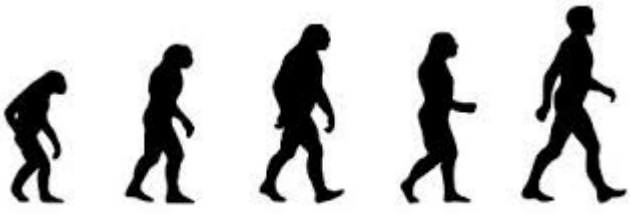

Origin Stories Being Human Episode 17: Speaking of Sex

Meredith Johnson
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This is Origin Stories, the Leakey Foundation podcast. I'm Meredith Johnson.

This episode is another of our live talks from the Being Human event series. This time, we're talking about sex differences and the human voice as a window into understanding human sexual selection.

We humans are very verbal compared to other animals. We talk all the time and our voices can signal lots of things beyond the meanings of the words we're saying, but what can our voices tell us about our evolutionary history? Our speaker is David Puts. Doctor Puts is an associate professor in the Department of Anthropology at Pennsylvania State University and his research focuses on the evolution and development of human sexuality and sex differences. He is especially interested in how sex hormones influence our psychology, behavior, and anatomy and how these traits were shaped by sexual selection. Here's David Puts, recorded live on stage at Public Works in San Francisco.

David Puts
Thank you very much. It's really great to be here. I can't really think of much I'd rather do than talk about human evolution with some smart people, maybe a few adult libations thrown in there. So how many of you, just show of hands, how many of you are interested in and coming to a talk about human evolution? Raise your hand. Okay, just about everybody. That's great. Now how many of you were interested in coming tonight because there was a talk with the word sex in the title? Not bad. Okay, several of you. Thank you for your honesty. The rest of you are liars. It's nothing to be ashamed of. So, happy Valentine's Day, belated. You know, Darwin was actually born two days before Valentine's Day and we're two days after Valentine's Day. Something you might not know about Charles Darwin is that he was a bit of romantic and in this is real. This is a

list of pros and cons that he made for himself about whether he should get married or not, okay? And I've just taken some choice ones that I like here, so not should he not get married or should he get married. So on the side of not marrying; freedom to go where one liked, conversation of clever men at clubs. Okay, I mean, I don't know why you can't do that if you're married, but maybe less of it. No expense and anxiety of children. Preach it, Charles. For sure. Not forced to visit relatives and bend every trifle. Every trifle. On the other hand, on the plus side children. I mean, they're little parasites, but God love them. Constant companion and friend in old age. That's nice. Charms of music and female chitchat. I don't know why you can't listen to music unless you're married. I guess there's more female chitchat if you're heterosexually married or married to one. How about— I like this one though. Picture to yourself; nice, soft wife, on a sofa with a good fire and books and music. That sounds nice, right? Sure. Nice soft wife. And then how about this one? Object to be beloved and played with. Wait, what? I don't know how romantic— and— I'm not kidding about this— better than dog anyhow. Okay, so Darwin the romantic, maybe sort of Victorian era pragmatist is maybe a little bit better.

Something else you might not know about Darwin is that the thought of a peacock's tail feathers made him sick to his stomach. Yeah, he said that and to understand why that was, you have to think about how he was thinking about how natural selection shaped organisms, because he was thinking about organisms being selected to survive in their, what he called, their conditions of life, right? To have traits that enable them to survive where they lived and so when he thought about a peacock's tail feathers he thought look this is a trait that is expensive to produce and maintain and makes them more obvious to predators, harder to get away from predators. I'm getting queasy just thinking about it. So he proposed another kind of selection in later editions of *Origin of Species* and then he wrote a book about it in 1871 about sexual selection. So Darwin said there's another kind of natural selection that favors traits in mating opportunities and in and a way if the trait was helpful enough in winning mates, it could compensate for some detriment to survival. So he called that sexual selection and there are multiple so-called mechanisms or modes of sexual selection, means of competing for mates and I'm going to talk about two of them because in most of this talk I'm going to use the voice as sort of a window into human sexual selection and the two types of sexual selection, the two mechanisms that are most relevant to voice and humans are contest competition and mate choice.

