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Title
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Journal
Proceedings of the Annual Meeting of the Cognitive Science Society, 13(0)

Authors
Drake, Carolyn
Palmer, Caroline

Publication Date
1991

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Recovering Structure from Expression in Music Performance

Carolyn Drake and Caroline Palmer

Ohio State University
Psychology Department
1885 Neil Ave
Columbus OH 43210
cdrake or cpalmer @ magnus.acs.ohio-state.edu

Abstract

Mental representations of structural content in music can be communicated to listeners by expressive variations in performance. We attempt to recover structural content from patterns of expression in skilled music performance, and we contrast possible mappings between structure and expression that allow communication of musical ideas. Three types of musical structure are investigated: metric, rhythmic grouping, and melodic accent structures. Skilled pianists performed musical sequences which were examined for expressive variations that coincide with each accent structure. The mapping of structure to expression is compared for music in which the accent structures are presented singly, are combined to coincide or conflict, or naturally co-occur. The findings suggest that associated sets of expressive variations in performance provide an unambiguous and flexible system for communicating musical structure.

A basic problem in domains such as speech, vision, and music, is how a perceiver is able to recover structure from a continuous input. One possible solution for music perception is that a performer emphasizes structurally important events, drawing the listener's attention to them and thus aiding the perception of structure. Successful communication between performer and listener requires that the listener distinguish between musical structure (information usually indicated in a musical score) and musical expression (particular methods of emphasizing structure) in music performance. This task is complicated by the fact that both are coded in the same acoustic dimensions such as frequency and intensity. However, systematic expressive marking of structural features in music performance may aid the perceiver's recovery of structure.

This paper focuses on the communication of musical structure through expressive variations in performance. We address how the mapping of structure to expression may be mediated by performers' mental representations. Events interpreted as structurally important are often performed in a way that draws attention, by playing them louder, longer, or more legato than surrounding events (Clarke, 1988; Gabrielsson, 1974, 1982; Palmer, 1989). Hypothetically, it should be possible for the listener to identify events played in this manner and infer their structural importance. Unfortunately, this direct recovery of structure from expression is problematic because music is typically composed of several superimposed structures, some of which contradict each other (Lerdahl & Jackendoff, 1983). Thus, a particular combination of expressive variations may arise from multiple structural descriptions, making the recovery of structure ambiguous.

The question arises as to which structural features of music receive emphasis through expression. Accents, events that stand out and capture a listener's attention, are possible candidates. Based on related findings in music perception and performance, we have investigated three accent structures (Drake, Dowling & Palmer, 1991; Drake & Palmer, in prep.). The first, metric accent structure, partitions the musical sequence into a periodic pattern of alternating strong and weak beats, with important events at the beginning of each measure. A second accent structure, rhythmic grouping, segments the sequence into groups of temporally proximal events: an event of long duration separates one rhythmic group from the next and is considered to be structurally important. A third accent structure, melodic jumps, segments the sequence on the basis of pitch height, and an event after a large change in pitch is structurally important. These three accent structures are explicitly marked in the musical score and examples are shown in Figure 1, with X's indicating accents. We predict that these events will receive emphasis in performance. Pianists can emphasize events in at least three ways: by changes in intensity, timing, and articulation. Intensity is influenced by the keypress force correlated with piano hammer velocities. Timing, in particular interonset timing, reflects event durations relative to those indicated by the musical score. Articulation is affected by the time between successive keypresses and releases, resulting in legato (smooth) or staccato (disjointed) events.

