Memorization by a jazz musician: a case study

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ABSTRACT To investigate the memory strategies of jazz musicians, we videotaped an experienced jazz pianist as he learned a new bebop piece. He had not previously heard a recording of the selection, nor had he seen the written music. The pianist provided detailed reports of the musical structure and the types of cues he used as landmarks to guide his memorization. Analysis of the videotapes, verbal reports, and multiple annotated copies of the music revealed that this jazz pianist's learning process was similar to that reported for classical musicians. That is, he used the musical structure as a retrieval scheme and practiced using performance cues to elicit knowledge of upcoming passages from long-term memory. However, this study looked only at the learning strategy for the note-by-note renditions that typically comprise the first choruses of jazz performances. The relationship between this original memorization process and the ability to improvise subsequent choruses will have to be addressed in future investigations.

KEYWORDS: *cognition, expertise, learning, music*

How do jazz musicians learn new music? Unlike performers in the western art music tradition in which the musician plays the score precisely as written, the jazz artist varies the melody, rhythm, even the time-signature from one performance to the next (Berliner, 1994; Sudnow, 2001). This quality of spontaneous variation lies at the heart of the difference between classical music and jazz. In both traditions, the performer strives to produce an interpretation that is unique and personal. Classical performers typically work out their interpretations in the privacy of the practice studio and then reproduce essentially the same rendition from one public performance to the next (Chaffin et al., 2007; Shaffer, 1984; Shaffer et al., 1985; see Gabrielsson, 1999, for a review). Jazz musicians, in contrast, do not produce the same performance repeatedly. Instead, they rely on their feelings of the moment to spark novel paths through each performance, bolstered, when needed or desired, by their 'bag of tricks' (e.g. favorite chord inversions or chord voicings). At his or her best, a jazz musician functions as a second composer, frequently making so many spontaneous

changes that the original creator might not recognize parts of his or her composition (Ward, 2000).

How do jazz musicians memorize a new piece when each performance will be different? Is the process similar to preparing a new piece in the classical idiom, or is it as different, as the very distinct performance conventions of the jazz and classical idioms suggest? Relatively little attention has been paid to the question. Lehmann and Gruber (2006) suggest that the stages for acquisition of improvisational ability are the same as those demonstrated for composition, and other researchers (e.g. Berliner, 1994; Pressing, 2000; Sloboda, 1994) have investigated the various abilities involved in playing jazz.

The differing performance expectations for the jazz and classical idioms suggest that musicians might use different memorization strategies for the two types of music. Scores for classical music are typically written out fully, containing every note to be played by the right and left hand, and performers are expected to faithfully reproduce every note. As a result, details of technique are typically settled and practiced so that motor memory is automatic. Most jazz selections, in contrast, are learned from *lead sheets*, which provide only the single notes of the melody, with chord symbols sketched in above them. Jazz musicians are expected to improvise, varying key, melody, and rhythm in each performance in spontaneous invention (e.g., Lehmann, 2005). Creative decisions are made in real time (Kenny and Gellrich, 2002), and the resulting melodies and harmonies frequently surprise even the performer (Berliner, 1994).

On the other hand, there are also important similarities between the jazz and classical idioms that might encourage the use of similar memorization strategies. In both idioms, performers must express the musical feelings and ideas represented by the melodic and harmonic structure of a piece. In jazz, this abstract conception of the piece is implemented as a sequence of chord changes using flexible rules enhanced with prelearned, integrated motor sequences that make up each artist's *riffs*, *chops*, or the aforementioned *bag of tricks* (Sudnow, 2001; Ward, 2000). Similarly, performers in the classical idiom have to understand the underlying structure of the piece in order to play the notes that the composer has specified with suitable musical expression.

Studies of musicians in the western art music tradition suggest that the abstract, conceptual representation of the melodic and harmonic structure plays a central role in their memorization. Hallam (1995a, 1995b, 1997, 2001) found that half of the experienced professional musicians that she interviewed used the hierarchical structure of the music to organize their memory for a new piece. The other half may also have used the musical structure for memorization, but this could not be determined from their self-reports; they reported memorizing automatically, without explicitly using any deliberate strategy.

Direct observation of practice also indicates that musical structure plays a central role in memorization for classical music. In a series of longitudinal case studies, Chaffin and his associates have described the learning processes of a classical pianist, singer, cellist and conductor (Chaffin, 2007; Chaffin and Imreh, 1997, 2001; Chaffin et al., 2002, 2003, 2007; Ginsborg et al., 2006; Imreh and Chaffin, 1996/97). They propose that experienced classical performers memorize in much the same way as expert memorists

in other domains. Like other expert memorists, the learning strategies of these musicians can be described in terms of skilled memory theory (Chase and Ericsson, 1982) and its subsequent refinement, long-term working memory (Ericsson and Kintsch, 1995). Experienced musicians make use of three strategies employed by expert memorists in many declarative memory tasks: chunking, organization and practice. Like skilled memorizers in other domains, classical musicians organize the material they must remember into chunks (e.g. grouping notes into familiar patterns such as scales and arpeggios), use the organization provided by the musical structure as a hierarchical retrieval scheme to organize memory for the music and engage in extended practice of retrieval from long-term memory.

