On time: the influence of tempo, structure and style on the timing of grace notes in skilled musical performance

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Introduction

This study focuses upon the execution of grace notes in musical performance in an attempt to address both musicological and psychological issues related to their timing. An experiment is reported which investigates the relationship between musical structure, predictions from the performance practice literature, and the timing of eleven grace notes in a short piano piece in five repeated performances at nine different tempi (Windsor, Aarts, Desain, Heijink and Timmers, submitted). Grace notes can be seen as additional notes that ornament or 'flavor' the melody and harmony, and can be omitted or added to a performance without fundamentally changing it. A grace note is notated as a small note before a regular note and its score duration is not precisely specified.

Within musicology, the study of historical performance practices has become a central topic and historical performance treatises have become more than just a scholarly concern. There has been a considerable growth in the application of such historical studies to contemporary performance practice. Neumann (1986) claims that the execution of any ornament is highly dependent on the musical context in which it is situated

Psychological studies of musical performance suggest that a performance conveys the musician's interpretation of the musical composition. The function of this interpretation can be seen as solving ambiguities in the composition, but also as a method of higlighting structural and emotional aspects of the music. Experimental research has shown that structural elements of music such as phrase boundaries or metrical pulses are marked by systematic changes in timing, articulation and/or dynamics (see Palmer, 1997 for an overview).

The study of motor aspects of musical performance has led to strong hypotheses concerning time-keeping mechanisms and motor programs. It has been argued that the performance of music is co-ordinated by an internal clock or clocks

and executed by a memorized motor program (see e.g. Shaffer, Clarke and Todd, 1985). In musical terms this would mean that performances of the same piece at different tempi by the same performer would be equal if they were scaled to the same length (Repp, 1994). This notion is called relational invariance. A related idea is that the timing of individual events in a musical sequence is controlled by a continuous function, commonly called a tempo curve. This tempo curve might be directly derived from the hierarchical structure of the music (e.g. Todd, 1985). If both these hypotheses were correct, a single tempo curve and some scaling factor could predict the timing of sequential events in a musical performance at different tempi.

Conflicting evidence has been obtained regarding these hypotheses. Repp (1994) has claimed that "the major (cognitively controlled) temporal and dynamic features of a performance change roughly in proportion with tempo, whereas minor features tend to be governed by tempo-independent motoric constraints" (Repp, 1994: 269). In a study of a different piece, Desain and Honing (1994) claim that next to motoric influences upon timing, the timing of a particular event may depend heavily on its structural function and its changes of duration over different tempi: its scaling behavior.

Desain and Honing's (1994) results are, however, inconclusive: only three tempo conditions were studied, making any claims about scaling behavior over a range of tempi difficult to substantiate. Furthermore, they fail to account for the effect that variations in local tempo might have had on their data: it is possible, for instance, that although the overall tempi of two performances may be different, the local tempo around the location of two grace notes in the same position in the music might be the same, or even might vary in the opposite direction.

In this study, we seek to develop a better understanding of the production of grace notes by explicitly testing the relationship between different structural classifications of grace notes and their timing at different tempi. We will attempt to show that the local structure of music has a systematic effect on both the durations of grace notes and the relationship between these durations and local tempo measurements. In this way we hope to clarify the processes necessary to control timing in musical performance, and to show that the study of psychological processes in music can benefit from detailed attention to hypotheses drawn from the musicological literature. We also hope to demonstrate that systematic empirical work on timing can make a contribution to musical knowledge. We will do this by directly studying the links between scholarly research in performance practice and the actual practice of a skilled musician.

Method

We used the theme from Beethoven's six variations in G-major WoO 70 (1795) on the duet "Nel cor più non mi sento" from the opera "La Molinara" by Giovanni Paisiello (Appendix 1 and Sound Example 1). The theme was chosen for its relative simplicity and brevity. It is especially suitable for this study as it contains 11 grace notes (numbered in square boxes in Appendix 1). Moreover, it is the same theme as was used in the study by Desain and Honing (1994), thus facilitating comparison with this earlier study.

A professional pianist played the piece at nine different tempi: 50, 52, 55, 57, 60, 63, 67, 71, and 75 dotted quarter note beats per minute. These tempi were chosen

because they span a reasonable range, yet are all within the bounds of technique and our musical taste. Within the experiment the pianist was instructed to play a sequence of a block of five repetitions of the theme at each of the nine tempi, giving a total of 45 complete performances.

