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A Qualitative Analysis of Strategies Employed in Efficient and Inefficient Memorization

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Abstract

The purpose of this study was to determine if there was a strategic difference in memorization between musicians who memorized quickly and those requiring more time. After memorizing a 36 measure exercise, eight university instrumentalists were chosen for an in depth analysis of the memorization process. Subjects were chosen based on speed of memorization with four representing the fastest memorizers (8.66 to 17 minutes) and four slower memorizers (66.83 to 100 minutes). A qualitative analysis of the practice was performed using a graphic analysis of the practice session, frequency distributions of starts, stops, pauses, and errors, transcriptions of interviews, and markings in the notation. Four strategies emerged from the data: Segmental, Holistic, Additive, and Serial (which is characterized by a return to the beginning following an error or memory lapse). The faster memorizers tended to favor the Holistic or Additive strategies and the slower memorizers favored the Segmental and Serial strategies.

Introduction

The process of memorizing a piece of music is of great concern to the performing musician. A desire to know the most effective and efficient strategies, preferably those, which will guarantee a flawless performance, is of primary interest. As yet, the answers to the question of the most effective memorization strategy are unknown, but research has begun to shed light onto the process of memorization.

Early research into memorization was primarily concerned with finding the most effective memorization strategy. Rubin-Rabson investigated various treatments on piano students including: analytical pre-study (1937 & 1941b), unilateral v. coordinated (1939), massed v. distributed practice (1940a), whole v. part (1940b), overlearning (1941c), and the use of incentives (1941a). Only analysis prior to initial practice (1937 & 1941b) and to some extent, distributed practice (1940a) facilitated the memorization process. Experimental research into memorization strategies may have been premature, as there was little understanding of the memorization process at this time.

In recent years, descriptive research has been the focus. Researchers have begun to delve into the process, which may in future inform experimental research into the most effective or efficient strategies for memorization. Research is primarily limited to experts and technically proficient students and relies on interviews and case studies, however from the evidence; a preliminary model of memorization is beginning to emerge.

Preliminary Model of Memorization

Musicians, particularly technically proficient musicians, appear to go through four stages in the memorization process: preview, notation-based learning, memorization, and review. Previous researchers and performers have remarked on the various stages in the memorization process (Chaffin & Imreh, 1994; Hallam, 1997; and Miklaszewski, 1995). Wicinski (1950 in Miklaszewski, 1989) identified three stages including getting to know the music, hard work on technical problems, and fusion of ideas and technical skills.

Initially, experienced musicians, including professionals and university music students, tend to preview the entire piece using a holistic strategy (Hallam, 1997; Miklaszewski, 1995; Nuki, 1984) to establish tempo, identify difficult passages, and to get an overview of the piece. It is unclear from the literature how extensive the orientation stage may be, but following this period of orientation, notation-based practice commences.

To an extent, memory automatically develops during the process of learning the technical aspects of a piece in both novices and experts (Hallam, 1997; Miklaszewski, 1989). Evidence in the form of self-reports (Hallam, 1997), verbal comments (Miklaszewski, 1989 & 1995), and performances (Lehmann & Ericsson, 1996; Miklaszewski, 1989) indicates that memorization of music begins early in the learning process, even in cases where memorization is not the primary goal. Lehmann and Ericsson have documented this incidental memorization by asking musicians to perform a score with isolated measures of the music omitted. Between 30 and 88 % of the missing notes could be recalled after just four performances. Miklaszewski (1989) deduced the amount of memorization of his subject by observing page-turning behaviors. Incidental memory is evidenced especially in pieces which are relatively short and simple. Longer, more complex pieces of music may require a focused, analytical strategy beyond automatic memorization (Hallam, 1997).

