REMEMBRANCES OF RITORNELLOS PAST: LISTENING, MEMORY, MEANING

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ABSTRACT

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Recent approaches to ritornello structure in J. S. Bach's Brandenburg Concertos have stressed the importance of the Baroque compositional technique of Fortspinnung. Yet, the examination of what a listener remembers of the music shows that the Fortspinnung sections seemingly do not play a role in how the music is remembered. This discrepancy suggests a closer look at how precisely musical data are dealt with by memory and how their interaction with other fields of musical activity, for example, the use of terminology (the term "ritornello" and the concepts of "ritornello structure" and "ritornello process"), influences memorization and remembrance of music.

In this inquiry, I have chosen not to take the metaphorical stance towards memory often adapted by musicologists; rather, I borrow information about the workings of memory from the more mechanistic accounts of experimental neuropsychology, specifically research into the remembrance of word lists. Since neuropsychology and musicology are not immediately compatible, I use semiotics as a "bridge discipline" between the two.

After advocating research into music listening habits in general and defining listening as the conceptualization of heard sounds through memory, I demonstrate the divergence of predictions in ritornello theory and the actual mnemonic practice of listeners. I introduce paradigmatic analysis as a means of graphic representation and Peirce's trichotomy of icon, index, and symbol as philosophical corollaries of observable effects in word list memory. At various stages of the study, references to the structure and process in BWV 1046/1 are

provided as examples for the application of the gained insights.

Keywords: BWV 1046, memory, neuropsychology, philosophy of music, ritornello, semiotics.

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PREFACE

This M.A. thesis has been in gestation for a long period of time and its sources go back to when I was still attempting to become a neuroscientist, musicology then being of lesser concern. Consequently, the list of people wittingly or unwittingly involved in the project is rather long. Hence, I will mention only the most pertinent influences.

At Brandeis University, Professor Michael J. Kahana introduced me to the neuropsychology of memory and, thus, elicited some strands of thought that here come to completion. At the University of Pittsburgh, Professors Andrew Weintraub and Jonathan Sterne offered a course on "Music and Communication" whose readings and discussions opened up new ways to attack the subject of this thesis when other strands of thought began to lame. Federico Garcia de Castro, as a colleague well-versed in typesetting and the Electronic Theses and Dissertations (ETD) program at Pitt, introduced me to LaTeX and patiently explained several of its idiosyncrasies to an incipient LaTeXnician. David Gerard Matthews helped me with last-minute conversions of several figures encoded in various graphics formats into the PDF-format. To the members of my committee, Professors Brodbeck, Lewis, and Rosenblum, I owe thanks both for my induction into musicology in the various courses they offered during the past three years and for their willingness to serve as conscientious readers of this thesis.

Academically, the person who was most involved in the development of these ideas, from an innocent ten-page midterm paper through advice on a conference presentation to three long semesters of patient, dilligent guidance, is Professor Don O. Franklin; I am deeply grateful for his sense and good humor (two character traits I may have gravely tested at times). Personally, my parents and my grandmother have shaped my outlook on life in more ways than probably both they and I are completely aware of; I do not know an equal of their support through what is now a good quarter-century.

1.0 INTRODUCTION

At the roots of this inquiry, about two years ago, lay a confusion on my side about what a ritornello was and how it could be reasonably identified by a listener. The specific case of Johann Sebastian Bach's *First Brandenburg Concerto* (BWV 1046) challenged my belief in the importance of the *Fortspinnung* principle for the memorization and subsequent identification of ritornellos in the movement. Rather than the standard parameters of *tutti* texture, tonal stability (at least in the opening and closing ritornellos), and a clearly recognizable theme, it seemed that a listener might rely on motivic cues to guide his or her perception of the movement's structure.[1] The association of certain melodic segments with the ritornello and others with episodes allowed me to view the task of listening for temporal structure as an exercise in the memorization and remembrance/recognition of motives, rather than in continuous analysis of texture, harmony, and coherence at each and every instance of listening. Once this tentative connection was made, I was able to find parallels between the recall of word lists, an experimental method employed in cognitive neuroscience, and the recall of ritornellos and larger sections of music. This paper presents one attempt to bridge the methodological gap that necessarily exists between cognitive neuropsychology and musicology. Because the gap in question is rather large and the philosophical reasoning required to bridge it to my satisfaction has taken ever more hold of my mind as this project progressed, reference to the original seed around which the theory crystallized, namely Bach's *First Brandenburg Concerto*, has of necessity been limited to a few chapters.

The paper is loosely divided into two parts, one clearing the way for introducing neu-

[1] My confusions and their temporary but imprecise resolutions were presented in "Remembrances of Ritornellos Past: A New Approach to Ritornello Structure in Bach's First Brandenburg Concerto," a paper read at the Tenth Biennial Conference on Baroque Music, 2002, at the Universidad de la Rioja in Logroño, Spain.

ropsychology into musical analysis (Chapters 2 through 7), the other forging the connection (Chapters 8 through 10). The second chapter gives a general account of listening and a more detailed view of the philosophical issues involved in creating an analytical theory appropriate to a listener's situation. To step away from the theoretical issues towards a more practical setting, the second half of the chapter describes a memory experiment; a listener's remembrance of melody in the first few measures of BWV 1046 is interpreted and compared with its equivalent in the score. In the third chapter, I review the tenets of Saussurean semiotics and I introduce paradigmatic analysis as a means of representing musical events. Against this background, the fourth chapter provides the basis for my thinking about ritornello structure; current ritornello theory is laid out and criticized, the criteria for analytical attention to incipits and cadences are given, and the analysis of an idealized ritornello movement renders generic structural characteristics of ritornello form. Based on this knowledge, I analyze BWV 1046/1 in depth in the fifth chapter. Several modifications to the graphic representations of the movement render insight into its structure but they also reveal the shortcomings of an approach concentrated solely on structure. Therefore, I abandon Bach's concerto in the sixth chapter for a different kind of semiotics (founded by Charles Sanders Peirce) that is more pliable to the analysis of temporal processes. The seventh chapter endows the notions of iconic, indexical, and symbolic signification with temporal meanings, which will be employed in different ways in the analysis of ritornello process.

The second part of the paper bears the heart of my argument: the eighth chapter gives a survey of the neuroscientific results I want to employ. Subsequently, I interpret the concepts developed by neuropsychologists in semiotic terms perhaps more familiar to musicologists; this actually necessitates analyzing neuropsychological experimental technique more than musicological principles. The tenth chapter returns to music; after a more theoretical excursion, I apply the developed general perceptional theory to ritornello process and derive a mnemonic theory for the memorization and remembrance of ritornellos and episodes. In the conclusion, I briefly survey the covered ground.

2.0 THE TASK OF LISTENING

2.1 DISCOVERING MUSICAL MEANING

What precisely constitutes "music" or (perhaps more felicitously phrased) "the human activity and traces thereof which we (in the English-speaking world) call 'music"' is a matter of debate, especially in the academic field "musicology" that by name and calling is ultimately bound to research music's relevance to human life. I should here qualify that music in my treatment is considered to be intimately related to the transmission of information by soundwaves. Whether music exists only when it is listened to, whether deaf people can still competently speak and think about music, in short, whether music is defined necessarily by its soundedness does not at the outset concern me; I take it as an axiom of my endeavor. I would venture that music has necessary features beyond sound but at this stage the reader should understand "music" to mean anything anybody could sound, transform into sound, or describe as sound.

As the previous sentence suggests, music is not only soundable (and, by implication, hearable) but also thinkable.[1] Yet, if thinking of music is possible, a new question emerges: how do we think of what we hear? There seem to be generalized activities with respect to the musical, framed by the concepts reception and production. All musical activities can

[1] I assume that any sound can be heard. Hearing here refers to nothing more than the transformation of information transmitted by air molecule density fluctuations into information transmitted by electric impulses in neurons. This transformation happens in the human ear, specifically the inner ear spiral known as *cochlea*. Other side effects of sound waves, such as vibrations of other parts of the body, are considered secondary.
Two excellent sources for definitions of sound are John R. Pierce, "The Nature of Musical Sound," 1-23, and Norman M. Weinberger, "Music and the Auditory System," 47-88, both in *The Psychology of Music*, 2nd edition [San Diego: Academic Press, 1999]. Pierce reviews the historically changing opinions about sound while Weinberger describes the acoustic limits of the human auditory system.

(in my opinion) be categorized as peculiar combinations of these two concepts. A closer inspection of the "musical" reveals that music (apart from its posited dependency on sound, actual or imagined) is not only cause for but also result of these activities, a malleable thing informed by the idiosyncrasies of its listeners, by their individual and collective power, by their willingness to do music themselves (as composers, performers, printers, patrons, critics, researchers, . . .), and by many other practices embedded in musical cultures, changing through musical histories. If we construe "musicology" to concern itself with that subset of the audible referred to as "music," and if musicology indeed processes this audible matter in the light of previously acquired knowledge, then the posited question—how we think of what we hear—should point to the heart of musicology's means and end, namely, *what music means*.

