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PAUSING AND TEMPO VARIATION AS STRATEGIES IN SIGNALLING POETIC STRUCTURE

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ABSTRACT

This study investigates how prosodic features reflect information structure and poetic organization during oral poetry performance. Specifically, we examined how repetition and structural position influence articulation rate (AR) and pause duration in spoken verse. Thirty-two native Czech speakers read three structurally comparable poems aloud, each differing in the presence and distribution of repeated lines. Poem 1 served as a baseline, containing no repetition; Poem 2 included a fully repeated final stanza; and Poem 3 featured repeated distichs within each stanza. Results showed that repeated lines (given information) were delivered at faster and more consistent rates than non-repeated lines (new information). Across poems with repetition, a gradual tempo decline followed by a tempo reset was observed, suggesting a strategic use of tempo modulation to signal textual recurrence. Additionally, pause duration reliably marked structural boundaries, with the longest pauses at stanza breaks. Discrepancies between syllabic and phonemic AR further highlighted the influence of phonotactic variability. Overall, the findings demonstrate that speakers intentionally manipulate prosodic timing to convey both informational and structural cues, enhancing listener comprehension of poetic form.

Keywords: poetry; information structure; phrasing; articulation rate; pauses

1. Introduction

Duration is one of the basic components of sound, employed in various ways for linguistic purposes. For example, it can support distinctions in vowel and consonant length, mark prominence, or cue prosodic boundaries within spoken utterances. Temporal aspects of speech may be expressed in terms of *duration* – such as the duration of individual phones or syllables – or in terms of *tempo*, defined as the rate of linguistic units over time. In this sense, the commonly observed phenomenon of final lengthening at the end of words or phrases may be more precisely characterized as gradual final *deceleration*, wherein speakers reduce their tempo to mark prosodic boundaries. Similar patterns can be observed in other acoustic parameters, including fundamental frequency (F0), intensity, and measures of voice quality (see Volín, Šturm, Skarnitzl, & Bořil, 2024, for evidence

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from Czech prosody). In addition, the presence of pauses in speech and their duration are also linguistically relevant parameters with a potential to signal the strength of prosodic boundaries (e.g., Zellner, 1994; Werner, Trouvain, & Möbius, 2022; Šturm & Volín, 2023).

There is considerable variation in pausing and tempo both across different speakers and within the speech of individual speakers. While speakers may display habitual temporal patterns, they also adapt their use of tempo in response to communicative intent, task demands, or genre conventions. For instance, Veroňková-Janíková (2004) found that the same speakers modified their overall tempo between read and non-read speech and varied their delivery between fairytales and other types of narration. In a similar vein, Volín (2022), analysing a larger sample of 24 speakers reading the same selection of texts, identified consistent tempo differences between two genres: news reading and poetry recitation. Specifically, speakers used a faster pace and exhibited greater tempo variation when reading the news than when performing poems.

Further evidence of systematic temporal variation comes from a large-scale study of spontaneous Dutch involving 80 speakers (Quené, 2005). The study examined both between-speaker factors (dialect region, sex, and age) and within-speaker factors (phrase length and the position of an utterance within an interview). While the topic of conversation was broadly controlled across participants, speech tempo, measured as average syllable duration (ASD) within inter-pause units, demonstrated complex patterns. Although initial models revealed significant differences across demographic groups, these effects disappeared once phrase length was considered as well. Longer inter-pause units were produced more rapidly, suggesting that speakers compress speech tempo over extended phrases (see also Crystal & House, 1990, for English).

Despite these findings, a considerable portion of tempo variation in Quené's study remained unexplained by demographic or structural predictors. This suggests the presence of systematic, communicatively driven tempo modulations within individual speakers. As Volín (2022) argues, such patterns likely reflect an underlying prosodic or temporal 'grammar' that governs how speech unfolds over time. Speech genres, speech styles, tasks, or units such as prosodic phrases may carry distinct norms of temporal realization shared among competent speakers.

Similarly, Nooteboom and Eefting (1994) emphasize the role of contextual factors in determining speech tempo. Their experiment found that ASD correlated well with the average number of phones per syllable in context-free sentences (thus replicating the above findings), but much less so – in fact, very poorly – in contextually embedded sentences. Phrase length may thus affect tempo primarily in cases involving simple, decontextualized utterances. The authors proposed that key factors include a phrase's position within a paragraph or the communicative relevance of its content (namely, given vs. new information).

The latter issue has been investigated by several researchers. For instance, Lieberman (1963) found that predictable words, which listeners could easily infer when omitted from the recording based on contextual cues, were pronounced faster and with greater acoustic reduction than less predictable words. This suggests that both speakers and listeners make use of the semantic and grammatical information included in meaningful utterances. Similar results were reported by Fowler and Housum (1987). In the production experiments, repeated words were shortened compared to their initial mentions in monologues. Perceptually, listeners were able to distinguish between new and repeated words, with new words being more intelligible in isolation. Crucially, listeners used this information to integrate words into context.

The reduction of words with low information value can be viewed as an intentional process that facilitates comprehension of an utterance's informational structure (cf. Chafe, 1974). In this argument, important elements of speech (new, less predictable information) may be highlighted not only through melodic or energetic accentuation but also through localized tempo decreases. In contrast, redundant words may undergo various reduction processes, including temporal reduction (i.e., faster tempo).

A more fine-grained analysis was conducted by Eefting (1991), whose experiment investigated the effects of *accentuation* (focus) and *information value* (given vs. new information) on target word durations. While accentuation had a major influence, the durational effects of information value were in comparison minor and statistically insignificant, yet directionally consistent with expectations. These results suggest that information value alone has negligible durational consequences, although it may exert an indirect influence through its association with focus, as new information tends to be accented and thus lengthened (slowed down for processing). Eefting also cautioned that conversational speech might yield different results from her controlled, read materials.

The present study has several objectives. Primarily, it aims to demonstrate the value of investigating a specific and relatively underexplored genre: poetry reciting. A sample of speakers read/performed a collection of poems (see Volín, 2022), providing rich material for multi-level analysis. This paper will be limited to two specific research questions.

First, it explores how information structure affects pronunciation, using textual repetition as a proxy for given information.[7] Three poems were selected for this purpose: one serving as a control with no repetition, one featuring a repeated stanza, and another with two repeated lines in each stanza. We hypothesize that repeated passages will be spoken at a faster tempo than non-repeated passages or first mentions (cf. Fowler & Housum, 1987; Eefting, 1991).

Second, given the formal nature of poetry, we investigate whether its textual structure – visible in stanza, distich, and verse line layout – affects performance in measurable ways. Šturm and Volín (2023) examined four poems in relation to pausing: both pause frequency and duration increased at stanza ends. The present study seeks to replicate these findings on a different selection of poems and extend the analysis to speech tempo. We predict that pauses will be longer at the end of a distich and even longer at stanza boundaries. Furthermore, speech tempo is expected to decrease in corresponding verse lines, based on the known function of final deceleration in prosodic phrases (Paschen,

[7] This heuristic is limited, however, as textual repetition does not always map neatly onto givenness. In utterances at the so-called 'second instance level', where all elements are context-dependent, but one is highlighted prosodically (Firbas, 1979: 46; Svoboda, 1981: 4), the repeated material may still bear heavy ad-hoc contrast and therefore not function as straightforwardly 'given'. For example: *The meeting was successful. John finished the graphs and Peter secured the flight.*
– So Peter came to the meeting?
– JOHN came to the meeting.
Here, the prosodically marked word *John*, although repeated, carries the highest communicative dynamism and becomes the most informative element in the final sentence.

