Why Frisian [ɪ] is really [i̞] or [e̞]

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Yn dit artikel ûndersykje wy de akoestyske posysje fan it Fryske heech-middel foarlike lûd dat meast as <ɪ> transkribearre wurdt en tusken de kardinale fokalen [i, e, ʉ, ɵ] pleatst wurdt. Op basis fan in grutskalich korpus mei foarlêzen en spontaan Frysk brûke wy Bayesiaanske mixed-effects-modellen om út te sykjen yn hokker diminsjes [ɪ] signifikant ferskilt fan dy oare lûden, en foar hoefier't dy ferskillen strike mei in transkripsje fan <ɪ>. De resultaten litte sjen dat de akoestyske posysje fan [ɪ] wat F1–F2 oangiet kompatibel is mei de posysje neffens [i] en [e] op 'e offisjele kaart fan 'e IPA. Wy konkludearje dat de Fryske [ɪ] akoestysk sjoen liket op [i̞] of [e̞], en dat in transkripsje fan <ɪ> notaasje-technysk passend is en in adekwate werjefte jout fan de wurklike fonetyk fan it lûd yn kwestje.

This paper investigates the acoustic position of the Frisian high-mid front vowel, traditionally transcribed as <ɪ> and located somewhere between the cardinal vowels [i, e, ʉ, ɵ]. Working with a large-scale corpus of read and spontaneously spoken Frisian, we used Bayesian mixed-effects models to find out in which dimensions [ɪ] differs significantly from these other vowels, and whether these differences are compatible with a transcription of <ɪ>. Results show that the [ɪ]'s acoustic position in F1–F2 space is compatible with its position relative to [i] and [e] on the official IPA chart. We conclude that Frisian [ɪ] is acoustically similar to [i̞] or [e̞], and that its transcription as <ɪ> is therefore not only notationally convenient, but also adequately representative of this vowel's actual phonetics.

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1 Introduction

The West Germanic language family exhibits a striking degree of richness and complexity within its constituent languages' vowel systems. While many vowels' realizations overlap (e.g. Frisian [i] is pretty much in the same spot as Dutch [i], English [iː], and German [iː]), there is a notable lack of commonality in the realizations of the vowels [ɪ, ʏ, ʊ, ə, æ, ɐ]. These vowels have no fixed locations in the vowel space, and hence may vary in ways that their placement in the usual IPA chart does not suggest. For example, [ʊ] in English is more central than the IPA chart would suggest, whereas in German the 'same' vowel by notation is realized further *back* than its position on the chart implies.

As Ladefoged and Johnson (2011) explain, for a vowel chart to be interpretable the vowels must be plotted with reference to certain fixed points. There are two types of fixed points available in the vowel space. First, the limits of the vowel chart anchor the possible vowel qualities defined in articulatory terms. For instance, the point in the extreme upper left corner represents a vowel with the highest and most front quality, [i]. Second, the vowel chart is further structured by the so-named *cardinal vowels*, proposed by Jones in his *Outline of English Phonetics* (1956). These vowels form reference points among the four levels of height and three levels of backness that the current version of the IPA chart (Figure 1) canonically distinguishes. Hence, cardinal vowels exist to provide reference points in a cross-linguistic perspective: any vowel quality, from any language, can be described by interpolating between these reference points.

