

Memorization strategies of atonal music

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Background in music education. Several studies have demonstrated that musicians use different strategies in order to memorize music (Giesecking and Leimer, 1932/1972, Hughes, 1915, Matthay, 1926, Mishra, 2005). However, all these studies indicate clearly the role of segmentation and they emphasized on the knowledge about the music structure in order to memorize music.

Background in music psychology. Musicians may use their knowledge about the music structure in order to memorize the music, by segmenting the piece according to the structure. Observational studies, testing experts and non expert pianists have shown that the more experienced pianists segmented the piece according to the formal structure (Chaffin and Imreh, 2001, Williamon and Valentine, 2002), relying on highly ordered retrieval structures confirming the Long Term-Working Memory Theory (Ericsson and Kintsch, 1995).

Aims. The aim of this study was to find out the strategies that different experienced pianist used in order to memorize an atonal music excerpt and how they segment the piece in order to memorize it.

Main contribution. 5 subjects (two students, two piano teachers, one expert) tried to memorize during one hour, part of an atonal piece composed by Mahnkopf. The procedure included the observation of the participants' one hour video-recordings (practice sessions and final performance by memory), comments the expert did (comments during the practice procedure, comments after the practice procedure) and an open-ended interview with the expert after finishing the memorization procedure.

Implications. The final performance by memory is related to the experience on the performance of atonal music. The expert had the best performance and students the worst. The more experienced performers were more consistent than students on segmenting the piece. The more experienced participants started learning the piece by memory earlier and used the stored knowledge in order to segment the piece in comparison with those without experience (except for one student with very good music theory background).

One of the most important difficulties that the performers in our century are hailing to face up is the memorization of the contemporary and specifically the atonal music. Having in mind that the definition of piano recital has attributed to Franz Liszt in 1840 in London, since then the level of the performers is getting higher and the repertoires they play are increasing in difficulty. The composers are demanding from the performers to play pieces which are longer or more

dextrous than the pieces of classical-romantic period.

The benefits of memorizing the music are very important. According to Williamon's research (1999) the performances by memory were better than the performances were not memorized, the extra time that dedicated by the performers for the memorization was beneficial for the quality of their performances, the musicians were biased positively for the performances without score and the audience showed to be influenced

positively by the performances by memory.

Furthermore, in conservatories the memorization of the repertoire is often compulsory in order to pass the exams, without this procedure being taught from the tutors. For memorization, is up to each student to find out the mechanisms and the strategies that are necessary to complete the task of playing the pieces by heart. In these foundations which are offering formal education of preparing soloists the memorization is one of the most important elements with which each of the future professional performers has to cope with during their careers (Humphreys, 1993).

The current research investigated the memorization strategies, the relation between the expertise level on playing contemporary music, the memorization process and final performance and how the expertise is encoding the information in order to perform atonal music by memory and the role of segmentation of atonal music on piano performance. Therefore three groups are tested, an expert in contemporary music (ET), piano teachers who have played some contemporary music but they were not experts and students whose experience in performance of contemporary music was very limited. Observations (from video recordings), comments and interview were used in order to collect the data.

Background in music education

Different pianists use different strategies in order to memorize music. However, educationalists suggest some models which can help the musicians to organize their strategies. In the current research, we tried to identify whether the strategies that

pianists used in the current research in order to memorize atonal music fit in their models. According to Mishra's (2005) model for the memory, the memorization procedure includes three stages: the preview stage (where the performer acquires a visual representation of the music (notation preview), an aural and a performance representation, the practice stage (where the performer can choose a strategy either the segmented, holistic, serial or the additive strategy) and over-learning stage (which is based on discovering repetitions and patterns and focuses on the recognition of the structure and finding familiar patterns).

Matthay (1926), Hughes (1915), Giesecking and Leimer (1932/1972) described the aural, visual and kinaesthetic methods used by performers in order to memorize the music. More specific, they emphasized on the knowledge about the music structure.

