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Musical Recall Memory: Contributions of Elaboration and Depth of Processing

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Abstract

This study investigated the roles of depth of processing and elaboration in incidental recall of musical passages learned in the course of several readings of an unfamiliar score. Pianists with performing experience played short passages four times each under instructions emphasising deep processing (focus on aesthetically perceived elements of the piece), shallow processing (focus on non-aesthetic elements of the piece), high elaboration (four different examples of deep or shallow focus) or low elaboration (one example of deep or shallow focus). In surprise-free and cued-recall tasks, the pianists were asked to play back as much of the pieces as they could remember. The principal finding was that the high-elaboration instructional condition favoured cued recall of deeply processed musical material over cued recall of shallow processed musical material. In the low-elaboration condition there were no differential effects for deep *versus* shallow processed music. These results are interpreted in terms of a transfer-appropriate processing framework applied to musical performance. Implications of the results for formal musical performance are discussed.

Musical recall is not only a practical concern for musicians, it also poses an interesting challenge for psychological theory. Consider the feat undertaken by a pianist performing a full piano recital. She will have to recall many tens of thousands of discrete, identifiable gestures – each corresponding to the playing of individual notes or the use of the pedals. These must be carefully choreographed to ensure fluid, accurate performance, and this often at great speed and under the pressure of performing before an audience. At the same time, the performance requires subtle nuances of touch to convey the artist's aesthetic intentions. What, then, are the processes that underlie musical recall? Are they unique to the music modality? Do the answers to these questions have practical implications for artists preparing to meet the recall demands of performance?

Interestingly, while many researchers have examined music recognition (see Peretz, 2000, for an important review), few have studied recall as it relates to music performance. For example, there are studies of recognition memory for musical pitch and melody (Dowling and Harwood, 1986; Dowling, Kwak and Andrews, 1995; Pechmann, 1998) and theoretical examination of the applicability of working memory models based on language to memory for music (*e.g.,* Berz (1995) on Baddeley's (1990) model). Perhaps, as Sloboda and Parker (1985) point out, studies of recognition memory may be more popular because the researcher has better control of the stimuli involved and can restrict the musician to easily

quantified responses. In contrast, measures of recall are often problematic since the production of remembered music – whether sung, performed on an instrument, or written – is a highly complex matter and recall data tend to be "messy" (Sloboda and Parker, 1985, p. 147). However, while recognition tests are more popular, they do suffer from having low ecological validity since the memory demands of musical performance seldom involve recognition. Recall tests, on the other hand, while problematic for the researcher, touch on precisely the kind of memory required by musicians when they perform notated music.

There is an interesting literature by musicians about performance memory and practice. For example, Josef Hofmann (1908/1976) refers to the importance of having an awakened interest that "usually comes with a deeper understanding of the music" (p. 115) if one is to enhance musical memory. He suggests ways of mentally rehearsing music by attending to difficult spots until one is able to "understand their construction" (p. 113). These and similar commentaries on how to enhance memory for performance purposes generally emphasise two points. One is that musical memory is aided by certain kinds of repetition, and the other is that it is aided by "understanding"* the music. At this somewhat simplistic level of abstraction these ideas are hardly controversial among musicians, but they do have parallels to controversies in the psychological literature about the roles of elaboration and depth of processing in memory. The present study addresses musical memory from this psychological perspective.

Elaboration refers to the adding of information to the representation of the to-be-remembered information. Elaborative rehearsal – thinking about the to-be-remembered information in different ways – is known to aid recall (Bellezza, 1996; Eysenck, 1979), whereas maintenance rehearsal – the simple repetition of the to-be-remembered item without any cognitive addition to the target information – does not (Craik and Watkins, 1973). The benefits of elaboration are usually explained in terms of a network metaphor of information retrieval. According to this view, elaboration creates multiple linkages between representations of the target and other points in the person's semantic network. During retrieval search, the existence of a rich set of connections between target and other parts of the network increases the probability that the target will be found.

Depth of processing effects refer to the memory advantage that comes from focussing on the deeper or more semantic aspects of the to-be-remembered information (Craik and Lockhart, 1972; Roediger and Guynn, 1996). Most research concerning depth of processing has involved verbal materials, where deep-level processing is identified with processing the referent meaning of words and shallow-level processing with processing the surface forms of words (upper/lower case of the letters making up the word; the phonological structure of the word, etc.).