Fuchs, & Seifart, 2022; Volín et al., 2024). In this way, stanzas may function similarly to paragraphs in prose, serving as higher-level organizational units.

2. Method

2.1 Material

The material analyzed in this study was drawn from a large corpus of poetry recitations (32 speakers, 60 poems) recorded at the Institute of Phonetics, Charles University in Prague. The description of the recording conditions and procedures is summarized in the next section (for more details, see Volín, 2022). Three poems (hereafter P1–3) were selected specifically for this analysis (note that they are different from those analyzed in Volín, 2022).

The selected poems were matched in overall length and structural features. Each consists of four stanzas, with four verse lines per stanza. The verse lines were comparable in length: all 11 syllables in P3, and alternating between 11 and 10 syllables in P1 and P2. All poems follow a regular rhyme scheme (either *abab* or *aabb*), although they differ in metre (P1 is dactylic, P2 iambic, and P3 trochaic) and in word count (106, 97, and 87 words, respectively).

A salient feature of all three poems is the internal structure of the stanzas, which are composed of two distichs (two-line units). These typically end with a full stop, while the first line of each distich is typically unpunctuated or ends with a comma. Crucially, each distich forms a coherent syntactic and semantic unit: the two lines belong together as a complete utterance.

The poems thus follow a consistent structure, repeated across all four stanzas (S1–4), with each stanza comprising four verse lines (VL1–4) organized into two distichs (D1–2). In subsequent analyses, three distinct positional types of verse lines will be considered: T1 = VL1 + VL3 (distich-initial lines); T2 = VL2 (distich-final but not stanza-final lines); T3 = VL4 (both distich- and stanza-final lines). An example from poem P2 is provided below:

S1	VL1	D1	T1	*Ty tóny duši rozrývají maně*	(11 syllables, 23 phonemes)
S1	VL2	D1	T2	*a pohádka to promrskaná dost.*	(10 syllables, 24 phonemes)
S1	VL3	D2	T1	*– Já o jedné jen sníval karavaně*	(11 syllables, 25 phonemes)
S1	VL4	D2	T3	*a na poušti se bělá její kost –!*	(10 syllables, 23 phonemes)

It should also be noted that the number of phonemes per line varies independently of the number of syllables. In this particular stanza from P2, the phoneme count ranges from 23 to 25, with the entire poem exhibiting a range between 23 and 29 phonemes per line.

The primary criterion for selecting these three poems was the presence or absence of textual repetition, which varied systematically across the set. P1 served as a baseline, containing no repeated verse lines; each line in the poem was unique. P2 exemplified a stanza-level repetition, with the final stanza (S4) being a verbatim repetition of the initial stanza (S1), while the intervening stanzas differed. In contrast, P3 featured distich-level repetition: within each stanza, the second distich (D2) was identical across all four stanzas. The text of the poems is included in the Appendix.

2.2 Speakers

The material consists of poetry recitations by 32 Czech speakers (16 male, 16 female, mean age = 24.3 years, range = 19–33 years), all current or former philology students at Charles University with non-professional but relevant recitation experience. The participants were unaware of the study's purpose, as recordings originated from a student speech performance database. Each had sufficient time to prepare and practice, reducing errors. Crucially, participants were instructed to *recite* – not just *read* – the poems, treating them as expressive performances rather than neutral readings. This approach emphasized the aesthetic function of poetry. For full details of the recording procedure, see Volín (2022).

2.3 Measures

Pause duration

Delimitating pauses in speech is not a straightforward task. While many studies adopt fixed cut-off thresholds to define pauses, alternative approaches have challenged this practice (Werner et al., 2022; Šturm & Volín, 2023). These authors argue that imposing arbitrary thresholds can distort the natural distribution of pauses by systematically excluding shorter ones (cf. Campione & Véronis, 2002).

In this study, we adopted a threshold-free approach. Silent intervals that are intrinsic to speech sounds – particularly the closure phases of word-initial plosives or affricates – were annotated as part of the corresponding segment. The duration of word-initial plosives was generally constrained to a range of 50–100 ms, unless produced with marked emphasis on the word. Any remaining silent or filled interval preceding this annotation was considered a pause, regardless of its duration.

Articulation rate

Speech tempo can be quantified in various ways, depending on the domain of measurement, the treatment of pauses, and the choice of unit. In our material, the domain was self-evident: the verse line, which often – but not always – coincides with major prosodic phrases. As a result, local fluctuations in tempo within verse lines were not modelled. A more complex decision concerned whether to include pauses in the calculation of tempo. We chose to measure articulation rate (AR) rather than speech rate (SR) since our objective is to describe strategies used to signal poetic structure. When a speaker inserts a pause within a verse line without altering the speed of articulatory movements, SR changes significantly, while AR remains stable. Although such pauses may be linguistically meaningful, they are less clearly interpretable as cues to stanza structure, which is our key concern here. Moreover, pauses occurring at verse line boundaries – potentially relevant to stanza organization – were analyzed separately and therefore need not be absorbed into SR calculations.

Tempo measures also vary depending on the unit being counted: words, syllables, phones, or phonemes. On the one hand, Trouvain et al. (2001) showed that word-based measures are poorly suited to express speech tempo, identifying realized phone rate as the most reliable predictor of domain duration. On the other hand, from the perspective of perceived tempo, syllables may be more informative. Pfitzinger (1998) conducted a perceptual study in which listeners ranked short speech segments by tempo and estimated their relative distances. Correlations with measured syllable and phone rates revealed that syllables aligned more closely with perceptual judgments. The strongest correlations were found for a linear combination of syllable and phone rates, with syllables weighted more heavily.

The complex syllable structure of Czech (Šturm & Bičan, 2021) also plays an important role. Verse lines with comparable syllabic ARs may differ substantially in phonemic AR. However, because the phonemic content of the text is determined by the poet's lexical choices, and our focus is on how speakers interpret and perform a fixed text, syllabic AR is prioritized in the analysis (but phonemic AR is also reported).

2.4 Analysis

The analysis of speech tempo was based on a total of 1536 tokens, as AR was measured for each verse line (3 poems × 16 verse lines × 32 speakers). In contrast, the data for pause analysis included fewer tokens (n = 1405). This reduction resulted from two factors: first, pauses were not measured after the final verse line of each poem; second, there were 35 additional instances in which speakers did not produce a pause following a verse line.

Two key variables were considered for each poem. In P1 and P2, verse lines (VLs) were categorized into three levels of STRUCTURAL TYPE (with treatment coding):

- T1: Distich-initial lines (VL1 and VL3)
- T2: Distich-final but not stanza-final lines (VL2)
- T3: Distich- and stanza-final lines (VL4)

In P3, the two T1 verse lines in each stanza required further differentiation, since one but not the other was repeated. As a result, a four-level VERSE LINE factor (VL1–VL4) was used instead of the STRUCTURAL TYPE classification applied in P1 and P2. The second factor considered across all poems was STANZA (S1–S4, treatment coded).

