

## Learning *Clair de Lune*: Retrieval practice and expert memorization Roger Chaffin

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### Introduction

The extraordinary memory abilities of many professional musicians can be explained in terms of general principles of memory functioning. Superior memory is due to a combination of knowledge, strategy, and effort (Ericsson & Kintsch, 1995). These principles were evident in a previous study of a concert pianist learning J. S. Bach's *Italian Concerto (Presto)* (Chaffin & Imreh, 2002; Chaffin, Imreh & Crawford, 2002). First, the pianist's memorization was built on familiar patterns. Second, she used the formal structure of the piece to organize memory. Third, she engaged in prolonged practice of memory retrieval throughout the 57 sessions and 33 hours of practice. In particular, she practiced beginnings of sections (where the upcoming passage must be recalled), *switches* (where there is a risk of confusing similar phrases from different sections), and *performance cues* (where particular features must be remembered for the performance to unfold according to plan).

What about music that does not require the prolonged practice required by the *Presto*? To find out, the pianist recorded her practice as she learned *Clair de Lune* by Claude Debussy. The slow tempo and simple structure of *Clair de Lune* give the pianist plenty of time to think about what comes next, making it relatively easy to memorize. As in the *Presto* study, the pianist gave detailed reports of her decisions about musical structure, technique, interpretation and performance. These were related to amount of practice and to hesitations during practice performances to see when memory practice occurred during learning.

### Methodology

*Clair de Lune* is harmonically complex but contains few technical difficulties and a simple *ABBA* structure. It takes about 5 minutes to perform and is scored in 72 bars in 9/8 time. The pianist, Gabriela Imreh, had played Debussy throughout her career as a concert pianist but had never learned this piece before,

The pianist video-recorded her entire practice over two weeks as she prepared for a public performance. The location of starts and stops during practice were transcribed along with the pianist's comments.

The mean *target tempo* of playing in each session was measured and the *practice rate* in each session computed (number of practice segments x mean length of practice segments in bars x 3

Predictor variable	Stage								
	Section-by-section			Putting-together			Polishing		
	Sessions 1-3			Sessions 4-5			Sessions 6-7		
	Repetitions	Starts	Stops	Repetitions	Starts	Stops	Repetitions	Starts	Stops
<b>Musical structure:</b>									
Beginning of section	17.22**	7.16	9.94**	-1.25	1.98*	-0.33	-0.79	2.33**	0.89
End of section	3.58	-4.07	7.92*	-2.38	0.23	1.21	-1.87	-0.33	0.25
Serial position in section	4.31***	2.12***	1.99***	-0.11	0.05	-0.03	-0.36	0.03	-0.01
<b>Performance cues</b>									
Basic	-4.17	-2.52	2.48	3.20**	0.16	0.11	3.21**	0.26	-0.02
Basic: bar before	0.01	1.43	-0.51	3.34**	0.27	0.59	2.41	0.18	0.07
Basic: bar after	-7.15*	0.66	-2.60	3.49**	0.19	0.68	3.50**	0.38	0.11
Interpretive	-3.50	1.42	-1.84	0.39	0.18	0.35	0.22	0.25	0.32
Interpretive: bar before	-3.56	-2.37	1.76	0.42	0.33	0.09	0.32	0.20	0.36
Expressive	-2.53	3.88	-3.58	-0.76	-0.91	0.51	-0.38	-0.09	-0.21
Expressive: bar after	6.97	1.77	6.79**	-0.43	0.52	-0.10	-0.52	-0.08	0.63
Number of notes	0.98***	0.38**	0.37***	-0.28***	-0.06*	-0.05*	-0.16*	-0.03	-0.02
R <sup>2</sup>	0.51***	0.38**	0.53***	0.42***	0.19	0.28*	0.31*	0.27*	0.16

beats/bar)/(playing time in minutes)). The ratio between the two measures (*rate/tempo ratio*) indicated the proportion of time spent thinking versus playing (Chaffin et al., 2002, p. 126-135).

Inter-bar intervals (IBIs) were measured for six practice performances from memory. Performances 1-3 and 4-6 were combined and differences between the earlier and later performance assessed.