If a piece is not memorized by the time it is technically learned, a repetition strategy is employed to complete the memorization process (Hallam, 1997). At this stage, segmentation of the piece appears common, though evidence of segmentation may appear during notation-based learning as well (Chaffin & Imreh, 1994 & 1997; Miklaszewski, 1989). Segments of a piece of music are repeated until remembered and linked to form a whole (Aiello, 2000; Chaffin & Imreh, 1997; Hallam, 1997; Miklaszewski, 1989) or increased in length during the rehearsal period (Chaffin & Imreh, 1994; Hallam, 1997; Miklaszewski, 1989 & 1995; Williamon & Valentine, 1999). Practicing of segments does not necessarily commence from the beginning of the piece. Segments from the middle or end of the piece may be isolated for practice then linked and the piece may be practiced in reverse order, starting with the segment at the end of the piece and gradually linking this segment with preceding segments (Miklaszewski, 1989). Segmentation varies with the formal structure and the difficulty of the piece. Larger formal segments may be fragmented into smaller sections when technically challenging (Chaffin & Imreh, 1994 & 2000; Miklaszewski, 1989.)

Segmentation appears to be based on the formal structure of the piece rather than randomly applied (Chaffin & Imreh, 1994, 1997, & 2000; Gruson, 1988; Hallam, 1997; Miklaszewski, 1989 & 1995; Williamon, 1999) and begins early in the rehearsal process (Chaffin & Imreh, 1997). However, musicians report structural analysis becomes a prominent strategy when memorization began after technically learning the piece (Aiello, 2000; Chaffin & Imreh, 1997). Patterns and similar segments are identified to facilitate memorization; however similar, but not identical, segments require special attention as they may be confused (Chaffin & Imreh, 1997).

Musicians appear to focus memorization on segments of the music and then systematically link or increase the length of the segments until the entire piece can be performed. There is preliminary evidence for segment length preferences among musicians. Some performers prefer a holistic approach where long sections are performed from the onset of rehearsals. Others prefer to master short segments before attempting longer segments (Miklaszewski, 1995; Nuki, 1984). A performer may also elect a mixed strategy in which short section practice is interspersed with longer sections (Chaffin & Imreh, 2000; Miklaszewski, 1995) or complete performances of the piece (Williamon, 1999). Individuals also vary as to when complete performances are attempted from segments (Miklaszewski, 1995). Segments may be consciously linked during interme-

diate stages of rehearsal, but become unconscious as work progresses into "concert" performances (Miklaszewski, 1995).

Practice continues past the point when the piece can be played by memory in toto. This overlearning is not well documented in the literature, though Rubin-Rabson identified this practice as common in her 1941 (c) study and attempted to determine whether certain amounts of overlearning would facilitate memorization (they did not). As musicians report increases in anxiety when performing by memory (Hallam, 1997 & Leblanc, 1994; Leglar, 1978), it is possible that this stage of the memorization process facilitates confidence levels.

Individual Differences

As might be expected, individuals vary considerably in the strategies employed in the memorization process. To some extent, variations in the memorization process appear linked to ability level (novices v. experts), but may also be linked to the difficulty of the music and individual preferences.

As well as a structural analysis of the score, use of aural, visual, and kinesthetic memorization strategies are reported by both novices and experts and many report using a combination of these strategies (Hallam 1997). The use of aural and kinesthetic strategies is almost universally reported regardless of expertise (Hallam, 1997). Visual strategies are reported less frequently and may include visualization of specific notation or a general format of the piece. Visual cues may be added to the notation to aid memorization especially in technically difficult or transitional parts of the music (Chaffin & Imreh, 1997). Analytical strategies which can involve formal or informal structural analysis appear to be utilized by expert musicians, but rarely, if ever, employed by novice performers (Hallam, 1997). It is unclear at this point whether any memorization strategy is superior to the others either in terms of performance quality or efficiency.

The amount of time required to memorize a piece of music varies considerably and has not been well documented in the research. Mishra (1999) found that university instrumentalists required between 8.66 and 100 minutes to memorize a 36 measure exercise. Nuki (1984) reported that university pianists given a 41 measure piece required at least 25 minutes for memorization and nearly 20 % were unable to memorize the piece within 60 minutes. In this study, musicians who reported employing a visual strategy memorized faster (M = 42.85 minutes) than musicians employing kinesthetic, aural, or mixed strategy (M = 58.00, 54.44 and 57.50 minutes respectively). Rather than short exercises, Chaffin and Imreh (e.g., 1997) have studied the memorization process of a full piano work. For a 210 measure J.S. Bach piece (*Italian Concerto*, 3rd movement), the first memorized performance was reported after practice session 12, with each session averaging 57 minutes.

