

ORIGINAL ARTICLE

# Persistence of voice pitch bias against policy differences

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## Abstract

We use an online experiment to study the relative effect on voter behavior of a candidate's voice pitch and policy stance. We demonstrate a strong voice-pitch bias: between candidates who are identical in every other aspect, voters are more likely to choose the one with the lower voice-pitch, and more so in elections between men than women candidates. We then introduce a novel phenomenon: persistence of voice-pitch bias is the amount of policy difference needed to compensate for voice-pitch bias. While persistence is also gender-dependent, the effect is now reversed: voice-pitch bias is more persistent in elections between women than men candidates. As a possible mechanism, we show that voters perceive candidates with lower voice-pitch as more competent and trustworthy.

**Keywords:** elections; online experiment; perception; persistence; voice-pitch bias; voting

## 1. Introduction

A growing body of literature has reliably established that political candidates benefit from having a lower voice pitch (as summarized in the next section). They are perceived to have higher leadership abilities. Hence, keeping everything else the same, a lower voice pitch brings in more votes. This *voice-pitch bias* might be the reason why Margaret Thatcher, one of the most important political figures of the 20th century, worked with a voice coach early in her political career to lower her voice pitch.<sup>1</sup> This begs the question: what alternative strategies can a politician employ to overcome voice-pitch bias, and how effective are they?

A candidate's policy position is arguably the most important aspect according to which she is evaluated by voters. Hence, by proposing a more desirable policy than her opponent, a candidate can be expected to offset the vote disadvantage due to voice-pitch bias. But in relation to one another, how important are voice-pitch and policy position? And how does the trade-off between the two depend on the candidate's gender, the socioeconomic characteristics of the voter, and the policy dimensions on which the candidates contend? The objective of our study is to answer these questions using an experimental methodology. To the best of our knowledge, this is the first study to approach these questions.

To analyze these issues, we propose a new measure that we call *persistence of voice-pitch bias*: the amount of policy difference that makes a voter indifferent between two candidates who have a unit difference in voice pitch but are identical otherwise. More formally, persistence of voice-

<sup>1</sup>Quoting Thatcher's (1995, p. 267) book, *The Path to Power*, "There was also the matter of my voice. ... an obvious problem for most women. ... my voice was naturally high-pitched, which can easily become grating. I had been told about this in earlier years and had deliberately tried to lower its tone. ... Gordon found me an expert who knew that the first thing to do was to get your breathing right, and then to speak not from the back of the throat but from the front of the mouth."

pitch bias is the marginal rate of substitution of voice pitch for policy in the voter's preferences.<sup>2</sup> Measuring its magnitude in an experimental setting, we find a *significant level of persistence in voters' revealed preferences*. Furthermore, we find that *the voice-pitch bias voters display is, on average, five times more persistent when evaluating women as opposed to men candidates*. Hence, a man candidate disadvantaged due to voice-pitch bias needs a much smaller policy adjustment than a woman candidate in a similar situation. Our experiment also corroborates the earlier empirical and experimental literature discussed in the next section in that the *average voter exhibits a significant voice pitch bias*. Furthermore, we find that *the average voter displays a higher voice-pitch bias when evaluating a man candidate than a woman candidate*.<sup>3</sup>

Our study has important implications for gender and politics. The female voice pitch typically ranges between 165 and 255 Hz while the male voice has typically a much lower pitch (LP), with a range from 85 to 180 Hz. As a result, signals of social dominance and trust perceived from the voice pitch leverages men over women. Even when the two candidates are of the same gender, the effect of voice pitch on perception is prominent, for example favoring women candidates with a lower voice pitch. Elections between men candidates suffer from a similar gender bias, and as discussed above, sometimes to a higher extent. Furthermore, we theorize that policy declarations by men candidates are taken much more seriously by voters, and that, a combination of these two biases results in our two main findings, namely that (i) voters exhibit a stronger voice-pitch bias when evaluating men candidates, and yet (ii) voters respond more strongly to policy differences between men candidates, making voice-pitch bias more persistent for women candidates.

We also analyze how participant gender affects voting behavior. We start with the case where there are no policy differences between candidates. For men participants, we find that a higher percentage vote for the LP candidate when choosing between men than women candidates. This is not the case for women participants. Hence, we conclude that it is men participants that drive the overall finding that voice-pitch bias is higher for men candidates than women candidates. On the other hand, both men and women participants strongly respond to a small policy difference between men candidates, but not between women candidates. Additionally, we analyze the implications of a variety of pre-treatment covariates<sup>4</sup> and demonstrate that our findings are robust against their inclusion in the analysis.

As two potential mechanisms for voice-pitch bias and its persistence, we also measure how a candidate's voice pitch affects the participants' perception of her/his competence and trustworthiness. Competence is closely related to social dominance and the literature discussed in the next section shows that a candidate with lower voice pitch is perceived as more competent. On the other hand, previous findings on trustworthiness, another important characteristic for a candidate, are mixed. We contribute to this discussion by showing that a lower voice pitch creates on our participants a perception of both higher competence and higher trustworthiness. Furthermore, the effect is stronger for voters evaluating men candidates. In Section 4 we discuss how these findings might provide an underlying mechanism for voice-pitch bias.

<sup>2</sup>A voter whose utility depends on the policy choice ( $p$ ) and voice pitch ( $v$ ) of a candidate will have a utility function of  $U(p, v)$  and the relative importance of the voice pitch will be captured in the marginal rate of substitution between the two:  $(\partial U/\partial v)/(\partial U/\partial p) = \Delta p/\Delta v$ . For a unit difference in the voice pitch,  $\Delta v = 1$ , persistence becomes *the amount of policy difference between the two candidates needed to offset the voter's voice-pitch bias*.

<sup>3</sup>In an election between a lower-pitch (LP) and a higher-pitch (HP) candidate who propose identical policies, a voter's *voice-pitch bias* can be measured via the likelihood that they will vote for the LP candidate. For an unbiased voter, this probability would be 50 percent, since the only difference between the two candidates—the voice pitch—would be irrelevant for them. If, however, the voter is more likely to vote for the LP candidate than can be attributed to chance, the difference in probability is a measure of the voter's voice-pitch bias.

<sup>4</sup>We consider age, gender, household income, whether the participant voted in the last election, left-right ideology, trust toward others, level of satisfaction from existing education and health policies, importance of government spending for education and health, views on whether men or women in elected office are better at handling issues with regarding to education or health, as well as participants' completion times, listening device (mobile phone versus computer), and medium of listening (earphones versus speakers).

We focus on two policy dimensions, namely, per capita *public spending on health* and *public spending on education*, varied in a between-subjects design. Focusing on per capita public spending allows policy differences between candidates to be measured in monetary terms. We choose health and education since both are major valence issues, that is, issues where there is a broad consensus that an increase in the current level of public spending is desirable in Turkey, where we run our experiment, and both have been salient policy dimensions around the world, especially after the onset of COVID-19. Additionally, the Turkish public is predominantly satisfied (dissatisfied) from government policies on health (education), hence allowing us to control for attitudes toward government.

