

Two Sides of the Same Coin? Investigating Iambic and Trochaic Timing and Prominence in German Poetry

Petra Wagner

Fakultät für Linguistik und Literaturwissenschaft, Universität Bielefeld, Germany

petra.wagner@uni-bielefeld.de

Abstract

This paper examines the acoustic and perceptual properties of iambic vs. trochaic meter in a large corpus of read German poetry. Psychoacoustic evidence of metrical grouping is not straightforwardly applicable to speech, due to the complex interaction of the involved acoustic parameters in prominence expression. It is possible that grouping effects in (poetic) speech are merely an artifact of listeners' expectations based on rhythmic alternations previously heard. Empirical findings show small but significant duration differences between iambic and trochaic feet. Furthermore, it was found that stressed and unstressed syllables are produced with a stable phase relationship of 3:2, independent of meter. Experience in poetry reading plays a role in production style. On the level of prosodic prominence, only subtle differences can be traced. Our findings do not provide convincing evidence for meter specific prosodic shapes and are compatible with an affordance based dynamic view of rhythmic structure.

Index Terms: grouping, rhythm, prominence, meter

1. Introduction

Even if the prominence structure of a prosodic phrase is known, its grouping into rhythmic feet is ambiguous if both iambic and trochaic (or other) patterns are allowed (cf. Figure 1): E.g., an alternating *weak-strong*-pattern could be perceived as

- a sequence of iambs
- a sequence of trochees starting with an unstressed anacrusis syllable
- an initial amphibrach followed by a series of iambs.

This ambiguity is not necessarily found on other levels of prosodic organization: Most if not all languages indicate the ends rather than the beginnings of prosodic phrases by final lengthening (e.g. [3]). On foot level, however, phonological analyses have determined language specific preferences for either trochaic or iambic grouping, the former building feet *starting with a stressed syllable*, the latter preferring *feet ending with a stressed syllable*.

Psychoacoustic investigations have shown that listeners use different acoustic cues to identify iambic vs. trochaic structures: Intensity increases tend to be interpreted as group beginnings while increases in duration tend to be interpreted as group ends [1]. Perhaps most strikingly, Hay and Diehl found out that these grouping preferences take place independent of the listeners' native language rhythm. However, listener judgements were strongly influenced by the initial pattern of a longer sequence of rhythmic stimuli: If an alternating sequence started *long-soft* or *loud-soft*, listeners would preferably hear trochees. They

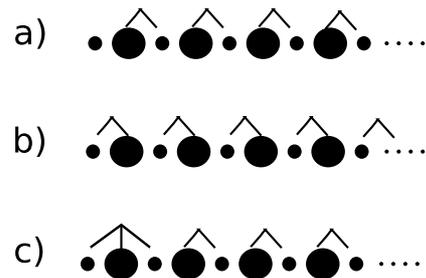


Figure 1: *Prominence patterns are ambiguous with respect to rhythmic grouping. E.g., a sequence strictly alternating in prominence can be interpreted as a series of trochees with an initial extra-metrical anacrusis syllable (a), a sequence of iambs (b), or an initial amphibrach followed by a series of trochees (c).*

would preferably hear iambs if the initial patterns were in a different order. Similar effects are reported for speech [2]. Attempts to integrate phonological and psychoacoustic evidence failed [4], since lengthening and intensity variations tend to correlate positively with each other and with other acoustic prosodic parameters such as f_0 and voice quality in signaling prosodic prominence, even though the individual contribution of each parameter may be language specific (e.g. [5]). It is possible that there is actually little or no acoustic prosodic difference between the different meters other than the initial grouping within a prosodic phrase: If the first two syllables in this phrase compose an iamb, we may continue to expect an iambic pattern and vice versa. Another explanation would be that even if listeners are not influenced by their native language when perceiving *non-speech* stimuli, they might use their native expectations when perceiving speech [6, 7].

