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A Turbulent Acceleration into the Stretto

Martha Argerich Plays Chopin's Prelude op. 28/4 in E minor

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This article is the result of a research project at the Lucerne University of Applied Sciences and Arts.

Just over twenty years ago, Todd and Clarke suggested that performers of Western art music use expressive devices in order to clarify their own perspective on the structure of a composition.[1] Performance analysis can study the characteristics of a performance in order to discover those structural features of the composition which are highlighted in the interpretation. In an earlier paper, we called this analytical process "inverse interpretation".[2]

This article presents our inverse interpretation of Martha Argerich's expressive timing during bars 13-16 of Chopin's Prelude op. 28/4 in E minor on her 1975 Deutsche Grammophon studio recording.[3] We focus on a few seconds of music in order to analyze them in detail. We intend to demonstrate that Argerich shapes her *accelerando* of bars 13-16 in response to certain structural features of Chopin's composition.

MEASUREMENTS AND METHOD

Our observations are based on precise note onset time measurements. For each note of the right-hand melody of the Prelude, and for each chord in the left-hand accompaniment, the moment of the physical onset has been determined, i.e. the very moment when the hammer hits the strings.[4] Since the Prelude's left-hand chords consist of three or more notes, only the onset time of the loudest note in each chord was measured.

The measurements were carried out in two stages, using the LARA analysis software:[5] first, the onsets were roughly marked in a sonograph with a precision of +/-20 milliseconds (ms); then a narrow band-pass filter (bandwidth = 100Hz) was applied to the signal. The filter was centred on the fundamental tone of a note (or, if needed, on one of its first partials). This was necessary in order to isolate the onset of this particular note from all the other simultaneously sounding events. Two different intensity levels of the residual signal were interpreted: a nimble peak level,[6] which follows the intensity surge caused by the onset with high temporal precision, and an anticipated RMS level,[7] which measures the general intensity. The physical onset was adjusted to the moment when the peak level first overshoots the RMS level.[8]

Fig. 1 shows the situation around the onset of the first note in Argerich's performance (B_3, see score in Fig. 2). The filter is adjusted to the fundamental tone of this first note (247 Hz). The detected onset (green vertical marker) was set to the moment when the first value of the peak level (blue) overshoots the RMS level (red).

Since this is the first event of the performance, which rises from silence, the physical onset could easily be determined in an oscillogram. It is marked by the black vertical line in Fig. 1. The detected onset is 3ms late in this particular example.[9]

In recent tests carried out at Hochschule Luzern, this method was applied to 88 sample piano sounds; the onsets in these tests were an average of 5.5ms late, with a standard deviation of 3.4ms.[10] The current results, however, are probably slightly more precise: outliers were not corrected in the test runs, but they can easily be spotted by an attentive and experienced analyst in an authentic analysis situation. It is safe to say that this method placed the detected onset within the first 10ms after the physical onset.

PHRASE STRUCTURE, RUBATO AND RITARDANDI

In Senn et al. 2009, the process of inverse interpretation was applied to bars 1-4 of Argerich's performance. Since the present paper scrutinizes a varied reprise of this opening in bars 13-16, the results of the older study are briefly reviewed here.

Fig. 2 shows Argerich's timing in her performance of bars 1-4. Above the score excerpt are two Nested-Squares-

