MEMORISATION OF ATONAL MUSIC

A thesis submitted to Guildhall School of Music & Drama for the degree of D.Mus. in the Department of Research

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DECLARATION

No portion of the work referred to in the thesis has been submitted in support of an application for another degree or qualification of this or any other university or institute of learning.

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ABSTRACT

Research on musical memory has focussed on the organisation of practice to develop and implement retrieval cues: locations in the music that trigger memory. Cues are distilled during extended practice. Those features of the music that still require attention in performance remain as Performance Cues (PCs). Scholarship demonstrates that theories of expert memory in other fields are also applicable to musical performance. The formal structure of the music provides a ready-made framework that can be used as a hierarchical retrieval scheme. This structure allows for content-addressable memory to meet the demands of performance. Landmarks remain in a musician's long-term memory, relating to structural boundaries and PCs established in practice. Existing research has largely focussed on tonal music, with musical structures that are apparent to the musician. This thesis adopts established methodologies from this body of literature to extend insights on musical memorisation in complex atonal piano repertoire.

Using a range of atonal music, the thesis initially questions how more complex structures affect the development of a retrieval scheme. The argument demonstrates that a musician uses a wide range of intuitive responses to the features of the score to establish a conceptual framework. It is helpful for performers to think in structural terms. Yet in reality a wider range of musical dimensions informs the practitioner. Secondly, the thesis questions how atonal music is memorised by performers. It argues that a wider range of kinaesthetic and conceptual techniques is needed for memorisation of atonal music in comparison to tonal equivalents. Finally, the thesis extends the discussion of replicated use of PCs across performances. Analysis focusses on the acoustic realisation of performance through the use of spectrograms. Examination of the changes in expressive execution of various PCs and musical features provides further insight into the role of memory in the creative act of performance.

The thesis seeks to extend analysis into the complexities of musical memorisation. Examination of intricate, unusual structures provides a great deal of insight in assessing how musicians adapt their wealth of domain-specific knowledge to tackle the challenges presented. As specific memorisation strategies for musicians remain an under-researched area – particularly for atonal music – the detailed examination of techniques is valuable in developing wider methods that can be applied across all types of repertoire. It is surprising that the teaching of memory technique remains largely absent in higher education institutions. As such, this analysis has broad implications for the educational environment, to develop more formal and integrated didactic procedures. Finally, examination of the varied acoustic realisation of retrieval cues provides original insights into the way in which memorisation can function in a spontaneous, creative manner: a fundamental aim of performance.

Word Count: 54,693 / 55,000

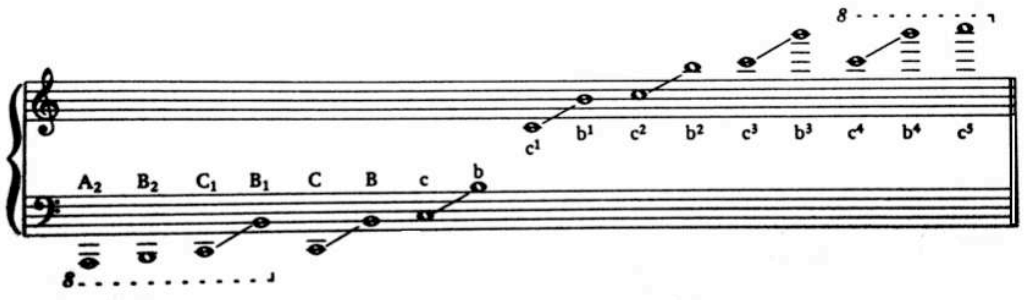
ABBREVIATIONS AND TERMINOLOGY

Associative chain	Memorisation that occurs during learning, where one musical phrase serially cues the next.
Chromaesthesia	Colour associations elicited by sound (see Synaesthesia).
Content-addressable memory	Memory cues that can be retrieved by thinking of the location of the relevant section of a composition.
Chunking	Bypassing the cognitive limits of short-term memory by organising data in larger groups. E.g. reading allows for processing of extensive data (letters) as they are grouped into larger schemas (words).
Cue/cueing	The process of assigning a mnemonic, pattern, schema or signal to a musical feature to enable retrieval.
dB	Decibel (intensity in volume).
Dodecaphony	Compositions employing twelve-tone techniques.
Hz	Hertz (frequency).
Lacunae	Locations in a score with lower mean probability of recall in long-term memory.
Landmarks	Locations in a score with higher mean probability of recall in long-term memory.
LTM	Long-term memory.
LTWM	Long-term working memory theory (Ericsson & Kintsch, 1995).
MMs	Musical mnemonics (Li, 2007; 2010).
PC/PCs	Performance cues.
Powercurve plug-in	An addition to the Sonic Visualiser software, producing a graphic representation of dynamic change, superimposed on a spectrogram.
PRS	Perceptual representation (a memory system in long-term memory).

Rechunking	The transformation of a musical retrieval cue during the learning process (e.g. a retrieval cue may refer to a technical issues at the beginning of the learning period, but extended practice may eliminate the need for this cue. It may be rechunked to address a different musical feature, or eliminated).
RQ	Research question.
Sensorimotor	Involving both sensory and motor functions / pathways.
Serial	Forming part of a series (N.B. not relating to twelve-tone compositional technique).
Spectrogram	A visual representation of spectrum of frequencies in sound. X-axis represents time; Y-axis represents frequency (Hertz). A further series is denoted by the intensity of colours in the plate, representing amplitude (volume). This ranges from dark green (softest sounds) to bright red (loudest sounds).
STM	Short-term memory.
Switches	Similar musical material that diverges upon repetition.
Synaesthesia	Cross-modal sensory interference, where sensory reactions in one domain automatically trigger perceptual responses in another.
VR	Video-recording.
VS	Video-session.

REGISTER

Generic pitch names are indicated in capitals (e.g. A♮). To indicate pitches in a specific register, a variation of the Helmholtz pitch notation is used:



CHAPTER 1

Introduction

Developing a mental representation of a piece of music is a fundamental part of practice, which involves a wide range of features at the instrument: kinaesthetic responses, aural understanding, visualisation of the score, as well as developing conceptual frameworks and structures. The end result, an artist's performance of the work from memory, is an impressive accomplishment. For a performer, the sensation of playing a challenging work from memory – and executing it exactly as desired on stage – is an exhilarating and cathartic experience.

In the Western Music tradition it is commonplace for artists to memorise for performance. Indeed, musical memorisation symbolises an artist's professionalism, expertise and dedication. It is often a prerequisite that music be memorised for performance, as exhibited by the regulations of numerous competitions and examinations for young professionals. This is customary, particularly for pianists. With numerous recordings available in a variety of easily accessible mediums, a larger audience is acquainted with the classical repertoire. Consequently, there is an increased focus in musical practice on textual fidelity, in both the memorisation stage and the final performance.

In piano pedagogy, memorisation, one of the most fundamental skills for performance, is a subject that is infrequently discussed or taught. Instead, there is a general understanding that every pianist memorises in a different way, usually by some combination of repetition at the instrument and analytical study of the score. In my own experience, the issue of memorisation has only been briefly discussed in a pedagogical environment. This usually concerns repertoire that is famous for testing the memorisation skills of a performer, often as a consequence of long repeated patterns with only minor variation. An example of this occurs in the last movement of the Schumann *Piano Concerto*, Op. 54, a standard work in the repertoire.

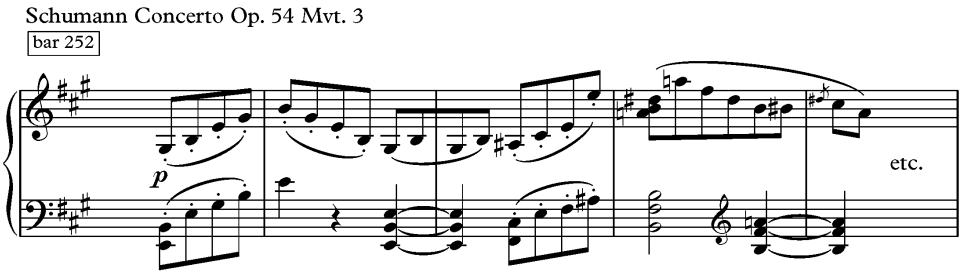


Fig. 1.1 *Motivic repetitions, Schumann Piano Concerto Op. 54.*

The motif in Fig. 1.1 is repeated across 75 bars, lasting approximately one minute. In this passage the motif is continuous, traversing a wide range of keys and registers. Susan Tomes has written about the challenges this work poses for memory in performance (2007). An added complication is that the passage is repeated in its entirety in a different key during the recapitulation. A standard memorisation aid for these passages is to create a mental map of each section, relating to the tonalities, and then compare the harmonic differences and changes in direction between the two passages. This is an example of a basic conceptual framework that is required should the automatic motor memory give way in performance.

Since Liszt transformed the perception and custom of a piano recital to focus on the performer as an artist, there has been an unwritten rule that pianists are expected to perform from memory as soloists.[1] Not to do so often becomes a talking point for musicians and audience alike. The exception for solo pianists is usually complex twentieth-century repertoire: for this genre it is generally considered acceptable to perform from the score. By contrast, accompanying pianists and chamber pianists perform from memory less frequently. There is an obvious practical consideration as the pianist plays from a full score and can therefore adjust for any ensemble problems that may arise during the performance. For other instrumentalists, it is common for solo performances to be performed from memory, but perhaps less expected than for a pianist. Such conventions are well established in young musicians in training: examined

[1] See: Walker (1983, pp. 285-318). He summarises Liszt's development of the performing pianist's career: "The modern piano recital was invented by Liszt. He was the first to play entire programmes from memory. He was the first to play the whole keyboard repertory (as it existed then), from Bach to Chopin" (p. 285). Clara Schumann and Paganini also contributed to the definition of what we now consider a solo recital.

recitals, competitions and major events at conservatoires all require performances from memory.

There are several highly prominent musicians who have chosen to play with the score, most notably Sviatoslav Richter later in his career.[2] Pianist Stephen Hough (2011) has written eloquently on the subject explaining "the fear of forgetting", and how this often leads pianists to situations where use of the score is acceptable, or even to different musical paths such as conducting or teaching (para. 5). Another outcome of this anxiety is a musician repeating the same concert programme over a lengthy period. This promotes greater security for the memory, but in turn provides numerous other challenges, particularly of keeping performances fresh and interesting.

Those who argue in favour of using a score often state that it alleviates this fear of forgetting, and allows for a greater and wider range of repertoire. Thus, using the score has the possibility of liberating the performer in a psychological sense. Hough (2011) also comments on the shared responsibility of memorisation when performing works of a living composer:

> A composer told [of] his mortification when he was a student and a piece he had written was being performed at an important concert. The pianist had learned the complex piece and was determined to prove he knew it 'by heart'. But in the concert he had a serious memory lapse and … the whole performance was a total mess (para. 5).

This is a valid consideration when presenting a contemporary work, especially if the composer is present. Yet, it is likely that during a difficult passage a pianist will have to look at the keyboard to guide the fingers, suggesting that some memorisation is also necessary when using a score, even if this occurs on a short-term or localised basis.

By contrast, the arguments in favour of memorisation include the fact it is physically liberating. The additional preparation taken to commit to memory ensures that there is greater comfort.[3] Thus, a performer is less likely to present a work that is not fully prepared. This liberation allows the musician to focus completely on the sounds being produced, without worrying about the need to

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[2] See: Rasmussen (2010).

[3] See: Hughes (1915), who asserts playing from the score reduces the "absolute freedom of expression and the most direct psychological connection with the audience" (p. 595).

look at the score. In addition, memorisation eliminates some practical concerns of using a score (finding a page-turner, lighting concerns, or the blocking of the instrument's sound by the music desk).

General Memory Theory

Memory is the process by which information is encoded, stored and retrieved by the brain. There are three types of memory: sensory, short-term and long-term. Sensory memory refers to the immediate visual or auditory storage when presented with stimuli for only a few seconds. Sperling (1960; 1963) found that the capacity of sensory memory was around twelve items in an experiment where subjects were briefly presented with a grid of twelve letters, and then asked to recall a certain row (1960, p. 20). Despite this level of data storage, the study also revealed that memory storage was "transient" and decayed very quickly (p. 30). Cowan (2008) asserts sensory memory may be "a side effect of perceptual processing" (Volume 2, p. 24). As such, this type of memory is an instant reaction to the stimuli presented, rather than actively controlled by cognitive processes.

Short-term memory (STM) is the capacity to hold information for a small amount of time, from between a few seconds up to a minute. As such STM is considered a store.[4] Miller (1956) proposed that the capacity of STM was seven items, plus or minus two.[5] However, more recently Cowan (2000) has suggested that the ability to store four items is a more accurate depiction of the capacity. Long-term memory (LTM) provides the possibility of storing a much greater amount of information for a much longer period, in some cases indefinitely. LTM is conceptualised as a process, and is generally thought as having three structures: procedural knowledge (operations: knowing how to do something, such as motor skills); semantic knowledge (facts); and episodic memories (autobiographical events). Most memory theory agrees that information can only be stored in LTM after it has entered STM (Atkinson & Shiffrin, 1968). This is

[4] More recent research argues that the concept of working memory is a more accurate description of the short-term store, as the theory suggests dual systems of visual-spatial and written-spoken, overseen by a central executive system (Baddeley, 1986; 2000; Baddeley & Hitch 1974).
[5] See: Tulving (1962); Mandler and Pearlstone (1966).

often referred to as the multi-store model. The number of times information enters the STM is fundamental to this process (Anderson, 1983).

In the latter half of the twentieth century, research progressed "from a descriptive science largely based on pioneering behavioural analyses … to a new mechanistic science of mind that combines these brilliant behavioural studies with an analysis of the underlying neural mechanisms" (Kandel, 2008, p. xvii). As such, research has sought to label the major systems of human learning and memory to further advance understanding of the complexity of the processes involved. Tulving (1972) developed explanations of LTM, highlighting the declarative system (conscious recall) and procedural system (unconscious motor skills, such as learning to ride a bicycle). He proposed that declarative memory is divided into semantic and episodic forms (p. 383). Semantic memory stores facts and concepts unrelated to specific experiences, whilst episodic memory stores autobiographical events that can be explicitly recalled, along with corresponding emotions. Schacter and Tulving (1994) refined this model, outlining five memory systems: procedural, perceptual representation (PRS), semantic, primary and episodic (p. 26).[6]

Expert Memory Theory

Memory strategy has been examined since Greek and Roman times. Most notable is the "Method of Loci", or memory palace, as described in Cicero's rhetorical treatise *De Oratore* (Cicero, 55BCE/1967). The method relies on the coupling of mnemonic devices with specific, familiar spatial locations. The technique uses the visualisation of a specific location, for example a table, house or theatre. Information can then be assigned to various parts of the location. Mentally navigating the location therefore enables memory retrieval. Cicero

[6] Procedural memory subsystems include motor skills, cognitive skills, simple conditioning and simple associative learning; PRS includes visual and auditory word form, and structural representation; Semantic includes spatial and relational subsystems; Primary (working) includes visual and auditory; whilst Episodic represents autobiographical event memory (p.26). Given the complexity of this subject matter it is impractical to elaborate in great detail here. For further discussion, see Schacter and Tulving, 1994; Eysenck and Keane, 2000. For a more comprehensive account of neurobiological, cognitive psychological and neuroscientific perspectives, see Byrne (2008: Volume 3). For neuropsychological insights, see Squire and Schacter, 2002.

attributes the birth of mnemonics to Simonides of Ceos (556-468 BC).[7] Simonides discerned that "the best aid to clearness of memory consists in orderly arrangement" (Cicero, 55BCE/1967, p. 355). Plato likened the human mind to a wax tablet and an aviary, with individual memories represented as birds (Plato, c.369BCE/1973, lines 191a-199e).

Since the pioneering research on memory by Ebbinghaus (1885/1913), a number of theories on memory expertise account for the increased capacity for memorisation. The theory that humans chunk information was proposed by the cognitive psychologist Miller (1956). He demonstrates that the capacity of STM when presented with a series of data stimuli is seven items, plus or minus two. By recoding information into larger chunks, this limit can be bypassed in order to retain more data.

> First, the span of absolute judgment and the span of immediate memory impose severe limitations on the amount of information that we are able to receive, process, and remember. By organizing the stimulus input simultaneously into several dimensions and successively into a sequence of chunks, we manage to break (or at least stretch) this informational bottleneck (p. 345).

An everyday example of this method is reading text. From an early age we are taught to recognise sequences of letters as larger groups of words. Cognitive processes are reduced, thereby enabling larger amounts of data to be stored. This process relies on existing knowledge: language.

Following the identification of chunking as a process, Chase and Ericsson (1981) proposed the theory of skilled memory to explain how experts are able to memorise seemingly overwhelming amounts of stimuli. It is based on three principles: experts are able to use existing structures and schemas in semantic memory to store information; this encoded material is organised into a retrieval structure using cues; and that the time required for encoding and retrieval diminishes with extended practice.

[7] Dinning at wealthy nobleman's house, Simonides recited a poem in praise of the host. He was later called outside by two men requesting to speak to him. Whilst outside the roof of the banqueting hall collapsed, crushing all of the guests. The bodies were excavated, however it was impossible to identify the guests. Simonides, however, was able to identify the guests from their position at the table and thus the bodies could be returned for burial.

This theory was later expanded and revised by Ericsson and Kintsch (1995), proposing the long-term working memory theory (LTWM). Analysis of a wide range of fields revealed the importance of the way in which domain-specific information is stored in semantic memory. Thus, experts of a particular domain use associations based on their specific knowledge to link items to other schemas in LTM. The theory of LTWM maintains the second and third principles of skilled memory theory (the use of a retrieval scheme, and time taken for retrieval decreases with practice). The theory has been researched in various domains: chess (Chase & Simon, 1973a; 1973b; Gobet & Simon, 1996a; 1996b), skilled electricians remembering circuits (Egan & Schwartz, 1979), medicine (Patel & Groen, 1991) and early investigations of deliberate practice for musicians (Ericsson, Krampe, & Tesch-Römer, 1993; Krampe & Ericsson, 1996).[8]

Music and Memory

Early research into musical memory largely focussed on the process of encoding material rather than memory retrieval. Experimenters began to look at various strategies employed by musicians to aid the assimilation of material, including: practising hands separately or together (Brown, 1933); the use of visual, aural or kinaesthetic systems (O'Brien, 1943); music analysis (Goodrich, 1906; Rubin-Rabson, 1937); whole or part strategies (Brown, 1928; Rubin-Rabson 1940); and blocking chords (Nellons, 1974). Psychological research involving the participation of professional performers has since sought to understand the nature of such expertise. Studies have shown that deliberate, prolonged practice – of a minimum of ten years – is fundamental to such expertise (Ericsson, et al., 1993; Ericsson & Charness, 1994; Sloboda, Davidson, Howe, & Moore, 1996). The amount of practice is directly related to the level of skill attained (Ericsson, et al., 1993) more accomplished performers practised a

[8] There are two further theories on expert memory. SEEK theory posits that experts have more knowledge in general, and make better searches and evaluations through their knowledge base when presented with new material (Holden, 1992). Template theory has been used extensively to examine chess players, examining how typical a scenario is and this impact on memorisation. Gobet and Simon (1996) researched chess players of various levels, who were presented with several setups of a board. Unusual board setups resulted in recall of only location of pieces, whereas more usual board setups resulted in recall of pieces, as well as some semantic information as to how the scenario played out.

greater amount (Sloboda et al., 1996), and practice is required to maintain the high skill-level achieved (Krampe & Ericsson, 1996).

More recent studies have employed interview techniques as a means of studying skilled musicians.[9] Perhaps the most diverse is Hallam's research (1995a; 1995b; 1997a) of 22 London-based professional musicians, demonstrating a wide age range (22-60 years old), varied musical activities (solo, chamber, orchestral, teaching and conducting) and a range of instruments. Each musician was given a musical score that was unknown to them, and were asked about the activities required to learn the piece, including analytical strategies, and whether practice was based on a holistic or segmented approach to the score. A range of practice strategies was reported, although certain strategies were more universal. The majority of musicians analysed the structure of the piece to form an overview of the tempo and technical difficulties, before continuing to adopt a problem solving strategies. There were fewer intuitive learners: those who worked segment by segment until the work in its entirety is achieved. This latter strategy was more often adopted in a mixed approach, combining holistic and segmented strategies (versatile learners).

A similar study was carried out by Gruson (1988), which examined the practice habits of 40 pianists of various abilities. The study revealed more accomplished performers tended to think in larger segments, or of the piece as a whole, whilst also practising with hands separately to a greater extent. Aiello (1999; 2000a; 2000b) has also used interview techniques to establish the importance of conceptual memory, with various studies of professional pianists and conservatoire students. In particular, pianists generally used strategies based on the structure of the music to aid memorisation. This included segmenting the piece according to structure, working out repeated melodic and harmonic patterns, and blocking the chords to practise unfolded chains as harmonic progressions (2000a).

In addition to practice strategies, the musician's knowledge of musical language and grammar is fundamental to effective learning. Halpern and Bower (1982) demonstrated that the schemas of traditional Western music, such as

[9] This type of research provides detailed accounts of the techniques used by professional musicians. However, there are also inherent shortcomings: the researcher only learns what they are told, and this may not actually represent what the musician does.

harmony, scales, arpeggios, chords and cadences, are fundamental when memorising music.[10] These arise through exposure to music, extensive practice, knowledge of traditional harmonic theory, as well as the ability to both produce a sound from notation and its inverse of notating a heard pitch. This knowledge allows for instantaneous recognition of familiar groupings of notes, or comparison with existing schemas stored in the memory for fast processing. In turn, memory load can be reduced by chunking large amounts of new material into schemas based on this existing knowledge. Similarly, Sloboda and Parker (1985) establish that memorising a single melodic line involves relating the melody to the underlying structure. Sloboda (1985) and Cook (1989) further highlight the importance of using the systematic set of schemas and patterns in a composition to enable effective memorisation.

Further studies report similar findings in relation to use of structure (Williamon & Valentine, 2002; Williamon & Egner, 2004). Miklaszewski (1989; 1995) further documented the use of formal structure as a learning device by accomplished pianists when learning new repertoire. By contrast, novices tend not to use analytical strategies when memorising (Aiello 2000a; Hallam, 1997b). Williamon and Egner (2004) have examined the neurological aspects of expert memory. Their study involved a visual recognition test of various bars of a Bach Prelude, which had been learned by six pianists. Responses were recorded on an electroencephalogram (EEG) and demonstrated a significantly faster recognition of structural bars, whilst also establishing that bars important for memory retrieval are encoded in a different manner from other bars.

Further observational methods have been used by Ginsborg (2000; 2002) to analyse the memorisation strategies of singers. Singers widely employed structural boundaries to organise practice, regardless of memorisation speeds (2002). In addition, recall was better for expert singers who memorised words and music concurrently than those who separated the two modes (2000). Based on the implications of the findings of previous research, general suggestions for memorisation strategy followed (Ginsborg, 2004). These included analysing the music to form a conceptual framework, segmenting the music into shorter

[10] This premise is also suggested by general theories of expert memory theory (See above: Chase & Ericsson, 1981; Ericsson & Kintsch, 1995).

chunks, and combining rote memory (kinaesthetic / tactile repetition) with aural and visual procedures (p. 137).

Herrera and Cremades (2014) used similar observational methods to examine pianists' memorisation strategies in the Mexican conservatoire system. Analysis of the score was prevalent among different age ranges. Noticeable differences in gender were also demonstrated, in particular with regards to vocalising the melody and rhythm and planning kinaesthetic movements ahead of time (p. 228). Similarly, Davidson-Kelly, Moran and Overy (2012) examined the role of mental rehearsal in advanced pianists studying at U.K. conservatoires. The study revealed a discrepancy between self-reports and practice. Whilst the pianists were aware of mental techniques, they were less likely to be implemented than physical rehearsal (p. 249).

Mishra (2011) has extended research into practice strategies employed by musicians. The study investigated the efficacy of four different memorisation strategies in 40 university wind players: holistic, segmented, serial and additive. Effectiveness was established by efficiency (how fast notated music could be learned), and stability (numbers of errors committed). For the holistic strategy, the musician repeatedly practised the piece in its entirety from beginning to end. The segmented strategy involved practice of discrete sections, before putting these segments together. Serial strategy, like holistic methods, involved practice from beginning to end, however the musician returns the beginning of piece when a mistake or hesitation is made. Finally, additive strategy, like segmented, involved practice of short sections: however, unlike segmented practice strategy, sections are immediately put together until the whole piece has been learned. The results demonstrated that for a short 16-bar piece, the holistic approach the most efficient.

In addition, Mishra (2005) has examined longer-term processes during the learning period, documenting that this period involves three procedures: preview, practice and over-learning. This model agrees with previous assertions, such as Wicinski's model: getting to know the music, hard work on technical problems, and fusion of ideas and technical skills (as reported in Miklaszewski, 1989, p. 96). The three procedures are in turn subdivided. The preview stage is divided into notational overview, aural overview and performance overview; the practice stage is divided into notational practice and conscious memorisation;

and the over-learning stage is divided into relearning, automatisation (embedding of kinaesthetic behaviour through repetition) and maintenance. Finally Mishra concludes that these processes are dynamic: that the performer uses each strategy as and when necessary to achieve the ultimate goal of a concert performance. Further study has examined the role of environmental and instrumental context on memorised performance by pianists (Mishra & Backlin, 2007). Whilst change in learning environment did not directly affect recall, unusual performance venues (in a lobby/ conference room) produced negative effects for recall. Most significantly, better recall was achieved when using the same instrument at rehearsal. Lower recall was produced when switching instruments, particularly when changing between piano types (upright/grand).

Performance Cue Theory

Early research into expert memory largely avoided studies of musical performance, most likely because of the complex and multidimensional nature of memorising music. More recent seminal research has sought to address this lacuna in the form of longitudinal case studies. Such research has validated theories of expert memory (Chase & Ericsson, 1981; Ericsson & Kintsch, 1995) by examining the learning and memorisation habits of performing musicians. The longitudinal approach was spearheaded by cognitive psychologist Roger Chaffin and pianist Gabriela Imreh (reported variously: Chaffin & Imreh, 1994; 1997; 2001; Chaffin Imreh & Crawford, 2002; Chaffin, Imreh, Lemieux, & Chen, 2003; Chaffin & Logan, 2006). The study examined the pianist's (Imreh) learning of Bach's *Italian Concerto* (*Presto*), documenting her decisions. Practice sessions were video-recorded, providing behavioural data for analysis in comparison to the first-person accounts from the pianist.

The findings demonstrated that theories of expert memory were applicable to piano performance, despite the addition of motor memory and aesthetic conditions (such considerations were negligible in studies of other domains such as chess). During practice, experienced musicians employ performance cues (hereafter referred to as PCs) relating to various features of the music. These are grouped into four categories: basic (the technical difficulties, such as fingerings, leaps or patterns), interpretative (dynamics and articulation),

expressive (the emotional content, character and expressive aims) or structural (the formal structure of the piece). As learning progresses, many of these cues may no longer require attention, or can be produced automatically by motor control. Those cues that remain after extensive rehearsal are PCs. These PCs are used during performance and are derived from the "landmarks in the musicians' mental map of the piece" (Ginsborg & Chaffin, 2011a, p. 340).

As thinking of complex and skilled movements during execution often is disruptive – a term denoted choking in "complex proceduralised sensorimotor skills" such as sports (Beilock and Carr, 2001, p. 722) – prolonged practice is necessary. This ensures that retrieval is instantaneous and PCs can be summoned without disruption. Musicians rely on a range of memory systems to assimilate and perform a piece, including auditory, motor, visual, emotional, structural and linguistic memory. When learning music, the spontaneous memory that occurs can be classed as an associative chain, where a phrase or passage cues the next. Deliberate memorisation allows for content-addressable memory (Chaffin, Logan and Begosh, 2009; Rubin, 2006). Thus, a performer can start at a particular point in the piece without having to start from the beginning:

> In a memorised performance, content-addressable memory provides a safety net that permits recovery in case the associative chain breaks and the performance is disrupted (Chaffin, Logan, & Begosh, 2009, p. 352)

The study by Chaffin, Imreh and Crawford (2002) demonstrated that the formal structure of the composition provides a template for content-addressable memory. The structure forms a hierarchical retrieval scheme: expert pianists divide music into segments and organise practice and rehearsal based on this structure (p.248-250). This supported, in a more comprehensive objective manner, the findings of previous research that noted the importance of structure (Aiello, 2000a; Miklaszewski, 1989; 1995; Williamon & Valentine, 2002; Williamon & Egner, 2004). The performer may not think about structure during performance: rather it operates in the background to be used if needed. Instead, PCs based on other dimensions may be at the fore (basic, interpretative or expressive).

These PCs must be practised in connection with an element of spontaneity. If an ideal performance focusses completely on the expressive

content, this must also be rehearsed. As such, the premise of rechunking of cues developed, outlining the process of "overlaying lower level retrieval cues used in the earlier stages of practice with new, higher level cues" (Chaffin et al., 2002, p. 250). This process may combine cues (for example a basic cue inside an interpretative cue), or simply to eliminate a cue when not needed. Regression analyses using data taken from practice sessions revealed that whilst rechunking occurred later in the process, attention to PCs was exhibited from an early stage. Once the music was memorised there was also a progression from basic PCs to expressive PCs as polishing of the piece occurs (2002, p. 253). Subsequent written recall of the piece after 27 months revealed highest probability of recall at section boundaries, with a negative decline the further away from the section start. Basic PCs followed an opposite trend: poorest probability of recall followed by an increase further from the cue.

The longitudinal case model has been replicated and extended to various instrumentalists and music styles: Debussy's piano music (Chaffin, 2007); a jazz pianist (Noice, Jeffrey, Noice, & Chaffin, 2008); an amateur pianist of Grade 7 ABRSM standard (Lisboa, Chaffin, & Demos, 2015) a cellist (Chaffin, Lisboa, Logan, & Begosh, 2007; 2009; Lisboa, Chaffin, & Logan, 2007; 2009a; 2009b; 2009c; 2011); a singer (Ginsborg & Chaffin, 2011a); guitar (Aranguren, 2009);[11] and shared PCs (Ginsborg, Chaffin, & Nicholson, 2006; Ginsborg, Chaffin, Demos, & Nicholson, 2013). A general trend reveals that the effect of musical structure is fundamental to practice strategy. The attention of the musician changed between basic, interpretative and expressive aims during the learning process. PCs were generally annotated on scores after performance, and subsequent written recalls of the music revealed the importance of PCs and structural boundaries in the conceptual framework of the musician. Analysis of PCs across musicians of various abilities demonstrates the importance of experience: experts generally use more basic PCs, conservatoire students more interpretative PCs, whilst less experienced musicians tend to rely on structural PCs to a greater extent (Chaffin, Demos, & Crawford, 2009).

Written recall after longer duration has been examined over a period of six years (Ginsborg & Chaffin, 2009; 2011a). Important landmarks were starts of

[11] Aranguren's study of six guitarists used qualitative interview techniques and is therefore less rigorous. However, similar findings add to the growing body of literature of PC theory.

sections and PCs for word stress yielding most accurate recall, before decreasing as the distance from the landmark increased (2011a, p. 354). In contrast, basic PCs produced lowest recall probability and increases as serial position from cue progressed. Ginsborg refers to these places as "lacunae" (p. 339). The study confirmed the findings of a similar recall by Chaffin et al. (2002, pp. 212-216). Played recall has also been examined in comparison to written recall (Lisboa, et al., 2009c; Ginsborg, Chaffin, & Demos, 2014). Accuracy greatly increased in played recall, demonstrating the importance of motor and auditory systems. This was particularly evident for the increase in recall accuracy of basic PCs. The difference is attributed to the addition of sensorimotor cues when playing (Lisboa, et al., 2009c, p. 319). Similar negative serial trends were demonstrated for structural and expressive PCs, further demonstrating their importance as landmarks providing access to content-addressable declarative memory (p. 320).

A limitation of the PC theory after this body of research was the impression that all performance aims were preconceived during practice, leading to replication on stage. This implication denies the transient and spontaneous nature of performance, that music is essentially a creative process (Clarke 1995; Neuhaus, 1973; Chaffin, Lemieux, & Chen, 2006).[12] However, PC theory has been significantly refined to examine to what extent a performance relies on spontaneous thought: aims outside the PCs developed in practice (Ginsborg & Chaffin, 2011b; Ginsborg, et al., 2014). The studies highlight that PC theory does not necessarily exclude other spontaneous thoughts. However, it does rule out the situation of no overlap between PCs and spontaneous thoughts (Ginsborg, et al., 2014, p. 207). In this study, previous longitudinal models were adapted for the singer to report both PCs and spontaneous thoughts after performance. The process was replicated after seventeen months and the results compared. PCs were found to be more stable over time, whilst fewer spontaneous thoughts remained after the relearning and subsequent performance. This confirmed that PCs were still used as landmarks as in previous research (Chaffin, et al., 2002; Chaffin & Logan, 2006; Ginsborg & Chaffin, 2011a) whilst "spontaneous thoughts reflect more transitory experiences and insights" (Ginsborg, et al., 2012, p. 201). In addition, evidence of flexibility was demonstrated given that use of

[12] Neuhaus (1973) states during practice and performance "an instantaneous and subconscious process of 'work at the artistic image' takes place" (p. 17).

PCs varied between performances. This suggests PCs can be adapted for immediate needs in performance. Substantial variation of PCs across performances has also been documented in a cello/piano duo (Lisboa, Chaffin, Demos, & Gerling, 2013) and in relation to the use of Schenkerian analysis for more challenging structure (Chaffin, Gerling, Demos, & Melms, 2013).

This growing body of literature has demonstrated the importance of PCs for memory retrieval. The use of structure, as previously suggested in observational and qualitative research (see above), is fundamental in organising practice, and remains in the conceptual memory, often to be used in subsequent reconstruction and relearning of a piece. The refining of the theory, suggesting that PCs are flexible across performances and do not discount spontaneous thoughts, has provided new insights into the creative aspects of performance.

Atonal Music

Longitudinal case studies examining PC theory have generally neglected contemporary music. The notable exception in PC research examines memorisation of the music of Schoenberg and Stravinsky by a singer (Ginsborg & Chaffin 2011a; 2011b; Ginsborg, et al., 2012; Ginsborg, et al., 2006). Li (2007; 2010) has also documented mnemonic strategies for a range of twentieth-century repertoire.[13] Theories of expert memory require extensive knowledge in a particular domain in order to process large amounts of new information in relation to knowledge of existing schemas and patterns (Chase & Ericsson, 1981; Ericsson & Kintsch, 1995). For musicians, knowledge of musical theory, harmony, and extensive practice of familiar patterns (such as scales and arpeggios) during formative training explain feats of memory (Halpern & Bower, 1982). In atonal music, this language is largely reduced, if not removed completely. Williamon (1999) has commented on the potential problems that may arise when attempting to memorise contemporary music:

> Memorising an atonal composition … may prove cumbersome and overwhelming if the performing musician is forced to memorise the piece note by note. Such a procedure would inevitably increase the demands of

[13] For a more detailed examination of studies on memorisation of atonal music, see chapter 3.

> cognitive process during performance and, thereby, reduce – or possibly eliminate – the advantages of performing from memory (p.94).

Aiello (2001a) has further suggested that techniques may differ for atonal memorisation: "It is possible that memorizing atonal music or contemporary pieces would require the performers to apply different memory strategies than the ones … to memorize baroque and romantic music" (para. 16), as unfamiliarity with the genre interferes with prediction and chunking. Studies have demonstrated that atonal music poses problems even for those with phenomenal memorisation abilities: so-called musical *savants* (Ockelford, 2011; Sloboda, Hermelin, & O'Connor, 1985). Professional pianists have also articulated the increased effort required to learn such compositions. Rudolf Firkusny remarked, "When you are memorizing complex modern works, the harmonies are more complicated and anything but what you expected. Then you need much more concentration" (Noyle, 1987, p. 84).

Research type

The nature of a performance-based doctorate positions performance studies at the centre of research. Recent trends have largely followed the use of recordings pioneered by the Centre for the History and Analysis of Recorded Music (CHARM).[14] This type of musicology has focussed on historical performance practice, psychological processes, and analysis of performance (Rink, 2004). Following this, the Research Centre for Musical Performance as Creative Practice (CMPCP) has explored various live-music practices through collaboration between researchers and performers.[15] In addition, there has been a trend in higher education institutions to promote practice-based research, whereby performers, teachers and composers pursue research into their own practice.[16] Such research develops an understanding of the processes associated with particular domains and helps inform other practitioners, both in the same field and beyond. Doğantan-Dack (2012) has also coined the term artistic research:

[14] See project website: http://www.charm.kcl.ac.uk/index.html
[15] See project website: http://www.cmpcp.ac.uk/
[16] 'Practice-based research' is used here. Elsewhere, it is referred as 'performative', 'practice-as' and 'practice-led'.

> I use the term 'artistic research' to refer to research activities that are methodologically integrated with an artistic creation and cannot be pursued without art-making. In this sense, the domain of artistic research does not necessarily overlap with that of 'practice-based' research where the practice involved does not always result in an art-product (p. 36).

Schechner (2002) elaborates on the process: "The relationship between studying performance and doing performance is vital" (p. 2). It is this experience that forms the basis of research methods, which may not start with a traditional research question:

> Practice-led researchers construct experiential starting points from which practice follows. They tend to 'dive in', to commence practising to see what emerges. They acknowledge that what emerges is individualistic and idiosyncratic. This is not to say these researchers work without larger agendas or emancipatory aspirations, but they eschew the constraints of narrow problem setting and rigid methodological requirements at the outset of a project (Haseman, 2006, pp. 100-101).

Furthermore, the role of the practitioner is vital: "The 'practice' in 'practice-led research' is primary – it is not an optional extra; it is the necessary pre-condition of engagement in performative research" (Haseman, 2006, p. 104).

Previous practice-based research, in particular the PC theory models, have combined the first-person accounts of the practitioner with more objective analysis of a disinterested third party: usually a cognitive psychologist. Given that this is a single-author thesis, in which the practitioner is also the researcher, it is impossible to combine such viewpoints. As psychologists tend to be doubtful of first-person accounts, this is a limitation with this study. Some mental processes cannot fully be explained by first-person accounts: "we may have no access to higher order mental processes such as those involved in evaluating, judgement, problem solving, and the initiation in behaviour" (Nisbett & Wilson, 1977, p. 232). Furthermore, such research that is heavily dependent on self-analysis is difficult, possibly leading to confusions and erroneous conclusions (Chalmers, 1990; 1996; Dennett, 1991; Ericsson & Simon, 1993).[17] Individual chapters will elaborate in greater detail on the methodologies used,

[17] See, for example Dennett: "One's current expectations and interests shape hypotheses for one's perceptual systems to confirm or disconfirm, and a rapid sequence of such hypothesis generations and confirmations produces the ultimate product, the ongoing, updated 'model' of the world of the perceiver" (1991, p. 39).

their limitations, and the manner in which such limitations are surmounted. A broader overview is outlined at the end of the research plan (below). In general, the thesis variously employs practice-based research, artistic research, analysis of performance through live recordings, and more conventional performance-practice research. Despite the limitations inherent in such an approach, the study is invaluable in providing insight into advanced memorisation techniques that will be of interest to musicians and cognitive psychologists alike.

Research Plan and Rationale

The broad aim of the thesis is to examine how atonal piano music is memorised. Given the nature of artistic and practice-led research (see above), in which the creative process is integrated with the research methodologies, no firm hypotheses were advanced at the outset of this study. However, building upon previous research, this thesis adopts the PC longitudinal study approach to argue that the formal structure remains an important framework for memorising atonal compositions. The study further investigates whether a wide range of conceptual and physical patterns are needed to assimilate compositions with language that is less familiar than tonal compositions. These patterns might replace the harmonic schemas used to memorise tonal compositions, and might serve to enable some prediction and chunking.[18]

The thesis examines this broad aim, addressing five research questions:

RQ1. With the introduction of innovative, complex structures that are often imperceptible, which domains serve to organise practice and remain as landmarks?

RQ2. When traditional harmonic language and patterns are removed, how is atonal music memorised?

RQ3. Can these strategies be transferred across repertoire of the same composer, or even different composers?

[18] With the exception of one multimodal approach to memorisation discussed in chapter 4, the analysis in the thesis focusses on work carried out at the instrument. Detailed analysis of mental practice was beyond the scope of this thesis, given the difficulty to quantify mental processes. The body of literature would benefit from further study: existing research has demonstrated that mental practice is an underused strategy, especially by musicians training at conservatoire (Davidson-Kelly, Moran, & Overy, 2012).

RQ4. What are the expressive outcomes of long-term re-approaches to memory: reconstructing a piece for performance several times across several years?

RQ5. How do other pianists memorise atonal compositions?

The thesis begins by extending existing PC research to investigate how atonal music was memorised by this pianist, documenting the learning process of the main solo piano cadenza in Messiaen's *Oiseaux Exotiques* (Chapter 2). In particular, this chapter addresses the first two research questions: examining how practice is organised, which landmarks remain as PCs, and how atonal music is memorised. Previous PC research has largely neglected atonal repertoire, and thus the study aims to extend the body of literature to examine the interactions of a pianist with atonal repertoire. This provides the potential for insight into the memorisation processes in a new area, examining the application of PC theory and the importance of formal structure on memory on a work with a more complex structure and musical language than those examined in previous studies.

In order to answer these questions, the chapter repeats the longitudinal PC case study (Chaffin, et al., 2002; Chaffin, Lisboa, et al., 2009). The rationale for choosing the research methods reflects these aims: analysis of first-person accounts (verbal comments and multiple annotated scores) is contrasted with analysis of behavioural data taken from recordings of practice sessions. The data obtained by these methods allows for analysis of how atonal music is memorised (RQ2), whilst the detailed behavioural records obtained from video-recordings, combined with annotated scores and post-performance PCs demonstrates the organisation of practice and development of PCs (RQ1). The findings shed light on complex memorisation procedures in a new musical genre: atonal music. Given the unfamiliarity of the musical style (limiting prediction and chunking), the findings may provide further insight into theories of skilled memory, and how experts retain extensive memorisation skills even when new material has limited connection to their domain-specific knowledge.

The third chapter continues analysis of the *Oiseaux Exotiques* cadenza from a different viewpoint to further examine how atonal music is memorised (RQ2). Moving away from the study of memory retrieval, the chapter illustrates various methods of encoding and assimilating atonal music, charting a wide

range of mnemonic, physical, conceptual and analytical memorisation devices. Scholarship of this type is not uncommon, where experienced performers collate strategies and pass them on to students. However, encoding of atonal music is an under-researched area in the study of musical memory. Consequently, this type of artistic, performance-practice research contributes original material that may be particularly informative to other practitioners. The chapter ends by ascertaining the likelihood of transferring strategies between works of the same composer: Messiaen.

Chapter 4 continues this line of enquiry by examining the possibility of using these encoding devices – either identical or modified – in a wide range of repertoire across the twentieth and twenty-first century. This chapter evaluates if general strategies emerge that can be applied to a range of different musical styles and languages in atonal repertoire (RQ3). The methods used in chapters 3 and 4 are derived from existing PC case studies. However, only annotated scores were collected. Given such a wide range of repertoire, it is impractical to complete longitudinal case studies for the repertoire analysed in these chapters. Instead, annotated scores were analysed retrospectively, and the findings reported qualitatively. The rationale for choosing this method reflects the aims of understanding how atonal music is memorised. Despite the limitations of self-reports, the analysis provides detailed accounts of the memorisation processes used by this pianist. As the study of memorisation techniques for atonal music is an under-researched area, these chapters add a system of musical memorisation strategies. These extend the understanding of memorisation process for atonal music (and tonal music) and provide the potential for insight and appeal to a range of musicians and psychologists alike.

The fifth chapter approaches long-term memory through multidimensional perspectives. It charts processes of relearning Boulez's *douze notations* over a seven-year period, from 2008 – 2015. As the initial learning of the work occurred before this research, the chapter begins with a brief analysis of encoding procedure taken from annotations made on the score in 2008. It provides an interesting comparison with devices in chapters 3 and 4, demonstrating how the procedures have developed in a single musician over a substantial period of time (RQ2 and RQ3). Established quantitative methods examining long-term recall are then used to examine the role of musical structure

as a landmark (see Chaffin, et al., 2002; Ginsborg & Chaffin, 2011a; Lisboa, et al., 2009b). The findings regarding the importance of structure contribute significantly to existing research, in particular given the complexity of the sixth movement, where structure is almost indiscernible (RQ1). The chapter concludes by extending the study of long-term memory reconstruction through analysing the expressive changes in three performances across the seven-year period (RQ4).

The rationale for this study is to examine both long-term recall and live-recording performance analysis extends perspectives of PC theory and further elucidates the seemingly paradoxical tensions of performance: how a work rehearsed repeatedly and extensively over a number of years can remain creative and spontaneous on stage (Clarke, 1995; Chaffin, Lemieux, & Chen, 2006). Previous PC research of this type has focussed on tempo changes (Lisboa, et al., 2007). Here, analysis examines acoustic realisation through analysis of spectrograms to extend understanding of the nature and variety in PCs in the performances of this pianist. The rationale for this method is to examine a new area of memorised performance. Previous research has documented the reuse of PCs across performances (Chaffin, et al., 2013; Lisboa, et al., 2013), as well as a performer's spontaneous thoughts in performance (Ginsborg, & Chaffin, 2011; Ginsborg, et al., 2014). Here, analysis of the acoustic execution of PCs (and some tempo changes) further elucidates the tension between replication and spontaneity in performance. Analysis of the changes of acoustic realisation of PCs across performances demonstrates how PCs – developed through extended practice – can remain spontaneous and malleable onstage. This allows for new insights into longitudinal expressive development in performance (RQ4) and the role of creativity in performance.

The final chapter provides a pilot study for future research. Memorisation strategies of three other pianists are examined and contrasted to techniques in earlier chapters to further clarify procedures used for atonal music (RQ5). The method used combination of interview techniques and annotated scores made by each pianist. The rationale of this method was to examine the strategies of other pianists memorising atonal music to evaluate if strategies are specific to musician and repertoire, or if some common strategies are prevalent amongst pianists. This study extends discussions on atonal memorisation, demonstrating that there may

be common strategies that can facilitate more effective and efficient memorisation. This primarily relates to atonal music, but provides implications repertoire of all types. Finally, the conclusions examine the benefits of this thesis for other practitioners, contextualise the research with regard to the PC theory and more general memory research and highlight some avenues for further study.

Disclaimer

At this stage, it is worth further outlining the methodologies used in the thesis. The longitudinal case model of previous research is applied to only chapter 2. This is for various reasons: first, it is impractical in the scope of a doctoral thesis to replicate the longitudinal model for so much repertoire, given the amount of data needing analysis. Secondly, it should also be noted that I am not a cognitive psychologist: as such, the aim of subsequent chapters is to examine my own working methods in atonal memorisation as a pianist. Here, the role of practitioner is fundamental to the research model and outputs (Doğantan-Dack, 2012; Haseman, 2006). The dangers of self-analysis have been noted above. Two methods in the thesis mitigate such problems. First, the initial discussion of memory technique (Chapter 3) employs retrospective analysis of the annotated scores of the *Oiseaux Exotiques* cadenza. As such, the longitudinal study in chapter 2 serves to factually confirm my own more experience-based conclusions in chapter 3. Secondly, chapter 6 investigates atonal memory techniques of other pianists (discussed below). This provides a wider comparison to further validate my own memorisation techniques.

Atonality, Serial and Dodecaphony

The music examined in this thesis covers a wide range of musical styles across the twentieth and twenty-first centuries. For simplicity, the terms ‘atonal’ and ‘atonality’ are preferred over ‘modern’, ‘contemporary’ or ‘twentieth-century music’. This is problematic given the wide range of musical styles. However, it is used loosely as an overarching term to describe music that does not follow functional tonal progressions or relationships. Given existing PC research uses ‘serial’ to denote linear place (for example the serial positions of a

chain of bars or beats), repertoire using twelve-tone techniques is identified as dodecaphonic to avoid confusion.

Why Memorise?

Extensive research has examined the value of performing from memory, as it is considered to enhance the creative and communicative effect. Similarly the execution of a memorised performance often creates the impression of a more thorough immersion and comfort with the music (Hughes, 1915; Matthay, 1926). Williamon's (1999) study suggests that performing from memory may aid communication, and that an unobstructed view of the performer "was extremely influential in allowing the audience to grasp the performer's expressive intentions" (p.93). Whatever the artistic choice of the performer, it is clear that the ability to memorise music is a fundamental skill that a performer must possess in his arsenal, regardless of whether the performance is from memory or with a score. If playing a contemporary composition from memory seems overwhelming, the same can be said of playing the piece from the score. It is likely that the pianist may need to guide the fingers with the eyes at moments of heightened difficulty. And given the amount of time needed to practise some atonal music, surely some memorisation is inevitable, even if this is achieved through rote memorisation of associative chains.

In light of the significant development of research into musical memory – encompassing qualitative, observational and quantitative psychological methods – the next chapter begins examination of the memory procedures required for the more complex language and structure often exhibited in atonal music. Chapter 2 follows previous longitudinal case study models (Chaffin, et al., 2002) to analyse the learning procedures encountered by the author when learning the main piano cadenza in Messiaen's *Oiseaux Exotiques*.

CHAPTER 2

Memorising Messiaen

Performance and memory strategy in Oiseaux Exotiques

As outlined in Chapter 1, feats of expert memory require the protagonist to rely heavily on their domain of expertise (Ericsson & Kintsch, 1995). This has been established for performing musicians (Krampe & Ericsson, 1996; Chaffin, et al., 2002). Previous research on the performance of tonal music has demonstrated that the hierarchical formal structure of a piece is important when creating a conceptual framework (Chaffin, et al., 2002; Chaffin, Lisboa, et al. 2009; Chaffin, Logan, et al., 2009; Ginsborg & Chaffin, 2011a; Ginsborg, et al., 2006; Lisboa, et al., 2004; Logan, et al., 2007; Noice, et al., 2008). Such a framework is content-addressable to allow for flexible retrieval during the demands of performance (Chaffin, Logan, & Begosh, 2009; Rubin, 2006). This chapter examines my own preparation for a performance of Messiaen's *Oiseaux Exotiques* for piano solo and small orchestra.

Professional musicians are taught from an early age various types of schemas and patterns, including scales, arpeggios and harmony. This system of knowledge is used to chunk new information (Halpern & Bower, 1989). Performance cues (PCs) are established during extended practice to enable immediate retrieval on stage. PCs also form part of a retrieval scheme. As with previous studies, four types of PC are identified: basic (technical issues), interpretative (dynamics, articulation, phrasing and pedal), expressive (the emotional content of the music) and structural (relating to the formal structure of the composition). Many musical features in these four domains can be instantly produced by motor recall after extended practice. PCs are those features that still require attention during performance (Chaffin & Ginsborg, 2011a).

This study analyses my own learning of the main solo piano cadenza from Messiaen's *Oiseaux Exotiques.* As such, it extends previous longitudinal models examining PCs to atonal music, memorised by a pianist. The first aim of this study is to examine the extent to which existing accounts of performance memory apply to atonal music, and what types of PCs are used. As expert memory relies on existing knowledge in a particular domain (Ericsson & Kintsch, 1995), what occurs when schemas relating to harmony do not occur in an atonal composition? Existing longitudinal case studies of twentieth-century repertoire have been limited to a singer's memory procedure, and confirmed the importance of PCs and the formal structure as a retrieval scheme (Ginsborg & Chaffin, 2011a). Similar outcomes are expected here: that the formal structure of the composition is used to organise retrieval, and that PCs are established through extended practice to enable the wide array of cognitive and physical demands in performance.

The second aim of this study is to examine how practice changed during the learning process. Various learning stages have been identified in previous scholarship (Chaffin, et al., 2002, Chaffin, Lisboa, et al., 2009; Wicinski, reported in Miklaszewski, 1989). Here, practice stages are initially identified from memory. Retrospective comparison with empirical practice graphs, examining whether practice focussed on short sections or larger passages, confirms the divisions used (Chaffin, Lisboa, et al., 2009). The study also aims to examine the changes in focus during practice, in particular when PCs are established and practised. Previous research has examined this question by analysing musicians' strategies in relation to start and stop locations during practice. Although this is a more descriptive study, similar procedures are followed here to examine whether comparable progressions are followed for atonal music. Based on previous research, it is likely that there will be similar outcomes: that PCs receive extended practice and that structural and expressive PCs are established and guide retrieval.

First-person perspective

Whilst previous studies in this field have integrated the practitioner in a collaborative study, this case study is unusual in having the practitioner as the

primary researcher. This provides a great advantage through comprehensive self-analysis and unparalleled access to a performer's thought-process. This insight has informed research decisions in previous research (Chaffin, et al., 2002; Chaffin, Lisboa, et al., 2009). There are, however, difficulties in this type of study that must be addressed. The subjective nature of self-reports as an evaluation model can lead to bias and mistaken conclusions (Chalmers, 1990; 1996; Dennett, 1991), whilst some higher cognitive processes cannot be fully explained through self-reflection (Nisbett & Wilson, 1977). The objectivity of a third-person perspective has previously been used to provide insight into the practice habits of a performer (Chaffin, 2007; Chaffin, et al. 2002; Chaffin, et al., 2009; Ginsborg & Chaffin, 2011a; Ginsborg, et al., 2006; Ginsborg & Sloboda, 2007; Lisboa, et al., 2015; Noice, et al., 2008).

The behavioural record from video-recordings of practice sessions in the present study provides an objective account of the process to validate first-person insights. To reduce any effects regarding my expectations of possible outcomes of the study, the roles of practitioner and researcher were divided. The initial procedure was entirely as a pianist, focussing on learning the music and preparing for performance. Whilst extended documentation of the process was recorded, this was limited to video-recordings, verbal comments during practice, and completing annotated scores at three points during practice: this can be considered part of the learning process. Previous studies have retrospectively documented decisions during practice. In the present study, both concurrent and retrospective annotations were carried out. Three annotated scores were completed during the learning process (Annotated Scores 1-3), and one score was completed retrospectively, after the performance (Annotated Score 4). This final score detailed the PCs used.

Given that the assimilation of this atonal musical language required a process of developing new conceptual and kinaesthetic patterns (discussed in detail in the following chapter), from the earliest practice sessions it was apparent that simultaneous documentation needed to take place. It is likely that retrospective reporting would be unable to comprehensively detail the strategies once various memorisation methods could be automatically produced by motor responses. Other mental practice and self-reflection on the learning process were avoided in this stage (Chaffin, et al., 2002; Chaffin, Lisboa, et al., 2009). Only

after the public performance – and the completion of the practitioner role – was the role of researcher adopted, categorising and transcribing the various data collected during the learning process.

Method

The Pianist

The pianist for the study is also the primary author: myself. I am formally trained as a concert pianist, studying at Guildhall School of Music & Drama. Preceding this, I completed an undergraduate degree in traditional musicology at the University of Cambridge. Prior to the study, I had experience performing a variety of atonal music. A regular performing schedule was maintained during the course of this study.

The Music

This case study examined my own preparation for a performance of Messiaen's *Oiseaux Exotiques* for piano solo and small orchestra. The piece has a prominent role for the piano including several solo cadenzas. Despite performing the complete work, for the purpose of this study, I have narrowed my scope of enquiry to focus on the memorisation processes of the largest solo piano cadenza before the final tutti: Figs. 24 – 25 in the score (Messiaen, 1959). The duration of the entire work is around sixteen minutes, with the cadenza beginning around ten minutes into the piece, lasting for approximately two and a half minutes. The cadenza provides the opportunity to investigate memorisation procedure solely based on the piano part and not on the interactions of the pianist with the ensemble. The language and structure of this cadenza are far removed from traditional tonal counterparts. Rhythm is often based on Greek and Hindu rhythms less familiar to classically trained musicians.

Although Messiaen's musical language contains some fixed pitches, with elements of the transcriptions of actual birdsong transformed into musical motifs, extensive melodic elaboration is preferred to repetition. This imitates the joyous and improvisatory features of the *Bobolink* birdsong, which the composer himself described as having "Brilliant melodic figures, great virtuosity" (Messiaen, 1959, p. xii). The motivic material of this cadenza is also new to the

formal structure, with two birdcalls specifically introduced (the *Oiseau-chat* and the *Bobolink*). Finally, the fast tempo of the cadenza, coupled with near constant demisemiquaver figurations, require a huge amount of information to be retrieved and executed instantly by the performer. For these reasons the cadenza seemed a suitable choice: appropriate in length and character, with the complexity of the score providing ample opportunity for discussion.

Procedure

Practice sessions

The model used for this case study is the longitudinal method pioneered by Chaffin and Imreh (1994; 1997; 2001; Chaffin, et al., 2002). Practice sessions were video-recorded from the first interaction with the score to the public performance. There were sixteen practice sessions, totalling 30 hours and 51 minutes. Two practice sessions were unplanned before ensemble rehearsals, and therefore unrecorded, whilst three sessions were corrupted. As such, eleven video-recorded sessions remained. For clarity, the terms practice sessions and video-recordings are used to avoid confusion.

During practice, verbalised comments were recorded during pauses in practice, with the larger aims discussed at the beginning or end of an individual session. Verbal comments were transcribed after the learning process and performance had been completed, and documented various strategies, problems or decisions during practice, as well as some metacognitive thoughts. In total, 59 comments were retrospectively transcribed from the eleven video-recorded sessions. Comments related to various issues during practice: basic (31%), interpretative (15%), expressive (20%), structural (14%) and metacognitive (20%).

After the public performance, the video-recordings of practice sessions were also transcribed by recording the frequency of starts and stops per beat (Chaffin, et al., 2002; Chaffin, Lisboa, et al., 2009; Ginsborg & Bennett, 2015; Ginsborg & Chaffin 2011a; 2011b; Ginsborg, et al., 2012; Ginsborg, et al., 2006). Unlike previous studies which grouped these frequencies per half-bar or bar, beats were chosen as the cadenza is written in free metre (discussed below). Sessions were divided into four periods that corresponded to retrospective overview of the learning process.

Annotated reports

The pianist reported decisions and musical features requiring attention during practice by annotating multiple copies of the score (Chaffin, et al., 2002; Chaffin, Lisboa, et al., 2009; Ginsborg, 2011a). Three annotated scores were made concurrently during the learning process: after the initial learning of the cadenza (after practice session five), immediately prior to the first ensemble rehearsal (after practice session twelve), and on the eve of the concert, after a further three practice sessions (after practice session fifteen). A fourth score was completed immediately after the performance. This detailed the musical features paid attention to in performance: the PCs. Seventeen dimensions were reported during the process (Table 2.1).

Table 2.1 *Dimensions used by the pianist to report features requiring attention during practice and PCs annotated after performance*

DIMENSION		**DESCRIPTION**
Basic	Intervallic	*including both harmonic implications and other structures (tritones, sevenths)*
	Hand shapes	*chordal shapes and fingerings*
	Piano shapes	*patterns formed by keyboard layout*
	Voice leading	*linear connections and progressions*
	Rhythm	*groupings and mathematical motifs (retrograde/additive rhythms)*
	Verbal associations	*mnemonic devices*
Interpretative	Phrasing	*groups of notes forming musical units*
	Dynamics	*variety of loudness and articulation*
	Tempo	*variation in speed*
	Pedal	*use of pedal*
Expressive		*character and emotional content*
Structural	Phrases	*Starts of phrases*
	Formal structure	*Section boundaries*
PCs	Basic	|
Reported	Interpretative	|*Subsets of Basic, Interpretative,*
Post performance	Expressive	|*Expressive dimensions*
	Structural	*Starts of phrases and sections*

The dimension type and beat location were annotated above the score. Retrospectively, the dimensions were grouped into the four categories described above: basic (relating to technical issues), interpretative (relating to the dynamic, articulation, phrasing and pedal), expressive (the emotional content) and structural (relating to the formal structure of the score). The beat location of dimensions was also transcribed.

Results

For clarity, the various qualitative and quantitative data sets are listed in Table 2.2, noting the source of the data, the collection period, and any retrospective analysis.

Table 2.2 *Summary of data sources, collection period and analysis*

Data type	Source	Collection Period	Analysis
Verbal Comments	Video-recordings	During learning process	Retrospectively transcribed
Pianist's reports	Annotated Scores 1-3	During learning process	Retrospectively categorised
PCs	Annotated Score 4	Retrospective	Retrospectively categorised
Practice records	Video-recordings	During learning Process	Retrospectively transcribed to locate starts, stops, repetitions and practice graphs.

The initial discussion in this chapter outlines the process of learning and memorising the cadenza. Learning stages are identified, and related to previous models. Initially, these stages were recalled from memory (Chaffin, et al., 2002). Stages were then compared with practice graphs to examine the progression of learning from sectional practice, the repetition of short segments, to integrated practice, when larger sections are joined together (Chaffin, et al., 2002, pp. 116-119; Chaffin, Lisboa, et al., 2009, p. 6). The changing role of larger dimensions subsets (basic, interpretative, expressive and structural) is then analysed through

examination of the annotated scores. This analysis also documents the PCs used, and compares the findings to previous studies.

Analysis then examines behavioural data transcribed from the video-recordings. Initially, general trends are identified from the empirical records. Subsequently, multiple regression analyses are carried out to examine the effects of basic, interpretative, expressive and structural variables – and their PC subsets – on the location of starts, stops and repetitions during practice. The aim of this analysis is to understand how the practice changed as learning and memorisation progressed. Previous research has demonstrated that practice strategies are denoted by where musicians start, stop and repeat passages. Similarly, PCs receive extended practice during the learning process, and that recall is organised by expressive and structural PCs, which become landmarks developed through extended practice (Chaffin, et al., 2002; Chaffin, Lisboa, et al., 2009; Ginsborg & Chaffin, 2011a).

It is likely that similar methods are used in the learning and memorisation of atonal music. The results of the regression analyses are then compared with the verbal comments transcribed from the video-recordings. Musicians are keenly aware of the strategies they use to learn music (Hallam, 1995a; 1995b; 1997a). As such, comparison of self-reflective comments with the objective behavioural record of practice can illuminate practice habits (Chaffin, et al., 2002, Chaffin & Logan, 2006, Chaffin, Lisboa, et al., 2009; Ginsborg & Chaffin, 2011a).

Memorising the Cadenza

The learning process for the cadenza took just over two months, from 20th December 2011 until the concert performance of the complete work on 23rd February 2012. Table 2.3 outlines the practice sessions. No previous research had been undertaken, with the exception of watching a video performance whilst following the piano part a few weeks prior. In total, it took 30 hours 51 minutes of practice to memorise the cadenza. The total is similar to Imreh's memorisation of the Bach Italian Concerto Presto in 33 hours, for a work that lasts a little over three minutes (Chaffin, et al., 2002, p. 98). The differences in learning time for a piece almost a minute longer (Bach's Presto from the *Italian Concerto*) can be

accounted for in various ways: the complexity of Messiaen's musical language, the wider range of textures and registers, or simply the different speeds of memorisation of the two pianists.

The initial learning period took place over five days. The six piano pages of the score were divided into segments, and memorised in a linear manner (Ginsborg, 2004). Although I did not analyse the structure of the cadenza until after the performance, the segmentation was later compared to the structure of the cadenza and was almost identical. This was aided by the visual elements of the score (changes in musical dimensions at structural points) along with the rondo structure depicting different birdsongs. The first learning period was extremely intensive, lasting 10 hours. By the end of this period, the notes of the cadenza were learned. There was a decrease in practice intensity over these five days. Consequently, memorisation felt more secure on the first half of the cadenza. The main focus was learning the notes and rhythm of the score, coupled with the assimilation of these dimensions into the motor responses.

There followed a break of over a month, during which I played through the cadenza slowly four times as a memory refreshing, but without any sustained practice. Practice sessions for the cadenza resumed on the 28th January, for three days. Practice involved larger segmentations of three pages, with a process of working backwards on the final third day. Other musicians have employed such a strategy (Ginsborg & Chaffin, 2011a, p. 346). I was surprised at the beginning of these three sessions that so much had settled and was remembered correctly. Later transcription revealed 90 percent of the session on 28th January had been practised from memory (Table 2.5). Progress was quicker than the initial learning period, and broadened to include expressive aspects. At the end of this period, I was able to play through the cadenza at a tempo approaching Messiaen's metronome mark, at a reasonable level technically and musically.

After a further break of two weeks, practice resumed on the 16th February for 8 days leading up to the concert. This included the rehearsal schedule with full ensemble: one rehearsal with wind only, and three full rehearsals. This period also included the only lesson I had on the work. My own practice of the main cadenza fluctuated. Initially, I relegated practice on it in order to focus on the rest of the piece so that the first rehearsal (16th February) would be successful in terms of ensemble. An intensive technical refreshing of the cadenza then

followed before the second rehearsal (20th February). This rehearsal was very successful, as the full ensemble was present and the rehearsal took place in the concert hall.

Table 2.3 *Practice sessions*

Session	Date	Duration	Video Session
1	20/12/11	3 hours	1
2	21/12/11	1 hour 47	2
3	22/12/11	2 hours 13	3
4	23/12/11	2 hours 30	-
5	24/12/11	1 hour 34	-
6	28/1/12	1 hour 35	4
7	29/1/12	1 hour 46	5
8	30/1/12	1 hour	6
9	16/2/12	1 hour	-
10	17/2/12	2 hours	7
11	18/2/12	2 hours 16	8
12	19/2/12	1 hour	9
13	20/2/12	2 hours 20	-
14	21/2/12	45 minutes	10
15	22/2/12	3 hours 20	11
16	23/2/12	2 hours 30	-
		Total 30:51	

The penultimate rehearsal was rewarding with regards to the ensemble: however, the cadenza felt much less secure than the previous rehearsal. In particular, I noted that I was physically uncomfortable, and felt overly reliant on motor memory. Consequently, on the following day my practice session was intensive, focussing on slow practice to emphasise physical comfort, followed by a session to highlight exactly where large-scale repetitions of material diverged: switches (Chaffin, et al., 2002). This latter practice served to reinforce my own mental representation of the shape of the cadenza. At the end of these sessions followed several trial performances, focussing solely on the colour of the birdsong.

The next day was the final rehearsal followed by the lunchtime concert. The only intensive practice took place that morning, repeating the practice strategies from the previous day. The performance itself was very satisfying. With regard to the main cadenza, my main worries of remembering points of

divergence and an over-reliance on motor memory were in the end not merited. In general I felt physically comfortable during the cadenza.

Stages of Practice

There have been several theories concerning the way in which musicians set about structuring their practice. Wicinski's study of ten Russian pianists identified three stages: preliminary ideas, technical work, and trial performances (Wicinski, reported in Miklaszewski, 1989, p.96). Chaffin, Imreh and Crawford (2002) expanded this concept into five stages: "scouting it out, section by section, the gray stage, putting it together, and polishing" (p.100). Chaffin, Lisboa, Logan and Begosh (2009) reinforced this idea, whilst highlighting the importance of the alternation of sectional practice with integrated practice, in which smaller sections are joined together (p.3).

Table 2.4 *Comparison of learning periods*

Wicinski	Chaffin & Imreh	Chaffin & Lisboa	Soares
Preliminary Ideas	Scouting out	Exploration	Understanding
Technical Issues	Sectional	Smoothing Out	Sectional
-	Grey Stage	Listening	Re-approach
	Putting together	Reworking Technique	Evaluation
Trial Performances	Polishing Maintenance	Performance Preparation	Preparation

Further research has documented the varying use of such strategies by professional musicians (Hallam, 1995a; 1995b; 1997a; Miklaszewski, 1989; Mishra, 2011). In the present study, five learning stages were identified retrospectively. My initial stage, labelled understanding, occurred whilst watching the video recording prior to learning. Then followed four practice stages. Table 2.5 outlines these stages in comparison to previous studies.

Sectional practice formed the main part of the initial learning period. This covered the first five practice sessions. Comparison with practice graphs reveal the tendency to work in short segments. Practice graphs are read from bottom to top, with each horizontal line represents a practice segment (starting and stopping at particular beats in the score, as shown on the x axis). Fig. 2.1 highlights typical practice procedure in this stage, illustrating practice session 1 (video-recording 1).

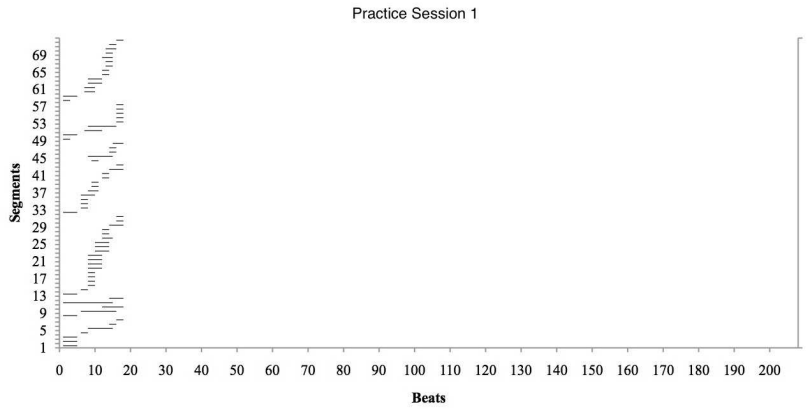


Fig. 2.1 *Practice Graph of practice session 1.*

The second learning period, re-approach, focussed on integrated practice to fit the cadenza together (Chaffin, et al., 2002; Chaffin, Lisboa et al., 2009). This covered practice sessions six to eight. By the end of this learning period, I was able to perform the cadenza, but there were minor hesitations and repetitions. Imreh commented on the difficulties of this period (the grey stage), in which the mental conception of the piece comes together with the motor responses for retrieval in the real tempo of the piece:

> The gray stage is, in some ways, the hardest. It is frustrating. Your memory is starting to be accurate but the playing is not so good yet. You don't yet have good coordination between mind and fingers (Chaffin, et al., 2002, p. 102).

Fig. 2.2 demonstrates the development of integrated practice in practice session 6 (video-recording 4). The first part of the session involves piecing the whole cadenza together.

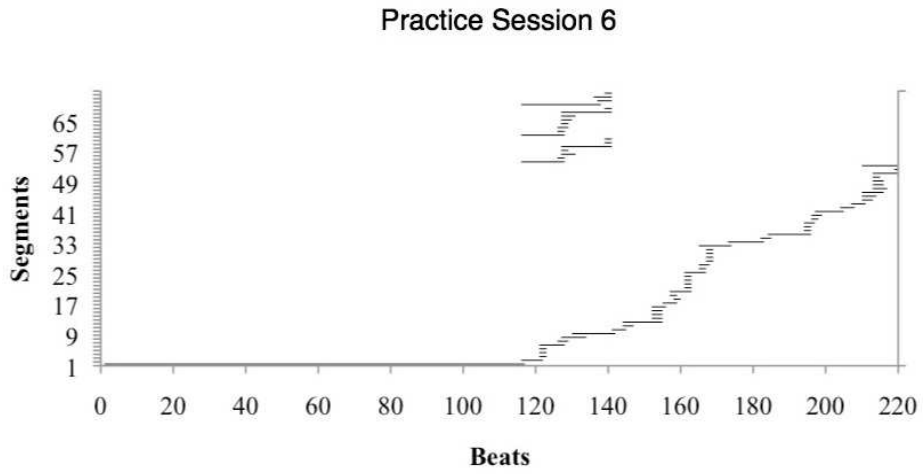


Fig. 2.2 *Practice Graph of practice session 6.*

The third practice stage further developed integrated practice. The opening of practice session 11 (video-recording 8) reveals the entire cadenza practised serially, with fewer hesitations. Then follows further sectional practice, as demonstrated in Fig. 2.3.

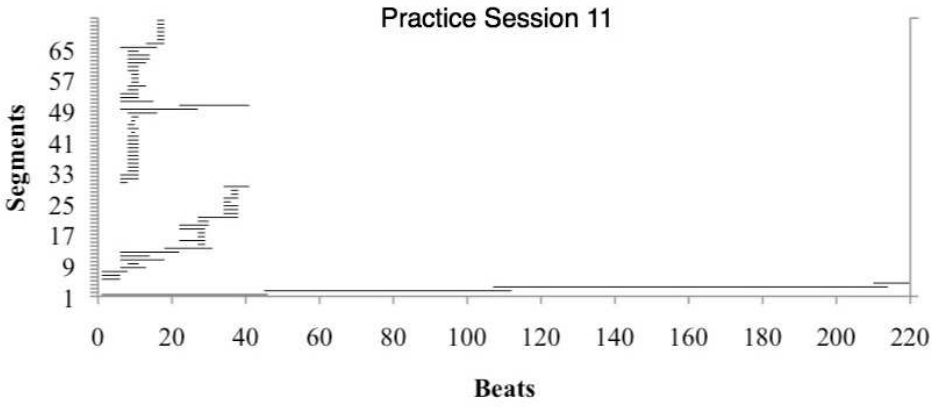


Fig. 2.3 *Practice Graph of practice session 11.*

The fourth and final practice stage, preparation, demonstrates the greatest amount of integrated practice, as demonstrated in Fig. 2.4: the opening of practice session 15 (video-recording 11).

