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This paper promotes a sophisticated treatment of gender in variationism through a large-scale quantitative analysis of creak, a nonmodal voice quality stereotypically associated with women in US English. An analysis of our gender-diverse corpus, including cisgender, transgender, and nonbinary individuals, finds that gender does not predict variation; all gender groups produce high rates of creak. However, gender does interact with style: all speakers use more creak in interview speech compared with read speech, but some groups style-shift more than others, suggesting that gender remains a relevant factor in capturing how creak is deployed as a resource in social practice. We use this analysis to advocate for a move beyond the gender binary in quantitative descriptions of sociolinguistic variables and call for the greater inclusion of trans+ individuals in sociolinguistics.

[illegible]: creak; creaky voice; voice quality; gender; transgender; trans+; nonbinary

by the literature. Some studies confirm this finding: Szakay and Torgersen (

differentiation in language use. The following section outlines how we aimed to do this through our binning strategy.

Speakers

From a larger corpus, we analyze forty-three individuals who are diverse with respect [illegible] **1.** Gender categori ations for the fort -three participants in our sample

		Identif as omen	Identif as men	Identif as non-binar	Total
[illegible]	[illegible]	cis omen	**2** trans men not on testosterone	non-binar AFAB indi iduals not on testosterone	**14**
	[illegible]	**0**	trans men on testosterone	non-binar AFAB indi iduals on testosterone	**12**
[illegible]		trans omen	cis men	non-binar AMAB indi iduals	**1**
[illegible]		**12**	**14**	**1**	**43**

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Each sound file was transcribed orthographically and fed through the Forced Alignment and Vowel Extraction (

voice quality coding was 86%. In situations where the two coders disagreed, a third resolved the discrepancy; if this did not resolve disagreement, the vowel was removed from analysis. Our methods yielded a dataset of 34,078 vowels, an average of 793 per speaker.

A series of mixed-effects logistic regression models using the lme4 package (Bates, Mächler, Bolker, & Walker, 2015) in R were fit to the data. We collapsed the codes for voice quality into a binary response variable, creaky versus noncreaky. In all models, positive estimates indicate higher creak. The fixed effects were Style (two levels: interview, reading), IP Boundary Tone (four levels: High-Rising [HH], High-Plateau [HL], Low-Rising [LH], Low-Falling [LL]), Stress (two levels: unstressed, stressed), Pitch accentedness (two levels: unaccented, accented), Position-in-IP (two levels: IP-final, nonfinal), IP Initial Vowel (two levels: yes, no), and Gender. Word and Speaker were included as random intercepts.

We explored the operationalization of Gender in a variety of ways. In terms of binning, there were two main options given the information summarized above in Table 1. The first was to treat Assigned Gender + testosterone exposure (three levels: AFAB no testosterone, AFAB + testosterone, AMAB) and Gender Identity (three levels: women, men, nonbinary) as two separate interacting factors. Another option was a combined factor (eight levels: cis women, trans men, nonbinary AFAB, trans men on testosterone, nonbinary AFAB on testosterone, trans women, cis men, and nonbinary AMAB).

Before comparing these options, we attended to releveling. While R defaults to the alphabetically first factor of a categorical variable as the reference level, many scholars choose to select a more meaningful baseline. We resisted selecting any one category as "normative," given our theoretical stance on gender diversity and so, instead, selected the category with the largest number of observations, a deliberately neutral choice, making our reference level for Assigned Gender AMAB, for Gender Identity nonbinary, and for the combined factor nonbinary AFAB on testosterone. For models with separate gender factors, we included an interaction term. We also explored the interaction of gender and style but did not explore interactions between linguistic and social factors due to space and modeling constraints. We assessed model fit through ANOVA comparisons in R.

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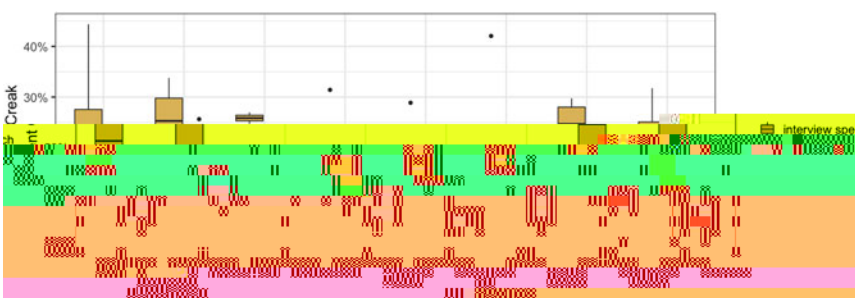
Due to space constraints, we do not discuss here the findings for prosodic factors, except to note that they align with the prior literature: creak is significantly more likely in syllables that are unaccented (Roessig, Winter, & Mücke, 2022:4), onsetless IP-initially (Dilley et al., 1996:423; Garellek, 2014:106), IP-final (Abdelli-Beruh et al., 2014:187; Podesva, 2013

