

# MEMORY FOR MUSIC PERFORMANCE: COMPARING PLAYED AND WRITTEN RECALL

Tania Lisboa<sup>1</sup>; Roger Chaffin<sup>2</sup>; Topher Logan<sup>2</sup>

<sup>1</sup>Royal College of Music, London, UK & Orpheus Institute, Belgium;

<sup>2</sup>University of Connecticut, USA

## ABSTRACT

A solo cellist learned and memorized the Prelude from J.S. Bach's Suite No. 6 for solo cello for performance and identified features that she had attended to in practice and performance. After ten months she wrote out the score from memory and two months later played the piece from memory. More than three years later she repeated the two tests in the opposite order. On both occasions, played was much better than written recall. Written recall was best at expressive and structural performance cues and worst at basic performance cues for technique. Sensori-motor cues provided by playing appear to be responsible for the better recall when playing.

## 1. INTRODUCTION

Concert soloists have been performing from memory at least since Clara Schumann and Franz Liszt created a stir in European salons and concert halls of the 1830's by playing without a score. The demands placed on memory are extraordinary and, not surprisingly, memory and attentional lapses are not uncommon. Thus, when preparing for a memorised performance, it becomes important for musicians to develop a memory retrieval system that is flexible and that will permit the performance to proceed, whatever may go wrong (Chaffin, Imreh, & Crawford, 2002; Hallam, 1995; Lehmann & Ericsson, 1998). During music performance, memory for what comes next is normally activated by *serial cuing* as the current passage cues motor and auditory memory for what comes next (Chaffin, Logan & Begosh, 2008). Serial cuing has the limitation that the chain of cues starts at the beginning of the piece so that if the performance is disrupted the musician is faced with the embarrassment of having to start over. For this reason, experienced performers usually prepare an alternative memory retrieval system that provides *content addressable* access, allowing the musician to recall any passage in the piece by simply thinking of it (e.g. the "A section"). Content addressable access is provided by *performance cues (PCs)* representing landmarks in the music that the performer is able to consciously think about during performance. PCs provide a mental map of the music that allows the musician to monitor the performance as it unfolds and to recover from mistakes and memory lapses.

Written recall of the score has proved an important source of evidence that PCs provide content addressable access to memory (Chaffin & Logan, 2006; Ginsborg & Chaffin, 2007). Recall is better at PCs representing musical expression and structure and declines in the bars that follow (an effect of serial position). This pattern of results suggests that musicians have content addressable access to memory at these points and then retrieve the following bars by serial cuing. In contrast, recall is poorer at PCs

representing decisions about basic technique. One possible explanation is that musicians rely more on serial cuing in places where there are issues with technique.

This study tested this explanation by comparing written and played recall of a well-prepared piece after many months without practising it. We have reported elsewhere that the *written* recall was better at expressive and poorer at basic PCs (Chaffin & Lisboa, 2008; Chaffin, Lisboa, Logan & Begosh, 2009). Here we ask whether the same effects occurred when the musician *played* the piece at around the same time.

## 2. METHOD

**The participant:** Tânia Lisboa, the cellist and first author was trained in classical cello and piano in Brazil, England and France, and she currently lives in London performing as a cello soloist.

**The music:** The *Prelude* from J.S. Bach's *Suite No. 6* for solo cello was chosen as a piece that explores both the mellow quality and virtuoso aspects of the instrument. Although the cellist was very familiar with the *Prelude* and had played other works by Bach throughout her career, she had never learned the *Suite No. 6* for performance before. Written for an instrument with five strings, *Suite No. 6* presents contemporary cellists with substantial technical challenges because fingerings and left-hand positions must be adapted to play the notes written for the fifth string on the four strings of a modern cello. Musically, however, the *Prelude* is comparable to the other five Bach cello suites. Notated in 104 bars in 12/8 time, the piece takes about five minutes to perform.

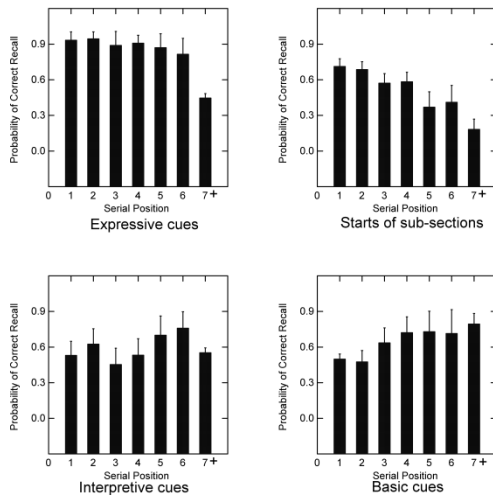
**Procedure:** The cellist videotaped her practice from initial sight-reading to the last of 8 public performances, 92 weeks later. She provided reports describing the musical structure, decisions about basic technique (e.g., bowing), interpretation (e.g., dynamics), and various kinds of PCs she attended to during performance (expressive, structural, interpretive, intonation and basic technique separately for left and right hand). The practice sessions and performances have been described elsewhere. Ten months after the public performances, the cellist was asked to write out the score from memory. Seven weeks later, she recorded herself playing the piece from memory. She had not practiced or performed the piece in the intervening weeks. After a period of more than three years, a second pair of tests was carried out, this time reversing the order of recall: played recall first and written recall second.