*Most musicians would agree that memory at high levels of performance is ultimately contingent on "understanding". Considerable differences in opinion, however, exist on precisely what should be "understood" and how this understanding might best be committed to memory. Some idea of the range of approaches to the problem can be gauged from the following selected examples: "muscle memory" automated through persistent mechanical repetition (Kalkbrenner, 1830), technical phrasing (Busoni, 1968), textual visualisation (Gieseking and Leimer, 1972); imagery and symbolic representation (Bonpensiere, 1952), structure (Tureck, 1960); tactile reference (Jaell, 1896). In addition, some accomplished players claim they instinctively "know" a complex work at first sight (or after a minimum number of readings) and are able to perform it accurately by memory *prior to active practice.* Cohen (1998) postulates that near instantaneous performance memory is achieved by means of the aesthetic ordering of multiple sensori-motor pairings. The resultant pairings are perceived as unified, *i.e.,* as a single, experienced action in real time.

A similar distinction can be made with respect to music. While there is much less consensus as to what constitutes meaning in music compared to meaning in language (Raffman, 1993), the approach of Reimer and Wright (1992, p. 212) is useful for our present purposes. They view meaning in music as "a function of the quality of experience one undergoes when engaged with sounds organised in expressive interrelationships". While it may seem obvious, the important point here is the reference to "expressive interrelationships". In psychological studies of how performers communicate musical intentions, a number of authors have similarly focused on the expressive, conceptual and interpretative dimensions of the music (Clarke, 1985; Palmer, 1996; 1997; Repp, 1992). We refer more generally in this paper to such communicative intentions as the performer's aesthetic intentions. These, of course, are ultimately realised by manipulating more surface-level qualities of the music, such as tempo and dynamics. We identify an aesthetic focus on the music with deep-level processing, analogous to deep-level (meaning) processing in studies of verbal memory. This deep-level processing can be contrasted with processing that focuses on the surface form of the music, such as the individual notes and their characteristics taken without reference to their contribution to the aesthetic dimension of the music (analogous to focusing on the letters or sounds that make up a word without reference to its meaning).

In the general literature on memory processes, most of which does not deal with musical memory, there is considerable evidence to suggest that processing for meaning does enhance recall. One important challenge in this area, however, is the following. Research on the role of elaboration and depth in recall must address the possibility of confounds between them. For example, inducing elaboration often involves eliciting deeper processing of the target items, thereby creating a potential confound with depth of processing explanations of memory. Similarly, deeper processing (*e.g.,* asking one to focus on the meaning rather than the sound of a word) may involve creating associations that are inherently richer – hence involve more elaboration – than when processing is shallow. Thus facilitation of recall by deep processing may involve a confound with greater elaboration.

To address such confounds, Hashtroudi (1983) pitted elaboration and depth against each other in a clever research design. In her study, participants processed nouns by focusing either on core aspects of their meanings (deeper) or on peripheral aspects of meaning (shallower), and in ways requiring more or less elaborative processing. Results supported a depth of processing account of retrieval over an elaboration account.

The present study addressed the distinction between elaboration and depth in the context of musical recall using an adaptation of Hashtroudi's (1983) study. Experienced pianists saw four unfamiliar pieces of music, each to be played four times using a special set of focus instructions each time. For two pieces, focus was on aspects closely related to the aesthetically perceived qualities of the piece (deep processing) while for the other two, focus was directed toward non-aesthetically perceived elements of the piece (shallow processing). Also, for two of the pieces, instructions indicated four different ways of focusing on the music (high elaboration), and for the other two, instructions indicated only one (low

elaboration). Instructions were crossed so as to produce four reading conditions: deep–high, deep–low, shallow–high and shallow–low elaboration.

Ten minutes after completing all the reading tasks, musicians received two incidental recall tasks. One was a free recall test in which they were asked to play back the pieces from memory. The other was a cued recall test in which they had to play the pieces from memory given the opening two measures as a cue. Listeners blind to the conditions judged recall success. The analyses of recall quality compared the relative contribution of depth and elaboration to recall success.

Method

Participants

Sixteen pianists (11 females), aged 19 to 72, participated. Prior to testing, all confirmed they were able to read a simple unfamiliar score, had studied music at university or conservatoire, had given stage performances, considered piano as their major focus and were able to play music from memory.

Procedure

General. Testing took place in a small recital hall with a concert grand Falcone piano on a stage. Each pianist was given preliminary instructions, asked to fill out a consent form, and then given about five minutes to warm up and familiarise themselves with the instrument. There were four blocks of four reading trials, each block with a different piece of music. Following each reading trial, there was a two-minute visual non-musical distraction task. Following the last reading trial there was a ten-minute visual distraction task. Next followed a surprise free recall test, and finally a cued recall test (cue was the first two measures of the piece). Everything was audio and video recorded with the pianists' knowledge.