Background in music psychology

Observational studies try to answer different questions about the memorization learning strategies and the role of the expertise. In particular, the questions they try to answer are about the strategies that an expert pianist used in order to memorize a very difficult tonal piece of music (Chaffin and Imreh, 2001, 2007), what the strategies are and similarities-differences of two students (skilled) who tried to memorize difficult tonal pieces on piano (Nielsen, 1999b), the relation between the familiarity of music and the memorization process (Oura-Hatano, 2004), the behavioural actions of skilled and less skilled performers during the sight-reading, rehearsal and performance and the existence of universal principles or aptitude that affect the learning

process (Rostron and Bottrill, 2000), the role of segmentation and the music material as strategies in the memorizing process (Miklaszewski, 1989), the importance of the structure and how it is related with the level of the music skill, the encoding and the retrieval of music, (Williamon and Valentine, 2002). Moreover, tonal and modal pieces were used in the current studies (tonal: Chaffin (2001, 2007), Nielsen (1999), Miklaszewski (1989), Rostron and Bottrill (2000), Williamon and Valentine (2002) and tonal with modal: Oura-Hatano, 2004).

Chaffin and Imreh (2001) tested how an expert can memorize the Italian Concerto composed by Bach and they found that the expert segmented the piece according to the formal structure. Williamon and Valentine (2002) tested twenty two piano students, divided into four levels and they studied a different piece of Bach for each level. They found that the students segmented the piece in order to memorize it and that the more experienced the students were the more structured bars they focused on.

Since the music is one of the most representative samples of the skilled performance, theories of skilled behavior and more particularly of the structure value in cognitive organization have been developed such as the Chunk Theory, the Skilled Memory Theory, the Long-Term Working Memory (LT-WM) Theory (Williamon and Valentine, 2002). According to LT-WM (Ericsson and Kintsch, 1995), the skilled performers memorize task domain information and store them in the Long Term Memory organizing them into retrieval structures or using the knowledge-based organization or both.

Moreover, there are different theories which try to describe the perception of the tonality such as the Generative Theory of Tonal Music (GTTM theory,

Lerdahl and Jackendoff, 1983) and Gestalt theory. Sundberg and Lindblom's model (1976) suggested a hierarchical metrical tree which includes the subdivisions of the melody into phrases, bars and beats. In the base of this tree there is the harmony and the rhythm on which the pitches are built.

In the memorization process the pre-existing knowledge is a very important factor for the successful memorization. That means that the tonal music is easier in memorization than the atonal (Nuki, 1984; Sloboda, Hermelin & O'Conor, 1985a) or modal music (Oura and Hatano, 1988). The identification of familiar patterns from pre-existing knowledge makes the memorization of a new piece easier (Sloboda, 1985b).

Aims

This study aimed to find out the strategies that pianists with different experiences used, in order to memorize an atonal music excerpt and how they segmented the piece in order to memorize it.

Two hypotheses were tested:

H1: The final memory performance will be related to skill. The expert will have the best performance and students will have the worst.
H2: The more experienced performers will be more consistent than students on segmenting the piece.

Method

Participants

Five volunteers participated in the research: two students (mean age: 31.5 years, mean piano experience: 11.5 years, 2 males), two piano teachers (mean age: 35 years, mean piano experience: 40 years, 1 male, 1 female) and one expert (age: 27 years, piano experience: 20 years, male).

Materials

The excerpt that the participants were tested on was a part of 7 bars from the atonal piece *Prospero-Fragmente* composed by Mahnkopf in 2006 and more particularly the bars 34-40. This excerpt is the beginning of the Fragment 4. The piece was chosen after research to find a piece that could be unknown to all participants. However, some changes on the piece were essential in order to test the memorization process decreasing other factors that can affect the process; reduce the notes of the chords on the right hand so as the participants will not focus on solving very difficult technical problems such as difficult chords. Secondly, transportation of the excerpt one octave higher since the frequencies/pitches at the same level of loudness in addition to the short notes' duration makes the memorization process more difficult according to the "Annotated equal loudness curves" (<http://hyperphysics.phy-astr.gsu.edu/hbase/sound/earcrv.html#c1>).

Procedure

Each participant undertook one session lasting exactly one hour which was video-recorded. At the beginning of the procedure they could listen to the piece from MIDI file as many times as they wanted. During the procedure they could listen to it again unlimited times. After finishing the practice session they had two opportunities for the final performance by memory but they chose the performance they considered as the best to be their final performance. This decision had been made in order to minimize the levels of their stress. So, their final performance by heart was a result of the strategies that they used in order to memorize the piece and not to be

affected a lot by their psychological situation.