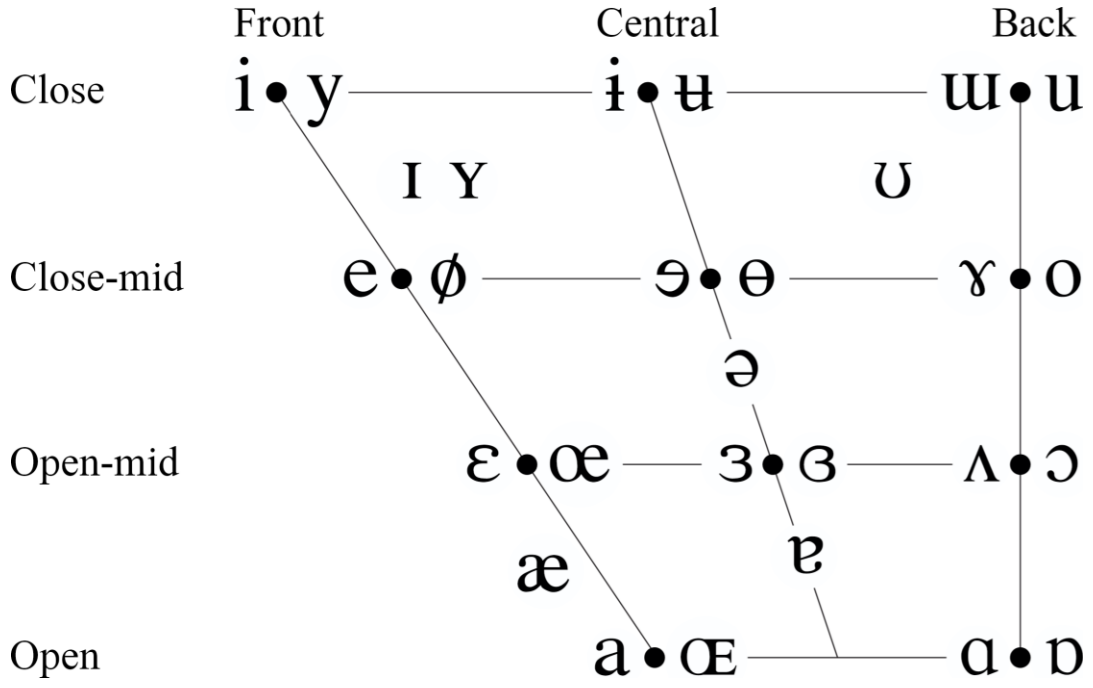


Figure 1: The official IPA chart (International Phonetic Association 2026). Reproduced with permission. Where symbols appear in pairs, the one to the right represents a rounded vowel.

The lax vowels /ɪ, ʏ, ʊ, ə, æ, ɐ/ are located at noncardinal positions. Despite the visually fixed position in which they are presented in Figure 1, their phonetic implementation is not shared across different languages, which makes it impossible for a professor of Phonetic Sciences to teach students any canonical perceptual goals, auditory cues, articulatory implementations, acoustics, and their relations, for those vowels. The IPA chart, whether intentionally or out of necessity, sidesteps this issue by projecting the rich human vowel space onto the necessarily limited 2-D axis system shown above, which necessarily incurs the loss of any differences along other dimensions like tenseness (if such a label is even descriptively accurate at all; cf. Rietveld & van Heuven 2009: 72). The current paper investigates the height–back positioning of one of these 'uncanonized vowels': the Frisian high-mid front vowel [ɪ]. Using a large corpus of spoken Frisian, we compare the F1 and F2 values of [ɪ] to those of its four surrounding vowels [i, e, ʉ, ɵ][1]. The aim is to verify whether <ɪ> is the right notation for this Frisian phoneme, as heard in words such as *ik* 'I', *dit* 'this', and *skip* 'ship'. More broadly, this question touches on an issue central to Boersma's work on the phonetics-phonology interface: how structured phonetic input relates to acoustic category formation and phonological or lexical representation (cf. Boersma, Chládková & Benders 2022).

The transcription of the Frisian [ɪ] has a convoluted history. Phonologically, it is said to form a pair with the long /eː/, making it the only short–long opposition in the Frisian inventory traditionally represented by different IPA symbols (Visser 2015). The qualitative nuances of this vowel were noted long before the IPA gained ubiquity. Early grammarians categorized it using descriptive labels such as *scherpkorte i* ('sharp-short i'; van Blom 1889: 16–17), *klear koart sletten* ('clear short closed'; Postma & de Clercq 1904: 6), or *dofkorte i* ('muffled short i'; Sytstra & Hof 1925: 16). Modern grammars (Popkema 2018, Tiersma 1999) generally classify the vowel as a short high-mid front unrounded vowel, typically employing the symbol <ɪ>. However, traces of descriptive labels remain: Shimizu (2006:56) uses <ɪ> but feels compelled to add the clarifying gloss *i 閉* 'closed i'. The exact position of the vowel has been described differently in literature. Eykman (1907: 32) opted for <E>. He wrote:

[1] The phonologically inclined reader, especially when familiar with the Frisian transcription tradition, might wonder why we write the final two vowels as <ʉ, ɵ> rather than <y, ø>. The answer is that the focus is phonetic here: while true [y] exists in languages like French, the corresponding vowel in Frisian (and Dutch) is consistently more mid-front, and although this category has sometimes been labelled as /y/ at the phonemic level, this carries no necessary implications for its phonetic realization. We therefore, correctly, write <ʉ>. Similarly, we use <ɵ> to describe the vowel in words like *put* or *suster*.