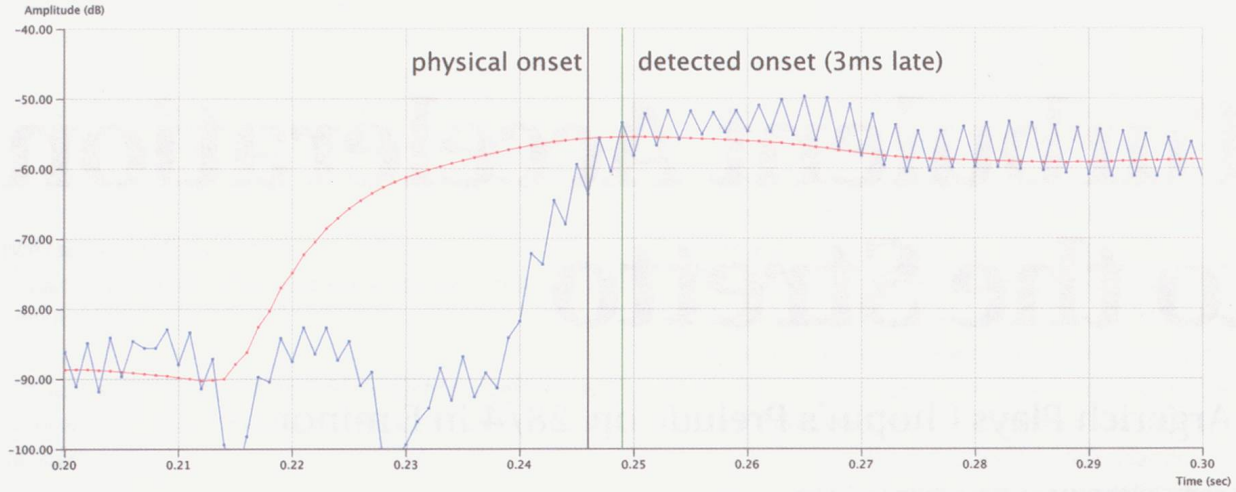

Fig. 1: Onset detection function with RMS level (red), peak level (blue), the physical onset (black, detected with an oscillogram) and the detected onset (green) set to the moment when the peak level first overshoots the RMS. The time resolution of both curves is 1ms.