So conscious competition is the use of force or threat of force to exclude same-sex competitors for mating opportunities and it favors traits like large body size and strength and anatomical weapons, like large canine teeth or antlers. Dominance displays to avoid fights because "look I'm definitely going to win, so you should just back down." And then mate choice is just what it sounds like and it favors traits that are attractive to the opposite sex. Sexual displays and ornaments that sort of thing. So, question: Which mechanism of sexual selection is depicted here, of contest competition and mate choice? Contest. Thank you. Good job. Okay, and this is also

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why you don't put two adult male gorillas in the same enclosure in a zoo. They will hurt each other. Doesn't it remind you of football a little bit maybe? Like a defensive lineman? They look like they work out. This is a bird. That's a male right there. A superb bird of paradise. The male takes his feathers and he sticks them out, does a little dance and the female may mate with him or she made fly away. So what mechanism of sexual selection is that? Mate choice. Okay, good job. So I asked you not just to test whether you're paying attention, but also to make the point that we can infer ancestral selection pressures by looking at the traits those selection pressures designed. Form follows function, right? That's going to be important because what we'll do is we'll look at human traits and say "You know, how do they function? What does it look like they were designed for?" What kinds of selection pressure shaped them?

Now before we get back to people I have a little experiment for you. So if you have cell phones, this involves— you're doing a little experiment. I'm going to play this— just the women first. I wanted to do both sexes at the same time; technical reasons didn't work out, so just the women and then we'll do just the men, okay? So I'm going to play two sets of stimuli for you and for women there is a male voice and it's just a pair and you'll tell me which one, the first or the second is more sexually attractive, okay? I'll do it for one stimulus pair and you vote and then I'll do it for another stimulus pair and you vote on that. Which one's more sexually attractive. Okay, you ready? So here we go. Here's the first stimulus pair. They act as a prism and form a rainbow. They act as a prism and form a rainbow. You don't have to want to have sex with this man, but if you had to pick? Okay, did you do it? All right, ready for the next one? This is stimulus B. This is guy B here. They act as a prism and form a rainbow. They act as a prism and form a rainbow. Okay, so now men, your turn. Here's what you're going to answer, if you will oblige me. You guys answer which one sounds more physically dominant, like able to win a fight, okay? Everybody ready? Okay, I'm going to play them. Now this is for guys. They act as a prism and form a rainbow. They act as a prism and form a rainbow. That was the first one, you pick which of those sounds more dominant, first or second. Oh, darn. Hey, the show will go on. I have a feeling our results are going to be difficult to interpret. Okay. Well anyway, should we try one more anyway? would try one more anyway so this again you get to pick which of these two sounds more dominant. Guys, here we go. First or second? They act as a prism and form a rainbow. They act as a prism and form a rainbow. Anyway, okay, so if you've done that, what I manipulated there was the same two guys. One guy's voice and another guy's voice and each of those was just manipulated in fundamental frequency.

And so, real quick acoustics lesson here for you. This is the boring part, then we'll be able to carry through the rest of the talk. So, fundamental frequency is just the rate of vocal fold vibration during phonation. So when we speak air from our lungs force past our vocal folds and they vibrate and things that vibrate more quickly, we perceive as a higher pitch. They're more cycles per second or hertz and things that vibrant more slowly, we perceive that as a lower pitch.

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So fundamental frequency or FO is the acoustic parameter that's closest to what we perceive as pitch and that's what was manipulated there and there's a sex difference in pitch, as you probably know. So boys and girls, there is no sex difference. Eight, nine, ten, eleven years old, there is no difference in fundamental frequency. Sometime between eleven and nineteen years male voice pitch drops precipitously to be half the fundamental frequency, half the cycles per second of female, which corresponds to about an octave in pitch. So there's a big difference and it happens at puberty. Why? Because male testes start producing high levels of testosterone and testosterone cycles through the body, through the blood, like hormones do and everywhere in the body there is tissue that has androgen receptors for that hormone. The hormone binds on and it changes gene expression. So it changes the development of tissue and our vocal folds are lousy with androgen receptors and our vocal folds are skeletal muscle and so testosterone does to them what it does to other muscles, which is it makes them go bigger and that's why athletes abuse anabolic steroids because it makes muscle grow bigger. So that's what happens to men's vocal folds at puberty and as you know from looking inside of a piano, longer thicker things vibrate more slowly and we perceive that as a lower pitch.