It has often been assumed that poetic speech shows a more systematic rhythmic structure compared to prose (e.g. [8]). [9] could show that listeners can easily distinguish between identical texts spoken in poetic and in prose style. Also, poetic meter is a strong indicative of the metrical pattern of the language the poetry is written in [10] and reacts to language change [11]. German poetry knows both iambic and trochaic meter, even though German has usually been analyzed as having trochaic stress [12]. Thus, German poetry provides a nice test case for an investigation of meter distinctions in production and perception.

2. Prosody of Poetic Rhythm

Previous investigations unveiled meter specific phonetic variation: Iambic patterns are characterized by a stronger relative lengthening of the stressed syllable in Swedish and German poetry [9, 13] and exhibit a larger fundamental frequency difference between stressed and unstressed syllable [14]. [15] found out that fundamental frequency plays an important role in the perception of rhythmicity – but their investigation treated iambic and trochaic patterns as equal, so no conclusions with respect to rhythmic grouping can be drawn. Furthermore, [9] provided evidence that – other than often assumed – German poetry shows no signs of compensatory shortening when comparing feet or phrases containing different numbers of syllables. Thus, even a weak version of the isochrony hypothesis could eventually be falsified – even for highly rhythmic speech.

Summing up, while we have some indications on what constitutes trochaic vs. iambic grouping in the speech signal. It is still unclear, whether and how these differences are perceptually relevant.

3. Empirical Study: Investigating Rhythmic Grouping in German Poetry

Previous analyses have indicated that iambic and trochaic structures indeed show language dependent differences in duration, intensity and fundamental frequency. However, the relationship between prominence structure and meter has to our knowledge not been investigated in detail. Furthermore, it has not been resolved whether the acoustic prosodic differences between iambic and trochaic grouping also effect relative prominence and perceived grouping. If there is a robust correlation between perceptual and acoustically expressed prominence, meter specific rhythmic adjustments ought to affect prominence patterns as well as perceived grouping. Thus, we will test the following hypotheses:

- There are meter specific rhythmic adjustments of acoustic prosodic correlates (H1)
- These adjustments depend on the type of the speakers' experience and speaking style (H2)
- These adjustments are reflected in perceptual prominence (H3)

These hypotheses are investigated in a large corpus of German poetry based on analyses of duration, relative timing and perceptual prominence.

3.1. The APROPOS Corpus

The examined corpus [9] contains read speech by 6 professional actors trained in reciting poetry (henceforth: actors) and 6 nonprofessional singers in a jazz choir (henceforth: singers). Each speaker read 3 trochaic, 4 iambic, 2 dactylic and 2 poems with variable numbers of syllables per foot ("lied"). The poems had been checked by a university lecturer for literature for the intended meters. The texts were read in two conditions by each speaker: In the first recording condition, the poem was typeset like "normal" prose, and followed standard punctuation rules (prose condition), the second version was typeset following the original verse structure chosen by the authors (poetic condition). Speakers were instructed to pay attention to meter in the poetic condition. Recordings were supervised by a trained percussionist who checked that the intended meter was

Table 1: Shown are absolute durations (ms) and standard deviations (in brackets) for iambic and trochaic unstressed and stressed syllables for both speaker groups, namely actors and layperson singers.

Style	Unstressed	Stressed
iambics actors	179 (85)	253 (114)
iambics singers	223 (98)	326 (125)
trochees actors	179 (81)	237 (110)
trochees singer	212 (84)	303 (107)

Table 2: Shown are the mean relative durations for both speaker groups and both trochaic and iambic feet as a percentage of total foot duration. Results are shown for unstressed and stressed syllables for both speaker groups, namely actors and layperson singers.

Style	Unstressed	Stressed
iambics actors	41.4%	58.6%
iambics singers	40.6%	59.4%
trochees actors	43.0%	57%
trochees singer	41.2%	58.8%

audibly realized by all speakers in the poetic condition. Generally, it was found that the singers produced a much more rigid rhythmic style, often ignoring the poems' semantic content and overemphasizing meter, while the actors clearly realized meter but were able to avoid the impression of monotony. The following analyses are only based on the poetic recording condition and concentrates on iambic and trochaic meter. Some analyses of dactyls are introduced later.