Variations in memorization strategies are being identified through interviews, and to a lesser extent, case studies. It is unknown as yet whether these differences affect the quality or the speed of memorization. The present study focuses on the question of memorization efficiency and whether there is a qualitative difference in the memorization strategy employed between musicians who memorized a musical exercise relatively quickly (8.66 to 16.66 minutes) and those who required more time (66.83 to 100 minutes). Further, the viability of the preliminary model of memorization detailed in this survey was investigated.

Methodology

As part of a previous study (Mishra, 1999), 60 university instrumentalists memorized a short, 36-measure exercise. The exercise was adapted from the *Farnum String Scale* (1969). When adjusting the exercise for winds, particular attention was given to the key and range parameters using exercise 9 of the *Watkins-Farnum Performance*

Scale (1962), which is similar exercise, as a guide. No limitations were imposed as to memorization strategy and no time limits were imposed. The amount of time required to memorize the exercise varied considerably from 8.66 to 100.00 minutes (M = 40.90, SD = 17.91). Subjects also participated in a semi-structured interview to determine whether a conscious memorization strategy had been employed and the extent of their memorization training and experience. As no obvious patterns emerged in the subjects' backgrounds (e.g., Suzuki training, marching band experience, and jazz ensemble) or a technical ability to account for this range of memorization efficiency, a more in depth analysis was conducted.

For this analysis, eight subjects were chosen from the 60 original subjects. The practice sessions for the four who required the least amount of time (8.66 to 16.66 minutes) and the four who required the most amount of time (66.83 to 100.00 minutes) to memorize the exercise were studied. It should be noted that all eight subjects were able to perform the exercise from memory, the difference lay in the amount of time necessary to memorize the exercise.

Participants

Subject 1 was a sophomore, female trumpet player who memorized the exercise in 15 minutes 40 seconds. She was an undergraduate music education major performing in the top band at the university. Though she had played in marching band in high school, the students used lyres and were not required to memorize.

Subject 2 was a male french horn player who memorized the piece in 16 minutes. At the time of this study, Subject 2 had finished his coursework for an undergraduate music performance degree, but was required to perform his senior recital before graduation. Though finished with his coursework, he continued to perform as principal horn in the orchestra. Subject 2 reported memorizing music for his high school marching band.

Subject 3, a male trumpet player in his sophomore year, memorized the exercise in 8 minutes 40 seconds. His major was undeclared at the time of the study. He performed with the top band and with the university jazz bands. He attributed much of his success in memorization to his experiences in the jazz bands as well as high school marching band.

Subject 4, a female cellist, memorized the exercise in 16 minutes 40 seconds. She performed last chair in the orchestra as part of her training at a neighboring community college. Subject 4 had been playing cello since she was 10, but was not Suzuki trained. Though Subject 4 was a cellist, she also had played flute in her high school marching band.

Subject 5 was a female trombonist from the community who was not currently pursuing a degree at the university, but performed in lower band and the university orchestra. Subject 5 had an associates degree in music, but did not hold a bachelor's degree in music. Subject 5 memorized the piece in 66 minutes 50 seconds and had not participated in marching band.

Subject 6 was a male, freshman saxophone player performing in the lower band. His major was undeclared at the time of the study. He memorized the exercise in 68 minutes. A technical failure rendered this interview unusable thus further background information was unavailable.

Subject 7 was a female who performed principal flute in the top band as well as in the orchestra. She was a sixth year senior and graduated with a music performance degree at the end of the semester in which this study was conducted. She memorized the exercise in 82 minutes.

Subject 8 was a female flutist who played in the lower band. She was a freshman who had not declared a major at the time of this study. She required 100 minutes to memorize the exercise. This subject chose not to participate in the interview after her lengthy memorization session.

Results

Each interview and practice session was transcribed and graphed. Particular attention was given to starting points, ending points, pauses, errors in performance, and repetition of measures. A musical graph of each practice session was constructed with each horizontal line representing one practice segment (see Figures 1 & 2). Chaffin and Imreh (1997) and Williamon and Valentine (2000) have utilized this procedure. A frequency distribution was also compiled indicating the number of starts and stops in each measure (see Figure 3). In four cases (Subjects 5, 6, 7, and 8), the notation used during memorization was collected because it contained markings made by the subjects during practice.