> To distinguish this lax sound from the tense [e] […], I had to use a special sign. I didn't choose [ɪ] because that sign designates a sound that is more closed than [e] […]. In the speech of most of the inhabitants of Grouw, the vowel in *Ek* ('I', 'also') is more open than that of the Dutch word *ık* ('I'). Moreover, the short E is far from stable: it varies between ɪ and E. (our translation)

Sipma (1913: 8) mirrored this observation by placing the vowel lower than [eː] in his vowel triangle, despite using the notation <ɪ>. This discrepancy persists in later works. The first edition of Tiersma's grammar (1985: 12) states that [eː] is "slightly lower" than [ɪ]. In the second edition (1999: 10), this claim changes: the main difference is instead the long vowel's slight diphthongal quality, written as <e.^{i}>.

Conversely, Cohen et al. (1978: 113) asserted that *de [eː] is meer gesloten dan de [ɪ]* 'the [eː] is more closed than the [ɪ]'. Acoustic data have yet to provide a definitive resolution. The F1–F2 plot in de Graaf and Meinsma (1980) showed [eː] and [ɪ] at the same height, but with the latter slightly further back. Later measurements by de Graaf (1985) indicated that [ɪ] (F1 380 Hz) is actually lower and further back (1,820 Hz) than [eː] (F1 320 Hz; F2 2,060 Hz). All in all, these conflicting accounts beg the question where Frisian [ɪ] is *actually* located in the vowel space.

2 Method

2.1 Dataset

Our dataset is the Boarnsterhim Corpus, a multi-year, multi-generational corpus of a hundred years' (in apparent time) worth of spoken Frisian (and also Dutch, which is not used in the present study) (Kingma et al. 2026).[2] The corpus includes 112 speakers (57 female, 55 male) born between 1897 and 2001 and recorded in two periods (1982–1984 and 2017– 2019) and covers approximately a century of birth years, from 1897 to 2001. The sample used in this study consists of all 266 available the Frisian recordings, of which 134 recordings are spontaneous (mean duration = 10m36s) and 132 are read speech (mean duration = 4m47s). As detailed further in Kingma et al. (2026), the data in the corpus have been transcribed orthographically and manually aligned at the sentence level; subsequent alignment at the word and phone level were done automatically using the Montreal Forced Aligner (McAuliffe et al. 2026).

[2] The Boarnsterhim Corpus is available via: http://hdl.handle.net/10032/tm-a3-c6

Our interest was in the vowels [ɪ] (54,473 tokens, measured at the vowel midpoint), [i] (44,098 tokens, taken from the midpoint of the phonemes /i, iː/), [e] (14,650 tokens, taken from the 25% point of the phoneme /ei/[3] as in the word *nee* 'no'), [ʉ] (5,659 tokens, taken from the midpoint of the phonemes /ʉ, ʉː/ as in the words *brún* 'brown' or *drúf* 'grape'), [ɵ] (8,778 tokens, measured at the midpoint of the /ɵ/ phoneme in words like *suster* 'sister').