An important additional strategy used by the classical musicians studied by Chaffin and colleagues (e.g. Chaffin et al., 2002) was their selection of particular features of the music to serve as retrieval cues to elicit memory for the piece as it unfolds during performance. These *performance cues* serve as landmarks to guide performance. Attention to performance cues provides the classical musician with cognitive control of the highly practiced and automatic movements of the performance. Other studies of classical musicians have also revealed the same use of the formal structure and extensive overlearning (e.g. Williamon and Valentine, 2002). Thus, starting to play at a particular location establishes a link between the representation of the music in working memory and the motor sequences needed to produce the notes. Thinking of the music becomes a retrieval cue, automatically eliciting the highly practiced movements of the performance. Extended practice is needed to make performance cues function rapidly and reliably enough to perform under the pressures and distractions of a live concert. One study documented 10 hours of practice for each minute of performance (Chaffin and Imreh, 2002), and Lehmann and Ericsson (1998) studied an advanced student pianist who devoted 15 hours of practice for each minute of performance.

The encoding and retrieval processes of other types of performing artists have also been shown to involve the same memory principles. Two of the authors of this article have written extensively on the learning strategies of professional actors (for reviews, see Noice and Noice, 2002, 2006) and have found that these strategies also appear consistent with the principles of both skilled memory theory (Chase and Ericsson, 1982) and long-term working memory (Ericsson and Kintsch, 1995). That is, the actor possesses domain-specific information in long-term memory on human motivations and the myriad specific objectives that are used to act upon those motivations. The text input is classified in terms of these objectives. ('In this section, I'm trying to soften him up. Then, in the next section, I go in for the kill.') These objectives then serve as efficient retrieval cues and the entire succession of objectives constitute a retrieval structure for the complete role. Thus, residing in long-term memory are both the exact dialogue and the necessary performance information (i.e. the reasons for uttering the dialogue). As already pointed out, this memory model would have equal application to musicians. The formal structure of the music and the performance cues established during practice would constitute a highly efficient retrieval structure.

However, the particular nature of the actor's strategy results in a script-acquisition process that bears similarities to both classical and jazz music. That is, just as the classical musician renders the score with note-for-note fidelity, the actor must render the

original script with word-for-word fidelity. However, the classical musician generally *plans* the expressive cues in advance, deciding that certain passages will be played with gaiety, surprise or excitement (Chaffin and Imreh, 2002). Of course, some changes occur spontaneously in classical concerts, but they are more of degree than of kind (e.g. varying the dynamic range of various passages), resulting in certain unique ineffable musical feelings being communicated at every performance. This is frequently true for acting, as well; however, on some occasions, actors actually change the underlying meaning of their utterances so that the same words may be defiant in one performance and apologetic the next. In this sense, actors are more akin to jazz musicians. That is, depending on their impulses at the moment of performance, today's scene of confrontation may become tomorrow's scene of conciliation.

For example, two actors (playing husband and wife) might have the following exchange: The male actor says, 'Look, don't argue, just do it.' The female actor replies, 'That's it? Just do it?' The husband's intention (derived from an analysis of the script) is to make an angry demand of his wife. Her intention (also derived from gleaning the playwright's intended meaning) is to challenge her husband's right to make such a demand. However, one night, the male actor might spontaneously use his dialogue more as a confession of desperation than an attack. (Why it comes out that way, the actor probably doesn't even know – but most professionals report that such spontaneous changes do occur on stage from time to time.) Because the female actor is closely attuned to the male actor's utterances, she responds 'in the moment' to this new meaning with a slight smile. Her line of dialogue then becomes wryly conciliatory. It might be thought that the actors' openness to such impulses could distort the play's meaning. However, well-written plays can almost always accommodate spontaneous acting without violating the playwright's intentions. The characters of Blanche and Stanley in *A Streetcar Named Desire* (Williams, 1947) are so well delineated that the play's overall thrust will not be altered by genuine give-and-take at each performance. That is, in her many confrontations with Stanley, Blanche may sometimes seem to win and sometimes to lose, but these small gains and losses will not lessen the overwhelming tragedy of her being led off to the asylum in the last scene. In fact, there is an old theatrical saying: 'The only way to keep a scene the same is to let it change.' Acting that is rooted in real give-and-take insures that the performance retains the original vitality but rarely distorts the play's overall meaning or impact.[1]

Directors vary in their reaction to this aspect of acting. Some embrace it because of the exciting, unpredictable performances it produces, while others prefer the same denotative meaning at every performance, accepting only minor differences in emotional valance from one rendition to the next. Film directors frequently ask actors to engage in completely different dramatic intentions on different takes, so they can choose between them during the editing process. (For a discussion of acting expertise, see Noice and Noice, 1997, 2001, 2002, 2006. For comparisons between acting and jazz, see Noice et al., 2002.)

Thus, it could be said that these arts lie on a continuum, with classical music on one end (most interpretations planned in advance, with only emotional thrust varying), acting in the middle (some interpretations planned in advance but some new *meanings* actually being created at each performance) and jazz at the other end (new melodies and harmonies created at every performance). Of course, this comparison

only looks at a single aspect of these art forms. Their essential complexity is far too great to be captured along one dimension.