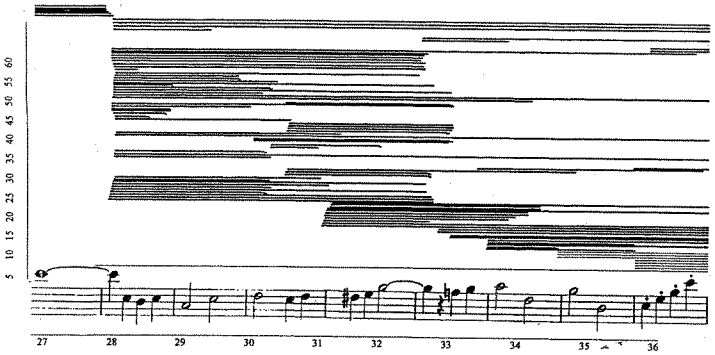


Figure 1. Initial practice sessions for Subject 5.

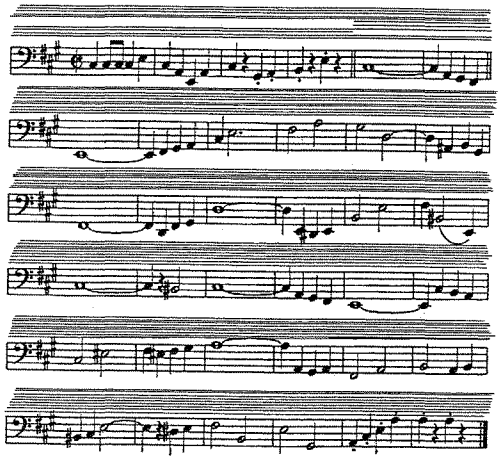
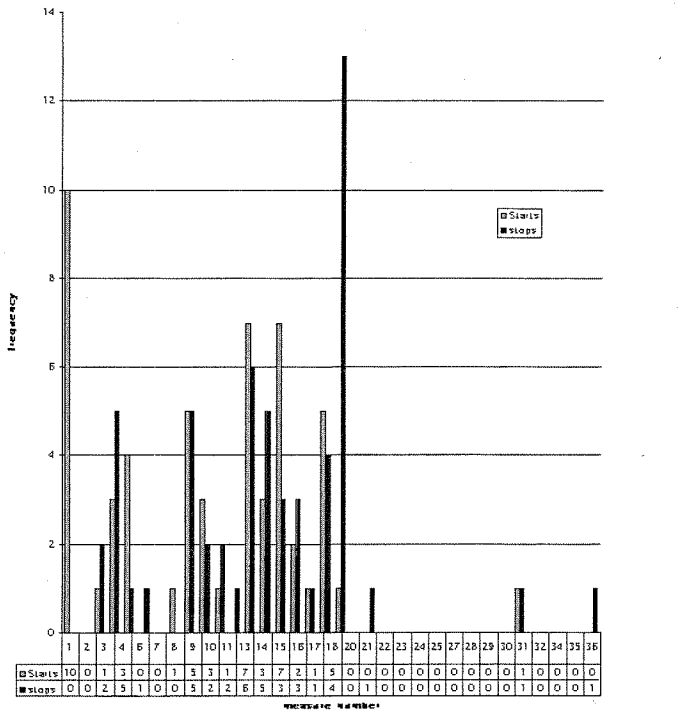


Figure 2. Initial practice sessions for Subject 4.



measure number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	20	21	22	23	24	25	27	28	29	30	31	32	34	35	36
Starts	10	0	1	3	0	0	1	5	3	1	7	3	7	2	1	5	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	
Stops	0	0	2	5	1	0	0	5	2	2	6	5	3	3	1	4	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	1	

Figure 3. Frequency of starts and stops for each measure in first 8 minutes of practice session for Subject 1.

Musical graphs, frequency distributions, interview transcriptions and notational markings (if any) were analyzed separately for each subject to determine patterns in the memorization. No attempt was made to determine similarities between subjects until after the initial analyses.

