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ORIGINAL ARTICLE

Partisan conflict in nonverbal communication

Mathias Rask[1] and Frederik Hjorth[2]

[1]Department of Political Science, Aarhus University, Aarhus, Denmark and [2]Department of Political Science, University of Copenhagen, Copenhagen, Denmark
Corresponding author: Frederik Hjorth; Email: fh@ifs.ku.dk

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Abstract
In multiparty systems, parties signal conflict through communication, yet standard approaches to measuring partisan conflict in communication consider only the verbal dimension. We expand the study of partisan conflict to the nonverbal dimension by developing a measure of conflict signaling based on variation in a speaker's expressed emotional arousal, as indicated by changes in vocal pitch. We demonstrate our approach using comprehensive audio data from parliamentary debates in Denmark spanning more than two decades. We find that arousal reflects prevailing patterns of partisan polarization and predicts subsequent legislative behavior. Moreover, we show that consistent with a strategic model of behavior, arousal tracks the electoral and policy incentives faced by legislators. All results persist when we account for the verbal content of speech. By documenting a novel dimension of elite communication of partisan conflict and providing evidence for the strategic use of nonverbal signals, our findings deepen our understanding of the nature of elite partisan communication.

Keywords: computational models; legislative politics; audio as data; nonverbal communication; polarization; text as data; party competition

1. Introduction

On January 19, 2004, Vermont Governor Howard Dean doomed his presidential campaign. In an attempt to rally his supporters after a disappointing third place in the Iowa caucuses, Dean shouted a list of the primary states ahead followed by a loud, primal yell, now known as the 'Dean Scream.' Its subsequent internet virality is widely perceived as a contributing factor in ending Dean's presidential aspirations. The use of vocal style in politics can also be more deliberate. After becoming the United Kingdom's prime minister, Margaret Thatcher famously went through extensive voice coaching, dramatically altering her vocal style in order to present a more powerful persona. The 'Dean Scream' and Thatcher's engineered voice change illustrate the role of vocal style, and the nonverbal dimension more generally, in elite political communication.

Although nonverbal communication is broadly understood to matter in the abstract, researchers almost exclusively study the verbal dimension of elite political communication in practice (Taylor *et al.*, 2023). Most notably, a rich literature uses parliamentary speech as a window to party competition, particularly in systems where party cohesion masks within-party differences. This work typically builds on scaling methods using speech word counts (Slapin and Proksch, 2008; Hjorth *et al.*, 2015; Lauderdale and Herzog, 2016), and more recently word embeddings (Rheault and Cochrane, 2020)

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to capture parties' and individual legislators' ideological positions. Another line of work uses statistical models (Gentzkow *et al.*, 2019) and machine learning classifiers (Peterson and Spirling, 2018) to measure polarization from word choice. Finally, scholars have used sentiment and content analysis to uncover non-positional dimensions of partisan conflict (Proksch *et al.*, 2019). While studies in this vein tap into different aspects of partisan conflict, e.g., positional vs. non-positional (Serra, 2010; Jung and Tavits, 2021; Skytte, 2021; Bjarnø e *et al.*, 2023), they share a focus on word choice, i.e., the verbal dimension of speech.

In this paper, we expand the study of elite partisan conflict to the nonverbal dimension. We do so by developing and validating a measure of nonverbal signaling of conflict based on variation in a speaker's emotional arousal, as indicated by changes in a speaker's vocal pitch relative to their own baseline. We test our approach using audio data from more than two decades of parliamentary debates in Denmark, the largest collection of natural audio in political science. To preview our findings, we find that emotional arousal measured using vocal pitch closely tracks lines of partisan polarization and that it predicts subsequent partisan behavior in the form of legislative voting. We also find that legislators use heightened arousal in more visible and high-profile debates and when addressing parties with greater policy bargaining leverage, both consistent with legislators using nonverbal communication strategically to signal to voter constituencies and to pressure pivotal parties.

We make three distinct contributions. First, we document a novel dimension by which partisan elites communicate conflict to citizens. This finding challenges the prevailing near-exclusive focus on verbal communication in existing research and highlights the need for multimodal studies of elite political communication.

Second, we extend the emergence of "audio as data" methodology to a novel domain. Earlier work has used audio data to study topics such as judicial decision making (Dietrich *et al.*, 2019), oral court arguments (Knox and Lucas, 2021), and gender representation (Dietrich *et al.*, 2019; Rittmann, 2024). However, we are the first to use audio data to study multiparty conflict.

Third, and more substantively, our findings shed new light on the strategic nature of elite nonverbal communication. To reiterate, we find that changes in vocal style are highly predictable from legislators' vote-seeking and policy-seeking motives, indicating that legislators use vocal style strategically to further their political objectives. Hence, our findings indicate that deliberate, strategic use of nonverbal communication (as in the case of Margaret Thatcher) is widespread in our empirical setting, and spontaneous, non-strategic use (as in the case of Howard Dean) is much less so. Notably, this conclusion cuts against some earlier work seeing vocal style as beyond the speaker's control (Dietrich *et al.*, 2019). This difference is plausibly attributable to differences in speakers' institutional constraints, but our findings nevertheless add to our understanding of the nature of elite nonverbal communication. We revisit this question in the concluding section.

We proceed as follows: We elaborate on each of our contributions, situating them in the existing literature. We present our measurement approach, data, and measures for studying the nonverbal dimension of elite partisan conflict. We develop four hypotheses, which we evaluate in the results section. In the concluding section, we discuss the implications of our findings for future work.

2. Nonverbal communication of partisan conflict

Political scientists have developed an array of tools for characterizing political conflict, particularly along partisan lines. The two most prominent are, arguably, roll calls and parliamentary speeches. The former has been used predominantly in Congressional scholarship using DW-NOMINATE scores to study positional polarization between Republicans and Democrats (e.g., McCarty *et al.*, 2016) but also in multiparty contexts such as the European Parliament (e.g, Høyland, 2010). Approaches based on parliamentary speech have documented rising partisan polarization reflected in word choice (Peterson and Spirling, 2018; Gentzkow *et al.*, 2019). While communication-based measures of partisan polarization accommodate the shortcomings of roll-call votes, existing measures have strictly

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relied on the verbal content of speech, i.e., the words used by partisan elites rather than the style in which they are used. Although a meaningful reduction from a methodological point of view, this narrow focus on verbal content limits our substantive understanding of the nature of partisan polarization in elite communication.