Reading. At the beginning of each reading block, the pianist looked at a short piece of music for about one minute before attempting to play it from the score. The pianist was then given written and verbal instructions on how to focus on the music while playing it through once. Focusing instructions were given prior to playing the same piece a second, third and fourth time (see Table 1 for details of the instructions directed the pianists' attention).

Each pianist participated in four different reading blocks, formed by crossing conditions of deep and shallow focus with conditions of low and high elaboration.

Instructions for the deep condition directed the pianist's attentional focus toward aesthetically perceived qualities of the piece (*e.g.,* play as expressively as possible). Instructions for the shallow condition directed attention away from aesthetically perceived qualities (*e.g.,* focus on mechanical, accurate playing of the notes). The low elaboration condition required the same deep (or shallow) focus on each of the four readings. The high elaboration condition required different examples of deep (or shallow) focus on each of the four readings.

Recall. In the free recall task, the pianist was asked to play the four pieces from memory in any order. In the cued recall task the pianist was shown a page containing the first two measures of each piece from which he or she attempted to play the pieces from memory in any order. Each recall task lasted about five to six minutes.

TABLE 1
Reading instructions.

On Trial 1 of each condition, pianists were asked to look at a musical text for a few moments and then to sight-read it. On each subsequent trial they were asked to play the piece again while looking at the text. They were reminded before each attempt that they would be recorded so that their playing could be analysed later. The following instructions specific to each condition were also given:

Shallow–Low Elaboration

Trial 1: Please focus all your attention on mechanical, accurate playing of the notes and timing.

Trial 2: We are again interested in how accurately you play with respect to the notes and timing.

Trial 3: We are still interested in how accurately you play with respect to the notes and timing.

Trial 4: We are still interested in how accurately you play with respect to the notes and timing.

Deep–Low Elaboration

Trial 1: Please focus all your attention on how the upper part harmonises with the lower part.

Trial 2: We are again interested in how you are able to make the upper part harmonise with the lower part.

Trial 3: We are still interested in how you are able to make the upper part harmonise with the lower part.

Trial 4: We are still interested in how you are able to make the upper part harmonise with the lower part.

Shallow–High Elaboration

Trial 1: Please focus all your attention on mechanical and accurate playing of the notes and timing.

Trial 2: This time, please focus all your attention on making a stress on the second and last beats of each bar.

Trial 3: Now we would like you to focus all your attention on voicing the next to bottom note in the left hand.

Trial 4: This time please focus all your attention on making the left hand louder than the right hand.

Deep–High Elaboration

Trial 1: Please focus all your attention on playing as expressively as possible.

Trial 2: This time, please focus all your attention on how to make the upper part harmonise with the lower part.

Trial 3: Now we would like you to focus all your attention on the longest possible phrase units.

Trial 4: This time please focus all your attention on creating meaningful articulation differences between the two hands.

Materials

The four pieces to be learned were short, relatively simple, obscure pieces by Haydn, Mozart, Stravinsky and Villa Lobos (16 measures each), presented without title, composer name or performance indications. Post-experimental interviews indicated no piece was recognised by any of the participants.

Design

Each pianist took part in four reading conditions: shallow–low, shallow–high, deep–low and deep–high elaboration. Order of conditions and assignment of piece of music to a condition were counter-balanced across pianists (4×4 Greco-Latin square) to fully counter-balance instruction-piece combinations and order of presentation.

Results

Initial attempts to score each recall attempt quantitatively (*e.g.*, number of measures recalled, errors, etc.) failed as recall was generally too fragmentary. As a result, each pianist's free and cued recall attempts for the four pieces were re-recorded with the four pieces appearing in the same fixed order for everyone (and therefore counter-balanced as to condition since the pieces were counter-balanced across conditions). In a blind procedure, three of the authors listened to the tapes without knowledge of who the pianists were or what conditions the pieces had been learned under. For each pianist's recall effort, and separately for free and cued recall, the four pieces were rank ordered in terms of recall success. Tapes were listened to from one to four times as needed. The judges used the following general criteria: number of measures reproduced and degree to which the correct general musical structure appeared to be evident. In all cases judges came to a unanimous decision on the ranks. Thus, for each pianist, the pieces – and hence the conditions – were ranked in terms of recall success, with tied ranks given for cases which could not be distinguished.