The expert, during and after the video recording of the practice session and final performance, commented about his strategies and his goals that he was trying to achieve during the memorization practice (contemporaneous and retrospective comments). The collected retrospective comments will help the interpretation of his decisions about practicing. After finishing the procedure of practicing and performing the piece by memory, an open-ended interview took place where he explained in detail his procedure and strategies based not only on the particular piece but using, as references, other pieces he had practiced in the past.

Analysis

Observation

In order to analyze the data two axes tables were used which represent the notes of the piece on the horizontal axis while the vertical axis represents the serial numbers of the trials the performer did. The trials represent the segments where the performer started and stopped playing. On the horizontal axis the notes of the chords are split and each note is autonomous. The shaded area under the notes declares that they comprise a chord. There is a different table for each hand.

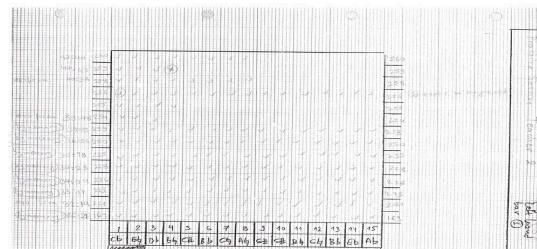


Table 1. Table describing the left hand playing the first bar pitches related with the practice progression (serial number of trials). The two first notes are a "chord".

These tables describe in detail what the performer did in order to memorize the piece. So, it gives us information about the notes the performer played, with which hand, the notes played correctly and where he/she made mistakes, and finally the exact timing of the video recordings that the particular segments were performed by the performer.

After completing these tables a new table that shows the cumulative practice was designed so as the segments and practice development are very clearly shown.

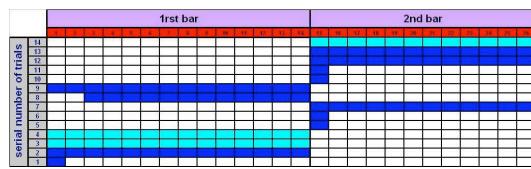


Table 2. Cumulative practice

Table 2 was organized in the same way that table 1 was organized with the difference that the cumulative table represents the music events for both hands, so there were no different tables for the right and the left hand but there was only this table which shows what parts/segments the performer practiced either with the right or the left or with both hands. The dark colored columns show the trials by reading the score, while the light colored columns the trials played by memory.

Comments and open-ended interview

In order to analyze the comments that took place during the practice session and the final performance (contemporaneous comments), the comments after finishing the practice session and the final performance (retrospective comments) and the open-ended interview, content analysis was used.

Results

| | Student 1 | Student 2 | Teacher 1 | Teacher 2 | Expert |
|------------------------------------------------------------|-----------|-----------|-----------|-----------|--------|
| errors during the final performance | 57 | 23 | 17 | 2 | 0 |
| mean of errors during the final performance | 40 | | 9.5 | 0 | |
| stops during the final performance | 5 | 0 | 8 | 0 | 0 |
| mean of stops during the final performance | 2.5 | | 4 | 0 | |
| final errors (errors + stops) during the final performance | 62 | 23 | 25 | 2 | 0 |

Table 3. Errors and stops during the final performance by memory

The results showed that the expert didn't have any errors at the final performance by memory, the teachers followed with 9.5 mean errors at the final performance by memory and the students had the worst performance with 40 errors (mean errors).

| | Student 1 | Student 2 | Teacher 1 | Teacher 2 | Expert |
|----------------------------------------|-----------|-----------|-----------|-----------|--------|
| All Trials | 460 | 321 | 351 | 350 | 230 |
| Trials by Memory | 29 | 74 | 15 | 43 | 85 |
| Percentage of trials by memory | 6,3% | 23,1% | 4,3% | 12,3% | 37% |
| Mean of All Trials | 390,5 | | 350,5 | 230 | |
| Mean of Trials by Memory | 51,5 | | 29 | 85 | |
| Mean of Percentage of Trials by Memory | 13,20% | | 8,30% | 37% | |

