Studia Metrica et Poetica 3.1, 2016, 33–52

Rhythmic entropy as a measure of rhythmic diversity (The example of the Russian iambic tetrameter)

Andrei Dobritsyn*

Abstract: This paper examines the frequencies of the rhythmic forms of the iambic tetrameter in the oeuvre of various Russian poets of the 18th, 19th and 20th centuries. The assumption is that this parameter describes the perceptible peculiarities of rhythm better than the so called stress profile. Entropy is proposed as a measure of rhythmic diversity. Variations of the quantitative value of rhythmic entropy in the works of different poets (or the same poet in different periods of his/her poetic career) are due to the changes in the preference for particular rhythmic forms. It is demonstrated that in the majority of poets the entropy in their early poems is much lower than in their mature period. In order to assess the difference between poetic rhythm and natural language rhythm, the Kullback–Leibler divergence is calculated. It is the divergence of the distribution of rhythmic forms in a particular poem or group of poems from the modelled (language-based or speech-based) distribution of the same forms. It is revealed that in some poets of the 1920s, the poetic rhythm is very close to the "natural" distribution of the rhythmic forms of the iambic tetrameter. It is also shown that the rhythm of stanzaic and text endings differs from the rhythm of a stanza or the entire poem (the endings have a different level of entropy and a different divergence from natural speech).

Keywords: Russian iambic tetrameter, rhythmic forms, frequency, entropy, modelled distribution, Kullback–Leibler divergence

* Author's address: Andrei Dobritsyn, l'Université de Lausanne, Section de langues et civilisations slaves et de l'Asie du Sud, Anthropole 4085, CH-1015 Lausanne, Switzerland. E-mail: andrei.dobritsyn@unil.ch.

doi: dx.doi.org/10.12697/smp.2016.3.1.02

Statistics is a good persuader only when the real causes are unknown.
Ilya Shkrob

I. The stress profile and the distribution of rhythmic forms

One of the most studied characteristics of the syllabic-accentual rhythm is the rhythmic profile, also known as the stress profile (i.e. a diagram of the average ictic stress on each foot). This characteristic has its undeniable value. Using this parameter, Andrei Belyi (1910: 262) discovered a drastic change in the rhythm of the Russian iambic tetrameter in the early nineteenth century. Later Kiril Taranovsky (1953: 66–92) described in detail the peripeteias of this "rhythmic revolution".

It should be remembered, however, that the procedure of averaging in the construction of the stress profile is applied in a somehow unusual situation. In natural sciences, the measurement data are normally averaged in order to get a value that is closest to the true value of a certain real quantity (the strength of current, frequency of a sound, etc.). In the case of the rhythmic profile, we do not calculate a value of any real stress. We consider the foot (ictus) as either stressed or unstressed, which means that the measured quantity takes value 0 or 1, whereas a fractional number does not (and cannot, in principle) describe any real object. A reader or listener is hardly able to detect by eye or ear such a quantity as the average degree of stressing in hundreds lines of verse.

Nevertheless, the rhythmic profile corresponds to a certain kind of perceptible reality. More precisely, it reflects the balance of rhythmic forms (variations) of a given metre.[1] For example, in the iambic tetrameter 60% of stresses in the first ictus mean that Forms I, III, IV and VII are 1.5 times as frequent in the corpus of texts under consideration as Forms II and VI (see below for the list of forms). The frequency of various rhythmic forms, especially the frequency of unusual or rare forms, can sometimes be detected by the ear.

An example might be Vladimir Nabokov's review of Vladimir Pozner's book of poetry titled *Stikhi na sluchaj* (*Occasional Verses*, Paris 1928):

[1] The present paper analyzes only the rhythmic variations related to skipping the schematic (i.e. ictic) stress. Neither the extra- schematic (i.e. non-ictic) accents, nor the rhythmic variations related to word boundaries, nor the rhythmic factors conditioned by the interrelation between metre and syntax are taken into account.

> Мучительно-знакомо и другое – то манерное злоупотребление средними в ямбическом стихе пэонами (отчего стих посредине как бы проваливается), которое могло бы заставить поверхностного читателя поверить в «насыщенность» познеровского стиха. Этот проваливающийся ямб такой же модный недуг, как уже однажды отмеченная мною любовь "парижских" молодых поэтесс к длинным, якобы музыкальным, прилагательным, начинающимся с "не". (Nabokov 1989 [1928]: 104)
>
> [Yet another thing is painfully familiar – a mannered abuse of paeons in the middle of iambic lines (so that the middle of the line droops, as it were), which might make a superficial reader believe in the "richness" of Pozner's verse. This bending iambus is the same fashionable disease as the young "Parisian" poetesses' fondness for long, supposedly musical adjectives beginning with "non-", as I have noted elsewhere.][2]

Nabokov noticed the presence of the real objects – namely, the lines belonging to Form VII, with ictic stresses skippped on the two middle feet (xX|xx|xx|xX). As regards the stress profile of *Occasional Verses*, it is not at all "bending", that is the *average* stress on the second and third feet is not lower than the *average* stress on the first foot. The profile would have been "bending", if Pozner had been only using Forms III (xX|xx|xX|xX) and IV (xX|xX|xx|xX), but in the latter case Nabokov's rhythmic feelings would have been different, and he would not have reproached Pozner's verse for excessive paeonicity.