For each poem and parameter, a linear mixed-effects (LME) model was fitted using *R* version 4.2.1 (R Core Team, 2022) and the *lme4* package version 1.1.3 (Bates, Maechler, Bolker & Walker, 2015). Table 1 presents the six resulting models, including the specified effects and interactions. STANZA was modelled as a fixed effect in interaction with either STRUCTURAL TYPE or VERSE LINE, depending on the poem. For P1 and P2, random intercepts were specified for SPEAKER (32 levels) and ITEM (16 levels, corresponding to individual VLs); for P3, only speaker was included as a random intercept. Additional random slopes beyond those reported in the table could not be estimated due to convergence issues or singular fits.

In contrast to AR, which was modelled directly, pause duration was log-transformed prior to statistical analysis (cf. Šturm & Volín, 2023) and subsequently back-transformed for reporting and visualization. Tukey post-hoc tests were conducted using the *emmeans* package version 1.8.2 (Lenth, 2022), typically to compare STRUCTURAL TYPE within STANZA, and vice versa. *P*-values were adjusted by the Bonferroni method, based on the number of comparisons performed. The significance level was set at $\alpha = 0.05$.

Table 1 Specification of LME models for each poem (P1–P3) and parameter.

Poem	Parameter	Fixed effects	Random effects
P1	log(pause duration)	structural type * stanza	(1|speaker) + (1|item)
P2	log(pause duration)	structural type * stanza	(1|speaker) + (1|item)
P3	log(pause duration)	verse line * stanza	(1|speaker)
P1	AR in syllables/s	structural type * stanza	(1+structural type|speaker) + (1|item)
P2	AR in syllables/s	structural type * stanza	(1+structural type|speaker) + (1|item)
P3	AR in syllables/s	verse line * stanza	(1|speaker)
P1	AR in phonemes/s	structural type * stanza	(1+stanza|speaker) + (1|item)
P2	AR in phonemes/s	structural type * stanza	(1+structural type|speaker) + (1|item)
P3	AR in phonemes/s	verse line * stanza	(1|speaker)

3. Results

3.1 Pause duration

Figure 1 displays the raw (non-log-transformed) durations of pauses occurring after individual verse lines, excluding the final verse line in each poem. As expected, the distribution of pause durations is skewed toward shorter values, with a number of outliers at the upper end. Across all three poems, a clear effect of structural type emerged: pauses following ends of higher units (= T2, T3) were longer than pauses following VLs that were not distich-final (= T1). In most cases, pauses in T3 contexts were also longer than those in T2, reflecting the additional boundary at the stanza level. By contrast, no obvious effect of stanza appeared, as pauses seemed to have similar durations throughout the poem. Importantly, there was also no evident effect of repetition (in S4 of P2, or repeated distichs of P3).

No significant interaction was found between STRUCTURAL TYPE and STANZA in P1 ($\chi^2(5) = 3.5$, $p = 0.617$). While the inclusion of STRUCTURAL TYPE significantly improved the model ($\chi^2(2) = 22.2$, $p < 0.001$), STANZA did not contribute significantly ($\chi^2(3) = 2.0$, $p = 0.569$). Figure 2 on the left plots the predicted values from the LME model without interaction for the three levels of STRUCTURAL TYPE (values back-transformed to seconds). Pauses following the distichs (T2, T3) were longer than pauses in the middle of the distichs (T1), while stanza-final pauses (T3) were in addition longer than T2. All pairwise differences were statistically significant, as confirmed by Tukey post-hoc comparisons (see Tab. 2, top).

A nearly identical pattern was observed for P2 (Fig. 2 on the right, Tab. 2, bottom). Again, there was no significant interaction between STRUCTURAL TYPE and STANZA ($\chi^2(5) = 0.6$, $p = 0.989$), and only structural type emerged as a significant predictor ($\chi^2(2) = 23.1$, $p < 0.001$).

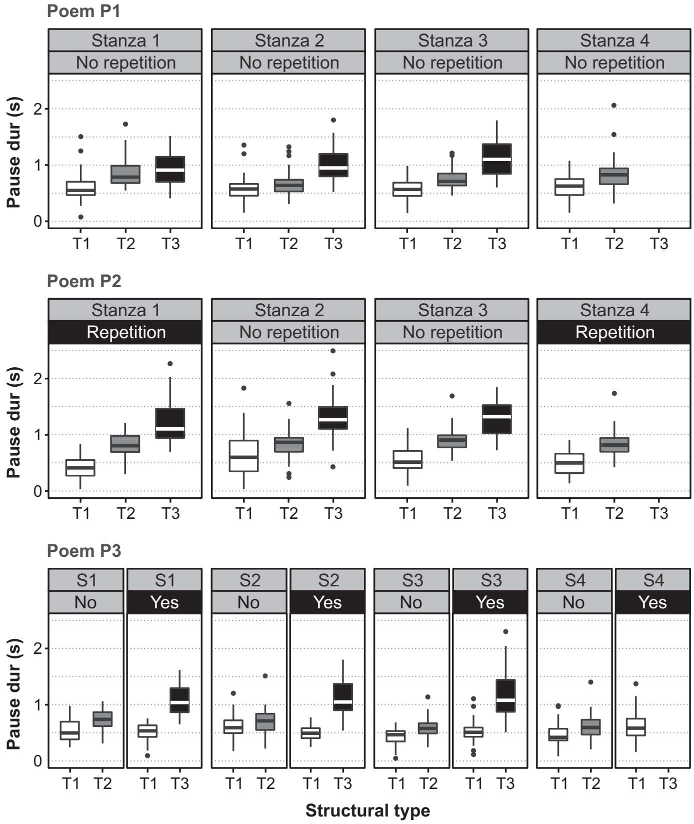

Figure 1 Duration of pauses (in seconds) as a function of STANZA and STRUCTURAL TYPE (T1: distich-initial line, T2: distich-final, stanza-non-final line, T3: stanza-final line). Black panels indicate repeated passages in P2 and P3, while grey panels indicate non-repeated passages.

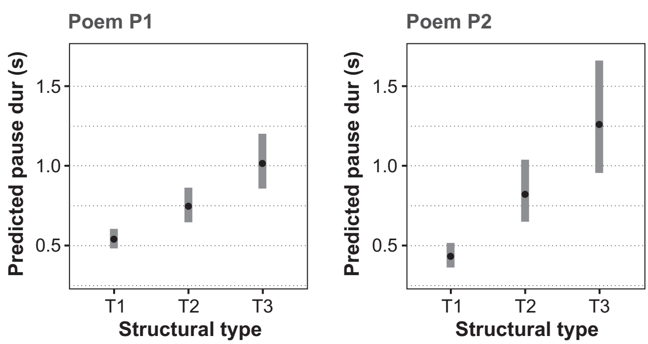

Figure 2 LME effect plot showing pause duration (back-transformed to seconds) as a function of STRUCTURAL TYPE (T1: distich-initial line, T2: distich-final, stanza-non-final line, T3: stanza-final line). Results are shown separately for poems P1 (left) and P2 (right).

Table 2 Tukey post-hoc comparisons of STRUCTURAL TYPE for pause duration, averaged over the levels of STANZA. Values represent duration ratios, with tests performed on the log scale. Results are shown for poems P1 and P2.

