TEMPO AND LOUDNESS ANALYSIS OF A CONTINUOUS 28-HOUR PERFORMANCE OF ERIK SATIE'S COMPOSITION 'VEXATIONS'

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ABSTRACT

Background and aims. This study fills a significant gap in music performance research, namely the analysis of long-term performances. The importance of performance analysis from a global perspective is demonstrated, using an uninterrupted recording of Erik Satie's 'Vexations' performed by one pianist over almost 28 hours.

Method. In a single case study, the MIDI and acoustical data of the performance are analysed in order to explore changes in tempo and loudness. Additionally, EEG data were recorded to reveal the influence of different states of consciousness (alertness, drowsiness, trance) on tempo stability. Finally, a new method of performance visualisation will be demonstrated.

Results. The performer's changing states of consciousness (alertness, trance, drowsiness) were seen to exert a strong influence on tempo and loudness stability. Tempo and loudness remain stable over the first 14 hours of alertness. The state of trance begins after 15 hours and shows a destabilisation of tempo, folowed by uncontrolled deviations in loudness. However, the stability of tempo and loudness was affected by states of consciousness in different ways: control of tempo diminished earlier than control of loudness. The integrated view of tempo and loudness changes over the entire performance shows independent variations: faster does not mean louder.

Conclusions. It could be demonstrated that the analysis of long-term musical performance and the development of adequate analytical tools remains a challenge for performance research. The visualization of performance data showed large-scale periodicities in timing and dynamics.

1. INTRODUCTION

In 1893, the eccentric French composer Erik Satie composed a three-part piece for piano which he entitled 'Vexations'. The work is the second movement of *Pages Mystiques*, a collection of three short compositions, and consists of exactly 133 notes, and a bass theme with a length of 18 notes. There are no metronome indications; however, the piece is to be performed 'très lent'. 'Vexations' remained unknown until it came to the attention of the American composer John Cage, while doing research in France in 1949, and was first published in the same year. The most remarkable feature of 'Vexations' was Satie's enigmatic instruction at the top of the score: "To play this motif 840 times in succession, it would be advisable to prepare oneself beforehand, in the deepest silence, by serious immobilities."

The composition joins the tradition of extremely long-lasting musical pieces in European avant garde music, which includes works such as Morton Feldman's *Second string quartet* (with a duration of about 5 hours) and John Cage's *ORGAN^2 ASLSP* (ASLSP stands for "As slow as possible"). The first public and complete performance of Satie's 'Vexations' was organised by John Cage and took place in New York in 1963, with a total performance duration of 18.40 hours. However, Cage shared the task with 9 other pianists.

The chosen tempo is decided by the player and thus the total performance duration of all 840 renditions varies between 5.48 and 24.46 hours [1]. In a recent publication, deeper insights into the pianist's coping strategies for the specific demands of a performance are investigated in an extensive interview with the solo performer of 'Vexations' by Kopiez [4].

1.1. Early investigations

The interest in the field of music psychology in 'Vexations' can be traced back to 1974. At this time Michon [8] was interested in the question of whether note durations in a very slow tempo such as in 'Vexations' show a higher deviation in interonset intervals (IOIs) than in medium and fast tempi. With regard to the extremely long performance duration of 'Vexations', the author examines how tempo stability is controlled during the course of performance. Despite several technical insufficiencies, Michon's study marks the beginning of research interest in long-term performances and remains a pioneering work.

The second approach was realised by Clarke [2] who analysed (a) the relationship between tempo and grouping of note events and (b) the relationship between tempo and overall tempo drifts. His analyses were based on one-hour recordings of 'Vexations' effected through a grand piano equipped with photocells under each key, measuring note onset, offset and hammer velocity (loudness) and attached to a computer. Two subjects were instructed to vary tempo within given limits and to perform repeatedly about one hour of 'Vexations'. Firstly, the performances showed an overall tempo drift effect: faster tempi became progressively slower

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while slower tempi became progressively faster. Secondly, analyses of quarter and eighth-note duration distributions showed that tempo control increases when tempo increases. Thirdly, the number of note groups increased with slower tempo. This finding is interpreted as a tendency for Gestalt dissociation when group duration exceeds certain limits. Thus, the author's assumption that a dependancy between tempo and grouping of note events could be confirmed.