Similarly, Belyi's and Taranovsky's observation concerning the rhythmic revolution in the early nineteenth-century Russian poetry can, on afterthought, be re-stated in the language of rhythmic forms: a transition from the *U*-shaped profile to the *N*-shaped profile occurred mainly due to the decrease in the proportion of Form III and the increase in the proportion of Forms VI and II. However, this formulation is much less demonstrative. Moreover, it is not so easy to guess a priori, which forms and which correlations between them should be tracked.

In connection with the above, we can pose a question about the possibility of restoring the distribution of rhythmic variations on the basis of the rhythmic profile. Distribution of forms on the basis of the stress profile is not uniquely recovered, because there are only 4 equations for 6 unknowns. Six unknowns are the shares of six rhythmic variations (I to VII, minus the rare Forms V and VIII). Four equations are conditions of the level of stressing of each of the four

---

[2] All translations from Russian are ours. – *Eds.*

ictuses.[3] It follows from this that a given stress profile can result from various combinations of rhythmic forms taken in different proportions. This is how accents are distributed among the six forms of iambic tetrameter:[4]

Table 1. Stressed and unstressed ictuses in the rhythmic forms of the iambic tetrameter.

ictuses / Forms	1	2	3	4
I	+	+	+	+
II	–	+	+	+
III	+	–	+	+
IV	+	+	–	+
VI	–	+	–	+
VII	+	–	–	+

The sum total of fractions of Forms I, II, III etc. (x_1, x_2, x_3, x_4, x_6, x_7) equals the stressing of the correspondent ictuses p_i. Thus, a system of equations is created (see Prokhorov 1984: 97):

$$x_1 + x_3 + x_4 + x_7 = p_1$$
$$x_1 + x_2 + x_4 + x_6 = p_2$$
$$x_1 + x_2 + x_3 = p_3$$
$$x_1 + x_2 + x_3 + x_4 + x_6 + x_7 = p_4 = 100$$

As we have 6 variables and 4 equations, we can express the fraction of any two forms in terms of the fractions of the other four.

Let us consider a very simple example. Form VII is absent from many texts: $x_7 = 0$. Let us express the proportions of Forms II, III, IV and VI (x_2, x_3, x_4, x_6) in terms of the fully-stressed Form I (x_1):

$$x_2 = p_2 + p_3 - 100 - x_1$$
$$x_3 = 100 - p_2$$
$$x_4 = p_1 + p_2 - 100 - x_1$$
$$x_6 = 200 - p_1 - p_2 - p_3 + x_1$$

[3] "In the classic pattern of Russian syllabic-accentual verse", the very last ictus "always carries a word stress" (Jakobson 1960: 361), and therefore its level of stressing is 100%.

[4] It is widely accepted now to use the form numbers proposed by Shengeli (1923: 139–141). Shengeli's Form VII is what Taranovsky calls Form V.

With selected fixed values of p_i, we can substitute different proportions of x_1 into these formulas. As a result, we can have different combinations of forms (x_1, x_2, x_3, x_4, x_6), which constitute the same stress profile.

Since all values must be positive, this implies certain restrictions on the profile:

$$p_2 + p_3 > 100$$
$$p_1 + p_2 > 100,$$

and restrictions on the share of a particular form:

$$p_1 - p_3 < x_4 < 100 - p_3$$

etc.

Moreover, some shares and the total share of different forms are determined by the stress profile:

$$x_2 + x_6 = 100 - p_1$$
$$x_4 + x_6 = 100 - p_3$$
$$x_3 = 100 - p_2$$

This means: if Form VII is absent, the percentage of Form III is only determined by the stressing of the second ictus (and vice versa: the stressing of the second ictus is only determined by the percentage of Form III).

In 1984, Aleksandr Prokhorov published a paper, in which he proposed to add to the four obvious linear equations given above, the principle of minimal "relative entropy", also known as the Kullback entropy or the Kullback–Leibler divergence (Prokhorov 1984: 94–97). This quantity is a measure of divergence between two probability distributions (in this case, the theoretical distribution of accents and the restored distribution with a given rhythmic profile). In other words, a distribution was constructed, which produced a given stress profile and was at the same time as close to the theoretical distribution as possible. The less the Kullback–Leibler divergence was, the greater this proximity was considered (more on this below).

With such a procedure, a particular distribution of forms is uniquely restored. As Prokhorov's calculations demonstrated, in many cases the result is close (sometimes very close) to the correct result. That is to say, the principle of minimal Kullback entropy is confirmed empirically for many cases, but not for all cases, as acknowledged by the author himself:

> Deviations from this conclusion mainly deal with rare forms and can serve as meaningful characteristics of the individual image of the metre,[5] which cannot be deduced from general language laws. (Prokhorov 1984: 97)

It is worth making the next step and assuming it is possible to calculate the distance between the rhythm in the works of a particular poet and the modelled language rhythm, in the hope that this distance will be of an informative value, at least to a certain extent. The simplest measure of the distance between the rhythms is the divergence between their entropies.

II. The entropy

If we make the main subject of our study the rhythmic form of a given metre, the natural question raised is that of the frequency with which these forms occur, i.e. the question of the distribution of rhythmic forms in the works of various poets, in various periods, in various genres, etc. The poets can prefer some forms in one period, and prefer other forms in another period; consequently, poets may be constant or changeable in their preferences.

For example, in 1741, Mikhail Lomonosov tried to compose pure, fully-stressed iambs. According to Taranovsky, 95% of Lomonosov's lines of verse written during this year belong to Form I (cf. Form III: 2.5%, IV: 1.8%, and II: 0.7%). Therefore, the level of rhythmic diversity is very low. These data were corrected by Maksim Shapir who discovered the fact that Lomonosov's rhythm changed drastically in autumn 1741, whereas in summer 1741 the proportion of Form I was even higher: 96.6%, cf. Form III: 1.6%, IV: 1.4%, and II: 0.5% (Shapir 1996: 100, Table 2).