How do expressive variations reflect a performer's interpretation of musical structure? Theoretically, a performer could use all methods of expression (intensity, interonset timing, and articulation) for each of the

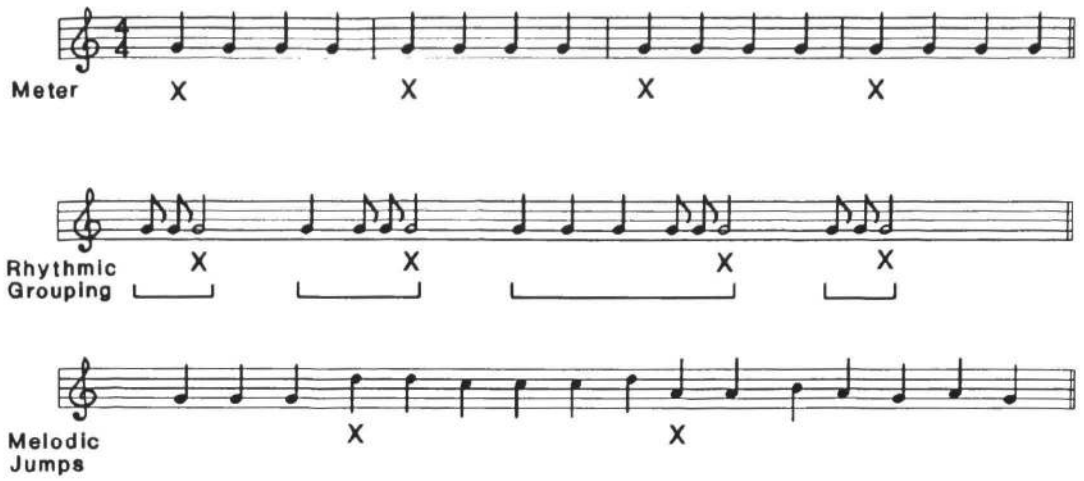

Figure 1. Examples of accent structures. X denotes an accent.

accent structures (meter, rhythmic grouping, and melodic jumps) so that each type of accent would be associated with expressive variations in all three performance measures. This is indicated in Figure 2A where lines join all possible accents with all possible expressive variations. In this type of mapping, the recovery of structure from expression can be ambiguous: an event may be expressively marked as structurally important, but it may be difficult to distinguish which accent structure is implicated.

A second class of mappings associates each accent structure with variations in only one expressive dimension. For instance, Figure 2B shows metric structure associated with variations in intensity, rhythmic grouping with temporal distortions, and melodic jumps with articulation. This would be a completely unambiguous communication system: for instance, a loud event could be interpreted unambiguously as being metrically important.

In a third class, each accent structure would be related to an associated set of expressive variations unique to each accent structure. For instance, Figure 2C shows metrically important events played both louder and longer in duration, whereas rhythmic grouping accents are played longer and more legato. To distinguish between musical structures giving rise to the expressive output in this mapping, listeners would have to be sensitive to associated combinations of variations.

We present evidence from skilled music performance that allows us to distinguish among these mappings of structure to expression. We will contrast findings from empirical studies presented in detail elsewhere (Drake & Palmer, in prep.). First, we examine performances of musical sequences in which only one accent structure is presented at a time, to determine expressive variations used in the absence of

