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Meter Specific Timing and Prominence in German Poetry and Prose

This paper examines the durational and perceptual properties of iambic, trochaic and dactylic meter in a large corpus of read German poetry and prose. Prominence patterns – e.g. alternations of stressed and unstressed syllables – are metrically underspecified since they lack information of foot boundaries. Such boundaries differentiate poetic meter, e.g. by specifying whether a foot starts or ends with a stressed syllable. Psychoacoustic evidence related to foot boundary placement is not straightforwardly applicable to speech. It is still possible that metrical grouping in poetry (and possibly prose) is merely an artefact of listeners' expectations based on rhythmic alternations previously heard. Our study reveals small but significant differences of the durational characteristics between iambic and trochaic feet. Furthermore, it was found that stressed and unstressed syllables are produced with a fairly stable phase relation of 3:2, independent of meter. Dactyls show the same relative timing patterns as trochees, but reverse phase relations. Experience in poetry reading and musical training plays a role in the poetic production style. Prose reveals similar, albeit less regular phenomena. On the level of prosodic prominence, meter specific phenomena are revealed as well. These are explicable with a listener's tendency to perceive foot initial rather than foot final (iambic) stress. Our results are compatible with an affordance based dynamic view of rhythmic structure.

1 Introduction and Motivation

The prosodic enhancement of beginnings or ends of phonological groups (feet, prosodic phrases, intonation phrases…) seems to be a universal tendency in the languages of the world. The communicative function of these enhancements is obvious: They indicate important boundaries (utterance beginnings or ends, syntactic boundaries, word boundaries, semantically coherent passages) to the listener, that way simplifying cognitive processing of speech such as parsing, lexical retrieval or semantic interpretation by guiding the listener's attention. These functions rely on the unambiguous interpretation of prominent events as either beginnings

or ends. In this paper, we investigate a potentially problematic case where this criterion is perhaps not met: German prosodic feet.

The *prominence structure* of a prosodic phrase (i.e. its distribution of stressed and unstressed syllables), may be independent of its *foot structure* (i.e. its division into subgroups consisting of one prominent and one or several non-prominent syllables). If feet thus constructed show a predominant, recurring pattern, this serves as the *meter* of the sequence. The produced prominence pattern, including feet possibly deviating from the meter, is the *utterance rhythm*. If a language allows both iambic and trochaic (and possibly other) meters, a strictly alternating prominence sequence of stressed and unstressed syllables is metrically ambiguous (cf. Figure 1), since it could be perceived as either

a. a sequence of trochees starting with an unstressed anacrusis syllable, or
b. a sequence of iambs, or
c. an initial amphibrach followed by a series of iambs.

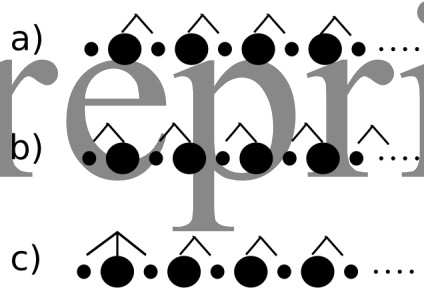

Figure 0: Metrical Ambiguity in Alternating Rhythms

Such an ambiguity is not found on all hierarchical levels of prosodic organization: Most if not all languages indicate ends more prominently than beginnings of prosodic phrases by final lengthening (e.g. Vaissière, 1998). 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 of non-speech stimuli 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 (Hay and Diehl 2007). While Hay and Diehl found that these grouping preferences take place independently of the listeners' native

language rhythm, Kusumoto and Moreton (1997) and Patel et al. (2004) report that native language influences listeners' grouping of non-speech stimuli. It is to be expected that even if listeners are not strongly influenced by their native language while perceiving non-speech stimuli, they should do so when perceiving (poetic) speech (Eriksson et al. 2002; Wagner 2005). Also, Hay and Diehl (2007) show that listeners' perceptual groupings were strongly shaped by the initial pattern of a longer sequence of rhythmic stimuli: If an alternating sequence started long–short or loud–soft, listeners would preferably hear trochees. They would preferably hear iambs if the initial patterns were in a different order. Similar effects are reported for speech (Niebuhr 2009). So far, no clear integration of phonological and psychoacoustic evidence of grouping has been achieved (Kingston 2007; van de Vijver 1998). This may be due to the fact that both grouping and prominence are expressed by similar acoustic cues. Especially lengthening is a robust cross-language parameter expressing both prominence and finality. Prominence seems to correlate positively with intensity related acoustic parameters in many languages, even though its impact may be language specific (e.g. Tamburini 2005). Due to the interaction of intensity and prominence, the metrical ambiguity cannot be resolved in speech as it is in non-speech. It is therefore possible, that there exists actually little or no acoustic prosodic difference between iambs and trochees other than the initial grouping within a prosodic phrase: If the first two syllables in a phrase compose an iamb, listeners may continue to expect an iambic pattern and vice versa.