"Musical meaning" does not have a clear, universally accepted definition and each individual using the term will endow it with a specific linguistic shade, providing the unique basis for his analytical or scholarly endeavor. The previous paragraph pointed towards aspects in the human attitude to music that deserve closer attention. Which combination of a musical activity and a means of human thinking, we ask, allows us (and anyone else) to react in suitable ways to music, to structure it, to relate it to other social practices, and to treasure it? I would like to suggest that (whether engaged in productive or receptive musical activities) *one* human perceptual practice and *one* faculty of the participant's mind are common denominators when humans conceptualize (about) music: the practice is *listening* and the faculty informing it is *memory*.

To give a simple definition, listening may be conceived of as hearing informed by the actions of memory. Listening is fundamental to many activities associated with music: in dance, the dancers position themselves and orient their movements according to the beats, the patterns, and the phrases of the accompaniment; in composition, the practicioners learn their craft through listening and choosing the interesting auditory ideas of other music; in a newspaper, the critical evaluation may comment on the circumstances of the performance but usually also refers to the auditory impression as a marker of the performance's quality; in musicological study, finally, research is purported (by some) to refer only to the score, but the choice of the research object as well as the researcher's necessary persistence is

surely aided and encouraged by affinity to the music gained through listening.[2] While the involvement of memory in all of these activities is widely differing (a few seconds only in the coordination of dance-steps, as much as a lifetime in musicology), they require both auditory perception of sound and its mnemonic retention. With due care, we can think of listening and, by implication, memory as musical universals, or at least as close approximations of such entities.

Listening and memory are not understudied subjects in musicology (conceived here to include all music-related fields of study, such as historical musicology, ethnomusicology, music theory, music analysis, acoustics, music perception, or music philosophy); even a cursory look at the literature reveals countless entries dealing with musical memory and with listening under the heading of music perception.[3] Most attempts to reach some understanding of the complex processes that enable us to "do music," that is, to perceive and enact it, to receive and produce it, as well as to derive meaning from it, have set their sights on ways of participation that involve manifold influences—cultural, political, social, aesthetic—on the musical subject, the listener. All of these influences are active in the present moment, as the listener perceives the sounded object, but arose as conventions in the past, both in the collective cultural past of history and in the individual past of the listener's biography. To investigate listening is to investigate a current process, but one not easily defined and distinguished from the individual's and her culture's past. Perceptional analyses and experiments give perhaps too much weight to the present-ness of perception rather than the past-ness of the musical conventions guiding perception. Conversely, musicological discussions and analyses

[2]In general, it might be more challening to come up with musical activities not dependent on listening. Being a historical musicologist myself, branches like paleography and the physical study of musical scores come to mind. Yet, the comparison of notation styles is usually motivated by a problem evident only in music sound and, hence, checked by reference to music sound, be it the practical interpretation of Carolingian neumes, or the time of origin and historico-cultural circumstances of a piece by Mozart which allow us to reason for its place in the development of Mozart's understanding of sound. In both cases, classifying the physical research under a concern about sound may not do justice to the expertise and interest of the researchers but it probably reflects the thinking and desires of the "average musicologist" (an ideal as difficult to fathom as the "ideal listener" required by some methods of music analysis).

[3]Apart from the sources mentioned later, Candace Bower's articles "Memory and the Perception of Rhythm" [*Music Theory Spectrum* 15 (1993): 19-35] and "A Cognitive Theory of Musical Meaning" [*Journal of Music Theory* 44 (2000): 323-379] offer two exciting attempts. My path diverges from hers for two reasons: my interest in continuous processes like listening favors a different view of memory as a basis; and her focus on bodily experience as generator of meaning is difficult to match with my more intellectualized, language-based approach. Also, from a neuropsychological point of view, the theory of memory she adopts, multi-store models, is not without its problems; the eighth chapter will give a detailed review.

of a piece in terms of cultural and historical criteria often focus on the general characteristics representative of a style only, to the detriment of gaining insights about the individual relevance of these characteristics on the listening experience. This study attempts to go what I consider the middle way, on one hand appealing to experimental results and projecting them onto the putative intellectual processes within a listener's mind, on the other hand grappling with the divide between past and present that is so easily and naturally overcome in any act of listening yet confronts us as such a formidable intellectual boundary when we think about thinking about music.

These two objectives informing my study will also inform how I restrict the definition of "musical meaning" for my purposes. As mentioned, the term "memory" plays a large role in musicological literature nowadays. Here, I restrict its meaning for music to neural processes whose results are measurable and to neuropsychological theories whose predictions are experimentally verifiable. This adoption of the neuropsychological definition into a musicological environment necessitates a more detailed exposition of what neuroscientists have discovered about memory and its quirks, to be provided in the eighth chapter. I will describe discoveries illustrative of problems in neuroscientific interpretations of memory adopted into musicology and different interpretations I integrate into my own model of listening and musical memory.

This very limited interpretation of "memory" requires me to find an analytical representation of music capable of producing musical units conducive to manipulation as neuropsychological units of memory. The field of music semiotics offers two approaches, based on the theories of Saussure and Peirce, both of which have already been applied in the analysis of music and both of which, with certain modifications and caveats, are applied here. The modifications wrought on music semiotics are, incidentally, forced by the second objective described above, the communication of past and present in the listening process.

Temporality is hence, next to memory, the second concern of this study. While memory is here assumed to be effective primarily in the domain of the individual's mind, temporality represents the quintessentially independent factor in human musical perception. However, memory transgresses its domain as it becomes manifest in music composed and historically transmitted, thereby being subject to temporality. Temporality, on the other hand, is effective both in large-scale historical processes *and* in the ordering of musical instances regarded

and processed by individual memory. The two primary informants and determinants of what I here consider musical meaning overlap and merge; my task will be the calibration of their relationship such that an interesting and stimulating methodology arises.[4]

2.2 RESEARCHING LISTENING PRACTICE

Before I turn to the first formal step of this inquiry, a description of the semiotic method, an example of the effects of listening and memory on the individual human mind might illuminate my point. Proposing new theories about listening is a fair business but proposing a new practice of looking at musical processes seemingly quite familiar will perhaps provide a necessary jolt for our analytical minds, an awakening from the dogmatic slumber of current musical analysis.

From the definition of listening as the perception and mnemonic manipulation of sound, the realization dawns that we ourselves are certainly capable of listening. Hence, it should be illuminating to study our own response to music. Instead of asking how *a listener* reacts to music, we shall ask here: How do *we* react to music? How do *we* remember it? The resultant picture will not be objective, but (if the inquiry has been well framed) it may be representative of human listening practice.

In our informal memory experiment, the test case will be the ritornello of BWV 1046/1. My reasons for choosing the piece are partly practical—the piece will be my main example for the semiotic segmentation of music and its shortcomings when applied to memory—and partly sentimental; thinking about ritornello structure in the *Brandenburg Concertos* and evaluating current theories against my own instincts and memories led step by step to the theory exposed in this paper. I will discuss the complications of the first movement under the banner of ritornello theory later; here, we shall focus on a simple question: after listening to the movement for many times in the past few years, what am I able to recall?

Figure 1 is a representation of the melody I remembered after not having heard a record-

[4]The problems inherently presented by temporality were the reason for postponing a detailed discussion of memory to the latter half of this paper. Only when the analytical representation is aligned with temporal concerns do I proceed to outline memory and the interpretation which forms the core of my account of the listening process.