Model	Comparison	Estimate	Stan. Error	*Z*-ratio	*P*-value
P1	T1 / T2	0.723	0.058	−4.015	<.001
	T1 / T3	0.532	0.049	−6.862	<.001
	T2 / T3	0.736	0.076	−2.982	0.009
P2	T1 / T2	0.526	0.072	−4.693	<.001
	T1 / T3	0.343	0.053	−6.869	<.001
	T2 / T3	0.652	0.114	−2.454	0.042

In contrast to P1 and P2, a significant interaction between VERSE LINE and STANZA was found for P3 ($\chi^2(8) = 39.3$, $p < 0.001$). The corresponding effect plot is shown in Figure 3 (relevant post-hoc comparisons are reported in Tab. 3). In all stanzas (S1–S3), there was a robust difference between VL4 (= T3) and the other three verse lines, with statistically longer pauses at the ends of stanzas. However, unlike in the previous poems, VL2 (= T2) was significantly different from VL1 in all stanzas other than S2. However, the primary source of the interaction appeared to be the behaviour of VL3. In S1, pauses after VL3 were not significantly different from those after VL1, as expected, since both are of type T1. However, in S2, VL3 was associated with significantly shorter pauses than VL1, while in S3 and S4 the pattern was reversed.

A comparison of VL1 and VL2 (non-repeated text) with VL3 and VL4 (text repeated across stanzas) revealed no clear influence of repetition on pause duration. The fact that pauses in T3 contexts in the repeated passage were longer than T2 pauses in the non-repeated passage (= rows VL2/VL4 in Tab. 3) is consistent with the previous poems, and thus reflects structural effects rather than an effect of repetition.

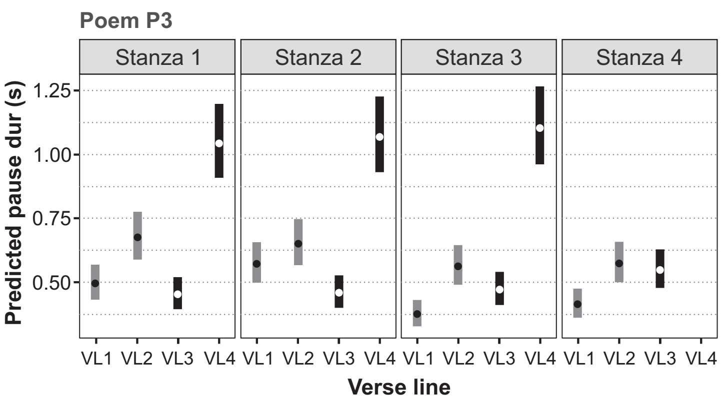

Figure 3 LME effect plot showing pause duration (back-transformed to seconds) as a function of STRUCTURAL TYPE (T1: distich-initial line, T2: distich-final, stanza-non-final line, T3: stanza-final line) and STANZA (S1–4), for poem P3.

Table 3 Tukey post-hoc comparisons of VERSE LINE within STANZA for pause duration for poem P3. Values represent duration ratios, with tests performed on the log scale.

Stanza	Comparison	Estimate	Stan. Error	*Z*-ratio	*P*-value
S1	VL1 / VL2	0.733	0.056	−4.038	< 0.001
	VL3 / VL4	0.433	0.033	−10.861	< 0.001
	VL1 / VL3	1.094	0.084	1.171	1.0
	VL2 / VL4	0.647	0.049	−5.652	< 0.001
S2	VL1 / VL2	0.879	0.067	−1.679	0.558
	VL3 / VL4	0.429	0.033	−10.996	< 0.001
	VL1 / VL3	1.247	0.096	2.865	0.025
	VL2 / VL4	0.609	0.046	−6.452	< 0.001
S3	VL1 / VL2	0.665	0.051	−5.292	< 0.001
	VL3 / VL4	0.425	0.032	−11.113	< 0.001
	VL1 / VL3	0.795	0.061	−2.980	0.017
	VL2 / VL4	0.508	0.039	−8.802	< 0.001
S4	VL1 / VL2	0.720	0.055	−4.271	< 0.001
	VL1 / VL3	0.754	0.058	−3.670	0.002

3.2 Articulation rate (syllables)

Figure 4 presents the syllabic AR of individual verse lines. In Poems P1 and P2, T2 lines were consistently delivered at a slower tempo than T1 lines. However, in P3, the opposite was the norm, except for the last stanza. T3 showed less consistent behaviour in P1 and P2, but in P3 it was notably stable and characterized by a fast AR. Regarding stanza-level trends, P1 did not show any descending tendency across stanzas, while P2 exhibited a gradual decline in AR from S1 to S3, followed by a reset in S4, which repeated the text of S1. In P3, the non-repeated lines (VL1 and VL2) showed a subtle downward trend in tempo across stanzas, while the repeated lines (VL3 and VL4) maintained a more consistent rate throughout.

In P1, there was no significant interaction between STRUCTURAL TYPE and STANZA ($\chi^2(6) = 12.6$, $p = 0.051$). However, including STRUCTURAL TYPE significantly improved the model fit ($\chi^2(2) = 18.9$, $p < 0.001$), as did including STANZA ($\chi^2(3) = 10.0$, $p = 0.019$). Figure 5 displays the predicted values from the linear model (STRUCTURAL TYPE on the left, STANZA on the right), while pairwise comparisons are summarized in Table 4. T2 lines were articulated significantly more slowly than T1 and T3, whereas there was no significant difference between T1 and T3. In contrast, only one significant pairwise comparison was found for STANZA (Tab. 3).

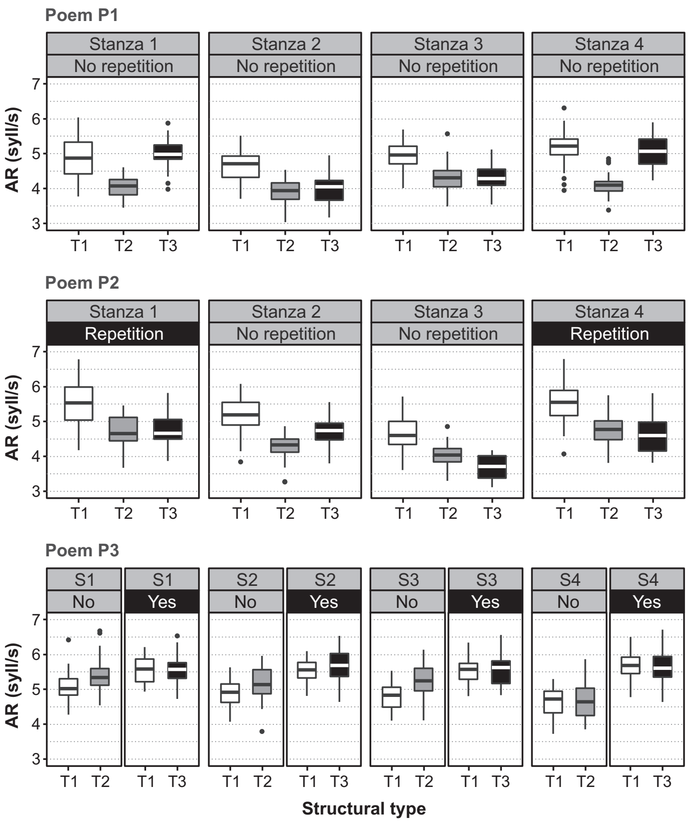

Figure 4 Articulation rate (in syllables per second) as a function of STANZA and STRUCTURAL TYPE (T1: distich-initial line, T2: distich-final, stanza-non-final line, T3: stanza-final line). Black panels indicate repeated passages in P2 and P3, while grey panels indicate non-repeated passages.