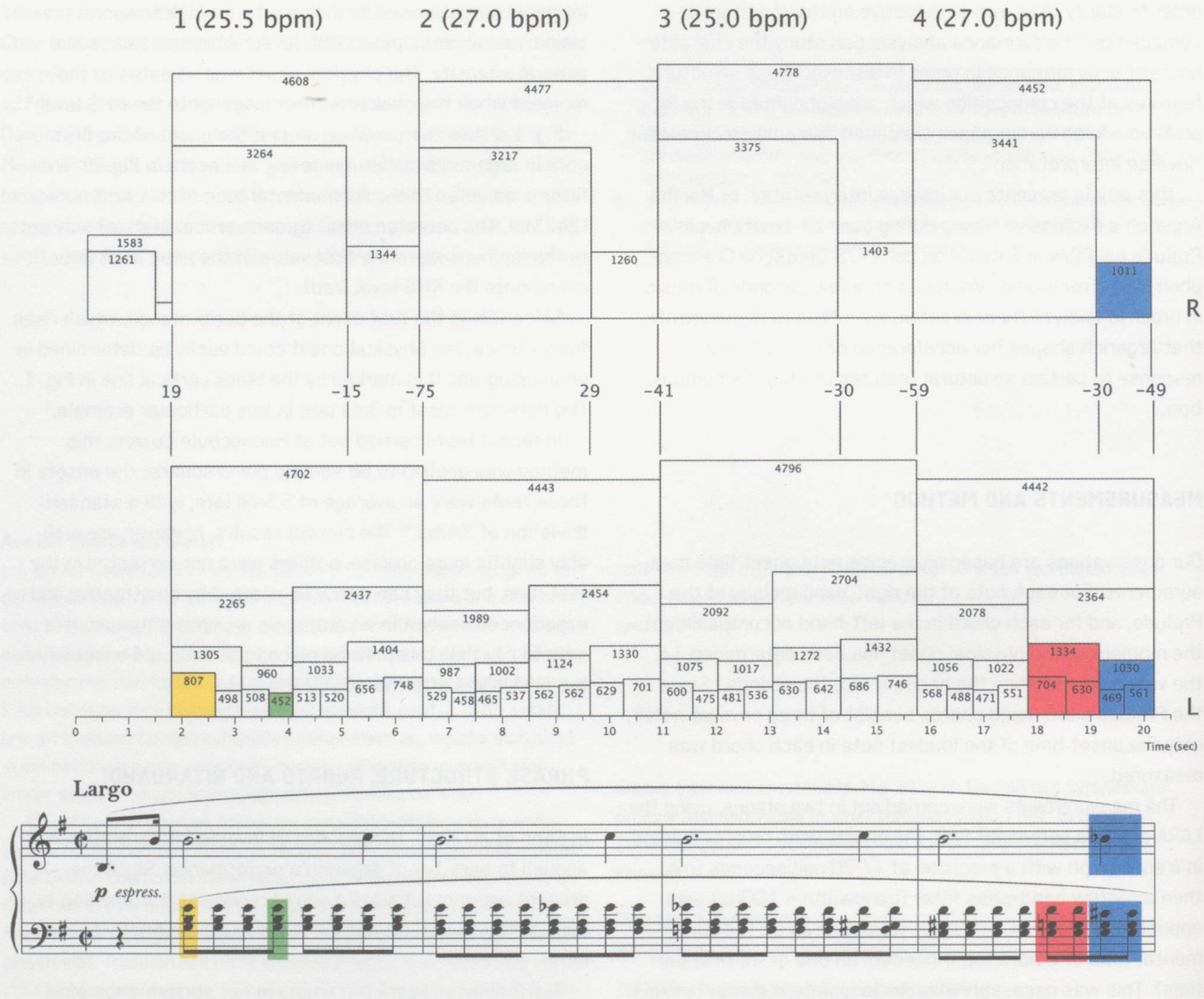

Fig. 2: Nested-Squares-Diagrams (NSDs) and score of bars 1-4. Right-hand NSD on top (R), left-hand NSD below (L).

Diagrams (NSDs). The NSD labeled 'L' (for 'left hand') represents the timing of the accompaniment. Every vertical line on the timeline marks the timing of a detected onset. The width (and consequently the height) of the squares represents the Inter-Onset-Intervals (IOI) between onsets. If space permits, IOIs are given in milliseconds in the upper part of each square. The smallest squares (452-807ms) stand in for the IOIs between neighbouring eighth notes. The largest squares (4442-4796ms) signify IOIs between the primary downbeats of neighbouring bars – they represent bar duration.

The top NSD labeled 'R' (for 'right hand') represents the timing of the solo melody. The smaller squares stand for the anacrusis, the dotted half notes and the quarter notes respectively. The largest squares represent bar durations, in analogy to the left-hand NSD. Both diagrams (R+L) are horizontally adjusted to the same timeline below the left-hand NSD. Tempo averages in parentheses on top are calculated in beats-per-minute (bpm) for the *alla breve* half note on the basis of the right-hand bar duration.

The numbers between the diagrams represent timing differences between onsets in the right and the left hand, which in the score are notated at the same metric position. Negative numbers indicate right-hand or melody lead in milliseconds, positive numbers indicate that the right-hand melody lags behind the accompaniment.[11]

In the score, the eighth-note chords of the left hand are rhythmically uniform. However, Argerich plays them with a high degree of *rubato*. The longest eighth-note chord (807ms, yellow) within this passage is 78% longer than the shortest (452ms, green). One pattern is omnipresent: Argerich starts each bar rather quickly, but then loses momentum. In each bar, the second half is longer in duration than the first. Argerich's performance of these initial bars gives an impression of recurring deceleration, even though the overall tempo remains stable.

Bar 4, which closes the first four-bar phrase, is of particular interest. Several studies have shown that there is a strong correlation between phrase structure and tempo: at the end of a melodic phrase, performers normally slow down.[12] Important phrase boundaries within the composition are accentuated by particularly strong *ritardandi*. This correlation has proven to be so stable that scholars have developed algorithms to predict tempo from phrase structure.[13]

The end of bar 4 is not a strong phrase boundary by any standard, since it is not enhanced by a harmonic cadence. But it marks the moment when the right-hand melody stops repeating the opening motif and begins its chromatic descent. Unlike bars 1-3, Argerich's playing slows down on the third quarter (red) of bar 4, but accelerates again on the fourth quarter (blue). The fourth quarter brings about this evolution by moving away from the repeated C_5-B_4 motif to $B\flat_4$-A_4 in the right-hand melody. The $B\flat_4$ is heard as an anacrusis to bar 5 and thus belongs to the next four-bar phrase. Consequently, Argerich's performance speeds up again at this point. The strong correlation between phrase structure and *ritardando* apparently affects the minute inner workings of bar 4.