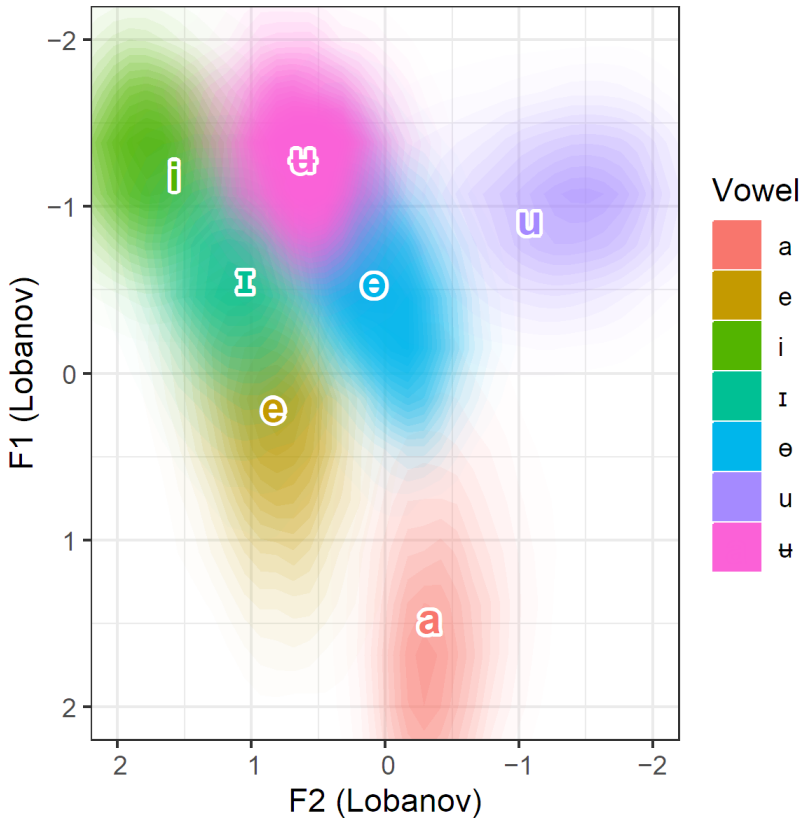


Figure 2: Vowel-space plot of all data from the Boarnsterhim Corpus used in the present study, showing the median positions of the relevant vowels in F1–F2 space and their densities based on 2-D kernel density estimation.

We used Praat (Boersma & Weenink 2026) to extract F1 and F2 of these vowels at the indicated measurement points using the formant settings recommended by van der Harst (2011): Burg algorithm, time step 10 ms, 5 formants, cutoff point

[3] Following our measurements, we consider this phoneme, previously often described as /eː/, to be a diphthong [ei], as it is in Dutch (Voeten 2020). An anonymous reviewer asks whether the 25% point of this diphthong really represents a target and whether it is very comparable across tokens. Based on Dutch, the answer to both questions is 'yes': van der Harst (2011) found that the 25% point is the first measurement point where the vowel is no longer colored by its left context, i.e. where it reaches its own target, and Voeten (2021) showed that the 25% point adequately represents the nucleus position of the Dutch /ei/ vowel. For Frisian, similar results are not yet available, nor can we comment on their across-token reliability; however, we have no indication to suggest that the situation in Frisian would be different from that in Dutch.

5,000 Hz for men and 5,500 Hz for women, window length 25 ms, pre-emphasis from 50 Hz. Instead of following the empirical guidelines of van der Harst (2011) further and removing outliers, we decided (on both theoretical and empirical grounds) to not remove outliers from the data. Instead, we follow Voeten (2021) in analyzing the data using statistical models based on the t_3 distribution, which is robust to influences from outliers. We thus normalized the data directly using Lobanov normalization (cf. Voeten, Heeringa & Van de Velde 2022), based on *all* the data (including all the vowels) available in the corpus. Finally, we subset the data on the vowels of our interest. Figure 2 shows a vowel-space plot of these five vowels of interest (in addition to [u] and [a] for context).

2.2 Operationalizing vowel positions

As discussed in the introduction, the IPA vowel quadrilateral distinguishes four canonical levels of height and three canonical levels of backness. Figure 3 shows the cardinal positions (on the outside 'axes', in what we call 'ca' or *cardinal* units) and the way we map them to Lobanov units (on the inside 'axes', in what we call 'L' or *Lobanov* units).