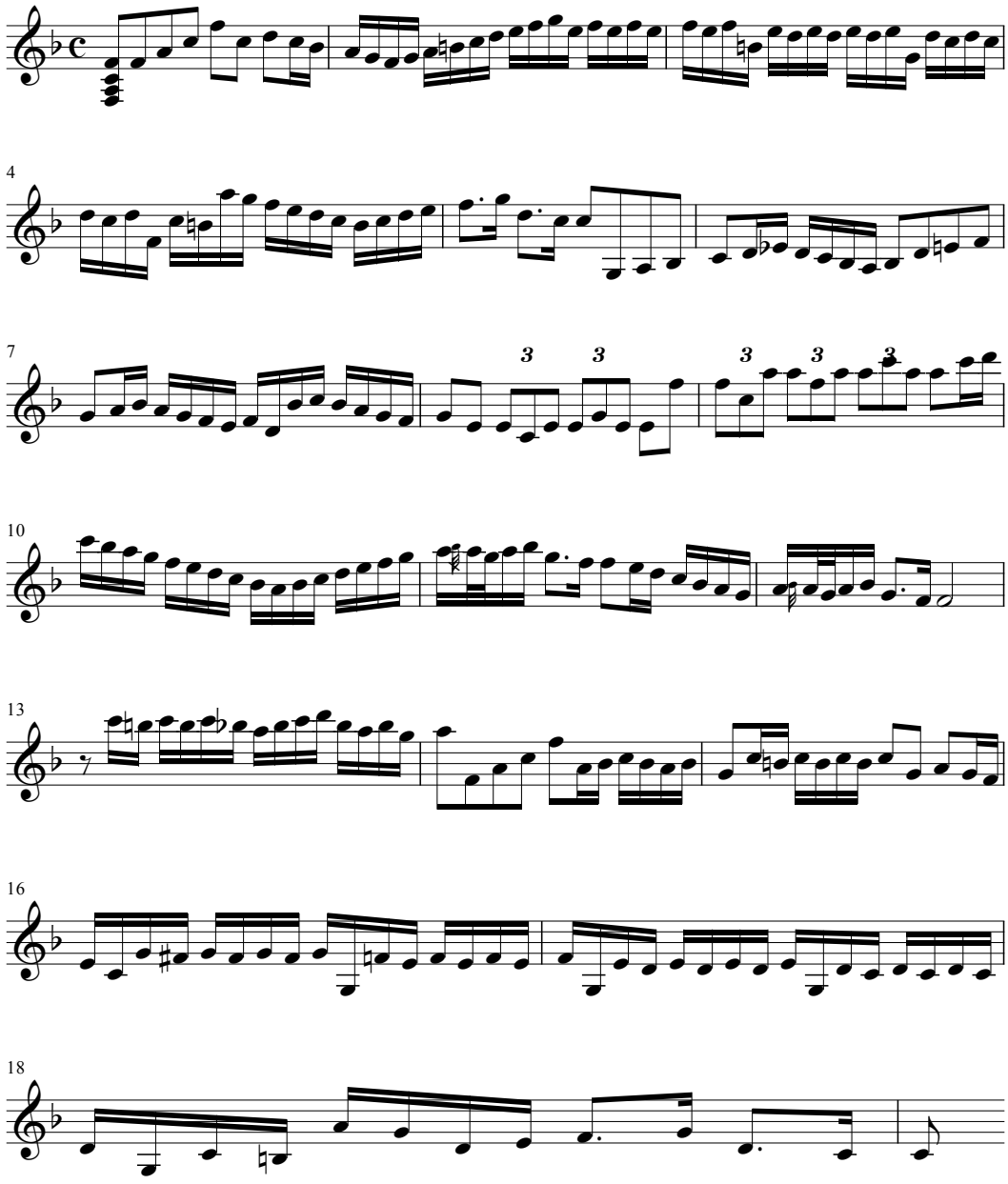

Figure 1: Remembered Melody from BWV 1046/1

ing or performance of the music for at least three weeks. (The writing out of this memory trace happened in Fall 2003; since then, I have again listened to the movement but my results, at least for the purpose of this demonstration, would not be much different.) The general procedure for preparing Figure 1 started with the writing down of notation symbols thought appropriate, followed by aural checks of the notated melody, repeated many times. Once the notated melody sounded "similar" enough to the remembered melody, it was considered mnemonically "accurate" enough. Correcting possible errors in parts of the melody at that point would have caused changes resulting a greater inaccuracy of the whole.

The draft was prepared in a music notation program by directly entering the notes into the measure-and-staff grid provided; visual memories may thus have had as much of an influence on the final result as aural ones. Yet, the mistakes, for example, in the alignment of first beats in the original and bar lines in the memory transcription, are themselves illustrative of the successes and failures of memory. Of course, the likelihood of such cross-reactions between aural and visual memory might be diminished by recording a sung version of the memory trace, followed by a melograph transcription of the recording and a subsequent analysis of the graph and a secondary transcription into staff notation. While the latter method would have been more scientifically accurate, it would also have required more time and equipment without contributing to my argument here or elsewhere.

Notably, I used two means of checking my aural memory against an aural version of the notational trace: I played parts of the notated melody on an electric piano, and I used the notation program's instant replay feature. The latter technique of memory reinforcement, in particular, revealed several aural flaws I found in the version presented here: the scalar motions in m. 4 should sweep farther down and up and take up more time, the music in m. 7 should extend longer and use other motives, too, and the insertion of the triplets into the transcription is awkward. Again, calibrating the relations of these particulars to the remainder of the melody would endanger the relative accuracy of the whole. Given the strictures of having to produce a score rendering, Figure 1 represents my remembrances of the initial few measures quite well and provides thus a basis for observations about my mnemonic facility.

The transcription process already provides insights into the workings of memory. Cer-

tain sections required much more time and multiple replays to be rendered with acceptable mnemonic accuracy. Among these are mm. 3-4, mm. 8-10, and mm. 16ff. Moreover, the effort of recalling the precise events following m. 18 proved to be so great that the transcription was at that point terminated. I could have continued *inventing* melodic fragments effortlessly beyond this point; my interest in mnemonic accuracy, in relative confidence about the content of the transcription, sagged, however. I was not able to assign to m. 19 a precise motive without feeling compelled to consider other, equally mnemonically valid choices.

Now I shall compare this memory trace to the compositional trace, that is, the score of the first several measures in the first movement of BWV 1046 as it is available in a modern edition.[5] Figure 2 shows an extraction of the ritornello melody; I tried to correlate the sections in Figure 1 that my own recollection focused on with corresponding parts in the full score. Of course, my recollection switches quite erratically between different instrumental parts, just as my attention veered from one instrument to another in the act of listening. To aid comparison between Figure 2 and the original score, I noted the instrumental part (violin, horn, or oboe) from which my memory image was likely derived.[6]

Vis-à-vis accuracy, I would like to draw attention to the differences between the original and the memory image, the failures of memory, so to speak. The beginning of the excerpt is relatively correctly rendered but within m. 3 mistakes begin to show. The recalled image is again relatively close to the score in m. 5, at the cadence of the ritornello's first half in the dominant and the beginning of the second half. In the middle of the second half (mm. 7-9), the exactness of recall again begins to wander until we reach the last few bars (mm. 10-12) where the rendering is again closer to the original (or better, to the score). After m. 14, accuracy drops off steeply.

Curiously, the parts that took the longest time to remember also rate low in accuracy. Equally remarkable is their coincidence with parts generally described as products of the Baroque compositional technique of *Fortspinnung*.[7] As an initial hypothesis for our inquiry

[5]Johann Sebastian Bach, *The Six Brandenburg Concertos and the Four Orchestral Suites in Full Score* [New York: Dover Publications, 1976].

[6]The designation in Figure 2 of each staff as played by the violin is due to an error of the notation program. A better representation, eschewed here for lack of space, would trace the memory image through the full score and point out all instruments that could have given rise to the memorized melody.

[7]The explanation of the technique, as well as a general review of ritornello theory, will be given in the fourth chapter.