Now how big of a sex difference is this? It's really big. That's why you chose— and I study lots of them and students in my lab study lots of different sexually dimorphic characteristics. Characteristics that show sex differences in people; psychological ones, anatomical ones, but voice pitch is a really nice example because it is so dimorphic. Just to give you some examples, I mean, you know that there is a sex difference in height. Men tend to be taller, but there is substantial overlap. The sex difference in fundamental frequency is way bigger. So to give you one example, when we measured over six hundred young adult men and women, there was no overlap. The average speaking fundamental frequency of the highest pitched guy's voice was lower than the average speaking fundamental frequency of the lowest pitched woman's voice. That's a big sex difference of almost six standard deviations, okay? And this is not something that depends— you see the same sex difference regardless of population and language. So these are some data from the Chumani are forger horticulturalists, and so anyway, you see the same thing across societies and what a nice trait then to use as a sort of lens for studying human sexual selection.

Sexually selected traits like a peacock's tail feathers tend to emerge— oh, Spartans? Yeah this is Michigan State, the Spartans— yeah I should've mentioned that. Sexually selected traits tend to emerge at sexual maturity and they tend to show sex differences like a peacock's tail feathers. Peahens don't have them. Peacocks have them and they grow then at puberty. So here's a question; why do we have— we are in incredibly verbal species. We communicate acoustically through vocalizations like no other species and both sexes do it. So why would there be such a big sex difference in a mode of communication that both sexes use so equally and so that's a really important question to try to address because it can tell us something about our

evolutionary history and how selection has shaped us. Now, one of our approaches to studying this question has been to look at sex differences and fundamental frequency in primates generally. And so what we did is we collected the largest, to our knowledge, the largest in the world collection of primate vocalizations. Anthropoid primates, so monkeys and apes of known sex and adult status. As far as we know the biggest collection the world. Thousands of recordings. We selected over 1700 of them that were of sufficiently high quality and we measured fundamental frequency in all of those so we could characterize the magnitude of the sex difference in each species, okay? So these are the species shown here for which we have both sexes represented well and the green, by the way, is the range of nonhuman primates in the world. So you can see that our collection covers the range pretty well too. You want to hear some? Okay, so I'll play a few for you. What animal do you think probably has low pitch vocalizations, like a male gorilla, right? Okay, so here's that. That's a bit intimidating. If you're walking through the jungle and you heard that. "That's the end of me." Okay, prepare yourself. This is not going to be pleasant. So that's the low range. This is the high end of the range. This is a cotton-top tamarind. Sounds like somebody with a balloon. This one I love. This is a silvery gibbon and it's haunting. It's kind of beautiful. Anyway, so this is actually a female silvery gibbon. Catcalling.

So that's the range of the variation and we could use this cross-species comparison to try to figure out about the evolution of sex differences in fundamental frequency and anthropoid primates in general. And one of the explanations that we could rule out early on is that we have our sex difference due to something called phylogenetic inertia. Basically we just inherited it from a common ancestor, but there hasn't been any selection in our species to have a sex difference. It's kind of been moving along from an ancient ancestor, but in fact— this is, I know, this is a bit of complicated phylogeny, although I hear that you've seen other ones before— and so you're okay with these, but anyway, these are the sex differences and this is male over female fundamental frequency. So the smaller the number, the more . The bigger the sex difference the smaller the number and what you can see and hear, this is us. Homosapiens and what you can see when we reconstruct ancestral states, this is the common ancestor of the apes, here's the common ancestor of the African apes, that's what we are, here's the common ancestor of the great apes and then chimps and humans. There's a monotonic increase in sexual dimorphism. Males get lower pitch relative to females, as you get closer to people until you get to humans where of all the apes that we measured, we are the most sexually dimorphic in fundamental frequency, even more than gorillas and orangutans.