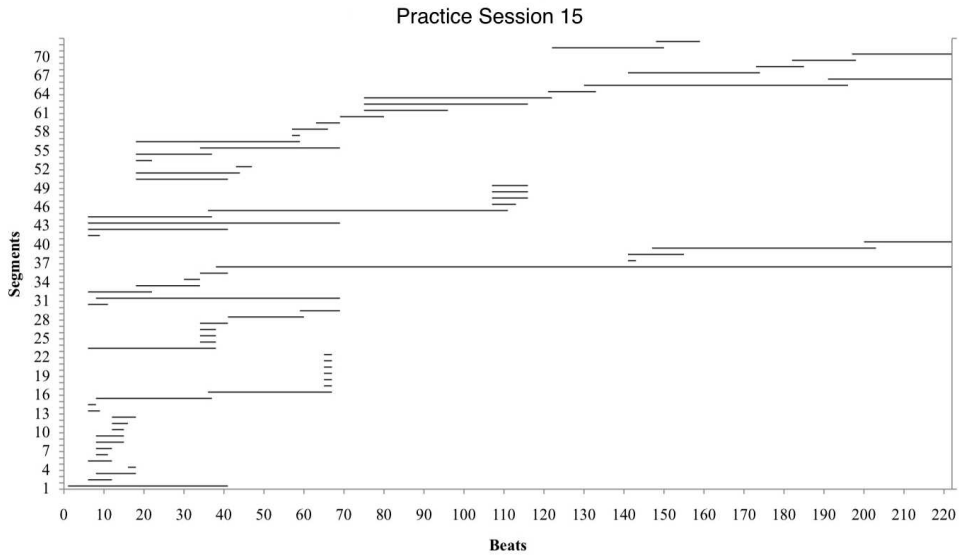


Fig. 2.4 *Practice Graph of practice session 15.*

Reports

During the learning process, the pianist reported every decision made with regard to with regard to the musical features during practice. Three reports were made during practice stages by annotating copies of the score. Decisions were subsequently categorised into four categories: basic, interpretative, expressive and structural (Table 2.1). The first of these was completed immediately after the first practice stage, and reproduced in Appendix 1 for reference. The second score was annotated after the third practice stage (practice session 12), immediately before the first rehearsal. The third annotated score was completed on the eve of the concert after three further practice sessions. A final fourth report was completed immediately after the performance. As with previous research, this last annotation documents PCs (Chaffin, et al., 2002; Chaffin, Lisboa, et al., 2009; Ginsborg, et al., 2006a; Ginsborg, et al., 2012; Ginsborg & Chaffin, 2011a).

The chart in Fig. 2.5 demonstrates how the percentages of the various dimensions changed across the learning period. Immediately apparent is the high proportion of basic dimensions used in the first practice stage (practice sessions 1-5). This is understandable as the primary concern at this stage was to assimilate the technical demands of the music. The use of basic dimensions decreases across the learning periods. However, the final practice report demonstrates a slightly higher number of basic dimensions than the second report. Comparison

with the overview of learning explains this: during rehearsals in the days leading up to the performance there was some physical discomfort in the cadenza, leading to an increased focus on technical practice.

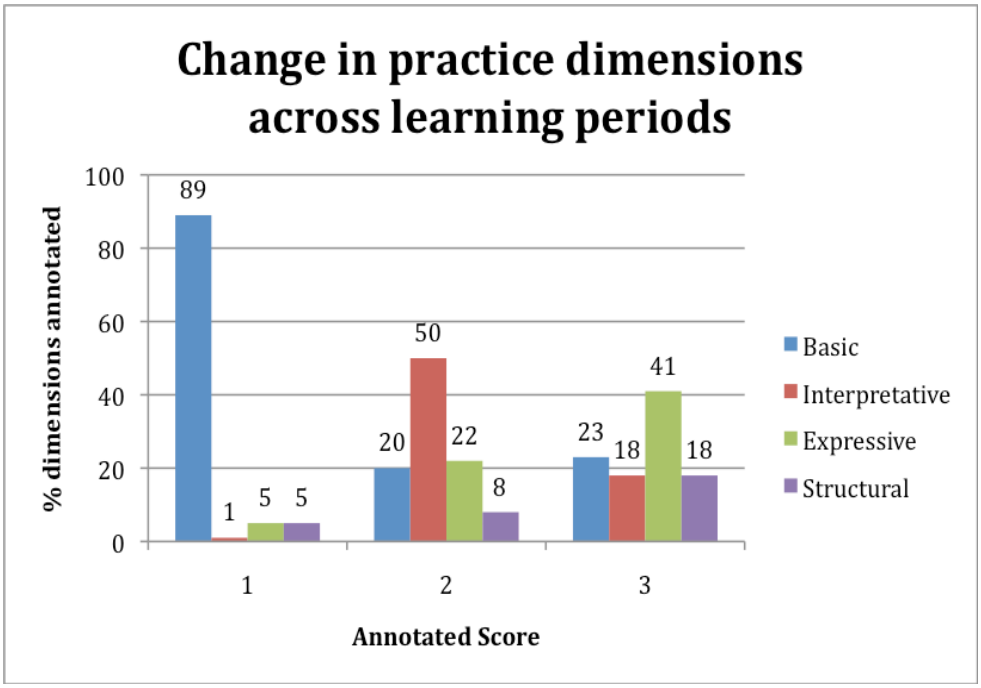


Fig. 2.5 *Changes in practice dimension by percentage across annotated scores.*

Interpretative dimensions were almost non-existent in the first sessions, but were the main concern in the second report. Interpretative issues were of a similar proportion to basic and structural dimensions in the final report. Both expressive and structural dimensions show a positive trend throughout the learning process. Expressive aims were at the forefront of practice concern in the final report. The increase in structural dimensions may indicate an increased awareness of the form of the cadenza as learning progressed, particularly with regard to phrases. The segmentation of the cadenza at the start of the learning stages was largely based on changes in tempo, texture, dynamic and motif. Whilst it was strongly aligned to the formal structure, the self-reports suggest an intuitive reasoning to form segments based on this range of dimensions, as I was not aware that the formal structure was a rondo at the beginning of the learn.

A final point of discussion relates to the number of dimensions reported in each annotated score: n=276, n=156 and n=66 respectively. This confirms previous findings that many dimensions are assimilated by kinaesthetic motor control, that hierarchical retrieval schemes are used, and a large number of dimensions are rechunked into a smaller number in order to facilitate recall during performance (Chaffin, et al., 2002, p.197-239).

Performance Cues

In total, fifty locations were classified as PCs after the performance (the fourth annotated score). These are summarised by type as a percentage in Fig. 2.6.

Fig. 2.6 *Performance Cues reported showing percentage by type.*

Previous research has examined variation in use of PCs between musicians of varied expertise (Chaffin, Demos, & Crawford, 2009a; 2009b). More difficult music often requires a higher number of cues, whilst professionals use more basic PCs. Musicians with less experience tend to use a greater number of interpretative or structural PCs (2009a, p. 2). The analysis here differs somewhat. Expressive PCs formed the highest classification of PC, whilst the remaining types of PC were relatively equal. Given the near constant demisemiquaver activity and complex language, enough practice was needed to ensure basic dimensions were assimilated with natural kinaesthetic responses. As such, extended practice may have reduced the need for basic PCs. This notion is

reinforced when examining the large reduction in basic dimensions across the annotated scores (Fig. 2.6). A final explanation might simply relate to the varied technical habits of different performers.

Formal Structure

The analysis of the structure of the cadenza occurred retrospectively. This was planned to allow for a more intuitive understanding to develop at the keyboard during the learning process. This understanding was developed from the manner in which I initially segregated the cadenza, and progressed through extended practice. The division was almost identical to the structural diagram (Fig. 2.7). This suggests that my practice was organised by the intuitive sense of the structural division, guided by changes in texture and register, and the more obvious structural points identified by changes in birdsong motif and tempo.

The formal structure is a rondo, with *Oiseau-chat* chordal motifs alternating with episodes of the *Bobolink* motif. The episodes are improvisatory in character with some motivic connections, notably the starting motifs (grace-note punctuation before more florid passagework) and rhetorical codettas. Modified *Oiseau-chat* motif interruptions also provide strong aural landmarks. Whilst the rondo structure might seem simple, the 'A' sections denoting the *Oiseau-chat* motif last only one bar (five beats). Therefore the majority of the cadenza based on the *Bobolink* episodes provided significant structural complexity. Fig. 2.7 outlines both the bar numbers of the main sections and subsection phrases.

Oiseaux Exotiques Formal Structure

Main cadenza :: Fig 24 :: bars 1 – 63

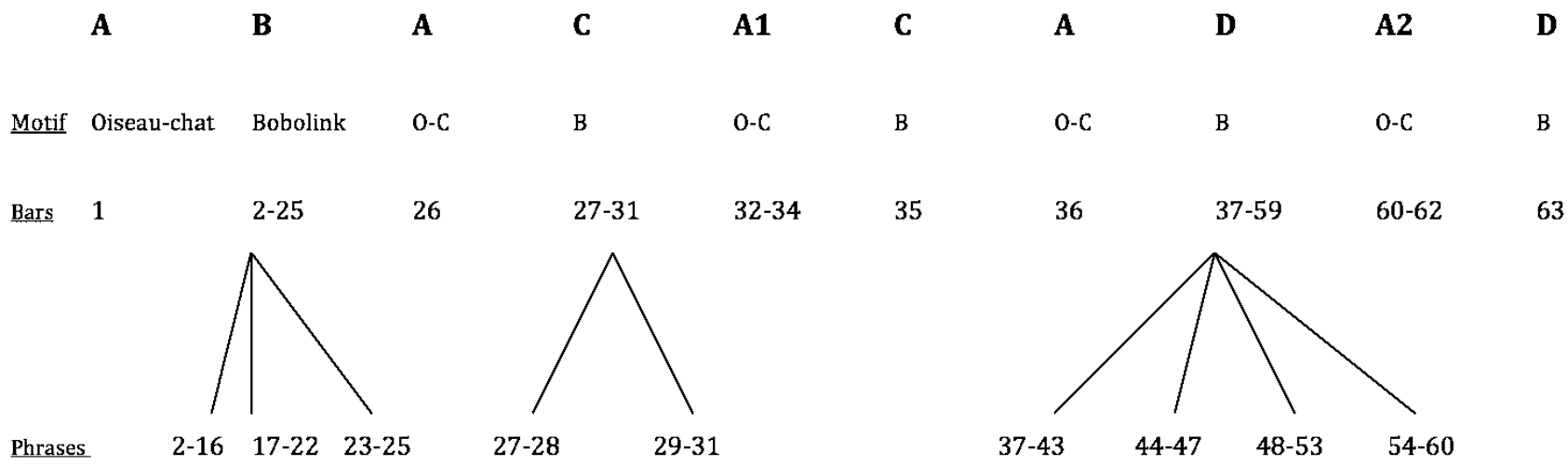


Fig. 2.7 *Messiaen Oiseaux Exotiques Cadenza: formal structure.*

Analysis of Practice Sessions

Music practice provides a detailed behavioural record as the musician constantly stops, starts and repeats whilst reviewing many dimensions, including technique, interpretation and expression. Analysis of this behavioral record provides "a window into the cognitive processes involved in developing a high level skill" (Chaffin & Logan, 2006, p. 114). To be of analytical use, such a behavioral record must be compared with the musician's aims during practice (Chaffin & Imreh, 2001, Chaffin, et al., 2002). Experienced musicians are extremely aware of their practice strategies (Hallam, 1995a, 1995b), thereby allowing a thorough examination of the practice process. The second part of this chapter examines data obtained from practice records to provide a more objective account of the memorisation procedure.

Bars vs. Beats

The technique for transcribing practice used *SYMP* (*Study Your Music Practice*) software (Chaffin & Demos, 2012). It requires the score to be divided into bars or beats to correlate various dimensions. The main cadenza is written in a free metrical form, without time signatures. Counting the time signatures of bars revealed a range from 2/32 to 67/32. This large variation is unsuitable for analysis: instead, beats were used. This posed certain difficulties. Whilst there is a fairly constant quaver pulse throughout, Messiaen's use of additive rhythms meant that the actual beat divisions used here varied from 3 demisemiquavers to 6 demisemiquavers. These divisions were firmly reliant on Messiaen's markings in the score: articulation, beaming of groups of notes, and bar divisions.

In total there were 222 beats in the main cadenza. The lack of uniformity of beat length is a limitation in this analysis. However, I argue that this is mitigated by the fact that the difference in beat length is reduced to the smallest possible durations (demisemiquavers), and thus the difference is only milliseconds at performance tempo. Whilst the difference is heightened at slower practice tempi, I believe this methodology provided the best solution as it reflected the visual content of the score, an important memorisation aid. Other

beat-division options were considered: mean bar signatures, constant quaver beats and a systematic demisemiquaver beat divisions. These were rejected for lack of connection to the visual content of the score and rhythmical gestures, or proved too cumbersome to be useful for analysis.

Transcription Process

Of the sixteen practice sessions in total, eleven were video-recorded (Table 2.3). As noted, three sessions were corrupted (practice sessions 4, 5 and 9), and two sessions were unplanned (practice sessions 13 and 16). Nonetheless, the eleven sessions provide ample practice material for analysis. For each video-recording, various data were entered into the *SYMP* spreadsheet: start time (in minutes and seconds) of a practice segment; time spent talking; the start and stop beats of a segment; the aim of practice (details or big picture); which hand was used (left, right, or both) and whether the score was used or not. A practice segment was defined as the period between each start and stop. This could be as little as a beat, or the whole cadenza. A summary is provided in Table. 2.5.

Various trends are evident across the eleven video-recordings. The majority of practice was hands together, even at the earliest stages. A great deal of the practice occurred from memory, between 36% and 55% in the first three video-recordings (which represent the very first sessions working on the cadenza). The high value (90%) in the fourth video-recording indicates that the cadenza had largely been memorised. Some reinforcement was needed, accounting for the lower percentages in the subsequent two video-recordings (between 71% and 75%). Video-recording 7 represents the start of the third practice stage. From this point it is clear the cadenza was fully memorised. The final practice stage is represented by video-recordings 10 and 11.

Table 2.5 *Empirical records of practice across 11 video-recorded sessions*

Video Session Number	Average Segment Time (s)	Average Number of Beats played	Average segments per minute	Segments from memory (%)	L (%)	R (%)	Hands together (%)
1	3.14	2.64	14.93	36	3	4	93
2	3	2.1	20.22	39	10	5	85
3	2.86	2.26	18.9	55	4	7	89
4	3.71	5.36	14.74	90	4	2	94
5	4.17	4.3	13.8	71	2	1	97
6	7.19	9.81	7.81	75	3	4	93
7	3.45	4.33	16.75	95	4	0	96
8	4.49	5.88	12.33	99	0	1	99
9	4.55	6.42	12.12	96	2	1	97
10	19.3	16.21	4.81	90	2	1	97
11	11.73	15.39	4.77	95	2	1	97

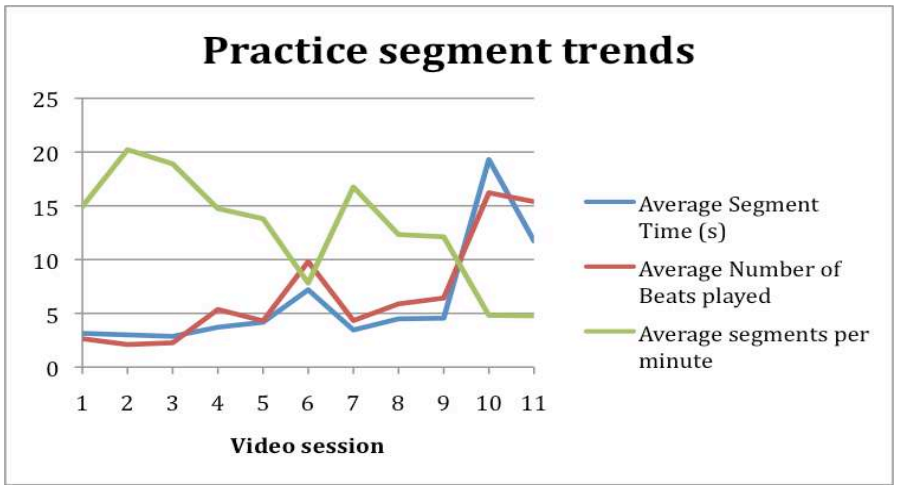


Fig. 2.8 *Practice segment trends across video-recordings, showing changes in segment time (blue), number of beats (red) and segments per minute (green).*

Fig. 2.8 produces the remaining trends in graphical form. The horizontal axis represents video session, whilst the vertical axis is a numerical count. It is worth remembering that a break of two weeks occurred between video sessions 6 and 7. This break in practice explains the disruption to the generally linear trends of the three series. The average number of segments per minute (marked in green) decreased across practice. In contrast both the average segment time in

seconds (blue) and average number of beats played (red) increased.[19] In the final session the trend reversed, revealing the preoccupation with technical issues following the week of rehearsals with the ensemble.

As a precursor to the statistical analysis below, a final summary of the starting locations across all practice sessions is demonstrated in Fig. 2.9. Whilst the regression analyses investigate in greater detail the effect of various musical dimensions on the locations of starts, stops and repetitions in practice, the summary highlights the importance of structure in practice.

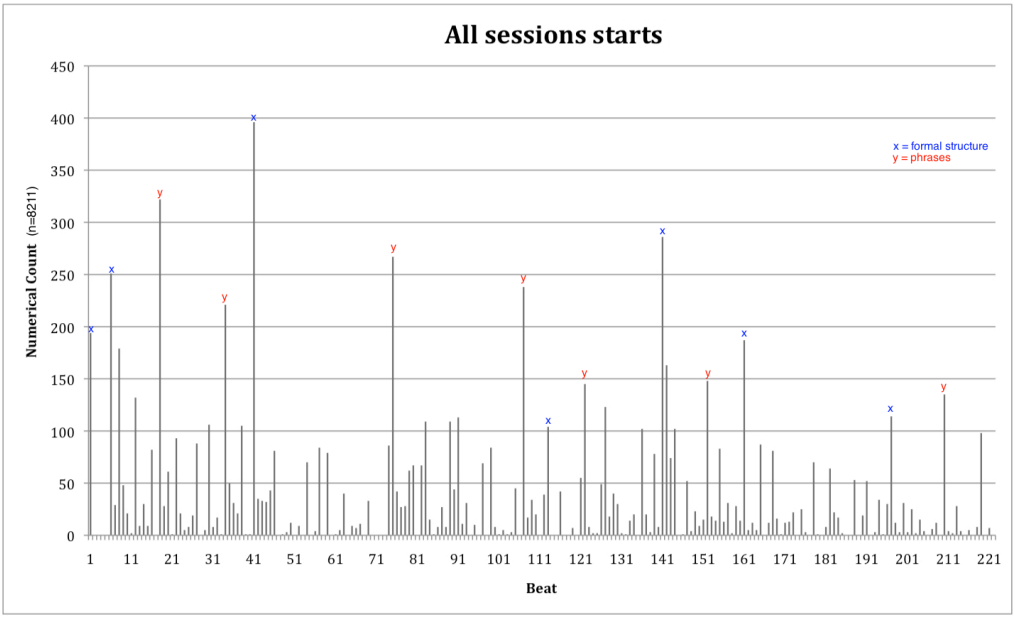


Fig. 2.9 *All session starting points in relation to section boundaries (x) and phrase starts (y).*

Regression Analysis

Regression analysis allows for a more detailed inspection of practice records. It examines if certain musical features were consistently used as starting or stopping points during practice, or if certain features were repeated consistently (Chaffin & Imreh, 2001). This provides useful information regarding practice habits: starts indicate a decision that has been made, stops demonstrate a particular problem, whilst repetitions highlight attention given to a particular feature in the score (Chaffin, et al., 2002, pp. 178-9). The significance level of an effect (the *p* value) provides a measure of reliability, and reveal which features

[19] As the size of beats varied, some scrutiny must be given to the change in number of beats across sessions. However, the general trend of an increase across sessions confirms previous studies (Chaffin, et al., 2002).

were practised most consistently at a particular stage.[20] Positive regression coefficients indicate that beats containing a particular feature were started on, stopped on or repeated more often. Negative values indicate practice avoided starting, stopping or repeating a feature.

Following the transcription process, the eleven video sessions were placed into four groups based on the four practice stages described above (Video-recordings 1-3; 4-6; 7-9; and 10-11). A tally of starts, stops and repetitions for each beat was recorded for each practice stage. The seventeen dimensions reported (Table 2.1) were placed into four groups for each of the three annotated scores. The categories were basic, interpretative, expressive and structural (as described above). In addition the PCs of these subsets were also noted. As with the starts, stops and repetitions, tallies of these dimensions were recorded for each beat, for each of the three annotated scores.

Table 2.6 provides the descriptive statistics. This lists the totals, mean average, standard deviation, range and number of zero values for each variable. This includes the starts, stops and repetitions for the four practice stages, and the musical dimensions reported. The regression analyses are organised by the four practice stages and compared with the relevant annotated scores. As only three annotated scores were completed during the learning process, musical dimensions recorded in the second annotated score are compared with practice stages 2 *and* 3. This score was completed after the third practice stage and thus provides suitable reference for comparison with both practice stages. The use of beats as a method to segment the cadenza for analysis has been described above. Previous studies have used bars or half bars (Chaffin et al., 2002; Chaffin, et al., 2009). Given the use of smaller beats, a higher proportion of zero values arise for individual variables. This is an unavoidable limitation of this study, and as such some caution is necessary when interpreting the results of the regression analyses.

[20] The *p* value relates to the null hypothesis: if a null hypothesis is true, then the result of the outcome variable is due to chance (i.e. the predictors have no effect). The *p* value indicates the likelihood of the data, assuming a true null hypothesis. Low *p* values indicate that the data are unlikely with a null hypothesis, therefore it is likely the predictors have a significant effect.

Table 2.6 *Descriptive statistics for starts, stops, repetitions and reported musical dimensions, grouped by practice stages*

Practice Stage 1

Type	Total	Mean per beat	Standard Deviation	Range	Zero Values
Basic	259	1.17	1.21	6	82
Interpretative	17	0.08	0.27	1	205
Expressive	6	0.03	0.19	2	217
Structural	11	0.05	0.22	1	211
Basic PCs	8	0.04	0.19	1	214
Interpretative PCs	0	0	0	0	222
Expressive PCs	2	0.01	0.1	1	220
Structural PCs	10	0.05	0.21	1	212
Starts	3305	14.89	28.12	157	114
Stops	3297	14.85	25.02	153	96
Repetitions	10974	49.43	57.04	312	64

Practice Stages 2 and 3

Type	Total	Mean per beat	Standard Deviation	Range	Zero Values
Basic	43	0.19	0.44	2	183
Interpretative	112	0.5	0.69	4	131
Expressive	46	0.21	0.42	2	177
Structural	24	0.11	0.31	1	198
Basic PCs	7	0.03	0.18	1	215
Interpretative PCs	12	0.05	0.23	1	210
Expressive PCs	7	0.03	0.18	1	215
Structural PCs	6	0.03	0.16	1	216
Starts (Stage 2)	2128	9.59	16.77	102	91
Stops (Stage 2)	2132	9.6	11.84	69	26
Repetitions (Stage 2)	14637	65.93	26.97	148	0
Starts (Stage 3)	2286	10.3	23.97	240	98
Stops (Stage 3)	2269	10.22	14.72	88	28
Repetitions (Stage 3)	14448	65.08	39.27	257	0

Table 2.6 (continued) *Descriptive statistics for starts, stops, repetitions and reported musical dimensions, grouped by practice stages*

Practice Stage 4

Dimensions	Total	Mean per beat	Standard Deviation	Range	Zero Values
Basic	15	0.07	0.27	6	208
Interpretative	40	0.18	0.49	1	189
Expressive	32	0.14	0.38	2	192
Structural	21	0.09	0.29	1	201
Basic PCs	12	0.05	0.23	1	210
Interpretative PCs	10	0.05	0.21	0	212
Expressive PCs	12	0.05	0.23	1	210
Structural PCs	12	0.05	0.23	1	210
Starts	492	2.22	5.89	157	150
Stops	493	2.22	6.86	153	106
Repetitions	8257	37.19	15.57	312	0

Table 2.7 *Effects of predictor variables on locations of starts, stops and repetitions during practice stages 1-4*

Predictor variable	Sd. Error	β	B
	Practice Stage 1		
Starts (R^2 0.41‡)			
Basic	1.26	0.44	10.21***
Interpretative	6.78	0.15	15.28*
Structural PC	8.28	020	24.34**
Stops (R^2 0.09‡)			
Basic	1.40	0.27	5.51***
Repetitions (R^2 0.30‡)			
Basic	2.80	0.52	24.32***
Interpretative	14.97	0.15	30.99*
	Practice Stage 2		
Starts (R^2 0.43‡)			
Interpretative	1.39	0.13	3.05*
Expressive	2.44	0.14	5.46*
Structural PC	4.60	0.51	37.94***
Repetitions (R^2 0.06‡)			
Structural PC	9.45	0.22	26.04**
	Practice Stage 3		
Starts (R^2 0.41‡)			
Structural	5.69	-0.15	-11.49*
Interpretative PC	6.33	0.12	14.29*
Repetitions (R^2 0.14‡)			
Basic	6.04	0.24	21.08***
	Practice Stage 4		
Starts (R^2 0.36‡)			
Structural PC	2.66	0.35	9.18***
Stops (R^2 0.24‡)			
Structural	2.27	0.50	5.17***
Repetitions (R^2 0.04)			
Interpretative	2.94	0.24	7.49**

* $p<.05$ **$p<.01$ ***$p<.001$
‡ $p<.05$ (ANOVA)

Twelve multiple regression analyses were carried out, with a single dependent (outcome) variable for each analysis. Dependent variables were the starts, stops and repetitions. The predictor variables were the 8 variables transcribed from the annotated scores, relating to musical features as listed in Table 2.6 (basic, interpretative, expressive and structural dimensions, with their corresponding PC subsets reported retrospectively). These were entered simultaneously into each regression analysis.

As a precursor to the regression analyses, two analyses were carried out. First, correlations of the predictor variables were completed to verify that they were relatively independent, an assumption of regression analysis (Chaffin & Imreh, 2001, p. 52; Field, 2009, pp. 197-224). There were relatively low correlations amongst variables. The exception was between a particular PC dimension and its respective subset (e.g. basic PCs and basic dimensions). Similar moderate correlations were identified in previous research (Chaffin, et al., 2002). Secondly, an ANOVA test was carried out for each predictor: those without significant effect were not entered into the multiple regression analysis.

Table 2.7 reports the outcomes of the regression analyses. Regression coefficients (unstandardised: B, and standardised: ß) are reported along with standard error and R^2 values. For clarity, only relationships between outcome and predictor variables that are statistically significant are listed ($p<.05$). The R^2 values of the regression analyses demonstrate that predictor variables accounted for between 4% and 43% of the variance. All R^2 values were statistically significant ($p<.05$) with the exception of repetitions in practice stage 4. Of the 96 possible effects of the predictors, 16 were statistically significant. The first practice stage was primarily concerned with basic dimensions: significant effects are demonstrated for starts, stops and repetitions. This focus was natural, as the period comprised of the initial dealings with the score. Interpretative effects were also significant for starts and repetition. The effect of structural PCs on starting locations was evident from the earliest stages, indicating that forward planning of the global layout occurred early on in practice. This can be attributed to the manner in which I initially segmented the cadenza.

As described above, the segmentation was closely aligned to the formal structure and the eventual structural PCs that were reported. The fact that structural PCs were significant, but the corresponding subset did not produce a

significant effect is intriguing. Review of the practice graph from the opening of the first session in this period might explain this difference (Fig. 2.1). The larger category of structural PCs was almost identical to the segmentation of the score, whilst the structural subset noted in more detail the structural boundaries and phrase starts. As practice was dealing with the cadenza for the first time, smaller chunks were put together in serial chains (Chaffin, Logan, & Begosh, 2009). This occurred in a linear process from major structural points, as the playing was not fluent enough to deal with phrases. Consequently, the major structural landmarks (i.e. structural PCs) seem to have been a more important method of organising practice, followed by serial and additive methods of assimilation (Mishra, 2011). The short segment lengths in Fig. 2.1 demonstrate this, whilst major structural points have a greater number of starts (in this case, the beginning of the piece, beat 1).

The importance of structural PCs remained in the second practice stage, for starts and repetitions. This reflects the strategy of organising practice by larger segments, and even working backwards in the final session of this learning period (a procedure also reported by Ginsborg & Chaffin, 2011a, p. 346). The focus of practice progressed to interpretative and expressive dimensions, as indicated by the results of the significant starts.

The third practice stage occurred after a break of two weeks. Accordingly, basic dimensions had a significant effect with regard to location of repetitions to re-familiarise motor responses with technical features. The structural dimension was significant for starts. The negative value of the regression coefficient reveals that section boundaries and phrases were avoided as starting points. Instead of starting at structural points, practice focussed on integrating sections. The development of interpretative PCs is also evident in the regression analysis at this stage.

The fourth learning period demonstrates the significance of structural PCs on starting locations. Fig. 2.10 demonstrates this type of practice in the final practice session. Downward arrows indicate starts of sections, whilst rising arrows highlight the start of a phrase.

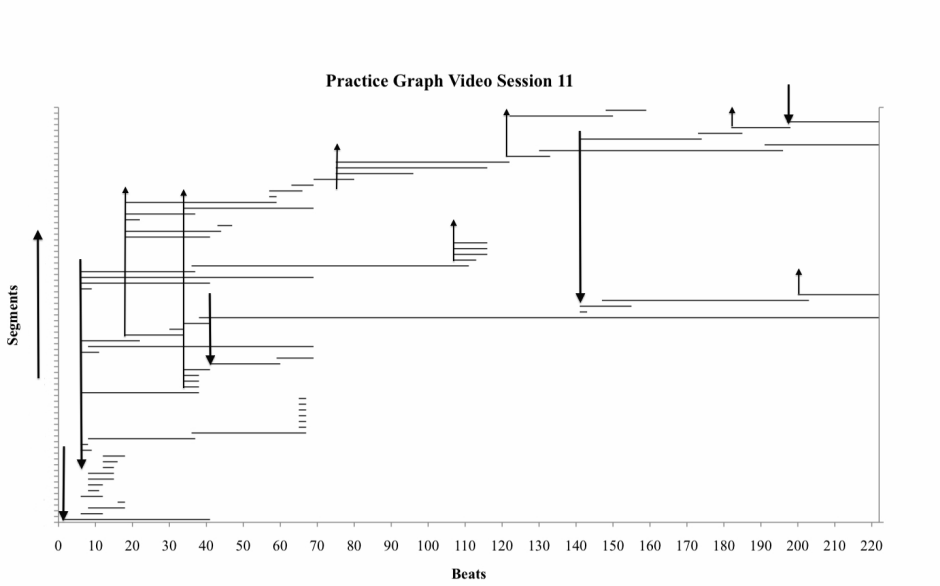


Fig. 2.10 *Practice Graph of video-recording 11, demonstrating organisation of practice by sections (arrows down) and phrases (arrows up).*

Structural dimension produced a significant effect on the location of stops: Fig. 2.10 also demonstrates the tendency to stop in similar locations (phrase boundaries). There was also a significant effect for interpretative dimensions on repetitions in this final practice stage.

The changes in dimensions during practice correspond to previous studies (Chaffin, et al., 2002; Chaffin, Lisboa, et al., 2009; Ginsborg & Chaffin, 2011a). There are fewer significant predictor effects for starting locations as the learning periods progress, and the general trend moving from basic dimensions to interpretative dimensions is followed (Chaffin, et al., 2002, pp. 190-195). The pervasive significance of structural dimensions across learning periods implies that the formal structure was used to organise practice, as suggested anecdotally in the beginning of the chapter, and indicated by the overall tally of starting points across all sessions (Fig. 2.9). This reflects previous longitudinal case studies investigating tonal music (Chaffin, et al., 2002; Noice, et al., 2008; Chaffin, et al., 2010) in addition to more complex structures of contemporary repertoire (Ginsborg & Chaffin, 2011; Ginsborg et al., 2006). PCs were identified and practised at various practice stages, with similar outcomes to previous studies. The one exception is the lack of significance with regard to expressive PCs. The importance of these PCs might not have been consistent enough in practice to register a significant effect in the regression analyses.

A more likely alternative might relate to the nature of the structural PCs. Previous study of PCs across various performers demonstrated that experienced performers tend to use structural PCs on fewer occasions. Indeed, less experienced musicians and amateurs rely on structural PCs to a greater extent (Chaffin, Demos, & Crawford, 2009). The high proportion of these PCs in this study (20%) most likely relates to the semi-programmatic nature of the cadenza, in which structural boundaries are associated with a particular birdsong, which, in turn, has its own expressive quality. Whilst the rather condensed learning period may have contributed to a higher proportion of structural PCs used in performance, it is more likely that the structural elements of the piece – with their respective expressive characteristics – replaced PC types more common in performances of tonal repertoire. Previous studies have also demonstrated the correlation between expressive and structural domains (Chaffin, Lisboa, et al., 2009). A final explanation might relate to the contextualisation of expressive PCs. As Ginsborg and Chaffin (2011a) suggest, musicians avoid starting on these cues, as whole phrases of sections may need to be played to elicit the particular character of the cue:

> The singer avoided starting at expressive performance cues where a whole phrase needed to be sung in context in order to evoke a particular feeling, for example, to convey 'dancing' or 'yearning' (p. 348).

Pianist's Comments

Analysis of verbal comments during video-recordings provides a different method of examining the learning process (Chaffin & Imreh, 2001; Chaffin, et al., 2002, Chaffin, Lisboa, et al., 2009). 59 verbal comments were retrospectively transcribed from video-recordings and grouped into five categories: basic (31%), interpretative (15%), expressive (20%), structural (14%) and metacognitive (20%). Fig. 2.11 outlines the percentages of the five types of comment across the four practice stages. Immediately apparent is the reduction in basic comments relating to technical issues as practice progresses. Similarly, expressive comments increase throughout the learning stages. There are a high proportion of structural comments in the first practice stage, but none in the second. Comments reveal an increase in metacognitive comments in the second practice stage. The lack of structural comments provides further evidence of

integration as a practice strategy, in which the larger structural issues are put aside as the cadenza is pieced together. Structural comments then increase through practice stages 3 and 4. Interpretative comments feature prominently in practice stages 2 and 3. In the ensuing discussion, verbal comments are related to location in the learning process in shorthand, identifying the practice stage and video-recording to which they refer (for example, 1:VR3 refers to the first practice stage, third video-recording).

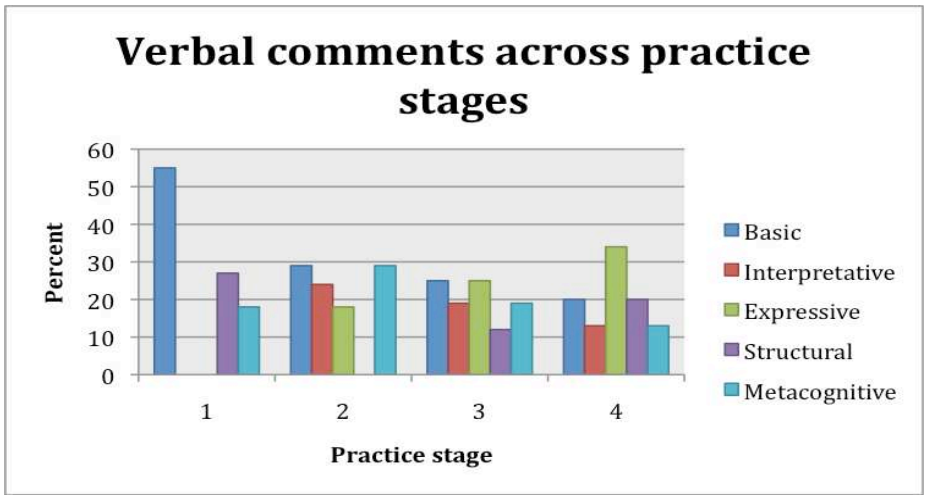


Fig. 2.11 *Verbal comments by percent across practice stages.*

Basic dimensions

Comments in the first practice stage were primarily regarding technical issues. This involved identifying patterns:

> "*I was looking at starting notes of rhythmic groups to find patterns in voice leading.*" (1:VR2).

Assimilation of rhythm occurred through filling in longer note durations with the lowest rhythmic denominator, to internalise gesture:

> "*I was filling in rhythms with demisemiquavers.*" (1:VR2; 1:VR3).

Additionally, integrated practice was identified at this early stage for small fragments:

> "*Fairly early on, I worked out the final metronome markings and played small chunks at tempi approaching the marking*." (1:VR2).

The second practice stage identified changing some fingerings:

> "*Fingerings were changed in the bottom system of the first page of the cadenza: previous fingerings were less comfortable at faster tempi.*" (2:VR4).

The faster tempi created problems with motor control:

> "*The demisemiquavers need time to speak.*" (2:VR4; 2:VR5).

Further patterns were established for switches:

> "*Verbal association patterns were assigned to the two codettas: Washington D.C. to encode the starting notes D natural and C natural*." (2:VR5).

There were fewer comments in the third and fourth practice stages. The comments reported revealed a concern with the tendency to rush, and the lack of control and physical discomfort this caused. This type of comment was a particular concern in the fourth practice stage:

> "*The cadenza feels like it's running away with itself: slow 'drilling' practice is needed to counteract this."* (4:VR11).

Interpretative Dimensions

The first practice stage registered no comments for interpretative issues. The highest proportion of comments for this dimension occurred in the second practice stage. This indicated that interpretative dimensions were slowly being assimilated with motor responses.

> "*I was beginning to shape gestures with dynamics*." (2:VR6).

> "*The end of the first section needs to be quieter*." (2:VR4).

The wider effect of interpretative dimensions was reported in practice stages 3 and 4:

> "*The playing feels flat: it needs more contour, shape, and dynamic variation*." (3:VR7).

> "*Practice involved going through the cadenza to maximise the phrasing, dynamics and articulation*." (4:VR10).

Expressive Dimensions

As with interpretative dimensions, no expressive issues were reported in the first practice stage. The second practice stage reveals an awareness of the lack of expression in the playing:

> "*It needs to sound more like birdsong."* (2:VR4).
>
> *"The faster passages are beginning to sound like birdsong"* (2:VR6).

The third practice stage reveals expressive dimensions included wider aims:

> "*I was working on expression, focussing on the sound quality and contour of the figurations in small sections."* (3:VR7).
>
> "*The trial performance was lacking in colour."* (3:VR8).

This concern is also reflected in the fourth practice stage:

> "*It was generally all there, but needed to aim for greater colour."* (4:VR10).
>
> "*There was some singing in this session to make sure gestures were fully characterised and shaped.*" (4:VR11).

Structural Dimensions

Structural dimensions were reported from the first practice session:

> "*I was jumping between locations to get an idea of the big picture of the cadenza. Connections between the segments I had divided the cadenza into became apparent."* (1:VR1).
>
> "*I was working out the structure globally, and placing the Oiseau-chat motif in context.*" (1:VR2).

Structural comments returned in practice stages 3 and 4:

> "*I was jumping between phrases in sections to refresh my memory of the bigger picture.*" (3:VR8).
>
> "*There was some practice joining phrases to ensure the structure and progression of the playing remains intact.*" (4:VR11).

Metacognitive Dimensions

Metacognitive comments related to awareness of practice strategies and progression throughout the memorisation process. As such, the comments deal in more general terms:

> "*I was testing memory of small passages at an early stage.*" (1:VR2).
>
> "*I began with a recap to test memory.*" (1:VR3).
>
> "*The trial performance showed memory was largely intact, with some minor hesitations. Although the score was not used, hesitations often occurred at page turns. Perhaps my use visual memory is failing here.*" (2:VR6).
>
> "*There were some hesitations in runs of sections.*" (3:VR9).
>
> "*The playing feels overly reliant on muscle memory: there is a lack of control as the fingers take over.*" (4:VR11).

Comparison with regression analyses

Regression analyses and verbal comments provide different and independent sources of information regarding practice processes (Chaffin & Imreh, 2001). Comparison of the two reveals whether the pianist's insights agreed with the behavioural record (Chaffin, et al., 2002; Chaffin, Lisboa, et al., 2009; Ginsborg & Chaffin, 2011a). The regression analyses demonstrate significant effects for basic and structural dimensions in the initial practice stage, with interpretative and expressive issues addressed later in practice. The general trend is repeated in verbal comments (Fig. 2.11). As with previous studies, this pattern indicates that verbal comments are a reliable source in documenting what the pianist practised, and the effects of the regression analyses reveal what was dealt with in practice (Chaffin & Imreh, 2001).

Inconsistencies are also apparent in the two results. Interpretative comments were nonexistent in the first practice stage. However, there was a significant effect of this variable on starting locations. It is likely that more overt dynamics were intuitively practised during that stage, with verbal comments occurring later in the process. Another interesting discrepancy relates to

structural dimensions in practice stage 2. The regression analyses reveal significant effects for structural PCs on starts and repetitions. No verbal comments occurred in this practice stage. As the regression analyses confirm, practice of larger structural PCs occurred in the first practice stage, and as such, comments were not needed regarding this dimension. Structural comments in the third practice stage also clarify the negative coefficient for the effect of structural variable on starts: indicating that practice avoided starting on this variable. Comments confirm that practice jumped between phrases and sections to reinforce the progression of the cadenza.

A final inconsistency in the two analyses relates to basic comments in the final practice stage. These highlighted the need for more technical practice, yet there is no effect of basic dimensions on practice. This is harder to explain. It may be that practice of this dimension was not consistent enough to register an effect, or it may be that the concerns at the time were unwarranted.

Conclusions

The findings in this chapter largely correspond to existing longitudinal studies on PC theory. Similar practice stages were identified (Chaffin, et al., 2002; Chaffin, Lisboa, et al., 2009; Wicinski, reported in Miklaszewski, 1989). Musicians use the formal structure of the work to organise practice (Chaffin et al., 2002; Chaffin, Imreh, et al., 2003; Chaffin, Lisboa, et al., 2009; Chaffin & Logan, 2006; Ginsborg & Sloboda, 2007; Ginsborg & Chaffin, 2011a; Noice, et al., 2008). This study confirms the theory and extends the literature to examine the memorisation procedure for atonal music by a pianist. As no prior analysis was undertaken, the musician was not fully aware of the formal structure. Instead, first-person accounts demonstrate that the cadenza was segmented by intuitive awareness of changes in motif, tempo and various musical dimensions. This division was closely aligned with the formal structure and suggests that the pianist used a wider musical knowledge to ascertain an unfamiliar structure to organise practice.

Whilst more research is needed to establish whether the use of the structure as a hierarchical retrieval scheme is prevalent across atonal music, it is likely that experienced musicians are able to analyse detailed musical features at

the instrument to understand more complex structures.[21] The importance of structure in organising practice is confirmed by the more objective analysis of video-recordings. First, the total number of starts across all sessions reveals greater tallies on structural boundaries and beginnings of phrases (Fig. 2.9). Secondly, the regression analyses indicate significant effects of structural boundaries and structural PCs on practice: structure was used to organise practice and also became content-addressable locations (Chaffin, Logan, & Begosh, 2009).

The focus of practice also changed across the sessions. Basic dimensions were prevalent in earlier sessions, but became automatic and attention was no longer required in the final sessions. There was an increased focus on interpretative and expressive dimensions as the learning progressed, following previous trends in other musicians (Chaffin, et al., 2002). Different types of PCs were established and practised at different points during the process. In this study, it is likely that a combination of PCs and serial chaining was used. There is strong evidence for the use of PCs: however, the relatively condensed learning period, coupled with technical concerns in the final sessions may suggest that serial chaining was also present in memory procedure. Although the performance was a success and the technical concerns were unwarranted, it is likely that more time for over-learning may have improved comfort (Driskel, Willis, & Copper, 1992).

Did undertaking the case study affect the learning process? Whilst minor changes in practice inevitably occurred, including increased verbalisations during practice, and completing annotated scores at various stages, it is unlikely that this had much effect. My preoccupation was always to ensure that the score was memorised and the performance would be to the highest level possible. Practical concerns, along with the influence of existing literature were forgotten in the practice room: the focus was solely on the playing. As such, the data collected concurrently can be seen as extensions of this process.

The limitations of combining the practitioner-analyst roles are harder to unpick. Over-reliance on self-reports is dangerous and prone to confusion and erroneous conclusions (Chalmers, 1990; 1996; Dennett, 1991; Nisbett & Wilson,

[21] More complex, unfamiliar formal structures are discussed in Chapter 5.

1977). The strict segregation of the roles of practitioner and researcher aimed to reduce any expectations I had on the outcome of the study. As with previous studies, the objective behavioural record of the video-recorded sessions was used to verify first-person accounts. The statistical model was based on existing research (Chaffin et al., 2002; Chaffin, Lisboa, et al., 2009). Given the high number of zero values for particular variables, some caution is necessary when interpreting the results.

More recent research has used mixed models for regression analysis (Ginsborg & Chaffin, 2011; Lisboa, et al., 2015). Given that the author's training is in performance and traditional musicology, such complex models are beyond the scope of this research. Whilst further review and future research would benefit from the expertise of a cognitive psychologist, it is likely that the outcomes of this descriptive study – with comparison to existing literature – provide enough detail regarding general practice trends for the purpose of this study, and extends the body of literature to a pianist's interaction with atonal music.

The following chapter continues analysis of *Oiseaux Exotiques* from a different approach, in the form of a detailed analysis of memory strategy at the keyboard. The chapter addresses how atonal music can be memorised. This examines what occurs when the usual patterns in a musician's knowledge (scales, arpeggios and harmony) cannot be used. As such patterns form a fundamental part of expert memory theories (Ericsson & Kintsch, 1995), how are they replaced in atonal music? In many ways, this is similar to traditional analysis. However, instead of analysing dimensions that are compositionally significant to the structure and motif of the work, the focus examines any significant dimensions for memory procedure. Hence, a much wider variety of features can be classed as significant, ranging from more typical dimensions (motivic features, rhythm and structure) to the more inventive methods required to memorise atonal music (hand shapes, visualisations, body movements and verbalisations). This analysis in particular contributes new, alternative narratives to research on musical memory theory, by examining on a detailed level they manner in which a musician (myself) commits the actual stimuli to long-term memory.

CHAPTER 3

Memorising Messiaen

Methods of Memorisation

The focus of the thesis in the following two chapters examines strategies for encoding musical features during practice. Whilst musical examples of PCs have been reported in previous research (Chaffin, et al., 2002; Chaffin, Lisboa, et al., 2009; Ginsborg & Chaffin, 2011a), more detailed analysis of encoding at various stages of practice has been under researched. This is most likely for two reasons: first, it is generally assumed that musicians form individual strategies for memorisation (Hallam, 1995a; 1995b; 1997a). Secondly, given the fundamental role of harmonic schemas in learning, such analysis for tonal music may be of less interest to musicologists. The theory of skilled memory proposes that an essential part of the extended memorisation technique is a specialist's knowledge of a particular domain in order to deduce patterns (Chase and Ericsson, 1981; Ericsson & Kintsch, 1995). Halpern and Bower (1982) have established the importance of formal training that instils scales, arpeggios and chords as immediately recognisable schemas in the musician's vocabulary (p.42). Previous studies in musical memory have relied on this principle.

Yet, in music such as Messiaen's *Oiseaux Exotiques*, this feature is severely diminished, if not entirely removed. Harmonies may indeed be memorable and evocative as individual objects, but if there is no pattern to relate to, can a performer memorise the music without the need actively to think about every note during performance? Williamon (1999) has commented on the difficulties of memorising atonal music and the problems it may pose leading cognitive overload. Similarly, problems arise for auditory memory, as elucidated by Crawford:

> I would guess that auditory memory is so vital and automatic that it is often simply taken for granted. I would expect it to be noticed only when the performer is learning polyphonic or atonal music, where the profusion or lack of expected aural patterns can cause serious difficulty (Chaffin, et al., 2002, p. 37).

Sloboda (1985) explains how such patterns are vital for effective musical memorsation:

> Effective musical memory depends upon the ability to represent music in terms of the grouping of notes which can be related to familiar stylistic patterns and structures and also other sequences within the same piece (p. 95).

Cook (1989) further elaborates on this necessity in relation to formal analysis:

> The ability to set aside details and see large-scale connections appropriate to the particular musical context, which is what analysis encourages, is an essential part of the musician's way of perceiving musical sound. For a performer, it is obvious analysis has a role to play in the memorization of extended scores, and to some extent in the judgment of large-scale dynamic and rhythmic relationships (Cook, 1989, p. 232).

Familiar patterns are evident in tonal music, where motivic patterns are often repeated in various keys, registers, voices and other musical dimensions. This allows faster assimilation and cross-referencing, both within the piece and in comparison to existing knowledge. The difficulties and complexities of atonal music do not necessarily mean there is an absence of patterns. Instead, the familiarity of such patterns is greatly reduced, and the prospect of memorising often seems daunting. As such, the following two chapters analyse in detail my own memorisation techniques, initially evaluating procedures used in the *Oiseaux Exotiques* cadenza. This is then compared with procedures adopted in other works by Messiaen. The following chapter extends the analysis to a wider range of repertoire. The aim here is to discover if methods employed can be replicated in a variety of different styles of atonal music, and thus, whether these strategies can inform other practitioners as to the effectiveness of such devices.

The documentation of memorising strategies by expert performers is a familiar process, either by the performer themselves or in dialogue with an independent party. This serves to aid students or to inform those interested in the demands of a performing musician. The most notable is Gieseking's

recommendations for visualising the score as a tool for effective memorisation (Gieseking & Leimer, 1978, p. 11). Various studies have used interview techniques to examine practice strategies of concert pianists (Benser, 2012; Brower, 1926; Cooke, 1948; 1999/1917; Dubal, 1997; Elder, 1986; Horowitz, 1982; Noyle 1987; Portugheis, 1993; 1996; Rosen, 2002; Wallick, 2013). General anecdotal evidence, such as the use of analysis, combination of kinaesthetic and aural approaches, practising away from the keyboard and chunking the composition into sections, reaffirms more detailed observational studies reviewed in chapter 1.[22]

Although there are more detailed investigations, analysis with specific musical examples has largely been neglected. Nellons (1974) has examined the effect of blocking chords: forming chains of notes to their corresponding harmonies as an aid to memorisation. More recently, Li (2007; 2010) has developed more interesting strategies for memorisation, several of which are comparable to the methods described below. Her research largely focusses on tonal music, with one short contemporary piece. Li labels six strategies as musical mnemonics, hereafter referred to as MMs (2007, pp. 43-60). The first, Inner Speech MMs, refer to various internal verbalisations, including solfège, beat counting and verbal connotation. Kinaesthetic MMs refer to memorisation by rote, a topic covered extensively in other research (see chapter 1). Key Note and Imagery MMs represent aural and visual memory. Interval MMs refer to recognition of similar interval types. Finally, Relative MMs are employed in passages that seem more random and are harder to memorise. This often involves finding a note repeated between the hands to "…'hold on' to their memorisation" (2007, p.56).

Li's strategies provide an interesting output for the practitioner: however, there are several limitations. First, the analysis primarily investigates standard tonal repertoire. More interesting devices (such as the Interval MMs) are likely subsumed in a musician's general knowledge of harmony (see Halpern & Bower, 1982). In addition, the analysis is extremely brief. The case study of a short, simple contemporary piece contains only four uses of the techniques. Consequently, it is not possible to evaluate how repeated use of various MMs

[22] See: Rubin-Rabson, 1937; 1940; Brown, 1928; Ginsborg, 2004; Hallam 1995a; 1995b; 1997a; Miklaszewski 1989.

can be related within a piece, or even across different repertoire. Furthermore, the use of MMs occurs on a surface or localised level, often highlighting a single note repeated between hands, or a single interval. The strategies are extremely useful for encoding particular passages (especially in STM), but there is little contextual analysis demonstrating their suitability as a global system across a large piece or varied repertoire. Sloboda's (1985) description of effective memorisation asserts the importance of this contextual relationship of structures and patterns.

The following techniques, arrived at separately during the rehearsal process, seeks to redress this problem and propose strategies that have a wider impact on atonal memorisation, in addition to localised encoding of information into STM. Examples in the following two chapters were taken from annotated scores. The initial analysis of the *Oiseaux Exotiques cadenza* uses the three annotated scores completed in the practice stages (see chapter 2). Annotated scores were completed during the learning process for the other repertoire analysed in chapters 3 and 4. In all cases, analysis was conducted after the learning periods and performance of a particular work. The analysis is reported qualitatively according to the major cue types that consistently appeared during retrospective examination. The research type can be described as artistic research (Doğantan-Dack, 2012). The artistic practice here is central to the research methodology (Haseman, 2006). In addition, the outcomes – novel techniques for atonal memorisation – are dependent on this artistic practice in order to gain new insights that can be applied in the future, and to inform other practitioners. As discussed, the longitudinal case-study model of the previous chapter is not replicated across the range of repertoire, as the aim is to examine my own memorisation techniques.[23] The chapter begins with analysis of cueing strategies

[23] The methodology of the following two chapters has been discussed in chapter 1, but it is worth repeating again. The analysis is reliant on self-reports, of which psychologists tend to be skeptical. Analysis begins with the *Oiseaux Exotiques* cadenza. Consequently, the previous chapter validates the more experienced-based conclusions in the present study, and allows for extension of the methods here to the other repertoire discussed. Chapter 6 broadens the discussion by examining memorisation strategies of three other pianists.

employed in the *Oiseaux Exotiques* cadenza, before examining the application of these cues in other compositions by Messiaen.[24]

Intervallic

The recognition and connection of intervals, and their relation to certain motifs, was an invaluable strategy, particularly with regard to the *Bobolink* birdcall. The first type of intervallic cueing involved finding any relationship in a motif to existing knowledge, especially if there was any allusion to a chord (tonal or otherwise). The initial use of this cue was purely for encoding, and shows similarities with Li's Interval MMs (2007). In some cases, this provided a useful means of memorisation by reducing a passage to an unfolded tonal harmony, even though this harmony was not sounded at all. Thus, an established pattern served merely as a means of assimilating a group of notes. Fig. 3.1 demonstrates the process: although not sounded or acting as functional harmonies, the melodic contour of the right hand highlights a C-major dyad, followed by a D-major dyad. The F♯ of this dyad then leads to G♮ imitating a leading note to tonic note progression, albeit displaced by an octave. Although these tonal harmonies are not sounded or functional, this proved an important cueing technique in combination with the associated hand shapes.

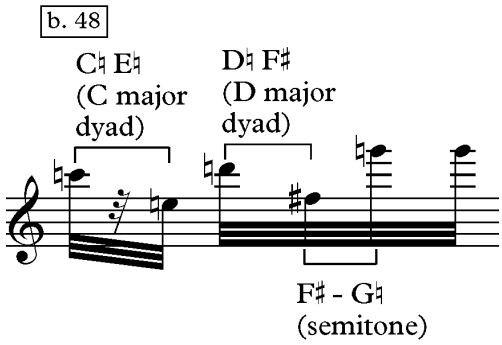


Fig. 3.1 *Tonal allusions, Oiseaux Exotiques.*

A further technique involved the denoting of certain intervals as hierarchically and motivically significant. Fig. 3.2 highlights the dominance of the oscillation of the seventh interval, combined with a tritone. A further

[24] The terms 'cue' and 'cueing' are used to refer to the encoding procedure. It is possible that some of these cues may end up as PCs, although the majority of this analysis examines patterns relating to basic technical dimensions. Such cues may be of great importance during the initial learning periods, before being eliminated or subsumed by motor memory.

connection is established by the realisation that the C-natural pitch ($c\natural^3$) is a centre anchor pitch with the seventh oscillation motif above and below.

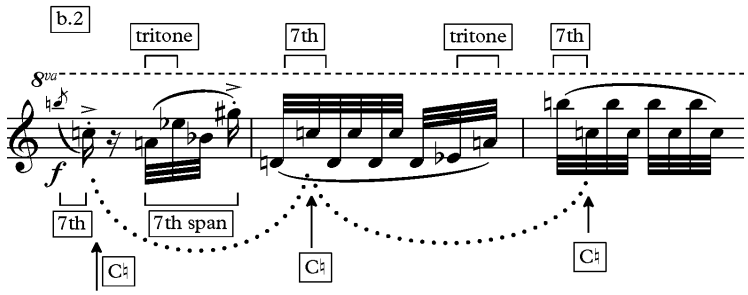


Fig. 3.2 *Tritones and seventh interval cues, Oiseaux Exotiques.*

The seventh interval oscillation is one of the main motivic features of the *Bobolink* birdsong. As this birdsong is improvisatory in character, the awareness of intervallic hierarchy became an important memorisation cue. When the oscillating seventh motif does not occur, is there some relation to this motif in the more spontaneous musical figurations? The answer is highlighted in Fig. 3.3 in which the dominance of sevenths is combined with tritones, with the latter interval increasingly important as the cadenza progresses. These served as vital markers in establishing memorisation cues.

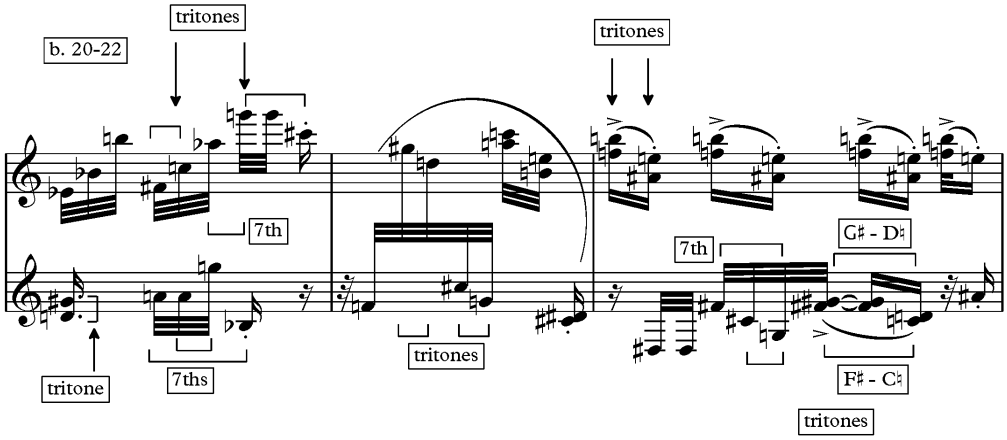


Fig. 3.3 *Tritones and seventh interval cues, Oiseaux Exotiques.*

This hierarchy of intervals is employed throughout the cadenza. A further example can be seen towards the end of the cadenza, leading to the climax (Fig. 3.4). Here the two intervals are separated between the hands: rising sevenths in the right hand, and descending fifth dyads a tritone apart in the left hand.

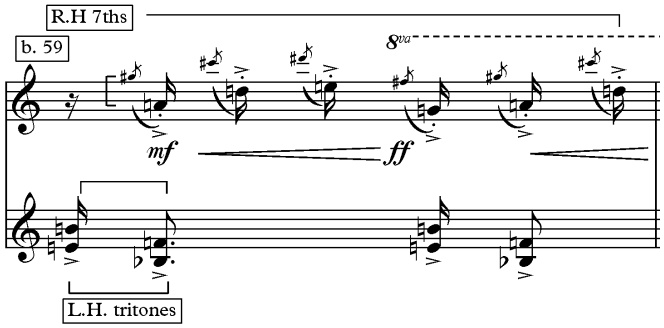


Fig. 3.4 *Tritones and seventh interval cues, Oiseaux Exotiques.*

The intervallic cues used in Fig. 3.4 were also combined with other techniques to reinforce memorisation. The left-hand fifth dyads have tonal associations, whilst the hand shape of the right hand sequence (a black grace-note leading to a white note played with the thumb) provided an additional technical cue.

The preceding examples give a clear indication of the intervallic hierarchy used in the cadenza: how Messiaen derives improvisatory figures from the *Bobolink's* main motif of an oscillating seventh call. However, these examples do not completely elucidate the memorisation processes undertaken in relation to this type of cue. Whilst some examples (Fig. 3.4) are explicit derivations of the intervallic motif, and therefore actively encoded in this manner, during the learning process it was not practical or necessary to actively encode every single important interval. As Williamon (1999) has suggested, this process would increase cognitive processes in performance to such an extent as to render effective memorisation impractical (p.94). Yet, application and understanding of repeated patterns is important for such extended memorisation (Ericsson & Kintsch, 1995; Sloboda, 1985). Humans are, after all driven by pattern spotting:

> One defining characteristic of humanity is its ravenous appetite for facts. But we don't hunger for any old ragbag of information – no, we especially crave that small subset of knowledge that involves patterns. (Bor, 2012, p. xv).

Instead, the intervallic connections described above were established through immersion in the learning process. For this cadenza, the sevenths and tritone intervals were initially designated as cues. However, as learning progressed, I relied more on awareness in the consciousness of the prevalence of

these cues, both sonically and physically. Thus, this device became subsumed in the sonic and kinaesthetic traits of the music. It is this tension between actively encoding a particular cue and the ability to be aware of a cue type that facilitates such extended memory procedure.

Hand Shape and Fingering

Another important cueing technique was an awareness of repeated hand shapes.[25] An example of this is the recurring motif in the left hand that segregates the hand into two clusters of two notes. The lower two notes are taken by the fourth and fifth fingers, whilst the upper two notes are both taken by the thumb. In addition to the symmetrical aspect of the hand shape, the memory cue is reinforced in several manners. First, the stretch usually starts on black notes (fingers four and five) and leads to white notes (thumb); secondly, the trait of the thumb taking two notes in itself aids the kinaesthetic memory; and finally this hand-shape cue combines with the previous cue type (intervallic). As seen in Fig. 3.5, the left-hand motif is formed of two seventh intervals, derived from the characteristic motif of the *Bobolink* birdsong. This procedure was used for a variety of cues, most notably establishing connections between similar chord shapes.

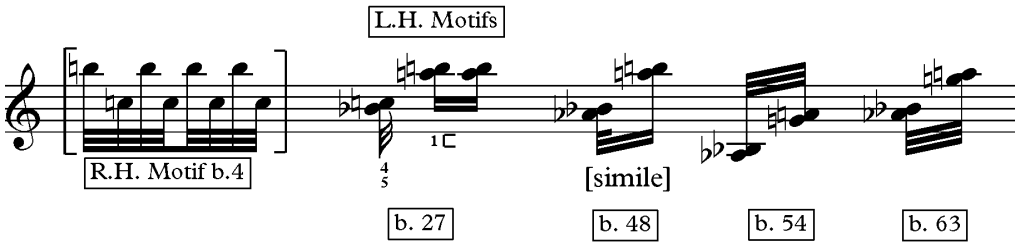


Fig. 3.5 *Hand-shape cues based on combined seventh intervals, Oiseaux Exotiques.*

[25] Musicological studies have examined hand shapes in relation to tonal harmony (Nellons, 1974). More recent neurological studies have asserted that there are "syntactic structures regulating the progression of motor acts associated with producing music" (Sammler, Novembre, Koelsch, & Keller, 2012, p. 2; see also Novembre & Keller, 2011). Pianists' imitation of silent chords was faster for chords obeying harmonic features. The assertion that there is a neurological "grammar of musical action" (Sammler, et al., 2012, p.1) has significance relating to the adoption of hand-shape cues for memorisation, even for music not obeying traditional harmonic progressions.

The procedure for fingering cues followed a similar structuring, with fingering often chosen to establish a connection with what comes next, as demonstrated in Fig. 3.6:

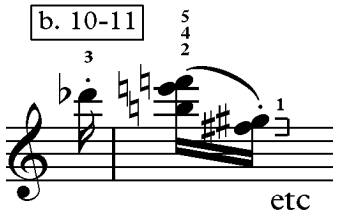


Fig. 3.6 *Fingering cues used to establish serial chaining, Oiseaux Exotiques.*

Here the upbeat to bar 11 ($d\flat^3$) is designated to the third finger to allow the following chord to be struck without any lateral movement, as the third finger ensures the chord is already under the hand shape. There is a further kinaesthetic cue in the black-note tone dyad taken by the thumb: this separation of the thumb from the rest of the hand is a familiar pianistic pattern as the thumb is often used as an anchor in chordal passages (for example, broken octaves, which occur frequently in repertoire from the classical period onwards).

A further cue type involved the encoding of symmetrical hand shapes and fingerings as a kinaesthetic marker. Fig. 3.7 demonstrates this type of cueing method. In this bar, three cues are used. First, the awareness of a similar hand position (cue 1), secondly, the physical encoding of the thumb of each hand playing the same pitch (cue 2), and finally, awareness of a symmetrical hand span between the thumb and fifth finger of each hand (cue 3).

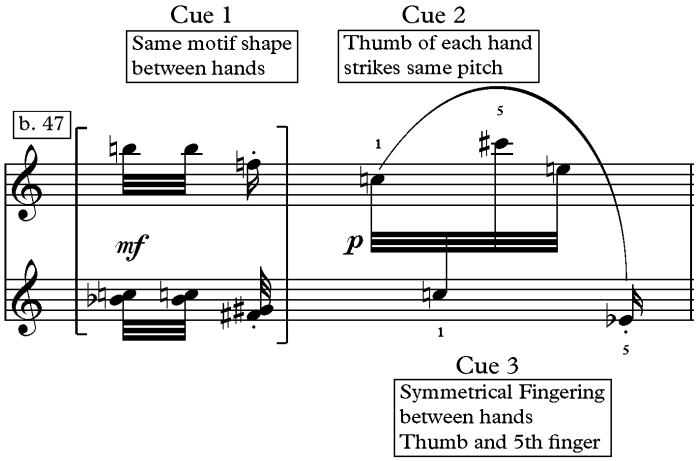


Fig. 3.7 *Symmetrical hand-shape cues, Oiseaux Exotiques.*

A final example of the hand-shape cue is demonstrated by the encoding of the *Oiseau-chat* birdsong motif. This motif is used sparingly in the cadenza, only appearing in seven of the sixty-three bars. Accordingly, this motif takes on both a structural and expressive importance. It is the first motif sounded in the cadenza, and exact repetition acts as a type of punctuation to establish a new section. Thus, the motif can be identified as aural landmarks for the performer and listener. The modified form of the motif is sounded twice at climactic, cadential points, at the end of the first half of the cadenza and the conclusion.

The importance of this motif is reinforced by the use of chords in contrast to the *Bobolink's* running melodic figurations. Fig. 3.8 demonstrates the hierarchical assigning of cues to the first modified statement of the *Oiseau-chat* motif. At the lowest level is the encoding of the contrary motion shifts of the chords in the bottom four parts, cueing that the hand shape spreads. At the top, however, the pitch remains the same. This is counterpointed with the encoding of the main cue: e♮^{2} to g♮^{2}. This minor third stood out during the initial learning process as particularly expressive, and remained the most important cue throughout the practice stages in memorising this bar.

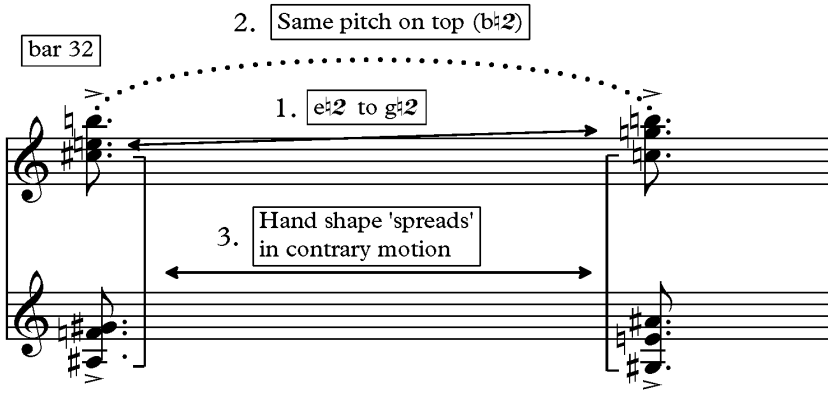


Fig. 3.8 *Hand-shape cues, Oiseaux Exotiques.*

The second statement of this motif was memorised in a similar manner (Fig 3.9). As with the initial statement, the right-hand chord position spreads. The lower parts move down a tone and a semitone respectively, with the top pitch remaining constant. However, the motif has been transformed so that the two chords are displaced by an octave, rather than falling under in the same hand position. In the right hand, the hand position of the second chord serves as a

memory cue in two manners. First, as established, the top pitch remains constant (D♯) and thereby serves as an anchor in the leap. Next, the second chord is formed solely of black notes, a strong kinaesthetic cue.

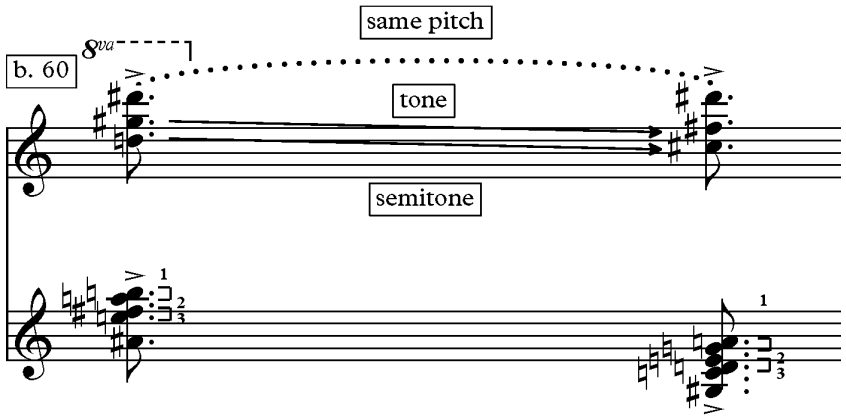


Fig. 3.9 *Hand-shape cues, Oiseaux Exotiques.*

The left-hand memorisation similarly used a cue system based on the hand shape. In both chords the thumb is used to play a cluster of two white notes, whilst the fifth finger strikes a black note. This is a derivation of the cue type seen in Fig. 3.5. Furthermore, the second and third fingers play two notes a tone apart, mirroring the thumb cluster. A final point of reference in the second chord is that without the bottom note, the chord is a C-major triad with two tones that lie under the hand to form a cluster of natural pitches. The encoding of various cues in this bar was particularly important as the three-bar passage (bars 60-62) contains continuous leaps between chords. Thus, such encoded information served to anchor the hand position to ensure the correct chord was struck. Eventually, with extended practice, this information became a natural part of the kinaesthetic memory with only certain features of this group of cues needing recall, if at all.[26]

[26] The analysis of hand-shape cues described here is primarily focussed on the encoding of new musical material into STM. Recent research has studied the body movements of musicians and singers, largely evaluating how such gesture can communicate performance intentions (Buck, MacRitchie, & Bailey, 2013; Davidson, 1994; 1995; 2002; Doğantan-Dack, 2011; Gritten & King, 2011). Future research might evaluate the development of gesture in relation to memory cues during the learning process of a particular work.

Piano Shapes and Patterns

The layout of the keyboard provides an instant group of visual patterns to aid memory. Perhaps the most useful of these for Messiaen's cadenza, which exploits the full register, is the immediate aural and tactile response of the lowest note of the piano ($A\flat_2$). The timbre of this pitch, as well as the hand position are recognisable to trained pianists as it occurs frequently in the piano repertoire from the middle of the nineteenth century.

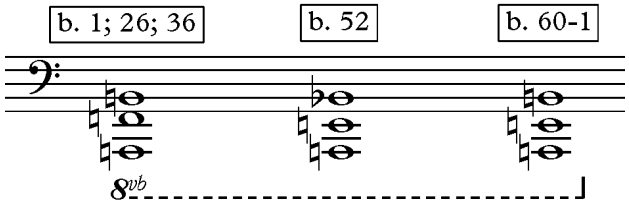


Fig. 3.10 *Cues associated with the lowest note of the keyboard, Oiseaux Exotiques.*

The lowest pitch ($A\flat_2$) provides a kinaesthetic anchor, from which I was able to use a combination of hand-shape cues, and intervallic cues to memorise these sections. Further reinforcement was a structural cue: this lowest register of the piano is reserved for the *Oiseau-chat* birdsong in the cadenza.

