

Letter

Does Men's Voice Pitch Signal Formidability? A Reply to Feinberg *et al.*David A. Puts^{1,*} and Toe Aung¹

Low-frequency vocalizations may have evolved in males of some species to exaggerate apparent size by exploiting pre-existing sensory biases [1]. Feinberg, Jones, and Armstrong [2] (henceforth FJA) adopt this explanation for men's low voice pitch compared to women's: ancestral males with a lower voice pitch sounded larger to conspecifics and consequently won mating opportunities by attracting mates and/or intimidating rivals [3]. FJA further suggest that voice pitch is not in fact a valid cue to male formidability, and that people's tendency to perceive it as such is a byproduct of a predisposition, evolved in other contexts, to ascribe largeness to low pitch. We contend that selection is unlikely to have maintained costly deference to a character state that is unrelated to formidability.

First, it is important to distinguish between (i) why attention to vocalization frequencies initially evolved, and (ii) how this attention has been maintained. The tendency to associate low frequencies with large body size is probably ancient in vertebrates, and may have evolved because of the importance of assessing size in both inter- and intraspecific competition over resources [4]. In general, larger animals produce lower-frequency vocalizations [3,4].

Of course, attention to vocalization frequencies is open to exploitation by a vocal apparatus that exaggerates apparent size, but game-theory models suggest that such deceptive signaling must be

infrequent for the signaling system to be evolutionarily stable [5]. Otherwise, two outcomes are possible: either organisms will evolve to ignore the signal entirely, or they will evolve to discriminate the deceptive signal from similar environmental stimuli that provide accurate fitness-relevant information [6]. The latter seems to have occurred in fish of the subfamily Goodinae, in which males evolved tails that exaggerate characteristics of their prey, and females subsequently evolved partial resistance to the mimetic stimulus, but not to the prey [6].

However, when traits evolve to exploit a pre-existing sensory bias, sensitivity to them can be maintained if there are attendant benefits. In the frog *Physalaemus pustulosus*, males may have evolved low-frequency 'chuck' portions of their calls to leverage a pre-existing female preference, but the preference is probably maintained in part because males with deeper chucks are larger and leave fewer eggs unfertilized [7]. Men with deeper voices have been found to earn higher incomes [8], win more political elections [9], have more sexual partners [10], and leave more offspring [11]. If men's voice pitch is unrelated to formidability, then the loss of status, mating, and reproduction incurred by deference to men with low voice pitch should favor inattention to this trait. Given that humans have evolved neither insensitivity to pitch generally nor to men's voice pitch in particular, it stands to reason that there are benefits of remaining sensitive to this trait.

One possibility is that women's preferences are maintained via Fisherian processes owing to the benefit of producing attractive sons. Even so, this would not explain the salience of voice pitch in men's intrasexual competition, which has probably been more influential than female choice in the evolution of low male vocalization pitch among anthropoid primates, including humans

[3]. A fundamental question, then, is why people continue to perceive deep-voiced men as formidable, ceding them resources, status, and reproductive opportunities. The likeliest answer would seem to be that the signal is at least partly honest.

This much has already been demonstrated by studies showing that men with low voice pitch tend to be larger and stronger, as FJA note. Nevertheless, as FJA also point out, these associations are weak – perhaps too weak on their own to maintain the strong effects on perception of size and dominance. Beyond strength and size, which may more readily be assessed visually, voice pitch may index underlying health, vigor, and condition more generally (Figure 1). These depend on the interaction of genetic susceptibilities with environmental factors, such as nutrition, parasites, and social stressors, and should be reflected in hormonal profiles. In particular, relatively low stress coupled with good nutritional status should contribute to higher testosterone and lower cortisol levels in males, a hormonal profile that has also been tied to immunocompetence [3]. Precisely this hormonal profile predicted lower voice pitch in two samples of men, but not in a sample of women, explaining ~14% of the variation in men's voice pitch [3]. Voice pitch is also sensitive to social context. In one study, men lowered their voice pitch when addressing a competitor if they viewed him as less formidable, but raised their pitch if the opposite was true [12].