It has often been assumed that poetic speech shows a more systematic rhythmic pattern compared to prose (e.g Cummins and Port 1998), but this assumption has to our knowledge never been empirically confirmed. Perceptually, poetic speech and prose are distinguishable (Bröggelwirth 2006), but no conclusions can be drawn with respect to the amount of rhythmicity present in the different styles or how a higher degree of "rhythmical regularity" can be described.

Traditional and modern German poetry knows both iambic and trochaic meter, even though German phonology has been analyzed as preferring foot initial trochaic stress (Wiese 1996). Thus, German poetry provides a nice test case for an investigation of meter distinctions. Even if distinct iambic patterns appear in poetry, they may not be traceable in prose, since it is yet unclear whether and how language specific and speaking style specific rhythms are intertwined. It is possible that poetry and prose rhythms are somewhat independent, since poetry may be driven by both cultural and language specific rhythmic styles, similar to musical

rhythm.[1] That is, contrary to poetry and in line with phonological analyses, German prose might not show a systematic prosodic difference between iambs and trochees. However, such a view would contradict findings that poetic meter is a strong indicative of the metrical pattern of the language the poetry is written in (Cutler 1982). It has also been found that poetic styles react to language change (Opitz 1624).

Previous investigations unveiled meter specific phonetic variation in poetry: Iambic patterns are characterized by a stronger lengthening of the stressed syllable in both Swedish and German poetry (Nord et al. 1996; Bröggelwirth 2006) and exhibit a larger fundamental frequency difference between stressed and unstressed syllable (Kruckenberg and Fant 1993). Barry et al. (2009) found out that fundamental frequency plays an important role in the perceived level of rhythmicity – but since their investigation treated iambic and trochaic patterns as equal, no conclusions with respect to rhythmic grouping can be drawn.

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, whether these differences are present in both prose and poetic speech, and whether the stronger perceived "rhythmicality" of poetic speech can be traced in the signal.

2 Empirical Study: Grouping in German Poetry

Previous analyses 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. 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. It is also not clear whether German prose shows iambic patterns as well as trochaic ones, or whether foot final stress is a phenomenon exclusive to poetic speech. It may well be that the realization of meter may differ as a function of rhythmic training, e.g. a musician may perform differently from a non-musician. In order to shed some light on these research questions, the following hypotheses will be tested:

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[1] For example, oriental rhythms are popular across countries sharing cultural rather than linguistic identity (Turkish, Farsi, Arabic etc.).

- There are meter specific rhythmic adjustments of acoustic prosodic correlates. (H1)
- These adjustments depend on the type of the speakers' experience and training. (H2)
- These adjustments are reflected in perceptual prominence. (H3)
- These adjustments are stronger in poetry than in prose. Possibly, a distinct iambic vs. trochaic grouping is restricted to poetic speech. (H4)

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

2.1. The APROPOS Corpus

The examined corpus (Bröggelwirth 2005, 2006) contains read speech by 6 professional actors trained in reciting poetry (henceforth: actors) and 6 layperson singers in a jazz choir (henceforth: singers). Each speaker read 3 trochaic, 4 iambic, 2 dactylic poems and 2 poems with variable numbers of syllables per foot ("lied"). The poems were checked by a university lecturer for German literature to ensure that they conform to the intended meters. The texts were read in two conditions by each speaker: In the initial 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). A few times speakers recognized the poem during the prose reading condition. In the majority of cases, though, the speakers did not recognize the poetry and thus could not follow a stylized, memorized rhythmic pattern in the prose condition. Naturally, the resulting speaking style constitutes typical "read speech" still differing much from more spontaneous styles. In order to be able to assess the potential difference from other types of read speech at a later stage, the speakers were furthermore asked to read passages of newspaper articles. Speakers were instructed to pay attention to meter in the poetic condition. If necessary, the intended meter of the poem was discussed prior to recording. Since all speakers had some education in either reciting poetry or singing, the concept of meter was generally known. All recordings were supervised by a percussionist. She monitored that the intended meter was realised audibly by all speakers in the poetic (though not in the prose) condition. Impressionistically, 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 compare poetic and prose recording conditions of iambic and trochaic meter. Some analyses of dactyls are introduced later. Prior to recording, each text was classified top-down as consisting of feet belonging to one particular meter based on expert analyses in literature studies. That way, circular reasoning is avoided which may have been a danger had the analyses rested on the experimenter's classification of whether a foot is iambic, trochaic or something else.