Although the focus on verbal content is substantively and analytically reasonable in many cases, it ignores a significant dimension of human communication. Most importantly, it strips away *nonverbal* elements of speech as an important marker of interpersonal conflict (Deutsch *et al.*, 2011). Nonverbal speech includes aspects like intonation, volume, and accent, commonly referred to as paralinguistic cues (e.g., Scherer *et al.*, 2003). This omission is remarkable given that the centrality of nonverbal communication in human and social interaction has been firmly established in thousands of linguistics and psychology studies.[1] This literature shows that listeners rely on speakers' vocal cues to make inferences about speakers' emotional state, intentions, and character traits (Scherer *et al.*, 1984, 2003; Zuckerman and Driver, 1989; Banse and Scherer, 1996; Owren and Bachorowski, 2007; Anderson *et al.*, 2014; Laustsen *et al.*, 2015).[2]

We build on earlier work, including a substantial body of experimental evidence, that documents the distinct role played by nonverbal communication in shaping listeners' perceptions and evaluations. In a validation study, Cochrane *et al.* (2022) show that human coders consistently infer sentiment (i.e., positive vs negative) from text and audio clips, but arousal (i.e., how activated a speaker is) is not detected reliably from text, only from audio. Moving this fundamental insight to the political domain, a small number of studies examine how voters' evaluations of candidate traits are affected by voice characteristics, with lower-pitched candidates being rated as more competent and receiving more votes than higher-pitched candidates (Touati, 1993; Klofstad *et al.*, 2012; Tigue *et al.*, 2012; Klofstad, 2016; Cinar and Kıbrıs, 2023). Recently, Taylor *et al.* (2023) developed a framework to study the causal effects of multimodal political data sources, such as campaign speeches. Using the framework, they show that vocal delivery matters for voters' impression and evaluation of political candidates, even when verbal expressions are held constant.

This experimental body of work mostly considers between-speaker differences in voice characteristics in a small set of audio recordings, but a burgeoning literature is studying within-speaker changes in nonverbal expressions using massive audio collections. For example, Dietrich *et al.* (2019) and Rittmann (2024) show that changes in legislators' vocal pitch contain information about a legislator's issue engagement. Another line of work finds that political candidates strategically shift their rhetorical style to align with the demands of their audiences by lowering and heightening their phonetic articulation of vowels (Neumann, 2019). Finally, nonverbal speech characteristics convey the attitudes of US Supreme Court Judges (Knox and Lucas, 2021) and their subsequent voting behavior (Dietrich *et al.*, 2019).

2.1. Voicing partisan conflict

We use these diverse sets of literature as our point of departure to theorize how legislators use nonverbal communication to signal partisan conflict. We focus on a particular aspect of nonverbal communication: the vocal dimension. To be sure, nonverbal communication also involves non-vocal features such as facial expressions, gestures, and body language (Joo *et al.*, 2019; Boussalis *et al.*, 2021; Neumann *et al.*, 2022). Still, vocal communication makes up a significant part of nonverbal communication (Patel and Scherer, 2013) and is particularly relevant in understanding inter-human conflict

[1] A Google Scholar search for "paralinguistic" returns ≈98,500 hits in December 2023.
[2] See Knox and Lucas (2021) for a review.

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(Deutsch, 1973).[3] We refer to the vocal dimension as *nonverbal speech* throughout and use *nonverbal signaling* to denote situations where nonverbal characteristics of a speech contain signals about partisan conflict.

We start from the simple observation that a higher voice is associated with conflict throughout social life. When having emotionally charged discussions with family members, debating politics with friends, or protesting in the streets, humans heighten their voices when they disagree. Intuitively, this happens since disagreement and conflict involve an emotional component that makes a speaker more emotionally activated, reflected in, e.g., a heightened voice. (We refer to 'voice in an auditory sense [e.g., loudness and pitch] and not in the metaphorical sense of being heard or represented [e.g., Mansbridge 1999]). In the following, we use the term 'emotional arousal' (or, interchangeably, simply 'arousal') to denote any perception of a speaker being more or less emotionally activated. We stress that 'emotional' in this context does not imply autonomic, i.e., arousal can potentially be employed strategically.

The association between a speaker's emotional arousal, whether strategic or not, and nonverbal conflict signaling is likely to hold in the political domain as well. In the following, we focus on this link as it manifests in speeches given in parliamentary debates, which legislators use primarily to signal the positions of the parties on issues that are up for discussion (Proksch and Slapin, 2012; Bäck *et al.*, 2021). Since most of the deliberations and negotiations over bills take place in committees and behind closed doors, the parliamentary debates generally serve to showcase policy positions and arguments publicly, and to highlight partisan differences (Laver *et al.*, 2021), even when parties are not ideologically distinct (Kosmidis *et al.*, 2019).

When should we expect the emotional arousal of a legislator to convey signals of partisan conflict? We focus on two theoretically plausible drivers of partisan conflict—*polarization* and *policy disagreement*—that may cause variation in a speaker's emotional arousal and discuss and hypothesize how each likely manifests in nonverbal communication. Although legislators can be aroused for other reasons than partisan conflict, this motive is likely to dominate other drivers (e.g., issue engagement) in certain parliamentary speeches, such as dyadic exchanges. We use the term 'dyadic exchanges' to refer to speeches in which the speaker addresses a single party by name or an individual legislator from that party. To fix terminology, we call the party of the former the *speaker party* and the latter the *target party*.

First, we expect arousal to reflect prevailing patterns of partisan polarization. Across dyadic exchanges, interactions between highly polarized pairs of speakers, as indicated by their partisanship, should be more conflictual on average. To the extent that partisan polarization is a driver of emotional arousal in the context of dyadic exchanges, this should then be reflected in legislators' nonverbal signals. In European multiparty systems, party competition is generally structured by multiparty blocs (Bale, 2003), which is also true of the Danish case (Kosiara-Pedersen and Kurrild-Klitgaard, 2018). As a result, we test the first hypothesis based on party blocs rather than individual parties, but the approach easily generalizes to non-bloc settings.[4] Hence, we expect:

> H_1: Emotional arousal is higher in speeches with outbloc target parties than in speeches with inbloc target parties.