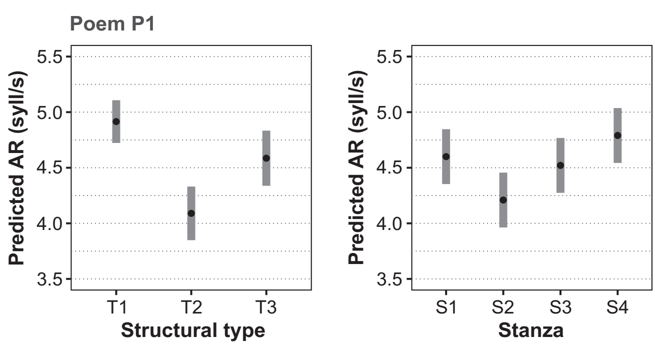

Figure 5 LME effect plot for AR (in syllables per second) in P1 (without interaction). Effect of structural type on the left (T1: distich-initial line, T2: distich-final line, T3: stanza-final line), effect of stanza on the right.

Table 4 Tukey post-hoc comparisons (difference of AR in syllables per second) for STRUCTURAL TYPE and STANZA for P1 (averaged over the levels of the other effect).

Main effect	Comparison	Estimate	Standard Error	*Z*-ratio	*P*-value
Structural type	T1 – T2	0.825	0.137	6.004	< 0.001
	T1 – T3	0.329	0.140	2.351	0.056
	T2 – T3	−0.496	0.161	−3.088	0.006
Stanza	S2 – S4	−0.581	0.159	−3.663	0.002

In P2, there was a significant interaction between STRUCTURAL TYPE and STANZA ($\chi^2(6) = 17.3$, $p = 0.008$). Focusing first on structural differences, T1 lines were articulated at a consistently faster rate than both T2 and T3 lines across all stanzas, with all comparisons reaching significance ($p < 0.001$). The contrast between T2 and T3 lines, however, was less reliable: it was not significant in S1 and S4 ($p > 0.05$), while it reached significance, but in opposite directions, in S2 (T2–T3 = −0.449, SE = 0.108, z-ratio = −4.168, $p < 0.001$) and S3 (T2–T3 = 0.335, SE = 0.108, z-ratio = 3.110, $p = 0.006$).

Comparisons of the same structures across stanzas (see Tab. 5) confirmed that AR generally decreased from S1 to S3. This decline was statistically significant at all steps, except for the S2–S3 transition for T2 lines and the S1–S2 transition for T3 lines. Importantly, for any VL type, there was no significant difference between S1 and S4 and, at the same time, S4 lines were significantly faster than the corresponding lines in S3 – highlighting a return to the initial tempo pattern.

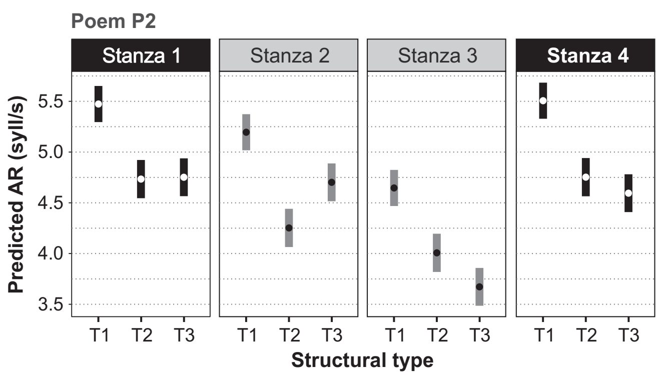

Figure 6 LME effect plot for AR (in syllables per second) in P2 as a function of STRUCTURAL TYPE (T1: distich-initial line, T2: distich-final, stanza-non-final line, T3: stanza-final line) and STANZA (1–4) in interaction. Darker shades indicate repeated passages (S4 identical to S1).

In P3, a significant interaction was found between VERSE LINE and STANZA ($\chi^2(9) = 108.2$, $p < 0.001$). Focusing on the effects of structural type, in the first distich, the difference between T1 and T2 was statistically significant in S1 to S3 but not in S4 (see Tab. 6). Namely, T2 verse lines were articulated significantly faster than T1, contrary to previous poems (where slower tempo occurred). In addition, regarding the second distich, there

Table 5 Tukey post-hoc comparisons (differences of AR in syllables per second) for STANZA within STRUCTURAL TYPE for P2.

Structural type	Comparison	Estimate	St. Error	*Z*-ratio	*P*-value
T1 (distich-initial line)	S1 – S2	0.278	0.075	3.730	0.001
	S2 – S3	0.547	0.075	7.334	< 0.001
	S3 – S4	−0.860	0.075	−11.534	< 0.001
	S1 – S4	0.035	0.075	−0.470	1.0
T2 (distich-final line)	S1 – S2	0.481	0.105	4.563	< 0.001
	S2 – S3	0.243	0.105	2.307	0.127
	S3 – S4	−0.746	0.105	−7.073	< 0.001
	S1 – S4	−0.021	0.105	−0.203	1.0
T3 (stanza-final line)	S1 – S2	0.050	0.105	0.474	1.0
	S2 – S3	1.027	0.105	9.746	< 0.001
	S3 – S4	−0.923	0.105	−8.754	< 0.001
	S1 – S4	0.155	0.105	1.466	0.856

was no significant difference between T1 and T3 in any stanza ($p > 0.05$). This means that the structural effect was limited to the non-repeated portion of the poem, and manifested in a reversed direction to that observed in P1 and P2.

Moreover, there was no significant effect of STANZA on the repeated VLs ($p > 0.05$), which were articulated at a similar tempo throughout the poem. In contrast, tempo tended to decrease in the non-repeated passages, namely, between S1 and S2 and between S3 and S4, but not between S2 and S3 (for pairwise comparisons, see Tab. 7). As a result, the difference between D1 and D2 gradually increased across stanzas (see the estimates for VL1 – VL3 and VL2 – VL4 in Tab. 6).

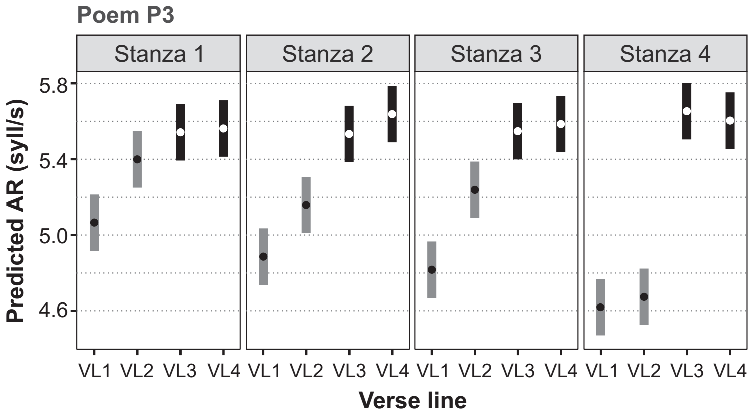

Figure 7 LME effect plot for AR (in syllables per second) in P3 as a function of VERSE LINE (lines 1–4, with VL2 corresponding to T2, VL4 to T3 in previous analyses) and STANZA (1–4) in interaction. Darker shades indicate repeated passages (identical distich appeared in VL3+VL4).