A similar framing device was used to cue the melodic figurations at the uppermost register of the piano in the right hand. Fig. 3.11 demonstrates the awareness of the registral peak ($g\sharp^5$) framing the melody. This peak pitch is repeated on numerous occasions. Three associations reinforced the strength of the cue for memorisation. First, the pitch often falls a tritone to C♯, thus providing a tactile imprint. Secondly, the pitch is usually repeated in demisemiquavers or in a similar rhythmical variant, instilling an aural cue in the memorisation procedure. Finally, this registral peak often occurs at the ends of phrases or gestures, and is even the final dominant pitch sounded in the cadenza. In this manner, the repeated use of this pitch takes on a more structural and cadential role.

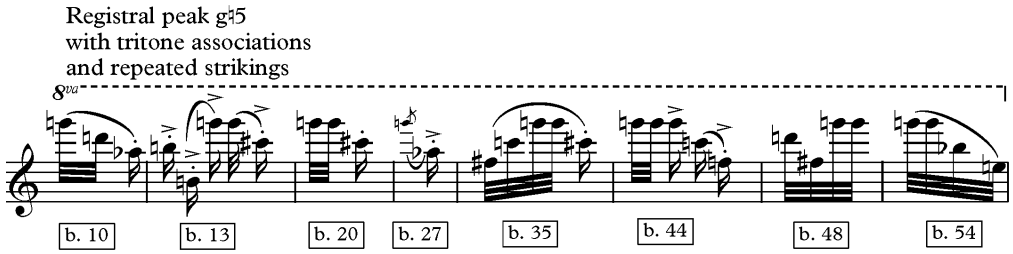


Fig. 3.11 *Registral peak cues, Oiseaux Exotiques.*

This memorisation process highlights the complex encoding of such a cue. Whilst some of these melodic fragments are instantly recognisable in comparison to others (for example bar 20 and bar 35 above that contain the same motivic cell), it was only later in the learning process that I was able to understand this pitch to be a peak. In other words, full awareness of this cue only occurred once technique had been learned and the conceptual layout of the cadenza had been achieved.[27]

Voice Leading

A further cue type involved grouping figurations into smaller patterns:

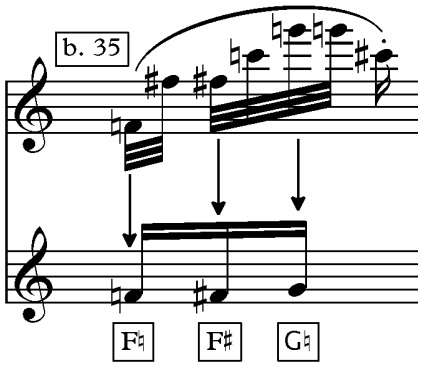


Fig. 3.12 *Voice-leading cues, Oiseaux Exotiques.*

This type of memory procedure relies on the chunking of a group of data into smaller segments. Fig. 3.12 demonstrates how the contour of this phrase is reduced into semitone steps (displaced by octaves). This is not traditional voice

[27] Neurological research into the relationships between syntactic structure and the execution of motor acts has demonstrated faster motor response for harmonic chords (Sammler, Novembre, Koelsch, & Keller, 2012; see also Novembre & Keller, 2011). This provides a neurological perspective on the importance of harmonic schemas for the performing musician (Halpern & Bower, 1982). It is likely that the patterned layout of the keyboard might also form part of an action grammar, given a pianist's extended exposure during the deliberate practice required to reach an expert level (Ericsson, et al., 1993). The use of shapes derived from the keyboard layout seems an inevitable and useful method of encoding in the absence of tonal figurations.

leading, but a derived means of establishing connections. It is more suited to encoding of material on a localised basis, and resembles Li's Relative MMs (2007, p. 56). Following on from this, another hierarchical cue was the awareness of a repeated pitch but with different accidentals:

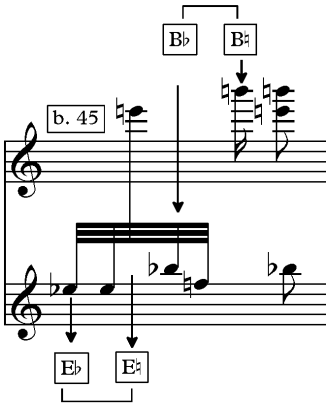


Fig. 3.13 *Voice-leading cues of enharmonic alterations, Oiseaux Exotiques.*

Here the two semitone clusters a fifth apart provide a framework for the motif, as well as the last chord in the bar. A further method of encoding combined this type of cueing with physical aspects of the hand shape or fingering. Fig. 3.14 highlights the melodic distillation of the *Bobolink* birdsong to the top of each rhythmical grouping, struck with the fifth finger of the right hand, with this fingering cue eliciting the ensuing pattern.

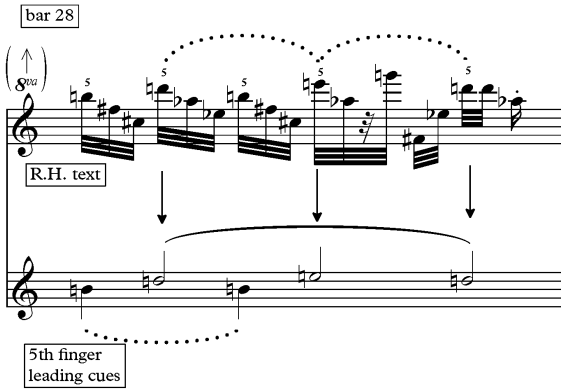


Fig. 3.14 *Voice-leading cues of melodic registral peaks, Oiseaux Exotiques.*

Fig. 3.15 demonstrates another cue type derived from this procedure: the memorisation of melodic figurations as chords. This follows a similar process to the blocking strategy proposed by Nellons (1974). In the right hand, the initial cue type is as above, with the fifth finger used to cue the ensuing group. This

then changes to three successive chordal cues, reinforced by the tonal association of the chords [C sharp; F-sharp major and G-sharp minor]. As with the intervallic cueing method based on tonal patterns (Fig. 3.8), the grouping serves as a strong cue, despite the harmonies not actually sounding in their functional form.[28] This example also includes the left-hand cueing technique, one of the few examples in the cadenza of a scalic feature.

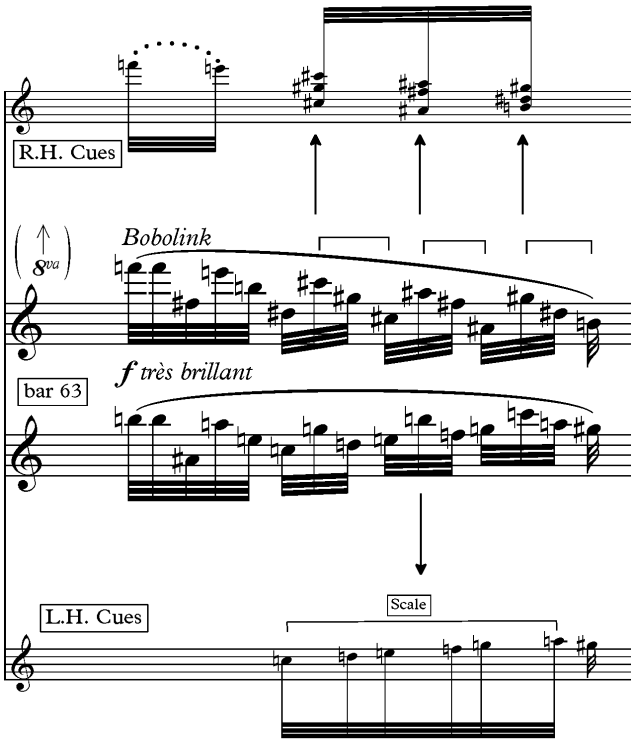


Fig. 3.15 *Blocking cues, Oiseaux Exotiques.*

[28] The method differs to Nellons' blocking, where the main outcome is the "musical realization derived through aural association" (1974, p. 28). The tonal associations in Fig. 3.15 are lost when the chords are unblocked. The strength of this cue lies in tactile and visual memory.

Verbal Association

I also used verbal procedures to memorise the starting notes of runs. In particular, this cue type was useful for the cadential passages that end the cadenza (bar 63), and the corresponding passage around the halfway point (bar 35).

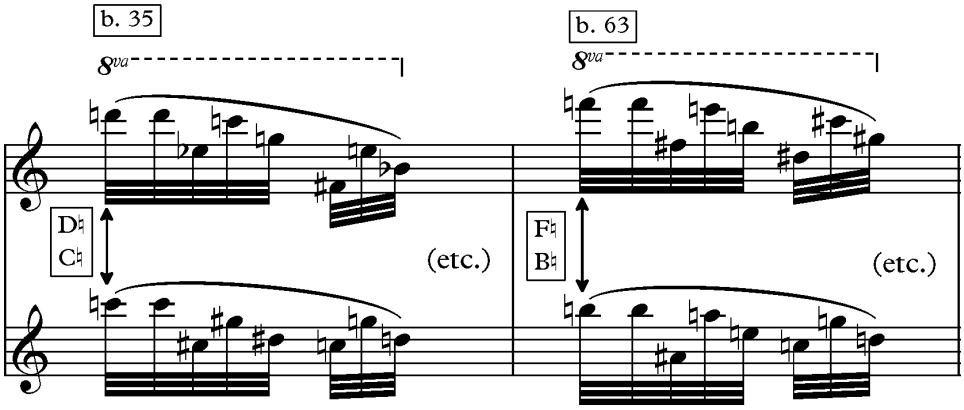


Fig. 3.16 *Verbal association cues, Oiseaux Exotiques.*

In Fig. 3.16, the runs start with D♮/C♮ and F♮/B♮ pitches. Initially, my cue was to associate the first run with the phrase "Washington **D**.**C**." and the second run with the word "**F**a**B**". This type of cue aided memorisation of an exposed run with two different paths (a switch). Eventually, I found that this cue became absorbed with motor functions during the practice process. Both of the examples in Fig 3.16 were new attack points signalling a structural cue (the start of a phrase). This type of verbal association was used to differentiate between different manifestations of a similar motif or melodic figuration.

Rhythm

The cadenza is written without time signatures, with free rhythmical groupings. The *Bobolink* birdsong is largely continuous demisemiquavers grouped in two, three, four, five and six. The groupings relate to the phrasing only, not denoting any rhythmical changes (for example a group of three demisemiquavers does not indicate a triplet). Rhythmic groupings did provide the possibility of cueing, such as the phrases that all begin with groups of three (bars 9, 28, 44, 48 and 54).

For repeated oscillations, the rhythm was immediately chunked into semiquaver groups:

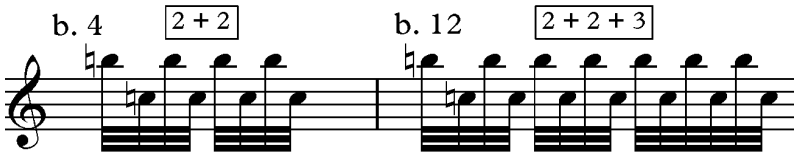


Fig. 3.17 *Rhythmic groupings, Oiseaux Exotiques.*

Such groupings sometimes formed mathematical sequences, a technique Messiaen used often and describes in his rhythmical treatises (Messiaen, 1944).[29] For example, Fig 3.18 demonstrates an additive sequence of rhythmical groupings, where groupings expand from three notes to four, and then five. This provides a clear memorisation cue, reinforced by the registral expansion.

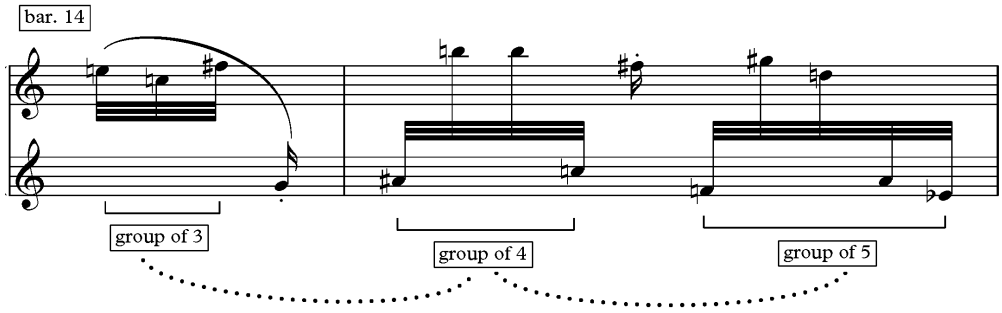


Fig. 3.18 *Additive rhythmic groupings, Oiseaux Exotiques.*

A further rhythmical technique was the use of rests to punctuate gestures. As a rhythmical memorisation cue this aided in segmenting a large gesture into smaller motifs, as seen in Fig. 3.19:

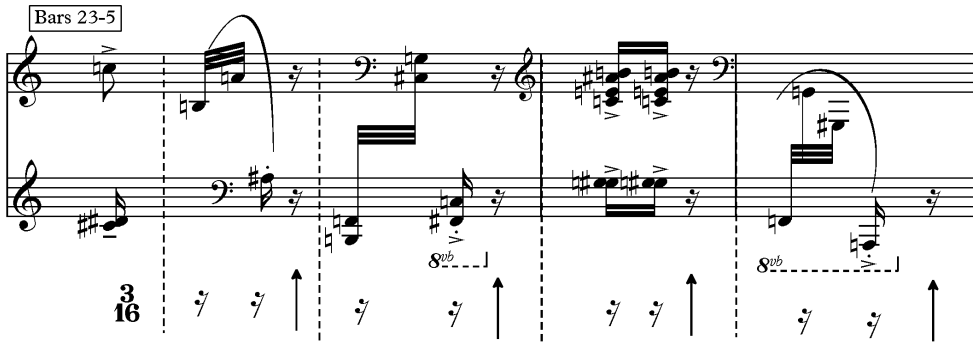


Fig. 3.19 *Rest cues, Oiseaux Exotiques.*

[29] Li (2007) provides a similar method for groupings in Prokofiev's *Third Piano Concerto* (p. 45)

Here the semiquaver rest punctuates the third beat of four gestures, which can be divided and memorised as four 3/16 bars. The type of cue is memorable simply as there is a repeated pattern across the gestures. It was particularly important to recognise these types of patterns as the majority of the cadenza takes the form of rhythmical elaboration.

A similar subdividing was used in the main *Oiseau-chat* motif:

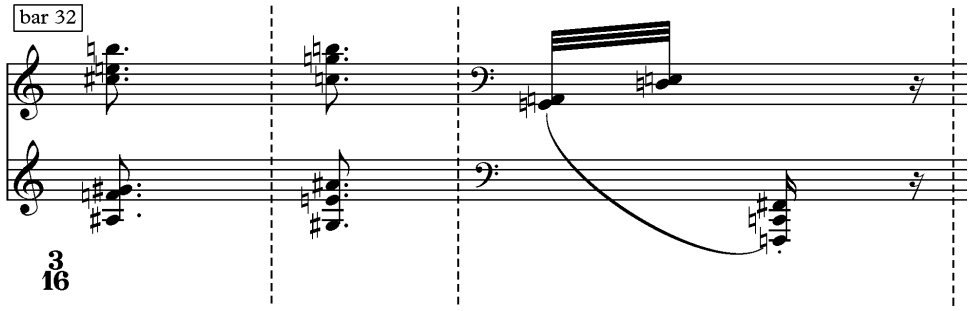


Fig. 3.20 *Subdivision of rhythmic gestures, Oiseaux Exotiques.*

A final rhythmical cue was the use of palindromic figures and symmetrical motifs common in Messiaen's music, as seen in Fig. 3.21:

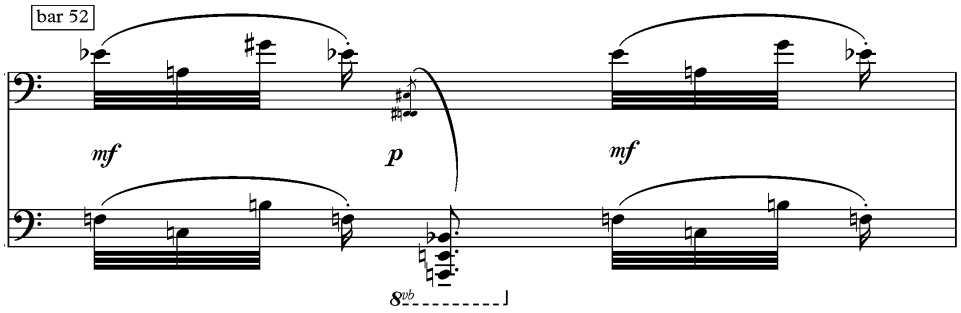


Fig. 3.21 *Palindromic rhythmic cues, Oiseaux Exotiques.*

The rhythmic symmetry here is reinforced by both the dynamics and the motivic gestures at the beginning and end of the bar: the circular motion of the hands, which are rhythmically in unison.

Extended Practice techniques

An overview of the learning process demonstrates that the progression to performance level occurs through a stepwise increase in tempo, with segment lengths increasing throughout the learning process (Table 2.5). Practice may be categorised by work on smaller segments, or runs, where smaller segments are joined into larger phrases (Chaffin, et al., 2002). Previous studies have examined the change in tempo (Chaffin & Imreh, 2001; Chaffin & Lisboa, 2008; Chaffin & Logan, 2006). It is worth highlighting two techniques used during slow practice develop speed of retrieval, commonly used by pianists. The first technique relates particularly to the practice of passagework in dotted rhythms, as demonstrated in Fig. 3.22:

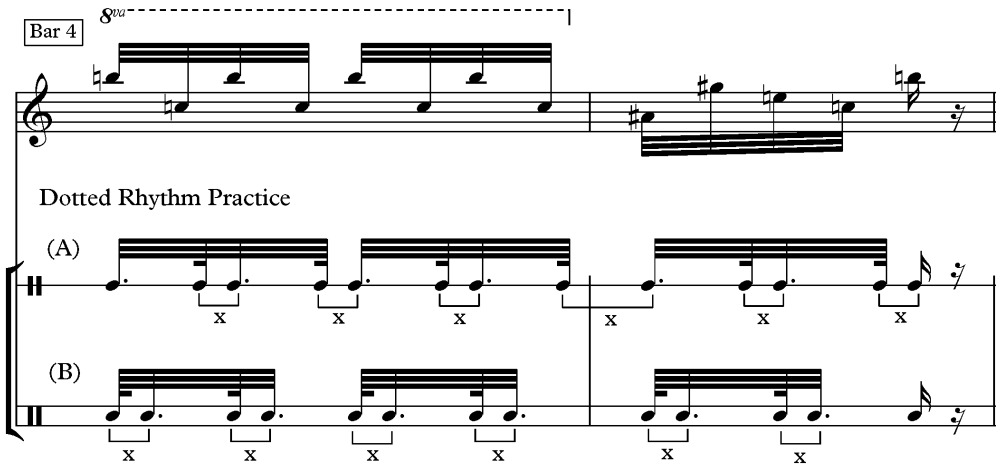


Fig. 3.22 *Practice techniques.*

Here passagework is played in two contrary dotted rhythms at a slow tempo (A and B). Label 'x' reveals the benefit of such practice: that half the figuration in a particular dotted rhythm is played at twice the speed. Once both rhythms are practised, the passage has been played at twice the speed of the actual tempo. This type of practice aids the fast retrieval of material whilst also allowing time so that the cognitive processes are not overloaded. This method can be extended (such double dotting, or more inventive rhythms) with the same goal of focussing on anticipation.

The second technique involves a similar practice of anticipation to develop faster retrieval. The technique involves the practice of a passage at a

slow tempo, but with very fast movements in between each note to arrive at the next note, which is not struck, but instead sounded silently by the hand position. Whilst this can be used for passagework, it is most effective in chordal passages, and passages with large leaps across the register.

Awareness vs. Active Encoding

The cue-type examples described above provide a detailed summary of the techniques used in encoding the technical dimensions in the cadenza. Given the complexity of the music, and the need for a basic cue on almost every note on the score, such analysis seems to confirm the notion highlighted by Williamon (1999), that memorising contemporary music overloads the cognitive processes required during performance, thereby limiting effectiveness (p.94). However, this analysis demonstrates that the process of chunking does occur. Moreover, as described in the previous chapter, the total number of hours required to bring the cadenza to performance level compares favourably to existing studies. This implies that the cognitive demands can be adequately managed.

The answer to this apparent inconsistency may lie in the difference between active encoding of a memorisation cue and simple awareness of a musical or technical feature. This latter technique often means that once a feature of the score has been identified, or related to existing knowledge of the framework of cues, it does not require further encoding as a cue. This is not to say, however, that this awareness does not need to be reinforced or refreshed during the learning process. Instead, it reveals one of the key methods in reducing cognitive processes during the learning stages. Regarding memory systems, this refers to declarative (explicit) memory.[30] Once a cue has been established, faster assimilation as comparison with existing material is possible.

A further aspect to this concept is the idea of discovering this awareness. Connections, both actively encoded and unconsciously registered, become important cues themselves. This process is intrinsically related to the individual piece being studied, and is completely subjective, therefore proves difficult to compare to existing studies. In this study, a good example can be seen in the intervallic cue in Fig. 3.5. The left-hand motif occurs throughout the cadenza as

[30] See Chapter 1; Schacter & Tulving, 1994.

described. During the initial stages of the learning process, I was unaware of this motivic connection.

However there was perhaps an unconscious awareness that each time this motif occurred it was easier to place at the keyboard, and finally I became aware of the connection of this motif. It is likely that the repeated aural encoding of such cues in sensory memory and STM, even before a cue reference has been established, aids learning.[31] A more explicit example of awareness enabling instantaneous cueing and retrieval relates to the intervallic hierarchy. As discussed, both the tritone and the seventh form an integral part of the harmonic and motivic structure of the cadenza, thus these figurations were very quickly encoded once the identification of their structural and motivic importance had taken place.

Conceptualising Strategies

A further extension from previous research was the varied conceptualising of the strategies above. Previous studies of tonal music have used clear divisions of music features (basic, interpretative, expressive and structural). Whilst identical divisions were used to group these features in the previous chapter, it was more difficult to unpick the categorisation of the strategies. On the whole, techniques dealing with the physicality of playing (intervallic and hand-shape / fingering cues) and the execution of gesture (rhythmic cues) were considered basic dimensions, whereas other conceptual patterns (verbal association cues) and melodic connections (voice-leading cues) were categorised as interpretative dimensions. The categorisations were guided by my aims during practice as reported concurrently on annotated scores 1-3. The varied approach contributed to my own understanding of my approach to memorisation: whilst this categorisation was followed, it is likely that the strategies described above were more flexible in approach, particularly when considering the process of rechunking that occurs during the practice stages.

[31] See: Chapter 1; Eysenck & Keane, 2000.

Messiaen Revisited

The analysis of the *Oiseaux Exotiques* cadenza above demonstrates the wide variety and detail when forming cues. A larger range of musical dimensions indicates that, when presented with contemporary music, the whole arsenal of playing the piano can be used as memory cues. Harmonic allusions and intervallic relationships are apparent, yet there is also a much greater emphasis on the physicality of playing. Hand shapes, registral gestures and even body movements become actively important as cues. This type of research contributes to recent studies on the nature of gesture in performance, albeit from the perspective of learning and memorisation, rather that in a live performance context (see, for example: Davidson, 1994; 1995; 2002; Doğantan-Dack, 2011).

Undoubtedly, there is no less emphasis on the physicality of playing in the standard tonal repertoire. However, in my own experience it less frequently becomes an active cue for memorisation (the type of intervallic, hand-shape cues analysed here are so fundamental to harmonic music: although they may require extensive practice, they may be taken for granted). In tonal repertoire, knowledge of harmony enables a great many cues to be translated or modified without much difficulty, between works of the same composer or between different composers. Does the same hold true for contemporary music? Can this wider range of cue types, including intervallic, physical and verbal, be reused to aid swifter memorisation? Whilst subsequent chapters will examine the challenges different composers pose for memorisation, this section investigates memorisation relationships in other compositions by Messiaen. In particular, this section will examine how existing cues formed in *Oiseaux Exotiques* can be reused, modified or translated.

Birdsong was one of Messiaen's greatest compositional inspirations, with a great number of compositions using transcribed motifs, not least *Catalogue d'Oiseaux, Des Canyons aux Étoiles, Le Réveil des Oiseaux* and *Quatuor pour la Fin du Temps* (Hill & Simeone, 2005). Given such a proliferation of birdsong material it seems likely that there might be some repetitions or connections that a musician can use to aid memorisation and learning. In a similar manner, does the

harmonic language provide long-term cues for memory? Or do distinct works contain their own sonic language that must be learned separately? In the three years following the performance of *Oiseaux Exotiques*, three other works by Messiaen were in my schedule to be learned and performed: *Quatuor pour la Fin du Temps*; *Regard de l'esprit de joie*, from *Vingt Regards sur l'Enfant-Jésus*; and *Des Canyons aux Étoiles*. This section of the chapter examines cue relationships between these three works and *Oiseaux Exotiques* to understand how much overlap – if any – occurs, thereby revealing the effect of repeated study of a composer.

Intervallic Cues

Harmonies formed from sevenths and tritones form an important part of Messiaen's musical language, as demonstrated in *Oiseaux Exotiques* discussion. The *Quatuor pour le fin du temps* has a much more varied harmonic language. This is perhaps not surprising given that the work was composed in 1941, relatively early in his career. Along with tonal harmony, octatonic clusters and whole-tone scales, harmony based on sevenths and tritones is also prevalent. In discussing memorisation cues, it is the latter type of harmonic feature that is most interesting and relevant to investigate here. The tonal harmony used, despite not being functional, is fairly straightforward to learn and memorise in this piece. It either is extremely repetitive, or can be identified as a landmark cue in a sequence of more complex harmony. The stronger tonal allusions here are more closely related to Nellons' blocking technique (1974). These two outputs of tonal harmony are demonstrated in Figs. 3.23 and 3.24 respectively.

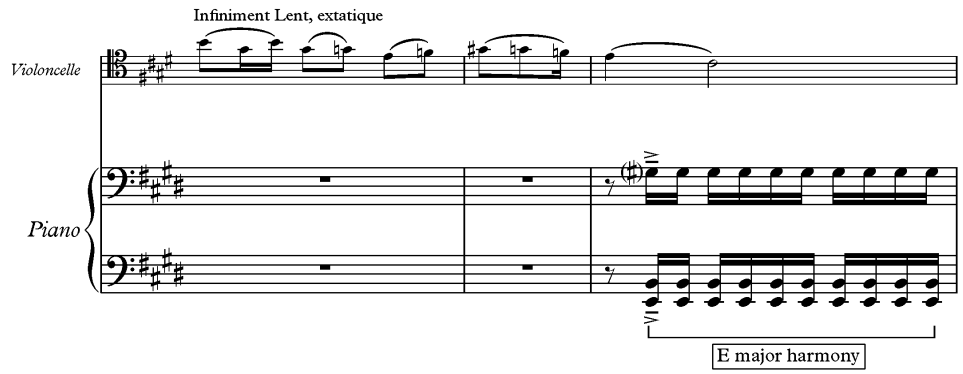


Fig. 3.23 *Tonal allusions, Louange à l'Éternité de Jésus (Quatuor).*

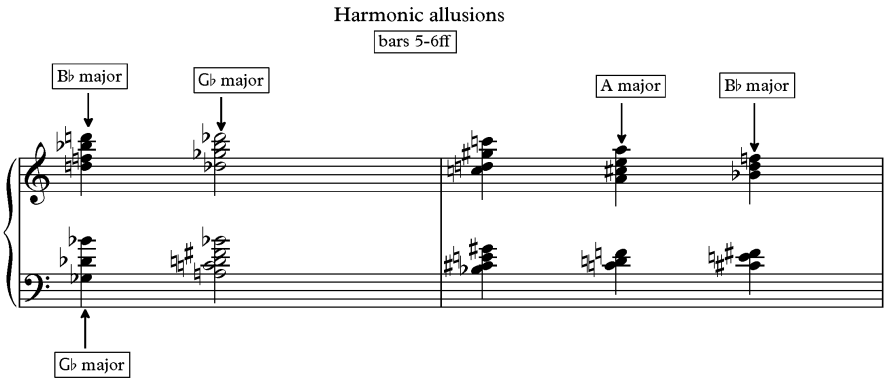


Fig. 3.24 *Tonal allusions, Liturgie de Cristal (Quatuor).*

In a similar manner, whole-tone scales and octatonic formations provide readily accessible memory cues given that these musical modes are taught and learned in a range of musical genres, from traditional analysis to jazz theory (see Halpern & Bower, 1982).

Turning to intervals further removed from tonal hierarchies, the strategies employed to cue musical material were very similar to those used in *Oiseaux Exotiques*, as demonstrated by Fig. 3.25:

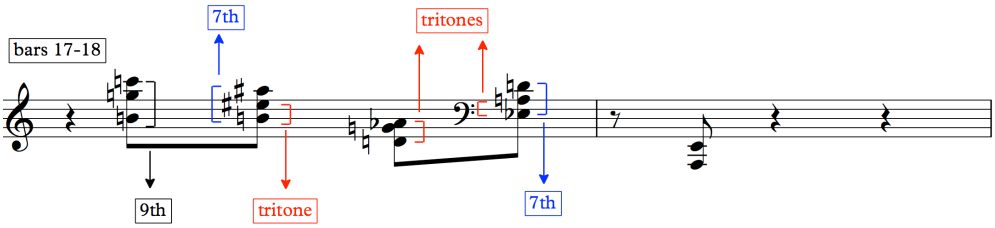


Fig. 3.25 *Right-hand Intervallic cues based on sevenths and tritones, Vocalise, pour l'Ange qui annonce la fin du Temps (Quatuor).*

Whilst the chords are formed of a variety of intervals, there is a similar predominance of sevenths and tritones. These intervals are often combined: for example, the second and fourth chords of Fig. 3.25 (a seventh chord with a tritone in between this interval from the bottom voice).

The use of these intervals is also evident in *Regard de l'esprit de joie*, as demonstrated in Fig. 3.26. Annotations above the staff highlight the use of sevenths. Unfolded sevenths in the melody are highlighted with square brackets, whilst chordal statements are demonstrated with black arrows. Blue annotations below the staff highlight the use of tritones. Similarly to Fig. 3.25, tritones and seventh intervals are combined in chordal statements, as shown where blue and

black arrows align. Combinations of intervals serve to strengthen memory cues, thereby aiding retrieval.

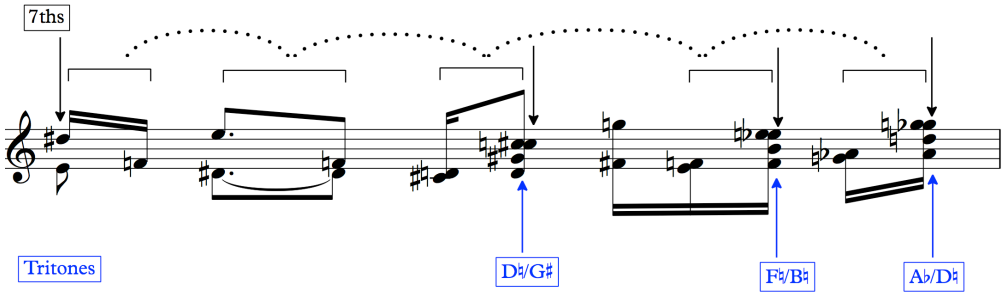


Fig. 3.26 *Intervallic cues, Regard de l'esprit de joie (Vingt Regards).*

Whilst these intervals are important in the two works examined above, their significance is not as pervasive as in *Oiseaux Exotiques*. This can be explained in a number of reasons. First, many of the religious leitmotifs in the *Vingt Regards* are based in tonality, with several individual movements as well as the apotheosis of the work set around the tonal centre of F-sharp major. Secondly, both of these works were written in the early 1940s, whilst Messiaen was developing his musical language. *Oiseaux Exotiques* was not written for another ten years (1955-56). Indeed, Messiaen's treatise *Technique de mon langage musical* was published in 1944, after these two works were completed, thereby suggesting that the musical language in these works was still developing. The wider range of harmonic languages (tonal, whole-tone, octatonic and atonal) supports this notion.

However, the memory procedure of a later work, *Des Canyons aux Étoiles* (1974), demonstrates that the intervallic cueing method based primarily on sevenths and tritones is extremely transposable between works. This is perhaps partly owing to the focus on the same subject matter of birdsong. Yet, given that more than a quarter of a century of Messiaen's compositional output is devoted to birdsong, the memory technique is particularly valuable to study, especially given the length and size of Messiaen's later works. The initial piano solo in the first movement, *Le Désert*, demonstrates the predominance of these two intervallic cues:

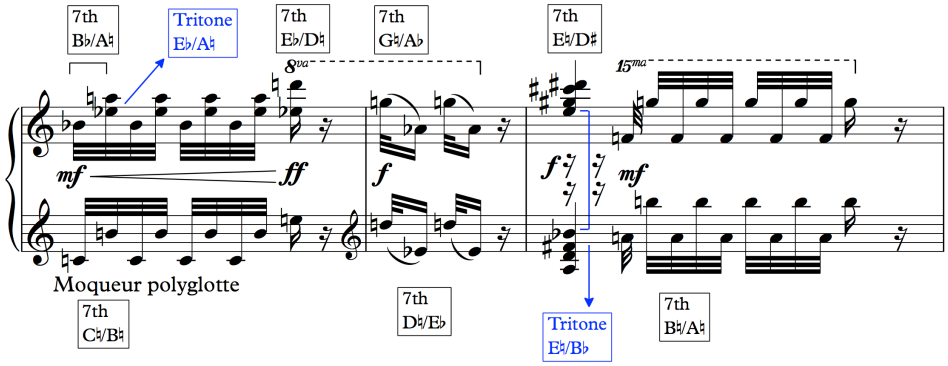


Fig. 3.27 *Intervallic cues, Le Désert (Des Canyons).*

Intervallic cues based on tritones and seventh harmony are also assigned to the eighth movement, *Les ressuscités et le chant de l'étoile Aldébaran*. Fig. 3.28 demonstrates a piano figuration made up entirely of these cues, with some dyads of identical pitch as in the previous example (B♭/A♮ seventh, and A♮/E♭ tritone).

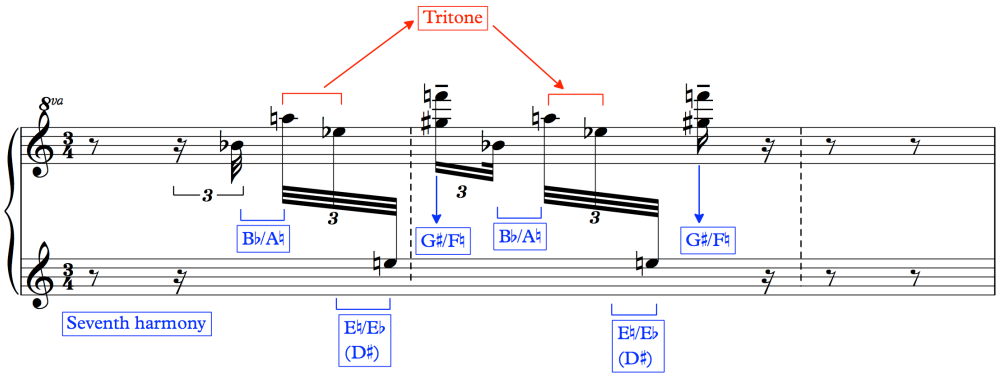


Fig. 3.28 *Intervallic cues, Les ressuscités et le chant de l'étoile Aldébaran (Des Canyons).*

Hand Shapes

The use of the thumb (usually in the left hand) to strike two notes was a common memory cue in the *Oiseaux Exotiques* cadenza. This is greatly expanded in *Des Canyons* to such an extent that it occurs on most pages of the piano part throughout the piece. Fig. 3.29 demonstrates this cueing method in the second movement, *Les Orioles*.

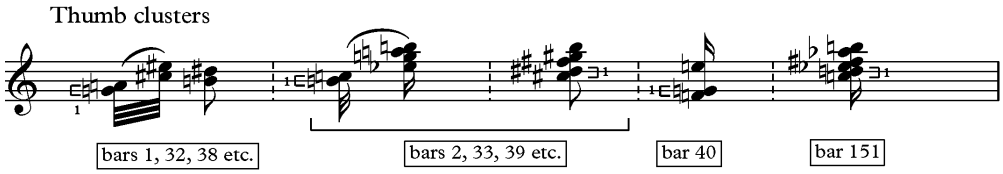


Fig. 3.29 *Hand-shape cues, Les Orioles (Des Canyons).*

Here the use of the thumb cluster is primarily in the right hand, starting on white notes. This is in comparison to the predominantly left-hand figurations in *Oiseaux Exotiques* (Fig. 3.5, above).

Voice Leading

The method of cueing based on voice leading will inevitably be based on the specific musical material, unlike intervallic cues that use specific intervals as common denominators between different pieces. It is nevertheless worth examining if this technique is employed at all, and if so, whether the same methods are involved. In *Oiseaux Exotiques*, voice-leading cues were usually ascribed to the beginnings of rhythmical patterns (often the beginning of a beamed figuration). Any voice-leading relationships were then formed using the first note of a figuration as an anchor from which connections could be examined (see Figs. 3.12 and 3.13, above). This technique was adapted when memorising the *Quatuor*, as demonstrated in Fig. 3.30, below. Figurations ascend by a tone from d♮^{1} to e♮^{1}, followed by an arrival on F♯ (or its enharmonic G♭). Figurations then remain with this starting pitch in various octaves. This cue is particularly useful in this instance given that the figurations are displaced by two octaves. Hence, the voice-leading cue also aids the physical memory, to recall the correct serial chain after the registral displacements between the second and third beats of the first bar, and the displacements in the second bar.

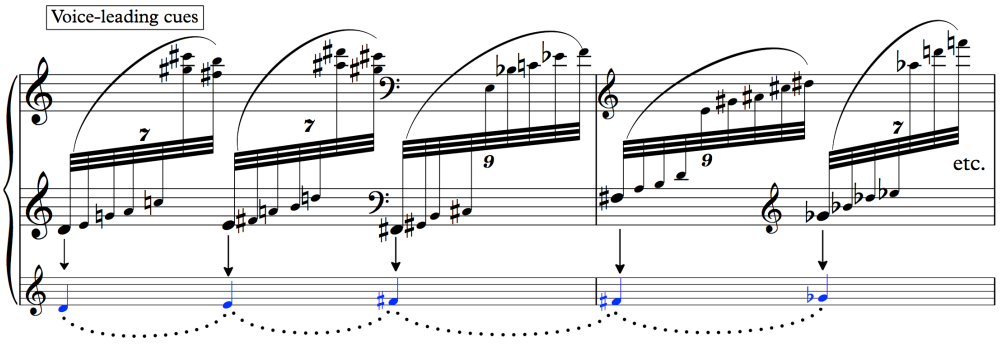


Fig. 3.30 *Voice-leading cues, Fouillis d'arcs-en-ciel (Quatuor).*

A similar cue technique was used in *Des Canyons*, as demonstrated in Fig. 3.31:

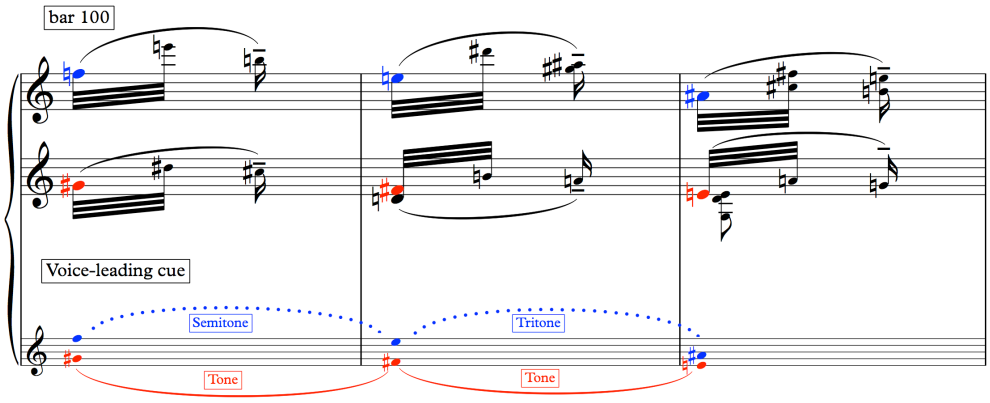


Fig. 3.31 *Voice-leading cues, Les Orioles (Des Canyons).*

The rhythmically identical figurations in both hands descend: the left hand by a step of a tone; the right hand initially by a semitone; followed by a tritone. In addition, the intervallic dyads between these hands are two sevenths and a tritone, as displayed on the bottom staff.

Voice-leading cues are similarly associated with hand-shape cues and intervallic cues to reinforce memorisation. Fig. 3.32 demonstrates such a combination of cues in *Regard de l'esprit de joie*. In the right hand, chords are formed from a first inversion major or minor chord. This cue is strengthened by a hand-shape memory cue (marked in blue) denoting that the first chord is repeated once per bar. For the first two bars of this example the repetition is on the penultimate quaver of the bar. This is then modified to the final quaver in the last bar. In addition, a voice-leading cue is ascribed to the upper voice of the chords. As demonstrated in the upper staff, this progression rises by a minor third and then falls by a semitone from the initial chord. The progression finally rises a tone to the next bar, where it is repeated. There is a further voice-leading cue for the left hand. The upper voice consists of a sequence of rising chromatic scales, with the starting note of each sequence forming a descending chromatic line (marked in red).

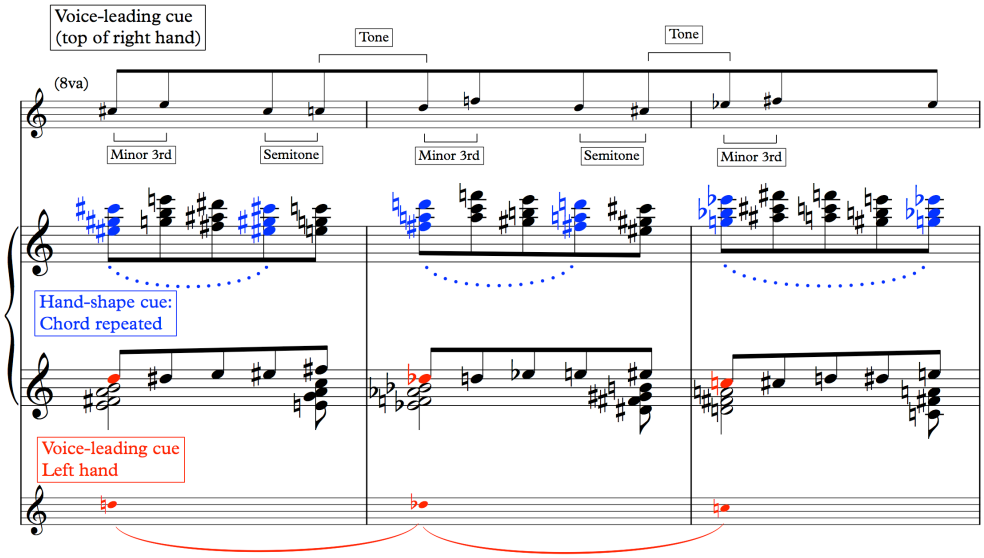


Fig. 3.32 *Voice-leading cues, Regard de l'esprit de joie (Vingt Regards).*

Voice-leading cues can also be combined with fingering to strengthen memory. In the right-hand cue in Fig. 3.33, a fingering pattern (5-4-3-3) is coupled with the upper voice of a triplet figuration in which $f\sharp^3$ is struck and repeated twice with fingering 5-4-3, before an ascent of a tone to $g\sharp^3$, also struck with the third finger.

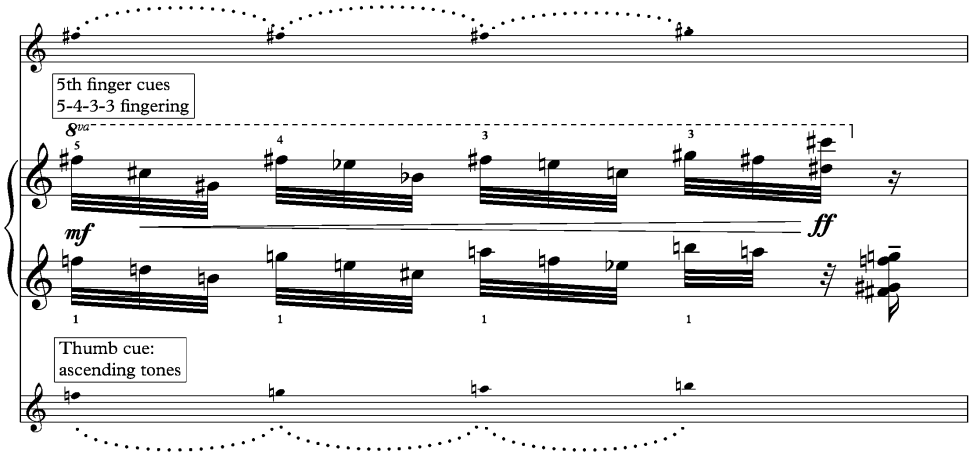


Fig. 3.33 *Voice-leading and fingering cues, Les Orioles (Des Canyons).*

Further combinations of cueing types are demonstrated in Fig. 3.34, from a sequential passage of thirteen bars in *Regard de l'esprit de joie*. Here voice-leading cues, intervallic cues and harmonic allusions combine to reinforce memory of a particularly difficult section. Voice-leading cues are assigned to the

beginning of each triplet group in the right hand. This progression is formed of two ascending semitone steps followed by a rising sixth (blue), followed by an arrival throughout this section on e♮^{2}. In the left hand, green labels show the intervallic cue between the first and second trills of each bar. This progression starts as a rising perfect fifth, before the interval gradually diminishes in each successive bar. Later in the sequence this reaches a semitone, at which point the interval descends and widens.

A final cue in this section is the harmonic allusion on the third quaver beat in each bar. As demonstrated, the first bar highlights A♭ major, with G♯$_{1}$ (or enharmonic A♭$_{1}$) and c♮^{3} are sounded. In each consecutive bar the harmonic allusion descends by a semitone, hence the second bar sounds G major, the third bar G♭ major, and so forth. By the end of the thirteen bars, the progression has descended a complete octave to sound A♭ major once more.

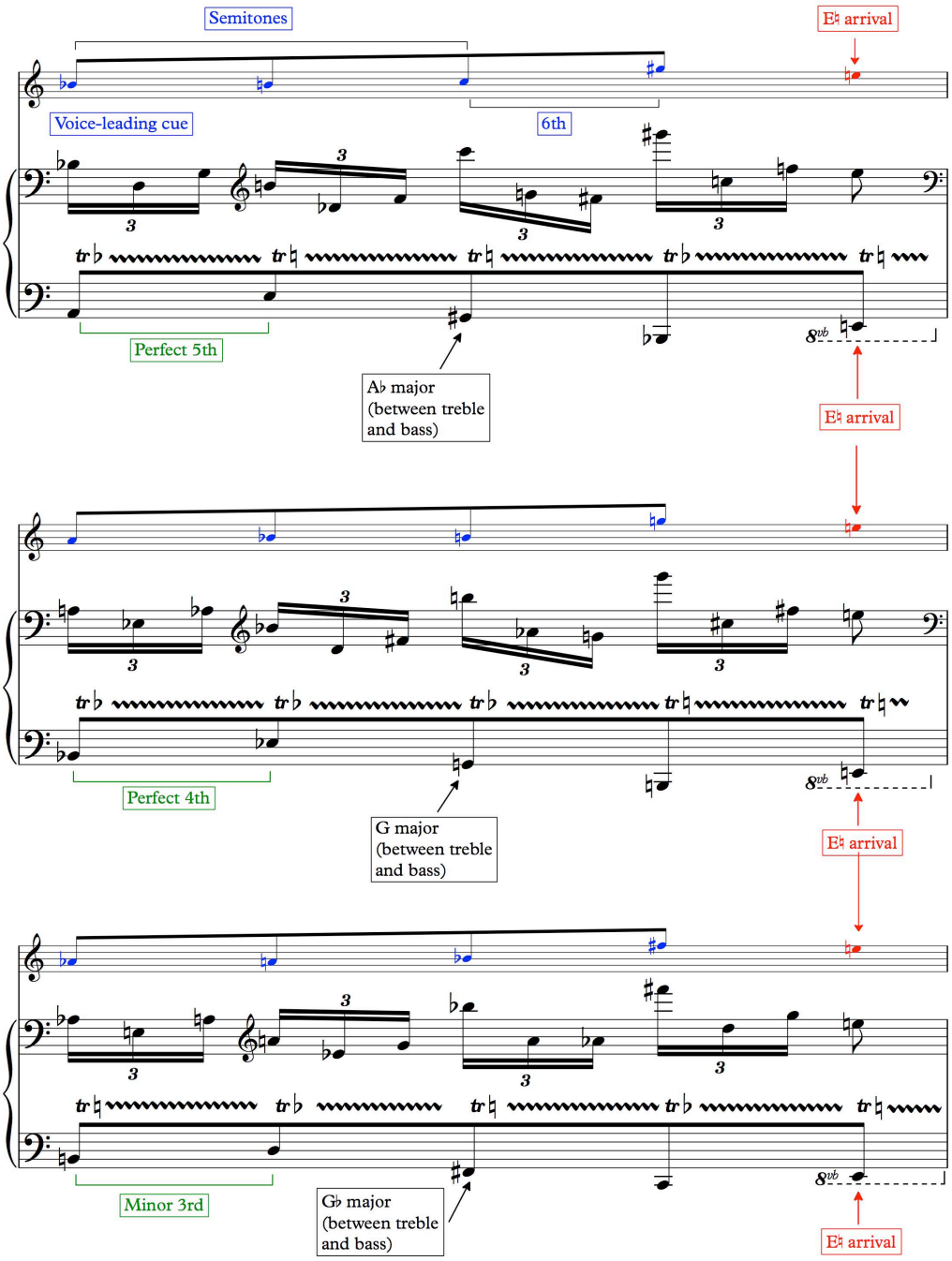


Fig. 3.34 *Combined use of intervallic, voice-leading and tonal allusion cues, Regard de l'esprit de joie (Vingt Regards).*

Rhythm

Figs. 3.17 and 3.20, above, demonstrate two of the main memory cues used to assimilate rhythm in *Oiseaux Exotiques*. First, this involved memorising groups of notes based on the smallest rhythmic notation (in the case of *Oiseaux Exotiques*, the demisemiquaver). Thus, three demisemiquavers could be chunked into a group of three, and so forth.[32] The second memory cue involved awareness of non-retrogradable rhythm, Messiaen's term denoting a rhythmical palindrome. These cueing methods were similarly applied to the three works in the present analysis.

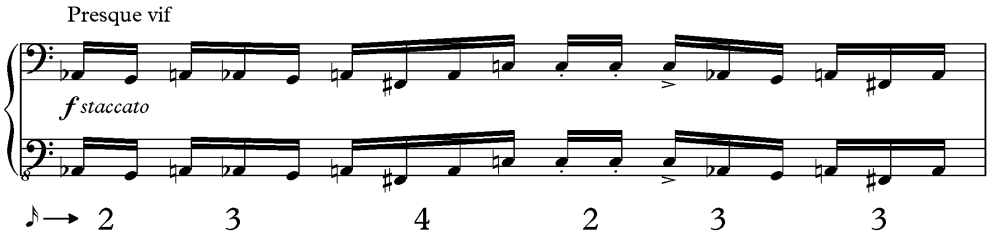


Fig. 3.35 *Rhythmic groupings, Regard de l'esprit de joie (Vingt Regards).*

Fig. 3.35 demonstrates the first cueing technique of chunking a line of repeated semiquavers into larger groups. This cue is reinforced with a visual reinforcement of how the music is typeset on the printed score.

Both rhythmic cue types are evident in perhaps the trickiest rhythmical passage in the *Quatuor*, with all four instruments in unison:

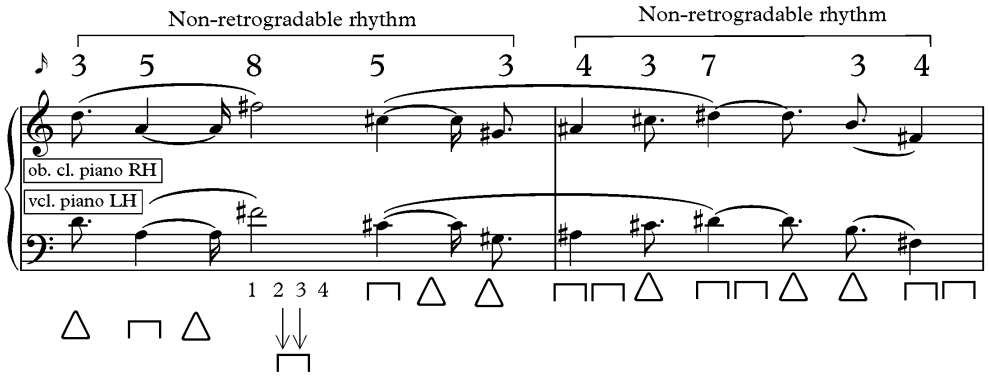


Fig. 3.36 *Additive rhythmic cues, Danse de la fureur, pour les sept trompettes (Quatuor).*

Rhythmic durations are divided into groups of semiquavers: in addition, each bar is formed of a non-retrogradable rhythm. A further rhythmic cue of dividing

[32] See: Li, 2007, p. 45.

groups of semiquavers subdivisions into groups of two or three is assigned in order to strengthen memory and facilitate performance. This highlights an example of a shared PC, given that the entire ensemble learns this information. It became clear in rehearsal the importance of using the same rhythmical strategy to guarantee accuracy in performance (for further discussion on shared PCs, see Ginsborg, et al., 2006).

Conclusions

Whilst the musical examples analysed in the second part of this chapter illustrate a sample of the memory cues employed in the three works, there are clearly significant parallels when cueing different works in Messiaen's oeuvre. In particular, intervallic cues formed from a seventh and tritone seem to be a primary cue to enable faster chunking of material during the learning process. This intervallic importance occurs both because of the nature of Messiaen's musical language, but perhaps also as a symptom of compositional technique in atonal music. Certain intervals that are fundamentally important to tonal music (thirds, fifths, sixths and octaves) are often relegated in favour of intervals further removed from traditional harmony: sevenths and tritones in this case, but also seconds fourths, ninths and alterations to the perfect octave.

Whilst subsequent chapters examine whether these strategies can be applied to other composers, the reuse of intervallic memory cues as demonstrated above suggests that it is possible for a musician to form a system of cues to replace – at least partially – cues based upon traditional tonal harmony, thereby speeding the process of chunking. Of course, there are limitations to this assertion: perhaps it is only with Messiaen's music that these cues are predominant, or perhaps it is my own memory techniques that have ascribed significant cues to these intervals. Nevertheless, the musical examples above strongly demonstrate that intervallic cues can be directly applied between Messiaen's piano works. The following chapter investigates this application across a wider range of repertoire.

The remainder of cueing techniques of other musical dimensions can be categorised as prescriptive. Instead of re-using a specific cue, it is rather the technique that is applied to different musical material. Hence, when examining

voice-leading cues, connections are established between certain parameters of the music. This is either the beginnings of groups of notes, or the upper and lower registers of sequences of figurations. In this sense, voice-leading cues tend to examine the big picture of a passage, by framing the registral range of a certain musical gesture, without needing to cue all of the notes in between (these can be memorised using combinations of different musical dimensions). There is also a strong rhythmic connection between the pieces studied here. This is perhaps because of Messiaen's distinctive compositional style. It is possible that the rhythmical connections with other composers might decrease given how specific certain rhythmic cues are to Messiaen's music, in particular the use of non-retrogradable rhythm cues.

When approaching the memorisation of a new piece by Messiaen, there is unquestionably a whole set of new cues that must be identified, formed and practised until retrieval is immediate. Given the range of almost 35 years between the compositions examined above, there will also be differing techniques and musical dimensions involved, of varying hierarchical importance. However, much like approaching different tonal works, the evidence suggests that there are substantial elements that can be transferred between works. This serves both to aid the process of chunking, reinforce memory, as well as accelerate the learning process. Wider conclusions are drawn at the end of the following chapter, which examines similarities of memory technique for various other composers. This also investigates the demands that other compositional styles and structures place on a musician's memory. As such, analysis examines the extent to that memory cues can be used across atonal music.

CHAPTER 4

Transformations in Memory Strategy

Strategies across contemporary repertoire

The musical material analysed in the previous chapter provides a specific set of demands for memorisation. The *Oiseaux Exotiques* cadenza is relatively short, lasting a little over two minutes. Whilst there is a great range in textures and registers, the motivic construction is limited to the elaboration of two birdsongs. Furthermore, whilst the musical language is removed from traditional functional harmony – a primary schema for memorising music (Halpern & Bower, 1982) – other musical dimensions such as structure, rhythm, and phrase construction are reasonably straightforward to assimilate for a musician who has had experience performing repertoire of the late nineteenth and early twentieth centuries. The replication of cues in further compositions by Messiaen demonstrates the similarities of approach. Memorisation cues needed to be highly inventive and organised for certain musical domains (in particular the musical language), whereas other dimensions could be memorised with more intuitive methods, derived from existing musical experience.

Given the vast variety of musical material and style of atonal music, this chapter evaluates memory strategies adopted for a wider range of styles and composers. In particular, this section aims to evaluate how different demands of repertoire require adjustments, manipulations and inventions in memory strategy. What are the impacts on memory when learning music of the new complexities composers, such as Ferneyhough, in which not only pitch is far removed from traditional musical experience, but also rhythm, gesture, phrase and structure? How is strategy affected when learning a much longer piece, lasting fifteen minutes? And can memory cues be sustained over a much larger scale, for example a 90-minute work? In contrast, how effective are memory cues in musical material that is extremely concise? Does varied repetition of a very small amount of musical material allow for efficient memorisation? Can long passages of music be memorised if there is much similarity within a piece? In addition,

how does memory procedure occur when a musician is forced to speed learn a piece? And does this wide range of challenges require new interpretations and definitions of what constitutes an efficient and successful memory cue? Before investigating this broad range of questions, the first part of this chapter analyses how existing cues developed in the *Oiseaux Exotiques* can be adopted in repertoire by other composers. This analysis is particularly important to gain further insight into how memorisation strategy for atonal music can be efficient and effective. This section is distilled to avoid unnecessary repetition of the previous chapter.

A range of repertoire taken from my performances is analysed in this chapter: Copland *Piano Variations* (1930); Hugh Wood *Three Piano Pieces,* Op. 5 (1962-63); Brian Ferneyhough *Three Pieces* (1966-67); John Tavener *Palin* (1977); Tristan Murail *Treize Couleurs du Soleil Couchant* for quintet (1978); Julian Anderson *Études* (1997-99); György Kurtág *Hommage à Pierre Boulez* (2000); Elliot Carter *Rétrouvailles* (2000) and Martin Butler *Funérailles* (2005). In addition, to investigate memory procedure in large-scale works in the second part of this chapter, Messiaen's *Des Canyons aux Étoiles* (1974) is revisited. The repertoire is limited to that which I have undertaken for performance during the course of this research, as dictated by various performance commitments.[33] Nevertheless, there is a wide range of styles, challenges and differing requirements placed on the musician in these works, thereby providing suitable diversity for analysis in this chapter.

As with the previous chapter, annotated scores were completed during the learning process of individual compositions. These were analysed retrospectively and are reported qualitatively in the present study. The primary aim in this chapter aim is to evaluate the progression of memorisation techniques across a range of repertoire to establish the effectiveness of the specific cues (as documented in the previous chapter). As such, the analysis seeks to examine the

[33] The only exception is the Murail quintet, learned a year prior to the research. An annotated score was completed retrospectively, approximately eighteen months after the study. This limitation is mitigated by the fact that transcription of portions of the handwritten score was completed during the learning process, in order to clarify complexities in the score and notate certain strategies for performance. These transcriptions form the basis for the analysis in the chapter.

contextual importance of the cues to demonstrate that the devices can be transferred across atonal repertoire.

I. Adapting existing memory cues

Intervallic

One of the most immediate and efficient methods to assimilate musical language in the *Oiseaux Exotiques* cadenza was the use of intervallic cues to encode predominant intervals for retrieval. The intervals of a seventh and tritone were recognised as hierarchically significant to the composition. As the learning process progressed, musical material using these intervals was more easily and efficiently encoded. This cue type offers the possibility of simple manipulation to aid memorisation for other compositions in which different intervals are important. Figs. 4.1a and 4.1b demonstrate such a treatment in Anderson's *Études* for piano (1998).

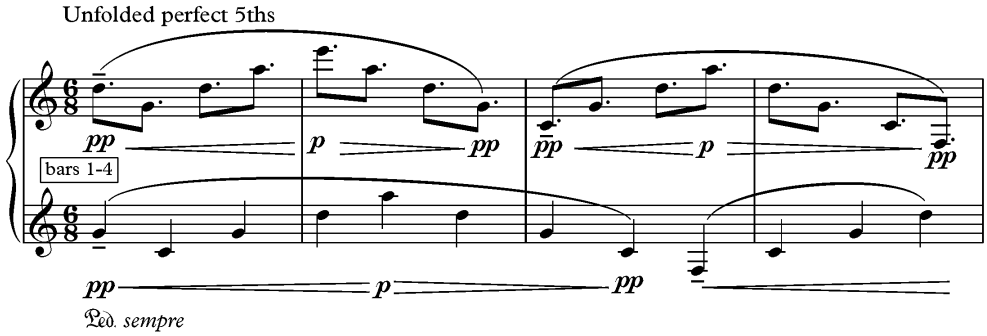


Fig. 4.1a *Intervallic cues, Anderson Étude No. 3.*

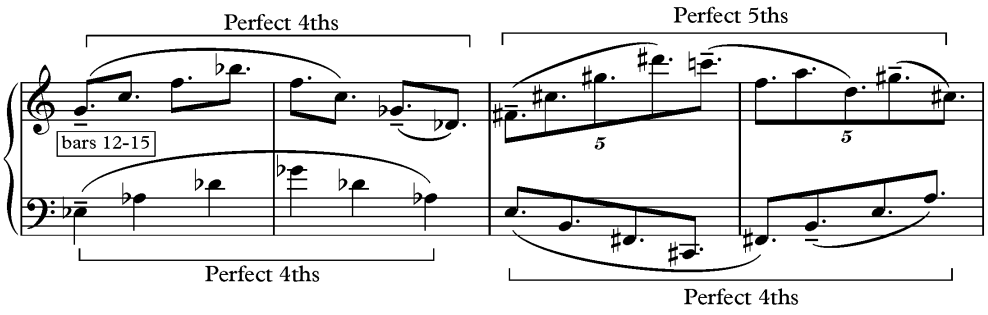


Fig. 4.1b *Intervallic cues, Anderson Étude No. 3.*

Étude No. 3 (...Arpèges Composées) demonstrates the prevalence of intervals of a perfect fifth and, to a lesser extent, its inverse of a perfect fourth. In addition, the continuous use of pedal creates an aural effect in which the unfolded fifths

combine to resound chords based around ninth harmony, whilst unfolded fourths state seventh harmonies. Blocking chords to establish harmonic underpinning has previously been limited to tonal music (Nellons, 1974). Given the tonal allusions in the piece, this technique proved useful in developing an aural picture of the musical language.

A similar cue type is used in Butler's *Funérailles* (2005). Instead of unfolded harmony, chordal textures are used to evoke clanging bells. Memory cues were established by the awareness of the interaction of intervals of a fourth and fifth. These intervals are almost continuous in certain passages such as the opening, demonstrated in Fig. 4.2.

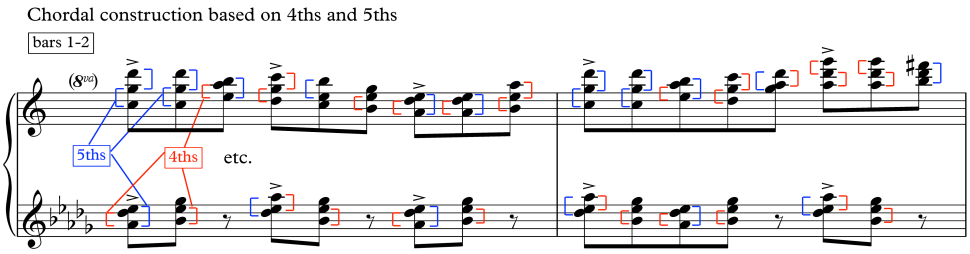


Fig. 4.2 *Intervallic chordal cues, Butler Funérailles.*

This intervallic memory cue is reinforced by two further techniques. First, awareness that the musical material is formed from a limited number of repeated chords aided memorisation. There are three chords in the left hand treated in a cyclical progression (X-Y-Z-Y etc.) and nine chords in the right hand. The right-hand progression is less systematic, instead following the rise and fall of the melodic top line. The second cue reinforcement is the assimilation of the hand shapes of this set of chords (Fig. 4.7, discussed below).

Tritones and seventh intervallic dyads, important basic cues in the *Oiseaux Exotiques* cadenza, are readily applied to other repertoire. Fig. 4.3 demonstrates the use of such cues in Wood's *Three Piano Pieces*, Op. 5 (1962-63). Tritone cues are marked in red, and seventh cues in blue. Of particular note is the combination of both cues, in which the melodic figuration outlines a seventh interval with a tritone in between (a compositional technique heavily used by Messiaen). In addition this creates a hand-shape cue to reinforce memory procedure.

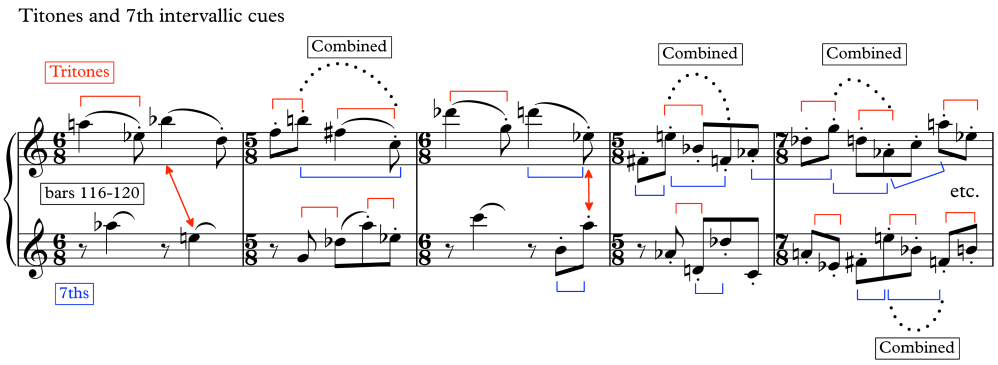


Fig. 4.3 *Tritone and seventh Intervallic cues, Wood Three Piano Pieces.*

A derived version of the intervallic cue type was employed in Carter's *Rétrouvailles* (2000). Commissioned for Boulez's 75th birthday, the work uses a cipher to form its musical language:

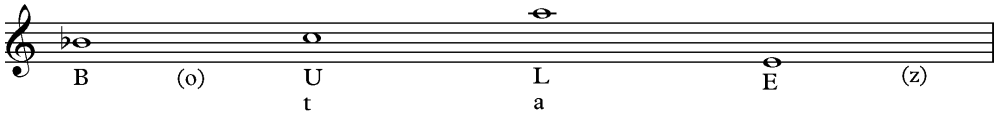


Fig. 4.4 *Musical cipher, Carter Rétrouvailles.*

The cipher is translated into intervallic cues in two separate manners. First, the motivic motto is repeated throughout the short piece, usually at the same pitch. This acts as a sonic landmark: in particular the two dyads of $b\flat^1 – c\natural^2$, and $c\natural^2 – a\natural^2$. Fig. 4.5 displays the repetitions of the cipher:

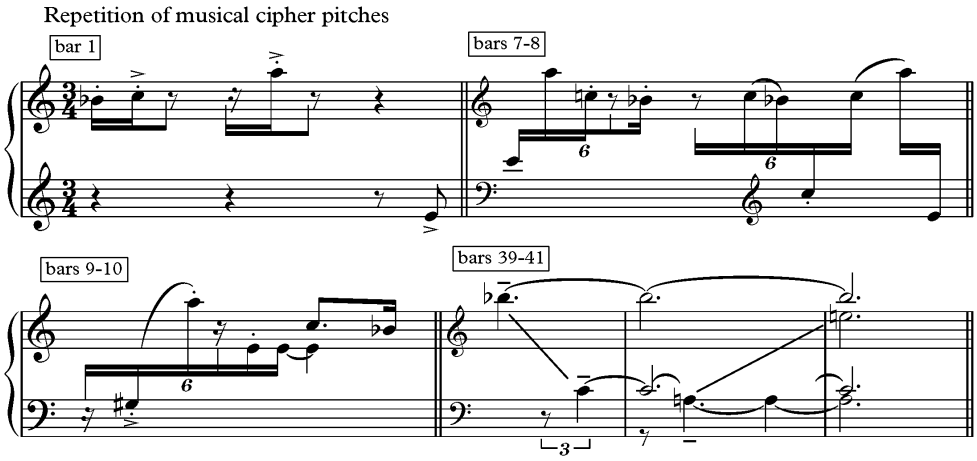


Fig. 4.5 *Intervallic cues based on musical cipher, Carter Rétrouvailles.*

The second cue type derived from the cipher relates more directly to the intervals used. Hence, there are fundamental intervals that generate the musical harmony of the piece: a tone ($b\flat^1 – c\natural^2$), sixth ($c\natural^2 – a\natural^2$), seventh ($b\flat^1 – a\natural^2$) and major third

(inversion of c♮^{2} – e♮^{1}). Repetitions of these dyads formed strong intervallic cues for memorisation.

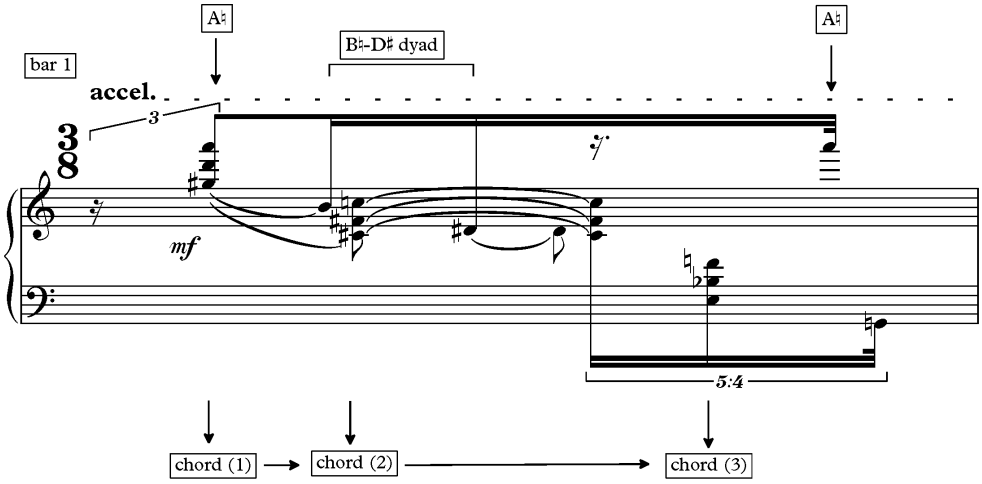


Fig. 4.6a *Intervallic cues, Ferneyhough Three Pieces for Piano (I).*

Intervallic cues formed the primary basis for assimilating Ferneyhough's *Three Pieces for Piano*. Fig. 4.6a demonstrates techniques used to memorise the first bar. The first of the right-hand cues is a B-major dyad (b♮^{2} to d♯^{2}, beat 2). This is easily recognisable because of the tonal implications of this interval, and is further reinforced by the fingering I employed: fifth finger to second finger, as used in a B-major arpeggio. The next cue is awareness of the registral peak in the bar: a♮^{3}. This occurs at the beginning and end of the bar in the right hand, framing the previous dyad cue. Perhaps the strongest cue was derived from the three chords (labelled 1-3 at bottom Fig. 4.6a).

As Fig. 4.6b highlights, these chords are formed of a tritone and either a fourth or a fifth. Despite the slightly different sonorities between the chords (two contained in a ninth interval and one in a seventh) the intervallic relationship between these chords formed a strong cohesion to the bar. The intervallic detail of the cue is further reinforced by two other properties. First, chords are sounded on each beat of the bar, thus awareness is reinforced by repetition. Secondly each chord uses a similar hand shape of a distorted octave, forming a kinaesthetic element to the cue.