Second, we consider policy disagreement a source of conflict. To form this expectation, we turn to the coalition literature, which has shown a close connection between intra-coalition conflict and the fate of bills: Bills on which coalition parties disagree are introduced later to the agenda relative

[3] A multimodal approach combining text, audio, and video in studying political conflict is an important next step in unpacking the dimensions of political conflict. A multimodal approach has been pursued by Boussalis *et al.* (2021) in another domain, studying candidates' emotional displays and voters' reactions to them.

[4] The use of blocs to capture the ideology of legislators in a multiparty setting like the Danish parliament is also used by Laustsen and Petersen (2017).

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to when coalition parties are united (Martin and Vanberg, 2004), take longer to pass (Martin and Vanberg, 2011), and are subject to greater scrutiny by non-coalition partners (Wonka and Göbel, 2016; Fortunato *et al.*, 2019; Behrens *et al.*, 2024). Moreover, policy disagreement is known to be reflected in verbal expressions: The sentiment expressed by the opposition predicts whether the bills are passed unanimously (Proksch *et al.*, 2019). While the government-opposition divide generally dominates legislative work (e.g., Hix and Noury, 2016), conflict should also arise at the level of each bill (Proksch *et al.*, 2019). Specifically, regardless of the ideological distance and the government-opposition status of the parties, interactions between speakers who disagree on a bill should be more conflictual on average than interactions between speakers who agree. To the extent that policy conflict is a driver of emotional arousal in dyadic exchanges in parliamentary debates on bills, this should be reflected in legislators' nonverbal signals. Hence, we expect:

H_2: Emotional arousal is higher in speech directed at target parties with whom they disagree on a bill than in speech directed at target parties with whom they agree.

At this point, it cannot be ruled out that H_2 is just a downstream cause of the stable bloc polarization tested formulated in H_1. To rule out that a relationship with policy disagreement does not merely reflect pre-existing polarization between parties, we add a test of H_2 including dyad fixed effects, which controls for differences in bloc affiliation and any other stable dyad-level differences in party alignment.

2.2. The strategic use of nonverbal signals

The first two hypotheses predict that legislators' nonverbal conflict signals, in the form of heightened emotional arousal, systematically reflect partisan polarization and policy disagreement. Still, they leave open the question of whether it is strategic. We now turn to this question, developing two hypotheses that test key observable implications of strategically used nonverbal conflict signals. We first explain why signaling conflict in parliamentary debate can exert pressure on a target party. We then develop specific expectations of which parties are strategically important to pressure and under which conditions.

To explain how nonverbal conflict signals can put pressure on target parties, we highlight the role of selective media uptake. News media are more likely to cover conflictual and emotional interactions (Schulz, 2007; Dietrich *et al.*, 2018; Gennaro and Ash, 2023), and conflict often appears as a criterion in its own right in contemporary typologies of news selection criteria (Harcup and O'Neill, 2017). As a consequence, conflict signals increase the probability that an exchange in parliament will be picked up in news media. This heightened visibility can, in turn, put pressure on the target party to justify or potentially reconsider its position on the agenda item.

Crucially, legislators' ability to exploit the media channel varies across debates. The legislative calendar features a subset of *high-profile debates*, most notably the opening and closing debates in each parliamentary term. These debates are characterized by full attendance, a focus on principled policy debate rather than lawmaking, and most importantly significantly increased media coverage. Given the heightened availability of the media channel, we expect legislators to concentrate expressions of conflict in these debates strategically:

H_3: Emotional arousal is higher in high-profile than low-profile debates.

Our third hypothesis corresponds closely to the primary hypothesis in Osnabrügge *et al.* (2021) that legislators strategically employ emotive language in high-profile debates where legislative rhetoric is more likely to reach voters. This expectation is robustly supported by showing that the verbal content of speech varies systematically across debate types in the UK House of Commons. Our third hypothesis articulates our expectation that the strategic language use identified by Osnabrügge *et al.* (2021)

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extends to the nonverbal dimension. To isolate the distinct role of the nonverbal signals, we test H_3 using covariates capturing the verbal use of emotive language.

Strategic use of nonverbal communication has implications not only for when legislators signal partisan polarization but also for which partisan outgroups are targeted. Whereas H_3 captures legislators' vote-seeking motives (Mayhew, 1974), our next expectation captures policy-seeking motives in the context of parliamentary debate. Given policy-seeking motives, we expect that legislators focus on target parties with the greatest influence on policy-making. Specifically, we expect parties to concentrate conflict signals on target parties with greater *bargaining leverage*, since they are most likely to ultimately affect policy, through either the existing governing majority or an alternative majority. This leads to our fourth and final hypothesis:

H_4: Emotional arousal is positively associated with the target party's bargaining leverage.

Following traditional conceptualizations (Shapley and Shubik, 1954), we understand bargaining leverage as a function of parties' probability of participating in an alternative government, were one to form. We measure bargaining leverage using a recently developed approach (Kayser *et al.*, 2023) (see 'Data and Methods' below).

Importantly, the prediction in H_4 cuts against what a theory of non-strategic nonverbal communication would predict. If nonverbal communication is primarily or entirely a non-strategic, affective reflex, nonverbal signals of conflict should be greater in speeches directed at more extreme targets, which are more likely to arouse anger (Webster, 2021). In Supplementary material, Appendix A, we show that bargaining leverage is higher for mainstream parties and lower for challenger parties at the ideological extremes. Hence, if nonverbal signaling of conflict were primarily an affective reaction to extreme parties, we should expect the opposite of the predicted association. Hypothesis 4 therefore aims to discriminate between the predictions of strategic vs. non-strategic theories of nonverbal communication.

We stress that these hypotheses are implicitly causal, i.e., they reflect our theoretical understanding of nonverbal communication as a reflection of partisan conflict. In some cases, the temporal order of variables rules out reverse causation (e.g., party affiliation temporally precedes nonverbal communication), but confounding remains a concern. As discussed below, we introduce a rich set of covariates to address confounding concerns. That said, causal identification is ultimately limited by the fact that policy conflict is not randomly assigned.