Table 6 Tukey post-hoc comparisons (differences of AR in syllables per second) for VERSE LINE within STANZA for P3 (comparisons VL3 – VL4 were not significant in any stanza).

Stanza	Comparison	Estimate	St. Error	*Z*-ratio	*P*-value
S1	VL1 – VL2	−0.334	0.067	−4.986	< 0.001
	VL1 – VL3	−0.476	0.067	−7.118	< 0.001
	VL2 – VL4	−0.163	0.067	−2.432	0.090
S2	VL1 – VL2	−0.272	0.067	−4.065	< 0.001
	VL1 – VL3	−0.647	0.067	−9.667	< 0.001
	VL2 – VL4	−0.4795	0.067	−7.166	< 0.001
S3	VL1 – VL2	−0.422	0.067	−6.299	< 0.001
	VL1 – VL3	−0.730	0.067	−10.914	< 0.001
	VL2 – VL4	−0.3465	0.067	−5.178	< 0.001
S4	VL1 – VL2	−0.055	0.067	−0.828	1.0
	VL1 – VL3	−1.034	0.067	−15.450	< 0.001
	VL2 – VL4	−0.929	0.067	−13.883	< 0.001

Table 7 Tukey post-hoc comparisons (differences of AR in syllables per second) for STANZA within VERSE LINE for the first distich in P3 (no such comparison was significant for the second distich, left out here).

Verse line	Comparison	Estimate	St. Error	*Z*-ratio	*P*-value
VL1	S1 – S2	0.178	0.067	2.663	0.046
	S2 – S3	0.072	0.067	1.071	1.0
	S3 – S4	0.198	0.067	2.961	0.018
VL2	S1 – S2	0.239	0.067	3.584	0.002
	S2 – S3	−0.077	0.067	−1.164	1.0
	S3 – S4	0.564	0.067	8.432	< 0.001

3.3 Articulation rate (phonemes)

Figure 8 presents the phonemic AR of individual verse lines. In P1, no consistent structural pattern can be identified. In P2, higher-level units (T2, T3) were associated with slower tempo than T1, with no obvious effect of repetition. In P3, a large effect of structural type is evident in the repeated lines (VL3 and VL4), and a smaller one in the non-repeated lines (VL1 and VL2), with higher levels being associated with slower tempo. The only obvious effect of repetition is that the repeated T1 lines were articulated at a higher phonemic AR than the non-repeated T1 lines.

In P1, there was no significant interaction between STRUCTURAL TYPE and STANZA ($\chi^2(6) = 12.0$, $p = 0.061$). None of the two fixed effects reached significance (STRUCTURAL TYPE: $\chi^2(2) = 2.85$, $p = 0.241$; STANZA: $\chi^2(3) = 3.9$, $p = 0.274$). Phonemic AR seems to

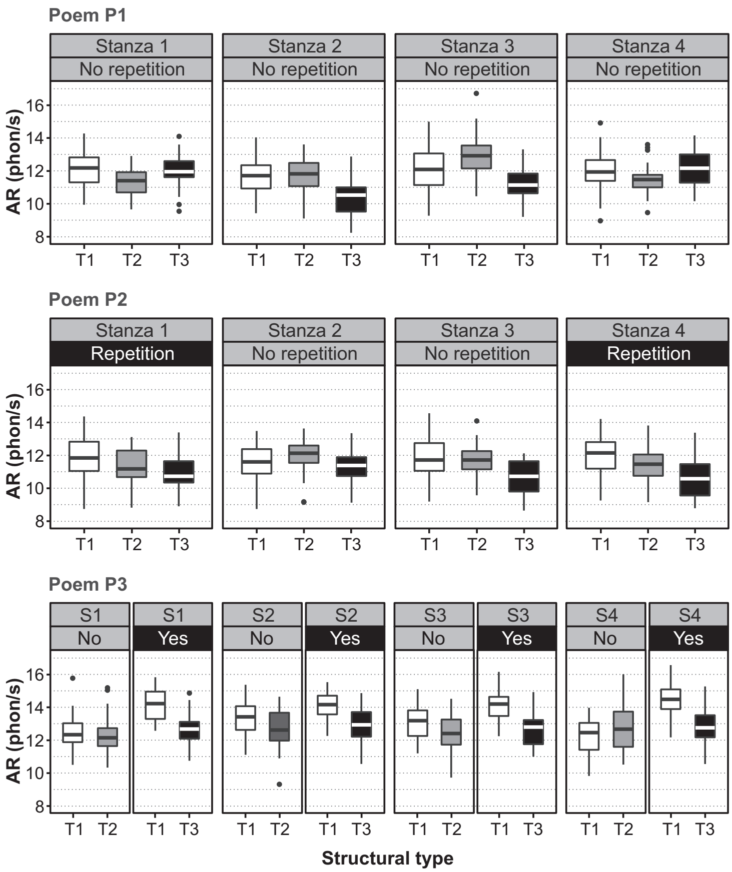

Figure 8 Articulation rate (in phonemes per second) as a function of stanza and STRUCTURAL TYPE (T1: distich-initial line, T2: distich-final, stanza-non-final line, T3: stanza-final line). Black panels indicate repeated passages in P2 and P3, while grey panels indicate non-repeated passages.

vary inconsistently across stanzas and types of verse lines in P1, leading to no significant effect.

Similarly, the interaction between STRUCTURAL TYPE and STANZA did not reach statistical significance in P2 ($\chi^2(6) = 11.8$, $p = 0.066$). However, this time the inclusion of STRUCTURAL TYPE significantly improved the model fit ($\chi^2(2) = 15.9$, $p < 0.001$), although this was not the case for the inclusion of STANZA ($\chi^2(3) = 0.3$, $p = 0.964$). Specifically, the final lines in a stanza were articulated at a significantly slower phonemic rate than the distich-initial lines (T1–T3 = 0.976, SE = 0.197, z-ratio = 4.940, $p < 0.001$) and the distich-final VL2 (T2–T3 = 0.716, SE = 0.213, z-ratio = 3.358, $p = 0.002$). There was no significant difference between T1 and T2 (T1–T2 = 0.259, SE = 0.190, z-ratio = 1.364, $p = 0.518$). The effect plot is shown in Figure 9. Phonemic AR was comparable across stanzas, yielding no effect of repetition in S4.

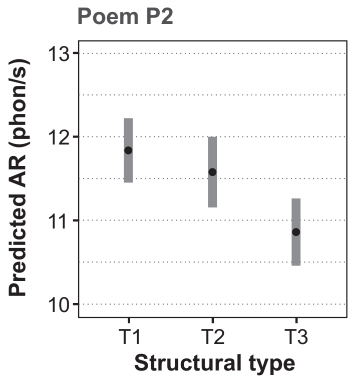

Figure 9 LME effect plot for AR (in phonemes per second) in P2 as a function of STRUCTURAL TYPE (T1: distich-initial line, T2: distich-final, stanza-non-final line, T3: stanza-final line).