Table 4. Total trials and trials by memory: counts, percentages and means

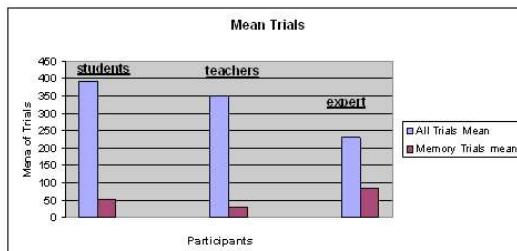


Figure 1. Means of total trials and trials by memory of the groups

Among the three groups, the students' group had the highest number of total trials to study the piece (mean: 390.5 trials) the teachers' group followed with mean trials: 350.5 trials while the expert did the less total trials in order to learn the piece by memory (230).

Looking at the individual percentages of trials by memory it is clear that the participants with the best performances (expert, teacher 2 and student 2) had the highest percentages of trials by memory in

comparison with other participants. However, the students and teachers' percentages of trials by memory are significantly less than those of the expert's. That means that the teachers and the students didn't possess encoding strategies that could make them start the practice by memory earlier.

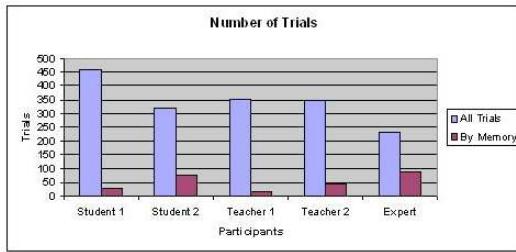


Figure 2. Total trials and by memory trials of all the participants

| | STUDENT 1 | STUDENT 2 | TEACHER 1 | TEACHER 2 | EXPERT |
|------------------------------|-----------|-----------|-----------|-----------|--------|
| 1st half of trials by memory | 2 | 20 | 1 | 26 | 38 |
| 2nd half of trials by memory | 27 | 54 | 14 | 17 | 47 |
| Total trials by memory | 29 | 74 | 15 | 43 | 85 |

Table 5. Distribution of the "by memory" trials

The expert had almost the same number of trials by memory during the two halves of his practice in reverse with the students and the teacher 1. Therefore, the earlier the performer starts the memorization the better the results.

In order to test the role of the segmentation and how the participants segmented the piece aiming to memorize it, a table with the number of starts and stops was used in order to describe where the participants started to practice and where they stopped.

The starts show the shots where the pianist thought that it was important to retrieve the segment from this point, whereas the stops have two meanings: either the points where the performer stopped as part of deliberate practice or as points with

problems (technical, fingering, memory). The 69 events of the musical excerpt were considered as possible spots where the performers can start or stop their practices. The results show that some events are used as starts more than others, and some other events are used by the performers as stops, more than other events.

| I | music events | EXPERT | | STUDENT 2 | | STUDENT 1 | | TEACHER 2 | | TEACHER 1 | |
|---------|--------------|--------|-------|-----------|-------|-----------|-------|-----------|-------|-----------|-------|
| | | Starts | Stops | Starts | Stops | Starts | Stops | Starts | Stops | Starts | Stops |
| 1st bar | 1 | 29 | 1 | 52 | 19 | 183 | 68 | 77 | 1 | 57 | 5 |
| | 2 | | | 2 | 1 | 6 | 30 | | 3 | | 7 |
| | 3 | 1 | | 1 | 1 | 21 | 30 | | 7 | 1 | |
| | 4 | | | 1 | 2 | | 5 | | 1 | 1 | |
| | 5 | | | | | 3 | 12 | | | | |
| | 6 | | | 1 | 1 | 1 | 10 | | | | 3 |
| | 7 | | | 1 | 2 | 8 | 15 | | 3 | | 1 |
| | 8 | | | 1 | 2 | 3 | 1 | | | 1 | 3 |
| | 9 | | | 3 | | 4 | 6 | | | | 1 |
| | 10 | | | 1 | | | 2 | | | | |
| | 11 | | | 2 | 1 | 3 | 1 | | | | |
| | 12 | | | | 2 | 5 | | | 1 | | |
| | 13 | | | | 1 | 12 | 1 | | | 1 | 1 |
| | 14 | | 5 | | 3 | 22 | | 1 | | 14 | |
| | 15 | 10 | 4 | 28 | 20 | 131 | 55 | 9 | 9 | 36 | 2 |
| | 16 | 0 | | | 3 | 7 | 42 | | | | 13 |

Table 6. Number of starts and stops on each event of the music excerpt. This is a part (1st bar) from the whole table.