The pianist reported the location of section boundaries and the location of basic, interpretive, and expressive performance cues by marking them copies of the score (Chaffin et al., 2002). The reports were coded as dummy variables which served as predictors in regression analyses in which the dependent variables were the number of starts, stops, and repetitions per bar and IBI.

## Results & Discussion

**Comments about memory.** The pianist's comments show that she put great effort in to playing from memory right from the start.

*"Okay, I have to remember this.... [plays] As you see, I am trying to play as much as possible from memory..."* (session 1)

*"Anyway, I'm trying to muddle through without music just to see what I remember. Actually from the whole [first] page there was one place where I could not continue, and maybe I wasn't concentrating hard enough, because probably, given enough time, I could have gotten through it."* (session 2)

**Practice.** The pianist focused on the formal structure and on performance cues throughout (Table 1). Practice segments started or stopped at section boundaries more than at other locations showing that the pianist had the formal structure in mind during practice and was establishing beginnings of sections as retrieval cues (Williamson & Valentine, 2002).

The effects of expressive performance cues in sessions 1-3 were similar to those for section boundaries, suggesting that expressive cues subdivided the formal sections of the piece into expressive phrases. Basic performance cues became the focus of attention in sessions 4-5 and 6-7. Efforts to play longer passages from memory were interrupted by repetition at these points, suggesting that memory retrieval was not yet working reliably (Chaffin al., 2002).

Table 1: Regression coefficients and  $R^2$  for the effects of musical structure and performance cues on the number of repetitions, starts, and stops during practice

$p < .05$ , \*\*  $p < .01$ , \*\*\*  $p < .001$

**Memory retrieval during practice performances.** Basic performance cues and switches were played at a slower tempo in the earlier than in the later performances suggesting that the pianist was hesitating to recall what came next (Table 2). For basic cues, the effect was so disruptive that it continued into the following bar. In the later performances, retrieval had become more automatic and playing was no longer slower at these points.

Other differences between earlier and later performances were due to the development of interpretative gestures in later performances. Tempo increased in bars with more notes, accentuating the musical tension in these bars. Other effects were due to increased use of tempo to delineate sections and expressive phrases.

Table 2: Regression coefficients and  $R^2$  for the effects of musical structure and performance cues on differences in tempo of earlier compared to later performances. (Faster tempi are indicated by positive effects, slower by negative effects).

Predictor variable	Differences from the other composite performance	
	Composite performance	
	Earlier (1-3)	Later (4-6)
Other performance as covariate	0.93***	0.77***
<b>Musical structure:</b>		
Beginning of section	9.54***	-7.58**
End of section	5.52 <sup>†</sup>	-8.82***
Serial position in section	-0.31	0.58 <sup>†</sup>
Switch	-7.95**	5.53 <sup>†</sup>
<b>Performance cues:</b>		
Basic	-3.39**	3.24**
Basic: bar after	-5.80***	5.23***
Interpretive	-1.61	1.15
Interpretive: bar before	1.10	-1.01
Expressive	0.43	-0.49
Expressive: bar after	3.66 <sup>†</sup>	-2.67
Number of notes	-0.14	0.19***
$R^2$	0.79***	0.82***

$p < .05$ , \*\*  $p < .01$ , \*\*\*  $p < .001$

### The rate/tempo ratio as a measure of retrieval practice

A measure of the effort put into memory retrieval practice comes from comparing the *target tempo* at which the pianist was trying to play with the *practice rate* at which she actually played. The discrepancy (the *rate/tempo ratio*) indicates of the proportion of practice time spent in hesitations and micro-pauses -- momentary stops for thought. The rate/tempo ratio increased across sessions from .59 to .83, with a mean of .72, i.e., if she had kept to her target tempo the pianist could have played half as much music again. Thus, she spent a lot of time thinking. Given the salience of memorization in the pianist's comments and practice, much of the time spent in thought was probably devoted to memory retrieval.

### Conclusion

Although the total practice time for *Clair de Lune* was 1/7<sup>th</sup> of the 33 hours that the same pianist took to learn the more challenging *Presto*, the same principles of expert memory appear to have been at work in both cases: use of the formal structure as a retrieval organization and extended practice of retrieval from long-term memory.

## References

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