3. How partisan conflict is reflected in audio data

Analyzing how partisan conflict is signaled in politicians' nonverbal communication is challenging. Whereas verbal measures such as negativity or scaling estimates can be derived from speech transcripts, nonverbal features of speeches are generally stripped away in transcription. Consequently, text-only transcripts are often ill-suited to study nonverbal dimensions of speech. Second, text-based measures of nonverbal communication rely on the coding procedures of data sources. For instance, Imre *et al.* (2023) develop a novel measure of 'coalition mood' based on applause patterns in parliamentary debates between coalition partners in Germany and Austria. While valuable, this measure depends on the availability of stenographic protocols marking nonverbal communication in party-to-party interactions.

To deal with these shortcomings, we turn to audio recordings of political speeches. Although recordings are widely and publicly available across many political institutions, they have received only scant attention from political scientists (though see Dietrich *et al.*, 2019; Neumann 2019; Knox and Lucas, 2021; Rittmann, 2024). In addition to conveying the verbal content of speech (i.e., spoken words), audio contains information that goes beyond what we can infer from words alone, and most importantly, it conveys information on the emotional arousal of a speaker (Cochrane *et al.*, 2022).

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3.1. How pitch reflects emotional arousal

Our indicator of emotional arousal is based on changes in a speaker's vocal pitch, the perceptual analog of the fundamental frequency (*F*0) of a waveform (Rabiner and Schafer, 2010).[5] The perception of the vocal pitch increases monotonically, but not linearly, with *F*0 such that a voice with a higher *F*0 is perceived as higher and vice versa. Each speaker has a baseline *F*0 which is largely explained by biological and physiological factors such as sex and height (Evans *et al.*, 2006; Pisanski *et al.*, 2016). However, a rich psychological literature on the vocal expression of emotions shows that variation in pitch is a robust and strong indicator of expressed and perceived emotional arousal, independently of the verbal content (Banse and Scherer, 1996; Scherer *et al.*, 2003; Bänziger and Scherer, 2005).[6]

Politicians also use other nonverbal signals such as loudness, speech rate, or jeering to convey partisan and policy disagreement. We focus on the vocal pitch for three reasons. First, as already outlined, vocal pitch is a robust indicator of emotional arousal, which we expect to be higher in conflictual and polarizing contexts. Second, vocal pitch is shown to predict legislators' issue engagement and policy priorities in both presidential and parliamentary democracies (Dietrich *et al.*, 2019; Rittmann, 2024) and judges' vote intentions (Dietrich *et al.*, 2019). Third, pitch estimation is less sensitive to recording quality than features such as loudness since it depends less on the spectral characteristics of a sound (Vainio *et al.*, 2023). This is particularly important when analyzing nonverbal features of speech over time.

3.2. Conflict-driven arousal in dyadic exchanges

To be sure, variation in pitch can reflect other motivations than partisan conflict. To mitigate this issue, we consider only a type of interaction in which partisan conflict motives are likely to dominate. Specifically, we consider dyadic exchanges in parliamentary proceedings, where higher emotional arousal expressed in a speech is more likely to indicate partisan conflict than, for example, issue engagement due to the nature of this type of interaction. The partisan nature of such interactions makes them a prime avenue for the expression of partisan conflict. Hence, when legislators target out-partisans in a dyadic exchange, a heightening pitch is, on average, more indicative of partisan conflict in that specific context. Conversely, when legislators heighten their pitch when mentioning their social groups, this is likely more indicative of issue engagement and group commitments (e.g., Dietrich *et al.*, 2019).

3.3. Other drivers of emotional arousal

While we expect conflict motives to dominate variation in arousal in dyadic exchanges, partisan conflict is not the only potential driver of arousal. We illustrate our measurement model in Figure 1 in the form of a directed acyclical graph (DAG).

We rely on theory and evidence establishing pitch as a measure of emotional arousal (link [a]), and we expect arousal to be heightened under conditions of partisan conflict (link [c]). At the same time, prior work has found vocal pitch to be informative of other motivations. Most pertinently, Dietrich

[5]The *F*0 is a physical property of any sound wave whether it arises from human speech, animal calls, explosions, or traffic noise. In the case of human speech, it is defined as "the number of vibrations per second made by vocal folds to produce a vocalization" (Tusing and Dillard, 2000, 150).

[6]The link between pitch and emotional arousal is based on a continuous model of emotions where a human's emotional state can be placed in a two-dimensional space of valence (i.e., sentiment) and intensity (i.e., arousal). Pitch is a measure of the latter and is found to increase in both positive (joy/happy) and negative states (anger, fear, sad). Another model uses discrete emotions such as fear, joy, anger, etc. (Ekman, 1992; 1999). However, while pitch is a reliable indicator of how strong (i.e., aroused) emotions are expressed (Banse and Scherer, 1996), it is a challenging task to discriminate between discrete emotions from *F*0 contours. For this task, text-based measures achieve better results (Widmann, 2021).

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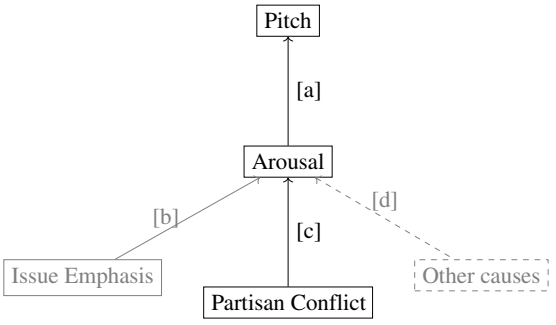


Figure 1. Directed acyclical graph illustrating documented and hypothesized links between pitch, arousal, conflict, and other causes. The link from partisan conflict is highlighted to illustrate that we expect this motive to dominate in the context of dyadic exchanges.

et al. (2019) and Rittmann (2024) use pitch as an indicator of issue emphasis in parliamentary speech. We illustrate this established link as [b] in Figure 1.

Other work uses pitch as an indicator for other types of motivations, namely voting intentions (Dietrich *et al.*, 2019), and inter-party politics (Arnold and Küpfer, 2024). For simplicity, we represent these and other potential drivers of heightened arousal as link [d] in Figure 1. While we theorize that legislators use arousal as a conflict signal in strategic ways (see the presentations of hypotheses 3 and 4), we note that this measurement model in itself does not hinge on that point, i.e., arousal can signal conflict for either strategic or non-strategic reasons.