In this article, we propose that the same principles of expert memory specified by Ericsson and Kintsch (1995) that we have previously suggested lie behind actors' remarkable retention of complex text and classical musicians' flawless rendering of western art music, also apply to jazz, at least during initial learning of a piece from the printed score.[2] We asked a jazz pianist to memorize an unfamiliar piece from a lead sheet and observed his practice as he did so. We expected to find that this jazz musician, like classical musicians, would use the formal and harmonic structure of the music to guide his practice and memorization, and would prepare performance cues to guide him.

The pianist was asked to practice the music he was given until it was ready for performance. Because the goal of the present study was to understand memorization, we limited our observations to the initial preparation and did not observe finished, improvised performances. The musical structure and performance cues that the pianist practiced during his initial work on the piece would, however, provide the basis for later improvised performances. Depending upon how much or how little true composition[3] occurs during improvisation, decisions about interpretation and technique (e.g. the positioning of the hand to start on the proper finger for executing a scale over an anticipated chord progression) may have to be made in advance and performance cues prepared for their implementation. If they are to guide the musician's playing during performance, the musical structure and performance cues must be committed to memory and their retrieval practiced during the preparation of a new piece for performance. The present study, thus, examined the use of structure and performance cues by a jazz musician learning the note-for-note version of a new piece (prior to improvising), adapting the methods used by Chaffin and colleagues for studying the practice of musicians in the classical genre.

Method

A freelance jazz pianist videotaped his practice as he learned a new piece that he had never seen before. In answer to a request for his background he supplied the following:

> I grew up in a home with a father who is a jazz musician (vibes/piano), so I was surrounded with jazz. He did not push me into playing, but in the summer between third/fourth grade, after I showed interest by teaching myself to read treble clef and play basic chords and blues progressions, he connected me with a great pianist in Chicago. I mainly played classical pieces, but my teacher sketched (sometimes in less than a minute or two) simple stride piano arrangements of standard tunes. So, I was introduced into jazz and some underlying theory in addition to developing technique needed in both classical and jazz piano. Later, I took up bass; in fact worked my way through college mainly as a bassist because of the demand, but I never stopped playing jazz piano, which accounts for most of my gigs these days. I've been playing professionally for well over 20 years.

The experimental instructions emphasized that the pianist should learn the selection as if preparing for a solo performance. The pianist learned the piece in two videotaped practice sessions, 10 days apart (one 15 minutes, and one 30 minutes), during which he simultaneously verbalized his thoughts. The piece was *Funk in Deep Freeze* by

Hank Mobley, an infrequently played selection of the bebop repertoire. The score was notated in two eightbar sections with repeats in AABA form, including variations such as second endings, common in lead sheet musical notation.

After learning the piece, the pianist provided reports about musical structure and about decisions about technique, interpretation and performance by marking the features of each dimension reported on a copy of the score. The pianist reported the location of section, subsection and phrase boundaries, technical difficulties, and the basic and expressive performance cues he relied upon to direct his playing of the piece. These musical features and performance cues were coded with dummy variables representing the start and end of each subsection, the start of each phrase, and location of each basic and expressive performance cue. The pianist also rated the technical difficulty of each bar on a 10-point scale.

The pianist's comments during practice were transcribed and classified by topic into nine categories (see Table 1). The classification was done independently by two judges with 85 percent agreement and differences were reconciled by discussion. Practice was transcribed by recording the locations in the piece where the pianist started and stopped, and by counting the number of starts, stops and repetitions for each bar. These starts, stops and repetitions served as dependent measures in multiple regression analyses in which the predictor variables were the musical features, performance cues and ratings reported by the pianist. Preliminary analyses included all predictors, but only those predictors that had significant effects were included in the analyses of practice reported below.

Results and discussion

The pianist's practice (shown in Figure 1) was similar to that of classical musicians in following a run–work–run pattern in which episodes of work (repetition of short segments) alternated with longer runs that tied the shorter segments together (Chaffin et al., 2002; Miklaszewski, 1989).

Session 1 began with an uninterrupted run through A1 and A2 (bars 1–16). The pianist then worked on these sections until the end of the session, which concluded with a final run that continued through B, previewing the work that remained to be done. Session 2 began in similar fashion with a run through A1 followed by work on A1 and A2 concluding with a run through A1 and A2. Next, the pianist worked on B, concluding with a run that tied A1, A2, B, and A1' together for the first time, providing the first (albeit interrupted) performance of his preferred form for the piece. The second half of session 2 was devoted to additional practice performances, interspersed with work on the A and B sections, and concluded with another (interrupted) run through the whole AABA form. At the end of session 2, the piece was almost ready for performance. The pianist said: 'So, I'm feeling it's pretty much there. It's just a couple of things . . . [I need] about another five minutes.'