The level of rhythmic diversity is measurable, and entropy is well suited to serve as its numerical value. Entropy is usually introduced as a measure of disorder, or rather, a measure of uncertainty or unpredictability of random events. Let us consider a die, each face of which shows "6". The outcome of any throw is "6", therefore the uncertainty equals 0. If one face features "1", the degree of uncertainty is higher than 0, but not very high (although an outcome may be "1", the chances are 5/6 that we'll have "6"). If one face features "1", and another features "2", the degree of uncertainty increases, and if any number from 1 to

---

[5] The concept of "the image of the metre" was introduced by Andrei Kolmogorov who conceived of the metre as "an artistic image" and distinguished between "(a) the sound image of a given metre and (b) its artistic interpretation" (Kolmogorov, Prokhorov 1963: 83).

6 can come up with an equal probability, the degree of uncertainty reaches the maximum. The degree of uncertainty is called entropy (or information).

The method for calculating entropy must meet certain conditions. Clearly, the degree of uncertainty depends on the probability of the events, and if the probability of an event is equal to one, then there is no uncertainty, and the entropy must equal zero. As is known, the probability that several independent events occur together is equal to the product (the result of multiplication) of the probabilities of each of these events, while it is intuitively clear that the entropies of the events in such a situation should be added (if the degree of uncertainty of the first event is h_1, and of the second event is h_2, then the degree of uncertainty that both events occur should be $h_1 + h_2$).

In the case of equiprobable events, it is also clear that with an increase in the number of events, i.e. with a decrease in the probability of each event ($p_i = 1 / n$), the degree of uncertainty should increase; and, on the contrary, with an increase in the probability, uncertainty should decrease. There is only one function that satisfies all these conditions, i.e.

a) it is a decreasing function,

b) this function is equal to zero when the value of the argument is equal to one, and

c) such a function maps a product of arguments into a sum of values.

This function is the minus logarithm.

Consequently, the entropy of a single event is defined as $H = -\ln p$, and the entropy of a sequence of random events is defined as the average of the logarithm of their probabilities with sign reversed:[6]

$$(1) \quad H = -\Sigma\, p_i \ln p_i$$

As a random event we will consider the appearance of any rhythmic form of the iambic tetrameter. Let us select any text or a corpus of texts, such as a book of poetry (e.g. Vladislav Khodasevich's *Heavy Lyre*, 1923) or the poems of a particular period (e.g. Marina Tsvetaeva's poems composed from 1921 to 1923 using the iambic tetrameter). Let us assume the probability of the form is given by the percentage of the lines that belong to this form. Then, using formula (1), we can calculate the rhythmic entropy of the selected corpus of poetic texts, or its measure of rhythmic diversity. It reaches a maximum value in the case of equipartition, $H = \ln 6 = 1.79$. In Taranovsky's "T-Model", the

[6] For the details see Yaglom & Yaglom 1973. Of course, logarithms to any base are adequate. In this paper, natural logarithms are used throughout.

entropy $H = 1.69$, and in his "S-Model" the entropy is even higher: $H = 1.71$ (see Taranovsky 1971: 426, Table 2).[7] In Sergei Liapin's model (see Liapin 2001: 149), the iambs at the beginning of a sentence have $H = 1.62$, while the iambs at the end of a sentence have $H = 1.67$ (that is, the end of the phrase imposes a little less restrictions on rhythm than its beginning).

In different periods, as well as in different poets, rhythmic diversity either decreased or increased. The parameter of entropy allows us, albeit roughly, to track such changes, and, in particular, to outline the evolution of the poet's rhythm. It is worth noting that the rhythmic entropy is an integral characteristic, which allows us to assess the rhythmic diversity, but not particular aspects of this diversity. If we swap the proportions of two forms (for instance, one distribution has 40% of Form IV and 1% of Form VII, whereas another distribution has 1% of Form IV and 40% of Form VII, other things being equal), then the quantity of entropy (i.e. the degree of diversity) will remain the same, although the verse will sound quite different.

A more detailed characterization could be obtained by calculating the Kullback–Leibler divergence $D_{KL}(P,Q)$:

$$(2) \quad D_{KL}(p,q) = \Sigma\, p_i \ln (p_i / q_i),$$

where p_i is the required distribution, and q_i is the model probability distribution. Its peculiarity is that it is not a distance *sensu stricto*, because it is not symmetrical. The distance from the distribution P to the distribution Q is not equal to the distance from Q to P. Therefore, in order to use it, we should select a certain basic distribution of rhythmic forms Q – for example, any speech-based or language-based distribution – and compare all real distributions with this selected distribution.

In the following sections of the paper, the parameters of rhythmic diversity in the works of the poets of the eighteenth, early nineteenth and early twentieth centuries are calculated (the entropy and the Kullback–Leibler divergence from the speech-based and/or language-based distribution). The calculations are based on Taranovsky's data, unless stated otherwise.

---

[7] The "T-Model" is a theoretical (language-based) model, in which the probability of a rhythmic form is calculated on the basis of the frequencies of the words of various rhythmic types in the thesaurus of a given corpus of texts (for example, in the dictionary of the writer's language). The "S-Model" is a speech-based model, in which the probability of a rhythmic form is given by the frequency of the sporadic appearance of this variation in "speech", i.e. in a certain corpus of prose texts.