3.4. Standardization of vocal pitch

We follow extant work and use a standardized measure at the speech level where the pitch is converted to standard deviations above or below a speaker's average (Dietrich *et al.*, 2019; Rittmann, 2024). This is done to parse out heterogeneity arising from speaker-specific voice differences such as physiological and biological factors, akin to the reason for including unit fixed effects in dealing with panel data (Rheault and Borwein, 2019) and to take possible measurement error into account (Dietrich *et al.*, 2019). As a consequence, the estimates reflect within-speaker changes in pitch. We compute the baseline of each speaker as the average pitch in all speeches given by a speaker in our corpus (see 'Data and Measures'). Further information about our pitch measure and the implication of standardization is shown in Supplementary material, Appendix B.[7]

Yet, standardization is not without drawbacks. By removing speaker heterogeneity, we pay the cost of not being able to examine the role of stable speaker-level differences in vocal pitch. Most obviously, the gender gap in vocal pitch suggests that men and women face very different constraints and roles expectations regarding vocal style (Boussalis *et al.*, 2021). In Supplementary material, Appendix C, we show that we find no appreciable effect heterogeneities with respect to gender. The question of individual, including gendered, differences is revisited in the concluding section.

3.5. Validation

The link between vocal pitch and emotional arousal has been extensively validated in the psychological literature (see e.g., Supplementary material of Dietrich *et al.*, 2019), but not explicitly in the context

[7]The unstandardized pitch distribution (Panel F2a) has a bimodal shape arising from the physiological differences in the size of the vocal cords between men and women. If we were to interpret changes in absolute differences in pitch, the results would primarily reflect gender differences rather than differences in nonverbal signals of partisan conflict. Standardization effectively removes this heterogeneity, parsing out all time-invariant speaker-level characteristics.

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of parliamentary speeches and as an expression of partisan conflict. To validate that vocal pitch is a valid measure arousal in such setting, we conduct three validation exercises and an analysis of the measurement error, which we present in additional detail in Supplementary material, Appendix D. To summarize the results of the validation analysis, we show that (1) coders are able to consistently and reliably infer a legislator's emotional arousal from speech-level audio recordings, (2) speaker-standardized speech-level estimates of vocal pitch are strongly correlated with the manual arousal codings, and (3) that pitch is negatively associated with text sentiment, consistent with the assumption that variation in arousal in the context of dyadic exchanges reflects conflict.

4. Data and measures

We validate our approach in the context of parliamentary debates in the Danish parliament, the Folketing. Audio recordings are available for a vast amount of political institutions (e.g., Barari and Simko, 2023), but legislatures, in particular, maintain comprehensive archives with more than a thousand hours of recordings. We focus on Denmark since it is possible to obtain digitized recordings spanning more than two decades of debate, longer than any other archive to the best of our knowledge.

4.1. Text-audio corpus and alignment

We collect all available recordings of plenary sessions in the Danish parliament from October 2000 to September 2022 covering six national elections (2001, 2005, 2007, 2011, 2015, and 2019), 28 parliamentary terms, and a total of 2,186 debates containing 850, 357 speeches. To obtain transcripts of the recordings, we rely on a combination of ParlSpeech V2 and manually scraped XML files. We follow extant work using parliamentary speeches (e.g.,Dietrich *et al.*, 2019; Silva *et al.*, 2025) and remove shorter speeches from the corpus. Shorter speeches are typically either procedural or interjections and interruptions that carry little substantive information for the study of partisan and policy conflict. For the main analysis, we use a threshold of 40 or more words but we show in Supplementary material, Appendix E that the results are nearly numerically identical to the choice of threshold.[8] This leaves us with a total of 393, 264 transcribed speeches. As the next step, we align the transcripts with the corresponding audio using the `Python` library *speechannote*. We were able to align text and audio for 96.3 pct. of our speeches (a total of 378, 566). We elaborate on how we construct and preprocess our data in Supplementary material, Appendix F.

4.2. Legislative votes

For our second hypothesis, we measure policy conflict based on disagreement in legislative voting. We obtain voting records from an enhanced version of ParlSpeech V2 (Rauh and Schwalbach, 2020) where speeches are linked to legislation. This data is available from November 2007 to September 2022. As a final step, we match each speech containing voting records with our preprocessed transcript using fuzzy string matching based on the Jaro–Winkler distance. We were able to match 80 pct. of the speeches in the enhanced ParlSpeech V2 to our transcript.

4.3. Party dyads

Three of our four hypotheses regard dyadic exchanges in parliament, i.e., where the speaking legislator addresses a party either by name or in the form of an individual legislator from that party. To identify dyadic speeches, we rely on a dictionary approach containing the names of all parties and legislators (Schwalbach, 2023). To be classified as a dyad, the speech must reference one party or one of more of its MPs. We refer to such dyadic exchanges as *party dyads* (or, interchangeably, simply 'dyads').

[8]We also remove speeches given by chairs as these contain no substantive information.

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We identify dyads in 38.9. pct of all aligned speeches. Supplementary material, Appendix G shows how the share of party dyads varies over time, and how this relates to the development of inbloc and outbloc dyads.[9]

We use the party dyads to define our main predictors in H_1 and H_2. For H_1, we use a binary measure based on a party's bloc affiliation. The Danish party system is characterized by two blocs, one denoted as left and the other as right. While each bloc contains substantial party differences, this has typically dominated party competition at the national level (Kosiara-Pedersen and Kurrild-Klitgaard, 2018). For H_2, we also use a binary measure based on whether two parties voted together. Importantly, this is conceptually and empirically distinct from H_1 as parties vote across their bloc affiliation.[10] While the share of votes where parties agree is larger within blocs, parties vote between blocs on several occasions (approx. 39 pct.).

4.4. High-profile debates

Our third hypothesis H_3 predicts that legislators signal higher emotional arousal in debates that generate citizen and media attention. This prediction cuts across both dyadic and non-dyadic exchanges. While most debates are low-profile with a principled focus on law-making, the opening and closing debates of parliamentary terms stand out. These debates last an entire day, often over 12 hours, and cover programmatic policy differences rather than specific legislation. Because of their formal status and ideologically charged content, opening and closing debates receive considerable attention from voters, either directly or indirectly through the extensive media coverage of the debates (Osnabrügge *et al.*, 2021). Hence, we define opening and closing debates as high-profile debates here and use the remaining set of debates as the reference category. We collect the dates of these debates, match them to our dataset, and finally generate an indicator of whether a speech is given in a low- or high-profile debate (a total of 6,116 party dyads).