3.2. Duration Analyses

In line with previous analyses, small but clear systematic differences (cf. Section 1) were found in the absolute durations between iambic and trochaic patterns. Iambics show stronger lengthening of stressed syllables relative to the unstressed syllable in a foot. These differences are highly significant for pooled speaker groups (Welch two-sample t -tests, $p < 0.0001$) and look similar in both speaker groups, actors and singers, even though actors show an overall faster production style (cf. Table 1). Compared to trochees, iambs are characterized by slightly stronger lengthening of the stressed syllable *relative* to the unstressed one in both speaker groups (cf. Table 2). It is unclear, though, whether this truly reflects a difference in metrical organization or is the influence of a more frequent insertion of phrase boundaries, increasing final lengthening effects. Furthermore interesting is the higher amount of duration variation present in unstressed trochaic feet indicating less stability during iambic foot production (F-test, $F = 1.32$; $df = 2911$, $p < 0.0001$).

3.3. Relative Phases in Poetic Feet

From an affordance based point of view, rhythmic timing is expressed as more or less stable phase relationships between oscillating systems (e.g. [17]). If the duration results above are interpreted in this view, beginnings of stressed and unstressed intervals in poetic feet can be described as having the same frequency and standing in a phase relationship of roughly 3:2 in

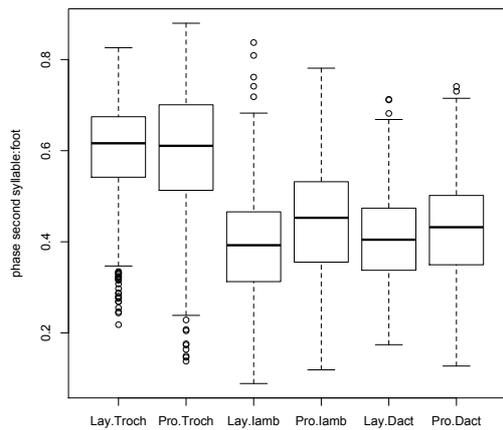


Figure 2: Shown are the relative beginnings of the second syllables in iambic, trochaic and dactylic feet. Stressed and unstressed syllables are in a stable 3:2 phase relationship to each other, holding for all meters. These relationships are similar for both speaker groups, actors (=pro) and singers (=lay).

both iambic and trochaic feet: Relative timing between stressed and unstressed syllables is rather similar for both meters. We can now say that after the beginning of each stressed syllable in a binary poetic group, we “count to three” until the unstressed syllable is produced, during which we “count to two” (cf. Figure 2). It is important to notice that this counting is a metaphor describing the attractors of relative timing and does not imply an isochronous reference interval. The phase relationships are similar for both speaker groups, despite tempo differences, i.e. the actors speak faster than the singers (cf. Section 3.2). However, singers seem to obey the proposed simple phase relationships quite rigidly in iambs. Their stressed syllable starts after 39% of the foot interval has elapsed (= 0.39 median phase). The actors tend to a relative timing that results in less contrast between stressed and unstressed syllable (= 0.43 median phase). Interestingly, the 2:3 relationship also holds for a ternary poetic meter, namely dactylic groups (cf. Figure 2), even though these tend to be longer than both iambs and trochees [9]. Again, similar patterns are found for both speaker groups. The main difference between binary and ternary rhythms is the reversed prominence distribution, i.e. the relative timing between an unstressed and a following stressed interval in a trochee/iamb is similar to the timing between a stressed and a following unstressed interval in a dactyl (cf. Figures 3, 4).

3.4. Prominence Analyses

Prominences were annotated for the nonprofessional speakers by a graduate student of phonetics using the 31-level scale suggested by [16], i.e. a syllable with a label above 20 can be assumed to be prominent, below 10 as lacking prominence. Prominence patterns show small differences between iambic and trochaic grouping. Unstressed syllables are perceived as slightly more prominent when appearing in iambic feet (median prominence values 5.1 vs. 3.7). Stressed syllables are perceived as marginally more prominent when appearing in trochaic feet