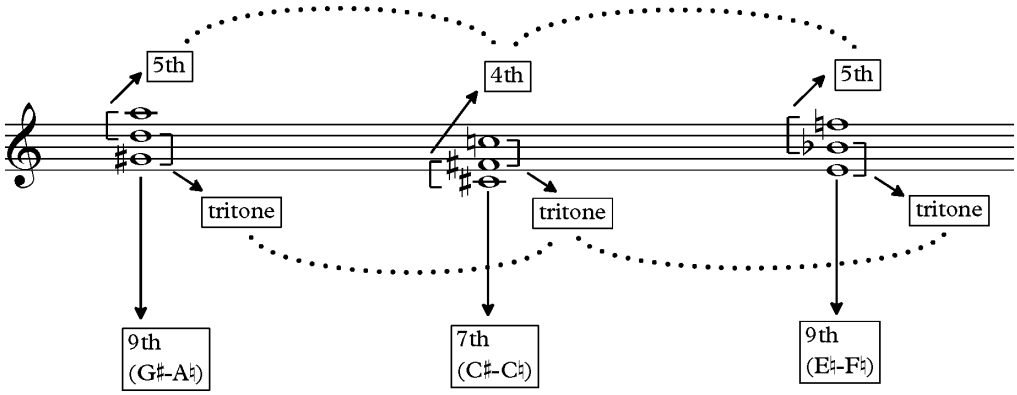


Fig. 4.6b *Intervallic chordal cues, Ferneyhough Three Pieces for Piano (I).*

As with the intervallic cues used in the previous chapter, encoding techniques develop the localised methods proposed by Li (2007), contextualising the method within an individual piece. This relationship is a fundamental part of effective memorisation (Sloboda, 1985).

Hand Shape

As described above, hand-shape cues formed a memorisation technique in the chordal sections of Butler's *Funérailles*. Fig. 4.7 shows this process in greater detail:

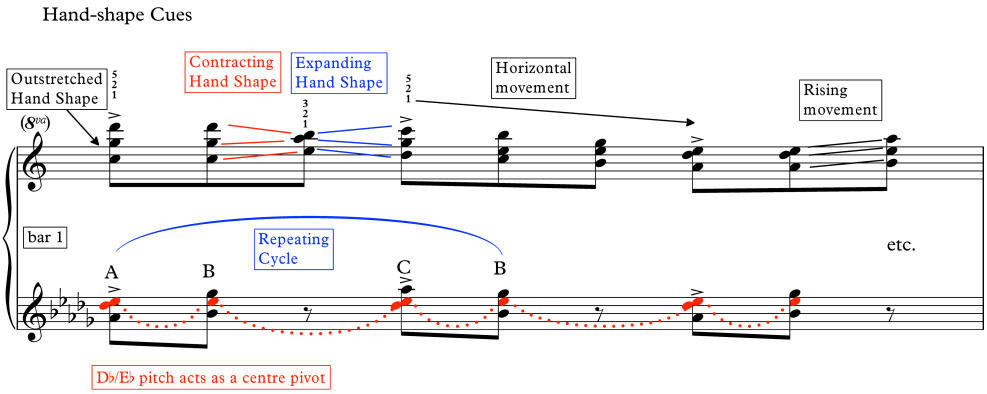


Fig. 4.7 *Hand-shape cues, Butler Funérailles.*

Hand-shape cues in the right hand are formed by the serial relationship of chords. Thus, for example, the initial outstretched chord based on fifths initially contracts (shown in red), and then expands (blue) over a fixed wrist position (i.e. the location of the hand is unchanged). The wrist and hand position then follow a descending horizontal movement to the lowest chord, before each part rises. The

left hand rotates cyclically, with the pitches e♭^{2} and d♭^{2} acting as a central pivot in the progression (marked in red). Hand-shape progression cues in the right hand are assimilated without a great deal of cognitive overload given that there are a limited number of chords used. The chordal material nearly always follows a step-wise progression: there are nine chords used in descending or ascending pattern with only a few hand movements where chords are not next to each other. Therefore hand-shape cues are limited to a small number that can be assimilated during practice, most likely in STM (Miller, 1956; Cowan, 2000).

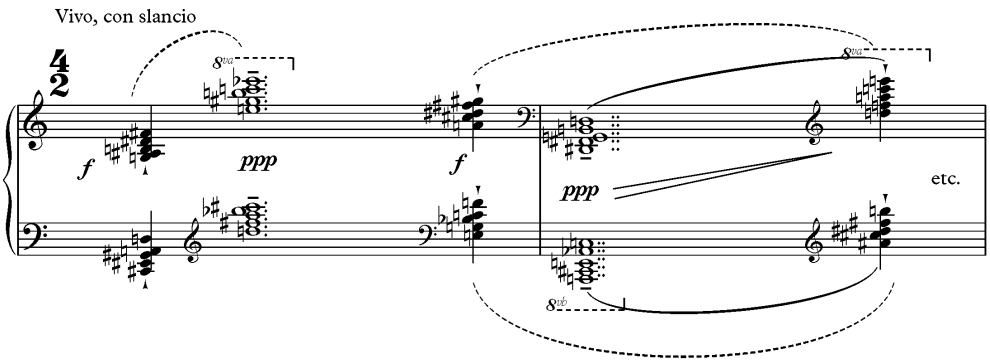


Fig. 4.8a *Hand-shape cues, Kurtág Hommage à Pierre Boulez.*

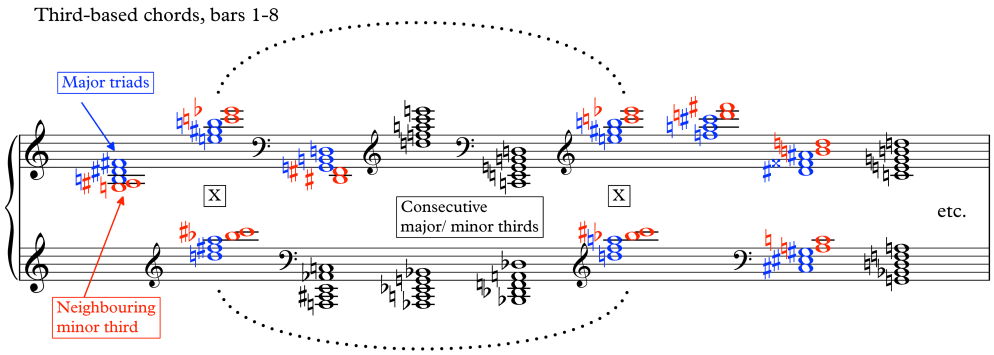


Fig. 4.8b *Examples of hand-shape cues, Kurtág Hommage à Pierre Boulez.*

Simpler hand-shape cues were employed in Kurtág's *Hommage à Pierre Boulez* (2000). Lasting just over three minutes, the two outer sections of the ternary form consist of a sequence of ten-part chords, jumping across the whole register of the piano. The opening two bars are reproduced in Fig. 4.8a. Throughout the learning stages it became apparent that the chords were built around thirds. Often this takes the form of a major triad, with a minor third attached a semitone above or below. Intervallic and hand-shape cues were assigned to these chords, as demonstrated in Fig. 4.8b. Hand-shape cues were

employed for two types of chord. First, marked in colour, chords based around a triad (marked blue) with a minor third (marked red). The minor third is always sounded a semitone below the root of the triad or a semitone above the fifth. This division split the hand in two, forming an additional fingering cue, with the minor third taken by either the thumb and second fingers, or the fourth and fifth fingers.

The second hand-shape cue, marked in black, was formed of chords made entirely of major and minor thirds. Although not functionally harmonic, knowledge of the patterns and schemas undoubtedly aided assimilation of the chordal progressions (Halpern & Bower, 1982). The stretch of the hand over a ninth, with each finger a third apart, creates a physical impression that is particularly useful as a memory cue: whilst the majority of the chords were comfortable to play, there is an element of physical stretching to play these wide-spaced chords. Further cues were derived, including piano-shape cues, such as chords based on thirds that were formed entirely of white notes. This combination of cues served to reinforce memory procedure.

Furthermore, certain chords of this type were assigned structural cues. In particular, the chord marked X in Fig. 4.8b occurs as an important repeated sonority throughout the piece: it is both the second chord played, and the penultimate sonority. In the last seven bars, it is sounded three times, and a further three times with altered left-hand harmonies. Associating sonority with structure is a further method of establishing particular landmarks in a score. Williamon and Egner (2004) demonstrated that structural bars are processed differently in tonal music, and recalled faster in visual memory tests. For more complex atonal structures, it is likely hierarchies of other sensory modalities (such as the aural association described here) may be processed similarly in place of a more obvious structure.

Voice Leading

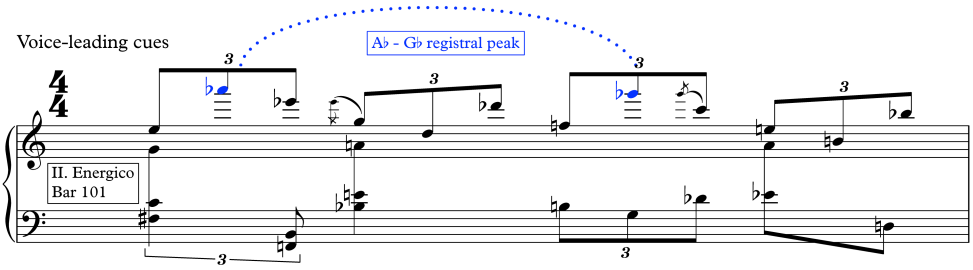


Fig. 4.9 *Voice-leading cues, Wood Three Piano Pieces (II. Energico).*

In assigning voice-leading cues, similar techniques were used to the *Oiseaux Exotiques* cadenza. Often this involved connections between registral peaks in passagework. This type of cue is demonstrated in Hugh Wood's *Three Piano Pieces*, Op. 5 (Fig. 4.9).

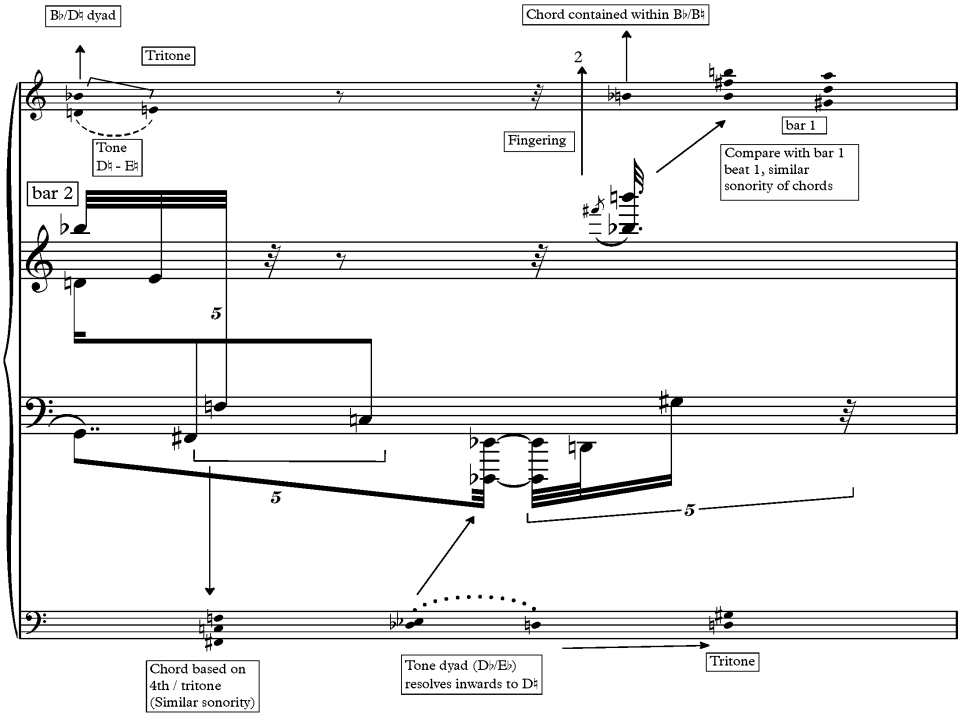


Fig. 4.10 *Voice-leading cues, Ferneyhough Three Pieces for Piano (I.).*

Voice-leading cues were combined with intervallic and fingering cues in Ferneyhough's *Three Pieces for Piano*. The lower stave of Fig. 4.10 demonstrates the memorisation cues for the left hand in bar 2. Beats 1 and 2 were encoded as a chord (F♯-c♮-f♮), forming an intervallic cue of a tritone and a fourth. This cue was reinforced by a hand shape cue (fingering ^5-^3-^1) and was contained within a stretch of F♯ to F♮, a distortion of an octave hand shape. The

next cue encoded the major ninth (D♭1/E♭) as a major second, which resolves inwards by a semitone to D♮, to form a voice-leading cue. In turn this D♮ forms an intervallic cue of a compound tritone with the ensuing g♯. This intervallic cue was reinforced by a fingering cue, with the D♮ encoded as a fifth finger in order to facilitate the leap to g♯.

Piano Shapes

Piano-shape cues were primarily formed on the relationship between black and white notes on the keyboard, eliciting visual and kinaesthetic memory systems (Chaffin, Logan and Begosh, 2009). Fig. 4.8b (above) highlights the cue used in Kurtag's *Hommage*, of white-note chords formed from thirds. A more general cue was employed in Butler's *Funérailles* to assimilate the bitonal elements. Namely the left hand is always harmonically 'flatter' in chordal sections. This is demonstrated in Fig. 4.2 in which the right hand strikes mainly white notes and the left hand strikes exclusively black keys. Whilst this division is not always as consistent throughout similar sections in the piece, the basic organisation was still applicable.

A further piano-shape cue was derived from the interlocking of perfect fifths at the start of Anderson's *Étude No. 3*. On the printed page it is obvious that both hands play a chain of unfolded perfect fifths, and this is an important visual cue for memorisation. As the layout of the keyboard is a uniformly repeated pattern, with the possibility to extend chains of fifths through multiple octaves, a further cue was added to where the hands overlapped. Whilst sonically this negated the effect of two separate chains unfolding, technically and physically this was a fundamental cue in the early memorisation stage to ensure the correct progression occurred. As demonstrated in Fig. 4.11, the cue focusses on the repetition of notes where converging or diverging motifs overlap:

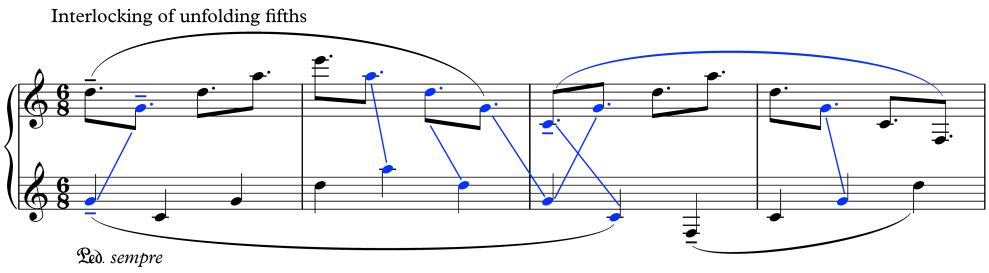


Fig. 4.11 *Piano-shape cues, Anderson Étude No. 3.*

This type of cue has strong associations with intervallic and hand-shape cues. The physical nature of the cue, combined with the pattern of playing fifths on the keyboard, suggest a visual cue related to the construction of the keyboard aided memorisation.

The analysis in this first section reveals that existing cues can readily be adapted or reused. Such use of cues uncovers an interesting aspect of the relationship between performer and composer. As a performer, the manner of approaching music is shaped by the particular habits of a composer. These habits are analysed and practised at the instrument to help learn and play the piece. This is particularly evident for intervallic cues. Messiaen's music is habitually formed of tritones and seventh intervals, and as such cueing technique is shaped by these traits. The cue is easily manipulated to other intervals as required, for example focusing on fourth and fifth intervals in the Anderson and Butler examples above.

Other cue types are more fixed but nevertheless adaptable, for example the voice-leading cues assigned to the registral peaks of passagework (see Fig. 4.9). The particular cue will of course vary from piece to piece. However it seems that the extremity in register strengthens the cue: it is the uppermost pitch (in the right hand) or lowest pitch (in the left hand) that is most memorable. This is perhaps connected to visual and physical stimuli, as the fifth fingers contain the register of the musical material, being the last digit. The registral low point of the right hand (usually in the thumb) is used less as a cue. This might be a personal coincidence, or possibly that the hands unite in the middle of the keyboards and hence there is less of a distinction between the two thumbs as compared to the fifth fingers. Further cue types, especially rhythm, structure and phrasing, are omitted from this section. In some cases this is because the construction was recognisable and assimilated intuitively thanks to existing knowledge and experience. In other cases, further memory techniques were required. These procedures, along with other challenges, are discussed in the next part of this chapter.

II. Further Methods of Memorisation

The second part of this chapter examines how different styles of repertoire require changes, alterations and inventions in memory strategies. Initially, this explores long-term memory procedure employed in large works and if this causes cognitive overload (Williamon, 1999). Secondly, analysis discusses approaching music of extreme complexity and the process of distillation it requires. Further strategies are also investigated, including strategies for speed learning, memorising musical material based on utmost concision or extended repetition of identical or similar motifs.

Large-Scale Memory Strategy

Analysis so far has been limited to relatively short works or small sections of pieces. The demands of learning the *Oiseaux Exotiques* cadenza are considerable, however, the short duration and few pages of the score reduce these challenges. Furthermore, as discussed previously, there are issues that ease the burden of the numerous challenges for memorisation. First, the motivic material is limited to two birdsongs; indeed, the *Oiseau-chat* motif appears in only 11 of the 63 bars, thus the cadenza is primarily based on the *Bobolink* birdsong. Similarly, structure is a straightforward rondo, which poses no great challenge to memorise. The structure is clearly defined given the alternation of birdsong motifs. This acts as punctuation allowing a performer to divide the cadenza into small segments to organize practice and retrieval. There are few switches: areas of similar material that subsequently diverge, usually posing problems for retrieval of serial chains. Finally, whilst the cadenza is technically difficult, other domains such as rhythm and phrase construction are relatively uncomplicated to deduce and assimilate.

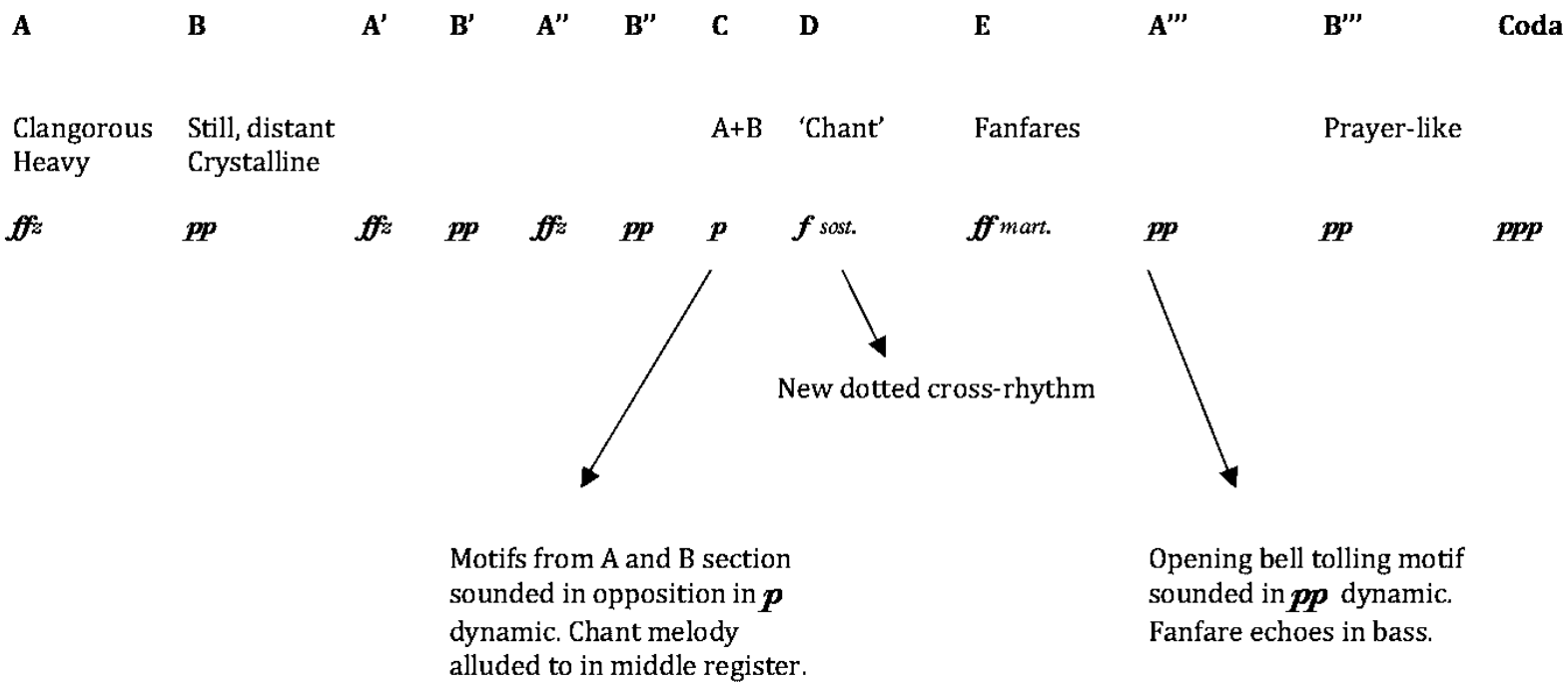


Fig. 4.12 *Structural summary, Butler Funérailles.*

How does memory procedure change when the work is of a much larger scale? Butler's *Funérailles* provides a pertinent example. At a little over fifteen minutes long, the intense learning process used for the *Oiseaux Exotiques* cadenza is unsuitable. The structure contains large sections that are repeated in different harmonic languages. Within these sections, there are numerous switches and changes in cyclical patterns. Whilst the inspiration of a tolling bell remains throughout the piece, there are several motifs that overlap at various sections. The structure initially appears to alternate contrasting motifs. Whilst the delineation of structural sections is extremely clear, motivic use is increasingly complex, as demonstrated in Fig. 4.12. A large-scale ternary form, the opening A and B sections are repeated and gradually combined leading to the middle sections, D and E. These are a chant motif in a dotted cross-rhythm, and "*raging fanfares*" of repeated notes. The opening A and B sections are then repeated in hushed dynamics, with fanfare interjections in the bass. The structural simplicity belies a great deal of complexity of motif and harmony.

The initial difficulty for memorising a longer piece was the accumulation of repetitive chordal figurations. Establishing a successful cueing method when so much material is repeated proved difficult. Fig. 4.7 demonstrates the basic cues of memorising the constituents of each chord. However, the difficulty lies in the fact that the first 26 bars in this A section contain the set of chords (nine in the right hand, four in the left hand) in varied rhythms and orders. Memory strategy was devised in five categories: sonic-resonance cues (my own term, see below), left-hand rhythm, hand movements, melody of top part (especially in the groupings of five quavers) and the starting chords of each new phrase block.

These strategies are illustrated in Fig. 4.13. Sonic-resonance cueing is the combination of the physical familiarity of hand-shape cues and aural recognition of repeated sonorities, which leads to a strong memory cue. The strategy derived from the cumulative nature of the musical material. With so much resonance building up with chords stuck over a held pedal, a strong aural cue was establishing where important chords repeated throughout a phrase. Chords were denoted as important for two features: either it was the start of a phrase or block, or it was struck twice consecutively. In many phrases these two features combined. This is shown in blue in Fig. 4.13, where the first chord of the piece is

struck twice, at the beginning of a phrase. The sonic-resonance cue for individual chords is illustrated with dotted slur lines above the staff.

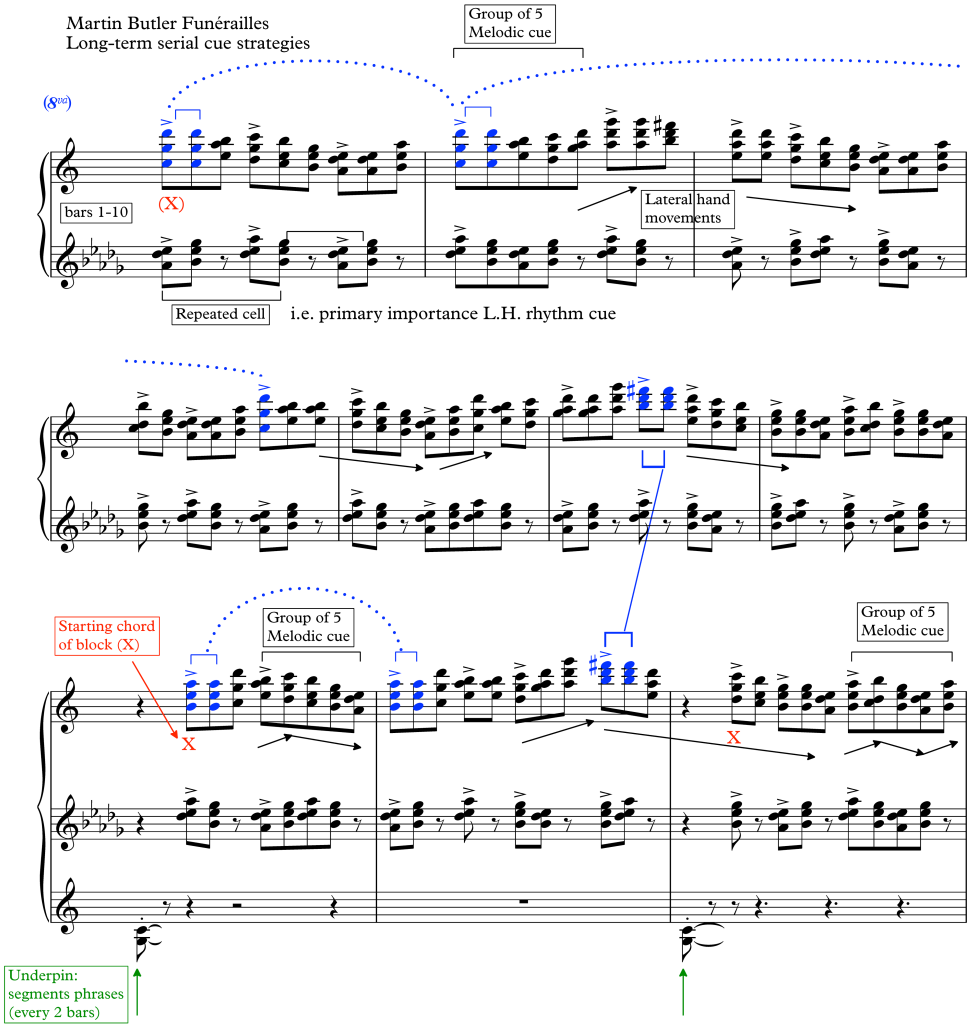


Fig. 4.13 *Cueing strategies, Butler Funérailles.*

Sonic-resonance cues reinforce several memory systems. Initially kinaesthetic and motor memory is involved, given the shape of the chord in the hand, and the fact it is repeated. Secondly, aural memory is triggered, as the practice of this cue relies heavily on the ear prolonging the sonority of the chord until the next strike. Thirdly, the cue elicits structural memory as certain points of arrival in a phrase are recalled. Given the constant rise and fall of the right hand, I compared this cue process to outlining a skyline in which certain features were more apparent and striking than others. In certain aspects, this process can be seen as an expansion of voice-leading cueing procedure (see Fig. 4.9). The left-hand rhythmic cue provided a simpler assimilation process. As discussed, the material is made up of three chords that repeat in a circular manner (X-Y-Z-Y

etc.). Thus, the primary cue for the left hand was a rhythmical one, to work out and learn how the rhythmical pattern fits in with the cycle of right-hand chords. This is aided by the fact that the left-hand gestures align with the right-hand melody (as demonstrated by the alignment of accents between hands). The melodic memory cues in the right hand were combined with lateral hand-movement cues to strengthen aural understanding and retrieval. Lateral hand movements are depicted with black arrows between the staves. Of particular importance as a memory cue was the combination of aural cues and physical lateral movement cues in beamed groupings of five quavers. Despite the importance of these cues, it is unclear whether these became landmarks (part of content-addressable memory). Given the continuous, repeated chordal figurations, serial chaining was most likely still needed to ensure the correct progression. Further practice most likely would have strengthened the sonic resonance cues in content-addressable memory.

Switches

The bottom system in Fig. 4.14 illustrates the beginning of five two-bar phrases, each punctuated by the g♯/c♯[1] dyad at the beginning (marked in green).

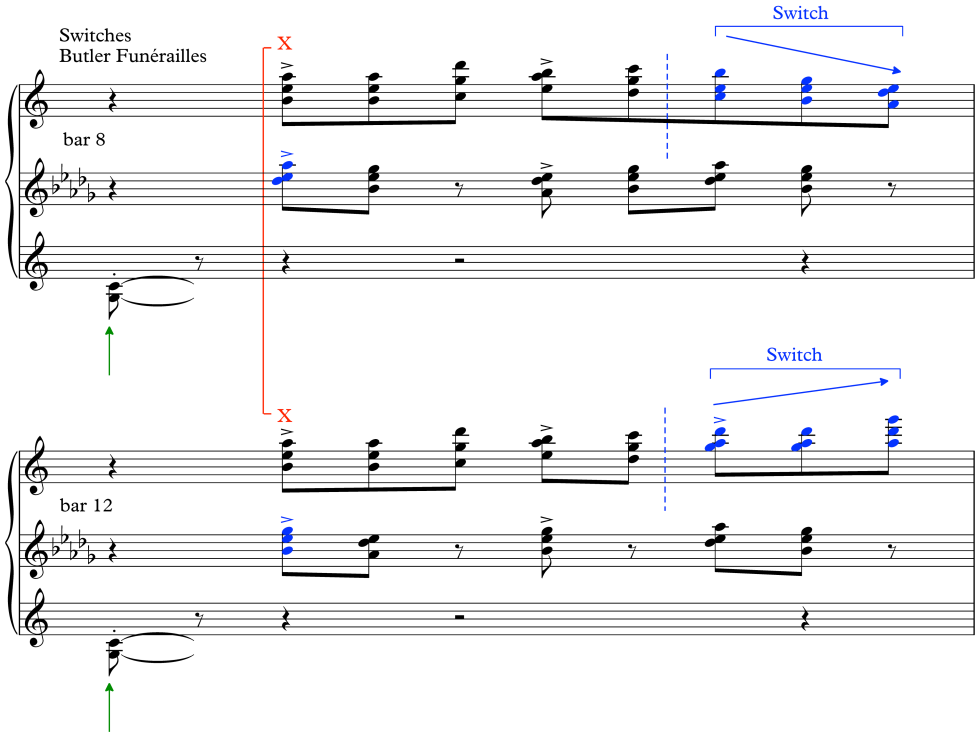


Fig. 4.14 *Switch cueing, Butler Funérailles.*

Given the identical length and character of each phrase there were challenges in learning and retrieving serial order, even with considerable practice. In addition to employing the strategies of sonic-resonance cueing and melodic cueing as described above, particular consideration was given to memorising these switches. To do so, the first chord of each two-bar block was memorised to create a larger framework. Secondly, differences in direction were fundamental cues to ensure correct serial order was retrieved in performance. Fig 4.14 outlines one such switch in bars 8 and 12. The right-hand starting chord (marked x in red) is identical, with the same right-hand shape across phrases until the last three chords. Here, the switch takes place (marked in blue). In the second phrase, the right hand moves in the opposite direction to the previous statement.

Switches were not limited to surface detail. The large repeated sections also required memory strategies to ensure correct retrieval. Fig. 4.15 illustrates the various statements of the A section throughout the work. Instead of specific cues relating to surface details, more general structural, expressive, aural and physical cues were employed. In turn, these cues involved a number of different memory systems: emotional, visual, linguistic and conceptual. The first structural cue was the assimilation of the tempi and character of each statement: in the exposition, the three statements (A1-3) are the fastest versions, marked "*clangorous, heavy*". The dynamic is ***ffz,*** with accents on the first of each beaming. By contrast, in the modified recapitulation, the two statements of the material are at a slower tempo, in ***p*** or ***pp*** dynamic without accents ("*uguale*"). This tempo change is illustrated in green in Fig. 4.15.

The structural cues were strongly associated with aural and expressive cues that informed the emotional memory system (these cues are marked in red). Defining the role of the emotional memory system in musical memory is particularly difficult given the large range of systems required to memorise a piece. However, the combination of aural and expressive domains is fundamental to encode memory in this system: "…it seems clear that the performer's visceral response to the music contributes to musical memory" (Chaffin, Logan, Begosh, 2009, p. 356). In the exposition, the initial statement was memorised using a range of surface cues as described above (Figs. 4.2 and 4.7).

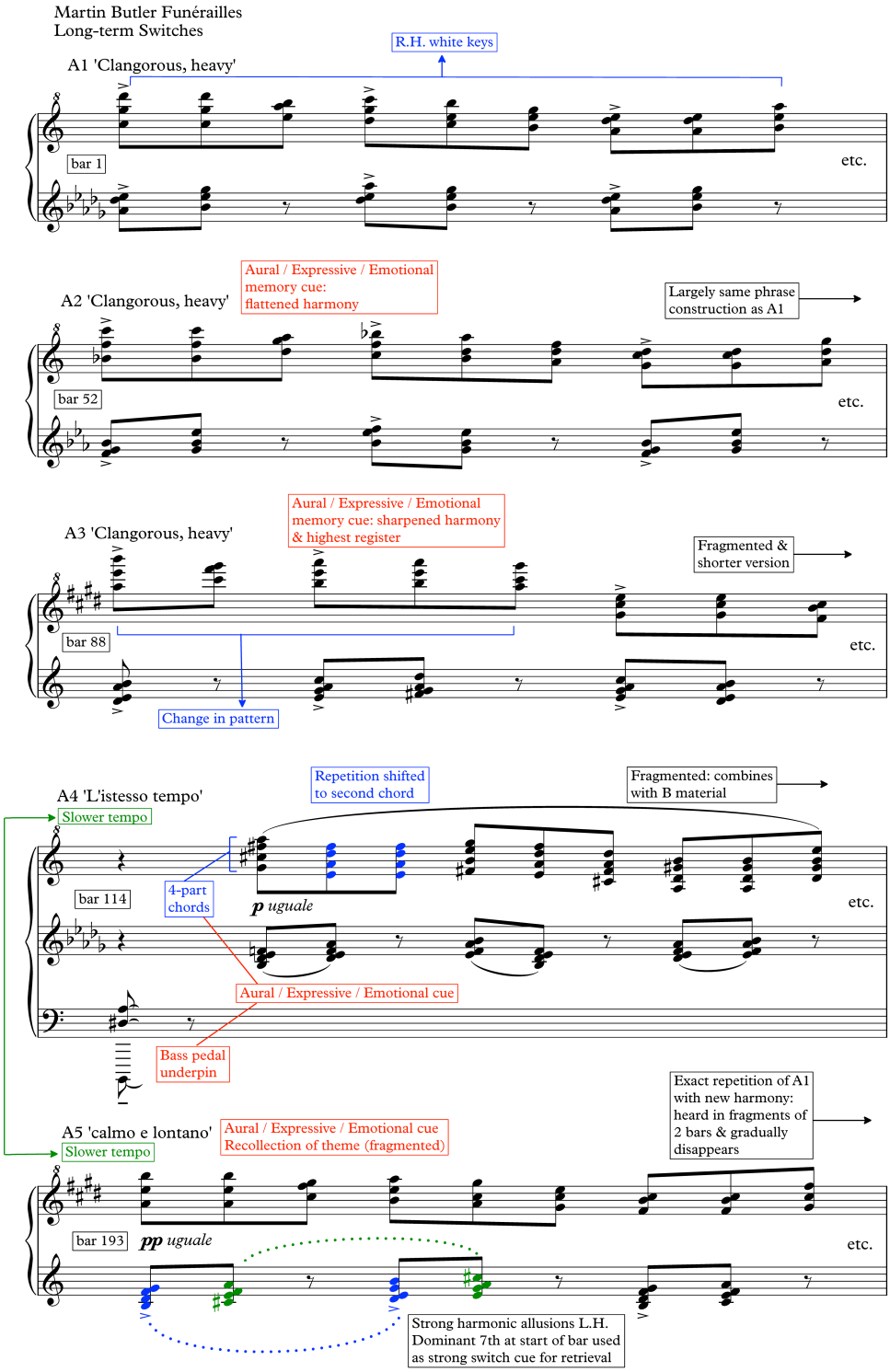


Fig. 4.15 *Structural switches, Butler Funérailles.*

This statement was cued as a 'neutral' aural statement. 'Neutral' was identified for two reasons: first, the right hand strikes white keys almost exclusively, and secondly it was the initial statement learned. Subsequently, cues were ascribed to the aural and expressive differences of each statement. The

second statement (A2) consisted of a flattened transposition of the opening. The aural and expressive effect of this harmonic shift was much greater warmth. The previous bitonal opposition between the hands in the exposition created a much more cohesive and holistic sonic language in this second statement. In contrast the third statement (A3) consisted of sharpened harmony, combined with the highest registral utterance of the motif. Furthermore, the phrase shape and rhythm of the motif is modified in this section. As such the character evoked was a more urgent rendition of the material.

The fourth statement (A4) radically alters the character of the motif. It is the first statement with any bass register involved: almost the lowest register of the piano is used ($B\natural_2$). The bass pedal is the first of the strong tonal allusions associated with the motif, outlining a dominant seventh: $B\natural_2 – d\sharp – a\natural$. This is not functional harmony, as the two staves above contain opposing bitonal harmony. However, this tonal allusion at the start of the section creates a strong structural and aural cue to help develop a mental map of the piece and highlighting the switch in the material. Further changes in this section include the addition of a fourth voice in the right-hand chords. Despite the low dynamic, this creates a heavier and submerged character. A further expressive cue was ascribed to this trait to further strengthen the switch. Moreover, the opening of the motif is modified. Previously, the motif started with two statements of the opening chord (X X Y). Here, this repeat is shifted to the second chord (X Y Y).

The final statement of the theme was similarly cued by an allusion to a dominant seventh in the left hand ($b\natural – d\sharp^1 – f\natural^1 – g\natural^1$). Indeed the left hand is formed of further tonal allusions of either dominant sevenths or triads with an added sixth. This formed a strong aural and expressive cue for this section, in which the pale character of the right hand (in terms of both harmony and dynamic) is contrasted with the warmth of the left-hand tonal allusions. A further structural and expressive cue was assigned to the character of the section: the motif is a recollection of the opening (marked "***pp*** *e lontano*") and heard in its entirety. However, the motif is increasingly interrupted at shorter intervals by the previous fanfare motif (E section). The composer's treatment of phrase structure in this manner formed a larger conceptual cue regarding for each of the statements (illustrated in black at the end of each system in Fig. 4.15). A2 is a

relatively unchanged statement from the opening. However, from this point on there are more varied treatments: A3 employs a much wider register, and phrase structure is altered. A4 returns to the opening phrase structure (with minor alterations as discussed), but is quickly merged with material from the B section (after four bars). The final statement (A5) is sounded in full, but is fragmented. The combination of memory strategies to encode switches (repetitions of similar material) reveals that the larger structural, aural and emotional traits of each section are used to create a conceptual framework of the narrative. The importance of structure in developing a conceptual framework supports the evidence of observational and longitudinal studies of memorisation (Chaffin, et al., 2002; Ginsborg, 2002; 2004; Ginsborg & Chaffin, 2011a; Ginsborg & Sloboda, 2007; Hallam, 1997a; Lisboa, Logan, & Begosh, 2010; Miklaszewski, 1989).

Use of Individual Cues

The cues used in the *Oiseaux Exotiques* cadenza enabled a cohesive and tightly organised hierarchical retrieval framework. As demonstrated in chapter 3, a great many of these cues can be applied to Messiaen's other works. In particular the intervallic cues based on a seventh became a primary memory cue in his works from 1950 onwards. What happens, then, if such a cue is used for a much larger piece? Can an individual cue still function in a successful and efficient manner if a work is 90 minutes long, such as *Des Canyons aux Étoiles*? Initially, it is worth briefly re-examining the role of such a cue and its relationship to other material. Given the short duration of the *Oiseaux Exotiques* cadenza along with the repetitive rondo structure, the range of cues provided both enough continuity to create connections, whilst also allowing for the diversity in the musical material. Hence, methods of assimilation such as the intervallic seventh cue were successful as they were easily transferable, and also because there was enough diversity between these and other cues to memorise the musical material (Figs. 3.1 – 3.4). The short duration of the cadenza and the limited occurrence of the seventh intervallic cue reveal its effectiveness.

Des Canyons provides a very different challenge. Previous unfolded melodic material based on sevenths is still present: however, there is also an

abundance of chords based around seventh intervals. Early on in the learning process this aided assimilation. However, as the learning progressed, whilst recognition of seventh intervals undoubtedly increased the speed of reading, the efficiency and success of the cue diminished. Given the saturation of this musical material in *Des Canyons,* the learning strategy was transformed. Fig. 4.16 illustrates this change:

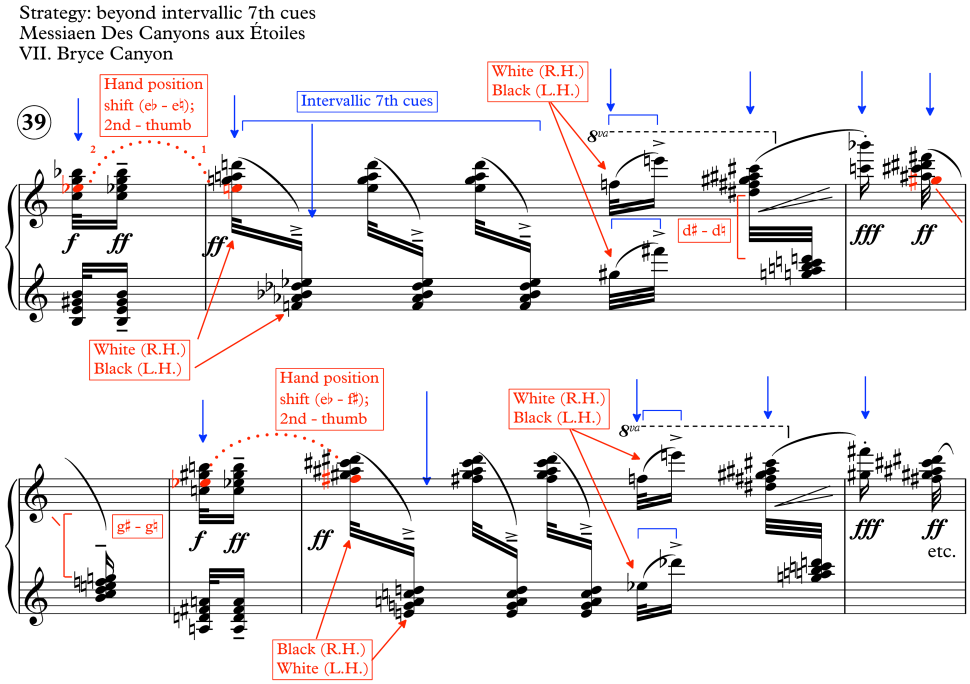


Fig. 4.16 *Extensions to intervallic cueing, Bryce Canyon et les rochers rouge-orange (Messiaen Des Canyons aux Étoiles).*

This passage of seven bars summarises the saturation of seventh harmony in the work. Blue arrows indicate 12 separate versions of the seventh harmony in this short section. Whilst the awareness of seventh harmony and use of intervallic cues occurs, unlike the *Oiseaux Exotiques* cadenza, this saturation required different domains to be examined when forming memory cues. These are shown in red in Fig. 4.16. As demonstrated, this often involved examining the relationship between consecutive gestures to encode serial progression (i.e. chunking). Thus, for example, instead of actively encoding two seventh chords, the intervallic cue was a more unconscious association or assumption, whilst a cue was assigned to connect the narrative. This is seen in the first bar of Fig. 4.16 in the right hand, in which the hand position shift between two seventh harmonies becomes the most important cue. The e♭^{2} taken by the second finger in

the right hand chord shifts to e♯^{2}, now the bottom of the chord (illustrated by the dotted slur). Further relationships include the awareness of thumb relationships, here a semitone apart, as in bars 2 and 3-4 in the example. A final serial cue was encoding chords and hands in relation to black and white keys (piano-shape cues). The increased experience with Messiaen's music may indicate that the familiar sonority and kinaesthetic trait of the seventh interval had developed into a schema in the semantic memory – much like a scale or arpeggio – allowing expert memorisation (Chase & Ericsson, 1981; 1982; Ericsson & Kintsch, 1995).

Concision of Musical Material

There are similar challenges for memorisation when approaching music constructed with absolute concision in mind. Copland's Piano Variation (1930) provides the foremost example. The theme, 20 variations and coda lasts around 11 minutes, with a cell of four pitches generating the entire musical material (illustrated in blue, Fig. 4.17). Despite the early date of this work in the twentieth century, the modernist style and concision provide numerous challenges for memorisation, not least the various switches as the cell is manipulated. Fig. 4.17 illustrates one such manipulation in variation 18, and the memory cues employed:

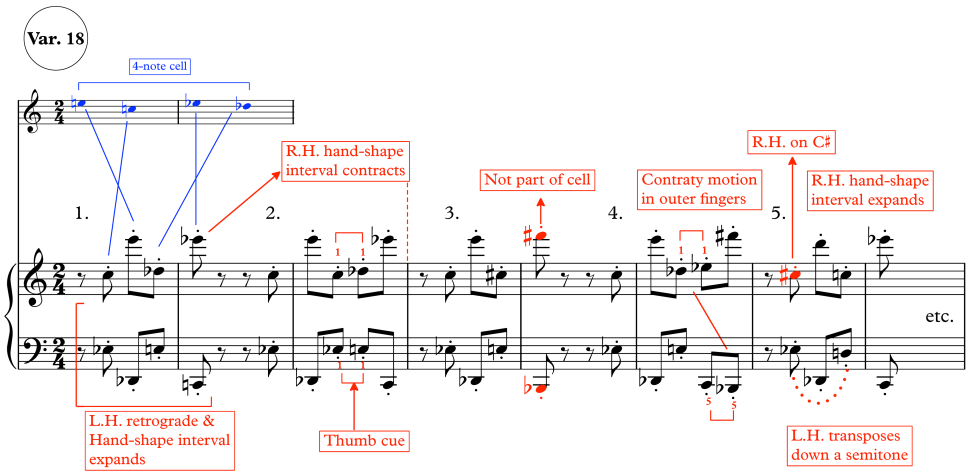


Fig. 4.17 *Motivic cue derivations, Copland Piano Variations.*

As demonstrated, the similarity between versions of the motif challenges memory procedure. These are overcome by various means. Initially, awareness of the hand-shape positions formed the strongest cue. For example, the first

statement the right-hand span contracts (c♮^{2}/e♮^{3} – d♭^{2}/e♭^{3}), whilst the left-hand span expands (D♭/e♭ – C♮/e♮). This left-hand version is also a retrograde statement of the right hand. The second statement repeats the initial version with a repetition of the first note in each hand. This creates a kinaesthetic cue as the thumb is used consecutively on two notes. The third statement introduces pitches alien to the motivic cell (B♭$_1$ in the left hand, and f♯^{3} in the right hand). The fourth statement reuses the repeated thumb gesture, although in the left hand this is modified to the fifth finger. Finally, the fifth gesture returns to cues based on hand-shape movements: the right-hand interval expands (c♯^{2}/d♮^{3} – c♮^{2}/e♭^{3}) whilst the left-hand spread shifts down a semitone (D♭/e♭ – C♮/d♮). This last version is the only statement in which the starting note alters: the right hand starts on c♯^{2} here, instead of the usual c♮^{2}.

Despite the brevity of this example, Fig. 4.17 provides a clear summary of the techniques involved in memorising very similar statements of the motif. The awareness of both similarities and differences play an important part in enabling serial chaining in retrieval, with more specific individual cues relegated in favor of more general and physical methods. In particular, the hand-shape patterns, of both hands separately, and their relationship together, are fundamental in the learning process. As with large-scale works containing much repetition of musical construction and motif, material in which concision is one of the primary aims in compositional construction both aids and challenges memory. The generating cell of Copland's Piano Variations (shown in blue) can be reduced to four intervals: a semitone, a tone, a minor third and a major third. Awareness of this limited number of permutations enables a fast initial assimilation of the work at the very earliest stage. However, it is this economy that challenges memorisation as there is so much repetition with minimal variation. The progression from specific (intervallic) cues to more physical and conceptual cues (hand-shape cues and the awareness of similarities and differences) seeks to overcome the challenges arising from a saturation of one particular musical dimension.

Extremes of Musical Complexity

How does memory strategy differ when music is much further removed from a musician's experience? Can a performer successfully memorise when new notations, rhythms, structures and sound worlds are encountered. This section will briefly examine Tristan Murail's *Treize Couleurs du Soleil Couchant* ('*Thirteen Colours of the Sunset', 1978*).[34] The work is scored for flute, clarinet in B♭, violin, cello, piano and digital reverberation.[35] The complexity of the score has contrary impacts for memorisation. First, it was necessary to memorise a great deal of the piano part in order to focus on the relationships with the other parts. However, given the great deal of detail in all parts, I found it necessary to play from the score in performance. Whilst there are many extended techniques for the wind and string parts (including quarter-tones and tones modulating just above and below a pitch) the primary complexity arises from Murail's particular notation that relies heavily on the visual impact of the score. Main beats are marked with vertical lines above the staff, at 2cm intervals: this 2cm equates to one second. Thus, the space in between two lines is the duration of one beat lasting one second. Standard rhythmical durations are used (crotchets, quavers etc.), however, these notations are subservient to the location of the attack or starting point of a note. In other words, the location of a note within the 2cm space of a beat defines where the note should be played. The opening piano figuration (Rehearsal Figure 1a in the score) shows this notation. Underneath the staff is one possible interpretation of the rhythm provided by the conductor Pierre-André Valade (Fig. 4.18).

To further complicate metrical notation, there are a few bars notated with conventional time signatures. Meanwhile the length of a beat (the gap in between two lines) changes, and different instruments play at different metronome marks. In the latter case, at rehearsal figure 12b onwards the piano has a series of chords that slow from a crotchet pulse of 60 beats-per-minute to half speed, in stepwise

[34] As noted in the introduction to this chapter, the work was learned prior to research. Consequently, an annotated score was completed retrospectively. However, detailed transcriptions of the handwritten score were made during the learning process: these form the basis of the analysis here.

[35] Analysis here is limited to the piano part. For a discussion of collaborative memory processes, see: Ginsborg, Chaffin, & Nicholson, 2006; Ginsborg, Chaffin, Demos, & Nicholson, 2013.

§descent through 40bpm, 36bpm and 33bpm. This is set against the other parts and conductor who remain at 60bpm. This wide range of difficulties required a great deal of personal and ensemble cues and strategies.

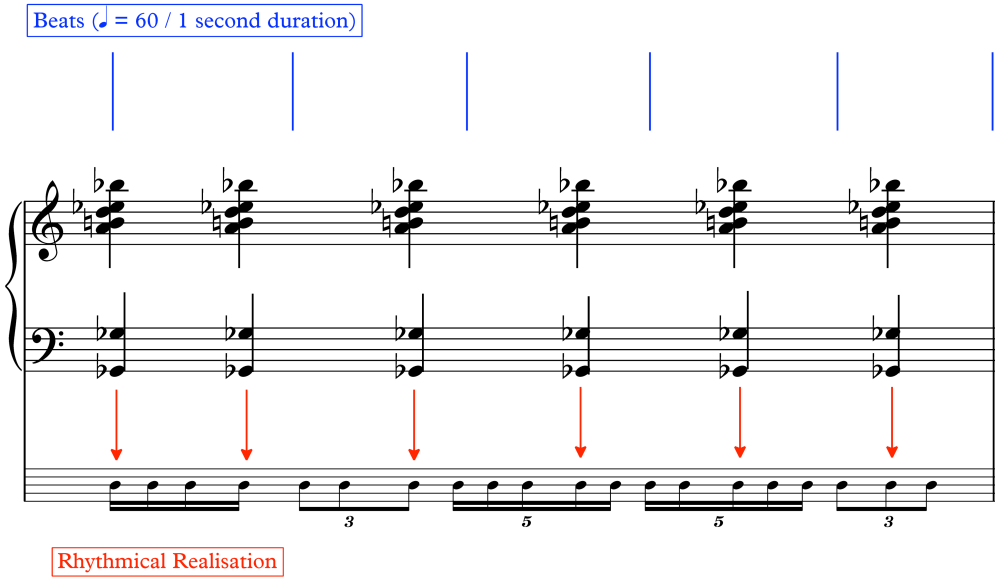


Fig. 4.18 *Visual-rhythmic derivations, Murail Treize Couleurs du Soleil Couchant.*

A wider combination of practice strategies and memorisation cues were employed in order to assimilate this complexity. Fig. 4.19a illustrates one of the most difficult passages for the piano, starting at rehearsal figure 7 (this is a scan of the handwritten score). The conductor beat is missing at the start of the passage (an error in the score): this is five beats-per-measure (♩ = 60). The fourth bar (marked with a large '5') is therefore in the same metre. The piano part begins with descending cascades of demisemiquavers that do not align with the conductor's beat. Careful inspection of the score reveals that these figurations align with the violin part, in a different tempo (♩ = 70).

Initially in a single voice, the cascades are treated polyphonically with three parts overlapping. The figurations gradually extend down the piano register and take the form of a written out *ritardando*. From the third bar of 7, each individual line also has a *decrescendo* from the top register to the bottom. The original notation renders this musical gesture with extreme visual clarity. However, this clarity is at the expense of legibility when playing at the instrument. The fact that the piano and strings are at different tempi with the

conductor increases the complexity of this passage. Given this range of difficulties, I found it essential to memorise this short passage to enable interaction with the ensemble and conductor.

Thus, the first process in order to memorise this passage was a transcription from Murail's original score to standard notation. This is presented in Fig. 4.19c (coloured labels in this figure refer to additional memory cues discussed below). The priority in transcription was to ensure that the beats align with the conductor (𝅗𝅥 = 60). A 4/4 metre was selected for simplicity, and the downbeats of each bar were clearly highlighted as visual markers to aid ensemble both in rehearsal and performance (the main downbeats are marked in green in Fig. 4.19c). This transcription inevitably loses the visual clarity of the original score with regard to gesture. For example, from the second bar onwards, the transcription merges polyphonic lines together into demisemiquavers (the separate lines are briefly outlined in blue in bar 2 of Fig. 4.19c). Instead, the result is a much more general cascading shape as various polyphonic lines are conflated to allow for ease in performance, whilst simultaneously creating a more precise rhythmical imprint of the passage. This transcription process served as a precursor to more detailed memory cues. Initially, the harmonic fragment for this passage was identified as a group of fourteen pitches that gradually extends down the register from a c♯^{4} to F♮$_1$, as demonstrated in Fig. 19b. The registral peak (c♯^{4}) was identified as a strong cue, with the polyphonic lines initially starting at this pitch. The left-hand cues were particularly strong (marked in red), with generally a grouping of two pitches extending downwards, whilst retaining one of the previous pitches: p-q; q-r; r-s etc.

There were limitations and difficulties in assimilating this transcription. First, whilst the transcription lines up with the conductor, the physicality of the original notation – the top of each grouping with an accent – was such a strong pianistic cue that it often derailed the modified transcription. This was particularly true of the first bar: I found the natural tendency was to accent the registral peak of each group (usually c♯^{4}), as grouped in the original notation. However, this accent invariably began to align with the beat of the conductor. Through a process of trial and error, a solution emerged to aim for the main downbeats, whilst also acknowledging when smaller features coincided with the

conductor's indications. For example, in Fig. 19c, the major arriving points are illustrated with green arrows, denoting the conductor's main beats. Further signposts are used to ensure the rhythmic progression remains on track, such as bar 1 beat 3, where a registral peak aligns with a conductor's beat.

A further limitation was memorising and practising the *diminuendo* effect for each polyphonic line, when lines have been merged and have lost their individual identity. Despite this, the reaction to registral changes is a fairly instinctive awareness in trained musicians, and my solution to consider the larger dynamic structure seemed to work successfully. Given the speed of motion (largely demisemiquavers at the outset), it would be hard to evaluate the difference in auditory perception for either performer or listener between this solution and one that seeks to preserve the individuality of separate voices. Undoubtedly, there are several possible solutions to assimilating this passage. My own were mainly led by external factors: at the first rehearsal, the conductor replaced the hired score and parts with his own version, which required a great deal of modification of learning and memory strategies in a short period of time.

The process is also the only example of a multimodal approach to memorisation discussed in the thesis (such strategies have generally been avoided in research method given the difficulty to analyse such mental processes). Despite the extreme complexity of the composition, it is likely that the process had a fundamental contribution to my understanding of the section of the piece, and hence my learning and memorisation of the passage. This was particularly significant with regard to the structure of the section (working out the registral peaks, harmonic fragment and patterns in the hands) in addition to understanding how my part interacted with other members of the ensemble and conductor.

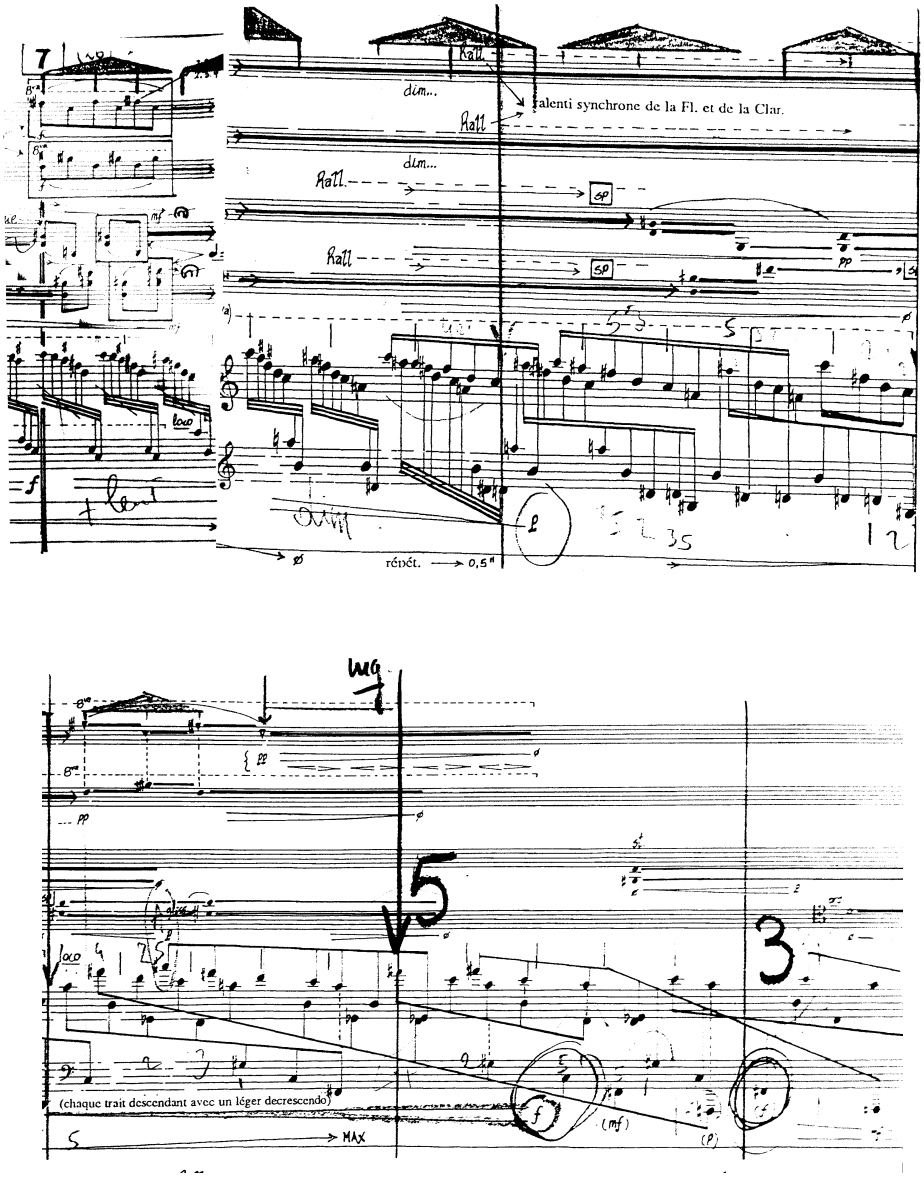


Fig. 4.19a *Murail Treize Couleurs du Soleil Couchant: Rehearsal Figure 7, original score.*

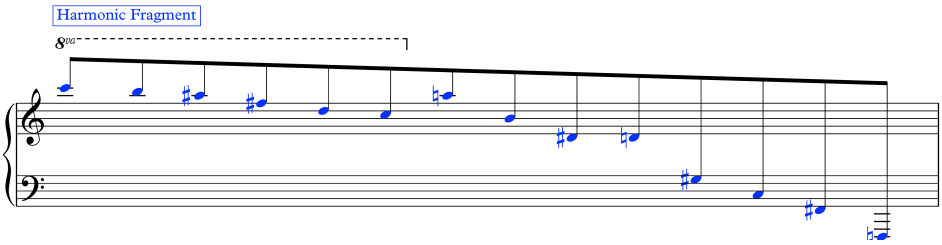


Fig. 4.19b *Harmonic fragment Murail Treize Couleurs du Soleil Couchant: Rehearsal Figure 7.*

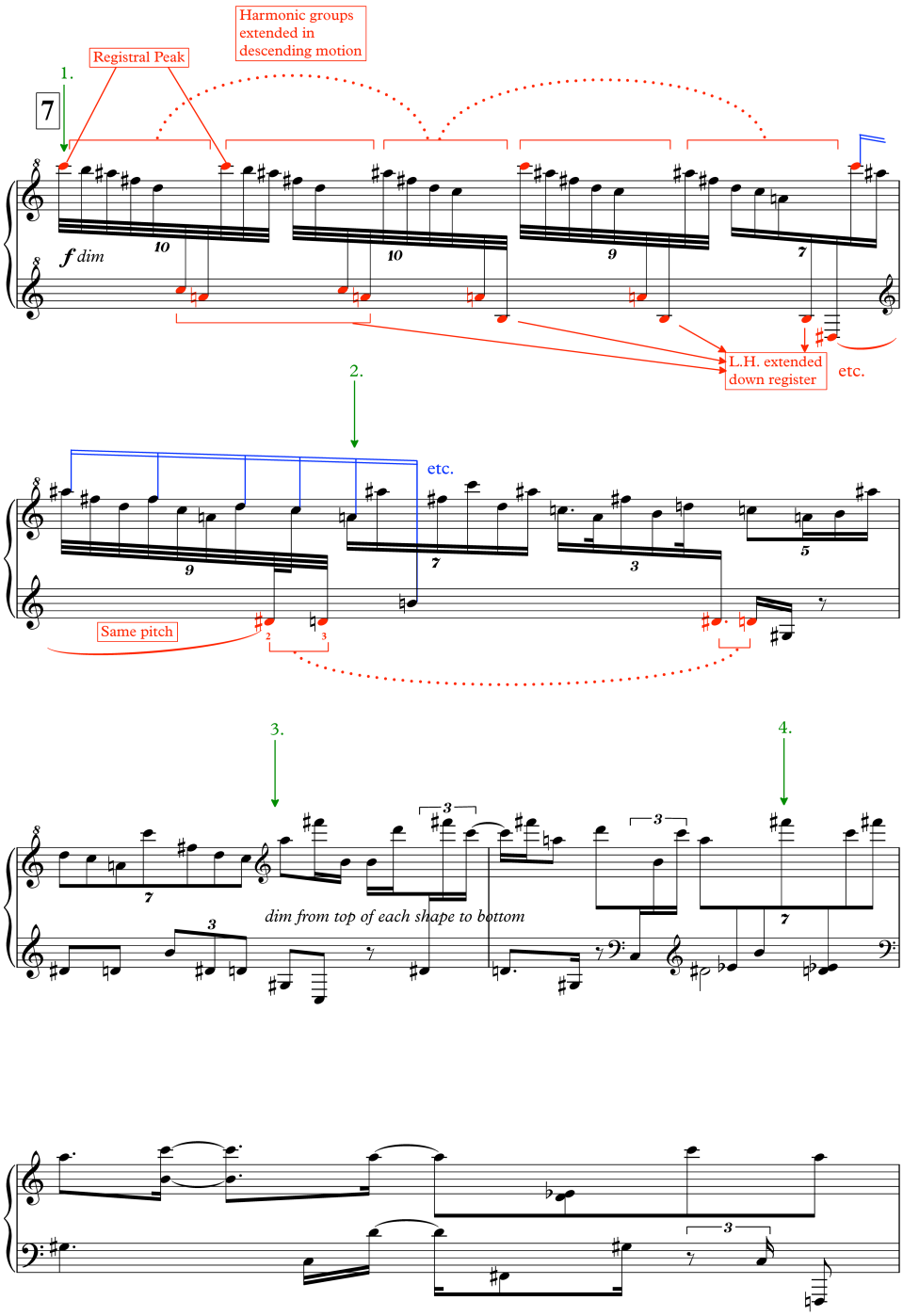


Fig. 4.19c *Re-notated version with memory cues and performance cues.*

Speed learning

Establishing memory cues for instant retrieval during performance invariably takes a great deal of practice. Time is required to discover and relate individual cues to others in order to build a conceptual framework a certain piece. How does the learning process change when time is limited? Can a framework of cues be firmly established? This process is examined in relation to Wood's *Three Piano Pieces*, Op. 5, learned for the celebration of the composer's 80th birthday. Given the demands of my schedule at the time, I was unable to start the work until three weeks prior to the main performance. In addition, at the beginning of the week before the concert I had two practice performances: one to my teacher, and one to the composer himself. Thus, the piece had to be learned and memorised in two weeks

With a duration of just under eleven minutes, the task was quite demanding in the time frame. There were certain elements to facilitate the task. First, I devoted my practice exclusively to this work, given the venue of the concert was fairly high profile. Secondly, the outer movements posed few technical problems, with slow tempi and sparse textures. The third movement in particular is very short and only took a day to memorise. Thus, the main challenge was the second movement, a virtuosic toccata-style rondo. Finally, despite the technical challenges in this movement, other musical domains were more accessible. Despite regular metre change, the rhythm did not prove difficult to assimilate. The structures were familiar ternary and rondo forms with clearly defined sections, and the musical language felt very familiar. In particular, the influence of Schoenberg was most striking from the outset.

The strategy involved was extremely intensive and highly organised. The first movement (four pages) was learned in two days. The central movement took a week, at a pace of roughly two pages a day, and the third movement took one day to learn. The rest of the three weeks was devoted to polishing the work. This mainly focussed on mastering the technical aspects the second movement. Practice strategy involved very segmented approaches. Given that the average rate of learning was two pages a day, practice was divided into one-page segments (one page in the morning, one in the afternoon). Practice was also highly repetitive, even more so than normal. The methods are similar to general

suggestions for effective memorisation regarding segmentation and memorisation by rote (Ginsborg, 2004; Mishra 2005; 2011). The focus was attaining fluency as quickly as possible through extensive repetition. In addition, a portion of practice each day was allocated to reviewing the previous pages learned. The practice performances in the week leading up to the concert were successful. However, there was some physical tightness and a tendency to rush in the second movement. Extensive practice continued right up until the concert. On the day of the concert itself, I felt I needed to play a great deal to alleviate the nervous tension. The concert in the end was a success, and the performance felt surprisingly comfortable.

Fig. 4.3 demonstrates the important role intervallic cues played in the memorisation process. As described, the use of tritones and sevenths were a fundamental means of assimilating and encoding data from the very first learning sessions. Similarly, intervals involving semitones (minor seconds and their compound, minor ninths) also proved useful when first forming intervallic schemas. The use of these intervallic cues of course relates to the compositional make-up of the score. However, to some extent the use of these particular cues was influenced by the use of similar cues in the *Oiseaux Exotiques* cadenza, which was learned only three months prior. For example, there are numerous passages in which perfect fourths are the primary intervals. Whilst I was aware of this intervallic motif, the short learning period meant that full exploration of this interval as a cue was relegated in favour of a more familiar cue.

Despite the awareness and use of intervallic cues, the construction of a cue framework did not take place to such an extent as with the Messiaen cadenza. Instead, an over-reliance on physical and kinaesthetic traits in practice brought about the memorisation procedure. Similarly, there was an extremely narrow pool of cue types, as muscle memory combined with certain structural elements to govern memory processes. This combination of factors seem to explain the nervous energy surrounding the performance, whilst at the same time revealing the necessity to practise to such an extent on the day of the performance. Given the predominance of kinaesthetic elements as memory cues, it was important to feel as comfortable as possible in order to execute the performance onstage.

The apparent lack of a conceptual framework provides interesting questions regarding muscle memory. The relatively short duration of the work allowed for this memory procedure to be maintained, most likely relying on serial chaining (Chaffin, Logan and Begosh, 2009), and with little overlearning factored into the practice process (Driskel, Willis, & Copper, 1992). However, for longer works, the strategy would likely prove unsuccessful, requiring content-addressable memory (Chaffin, et al., 2009; Rubin, 2006). Furthermore, despite my personal satisfaction with the performance itself, the whole process was far from comfortable, and provides little opportunity for long-term recall. I have not had the opportunity to relearn the work: however, I imagine a great deal of work would be required in comparison to works that have had a longer gestation period, as suggested by early theories of memory retention (Ebbinghaus, 1885/1913).

Concision and Complexity

The final work analysed in this chapter is Tavener's *Palin* (1977). The work was written in the composer's earlier period before his conversion to the Russian Orthodox Church and his subsequent shift in compositional style. It is still possible to hear the influence of Stravinsky and Messiaen in the rapid chromatic figurations and the wide range of colours. Additionally, there is influence of dodecaphonic technique, as demonstrated by the use of twelve-tone *ostinati*, although adherence to the technique is not strict. The work is of interest for this study given to its palindromic construction, as alluded to by the title of the piece. Both the larger structure, as well as the motivic figurations, form mirror images. Indeed, the second half of the piece an exact reversal of the opening, forming a structure of **A B C || C' B' A'**. This provides a great challenge for memorisation, as there is both concision in pitch, and complexity in the proliferation of chromatic melodies. Despite the apparent concision of material (it is all stated in the first half of the composition), cognitive processes were extended as the material needed to be learned backwards in the second half. Analysis of the second section of the piece, and its recapitulation demonstrates some of the methods involved in assimilating the material. The left hand is formed of a repeating *ostinato* of twelve pitches, proving simple to memorise. It

is the rapid right-hand figurations that challenge memory technique. The shorter figurations are largely assimilated with ease into the short-term memory, with simple awareness of pitch deviations, as seen in Fig. 4.20:

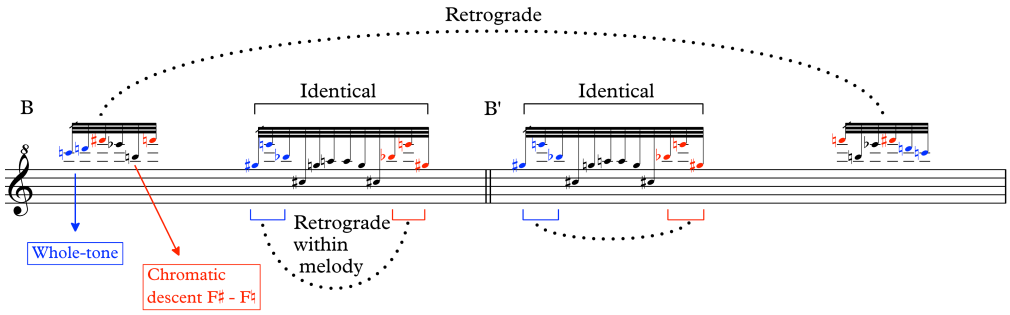


Fig. 4.20 *Motivic variation in Tavener's Palin.*

As demonstrated, the shorter figurations are easily memorised. The first fits under the hand and is reinforced by voice-leading cues including whole-tone components (in blue) and chromatic descent (in red). The second figuration and its repeat are identical. The figuration itself is also a retrograde, with a cue reinforcing the different order of pitch at the beginning and end (highlighted in blue and red).