4.5. Target bargaining leverage

Our fourth hypothesis H_4 predicts that legislators use heightened emotional arousal to put pressure on parties with higher bargaining leverage. We measure this using a recent approach introduced in Kayser *et al.* (2023). Briefly put, the authors start from the premise that parties' leverage in the policy process ultimately arises from credible threats to leave the government or the ability to join an alternative government. Building on this notion, Kayser *et al.* (2023) calculate coalition inclusion probabilities (CIPs) using a predictive model with data on historical coalition patterns, party types and ideologies, election results, public opinion polls, and country-level institutional features as inputs. We use CIPs for Danish parties, which Kayser *et al.* (2023) provide at the monthly level starting in 1970. We rely on the static version of the CIP data, which does not rely on information from between-election opinion polls. In Supplementary material, Appendix A, we present the CIPs for each party from 2000-2019.

4.6. Verbal covariates

To rule out that any observed relationship arises due to a strong correlation between verbal and nonverbal speech features, we generate three text-based measures. One reasonable concern is that our nonverbal measure of partisan conflict is encoded in speech sentiment. To account for this possibility, we first define a measure of sentiment capturing the relative use of positive and negative words in a speech using the Danish sentiment tool Sentida (Lauridsen *et al.*, 2019). A separate concern is

[9]We illustrate the distribution of dyads disaggregated to the party level in Panel G2a in Supplementary material, Figure G2 in Appendix G.

[10]See Panel G2b in Supplementary material, Figure G in Appendix G for a visualization of the distribution of voting dyads.

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that our measure merely tracks emotive rhetoric (Osnabrügge *et al.*, 2021). To address this, we follow the approach suggested by Gennaro and Ash (2022) and construct a continuous measure of emotionality at the speech level as our second measure. A final concern is that variation in our nonverbal measure is explained entirely by the topics discussed in party dyads. If polarizing and conflictual policy topics are discussed more in party dyads with an out-party target than in-party targets, an observed relationship could reflect topic selection rather than partisan conflict. If so, this suggests that issue engagement is a confounder. To account for this, we estimate a Structural Topic Model (Roberts *et al.*, 2014) with $k = 40$ and include the resulting topics as fixed effects. For details on how each verbal covariate is constructed, see Supplementary material, Appendix H.

5. Results

We now present results from tests of each of the four hypotheses. To simplify exposition, we first jointly present the results for H_1 and H_2, then results for H_3 and H_4. For each hypothesis, we estimate a series of linear regression models using the OLS estimator. For H_1, H_2, and H_4, the data consists only of speeches classified as party dyads. The dependent variable in all models is the speaker-standardized speech-level vocal pitch during a speech i by each legislator j. We refer to this simply as 'pitch' or 'vocal pitch.' All regression tables are in Supplementary material, Appendix I.

5.1. Hypotheses 1 and 2: polarization and legislative voting

We present results for H_1 and H_2 in Figure 2. Panel 2a tests our first hypothesis predicting that legislators speak with a higher pitch in speeches between polarized pairs of legislators. We test this using an indicator of whether a speech is directed at an outbloc or inbloc legislator. The outbloc measure is a binary indicator that takes the value of 1 if the target and speaker blocs differ and 0 otherwise.

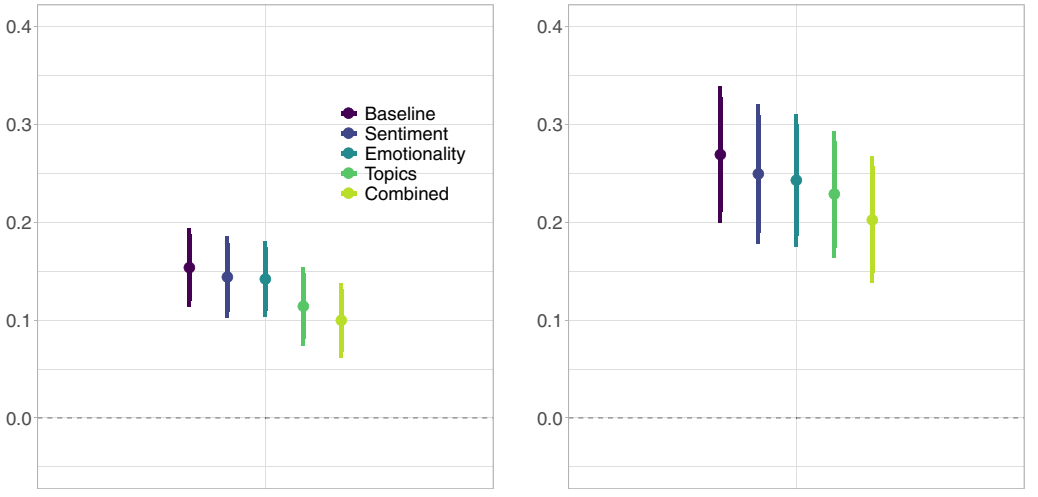
Across all five models, we estimate a positive and significant ($p < 0.001$) coefficient. On average, the estimated effect size indicates that legislators speak with a pitch roughly 0.15 standard deviations higher when talking to outbloc legislators than when talking to inbloc legislators. The relationship is robust to the inclusion of covariates capturing text sentiment, emotionality, or speech topic fixed effects and is only slightly reduced when all three text measures are included. While sentiment and emotionality have virtually no impact on the estimate, speech topic fixed effects result in a minor decrease but remain highly significant ($p < 0.001$).

Turning to Panel 2(b), we test whether changes in pitch also conveys signals of partisan conflict when the conflict concerns policy disagreement and not general polarization. To do this, our second hypothesis turns the focus to legislative bills, where we predict that nonverbal signals also signal a party's bill-level disagreement with other parties. If so, legislators should speak with a heightened pitch when addressing legislators from parties with whom they vote differently.