1.2. The rationale of the study

Although performance research has made significant progress in the last decade, there is a lack of investigation which considers musical performance not only from a local (e.g. note to note) but from a global perspective (e.g. the long-term performances of an entire movement). From a global perspective, the composition 'Vexations' offers the greatest challenge to performance research due to its quasi 'infinite' duration. The *first aim* and main focus of the study is a global examination of tempo and loudness in that performance. The precondition for an investigation of expressive deviations within large time frames is an uninterrupted performance by one performer and an uninterrupted recording. The *second aim* of the study was to develop adequate methods for long-term performance analysis. Up until now there has been a significant lack of methods for the handling of entire performances with time-frames of more than a few minutes. As a *third aim*, we examine the role of trance in music performance: how is psychomotor control affected by different states of consciousness?

2. ANALYSIS OF PERFORMANCE DATA (TEMPO AND LOUDNESS)

2.1. Method

Participant. The composition was performed by a 40 year-old professional pianist, who had previously performed 'Vexations'.

Material. The performance was played on a grand piano (Yamaha DS 6 Pro Disklavier) with a built-in MIDI interface. MIDI data and the acoustic recording were stored on hard disc.

Procedure. The recordings took place in a concert hall in Dresden, Germany. The entire performance of Erik Satie's 'Vexations' commenced at 5 pm and ended at 8.47 pm the following evening. An initial tempo of 52 bpm (eighth notes) was chosen by the performer and established by use of a light-emitting metronome. No specific instructions were given to the performer. Total recording time was 27.47 hours. For detection of the pianist's changing states of consciousness (alertness, drowsiness, trance) we recorded (a) an oberserver's protocol and (b) compared this to the pianist's retrospective protocol written down immedeately after the end of the performance. Additionally, a long-term EEG with electrodes P3 and P4 was recorded. For a detailed description of the entire procedure see [5].

Basic analytical method. In a first step the loudness curve of the entire performance was calculated in sone by use of a researcher-developed software. Time resolution of the loudness curve was 10 ms. In a second step onsets were detected and erros were corrected manually.

2.1. Tempo analysis

As Figure 1 shows, the development of tempo over the entire performance duration of 27.5 hours, mean tempo remained surprisingly stable over the first 15 hours of performance (mean tempo for 00.00-14.00 hours = 54.7 bpm, *SD* = 5.6 bpm). The mean tempo curve in Figure 1 was calculated by averaging the current tempo over 35 data points on either side of the current IOI-value within a rectangular window (corresponding to 71 values within each of the 840 renditions of the score). No general trend in tempo change could be observed in this first section. Commencing with the transition to the trance section at t = 14.00 hours a slight increase in tempo and tempo instability can be observed (mean tempo 14.00-16.08 hours = 56.0 bpm, *SD* = 8.8). However, according to the different states of consciousness as reported in the pianist's retrospective protocol [3] we have to bear in mind that the pianist was in deep trance between 14.10 and 19.09 hours.

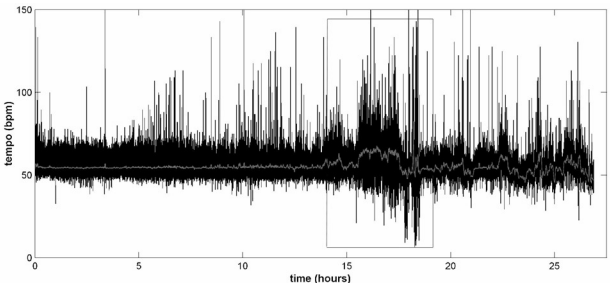

Figure 1: Development of tempo changes over the entire performance duration of about 28 hours. The bright line represents the smoothed mean tempo curve. The box indicates the state of trance.

2.2. Loudness analysis

The most obvious result of the analysis of the overall loudness curve (see Figure 2) is the segmentation of the loudness curve into two parts: a first part which is characterised by an overall decline of loudness over the first 18 hours, and a second part which shows more dynamic instability than the first part. We have to remember that the second part corresponds to the end of the trance section (about 14.00-19.00 hours). However, as the averaged loudness curve shows, the beginning of trance at 14.00 hours does not seem to influence the stability of the general decline. The sudden loudness burst at 19.00 hours corresponds to the end of the trance section. Surprisingly, the beginning of tempo instability at 14.00 hours (see Figure 1) does not coincide with the onset of dynamic instability at 18.00 hours. Although the increasing instability in tempo and loudness seem to be two independent processes, we can observe a synchronisation between tempo and loudness instability at about 19.00 hours after the end of the trance section. From this point on until the end of the performance, both tempo and loudness are characterised by constant instability and reduced control.