Style	Meter	Experience	Unstressed	Stressed	FootDur
Prose	Iamb	Actors (N = 1667)	161 (36%)	269 (61%)	443
		Singers (N=1687)	148 (38%)	239 (60%)	395
	Troch.	Actors (N=1178)	155 (41.5%)	211 (57%)	373
		Singers (N=1239)	144 (43%)	190 (56%)	338
Poetry	Iamb	Actors (N = 1650)	187 (36%)	313 (60%)	518
		Singers (N = 2014)	200 (39%)	317 (62%)	513
	Troch.	Actors (N = 1138)	178 (39%)	252 (56%)	454
		Singers (N = 1375)	188 (40%)	286 (60%)	473

Table 1: Shown are the median durations in ms and percentages of median foot duration (in brackets) for stressed and unstressed syllables in both speaker groups, iambic and trochaic meter, and in poetic speech and prose. Median foot durations are shown as well. Medians are chosen due to the large percentage of speaking style induced outliers in the data.

2.2. Duration Analyses

Duration analyses were restricted to feet containing no pauses and consisting of the meter specific number of syllables, i.e. iambic and trochaic feet are only considered if they had two syllables, dactyls only if they had three syllables[2]. Analyses revealed that iambic feet (n= 18340, M= 502ms,

[2] In real, not constructed poetry, monosyllabic feet occur quite frequently in both iambs and trochees. Dactyls show a high percentage of trochaic feet.

SD= 220ms) are significantly longer than trochaic feet (n= 12167, M= 459ms; SD= 178ms), if all data is pooled (Welch two-sample t-test, t[29359]= 18.75, p<0.001), i.e. for both prose and poetic speech and for both singers and actors. In line with previous analyses, clear systematic differences (cf. Section 1) were found in the durations of stressed syllables between both meters. It is interesting, that these differences occur in both prose and poetry reading as well. Iambs generally show stronger relative lengthening of stressed syllables, i.e. less time is spent on the duration of a unstressed syllable in an iambic foot (cf. Table 1). The effect looks similar for both actors and singers, even though actors show an overall slower speaking rate in prose reading (cf. Table 1). A two-way ANOVA reveals a significant interaction between the two factors stress and meter on syllable duration (F[2,13294]= 19.39, p<0.001), thus providing additional proof for the impression that the durational behaviour of syllables differs systematically between iambs and trochees. The iambic lengthening seems to be responsible for the overall longer production of iambs, since unstressed syllables are even significantly longer in trochees (M= 282ms; SD= 179ms) than in iambs (M= 247ms; SD= 120ms) (Welch two sample t-test, t[2137]=12.843; p<0.001).

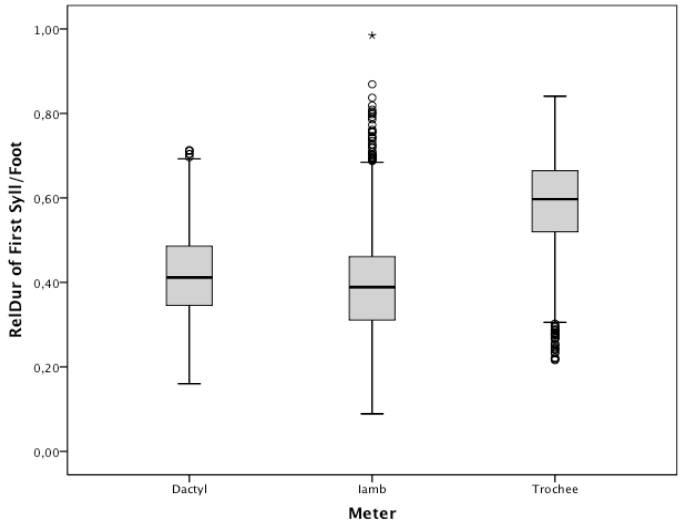

Figure 2: Durations of first syllables in dactyls, iambs and trochees relative to normalised foot duration = 1.