As for the first hypothesis, we find a positive and significant ($p < 0.001$) coefficient across all five models. The relationship is almost invariant to the inclusion of verbal covariates across the board. Once again, sentiment and emotionality have no impact on the result, but the inclusion of speech topic fixed effects slightly reduces the estimate. Yet as for H_1, it remains highly significant ($p < 0.001$). The estimated coefficient is twice the size of the coefficients for H_1 (0.2) in the full model. Together, the results strongly indicate that legislators use nonverbal communication to signal partisan and policy conflict and that it accounts for a distinct dimension of elite partisan polarization compared to what is captured by verbal expressions alone. The coefficients for policy agreement are roughly twice the size for bloc polarization. This suggests that nonverbal signals of partisan conflict primarily reflect disagreement over policy, at least in the parliamentary arena.

To verify that the results in Panel 2(b) do not simply reflect bloc differences, we also test H_2 using models including dyad fixed effects. We present these models in Table J1 in Supplementary material, Appendix J. The coefficient for policy disagreement is robustly significant across these models and

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(a) Partisan Polarization **(b)** Policy Conflict

Figure 2. Coefficients for partisan polarization (left panel) and policy conflict (right panel) with standardized pitch as the outcome. Predictors are whether the target party is outbloc (left panel) and whether the target party voted differently in a legislative vote on a specific bill. Standard errors are clustered at the dyad level (speaker party ↔ target party). Thick and thin error bars are the model-specific 90 and 95 pct. confidence intervals respectively. Y-axes are held fixed across the two panels to maximize comparability. (a) Partisan polarization and (b) policy conflict.

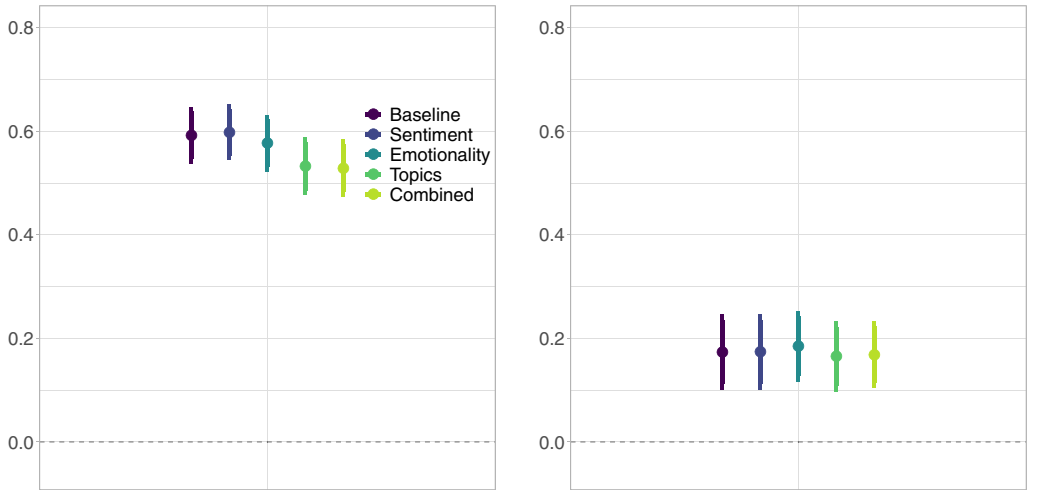
retains the entire magnitude (0.2025 compared to 0.2021) of the coefficients shown in Panel 2(b). Hence, even considering only variation within the same party dyads, nonverbal conflict signals strongly predict policy disagreement. As an additional robustness check, we use legislative vote margin to measure policy disagreement. In Supplementary material, Appendix J, we show that results for H_2 are robust to using this alternative measure. Lastly, to explore the potentially confounding role of time-specific factors, we show results by year and weekday in Supplementary material, Appendix J, finding no significant heterogeneity with respect to time.

5.2. *Hypotheses 3 and 4: Debate type and target bargaining leverage*

We now turn to our third and fourth hypotheses, which are observable implications of a strategic model of nonverbal communication. We use the same specifications with the only change being the predictor in each test. The results are in Figure 3.

Panel (a) reports the results for our third hypothesis, predicting that legislators signal more partisan conflict in debates that attract substantial attention from the general public. We test this by regressing vocal pitch on an indicator of whether the debate is high-profile (= 1) or low-profile (= 0) across both dyadic and non-dyadic exchanges. The estimates reported are the coefficients on this indicator, which capture the average difference between high- and low-profile debates. Consistent with the reasoning in Osnabrügge *et al.* (2021), we expect a positive estimate if legislators use vocal style strategically. Across the five models, this is also what we find. The coefficient is large, positive, strongly statistically significant ($p < 0.001$), and largely invariant to the inclusion of verbal covariates. Once again, the estimate is invariant to sentiment and emotionality but is slightly smaller when topics are included in the model. These results also mirror the findings in Osnabrügge *et al.* (2021), where the relationship is only slightly reduced. In the full model, legislators speak with a .51 standard deviation higher pitch in high-profile debates than in low-profile debates. We interpret this as indicative of a

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(a) Electoral: High- vs. Low-Profile Debates. **(b)** Policy: Target Party Bargaining Leverage.

Figure 3. Coefficients for debate type (left panel) and bargaining leverage (right panel) with standardized pitch as the outcome. The predictors are whether the speech is given in a high- compared to a low-profile debate (left panel) and the policy bargaining leverage of the target party (right panel). Standard errors are clustered at the dyad level (speaker party ↔ target party). Thick and thin error bars are the model-specific 90 and 95 pct. confidence intervals respectively. Y-axes are held fixed across the two panels to maximize comparability. (a) Electoral: high- vs. low-profile debates. (b) Policy: target party bargaining leverage.

strategic model of nonverbal communication as high-profile debates reach a much larger electoral audience.

Turning to Panel (b) and our final and fourth hypothesis, we find that nonverbal signaling of conflict, as indicated by changes in pitch, correlates positively with a party's bargaining leverage. In the bivariate specification, moving across the full range of bargaining leverage is associated with the standardized pitch rising by nearly 0.168 standard deviations. As for the other hypotheses, the relationship is highly robust to including controls for verbal content, and the coefficient in the specification with the full set of controls remains virtually unchanged. Compared to Hypothesis 1-3, topics have no impact on the relationship. Together, the results for H_3 and H_4 are consistent with a strategic model of nonverbal signaling of conflict, suggesting that legislators deliberately use nonverbal communication to further their electoral or policy goals. In substantive terms, the results across the four hypotheses show that nonverbal communication captures a distinct dimension of partisan and policy conflict, and indicate that legislators use nonverbal communication strategically.