In our experiment, participants listen to two voice recordings (i.e., candidates). On a given policy dimension, each recording declares a policy stance (e.g., I will annually allocate  $X TL^5$  per person for public health expenditures). To control for unobservable individual differences between candidates, the two voice recordings are obtained from the same person and digitally manipulated to either a higher or an LP to create a difference of 1 equivalent rectangular bandwidth (ERB) (roughly 40 Hz) between them. We refer to these two recordings as the *LP* and the *HP* candidates.<sup>6</sup> In our design, a participant is exposed to candidates of only one gender. Our experiment was carried out online. Online voice-pitch experiments have been shown to produce results that are comparable to laboratory experiments (Feinberg *et al.*, 2008).

## 2. Background and hypotheses

Voice pitch is a prominent vocal feature that has significant effect on humans' perception of others. It can be defined as the number of vibrations per second made by the vocal folds to produce a vocalization (Tusing and Dillard, 2000). Larger vocal folds generate lower frequencies due to slower vibrations, and hence produce lower sounding voices. Additionally, the human voice pitch is sexually dimorphic (Puts *et al.*, 2007). The voice pitch of an average male is almost half of that of an average female (Titze, 1992; Feinberg *et al.*, 2005a; Vieira *et al.*, 2015). The discernible dimorphism can be attributed to factors beyond mere discrepancies in physical dimensions between genders. It has been observed that men tend to have a lower vocal pitch in comparison to women and prepubescent children of both sexes when taking into account their respective height and body volume (Titze, 2000). According to the literature, the emergence of sexual dimorphism in the human voice can be attributed to sexual selection, specifically through the process of female mate choice (Darwin, 1888; Collins, 2000). The literature shows that the voice pitch is perceived to signal information about physical and psychological traits such as attractiveness (Collins, 2000; Collins and Missing, 2003; Feinberg *et al.*, 2005a, 2005b; Jones *et al.*, 2008), social and physical dominance (Puts *et al.*, 2007; Tigue *et al.*, 2012; Rezlescu *et al.*, 2015; Schild *et al.*, 2022), and reproductive capabilities (Feinberg *et al.*, 2005b). Lower voices are perceived to signal masculinity, trustworthiness, competence, and strength (Feinberg *et al.*, 2005b; Puts *et al.*, 2007; Feinberg *et al.*, 2008; Jones *et al.*, 2010; Klofstad, 2016; Banai *et al.*, 2017; Klofstad, 2017; O'Connor and Barclay, 2017). Hence, in environments where these traits are desirable listeners are expected to exhibit a bias against higher-pitched speakers.

In the context of politics, a number of experiments demonstrate that candidates with lower voices receive higher votes and have a higher probability of winning elections (Anderson and Klofstad, 2012; Klofstad *et al.*, 2012; Tigue *et al.*, 2012; Klofstad *et al.*, 2015; Klofstad, 2016).<sup>7</sup> Banai *et al.* (2017) support these findings in an empirical study of 51 presidential elections around the world. Klofstad (2016) analyzes the 2012 US House Elections and provides an overall

<sup>5</sup>We use Turkish Liras (TL) as our experimental currency. At the time of the experiment 6.9 TL was equal to 1 USD.

<sup>6</sup>In line with the literature (e.g., Klofstad *et al.*, 2012 and Tigue *et al.*, 2012) and as confirmed with our validation tests, the voice-pitch difference between the two recordings is sufficient to create on the listener the impression that the two voices do not belong to the same person.

<sup>7</sup>Similar results prevail outside the context of politics, for example in case of job applications (Ko *et al.*, 2009).

support with an exception that will be discussed below. Some studies also analyze how voice-pitch bias interacts with other variables. Laustsen *et al.* (2015) find in survey experiments that voters with a more conservative stance display a higher voice-pitch bias than more liberal voters. Using empirical data as well as survey experiments, Klofstad (2016) shows that older, well-educated, and politically engaged voters are the most biased in favor of candidates with lower voices. In an experimental study, Klofstad *et al.* (2015) establish candidate age as an important determinant of voter choice and shows voice pitch to have an effect on perception of candidate age. In an empirical study, Klofstad and Anderson (2018) find no correlation between a politician's voice pitch and leadership ability.

The first main contribution of our paper is to this literature. First, we replicate the aforementioned finding that between two candidates who are identical in every aspect but their voice pitch, a voter is more likely to vote for the one with the lower voice.<sup>8</sup>

More importantly, in a novel experimental design that has not been considered before, we differentiate the two candidates on the policy space and study how voice-pitch bias interacts with such differences. Specifically, we measure how much of a policy difference between the LP and HP candidates is sufficient to offset voice-pitch bias. As discussed in Section 1, this amount gives us an estimate of the voter's marginal rate of substitution between voice pitch and policy. It is what we refer to as *persistence of voice-pitch bias*.

Hypothesis 1: By proposing a more desirable policy than her (his) opponent, a candidate can offset the vote disadvantage due to voice-pitch bias.

Gender is one of the most prominent traits voters perceive at first sight. Hence, its effects on politics have been the subject of extensive research. The literature indicates that voters believe women politicians to be warmer, more compassionate, better able to handle education, family, and women's issues, more liberal, and feminist than men, whereas men politicians are seen as strong, intelligent, better suited to handle crime, defense, and foreign policy issues, and more conservative (see Johns and Shephard, 2007; Dolan, 2010 and the literature cited therein). These gender stereotypes affect voting behavior significantly. Koch (2000) analyzes data from the 1988–1992 Pooled Senate Election Study to show that even after candidates' individuating ideological orientations are taken into account, candidate gender still exerts substantial effect on how voters perceive a candidate's ideological orientation. Eagly *et al.* (2003) show that voters are more likely to vote for candidates who endorse a position typically favored more by their own gender. Dolan (2010) examines how gender stereotypes shape voters' support for women candidates in various electoral circumstances. Johns and Shephard (2007) find that men voters are more inclined than women to see men candidates as stronger and to prioritize strength while voting. Bernhard (2023) finds that women candidates significantly benefit from being taller than their opponents while the benefit of height is not significant for men.

Mo (2015) analyzes how candidate quality and voter gender bias interact to determine candidate evaluation. Relatedly, Bauer (2020) finds that voters hold women politicians to higher qualifying requirements than men. These higher standards make it more difficult for women candidates to acquire electoral support. Hence, women candidates on average are more qualified than their men counterparts. Furthermore, Fox and Lawless (2004) uncover that, on average, women, even those with the highest levels of professional achievement, are less likely than men to consider running for political office.