We examined accuracy of recall as a function of serial position before and after PCs. We also measured the tempo of the first played recall using a sound wave processing

program to measure the duration of each half bar. Measurement of the tempo of the second played recall is ongoing.

### 3. RESULTS

We previously reported that *written recall* was 52% accurate, showing considerable forgetting (Chaffin & Lisboa, 2008). Figure 1 shows mean recall probability as a function of serial position; Table 1 summarizes the results of a multiple regression analysis that showed that all of the effects of serial order evident in the figures were statistically reliable except for interpretive PCs.



**Figure 1:** Mean probability of written recall of the score (with standard error bars) for serial position of half bars numbered sequentially starting at expressive PCs, starts of subsections (structural PCs), interpretive PCs, and basic PCs.

Effect of serial position from	Regression coefficient
PC: Expressive	-0.089***
Starts of subsections	-0.072***
PC: Interpretive	0.005
PC: Basic	0.066***
$R^2$	0.29***

\*\*\*  $p < .001$

**Table 1.** Regression coefficients (unadjusted) for the effects of serial position of half-bars from PCs and beginnings of subsections of the musical structure on probability of correct recall, with  $R^2$ .

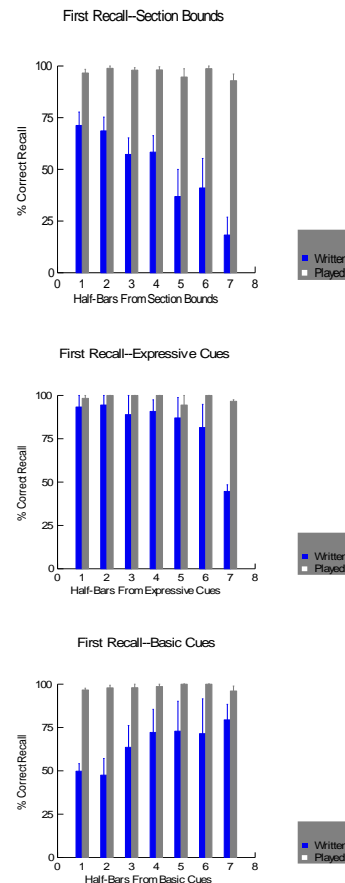
Probability of recall was highest at expressive PCs and beginnings of sub-sections and declined as distance increased – negative serial position effects. For basic PCs the serial position effect was positive – probability of recall was lowest at basic PCs and increased with distance.

The effects for expressive PCs and subsections suggest that these were the main landmarks of the cellist’s memory. Once the beginning of each passage was retrieved, it cued recall of what followed until, at some point, a link failed

and the chain was broken, resulting in a poorer recall as distance from the landmark increased (Roediger & Crowder, 1976). Expressive PCs were more effective retrieval cues than beginnings of subsections. Recall was nearly perfect at expressive PCs and lower at subsection boundaries ( $M = 0.93$  and  $0.65$  respectively,  $t(32) = 2.72$ ,  $p = .01$ ).

The effect of basic PCs on recall was in the opposite direction. Recall was lower at basic PCs and increased as distance from the cue increased. The effect suggests that basic PCs did not provide direct, content-addressable memory access, but operated instead as part of a serial chain of associations, reminding the musician about important details of technique (Chaffin et al., 2009; Rubin, 2006). In writing out the score from memory, the cellist was not performing the relevant actions, and so the memories associated with them were less available.

This interpretation was consistent with the results for the *played recall* which are compared with those for the written recall in Figure 2. Played recall was almost perfect and showed no drop of with serial position following any of the different types of PCs. When the sensori-motor context provided by performance was present, recall was much better than for the written recall.



**Figure 2:** Mean probability of written and played recall for serial position of half bars numbered sequentially starting at expressive PCs, starts of subsections, and basic PCs.