PIANIST'S COMMENTS

The participant's comments during practice indicated that he was concerned in approximately equal measure with issues of performance structure, technique and metacognition. Across the two sessions, each of these four main topics accounted for

TABLE 1 *The percentage of comments on structure, technique, and performance in sessions 1 and 2*

| Topic	Example	Percent comments			
		Session 1	Session 2	Session 1	Session 2
Structure					
Harmonic	What I usually do is analyze the chord progressions	14	11	26	12
Formal	Two A sections, then it goes into this B section	5	3	9	3
Technique					
Rhythm	The toughest part is the rhythm	13	20	25	22
Fingering	I have to figure out the fingering on this one line	0	1	0	1
Performance					
Memory	I'm just trying to memorize this first line	10	8	19	9
Improvisation	If I were to improvise on this I would . . .	1	5	2	6
Expression	Okay, like a deep freeze	2	1	4	1
Metacognitive					
Evaluation	So, I'm feeling like it's pretty much there	1	29	2	33
Plan	I just have to really work on a melodic line here	7	11	13	12
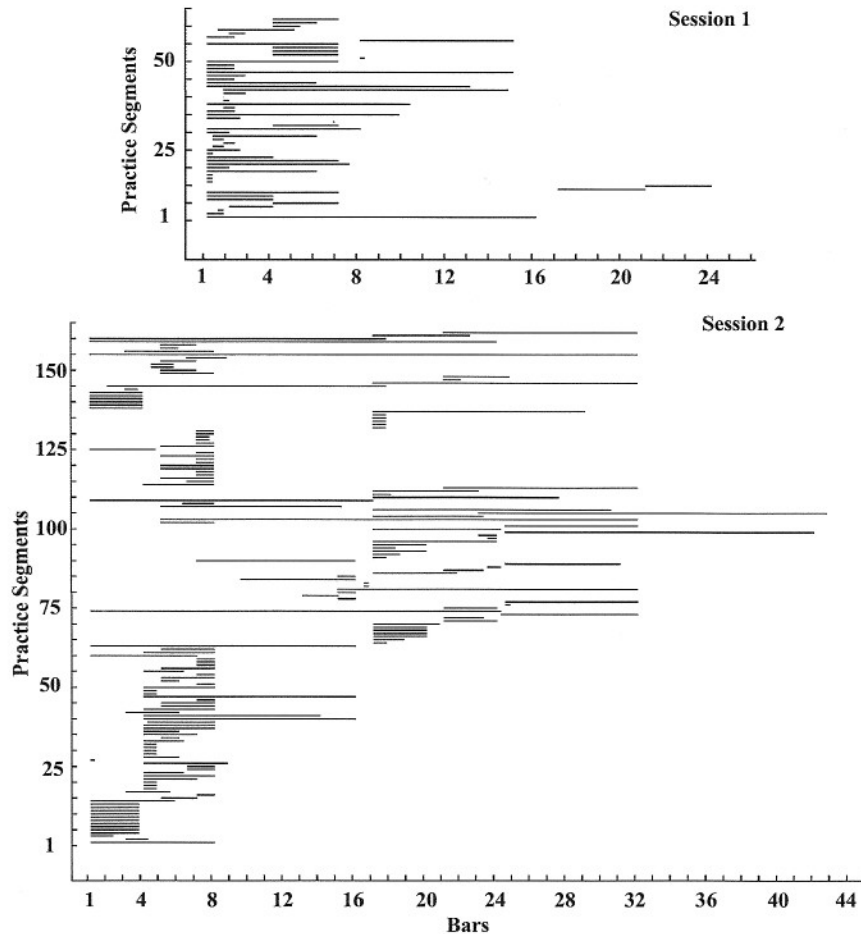
FIGURE 1 *Practice graphs generated during sessions 1 and 2.*

20–30 percent of the comments (Table 1). Memorization was the main performance issue, especially in session 1. Memorization was also behind the focus on musical structure, which was also more pronounced in session 1. The link between structure and memorization is apparent in the following series of comments at the beginning of session 1.

> Okay . . . Like a deep freeze . . . so it's an F minor blues type thing . . . It's basically a . . . typical eight-bar . . . two A sections and then it goes into a B section . . . [then] back to the beginning . . . Typically with a . . . minor blues [progression] you're always lead-ing into the dominant, so that's easy to remember . . . So, now I'm going to start mem-orizing without even looking at the second part of the chart.

In these comments, the pianist appears to be identifying the harmonic and formal structure, noting the link between structure and memorization, and deciding that his understanding of the structure is sufficient to begin memorizing.

The main difference between the two sessions was the increase in evaluative comments in session 2 as the pianist continuously assessed the accuracy of his playing:

> It's almost there. It's just not exact . . . So what I'm trying to do is just iron out the little biases that I have, how I want to play it, versus how it's actually written . . . That's not what the composer wanted.

Memory and rhythm were the main issues. Rhythm presented technical challenges in the piece.

As the pianist noted in session 2: 'This is really tricky . . . because this is not a typical rhythm.'

Two sections of the piece in particular (bars 4–8 and 22–24) involved notes tied across the bar line and characteristic bebop rhythms that posed technical problems.