Cued recall results. For purposes of exposition we report the analyses of the cued recall condition first. The cued recall success scores (ranks) were first submitted to repeated measures analysis of variance with the factors Elaboration (high, low) and Depth (deep, shallow). While it is unusual to do such an analysis with ranks, the problem that potentially arises from doing so is that the test can be very conservative; if the data depart from normality due to the flattened tails in the distribution of the ranks, the chances of a Type II error (failure to find significance) increases. Preliminary analysis determined that the variances of the four cells did not differ significantly. The analysis yielded no significant main effects for Depth or Elaboration (both Fs < 1). There was, however, a significant interaction effect (F (1,15) = 12·739, MSe = 10·563, $p < ·003$) with *post hoc* Newman–Keuls tests revealing superior recall for pieces originally read under deep–high elaboration instructions (mean rank = 3·063) compared to those read under deep–low elaboration (2·313) ($p = ·05$), and inferior recall for pieces read under shallow–high elaboration instructions (1·875) compared to those read under shallow–low elaboration instructions (2·750) ($p = ·05$). There was no significant difference between the deep and shallow–low elaboration conditions (2·313 *versus* 2·750) (Figure 1).

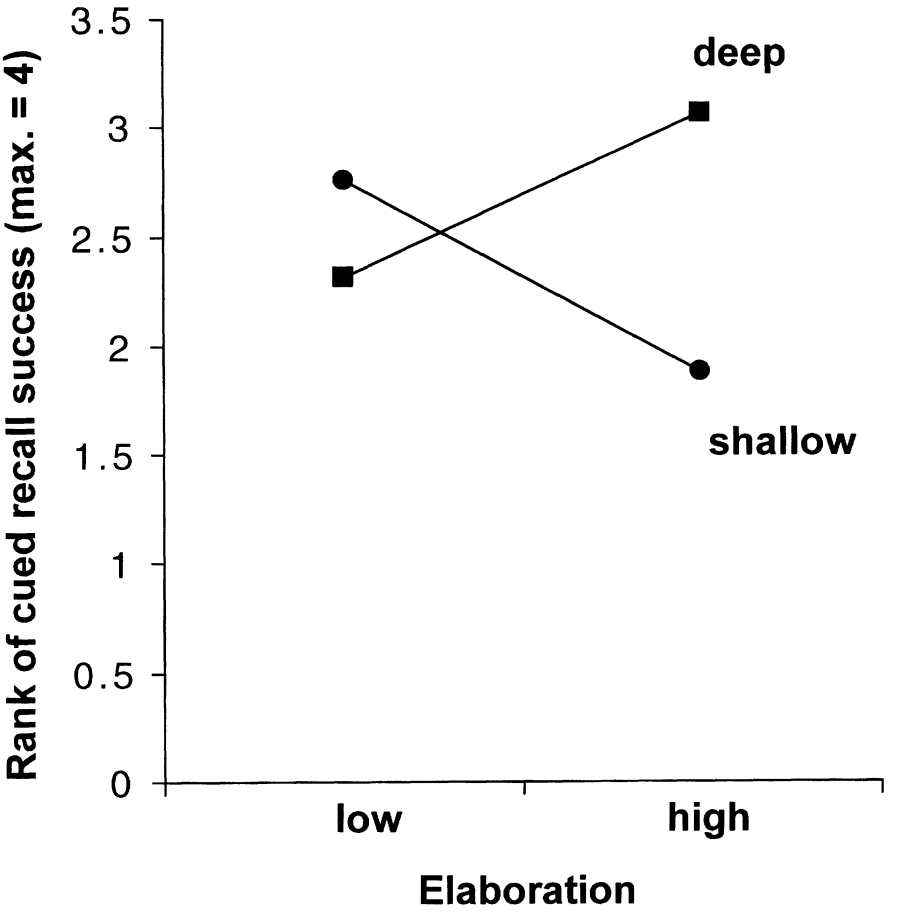

FIG. 1

Cued recall success ranks as a function of the depth of processing (shallow, deep) and the level of elaboration (high, low) under which the pieces were played.