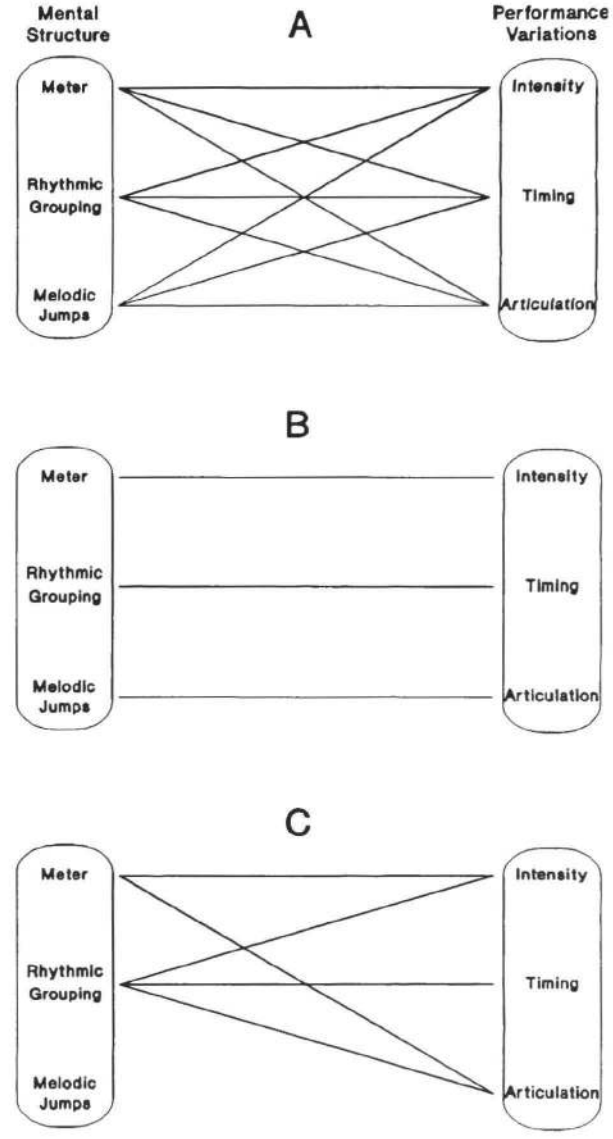

Figure 2. Three theoretical mappings of structure to expression.

other accents. Second, we examine the performance of simple musical sequences in which the three accent structures are combined in different ways so that they conflict or coincide, to determine how the presence of each structure influences the expression of other structures. Third, we analyze a performance of complex music in which the three accent structures naturally co-occur. By using progressively more complex stimuli, we hope to distinguish among possible mappings of structure to expression in skilled music performance, and to test whether or not this mapping is dependent on the musical context in which the accent structures are presented.

A. Isolated accent structures

Ten skilled pianists performed simple musical sequences in which each accent structure was presented in isolation. Examples of the sequences are shown in Figure 1. To evaluate the relative contributions of emphasis of structurally important events versus lack of control (noise), pianists were instructed to perform each sequence in two ways: first musically and then mechanically (without adding any expression). Performances were recorded on a Yamaha Disklavier acoustic upright piano monitored by a personal computer. Only results reaching statistical significance ($p < .05$) from analyses of variance are described here. For each accent structure, the expressive variations coinciding with accented events in Figure 1 were compared with those on surrounding events: for instance, events on the first beat in the measure were compared with all other events, the first and last events in a rhythmic group were compared with the other events, and events on melodic jumps and turns were compared with events preceding and following them.

Musical performances. The expressive variations observed in the musical performances are shown in Figure 3. Events on the first beat in the measure were played louder and more legato than other events in the measure. The end of a rhythmic group was emphasized by being played louder, delayed, and preceded by a short pause. Thus, consistent expressive variations were related to metrical and rhythmic grouping accents but not to melodic jumps.

Mechanical performances. The expressive variations observed in the mechanical performances of the same musical sequences are shown in Figure 4. No expressive variations were recorded for either meter or melodic jumps, but the rhythmic groups were emphasized with the same timing and overlap variations as seen in the musical performances. With these two exceptions, the mechanical performances demonstrate that the mapping of structure to expression is voluntary and related to the performers' emphasis of musical structure.

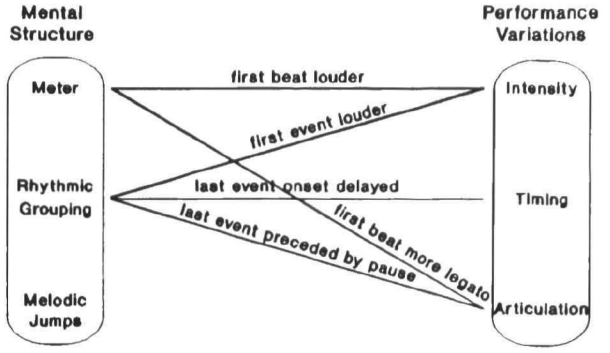

Figure 3. Observed mappings for musical performances of isolated accent structures.