Problems arose when retrograde versions of certain figurations (in the **B'** section) were almost identical to separate figurations in the in the **B** section. Here active encoding of the difference, or switch, was necessary. Fig. 4.21 compares the fifth figuration in the B section with the retrograde of the opening fourth figuration:

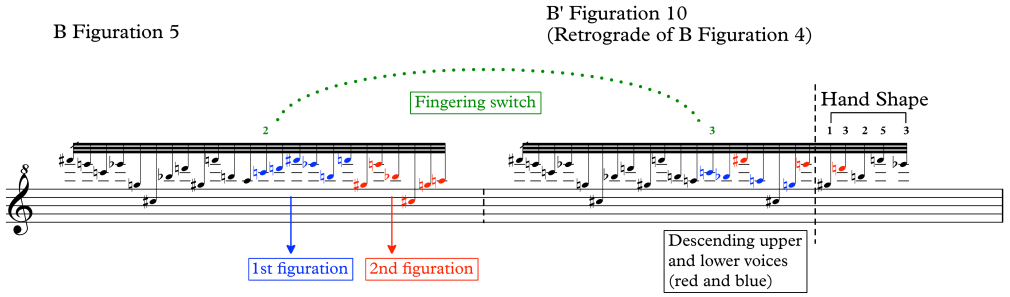


Fig. 4.21 *Fingering cues for switches, Tavener's Palin.*

As demonstrated, the first half of each figuration is identical. The change was actively encoded with a fingering cue (marked in green). This was the most fundamental cue to ensure that the correct figuration was recalled. Indeed, in

practice it was very easy to confuse the two figurations, usually in the **B'** section, resulting in a mistaken return to the exposition. The first figuration was easily encoded after the fingering cue, as it is formed from the opening two motives of the **B** section (Fig. 4.20). The second figuration proved more difficult to assimilate, and was encoded through a combination of descending scalic voice-leading cues (highlighted in red and blue), and a hand-shape / fingering cue at the end of the fragment.

This last example was additionally important in the conceptual memory of both passages. Given the great similarities in the figurations of this passage (thirteen figurations and their equivalent retrogrades), memorising the serial order was an added difficulty. Memory retrieval was easier at the beginning and end of each section, where the fragments are shorter. As this figuration was near the middle of the section, it served as a signpost to ensure correct recall, in particular the fingering-switch cue. As each fragment starts on the last note of the previous melodic figuration, the cue was vital in enabling correct recall.

Conclusions

The analysis in the previous two chapters has sought to examine my own memory techniques in a wide range of atonal repertoire. Framed as *artistic research*, the role of the practitioner is fundamental to the research methods and the outcomes. These experienced-based results aim to develop theory on practice of musical memorisation techniques. As such, the findings are informative to other practitioners, and it is likely the findings can be transferred across instruments and repertoire with success. Given the predominance of tonal schemas in a musician's knowledge (Halpern & Bower, 1982), and the importance of these patterns for expert memorisation (Chase & Ericsson, 1981; Cook, 1989; Ericsson & Kintsch; Sloboda, 1989), the analysis initially sought to examine how this domain-specific knowledge is adapted and replaced for repertoire in which the occurrence of conventional tonal patterns is reduced.

The initial analysis of the *Oiseaux Exotiques* cadenza in chapter 3 demonstrated the techniques used in one composition. Conceptual patterns relating to intervals formed one of the primary techniques in establishing larger connections across the cadenza: a fundamental principle of effective memorisation (Sloboda, 1985). As such, the use of intervallic cues progressed

beyond localised use (Li, 2007; 2010), to establish a schema of patterns related to the particular composition. Whilst the primary intervals used to achieve memorisation were sevenths and tritones (intervals less used in tonal music, with the obvious exception of dominant sevenths), the strength of the cue lies in the existing knowledge in the semantic memory. Music theory is a fundamental part in the years of formative training of musicians, which is necessary to reach the highest level of skill (Ericsson, et al., 1993). Knowledge of intervals is a vital part of this training, and so provides a relevant schema in the musician's lexicon with which new material can be compared. Whilst the intervals used in atonal compositions may be atypical (such as sevenths and tritones), the application of previously acquired domain-specific knowledge is still possible.

Other cue types related to kinaesthetic, structural, verbal and registral assimilation of the features of the score. Some cue types, such as hand-shape cues, could be applied on a wider basis across the cadenza. These developed intuitively through practice, as physical and aural awareness of the features in the composition were established through extended practice. Contrastingly, some cue types were used on a localised basis to aid memorisation of a particular gesture or phrase (Li, 2007), or to clarify difficult switches relating to structural points in the score, such as the verbal-association cues (Fig. 3.16). Rhythmic gestures were primarily memorised using mathematical frameworks relating to the additive rhythms, or beat counting of groupings of units (Li, 2007).

Subsequent analysis over the two chapters sought to evaluate the wider application of these cue types across varied repertoire. The evidence suggests the effectiveness of the strategies for atonal music. Intervallic cues establish a set of patterns for a particular piece, enabling effective memorisation. Parncutt and McPherson (2002) discuss this compositional tendency: "Atonal compositions tend to be based on patterns and sonorities that are unique to the piece itself more so than tonal compositions" (chapter 11). These patterns can be replicated across a composer's compositions in identical form in which the style and musical language is similar (see for example Figs. 3.25-3.28). Similarly, cues can be replicated in repertoire that is influenced by a certain compositional style, as demonstrated by the use of sevenths and tritones in Wood's *Three Piano Pieces* (Fig. 4.3). Furthermore, the intervallic strategy allows for simple transformation to aid memorisation of repertoire based on different intervals. This follows a

process of intuitive and reasoned analysis at the instrument, in which the compositional habits of a particular composer are deduced and form the basis of a new set of intervallic schemas (see, for example, intervallic cues based on fourths and fifths, Figs. 4.1-4.2).

Hand-shape cues exhibit similar possibilities for deduction and transformation, given their similarity to intervallic cues. Indeed, the hand-shape cues can be seen as a kinaesthetic realisation of the more conceptual intervallic equivalents. Repeated inculcation of similar hand-shapes in a composition further establishes a set of patterns that leads to efficient and effective memorisation. Furthermore, analysis in this chapter has demonstrated how this type of cue synchronises with other techniques (visual, intervallic and the patterns formed by the keyboard layout) to reinforce and strengthen memory procedure. The effectiveness of this combination allows for memorisation of a range of complexities in atonal repertoire, such as the repetition of material based upon similar, concise motivic devices. Voice-leading cues demonstrate similar possibilities for transfer across repertoire. In contrast, the technique is most useful on a localised level, to aid retrieval of a particular passage.

The analysis in this chapter also documents extensions to the strategies, particularly for larger works. In particular, this included establishing structural cues for repetitions of existing material (Fig. 4.15). This was often based on a range of memory systems, most notably the emotional system, to reflect the musician's visceral response to a particular passage (Chaffin, Logan, & Begosh, 2009). Larger works also clarified the relationship between the more conceptual intervallic cue and the kinaesthetic hand-shape cue. This resulted in the sonic-resonance cueing strategy, in which the aural constituent of a chord further reinforced memory procedure, to combine with the previous mental and physical techniques.

A final development related to use of the original intervallic cue (based on sevenths and tritones) in a composition that is saturated with this musical language. Analysis of *Des Canyons aux Étoiles* highlighted the development of the cueing strategies as a group of techniques (see Fig. 4.16). When the effectiveness of one cue type was reduced (in this case the intervallic cue), given the large-scale repetition of similar musical material, other strategies – including hand shapes, piano shapes, voice leading and fingering – were able to fill the

void. A further suggestion in this analysis is the acquiring of atonal schemas in the semantic memory. Anecdotal evidence highlights an increased familiarity with the hand shapes and intervallic patterns across Messiaen's output, particularly regarding the later works based on birdsong. Further quantitative study of the development of knowledge in musicians experienced in performing atonal music is necessary. However, it is likely that increased exposure develops schemas relating to atonal music in the semantic memory.

The analysis in these two chapters provides a compelling argument as to the effectiveness of these cueing strategies for atonal music. Whilst providing extensive insight, it is dangerous to overstate the implications of the findings at this stage, given the self-reflective nature of the discussion. Consequently, the sixth chapter extends the examination of memory strategy to three other pianists and their individual techniques for memorisation. This serves to validate my own experienced-based conclusions, and offer alternative procedures.

Prior to this, the next chapter examines long-term recall in Boulez's *douze notations* (1945) from a different perspective. First, examples of cueing procedures realised before this research provide interesting embryonic techniques for comparison with the results of the present discussion. Secondly, analysis of two played recalls examine what landmarks remain in a musician's memory, extending previous research to another performer and musical style (Chaffin, et al., 2002; Chaffin, Lisboa, et al., 2009; Lisboa, et al., 2009c; Ginsborg & Chaffin, 2009; 2011a). Variation in use of PCs across performances is also examined here. Finally, analysis of the expressive changes across a longitudinal time frame extends discussion of the effects of long-term memory through the examination of audio recordings of three public performances in 2009, 2014 and 2015. Previous research has examined tempo fluctuations across performances (Lisboa, et al., 2007). Analysis is extended to investigate the acoustic realisation of musical gestures through the use of spectrograms.

CHAPTER 5

Re-approaching Memory

Boulez douze notations for piano

The previous three chapters have examined the process of memorisation when learning repertoire for the first time. The demands placed on memory during this initial learn are considerable. Memory cues must be established and practised until retrieval is immediate and part of instinctive kinaesthetic responses (Chaffin, et al., 2002; Ericsson & Kintsch, 1995). These cues must then undergo numerous transformations, modifications and reinforcements as different musical dimensions are addressed in practice. The end result is the performance. The function of memory here is of course vital, but ideally plays a passive role as the focus switches to the spontaneity of creating sounds in the particular acoustic.

Despite the attainment of a complete conceptual memory framework of a piece, the nature of memory is to decay. Ebbinghaus (1885/1913) initially examined this process by comparing the retention of nonsense syllables in original learning periods and subsequent relearning. This was refined to trace decay theory, referring to the passing of time when memory representations are not retrieved (Thorndike, 1914; Jenkins & Dallenbach, 1924). A further model is interference theory, asserting the detrimental effect that learning new information has on existing memory schemas (McGeoch & McDonald, 1931). Tulving (1974) proposed that memory decay occurs for two reasons: trace-dependent forgetting, in which information is no longer stored in the memory, and cue-dependent forgetting, where the information is stored in memory but cannot be accessed (p.74).[36]

Previous longitudinal case studies of musical memory have examined various aspects of long-term memory recall. Landmarks relating to structural boundaries and particular PCs remain in the memory, signified by a greater

[36] Further research has addressed the contextual change theory of memory loss, asserting that decay occurs because of subtle changes in environmental cues (Bouton, Nelson, & Rosas 1999; Riccio, Richardson, & Ebner, 1999).

accuracy in long-term recall. In contrast, lacunae, places with a higher probability of incorrect recall, usually relate to basic dimensions (Chaffin et al., 2002; Ginsborg & Chaffin, 2011a). Studies demonstrate that played recall provides better accuracy than written recall, given the addition of sensorimotor cues (Lisboa et al., 2009c). Further research has examined repeated use of PCs across performances, demonstrating that they remain relatively stable, whilst also allowing for more spontaneous thoughts during performance (Ginsborg, et al., 2012). Similarly, PCs remain flexible to allow for the different demands of a particular performance (Chaffin, et al., 2013; Lisboa, et al., 2013).

The study examines my own learning procedure in Boulez's *douze notations* (1945), across a seven-year period. The initial learn occurred prior to the study, in 2008. Three research questions were formulated at the beginning of this study. First, how was the music memorised? Secondly, did PCs vary across performances, and were landmarks and lacunae demonstrated in LTM? And finally, how did the expressive realisation of the composition vary across performances? The chapter deals with each of these questions in turn. Based on previous findings, similar results were expected for the second question: that PCs would remain relatively stable, with some alteration between performances, and that the structural boundaries would remain as landmarks in LTM. Hypotheses were less certain for the remaining two questions. It seemed probable that memorisation strategies would be similar to those documented in the previous chapters, and that expressive execution would vary across performances. After outlining the music and the procedure, the following method section elaborates on the analysis undertaken.

Method

Pianist and Music

The pianist in the study is myself. The repertoire selected is Boulez's *douze notations* for solo piano (1945). The twelve movements, each twelve-bars long, demonstrate Boulez's early experimentation with dodecaphony. Whilst not strictly adhering to the technique, many principles are employed, including manipulations of tone rows, and the allusion to aleatoric elements used in later compositions.

Procedure

The work was initially learned prior to this research in December 2008. Six performances followed across the subsequent eighteen months until June 2010. This period will henceforth be referred to as the initial learn. The six performances were evenly spread out, and the work was performed less formally in lessons and masterclasses. Accordingly, the work was practised regularly to maintain performance standard. During the initial learn, annotations were made on the score. As this was one of the first atonal compositions that challenged my memorisation ability, the majority of these markings concerned memorisation. I also completed an undergraduate dissertation at the time. Whilst primarily from the viewpoint of a traditional analyst, the understanding of the compositional techniques further aided my memorisation strategies. An audio recording of a practice performance was also made in this period (2009).

After the initial learn, I did not practise or perform the work until the beginning of the present study (December 2013), three-and-a-half years later. Two public performances of the work were scheduled in April 2014 and March 2015. As such, this schedule offered the opportunity to study two successive relearning processes and their outcomes. Three discrete sets of data were obtained. First, an audio recording testing played recall of the first six *notations* was made at the beginning of each of the subsequent relearning periods (December 2013 and early March 2015). Played recall was preferred given the physical demands of the score (Lisboa, et al., 2009c). Secondly, PCs were annotated on two copies of the score after each of the performances (2014 and 2015). As with the recall, these markings are limited to the first six movements. The third data obtained were audio recordings of the public performances in April 2014 and March 2015.

Analysis

The first part of this chapter examines my memorisation techniques, through retrospective analysis of the original annotations on the score and comparison with the formal analysis.[37] The discussion is brief to avoid repetition of the previous chapters. It provides interesting, embryonic examples of the techniques previously discussed in previous chapters. This section provides further insight into memorisation process for atonal music. Given that the initial learn took place prior to this research, the techniques analysed are completely free of any influence of the outcomes of this thesis.

The second part of the chapter initially outlines variation in PC types across the two performances. Subsequently, the section analyses the trends in mean probability of recall as a function of serial position following basic PCs and structural boundaries. As stated, the hypothesis expected similar findings to previous studies: that structural boundaries remained as landmarks in the pianist's memory, and that probability of recall would decline as the distance from these landmarks increased (Chaffin, et al., 2002; Chaffin, Lisboa, et al., 2009; Ginsborg & Chaffin, 2011a).

The final section of this chapter compares the two recordings (2014 and 2015) with a performance made during the initial learn (2009). The aim is to examine to changes in expressivity over the course of a six-year period. Previous PC research has investigated expressive changes through tempo variation (Lisboa, et al., 2007). As such, the analysis extends longitudinal studies on memorisation to examine the acoustic realisation of memorised cues and the musical material that they retrieve during live performances. For clarity, Table 5.1 outlines the various data types, with their sources, collection period and analysis procedures.

[37] As the piece was one of the first compositions that challenged my memorisation ability, the annotations made on the score were detailed, and remained unchanged from 2008. As such, I am confident that the discussion presented below is an accurate description of my memorisation methods.

Table 5.1 *Summary of data sources, collection period and analysis*

Data type	Source	Collection Period	Analysis
Memory strategies	Original score annotations	2008 (pre-study)	Retrospective 2015
Formal analysis	Undergraduate dissertation	2008 (pre-study)	Retrospectively compared to original annotations
Played recalls	Audio-recordings	2013 & 2015	Retrospectively analysed in comparison to PCs
PCs	2 annotated scores	Retrospective after 2014 & 2015 performances	Retrospectively categorised
Performance recordings	Audio-recordings	2009, 2014 & 2015	Retrospective

I. Early Memorisation Strategies

As a precursor to the quantitative analyses of this case study, I will outline some cueing techniques used in 2008. These cues do not attempt to provide full documentation of memory process, merely to serve as examples of memory procedure before the thesis was started. The analysis in this section focusses on the first six movements. The discussion provides an interesting comparison to the techniques in earlier chapters, demonstrating their evolution into the comprehensive strategies in chapters 3 and 4. This is particularly evident with regard to intervallic cueing.

Examples are taken from my own annotations in the score, combined with connections in the structural analysis. Much of the structural analysis was not particularly useful for memory, given the propensity for dodecaphonic analysis to reduce musical lines to more abstract data, such as row numbers and transformations. Whilst the connection between pitch classes may prove illuminating in traditional analysis, there are limitations to this type of study when considering memory. Performers and listeners alike do not hear atonal progressions as they do harmonic ones. However, the structural analysis did provide techniques that were helpful in affirming my own intuitive cues. This was particularly evident relating to Boulez's manipulation of pitch cells, with dyad combinations formed from the tone row recurring throughout the work. In addition, analysis of Boulez's tight structuring of each movement also provided a long-term framework in my memory of the shape of each *notation*.

Pitch and Intervals

Fig. 5.1a demonstrates the tone row Boulez uses in the work:

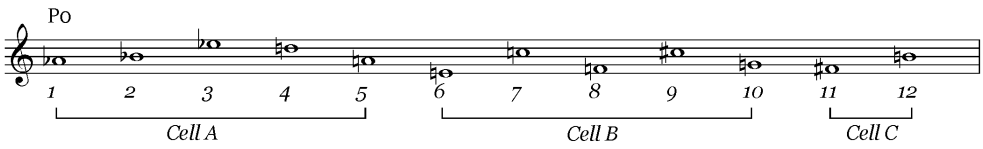


Fig. 5.1a *Tone row used in Boulez's douze notations.*

The division into three cells (A, B and C), two groups of five notes and one dyad, formed the melodic bases for the first four bars of the first notation, as seen in Fig. 5.1b:

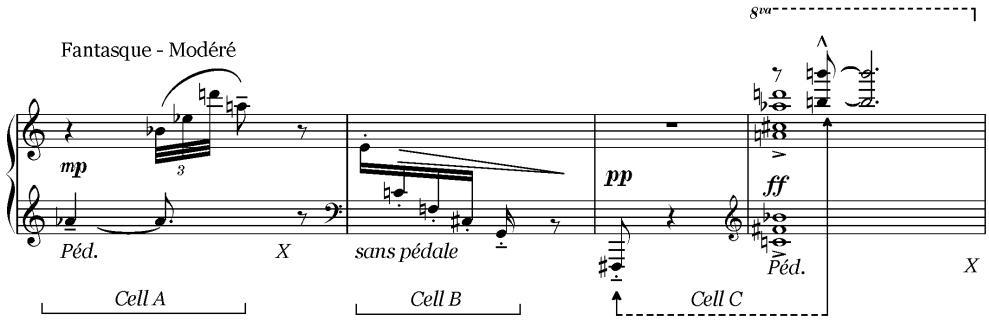


Fig. 5.1b *Derivations from tone row.*

Whilst the row was not learned as a memory cue, the structural analysis reinforced an intuitive cue of separating the row into dyad pairs, treated melodically or harmonically (Fig. 5.2).

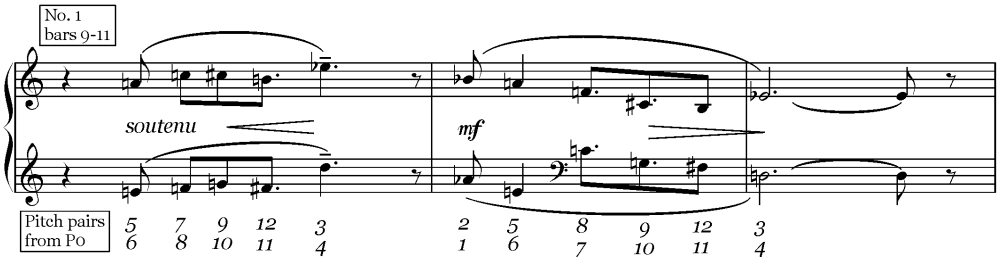


Fig. 5.2 *Pitch combinations of tone row.*

However, the use of row numbers was too abstract to form a convincing cue at the keyboard. Instead, the analysis confirmed my own realisation of sonic cues, relating to the hierarchical pairing of pitches throughout the work. Initially, awareness of these pitch-interval cues was somewhat intuitive: a vague sonic recollection as learning progressed. Later in the practice stages, several pitch combinations became instantly recognisable, forming active memory cues. In particular the dyad B♭/A♭ was significant, not least because it started and concluded the work. Fig. 5.3 demonstrates several examples of this dyad used as a memory cue:

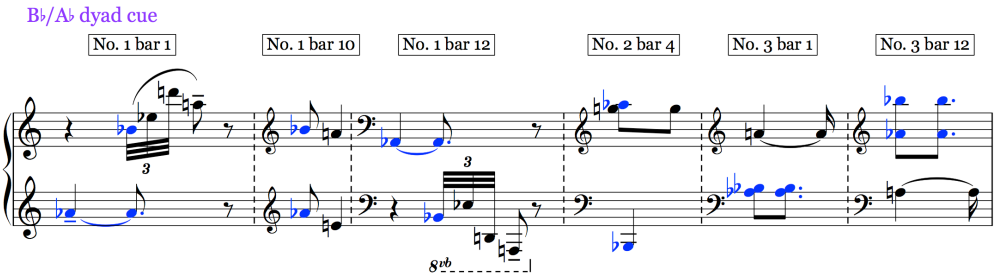


Fig. 5.3 *Intervallic cues derived from pitch combinations of the tone row.*

Further cues were assigned to repeating pitch dyads B♮/F♯, D♮/E♭, and A♮/E♮. Although not as strong a memory cue as the B♭/A♭ dyad, the familiarity of these cues served to create strong memory connections throughout the work.

Hand Shapes and Fingering

Another memory cue was formed from grouping unfolded chains of notes into chords. This is a common procedure for tonal music, in which melodic patterns often have a harmonic underpinning and are vital for expert memorisation (Halpern & Bower, 1982; Nellons, 1974; Sloboda & Parker, 1985). Although I was less aware of it, this type of cue developed into a widely used cue in my approach to atonal music: the hand-shape cue, described in preceding chapters.

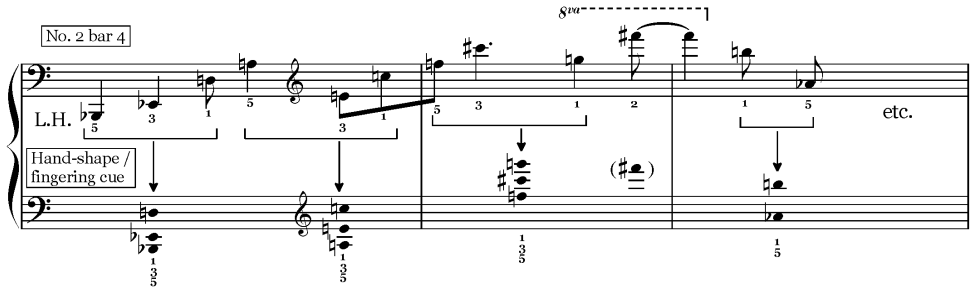


Fig. 5.4 *Hand-shape cues derived from chordal blocking.*

Fig. 5.4 demonstrates the chunking of a linear melodic line, ascending the entire range of the keyboard, into four chords. This cue is reinforced by the repeated fingering used for the first three chords (5-3-1), and a modification for the fourth dyad (5-1).

Chromatic Filling

A further cue type used was the awareness of how the chromatic space is filled. This memory technique examines Boulez's use of 'sound-blocks', or *blocs sonores*, to replace traditional chords (Goldman, 2011, p. 25; Ruwet, 1959). The fourth *notation* demonstrates this procedure. The left hand is formed of an *ostinato*, which varies only by its location in the bar. This forms a hexachord. Set against this, the remaining six pitches are taken in the right hand. This gradually expands, starting on d♯², eventually completing the second hexachord by spreading in both directions:

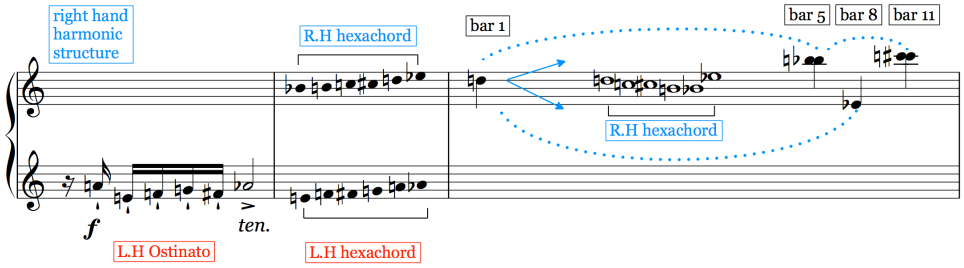


Fig. 5.5 *Cues derived from chromatic-filling hexachords.*

Rhythm

There is much connection between Boulez and Messiaen's rhythmic techniques. This is not surprising given that Boulez had enrolled in Messiaen's advanced harmony class in 1944 (Peyser, 1976, p. 30). Messiaen's influence of additive rhythms, non-retrogradable rhythms, diminution and augmentation is clear. This is demonstrated in Figs. 5.6a and 5.6b. The distinctive distorted rhythmical character of the two phrases combined with the mathematical relationships between durations provides very strong memory cues. Li (2007) describes similar beat counting techniques (p. 45).

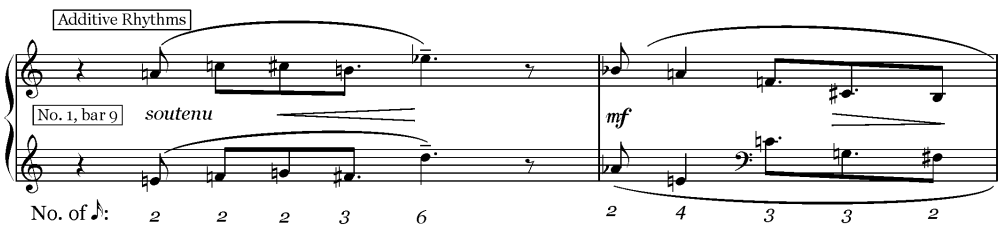


Fig. 5.6a *Rhythmic groupings by beat counts.*

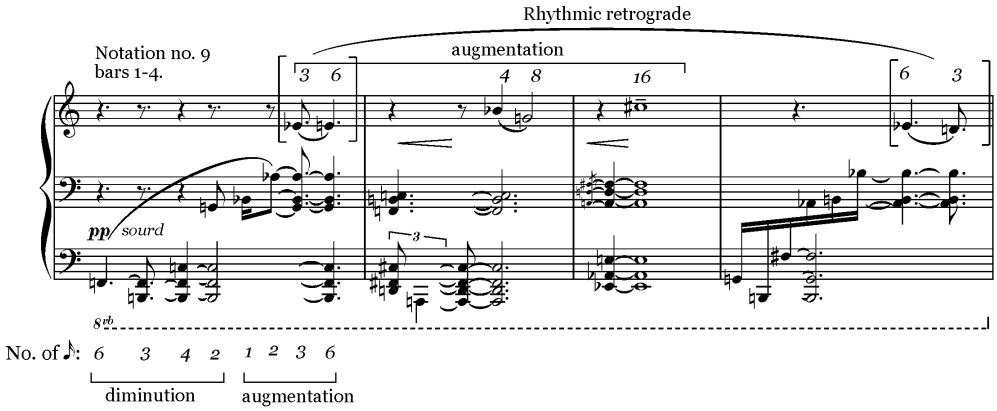


Fig. 5.6b *Rhythmic groupings by beat counts.*

A further memory cue was assigned to the order of hand attacks in more complex groupings:

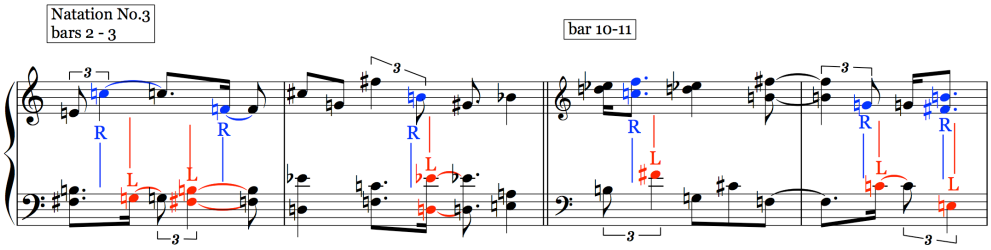


Fig. 5.7 *Rhythmic cues derived from ordering of hand attacks.*

Fig. 5.7 highlights the cueing method used for complex cross rhythms (semiquavers against triplet quavers) by memorising the order in which the hands strike the keys. Here, it is always the right hand followed by the left, apart from the single opposite in the first bar of the example.

Structure

Given the brevity of each movement and economical use of motif, structural connections were often immediately apparent. Particularly significant was the awareness of the connection between the first and last bar of each movement. In the first *notation*, bar 12 is an inversion of the first bar, in a lower register. The second *notation* repeats the opening three bars at the end in retrograde form with rhythmical diminution. The opening line of the third movement is heard in retrograde at the end, and the left-hand *ostinato* unites the beginning and end of the fourth *notation*. This structural device is largely continuous throughout the work. Consequently, this provides a strong memory

cue every twelve bars, outlining the shape of each movement. Additionally, more conceptual frameworks were used as cues for structure of individual movements. This took the form of identifying the graphical shape of the movement, ascribed to the register and dynamics. *Notations* 2 and 4 exhibit this clearly. The second *notation* can be characterised as an arc, with palindromic glissandi either side.

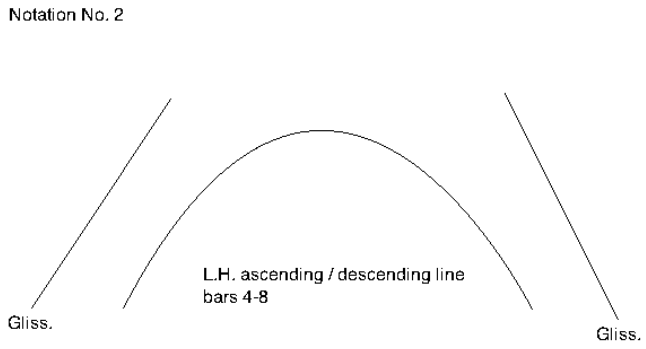


Fig. 5.8 *Graphical representation of structure, notation no. 2.*

Whilst Fig. 5.8 predominantly demonstrates pitch and register, the vertical axis of this diagram also relates to dynamic, with loudness corresponding to height. Thus, the top of the left-hand arc is the loudest, as are the tops of the glissandi. Similarly, the chromatic-filling cue as examined in Fig. 5.5 was strongly associated with a visual-structural cue. Fig. 5.9 outlines the fourth *notation*, with the right-hand registral expansion memorised as a wedge, diverging from the initial strike (d♯^{2}). Whilst these structures are simplistic, they do represent the concise miniature forms employed in the work. The acoustic realisation is examined later in the chapter (see Plate 5.13).

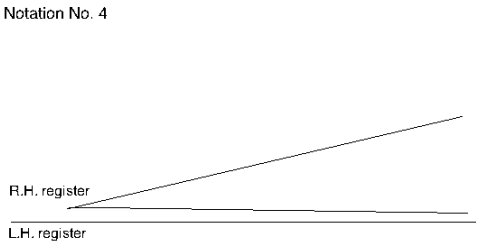


Fig. 5.9 *Graphical representation of structure, notation no. 4.*

The cueing methods outlined above provide an insight into the initial manner by which I committed the *douze notations* to memory. Compared to methods in previous chapters, the techniques seem relatively undeveloped. This is understandable, given my lack of experience performing atonal music, coupled with the fact that there were fewer annotations in the score (my aim at the time was not to research memory theory but solely to learn the music). Moreover, the individual movements of the work are extremely concise, with economical use of material favoured over proliferation. Finally, it is also important to factor in the stage I was at in development as a performer. Although I had performed extensively, I was only beginning to experience performing professionally. As stated above, the work was one of the first atonal compositions that challenged my memorisation ability. As such, the cues described above represent an initial approach to tackling these challenges.

Notation No. 6

The sixth *notation* is the most complex of the set, requiring a great deal of pianistic athleticism. Fig. 5.10 reproduces the complete movement. It is analysed separately because of its complexity. During the initial learn, little active thought was given to establishing cues. Instead, the twelve bars were divided into seven sections and learned in a cumulative process very close to the serial and additive techniques suggested by Mishra (2011, p.60). Analysis here provides the potential for insight for two reasons. First, it is possible to examine my own decisions relating to organising practice, completely free of any influence of research on this subject. Secondly, it is possible to compare these decisions with

the compositional structure to see if this domain (unknown at the time of learning) had any effect on memorisation procedure. In other words, is there any instinctive connection between complicated and unknown musical structures and practice structure, derived by choices based on the surface material?

Fig. 5.10 demonstrates permutations of dodecaphonic rows in black above the systems. The left hand imitates the right at the distance of a quaver, until the midpoint, marked m, at which point the left hand changes to an inversion. Coloured markings document my decisions during the practice stages. First, structural practice segments are marked in red. These reveal the order in which the material was assimilated after I had worked out the fingerings of the whole movement. Secondly, fingerings are marked in blue (for clarity, only fingerings at the beginning of segments are included). Immediately apparent is that the first segment is in the middle of the piece, just after the midpoint. This choice was purely technical, as the hands are close together with relatively few leaps. This enabled me to develop a physical sensation at an early stage of how it felt to play the piece.

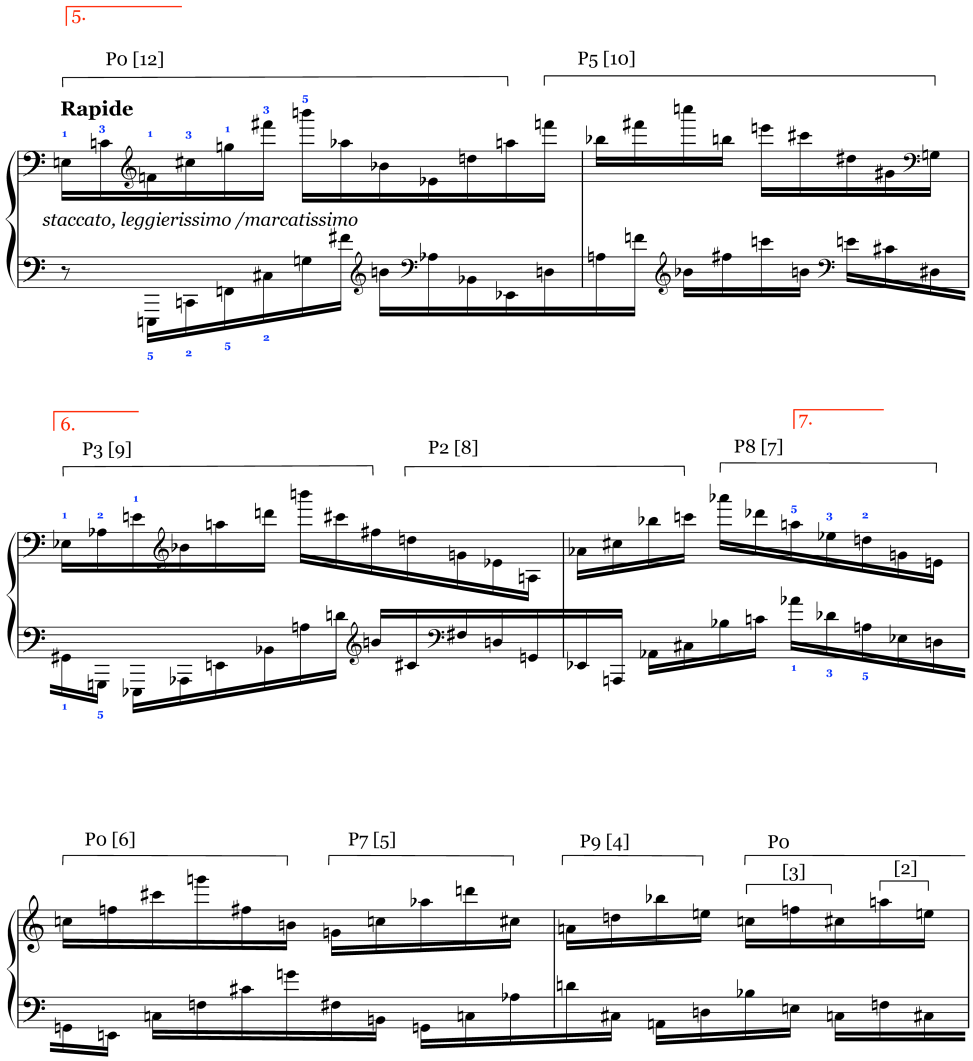
The choice of segmentation is also interesting in comparison to the dodecaphonic structure. It is clear that the visual layout of the piece was extremely important in choosing segments, with segments starting on beginnings of bars and beamings of semiquavers (segments 5, 6, 2 and 3). Of these, two segments aligned with changes of serial row (5 and 6), whilst the other two segment choices started a semiquaver either side of a row change. Further examination reveals an instinctive adoption of musical and compositional traits to choose segments. Registral low points were used in segments 5 and 6. Segment 1 demonstrates the importance of similar motion between the hands (also a row change in the right hand). It is perhaps unusual that the midpoint m does not form a segment start. However, the start at segment 1 seems a much stronger starting place given the similar motion in the hands, and the harmonic and melodic implications of the particular row combinations. This short passage was one of the easier passages to memorise given its sonic memorability.

The ordering of the segments in a non-linear fashion seems contrary to the notion of serial chaining (Chaffin, Logan, & Begosh, 2009). Whilst the initial assimilation of the notes, fingering and technical difficulties did follow a

standard linear progression, this ordering formed the second stage of practice. The reasoning was simply to make the quickest progress possible in such a technically challenging piece. The central segment (1.) has the hands in similar motion at the loudest dynamic, and was therefore the easiest segment to retain. By comparison, the opening of the piece (5.) has the largest jumps at the softest dynamic, and proved hardest to assimilate.

Of further importance is the use of fingering to govern segmentation. Primarily, segments are started in either the thumb or fifth finger (often preceded by a jump). This analysis does not reveal that the musician has an understanding of the structure of rows in serial music. Instead, it demonstrates that a reasoned examination of the physical demands of the music, the larger musical gestures (such as register), combined with visual layout of the music can produce a very effective 'structure' to inform and organise practice. This marries physical aspects of playing with the compositional techniques used by the composer.

6.


5.
P0 [12]
P5 [10]
Rapide
staccato, leggierissimo /marcatissimo
6.
7.
P3 [9]
P2 [8]
P8 [7]
P0 [6]
P7 [5]
P9 [4]
P0
[3]
[2]

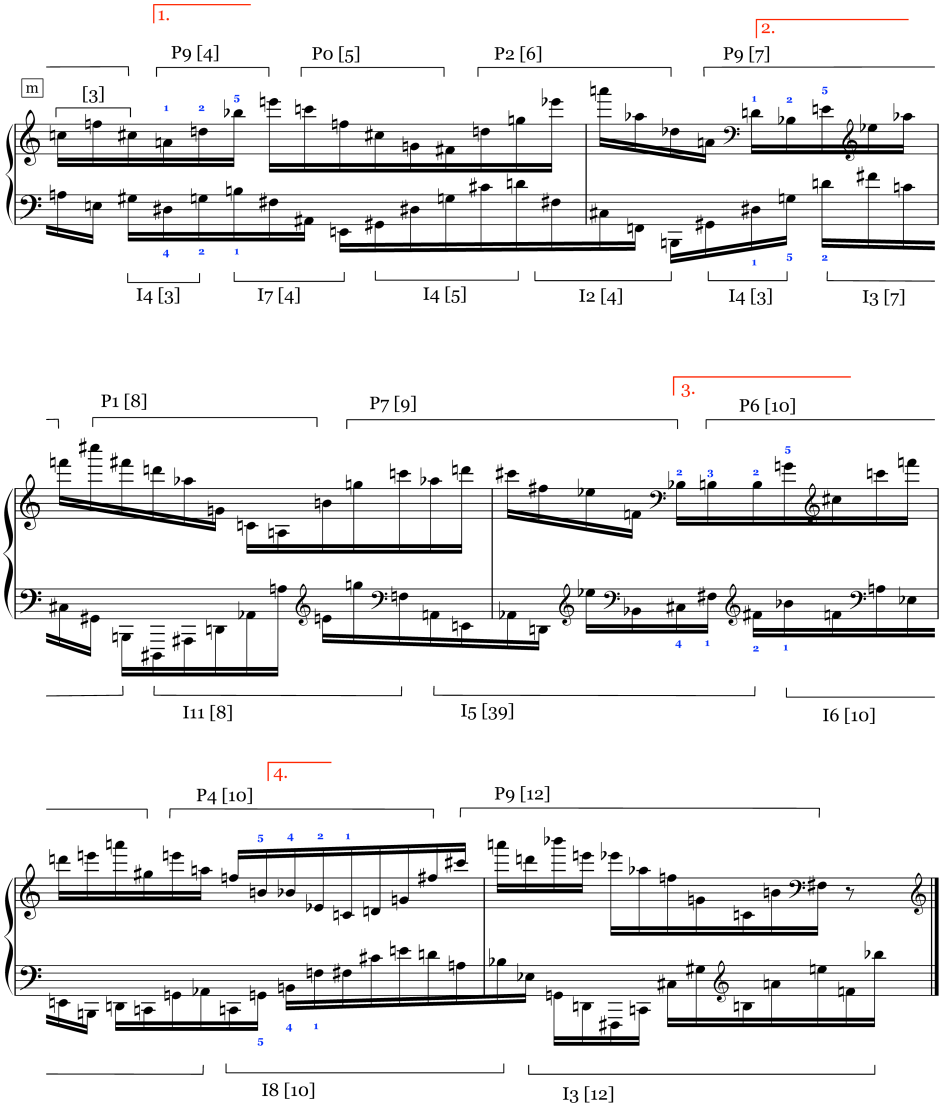


Fig. 5.10 *Notation no. 6, demonstrating dodecaphonic rows (above, black) and practice segmentation (above, red).*

II. Performance Cues and Long-Term Recall

When re-approaching a piece that has already been learned, there are many factors that have already been addressed. A clear idea of the overall structure has been established, the technical issues have been mastered (albeit forgotten), and the emotional content and character of the music has been absorbed. Most importantly, a performance has been executed. Even when the return to a piece feels like starting afresh, usually practice achieves the desired outcomes much more swiftly. This is because the piece has been learned already, but also because the various practice techniques have already been established. Landmarks remain in a musician's memory and affect long-term recall and subsequent reconstruction (Chaffin, Lisboa, et al., 2009; Ginsborg & Chaffin, 2011a; Ginsborg, et al., 2012).

Yet, it is inevitable that memory decays. Musicians rely on a range of memory systems to assimilate and perform a piece, including auditory, motor, visual, emotional, structural and linguistic memory (Chaffin, Logan and Begosh, 2009, pp. 355-7). Given such complexity, which of these memory structures survive? The third principle of Chase and Ericsson's (1981) theory of skilled memory states that extended practice is required to retrieve stored information instantaneously. Therefore, it seems apparent that kinaesthetic responses decay in the interim period between practising a work. This idea is justified by the fact that tempo often has to be reduced when first relearning a piece.

Chase and Ericsson (1982) also suggest that decay, or interference in memory is often because of a loss of knowledge of order information, rather than a weakening of semantic knowledge (p. 38). This suggests that the structuring of the hierarchical cue system degrades when not practised. It also accounts for the fact that sometimes a long-term memory recall can be near perfect, but a minor disruption of an associative chain causes recall to abruptly end. This section examines probability in recall in two subsequent relearning procedures: December 2013 (after a break from playing and practising the piece of three and a half years) and March 2015 (after a break of eleven months). These two recalls focussed on the first six movements. Played recall was preferred to written recall given the importance of sensorimotor cues, in particular given the physical

demands of the sixth movement (Lisboa, et al., 2009c). The performances were audio recorded, and played without the score. As a precursor, the stability and variation of PCs are outlined across performances in 2014 and 2015. These were recorded on two copies of the score after the relevant performances.

Performance Cues

Previous research examining repeated use of PCs across performances has demonstrated that they remain relatively stable, whilst also allowing for more spontaneous thoughts during performance (Ginsborg, et al., 2012). Similarly, PCs remain flexible to allow for the different demands of a particular performance (Chaffin, et al., 2013; Lisboa, et al., 2013). Fig. 5.11 demonstrates the differences in reported PCs in the 2014 and 2015 performances of *douze notations*.

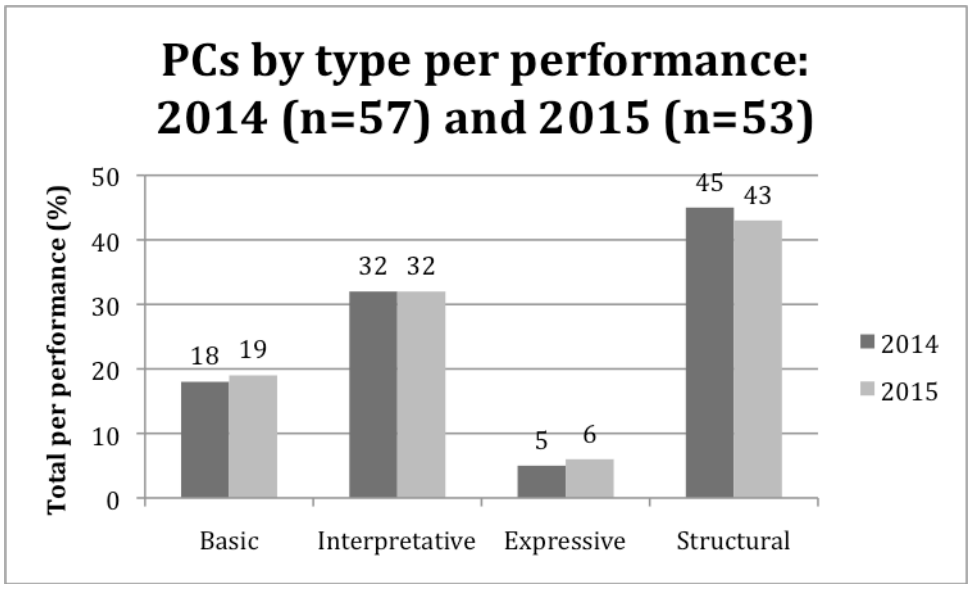


Fig. 5.11 *Total PCs (percentage) by type across 2014 and 2015 performances.*

As demonstrated, there are near-identical totals for PC groups between the two performances. There are two possible explanations for this: first, the complexity of the musical language and technical difficulty of the composition may have caused the pianist to adopt nearly identical cues to navigate these challenges in performances. Secondly, the 2015 relearning was a very quick process. Practice of the work began in early March 2015, for a performance at the end of the same month. As such, this compressed learning period, whilst successful, may have

resulted in an adoption of familiar PCs to facilitate rapid reconstruction of the composition. Of final note is the variation in number of PCs used (57 in 2014, 53 in 2015). Whilst totals are similar, the reduction indicates a greater assimilation of the material into motor control. Analysis here is limited to the total number of cues used in performances. Further research would benefit from examining the locations of these cues to identify the correlation (i.e. if cues were used in the same location, across performances). This would further establish the long-term stability of PCs.

First Recall: December 2013

The first long-term free recall occurred on 10th December 2013 and lasted a total duration of 1'36". This duration is significantly reduced from the normal playing time of around four minutes, as a great deal of the music was forgotten. Where music was forgotten, recall started at the next phrase remembered. The fifth and sixth *notations* were not recalled at all, and are excluded from the analysis. Figs. 5.12 and 5.13 outline the mean probability of recall as a function of serial position following starts of sections and basic PCs (see Chaffin, Lisboa, et al. 2009; Ginsborg & Chaffin, 2011a). Locations where these two dimensions were reported are designated '1'. Subsequent serial positions relate to ensuing beats. Given the brevity of the movements, beats were preferred to bars or half bars. As with the analysis of the *Oiseaux Exotiques* cadenza (chapter 2), beats varied in length given the use of additive rhythm. Recall accuracy was tallied per beat, taking into account the recall of pitch and rhythm.[38]

The results for section starts display strong similarities to previous research (Fig. 5.12). Structural boundaries serve as landmarks, with recall probability decreasing as distance from this landmark increases. The conclusions relating to basic PCs are slightly harder to evaluate. There is evidence that these locations are lacunae, places that are recalled worse (Ginsborg & Chaffin, 2011a). Previous studies indicate positive trends following these locations

[38] For each beat, a total number of recall points (rhythmic units and pitches) were worked out. Correct recall earned a mark of 1, incorrect recall earned 0. Recall probability was worked out by dividing the correctly recalled points by the total number of recall points in the beat. (e.g. four semiquavers would contain four rhythmic units and four pitches: in total eight possible points of recall. If 4 rhythmic units and two pitches were recalled correctly, the recall probability would be 6/8, or 0.75). Beats were then arranged according to serial distance from section starts and basic PCs, and a mean average of recall probability was calculated.

(Chaffin, Lisboa, et al., 2009). The results here (Fig. 5.13) initially confirm this notion: however, a negative trend follows from serial positions beyond the second beat from these PCs. It may be that recall was not accurate enough to establish the trend, or that not enough material was tested (the first four movements represent only 48 bars).

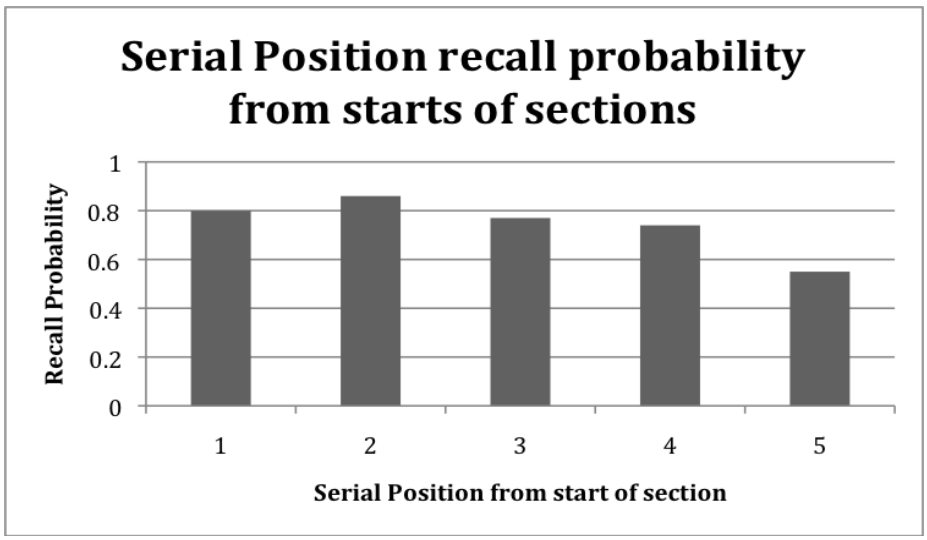


Fig. 5.12 *Mean probability of correct recall following section starts, notations 1-4, 2013 recall.*

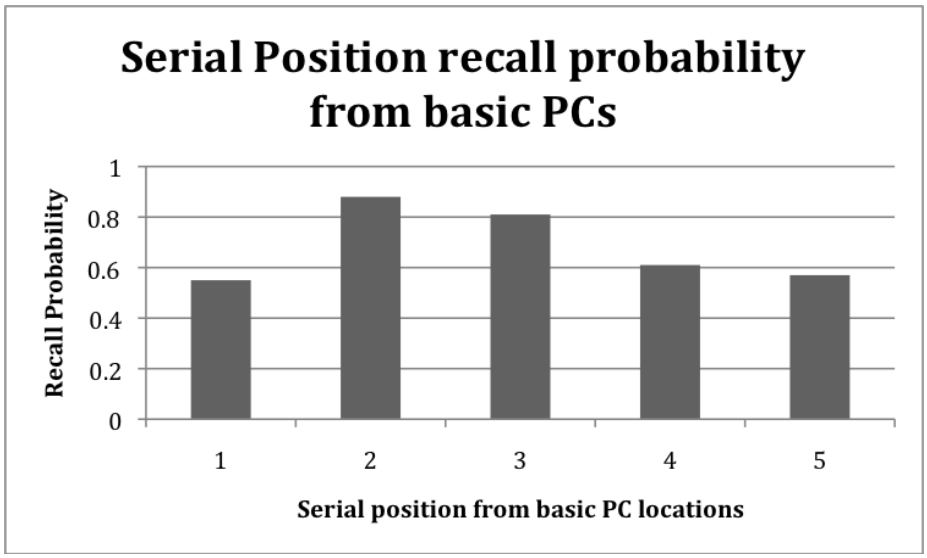


Fig. 5.13 *Mean probability of correct recall following basic PCs, notations 1-4, 2013 recall.*

Second Recall: March 2015

The second recall took place in early March 2015, after a break of eleven months. The duration of the recording, for the first six movements, was 4'31'',

similar to the performance lengths. Unlike the 2013 recall that produced clear negative serial trends of memory retrieval, especially for structural sections, recall was more varied. The first five *notations* were recalled to a high accuracy level. The low error rates provide little material for analysis, and as such are ommited from the discussion. The sixth *notation*, despite its brevity, contains a great deal of material for examination. No basic PCs were reported after the 2015 performance. Given the extreme complexity and speed of the *notation*, there is not time to think of such cues during performance. Analysis therefore focusses on structural elements. Given, the visual homogeneity of the score, structural boundaries are related to the manner in which I segmented the score to organise learning and practice. These segments were first used in the initial learn (discussed above). Markings remained on the score and were reused in both of the subsequent reconstructions.

Unlike the 2013 recall, the sixth *notation* was recalled to a far greater extent in 2015 (Fig. 5.14). The first 8 bars were recalled to a high degree of accuracy. From bar 9, there was an abrupt disruption to the recall of serial chains, and from this point until the end, the only recall was of the first four notes of segments 3 and 4 as labelled in Fig. 5.10 above:

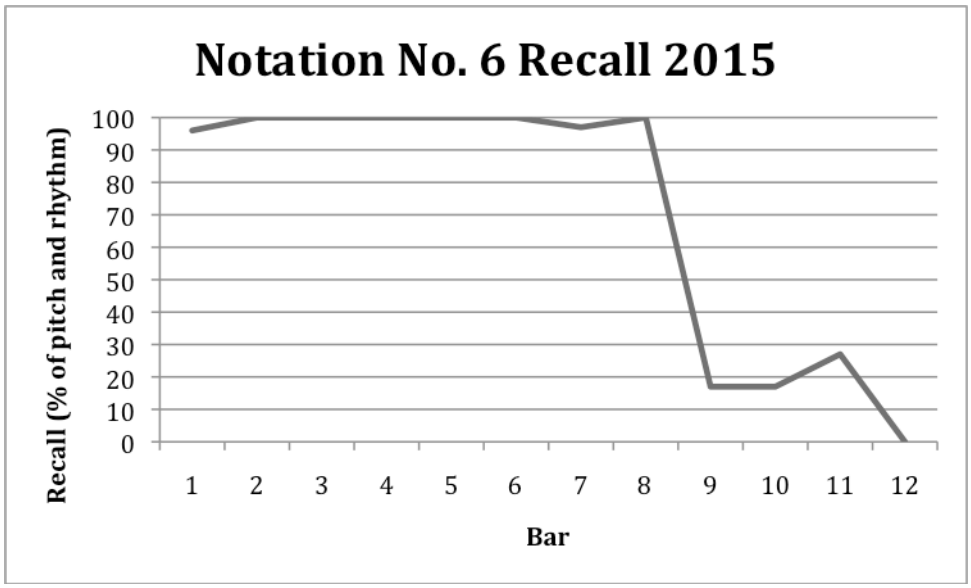


Fig. 5.14 *Recall accuracy of rhythm and pitch (%) by bar, notation no. 6.*

The importance of the structural segments in the 2015 recall is demonstrated when analysing the percentage recall in relation to the serial position of these cues, as shown in Fig. 5.15.

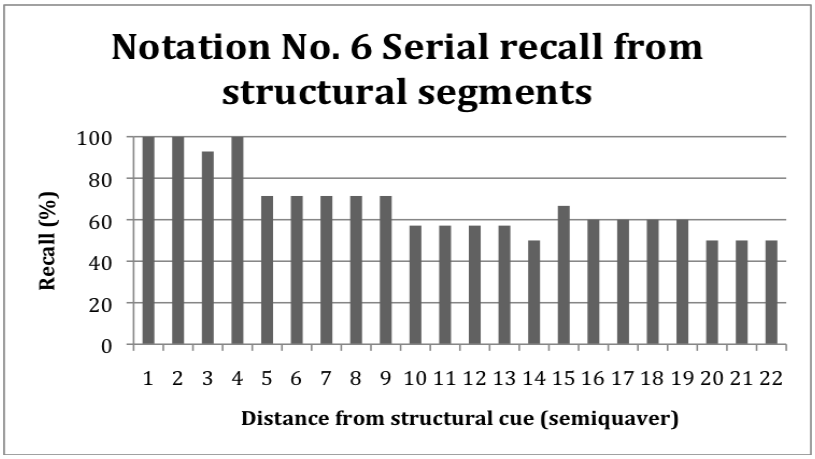


Fig. 5.15 *Mean recall probability for structural segments, showing serial decline in recall as distance from structural landmarks increases.*

The x-axis shows the serial position in semiquaver beats from the start of the segment, with 1 denoting the segment start. The y-axis shows the recall accuracy in percentage. A negative serial trend is apparent, suggesting the segments formed a hierarchical retrieval structure in practice and performance. Once retrieval of a landmark was established, recall proceded until a serial chain was broken, resulting in poorer recall as the distance from a landmark increased (Roediger & Crowder, 1976). The results support the findings of previous studies of played and written recall (Chaffin, et al., 2002; Chaffin, Lisboa, et al., 2009c; Ginsborg & Chaffin, 2011a).

Earlier discussion revealed the choice of segments was based on an intuitive response to the score. Register, rhythmical beamings and the visual layout of the score were important features in deciding a segment starting point. Whilst some of these segments related directly to the compositional structure, others had limited connection. Despite this, the greater recall at the start of these structural segments suggests that it is helpful for memory retrieval for the performer to think of cues as structural, even if they are not directly related to the compositional structure. This is particularly pertinent for contemporary music where the structure of the music is not as obvious, even to trained musicians.

Graphic representation

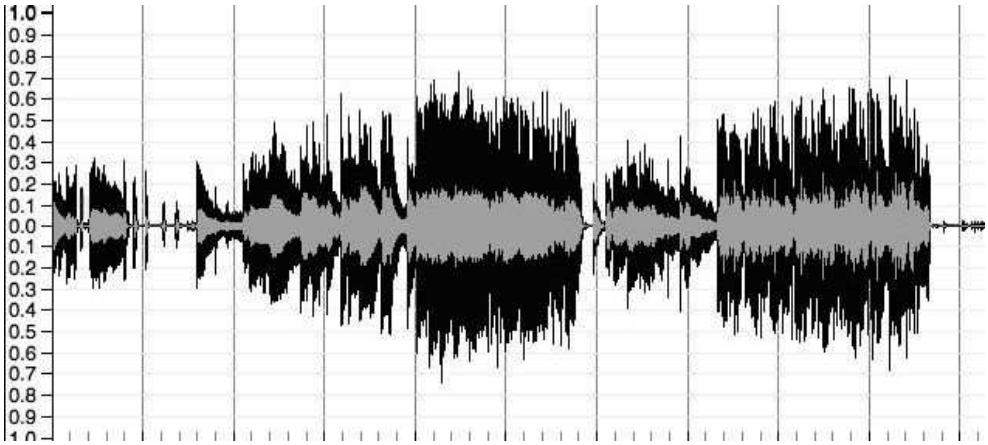


Fig. 5.16a *2013 recall.*

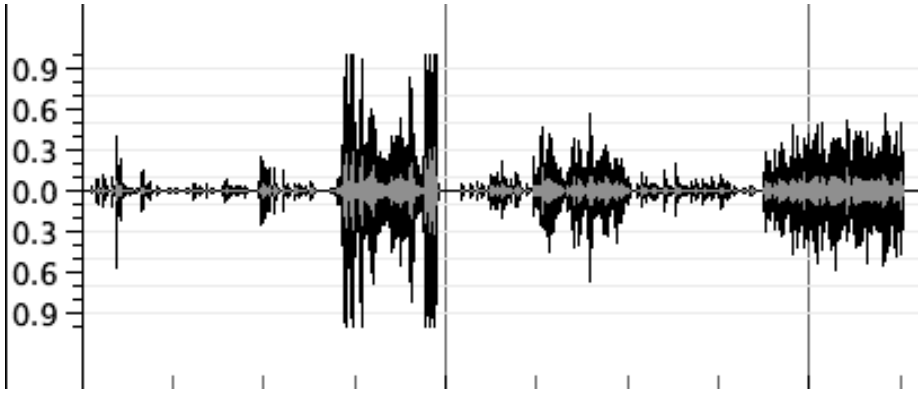


Fig. 5.16b *2009 performance.*

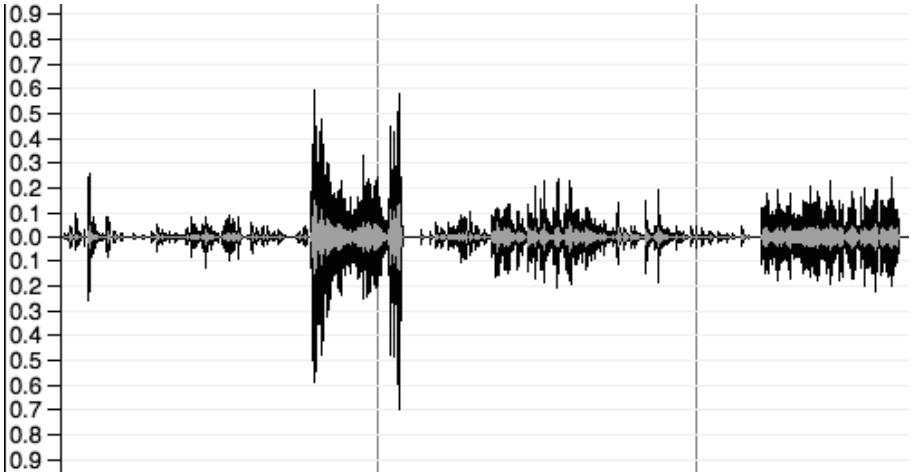


Fig. 5.16c *2015 recall.*

A final example (Fig. 5.16a-c) of the decay in long-term memory recall can be examined when contrasting the graphical representation of the recalls with

the concert recording in 2009. The rationale for this analysis is to present a clear, visual representation of the variety in acoustic detail and dynamic. As such, it demonstrates the acoustic effect of memory decay (in particular, how the range amplitude is reduced). The first four *notations* are shown here, with the 2009 performance in between the two recalls for comparison.

Although the graphical display does not allow for analysis of details, general trends are evident. It is worth noting that the 2013 recall recording is of shorter duration, given the memory decay of the third and fourth movements. The general amplitude trends in all examples give a general outline of the four movements. This is clearest in Fig. 5.16b: the first movement of low amplitudes with few intensities, followed by a period of sustained intensity (movement two). Movement three is moderate in intensity, followed by the fourth, in which the amplitude is greater and generally uniform throughout.

The most striking contrast in the 2013 recall (Fig. 516a) is the uniform amplitude. Not only is there little variety within individual *notations*, but also the larger expressive and structural cues concerning the character of each movement have diminished. It is clear that the outer regions of the dynamic spectrum, very soft and very loud, have also reduced. Individual dynamic nuance of gesture has reduced to a flatter, more constant amplitude. This is not surprising, given the natural process for memory to decay.

In contrast, the similarities between the 2009 performance recording and the 2015 recall are strong. The general outlines of each movement are evident in Fig. 5.16c, with a wide variety of intensity indicating that dynamics and expression had remained largely intact. The 2015 recall reveals a greater uniformity in amplitude in comparison to the 2009 performance. This is unsurprising given the lack of practice. However the strong recall in 2015 is striking in relation to both the accuracy and range of dynamics and interpretative features.

Discussion

The analysis in this section largely corroborates the findings of previous research, establishing structural boundaries as landmarks in the LTM of a performer (Chaffin, et al., 2002; Chaffin, Lisboa, et al., 2009; Ginsborg & Chaffin, 2011a). The evidence for lacunae relating to technical issues is less clear. The demands of this music may have disrupted positive trends, or that not enough of the music was recalled (2013) to establish similar trends. Further evidence suggests improved recall when repeatedly reconstructing a piece in a longitudinal approach. It is dangerous however, to draw this conclusion with certainty, as other factors may also dictate this accuracy of recall.

First, the breaks of three and a half years and eleven months respectively prove challenging to compare. As mentioned in the introduction of the thesis, the nature of this research is closely aligned to the ecological experience of a performer. Given the difficulty of programming contemporary music on a regular basis, it was beyond the scope of this chapter to form a more controlled test in relation to the duration of the breaks between relearning. Indeed the dates of recall were governed purely by external forces: concert engagements. Another factor influencing recall efficacy is the technical and artistic progression that inevitably occurs during intensive study in a conservatoire setting. Despite these concerns, it is likely that the increase in recall is largely a result of the long-term repetition of practice and immersion of the memory cues and strategies in the practice process.

The final part of this chapter examines three concert performances, to evaluate how this longitudinal practice of memory cues and general practice strategies effects the long-term development of the acoustic, interpretative and expressive outcomes in performance. Previous PC research has investigated tempo fluctuations in performances of varied expression (Lisboa, et al., 2007). The present study extends analysis to examine the acoustic realisation of the score using spectrograms.

III. Comparison between Performances

The final part of this chapter analyses the differences between three recordings of the *douze notations*. This comparison is between concert performances in 2009, 2014 and 2015. The 2009 performance was recorded in my studio, in front of a small group of family and friends. The concert performance in 2014 was recorded professionally in Milton Court Concert Hall.[39] The performance was an audition with a panel of two musicians. The 2015 performance took place in LSO St. Luke's as part of the weekend of events celebrating Boulez's 90th birthday. The hall, seating 450 people, was nearly full, and the performance was recorded for broadcast on BBC Radio 3. In all cases, recordings were live and unedited. For analysis, the recordings will be labelled by recording date (2009, 2014 and 2015).

The three recordings provide great deal of scope for analysis. However, there are some limitations needing discussion. First, the variety of performance settings may have had some effect on the outcome. The difference between performing in the practice studio and for an audition panel is notable, requiring very different energies and inevitable changes in mindset. Similarly, performing live with the knowledge that the performance will be broadcast can affect certain aspects of freedom in the playing. The 2015 audience contained a variety of senior figures from the press and the BBC, a daunting prospect for a performer emerging from conservatoire.

Despite this variety of settings and performance demands, it is likely that the psychological differences were minimal. In all three performances I felt completely relaxed and comfortable at the instrument, demonstrated by the success of each concert. The second limitation relates to acoustic and recording set up. The three venues were very different: a small studio with a mid-range concert grand, a fairly large 700-seat hall with a full-length concert grand

[39] The 2014 concert performance is reproduced at:
http://www.youtube.com/watch?v=W0RjPmjW04c

(Milton Court), and a medium size hall of 450 seats with another concert grand (LSO St. Luke's). The variety of pianos, audience size, acoustic, and recording equipment all have an impact on the final recording. Whilst the 2014 and 2015 performances had similar piano size, resonant acoustic and professional recording equipment, the 2009 recording was quite different: a small room and audience, and a decent digital recorder (not of professional quality). In addition, the digital recorder was placed directly next to the open lid of the piano. As such, the intensity and onset of notes are exaggerated. There was similar microphone proximity in 2015, however the 2014 microphone was suspended from the high ceiling of the hall. Nevertheless, there is still scope for detailed comparison between these recordings. Issues relating to recording quality and acoustic are addressed in relation to the musical examples.

What does studying recorded performance tell us about memory procedure? When taken on its own, a recording only provides limited information. However, when combined with subjective analysis regarding memory, analysis of performance can reveal exactly what a performer achieves during performance, and hence whether the aims of practice regarding memory procedure are realised. Given the hierarchical importance expressive cues hold in memory structures, the aim of this section is to study the acoustic reality of expressive gestures in performance. Therefore, this reveals the long-term outcome of repeated practice of memory procedures during practice.

There are several ways in which researchers can analyse recorded music. Simple observational close listening combined with markings on a score is the most rudimentary and fundamental skill in this line of research (Leech-Wilkinson, 2009). Whilst invaluable in providing an objective analysis of a performance, for the purpose of this study the technique is problematic, given the roles of practitioner and researcher are combined. It is difficult to remain impartial and objective about the expressive details in a recording when the researcher has undergone the procedure of establishing the expressive gestures in the practice room. Thus, a further level of objectivity is required to address this problem. This is achieved with the use of technology: various sound-editing software with quantitative outcomes that can be interpreted. While interpretation here is informed by the role as practitioner (and hence still somewhat liable to

partiality), the data it produces are objective, thereby serving to validate first-person perspectives. Leech-Wilkinson (2009) describes an expressive gesture as:

> An irregularity in one or more of the principal acoustic dimensions (pitch, amplitude, duration), introduced in order to give emphasis to a note or chord—usually the start of a note or chord (chapter 8.1, paragraph 15).

Much technological research examining expressivity in recording has focussed on tempo mapping, given the strong correlation between the two dimensions in the performance tradition (Cook, 2013; Leech-Wilkinson, 2015; Repp, 1991; Shaffer, 1984). Research has also examined the connection between memory and tempo. The correlation between these two dimensions is particularly strong: "memory for music seems to preserve the absolute tempo of the musical performance" (Levitin and Cook, 1996, p.927). In other words, long-term recall of a melody is retrieved with an accurate recollection of tempo. As with observational listening, this analysis is problematic. Much atonal music, including the *douze notations*, is devoid of uniform pulse, thereby rendering the study of tempo changes (and the correlation to expressivity) ineffective.

Considering these difficulties, the most objective and illuminating method by which to accomplish the study of expressivity is through the use of spectrograms, in which recorded music is represented graphically on three dimensions. The vertical axis demonstrates frequency (hertz), whilst time is shown on the horizontal axis. A third dimension is amplitude, or intensity of an individual sound, is denoted by particular colour on the spectrogram. In this thesis, colours representing intensity range from dark green (softest sounds), progressing through lighter green, yellow and red for the loudest noises.[40] To examine the three recordings I used the freeware software *Sonic Visualiser* (Cannam, Landone and Sandler, 2010). Spectrograms offer the possibility to study the expressive outcomes of a recording, and hence what the performer is actually doing, in a relatively detailed and objective manner.

Analysis primarily focusses on dynamic variation. An additional graphic representation highlighting dynamic level is shown in purple at the top of the plates. This was generated using *Powercurve smooth* plug-in from the Centre for

[40] See: Cook, & Leech- Wilkinson, 2009.

the History and Analysis of Recorded Music's Mazurka Project.[41] Tempo mapping and the correlation with dynamics is restricted to the eighth *notation*, which has a regular pulse. The *Powercurve* plug-in examines the acoustic intensities in some detail, and is an invaluable resource for analysis. Whilst the analysis is illuminating in demonstrating the acoustic variation, and hence dynamic manipulation, gesture and sound heard in real time is likely heard in a more generalised manner according to larger gestures. Whilst there are striking differences between recordings, particularly with regard to detailed dynamic control, as a performer such divergences do not detract from the success of an individual performance it its entirety.

Examining Spectrograms

Dynamic control

Plate 5.1 is an example taken from bars 5-6 of the first *notation*, 0'16" to 0'25" in the 2009 recording. Fig. 5.17 is the section of the score to which it corresponds. On the vertical axis is amplitude (decibel, dB), and time elapsed on the horizontal axis.[42] The horizontal axis represents time, and this example lasts nine seconds, or two bars worth of music. Thus, Plate 1 demonstrates the repetition of a similar rhythmic unit (a quaver) exhibited by the repeated length of attacks on the horizontal axis. This passage was reported as an Interpretative PC in both the 2014 and 2015 performances.[43]

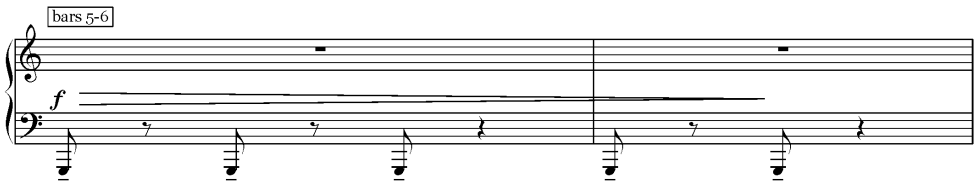


Fig. 5.17 *Notation no. 1, bars 5-6.*

[41] Retrieved from: http://sv.mazurka.org.uk/

[42] The addition of the plug-in places decibel on the y-axis. Hertz is still the primary measurement: see Plate 5.14 for example of the frequency scale.

[43] As the 2009 performance took place prior to this study, no PC reports were filled out for this performance. Whilst this is a limitation of the study, the primary aim here is to examine the expressive changes across performances. Given the stability of PCs across the 2014 and 2015 performances, it is likely that the PCs existed in the 2009 performance, even if I was unaware of them at the time.