From Table 6 we conclude that all the participants understood the structure of this excerpt mainly as segments of single bars. However, the expert segmented the piece into five main segments (1-2, 3, 4, 5, 6-7). In particular, the segments according to the events are: first segment 1 - 26, second segment 27 - 36 from which the third bar (second segment) consist of two sub-segments, 27 - 33 and 33 - 36, third segments 37 - 47, fourth segment 48 - 53, fifth segment 54 - 69 which consists of two sub-segments 54 - 59 and 60 - 69.

However, student 2, (the best memorizer among the students) started studying the chords of each bar. He wanted to memorize the progression of the harmony initially before adding the other elements, such as the melody on the left hand. After memorizing the harmony sequence, he then added the melodies.

| | EXPERT | STUDENT 2 | STUDENT 1 | TEACHER 2 | TEACHER 1 |
|--------|--------|-----------|-----------|-----------|-----------|
| STARTS | 66.60% | 37.70% | 66.60% | 60.90% | 50.80% |
| STOPS | 42% | 21.20% | 49.30% | 18.90% | 33.30% |

Table 7. Percentages of the events which were never used as starts or stops

Table 7 shows the percentages of the starts and stops of the total events that were never used as starts and stops. In other words table 7 shows the percentages of blank events out of the total events for each participant in Table 6. Looking at table 7, we conclude that the expert used the fewest events as starts in comparison with the other participants except for student 1 who stopped his practice at the third bar and all the events after this bar were considered as non starts and therefore the results were affected. If we check with the same way, with the exception of the student 1 for the same reason, we can see that the expert made the fewest stops during the practice (or he didn't stop most of the times -42%- in comparison with the other participants). In other words, the expert is more consistent in his practice and the segmentation strategy while the students are more inconsistent on starts as compared to the teachers and the expert. Student 2, using the strategy of the harmony sequence, affected his results and seems to be more consistent than teacher 1.

Comments and open-ended interview

The comments the expert made during and after the practice session and the final performance were grouped into main themes related with the current research. The main themes derived from the comments during the practice were i) technical difficulties, ii) the segmentation where the expert referred that he segmented the piece using the stored knowledge from tonal

music in order to segment the piece and more specific the phrases proving that his strategy was segmented and not holistic or additive, iii) memorization problems such as storing information in a very short time.

The themes derived from the retrospective comments were i) technical difficulties and ii) structure. The expert commenting on the last topic said that the structure of the piece is exactly based on the metrical indication and therefore on the bars' changes but probably he unconsciously used the phrases as cues in order to retrieve the performance from these points.

The main themes obtained from the interview were i) the memorization of atonal music where the expert referred on the collaboration between the style-general knowledge (the knowledge that the performer already has about a subject) and the style-specific knowledge (the knowledge that the person acquires when he tries to encode information that don't fit with the stored knowledge) which is using (one or most likely both of them) in order to learn a new piece by memory, ii) the memorization of tonal and atonal music where the expert referred to the role of the enculturation and how it affects the way we learn music and iii) the role of the analysis and the role of segmentation as a strategy of memorization. More specifically he said that the performer has to recognize the general communication system in order to communicate with the ideas that he will discover through the practice. That means that the performer is not bound to analyze every single detail of the structure in order to perform or to memorize the piece but to find out his systems and he will encode the meanings and the ideas that the structure communicates.

Discussion

The current study tested the memorization process and the segmentation strategy in three groups of different levels of experience in performing contemporary atonal music. The results of this research showed that the more experience the performer has the more consistent they will be in segmenting the piece, whilst the less experienced performers will segment the piece inconsistently and their final performance will contain more errors than the experienced performers'. Moreover, the expert in order to encode the information of the piece used the implicit stored-knowledge which interacted with the new information that the piece offered. Some of the knowledge that the expert retrieved during the memorization process included the use of the phrase as a segment or sub-segment, sequences of notes and the use of the tonal chords to encode the atonal chords. Moreover, the sequences of notes can be encoded as scales of six notes and other different types of scales. This strategy (integration between the stored-knowledge with the new information), used by Sloboda (1985, 2005b), Rostrom and Bottrill (2000) and Nielsen (1999), is one of the core strategies that the current study proved. The expert didn't only use the stored-knowledge to recognize the musical phrases in order to segment the piece but also he used the tonal chords and scales to encode the new information the piece included.