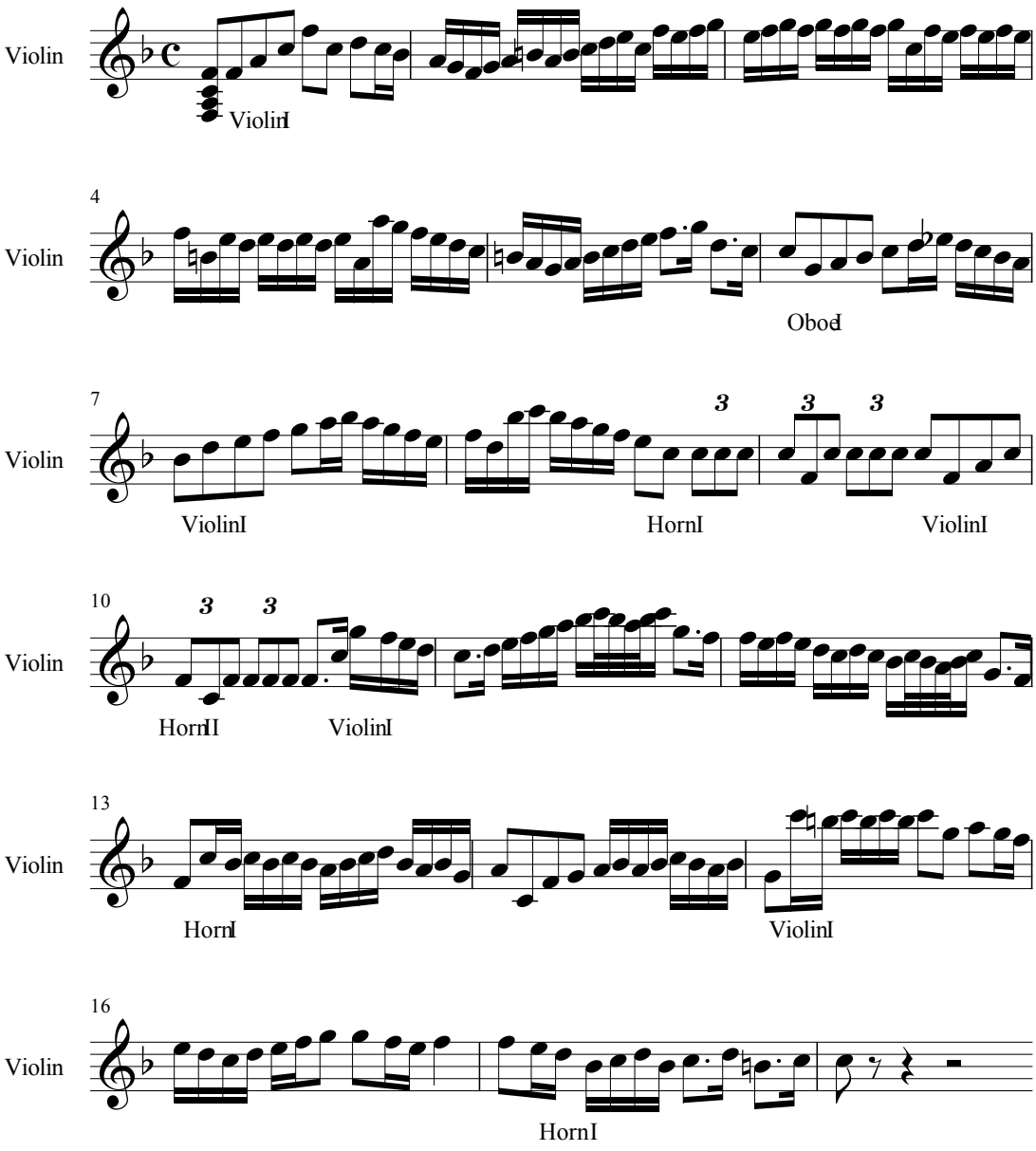

Figure 2: Extraction of Ritornello Melody in BWV 1046/1

into the workings of remembrance, we will thus take the stance that the measures before and after cadences seem to be well remembered, and that *Fortspinnung* sections seem to be badly remembered. Thus, our preliminary practical task will be to explain the former phenomenon and to prove or disprove a causal connection between compositional technique and mnemonic activity in the latter.

3.0 SEMIOLOGY IN MUSICAL ANALYSIS

3.1 SEMIOLOGY

In principle, musical thoughts can signify music in two fashions, which in semiotics (whether musical or general) are represented by two different approaches: language-based or not. In the first case, the representation is one-to-one, where each musical meaning (usually a word) has a specific musical reference (such as a motive or a section); each concept is attached to a musical unit.[1] Meaning and music are distributed as if in a dictionary. The first linguist to study this conception of meaning with regards to language was Ferdinand de Saussure. His ideas were in the mid-1950s applied to the study of culture and, eventually, to music.[2] My analyses and suggestions for the structure of the *First Brandenburg Concerto*'s first movement in the next chapter will employ some methods of representation based on structural linguistics, notably paradigmatic analysis. While this solves the problem of representing putative mnemonic structures, it does not provide information about which step taken at which time is mnemonically preferable. The processual nature of listening is thus toned down in a Saussurean semiotic account. In view of finding a semiotic model that easily allows neu-

[1] In my opinion, a musical unit can be anything that has influence on the definition of the associated concept, not just a musical motive or phrase but also, for example, the situation of the music in its culture, or related historical concepts that influence and form the present meaning. Traditional musical semiotic analysis as presented here does not interpret the "musical unit" quite that broadly.

[2] Saussure's founding text for the linguistic branch of semiotics (often referred to as "semiology") is the *Cours de linguistique générale* (1916) [current English translation: *Course in General Linguistics*, ed. Charles Bally and Albert Sechehaye, trans. and ann. Roy Harris, LaSalle, Ill.: Open Court, 1986]. The applications of Saussure's thoughts to extra-linguistic matters are often grouped under the heading "structuralism"; Claude Lévi-Strauss's work in anthropology is the best known example. A very compelling application of some of Saussure's ideas to music can be found in Victor A. Grauer, "A Field Theory of Music Semiosis I" [*Eunomios* 2000, available at http://www.eunomios.org/contrib/grauer1/grauer1.html]. I thank Mr. Grauer and Professor Mathew Rosenblum for presenting me with a print version of this article in the context of Professor Rosenblum's seminar on musical semiotics.

ropsychological propositions to enter my argument, I introduce a more differentiated view of signification modes, based on the work of Charles Sanders Peirce, later on. That model will allow accounting for temporal processes more easily.

Early music semiologists expressed an interest in what Nicholas Ruwet termed "explicit discovery procedures," that is, the inclusion of analytical decisions and their reasons in the analytical project.[3] Notably, such explicitness is absent in most culturally conditioned types of analysis such as Schenkerian analysis;[4] one knows what a phrase, a tonic key, or a set is, and how it might affect the piece, before one approaches the music material. Unfortunately, the movement towards the acknowledgement and founding of the analytical process stopped short of inquiring into the possibility of defining paradigms, the analytical representations of structurally salient musical units, from first (acoustic and psychological) principles. Usually, an effective paradigm (effective in the sense that by its employment in analysis a structural feature of the music is highlighted) will have been chosen due to the pre-formed idea that it may be useful. In the course of analysis, a more fortunate or opportune choice of paradigms may offer itself, leading to another round of paradigm characterization and renewed scrutiny of the music.

The methodology of semiotic analysis rests on the theoretical foundation of musical signification in a tripartite model, expounded by Jean-Jacques Nattiez in his book *Fondements d'une Sémiologie de la Musique*.[5] Nattiez differentiates three kinds of signification processes in typical musical signification: the poietic, the neutral, and the esthesic. The first, poietic, encompasses all influences on the musical piece, including the composer's work; the second, neutral, represents the compositional trace, that is, the score, or a recording when no notation is available; the third, esthesic, accounts for the reception and reception history of the particular piece. The separation of these three levels encourages analyses of the

[3]Nicholas Ruwet, "Methods of Analysis in Musicology" [trans. Mark Everist, *Music Analysis* 6 (1987): 3-37].

[4]For a description of the Schenkerian method, the reader is referred to Felix Salzer's book *Structural Hearing: Tonal Coherence in Music* [2 vols. New York: Dover Publications, 1962]. While the focus of Schenkerian analysis on long-range listening and on the derivation of structure from the listening process make it an inspiration for my own research, the methodological difficulties of meshing it with memory research foreclosed a more intensive engagement in this paper.

[5]Jean-Jacques Nattiez, *Music and Discourse: Towards a Semiology of Music* [trans. Carolyn Abbate, Princeton, N. J.: Princeton University Press, 1990].

neutral level in the fashion of Ruwet and does not sacrifice the standards of the scientific process demanded by Nattiez[6] while allowing to factor into signification the production and reception of the music. Analyses of the esthesic or poietic levels, not bound for structure and not under the pressure to yield reproducible results, are free to employ any method the analyst considers promising. For analysis of the neutral level, however, music semiologists have developed a preferred method, paradigmatic analysis.

3.2 PARADIGMATIC ANALYSIS

The graphical products of structuralist semiological analysis most often encountered in musicology are referred to as paradigmatic (or taxonomic) analyses. Paradigmatic analysis breaks the music under scrutiny down into small but sensibly chosen fragments, called "syntagms," which are ordered according to their resemblance of "paradigms," particular melodic or rhythmic patterns that inform large parts of the melody of the piece in question.[7] Normally, paradigmatic analyses render the melody in a table whose columns represent the paradigms and whose rows contain the occurrences of the syntagms in temporal order. Reading through each row from left to right and row by row from top to bottom, the original melody can be recreated. In a second step, borrowing from the linguistic methods of Saussure, successions of paradigms typical to the piece are noted and a syntax is developed. Thus, the piece's melody may in fact be reduced to a formula or diagram denoting the typical succession(s) of paradigms. Although the reduction to a formal logical expression is not often done, generally paradigmatic analysis attempts to understand the rules of succession between all paradigmatic sections of the piece.

At first view, paradigmatic analysis is the ideal analytical stepping stone for a project that attempts to deal with the parsing and memorization of extended melodies (or conceptual representations of these in the mind). However, both parsing and mnemonic representations

[6]For example, in his earlier article "Linguistics: A New Approach for Musical Analysis?" [*International Review of the Aesthetics and Sociology of Music* 4 (1973): 51-68].