Preparation time

Relevant to total memorization time is the amount of preparation time each subject required. No instructions were given to the subjects concerning how quickly the memorization procedure was to begin. Subjects may have required time to tune and warm-up and may also have elected to study the exercise prior to playing. Preparation time was measured from the moment notation was placed on the music stand until the first note of the exercise was played (see Table 1). Most subjects appeared to begin playing fairly quickly (M = 60 seconds; Efficient m = 29.25 seconds; Inefficient m = 97.25) after short warm-ups. It can be assumed that limited study of the piece occurred prior to playing, other than that required to absorb to the key-signature and the first note.

Tempo

Because overall performance time might be affected by rehearsal tempo, an average tempo was determined for each subject from ten tempo readings equally spaced throughout the practice session. Average rehearsal tempos ranged from 130 to 154 beats per minute (M = 135.5; Efficient m = 138; Inefficient m = 133). Neither average

rehearsal tempo nor the amount of preparation time could account for the large differences in memorization time between faster and slower memorizers (see Table 1).

Table 1
Amount of preparation time, average tempo, and total memorization time for each subject

	Preparation Time	Average Tempo	Total Memorization Time
Subject 1	22 seconds	117	15:40 minutes
Subject 2	14 seconds with warm-up	142	16:00 minutes
Subject 3	8 seconds	154	8:40 minutes
Subject 4	73 seconds with tuning	139	16:40 minutes
Subject 5	26 seconds	130	66:50 minutes
Subject 6	153 seconds with warm-up	140	68:00 minutes
Subject 7	110 seconds with warm-up	130	82:00 minutes
Subject 8	100 seconds	132	100:00 minutes

Subject 1

The initial performance contained two rhythmic errors (ms. 5 and 30), three pitch errors (ms. 14, 15, and 19), and one pause (ms. 34). Also, the subject repeated ms. 1-6, ms. 18-19, and ms. 31. Initially, the subject appeared to focus on ms. 1-19. The large number of starts in ms. 1 and stops in ms. 19 seem to support this interpretation (see Figure 3). Measure 19 may have served as a common stopping point due to the large number of errors, which occurred in this measure, but the subject appeared to stop at this point regardless of whether an error occurred. In general, the errors occurring in ms. 19 probably stemmed from the difficult leaps in ms. 18 (descending diminished fifth followed by a descending augmented fifth followed by an ascending major sixth into ms. 19). The large number of starts in ms. 13, 15, and 18 with corresponding stops in ms. 13, 14, 18, and 19 and ms. 17 and 18 with corresponding stops in ms. 18 and 19 may indicate a concerted effort on the part of the subject to deal with the technical issues involved in performing this difficult section. The subject referred to this difficult section in her interview. "Where there were accidentals and things I wasn't expecting I'd probably - there was a two measure part where there was a very odd fingering and I had to keep rehearsing that one over and over." Later, the subject added, "...for that A [the note at ms. 19] I was talking about, when I knew that was coming up, I physically thought to myself 'two fingers'"

During the second half of memorization process, Subject 1 shifted her focus to the whole piece, rather than concentrate on ms. 20-36 as a discrete segment. Because the subject appeared to add measures to a segment rather than focus on two discrete segments prior to linking them together, it was decided to term this memorization strategy "Additive" rather then Segmental or Holistic.

Subject 2

During the initial performance, rhythmic errors occurred in ms. 25 and 29 and pitch errors in ms. 16 and 17. Measures 16-17 were repeated extensively and, though few errors occurred at this point during sightreading, most rehearsal errors occurred in ms. 17. The large number of starts in ms. 16 and 18 corresponding to the large number of stops in ms. 17, 19, and 20 represent rehearsal of this technically difficult section.

Subject 2 began the memorization process by focusing on ms. 1-20, occasionally omitting the first four measures, interspersed with performances of the entire piece. The focus then briefly shifted to ms. 20-36, which was again interspersed with performances of the entire piece. Subject 2 apparently divided the exercise into two large parts and focused his rehearsal on each segment, interspersed with repetitions of the entire piece. Interview responses supported this interpretation:

> Interviewer: ...you broke it down into chunks? Were they phrases? Lines?
> Subject 2: Phrases. Yes. What I did was played it through a couple [of] times and then I picked up that the beginning was real easy and then I played the first section a few times then I tried it over... I'd run it all. I just built upon it.
> Interviewer: Were you always going back to the double bar [ms. 5]?
> Subject 2: No, once I got the middle-the first section down, then I started there [sing ms. 20].