When comparing prose and poetic speech, it seems to be a general effect that the polarity between stressed and unstressed syllables is exaggerated in poetry, yielding a longer duration of the stressed syllable in a foot. This tendency is found for both meters[3,4] and shows in both prose and poetry reading (cf. Table 2). It is also striking that productions in the poetic style seem to prefer a pattern, where the stressed syllable covers roughly 60% of the foot duration, while the unstressed syllable covers roughly 40% of the foot duration. This pattern is more evident in iambs than in trochees, shows up more clearly in poetic speech and is most strictly followed by singers (cf. Table 3) who were perceived to follow a very rigid alternating style. This style leads to significant differences in singers' poetry readings[5]. Interestingly, this effect may indicate that meters become less distinguishable in poetry, since these follow the 60%/40% distribution more precisely.

The relative duration of the stressed syllable in feet is fairly unaffected by total foot duration, as shown by significant ($p<0.001$) albeit weak correlations (Pearson, $cc= 0.208$ for trochees and $cc= 0.194$ for iambs). This is further evidence that meter is an independent means of durational organization.

Trochees		**Iambs**	
Poetry	Prose	Poetry	Prose
58.7%	55.7%	60.9%	60.6%

Table 2: Percentage of stressed syllables of total foot duration.

Trochees		**Iambs**		
Actors	Singers	Actors	Singers	
56.4%	57.9%	61.2%	60.3%	all data
61.1%	60.1%	61.4%	60.4%	poetry

Table 3: Percentage of stressed syllables of total foot duration.

3 Welch two sample t-tests for iambic feet, relative durations of stressed feet normalised to foot duration = 1: prose (n= 3354; M= 0.606; SD= 0.11 vs. poetry (n= 3664; M= 0.609; SD= 0.13), $t[7016]= 0.876$, $p<0.001$.

4 Welch two sample t-tests for trochaic feet, relative durations of stressed feet normalised to foot duration = 1: prose (n= 1239; M= 0.557; SD= 0.11 vs. poetry (n= 1375; M= 0.598; SD= 0.12), $t[2612]= 8.902$, $p<0.001$.

5 Welch two sample t-tests for relative durations of stressed feet normalised to foot duration = 1; actors (n= 1650; M= 0.61; SD= 0.12) vs. singers (n= 2014; M= 0.60; SD= 0.10), $t[3662]= 2.64$, $p<0.001$.

2.3. Relative Durations in Metrical Feet

From an affordance based point of view, rhythmic timing can be expressed as more or less stable phase relationships between oscillating systems (e.g. Cummins 2009). Metrical feet can then be seen as two oscillating systems, where one marks the beginning of the stressed parts of a foot, another marks the beginning of an unstressed part of a foot. Both systems are characterized by an identical frequency but a different phase, since the stressed and unstressed parts do not occur simultaneously. If the period of both systems is taken to be the foot length (= 1) and the beginning of the first syllable indicates a phase of 0, the phase of the second syllable of that foot can be seen as indicating the phase, e.g. 0.25, if occurring after one quarter of the total foot duration. The two phases can now be said to have a relation of 1:3, since within the period, the second syllable covers a duration 3 times as long as the first one. If the duration results above are interpreted in this view, beginnings of stressed and unstressed intervals in both iambic and trochaic feet can be described as standing in a phase relationship of roughly 3:2, i.e. the stressed part of the foot tends to cover 3/5 of the entire foot duration, the unstressed part covers roughly 2/5 of the entire foot duration. We can now say that after the beginning of each stressed syllable in a binary poetic rhythmic group, we "count to three" until the unstressed syllable is produced, during which we "count to two". It is important to notice that this "counting" ought to be treated as a metaphor describing attractors of relative timing and does not imply an isochronous reference interval during poetry production. As shown in the previous section, this 3:2 relationship is followed more rigidly in iambic meter and followed best in poetry and by singers. While the meter specific duration adjustments remain, these global tendencies remain evident as well. Phase relationships are similar for both speaker groups, despite tempo differences, i.e. the actors speak faster than the singers when reciting poetry (cf. Section 3.2). Interestingly, a similar 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 (Bröggelwirth 2006). These similarities are depicted in Figure 2, where the relative durations of the first syllables across various meters (poetic speech only) are shown relative to normalised foot duration (total duration = 1). In this representation, a (first) syllable that covers half of the total foot duration would have the value of 0.5, a syllable that covers one forth of the total foot duration receives a value of 0.25 and so forth. Here, the dactylic durational characteristics look very similar to what we previously found for iambs, i.e. their first syllable covers roughly 2/3 of the total foot duration, despite the fact that unlike iambic feet, dactyls start