[7]A very clear introduction to this method of analysis can be found in the fourth chapter of Jonathan Dunsby and Arnold Whittall's *Music Analysis in Theory and Practice* [New Haven, Conn.: Yale University Press, 1988].

of music pose problems that an analysis of the neutral level alone cannot answer. As we shall see, remembrance imposes on musical phrases hierarchies inherent in the functioning of human memory; sections of the music that seem to have the same importance in the score may not be retained by memory with equal fidelity. To hear the same motive twice does not mean that both instances are remembered equally well; to hear a succession of melodic segments in the same structural part does not imply their equal importance in terms of either the part's or the movement's structure in remembrance. Paradigmatic analysis thus suffers (at least in the analysis of musical memory) from a strong reliance on the visual compositional trace and the possibility to access the source, the neutral level, at the analyst's convenience. This is not so in the case of attending to a temporally limited, continuous performance. To develop a way of dealing with music from the *listener's* point of view, we will have to 'juggle' paradigms in a manner compatible with the abilities and limitations of human memory of extended, continuous processes. Hence, we need to consult neuroscientific research on memory before we can proceed to semiotic analyses.[8]

Furthermore, the description of the analytical process above already suggested that the discovery procedure may change; it is only natural that the analyst's view of the piece develops as he explores it. However, the trace of the semiotic analysis, such as a published paper, often does not acknowledge these changes because they do not offer information about the neutral level *per se*. But the changes in the process of listening to and analyzing the piece are themselves significant (pun intended!) evidence for the ways in which a piece encodes and transmits meaning. For example, certain structural features of a passage may only become available to the analyst once she has listened to that passage for a number of times (either thanks to the composer's repetition of it or thanks to the replay function of her CD player). Hence, traditional semiotic analyses often forgo parts of the semiotic process that formed the analytical concepts in the first place, an analytical endeavor that leaves parts of the discovery procedure *implicit*.

In contrast, we should pursue an analysis of the neutral level through our primary esthesic faculty, listening. Our sensory and intellectual experience of music through listening

[8]My attempts at the clarification of ritornello structure in the next two chapters are thus only preliminary attempts; whether a semiotic (in the Saussurean sense) analysis of mnemonically created structures is in fact possible remains to be shown.

provides the foundation for memorizing it; the memorized music forms the basis for the process we call "analysis of the neutral level." It is imperative that the constraints of the listening process be acknowledged, and that its influence be detected in the results of the analytical attempts in which we have been engaged naïvely for so long. Making all effects of memorization in musical analysis *explicit* may not be practically viable (each hearing of the musical example would have to be accounted for) but it could offer theoretical inroads into music understanding. I posit that the definition of syntagms, that is, their partition from other syntagms and their conceptualization through paradigms, while founded on features of human memory, is actualized through intervention of categories not contained in the neutral level but in older mnemonic traces. Therefore, I consider my project a neuropsychological-semiotic one: neuropsychology contributes the more refined vision of temporal structure in listening to music; semiotics offers a means of graphic representation, paradigmatic analysis, and a terminology that can be applied to the more varied situations posed by signification as a temporal process.

Regardless of the criticism expressed above, paradigmatic analysis can serve as a practical tool in the examination of musical memories. In the fifth chapter, I will suggest a segmentation of the first movement of BWV 1046/1 based on the discovery above that *Fortspinnung* material is perhaps less likely to be remembered than initial or cadential material. Even though paradigmatic analysis does not supply the reasons for the division into sections or the forgetting of Fortspinnung material or episodes, it still offers a means of representing the movement's structure such that it may be more pliable to analysis of mnemonic processes later on. Given that our discovery procedure does not derive from first principles but takes large amounts of Western music theory already for granted, we will have to properly introduce the most important theoretical issues before proceeding to tabulations and graphic representations of a ritornello movement, a task accomplished in the next chapter.

4.0 ANALYTICAL APPROACHES TO RITORNELLO STRUCTURE

4.1 RITORNELLOS AND EPISODES

The concept of ritornello, imported into instrumental music from the Italian opera aria, plays the role of unifying and structuring element in many first movements of Baroque concertos, among these the *Brandenburg Concertos*. Apart from its employment in opera and concerto, the ritornello as a structural principle found its way into so many genres of Baroque music that we may with some justification call it the primary means of temporal structuring in its time.

Etymologically, the term "ritornello" designates small sections of music returning within a movement;[1] sections of the movement not identifiable as ritornellos are commonly called "episodes." While the compositional principle is thus very simple, its realization in temporal structures provides ample challenge to the analyst precisely because the simple idea generates a wealth of possible parameters to consider. In particular, the ways in which the listener's mind is familiarized with the ritornello's melody and then follows it through the movement can resemble an intricate maze, with resting points here and there, hints and pointers towards the exit, obstructions, and possibly, a final resolution.

In concertos of the late Baroque period, the ritornello is defined as having three distinguishing characteristics: a recognizable theme, *tutti* instrumentation, and (at least in the initial and closing ritornellos) tonal stability.[2] The first is hardly surprising, given that re-

[1]The very earliest example of usage (from 1675) in the *Oxford English Dictionary* anglifies the word as "Returnello" [*Oxford English Dictionary*, 2nd edition, ed. John Simpson and Edmund Weiner, Oxford: Clarendon Press, 1989; accessed on 04 March 2004 through http://digital.library.pitt.edu/oed].

[2]Thus outlined, the definition can be found in many textbooks and articles, such as Martin Geck's "Gattungstraditionen und Altersschichten in den Brandenburgischen Konzerten" [*Die Musikforschung* 28 (1970): 139-152]. General information on ritornellos presented in this chapter has been taken from Michael

turn is usually signified by repetition of the ritornello's melody. One ought to note that not all parts of the ritornello need to be equally recognizable and that, in test cases like our earlier informal memory experiment, not all parts *are* equally memorable. Insecurity about the identity of currently heard music and its status either as ritornello- or as episodic material opens the door for the other two characteristics. The use of the *ripieno* section of the orchestra is a hallmark of ritornellos in late Baroque orchestral music. Consequently, a thicker texture of the music would indicate ritornellos and a thinner one episodes. Tonal stability seems to be not so much a prerogative of ritornellos in general as of the initial (and often the final) ritornello in particular. Straying from the tonic key, uncommon in the oldest forms of aria ritornellos, was more likely in concertos but still unusual. Texture and tonality thus enforce the identification of musical material as belonging to a ritornello section. Ideally, continual detection of textural and tonal cues together with the melodic line would allow the listener to orient himself in the movement's structure at will (at least regarding his present position in a ritornello or an episode). However, the helping hands of *ripieno* instrumentation and tonal closure can also obscure identification of a section's structural significance if they are used unconventionally.

Such unconventional use of texture and tonality makes the identification of the ritornello in Bach's *First Brandenburg Concerto* a particularly challenging task. A cursory look at the score reveals that textural density decreases slightly in m. 3, as the horns drop out, and that the music cadences in the dominant at m. 6/i. Texture in mm. 6-7 becomes even thinner than previously; orchestration seems to adopt an antiphonal alternation between a small subset of the orchestra (three or four instruments playing three melodic lines) and a larger subset of the whole ensemble (six instruments joining the smaller group, adding two more melodic lines). Textural density increases again from m. 8, with the continuous use of the full *ripieno* and the re-entry of first one horn and then both, until the ensemble reaches in m. 12 the strength it had in m. 1. Tonally, the piece modulates back to the tonic and cadences in the tonic key at m. 13/i. This cadence is followed by antiphonal exchanges as in mm. 6-7, but now involving the horns, too. The piece modulates towards the dominant again

Talbot's dictionary article "Ritornello" [*The New Grove Dictionary of Music and Musicians*, 2nd edition, ed. Stanley Sadie and John Tyrrell, London: Macmillan, 2001, accessed online on 03 May 2004 through http://www.library.pitt.edu/ articles/database_info/grove_music.html].

and cadences at m. 18/i. Only there can we discern an abrupt change of texture as would have been expected from the start of an episode. Yet, surely the ritornello would not end in the dominant key, and not after such a long stretch, involving several cadences, in the tonic and dominant, already? Moreover, texture already suggested a possible move towards a first episode in m. 6, and the grand finish towards the cadence at m. 13/i, a possible endpoint for the initial ritornello, is offset by the almost equally grand continuation. Examining our own analytical activity, we realize that the ruminations on texture and tonality in this paragraph were based on multiple references to the score; such rechecking is not possible as one listens to the movement. Practically, the two features we would expect to be our pillars of support in fact obfuscate the identification of the ritornello and, thus, endanger our ability to find our way through the movement as we continue listening.

I contend that the actual listening process, that is, the continual parsing of the movement into sections and their alignment with the concepts ritornello and episode, is sufficient for creating a mnemonic structure enabling the possible reconstruction of the movement in an aesthetically satisfying (though not necessarily complete) form. I believe, though, that the identification of ritornellos and episodes while listening does not primarily rely on the continual detection of textural or tonal cues. Rather, the delimiting or disjoining markers of initial and cadential motives serve to parse the movement and the succession of partitions favors particular patterns of memorization in the listener's mind, leading to hypotheses about the nature of the currently heard section and the sections preceding and following it. These hypotheses naturally change over the course of listening, leading to a processual rather than a static account of ritornello structure. To characterize initial and cadential motives from a listener's perspective and to determine their role in the creation of a mnemonic structure in the listening process is the practical analytical aim of this paper, an aim that, to make it sensible from the point of view of musical analysis, we will have to found on acute philosophical arguments. In the following sections, I will examine the roles of incipits and cadences in the determination of ritornello structure. The inherently processual nature of listening and memory formation will cause problems in the analysis based on the chosen graphic representation. The philosophical arguments enabling a true processual account of memory formation and an interpretation of the graphic representation in accord with the

nature of listening will be postponed until after the fifth chapter.