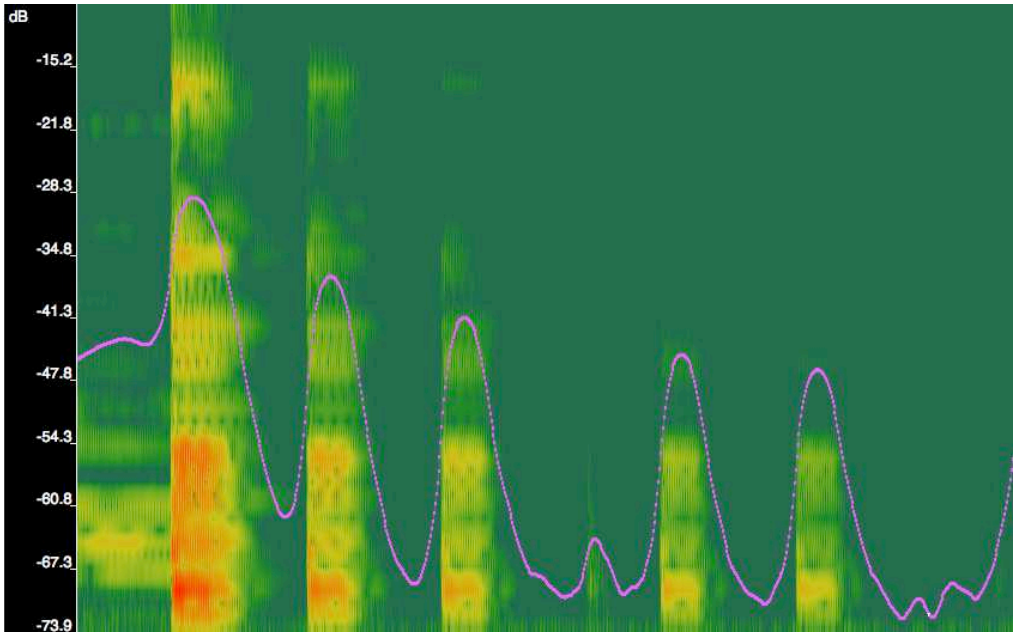


Plate 5.1 *Notation no. 1 (2009) 0'16" to 0'25''.*

In total, the quaver is repeated five times, represented by the five perpendicular columns, just under a centimetre wide. A greater number of overtones are produced by the louder dynamics, accounting for the difference in height of the columns, despite the repetition of the same pitch. The thin, faint line that appears between the third and fourth columns can be attributed to background recording noise: most probably the noise of a pedal being released. Of particular interest is the expressive control in the decrease in volume, the execution of the decrescendo, from the bright red on the first strike, to the duller yellow-green at the end of the spectrogram. The purple dynamic graph shows how successful the decrescendo is. The peaks at the tops of each column demonstrate the tonal control of the decrescendo when striking each quaver. The general slope is fairly even, although the steeper decline on the first three strikes levels off for the final two quavers. Indeed the volume of the final two quavers is almost identical.

Plate 5.2 illustrates the same passage taken from the 2014 performance, lasting eight seconds. Several differences are immediately apparent. First, whilst the colours similarly progress from red to green-yellow, the intensity is diminished in comparison to the 2009 recording. The most likely explanation is the closer proximity of the digital recorder in the 2009 recording.

The more resonant acoustic of 2014 recording is also demonstrated. The columns signifying the repeated quaver notes are less defined at the end of notes, indicating some reverberation. The purple dynamic line reveals both similarities and differences. The first bar follows a similar decline, although more gentle than 2009. The first quaver of the following bar extends the decrescendo further than 2009, however, the final strike upsets this progress and is louder than the previous strike. This is most likely a performance 'error': a momentary slip of concentration. This could relate to the acclimatisation of touch to the piano in the first twenty seconds of performance, or dealing with the bass register of a concert grand that is often harder to control. Of course, analysis here is at a detailed level, and the small dynamic deviations do not necessarily detract from the effect of a gesture.

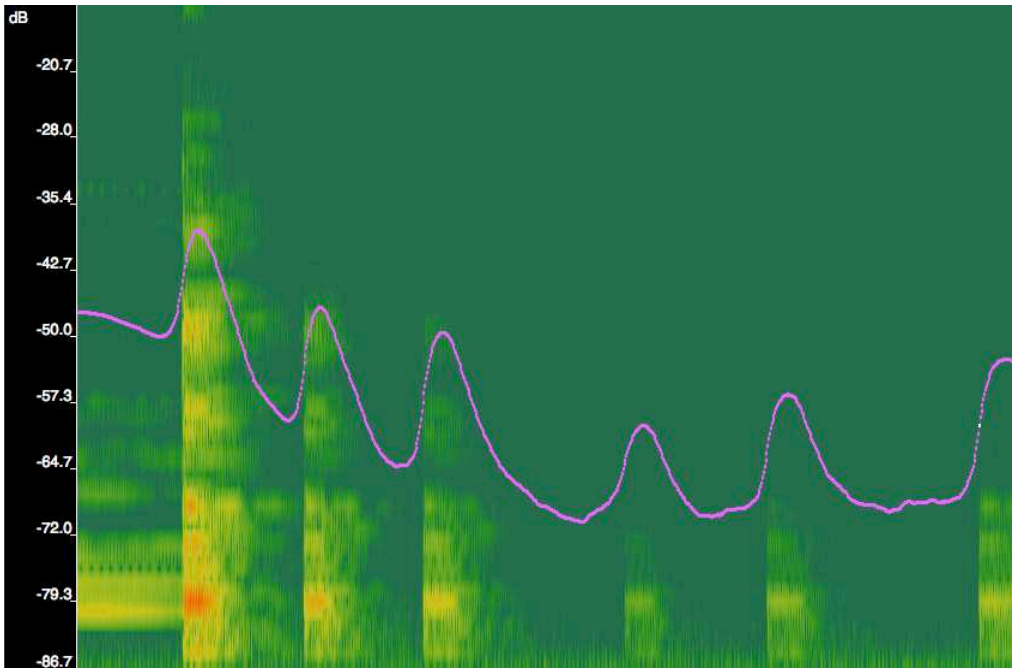


Plate 5.2 *Notation no. 1 (2014) 0'11'' to 0'19''.*

Plate 5.3 represents the same passage in the 2015 performance. The duration increased notably, lasting twelve seconds. Immediately apparent is a much greater decline of the decrescendo. The intensity of the colours has returned: again this is most likely resulting from the closer microphone proximity. The slope of the purple *Powercurve* dynamic line is much smoother, with the arcs at the peak of each column producing an almost linear slope. This recording also has the greatest range of amplitude: the distance between the top

of the first column and the top of the final column is the greatest here. Whilst there is room for further expressive manipulation, the expressive execution of this simple gesture has developed significantly across the six years.

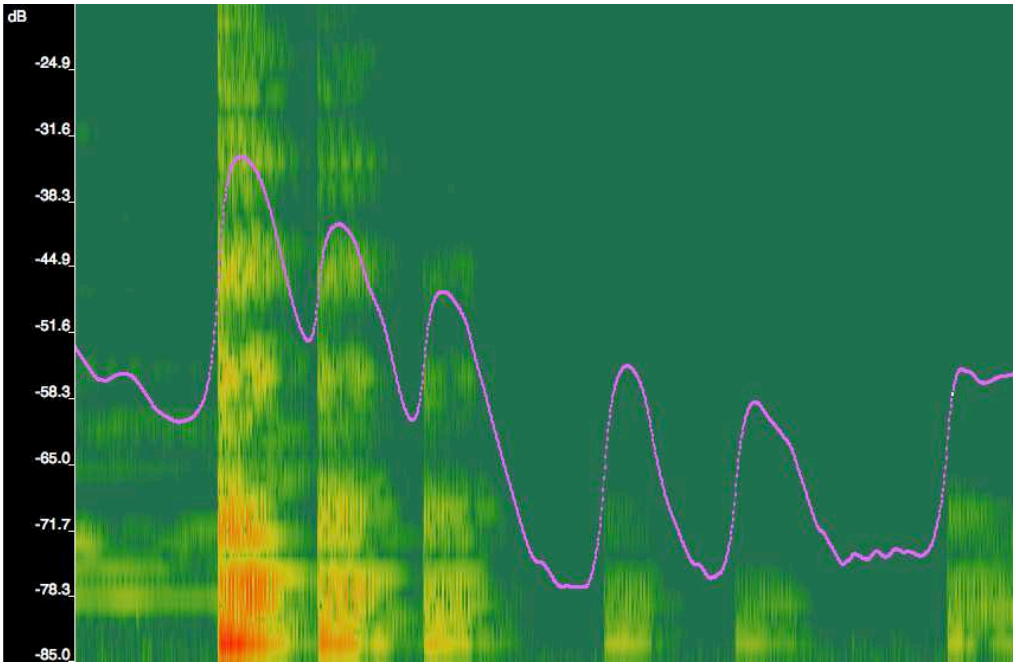


Plate 5.3 *Notation no. 1 (2015) 0'10'' to 0'22''.*

A similar expressive difference is demonstrated in bars 9-11 of the first *notation*.[44] The passage represented is bars 9-11 shown in Fig. 5.18:

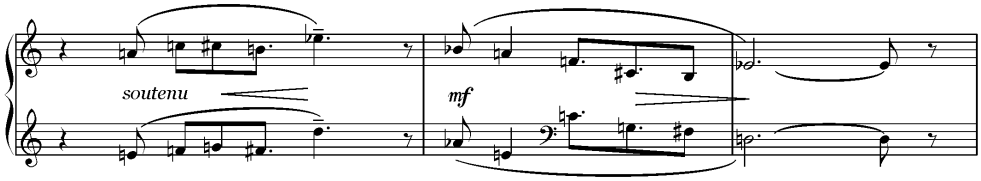


Fig. 5.18 *Notation no. 1, bars 9-10.*

The shape of the gesture is an increase in dynamics and register to a midpoint, followed by a decrescendo to silence over a three-bar span. The initial dynamic begins *pianissimo* from the preceding passage. Given that there is no dynamic marking at the top of the *crescendo* in bar 9 (the first bar of the example), there is room for interpretation. This could be a *crescendo* within *pianissimo*, with the following bar *mezzo forte*. Or the *crescendo* might lead to the *mezzo forte* in bar

[44] This passage was identified as an Interpretative PC in 2014 and 2015 performances.

10. My own thoughts settled on the d♯^{2}/e♭^{2} in bar 9 as the peak of the dynamic phrase, as it is the registral high point.

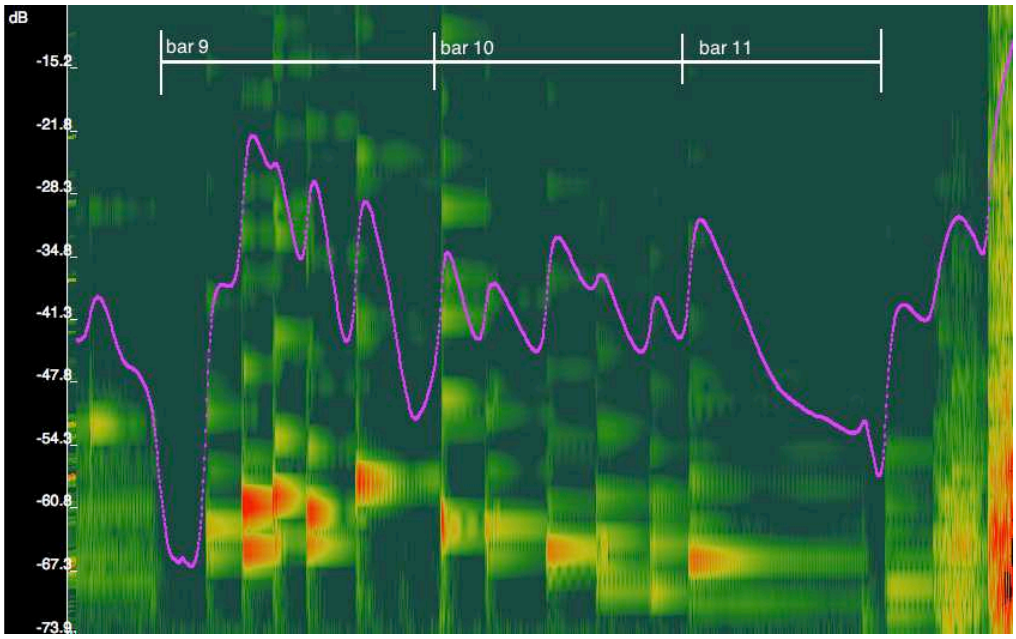


Plate 5.4 *Notation no. 1 (2009) 0'36" to 0'48".*

The passage is outlined in the 2009 recording with bar numbers in white (Plate 5.4). As the *Powercurve* plug-in demonstrates, the recording reveals a poorly defined *crescendo*, with an exaggerated increase to the second attack, followed by a gradual decay in bar 9. The *diminuendo* in bar 10 is equalised, even demonstrating a slight increase in intensity to bar 11. The spectrogram colour intensities of bars 10-11 do diminish somewhat from red to orange red. This could indicate that the close proximity of the microphone to the piano has exaggerated the attack of the notes: the point at which the hammer strikes the strings. However, the overall impression is of an ineffective utterance of the gesture. The sharp decline in bar 11 accounts for the natural decay of the piano and should not be attributed to the expressive control of the performer.

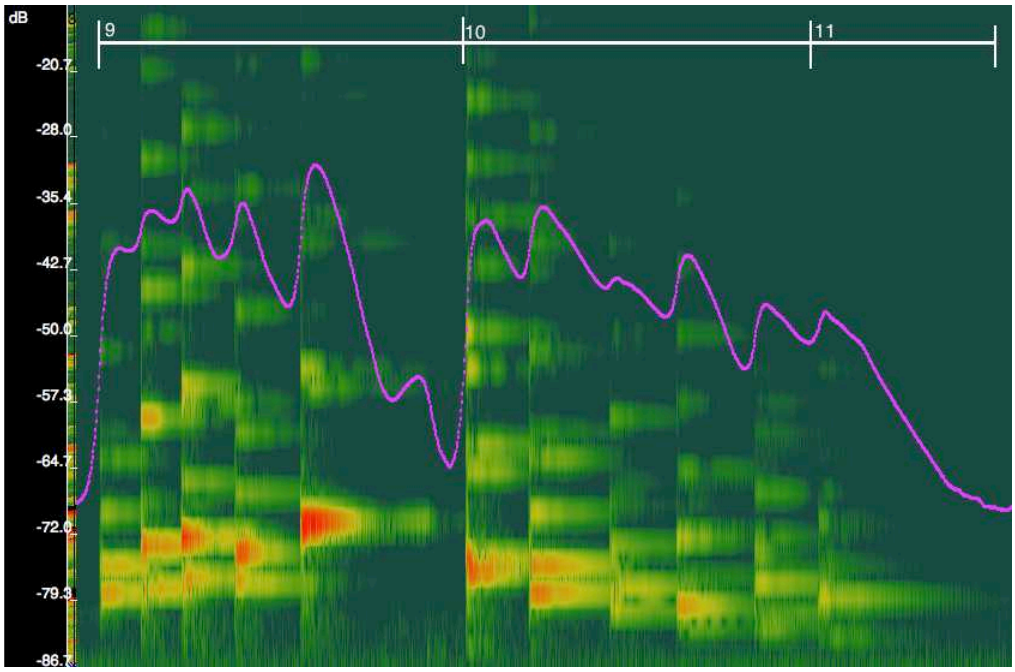


Plate 5.5 *Notation no. 1 (2014) 0'33" to 0'45".*

The 2014 recording (Plate 5.5) demonstrates greater accuracy of the acoustic realisation of the interpretative cues. A more graded *crescendo* in bar 9 with a clearly defined registral peak is evident, followed by a clear *diminuendo*. There is also clearer definition between bars 9-10, indicated by a quaver rest at the end of bar 9 (see Fig. 5.23). Despite the greater interpretative and expressive control of the 2014 recording, Plate 5.5 reveals more scope for expressive control. Both the *crescendo* and *diminuendo* are rather equalised, with fluctuations detracting from the ideal linear slopes.

The 2015 recording illustrates significant expressive gains with this passage (Plate 5.6). Of initial significance is the increased duration of seventeen seconds, compared to the twelve-second duration in both of the previous recordings. This indicates a greater degree of inhabitation of the rhythm of the gesture. This is particularly evident in the realisation of the additive rhythms of bar 10, with a greater contrast between the rhythmic units of the gesture, as seen by the varying widths separating each attack.

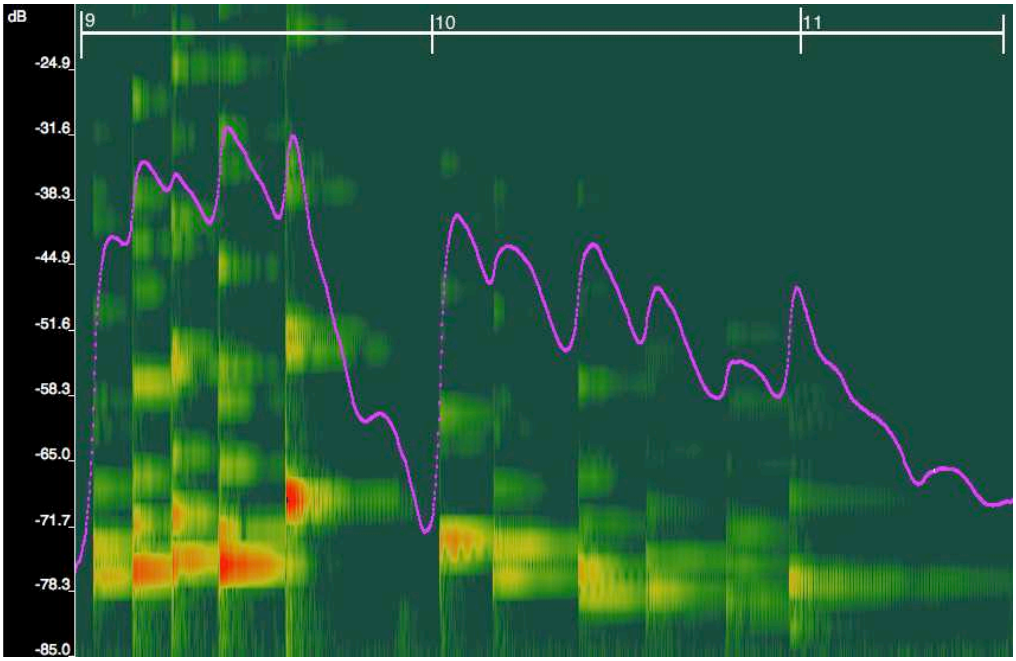


Plate 5.6 *Notation no. 1 (2015) 0'39" to 0'56".*

The gradations of the *crescendo* and *diminuendo* have a smoother incline and decline, revealing greater expressive control. By contrast, both the registral peak and low point in bars 9 and 11 respectively, are less clearly controlled within the dynamic shape of the wedge. This is particularly apparent in comparison to the previous 2014 (Plate 5.5). A final significance is shown in bar 11. Previously, the sharp linear decline in the preceding examples revealed the piano's natural decay of the resonance of the notes. In Plate 5.6, there is a small kick halfway through the bar, revealing a half-pedal change to further control the *decrescendo*. Whilst the success of this added interpretative cue is debatable in comparison to Plates 5.4 and 5.5, it does suggest a greater awareness and desire to fully execute the gesture.

Examination of the sixth *notation* demonstrates dynamic control in a larger-scale structural manner. The entire movement is reproduced earlier in the chapter (Fig. 5.10). It offers two interpretative possibilities as described by the composer: first, beginning *pianissimo leggierissimo* with a *crescendo* to *fortissimo marcatissimo* at the midpoint in bar 6, denoted as m, followed by a *decrescendo* back to *pianissimo leggierissimo*. The second option is the opposite: beginning *fortissimo marcatissimo* with a *decrescendo* to m, followed by a *crescendo* back to *fortissimo marcatissimo* at the end. For each of the performances I chose the former option. In the following three plates, the

midpoint is marked ‘M’ in white. The intensity colours of the spectrogram follow the previous examples, however, the loudest dynamics go beyond bright red to black.

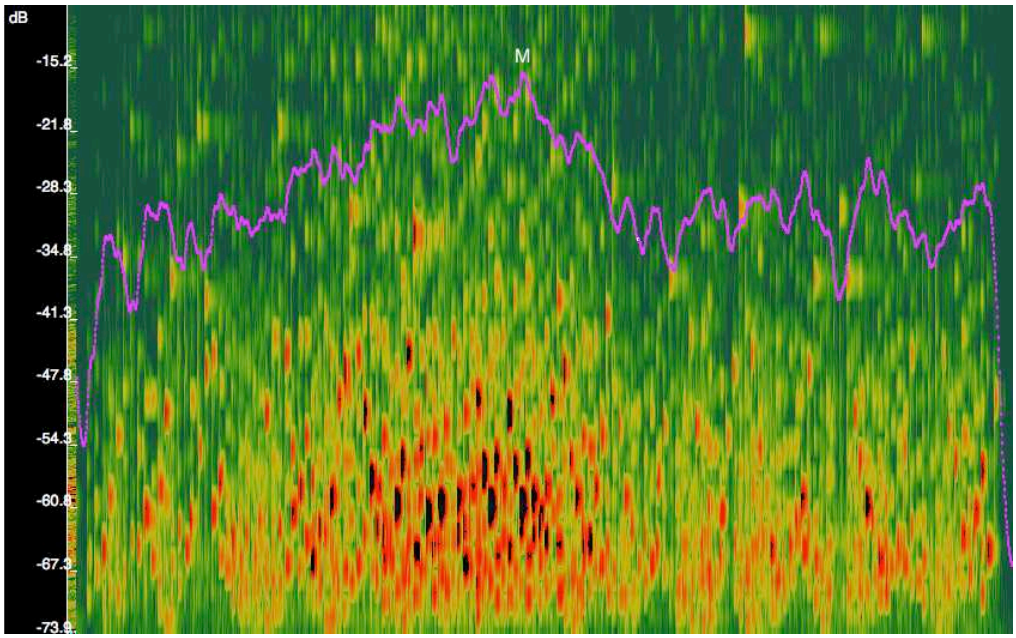


Plate 5.7 *Notation no. 6 (2009) 3’04” to 3’27”.*

The three plates are very similar, particularly the dense cluster of attacks around the midpoint. Previous examples have indicated that the durations of the 2015 recording were substantially longer than previous recordings. Comparing the start times of Plates 5.7 to 5.9 demonstrates this extended duration of consecutive performances: each occurring later in the piece, with the 2015 recording over a minute later into the work than the 2009 recording. This most likely indicates a greater comfort with the piece, that inculcation has resulted a more inhabited and nuanced execution of the rhythm and gesture of the piece.

This could be a factor of responding to different acoustics. However, given the importance of the final performance, my practice sessions also focussed to a greater extent on rhythmically refreshing my memory of the performance. This further explains the extended duration of the 2015 performance. By contrast, the movement is almost the exact same length across the recordings lasting 23, 24 and 25 seconds respectively. Given the extreme technical difficulty of the movement, this suggests that extended long-term practice reverted to a similar realisation, focussing on the most accurate technical execution possible.

Turning to the dynamic control, the 2009 recording in Plate 5.7 reveals the most fluctuation. The outline of the arc is somewhat defined, however, there is a greater number of smaller inflections on both incline and decline. This is somewhat avoidable given the registral differences of the piano, with lower register producing greater volume. Furthermore, the descent of the *decrescendo* is very rapid from the midpoint: after roughly an inch from the midpoint, the *decrescendo* tapers off and remains uniform. The midpoint in 2009 is the most defined as the dynamic peak.

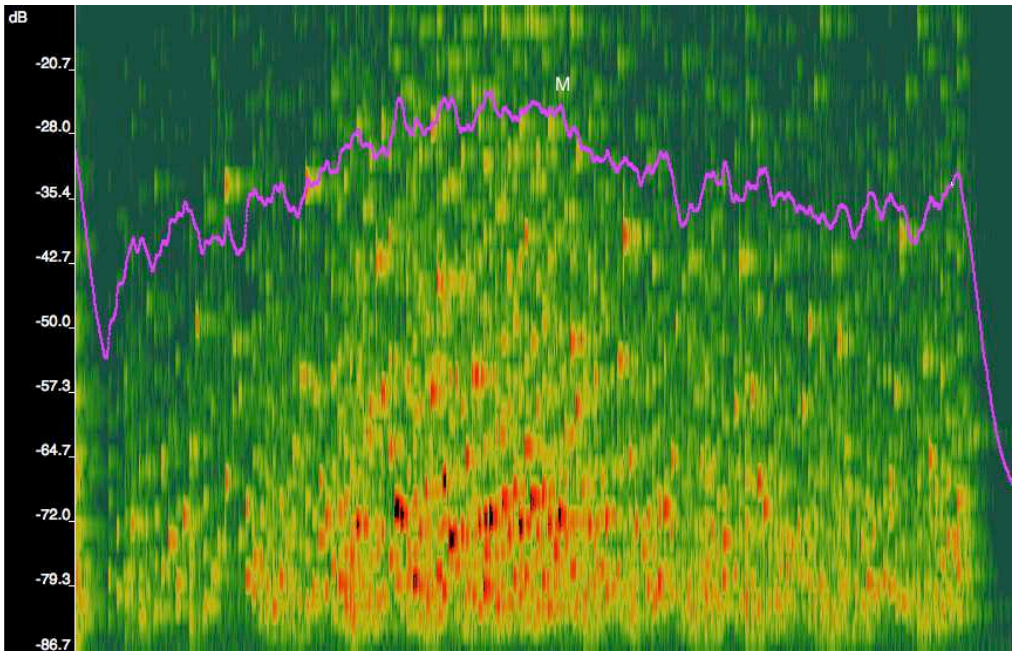


Plate 5.8 *Notation no. 6 (2014) 3'20" to 3'45".*

The 2014 recording in Plate 5.8 demonstrates a much smoother arc, both in terms of the overall shape, as well as the reduction in surface inflections. This might be caused by the more resonant acoustic and the distance of the microphone. The *decrescendo* in the second half of the movement is noticeably smoother than the 2009 recording. However, this appears to be only a small factor in the in the spectrogram. Whilst the dynamic control has progressed from 2009, there are some issues. First, the midpoint is less overtly the dynamic peak. Secondly, whilst the decline is smoother, the spectrogram shows that it is not symmetrical to the incline, beginning too soon after the midpoint. Finally, the end point, roughly a centimeter from the right side of the plate, demonstrates a small swell at the end of the movement, disrupting the slope of the arc. This is

apparent when comparing the beginning and end of the movement, as the dynamic is quite different between the two points.

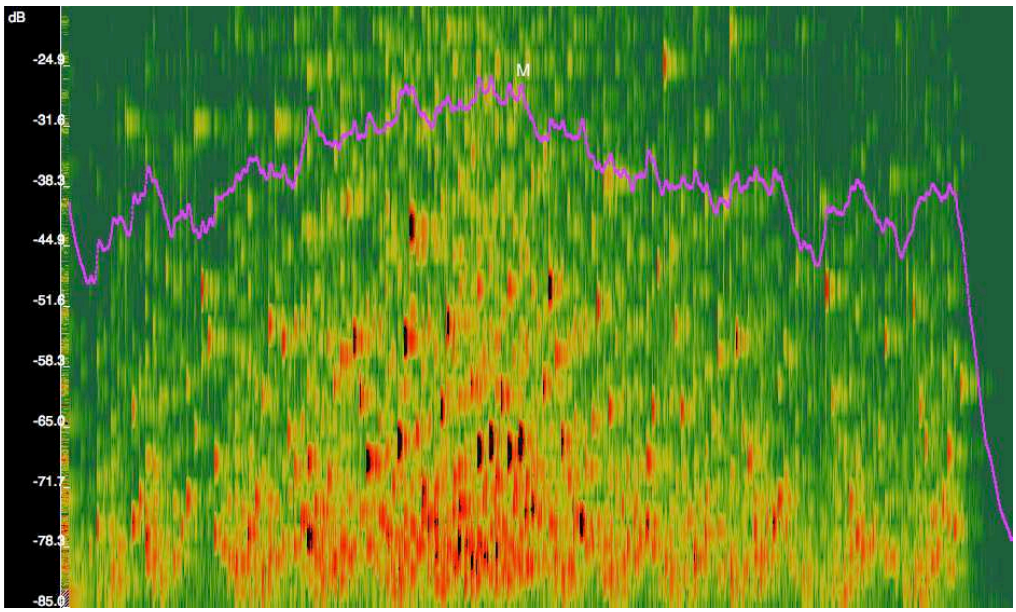


Plate 5.9 *Notation no. 6 (2015) 4'24" to 4'50".*

The 2015 recording (Plate 5.9) is fairly similar to the 2014 recording. The arc is again smooth, although there is greater inflection on the surface. Again this is possibly because of the close proximity of the microphone. The midpoint is slightly more defined than 2014, although the peak of the arc occurs slightly beforehand. The *decrescendo* similarly begins too soon, and is slightly more equalised than the 2014 performance. However, the dynamic of the start and end of the movement is much closer, and is the most accurate of the recordings. The similarity of the 2014 and 2015 recordings indicate a levelling off with regards to expressive development in the long-term study of the piece. The similar structures of these two spectrograms perhaps indicate that re-study of the memory cues and learning methods has reverted to a model to reproduce in performance. This is unsurprising given the demands of the movement, in which the technical challenges dominate the expressive aims to a certain extent. A key strategy in the final practice stages is listening to recordings of my own playing. The more generalised impression these produce, given that sound exists moment to moment, did not reveal the longer-term issues discussed. As such, the use of spectrograms would prove an invaluable visual aid to musicians during practice.

Tempo and Dynamics

A great deal of existing research analysing sound recordings has examined the correlation between tempo and dynamics, as these are two of the strongest measures of expressivity in a performance. As noted earlier, the composition is largely devoid of a uniform pulse. As such, this type of analysis proves difficult. However, the eighth *notation* provides a regular pulse and provides a suitable study. Whilst previous research focusses on the performer's manipulation of tempo within certain phrases, this examination differs in that the tempo variation is written into the score. There is a constant *accelerando* from bars 1-11, followed by a slightly slower tempo for the codetta in the final bar. This is paired with a constant *crescendo* throughout the piece from *pianissimo* to *toujours très sonore*. The entire movement is replicated in Appendix 2 for reference.

The *Sonic Visualiser* software provides an effective option to manually enter bars and beats to a sound recording. Given the variety of bar lengths in this movement, quaver beats were used instead. A *Time Instants* layer was superimposed on the spectrogram. The playback of the movement was slowed down for ease, and the quaver beat was manually tapped at the computer keyboard during playback. Given the number of repeated notes and constant *accelerando*, some editing of beat onsets inevitably occurred. Tempo changes were then produced in graphical form by copying this data to a *Time Values* layer. This enables a clear comparison with the dynamic variety (from the *Powercurve* plug-in) to examine the effectiveness of the execution of the two dimensions across the performances. Whilst this data can be exported to produce more traditional tempo-dynamic graphs, for this study it is clearer to superimpose the graphs directly onto the spectrograms. The *Powercurve* line representing dynamic change remains purple as before, whilst the tempo changes are shown in white.

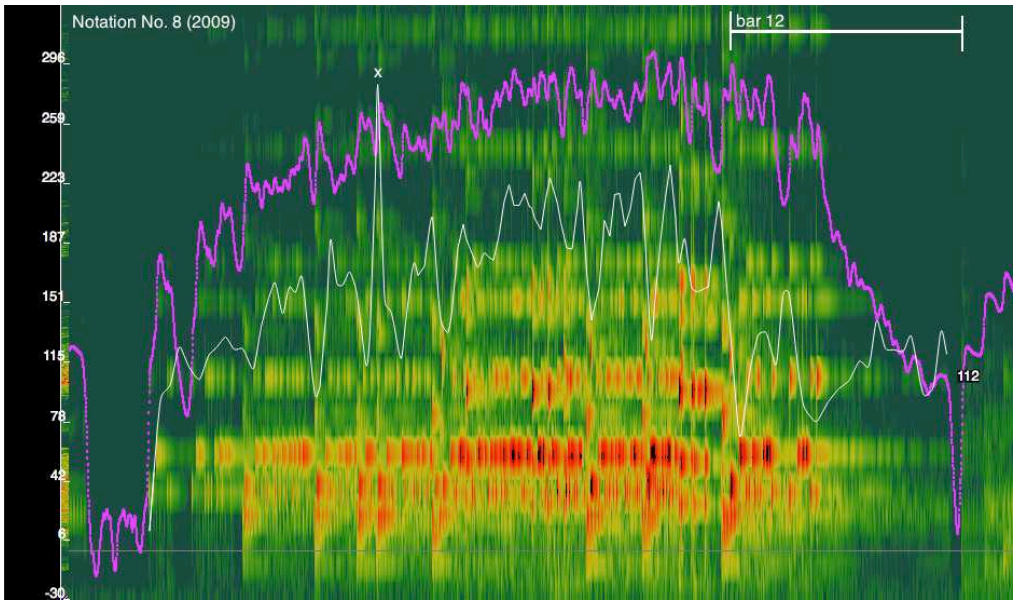


Plate 5.10 *Notation no. 8 (2009).*

Plate 5.10 shows the complete movement from the 2009 performance. The final bar at a slower tempo is marked in white at the top. The tempo change is demonstrated by the lower altitude of the white tempo line in relation to the y-axis for this bar. The dynamic also drops, despite the marking in the score as the loudest point in the piece. This is unavoidable as the texture thins dramatically. The sharp decline in the second half of the bar represents the natural decay of the resonance of the bar: the pause at the end of the movement with the sonorities held in the pedal. It is the preceding part of the x-axis, however, which is more illuminating for comparison. The 2009 recording shows both the *crescendo* and *accelerando*, denoted by the increase in height on the y-axis as time progresses. However, in both cases the incline is gentle, and generally equalised. There is one significant tempo anomaly, marked x, which represents a missed quaver rest in the performance. There are numerous inflections in tempo, with the lower altitudes representing the punctuation gestures on the bottom two staves of the score (see Appendix 2).

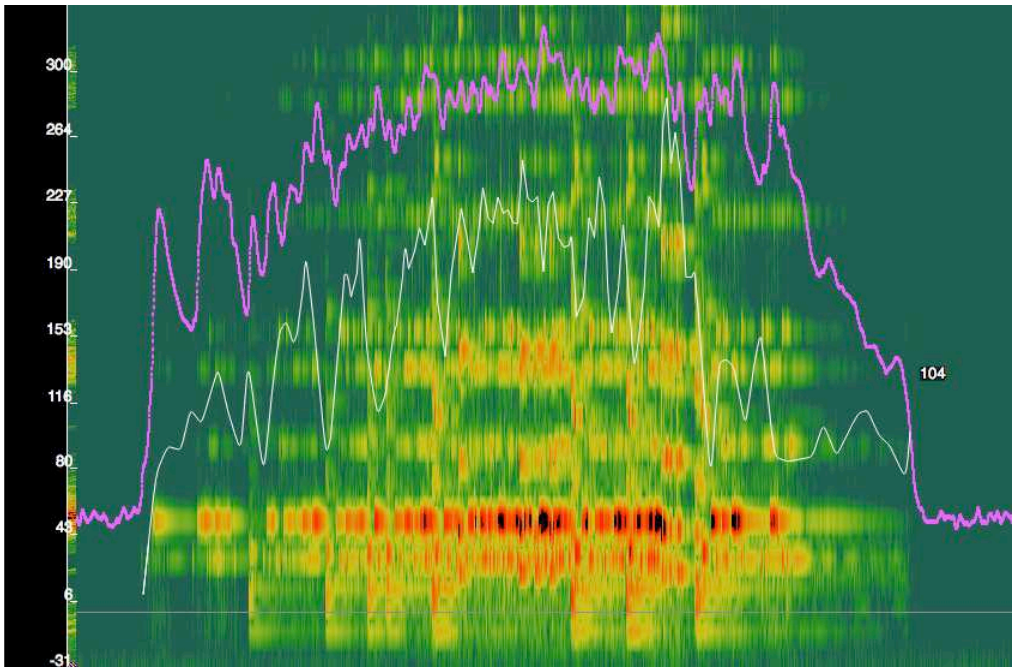


Plate 5.11 *Notation no. 8 (2014).*

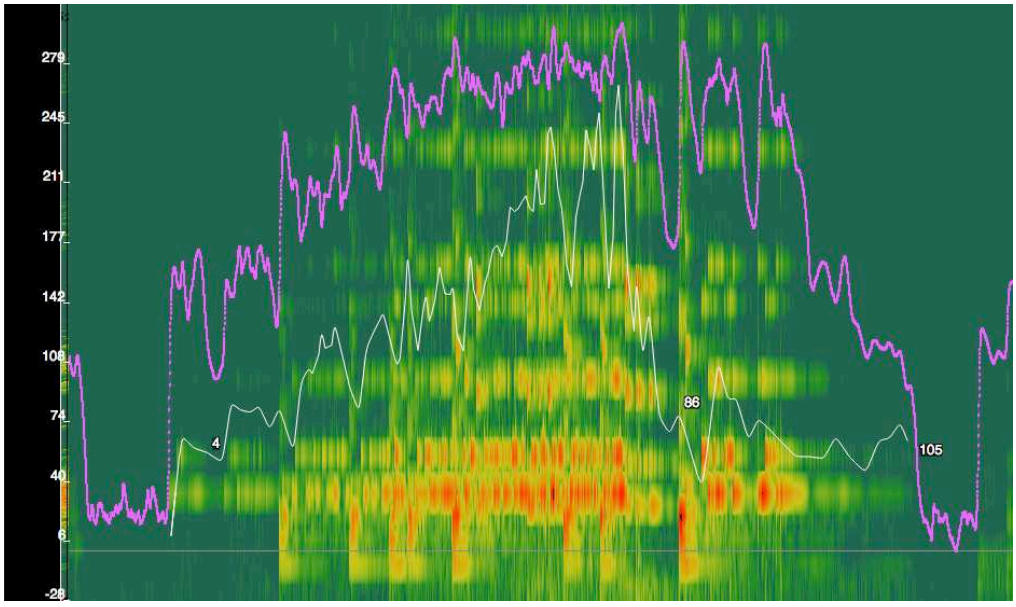


Plate 5.12 *Notation no. 8 (2015).*

The 2014 recording (Plate 5.11) retains these tempo fluctuations, however the incline is steeper. The dynamic gradient is also steeper, however the beginning of the movement shows a swell in the sound that does not fit with this incline. The final performance shows significant expressive gains in the management of tempo and dynamics (Plate 5.12). The tempo increase in particular forms a very steep gradient. This begins at a lower level than the previous recordings, and has fewer fluctuations, suggesting an increased

awareness and control of the variety of textures. The *accelerando* stops a bar earlier than previous recordings, coinciding with the marking *très violent* in the penultimate bar. Nevertheless, the dynamic peaks remain at a similar level in bars 11-12, despite the extended slower tempo. This comparison reveals a sustained and developed progress in the structural and expressive execution of the movement across the three recordings.

Structural representations

The first part of this chapter examined visual representations of the shape of individual movements and their importance as structural cues. The second *notation* provided a good example (Fig. 5.8). A clear illustration of the sonic realisation of this cue is demonstrated in Plate 5.13a. The vertical axis in this plate is now in *Hertz*, with 440Hz representing a♮^{1}. Given that my cue was primarily related to pitch, the shape of the two diagrams is almost identical. This also confirms my interpretative cues relating to dynamics, with the tops of *glissandi* and the top the central left-hand arcs in bright red and black, indicating the loudest moments. This is seen in levels 515Hz for the tops of *glissandi* at the beginning and end. The right-hand *ostinato* is shown as a constant vertical line around 796-890Hz. The only disparity is the left-hand arc. In Fig. 5.8 this does not climb higher than the right-hand *ostinato*. Plate 5.13b superimposes my own structural cue in white on the spectrogram for comparison. The actual shape of the left-hand line is shown in blue for comparison.

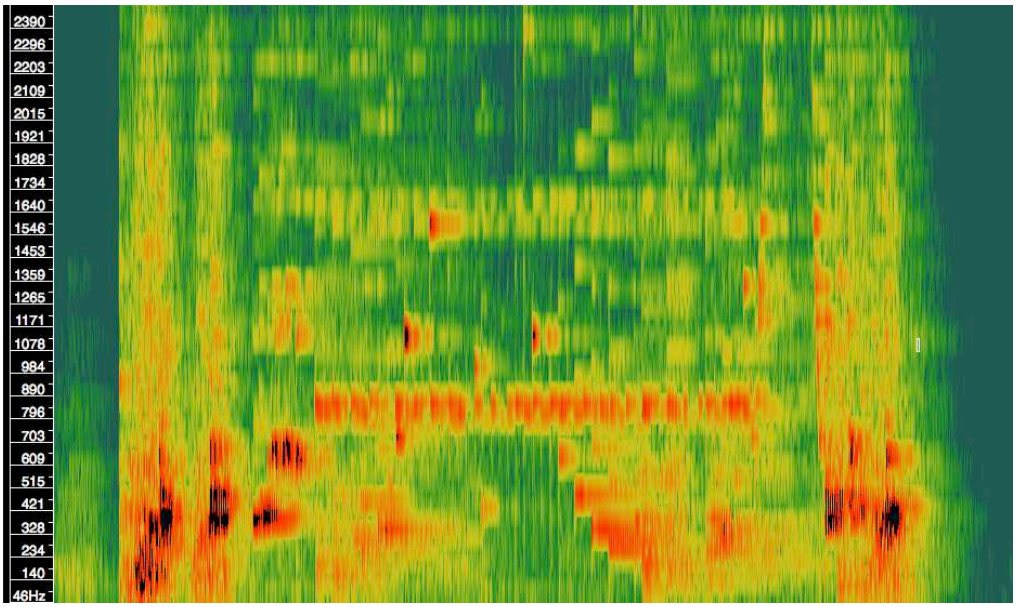


Plate 5.13a *Notation no. 2 (2015).*

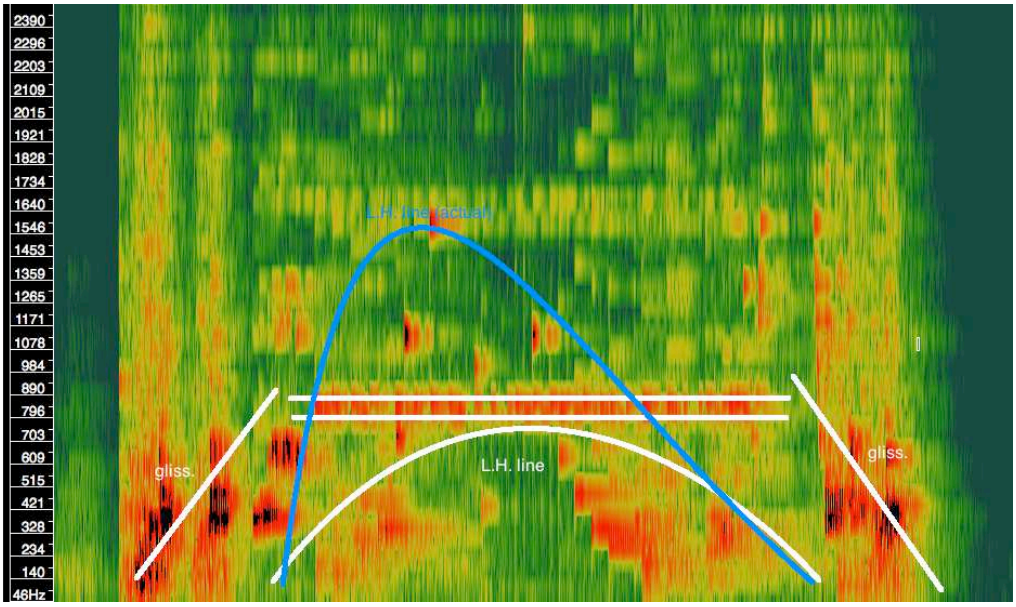


Plate 5.13b *Conceptual framework of notation no. 2 (2015).*

Conclusions

The process of relearning a composition illustrates the strengths and weaknesses of musical memory. Decay inevitably occurs, although it is difficult to fully understand the distribution of factors accounting for this tendency. Evidently, if we take the third principle of the theory of skilled memory, extended practice is required to ensure immediate retrieval of encoded data (Chase and Ericsson, 1981). If this extended practice is stopped, it is logical that there will be a negative effect on recall. This explains the slower tempi required when initially re-approaching a piece. It suggests the accuracy of Thorndike's (1914) decay theory in relation to musical memory, although it is harder to ascertain the influence of interference theory on musical memory (McGeoch and McDonald, 1931).[45] It seems likely that a combination of the two take effect: a lack of practice on a particular piece, along with extended practice of different repertoire contributes to the decline in memory retrieval.

By contrast, the conceptual framework of the *douze notations* largely remained intact, with major disruption occurring only when the technical demands were most complex. Additionally, during the 2013 and 2015 recalls, I was able to retrieve some musical material after disruption at structural boundaries. These two facets seem to affirm Chase and Ericsson's (1982) assertions that the semantic links are not weakened, but instead there is a loss or confusion in the serial ordering of information:

> The buildup of proactive interference over trials is due to a loss of connections between the location in the retrieval structure and the memory trace, because the memory trace is clearly accessible through the semantic code (p.38)

Similarly, this correlates with Ginsborg and Chaffin's study (2009) that: "Probability of recall increased as [she] approached section and phrase boundaries" (p. 27). The importance of structural boundaries as landmarks in LTM is evident. As discussed, the role of basic PCs as lacunae was harder to unpick. Further research would clarify the issue, but is beyond the scope of this study.

[45] See introduction to chapter.

Whilst the general shape of the conceptual memory is retained, the kinaesthetic ability to reproduce the encoded material is sometimes reduced (Figs. 5.16a-c). It is likely that the lack of physical habitude of the technical, interpretative and expressive gestures inhibits the ability to fully execute the intentions of the performer. The lack of consolidation of the memory cues, and hence intentions, causes a less-developed conceptual aural picture of the work. It is difficult to compare the two recall tests, given the difference in rest times: three and a half years and eleven months respectively. The significantly increased recall of the 2015 test could be solely explained by the fact the previous performance was relatively close. Nevertheless, a clear positive trend emerged in longitudinal recall that suggests that increased long-term practice of a piece increases recall after extended periods of non-practice (Ebbinghaus, 1885/1913). This study was largely dictated by external performance requests of the *douze notations*, and as such a more controlled test of long-term recall was not possible.

The most significant conclusion relates to the nature of the structural cues used in this composition. The formal structures of the movements, whilst concise, are complex and unfamiliar even to experienced musicians. The sixth *notation* provides the best example of this. Whilst structural cues were assigned to segments of the movement, retrospective comparison of the locations of these cues with the actual compositional structure revealed a mixed correlation. Instead, more intuitive locations resulting from a variety of musical dimensions were used to form the conceptual framework in the pianist's mental map of the movement. These locations then remained as landmarks from the initial learn to the 2015 recall. The evidence suggests that for the most complex structures, as with the sixth *notation*, it is helpful to *think* in structural terms, even if the particular cue associated with this dimension arises from more reasoned, intuitive assimilation of a variety of musical dimensions. Further research examining similarly intricate structures would further validate this conclusion.

The acoustic realisation of the expressive intentions in performance, as examined in the final part of the chapter, reveals a significant increase in the shaping and phrasing of gestures across the three performances. Whilst some surface details are stronger in earlier recordings, the analysis suggests that the performer is continually developing the expressive intentions of a piece, whilst at

the same time refining the execution of the interpretative PCs. The large span of these performances – some six years – provides a valuable insight of the outcomes of a performer's repeated re-acquaintance and practice of memory cues. The analysis contributes to a growing body of research into longitudinal memory procedure. This has previously documented landmarks in recall (Chaffin, et al., 2002, Chaffin, Lisboa, et al., 2009; Ginsborg & Chaffin, 2009; 2011a), expressive changes through tempo fluctuations (Lisboa, et al., 2007) and the stability and variance of PCs – and the addition of further performance thoughts - across performances (Chaffin, et al., 2013; Ginsborg & Chaffin, 2011b; Ginsborg, et al., 2012; Lisboa, et al., 2013).

The evidence in this chapter supports findings in existing studies. Further research of this type would further continue to demonstrate the expressive gains of longitudinal study. Similarly, additional research is required into the beneficial nature of the decay of memory. Could similar acoustic progress be achieved if the piece was continually practised without a break? Alternatively, is it fundamental to development in performance to return to a piece after a period of rest, as suggested by Ebbinghaus' *spacing effect* (1885/1913)? This seems to develop a longer-term version of the theory of wakeful rest purported by Dewar, Alber, Cowan and Della Sala (2014), that the consolidation of material without sensory stimulation is vitally important. The final part of this chapter suggests a similar process occurs in the LTM, and this highlights the need for further research in this area, which will add alternative dimensions to existing research on memory decay.

CHAPTER 6

Alternative Strategies

Memory techniques of other pianists

The preceding chapters have analysed in some detail my own approach when learning atonal music. This has examined how the features of the score are assimilated into various types of cue when there is an absence of traditional harmony, along with techniques to memorise innovative structures and rhythms. As discussed in the introduction of this thesis, there are difficulties in this type of research that straddles performance practice research, practice-based research and artistic research (Doğantan-Dack, 2012). Whilst self-analysis enables comprehensive and illuminating examination of my own memory techniques, there are potential pitfalls to such self-reflection, given the subjective nature of this thesis (Chalmers, 1990; 1996; Dennett, 1991; Ericsson & Simon, 1993; Nisbett & Wilson, 1977).

As such, this final chapter seeks to broaden the discussion of techniques for memorising atonal music by examining strategies employed by three other pianists. This serves as constructive comparison to my own strategies highlighting both similarities and differences, and extends the discussion of atonal memory techniques for highly skilled pianists. After outlining the pianists, repertoire and procedures, the study investigates general memory strategies employed by the participants, followed by particular techniques used to memorise the varied repertoire learned. The aim of this chapter is to understand how different pianists memorise contemporary music, and if there is any similarity to the techniques described in earlier chapters.

Method

Pianists

Three pianists were approach to take part in this study. The participants were chosen for their affinity and extensive experience in performing contemporary music. *Pianist A* (female, age 30) had trained at the Guildhall School of Music & Drama, completing a performance doctorate (D.M.A.) two years prior. *Pianist B* (female, age 28) had also studied at the Guildhall School of Music & Drama, completing a master's degree in performance (M.Perf.) the year prior. *Pianist C* (female, age 28) had completed a Master of Arts (M.A.) at the Royal Academy of Music. As such, all of the participants were trained to postgraduate level, and were pursuing performance-based careers. The sample size is noticeably small: the chapter can be considered a pilot study for future research, extending evaluation of atonal memory techniques. Nevertheless, the sample provides interesting analysis to examine alternative memory techniques, as well as to validate those discussed at length in Chapters 3–5.

The Music

So as to minimise any disruption to the participants' schedules and performance engagements, they could choose the repertoire themselves. In all cases, the pianists had engagements with contemporary repertoire and were able to combine their learning period with this study. *Pianist A* selected the opening two pages of Paul Wiancko's *Our Rusty Planet* (2015). The work contains some modal and tonal influence, with more angular chromatic sections. *Pianist B* selected the opening four pages of Claude Vivier's *Shiraz* (1977). The language of the toccata-style composition is far removed from traditional tonal music. *Pianist C* chose the fourth and fifth movements of Harrison Birtwistle's *Harrison's Clocks* (1998). The work is rhythmically complex, and the language is atonal. The relevant portions of the respective scores are reproduced in *Appendix 3*.

Procedure

Pianists were asked to annotate a short section of around two pages of their chosen piece. Annotations were to be made during the learning process on a copy of the relevant section of the score. These annotations detailed decisions each participant had made relating to memorisation of the musical features. Following this, a semi-structured interview was held with each participant. First, the pianists were asked to explain their annotations to clarify any strategies that were ambiguous from the annotated score. Secondly, they were asked about their general learning procedure with regard to contemporary repertoire.

To avoid any bias from the researcher, pianists were left to annotate decisions by themselves, and the interview was led by the participant, explaining general strategies and their annotations with minimal input from the researcher. Interviews were video-recorded for retrospective analysis. Any verbal comments listed in the following analysis are transcribed from these video sessions and are labelled in shorthand referencing the participant to which they refer (e.g. VS-A refers to the video session of *Pianist A*). The data is analysed following the major themes that emerged in the interviews, and reported qualitatively. This observational research methodology imitates earlier studies of the learning processes of musicians (Aiello, 2000a; Gruson, 1988; Hallam, 1995a; 1995b; 1997a; Herrera & Cremades, 2014; Miklaszewski, 1989; 1995). Analysis in this study outlines general memory procedures for atonal music, before analysing the memorisation strategies the participants used in learning the respective sections of their selected repertoire. The aim is to investigate how other musicians memorise atonal compositions. Similarities and differences to my own techniques are identified in the conclusion of the chapter.

Research Ethics

Ethical approval for the study was granted by Guildhall School of Music & Drama. The study used observational and interview methods, and as such was low risk and non-invasive. Nonetheless, the following procedures were followed in accordance with ethical guidelines. All participants provided consent for the study and were able to withdraw at any point. Participants consented to release their age, gender and qualifications to be reported. No other personal information was gathered. Anonymity protects the identity of the participants. Finally,

participants were notified and consented that all material gathered (annotated scores and interview recordings / transcripts) would be viewed solely by the researcher. The materials are stored on an encrypted hard drive for a period of one year, at which point they will be destroyed unless further written consent is provided by individual participants.

General Strategies

Pianist A used analytical techniques prior to practice to get a "mental grip on the contour and architecture of the piece" (VS-A). This involves analysis of basic harmony, melody and structure (see, for example: Ginsborg, 2004; Hallam, 1995a; 1995b; 1997a; Miklaszewski, 1989; Rubin-Rabson, 1937). The piece was then divided into smaller segments for practice. Strategies included practising hands separately (Brown, 1933), or learning one bar at a time through serial chaining (Chaffin, Logan, & Begosh, 2009). This type of practice has elsewhere been described as additive (Mishra, 2011) and integrated (Chaffin, et al., 2002). In addition, colour markings are annotated on the score to aid learning processes. These relate to tempi changes (new tempi, as well as *accelerandi* and *ritardandi*), pedal markings, and vertical lines to indicate the beat in more complex rhythmical gestures. The pianist also mentioned the use of tonal allusions as important features to encode atonal music:

> When I memorise contemporary pieces, which are less clearly grounded in tonal or modal harmonies, I always look for patterns that resemble conventional tonal harmonies as this gives my memory a 'hook' to grasp onto (VS-A).

Pianist B also used forms of analysis and segmentation during the learning process. In contrast to *Pianist A*, she preferred to start work at the instrument immediately to learn a short segment, to obtain a physical and aural impression of the piece. Following this, an overview of the score took place, noting particularly sections that are repeated, the most complex segments, and easier passages. The latter two categories were sometimes learned first, not adhering to the composition's linear order. In this sense *Pianist B* can be considered a versatile learner, combining holistic and segmented practice (Hallam, 1997a; Mishra, 2011). Prioritising complex passages was a strategic aim in order to give the maximum practice time available (a similar strategy was

employed in my *Oiseaux Exotiques* study, which highlighted the cadenza as the most challenging section of the entire work, and thus learned first). For simpler passages, learning was prioritised to gain a sense of achievement and progress ("It makes me happy" VS-B). Fingerings and rhythm learning were also completed in the early stages. Whilst the rhythm of this particular piece is fairly simple, *Pianist B* revealed that working away from the instrument to internalise rhythmic gestures was a common process in more complicated music.

Pianist C indicated prior analytical methods were often used when learning periods were reduced, or if the composition involved extended repetition. For the fourth and fifth movement of Birtwistle's *Harrison's Clocks*, more intuitive analytical methods were employed at the instrument during practice (similar procedures have been described above: see chapters 2 and 5). As with *Pianist A*, this involved coloured annotations on the score of various musical features, including dynamics, unusual rhythms and melodic fragments. In addition, in the days leading up to performance, larger sections were annotated labelling the character or emotional content of the music. In some cases, this included references to other composers if the sonic content of a passage in the score produced a notable comparison.[46] A wide range of practice strategies was employed. Hands separate practice was a fundamental method in the learning process. Memory tests were integrated into practice at various points to evaluate progress. Instead of closing the score, *Pianist C* placed it on the floor to the left of the piano stool: she indicated the increased comfort and reduced pressure this fostered.

Segmentation of the piece was used, often to work backwards through the piece (this technique has been described in Chapter 2, and documented in previous research: Ginsborg & Chaffin, 2011a). Such sectional practice often evolved: *Pianist C* described using systems in the score as sections initially, before adopting divisions based on musical features. She noted the usefulness of changing the starting points of segments to aid memorisation. The use of memory points was also mentioned as a useful strategy. Although the study here is more observational, it is likely that such points may end up as PCs for *Pianist C.* A final memory strategy was derived from "The Pomodoro Technique",

[46] Although no retrospective reports were made after *Pianist C's* performance, this process suggests anecdotal evidence for the development of expressive PCs.

which divides learning or practice into certain interval lengths, interspersed with a period of rest (Cirillo, 2007). Practice was chunked into ten-minute periods with the focus on memorising a particular portion of the score. The pressure of the timed element focusses learning:

> It's amazing how much you can get done in that time, but also how quickly that time goes: if you're aiming to get one hand [of a short section] up to performance standard with regard to memory, it's not very much time at all (VS-C).

Cueing Procedures

Tonal / Modal allusions

As mentioned in the discussion of general memorisation strategies, *Pianist A* relied on any tonal or modal allusions in order to assimilate the more complex writing in Wiancko's *Our Rusty Planet*. Although the piece has strong modal and tonal implications, the more contrapuntal elements proved more challenging to encode. Fig. 6.1 provides one such example, of how contrapuntal lines were associated with underlying harmony (Nellons, 1974), even if the harmonic implications didn't operate in a traditional functional manner. Of particular importance was the B-flat major chord sounded in the right hand in bar 45 (the final bar in this example), which served as a strong landmark in the passage.

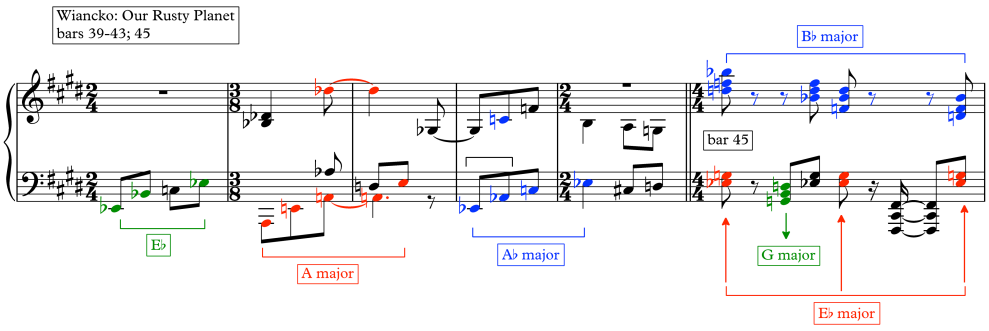


Fig. 6.1 *Tonal allusions in Wiancko's Our Rusty Planet (Pianist A).*

The fifth movement of Birtwistle's *Harrison's Clocks* exhibits fewer and less obvious allusions to tonal and modal language. Nevertheless, *Pianist C* used repeated octave utterances as strong cues to encode hand shapes in the toccata-

style writing. The use of a familiar sound (the octave) and physicality of the hand shape provided reference points in angular lines, as demonstrated in Fig. 6.2:

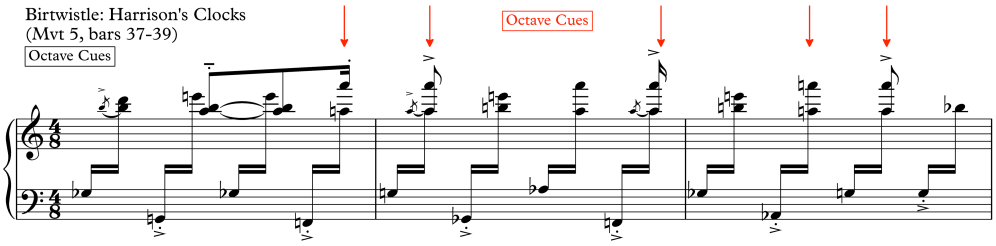


Fig. 6.2 *Octave cues in the fifth movement of Birtwistle's Harrison's Clocks (Pianist C).*

Hand Shapes, Fingering and Intervallic Cues

Pianist C additionally used intervallic cues in the same passage to memorise the lowest line in the left hand (marked in blue). Fig. 6.3 outlines the use of tones and semitones:

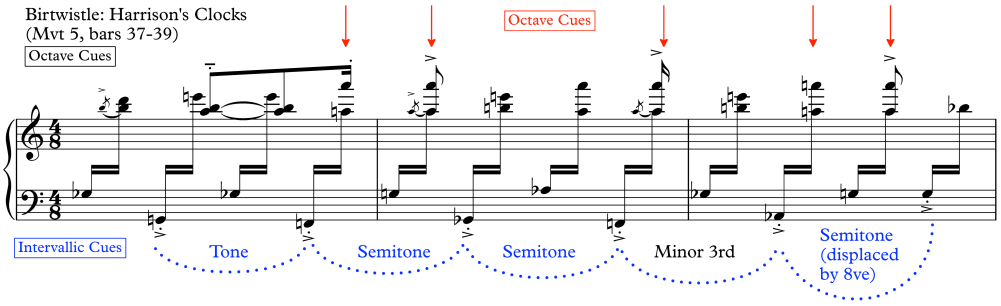


Fig. 6.3 *Intervallic cues in the fifth movement of Birtwistle's Harrison's Clocks (Pianist C).*

Pianist C also noted the kinaesthetic strength of intervallic cues stretching beyond an octave. Her hand span could stretch an octave comfortably, but intervals of a ninth and beyond proved difficult. This in turn became a cue, particularly for minor ninths: the physical strain of this interval left a strong kinaesthetic imprint that proved useful for assimilation. A similar kinaesthetic cue relating to extended stretches of the hand span was described in analysis of my own learning of Kurtág's *Hommage à Pierre Boulez* (see Fig. 4.8b).

Pianist A used kinaesthetic responses from hand-shape cues to memorise one of the harder passages in Wiancko's *Our Rusty Planet.* Given the repetitive nature of the left hand, such cues were more useful for memory procedure in the right hand, although there were connections between both hands. Fig 6.4 demonstrates the use of modified second inversion chords with an added tone or

semitone (shown in blue), chords based around a fourth with added tones or semitones (green), and major thirds containing a whole-tone (red), derived from the lowest three pitches of the left-hand *ostinato* chord. The modal, folkloric right-hand melody strengthened the hand-shape cues: "I believe that the process involved melodic aural memory and the physical memory of chord shapes that I had built up while learning the piece" (VS-A). The physical familiarisation with hand shapes during the learning process has previously been discussed (see, for example, Fig. 3.5).

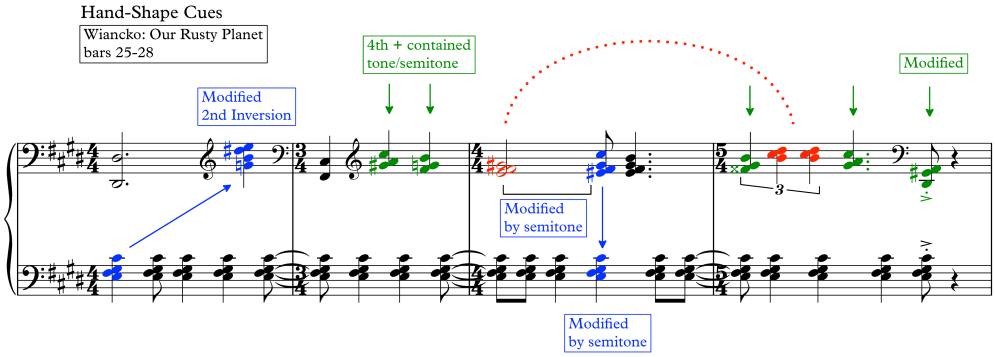


Fig. 6.4 *Hand-shape cues in Wiancko's Our Rusty Planet (Pianist A).*

Pianist B used hand-shape and fingering cues as a kinaesthetic means of cueing repeated chordal figurations, as demonstrated in Fig. 6.5:

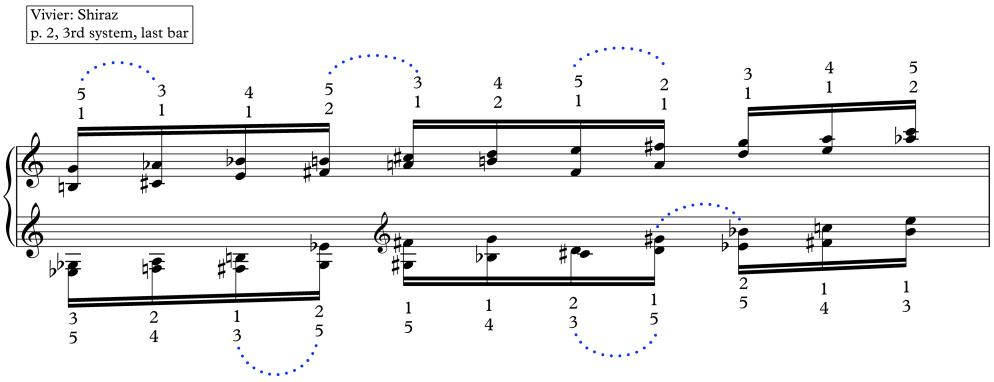


Fig. 6.5 *Hand-shape and fingering cues in Vivier's Shiraz (Pianist B).*

Particular strength was placed on the rotation of each individual hand to ensure legato, as *legato* connection itself strengthens the tactile response thereby aiding memorisation. The technique was used from the outset to ensure encoding started at the earliest stage possible:

> I have to find the fingerings straight away, because if I keep using different fingerings I'm just wasting my time: I'm not giving myself consistent information. That's a strong part of physical memory: you get to know the shapes your hand is doing (VS-B).

Intervallic cues were also used to strengthen memory retrieval of the top line of the chord in this passage:

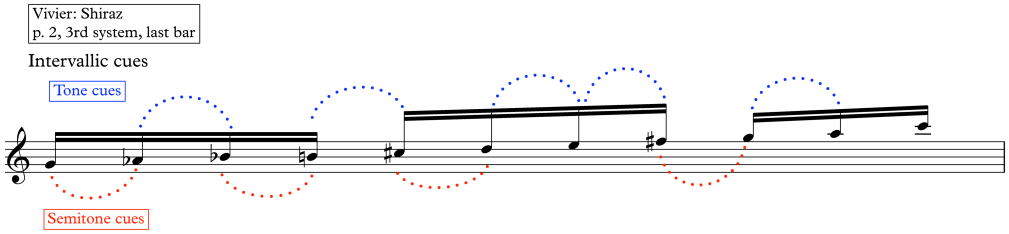


Fig. 6.6 *Intervallic cues in Vivier's Shiraz (Pianist B).*

The scalic fragment, initially outlining an octatonic scale, was a particularly strong cue to aid encoding, through a combination of hand-shape and fingering cues. Further colour cues relating to the pianist's synaesthesia strengthened memory retrieval (discussed below, Figs. 6.15-6.16).

Pianist C used blocking techniques (Nellons, 1974) to cue the hand shapes of linear passages. Fig. 6.7 demonstrates the blocking of a passage into two closely related chords, in which the second chord adds one note in each hand:

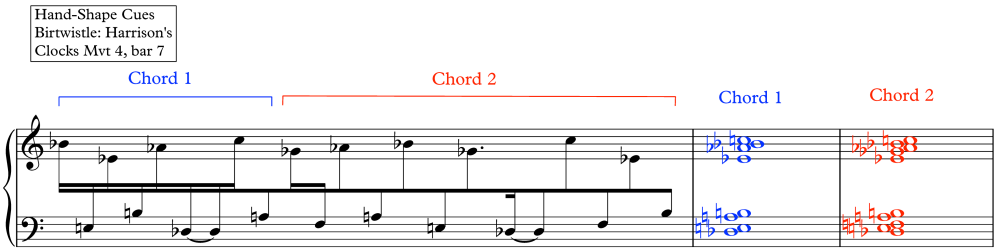


Fig. 6.7 *Hand-shape cues in the fourth movement of Birtwistle's Harrison's Clocks (Pianist C).*

Further hand-shape cues established the changing inner voices in chordal progressions, a technique demonstrated in my own memorisation strategies (see Figs. 3.8 and 3.9). Fig. 6.8 shows a harmonic reduction of the procedure in the fourth movement, bar 10:

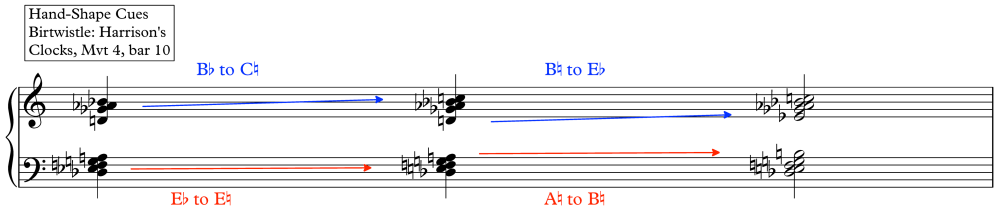


Fig. 6.8 *Hand-shape cues in the fourth movement of Birtwistle's Harrison's Clocks (Pianist C).*

Sonic Resonance

A further structural encoding of the chordal figuration by *Pianist B* involved the combination of hand-shape cues and aural recognition of repeated sonorities; a term described as sonic resonance in Chapter 4. The opening section of Vivier's *Shiraz* involves the gradual expansion of chordal figurations in contrary motion, before returning in retrograde progression, resulting in the complete statement in Fig. 6.9:

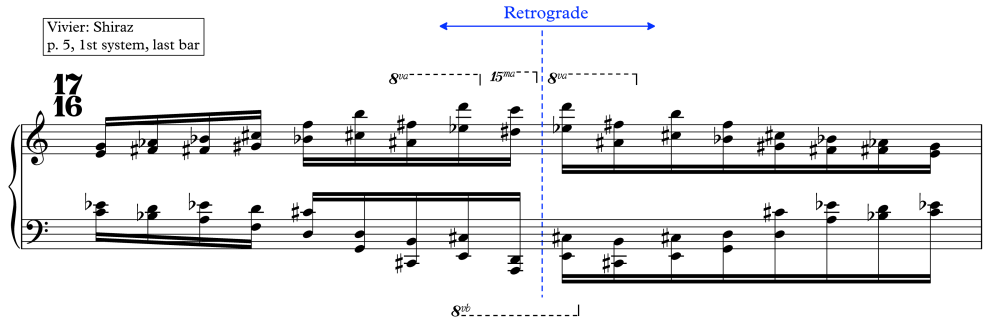


Fig. 6.9 *Encoding of repeated sonorities in Vivier's Shiraz (Pianist B).*

Initially, this begins with repetition of the first chord in the sequence at the beginning of the work, gradually expanding one chord at a time to the peak (the ninth chord in Fig. 6.9), followed by a similar progression back to the starting chord. This takes place across the opening four pages. As such the chords were encoded in structural terms, locating starting positions and peak chords of each gesture. The pianist described the learning process: "It's more like administration" (VS-B). The repetition of chords developed a strong aural connection that bears similarity to the encoding of repeated chordal sonorities in my learning processes of Butler's *Funérailles* (Fig. 4.13). This was combined with hand-shape cues, with particular attention to the leaps involved in the registral extremes.

Verbal Associations

Pianist C documented the use of verbal associations as a memory aid. In some cases, these were as simple as remembering melodic pitches. Fig 6.10 illustrates the assimilation of a melodic fragment in the fifth movement of Birtwistle's *Clocks*, bars 71-74. As the repetitive fragment revolves around middle c♮^{1}, Pianist C revealed the verbal connotation sought to "capitalise the melody" and thereby reinforce memory recall (VS-C). The technique has been discussed in previous research (Li, 2007).

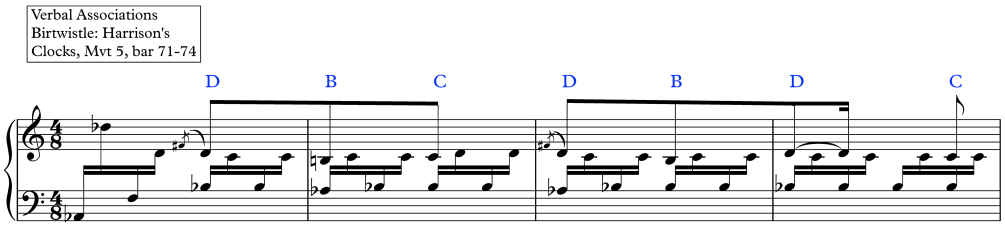


Fig. 6.10 *Verbal associations in the fourth movement of Birtwistle's Harrison's Clocks (Pianist C).*

Directional verbal associations were also used as cues to help memorise a particularly complex two bar passage (bars 45 and 47 in the fourth movement), which contains various grace-note accentuations in both hands preceding quaver chords. As demonstrated in Fig. 6.11, verbal cues denoting the direction to which the grace-note led, and if hands were combined, helped *Pianist C* memorise the passage.