In general, women candidates face gendered constraints when running for office, and are required to “double-bind” themselves by demonstrating the competence associated with masculinity and the tenderness associated with femininity (Bauer and Santia, 2022; Carpinella and Bauer, 2021). Relatedly, Schneider and Bos (2014) find that women politicians do not possess

<sup>8</sup>To the best of our knowledge, this study is the first to replicate this important finding in a non-English speaking context.

the traits attributed to women (e.g., warm, empathetic), and they have no advantage in terms of female-stereotypical characteristics. Dietrich *et al.* (2019) quantify lawmakers' emotional intensity by analyzing minor voice-pitch fluctuations. They find that women display greater emotional intensity when talking about women related issues than about other topics, and compared to men colleagues. Using role congruity expectations as a framework, Boussalis *et al.* (2021) examine how candidate gender affects usage of facial, vocal, and textual communication in German federal election debates (2005–2017), as well as voters' reaction to such communication. For example, they find that Angela Merkel expresses less anger than her male opponents, and that voters punish her for anger displays and reward her for happiness and general emotional displays. Carpinella and Bauer (2021) demonstrate that women candidates tend to blend male verbal assertions with feminine images such as presence of family, schools, and hospitals.

Regarding the effect of voice pitch, Searles *et al.* (2020) analyze relative effectiveness of man and woman voices in political advertising, in relation to the considered issues being masculine or feminine. Candidate and voter gender turns out to be important for voice-pitch bias as well. Klofstad (2016) analyzes 2012 data on the US House Elections and finds that when facing a woman opponent, a higher voice pitch increases votes. Anderson and Klofstad (2012) find that when considering men candidates for feminine leadership roles, women voters do not respond to voice pitch (while men voters do).

The second main contribution of our paper is to the literature on the effect of gender on voter preferences, summarized above. We first test whether the amount of voice pitch bias depends on the candidate gender. More importantly, we also test whether candidate gender affects the marginal rate of substitution between voice pitch and policy. We hypothesize that the effect of voice pitch is more persistent in case of women candidates and hence, to offset voice-pitch bias an HP woman needs to offer a much more desirable policy than an HP man.

**Hypothesis 2:** Voters exhibit a more persistent voice-pitch bias when voting between women candidates than voting between men candidates.

The literature shows voice pitch to have a strong influence on the perception of characteristics related to social power, such as competence or social dominance (e.g., see Aung and Puts, 2020). Individuals with lower voices are perceived to be more competent (Klofstad *et al.*, 2015), more socially dominant (Gregory, 1994; Puts *et al.*, 2007; Ko *et al.*, 2009; Jones *et al.*, 2010; Wolff and Puts, 2010; Borkowska and Pawlowski, 2011; Tigue *et al.*, 2012; Klofstad *et al.*, 2015; Laustsen *et al.*, 2015), and have better leadership abilities (Nagel *et al.*, 2012; Klofstad *et al.*, 2015). The effect of voice pitch on perceptions of trustworthiness is, on the other hand, gender-dependent. O'Connor and Barclay (2017) and Klofstad *et al.* (2012) find in two alternative contexts that lower-pitch women voices are perceived to be more trustworthy. For men voices on the other hand, O'Connor and Barclay (2017) find that an HP induces more trust, while Tigue *et al.* (2012) obtain an opposite finding. These contrasting findings present an interesting puzzle for us to focus on.

Our paper also contributes to this discussion by measuring voters' perceptions of competence and trustworthiness of both men and women candidates when they are recorded making a policy-neutral statement "Vote for me." In case of trustworthiness, our paper also serves to bring further evidence to the contrasting findings in the earlier literature.

### 3. Materials and methods

#### 3.1 Experimental stimuli

We recorded six native Turkish speakers—three women with an average age of 38 and three men with an average age of 40—making the following policy statements in Turkish: "Please vote for me" and "I will annually allocate  $X$  TL per person." Pisanski *et al.* (2021) show that studies on voice pitch obtain comparable results over different types of recordings, such as a series of vowels,

a single word, or a sentence as in our case. We recorded multiple speakers to reduce any individual-level effect of other vocal characteristics such as tone of the voice, rhythm, or tempo. The monetary amount  $X$  took six values, starting from 10, 000 Turkish Liras (TL) and decreasing by 200 TL at each step down to 9000 TL. Overall, we obtained seven recordings from each speaker.

We used monetary differences in per capita public spending to measure differences in policy. This is because monetary differences in per capita spending are easy to understand and their perception is uniform among participants (as opposed to e.g., differences in an abstract policy space). Also, they allow us to measure in objective units the persistence of voice-pitch bias (the trade-off between voice-pitch bias and policy differences).

As discussed in the previous section, we expect to corroborate the previous literature by finding that the LP candidate will receive significantly higher votes than the HP candidate. We then hypothesize that policy differences between candidates can first mitigate and then neutralize this voice-pitch bias, at which point the percentage of participants voting for the LP candidate will not be significantly different than 50 percent (see hypothesis 1). To measure how much of a policy difference is needed to neutralize the voice-pitch bias, we gradually made the policy declaration of the low-pitched candidate less desirable. After analyzing pre-test results, we determined these policy increments to be 200 TL.

To reduce any policy-specific effect on our findings, we chose two alternative policy dimensions. Our main objective in choosing education and health was to find valence issues where a higher public spending would be almost unanimously considered to be desirable. Figure A.2 in the Appendix shows that this is indeed the case for our participants.<sup>9</sup> Another reason for our choice of education and health was that the Turkish public is predominantly satisfied (dissatisfied) from government policies on health (education), hence allowing us to control for attitudes toward government.<sup>10</sup> This is indeed corroborated by our data, as displayed in Figure A.3 in the Appendix. Hence, any finding that holds for both dimensions cannot be attributed to the participants' attitude toward government. Finally, in a post-experiment survey, we asked the participants whether they think it is men or women in elected office that are better at handling each issue. As can be seen in Table 1 in the Appendix, more than 75 percent of our participants express no preference and the remaining group is equally divided between preference for men and women. Hence, we believe it is appropriate for our study to consider education and health as gender-neutral issues.

To find a common monetary unit for both education and health policy statements, we consulted the The Organization for Economic Cooperation and Development education and health reports for Turkey where the yearly per capita spending is stated to be approximately 2400 TL for both dimensions. We then chose our maximal amount (10, 000 TL) to be significantly higher.

Voices were recorded as .mp4 files.<sup>11</sup> We inspected each audio file aurally and visually in Audacity (v.2.3.3).<sup>12</sup> Before converting the audio files into .wav format, we ensured that the recordings were without speech errors and background noise. We used the *Get Pitch* command

<sup>9</sup>All tables and figures on our descriptive statistics are given in the Appendix.

<sup>10</sup>For example, see the 2020 Life Satisfaction Survey by the Turkish Statistical Institute.