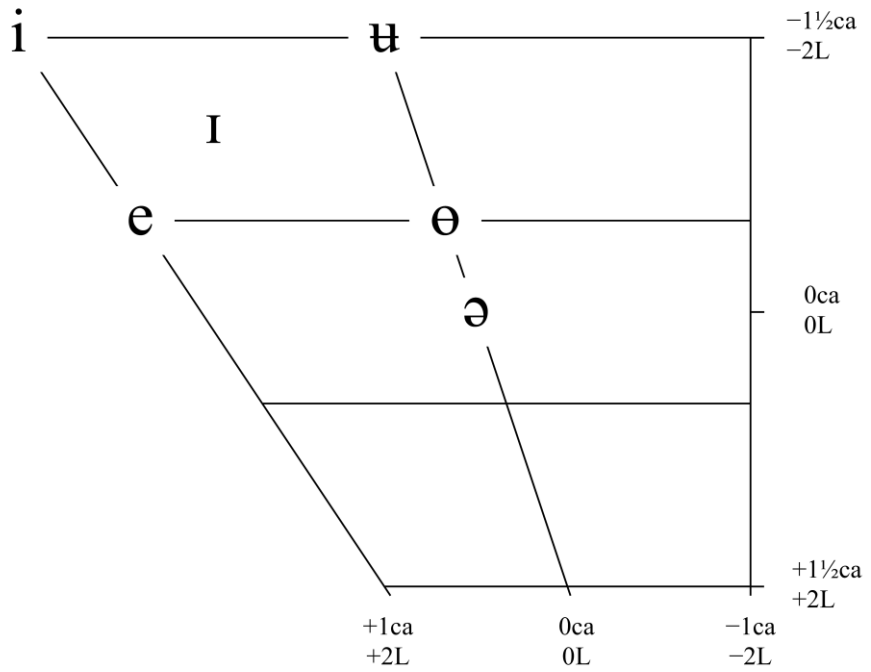


Figure 3: Vowel chart[4] with relevant vowels filled in, with axes for cardinal units (top units) and their mapping to Lobanov (bottom units) on the right and bottom sides.

[4] Note that this figure was made by one of the authors using TikZ, and is thus not related to the official IPA chart that is given in Figure 1. We provide this figure purely for illustration of the way we mapped between the two unit systems, and not as an authoritative or scale-accurate source of distances between vowels; for the distances we report later in this paper, we used (a printed version of) the official IPA chart instead.

Cardinal units are counted from the top right to the bottom left, such that [u] (not pictured) has the most negative cardinal position in both dimensions (i.e. (−1½, −1½) ca, which we explain below); [e] and [ɵ] are one full cardinal position more open; et cetera. We describe next how these cardinal units map to Lobanov, focusing on [ɪ] and the four vowels surrounding it plus, for reference, schwa. When mapping these cardinal units to the Lobanov vowel space, the midpoint, i.e. the schwa position, is a natural reference point. As the Lobanov formula is fundamentally a *z*-score, the midpoint of the vowel space is clearly defined at (0, 0) Lobanov. Its cardinal equivalent we denote as (0, 0) ca, where we define *ca* to mean 'cardinal units'. Starting from this point, the IPA vowel space then has 1½ cardinal positions above and below this position, and one cardinal position each to its left and to its right. Thus, the edges run from −1½ ca to +1½ ca vertically and −1 ca to +1 ca horizontically; for convenience, we assign the negative edges to the high and back position, just like the Lobanov system. The edges of the Lobanov space, in turn, run roughly from −2 Lobanov to +2 Lobanov. Then, to map cardinal unit to Lobanov values, we add (or subtract) 1⅓ Lobanov per vertical cardinal unit, and add (or subtract) 2 Lobanov per horizontal cardinal unit.[5] This mapping is shown in Figure 3.

Table 1 lists the theoretical positions thus assigned to the four vowels [i, e, ʉ, ɵ]. Each of these vowels occurs in Frisian, and together they constitute a 'bounding box' somewhere around the middle of which the vowel [ɪ] ought to be located. The theoretical position of [ɪ], which is not cardinal, was obtained by analogy in the following manner. In the vertical dimension, we observed that [ɪ] is exactly halfway between [i] and [e] on the IPA chart; thus, we assigned it an F1 position of −1⅓ Lobanov. The horizontal position required some more manual interpolation. We printed the official version of the IPA chart onto a page of A4 paper, and measured, at the midpoint of the <ɪ> glyph, the horizontal distance between the left cardinal line and the middle cardinal line. This distance spanned 2.25 cm. Along this distance, [ɪ] is located 0.5 cm off the left cardinal line, or −1.75 cm off the right cardinal line. It is thus 22% of the way from 1 ca to 0 ca, i.e. it is at 0.78 ca. Analogously, it is 22% of the way from 2 Lobanov to 0 Lobanov, i.e. it has an expected F2 value of 1.56 Lobanov.