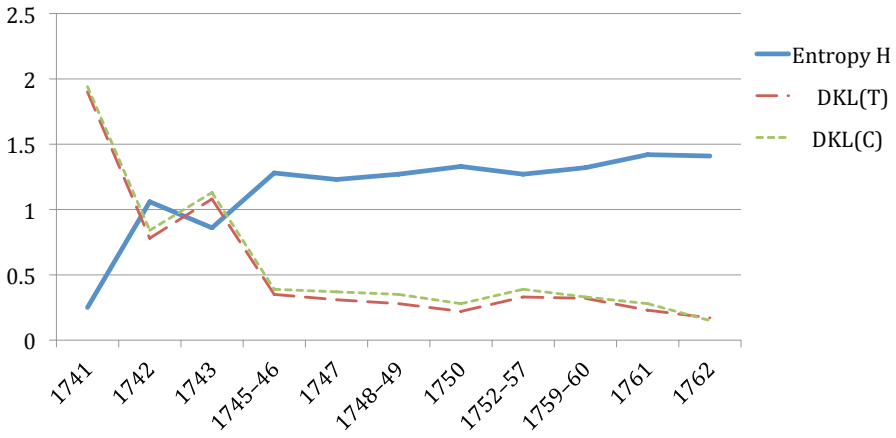
III. The rhythmic entropy and the proximity to the "natural" rhythm

1. Eighteenth-century poets

Let us start with the evolution of the rhythmic diversity of the iambic tetrameters of Lomonosov:

Table and chart 2. The evolution of the rhythmic diversity of Lomonosov's iambic tetrameters and the divergence from Taranovsky's model distributions (T and S)

Years	1741	1742	1743	1745–46	1747	1748–49	1750	1752–57	1759–60	1761	1762
H	0.25	1.06	0.86	1.28	1.23	1.27	1.33	1.27	1.32	1.42	1.41
D_{KL}(T)	1.90	0.78	1.08	0.35	0.31	0.28	0.22	0.33	0.32	0.23	0.17
D_{KL}(S)	1.94	0.84	1.13	0.39	0.37	0.35	0.28	0.39	0.33	0.28	0.15



We observe a pronounced, though not a monotonous, trend toward an increase in the rhythmic entropy, i.e. toward an increasing richness of rhythm.

Aleksandr Sumarokov's rhythmic diversity is similar to that of late Lomonosov. In this regard, Ermil Kostrov and Gavriil Derzhavin followed Sumarokov. Rhythmic diversity decreases to a certain extent in the poems

of Vasily Petrov and Ippolit Bogdanovich, while it decreases even more in Mikhail Kheraskov and Yakov Kniazhnin:

Table 3. Russian eighteenth-century poets: evolution of rhythmic diversity

Sumarokov	Kostrov	Derzhavin	Bogdanovich	Petrov	Kheraskov	Kniazhnin
H = 1.40	1.40	1.38	1.32	1.29	1.25	1.21

In the works of all the above mentioned poets there are three dominating modes (Forms IV, I, and III). The entropy in the works whose authors are placed at the end of the table decreases primarily due to the weakening of the secondary modes, i.e. a decrease in the proportion of relatively rare rhythmic variations (Forms II, VI, and VII). While in Sumarokov and Derzhavin the "rare" forms add up to 10%, in Kheraskov and Kniazhnin they hardly reach the total of 5%. Thus, a significant difference in the degree of rhythmic diversity is predetermined mainly by a relatively small difference in the frequency of marginal rhythmic forms.[8]

To put it otherwise, the eighteenth century poets developed a poetic style, in which the rhythmic variations of the iambic tetrameter are used in such proportions that the entropy was not high. This style, which can be described as focused on three principal rhythmic forms, was later adopted by several poets of the first decades of the nineteenth century. For example, Kheraskov's and Kniazhnin's entropy can be compared to that of Konstantin Batiushkov and Evgeny Baratynsky in his early writings (among the already mentioned poets, it is the lowest in Batiushkov, whose works of 1815–1817 have a two-mode rhythm: Forms I and IV add up to almost 87%).

2. The poets of the early nineteenth century

By 1820 the rhythmic predilections of Russian poets started to change: in Baratynsky, the third frequent variation is not Form III, as in his predecessors, but Forms II (in the early Baratynsky) or VI (in his later works). Of his contemporaries, Nikolai Yazykov prefers Form VI to IV, and II to III. In Aleksandr Pushkin (as well as later in Mikhail Lermontov) they are more or less equal, and oscillate by 2–3% from one poem to another.

[8] Note that Nabokov, in his review of Pozner's book cited above, pays attention to the increase in the frequency of the most marginal form. These relatively small changes in the frequency of uncommon rhythmic variations are readily perceptible to the ear.

Table 4. Batiushkov: evolution of rhythmic diversity

Years	1805–13	1815–17
H	1.19	1.13
D_{KL}(S)	0.51	0.48

In 1805–1813, three forms predominate: IV (43%), I (38%), and III (14%). In 1815–1817, only two: IV (57.5%) and I (29%).

Table 5. Baratynsky: evolution of rhythmic diversity

	Lyric poems			Narrative poems	
Years	1819–20	1821–28	1829–43	1826	1828
H	1.17	1.28	1.26	1.20	1.26
D_{KL}(S)	0.58	0.45	0.39	0.49	0.41

In 1819–1820, three forms predominate: IV (44.5%), I (40.6%), and II (8.3%).