In P3, there was a significant interaction between VERSE LINE and STANZA ($\chi^2(9) = 60.6$, $p < 0.001$). Figure 10 displays the interaction plot. Focusing on effects of structural type, in the first two lines, the difference between T1 and T2 was statistically significant in all stanzas but S1 (see Tab. 8). Namely, T2 verse lines were articulated significantly slower than T1 in S2 and S3 but faster than T1 in S4. Regarding the second distich, there was a consistent difference between T1 and T3, with the stanza-final lines being articulated significantly slower than the VL3. This suggests that the structural effect was relevant chiefly for the repeated parts of the poem, and appeared less consistently for the non-repeated parts. Importantly, the difference between repeated and non-repeated passages emerged only in the initial line of the distichs: VL3 was articulated significantly faster than VL1, while no comparable difference was observed in the final lines (see Tab. 8).

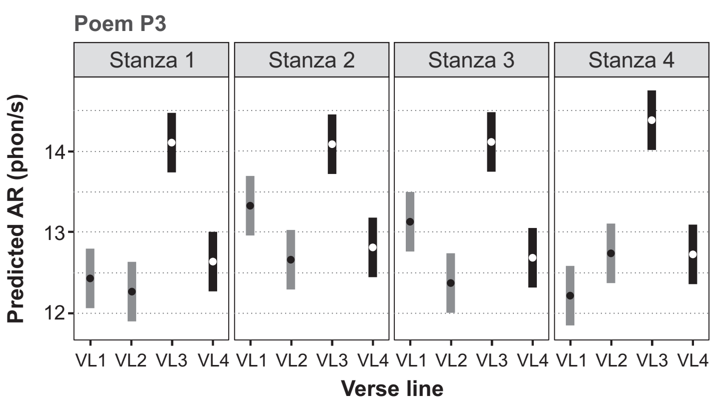

Figure 10 LME effect plot for AR (in phonemes per second) in P3 as a function of VERSE LINE (lines 1–4, with VL2 corresponding to T2, VL4 to T3 in previous analyses) and stanza (1–4) in interaction. Darker shades indicate the repeated part of the poem (identical distich in VL3+VL4).

Table 8 Tukey post-hoc comparisons (differences of AR in phonemes per second) for VERSE LINE within STANZA for P3.

Stanza	Comparison	Estimate	Stan. Error	*Z*-ratio	*P*-value
S1	VL1 – VL2	0.163	0.164	0.991	1.0
	VL3 – VL4	1.466	0.164	8.919	< 0.001
	VL1 – VL3	−1.673	0.164	−10.180	< 0.001
	VL2 – VL4	−0.370	0.164	−2.251	0.146
S2	VL1 – VL2	0.665	0.164	4.048	< 0.001
	VL3 – VL4	1.272	0.164	7.737	< 0.001
	VL1 – VL3	−0.758	0.164	−4.612	< 0.001
	VL2 – VL4	−0.152	0.164	−0.923	1.0
S3	VL1 – VL2	0.755	0.164	4.594	< 0.001
	VL3 – VL4	1.427	0.164	8.683	< 0.001
	VL1 – VL3	−0.983	0.164	−5.983	< 0.001
	VL2 – VL4	−0.311	0.164	−1.894	0.349
S4	VL1 – VL2	−0.571	0.164	−3.474	0.003
	VL3 – VL4	1.654	0.164	10.062	< 0.001
	VL1 – VL3	−2.212	0.164	−13.458	< 0.001
	VL2 – VL4	0.013	0.164	0.078	1.0

There was no significant effect of STANZA on the repeated verse lines VL3 and VL4, but also in the non-repeated VL2 ($p > 0.05$). Phonemic AR differed significantly across stanzas only for VL1: tempo increased between S1 and S2 (S1–S2 = −0.896, SE = 0.164, z-ratio = −5.450, $p < 0.001$), did not differ between S2 and S3 ($p > 0.05$), decreased between S3 and S4 (S3–S4 = 0.960, SE = 0.164, z-ratio = 5.842, $p < 0.001$).

4. Discussion

This study investigated how information structure – specifically the distinction between given and new information – and poetic structure interact to shape the temporal aspects of poetic delivery. Three structurally similar poems were selected to provide a controlled context for examining the effects of textual repetition and stanza structure. We examined how performers modulate pause duration and articulation rate (AR), both syllabic and phonemic, in response to these factors. Repeated lines, representing given information, were typically articulated at a faster rate and with more stable prosodic timing than non-repeated lines, which introduce new information. The findings demonstrate that performers consistently adjust temporal features to reflect informational status, even within the rhythmic and structural constraints of poetry.

Such adaptations not only serve to highlight informational prominence and guide listener attention but also contribute to the perceptual marking of the poem's textual architecture.

Poem 1: Baseline without repetition

P1, containing only non-repeated (new) lines, served as a control condition. As anticipated, no systematic variation in AR was observed across stanzas, suggesting the absence of repetition precludes consistent tempo adjustments. Variability in tempo across verse lines appeared to stem from local syntactic or lexical complexity rather than from structural positioning. However, pause duration robustly marked structural divisions: pauses were longest at stanza boundaries (T3), intermediate at mid-stanza breaks between distichs (T2), and shortest between the two lines within each distich (T1). Although tempo variation was a less reliable cue to this structure, T1 lines were also generally articulated at the fastest rates, while T2 and T3 lines were mostly associated with a decrease in tempo, which aligns with prior findings on prosodic boundary signalling (the so-called *final lengthening/deceleration*).

Poem 2: Full-stanza repetition

P2 introduced a full-stanza repetition: the final stanza was identical to the first. The expected prosodic cues for structural boundaries were again evident, with pause durations reliably distinguishing between T1, T2, and T3 positions. In contrast to P1, tempo patterns were this time more structured: syllabic AR tended to be highest in T1 lines and lowest in T3 lines, with T2 lines occupying an intermediate position. The final line is each stanza was also articulated significantly slower than T1 and T2 lines in terms of the phonemic AR.

A notable finding was the global declination of syllabic AR across the first three stanzas, followed by a tempo reset in the repeated stanza (S4), returning to the tempo of the initial stanza. This pattern thus mirrors prosodic phrasing in speech, where declining melody or tempo can reset at phrase boundaries (cf. Volín et al., 2024). Contrary to our expectation that repeated content would be delivered faster than its original occurrence, the repeated stanza was not faster than S1 – but it was significantly faster than both S2 and S3. This suggests a deliberate strategy: performers slow down progressively to prepare for signalling repetition via a tempo reset, rather than by accelerating the repeated lines themselves.

Poem 3: Distich-level repetition

P3 introduced a distinct repetition pattern: each stanza's second distich repeated across all stanzas, while the first distich remained unique. As predicted, the repeated lines (VL3 and VL4) were articulated at a consistently higher syllabic AR than the non-repeated lines (VL1 and VL2). However, although the contrast became more pronounced across stanzas, in line with our predictions, this was due to a tempo decline in the non-repeated section, not an increase in the repeated one (the repeated passage maintained a uniform tempo in all stanzas). This in fact replicates the pattern from P2, suggesting that performers use temporal declination in new content to create perceptual contrast against stable, and thus faster delivery of repeated material.