So phylogenetic inertia or no, it looks like there's been selection specifically in our lineage for a bigger sex difference. So why? Well, we tested the sexual selection hypothesis that it has to do with mating competition and in primates you get more intense mating competition among males in a polygynous mating system. So, in gorillas, one male can have multiple mates at the same

time, but then other males have no mates at all and so there is intense competition to be one of the males who has lots of mating opportunities versus one who has no mating opportunities and doesn't leave any offspring. In a monogamous species, sexual selection is less intense. Everybody has a mate, pretty much. Okay, so what we tested is when you see evolutionary transitions toward monogamy do you see an increase in fundament frequency dimorphism and yes you do and evolutionary transitions toward monogamy— did I just say polygyny or monogamy? I said it the wrong way— when you have evolutionary transitions toward polygyny you see bigger dimorphism. When you see transition toward monogamy there is a decrease in dimorphism. So that suggests a couple things; number one that sexual selection plays a role in the evolution of differences in pitch in nonhuman primates and it suggested it might have something do with male/male competition for mates because it's males that are competing intensely for mates in a polygynous mating system versus a monogamous one, but it still possible that maybe in humans there's been selection on women to have a high pitch, you know? Maybe that increases male attraction and for sure women's voices are important in mate choice in people. They contain information about mate quality and I'll just give you one piece of evidence that we've found in my lab and I just think is fascinating.

We measured the same women two times in the cycle. We tried to target the late follicular phase when conception risk is highest and the mid-luteal phase when conception risk is zero and we collected voice recordings and then saliva samples to measure estradiol and progesterone which have a one-to-one relationship with conception risk. Basically, when estradiol is high and progesterone is low, that's the fertile part of the cycle. The non-fertile part of the cycle, estradiol's low, progesterone is high and what we found is that changes in the same women, this is over two hundred women, in the same women changes over the cycle in estradiol and progesterone predicted changes in voice attractiveness. So the women's voices were most attractive when progesterone is low and estradiol is high corresponding with the fertile part of the cycle. That's cool and it suggested that and other types of evidence that link women's voices to mate quality suggests that maybe men's preferences for women's voices drove fundamental frequency up.

There are a couple of problems with that; number one, you remember women's voice doesn't get hire at puberty; its men's voice drops lower, but the more important one is that this isn't mediated by fundamental frequency. In other words, the change over the cycle in voice attractiveness is not because of a change over the cycle and pitch and furthermore, when you look at women's voices and you see how much of the variation voice attractiveness is explained by fundamental frequency, it's almost none when you control for other acoustic parameters. So that's probably not mainly what's going on, but there is better evidence for sexual selection in men and these are results from a study where I took the same voices and I manipulated them to be more masculine or more feminine, played them for women and these are all normally cycling women and I got

information about where they were in the ovulatory cycle and the prediction, and this is based on previous theory, was that a deep, masculine voice might be an indicator of genetic quality in males. So the prediction is that women would prefer a more masculine voices at the fertile time in the cycle and specifically for sex versus for a long-term relationship. That's when you could take advantage of mating with a male with good genes is having sex at the fertile time in the cycle and that's what I found and this result has been replicated by a couple of labs since then. However, the effect on— women like a more masculine voice, but a little bit. More at the fertile time of the cycle and more for sex and it's really not that big of an effect compared to the effect on the appearance of dominance to men. The effect size is fifteen times as great. The same manipulation in voice pitch has a fifteen times greater effect on how big and scary a guy sounds. It's like it's an exaggeration of size, you know? Some species do this pylo-erection, they stick up their hair. It looks like in humans that's what happened. Men evolved a deep voice to exaggerate their size.