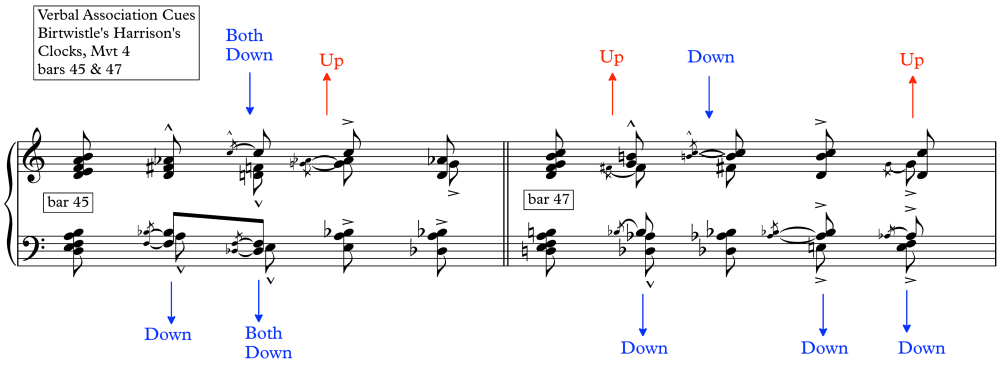


Fig. 6.11 *Verbal associations cueing grace-note direction in the fourth movement of Birtwistle's Harrison's Clocks (Pianist C).*

Rhythm

The rhythms used in Vivier's *Shiraz* were fairly straightforward for *Pianist B* to assimilate. For large bars of repeated chords, complex time signatures were simplified into more conventional groupings, for example the opening bar of the piece:

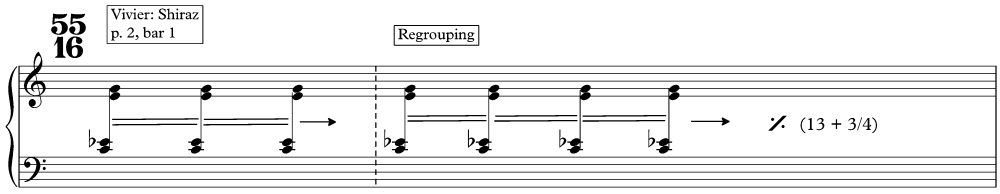


Fig. 6.12 *Rhythmic re-grouping in Vivier's Shiraz (Pianist B).*

The fifty-five semiquaver statements were grouped into thirteen bars of 4/16 and one bar of 3/16 (in total one beat short of fourteen complete bars of 4/16). In general, the simplicity of the rhythm did not require further strategies for memorisation. *Pianist B* did reveal the importance of time signatures, even when the rhythms didn't particularly correspond. She also described processes of working away from the instrument for more complex repertoire (as described above). As the rhythm was similarly less complex in Wiancko's *Our Rusty Planet*, *Pianist A* did not use any further encoding techniques other than beat annotations as described above. She did note the importance of rhythm to stabilise memory during performance:

> In performance, if I feel that nerves are likely to throw my memory off balance, I will often 'grip onto' the pulse. For some reason this seems to ground the memory (VS-A).

Pianist C used a variety of techniques to aid memorisation, given the complexity of the Birtwistle score. Beat counting was a primary strategy to assimilate repeated material (Li, 2007). Fig. 6.13 demonstrates an example of the technique at the beginning of the fifth movement:

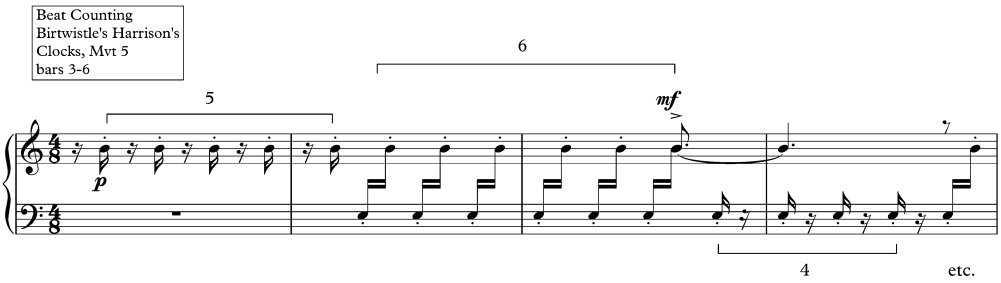


Fig. 6.13 *Grouping beat counts in the fifth movement of Birtwistle's Harrison's Clocks (Pianist C).*

The movement has a regular semiquaver pulse throughout the four minutes duration. On six occasions, however, there are triplet semiquaver interruptions to the pulse. *Pianist C* described how these points became moments of significance in the physicality of playing. These were accordingly annotated in yellow in the score:

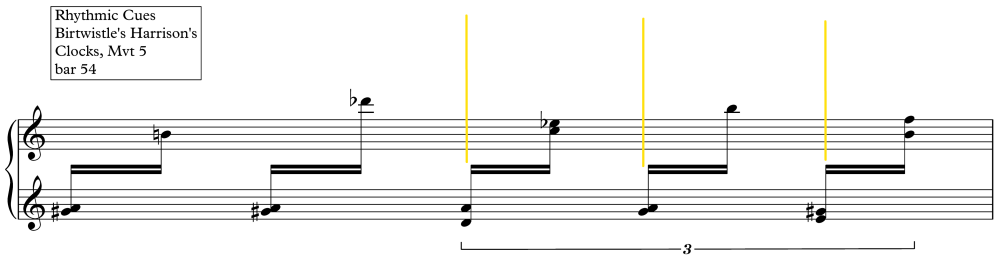


Fig. 6.14 *Cueing of rhythmic subversions in the fifth movement of Birtwistle's Harrison's Clocks (Pianist C).*

Synaesthesia

Pianist B used more unusual memory techniques derived from her synaesthesia. The term comes from the Greek: *syn* (union) + *aesthesis* (sensation). Cytowic describes the condition as follows:

> In those with synesthesia sensory interactions are entirely different: stimulation in one sensory modality automatically triggers a perception in a second modality, so that a sound, say, might instantly trigger a blob of color (Cytowic, 1989, p. xii).

Cytowic (1989) also suggests female synaesthetes predominate by a ratio of 3:1 (p. 2). Whilst the percentage of the general population affected by the condition is unclear, he estimates at least 1/25000 of the population display the condition where one sensation conjures another (1995). More recent studies suggest that 4.4 percent of the general population is affected, with no asymmetrical

experience in gender (Simner, Mulvenna, Sagiv, et al., 2006). There are over sixty known types of synaesthesia (Dutton, 2015). *Pianist B* experiences one of the more common forms: chromaesthesia, the association of colours and sounds. Research has suggested that synaesthetes of this particular type are more likely to play musical instruments:

> Individuals experiencing vision from music have particularly rich experiences (movement, textures, colour, shapes) and this may provide a source of motivation (Ward, Thompson-Lake, Ely, & Kaminski, 2008, p. 136).

Various composers are also said to have experienced chromaesthesia, notably Messiaen (Bernard, 1986) and Scriabin (Peacock, 1985). In addition to chromaesthesia, *Pianist B* also experiences a second colour association related to individual fingers. The two types of association are presented in Table 6.1.

Table. 6.1 Synaesthetic Colour Associations

Finger	*Colour*	*Pitch*	*Colour*
1	White	C♮	White
2	Orange	D♮	Orange
3	Blue	E♮	Electric Blue
4	Lemon Yellow	F♮	Orange/Pink
5	Pink Red	G♮	Black/Purple
		A♮	Mustard Yellow
		B♮	Brown

Fingering associations are identical between the hands, whilst pitch colours are replicated in each octave, with accidentals eliciting slightly brighter or duller colours compared to the naturals listed. *Pianist B* did note some distortion with relation to pitch colours in the lower half of the register of the piano (below middle $c♮^1$). This developed from her early formative training, where both hands were placed in close position to each other around $c♮^1$. As such, some of the pitch-colour associations had a slight symmetrical confusion. In particular she described confusing A♮ and E♮ as a child, given the visual similarity related to the keyboard layout. Despite this, the colour associations provided

strong cues for the encoding of musical material in various manners. Fig. 6.15 demonstrates the use of colour associations to encode right-hand fingerings (white thumb associations are shown in grey):

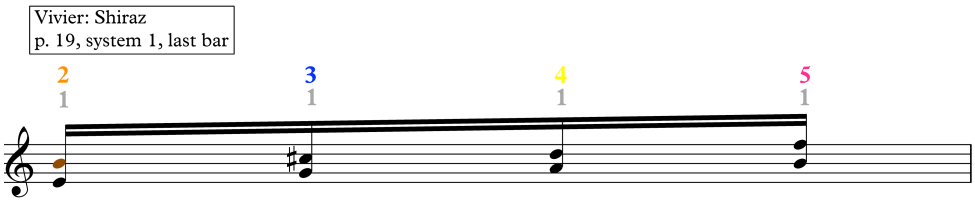


Fig. 6.15 *Fingering colour-association cues in Vivier's Shiraz (Pianist B).*

The upper voice was cued through use of fingering colour associations to strengthen the kinaesthetic fingering cueing types described earlier by the *Pianist B* (Fig. 6.5). The dyad combinations of pitches affected the colour associations. *Pianist B* described the colour associations of the fingering in the first chord: "The orange of the second finger is slightly diluted by the white of the thumb" (VS-B). In addition, a combined cue was used at the start of the bar to ensure the correct hand position was used to enable serial progression in the passage. This employed both types of colour association: fingering and pitch.

As demonstrated in Fig. 6.15, the b♮[1] elicits a brown association, whereas the second finger association is orange. This contradiction became a cue for the pianist: "I remember a brown B played by an orange finger: it's a nice way of knowing that particular starting position" (VS-B). The pianist reported flexibility in the use of colour associations when encoding new material. If fingering and hand shapes caused disruption during practice, fingering colour associations often proved useful cues to aid retrieval. However, if the actual pitches were not recalled correctly, a similar process of cueing was attributed to individual pitches to strengthen recall.

Colour associations also served as larger structural cues to aid serial chaining. At faster tempi, whole bars formed single colour units, with the particular colour serving as a cue for the whole bar. Fig 6.16 demonstrates this type of cue: a brown bar.

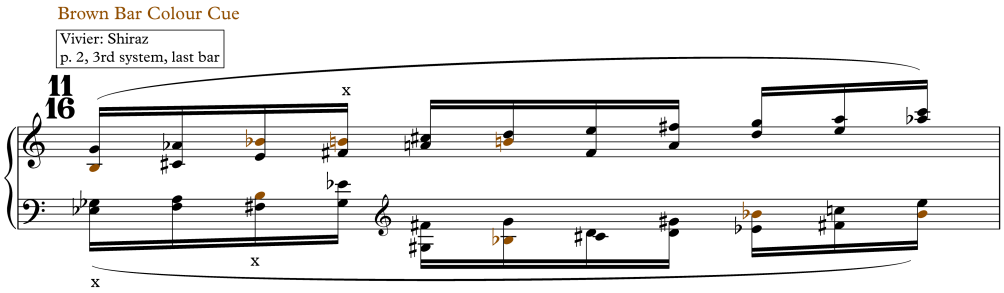


Fig. 6.16 *Structural colour associations in Vivier's Shiraz (Pianist B).*

As demonstrated, the prevalence of B♮/B♭ pitches elicited a brown tinge for *Pianist B*, which served to cue the serial location of the bar in practice. This reinforced the hand-shape, fingering and intervallic-melodic cues as described in Figs. 6.5 and 6.6. *Pianist B* describes the process:

> At first, when I'm learning step by step, I really focus on each individual colour. But as I start to step back, it becomes a general, more structured colour (VS-B).

A final use of colour association related directly to practice strategy. Much like hearing a wrong note, *Pianist B* was aware of wrong colour associations during faster practice of passages, which could then be corrected by re-establishing a colour association based on the association of either pitches or fingerings of a particular note, chord or figuration.

The synaesthetic memory strategies provide a fascinating alternative method of encoding of musical material. Given that only a small proportion of the general population experience automatic multisensory stimulation, it is unlikely that the techniques are transferable to most musicians. However, recent research suggests the same cross-modal mechanisms for perception are used in synaesthetes and non-synaesthetes, whilst non-synaesthetes display identical influences of timbre on colour (Ward, Hickstep, & Tsakanikos, 2006). Given the prevalence of colour as an expressive term in Western Art Music (Jewansky, 2003), structural associations based on timbre and harmonic colouring may be useful in the memorisation of contemporary music, even for those who do not experience synaesthesia.[47] More abstract associations derived from harmonic colouring, register and timbre – although not experienced on a synaesthetic level

[47] For further reference on cross-modal interference in musicians, see Parncutt (2013).

– provided a strong structural framework for my own memory procedure in Martin Butler's *Funérailles* (see Fig. 4.15).

Conclusions

This study aimed to investigate various pianists' techniques for memorising atonal compositions. Expert musicians are keenly aware of their own practice strategies (Hallam, 1995a; 1995b; 1997a). This is developed over the years of deliberate practice required to become a highly skilled performer (Ericsson, et al., 1993). The participants in this project exhibited similarly informed strategies in structuring their practice: hands-separate practice (Brown, 1933), sectional practice (Chaffin, et al., 2002; Chaffin, Logan, et al., 2009; Ginsborg 2004; Mishra, 2011), and forms of prior analysis (Aiello, 2000a; Hallam, 1995a; 1995b; Miklaszewski 1989; Rubin-Rabson, 1937). Given the greater complexity of the various scores, and the likelihood that the composition is less familiar, coloured annotation of musical dimensions was identified as an important strategy by two of the participants as a technique to emphasise important details of the score. The understanding of the psychology of memorisation was additionally evident for *Pianist C*, through the use of "The Pomodoro Technique" to structure practice in timed intervals interspersed with periods of rest (Cirillo, 2007), a more recent strategy arising from Ebbinghaus's spacing effect, demonstrating that studying in intervals in a longer time frame produces better results (Ebbinghaus, 1885/1913).

As harmonic schemas and patterns are fundamental knowledge in a musician's lexicon to enable expert memory (Halpern & Bower, 1982), it is not surprising that participants adopted any relation to these schemas. This was particularly true for *Pianist A*, as the repertoire examined here contained some tonal and modal allusions. Familiar hand-shapes derived from harmonic patterns also proved strong cues for memory. Moving beyond localised harmonic allusions, all three pianists displayed an increased focus on hand-shapes and fingering patterns to replace harmonic patterns. This included blocking of linear passages to familiarise the kinaesthetic element of the hand shape (Nellons, 1974), the tactile connection of fingerings to cue serial chains, and the accumulation of repeated hand-shapes to foster physical and aural familiarity.

Verbal association cues were employed by one pianist, and variety of rhythmic cueing, including beat counting (Li, 2007) and regrouping techniques, were evident.

Intervallic cues were also noted by two of the pianists, the particular strength seeming to be the assimilation of linear melodies. The techniques bear striking similarity to those described in the discussion of my own techniques, validating the analysis of previous chapters. Particularly evident is the use of intervallic, hand-shape and sonic resonance cues that proved fundamental to my own techniques of memorisation for atonal music. This evidence further suggests repertoire of this type requires the use of a greater combination of physical, aural and conceptual patterns to cue musical material in STM, before extended practice enables transfer to LTM. Different strategies are notable in addition. In particular, the use of synaesthesia to memorise music provides an unusual and interesting example of effective memorisation. The techniques are unlikely to be applicable to all but a few musicians: however, it is likely that those who do not experience synaesthesia use more abstract associations relating to timbre changes in conceptual memory (as described in Fig. 4.15).

Given the small sample size of this study, some caution is necessary in interpreting the results and drawing conclusions. Furthermore, as the participants annotated a small section of the repertoire they selected, it is difficult to examine whether any memory techniques progress from localised use in a particular passage and can be used across the piece: a vital component of effective memorisation (Sloboda, 1985). Further research expanding the sample size would certainly shed light on the nature of atonal memorisation amongst musicians. Nevertheless, whilst the participants demonstrate individual memorisation methods (Aiello, 2000a; Hallam, 1995a), it is clear that strikingly similar methods are used to learn atonal music. This reinforces the validity of my own techniques documented in earlier chapters. Considering my own practice with the participants of this chapter, it becomes apparent that the techniques used strongly correspond to existing memory studies: both general and musical. This is particularly true in the use of segmentation (either using the formal structure, or more arbitrary segments) and the use of physical and conceptual patterns (intervallic, hand-shape and sonic resonance cues) to enable some form of prediction and chunking in music with unfamiliar language.

CONCLUSIONS

Scholarship has highlighted the extreme difficulties atonal music presents for memorisation (Aiello, 2001a; Chaffin, et al., 2002; Miklaszewski, 1995; Noyle, 1985; Ockelford, 2011; Sloboda, et al., 1985; Williamon, 1999). Yet, many professional musicians perform contemporary works from memory. Given, the extreme demands of this musical language, such feats often seem near impossible. Humans are, after all, pattern-spotting creatures (Bor, 2012). Musical memory relies so heavily on established patterns (Halpern & Bowen, 1982), developed over extended, deliberate practice (Ericsson, et al., 1993). This domain-specific knowledge is a fundamental principle of expert memory theory (Chase & Ericsson, 1981; 1982; Ericsson & Kintsch, 1995). Atonal music is usually not devoid of patterns (Parncutt & McPherson, 2002); it is simply that these schemas are less familiar, even to experienced performers.

Consequently, this thesis addresses these issues through detailed examination of memorisation procedures for atonal piano music. Three aims were identified at the outset of the study. First, the thesis sought to understand if theories of expert memory previously established in tonal music applied to more complex atonal music. Secondly, analysis aimed to demonstrate how musicians accomplish memorisation, through detailed examination of specific techniques and strategies at the instrument. Finally, the thesis aimed to investigate how repeated re-approach to a piece over a longitudinal period – reconstructing the PCs and relearning the composition – affects the expressive outcomes in performance.

Addressing the first aim, regarding the application of expert memory to atonal music, the initial enquiry resulted in a longitudinal case study of the main cadenza in Messiaen's *Oiseaux Exotiques*. Previous studies, upon which this methodology was based, have largely focussed on musicians' learning processes for tonal music (Chaffin, et al., 2002; Chaffin, Lisboa, et al., 2009; Lisboa et al., 2009a; 2009b; 2009c; 2011; Lisboa, et al, 2007; Lisboa et al., 2015; Noice, et al., 2008). Practice was organised according to the formal structure of the work,

which remained as a landmark in LTM (see also: Williamon & Valentine; Williamon & Egner, 2004). PCs were established and practised at various stages in the learning process. Studies involving more contemporary music have corroborated these conclusions, but have been limited to a singer (Ginsborg & Chaffin, 2009; 2011a, 2011b; 2012), and shared PCs (Ginsborg, et al., 2006; Ginsborg, et al., 2013).

As such, the *Oiseaux Exotiques* case study (Chapter 2) extended discussions on atonal memorisation to examine the techniques used by a pianist. Following the rigorous models of previous research, the study hypothesised that similar learning methods would arise. Analysis of verbal comments, annotated scores and the behavioural data obtained from practice sessions provide further evidence for the PC theory. The importance of the formal structure of the compositions was clear, with the pianist (myself) more likely to start practice segments at structural boundaries and the starts of phrases, and avoid stopping at these points. The conclusions argue that the formal structure of the cadenza was used as a hierarchical retrieval scheme, providing further confirmation of the importance of this domain for memory. Various types of PCs were established and practised at different learning stages, following a similar progression from basic dimensions to interpretative dimensions, and finally, expressive dimensions (Chaffin, et al., 2002; Chaffin, Lisboa, et al., 2009).

Further evidence regarding structural landmarks was demonstrated through played recall of the first six movements of Boulez's *douze notations* in chapter 5. This occurred at two points across a seven-year period. Probability of recall in the concise movements increased for structural points. The strongest evidence came from the 2015 recall of the sixth *notation*, which demonstrated how structural segments established in the initial learn (2008) served as landmarks for memory. Probability of recall decreased as serial distance from the landmark increased, supporting prior research (Chaffin, et al., 2002; Ginsborg & Chaffin, 2011a; Lisboa, et al., 2009).

A more significant conclusion in this analysis relates to the nature of the structural segments. Whilst these segments were thought of as structural, there was limited relation to the actual compositional structure of the complex, dodecaphonic movement. Whilst some segments corresponded to structural points, others were identified through more intuitive methods relating to other

musical features, such as beaming of rhythmic units, registral changes, and the movement of the hands. Further observational analysis illuminated this issue. In chapter 6, *Pianist C* articulated a similar practice strategy for chunking material in more abstract, practical manners. This included segmentation according to the systems in the score, before sectional practice was organised by a more intuitive sense of the musical dimensions of the piece. Indeed, a similar process was followed in my own learning of Wood's *Three Piano Pieces* (outlined in chapter 4). Given the truncated learning period, pages of the score were used initially to segment the piece, before more musical decisions were made to organise practice.

The evidence suggests that for extremely complex atonal structures, it is helpful for a musician to *think* in structural terms as a means of chunking musical material. These chunks then remain relatively stable as structural landmarks, despite their limited correspondence to the compositional structure. Further research testing recall of the most challenging atonal structures is needed to corroborate this conclusion. Additional longitudinal study would clarify this issue to a greater extent. However, the conclusions point to an interesting learning technique for structures that are very unfamiliar to even experienced musicians. The results provide intriguing broader insights – particularly for cognitive psychologists – into the development of hierarchical retrieval structures by highly skilled musicians, for the most complex and challenging music. The evidence suggests that a much broader range of musical dimensions form a hierarchical retrieval scheme when learning complex atonal compositions. Less familiar structures may require a musician to examine the whole arsenal of their kinaesthetic skills, combined with a similar process of cross-referencing of their domain-specific knowledge. Intuitive responses to the score, using this kinaesthetic and conceptual knowledge, thereby enable reasoned, informed decisions to be made, in order to organise practice and retrieval. These decisions may be thought of in structural terms for simplicity: however, a much wider range of musical features is represented.

The second aim of this thesis was to examine the specific strategies and techniques used to memorise atonal music. Previous research has dealt with larger-scale practice strategies, such as the benefits of practising hands separately or together (Brown, 1933), the use of visual, aural or kinaesthetic systems

(O'Brien, 1943), music analysis (Rubin-Rabson, 1937), whole or part strategies (Brown, 1928; Rubin-Rabson 1940) and visualising the score (Gieseking & Leimer, 1978). Anecdotal evidence from professional pianists has also provided a different angle to the discussion (Benser, 2012; Brower, 1926; Cooke, 1948; 1999/1917; Dubal, 1997; Elder, 1986; Horowitz, 1982; Noyle 1987; Portugheis, 1993; 1996; Rosen, 2002; Wallick, 2013). Of particular note are two studies analysing techniques in relation to musical examples: that of blocking chords (Nellons, 1974), and the musical mnemonics (MMs) developed by Li (2007; 2010). Whilst both primarily examine tonal music, the studies provide examples of advanced assimilation techniques. However, the limited analysis of these studies failed to examine the wider application of the methods, both within the context of a single composition, and across a wide variety of repertoire.

This thesis sought to address this question. Chapters 3 and 4 analysed in great detail my own encoding techniques in a wide variety of repertoire across the twentieth and twenty-first centuries. The research methodology employed in these chapters straddled performance practice research and artistic research (Doğantan-Dack, 2012; Haseman, 2006). As such, the role of the practitioner is fundamental to the research method, with more intuitive experienced-based conclusions providing insights that are of interest to musicians and psychologists alike. Analysis initially displayed similar methods to previous research that were localised to particular passages in respective compositions. In particular, cues relating to tonal allusions, voice leading, verbal association, and rhythmic groupings usually related to specific passages in the score. Whilst these were helpful to encode the particular passage in question, the cues did not function contextually.

However, the most significant conclusions from the analysis relate to intervallic and hand-shape cues, and the derived cueing procedure based on these two features, which I have labelled sonic-resonance cueing. Perhaps the strongest cue-type in the analysis is that based on intervals. As the use of domain-specific knowledge is severely reduced for atonal compositions, the use of smaller patterns within a musician's lexicon seems a natural progression. The intervallic cueing method fulfils this function, as the knowledge of intervals is taught from an early age in music theory. The *Oiseaux Exotiques* analysis demonstrated that a hierarchical use of particular intervals (sevenths and tritones) was evident from

the score, and extended practice of the cadenza allowed for an intuitive discovery of the motivic and structural connections based on these intervals. The ability to form such a connection in motivic patterns has previously been described as fundamental to effective memory (Cook, 1989; Sloboda, 1985).

The significance of this method was revealed through further analysis of Messiaen's compositions, demonstrating how the cue was transferred identically to a much larger pool of repertoire spanning over thirty years. Examination of repertoire from a wider range of composers in the fourth chapter further demonstrated the strength of the intervallic cue, illustrating how it could be transformed to suit the compositional techniques employed by a particular composer. Whilst the hierarchy of intervals may change from piece to piece, or from composer to composer, the analysis argues that the intervallic cue formed a fairly reliable and robust method for finding patterns in a work and thereby allowing effective memorisation.

The physical importance of hand-shape cues, and their aural component (sonic-resonance cues) provided similar evidence of effective transferral and transformation across repertoire. Given the strong relationship to intervallic cueing, the grouping of these three cueing methods provides a strong basis for effective memorisation. This is based on familiarising the content of a composition into kinaesthetic, conceptual and aural patterns that can be used to create a system of cross-reference. In turn, this functions as a replacement for traditional harmonic schemas and patterns. The analysis displays an interesting and unusual interaction between the performer and composer, whereby the performer analyses the compositional techniques of the composer (often during practice whilst at the instrument) to derive a greater understanding of the processes and techniques involved in the piece. This understanding then forms the basis of the techniques used to memorise the work.

The study in chapter 6 broadened the discussion to investigate the strategies used by other pianists. As such, this chapter provides a comparison with my own techniques. The analysis demonstrated that musicians used some distinct techniques, agreeing with previous assertions (Aiello, 2000a; Hallam, 1995a). Of particular interest is the unusual use of synaesthesia as a powerful memorisation tool, even if these methods are limited to synaesthetes. Similarly, there were minor variations in practice strategies, relating to use of the score,

segmentation, and whether practice involved hands separately or together. Nevertheless, there were significant similarities in memorisation techniques amongst the participants. These strongly corroborate my own techniques and thereby add a further validation of the methods of analysis used earlier in the thesis. All three pianists employed hand-shape and intervallic cues, whilst sonic resonance cues and verbal association techniques were also employed.

The study further suggests that musicians employ conceptual and kinaesthetic patterns to a greater extent in atonal music. This compensates for the removal of the systematic patterns of harmony. Given the limited sample of participants in the chapter, some caution is needed in applying these conclusions. As the study involved small sections of repertoire, it is not possible to evaluate how the pianists applied cueing techniques on a wider level within the respective compositions. Future research would benefit from extending the study to involve a greater number of pianists, covering the totality of a score. In addition, research would benefit from evaluation of a wider range of instrumentalists. Further longitudinal case studies of atonal memory technique, coupled with retrospective analysis of cueing procedures across practice stages would further illuminate the manner in which experienced musicians replace and transform their existing domain-specific knowledge for atonal music.

The insights of this analysis have broad implications for performing musicians. Memorisation is a fundamental skill in the performance of Western Art Music. The analysis provides compelling evidence of the effectiveness of the strategies involved in learning atonal music. Furthermore, it is likely that such strategies would prove extremely beneficial for musicians learning other instruments, and for a much wider variety of repertoire, including compositions from all eras. Further deduction from these strategies may even provide insights for expert memory in other domains.

The third and final aim of the thesis was to evaluate long-term changes when reconstructing a piece over a span of several years. Recent research refining PC theory has examined the stability and variation of PCs across repeated performances (Chaffin, et al., 2013; Lisboa, et al., 2013), and the role of spontaneous thoughts during performance within the PC context (Ginsborg & Chaffin, 2011b; Ginsborg, et al., 2012). As music is essentially a creative act (Clarke 1995; Neuhaus, 1973; Chaffin, et al., 2006), these studies have sought to

redress the implications that PC theory engenders a rigid set of cues that result in replication during performance. The findings demonstrate that the PC model is flexible in its application, allowing for a range of different thoughts to occur on stage and guide performance.

Chapter 5 provides an alternative discussion on repeated reconstruction of a piece, through the analysis of three recordings of Boulez's *douze notations* over a seven-year period. Consequently, the analysis provides further insight into the nature of PCs in a longitudinal timeframe. As discussed, previous studies have largely focussed on stability, variation, or thoughts outside PCs to examine spontaneous thoughts. The analysis in this study analyses the nature of executing the PCs themselves, further elucidating the creative act of performance. As such, the study aims to "bring to life what is physically involved in making music and what this entails for musicology" (Doğantan-Dack, 2011, p. 260). The focus is primarily on interpretative issues, demonstrating the change in expressivity that occurs in performance, after repeated re-approach to a composition and re-establishing PCs.

In particular, it provides a method that allows a performer a greater understanding the physical and aural processes involved during performance. Moreover, it demonstrates the flexibility and variation in executing particular cues related to certain musical features that occurs in different performances. This type of research has important didactic implications for performers and would benefit from future study. The detail provided by spectrograms surpasses what can be heard by ear. As such, the analysis allows for detailed visual examination of the acoustic realisation of a performance. Alongside the more common technique of retrospective listening to a performance, the analysis would prove invaluable to performers seeking to develop the execution of interpretative and expressive dimensions across performances. Further discussion of the experience of performance would provide insights to practitioners, and further illuminate the creative process of performance.

The methods used in the thesis have centred on self-analysis, straddling practice-based and artistic research. The benefits of this type of research allow for comprehensive analysis of working strategies. However, psychologists tend to be skeptical of such methods as it easy to draw mistaken conclusions (Chalmers, 1990; 1996; Dennett, 1991; Nisbett & Wilson, 1977). Three elements

in the thesis sought to mitigate these dangers. First, longitudinal study of the *Oiseaux Exotiques* cadenza used objective behavioural data collected from practice sessions to contrast with self-reflection of verbal comments. Previous studies have integrated a cognitive psychologist into the research procedure. This is of course not possible in a single-author thesis. Comparison of the results to existing literature validated the conclusions formed in the study.

Secondly, the initial analysis of my own memory techniques used retrospective analysis of annotated scores from this longitudinal study. As such, the rigorous methods of prior case study sought to confirm that my own experience-based conclusions were supported factually as well as intuitively. The analysis of behavioural data taken from video-recorded practice sessions documents that the memorisation techniques discussed were largely assimilated into motor control as with previous studies of tonal music. The final mitigation involved broadening the discussion to involve three other pianists to examine similarities and differences in memorisation techniques to further reinforce my own theories. Whilst some caution is needed, given the small sample size of participants in the study, the findings strongly correlated with my own memorisation techniques. Consequently, I am confident that the analysis in the thesis is applicable in a broader context.

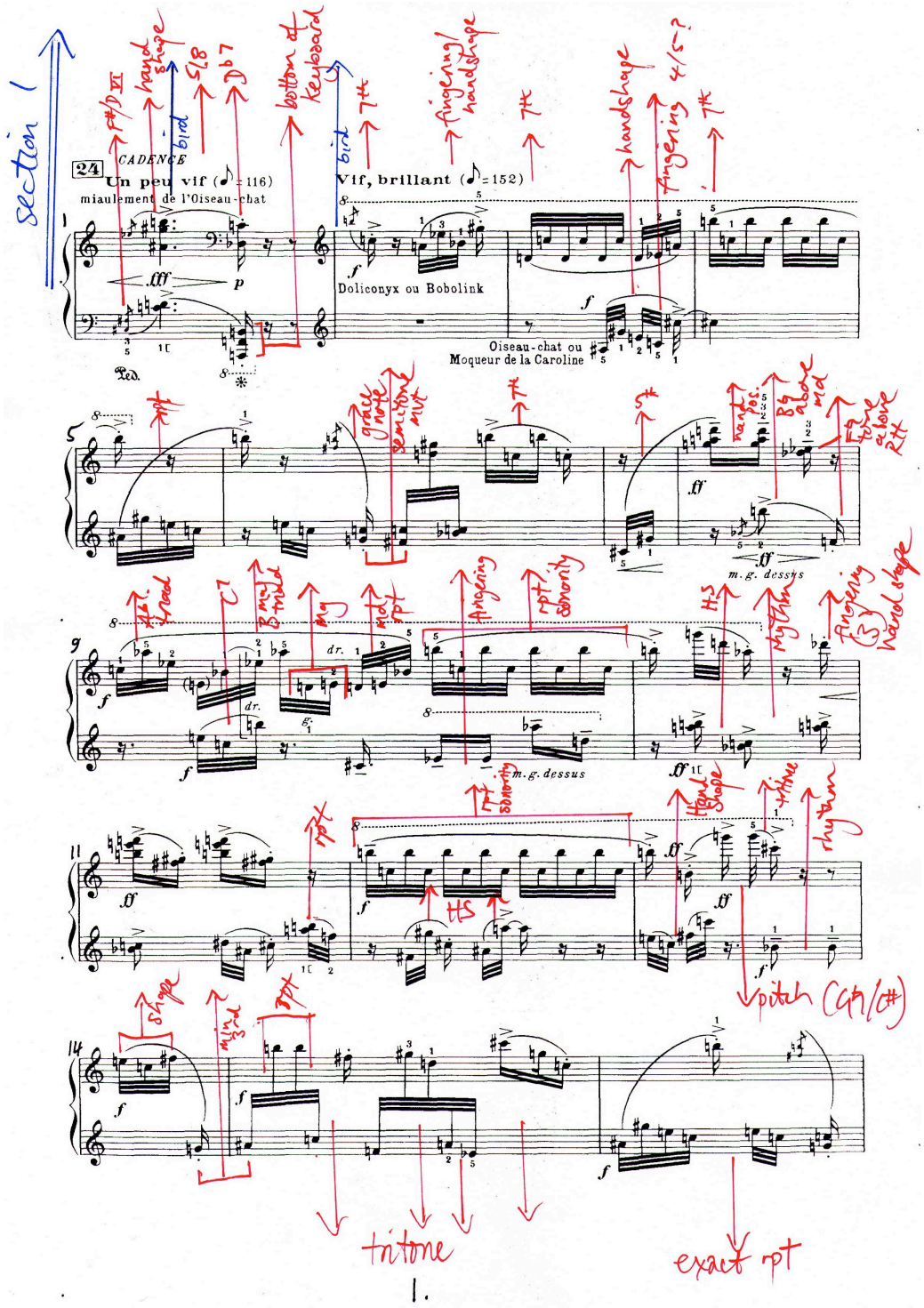
A final broader implication arises from the argument in this thesis. Whilst a number of practical guides for memorisation have been produced (see, for example: Ginsborg, 2004; Goodrich, 1906), specific analysis of memory techniques for musicians remains under researched. Indeed, it is astonishing that higher education institutions focussing on musical performance largely omit the teaching of memory in the course curricula. As such, the analysis in this thesis has much wider implications in an educational context. Performance anxiety is prevalent among musicians (Fishbein, Middelstadt, Ottati, Strauss, & Ellis, 1988; Valentine 2002) but improves with age (Wolfe, 1989). A substantial element of this condition is related to memory, as evidenced by the numerous references to the fear of forgetting by established musicians (Hough, 2011; Noyle, 1987). More recent research has begun to investigate the didactic possibilities regarding memory (Foletto, Carvalho, & Coimbra, 2013).

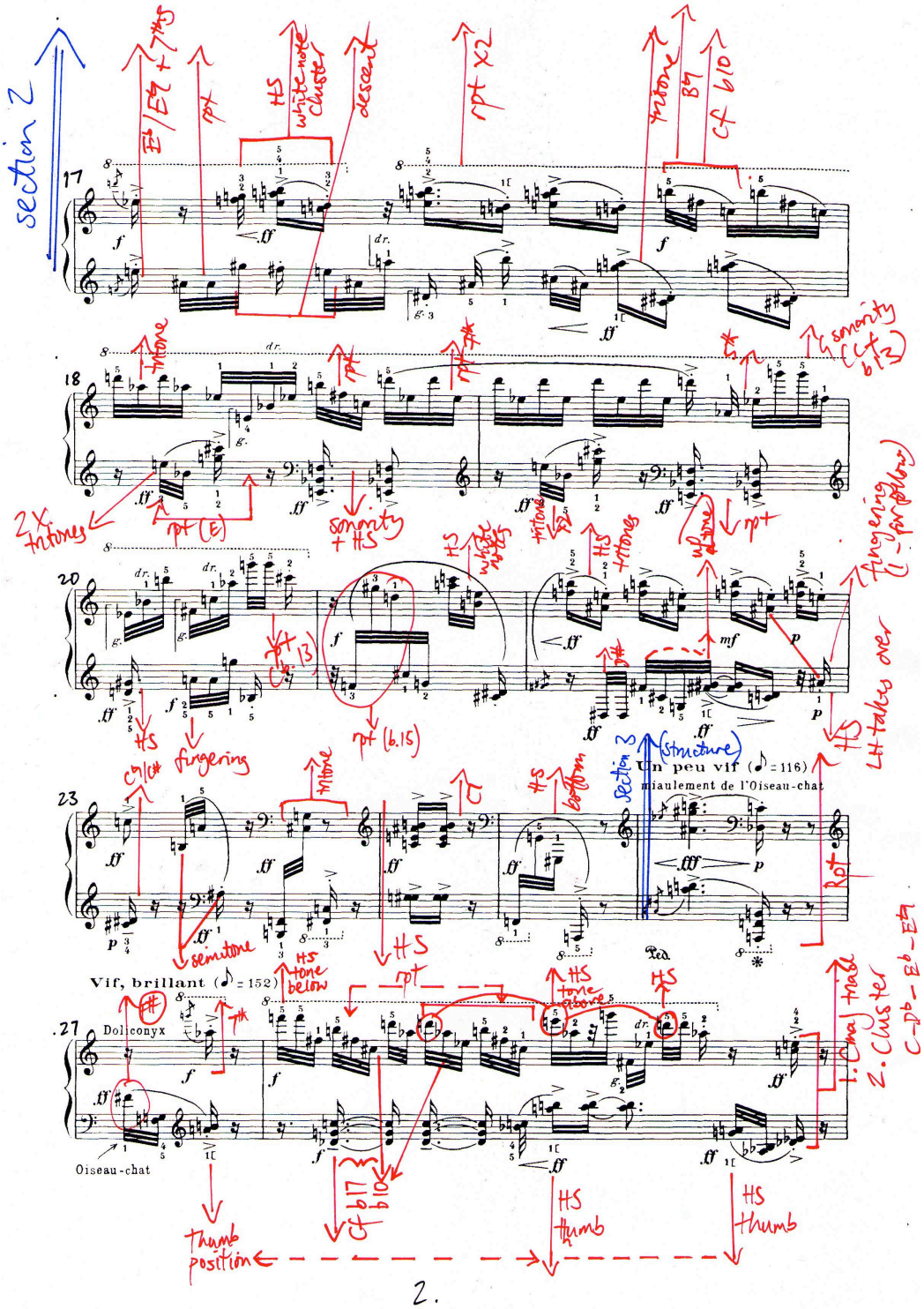
Research has also suggested that young performers – whilst aware of a range of memorisation strategies – tend to revert to familiar techniques based on

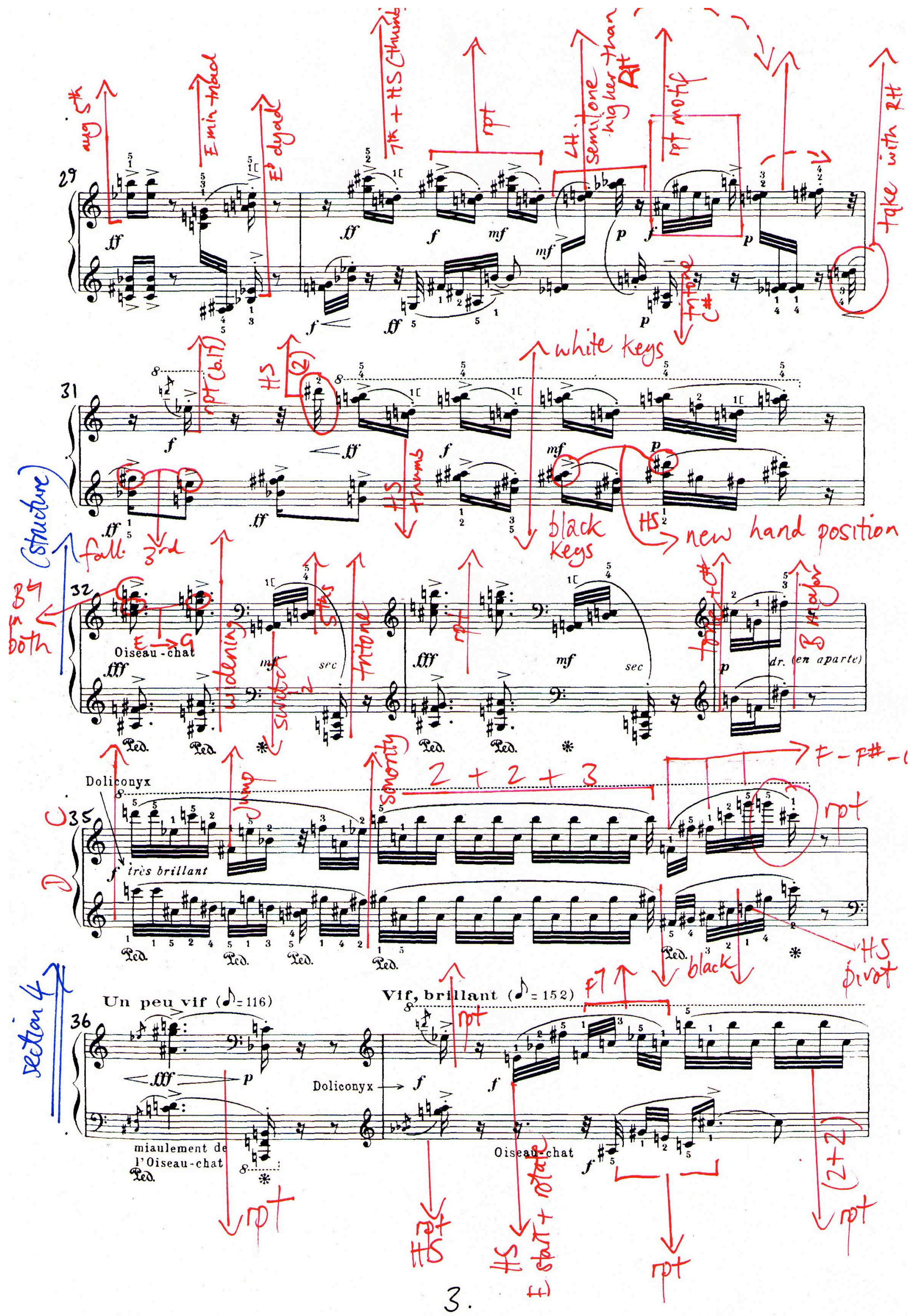
memorisation by rote (Davidson-Kelly, Moran, & Overy, 2012). The techniques and findings in this thesis provide great scope to establish more formal and integrated institutional teaching of memory procedure, which merit the same attention and focus placed on technical proficiency, musical theory, aural skills, and sight-reading. Redressing the current imbalance in the curricula of performance institutions would prove immensely beneficial to young musicians. This would serve to reduce long-term stress and performance anxiety, and to promote enjoyment in music making through the development of further techniques in the practice room. This would further illuminate the ultimate aim of spontaneous, creative performance.

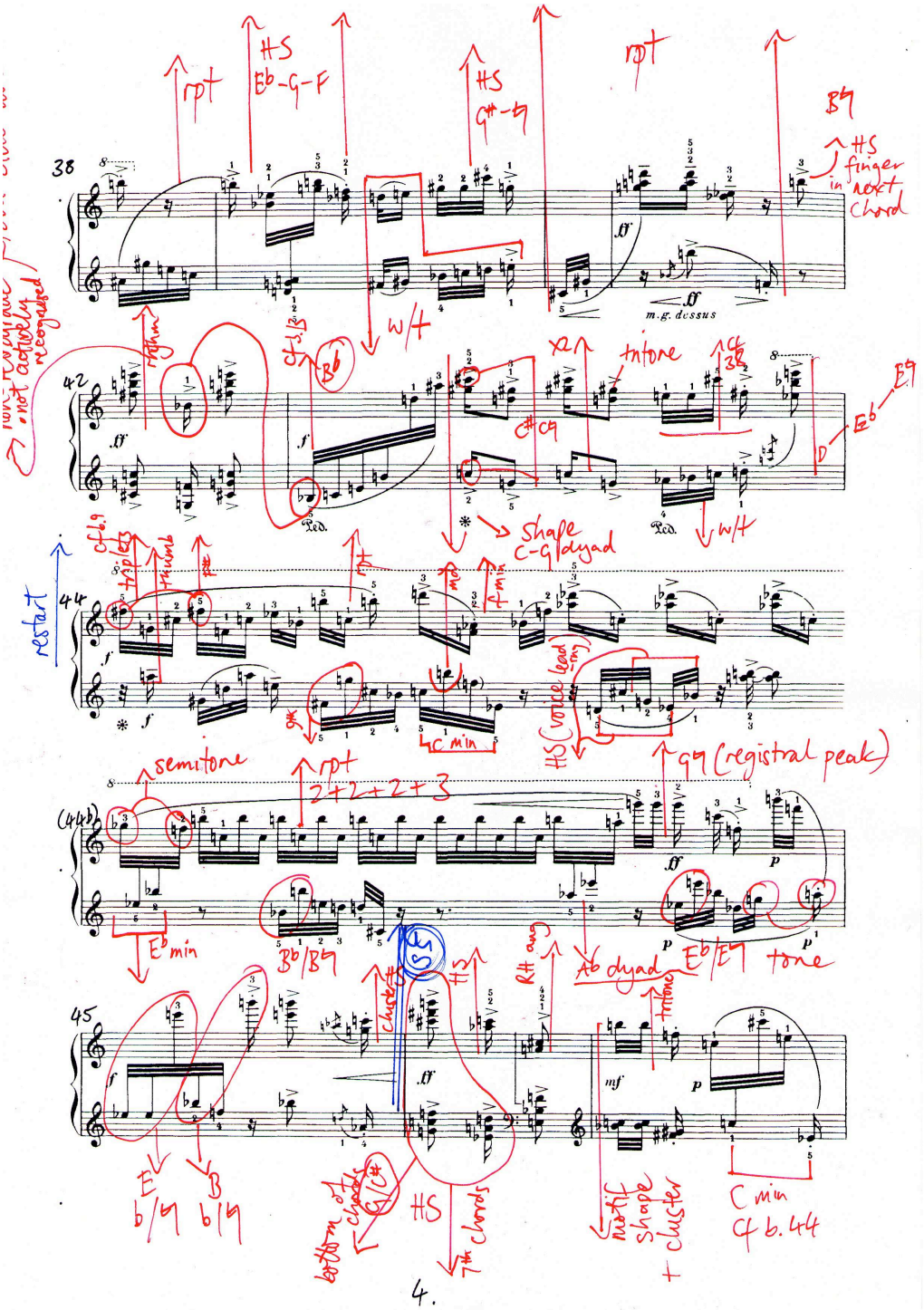
APPENDIX 1
MESSIAEN OISEAUX EXOTIQUES ANNOTATED

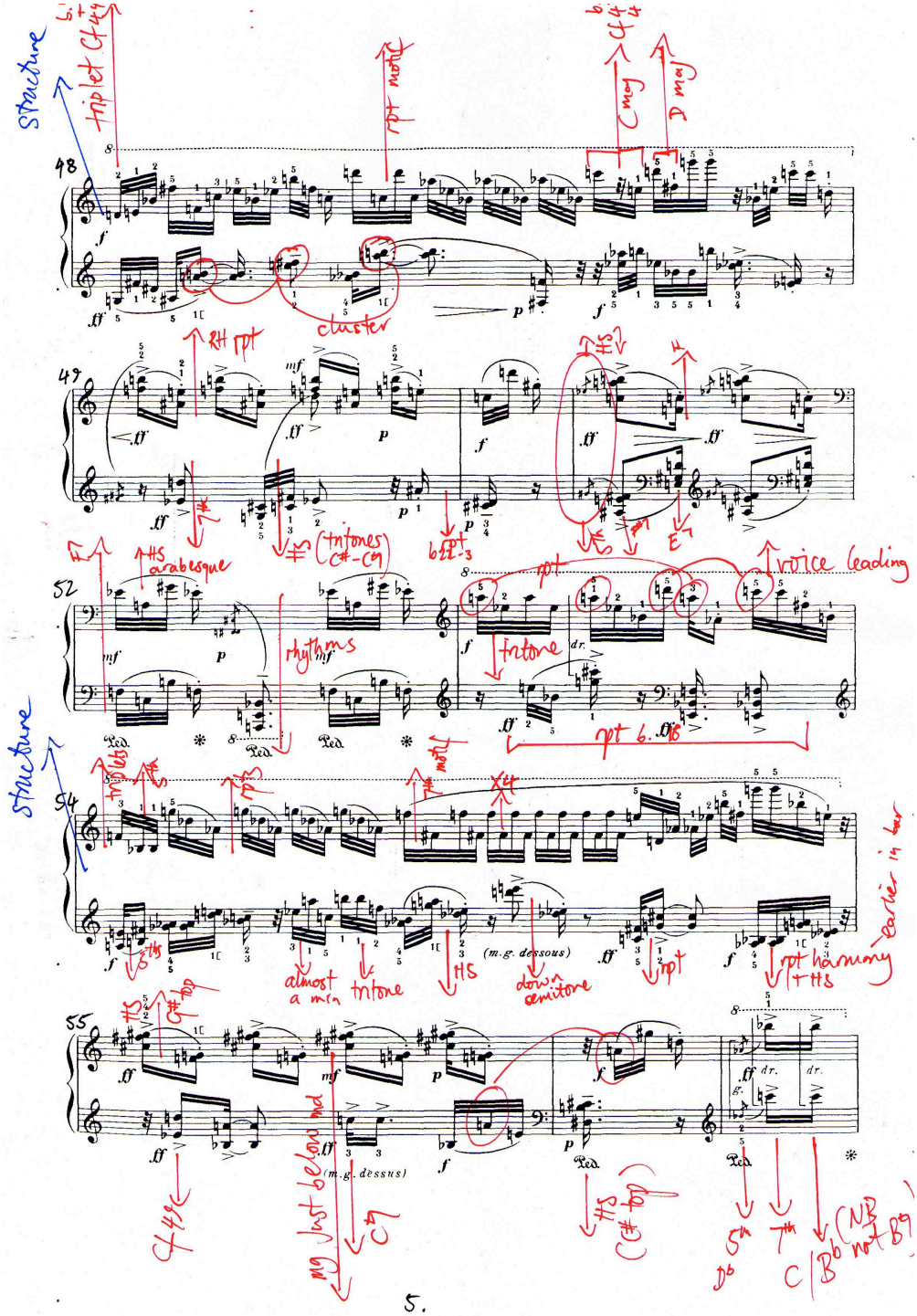
SCORE 1

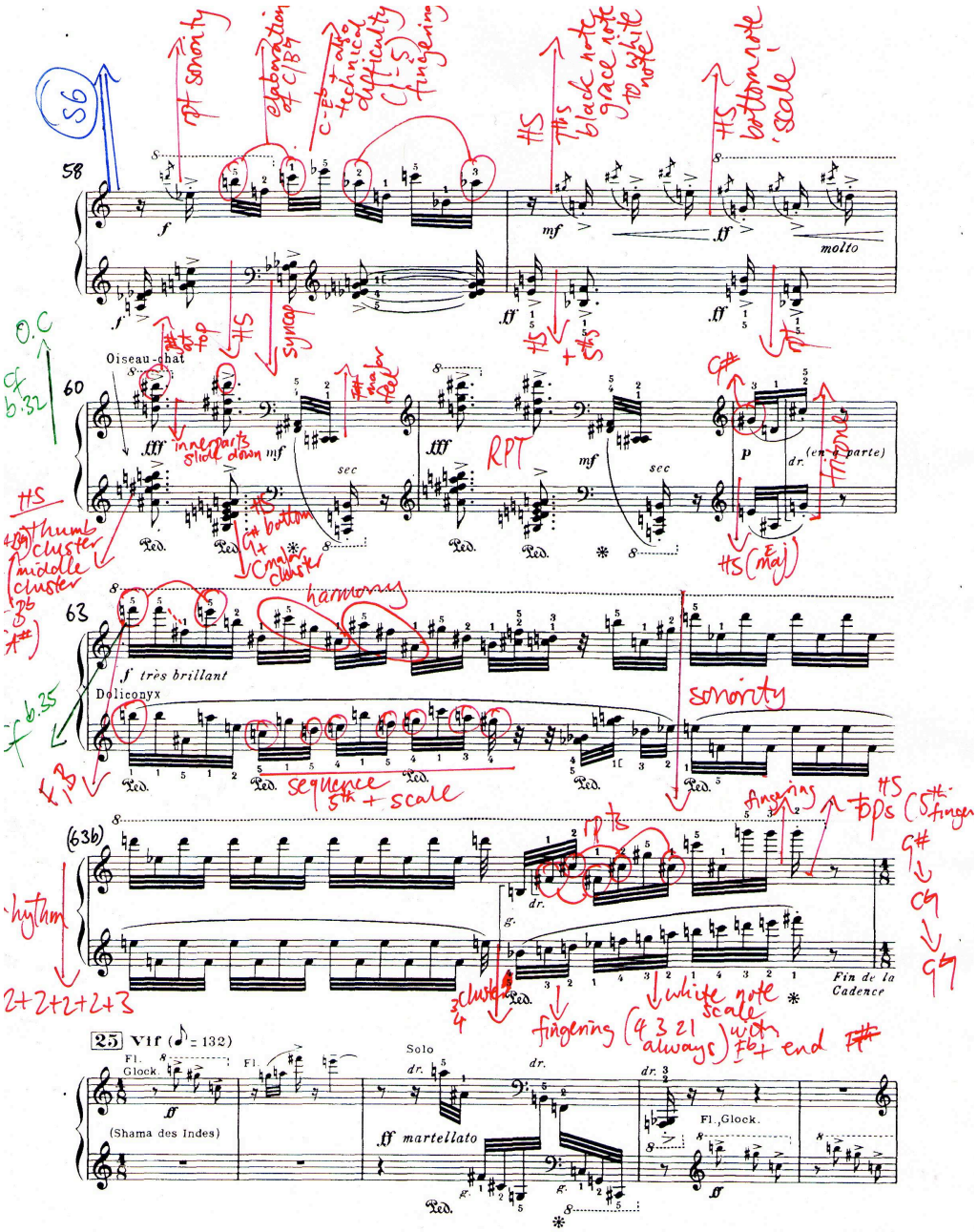



section 2
17
18
20
23
27
Vif, brillant (♪ = 152)
Dolconyx
Oiseau-chat
Un peu vif (♪ = 116)
miaulement de l'Oiseau-chat
Thumb position
HS thumb
HS thumb
2.


Oiseau-chat
sec
dr. (en aparte)
Doliconyx
très brillant
Un peu vif (♪ = 116)
Vif, brillant (♪ = 152)
Doliconyx →
miaulement de l'Oiseau-chat
Oiseau-chat
white keys
black keys
new hand position
take with RH
2 + 2 + 3
section 4
3.

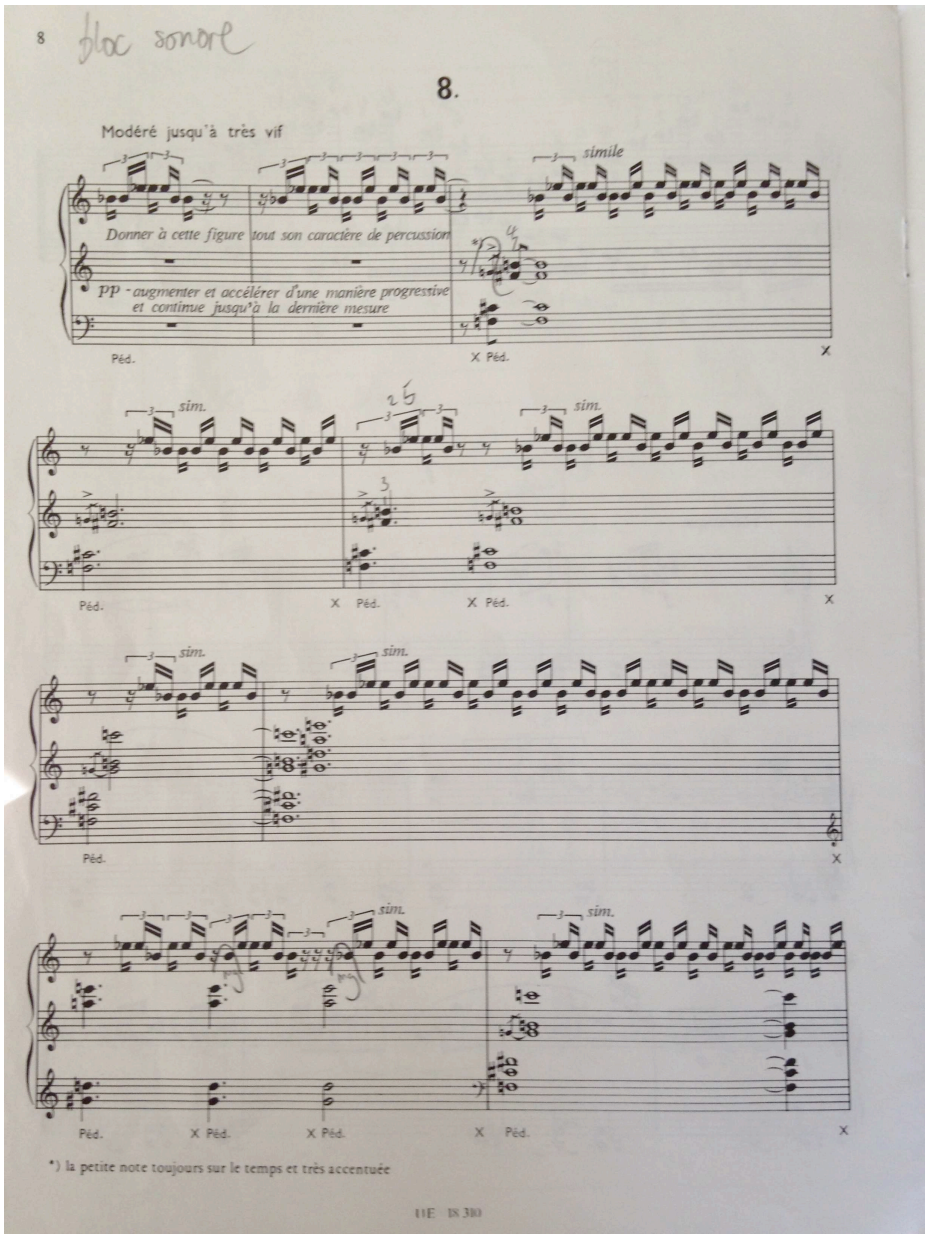

rpt
#5
Eb-G-F
#5
G#-B
rpt
B
#5 finger in next chord
38
ff
m.g. dessus
w/t
42
ff
f
Ped.
Ped.
tritone
x2
C#-G
Eb
E
D
Shape C-G dyad
w/t
restart
44
f
triplets
rpt
mf
f
#5 (voice lead into)
C min
semitone
rpt 2+2+2+3
(4+4)
ff
p
G (registral peak)
Eb min
Bb/B
#5
cluster
#5
A# aug
Ab dyad
Eb/E
tone
45
f
ff
mf
p
tritone
E
b/B
b/B
bottom of chords G/C#
#5
7th chords
motif shape + cluster
C min
4 b. 44
4.

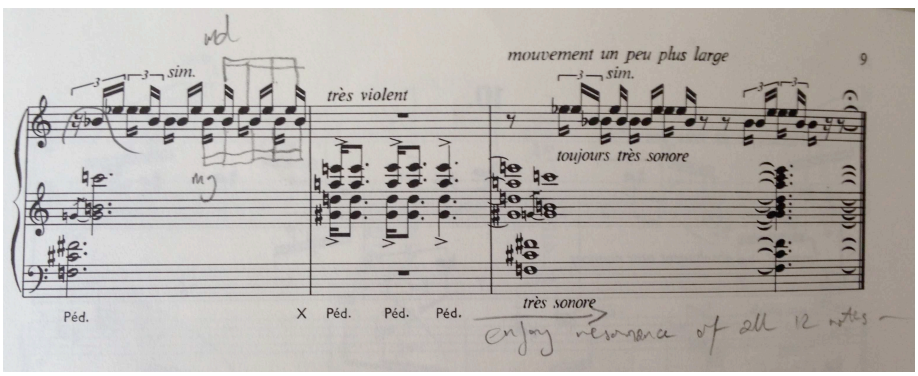

Structure
triplet
rpt motif
C maj
D maj
48
cluster
49
RH rpt
HS (tritones C#-G)
52
arabesque
rhythms
tritone
voice leading
rpt 6.
Structure
54
triplets
rpt motif
almost a min
tritone
HS
(m.g. dessous)
down a tritone
rpt
harmony
earlier in bar
55
(m.g. dessus)
HS (C# top)
Db
C
Bb (NB not B♮)


58
60
63
(63b)
Oiseau-chat
Doliconyx
très brillant
molto
RPT
harmonics
sonority
sequence
5th + scale
rhythm
2+2+2+3
Fin de la Cadence
25 Vif (♪ = 132)
Fl.
Glock
(Shama des Indes)
Solo
martellato
Fl., Glock.