On the other hand the students didn't show that they used any stored-knowledge from the tonal music. They followed the structure of the metrical indications without using the phrases as an indication of segmenting the piece. It is very interesting the way that the best memorizer from the students' group (student 2) started to study the harmony sequence first

(only chords) and then the melody. This strategy indicates a deliberate intent which was successful in producing good results. This way of memorizing the new information fits more closely with the model that Sundberg and Lindblom (1976) developed. The teachers used different strategies: teacher 1 included the segmentation on the metrical indications and teacher 2 the metrical indications with the phrase as segment. They were not so consistent in their stops and starts as the expert but their results were better than the students. According to their results the best student memorizer (2), even if he is an inexperienced pianist, achieved almost the same results to teacher 1 purely through the use of the harmonic sequence strategy. This means that the student 2 did not need to use the interaction between the stored-knowledge (phrases as segments) and the new information. In addition to this, Teacher 2 (the best teacher memorizer) encoded the new information using both the stored knowledge about tonal music and the successful encoding of new information including segmentation on each bar according to metrical indications. His results are very close to the experts' results. This means that the experience, along with the effective way of encoding the new information, helps the successful memorization of atonal music. These results support the interaction between the stored-knowledge and the new information.

Moreover, the number of retrieval performances seems to be an important factor in the memorization process and the final performance. The participants with the most of the trials by memory have better results in comparison with the other participant with the same experience.

The time that the expert needed to complete the memorization successfully was 30 minutes.

According Oura and Hatano's results (2004) the familiarity of the music plays a role in the time needed to perform a piece by memory, using half of the time the other participants used.

The participants in order to study the piece and to perform it finally by memory segmented it into meaningful parts and then they practiced on reconnecting the shorter parts. This strategy is consistent to Miklaszewski (1989), Nielsen (1999), Chaffin (2001, 2007), Williamon and Valentine (2002) each showed that lengthening the segmentation practice the performers joined the segments and practiced on a piece as a whole.

The decision to choose the piano in the current study as the main instrument in memorization of atonal music was made because of the researcher's experience as a pianist; piano is an instrument to which highly skilled performance theories and models about memory can be applied. Furthermore, extremely complicated atonal pieces have been composed for the piano.

Using comments, the researcher can collect the highest sum of information that a performer can give on his practice strategies, goals and explanations regard to his performance practice. In order to strengthen the results for the observational analysis and the comments, an open-ended interview was conducted. During this interview the expert used scores that he had studied in the past, clarifying and developing explanations about his experience while he was looking at other scores. Hence, his information about how to encode the atonal music was based not only on the excerpt used in the current research but on other pieces as well.

The theoretical background that the performers possess in regard to contemporary music can play an important role in the memorization process. The expert, teacher 2 (the best memorizer among the teachers) and student 2 (the best memorizer among the students) have deep knowledge in musicological studies.

In terms of theories of expert memory, the theory of Ericsson and Kintsch (1995) seems to be the most appropriate to explain the way that the performers perceived the structure of an atonal piece. Moreover, the notion of LT-WM Theory, that the retrieval schemas are more likely to be derived from highly skilled performers, fits with the results of the performers with theoretical music background. The fact is that contemporary atonal music does not have a common structural system that performers can communicate by. Each contemporary composer uses different structures from the classical or romantic periods. Also, each single piece has a new, different structure from all the others. Whilst recognizing that this makes the memorization difficult, it is not impossible. The performers through their experience in tonal music and through their experience of atonal music (where the performers have to discover a common system of encoding the new information) can memorize successfully. Finally, they can find many commonalities between the chunks of their knowledge applied in the same or similar way to atonal music and the segmentation strategy.

The fact that the participation was voluntary did not exclude the possibility that the piece of atonal music studied was liked by the participants (except for the expert whose career is based on his preference to atonal music). Therefore, an anxiety resulting from the differences on musical preferences

can affect the results achieved by the expert and the other participants.

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