with the stressed syllable. At first glance, dactyls behave similarly to iambs, just showing a reversed stress pattern. However, a one-way ANOVA reveals unique durational distributions for all three meters ($F[2, 7318] = 2437$, post-hoc Sheffé, $p<0.001$ for all comparisons]. Thus, the possible conjecture that, when regarding the relative durations of unstressed and stressed intervals "dactyls are iambs with a reversed stress pattern" is not supported by the data. In our analysis so far, the first syllables in feet were compared with regards to their relative lengths within the foot. These syllables are, metrically spoken, very different entities, namely

- A first stressed syllable in a binary foot (trochee)
- A first stressed syllable in a ternary foot (dactyl)
- A first unstressed syllable in a binary foot (iamb)

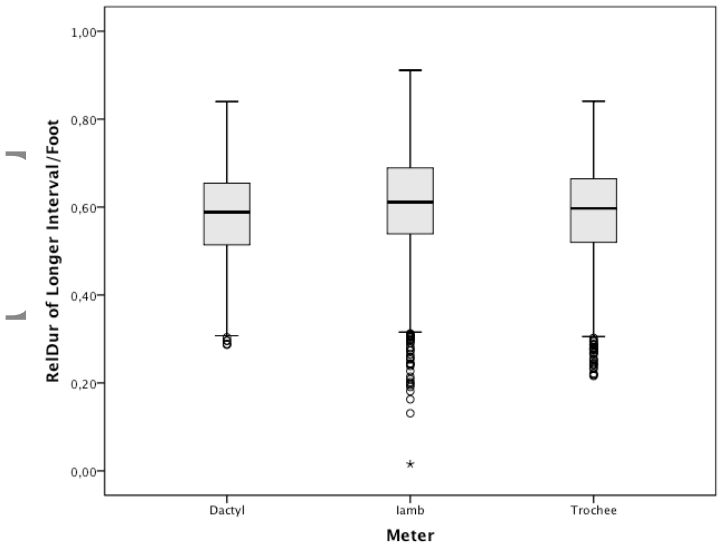

Figure 1: Durations of longer intervals in dactyls, iambs and trochees relative to normalised foot length = 1.

In order to heighten comparability across meters with regards to the observed 2:3 (or 3:2) phase relationships, Figure 3 depicts the relative durations of the longer interval for each foot. In iambs and trochees, that is the stressed syllable. In ternary dactyls this is typically the interval comprising the two unstressed syllables. We are now comparing

- The duration of the stressed part in a binary foot, consisting of one syllable (trochee, iamb) relative to a normalised foot duration = 1.
- The duration of the unstressed part in a ternary foot, consisting of two syllables (dactyl) relative to a normalised foot duration = 1.

Figure 3 underlines the impression of a general, meter independent tendency for a 3:2 distribution between long and short intervals. This visual similarity was tested statistically. A one-way ANOVA ($F[2,7318]= 41.3$, $p<0.001$) reveals that regarding the relative durations of longer intervals within metrical feet, both trochees and dactyls belong into one group (relative mean duration= 0.59, post-hoc Sheffé, $p= 0.43$), while iambs are still showing the characteristic slight additional lengthening of the stressed syllable, making them different in durational characteristics from both trochees and dactyls (relative mean duration= 0.61, post-hoc Sheffé, $p<0.001$).