APPENDIX 2

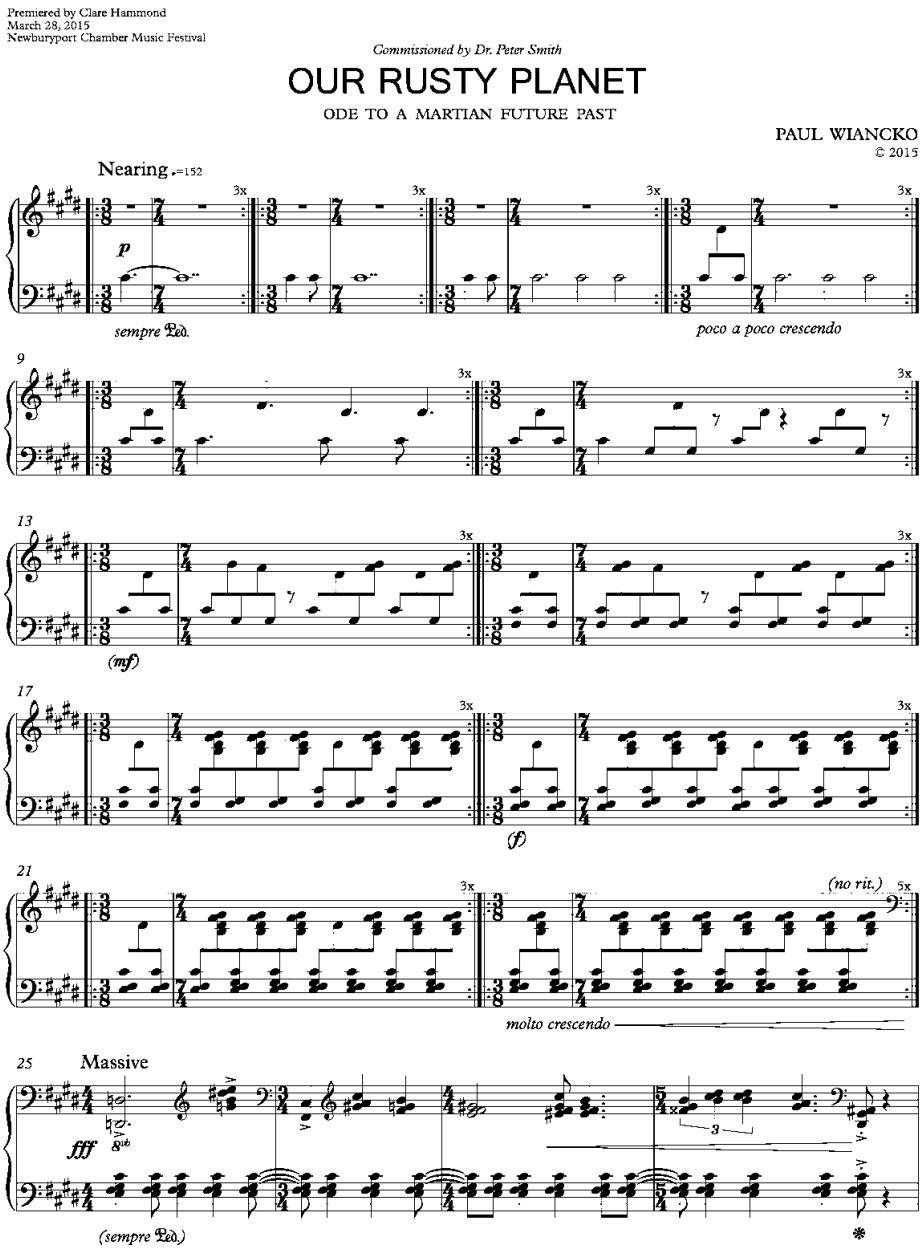
BOULEZ NOTATION 10

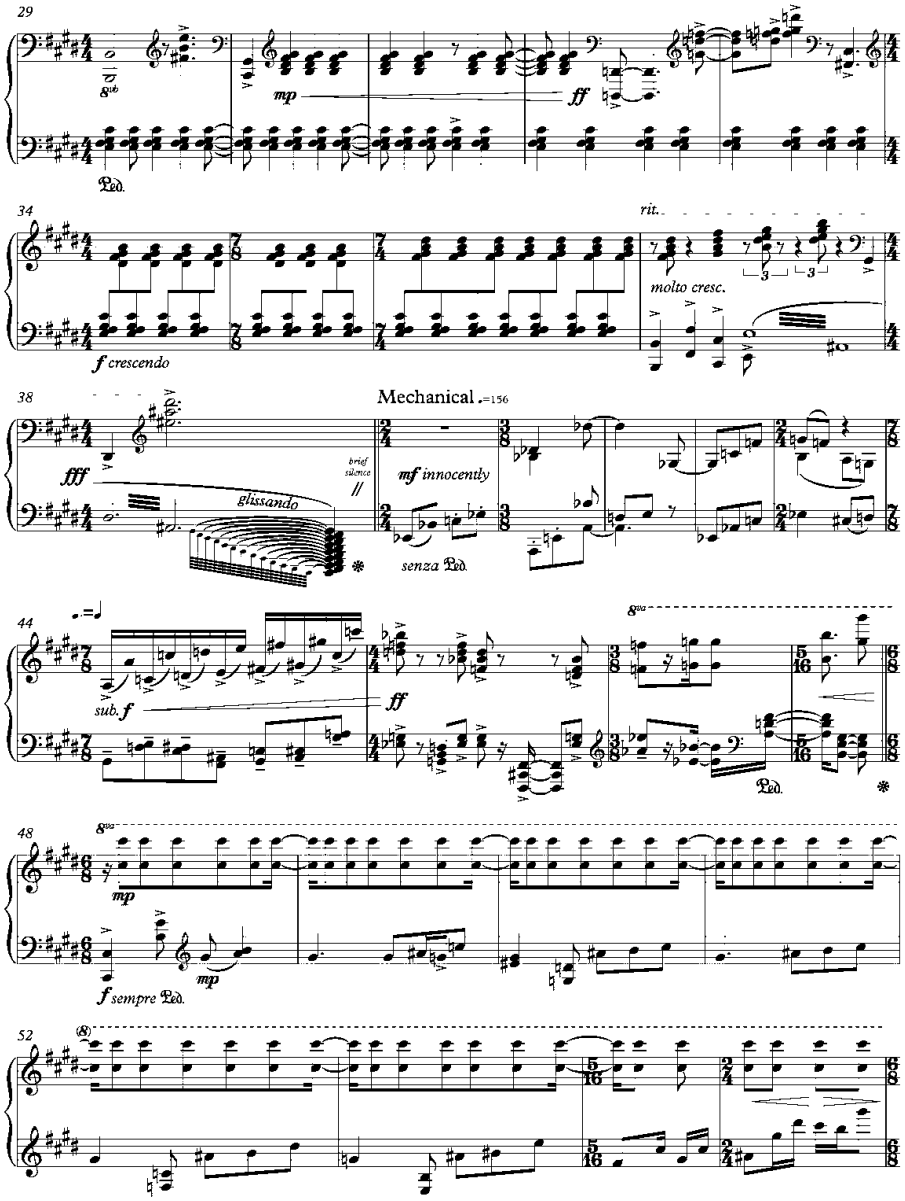




APPENDIX 3

PAUL WIANCKO *OUR RUSTY PLANET* (pp. 1-2)

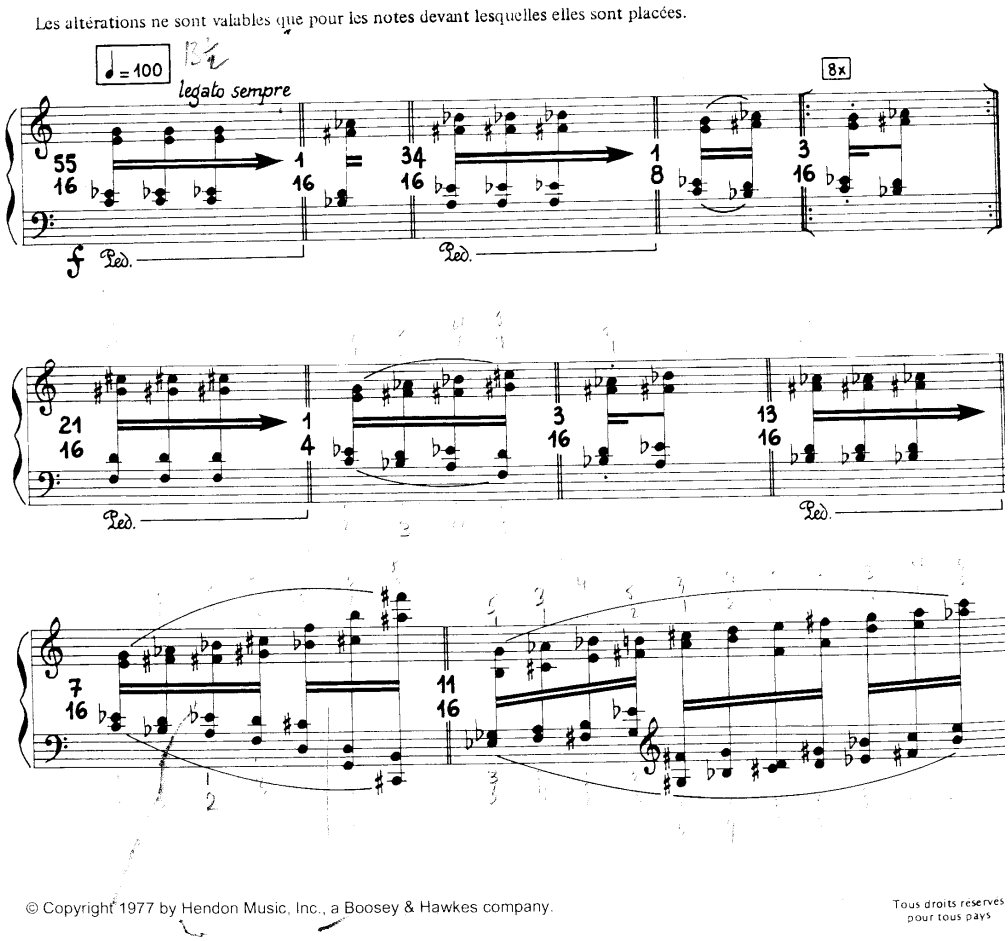


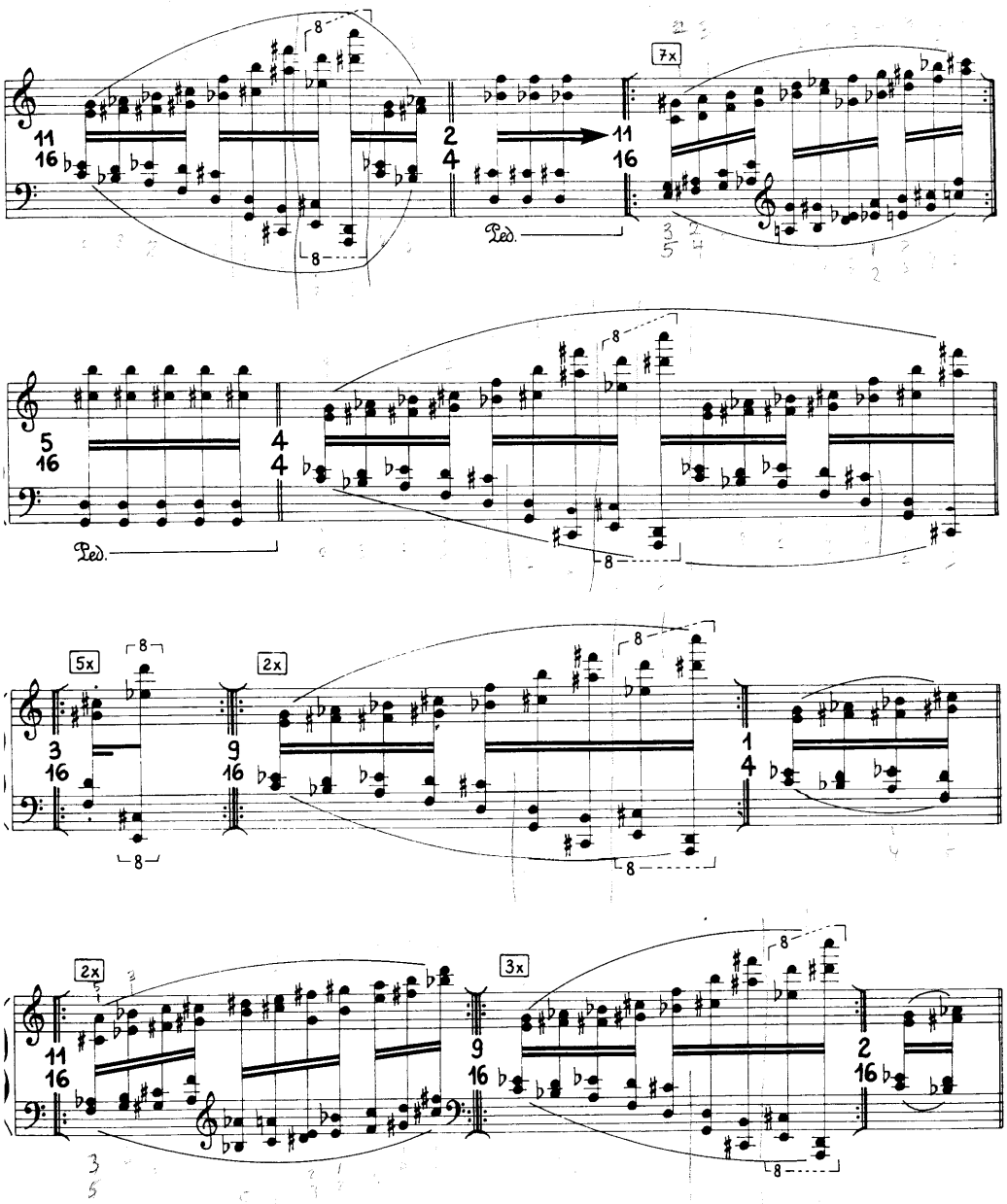

29
8vb
mp
ff
Ped.
34
rit.
molto cresc.
f crescendo
38
Mechanical ♩=156
fff
brief silence
glissando
mf innocently
senza Ped.
44
sub.f
ff
8va
Ped.
48
8va
mp
mp
f sempre Ped.
52
8va

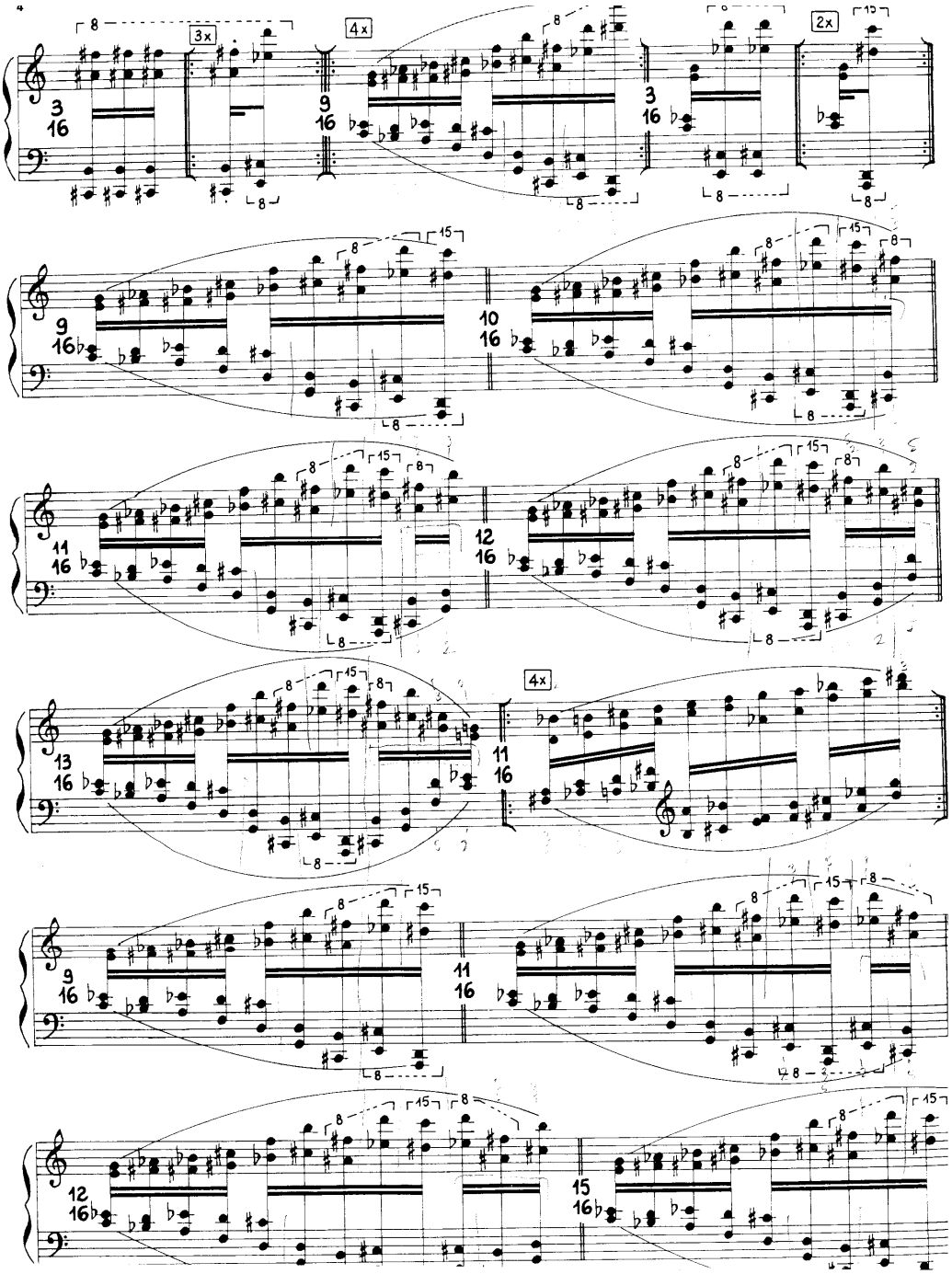
SHIRAZ

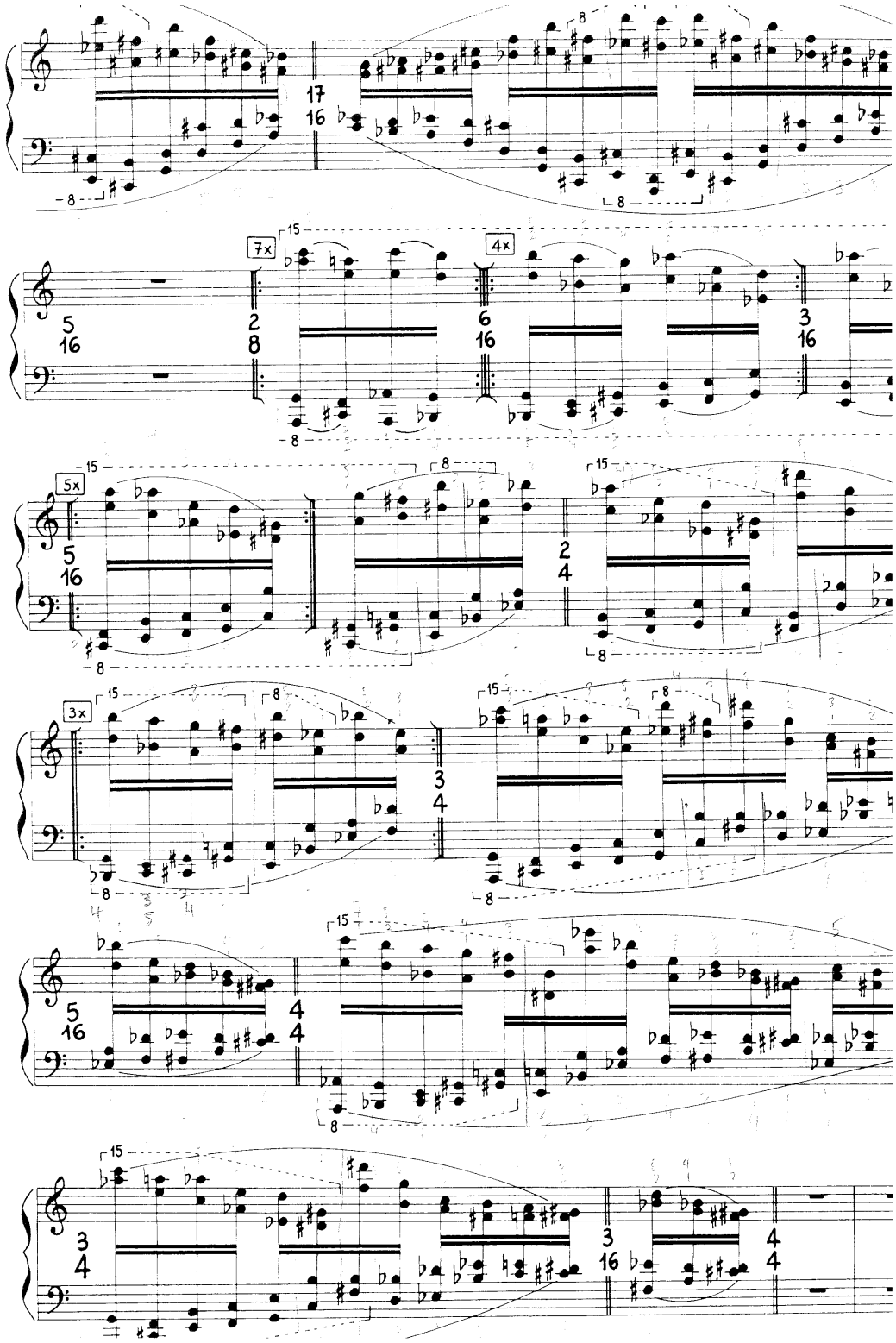
pour piano

Claude VIVIER




11
16
2
4
7x
Ped.
5
16
4
4
Ped.
5x
2x
3
16
9
16
1
4
2x
3x
11
16
9
16
2
16

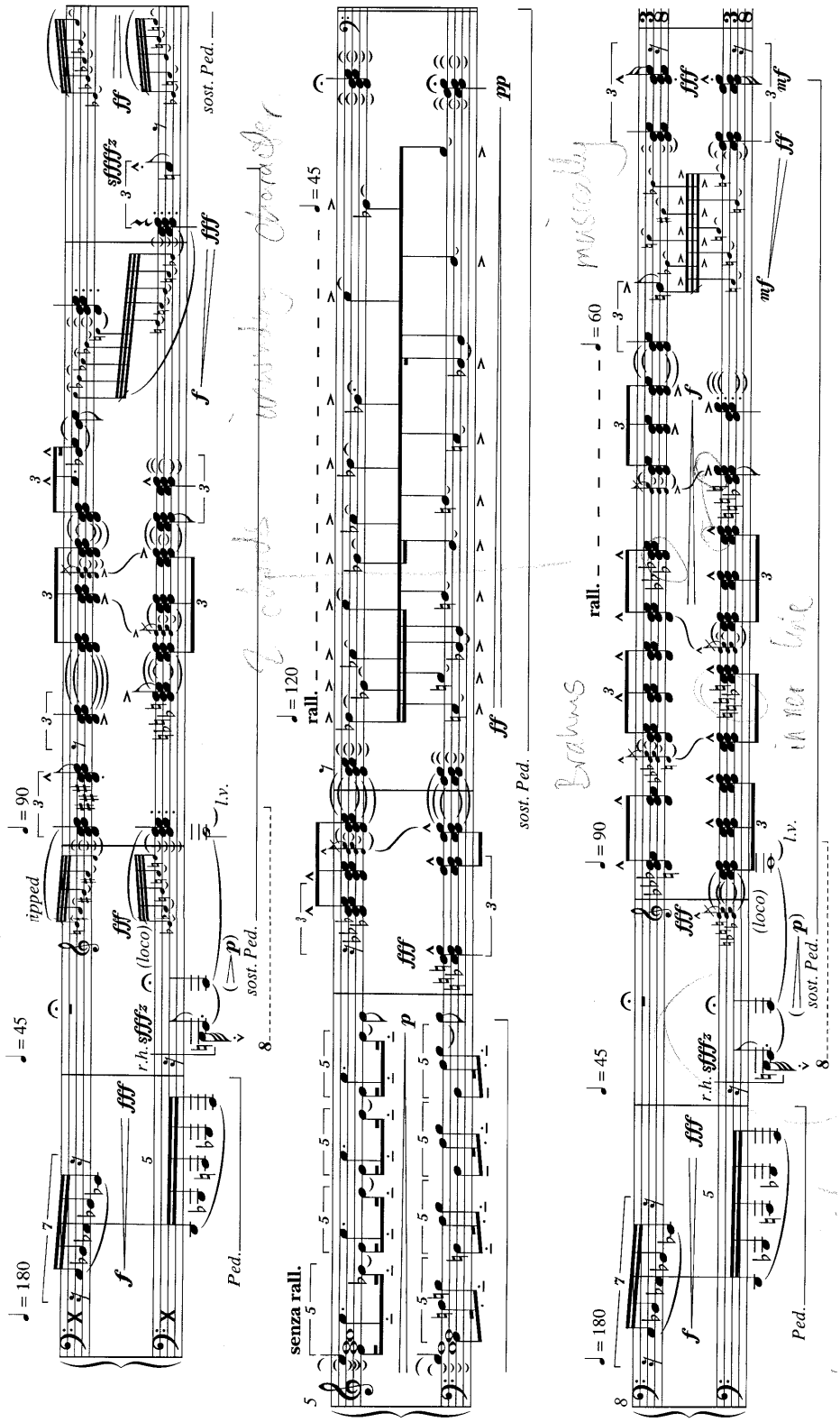

3x
4x
2x
4x

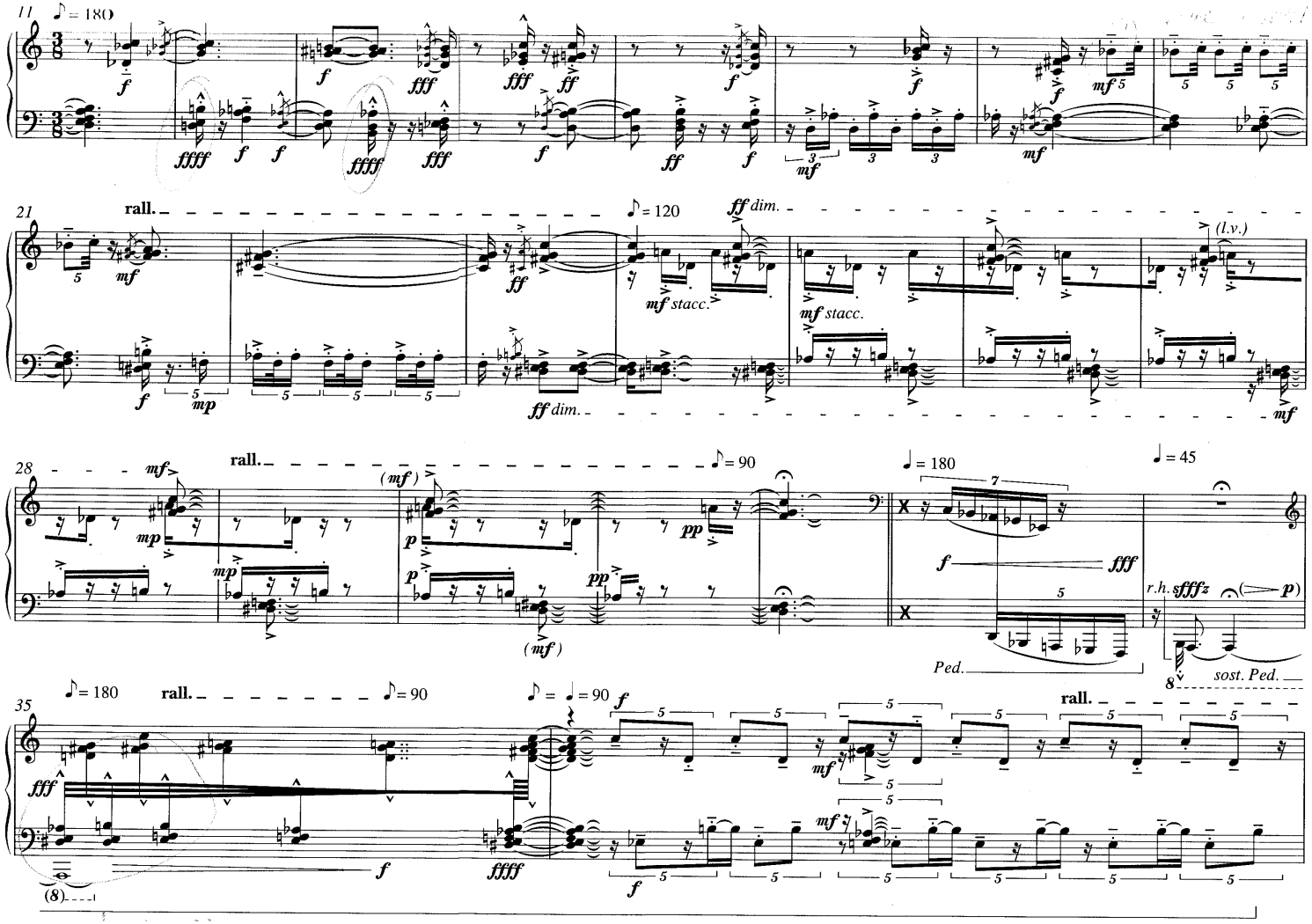

17
16
7x
4x
5
16
2
8
6
16
3
16
5x
5
16
2
4
3x
3
4
5
16
4
4
3
4
3
16
4
4

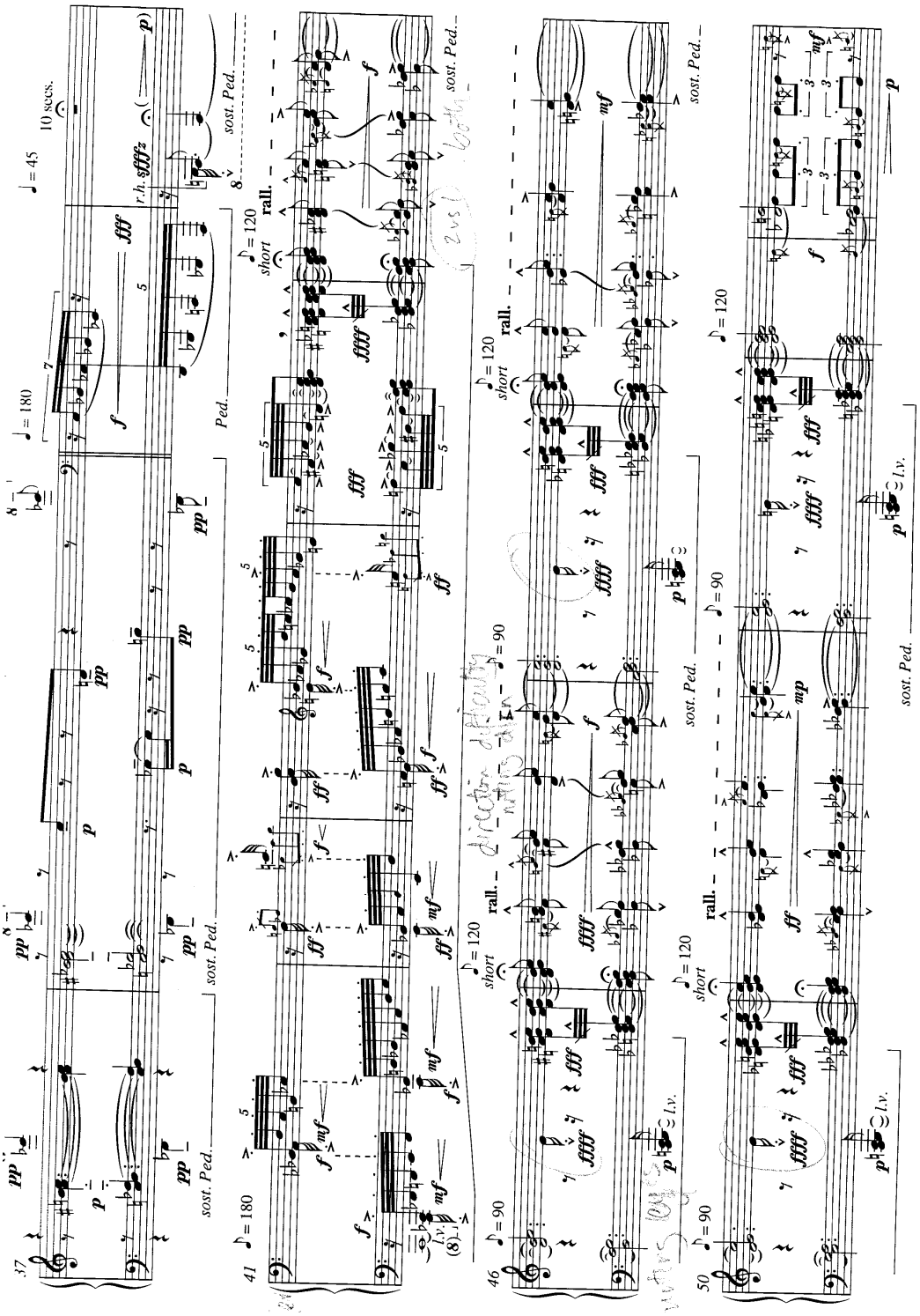
HARRISON BIRTWISTLE *HARRISON'S CLOCKS*

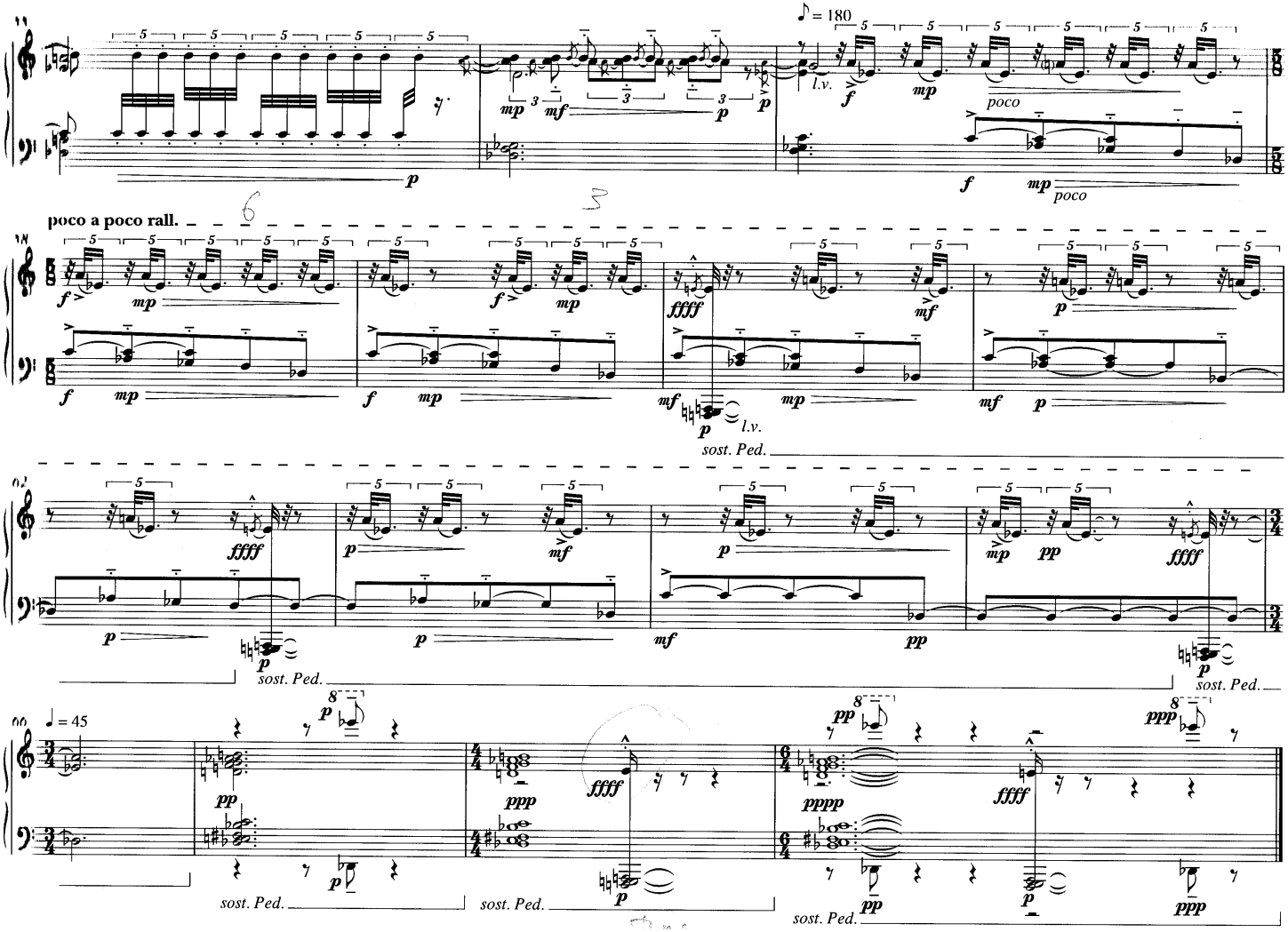
MOVEMENTS IV & V.

IV

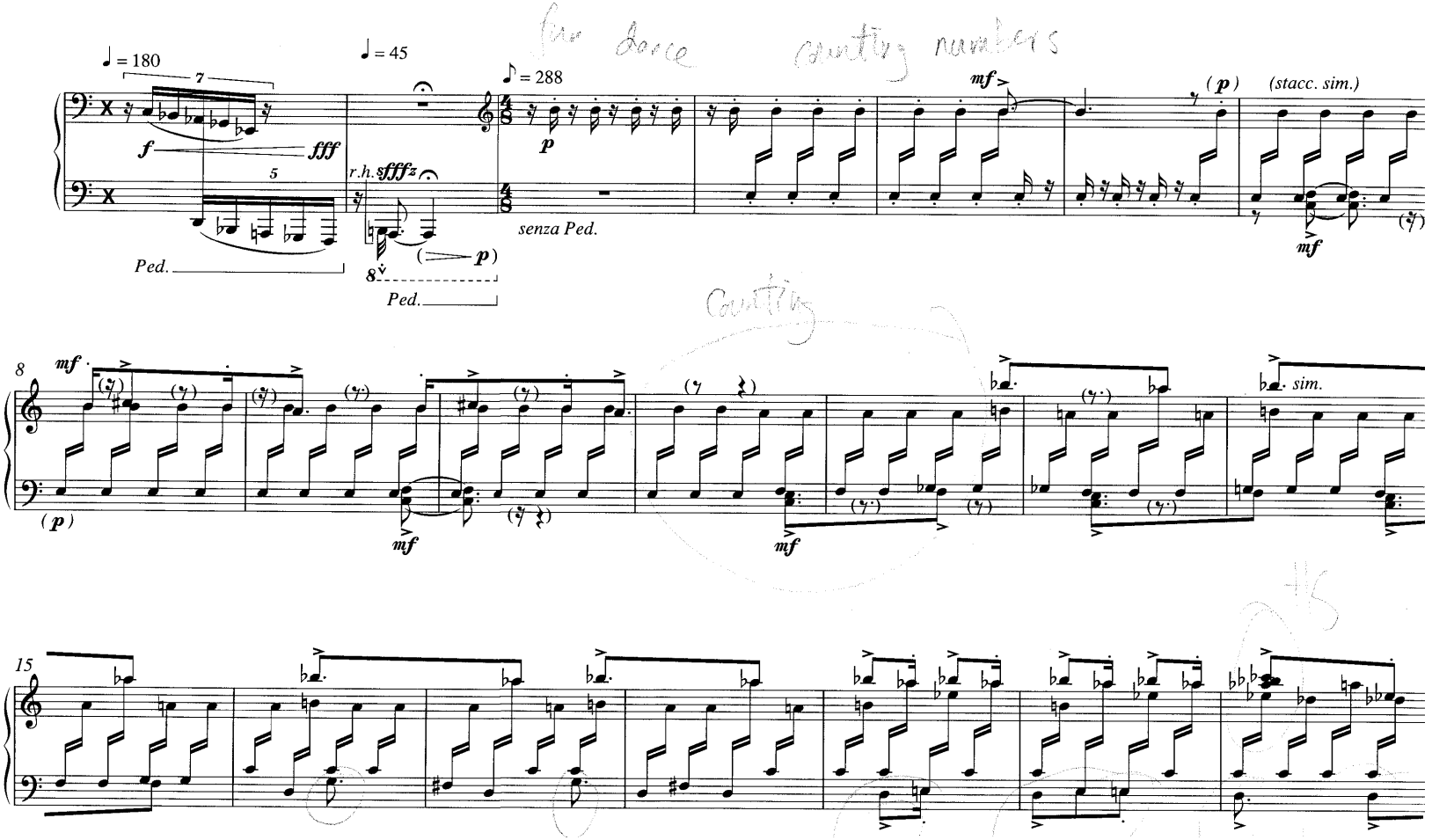


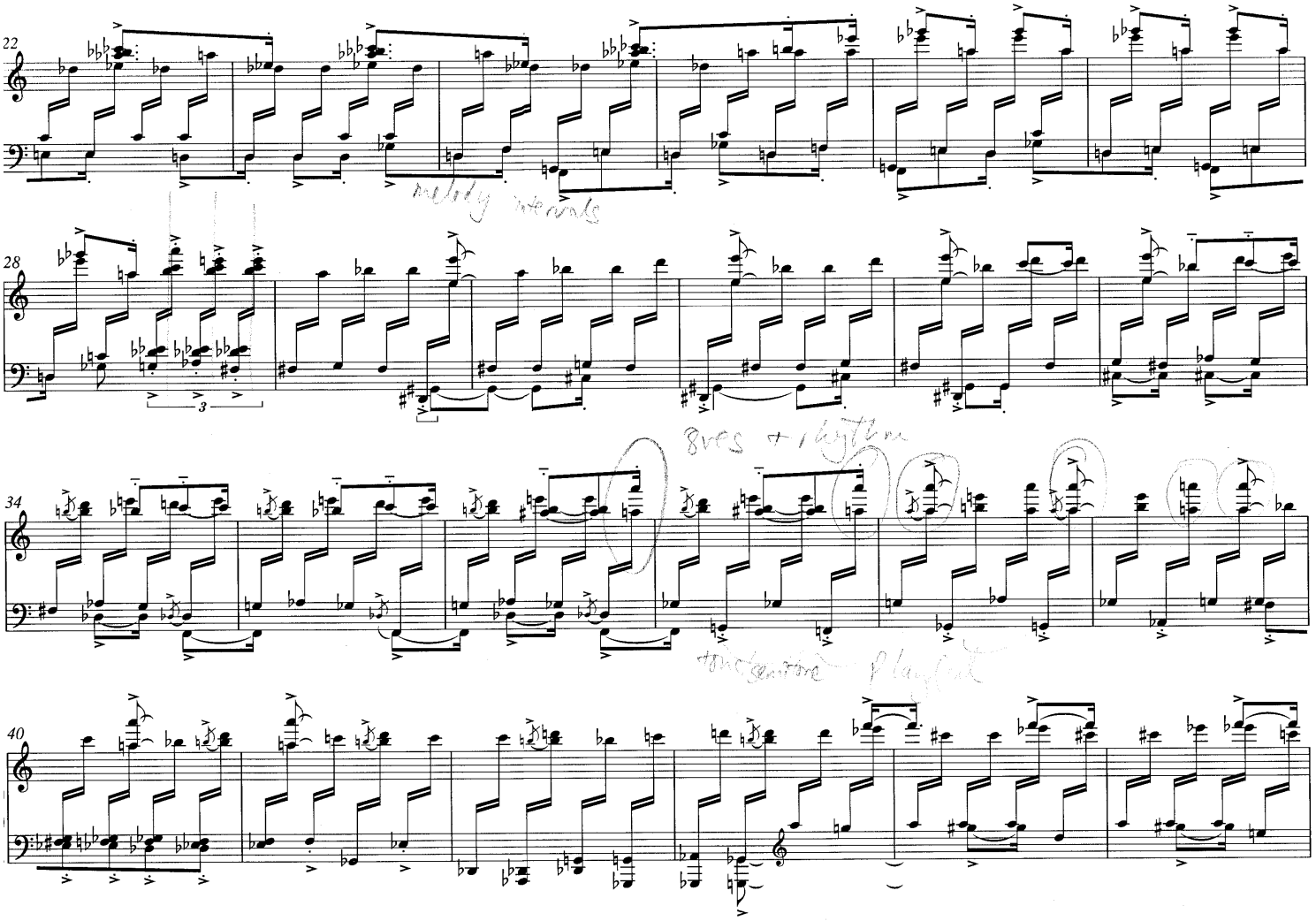

11
♪ = 180
21
rall.
♪ = 120
ff dim.
(l.v.)
mf stacc.
28
rall.
♪ = 90
(mf)
♩ = 180
♩ = 45
Ped.
r.h.
sost. Ped.
35
♪ = 180
rall.
♪ = 90
♪ = ♩ = 90
rall.

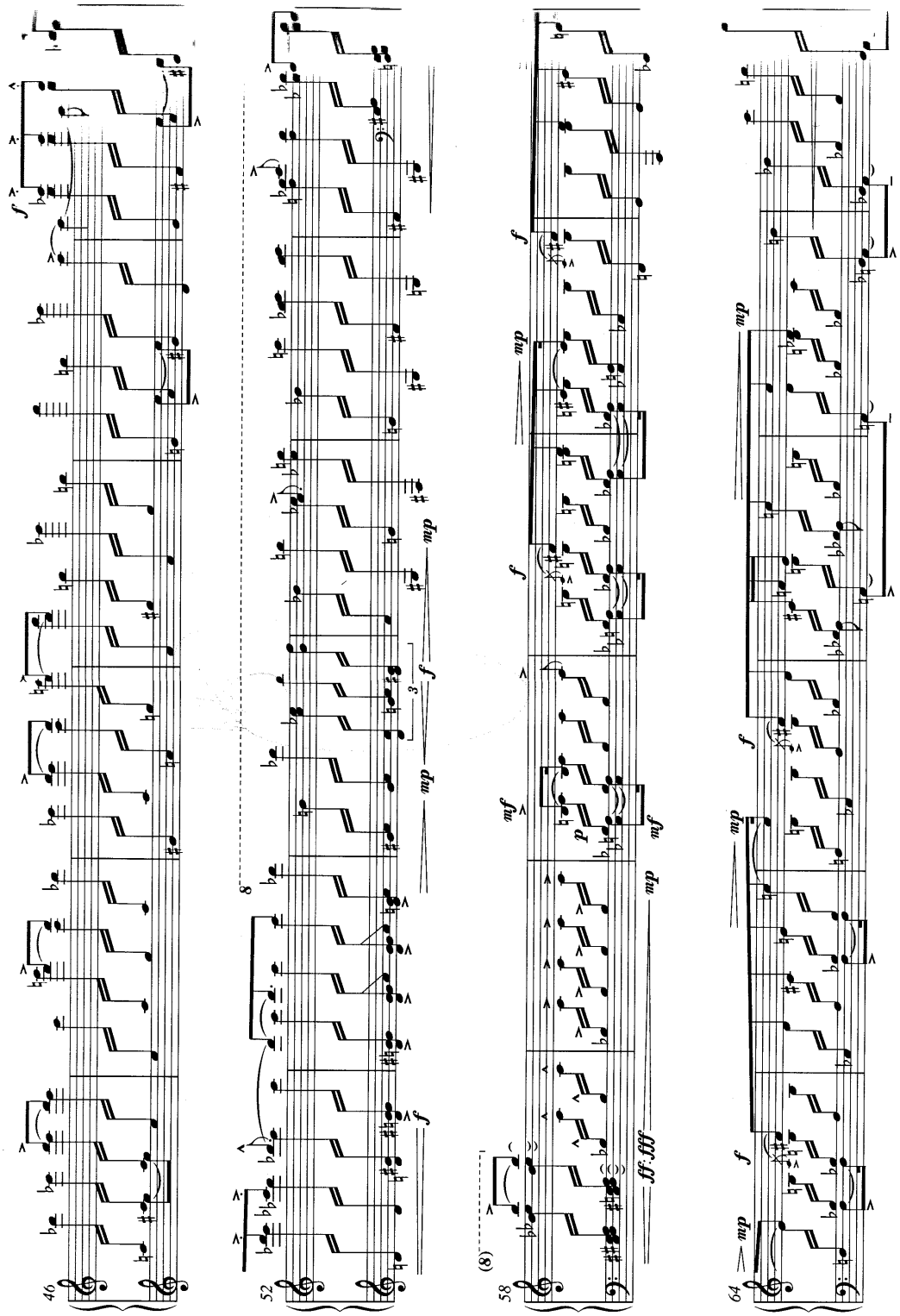

10 secs.
sost. Ped.
rall.
short
l.v.

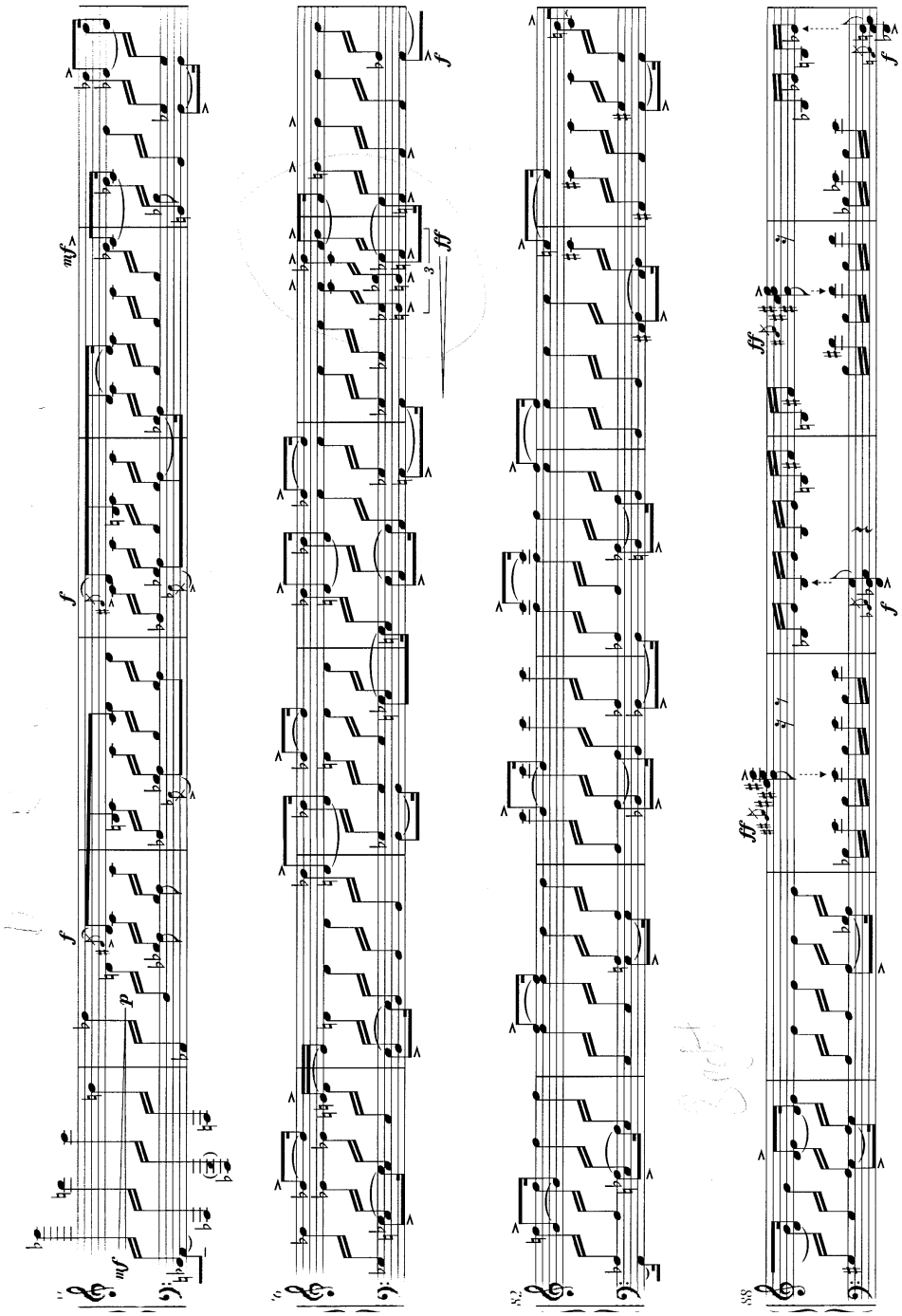

poco a poco rall.
sost. Ped.
sost. Ped.
sost. Ped.
sost. Ped.
sost. Ped.

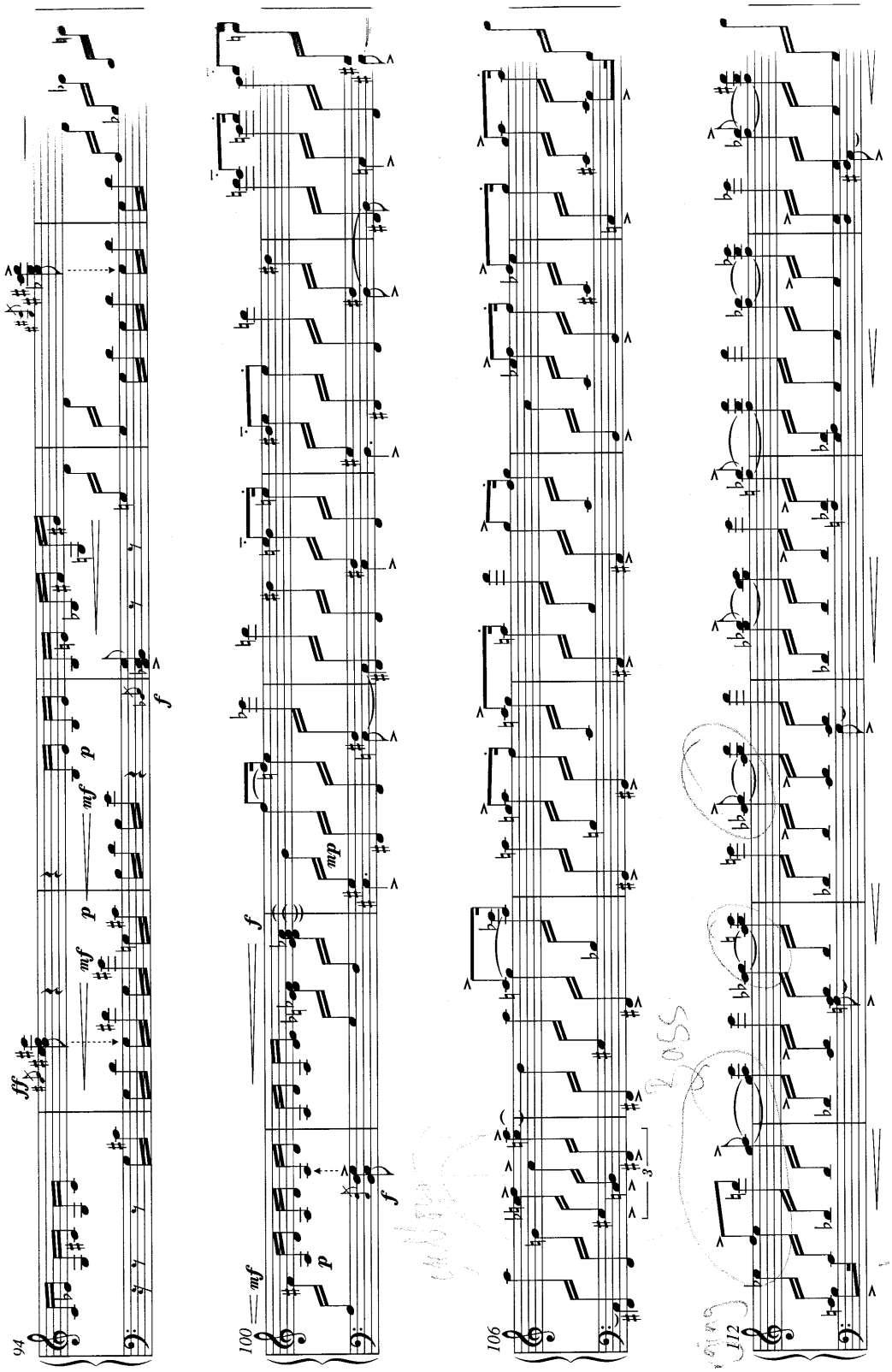
V

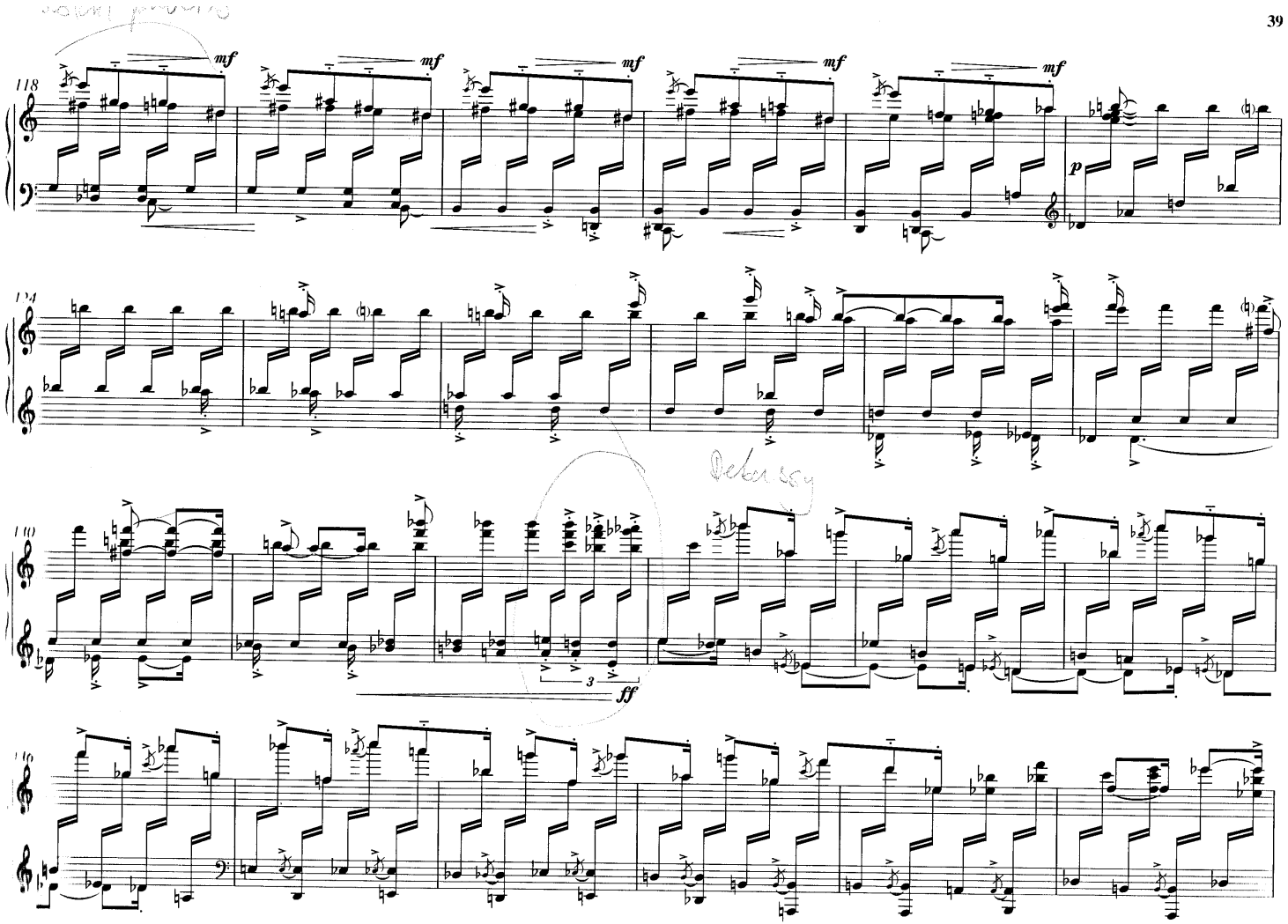

♩ = 180
7
f
fff
5
Ped.
♩ = 45
r.h. sffffz
(p)
8va
Ped.
♪ = 288
p
senza Ped.
mf
(p)
(stacc. sim.)
mf
8
mf
(p)
mf
mf
sim.
15

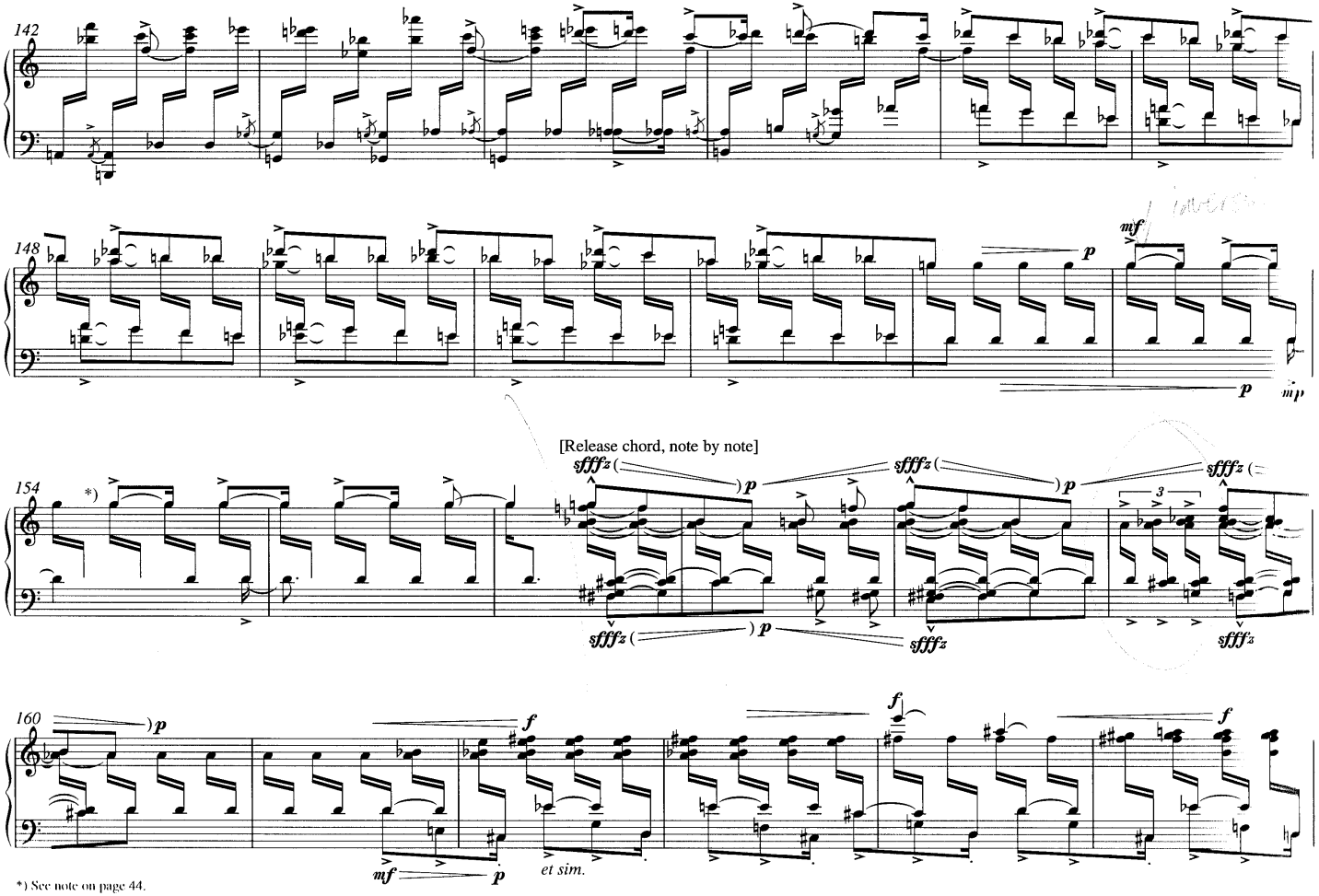

22
28
3
melody inverts
8ves + rhythm
34
40


46
52
58
64
f
mp
mf
ff. fff
(8)

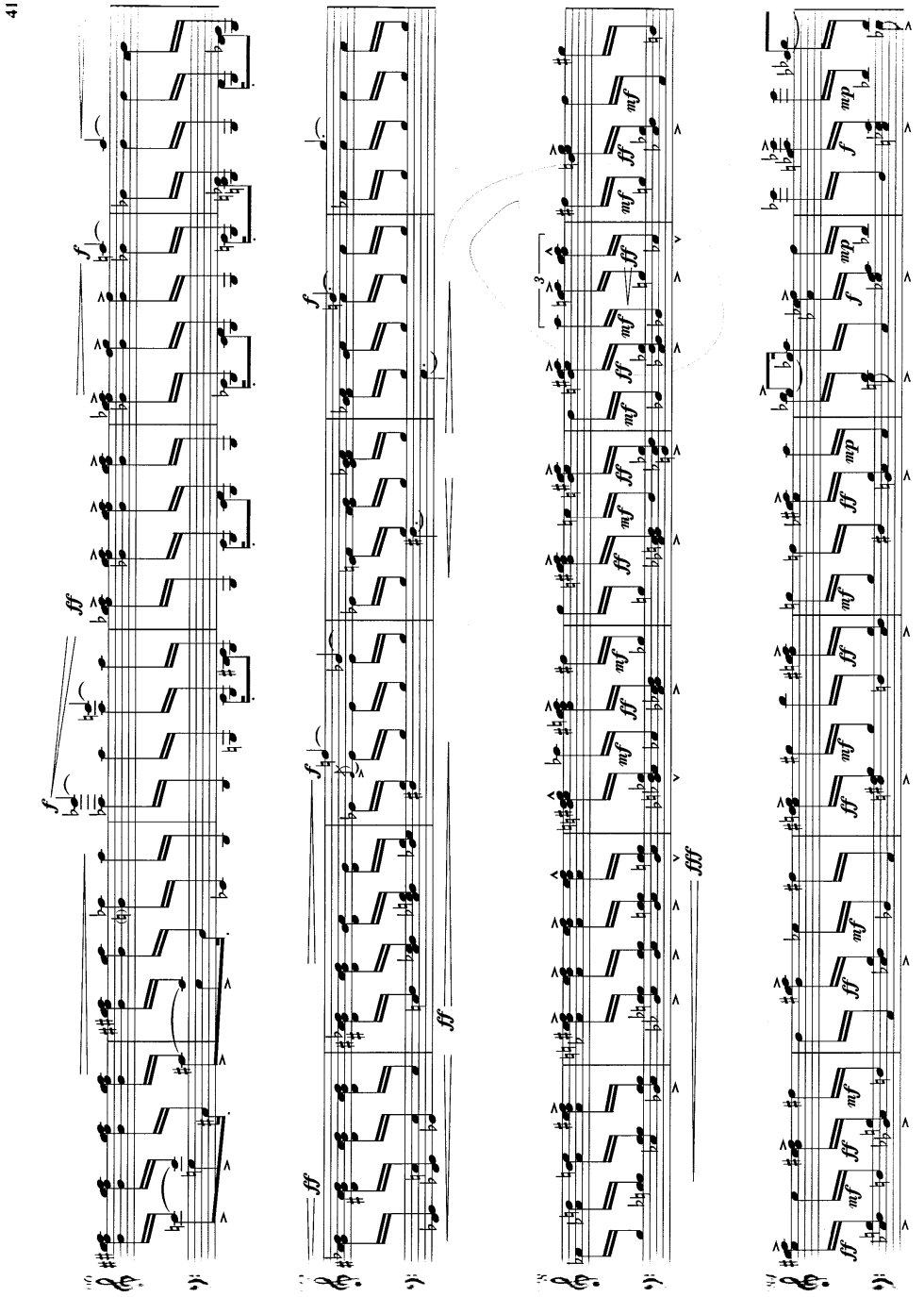

mf
f
p
mf
f
ff
3
f
ff
f

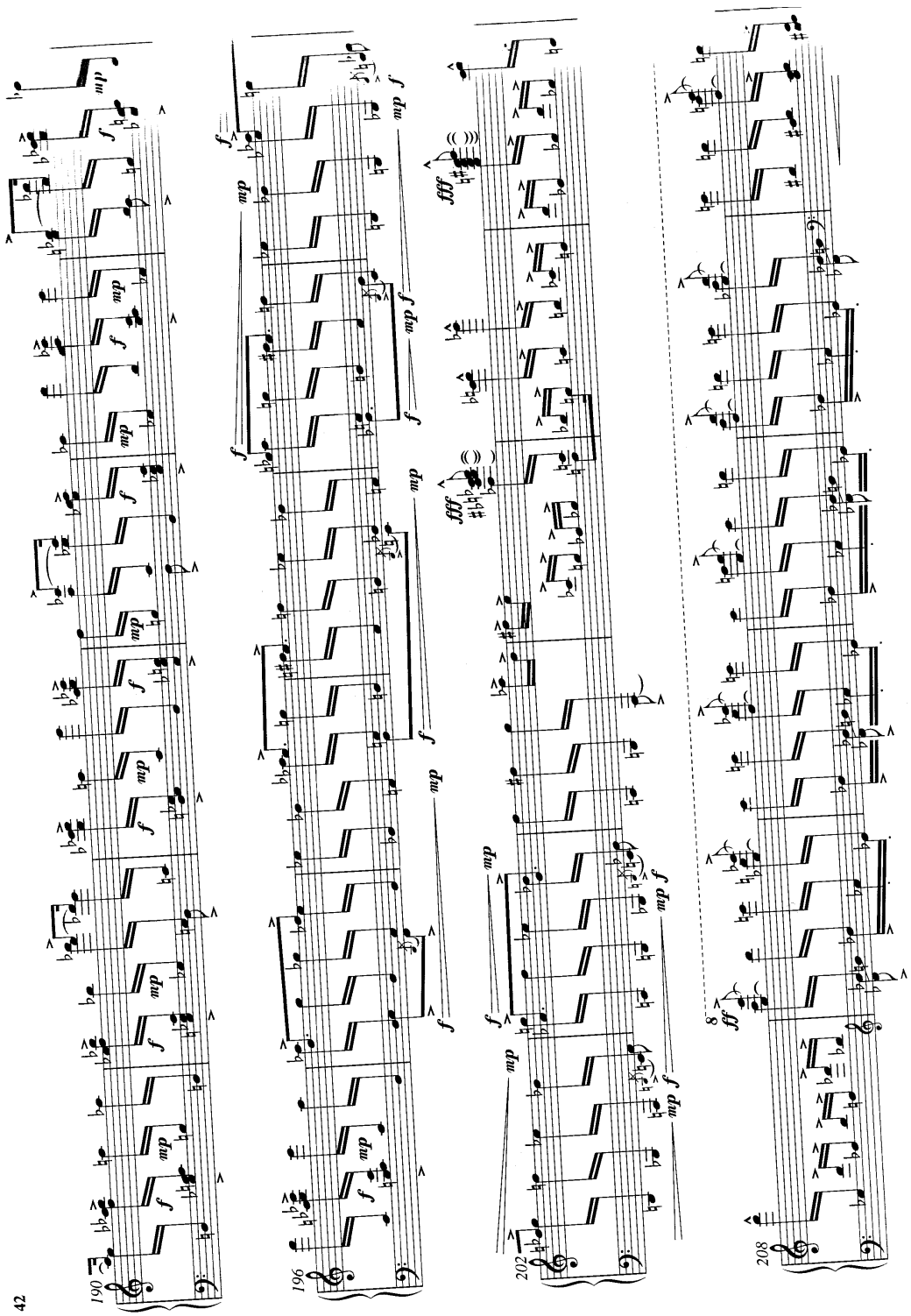

94
ff
f
mf
p
mf
p
100
mf
f
mfp
f
p
f
106
3
112

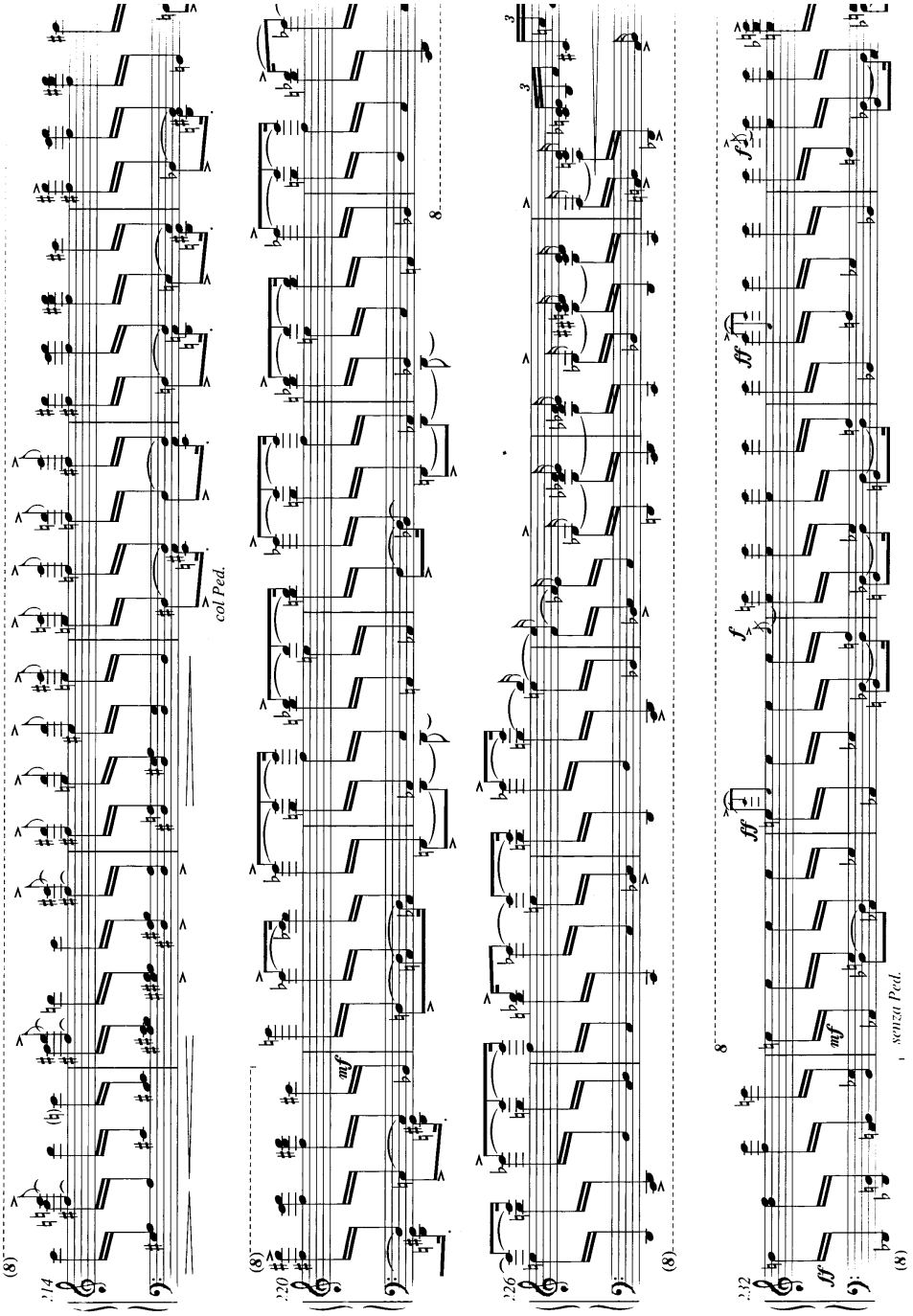

mf
mf
mf
mf
mf
p
3
ff

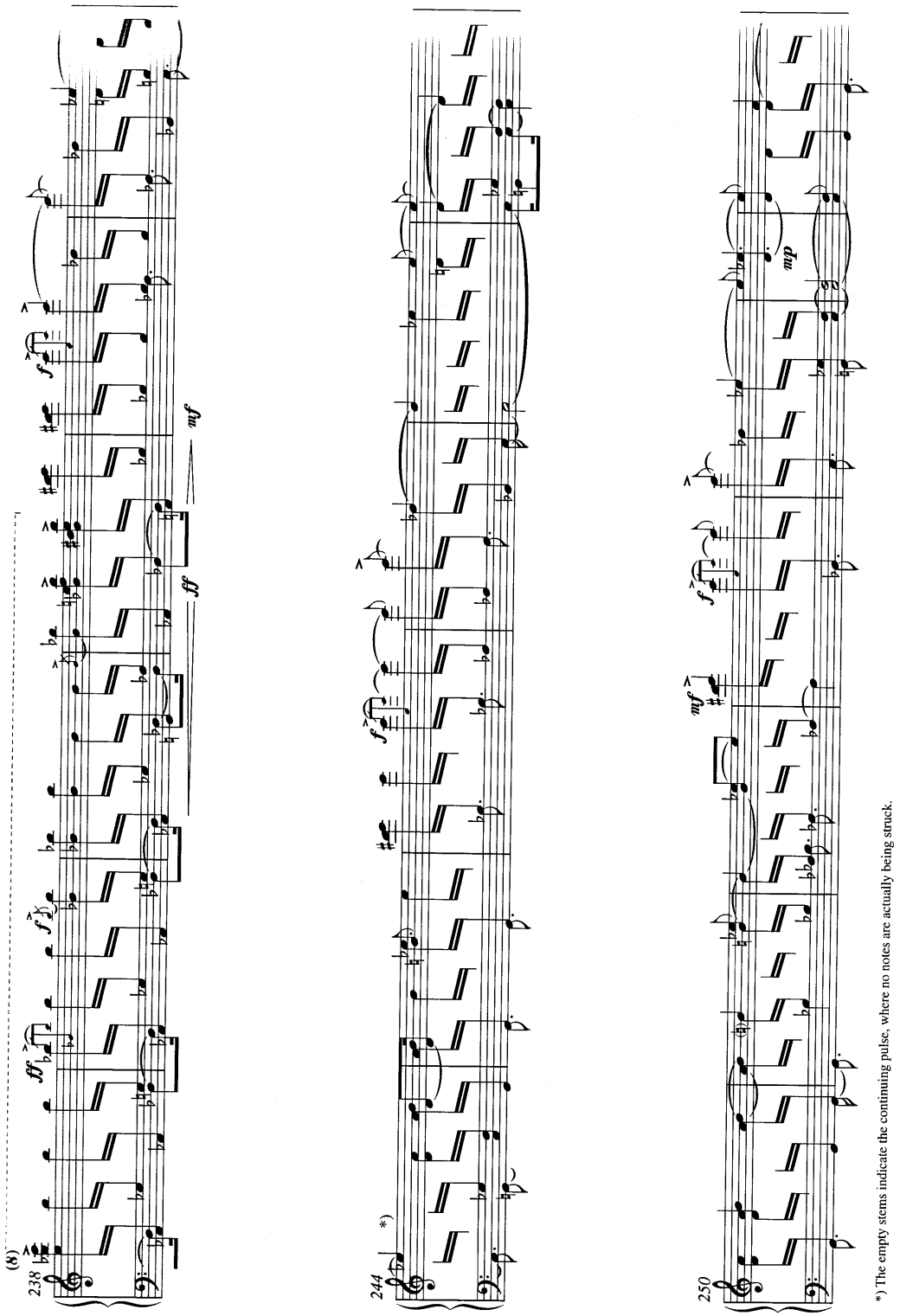


*) See note on page 44.

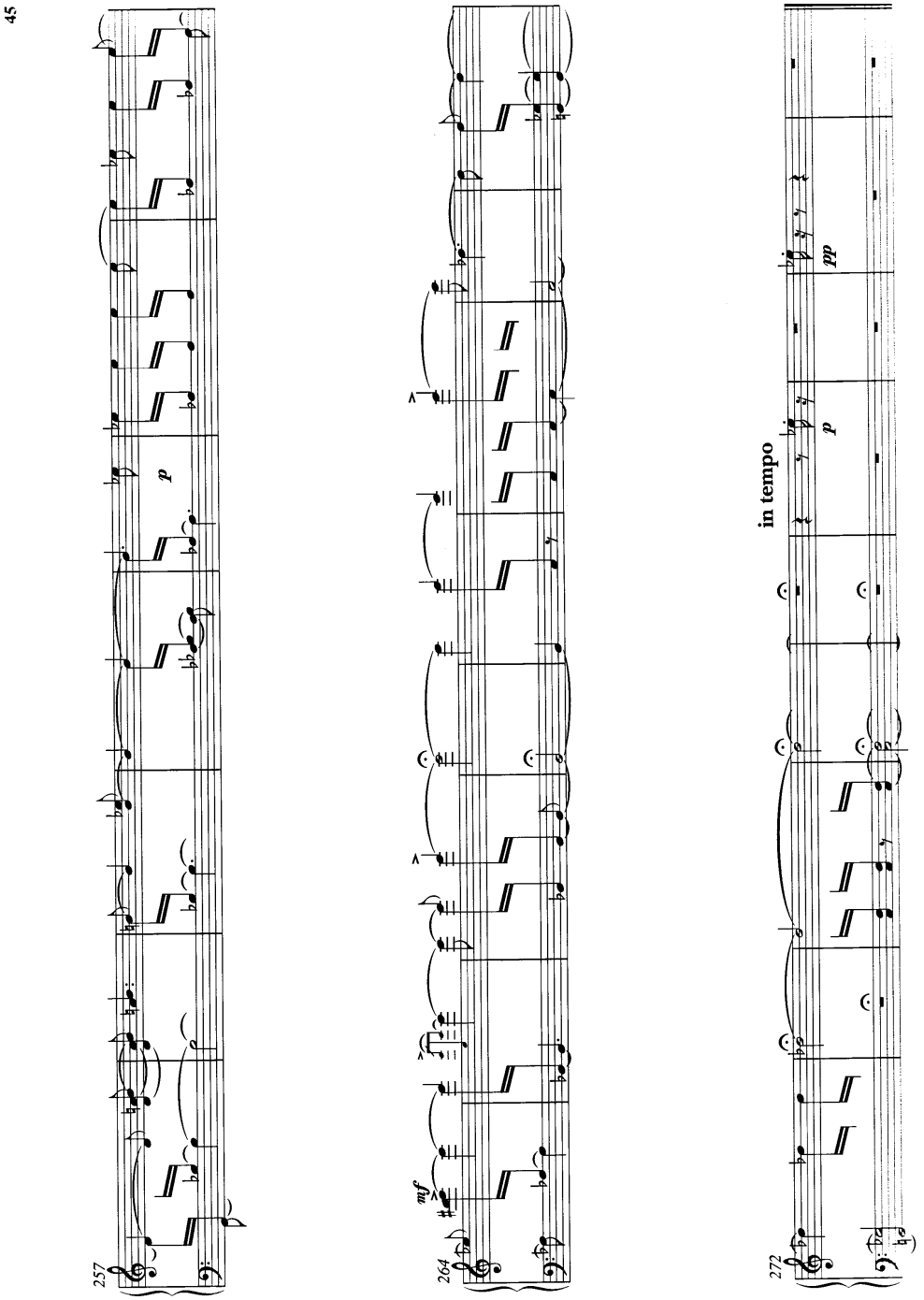

41
ff
f
mf
mp
fff


42
190
196
202
208
mp
f
fff
ff


col Ped.
mf
senza Ped.



*) The empty stems indicate the continuing pulse, where no notes are actually being struck.


45
257
p
264
mf
272
in tempo
p
pp

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