In the poems of Batiushkov and Baratynsky, entropy is not high and fluctuates rather chaotically, but there were nineteenth-century poets whose rhythmic diversity exceeds the level of late Lomonosov and late Sumarokov, gradually increasing from the initial low to higher quantitative characteristics. Let us take Vasily Zhukovsky and Petr Viazemsky as examples. In their poems entropy rises due to their use of the formerly unpopular variations, such as Form VI, and a more uniform distribution of Forms II and III. The corresponding tables and graphs are presented below. It is worth noting that Viazemsky began composing rhythmically diverse poems from the start of his poetic career (*H* = 1.38).

Table and chart 6. Zhukovsky: evolution of rhythmic diversity

Years	1797–1800	1803–13	1814–16	1818–19	1820	1821	1823–32	1842
H	1.19	1.28	1.48	1.41	1.43	1.42	1.46	1.43
D_{KL}(S)	0.46	0.38	0.23	0.20	0.20	0.22	0.24	0.31

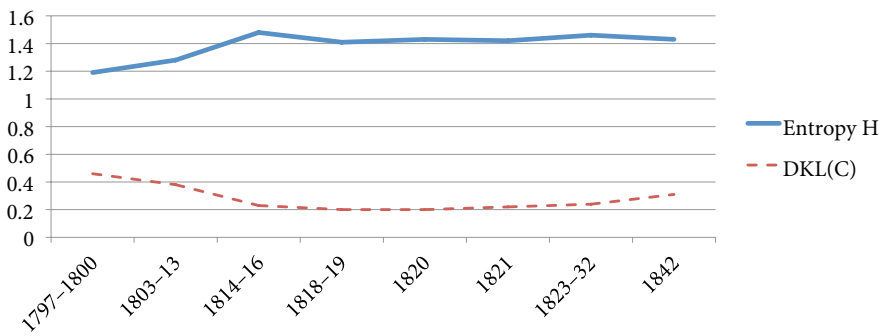
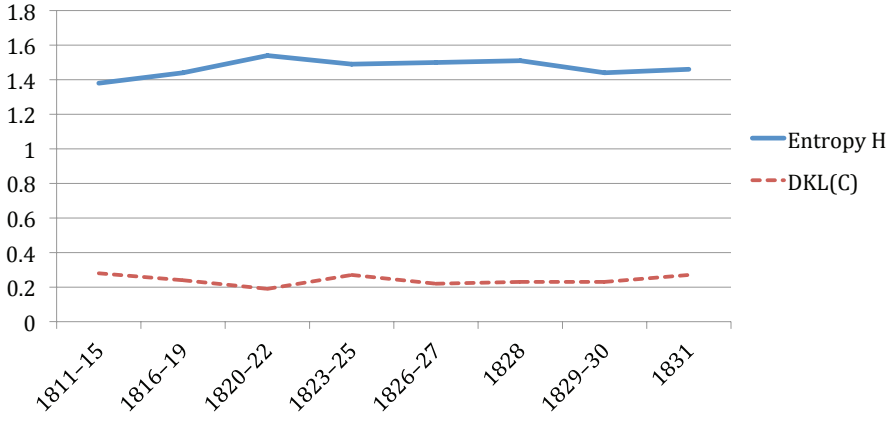


Table and chart 7. Viazemsky: evolution of rhythmic diversity

Years	1811–15	1816–19	1820–22	1823–25	1826–27	1828	1829–30	1831
H	1.38	1.44	1.54	1.49	1.50	1.51	1.44	1.46
D_{KL}(S)	0.28	0.24	0.19	0.27	0.22	0.23	0.23	0.27



Pushkin's rhythmic entropy increased with time on the whole, albeit not monotonously, but with significant fluctuations, and never reached the level of Zhukovsky and Viazemsky (1.4). The maximum was reached in the narrative poem *Count Nulin* (1824–1825) and the lyric poems of 1825–1826, as well as *Eugene Onegin* (1823–1830; $H = 1.35$; $D_{KL}(S) = 0.30$). An analysis of Pushkin's "novel in verse" by chapters may also give interesting results.

Table and chart 8. Pushkin's lyric poems: evolution of rhythmic diversity

Years	1814–15	1816	1817–18	1819–20	1821–22	1823–24	1825–26	1827	1828–29	1830–33
H	1.17	1.17	1.26	1.23	1.32	1.30	1.37	1.29	1.35	1.28
D_{KL}(S)	0.42	0.41	0.33	0.34	0.36	0.36	0.34	0.35	0.35	0.44