Thus, the previous results can be replicated, in the sense that the relative duration pattern of iambs differs from the others by a stronger lengthening of the longer interval. Trochees and dactyls, however, share surprisingly many characteristics. Both start with a stressed syllable and show identical relative durations of long vs. short intervals. The difference between both meters is the reversed phase relationship. Trochees show a 3:2 relationship between stressed and unstressed intervals, dactyls show a 2:3 relationship between stressed and unstressed intervals. A close look at the duration distributions revealed that iambs are special in that they do need a slightly stronger relative foot final lengthening, even though they appear to share superficial characteristics with trochees (3:2 phase relationships) and dactyls (foot initial shorter interval). Thus, foot final iambic lengthening indeed follows the iambic/trochaic law. The overall 3:2 phase relationships that we found for iambs and trochees are illustrated in Figure 4. Figure 4 does not reveal the fine-grained meter specific adjustments differentiating between iambs and trochees. Finally, Figure 5 exemplifies the close similarities between trochees and dactyls (identical relative durations between long and short intervals), but different phase relationships between stressed and unstressed intervals.

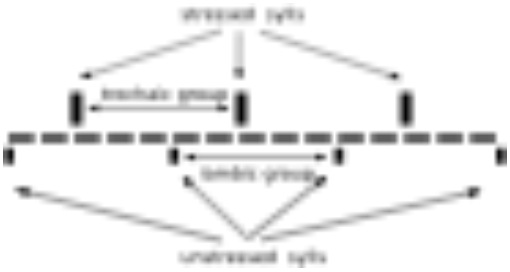

Figure 4: Iambs and trochees show roughly the same 3:2 phase relationships between stressed and unstressed syllables. However, the detailed patterns show meter specific adjustments of relative duration.

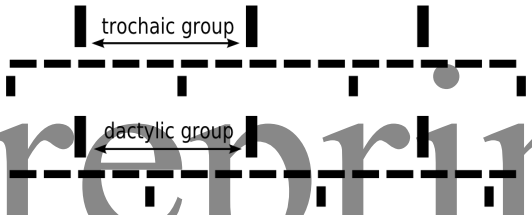

Figure 5: Dactyls show a 2:3 phase relationships between stressed and unstressed syllables, trochees show a 3:2 phase relationship between stressed and unstressed syllables. The relative durations of long and short intervals are identical in both meters.

3 Prominence Analyses

It has not been examined so far in what way poetic meters are perceived differently. Since the duration analyses revealed meter specific adjustments, it is likely that these have an impact on perceptual patterns. In order to analyse such potential effects, perceptual prominences of poetic speech (binary meters) were annotated for the non-professional speakers in the corpus described in 3.1. The annotations were carried out by (paid) graduate students of phonetics using the 31-level scale suggested by Fant and Kruckenberg (1989), i.e. a syllable with a label above 20 can roughly be assumed to be prominent, with a label below 10 as lacking prominence. However, in order to avoid a too simplistic distinction of prominent vs. non-prominent, fine-grained levels of perceptual prominence are intro-

duced. A comparison of iambs and trochees shows small meter specific differences in perceptual prominence. Unstressed syllables are perceived as similarly more prominent when appearing in iambic feet (mean prominence values 4.57 vs. 3.8; cf. Figure 6). Also, unstressed syllables in iambs show considerably more variation in prominence. Stressed syllables are perceived as slightly more prominent when appearing in trochaic feet (mean prominence 26.1 vs. 25.5; cf. Figure 6). While these subtle differences are statistically significant for both unstressed (Wilcoxon, W= 4517428, $p<0.001$) and stressed syllables (Wilcoxon, W= 4873073, $p<0.001$), it is unclear whether they are perceptually relevant, given the fine-grained prominence scale used (Jensen and Tøndering 2005). It is interesting in any case, that the measurable tendencies are contrary to expectations based on the duration analyses above: Duration differences between unstressed and stressed syllables 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 and that the duration contrasts are not mirrored directly in perception.

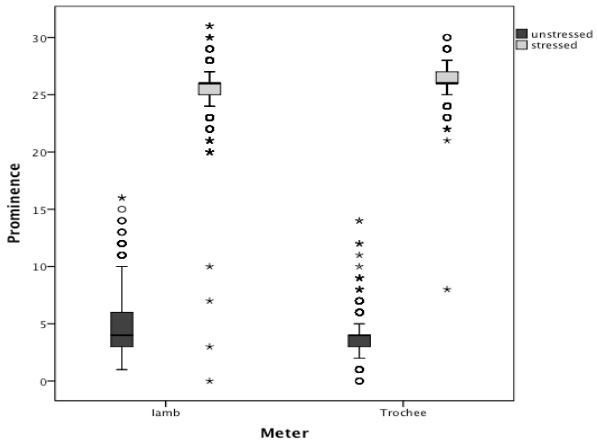

Figure 6: Perceptual prominences for stressed and unstressed syllables in trochees and iambs.