<sup>11</sup>The audio recordings were captured using a smartphone microphone, specifically an iPhone 11, in a quiet office environment. This was necessitated by the constraints imposed on data collection during the COVID-19 lockdown period. Existing literature suggests that while an environment with sound treatment is optimal for collecting voice samples, a microphone on a smartphone can still obtain recordings that are suitable for the analysis of acoustic signals, especially fundamental frequency ( $f_0$ ) (Van der Woerd *et al.*, 2020; Uloza *et al.*, 2023; Fahed *et al.*, 2022). More specifically, Van der Woerd *et al.* (2020) results indicate that there are no significant main effects or interactions observed for the average  $f_0$  across four recording conditions: (i) recording with an iPhone in an office setting, (ii) recording with a BlueYeti USB microphone in an office setting, (iii) recording with an iPhone in a sound-proof chamber setting, and (iv) recording with a BlueYeti USB microphone in a sound-proof chamber setting.

<sup>12</sup>Audacity® software is copyright ©1999–2020 Audacity Team. The name Audacity® is a registered trademark of Dominic Mazzoni.

in the Praat phonetic analysis program (Boersma and Weenink, 2020, v.6.1.15) to determine the mean pitch of each recording. For unaltered women voices, the mean pitch is 239 Hz and the standard deviation is 14 Hz. The mean pitch for unaltered men voices is 134 Hz and the standard deviation is 12 Hz. To create a lower-pitched and higher-pitched version of each recording, we used the Pitch-Synchronous Overlap Add (PSOLA) method in Praat.<sup>13</sup> Following the literature (e.g., see, Jones *et al.*, 2010; Klofstad and Anderson, 2018; Tigue *et al.*, 2012), we altered each recording by  $\pm 0.5$  ERB.<sup>14</sup> Hence, each recording was converted into a pair of recordings, one with an HP and one with an LP with 1 ERB difference between the two. The  $\pm 0.5$  ERB manipulation creates natural sounding voices and accounts for a perceivable shift of roughly  $\pm 20$  Hz. Manipulating the recordings by ERB corrects for the logarithmic difference between actual fundamental frequency and perceived fundamental frequency. Therefore, it produces a constant perceivable gap between the raised and lowered versions of a recording, regardless of its initial fundamental frequency. As explained in the Appendix, this is confirmed for our experiment as well.

### 3.2 Procedure

The experiment was carried out online, using software Qualtrics. Results obtained from online voice-pitch experiments have been shown to be comparable to those of laboratory experiments (Feinberg *et al.*, 2008). As summarized in panel (a) of Figure 1, the experimental conditions were assigned following a  $2 \times 2$  factorial design (with equal probability): the participants were randomly assigned to listen to policies about either only education or only health and the candidates they were evaluating in-between were either always both men or women. Participants compared recordings of multiple speakers in order to minimize pseudoreplication bias, whereby the idiosyncratic characteristics of any one speaker might influence the results of the experiment (Machlis *et al.*, 1985; Kroodsmas, 1990). The experiment was not pre-registered.

In the first part of the experiment (Figure 1, first step of panel (a)), a participant listened to six individual recordings (obtained from three speakers) speaking the sentence “Please vote for me.” After listening to each recording, the participant rated the candidate in terms of trustworthiness and competence.<sup>15</sup>

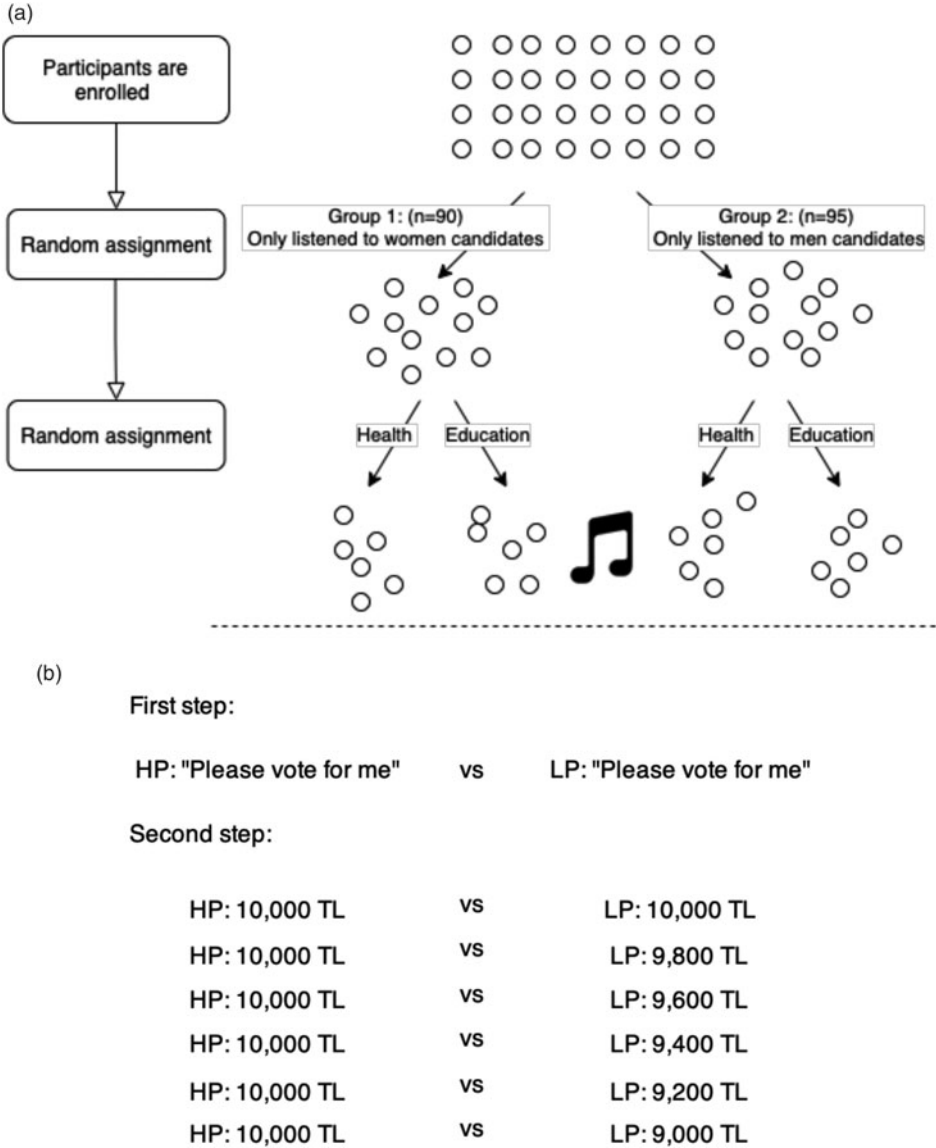
In the second part of the experiment (Figure 1, second step of panel (b)), a participant listened to 18 pairs of recordings obtained from three different speakers. After listening to each pair, the participant was asked to vote for one of the candidates (Figure A.1 in the Appendix presents a screenshot of a typical choice task). In the health policy treatment, each recording declared “I will annually allocate  $X$  TL per person for public health expenditures.” In each recording pair, both recordings were obtained from the same speaker but one was higher-pitched (HP candidate) and the other one, lower-pitched (LP candidate). While the HP recording always stated  $X = 10,000$  TL, the LP recording declared an  $X$  in between 9000 and 10,000 TL with increments of 200 TL. The order of recording pairs, as well as, the order of recordings in each pair, were determined randomly to eliminate order effects.