Now, let's have a look at your results from the experiment that we just did. This could be all over the place. Okay well, that's exactly what I said. I think that either worked or I just got super lucky. Women preferred lower pitch on average, but it had a little effect and lower pitch had a way bigger effect in dominance. Hey, that's great. We're doing a bigger version of the study across as many human cultures as we can collect right now, traditional societies and that sort of thing. So, this is promising because I haven't actually started looking at the data we collected from other societies. So the fact that it worked under these conditions, I'm optimistic. But here's the thing; when I started studying voice, I thought here's a trait that has to be sexually selected. It has all the hallmarks of a sexually selected trait. It emerges at sexual maturity, is highly dimorphic, that sort of thing and once I started studying it, I started finding these results and that was different from that of the literature that was around in evolutionary anthropology and evolutionary psychology at the time, which is that men were like peacocks and their traits were shaped by female choice and I wasn't seeing that. And when I started looking at other literature and doing research on other traits you see the same pattern over and over which is when you manipulate putative sexually selected traits in men, whether it's a masculine body or facial masculinity, just the same face, but manipulated to either be more feminine or more masculine or beards versus no beards, or voice, whatever it happens to be, women might prefer a little bit more masculine than average.

Generally, they prefer around the average. Very curvilinear. You get very masculine is less attractive. Women don't prefer as muscular of a guy as guys think that they do, for example. And women like a little bit taller than average, but not too tall and for face stuff some studies find that women prefer a little bit more feminine in the average face, but that is against the backdrop of a very constant effect of the more masculine, the more dominant. It really looks like we go back to form follows function and how we can infer your ancestral selection pressures by looking at the

traits that those design. Men's traits look like they were designed to function in contest competition. They are way better that than they are at attracting females. So, most studies find that beards make men less attractive. So public service announcement for the men out there. Although, the five o'clock shadow wasn't bad, but full beard, but it depends what you want because they are really good at making you seem older and more dominant. Now, so in this regard, our apple hasn't fallen far from the phylogenetic tree. We're like our closest relatives. Males compete for mates mainly via contest competition, but what kind of a Valentine's Day message is that? It's a little dark. It's well documented that you came to hear about sex and maybe love and I tell you about how our male ancestors intimidated one another and beat other up. Where's the love? Here it is. Maybe monkey love, but more to the point, this is a way in which we're different from many other primates. In some female primates like here, our closest relatives, chimpanzees, females advertise where they are in the cycle through genital swellings like these, changes in behavior and other primates may not have these really conspicuous cues to ovulation, cues when their fertile in the cycle, but nevertheless their ovulation is still conspicuous. You can tell.

But we're not like that all. So why is ovulation so hard to detect in people? Why does it look like it's been concealed over evolutionary time? This is why. These are data from chimpanzees and these are copulations with the alpha male. You can tell when females are ovulating, the alpha male or dominant males monopolized those copulations. These are from ten females across twenty six cycles total and look at this; the shaded is the fertile window and the alpha male monopolized not just copulations in the fertile window, but he even got the day before and the day after. He's got it and those other males may copulate with the females, but it's not during the fertile time of the cycle. Okay, that's fine if you're female in a species where all you can really get from males is sperm you know? But that's basically the benefit you get is good genes. Mate with the dominant male, you probably get healthier, stronger offspring, but some time in the last few million years, as our brains got bigger and our offspring got needier, men started investing in their mates and offspring and that's especially true for the subordinate males because for them that's a good deal. It's better to get a mate than not have any mate at all and direct your reproductive effort toward your own offspring, but that's the problem. If ovulation were not concealed then the dominant male would monopolize copulations and males couldn't invest in their own offspring. So, concealing ovulation is a strategy for females to control mating access to themselves and so we have all these changes. I think it's reasonable to say that all these things evolving together concealed ovulation, male investment, females having sex throughout the cycle, not just in the fertile window and evolving a preference for investing males that those are very much part of, in our lineage the evolution of romantic love, and that is a better Valentine's Day message don't you think? Thank you.

Meredith Johnson

Thanks for listening to this Being Human episode of Origin Stories. Being Human is a joint initiative of the Leakey Foundation and the Baumann Foundation. Dedicated to understanding modern life from an evolutionary perspective. If you are in the San Francisco Bay Area please join us for out next Being Human event. They're lots of fun! Our next event is call "Born and Evolved to Run" and the speaker is Daniel Lieberman of Harvard University. It's happening on July 28, 2016, and tickets are on sale now. You can go to leakeyfoundation.org/beinghuman for more information. That's L-e-a-k-e-y foundation.org.

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