4.2 CADENCES AND INCIPITS

Generally, we may define a cadence as music that (in the common-practice period) ends a section of a piece. An incipit, similarly, may be defined as music that starts a section of a piece. In multi-section pieces such as ritornello movements, both are (with two exceptions) related sequentially: incipits follow cadences and cadences precede incipits. The two exceptions are, of course, the beginning and end of the piece in question: the initial incipit is not preceded by a cadence (belonging to the same movement), and the final cadence is not prior to another incipit of the same movement.

This working definition of cadences, incipits, and their relationships is of little use in more sophisticated musical analysis, because it does not define a range of sounds and sound combinations over which the terms "incipit" and "cadence" extend as designators. Hence, I proceed to a more generic definition and from this develop criteria for identifying cadences and incipits while listening.

The generic description states that a cadence is the "conclusion to a phrase, movement, or piece based on a recognizable melodic formula, harmonic progression or dissonance resolution"; the term extends to cover "the [music-theoretical] formula on which such a conclusion is based."[3] Given the voice-leading conventions of the Baroque style, dissonance resolution at the cadence is subsumed to a large degree in harmonic progression to a stable (or temporarily stable) chord, usually a tonic chord or an intermediate tonic chord reached through modulation and preceded by its own dominant chord. The relation between harmonic progressions at cadences and the melodic formulas used by the composer are critical to recognizing melodic segments in a memory task like the one we assume listening to be.

In memory and recognition tasks, listeners seem to concentrate almost exclusively on melodic cues; harmonic progressions or the coherence provided by placing music in a key are

[3]W. S. Rockstro, George Dyson/William Drabkin, and Harold S. Powers, "Cadence" [*New Grove Dictionary of Music and Musicians* 3: 582-586, 1st edition, ed. Stanley Sadie, London: Macmillan, 1980]. In my parlance, Rockstro *et al.*'s "phrases" are referred to as "sections."

of little importance.[4] It would thus be tempting to disregard harmony and tonality in the mnemonic analysis of music altogether. However, harmony does have an influence on the aurally outstanding melodic line paired with it: it constrains the choice of possible melodic pitches placed above each chord. In the majority of the musical piece, these constraints do not sufficiently limit melodic possibilities to easily memorable pitch patterns. At a cadence, though, in the last few moments before the reaching of the tonic, the typically limited number of underlying harmonies and baroque conventions of voice-leading conspire to limit the possible melodic shapes to just a few. Of these few, the composer can choose particular patterns to repeat, creating handles for memorization.[5] The same considerations about limitations of pitch choices can be applied to the beginning of a phrase. Again, the number of possible harmonies is limited (most likely to the current tonic chord to define the base for any subsequent tonal developments), and the melody will elaborate on these pitches rather than introduce prominent dissonances right away.

Tonality plays an equally oblique role in informing listeners' expectations. Rather than expecting any section to be in any particular key, the listener will notice whether or not the current section stays in the same key and will base her decision about the section's formal function on this observation. Notice that these influences of harmony and tonality are perceivable through listening to the melody only, without reference to vertical parameters; harmonic constraints become evident in the choice of pitches, tonal constraints in the approach to the final pitch of the section.

Having circumscribed the vertical limitations on pitches in the melodic material of incipits

[4]Irene Deliège *et al.*, "Musical Schemata in Real-Time Listening to a Piece of Music" [*Music Perception* 14 (1996): 117-159]. Deliège presents experimental evidence for the assertion that harmonic cues are less likely to be abstracted and memorized than melodic ones (which she calls surface cues); while musicians are more likely to choose harmonic cues, even in this group melodic cues provide the majority of mnemonic material (153-154). Similarly, tonal function helps the organization of stored or provided music material on the putative timeline of a piece very little, even though musicians again make use of tonality a little more than non-musicians (154-155).

[5]This indirect influence of compositional strategies like harmony on the memorability of a melodic formula is not touched by Deliège's observations. The importance of harmony for motive recognition is a result of the historical process leading from monophonic music to Baroque conventions. Listeners of the Baroque (and those of later times familiar with Baroque conventions by ear) possibly found melodies at cadences easier to memorize because they shared with the composer common assumptions about how melodies were supposed to behave in the vicinity of a cadence. At present, the chicken-egg question about the primacy of a composer's vision of harmony or a listener's understanding of its implications for melody needs to remain unanswered.

and cadences, we turn to the horizontal limitations, the general criteria for a cadence's or incipit's temporal extent. Generally, I assume an incipit's beginning and a cadence's end to be unequivocally clear. The former will start on the first downbeat of the phrase (unless this was partially or completely taken up by the final of a prior phrase's cadence) or on an upbeat preceding the first downbeat; the latter will end on the last beat of the last tonic (or tonicized) chord of the phrase. These outer limits, dividing incipit and cadence from the neighboring phrases, are of less consequence for memorization, however. More complicated is the clear designation of inner limits, places within the phrase where memory may disengage from the incipit or re-engage at the cadence. Given that structural judgements are passed on the basis of recognizing melodic rather than harmonic cues, memory content will not derive from the melody placed with the last chord or the first chord only; the snippets of melody (often only a single pitch, especially at cadences) are too unspecific to be memorable. Instead, memory content will range over the melody several chords, or several beats, within the phrase's beginning and end. What are the criteria for how far these melodic formulas extend into the phrase?

Current theories about Baroque compositional practice do not help me solve this question. Scholars like Laurence Dreyfus have promoted the *Fortspinnung* model as generative process for the movement.[6] In this model, the ritornello is divided into three sections, corresponding to the incipit, a section using the *Fortspinnung* process, and the cadence. The process of *Fortspinnung* creates a melodic line through modified repetition of a motive; modifications may include sequencing, changes of minuscule parts of the motive (such as single pitches), or chord changes.[7] It would be fair to assume that memory neglects the repetitions and latches onto the generating motive as memorable incipit. Similarly, the end of modified repetition and the occurrence of new melodic material before the cadence would incite renewed attention. However, we cannot presume *a priori* that the listener is aware of the *Fortspinnung* material's lack of importance. Neglecting *Fortspinnung* sections outright, with

[6]Laurence Dreyfus, *Bach and the Patterns of Invention* [Cambridge, Mass.: Harvard University Press, 1996]. Another current model for explaining ritornello structure in the same body of works, Jeanne Swack's "Modular Structure and the Recognition of Ritornello in J. S. Bach's Brandenburg Concertos" [*Bach Perspectives* 4 (1999): 33-53] pays somewhat closer regard to considerations of listening and perception but shies away from formalizing these ideas.

[7]William Drabkin, "Fortspinnung" [*New Grove Dictionary of Music and Musicians* 6: 725, 1st edition, ed. Stanley Sadie, London: Macmillan, 1980].

little knowledge of the actually memorable cues in the currently heard music, might lead to confusion later on; the listener should thus safely store the *Fortspinnung* at least for the initial ritornello. In memory practice, this does not happen. My memory experiment earlier showed storage problems in the *Fortspinnung* sections of the first few measures already.[8] The process of *Fortspinnung*, thus, seems to be not a cause for but in coincidence with lack of memorability.[9]

Which factors other than *Fortspinnung* procedure could indicate to the listener the end of an incipit or the beginning of a cadence? We established that the melodic formulas, to be distinct and memorable, need to extend beyond their starting or closing harmony. In a cadence, the penultimate harmony (usually in dominant function to the cadencing harmony) provides more time for a memorable melodic segment to unfold; often, the harmony in question extends over the measure or half-measure before the cadencing downbeat. Often but not always, the penultimate harmony coincides with a more distinguishable rhythm. Quick passages of many notes with equal note-values are replaced by a larger variety of note-values, often including dotted rhythms and grace notes or ornaments. In BWV 1046/1, the preparation of the cadence at m. 13/i is exemplary: in m. 11 of the violin part, the first beat contains a dotted eighth-note thrice longer than the previously predominant sixteenth-note motion; it is followed by the thirty-second-note ornament on the third beat and another dotted eighth-note on the fourth beat; the latter two ideas recur in m. 12, leading to the otherwise unmemorable cadencing downbeat of m. 13. If our memory concentrated strictly on the downbeat, this cadence would be forgettable; by ranging over the way towards the cadence, the melodic formulas employed can become memorable signs for larger structural sections.