We did not inform the participants about the gender of the candidates they are listening to. Hence, any differentiation between two participants evaluating candidates of different gender is solely based on these participants’ perceived gender norms regarding women and men, particularly about their voice pitch.

<sup>13</sup>This method allows us to manipulate fundamental frequency and harmonics whilst controlling the other spectrotemporal aspects of the acoustic signal (Feinberg *et al.*, 2005a).

<sup>14</sup>In determining this magnitude, there is a trade-off between obtaining natural sounding voices—which favors smaller alterations—and creating the perception that the two voices are different—which favors bigger alterations. The previous literature suggests a  $\pm 0.5$  ERB alteration to provide a good trade-off.

<sup>15</sup>Participants chose whether to use computer speakers ( $n = 142$ ) or headphones ( $n = 45$ ).



**Figure 1.** Experimental conditions: (a) random assignment of experimental conditions (between-subject) and (b) decision tasks for each participant (within-subject, random order).

In the third and final part of the experiment, participants filled out a survey including questions on their birth year, sex, gender, education, family income, whether they voted in the last elections, political preferences, trust toward others, opinion on whether men or women politicians are better suited for public health/education issues, satisfaction level from public health/education services, and importance of government providing public health/education services. Participants were also asked if they had trouble listening to the recordings (Table 4 in Appendix) and the medium they used for listening (speakers versus earphones). Covariates on gender, age, ideology, income, turnout in the last general election, survey completion time, listening device (mobile phone versus computer), medium of listening (earphones versus speakers), and general trust show no significant differences across experimental groups (see Tables 3–5 in the Appendix).



## Participants

Participants ( $N = 185$ ) predominantly declared their gender as either woman (68 participants) or man (113 participants).<sup>16,17</sup> Participants ranged in age from 19 to 29 (mean age of the participants were 22 with a standard deviation of 0.12). Students who were enrolled in the introductory courses of economics received an email link that gave them access to the survey in the Qualtrics platform. Participants received course credit in exchange for their participation. They came from a diverse range of majors, belonging to the faculties of engineering, management, and social sciences. Anonymity of the participants was respected throughout the study, and their identities were kept confidential.<sup>18</sup>

Additional socioeconomic characteristics of our sample are as follows. Prior to our study, 93 percent of participants had voted in a real-life election. This is not significantly different than the 86 percent turnout rate in the 2018 Turkish elections, as published by the Turkish Statistical Institute. The monthly median family income in our sample is between 15, 000 TL (2170 USD) and 18, 000 TL (2600 USD), with a standard deviation of 10, 800 TL (1, 565 USD). The ideological distribution of our participants, another covariate that we are interested in, accumulates toward the mid-point, as seen in Table 1 (Appendix). Furthermore, as noted in Subsection 3.1, our participants consider a higher public spending on both health and education to be desirable (Figure A.2, Appendix). Additionally, they are predominantly satisfied with public health services while the satisfaction numbers are significantly lower for education (Figure A.3, Appendix). Tables 1 and 2 in the Appendix respectively present descriptive statistics for each experimental group and results of balance tests.

## 4. Results

### 4.1 Voice-pitch bias

We summarize the results of our experiment in Figures 2 and 3. For each level of policy difference (taking values from 0 to 1000 on the x-axis), we conducted separate linear regressions where the randomly assigned candidate gender is the independent variable. For each participant, the dependent variable is her average vote for the LP candidate, taken over the three choice tasks (recordings).

Figure 2 displays—for both men and women candidates—how the percentage of participants voting for an LP candidate changes in response to the policy difference between LP and HP candidates. For both LP men and LP women, a policy difference of no more than 1000 TL is sufficient to take this percentage down to a neighborhood of 50 percent, providing support for hypothesis 1. We hence conclude that by offering a more desirable policy than an LP opponent, an HP candidate can increase their vote shares and offset voice pitch bias. However, the amount of policy difference needed depends on the candidate gender, as discussed in the next paragraph.

Figure 2 shows that the percentage of participants voting for an LP man displays a sharp decrease to almost 50 percent as the policy difference between the candidates increases to 200 TL ( $p > 0.1$ ).<sup>19</sup> That is, by offering 200 TL more public spending than the LP man, the HP man is able to offset the vote disadvantages of voice-pitch bias. This observation is significantly different from what we see in elections between women candidates. As can be seen in Figure 2, the percentage of participants voting for an LP woman remains significantly higher than 50 percent ( $p < 0.05$ ) as the policy difference increases from 0 up to 800 TL. That is, even by offering an 800 TL more favorable policy than her opponent, an HP woman cannot offset

<sup>16</sup>Three participants preferred not to answer and one participant declared themselves queer.

<sup>17</sup>Protocols for this study were approved by Sabancı University Ethics Committee with protocol number FASS-2020-08.

<sup>18</sup>To be able to give bonus credits, course instructors were given the identification numbers of the students who participated in the study. But they did not have access to any other data.

<sup>19</sup>This p-value belongs to the one-sided *t*-test for the significance of the difference between the percentage votes an LP man receives at 200 TL and 50 percent. The other p-values in this section have a similar interpretation.

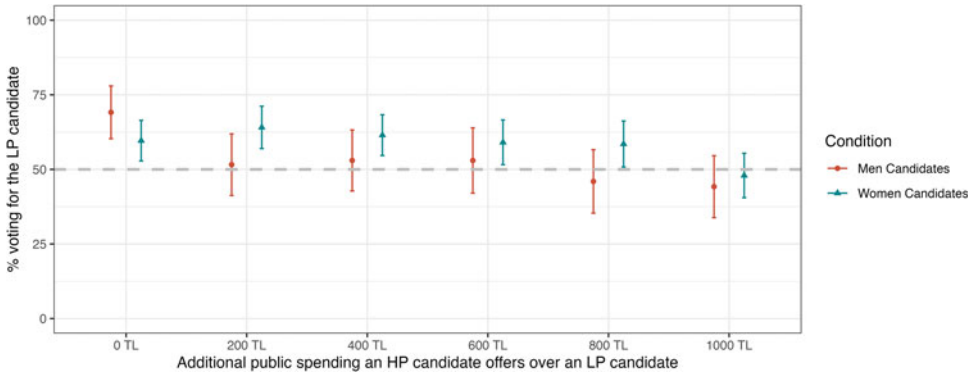


Figure 2. Percentage of participants who voted for the LP candidate by treatment condition, 95 percent CIs.