The inter-onset time between grace note and the note following the grace note was measured, as well as the inter-onset time between the note preceding the grace note and the note following the melody note to which the grace note belongs. This IOI was divided by the number of eighth notes in that time span, in order to calculate the local eighth note duration (also called local tempo). For details, see Windsor, Aarts, Desain, Heijink, and Timmers (submitted).

Results

There are four topics we would like to address here. We will argue that there are at least two different categories of grace notes, that the grace note IOI can be predicted partly from structural classifications of the grace notes, that relatively long grace notes scale differently over tempo to relatively short grace notes, and that there is a consistent relationship between grace note onset, main note onset and right-hand note onset. Of course, these findings apply to only one performer, to one piece and to one musical style.

Our results show that grace notes 2 and 10 (the two grace notes preceding a large descending pitch interval) are consistently played longer than the other grace notes over all the different tempi (Figure 1 and Sound Examples 2 and 3). Our hypothesis regarding this effect was that grace notes in different structural classifications would be played differently, regardless of tempo.

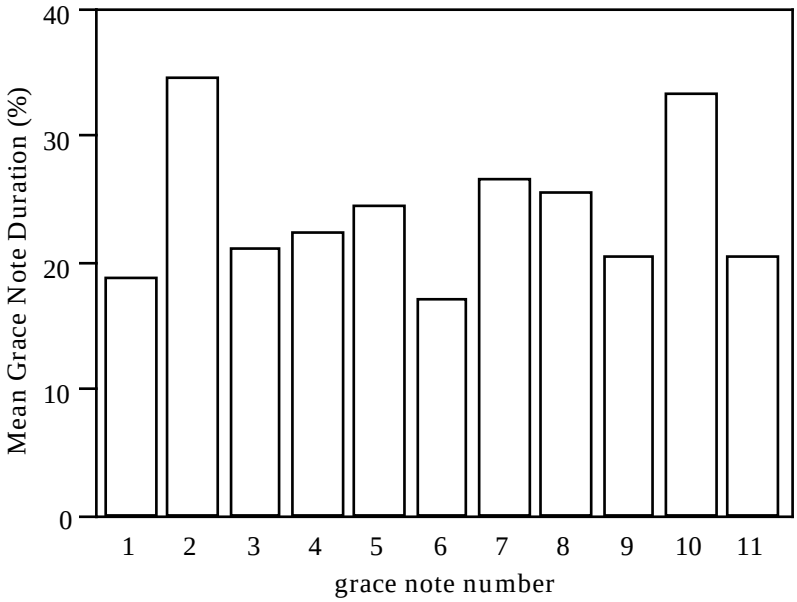

Figure 1. Mean proportional IOI (a percentage of local eighth note duration) for each grace note, averaged over all performances.

Figure 2 shows proportional grace note duration versus tempo. Different grace notes seem to exhibit different behaviour. In particular, grace notes 2, 7, 8, 9 and 10 scale significantly more than would be expected if grace note timing were relationally invariant (Sound examples 4 and 5). The other grace notes scale roughly linearly with

tempo. There is no single music-theoretical category into which grace notes 2, 7, 8, 9 and 10 fall, so it is difficult to make any definitive statement regarding why this effect should occur, but it does seem that longer grace notes scale more over tempo than shorter ones.

Lastly, the grace notes were timed such that they did not ‘take time’ from the main note they are nominally attached to, but from the preceding time interval. The main note was consistently and over all tempi timed some 15 ms before the right-hand note, while the grace note was consistently played before the right-hand note and the main melody note.

Close attention to the qualitative data provided by the pianist reveals that the relative timing of the grace notes is best explained by his efforts to mimic the motor constraints of vocalists and string players, and by his tacit avoidance of dissonant vertical relationships between melody and accompaniment. Both of these interpretative decisions are in line with an explicit decision to attempt to play the piece in a ‘song-like’ manner. This was specially apparent in the timing of grace notes 2 and 10, that were followed by a large melodic leap.