[5] In the horizontal dimension, the mapping is a little more complicated due to the quadrilateral shape of the IPA vowel space, which introduces an angle to the front cardinal line. The angle means that we have to take account of a vowel's height when we determine its cardinal position. That is, a vowel position of +1ca corresponds to the position of the left cardinal line *at the vowel's height*, so that [i] and [e] are both assigned a position of +1ca. This ensures that a monotonic relationship is maintained between cardinal units and Lobanov values.

Table 1: Theoretical positions in Lobanov of the vowels under investigation based on their positions in the IPA chart.

Vowel	Height (ca)	Backness (ca)	F1 (Lobanov)	F2 (Lobanov)
i	−1½	1	−2	2
e	−½	1	−⅔	2
ʉ	−1½	0	−2	0
ɵ	−½	0	−⅔	0
ɪ	−1	0.78	−1⅓	1.56

Following from the above, we seek to know whether the position of the Frisian vowel labelled as <ɪ> is significantly different from the positions of the other vowels, *by the expected amounts*. That is, we know that the vowel [ɪ] is significantly different from each of the other vowels in Table 1 (it is, after all, a separate phoneme), but what is crucial is whether the F1 and F2 differences are of the magnitude that they should be (or bigger) — which would argue in favor of a distinct transcription — or whether they are smaller — which would not support a distinct transcription. Since this question requires the ability to test effects not against zero, but against a specific theoretical value, and requires the ability to reject not only the hypothesis that the effect is not of the expected magnitude, but also the hypothesis that it *is*, we turned to Bayesian models to make the necessary comparisons.

2.3 Data analysis

We used Bayesian mixed-effects models to locate significant differences in the position of [ɪ] relative to the vowels [i, e, ʉ, ɵ], fitting a separate[6] model for each comparison, using the *brms* function from the eponymous R package (Bürkner 2017, 2018, 2021). Each model fit the F1 and F2 values simultaneously against a multivariate scaled Student-*t* distribution (with the two scale parameters σ and the single degrees-of-freedom parameter ν estimated as ancillary parameters). As predictors, we included (for each of the two responses) an intercept, a contrast for the relevant vowel comparison (henceforth 'Vowel'; deviation-coded such that [ɪ] = +0.5 and the relevant other vowel as −0.5), and effects for 'Birthyear' (scaled to the [0,1] interval and then centered around the median participant's birthyear; cf. Kingma & Voeten (2026), Voeten & Kingma (2026), 'Period' (i.e., recording

[6] While a frequentist analysis would need to include a correction for multiple comparisons when doing this, this concept does not exist in Bayesian analysis. An important added value of running separate models, rather than one big model, is computational feasibility: we had attempted to conduct our analysis using a single model with the different vowels as a factor, but found the sampling procedure to be prohibitively slow due to the large size of the dataset. Splitting the data up into repeated comparisons of [ɪ] versus a single other vowel each, however, did prove feasible.

period; deviation-coded such that 2010s = +0.5 and 1980s = −0.5), and 'Style' (deviation-coded such that read speech = +0.5 and spontaneous speech = −0.5)). These latter three predictors of 'Birthyear', 'Period' and 'Style' are nuisance variables. Hence, these predictors were not only included as main effects, but additionally as interactions with the critical factor of 'Vowel'. These interactions are not of empirical interest, therefore our discussion will solely focus on the main effect of 'Vowel'. We additionally included by-filename random intercepts and random slopes for 'Vowel'; making these by-filename rather than by-speaker ensures that they also absorb uninteresting variation in, e.g., recording conditions, and obviates the need for random slopes by 'Birthyear', 'Period', and 'Style'. These random slopes also included correlations, and furthermore were modelled as correlated between the F1 and F2 response. Similarly, a term was included to model the *residual* correlation between the two responses.