An unexpected result emerged in the first stanza: the repeated distich (D2) was delivered more quickly than the new distich (D1), even though it was the first appearance of both. A plausible explanation is that the speakers were already familiar with the text from prior rehearsal, during which they read each new D1 once, but D2 four times, effectively reclassifying it as given information in the first stanza despite its initial mention during recording. No tempo acceleration occurred across later iterations of D2, indicating that familiarity had plateaued.

General observations on temporal structuring

Across all poems, the typology of verse lines (T1, T2, T3) influenced temporal delivery. T1 lines (within distichs) were generally the fastest, while T2 (distich-final) and T3 (stanza-final) lines were slower and accompanied by longer pauses. Importantly, this pattern persisted even in P3, where all lines had equal syllable counts (11 syllables), unlike P1 and P2, where the T2 and T3 lines were shorter (10 syllables). This counters the possibility that tempo differences arise solely from line length (cf. Quené, 2005). Instead, it supports a structural explanation: unit-finality is associated with slower delivery and longer pauses, likely due, in part, to both syntactic closure and prosodic boundary marking.

Similarly, the stepwise decrease in AR across stanzas may serve as a general acoustic cue for stanza positioning, allowing listeners to infer where in the poem the speaker currently is based on tempo. However, since this pattern was absent in the baseline poem (P1), it is more plausibly interpreted as a deliberate strategy to signal upcoming repetition rather than stanza position alone.

Finally, it is important to consider how the choice of measuring AR primarily in syllables rather than phonemes influenced our results. While syllabic and phonemic AR were strongly correlated in all poems (P1: $r = 0.75$ [0.71, 0.78]; P2: $r = 0.74$ [0.70, 0.78]; P3: $r = 0.78$ [0.75, 0.82]; $p < 0.001$), they also exhibited distinct patterns, suggesting that each captures different aspects of speech tempo. We chose to calculate AR based on syllables because syllable counts were controlled across verse lines, unlike phoneme counts, which varied considerably and randomly due to differences in phonotactic complexity. In Czech, the presence of frequent consonant clusters (Šturm & Bičan, 2021) can lead to fluctuations in phonemic AR unrelated to structural or informational factors. Syllabic AR, by contrast, offers a more consistent approximation of perceived tempo when syllable length is held constant.

This distinction helps explain why phonemic AR did not vary systematically in P1, despite structural changes. In P2, phonemic AR was lower at stanza endings – consistent with syllabic AR – but remained stable across stanzas, showing no sensitivity to repetition. The most revealing discrepancies emerged in P3. In the non-repeated distichs, T2 lines were faster than T1 lines in syllabic AR but slower in phonemic AR (only the latter aligns with our expectations). Similarly, in the repeated distichs, syllabic AR showed virtually no difference between T1 and T3, whereas phonemic AR revealed a marked slowing in T3.

These results suggest that the most perceptually accurate measure of tempo might involve a composite metric combining syllabic and phonemic AR (cf. Pfitzinger, 1998). While the former reflects listener-perceived rhythm, the latter captures articulatory density. The two are not interchangeable, and their independent behaviour points to a more comprehensive model of perceived tempo that integrates both measures.

Acknowledgements

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APPENDIX

Poem P1
Viktor Dyk: 'Sentimentální balada'

I on ví: V království předků to kdesi,
uprostřed lesů, hor stojí ten hrad.
Není tam příšery, která tak děsí…
A kdo tam pronikne, umí se smát!

Smáti se do oblak, která tam čistá!
Smáti se v komnatách, kde bol vždy ztich!
Smáti se všemu, co vzrůsti se chystá!
Dětinský, veselý, volný ten smích!

To on ví. V paláci trvá však dále
uprostřed hladkých svých dvořanů řad.
Království spravuje ku Boží chvále.
Moudrý je, slavný je – nezná se smát!

A kdyby odešel, v nový cíl věře,
ví, hrad ten zaklel by démon mu pryč…
Devíti zámky by zavřel mu dvéře,
do řeky hodil by železný klíč!

Poem P2
Viktor Dyk: 'Na melodii neznámé písně'

Ty tóny duši rozrývají maně
a pohádka to promrskaná dost.
– Já o jedné jen sníval karavaně
a na poušti se bělá její kost –!

Je vzdálena a cesty neznámy mi.
Jen písek zříš, když hledíš do dáli!
A slunce líbá rety žíznivými
ty, kteří kostrou nyní zůstali…

A při rozmarném paprsků těch tanci
teď vzpomínám, co žilo v kostrách těch.
Jich táhlou vzpomínám já na romanci,
jich hořký smích a galantní jich vzdech.

Ty tóny duši rozrývají maně
a pohádka to promrskaná dost.
– Já o jedné jen snival karavaně
a na poušti se bělá její kost –!

Poem P3:
František Gellner: 'XXXI.'

V kavárně u stolku lecco se řekne,
srdce se zachvěje, srdce se lekne.
Trochu se vraždilo, trochu se kradlo,
pereme, pereme špinavé prádlo.

Otec tvůj poslední prodal již krávu,
matku bůh povolal ve svoji slávu.
Trochu se vraždilo, trochu se kradlo,
pereme, pereme špinavé prádlo.

Slova jsou slova a mladost je mladost,
genitálie si přejí svou radost.
Trochu se vraždilo, trochu se kradlo,
pereme, pereme špinavé prádlo.

Ve zraku holek plá nemilá tklivost,
hostinských zmáhá se netrpělivost.
Trochu se vraždilo, trochu se kradlo.
Pereme, pereme špinavé prádlo.

RESUMÉ

Studie se zabývá otázkou, jak prozodické prostředky odrážejí informační strukturu a básnickou organizaci při recitování poezie. Zaměřuje se na vliv opakování a hierarchické struktury verše na artikulační tempo a trvání pauz. Výzkumu se zúčastnilo 32 rodilých mluvčích češtiny, kteří přednesli několik básní, z nichž byly vybrány tři formálně obdobné básně lišící se mírou a rozmístěním opakovaných veršů. První báseň neobsahovala žádné opakování (kontrolní vzorek), v druhé básni se opakovala celá sloka a třetí báseň obsahovala opakované dvojverší v rámci každé sloky. Analýza ukázala, že opakované verše (považované za danou informaci) byly produkovány rychleji a s menší variabilitou než verše nové (s novou informací). Ve strukturách s opakováním se navíc objevoval postupný pokles tempa s následným obnovením původních hodnot, což naznačuje záměrné využívání modulace tempa ke zdůraznění

textového opakování. Trvání pauz spolehlivě vyznačovalo hranice vyšších strukturních celků, přičemž nejdelší pauzy byly zaznamenány na rozhraní slok. Rozdíly mezi slabičným a fonémickým artikulačním tempem dále poukazují na vliv fonotaktické variability češtiny. Výsledky celkově potvrzují, že mluvčí aktivně využívají temporální aspekty k vyjadřování informačních i strukturních vztahů v textu, čímž podporují srozumitelnost a vnímání básnické formy.

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