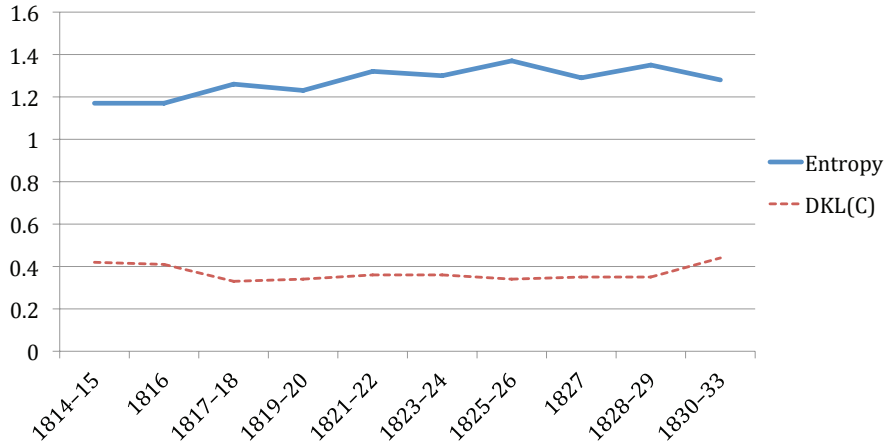
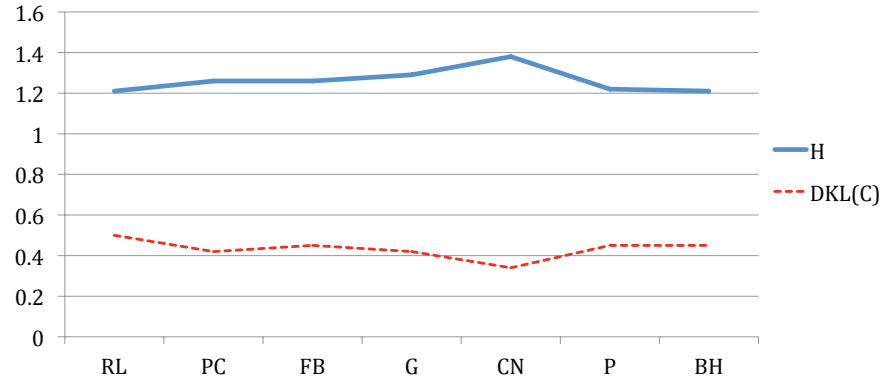


Table and chart 9. Pushkin's narrative poems:[9] evolution of rhythmic diversity

	RL 1817–20	PC 1817–20	FB 1822–23	G 1824	CN 1824–25	P 1828	BH 1833
H	1.21	1.26	1.26	1.29	1.38	1.22	1.21
D_{KL}(S)	0.50	0.42	0.45	0.42	0.34	0.45	0.45



[9] RL = *Ruslan and Liudmila*; PC= *The Prisoner of the Caucasus*; FB = *The Fountain of Bakhchisarai*; G = *The Gypsies*; CN = *Count Nulin*; P = *Poltava*; BH = *The Bronze Horseman*.

It is noteworthy that, in Pushkin's narrative poems, the Kullback–Leibler divergence from the speech rhythm is greater than in his lyric poems of 1817–1829, whereas the entropy of Pushkin's lyric and narrative poems is approximately equal. At first glance, one would rather expect the opposite: a narrative should apparently require an approximation to the natural language rhythm. As a matter of fact, however, a poetic narrative simply imitates the "natural" character of the prose narrative and uses versification devices that are impossible in prose (such as enjambments).

3. The poets of the early twentieth century

In the oeuvre of some poets, the evolution of rhythm can be described as an increase in the level of entropy.

Table 10. Valery Briusov's lyric poems: evolution of rhythmic diversity

Years	1894–97	1898–1901	1901–07	1907–12	1913–18	1919–24
H	1.12	1.36	1.34	1.37	1.39	1.21
D_{KL}(S)	0.40	0.37	0.42	0.36	—[10]	0.69

In late Briusov, a drastic decrease in the degree of rhythmic diversity is connected with a transition to a three-mode rhythmic style with a distinct preference for the fully-stressed Form I (I: 55.5%, IV: 25.6%, III: 9.5%). An analogue would be Lomonosov's odes of 1742 or Ivan Barkov's (1732–1768) "Ode to Priapus" (Taranovsky 1956: 22–23 and the final table; Shapir 1996: 100, Tables 2 and 3).

Table 11. Aleksandr Blok: evolution of rhythmic diversity

Years	1898–1900	1901–04	1904–08	1907–16
H	1.19	1.31	1.44	1.46
D_{KL}(S)	0.51	0.34	0.29	0.26

[10] A calculation of the Kullback–Leibler divergence is impossible in this case, because Form V (VII in Taranovsky's classification) is absent from Taranovsky's speech-based model (i.e. the probability is equal to zero). This form is, however, featured in Briusov's poems.

Table 12. Mikhail Kuzmin: evolution of rhythmic diversity

Years	1906–10	1912–13	1914–22
H	1.17	1.46	1.52
D_{KL}(S)	0.61	0.24	0.16

Andrei Belyi is different:

Table 13. Andrei Belyi: evolution of rhythmic diversity

Years	1903–09	1916–921
H	1.61	1.42
D_{KL}(S)	0.11	0.21
D_{KL}(T)	0.10	0.26

In the poems of Osip Mandelshtam (according to Gasparov 2005: 68), the entropy sometimes increased and sometimes decreased.

Table 14. Osip Mandelshtam: evolution of rhythmic diversity

Years	1908–09	1910–16	1917–25	1932–37
H	1.43	1.56	1.43	1.50
D_{KL}(S)	0.04	0.08	0.25	0.17
D_{KL}(T)	0.04	0.10	0.28	0.20

The distribution of forms in the oeuvre of the young Mandelstam is somehow unique. The thing is that the Kullback–Leibler divergence from the "natural" speech rhythm that corresponds to the distribution with the entropy ca 1.43 usually comes to 0.2–0.3. Meanwhile, in Mandelstam's early poems this divergence is less by an order of magnitude. In other words, at the average level of rhythmic diversity, the distribution of iambic forms follows the natural distribution very closely. Only Marina Tsvetaeva and Vladimir Pozner are as close to a speech-based distribution as Mandelstam (see below), but it is more expected of them, as their rhythm is considerably more diverse (H = 1.62 and H = 1.70 respectively).