STRETTO AND ACCELERANDI

When this opening music is reprised in bars 13ff., the tempo pattern changes completely: Fig. 3 shows the NSDs and score of bars 13-16. Argerich starts the passage at a tempo of 27.6 bpm in bar 13. This is similar to her initial tempo in bars 1-4. She then speeds up considerably: in bar 16 the music moves at 42.0 bpm; the tempo has increased by 52%. Argerich accelerates through the whole passage towards the *stretto*.

The transition from bar 12 (*rubato*, very slow at 20.1 bpm) to bar 13 (*a tempo* at 27.6 bpm) is particularly elegant. The triplet figure at the end of bar 12 (yellow squares in the right-hand NSD of Fig. 3) is the fulcrum of this transition: the first note of the triplet is, surprisingly, about the same length as the 2nd and 3rd notes taken together. And it is also the same duration as the 1st eighth note of bar 13 (yellow square in the left-hand NSD). Rhythmically, Argerich's triplet is not a triplet at all, but its altered rhythmic disposition effectively launches the reprise.

The most astonishing moment of the *accelerando* passage can be found in bar 14: the second half of this bar is longer than the first half. Here, at the centre of the acceleration process, Argerich holds back slightly. The 5th and 8th eighth notes (red and blue squares respectively in Fig. 3) are especially long compared to their predecessors.

An emphasis on the 5th and 8th eighth notes is quite common in the context of Argerich's performance: the blue columns in Fig. 4 show how Argerich, on average, distributes bar duration on the left-hand eighth note chords of bars 1-11 and 13-22.[14] The eighth notes around the barline (7th, 8th and 1st) take a large share of bar time, and the 5th eighth note is longer than its neighbours. The average distribution demonstrates how Argerich's *rubato* generally accentuates the *alla breve* metre of the piece: the primary downbeat is clearly emphasized by the long IOIs around the barline. The secondary downbeat receives an emphasis due to the lengthening of the 5th eighth note.

In bar 14 (red columns in Fig. 4) the average profile is sharpened: the 1st, 4th, 5th and 8th eighth notes occupy even more time in bar 14 than in the average bar. The expression of metre offers no sufficient explanation for this augmented *rubato*. Instead, our inverse interpretation looks at another structural aspect of the composition: the harmonic rhythm of bars 13ff.

Bar 13 begins a reprise of the opening of the piece, but it is literal only for one bar, after which the chromatic descents of the accompaniment voices occur faster than before. The 5th eighth note of bar 14 (red square in Fig. 3) is the first moment when this harmonic acceleration can be perceived. Argerich, by lengthening this very note, draws our attention to the change in harmonic pacing.

The second instance of harmonic acceleration can be observed on the 1st eighth note of bar 15 (green square in Fig. 3). Argerich's expressive timing does not affect the duration of the event itself. Instead, the last eighth note of bar 14 (blue square) is particularly long. Argerich emphasizes the primary downbeat of bar 15 by delaying its advent.