There were numerous, small hesitations in the played recall. If PCs serve as memory retrieval cues, as we have suggested, then we would expect these hesitations would occur at PCs as the cellist struggled to recall what came next. Table 2 lists the significant effects in a multiple

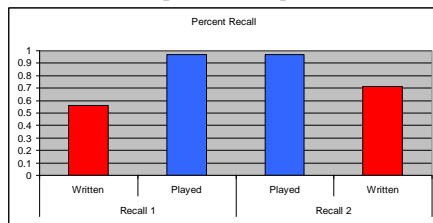
regression analysis of the tempo. Negative effects (bold faced) indicate that playing was slower at these places.

Effect	Regression coefficient
Section Begins	0.120***
Switches	<b>-0.332***</b>
PC: Expressive	<b>-0.152***</b>
PC: Interpretive	<b>-0.103**</b>
PC: Bowing	<b>-0.079***</b>
<i>R squared</i>	0.29***

\*\*  $p < .01$ , \*\*\*  $p < .001$

**Table 2.** Regression coefficients (unadjusted) for the effects of musical structure and PCs on tempo, with  $R^2$ . Negative values (bold faced) represent slower playing in bars containing the feature or cue in question.

Slower playing at switches and at PCs for bowing probably reflects hesitations due to memory retrieval problems. Switches are places where similar musical material is repeated at different points in the piece. These are places where it is easy to get confused; the cellist was apparently taking the time to think carefully about where she was in order to avoid mistakes. We have shown previously (Chaffin & Lisboa, 2008) that the cellist often used bowing to help her remember passages that were particularly difficult to memorize. The slower tempi at PCs for bowing, therefore, probably represent hesitations while she tried to remember these passages. Expressive and interpretive PCs were also marked by slower tempi. In these cases, the slowing could have been due to musical interpretation. We have previously reported that the cellist emphasized these places with slightly slower tempi in polished performances (Lisboa, Chaffin, R., Begosh, & Logan, 2007). Without additional analysis, we cannot say whether the slower playing at these locations in the played recall was due to the same kind of emphasis or to problems with recall.



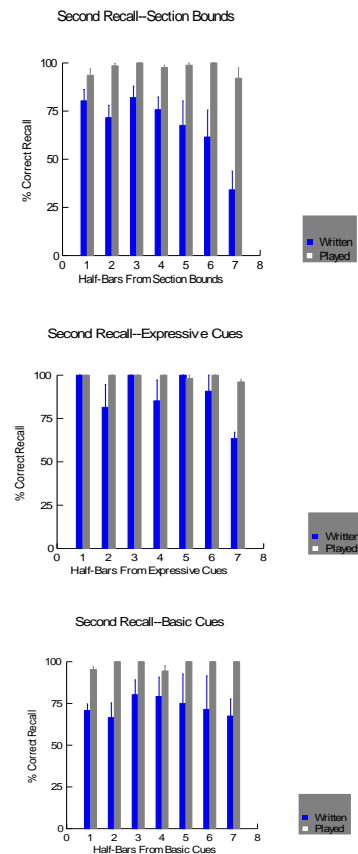
**Figure 3.** Percentage correct on two tests of written and played recall, shown in temporal order from left to right.

The second test carried out more than three years later revealed similar findings. Figure 3 (above) shows that recall was almost perfect for the two played tests and substantially lower for the two written tests. The difference demonstrates the large role played by motor and auditory memory. Written recall was better (71%) in the second round of testing than on the first (52%). The improvement was probably due to the recent played recall in which the cellist was able to play through the entire piece from memory.

Effect of serial position following	Effects	Interaction indicating difference between Recall Tests
Expressive PCs	-0.073*	0.033
Structural PCs	-0.032	0.025
Interpretive PCs	0.031	-0.007
Basic PCs	0.086**	-0.050*
Structural PCs x Expressive PCs	-0.018*	

**Table 3.** Regression coefficients for the effects of serial position of half-bars from PCs on probability of correct recall for first and second written recalls.

Table 3 summarizes the results of a mixed hierarchical regression analysis testing the effects of serial order and their interaction with first and second tests. For beginnings of sub-sections and expressive PCs, recall declined as distance increased (see Figure 4, top and middle panels respectively). For expressive PCs, the decline was less uniform on the second test. For basic PCs, the effect was in the opposite direction – probability of recall was lowest at basic PCs and increased with distance – and was larger on the second test (see Figure 4, bottom panel).



**Figure 4.** Mean probability of correct recall (written and played) as a function of serial position of half bars numbered sequentially from beginnings of subsections (structural PCs), expressive PCs, and basic PCs, for second recall tests.

## 4. DISCUSSION

Played recall was better than written recall on both sets of tests (97% accurate). The movements involved in playing apparently helped to remind the cellist of what came next. The sensori-motor context provided by playing aided recall by providing additional retrieval cues.