PRACTICE

Practice was organized by the formal structure. We have already described the large-scale organization of the practice shown in Figure 1: The pianist worked first on the A sections and then on the B, and then on integrating them. The summary of the regression analyses in Table 2 shows that practice was also organized by the formal structure at a more micro-level. The pianist used the beginnings of subsections as starting points in both sessions, starting on these bars 12.5 times more often than other bars in session 1. The effect is evident in Figure 1, which shows that the pianist preferred to start in some places more than others. For example, at the beginning of session 1, after playing through the first 16 bars, the pianist began first at bar 1, then at bar 3, then at bar 5. These are the beginnings of the first, second, and third subsections respectively. The pianist reported that he divided A into two-bar subsections and B into four-bar subsections based on harmonic progressions. For example, he described bars 5–6 (the third subsection of A) as 'a typical cyclical pattern of cycle-of-fourths with an inner chromatic pattern of tritones "buried" in the chords of the cycle'. The pianist's use of harmonic structure to determine starting places throughout his practice suggests that he continually had this structure in mind.

In session 1, the pianist also used the beginning phrases as starting points. Phrasing was determined mainly by the location of rests, which provided a 'breath', further subdividing the subsections. The absence of this effect in session 2 suggests that by this time the pianist had integrated phrases into the larger unit of the subsection and no longer found it necessary to make so fine a subdivision of the piece. The change reflects the increasing integration of smaller into longer practice segments already noted in the description of Figure 1.

The pianist started more at expressive performance cues in session 1 and started and stopped more at basic performance cues in session 2 (see Table 2). The change can be illustrated by comparing starts at bars 4 and 5, where the pianist reported respectively a basic and an expressive performance cue, the latter annotated 'crescendo'. In session 1, the pianist started eight times at the expressive cue in bar 5 and never at the basic cue in bar 4. In session 2, in contrast, he used bar 4 as a starting point 27 times in addition to continuing to start at bar 5. The difference between the two sessions suggests that the pianist began by establishing the expressive performance

TABLE 2 *Regression coefficients for multiple regression analyses of effects of musical structure and performance cues on starts, stops, and repetitions in sessions 1 and 2*

Predictor	Starts		Stops		Repetitions	
Session	1	2	1	2	1	2
Start of subsection	12.546*	5.163*	3.498	−1.010	18.143~	3.896
End of subsection	14.049~	0.113	4.224	3.136	20.545	2.300
Start of phrase	8.859**	2.953	0.903	0.837	5.991	3.888
Basic performance cues	3.779	6.070*	−1.141	5.877*	−0.323	5.436
Expressive performance cues	9.669*	2.956	0.423			1.604
R squared	0.523	.264	.088	.205	.054	.054

~ $.05 < p < .10$, * $p < .05$, ** $p < .01$

cues that determined the overall musical shape of the piece in session 1 and then added the basic performance cues needed to remember exactly what to play in session 2. Although practice in session 2 continued to be shaped by expressive cues, their effects were obscured by practice of basic cues that were a more urgent concern. Therefore, the effect of expressive cues was no longer significant.

There were no effects for technical difficulties whether coded with a dummy variable or represented by the pianist's ratings. These predictors were, therefore, not included in the analysis reported. Their absence is surprising, given that the technical difficulties all involved rhythm and that a substantial numbers of comments were made about rhythmic difficulties in both sessions. Although the pianist was clearly working on these difficulties, their effect was not reflected in the regression analysis for two reasons. First, they were few in number. Second, the pianist reported basic performance cues at the start of the rhythmically difficult passages and worked on these, therefore contributing to the effect of basic performance cues in session 2.

Conclusion

The musician in the present study showed the same kind of attention to musical structure and performance cues observed in earlier studies of experienced musicians in the western classical tradition learning new works for performance (e.g. Chaffin and Imreh, 2002; Ginsborg et al., 2006; Williamon and Valentine, 2002). Thus, the principles of expert memory (Ericsson and Kintsch, 1995) appear to be applicable to jazz as well as to musical performance in the classical idiom. Although the 45 minutes of the practice in the present study was much less than in the studies of classical performers, the piece was correspondingly shorter and technically simpler. The amount of practice and degree of preparation in the present study was roughly comparable to that described by Chaffin (2007), who observed a concert pianist learning the 1607 notes of *Clair de Lune* for performance in four-and-three-quarter hours.

As in earlier studies of the practice of experienced musicians (e.g. Chaffin and Imreh, 2002; Miklaszewski, 1989, 1995), the jazz pianist used the hierarchical structure of the piece to organize his practice, working on the piece in sections and using the beginnings of subsections and phrases as starting points. Sections, subsections and phrases represented three levels in the hierarchical organization of the piece, with phrases nesting within subsections nesting within sections. Interestingly, the pianist later pointed out that he chose starting locations for practicing mainly because they provided convenient points to get into rhythmically tricky phrases. This comment illustrates how musical structure provides a context for the more deliberate problem-solving efforts that are the conscious focus of a musician's efforts during practice. Although the pianist was not explicitly thinking about structure, his choice of starting points shows that it, nevertheless, provided a framework for his work. In the same way, the structure of a journal article provides a framework for a reader struggling to understand a particular argument. The reader does not normally think explicitly about the position of the argument in the formal structure of the article, but the implicit knowledge that the argument is part of the conclusion is important to understanding it.