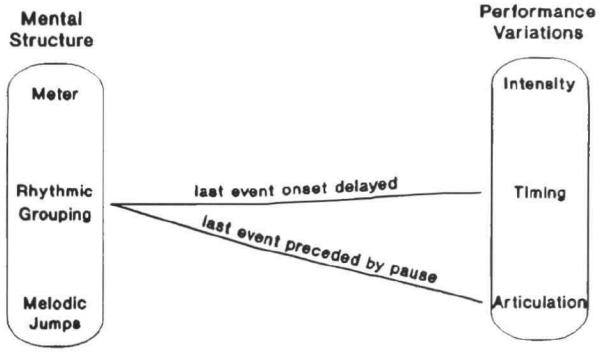

Figure 4. Observed mappings for mechanical performances of isolated accent structures.

B. Combined accent structures

The same pianists then performed musical sequences (in a musical fashion only) in which all three accent structures either coincided or conflicted. Examples of tunes in which accents coincide and conflict are shown in Figure 5, and the expressive performance variations are summarized in Figure 6. The same variations were observed for rhythmic grouping as seen in the musical performances of the isolated accent structures (last event played louder, preceded by a pause, and delayed). No systematic variations were observed for meter, but melodic jumps were preceded by a lengthened duration delaying their onset. These findings were consistent across performances of stimuli containing coinciding and conflicting accent structures. Note that three of the six expressive variations observed in the musical performances of the isolated accent structures (Figure 3) were also observed here, suggesting that they are unaffected by the presence or absence of the other accents.

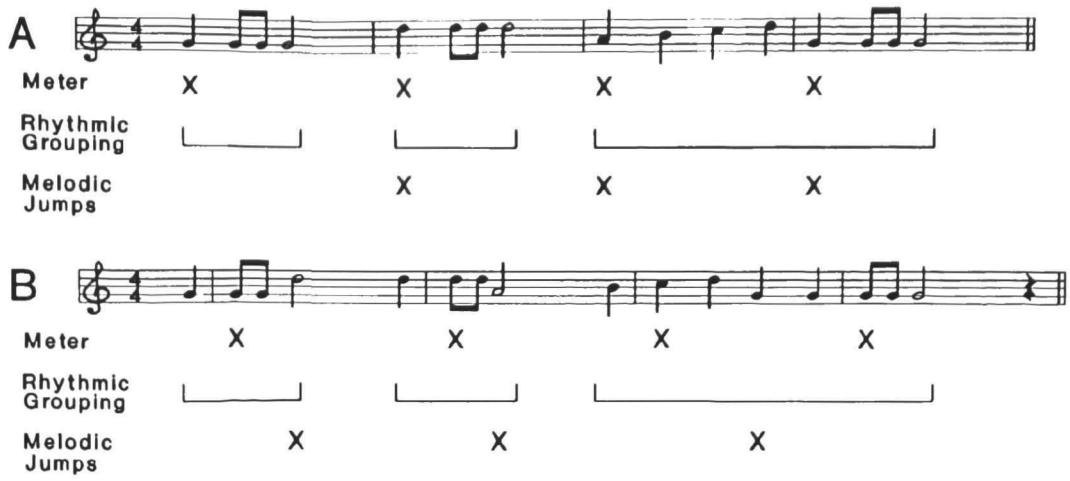

Figure 5. Examples of musical sequences in which accents (A) coincide or (B) conflict.

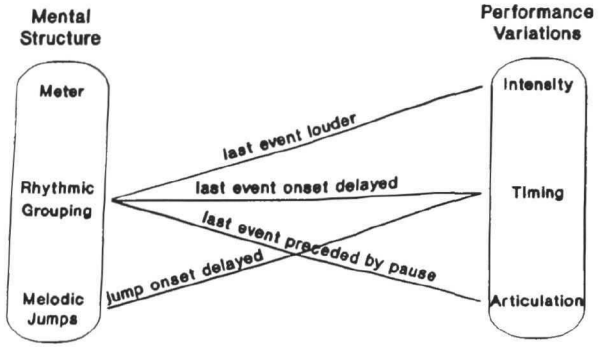

Figure 6. Observed mappings for performances of combined accent structures.

C. Complex music with co-occurring accent structures

An experienced concert pianist performed Beethoven's Piano Sonata Opus 111, with which he was familiar, on a computer-monitored grand piano. This piece was chosen because it presents a more complex case in which the three accent structures naturally co-occur: a significant correlation was found between the rhythmic grouping and melodic jump accents in the composition ($r = .38$, $p < .01$). The performance of the melody in the first movement was chosen for analysis because it contains many metric, rhythmic grouping, and melodic accents.