Parametric analysis of ranks is not conventional, so we also submitted the data to non-parametric analysis. Because we were interested in interaction effects, instead of employing a Friedman analysis of variance for ranks we used a chi-square analysis as follows. The expected probability of occurrence of the interaction pattern seen in Figure 1 was computed by examining the 41 theoretically possible different patterns that obtain from ranking four conditions, including the possibilities of ties between two, three or all four conditions (*e.g.*, the conditions might be given the ranks "1, 2, 3, 4" or "4, 2, 1, 3", etc. or in the case of ties "2·5, 1, 4, 2·5", etc.). Of these, only eight or 19·5% correspond to an interaction pattern in which recall of pieces played under deep processing is indicated as

being better with high than low elaboration while the reverse is simultaneously true for recall of pieces played under shallow processing. When the observed occurrences of this interaction pattern (nine cases or 56%) was compared with the expected occurrence (3·12 or 19·5%) in a chi-square analysis, the result was statistically significant (chi-square = 13·76, $df = 1$, $p < .001$). This confirms the previous analysis that the interaction pattern shown in Figure 1 is statistically significant.

Free recall. The free recall performance of the pianists was generally very poor, with most not able to recall anything other than a few notes of one or two pieces. This was reflected in the fact that tied ranks were required for ten of the 16 pianists in this condition (whereas only two required tied ranks in the cued recall condition). When the ranks were submitted to analysis of variance no significant results emerged (all Fs < 1).

Discussion

Overall, the results indicate that both elaboration and depth of processing play a role in musical recall, but the relationship is not straight forward.

First, no effects were found in free recall. This null result does not permit us to draw many conclusions about the roles of elaboration and meaning focus in musical free recall. However, given the positive results of the cued recall condition it would seem that the pianists did have memories of the pieces they had played, but possibly in the free recall condition they did not have entry points to stored representations that would permit them to initiate retrieval.

In the cued recall condition a different pattern emerged, as can be seen in Figure 1. With low elaboration, there was no significant effect of depth while with high elaboration there was. Finally, shallow processing combined with high elaboration led to significantly worse recall than when it was combined with low elaboration.

These results do not support a simple depth-over-elaboration interpretation of recall effects, as concluded by Hashtroudi (1983). Something more complex appears to be happening, as can be seen from two aspects of the results: (*a*) learning with deep processing resulted in better recall than with shallow processing, but only when combined with high elaboration; (*b*) learning with high elaboration actually resulted in worse recall than with low elaboration when processing was shallow.

While clearly neither a simple depth nor elaboration theory can account for these results, a transfer appropriate processing (Franks *et al.*, 2000; Roediger and Guynn, 1996) account may be helpful here. We assume that the musicians' natural strategy in recalling a given piece would be to try to remember the piece in terms of its musical "essence", that is, its perceived aesthetic qualities. Pieces played under instructions of deep processing will be encoded into a cognitive structure whose elements match those of the structure later activated during the search process. In other words, the original encoding will be appropriate for transfer to the recall phase of the experiment. High elaboration, by providing multiple encodings of the piece in terms of its aesthetically perceived elements, increases the degree of match and thereby raises the likelihood of successful retrieval.

In contrast, pieces played under instructions of shallow processing will be encoded into a cognitive structure whose elements do not match those of the structure involved in the search process. In other words, the original encoding will be *in*appropriate for transfer to the recall phase of the experiment. High elaboration, by providing multiple encodings of the piece in terms of non-aesthetic elements, increases the degree of interference (mismatch) between the elements sought out according to the search strategy and the elements actually encountered in memory. High elaboration will therefore lead to more interference and poorer recall than will low elaboration under conditions of shallow processing, which is what we observed.

This transfer appropriate processing approach to understanding memory in the performance of complex skills is supported by the results of a recent study by Franks *et al.* (2000). Their study, involving experiments with word judgement tasks (lexical decision, pleasantness ratings, letter counting, etc.) demonstrated that it is the overlap of specific *intentional* processes, not just the similarity in the stimuli involved, that is crucial to the memory enhancing effects of repetition. Thus, to reiterate the point, if the processes intentionally engaged in at the time of attempted recall match the processes intentionally engaged in at the time of learning, then recall will be more successful. Our results suggest that this is what happened in the recall of musical passages.

This transfer-appropriate processing interpretation of our results has important implications for questions about how to prepare effectively for a formal musical performance and how to reduce or avoid memory blocks during musical performance. In both cases, a transfer-appropriate processing approach would hold that it is not the sheer volume of practice and repetition *per se* that is important, but rather it is the musician's *intentional focus* during practice that is crucial. If the focus during practice does not match the cognitive context that will be established later during performance, then there is greater risk of performance failures and memory blocks than if there had been a match. The present results suggest that it is important for this intentional focus to be grounded in the aesthetic dimensions of the piece being learned and not in the more superficial structural aspects of the music. Of course, it is often necessary to focus on the structural features of the music during practice if one is to master important details. The present study suggests, however, that the most effective way to do so is to relate these structural details to those aspects of the music that will be the principal focus of attention during later performance; normally, this will involve "musicalising" the details by relating them to the larger musical message one intends to communicate at the time of formal performance.