In other studies of musicians, the formal structure has been shown to affect free recall and hesitations in practice performances from memory in ways that provide additional

support for this conclusion (Chaffin, 2007; Chaffin and Imreh, 2002; Williamon and Valentine, 2002). We suggest that the effects of the formal structure on practice in the current study indicate that the formal structure served the jazz pianist as a retrieval structure in the same way. Although it is beyond the scope of the present inquiry, we speculate that possession of a mental map of this sort may be essential for many aspects of jazz improvisation (e.g. Pressing, 2000; Sudnow, 2001; but see also Berliner, 1994). That is, the musical structure might provide a mental map that could be activated during performance, allowing the pianist to keep track of where he is in the piece and, perhaps, to decide where to go next.

The pianist reported that he used performance cues, paying attention to particular features of the music during performance in order to remind himself of what came next. He reported the location of the features that he used for this purpose, and the practice data were consistent with his report. The data indicate that expressive cues served as starting points for playing in session 1 and basic performance cues as starting and stopping points in session 2. Starting at these points would have established them as retrieval cues by linking the conceptual representation of the music in working memory with the motions needed to perform it and the sounds those actions would produce.

The order in which expressive and basic cues were practiced is surprising at first sight. One might expect basic issues of technique to be settled before nuances of expression come to the fore. It is, however, a characteristic of experts' problem solving that they begin with 'the big picture' while novices jump into the details without a clear idea of where they are going (Glaser and Chi, 1988). The expert approach to learning a new piece of music is strongly recommended by the noted piano pedagogue and pianist, Heinrich Neuhaus (1973) who urges the benefits of beginning work on a new piece with a 'musical image' for how it should sound in mind. Expressive performance cues represent the main musical turning points of the piece and their effects in session 1 suggest that the pianist in this study was following Neuhaus's dictum. Similar effects have been observed in other longitudinal case studies of classical performers learning new pieces (e.g. Chaffin et al., 2003).

The pianist explicitly acknowledged leaving technical details until later in his comments in session 1:

> Typically what I do is make up my own line for complicated syncopated lines . . . Mainly I am concerned first with 'Do I understand the harmonies?' . . . So I'm purposely just sort of ignoring the incorrect playing of the melodic line.

However, it was not until the end of session 2 that he explicitly referred to his musical image for the piece, using color as a metaphor: 'I think of most of this as purple with some lighter blue sections.' In a post experiment interview, he expanded on this by saying that he thinks of purple as the kind of music one might hear in a horror film.

The effect of basic performance cues on practice in session 2 but not in session 1 is another indication that the pianist became more concerned with details in the second session. The shift in focus was shown by session 2 comments reflecting his concern to eliminate inaccuracies introduced earlier:

> I'm hearing another song, that's why I want to jump to . . . Let me try that again . . . That's right. And so now I'm feeling a lot more comfortable with this line, and it is just little tiny pieces I have to iron out now. Let me just take that slow to make sure I'm doing that right. Yeah, I was playing that rhythm wrong . . . That's not what the composer wanted.

Basic performance cues reminded the pianist of the critical notes and rhythms needed to play the piece as written.

In session 2, the pianist was also beginning to play through the entire piece in practice performances and needed to remember what came next as he moved from one passage to the next. Basic retrieval cues elicited the necessary information from memory. For example, he described one of the basic performance cues in the following way: 'Playing the F in first subsection, B1 of section B, cues the phrase for the last half of the B-section, B2.' Attention to basic performance cues in session 2 thus reflected the pianist's concerns with both accuracy and playing from memory, reminding the pianist of the critical notes and rhythms needed to play the piece as written.

It might be thought that memorization was simplified because many jazz standards contain common progressions. According to the pianist, this was not the case with *Funk*. He said:

> It does not fit, in a full sense, any common (e.g. blues or *I Got Rhythm*) progression. The first four bars (the first subsection of the A section is repeated which also makes it bars 9–12) follow generally the minor blues progression. However, the second subsection of A diverges from this minor blues pattern and goes through a different common pattern (cycle of fourths) which is the land-back at a *turnaround* used in a minor blues. However, note that the A section is eight bars and minor blues (and blues in general) is 12 bars. Moreover, the rhythmic pattern of when the next chord is played (and the length of time one stays *on* that chord) is not common. The 'B' section has two subsections each, which is a typical II–V–I pattern, but each is in a different *temporary* key from the original F minor (first, B flat major; second, D flat major). I had to memorize what these temporary keys were. They are related to F minor/A flat major in an indirect way, but I still had to 'hear it in my mind' and memorize what these keys were before I could apply the 'common' chord progression pattern of II–V–I. Again, rhythm had to be memorized also.

In sum, the pianist noted that memorization was not materially aided by commonalities with standard tunes.

It is possible that if practice had continued, the pianist's attention would have returned to the musical image and to expressive performance cues as happened with classical musicians whose practice was followed to the point that they were ready to perform in public (Chaffin et al., 2002). In the present study, however, practice did not extend past initial memorization because available studio time was such that the pianist did not quite reach the level where he was ready for the first performance.