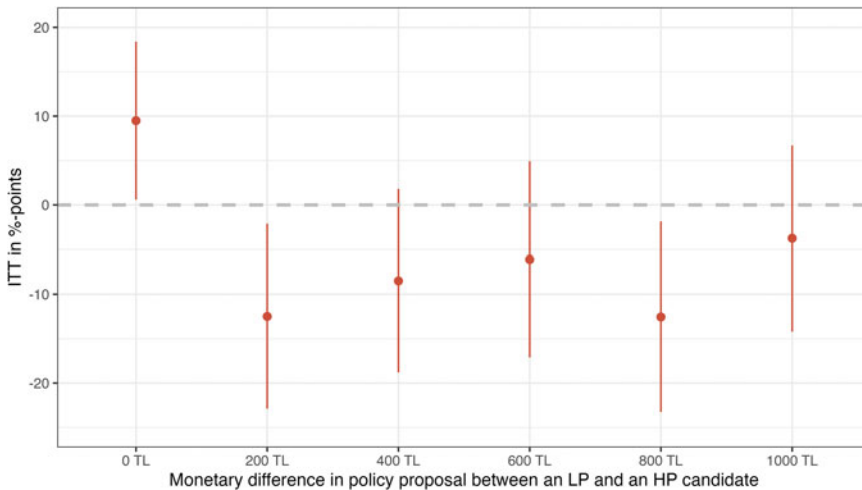


Figure 3. Effect of policy differences on the vote difference between an LP man and an LP woman.

the detrimental effect of voice-pitch bias on her votes. It is only when the policy difference reaches 1000 TL that an LP and an HP woman receive more or less the same number of votes ( $p > 0.1$ ). Overall, a comparison of men and women candidates shows us that voters exhibit a more persistent voice-pitch bias when voting between women candidates than between men candidates. Hence, our findings support hypothesis 2.

Figure 2 also provides support for the earlier literature by showing that voters exhibit a significant voice-pitch bias: when there is no policy difference between the LP and HP candidates, the percentage of participants voting for the LP candidate is 64.50 percent, which is significantly higher than 50 percent ( $p < 0.01$ ). We also analyze subsamples where all participants vote between either all men or all women candidates. We find the percentage of participants voting for an LP man to be 69.12 percent ( $p < 0.01$ ), in comparison to 59.63 percent for an LP woman ( $p < 0.01$ ). Hence, in both experimental groups the probabilities are significantly higher than 50 percent.

Finally, Figures 2 and 3 together show that the magnitude of voice-pitch bias responds to candidate gender. In Figure 3, when the horizontal axis is 0 TL (i.e., when both candidates offer the same policy) we see a significant ( $p < 0.05$ ) Intention-To-Treat (hereafter, ITT) effect of 9.49

percentage points. This means that the difference in votes received by an LP man and an LP woman is 9.49 percentage points. Hence, we conclude that voters exhibit a higher voice-pitch bias when voting between men candidates than voting between women candidates. Figure 3 also shows that the effect is reversed in case of a 200 TL policy difference. That is, an LP man receives 12.49 percentage points less votes than an LP woman ( $p < 0.05$ ). This is because an HP man offering 200 TL more than his LP opponent can overcome voice-pitch bias—decreasing his opponent’s votes down to approximately 50 percent—while an HP woman cannot, hence demonstrating hypothesis 2.

**4.2 Perceptions of trustworthiness and competence**

Figure 4 displays the effect of a switch in voice pitch from HP to LP on perceptions of competence and trustworthiness. For candidates of each gender, we conducted separate linear regressions with the candidate voice pitch as a binary independent variable and, for each participant, her average competence (respectively trustworthiness) evaluation as a dependent variable.

Over all experimental groups, the effect on a participant’s competence rating of a switch from an HP to an LP version of the same recording is 9.43 percentage points ( $p < 0.01$ ). Hence, perceptions of competence provide a possible mechanism for the effect of voice pitch on voting behavior. In the two experimental groups—participants who only listened to women candidates versus participants who only listened to men candidates—the effect is 6.20 percentage points ( $p < 0.05$ ) in case of men candidates and 12.84 percentage points ( $p < 0.01$ ) in case of women candidates.

We next analyze another theoretical mediator, trustworthiness. Figure 4 shows that, over all experimental groups, the effect on a voter’s trustworthiness rating of a switch from an HP to an LP version of the same recording is 5.13 percentage points ( $p < 0.05$ ). However, for reasons that will be discussed next, trustworthiness perception seems to be a less likely mechanism underlying voice-pitch bias. Namely, when the two experimental groups—participants who only listened to women candidates versus participants who only listened to men candidates—are analyzed separately, the effect on trustworthiness ratings largely diminish in significance. In case of men candidates the effect is 4.34 percentage points and not significant ( $p > 0.1$ ). In case of women candidates, the effect is slightly larger with 5.97 percentage points, and only significant with 90 percent confidence interval (CI) ( $p < 0.1$ ).

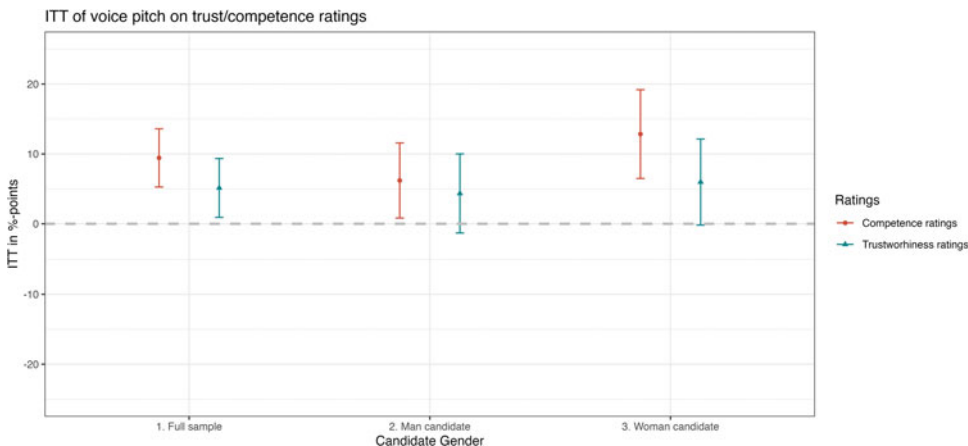


Figure 4. Effect of a switch in voice pitch from HP to LP on perceptions of competence and trustworthiness, 95 percent CIs.