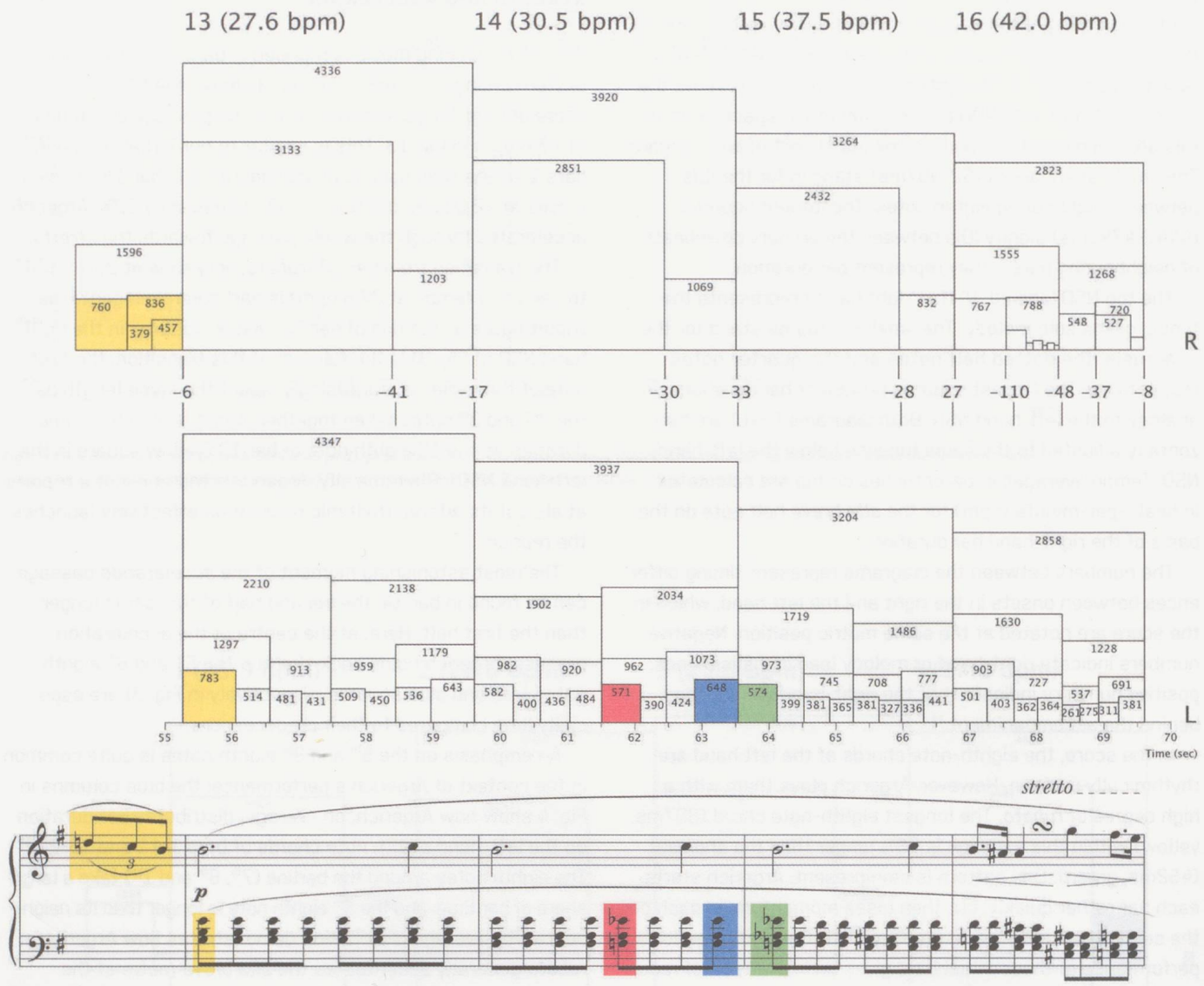

Fig. 3: Nested-Squares-Diagrams (NSDs) and score of bars 13-16.