We opted to use weakly-informative priors for all of the terms included in the model. For the two intercepts, we opted for an $\mathcal{N}(0, 1)$ prior; this follows straightforwardly from the intrinsic relationship between Lobanov normalization and the normal distribution, but that is all. That is, this prior describes the correct sampling distribution for the intercept predictor, but does not encode stronger assumptions, such as a potential assumption that the intercepts should probably have mean values a little bit closer to (−2, +2) Lobanov, since all vowels of interest are located in the upper-left quadrant of the vowel space. This is why we consider this prior *weakly informative*; we leave it up to the data to steer the model to the correct effect estimates. For all other fixed-effect predictors, we set $\mathcal{N}(0, 0.5)$ priors; this suggests effect sizes with mean values around 0 (like a null hypothesis), and with values that (95% of the time) are bounded around (−1, +1), i.e. that are unlikely to span more than half the vowel space, which again imparts *some* information, but is so vaguely informative that it allows the model ample freedom to settle on whichever effects the data suggest (including effects that exceed ±1 Lobanov, if the data warrant it). For the multiple σ predictors, i.e. the (square root of the) variance components for the various random effects and the two scale parameters, we opted for half-$t(3, 0, 1)$ distributions, that is, Student-t distributions truncated at 0 ('standard deviations cannot be negative') with 3 degrees of freedom, a location parameter of zero, and a scale parameter of one. This is based on our experience working with similar large-sample forced-aligned datasets (specifically, the one in Voeten 2021), which demonstrated t_3-distributed residuals; the location of 0 follows from our wish to be only weakly informative; and the scale of 1 follows from our observation that this would cause 95% of the values to be $\leq$2.87, which is appropriate for a random variable following a standard (due to the Lobanov transformation) t distribution. For the three correlation parameters (between the random intercept and random slope, between the random effects for F1 and those for F2, and between the residuals for F1 and

those for F2), we used an LKJ(1) prior, which is a (very-weakly-informative) prior that makes all correlations equally likely. For the degrees-of-freedom parameter v we used the *brms* default prior of $\Gamma(2, 0.1)$, which we found reasonable.

Models were fit using *brms*'s *cmdstanr* (Gabry et al. 2025) backend using four chains running 4,000 samples each, of which 1,000 samples were discarded as burnin samples. Convergence was assessed by observing the trace plots and on the basis of the $\hat{R}$ values. Hypotheses, i.e. tests whether the effects of the critical 'Vowel' factor were at least as big as expected based on Table 1, were tested using *brms*'s *hypothesis* function.

3 Results

All four models showed that their four chains mixed well and showed adequate $\hat{R}$ values (all ≤1.01). Table 2 shows the hypotheses that we tested using these models.

Table 2: Results of our hypothesis tests. Estimates are relative to the hypotheses' values; their addition, i.e. the *prediction*, is given in a separate column. The Bayes factors are reported on the $\log_{10}$ scale, where a magnitude of ≥0.5 indicates 'substantial' evidence for the stated hypothesis (even when credible intervals include zero).

Vowel pair	Formant hypothesis (Lobanov)	Estimate (Lobanov)	Prediction (Lobanov)	Credible interval (95%)	Bayes factor ($\log_{10}$)
[ɪ] − [i]	ΔF1 ≥ 0.67	0.23	0.90	[−0.51, 0.99]	0.35
[ɪ] − [i]	ΔF2 ≤ −0.50	−0.79	−0.29	[−1.54, −0.04]	1.36
[ɪ] − [e]	ΔF1 ≤ −0.67	−0.69	−1.36	[−1.42, −0.05]	1.17
[ɪ] − [e]	ΔF2 ≤ −0.50	0.46	0.04	[0.28, 1.17]	−0.75
[ɪ] − [ʉ]	ΔF1 ≥ 0.67	0.37	1.04	[−0.39, 1.13]	0.58
[ɪ] − [ʉ]	ΔF2 ≥ 1.56	−1.15	0.41	[−1.88, −0.38]	−2.14
[ɪ] − [ɵ]	ΔF1 ≤ −0.67	0.35	−0.32	[−0.38, 1.08]	−0.55
[ɪ] − [ɵ]	ΔF2 ≥ 1.56	−0.32	1.24	[−1.07, 0.44]	−0.48

For each of the four vowels [i, e, ʉ, ɵ], Table 2 shows whether the difference between itself and [ɪ] is at least as big as it should be theoretically as established in Section 2.2. The 'significance' of these differences was established based on Bayes factors, using the guidelines by Jeffreys (1961). Thus, if the $\log_{10}$ magnitude of the Bayes factor is at least 0.5, i.e. if the magnitude of the evidence is at least 3 : 1, we consider this to be 'substantial' evidence. This means that $\log_{10}$ Bayes factors ≥0.5 indicate support for the listed hypothesis, $\log_{10}$ Bayes factors ≤−0.5 indicate support *against* the listed hypothesis, and other values indicate

insufficient evidence. Other qualifiers used by Jeffreys are ‘not worth more than a bare mention’ (for Bayes factors with $\log_{10}$ magnitudes <0.5), ‘strong’ (≥1), ‘very strong’ (≥1.5), and ‘decisive’ (≥2).