Subject 3

During sightreading, rhythmic errors occurred in ms. 11 and 17 and a pitch error occurred in ms. 18. Subject 3 performed the piece repeatedly from the beginning to the end with ms. 14 and 31 also serving as common stopping points, though these measures also include points of frequent starts. Thus, when a stop occurred, the subject would attempt to start in the same place and press on to the end. Though few errors occurred during rehearsal, most occurred in ms. 9, another common stopping point. Subject 3 employed a Holistic strategy; repeatedly performing the piece from the beginning to the end. Interview data supported this interpretation:

> I would go on so that the repetition of playing the end so many times made it so I didn't have to stop and think about the end.... I went back to the beginning several times. I don't remember exactly what order I went back to the beginning. I know that after a while I started remembering things from the beginning and the end so I was kind of going-coming into the middle.... Maybe once or twice when I'd make a mistake I'd go back to the top and play the whole thing again, but for the most part it was trying to push ahead.

Subject 4

Subject 4 made the most errors during the initial sightreading, many of which were linked to the key signature (A major). Pauses occurred in ms. 11 and 17 and errors occurred in ms. 18, 25, and 26. During the initial read through the music, ms. 16-18 were repeated many times as were ms. 25-26. Subject 4 performed the entire piece repeatedly with the most starts occurring in ms. 1 and the most stops occurring in ms. 36 (see Figure 2). Thus, Subject 4 appeared to use a Holistic strategy to memorize the exercise. This interpretation was supported by interview data:

> Interviewer: Did you find yourself using a strategy?
> Subject 4: Just repeatedly playing through the piece and turning the page over so I could play it from memory and the sections I had trouble with I'd go back and play through and turn it over again and try and play through it...keep going through it basically...I'd play from the first measure to the middle-half way through the thing.

Subject 5

Subject 5 began by sight reading the exercise from the beginning to the end with errors occurring in ms. 1 and 25. The strategy adopted by Subject 5 was quite clear

from the onset (see Figure 1). She began memorizing with the final two measures (ms. 35-36), performing these measures repeatedly before adding the preceding measures, i.e., ms. 34-36. She continued this process until she was performing ms. 32-36. At this point, a second large segment was defined which ended at ms. 32 and the process of repetition and addition continued until ms. 28-32 could be performed. The two segments were then added together and ms. 28 to the end was performed repeatedly. This process of creating segments of two to four measures and repeating the segments in isolation (ms. 32-36, 28-32, 24-28, 20-24, 16-20, 12-16, 5-8, 1-4) and then combining with previously learned segments continued. The sheer number of repetitions (for instance, ms. 12-13 were repeated 43 times consecutively at one point) without errors helped delineate the Segmental strategy the subject employed.

This interpretation is supported in the interview: "I played through to hear the notes. I find that I like starting at the end and working backwards. I've picked that up other times because I don't know the last the best. So, I start backwards and try to compensate for that. But maybe go two or three measures, play through, hear the notes, then look at the rhythm...." Later, she added, "...I start with a little increment and then try to go into longer phrases.... Then I found that I kept forgetting the middle section so then I tried to analyze it further."

Markings on the notation delineated ms. 28-32, 20-28, 16-20, 12-16, 8-12, 5-8 and 1-4 with parentheses. Each segment was numbered 1-7. The number of starts (30+) at ms. 28, 24, 20, 16, 12, 5, 1 corresponds with most of these segments. The number of starts at ms. 8 does not support this as the start of a segment, though 21 stops at ms. 8 may indicate this measure was a common stopping point. The number of starts at ms. 24 supports this measure as the start of a segment. The frequency of stops at ms. 36 and 32 also indicates segment boundaries, though the large number of stops at ms. 13 does not. This could be explained as a point of technical difficulties since a large number of errors occurred at this point, however a large number of errors also occurred at ms. 18 without a corresponding number of stops. The use of a segmentation strategy is further supported by the number of pauses which occurred at phrase boundaries (ms. 16, 24, 28) as well as at the end of lines (ms. 12, 18, 30). Thus, it is clear that Subject 5 used a Segmental strategy to memorize the exercise.