As can be seen from the above tables and graphs, in the majority of poets, entropy in early poems is much lower than in their mature period. Nevertheless, some authors, after experiments with all the wealth of rhythmic diversity, in time return to a more parsimonious manner, i.e. to preferring a smaller number of rhythmic forms. However, the distribution of these forms at a later stage is different from the juvenilia. Thus, the rhythmic diversity of

Pushkin's "Ruslan and Liudmila" (1817–1820) is the same as in his "Bronze Horseman" (1833): the rhythm of the two poems is primarily determined by three modes. Moreover, the predominating variations in both poems are Forms IV and I (respectively, 51.8% and 29.6% in "Ruslan and Liudmila"; 49.7% and 32.2% in "The Bronze Horseman"). But those that rank third are different forms: it is Form III (9.9%) in the early poem, and Form VI (9.4%) in the chef d'oeuvre of the late Pushkin.

4. The rhythm of stanzaic and text endings

The concept of entropy can also be applied to the analysis of stanzaic and text endings. This problem was discussed at the *Gasparov Readings 2014* (RGGU, Moscow, 13–16 April 2014), both in my talk and in a paper delivered by Alina Bodrova and Mikhail Shapir.[11] Since many poems – and sometimes stanzas – end with a punch line (*pointe*) or another type of a striking finale, this begs the questions: Are any rhythmic predilections observed in such lines? And, do poets prefer any rhythmic forms to conclude a stanza or a poem? For example, in Khodasevich's collection of poems entitled *Evropejskaja noch'* (*European Night*, 1927) one third of all stanzas (33.7%) and more than half of the four-foot-iambic poems (9 out of 16) conclude with a line belonging to Form VI, although the overall share of Form VI in this collection is less than a quarter (24%). Moreover, Pozner, an epigone of Khodasevich, too frequently (i.e. abnormally often) concludes stanzas with the rare Form VII (15% in the concluding lines vs. 9% in the whole of *Occasional Verses*).

The following are the quantitative characteristics of the rhythmic diversity of the iambic tetrameters in Khodasevich's, Nabokov's and Pozner's books of poetry and in Tsvetaeva's poems written from 1921 to 1923, in comparison with corresponding characteristics of the stanzaic endings and text endings in the same poems (the frequency data are mine).

Table 15. Rhythmic diversity in Khodasevich's *Tjazhelaja lira* (*Heavy Lyre*, 1923)

Entire text	End of stanza	End of poem
$H = 1.48$	1.22	1.21
$D_{KL}(S) = 0.17$		
$D_{KL}(T) = 0.2$		

[11] See videos: http://ivgi.org/Konferencii/GCh

Table 16. Rhythmic diversity in Khodasevich's *Evropejskaja noch'* (*European Night*, 1927)

Entire text	End of stanza	End of poem
$H = 1.43$	1.38	1.10
$D_{KL}(S) = 0.15$		
$D_{KL}(T) = 0.16$		

Table 17. Rhythmic diversity in Nabokov's *Gornij put'* (*The Empyrean Path*, 1923)

Entire text	End of stanza	End of poem
$H = 1.34$	1.27	0.95
$D_{KL}(S) = 0.23$		
$D_{KL}(T) = 0.29$		

Table 18. Rhythmic diversity in Pozner's *Stikhi na sluchaj* (*Occasional Verses*, 1928)[12]

Entire text	End of stanza	End of poem
$H = 1.72$	1.68	1.46
—[12]		
$D_{KL}(T) = 0.035$		

Table 19. Rhythmic diversity in Tsvetaeva's poems, 1921–1923

Entire text	End of stanza	End of poem
$H = 1.62$	1.63	1.49
$D_{KL}(S) = 0.072$		
$D_{KL}(T) = 0.045$		

Interestingly enough, in the poems of Khodasevich, a traditionalist in metrics who made declarative statements about his orientation toward Pushkin, the rhythmic entropy is considerably higher than Pushkin's. Khodasevich is different from the poets of the Age of Pushkin in terms of the distribution of rhythmic forms. In the poems of traditionalist Nabokov, the rhythmic entropy is close to Pushkin's. The poetry of Pozner, a follower of Khodasevich, is characterized by exceptional rhythmic diversity. Perhaps this was a conscious design: Pozner's book is written entirely in iambs, and a need to use sophisticated rhythms to compensate for the metric monotony. As well as Tsvetaeva's, the rhythmic entropy in his poems approximates to speech entropy, but in

[12] Pozner used Form V (see footnote 10).

Pozner the rhythmic entropy is even higher than in the speech-based models described above. Therefore, the parameter of entropy confirms Tsvetaeva's and Pozner's striving for a "natural" language rhythm noted by some of their poetically aware contemporaries.

Conclusion

Scholars are often faced with the question whether a certain phenomenon is of aesthetic value or just a manifestation of the linguistic laws. However, such an approach is often wrong, as an approximation to the linguistic norm may itself be of aesthetic value. This happens, for instance, when a strong tradition exist which sharply differs from this norm, so that the return to the neutral norm appears as an unexpected deviation from the tradition (Juri Lotman termed this effect a "minus device").

In any event, in order to speak about a proximity to or a divergence from the natural state of things (in this case from the language/speech rhythm), we need to measure this divergence. Such a method of measurement has been proposed in this paper. Moreover, this comparison of rhythmic entropy (and the Kullback–Leibler divergencies) of different texts could enable us to take notice of objects suitable for the verification of certain hypotheses, such as the hypothesis of a correlation between rhythm and genre, the hypothesis of no correlation between the rhythmic diversity and the vocabulary, and so on.