The expressive variations in this performance are presented in Figure 7. The metric accent structure was marked by variations in intensity, with structurally important events played louder. Rhythmic grouping was emphasized again with the last event played louder, delayed, and preceded by a pause. In addition, the first events in a rhythmic group were preceded by a pause. There was also a more complex variation for intensity within the rhythmic group: the first event was the softest and the last event the loudest, with a slow increase throughout the rhythmic group. Melodic jumps were preceded and followed by a pause and a longer interval. Thus, similar expressive variations were observed in the performance of this complex music as in the performances of the isolated accent structures (Figure 3): five of the six variations were identical, as well as one additional variation related to rhythmic grouping and two related to melodic jumps. Therefore, the mapping of structure to expression is highly consistent in the presence or absence of other co-occurring accent structures.

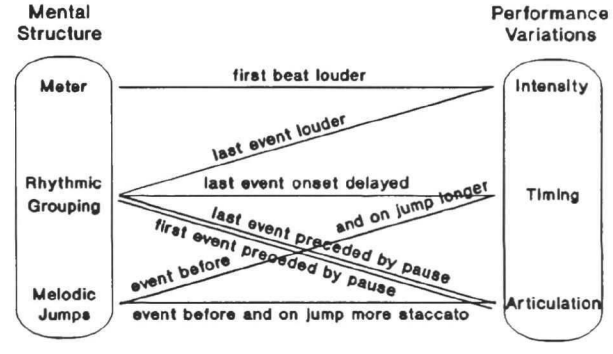

Figure 7. Observed mappings for performances of co-occurring accent structures.

Returning to the three possible classes of mapping presented earlier, these analyses provide support for the third class of mapping; associated sets of expressive variations reflect structural content. The other two classes of mappings are not supported because each accent structure is not related to variations in only one or all of the expressive dimensions.

Discussion

The recovery of structure from a rich continuum of input is a critical problem for many perceptual domains, including music. We have demonstrated that, in the case of music, performers use a wide range of expressive variations to disambiguate musical structure. This mapping of musical structure to expression in music performance must be sufficiently informative and robust across musical contexts to account for communication from performer to listener. The mapping described here, an associated set of expressive variations, is encouraging for theories that view music perception as the recovery of structure from expression because music performances provide the primary source of input for perception of music. To complete the chain of communication, listeners must be able to detect and interpret these expressive variations. Those described here fall within the range of perceivable changes (Drake, 1990), and there is evidence to suggest that listeners do detect and use these variations to interpret musical structure (Clarke, 1989; Nakamura, 1987; Sloboda, 1983).

In summary, the consistent findings across musical contexts suggest three important properties of the mapping of musical structure to expression. First, structurally important events are indeed emphasized through a limited set of expressive variations. In piano performance, important structural features may be performed louder, longer, and more smoothly. One or more of these variations may be applied at the same time; a single expressive variation may be used in simple musical contexts and multiple variations in more complex musical contexts, as evidenced by the increased complexity in the mapping from performances of simple musical sequences to more complex musical forms.

Second, the finding that many expressive variations greatly decrease or disappear in mechanical performances indicates that they are under voluntary control and reflect the performers' interpretation of the musical structure. This type of control is necessary for flexible performance that accommodates musical contexts in which structure covaries, yet maintains a determinate mapping of structure to expression.

Third, these findings suggest that an associated set of expressive variations consistently signals at least some structural content across musical contexts. The complex interplay between expression and structure reflects the flexibility attributed to skilled performance, in which an expressive dimension can be adjusted to accommodate different structural features in different performances of the same music. This view requires that both explicit expressive variations and the structural features implied by them contribute to the mental representations of musical knowledge shared by performer and listener.

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Acknowledgments

This research was supported by NIMH grant 1R2945764 to the second author. We are grateful to Mari Jones and Carla van de Sande for comments on an earlier version of this paper.