Subject 6

Subject 6 began by sightreading the exercise with performance errors occurring in ms. 5, 15, 18, and 25. The subject also repeated ms. 5, 11, 17, 18 several times as well as ms. 20, 26-27, 28, and 30. The subject then attempted complete performances of the piece with varying degrees of success. Though ms. 1 was the most frequent starting point, there was no corresponding common stopping point, which might indicate the end of a segment. Markings made in the notation were primarily rhythmic aids and pitch names, including a C natural written above the D sharps in ms. 18 and 20, possibly as incorrect enharmonic equivalents. The exercise, then, may have been technically difficult for this subject. The measures with frequent errors generally contained notational markings. The cluster of starting at ms. 16 and 17 and stopping points at ms. 17, 18, and 19 probably indicate technical problems rather than a musically defined segment due to the large number of errors occurring in ms. 17 and 18. However, focusing on a technically difficult passage seemed to be atypical for this subject. Generally when the subject encountered problems in his performance, whether due to a technical error or a memory slip, he returned to the beginning for another attempt. The strategy employed by Subject 6 did not appear to fit a Segmental, Holistic, or Additive strategy. It was decided to label this strategy as a Serial strategy due to the tendency to return to the beginning of the piece after an error or a memory lapse.

Subject 7

Subject 7 began by sightreading the piece with no errors. The subject then appeared to fragment the piece and combine segments to form longer sections. Initial segments were defined as ms 1-9 and 5-9, ms. 1-11 and 5-11, ms. 12-19 (forming segments ms. 5-19 and ms. 1-19), ms. 20-27 (combined to form segments 5-27 and 1-27), and ms. 28-31 and 28-36. Measures 1, 5, 12, 20, and 28 served as common starting points, while ms. 9, 11, 19, 27, 31, and 36 served as common stopping points. It is possible to reduce the number of segments to ms. 1-11, 12-20, 20-end, since errors occurred frequently at ms. 9 and 31 and a large number of pauses occurred at ms. 27. Thus, stopped at these points may be due to an error rather than a perceived musical segment boundary. Subject 7 employed a Segmental strategy to memorize the exercise.

Subject 8

Subject 8 sightread with only two rhythmic errors (ms. 4 and 32). Initially, the subject attempted to perform the piece from the beginning to the end, though she was not always successful in this regard. Though ms. 1 was the most frequent starting point, stopping points were spread randomly throughout (see Figure 4). After approximately 25 minutes, the subject appeared to change her strategy to focus on ms. 1-19. On two occasions, the subject made a concerted effort to deal with technical problems identified by the large number of errors occurring in ms. 11, 12, 17, and 18 and the large number of starts in ms. 10 and 17 and stops in ms. 12 and 18. Further, the subject placed horizontal lines in the notation at the end of ms. 9, 12, 16, and 20, which may have delineated these more difficult segments. During the last 25 minutes of her memorization, the subject shifted her focus to ms. 20-36. She also appeared to split this section into smaller segments (ms. 20-25 and 28-31) with a large number of starts in ms. 20 and 28 and a correspondingly large number of stops in ms. 25 and 31. The markings in her notation support these smaller segments with lines placed at the end of ms. 20, 24, 28, and 32. This Segmental interpretation was supported in the interview with Subject 8:

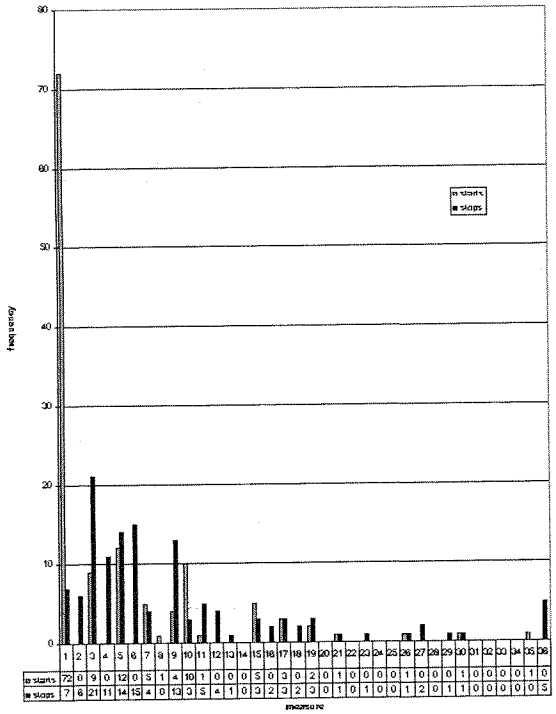
> I took as much of the first line as I think [sic] that I can handle and play it and keep playing it over and over and over again until I think I might be able to play it and turn my music around and try it... I started with lines and then when I decided it was too much then I broke it down into phrases like I started with two measures and when I decided that I could add some more to that I'd add some...The beginning took me the longest and I'm not sure why...