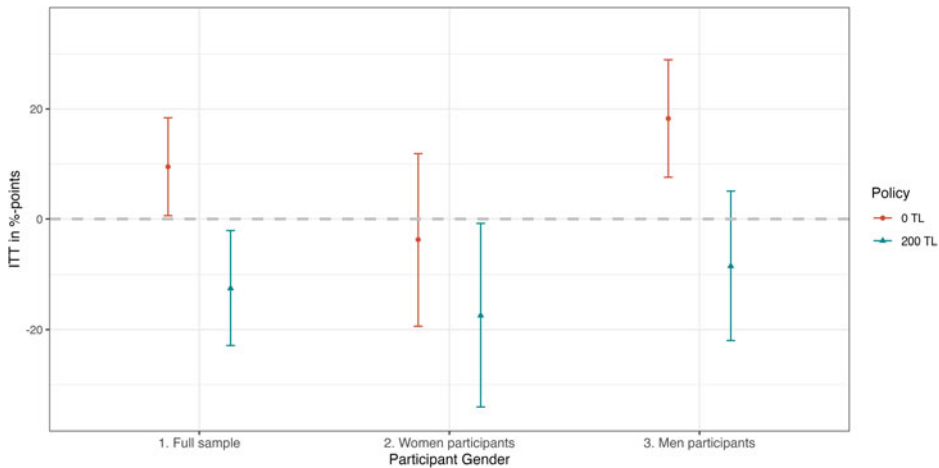


Figure 5. Effect of listening to men versus women candidates conditional on participant gender, 95 percent CIs.

### 4.3 Exploratory analysis: participant gender

In this section, we demonstrate that participant gender is an important factor in our findings on candidate gender that (i) voters exhibit a higher voice-pitch bias when evaluating men candidates but (ii) they exhibit a more persistent voice-pitch bias when evaluating women candidates. Figure 5 displays the effect of participant gender on voting behavior. We first look at the case when the policy difference between candidates is 0 TL. We find that men participants vote 18.3 percentage points more for an LP candidate in elections between men than women ( $p < 0.01$ ). In contrast, women participants vote 3.7 percentage points *less* for an LP candidate in elections between men than women, though the difference is not significant ( $p > 0.1$ ). Hence, we conclude that it is men participants that drive the overall finding that voice-pitch bias is higher for men candidates than for women candidates.

For comparison, in Figure 5 we also present the case when the policy difference between candidates is 200 TL.<sup>20</sup> Contrary to the previous case, we now find a similar treatment effect for both men and women participants. More specifically, women participants vote for an LP candidate 17.40 percentage points less in elections between men than women ( $p < 0.05$ ). Similarly, men participants vote for an LP candidate 8.46 percentage points less in elections between men than women, though the difference is not significant ( $p > 0.1$ ). Together with Figure 2, the above analysis suggests that for participants of both genders, a 200 TL difference between the candidates' policies results in a significant decrease in the probability of voting for an LP man, providing a mechanism for hypothesis 2.

## 5. Conclusion

By and large, our findings corroborate the stated hypotheses as well as the earlier literature. Our participants exhibit both voice-pitch bias and persistence of voice-pitch bias (hypothesis 1). Furthermore, voice-pitch bias is higher in elections between men candidates while it is more persistent in elections between women candidates (hypothesis 2). We find that men participants are mainly responsible for gender dependence of voice-pitch bias while both men and women participants drive gender dependence of the persistence of voice-pitch bias. We also identify the

<sup>20</sup>The other cases where the policy difference is higher look very similar to the case of 200 TL. Hence, for the sake of presentation we do not show those in Figure 5.

effect of voice pitch on perceptions of competence and trustworthiness as an important mechanism for voice-pitch bias.

Our results are robust to the inclusion of pre-treatment covariates, including participant gender, age, income level, turnout, ideology, general trust toward others, as well as survey completion time, which is a proxy for participant attention, listening device, and medium of listening. Additionally, our findings are consistent across the two policy dimensions—health and education—that we considered. Since the Turkish public is predominantly satisfied (dissatisfied) from government policies on health (education), we conclude that our findings are not driven by participants' attitude toward government.

While we find that candidates with a lower voice pitch are perceived to be both more competent and trustworthy, our results also display an interesting pattern. As can be seen in [Figure 4](#), the effect of voice pitch on perception is higher for voters evaluating women candidates. This difference is particularly pronounced in competence ratings. Even though our participants overwhelmingly declare both education and healthcare to be gender-neutral issues, the earlier literature establishes them to be women-congruent (Dolan, 2014). In relation to this literature, our study then shows that, on women-congruent issues, even a vocal characteristic signaling masculinity—voice pitch—can have a more significant effect on perceptions regarding women than men.

**Supplementary material.** The supplementary material for this article can be found at <https://doi.org/10.1017/psrm.2023.51>. To obtain replication material for this article, <https://doi.org/10.7910/DVN/QJGG6>

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## References

- Anderson RC and Klofstad CA (2012) Preference for leaders with masculine voices holds in the case of feminine leadership roles. *PLoS ONE* 7, e51216.
- Aung T and Puts D (2020) Voice pitch: a window into the communication of social power. *Current Opinion in Psychology* 33, 154–161.
- Banai IP, Banai B and Bovan K (2017) Vocal characteristics of presidential candidates can predict the outcome of actual elections. *Evolution and Human Behavior* 38, 309–314.
- Bauer NM (2020) Shifting standards: how voters evaluate the qualifications of female and male candidates. *The Journal of Politics* 82, 1–12.
- Bauer NM and Santia M (2022) Going feminine: identifying how and when female candidates emphasize feminine and masculine traits on the campaign trail. *Political Research Quarterly*, 75, 691–705.
- Bernhard R (2023) The Visual Conjoint: A New Solution for Social Desirability Bias. *PolMeth Europe Conference Paper*.
- Boersma P and Weenink D (2020) Praat: Doing Phonetics by Computer (version 6.1.15).
- Borkowska B and Pawlowski B (2011) Female voice frequency in the context of dominance and attractiveness perception. *Animal Behaviour* 82, 55–59.
- Boussalis C, Coan TG, Holman MR and Müller S (2021) Gender, candidate emotional expression, and voter reactions during televised debates. *American Political Science Review* 115, 1242–1257.
- Carpinella C and Bauer NM (2021) A visual analysis of gender stereotypes in campaign advertising. *Politics, Groups, and Identities* 9, 369–386.
- Collins SA (2000) Men's voices and women's choices. *Animal Behaviour* 60, 773–780.
- Collins SA and Missing C (2003) Vocal and visual attractiveness are related in women. *Animal Behaviour* 65, 997–1004.
- Darwin C (1888) *The Descent of Man, and Selection in Relation to Sex*. Albemarle Street: John Murray.
- Dietrich BJ, Hayes M and O'Brien DZ (2019) Pitch perfect: vocal pitch and the emotional intensity of congressional speech. *American Political Science Review* 113, 941–962.
- Dolan K (2010) The impact of gender stereotyped evaluations on support for women candidates. *Political Behavior* 32, 69–88.
- Dolan K (2014) Gender stereotypes, candidate evaluations, and voting for women candidates: what really matters?. *Political Research Quarterly* 67, 96–107.
- Eagly AH, Diekmann AB, Schneider MC and Kulesa P (2003) Experimental tests of an attitudinal theory of the gender gap in voting. *Personality and Social Psychology Bulletin* 29, 1245–1258.