Rhythm and harmony thus conspire to engage our attention towards the end of sections by following compositional conventions. Similarly, the ends of incipits are signified by a move away from the initial chord and an evening-out of the rhythmic motion. This may or may

[8] These were mm. 3-4, 8-10, and 16 in Figure 1; I still operate under the assumption that the extent of the ritornello is not completely clear. Note the higher mnemonic accuracy prior to and after cadences, though.

[9] Probably, the relation between *Fortspinnung* as a compositional procedure and *Fortspinnung* as a mnemonic sign is the same as between harmonic progressions as compositional trick and as sign for a cadence. In each case, compositional choices and listening expectations support each other's influence on the music and questions about the primacy of either would be premature or misguided.

not coincide with the beginning of *Fortspinnung* procedure; for my argument, *Fortspinnung* is not a necessary condition for lack of memorability. Therefore, *Fortspinnung* parts of ritornellos and episodes will be neglected; only incipits and cadences will become the basis for tabulations and graphs of ritornello structure.

4.3 THE HALLMARKS OF GENERIC RITORNELLO STRUCTURE

The reader will have noticed that I was careful above not to provide a clear defining moment for the ends of incipits or the beginnings of cadences. In each case, I assume that there is some latitude in deciding which segment of the melody belongs to which part of the musical section under scrutiny. This latitude allows for the listeners's variable familiarity with conventions of the music's style, their concentration when listening to the piece, and most importantly, differences in the performance attended to. If particular instruments are stressed more than others, the listener will likely remember their melodic lines better. Hence, different performances even of the same score may result in different memory images. Given the general criteria for melodic formulas in cadences and incipits advanced here, though, the temporal positions of both will be less arguable and, hence, the emerging perception of structure less variable.

The variability of individual perceptions of melodic formulas in incipits and cadences creates a problem for the designation of these formulas in graphic representations. (Instead of "melodic formulas in incipits and cadences," I will henceforth only use "incipits" or "cadences." The reader should remember that these terms now refer to stretches of melody, not only to the initial or the final cadencing pitch.) In paradigmatic analyses, the beginning and end of individual syntagms is usually very well defined; to presume such well-defined-ness in representations of putative perceptions of incipits and cadences would be unfair. Nevertheless, incipits and cadences are clearly distinguishable entities, hence deserving of separate labels. In graphic and tabular representations, I chose "Inc" for incipits, "Cad" for cadences. Usually, these markers are followed by a label for the section to which they belong, such as "IncD" for the incipit of section D. When measure numbers are desirable, for ease of reference to the score, I decided to treat the two types of melodic formulas differently. For incipits,

Table 1: Incipits and Cadences in an Idealized Ritornello Movement

Incipit	Cadence
IncR	CadR
IncE1	CadE1
IncR	CadR
IncE2	CadE2
IncR	CadR
IncE3	CadE3
IncR	CadR

the measure number indicates the measure when the incipit starts (not counting upbeats). For cadences, since the memorable portion of the melody happens before the downbeat of the actual (harmonic) cadence, I decided to defer to memorability and chose the measure number of the penultimate beat (or chord) of the cadence; the concluding downbeat of a cadence designated with the measure number "7," for example, thus actually occurs at m. 8/i. (Cadences on a weak beat of a measure will be designated by the number of this measure.) For reasons given in the previous paragraph, the extent of incipits and cadences into their section will not be represented by measure numbers.

Armored thus with a means of designating the incipits and cadences in a ritornello movement, we can now move towards the observation of ritornello structure. I will start with a generic example to point out the primary features of the ritornello process and their implications for memorization before moving towards our actual example, BWV 1046/1.

In Table 1, I have outlined the idealized structure of the movement type with a ritornello (R) and three mutually different episodes (E1, E2, and E3). Measure numbers are obviously of no use in this example. The incipits and cadences were put in separate columns, arranged such that after each cadence a new row starts. Reading left to right along the rows and down row by row, the original temporal succession of incipits and cadences can be recreated. Ideally, the arrangement according to division by cadences should allow the easy

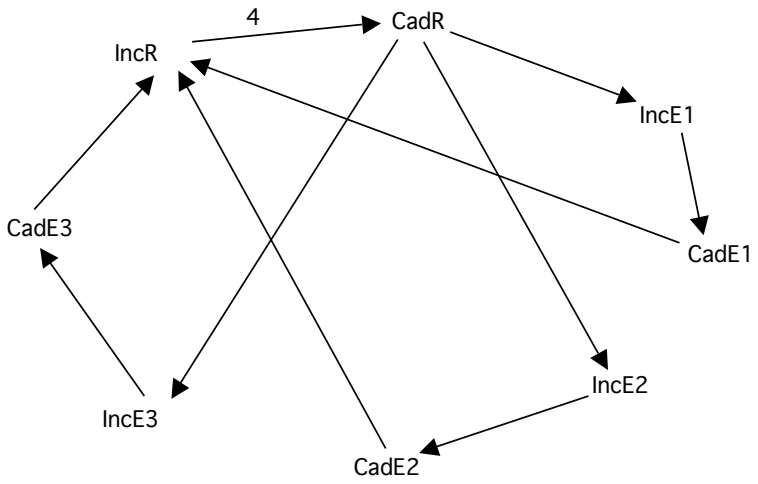

Figure 3: Successions in the Idealized Ritornello Movement

identification of ritornellos and episodes, since these formal sections alternate, since they each have identifiable incipits and cadences, and since the movement customarily begins with a ritornello. As we can see, the idealized movement divides nicely row by row into seven formal sections, with the ritornello repeating three times and the episodes interspersed. Drafted along a line representative of the passing time from left to right, the movement would present itself as

R - E1 - R - E2 - R - E3 - R.

A formulaic expression could be derived easily but would not elucidate the structure or the problems encountered by memory.

In the tabular representation or the timeline approach, each incipit or cadence is clearly situated between its neighbors. The choices that memory is presented with when reconstructing the movement from the listening experience are not apparent. Therefore, I present one other graphic representation which brings some of the issues in remembrance to the fore.

Figure 3 is a chart of the idealized ritornello movement from Table 1. The arrangement of the paradigms in a clockwise circle in the order of appearance caused the least confusion in the drawing of arrows; hence, it has been applied to all future figures of this kind. Paradigms

immediately temporally adjacent to one another have been connected with an arrow in the appropriate time direction. If one paradigm follows another several times, a number next to the appropriately pointed arrow indicates how many times this succession occurred. I did not specify the absolute temporal order of syntagms, numbering their occurrences for each paradigm, because this information can be easily derived from Table 1 and because providing the absolute temporal order obscures the problems that memory may have reconstructing it.

We can see that, in this overly simple ritornello structure, the succession representing the ritornello (stretching from IncR to CadR) is the only one occurring multiple times. Just by virtue of its repetition, the ritornello thus has prominence over the episodes and should be remembered better than they. The connections from the ritornello to the episodes are less clear. Notable is the structure of three intersecting cycles of ritornello-episode succession, with the ritornello the point of intersection between the three cycles. But the exact order of the episodes in remembrance is not evident. If this graph is indeed a representation of the ritornello structure in memory, CadR may be followed by any of IncE1, IncE2, or IncE3. Remembrance of the movement in the order presented in the score and in performance is not a necessary result of listening. Assuming that remembrance takes place after a complete listening, two possibilities seem more likely than others: either the last episode is recalled because it is the most recent one, or the first episode is recalled because it is the one immediately following the strongly remembered ritornello. Both cases are equally valid, given what we know about memory of temporal succession. In fact, the likelihood of remembering one episode rather than the other may change with increasing temporal distance from the listening event. A final decision on which kind of remembrance is more likely can only be made knowing the memorization process (that is, the listening process) and the external circumstances (that is, the biographical distance from the time of listening to the time of remembrance). The critical and least theorized factor is the process of memory formation that happens during listening. As I do not have any data about this process available for the idealized ritornello movement, I will now turn to a real example, the successions of incipits, cadences, ritornellos, and episodes in the first movement of BWV 1046.

5.0 RITORNELLO STRUCTURE IN BWV 1046/1

Guided by my private perception of the movement, Table 2 shows the thirty-one instances I consider to be of formal relevance in the memorization of the movement. Conventions of tabulating are the same as for Table 1; when several incipits followed one another before a cadence, these have been listed in the same row. As previously, reading through each row from left to right and row by row down, the timeline of the movement can be reconstructed. I have avoided the "ritornello"/"episode" labels for now, simply using letters from A to E for the different sections. The reader will note that I have decided not to apply labels consecutively; CadE should be called CadD but, as it immediately follows IncE, I have chosen to name it in accordance with the most recent new incipit. Measure numbers are included based on the observations about the extent of cadences and incipits made above. Hence, for each incipit, the measure number indicates the measure of the first downbeat; for each cadence, the measure number is that of the measure before the cadencing downbeat.