All the estimates above are expressed in standard deviations. To contextualize our results, our baseline estimates across tests correspond to around 9 percent (for the smallest observed differences) to around 33 percent (for the largest observed differences) of the difference in pitch between men and women in our sample. All baseline estimates exceed the estimated 'just noticeable difference' in pitch of around 5 Hz (Liu, 2013), i.e., the minimal difference that is discernible to the human ear. In other words, the differences we observe are noticeable, and for the largest estimates amount to around a third of the range in pitch between the average man and woman.

6. Conclusion and discussion

Elite partisan conflict is an important feature of democratic systems, yet our understanding of how elites communicate partisan conflict to citizens is limited, partly because existing approaches only

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consider the verbal content of communication. To expand the study of partisan conflict in elite communication to the nonverbal domain, we examine how elite partisan conflict is reflected in legislators' nonverbal signals. Analyzing audio data from two decades of debates in the Danish parliament, we find that partisan conflict is systematically reflected in a legislator's nonverbal speech signals and that these signals predict subsequent legislative voting. Furthermore, we find evidence consistent with a strategic use of nonverbal communication: Legislators react more strongly to outbloc targets in high-profile debates and when addressing parties with greater bargaining leverage. Importantly, these associations remain largely unchanged when we account for the verbal content of speech, which strongly suggests that nonverbal communication accounts for a distinct dimension of elite communication of partisan conflict.

Some caveats are in order. One set of caveats pertains to our measurement approaches. Our outcome, speaker-standardized vocal pitch, is a somewhat crude measure that may not capture every aspect of nonverbal signaling of conflict. We expect that using a richer set of audio features can provide a more nuanced and fine-grained measure of nonverbal signaling and increase the precision of the measure. Relatedly, conflict signals in a speech are in practice likely to be concentrated in particular sentences or even single words. Our choice to average pitch across the entire speech effectively glosses over this variation. Future research could improve on this aggregation problem, for example by making use of novel methods for multimodal alignment which enable linkage between text and audio data at the word level (Arnold and Küpfer, 2024).

A second set relates to our measures of the verbal content of speech. We have employed a rich set of text covariates, but if these measures do not fully capture the relevant dimension in speech verbal content, our control strategy correspondingly fails to fully account for the role of the verbal content of speech. We see the development of approaches to more directly compare the role of nonverbal communication to that of verbal content as an important avenue for future research.

A third set of caveats relates to external validity. The evidence presented here comes from the Danish parliamentary system, which is characterized by, among other features, high party cohesion, relatively high party system fractionalization, and a low level of partisan polarization. Without evidence from other contexts, it is uncertain how well these findings travel to party systems with other characteristics. This is also true of previous work on audio in politics, which mainly relies on the United States as a case (although see Rittmann, 2024). On this front, we see promise in the largely non-language-specific nature of nonverbal communication. Whereas text data approaches require a cross-language approach to extend to other contexts, a given measurement strategy based on audio features alone could in principle be directly applied in novel contexts without accounting for language changes (Scherer *et al.*, 2001) at least within non-tonal communities. Like Danish, the majority of Indo-European languages are non-tonal, meaning that variation in intonation does not change the meaning of words.

These caveats notwithstanding, our findings hold important implications for the study of political communication and representation. First, our findings expand the set of known features by which elites communicate partisan conflict to citizens. Specifically, we expand this set to the nonverbal domain, studied through legislators' vocal pitch. This in turn implies that any assessment of partisan polarization among elites based on verbal content alone is incomplete: Even in the hypothetical absence of conflict in the verbal content of speech, elites may still signal conflict by nonverbal means. As a consequence, efforts to encourage elites to engage in more civil, bipartisan, and conciliatory behavior should consider both verbal and nonverbal dimensions of communication.

Second, the indication in our findings that vocal style is employed strategically adds nuance to our understanding of the intentionality of nonverbal communication. Consider for example Dietrich *et al.* (2019), who work from the assumption that changes in vocal inflections are "beyond their conscious communication" (238). Consistent with this assumption, the authors find that vocal pitch in US Supreme Court Justices' oral arguments predicts voting over and above what can be predicted from other observables. Comparing our empirical setting to that in Dietrich *et al.* (2019)

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institutional constraints are likely an important moderator. Most obviously, US Supreme Court Justices are lifetime appointees and thus by institutional design immune from reelection incentives. In contrast, we study a parliamentary setting where reelection motives loom large. Our findings indicate that in a competitive parliamentary setting, nonverbal communication is not beyond the realm of conscious communication. Regardless of the role of these plausible institutional moderators, our findings imply that nonverbal communication cannot be assumed to be an 'honest' window into the speakers' true emotional state and that such an assumption would have to be justified in any specific application (see also Rittmann, 2024).

Our findings also have methodological implications for experimental political science. At present, survey experimental treatments in political science overwhelmingly consist of text vignettes designed to convey the stimulus of interest (though see Taylor *et al.*, 2023). This treatment mode dominates even though the nonverbal dimension of political communication carries significant information, which is not reflected in a text vignette but could be captured in, e.g., audio or video snippets. Our findings underscore that researchers have to consider the use of multimodal treatments in survey experimental design.

Fourth and finally, our findings have substantive implications for how individual differences in vocal style condition political representation. Our theoretical framework implies that citizens perceive higher pitch to reflect increased emotional arousal, and our findings and validation analysis are consistent with this dynamic. While our analysis parses out stable individual differences by standardizing pitch within legislators, it is worth considering how a given legislator's communication is affected by their vocal pitch (e.g., Cinar and Kıbrıs, 2023). For example, are legislators with a higher baseline vocal pitch generally perceived as signaling more partisan conflict? If citizens fail to adequately correct for elites' vocal style when interpreting their speech, it could lead to biased elite perceptions. Such misperceptions could underpin for example the perception of women in politics as more emotional, a trait ascription often used to dismiss women candidates (Campbell, 1994). The role of trait inferences, and potential misperceptions, based on vocal style and nonverbal communication more broadly, is an important topic for future research.

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