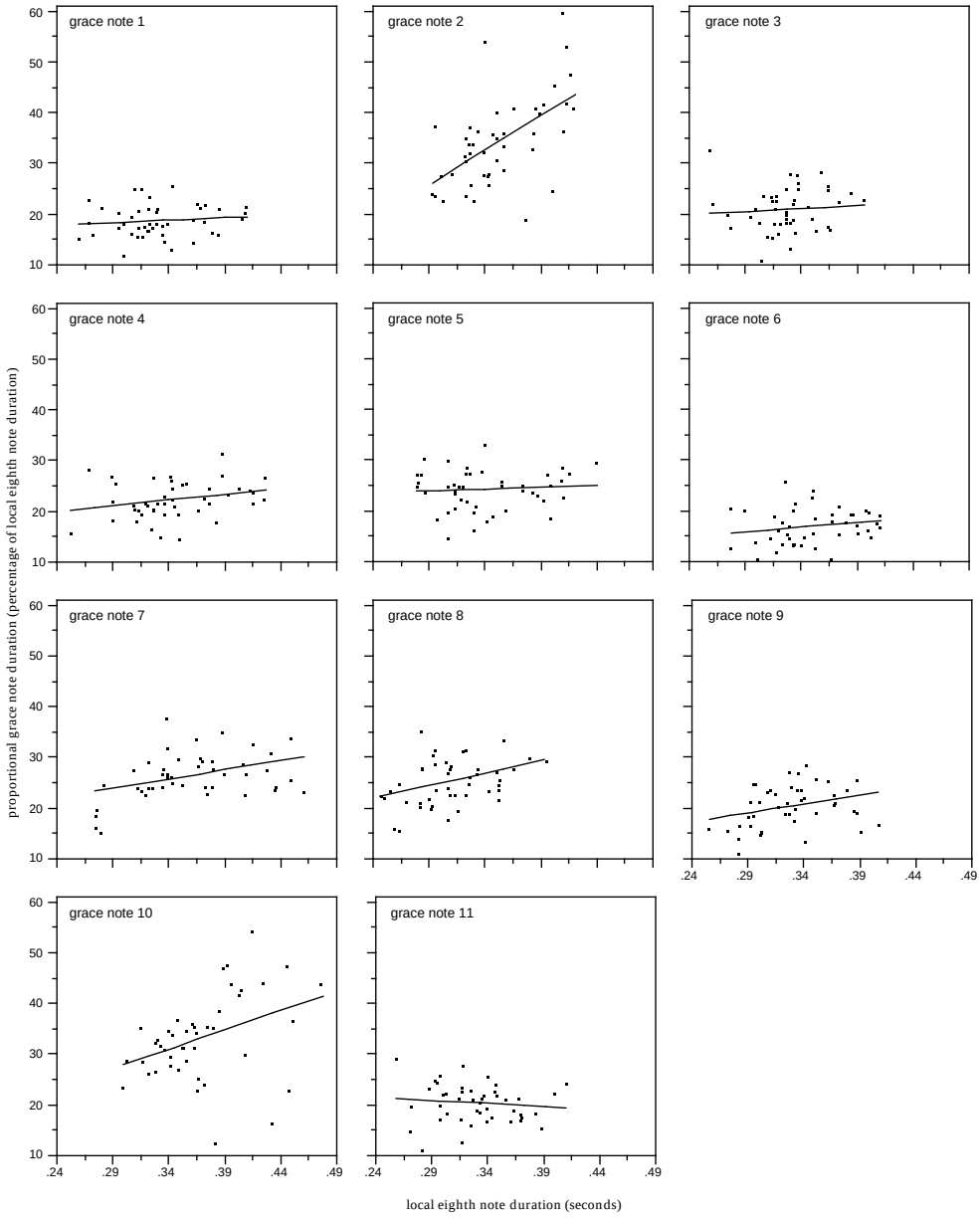

Figure 2. The relationship between local eighth note IOI and the proportional grace note IOI (a percentage of the local eighth note IOI), split by grace note. If the regression line is perfectly horizontal, relational invariance holds for that grace note.

Conclusions

The data provided evidence against the notion that changes in overall tempo leave the relative proportion of adjacent events invariant. Grace notes with a longer mean duration tended to lengthen significantly more than would be expected if they were relationally invariant, whilst shorter grace notes were roughly invariant over tempo. In summary, the results suggest that, in addition to the performer's grasp of musical structure, both overall tempo and subtle communicative issues play important and measurable roles in determining the timing of musical events.

Although musical structure may have an important influence upon the execution of grace notes, it cannot alone explain the differences we find in their

relative length, and does not seem to play a role in the changes in their execution at different tempi. Instead, the major influence on grace note timing seems to be more stylistic. The "character" of the melody, its origin in an operatic aria, combines with local differences in interval structure, small and large melodic leaps, resulting in subtle interpretative decisions that influence the length allotted to each grace note.

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Appendix 1