4 Discussion

H1 stated that we expect meter specific duration adjustments. These were found in a slightly stronger lengthening of iambic stress, both comparing it to stressed syllables in trochees and to longer, unstressed intervals in dactyls. Taking into account the significantly 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 due to the language-imposed dominance of foot initial stress. With an average of roughly 30ms additional duration in iambic stressed syllables and given an reference interval of roughly 300ms, that stronger lengthening of stressed iambic syllables compared to trochaic ones ought to be above the JND (Abel 1972). Another discrepancy remains: Iambs show more relative lengthening of the stressed syllable but their stressed syllables are perceived as slightly less prominent. One possible explanation for this may be the so-called time shrinking effect (Sasaki et al. 2004). Time shrinking leads to a perceptual shortening of long intervals following short intervals (as in iambs) and has recently been shown to be active also in speech-like data (Wagner and Windmann 2008). However, this hypothesis needs further empirical foundation. Another explanation would be based on language-specific expectancy patterns with respect to rhythmic groups: German listeners are used to foot-initial stressed syllables and are inclined to perceive a trochaic or dactylic pattern. This expectation is overridden actively by a stronger lengthening of the stressed syllable in an iamb on the side of the speaker. Such an explanation would automatically explain the higher perceptual prominence of foot initial unstressed syllables in iambs, which may be regarded as a phenomenon caused by listener expectations. An alternative explanation may be a trade-off between various prominence lending acoustic factors not looked at in this study–it is generally known that prominence perception relies on more than simply duration, but can be seen as a perceptual gestalt generated by several language-specific acoustic (spectral emphasis, f0 shape), cognitive and linguistic top-down processes (e.g. Wagner 2005; Tamburini 2005; Niebuhr 2007). In total, meter specific differences in both perception and production were detected in both poetry and prose (H1 and H3 accepted), but they cannot be fully explained based on the acoustic and perceptual data yet.

The analysis of phase relationships between long and short intervals revealed a strong preference for simple 3:2 (or 2:3) patterns independent of meter. This is strong evidence for a general timing strategy characterizing (German poetic) feet, even though slight meter specific adaptations

are carried out. So, we do accept H1, but we still see a general timing preference, which seems to be a driving force across various meters and stress distributions. A striking examination was that the 3:2 pattern 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 in reading 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.

When comparing poetry and prose, we see very similar patterns, even though poetic speech may indeed follow the strict 2:3 or 3:2 phase relationships more clearly. However, the stronger iambic lengthening effect was found in prose as well as poetry. It thus seems to be a phenomenon not restricted to poetic speech. There exists much evidence against H4! However, keeping in mind the chosen texts were carefully designed by their authors in order to elicit a particular metrical style, it remains to be shown how the iambic lengthening effect can be traced in speech, that is less regularly structured, e.g. conversational speech.

5 Conclusion

The data reveals meter specific patterns in both production and perception. The data also shows that a slightly stronger foot final lengthening is exclusive to iambs. Meters with foot initial stress show very similar relative durations, when comparing longer and shorter intervals. The iambic lengthening appears to be a compensation for the listener's expectation of foot initial stress, which is still unveiled in more prominent unstressed syllables in iambs. Despite meter specific duration adjustments, there exists a strong tendency to prefer phase relationships of 3:2 between stressed and unstressed syllables in binary feet, and of 2:3 in ternary feet.

Thus, taking into account global tendencies, iambs and trochees seem to be "two sides of the same coin", in that they are following similar phase relationships. Still, meter specific adjustments appear to be necessary in order to uphold the perceptual impression of an iambic or a trochaic pattern.

Future experiments ought to test to what extent meter perception can be influenced by the initial stress pattern, and possibly override meter specific duration patterns discovered above, or whether duration adjust-

ments are sufficient to turn a trochaic into an iambic poem and vice versa. Given the German default pattern of foot initial stress, it is expected that the conversion of a trochee into an iamb would be more difficult that the opposite.

6 References

Abel, S. (1972): Duration discrimination of noise and tone bursts. *Journal of the Acoustical Society of America* **51**, 1219–1223.

Barry, W., B. Andreeva and J. Koreman (2009): Do Rhythm Measures Reflect Perceived Rhythm? *Phonetica* **66**, 78–94.