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References

Baddeley, A. (1990). *Human memory: Theory and Practice.* Boston: Allyn & Bacon.

Bellezza, F. (1996). Mnemonic methods to enhance storage and retrieval. In: E. Bjork and R. Bjork (Eds), *Memory,* pp. 345–380. New York: Academic Press.

Berz, William (1995). Working memory in music: A theoretical model. *Music Perception,* **12,** 353–364.

Bonpensiere, L. (1952). *New pathways to piano technique: a study of the relations between mind and body with special reference to piano playing.* New York: Philosophical Library.

Busoni, F. (1968). *The new Busoni: exercises and studies for the piano.* Compiled and with an introduction by Franzpeter Goebels. Wiesbaden: Breitkopf & Hartel.

Clarke, E. F. (1985). Structure and expression in rhythmic performance. In: P. Howell, I. Cross and R. West (Eds.), *Musical Structure and Cognition,* pp. 209–236. London: Academic Press.

Cohen, P. (1998). Composing a performance: metaphor and the art of textual translation. Lecture-Master Class. Hyde Park Performance Group, Chicago.

Craik, F. and Lockhart, R. (1972). Levels of processing: a framework for memory research. *Journal of Verbal Learning and Verbal Behavior,* 11, 671-684.

Craik, F. and Watkins, M. (1973). The role of rehearsal in short-term memory. *Journal of Verbal Learning and Verbal Behavior,* **2,** 598–607.

Dowling, W. J. and Harwood, D. L. (1986). *Music Cognition.* New York: Academic Press.

Dowling, W. J., Kwak, S. Y. and Andrews, M. (1995). The time course of recognition of novel melodies. *Perception and Psychophysics,* **57,** 136–149.

Eysenck, M. (1970). Depth, elaboration and distinctiveness. In: L. Cermak and F. Craik (Eds.), *Levels of processing in human memory,* pp. 89–118. Hillsdale, N.J.: Erlbaum.

Franks, J., Bilbrey, C., Guat Lien, K. and McNamara, T. (2000). Transfer-appropriate processing (T.A.P.) and repetition priming. *Memory and Cognition,* **28,** 1140–1151.

Gieseking, W. and Leimer, K. (1972). *Piano Technique.* New York: Dover.

Hashtroudi, S. (1983). Type of semantic elaboration and recall. *Memory and Cognition,* **11,** 476–484.

Hofmann, J. (1908/1976). *Piano Playing with Questions Answered.* New York: Dover.

Jaell, M. (1896). *Le Toucher.* Paris: Costallat et Cie.

Kalkbrenner, F. (1830). *Méthode pour apprendre le pianoforte à l'aide de guide-main.* Paris: Meissonnier Fils.

Palmer, C. (1996). Anatomy of a performance: sources of musical expression. *Music Perception,* **13,** 433–453.

Palmer, C. (1997). Music performance. *Annual Review of Psychology,* **48,** 115–138.

Pechmann, T. (1998). Memory for chords: the retention of pitch and mode. *Music Perception,* **16,** 43–54.

Peretz, I. (2000). Music perception and recognition. In: B. Rapp (Ed.), *The Handbook of Cognitive Neuropsychology,* pp. 519–540.

Raffman, D. (1993). *Language Music and Mind.* Cambridge, MA.: M.I.T. Press.

Reimer, B. and Wright, J. E. (Eds.) (1992). *On the Nature of Musical Experience.* Niwot, Colorado: University Press of Colorado.

Repp, B. (1992). Diversity and commonality in music performance: an analysis of timing microstructure in Schumann's *Traumerei. Journal of the Acoustical Society of America,* **92,** 2546–2568.

Roediger, H. L. and Guynn, M. (1996). Retrieval processes. In: E. Bjork and R. Bjork (Eds), *Memory,* pp. 197–236. New York: Academic Press.

Sloboda, J. and Parker, D. (1985). Immediate recall of memories. In: P. Howell, I. Cross and R. West, (Eds.), *Musical Structure and Cognition,* pp. 143–167. London: Academic.

Tureck, R. (1960). *An introduction to the performance of Bach.* London: Oxford University Press.