While it appeared that Subject 8 began by attempting to perform the piece in its entirety, returning to the beginning after each breakdown (Serial strategy), she appeared later to switch to a Segmental approach.

Discussion

In this study, subjects used essentially four distinct strategies to memorize a piece of music: Segmental, Holistic, Additive, and Serial. All four strategies work, in that successful memorization of a piece was accomplished using these strategies. The more efficient musicians (Subjects 1, 2, 3, 4), appeared to use either a Holistic, in which the entire piece was repeatedly played from beginning to end, or an Additive strategy, focusing on a large section of the piece and then adding the remaining measures to form a whole. These two strategies differed only in the initial approach to the task of memorization. Subjects using the Additive approach initially began with a large segment and then focused on the whole piece. This differs from the Segmental approach in that the subjects did not focus on two discrete segments prior to linking them into a whole.

The musicians who required more time for memorization (Subjects 5, 6, 7, 8) either preferred a Segmental approach or returned to the beginning repeatedly when



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
starts	72	0	9	0	12	0	15	1	4	10	1	0	0	0	5	0	3	0	2	0	1	0	0	0	0	1	0	0	0	1	0	0	0	0	1	0
stops	7	6	21	11	14	15	4	0	13	3	5	4	1	0	3	2	3	2	3	0	1	0	1	0	0	1	2	0	1	1	0	0	0	0	0	5

Figure 4. Frequency of starts and stops by measure in first 25 minutes of practice session: Subject 8.

errors or lapses in memory occurred. The Serial strategy was characterized by a large number of starts in ms. 1 combined with no apparent pattern to the stops throughout the rest of the piece. The Serial method differed from the Holistic strategy in that subjects employing the latter performed to the end on nearly all repetitions. It is probable that memory lapses occurred using the Holistic method and the subjects referred to the notation, but the performance continued to the end of the example regardless of the amount of prompting required.

When considering whether the results of this study support the preliminary model of memorization presented earlier in the paper, it is important to note that a 36 measure exercise, which is not technically advanced, may not represent memorization as it occurs with standard repertoire. Strategies employed in the memorization of such a short example may be different from those employed by a musician memorizing a longer piece of music and/or one that is more technically challenging. The subjects in this study were able to memorize the exercise in less than two hours during the course of one day. However, some similarities exist between results of this study and those previously reported.

All eight subjects previewed the exercise in its entirety before individual memorization strategies emerged. Segmentation was common with all but two subjects fragmenting the exercise in some fashion. Segmentation did often appear at structural boundaries with the most common structural boundary occurring between ms. 19 and 20. Segments were increased in length or added together as has been reported by Chaffin & Imreh (e.g., 1997) and Miklaszewski (1989 & 1995). Memorization behaviors such as interspersing segment practice with performances (e.g., Subject 2) and starting the memorization process at the end (Subject 5) were observed. Reviewing the piece to finish the memorization process was not widely evident in this sample. Three subjects ended with 5+ performances of the piece. It is possible that the lack of review is a by-product of the task (subjects were asked to practice the piece until they could play it once from memory).

Though limited in generalizability and ecological validity, the results of this study may shed light on the process of memorization. In this study, four distinct memorization strategies appeared. A qualitative difference in memorization strategy did emerge which separated the faster memorizers from those who required more time. It is important to continue this line of inquiry to include not only other qualitative studies but also experimental methodologies which could determine whether memorization efficiency could be increased if a Holistic or Additive strategy were employed.

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