- Fahed VS, Doheny EP, Busse M, Hoblyn J and Lowery MM** (2022) Comparison of acoustic voice features derived from mobile devices and studio microphone recordings. *Journal of Voice*. Available online 12 November 2022.
- Feinberg D, Jones B, Little A, Burt D and Perrett D** (2005a) Manipulations of fundamental and formant frequencies influence the attractiveness of human male voices. *Animal Behaviour* **69**, 561–568.
- Feinberg DR, Jones BC, DeBruine LM, Moore FR, Law Smith MJ, Cornwell RE, Tiddeman BP, Boothroyd LG and Perrett DI** (2005b) The voice and face of woman: one ornament that signals quality?. *Evolution and Human Behavior* **26**, 398–408.
- Feinberg DR, DeBruine LM, Jones BC and Perrett DI** (2008) The role of femininity and averageness of voice pitch in aesthetic judgments of women's voices. *Perception* **37**, 615–623.
- Fox RL and Lawless JL** (2004) Entering the arena? Gender and the decision to run for office. *American Journal of Political Science* **48**, 264–280.
- Gregory SW** (1994) Sounds of power and deference: acoustic analysis of macro social constraints on micro interaction. *Sociological Perspectives* **37**, 497–526.
- Johns R and Shephard M** (2007) Gender, candidate image and electoral preference. *The British Journal of Politics and International Relations* **9**, 434–460.
- Jones BC, Feinberg DR, DeBruine LM, Little AC and Vukovic J** (2008) Integrating cues of social interest and voice pitch in men's preferences for women's voices. *Biology Letters* **4**, 192–194.
- Jones BC, Feinberg DR, DeBruine LM, Little AC and Vukovic J** (2010) A domain-specific opposite-sex bias in human preferences for manipulated voice pitch. *Animal Behaviour* **79**, 57–62.
- Klofstad CA** (2016) Candidate voice pitch influences election outcomes: voice pitch influences voters. *Political Psychology* **37**, 725–738.
- Klofstad CA** (2017) Looks and sounds like a winner: perceptions of competence in candidates' faces and voices influences vote choice. *Journal of Experimental Political Science* **4**, 229–240.
- Klofstad CA and Anderson RC** (2018) Voice pitch predicts electability, but does not signal leadership ability. *Evolution and Human Behavior* **39**, 349–354.
- Klofstad CA, Anderson RC and Peters S** (2012) Sounds like a winner: voice pitch influences perception of leadership capacity in both men and women. *Proceedings of the Royal Society B: Biological Sciences* **279**, 2698–2704.
- Klofstad CA, Anderson RC and Nowicki S** (2015) Perceptions of competence, strength, and age influence voters to select leaders with lower-pitched voices. *PLOS ONE* **10**, e0133779.
- Ko SJ, Judd CM and Stapel DA** (2009) Stereotyping based on voice in the presence of individuating information: vocal femininity affects perceived competence but not warmth. *Personality and Social Psychology Bulletin* **35**, 198–211.
- Koch JW** (2000) Do citizens apply gender stereotypes to infer candidates' ideological orientations?. *The Journal of Politics* **62**, 414–429.
- Kroodtsma DE** (1990) Using appropriate experimental designs for intended hypotheses in “song” playbacks”, with examples for testing effects of song repertoire sizes. *Animal Behaviour* **40**, 1138–1150.
- Laustsen L, Petersen MB and Klofstad CA** (2015) Vote choice, ideology, and social dominance orientation influence preferences for lower pitched voices in political candidates. *Evolutionary Psychology* **13**, 147470491560057.
- Machlis L, Dodd P and Fentress J** (1985) The pooling fallacy: problems arising when individuals contribute more than one observation to the data set. *Zeitschrift für Tierpsychologie* **68**, 201–214.
- Mo CH** (2015) The consequences of explicit and implicit gender attitudes and candidate quality in the calculations of voters. *Political Behavior* **37**, 357–395.
- Nagel F, Maurer M and Reinemann C** (2012) Is there a visual dominance in political communication? How verbal, visual, and vocal communication shape viewers' impressions of political candidates: visual dominance in political communication. *Journal of Communication* **62**, 833–850.
- O'Connor JJ and Barclay P** (2017) The influence of voice pitch on perceptions of trustworthiness across social contexts. *Evolution and Human Behavior* **38**, 506–512.
- Pisanski K, Groyecka-Bernard A and Sorokowski P** (2021) Human voice pitch measures are robust across a variety of speech recordings: methodological and theoretical implications. *Biology Letters* **17**, 20210356.
- Puts DA, Hodges CR, Cárdenas RA and Gaulin SJ** (2007) Men's voices as dominance signals: vocal fundamental and formant frequencies influence dominance attributions among men. *Evolution and Human Behavior* **28**, 340–344.
- Rezlescu C, Penton T, Walsh V, Tsujimura H, Scott SK and Banissy MJ** (2015) Dominant voices and attractive faces: the contribution of visual and auditory information to integrated person impressions. *Journal of Nonverbal Behavior* **39**, 355–370.
- Schild C, Braunsdorf E, Steffens K, Pott F and Stern J** (2022) Gender and context-specific effects of vocal dominance and trustworthiness on leadership decisions. *Adaptive Human Behavior and Physiology* **8**, 538–556.
- Schneider MC and Bos AL** (2014) Measuring stereotypes of female politicians. *Political Psychology* **35**, 245–266.
- Searles K, Fowler EF, Ridout TN, Strach P and Zuber K** (2020) The effects of men's and women's voices in political advertising. *Journal of Political Marketing* **19**, 301–329.
- Tigue CC, Borak DJ, O'Connor JJ, Schandl C and Feinberg DR** (2012) Voice pitch influences voting behavior. *Evolution and Human Behavior* **33**, 210–216.
- Titze IR** (1992) Control of vocal intensity and efficiency. *Journal of Voice* **6**, 135–138.

- Titze IR** (2000) *Principles of Voice Production*. National Center for Voice and Speech.
- Tusing KJ and Dillard JP** (2000) The sounds of dominance. vocal precursors of perceived dominance during interpersonal influence. *Human Communication Research* **26**, 148–171.
- Uloza V, Ulozaitė-Stanienė N, Petrauskas T and Kregždytė R** (2023) Accuracy of acoustic voice quality index captured with a smartphone—measurements with added ambient noise. *Journal of Voice* **37**, 465.e19–465.e26.
- Van der Woerd B, Wu M, Parsa V, Doyle PC and Fung K** (2020) Evaluation of acoustic analyses of voice in nonoptimized conditions. *Journal of Speech, Language, and Hearing Research* **63**, 3991–3999.
- Vieira RH, Gadenz CD and Cassol M** (2015) Estudo longitudinal de caracterização vocal em canto coral. *Revista CEFAC* **17**, 1781–1791.
- Wolff SE and Puts DA** (2010) Vocal masculinity is a robust dominance signal in men. *Behavioral Ecology and Sociobiology* **64**, 1673–1683.