It appears that the psychological processes responsible for jazz and classical memorization may be very similar. That is, from a cognitive perspective, the differences between performance practice in the two genres may be relatively superficial. In both, virtuosity, creativity, and musical expressivity are highly valued. The main difference is that in jazz, the ability to improvise in fresh and interesting ways is of prime importance, while in the classical tradition, a much narrower range of variation across performances is allowed. Even in the classical tradition, however, differences between performances are the norm and most performers appear to share the view of Emil Gilels, the noted Russian pianist, that such variation reflects well on the artist:

> When I am in top form . . . the ideas are always different. Sometimes I play with greater changes in dynamics, sometimes with less . . . I must say it is different each time I play, and it is a process which . . . includes mastery of the work, knowing the details, being comfortable with it, and then adding the fantasy. (Mach, 1991: 123)

However, these changes from performance to performance are very minor compared to those made during jazz playing. The difference between idioms is captured by this quote from jazz legend Keith Jarrett (who has also made many acclaimed classical recordings). He said of his solo jazz performances:

> When I go on stage, if I have an idea in my head, it's going to be in my way. Those notes and feelings come to the player, come to the improviser, if he lets them. But if there's an idea in the way, those notes and those feelings will be restricted to whatever that idea started to be.

In the same interview, he described the process of improvisation as: 'It's like you're under shock all the time – an electrical current is flowing through you' (Lehrer, 2005).

Despite the performance differences, it appears that the mental processes responsible for memorization are very similar in the jazz and classical traditions. This is not surprising given that similar principles account for expert memory in domains that are much more different than jazz and classical music performance, such as chess, acting, dance and waitering (Ericsson and Kintsch, 1995; Noice and Noice, 1997, 1999, 2006). With respect to memory for note-for-note rendition, differences between preparation for performance in the jazz and classical tradition appear relatively minor. Both require the performer to have a conceptual representation of the piece with a highly practiced retrieval scheme based on the musical structure. Both require use of basic performance cues to ensure that critical notes are played as planned. Therefore, the *starting point* for the jazz performer studied here and the classical performers studied previously appears to be very similar.[4]

The pianist in this study practiced until he was nearly ready to perform. Because our goal was to understand memorization, we did not try to observe finished, improvised performances. The practice that we observed did, however, provide the basis that could be used for later improvised performances. The structural and performance cues whose preparation we have described proved to be an effective memory retrieval organization and provided the framework needed for improvisation. The spontaneity of jazz performance requires suitable preparation. Depending upon how much or how little true composition occurs during improvisation, decisions about technique (e.g. playing over-the-bar phrases), and interpretation have to be made in advance and performance cues prepared for their implementation. If they are to guide the musician's playing during performance, the musical structure and performance cues must be committed to memory and their retrieval practiced during the preparation of a new piece.

NOTES

1. This discussion concerns only theatre in its most formal sense: a production in which the actors perform a playwright's script from memory. In improvised theatre, the actors *are* the playwrights, creating dialogue on the spot, constrained only by audience suggestions or certain stated 'rules of the game'.
2. New music may also be learned from listening to recordings or live performances, but this experiment looked at acquisition from a printed lead-sheet.
3. This musician uses the phrase, *true composition*, to refer to occasions where he surprises himself by playing something he does not recognize as anything he had ever played or heard before – something of which he says, 'I have no idea where that came from.'

4. This separation into jazz and classical musicians is for clarity and is intended to indicate the *primary* field of an artist. Of course, many players are adept at both types and go back and forth between fields.

REFERENCES

Berliner, P.F. (1994) *Thinking in Jazz: The Infinite Art of Improvisation*. Chicago: University of Chicago Press.

Chaffin, R. (2007) 'Learning *Clair de Lune*: Retrieval Practice and Expert Memorization', *Music Perception* 24: 377–93.

Chaffin, R. and Imreh, G. (1997) '"Pulling teeth and torture": Musical Memory and Problem Solving', *Thinking & Reasoning: Special Issue on Expert Thinking* 3: 315–36.

Chaffin, R. and Imreh, G. (2001) 'A Comparison of Practice and Self-report as Sources of Information about the Goals of Expert Practice', *Psychology of Music* 29: 39–69.

Chaffin, R. and Imreh, G. (2002) 'Practicing Perfection: Piano Performance as Expert Memory', *Psychological Science* 13: 342–9.

Chaffin, R., Imreh, G., and Crawford, M. (2002) *Practicing Perfection: Memory and Piano Performance*. Mahwah, NJ: Erlbaum Associates.

Chaffin, R., Lemieux, A. and Chen, C. (2007) '"It is Different Each Time I Play": Variability in Highly Prepared Musical Performance', *Music Perception* 24: 455–72.

Chaffin, R., Imreh, G., Lemieux, A. and Chen, C. (2003) '"Seeing the Big Picture": Piano Practice as Expert Problem Solving', *Music Perception* 20: 461–85.

Chase, W.G. and Ericsson, K.A. (1982) 'Skilled and Working Memory', in G.H. Bower (ed.) *The Psychology of Learning and Motivation*, pp. 1–58. New York: Academic Press.

Ericsson, K.A. and Kintsch, W. (1995) 'Long-term Working Memory', *Psychological Review* 102: 211–45.

Gabrielsson, A. (1999) 'The Performance of Music', in D. Deutsch (ed.) *The Psychology of Music* (2nd edition), pp. 579–602. San Diego, CA: Academic Press.

Ginsborg, J., Chaffin, R. and Nicholson, G. (2006) 'Shared Performance Cues in Singing and Conducting: A Content Analysis of Talk during Practice', *Psychology of Music* 34(3): 167–94.