Two sources of evidence suggested that the movements involved in bowing were particularly important: (1) the presence of hesitations at PCs for bowing in the first played recall and (2) the lower written recall of these same locations in both written recalls. First, during the first played recall, playing slowed at PCs for bowing, suggesting that the cellist needed to think about what came next at these points. It appears that bowing PCs provided retrieval cues that were not yet working up to the speed required for performance. Second, written recall was also lower in these same locations. Recall decreased at basic PCs, which included PCs for bowing, and increased in the bars that followed. The effect suggests that the cellist relied more on serial cuing by motor (and acoustic) cues at these points. Because these cues were absent during written recall, memory was poorer at these points. These two effects (hesitations and poorer recall) suggest that bowing provided the cellist with important retrieval cues.

The contribution of bowing to recall is further supported by spontaneous comments that the cellist made during practice, reported by Chaffin & Lisboa (2008). At one point during practice session 30, the cellist referred to difficulties that she was having in remembering a passage: “[It] actually helped [me] very much to remember where the up-bows were...”. In sessions 33, she said of the same spot, “Maybe the dynamics would help [me remember] because I’ve got a crescendo on the up-bow” (Chaffin & Lisboa, 2008). These comments indicate that the cellist used bowing direction to help her recall a passage that she was having difficulty with.

As previously reported, recall was better at expressive PCs and at the beginnings of subsections (Chaffin & Lisboa, 2008). The cellist was able to locate these places in her memory, even when she was unable to remember the bars that preceded them. The decrease in recall in the following bars was then due to serial cuing as, at each successive link in the chain, there was the possibility that retrieval would fail. The probability of recall, therefore, decreased as distance from the start of the chain increased, producing a *negative* serial position effect.

In summary, the new finding here was that played recall was better than written recall. The result is not surprising. Played recall provided serial cuing by the sensori-motor context that was absent in the written recall. What is interesting is the suggestion that basic PCs were responsible for the difference. The role of basic PCs in the played recall is eloquently described in an email that the cellist wrote shortly after the second played recall, describing her experience.

*“I... was hesitating all the way through but managed to get to the end. At some places... my fingers seemed to go by themselves... mostly it was thinking of bowing and fingering (basic PCs) that... got me through”.*

Basic PCs provided the cellist with content addressable access to her memory for the piece, allowing her to *think about* the bowings and fingerings she had selected during practice and used during performance. These retrieval cues

allowed her to play the piece the way she had learned it and her actions then provided additional retrieval cues that allowed her to remember the next passage. In this way, she was able to make her way through the piece.

## 5. REFERENCES

1. Chaffin, R., Imreh, G., & Crawford, M. (2002). *Practicing perfection: Memory and piano performance*. Mahwah, NJ: Lawrence Erlbaum Associates.
2. Chaffin, R. & Lisboa, T. (2008). Practicing perfection: How concert soloists prepare for performance. *Ictus*, 9, 115-142.
3. Chaffin, R., Lisboa, T., Logan, T., & Begosh, K.T. (2009). Preparing for Memorized Cello Performance: The Role of Performance Cues. *Music Psychology*, in press.
4. Chaffin, R., Logan, T.R., & Begosh, K.T. (2009). Performing from memory. In S. Hallam, I. Cross, & M. Thaut (Eds.), *The Oxford Handbook of Music Psychology* (pp. 352-363). Oxford: Oxford University Press.
5. Ginsborg, J. and Chaffin, R. (2007a). The effect of retrieval cues developed during practice and rehearsal on an expert singer’s long-term recall for words and melody. In A. Williamon and D. Coimbra (Eds.), *Proceedings of the International Symposium on Performance Science*, Association of European Conservatoires, Porto, November.
6. Lehmann, A. C., & Ericsson, K.A. (1998). Preparation of a public piano performance: The relation between practice and performance. *Musicae Scientiae*, 2, 69-94.
7. Lisboa, T. (2006, July). Action, thought, and self in cello performance. Paper presented at the Conference on Teaching, Learning and Performing Music, Royal Northern College of Music, Manchester, UK.
8. Lisboa, T., Chaffin, R., Begosh, K.T., & Logan, T. (2007). Memorizing in cello playing: Practice, performance and expression. Paper presented at the 3<sup>rd</sup> International Symposium on Cognition and the Musical Arts (SINCAM), Salvador, Bahia, Brazil.
9. Roediger, H. L., III, & Crowder, R. C. (1976). A serial position effect in recall of United States presidents. *Bulletin of the Psychonomic Society*, 8, 275-278.