3. Effect of St le and Gender on percent creak

	Estimate	Std. Error	Pr(>)	Tokens	Percent creak
(Intercept)	1.39106	0.30386	4.70e-96 ***		
St le (reference le el: inter ie)				22722	31%
Reading Passage	0.71606	−8.142	3.88e−16***	11356	26%
Interaction: St le*Gender (reference le els: inter ie nonbinar AFAB on testosterone)				1232	36%
reading:cis omen	0.68764	0.10558	7.38e−11***	671	39%
reading:trans men not on testosterone	0.08737	0.15184	0.565035	149	28%
reading:nonbinar AFAB not on testosterone	0.45048	0.11544	9.53e−05***	367	23%
reading:trans men on testosterone	0.17260	0.11859	0.145554	265	18%
reading:trans omen	0.35506	0.11230	0.001568**	423	26%
reading:nonbinar AMAB	0.30680	0.12236	0.012163*	303	27%
reading:cis men	0.28509	0.11381	0.012247*	350	21%

Despite the prevalent link between creaky voice and gender in the scholarship and public sphere, gender is not a significant predictor of creak in our data. There is, however, a significant interaction of gender and style. Overall, speakers use more creak in interview speech than in the reading passage, and there are significant differences in the degree of shift based on gender. Nonbinary AFAB individuals on testosterone and trans men, regardless of hormonal status, pattern similarly across styles, more greatly



2. Mean percent creak b St le and Gender.

differentiating interview speech from the reading passage. Notably, these speakers are all AFAB, but do not identify as women. In addition, two of these groups are composed of individuals who have elected hormone therapy to masculinize their bodies (the only two in our sample). Taken together, these results could suggest that individuals in these groups may be disinclined to use features linked ideologically with femininity when asked to perform a reading task. Despite different overall rates of creak (e.g., trans men not on testosterone are the creakiest in interview speech, at 39%, while trans men on testosterone are the least creaky, at 24%), one possible interpretation is that these speakers' investment in moving away from normative femininity is evident in their style-shift patterns.

In contrast to the above groups, nonbinary AFAB individuals not on testosterone, trans women, nonbinary AMAB individuals, cis women, and cis men all demonstrate a significantly less substantial change in creak use when moving from interview speech to the reading passage. Given the range of assigned genders at birth, current gender identities, and exposure to testosterone during puberty, we hesitate to offer an interpretation that unites these groups in somehow attending "less" to creak in a more formal style. Using our speculative interpretation above for three groups who may be invested in a greater reduction in creak use in more formal styles, it may within-group heterogeneity and bolstering our argument that quantitative scholars can and should supplement statistical findings with insight from analysis of individuals within these groups.

We elect here to focus on the creakiest speakers to demonstrate this approach. Figure 3 confirms that the highest rate of creak overall in the sample was produced by a cis woman, in line with prior research linking creak with cisfemininity. The ten creakiest speakers, however, are a diverse group including cis women, a trans woman, a trans man on testosterone, nonbinary AFAB individuals, nonbinary AMAB individuals, and a cis man. Figure 4 zooms in on the five creakiest speakers, with means grouped by style. We see both confirmation of the group-level style analysis (e.g., the nonbinary AFAB individual on testosterone shows a more substantial style-shift in the expected direction than others like trans woman Cleo) as well as disalignment in individual practice (e.g., both cis woman Jackie and the nonbinary AFAB individual show a higher mean in read speech). We move now to a presenta-

Excerpt 1: Cleo in elementary school

C Reasons for pulling me ... an in ...

vail ...

A ...

had

04 I: (Oh, wow.
05 J: ,
06 , ho al,
07 ,
08 In high sch .
09 .
10 cla .
11 I: Mhm. What kind of art do you do?
12 J: Um,
13 I'm interested in sculpture?
14 Um, so.
15 I, u .
16 I learned how to weld,
17 Then li ,
18 into metal cast ,
19 And ceramics and,
20 I was really into mobiles for a while.

The role of affect may be important specifically because of its indexical link to gender (Mendoza-Denton, 2011:266). Affect itself is gendered, and the ways in which individuals delve into different types of affect-laden topics could be one way creak accumulates gendered meaning. As a cis woman, Jackie's use of creak when less engaged could support the notion that cis women have stabilized with high rates of creak that they need not attend to; at the same time, she does make use of creak in social practice, departing from a baseline high rate as she expresses greater engagement. Cleo's analysis moves us beyond the group-level conclusions, as the use of creak to index negative affect is found across gendered groups and serves as a reminder that this linguistic resource, like others, will operate on the ground to index highly local and personal stances which may or may not come to be associated with gender or other larger social constructs.

[illegible]

Overall, we find that gender does not predict creak in our gender-diverse sample. All of our speakers produce extremely high rates of creak; the sample mean of 29% is higher than any reported in the related literature for English. While our sample of younger speakers is not directly comparable to other samples, it is worth noting that Podesva (2013:430), with an overall rate of 19% creaky syllables, found no age affect in his stratified sample, and Yuasa's (2010:325) sample finding rates of 12.5% for women and 5.6% for men was also restricted to young speakers. These studies are slightly older, making it likely that creak is continuing to increase in young speakers of English, a finding confirmed in Eckert and Podesva (2021:29-30). Importantly, all of our speakers are quite creaky, regardless of gender.