Glaser, R. and Chi, M. (1988) 'Overview', in M. Chi, R. Glaser, and M. Farr (eds) *The Nature of Expertise*, pp. xv–xxviii. Hillsdale, NJ: Erlbaum.

Hallam, S. (1995a) 'Professional Musicians' Approaches to the Learning and Interpretation of Music', *Psychology of Music* 23: 111–28.

Hallam, S. (1995b) 'Professional Musicians' Orientations to Practice: Implications for Teaching', *British Journal of Music Education* 12(1): 3–19.

Hallam, S. (1997) 'The Development of Memorization Strategies in Musicians: Implications for Education', *British Journal of Music Education* 14(1): 87–97.

Hallam, S. (2001) 'The Development of Metacognition in Musicians: Implications for Education', *British Journal of Music Education* 18(1): 27–39.

Imreh, G. and Chaffin, R. (1996/97) 'Understanding and Developing Musical Memory: The View of a Concert Pianist', *American Music Teacher* 46(3): 20–4.

Kenny, B.J. and Gellrich, M. (2002) 'Improvisation', in R. Parncutt and G.E. McPherson (eds) *The Science and Psychology of Music Performance*, pp. 117–34. New York: Oxford University Press.

Lehmann, A.C. (2005) 'Komposition und Improvisation: Generative musikalische Performanz', in T.H. Stoffer and R. Oerter (eds) *Allgemeine Musikpsychologie*, pp. 913–54. Göttingen: Hogrefe.

Lehmann, A.C. and Ericsson, K.A. (1998) 'Preparation of a Public Piano Performance: The Relation between Practice and Performance', *Musicae Scientiae* 2(1): 67–94.

Lehmann, A.C. and Gruber. H. (2006) 'Music', in. K.A. Ericsson, N. Charness, P. Feltovich, and R. Hoffman (eds) *Handbook on Expertise and Expert Performance*, pp. 457–70. Cambridge: Cambridge University Press.

Lehrer, J. (2005) Interview with Keith Jarrett, *The Newshour with Jim Lehrer Broadcasts*, 19 July. New York and Washington, DC: Public Broadcasting Service.

Mach, E. (1991) *Great Contemporary Pianists Speak for Themselves*. Mineola, NY: Dover Books.

Miklaszewski, K. (1989) 'A Case Study of a Pianist Preparing a Musical Performance', *Psychology of Music* 17: 95–109.

Miklaszewski, K. (1995) 'Individual Differences in Preparing a Musical Composition for Public Performance', in M. Manturzewska, K. Miklaszewski, and A. Bialkowski (eds) *Psychology of Music Today: Proceedings of the International Seminar of Researchers and Lecturers in the Psychology of Music*, pp. 138–47. Radziejowice, Poland.

Neuhaus, H. (1973) *The Art of Piano Playing*. New York: Praeger Publishers.

Noice, T. and Noice, H. (1997) *Expertise of Professional Actors: A Cognitive View*. Hillsdale, NJ: Lawrence Erlbaum Associates.

Noice, H. and Noice T. (1999) 'Long-term Retention of Theatrical Roles', *Memory* 7(3): 357–82.

Noice, H. and Noice, T. (2001) 'Learning Dialogue With and Without Movement', *Memory and Cognition* 29(6): 820–8.

Noice, T. and Noice, H. (2002) 'A Review of Recent Research on the Expertise of Professional Actors', *High Ability Studies* 13(1): 7–19.

Noice, H. and Noice, T. (2006) 'Artistic Performance: Acting, Ballet, and Contemporary Dance', in A. Ericsson, N. Charness, P. Feltovich and R. Hoffman (eds) *Handbook on Expertise and Expert Performance* pp. 489–504. New York: NY: Cambridge University Press.

Noice, H., Noice, T. and Jeffrey, J. (2002) 'Mental Representation of a Jazz Musician', poster presented at the 43rd Annual Meeting of the Psychonomic Society, November, Kansas City, MO, USA.

Pressing, J. (2000) 'Improvisation: Methods and Models', in J.A. Sloboda (ed.) *Generative Processes in Music: The Psychology of Performance, Improvisation, and Composition*, pp. 129–78. New York: Oxford University Press.

Shaffer, L.H. (1984) 'Timing in Solo and Duet Piano Performances', *Quarterly Journal of Experimental Psychology* 36A: 577–95.

Shaffer, L.H., Clarke, E.F. and Todd, N.P. (1985) 'Meter and Rhythm in Piano Playing', *Cognition* 20: 61–77.

Sloboda, J.A. (1994) 'Music Performance: Expression and the Development of Excellence, in R. Aiello and J.A. Sloboda (eds) *Musical Perceptions*, pp. 152–169. London: Oxford University Press.

Sudnow, D. (2001) *Ways of the Hand: A Rewritten Account*. Cambridge MA: MIT Press.

Ward, G. (2000) *A History of America's Music*. New York: Alfred Knopf.

Williamon, A. and Valentine, E. (2002) 'The Role of Retrieval Structures in Memorizing Music', *Cognitive Psychology* 44: 1–32.

Williams, T. (1947) *A Streetcar Named Desire*. New York: New Directions.

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