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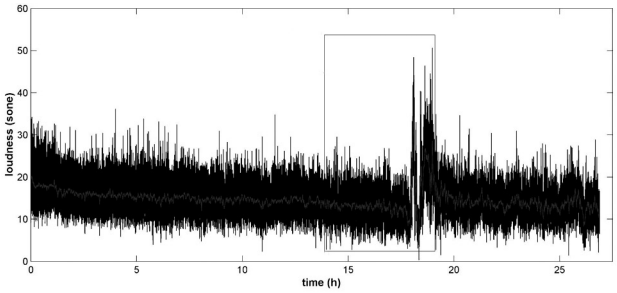

Figure 2: Development of changes in loudness over the entire performance duration of about 28 hours. The bright line represents the smoothed mean loudness curve. Box indicates state of trance.

2.3. Integrated view of tempo and loudness analysis

In the last step of data analysis we tried to integrate the development of tempo and loudness over time into a single figure. This integrative and inovative approach has recently been developed by Langner & Goebel [6, 7]. As Langner & Goebel claim, the human perception of expressive music performance differs from the usual methods in performance research in two points: (a) performance parameters are not perceived as separate streams of information (e.g. timing and loudness) and (b) changes in loudness and tempo are perceptually integrated over time in human perception so that sudden and very local changes in tempo or loudness do not correspond to the impression of an accelerando or a crescendo. Thus, a method for performance analysis that considers human perception should display the changes in tempo and loudness simultaneously over time. Figure 3 shows the development of loudness and tempo over the entire performance duration of about 28 hours. The trajectory has the form of a wool ball with more transparent threads in the periphery. The black spot marking a tempo vicinity of 55 bpm and 15 sone seems to be a kind of 'gravitational center' of the performance. In total, the entire performance shows that tempo and loudness vary independently: faster does not mean louder. Over most of the performance loudness varies between 10 and 15 sone, except for a loudness peak up to 35 sone. Tempo varies between 45 and 65 bpm, except for some extreme acceleration up to about 80 bpm. To summarise, we can say that the trajectory shown in Figure 3 corresponds well to the perceived overall impression of 'Vexations' as an inexpressive composition with no clear climax. The repetition, which is its main feature, is represented in the small variation of loudness and a higher variation in tempo. In the trajectory, these findings correspond to the small surface covered by the trajectory's trace.

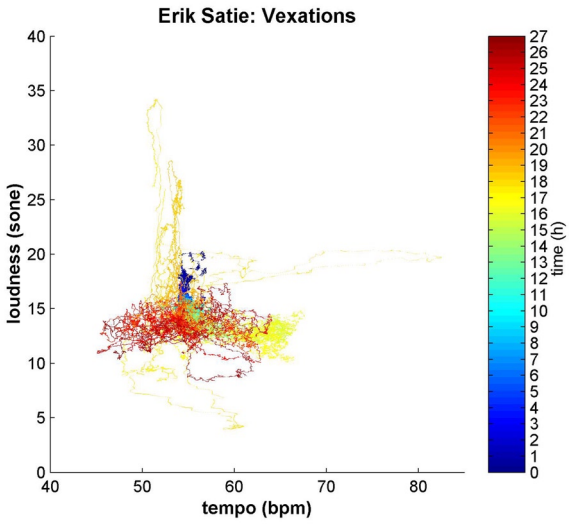

Figure 3: Colour-coded 28 hours tempo-loudness trajectory of Satie's 'Vexations' (x-axis: tempo in beats per minute, y-axis: loudness in sone).

3. SUMMARY

The main finding of this first analytical step was the high degree of mean tempo stability over a long period of time (about 14 hours). The analysis of the loudness curve over the entire performance showed a surprising result: over more than 18 hours a continuous decline of loudness can be observed. Tempo and loudness are controlled independently. The most remarkable feature of tempo and loudness analysis is a de-synchronised and increasing degree of instability over the first 19 hours of performance. A first explanation for this drift could be made by referring to changes in vigilance as a confounding variable. However, up until now the influence of endogenous rhythms on human musical performance remains open. The analysis of tempo and loudness fluctuations shows that an influence of endogenous processes on the long-term shaping of expressive parameters cannot be denied. The recording of 'Vexations' is a first step in the collection of long-term performance data and the 'Vexations' project is a contribution to fill in a significant gap in performance research, namely the large-scale analysis of musical performance.

4. AUTHOR'S NOTE

The recording took place in the Societaetstheater, Dresden, Germany, on May 20 and 21, 2000. The pianist was Armin Fuchs. Performance data and software used for data analysis can be obtained from the website http://musicweb.hmt-hannover.de/satie/.

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