially so within the context of male–male competition). Future research should continue to examine how these perceptions of leadership capacity might vary under different electoral contexts, such as wartime [17,34] and economic crisis.

These findings have two important implications. First, we have demonstrated that humans prefer leaders with lower-pitched voices, whether they are male or female. Consequently, male and female candidates with lower-pitched voices may be more likely to win elected offices. As a corollary, we also observe that notwithstanding countries that use gender quotas [51], women are vastly under-represented in leadership positions across the globe. While gender discrimination is an obvious cause of the under-representation of women as leaders, our results suggest that biological differences between the sexes, and our responses to those differences, could potentially be an additional factor to consider. More specifically, because women, on average, have higher-pitched voices than men, and because higher-pitched female voices are judged to be weaker, less competent and less trustworthy, the characteristics of this vocal signal could help explain why women are less likely to hold leadership roles than men. At the very least, voice pitch is a physical characteristic that does not counterbalance social norms that foster gender inequality. A test of this hypothesis would be to assess which sex fares better in a forced-choice election experiment when subjects are asked to choose between male and female voices with the same, and different, voice pitches.

Second, our results add to the growing evidence that vote choices can be made based on 'thin' impressionistic judgements [31–33]. They also add evidence to the literature showing that human behaviour is influenced by voice qualities in domains other than physical conflict and mating [14,20,24,28]. Consequently, our findings challenge existing theories of human behaviour, which assert that attitudes, such as partisanship and ideology are the primary force behind vote choice [30,52]. Thus, while social participation and political decision-making are viewed as higher level cognitive functions—the kind of thinking that sets us aside from other animals—our results clearly demonstrate that these behaviours cannot be understood in isolation from biological influences.

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