Bröggelwirth, J. (2005): A rhythmic-prosodic model of poetic speech. In: *Proceedings of Interspeech 2005, Lisbon, Portugal*, 2397-2400.

Bröggelwirth, J. (2007): *Ein rhythmisch-prosodisches Modell lyrischen Sprechstils*. Doctoral Disseration, Universität Bonn. URN: urn:nbn:de:hbz:5-12053

Cummins, F. and R. Port (1998): Rhythmic constraints of stress timing in English. *Journal of Phonetics* **26**, 145–171.

Cutler, A. (1994): The perception of rhythm in language. *Cognition* **50**, 79–81.

Eriksson, A., E. Grabe and H. Traunmüller (2002): Perception of Syllable Prominence by Listeners with and without Competence in the Tested Language. In: *Proceedings of the Speech Prosody 2002 Conference, Aix-en-Provence, France*, 727–730.

Fant, G. and A. Kruckenberg (1989): Preliminaries to the study of Swedish prose reading and reading style. *STL-QPSR* **2**, 1–83.

Cummins, F. (2009): Rhythm as an Affordance for the Entrainment of Movement. *Phonetica* **66**, 15–28.

Hay, J.S.F and R.L. Diehl (2007): Perception of rhythmic grouping: Testing the iambic/trochaic law. *Perception & Psychophysics* **69**, 113–122.

Jensen, C. and J. Tøndering (2005): Choosing a scale for measuring perceived prominence. In: *Proceedings of Interspeech 2005, Lisbon, Portugal,* 2385–2388.

Kingston, J. (2007): The phonetics-phonology interface. In: Paul de Lacy (ed.): *The Cambridge Handbook of Phonology* (pp.435-456) Cambridge: Cambridge University Press.

Kruckenberg, A. and G. Fant (1993): Iambic versus trochaic patterns in poetry reading. *Nordic Prosody* **VI**, 123–135.

Kusumoto, K. and E. Moreton (1997): Native language determines parsing of nonlinguistic rhythmic stimuli. *Journal of the Acoustical Society of America* **102**, 3204.

Niebuhr, O. (2007): *Perzeption und kognitive Verarbeitung der Sprechmelodie. Theoretische Grundlagen und empirische Untersuchungen*. Berlin/New York: deGruyter.

Niebuhr, O. (2009): F0-based rhythm effects on the perception of local syllable prominence. *Phonetica 66*, 95–112.

Nord, L., A. Kruckenberg and G. Fant (1990): Some timing studies of prose, poetry and music. *Speech Communication* **9**, 477–483.

Opitz, M. (1624). *Buch von der Deutschen Poeterey*. Leipzig: David Müller.

Patel, A. D., J.R. Iversen and K. Ohgushi (2004): Native language influences the perception of non-linguistic rhythm. In: J. Slifka, S. Manuel and M. Matthies (eds.): *From Sound to Sense: 50+ Years of Discoveries in Speech Communication*. Cambridge, MA: Research Laboratory of Electronics.

Sasaki, T., D. Suetomi, Y. Nakajima, G. and ten Hoopen (2002). Time-shrinking, its propagation, and gestalt principles. *Perception & Psychophysics* **64**, 919–931.

Tamburini, F. (2005): Automatic Prominence Identification and Prosodic Typology. In: *Proceedings of Interspeech 2005, Lisbon, Portugal,* 1830–1833.

Vaissière, J. (1998): Language-Independent Prosodic Features. In: A. Cutler and D.R. Ladd (eds.): *Prosody, Models and Measurements* (pp. 53–66). Hamburg: Springer.

van de Vijver, R. (1998): The iambic issue: iambs as the result of constraint interaction. *Doctoral dissertation, HIL dissertation series 37, The Hague.*

Wagner, P. (2005): Great expectations – Introspective vs. Perceptual Prominence Ratings and their Acoustic Correlates. In: *Proceedings of Interspeech 2005, Lisbon, Portugal,* 2381–2384.

Wagner, P. and A. Windmann (2009): No time to lose? Time shrinking effects enhance the impression of rhythmic "isochrony" and fast speech rate. In: *Proceedings of Interspeech 2009, Brighton, UK,* 1523-1526.

Wiese, R. (1996): *The Phonology of German*. Oxford: Oxford University Press.