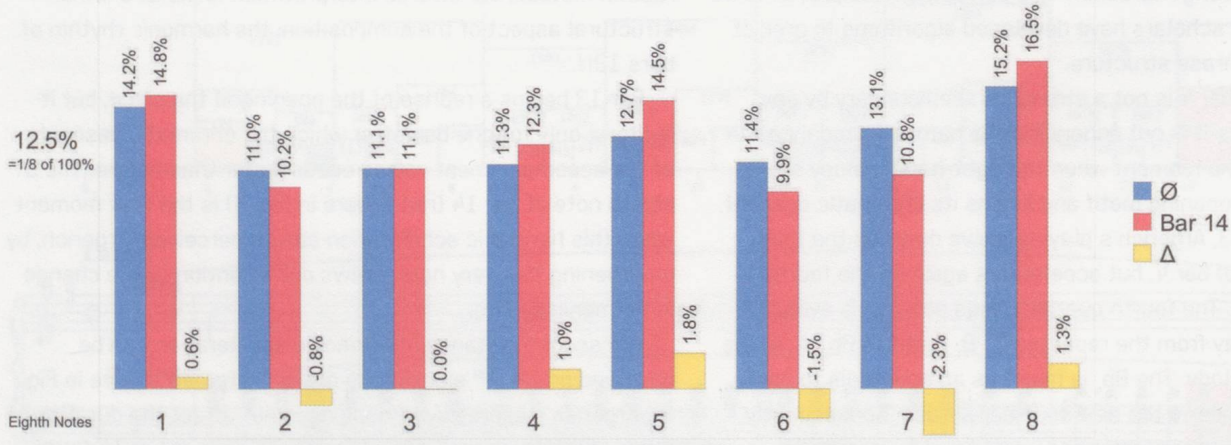

Fig. 4: Distribution of bar time on the eighth notes of the bar. Blue: average distribution of left-hand IOIs, bars 1-11 and 13-22. Red: distribution of left-hand IOIs in bar 14. Yellow: Difference between blue and red columns.

CONCLUSION

In her 1975 studio performance of bars 13-16 of Chopin's E minor Prelude, Argerich parallels the acceleration of harmonic rhythm by a breathtaking *accelerando*. At the bar level, this increase in tempo might seem straightforward and continuous. On sub-bar level, however, timing analysis shows that the pianist warps metrical and physical time in a highly differentiated and decidedly non-linear way. Our inverse interpretation suggests that Argerich's timing illuminates deep structural aspects of the composition, as seen in the accelerated harmonic rhythm of bars 13-16.

Argerich puts a special microtemporal emphasis on the two events which signal the harmonic acceleration. Subtly, and slightly paradoxically, a local *ritardando* intensifies an overarching *accelerando*.

1 Todd 1985, Clarke 1988, Clarke 1991. Pfleiderer 2006 offers a good overview of studies in this field.
2 Senn et al. 2009: 108. It must be emphasized that inverse interpretation never claims to reconstruct the intentions or thoughts of a performer; one rather tries to argue, from an observer's perspective, why a performance makes sense with respect to the score.
3 DG 2530 731, reissued as DG 415 836-2.
4 On the convergence of physical and perceptual onsets in piano sounds, see Camp et al. 2011.
5 The Lucerne Audio Recording Analyzer (LARA) can be downloaded for free at www.hslu.ch/lara (23.8.2012).
6 Frame size = 1ms, hop size = 1ms, no time displacement.
7 Frame size = 27ms, hop size = 1ms, time displacement = -27ms (anticipation).
8 This method is a variant of the analysis of moving averages, which is used in generating buy/sell signals in the technical analysis of financial markets.
9 Note that the peak level starts to rise earlier than the actual physical onset. This is somewhat counterintuitive, since we do not expect the sound energy level to rise before the hammer reaches the string. This early surge of the curve is an artifact of the narrow band-pass filtering process, which smears the time response of the signal.
10 These test results have not yet been published.
11 In the performance of piano music from the Western art music repertoire, the right-hand melody generally tends to slightly precede the accompaniment. A convincing theory on melody lead in solo piano music has been proposed by Goebl 2001.
12 Some selected readings about the correlation between expressive timing and phrase structure: Beran and Mazzola 2000, Sloboda and Lehmann 2001, Repp 2003, Honing 2005, Honing 2007 and Turner 2011.
13 Such models can be found in: Clarke 1988, Friberg 1991, Friberg 1995, Repp 1998, Juslin et al. 2002, Friberg et al. 2006, Ladinig 2009.
14 Bars 1-11 and 13-22 feature a steady and uninterrupted accompaniment of eighth-note chords. Since Chopin suspends the accompaniment pattern in bars 12, 23 and 24, they have been excluded from the analysis. In a first step, the distribution has been normalized for each bar; in a second step, the average distributions have been calculated. This prevents long (or slow) bars from being weighted more strongly than short (or fast) bars.

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