The interaction of gender with style offers tentative support for the perspective that creak indexes cisfemininity in some cases, if we interpret the more dramatic change from interview to read speech in most of the speaker groups assigned female at birth who are not women (nonbinary AFAB individuals on testosterone, trans men, and trans men on testosterone) as evidence of these speakers' modes of disalignment with cisfemininity. Importantly, these patterns were present only when comparing across styles, not in the groups' overall rates for creak. In this way our results do not align with the binary takeaway from the prior literature, that women are creakier than men. That being said, it is important to note that, had we sampled just the cis women and cis men here, we would find a significant difference between these two groups. It is only when expanding the sample for gender that this pattern falls away. This is a crucial contribution of our analysis–the significant patterns change when we sample the full range for our social variable. By analogy, we might imagine if the standard practice was to sample only upper- and lower-class speakers, find a difference, and then conclude we had presented an accurate picture of socioeconomic differentiation. For gender, by focusing on the two largest, most dominant groups, we may identify extremes but fail to document the fine-grained patterns of variation present in society, patterns that have been critical to the advancement of sociolinguistic theory. We argue that the use of similarly diverse samples could have enormous import for variationist sociolinguistics, both in revisiting classic findings for gender differentiation and for new research.

At the same time, we recognize a few realities. First, the gender binary is well-established in the literature, and comparability across studies is important to the field. Some have even argued that understanding language and gender is not the point of including binary gender as a factor in variationist analysis; instead, the gross categorization allows us to replicate and test for general principles of sociolinguistic stratification and language change (Labov, 1990:11). We do not reject this practice wholesale, but we believe responsible analysis of aggregate patterns requires more rigorous methods for collecting gender-related information, attention to the ethics of gender representation, and the exercise of caution and a critical mindset when interpreting these patterns.

Another reality is that community sampling can present challenges to building more diverse samples. While Eckert (2014:533) suggests it may not yet be possible to move beyond the binary with large-scale sampling, we believe that in many situations it is, and increasingly so. We also recognize that variationists will continue to build sampl(e)-3[(the)ojsoglyt(t)oi0s i-8.1e10.9(2(th)-6.1(e)23.1(t)-398.39binanng)-330.4(mil

well enough, our theories may dispense with some of those categories altogether." Such a shift would not only advance our discipline's theoretical capacities directly but also transform it into a field that engages and empowers trans+ students, scholars, and communities.

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1. Of course, not all studies, particularly outside Western contexts, find support for these adages (James, 1996).

2. https://dataverse.harvard.edu/dataset.xhtml?persistentId=doi:10.7910/DVN/M1EKER

3. In an exploration of correlations between auditory ratings for creak and acoustic cues, we found that higher ratings for creak correlated with lower f0, but not with H1-H2, and additional results were complex (Khan, Becker, & Zimman, 2015).

4. When providing a third forced-choice option, or the option to self-identify as neither female nor male, let respondents know your plan for analysis (i.e., that you will bin speakers into categories with enough members to compare across groups). This may allow a trans+ person to make a selection that will allow their voice to be included.

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1. Best Fit Model: Creak ~ IP.Boundar .Tone + PitchAccented + Stress + IP.Final + IP.Initial.Vo el + St le*Gender + (1 Word) + (1 Speaker) *Fixed effects:*

	Estimate	Std. Error	Pr(>)	Tokens	Percent creak
(Intercept)	−1.39106	0.30386	4.70e-96***		
IP Boundar Tone (reference le el: H-H%)				2382	22%
H-L%	−0.09123	0.06475	0.158825	8777	24%
L-H%	0.19677	0.06441	0.002252**	9180	26%
L-L%	0.84333	0.06225	<2e-16***	13739	37%
Pitch Accented (reference le el: not accented)				19572	28%
Pitch Accented	−0.09126	0.03371	0.006795**	14506	31%
Stress (reference le el: unstressed)				26167	30%
Stressed	−0.14701	0.04346	0.00719***	7911	27%
IP Final (reference le el: non-final)				24785	25%
IP-final	0.82772	0.03488	<2e-16***	9293	41%
IP-initialV (reference le el: initial non- o el)				30852	26%
Initial o el	0.83321	0.06024	<2e-16***	3226	47%
St le (reference le el: inter ie)				22722	31%
reading passage	−0.71606	−8.142	3.88e-16***	11356	26%
Interaction: St le*Gender (reference le els: inter ie non-binar AFAB on testosterone)				1232	36%
reading:cis omen	0.68764	0.10558	7.38e-11***	671	39%
reading:trans men not on test1Tf5.8t0H7-0(18.6135P9s.)132.7101e19677		0.30386	4.m(e)0339(848).1(1493771)-4473.2(39%)T0-.365		

Table 1. (*Continued.*)

	Estimate	Std. Error	Pr(>)	Tokens	Percent creak
reading:trans women	0.35506	0.11230	0.001568**	423	26%
reading:non-binar AMAB	0.30680	0.12236	0.012163*	303	27%
reading:cis men	0.28509	0.11381	0.012247*	350	21%

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