Table 2 shows that there is strong evidence that [ɪ] is at least the hypothesized distance away from [i] in the F2 dimension, and from [e] in the F1 dimension. Especially the F2 distance from [i] is notably larger than expected: the difference is −0.79 Lobanov larger than our hypothesized −0.50 Lobanov. The converse combinations, i.e., [ɪ]’s F1 difference from [i] and F2 difference from [e], are not as hypothesized. The F1 difference from [i] is not sufficiently different from the hypothesized difference to be able to draw any conclusion. The F2 difference from [e] is strongly different from what we had hypothesized: the vowels’ F2 positions are almost exactly the same, which is substantially different from the expected 0.50 Lobanov difference. Relative to [ʉ], [ɪ] is substantially different in its F1 (the difference between them is 1.03 Lobanov, which is sufficient to support our hypothesized difference of 0.67 Lobanov), but not in its F2: there is decisive evidence against the hypothesized F2 difference. For [ɵ], in turn, there is substantial evidence that [ɪ] was not more raised by the expected half cardinal unit, while the evidence is just barely insufficient to say the same for the expected half cardinal unit in the front–back dimension.

4 Discussion and conclusion

Based on the above results, we conclude that, in these data, there is at least substantial support that, in the Lobanov vowel space and hence by relation in the IPA vowel space of cardinal units:

- [ɪ] is (much) more back than [i];
- [ɪ] is higher than [e], and not more back than it;
- [ɪ] is lower than [ʉ], and not more front than it;
- [ɪ] is not higher than [ɵ].

We therefore conclude that the position of this vowel in the official IPA chart is a reasonably good match to its actual position in Frisian. The canonical position places [ɪ] more back than [i] and higher than [e], which agrees with our positive results, and is not contradicted by our negative results (i.e. the results for which the evidence was against our hypotheses). Of course, for more precise transcriptions than ‘reasonably good’, our results allow us to recommend alternative transcriptions of <i̝> (i.e. <i> plus <˕>) or <e̝> (<e> plus <˔>).

Two further alternative transcriptions are conceivable, but not recommendable: <ʉ̞> (<ʉ> plus diacritics <˕> and <◌̞>) and <ɵ̞> (<ɵ> plus diacritic <◌̞>). The former reflects our conclusion that [ɪ] is lower than [ʉ] and not more back than it, but it introduces an additional unrounding diacritic, which

is more cumbersome and moreover is something that we did not study in the present paper, making the motivation of this diacritic only theoretical and not empirical. The <ɵ̝> transcription has the same problem, acknowledging our finding that [ɪ] is not higher than [ɵ] (and making an arbitrary choice of equivalence on the front–back axis), but still importing the questionable problem of rounding. That said, the apparently close relationship between [ɪ] and [ɵ] may be taken to suggest that perhaps the latter could be, *as it often is*, transcribed as <ʏ>. That is, if one is willing to write <ɪ> — which our data suggest is not a poor choice —, it is logical and, based on these data, potentially even quite appropriate to also write <ʏ>. To investigate this further, we recommend that future research perform a similar analysis like we did focusing on [ɵ], and that this analysis explicitly include F3 as an additional response variable so that the roundedness of [ɵ] can be considered too. This study in that sense illustrates how precise phonetic investigation needs to be in order to feed our understanding of acoustic category formation and how phonetics feeds into the phonetics-phonology interface.

In conclusion, on the basis of our findings we can recommend phonetically transcribing the Frisian /ɪ/ phoneme as <ɪ> or, more precisely, <i̟> or <e̟>, given that the [ɪ] sound appears to be phonetically quite similar to [i̟] and [e̟]. For future students of Frisian, for whom this vowel's precise position in the IPA vowel space is (or ought to be) of some importance, being able to put a place (rather than a face) to the name should be a welcome relief.

5 References

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