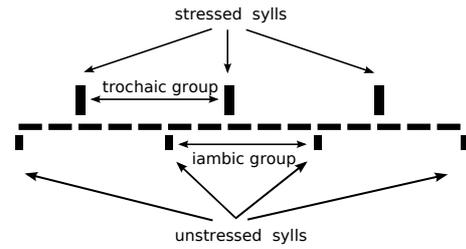


Figure 3: Iambs and dactyls show very similar 3:2 phase relationships between stressed and unstressed syllables (dactyls = 2:3)

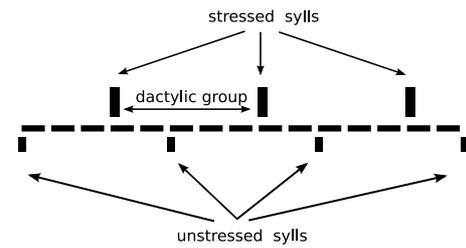


Figure 4: Dactyls show a 2:3 phase relationships between stressed and unstressed syllables

(median prominence 26.1 vs. 25.8; cf. Figure 5). While these subtle differences are statistically significant for both unstressed (Wilcoxon, $W = 4517428$, $p < 0.0001$) and stressed syllables (Wilcoxon, $W = 4873073$, $p < 0.0001$), it is unclear whether they are perceptually relevant, since the prominence scale employed may be too fine grained [18]. However, the measurable tendencies are contrary to expectations based on the duration analyses above: Differences between unstressed and stressed were stronger in iambic feet compared to trochaic ones. The prominence analyses show that on the level of perception, the contrast between stressed and unstressed syllables is slightly less strong in iambic feet. Thus, the prominence analysis reveals that the duration patterns cannot be interpreted as 1:1 correlates of prominence.

4. Discussion

H1 stated that we expect meter specific duration adjustments. These were found in a slightly stronger lengthening of iambic stress. Taking into account the smaller prominence contrast between unstressed and stressed syllables in iambic feet, the stronger lengthening observable in iambs may be necessary in order to sustain the prominence contrast between the stressed and unstressed syllable. Another reason for the stronger lengthening may lie in the higher frequency of phase final lengthening of stressed iambic syllables. However, a re-analysis of the data shows that the effect is robust against phrase final lengthening. The significant differences in stressed syllable durations remain (Welch two sample t-test, $t = 10.6969$, $df = 5739.891$, $p < 0.0001$). However, with an average of 18ms additional duration in iambic stressed syllables and given an average reference interval of 280ms, that difference would be only

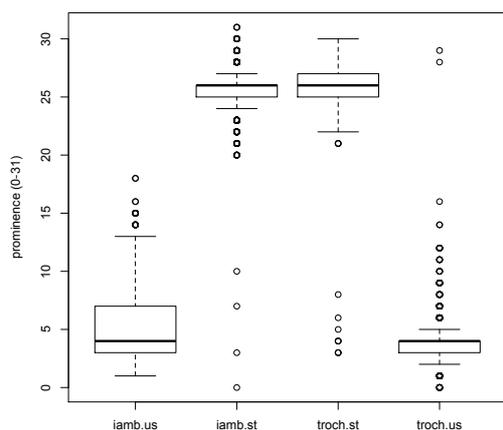


Figure 5: Shown are perceived prominence values for unstressed (=us) and stressed (=st) syllables in iambs and trochees for both actors (=pro) and singers (=lay).

marginally perceptible [19].

The analysis of phase relationships between stressed and unstressed syllables revealed a strong preference for simple 3:2 phase relations, independent of meter. This is evidence for a timing strategy characterizing poetic speech in general. It is thus unclear whether H1 can be accepted.

A striking examination was that the 3:2 relationship was more stable in singers' productions, who tended to fall into a very rhythmic, unnatural and monotonous speaking style. This speaker group was also the less experienced but highly trained in rhythmic production during singing. They obviously exaggerated a poetic speaking style by obeying the poetic timing relationships more rigidly, while actors took more liberties in their productions. We have clear evidence that various kinds of experience (e.g. musical training, poetry reading) may influence timing, albeit in different ways. H2 is thus accepted.