There are several possible directions for further research.

1) The obvious first step is to apply the proposed method of assessment of rhythmic diversity and divergence of the poetic rhythm from the speech rhythm to other metres (the iambic pentameter, the trochaic metres, etc.)

2) The rhythm of the word boundaries within the line can be studied. The number of the word-boundary variations is very high, and numerous combinations of these variations are very hard to track, therefore in this case an integral characteristic such as the entropy appears even more useful. If the statistics of word boundaries in prose speech is obtained, we can also calculate the divergence of the rhythm of word boundaries in prose from the natural rhythm of word boundaries.

3) The (un)stability and (un)uniformity of the distribution of rhythmic forms may be quantified.

Distributions of forms can be more or less uniform. Let us take a very common example to illustrate this point. Every poem in a book of poetry can contain approximately the same proportion of lines belonging to Form IV, the

same proportion of lines belonging to Form I, etc. The poems are thus rhythmically close to each other. From this point of view, the book in its entirety may be considered rhythmically homogeneous, although each poem, if taken separately, is characterized by a high level of rhythmic diversity.

Then let us take a reverse kind of example. Every poem in the book may be relatively poor in terms of rhythmic diversity, but still contain a peculiar set of forms. Then different poems would sound differently, and although each poem, taken separately, is monotonous, the book in its entirety may be considered rhythmically diverse. Thus, the entropy of every single poem composed by Tsvetaeva from 1921 to 1923, indicates a large spread of values (from 0.45 to 1.72), and the average entropy of an individual poem is not high (1.27), whereas the average entropy of the entire book is significantly higher (1.62).

Other peculiarities of the distribution of rhythmic variations in the books of poetry (or in the poems written in the same period) may also be of interest. In particular, one form may have a larger spread of the values around the mean, while another form may be distributed more compactly.

References

Belyi, Andrei 1910. *Simvolizm: Kniga statej*. Moskva: Musaget.

Gasparov, Mikhail Leonovich 2005. Ritmika chetyrekhstopnogo jamba rannego Mandel'shtama. In: Leving, Yuri; Ospovat, Aleksandr L'vovich; Tsivian, Yuri (eds.), *Shipovnik: Istoriko-filologicheskij sbornik k 60-letiju Romana Davidovicha Timenchika*. Moskva, Vodolej Publishers, 63–77.

Jakobson, Roman 1960. Closing statement: Linguistics and poetics. In: Sebeok, Thomas A. (ed.), *Style in Language*. Cambridge, Mass.: The MIT Press, 350–377.

Kolmogorov, Andrei Nikolaevich; Prokhorov Aleksandr Vladimirovich 1963. O dol'nike sovremennoj russkoj poezii (Obshchaja kharakteristika). In: *Voprosy jazykoznanija* 6, 84–95.

Liapin, Sergei Evgen'evich 2001. Ritmiko-sintaksicheskaja struktura strofy: (k probleme izuchenija vertikal'nogo ritma russkogo 4-stopnogo jamba). In: Gasparov, Mikhail Leonovich; Prokhorov, Aleksandr Vladimirovich; Skulacheva, Tat'jana Vladimirovna (eds.), *Slavjanskij stikh: Lingvisticheskaja i prikladnaja poetika: Materialy mezhdunarodnoj konferentsii 23–27 ijunja 1998 goda*. Moskva: Jazyki slavjanskoj kul'tury, 138–150.

Nabokov, Vladimir 1989 [1928]. Review of: Vladimir Pozner, *Stikhi na sluchaj*, Paris 1928. [With notes by Roman D. Timenchik]. In: *Literaturnoe obozrenie* 3, 104. (First published in: *Rul'*, 24 October 1928, p. 4.)

Prokhorov, Aleksandr Vladimirovich 1984. O sluchajnoj versifikacii (K voprosu o teoreticheskikh i rechevykh modeljakh stikhotvornoj rechi). In: Kholshevnikov, Vladislav Evgen'evich; Tsar'kova, Tat'jana Sergeevna (eds.), *Problemy teorii stikha.* Leningrad: Nauka, 89–98.

Taranovsky, Kiril 1953. *Ruski dvodelni ritmovi I–II.* Beograd: Naučna knjiga.

Taranovsky, Kiril 1955/1956. Ruski četvorostopni jamb u prvim dvema decenijama XX veka. In: *Južnoslovenski filolog* 21(1/4), 15–43.

Taranovsky, Kiril [Kirill Fedorovich] 1971. O ritmicheskoj strukture russkikh dvuslozhnykh razmerov. In: Alekseev, Mikhail Pavlovich (ed.), *Poetika i stilistika russkoj literatury: Pamjati akademika Viktora Vladimirovicha Vinogradova*. Leningrad: Nauka, 420–429.

Shapir, Maksim Il'ich 1996. U istokov russkogo chetyrekhstopnogo jamba: genezis i evoljutsija ritma: (K sotsiolingvisticheskoj kharakteristike stikha rannego Lomonosova). In: *Philologica* 3(5/7), 69–101.

Shengeli, Georgii 1923. *Traktat o russkom stikhe. Chast' 1: Organicheskaja metrika.* Izdanie vtoroe, pererabotannoe. Moskva, Petrograd: Gosudarstvennoe izdatel'stvo.

Yaglom, Akiva Moiseevich; Yaglom, Isaak Moiseevich 1973. *Veroiatnost' i informatsija*. Izdanie tret'e, pererabotannoe i dopolnennoe. Moskva: Nauka.