In sum, it is insufficient to claim that low voice pitch evolved in ancestral males to exploit a pre-existing tendency to perceive lower pitch as 'larger'. One must also explain why attention to this stimulus persists. Theory and data suggest that men's voice pitch signals formidability,

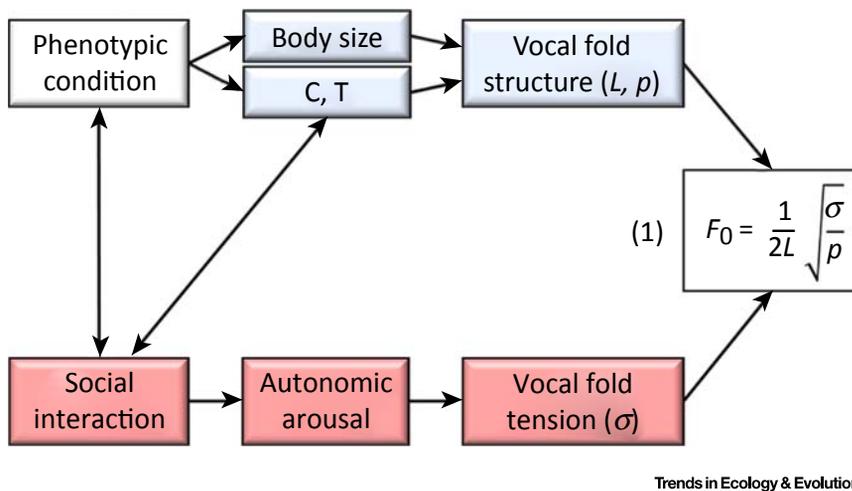


Figure 1. Hypothesized Relationships between Phenotypic Condition and Men's Voice Pitch. Genotype and environmental factors such as nutrition and parasite and pathogen loads (not shown), as well as interactions with conspecifics, determine phenotypic condition. Condition is hypothesized to affect voice pitch (measured by frequency of vocal fold vibration during phonation, F_0) through vocal fold length (L), density (ρ), and tension (σ). Males in better condition should tend to have longer and perhaps denser vocal folds as a result of higher testosterone (T), lower cortisol (C), and greater somatic growth, and should also experience less anxiety and hence less vocal fold tension during social interactions, all leading to lower F_0 . Equation 1 is from Titze [13].

and we hope that this becomes a focal point of future research.

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Letter

No Evidence That Men's Voice Pitch Signals Formidability

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We strongly disagree with Puts and Aung's [1] claim that empirical data support pitch functioning as an honest signal of men's formidability. First, we will outline the evidence for our view, as well as evidence suggesting voice pitch does not reliably signal two other aspects of phenotypic condition in men (immunocompetence and semen quality). Second, we will describe recent empirical work supporting

our suggestion that associations between voice pitch and perceptions of men's dominance are driven by the mistaken belief on the part of the perceiver that larger men have lower-pitched voices. Third, we will discuss some reasons why such misattributions may be maintained.

Voice Pitch Does Not Predict Formidability in Men

The study most commonly cited for associations between pitch and formidability in men is Puts *et al.* [2]. In this study, zero-order (i.e., simple) correlations examining relationships between pitch and height, weight, and arm strength found a significant correlation between height and pitch in the US sample, but not the Hadza sample, and no other significant correlations. The correlation between height and pitch in the US sample would not have been significant if alpha was corrected for multiple comparisons, however. In the Hadza sample, associations between pitch and height, weight, and arm strength were significant in regression analyses with all body measures entered simultaneously as predictors. An identical analysis showed no significant associations between pitch and arm strength or weight in the US sample.

That associations between measures of formidability and pitch were inconsistent across analyses and data sets in the study by Puts *et al.* [2] suggests they are likely to be false positives. Indeed, results of other empirical work support this interpretation. First, a meta-analysis [3] found no evidence that men's voice pitch is closely related to their body size (total $n = 1119$ men). This meta-analysis found that pitch accounted for only 1.7% of the variance in height and only 0.1% of the variance in weight among adult men. Second, many other studies investigating possible associations between pitch and men's physical strength (several of which tested multiple samples of men) have reported null results (e.g., [4–6]). Of these