The examination of meter specific prominence revealed a stronger prominence of unstressed feet in iambs compared to trochees. Even though it is unclear whether this difference is perceptually relevant, it is puzzling, since unstressed syllables in trochees are not lengthened more than in iambic ones. There may be an influence of other acoustic factors not looked at due to limited space. Another possible answer is the "trochaic tendency" of German, resulting in an increased prominence of phrase initial syllables, independent of their "stress status". Thus, slight meter specific differences in prominence were detectable (H3 accepted), but their perceptual relevance is doubtful.

5. Conclusion

While the data reveals slight meter specific patterns in both duration and prominence, it is unclear whether these are perceptually relevant. Thus, our results are still compatible with an interpretation that trochees and iambs are indeed "two sides of the same coin" – both on the dimension of prominence, absolute durations and relative timing. Meter perception would then be largely determined by the initial pattern of a poetic line; meter

productions are compatible with an affordance based point of view.

6. Acknowledgements

I would like to thank Jörg Bröggelwirth who compiled and organized the data annotation of the APROPOS corpus and one anonymous reviewer for very helpful comments.

7. References

- [1] Hay, J.S.F and R.L. Diehl (2007). Perception of rhythmic grouping: Testing the iambic/trochaic law, *Perception & Psychophysics*, 69(1):113–122.
- [2] Niebuhr, O. (2009). F0-based rhythm effects on the perception of local syllable prominence. *Phonetica*, 66 (1-2), 95–112.
- [3] Vaissière, J. (1998). *Language-Independent Prosodic Features*, in: Prosody, Models and Measurements. A. Cutler and D.R. Ladd (eds.), Hamburg: Springer, 53–66.
- [4] van de Vijver, R. (1998). *The iambic issue: iambs as the result of constraint interaction*. Doctoral dissertation, HIL dissertation series 37. Holland Academic Graphcs, The Hague.
- [5] Tamburini, F. (2005). Automatic Prominence Identification and Prosodic Typology. In: *Proc. of INTERSPEECH 2005*, Lisbon, 1830–1833.
- [6] Eriksson, A.; E. Grabe; H. Trau Müller (2002). Perception of Syllable Prominence by Listeners with and without Competence in the Tested Language. In: *Proc. of Speech Prosody*.
- [7] Wagner, P. (2005). Great expectations – Introspective vs. Perceptual Prominence Ratings and their Acoustic Correlates. In: *Proc. of INTERSPEECH 2005*, Lisbon, 2381–2384.
- [8] Cummins, F. and R. Port (1998). Rhythmic constraints of stress timing in English. *Journal of Phonetics*, 26, 145–171.
- [9] Bröggelwirth, J. (2007). Ein rhythmisch-prosodisches Modell lyrischen Sprechstils. Doctoral Dissertation, Universität Bonn. URN: urn:nbn:de:hbz:5-12053
- [10] Cutler, A. (1994). The perception of rhythm in language. *Cognition*, 50, 79–81.
- [11] Opitz, M. (1624). *Buch von der Deutschen Poeterey*. David Müller: Leipzig.
- [12] Wiese, R. (1996). *The Phonology of German*. Oxford University Press.
- [13] Nord, L.; A. Kruckenberg and G. Fant (1990). Some timing studies of prose, poetry and music. *Speech Communication*, 9, 477–483.
- [14] Kruckenberg, A. and G. Fant (1993). Iambic versus trochaic patterns in poetry reading. In: *Nordic Prosody VI*, Stockholm, 123–135.
- [15] Barry, W.; B. Andreeva; J. Koreman (2009). Do Rhythm Measures Reflect Perceived Rhythm? *Phonetica* 66 (1-2), 78–94.
- [16] Fant, G. and A. Kruckenberg (1989). Preliminaries to the study of Swedish prose reading and reading style. *STL-QPSR* (2/1989), 1–83.
- [17] Cummins, F. (2009). Rhythm as an Affordance for the Entrainment of Movement. *Phonetica*, 66(1–2), 15–28.
- [18] Jensen, C. and J. Tøndering (2005). Choosing a scale for measuring perceived prominence. In *Proc. of INTERSPEECH 2005*, Lisbon, 2385–2388.
- [19] Abel, S. (1972). Duration discrimination of noise and tone bursts. *JASA*, 51, 1219–1223.