My attempt to group the syntagms of the movement in different paradigmatic classes depended on many decisions that could, under regular circumstances, be considered problematic. For example, the copiously identified paradigm CadC, first heard in m. 17, points to one very obvious problem. (The reader is encouraged to engage the score.) CadC reappears in guises that may be considered sufficiently unlike the original to warrant a separate label. Characteristic for CadC is, in my opinion, the approach to the new tonic pitch *C* played by the horn. At least in the recordings I consulted, the horn seemed the most outstanding part and its pitches, therefore, became indicative of the cadence. In one of the potentially questionable cases (m. 47, identified as CadA), the second violin uses roughly the same figure as the horn in m. 17, considered to be CadC. However, in m. 47 the first violin plays a slightly higher version of the characteristic melody of CadA, doubled by the *violino piccolo*. Hence,

Table 2: Incipits and Cadences in BWV 1046/1

Incipit(s)	Cadence
IncA (1)	CadA (5)
IncB (6)	CadB (12)
IncC (13) & IncA (15)	CadC (17)
IncB (18)	CadA (23)
IncD (24) & IncA (27)	CadB (32)
IncE (33)	CadE (42)
IncA (43)	CadA (47)
IncD (48)	CadC (51)
IncA (52) & IncD (53)	CadC (56)
IncA (57) & IncC (58) & IncA (60)	CadC (62)
IncE (63)	CadE (71)
IncA (72)	CadA (76)
IncB (77)	CadB (83)

this syntagm has been relegated to paradigm CadA, not CadC. While this choice seems to be the most sensible in my opinion, it illustrates that identification of any specific syntagm as model for a paradigm as well as the subsequent recognition of any syntagm as an instantiation of the established paradigm are quite dependent on performance choices. A different performance or recording, with different stresses, might result in a different paradigmatic chart. Furthermore, apart from performance issues, the example illustrates once again how important the first occurrence of any paradigm (be it a cadence or a complete section) is for the later structuring of the movement. Insecure memorization implies insecure remembrance.

Another problem is posed by the chosen differentiation between CadA and CadB. Could we not consider them the same? My reason for keeping the distinction between the plain and the embellished version of this pair is quasi-autobiographical. In the paper that formed the source for this inquiry,[1] I assumed that the two versions played a role in signifying to the listener the fraction of the movement already heard. A short comparison of measure numbers will show that CadA reappears after roughly a quarter and at the halfway point of the movement, while CadB reappears halfway between the second and third appearance of CadA and, obviously, at the end of the movement. I had hoped to interpret this succession as an aural unfolding of the ritornello's two-section structure at two larger scales in the movement itself. Now, thanks to more research into mnemonic structures, I have become considerably warier of such assertions. To assert unfolding as a mnemonic structural principle, we will have to uncover how mnemonic structures are formed, a task only partially completed in this paper. The distinction between both versions of the cadence has been kept, though we shall consider the two paradigms sometimes as similar, at other times as distinct, depending on the strictures of the argument.

Given the tabular representation of BWV 1046/1 in Table 2, we can perform a translation into a graphic representation similar to that of Figure 3. Figure 4 does this. The conventions are the same as in Figure 3 with one addition necessitated by the more complex processes in BWV 1046/1. Double arrows (connecting two paradigms in both directions) indicate separate successions between the two paradigms in both time directions, at one time the second paradigm following the first, at another time the first following the second.

[1] Breuer, *op. cit.*

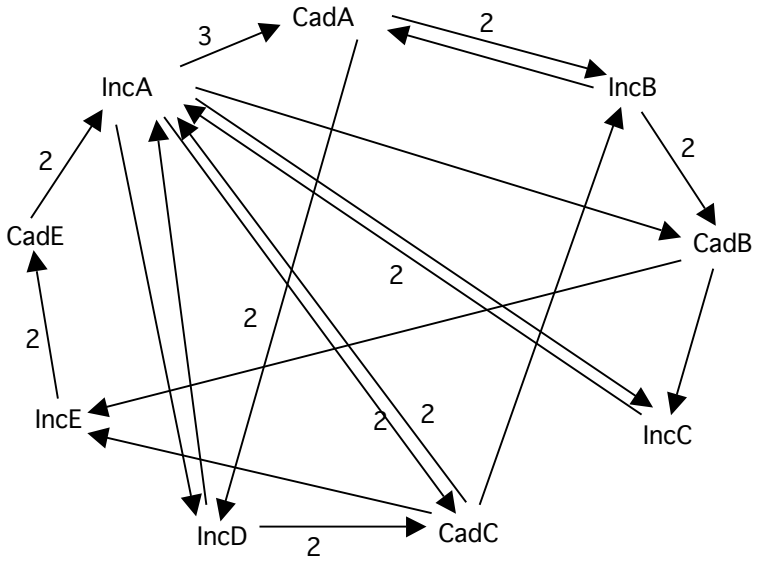

Figure 4: Successions in BWV 1046/1

The higher complexity of the movement is not surprising but it may impede easy recognition of the mnemonically important parts. The most common succession, occurring thrice, is that between IncA and CadA; hence, we might consider section A to be the movement's ritornello. Comparison with the score reveals that section A, while starting the movement and thus by convention part of the ritornello, actually cadences in the dominant (at m. 6/i). Mildly put, a tonally open initial ritornello in the Baroque style would be highly unusual. Hence, we are forced to consider section A together with the following section, B. The latter does in fact move back towards the tonic key, cadencing at m. 13/i. But in terms of temporal succession, the connection between the two parts and the relevance of B is questionable. The successions CadA-to-IncB and IncB-to-CadB both occur twice but so do many other successions, for example, those connecting section E to the putative ritornello and those connecting the ritornello incipit to what surely has to be episodic material (from sections C and D). By force of number, the composite ritornello A-B does not convince. Is CadB, in fact, remembered strongly as final ritornello cadence or does the ritornello's two-sectioned structure de-emphasize CadB? We remarked already that the instrumentation does not change

markedly until m. 18, so a listener might be tempted to consider section C on equal par with section B, the changing tonality notwithstanding. And even if one were to proceed with the hypothesis of continuous, strong connections as signs of ritornello material, what mnemonic function would one accord to section E? Judging purely from the graph, it might be considered a section of the ritornello although a listener would likely not come to the same conclusion, having heard the beginning of the ritornello at the beginning of the movement. As it clearly leads into the ritornello, we may well consider it a preparatory section. Would this suffice to mark it as episode? The strength of connections seems to be one indicator for the ritornello but certainly not the only or defining one.

The problems of definition are even larger when we look to immediate temporal succession as a marker for putative ritornello and episodic paradigms. One problem looms in the paradigms that we would generally consider parts of the ritornello: the succession CadA-to-IncB, though occurring twice, is countered by a succession in the opposite direction, IncB-to-CadA. If memory takes temporal succession as the basis for its construction of structure, this double arrow would indicate conflicting information about succession and, hence, a possible confusion of memory when called upon to remember the succession of paradigms CadA and IncB correctly in a given situation. One might say that, in the mnemonic structure created by the listener's mind, these successions cancel each other out. Another problem caused with regard to immediate successions arises in the paradigms assigned usually to episodes: IncC is more likely followed by a ritornello incipit, IncA, than its associated new cadence, CadC. Should we therefore consider it an episode, but the following section (IncA-CadC) a ritornello? CadC, however, does not only end sections that could be ritornellos but also others that are clearly episodes, for example those starting with IncD in the latter half of the movement. At best, after considering several possibilities, we might say that CadC has dual use as ending to ritornellos and to episodes. The only safe criterion for episodic material seems to be "anything but ritornello material," and this criterion does not allow easy application while listening to the movement and trying to orient oneself in it. Judgments about the dual nature of paradigms, like those made here, are possible only by virtue of hindsight, an option not available during listening.

Two problems from the previous discussion, the likelihood of using a particular succession

and the confusion created by mutually canceling successions, both point to graphic modifications that can be applied to Figure 4.[2] While they will not resolve the central problem of getting a grasp at the creation of structure in listening, they show that principles similar to those in Figure 3 are at work in BWV 1046, too.

Where would explicit concentration on multiply occurring successions lead us, assuming that they are actually lodged more securely in memory? This general idea has a scientific corollary in memory theory in the model of information storage developed by the neurophysiologist Donald O. Hebb.[3] Hebb suggests, in the roughest rendering, that mnemonic connections are more pronounced (and remembrance eased if it proceeds along them) if they are used multiple times. What Hebb originally intended to apply to the physiological reality of nerve cells in the brain we may apply to the network of conceptual connections rendered here. Assuming that repeated use will secure remembrance, we sever all successions that are used only once, however important for the structure and for the memorization of the movement they might be. The resultant graph is rendered in Figure 5.

Applying Hebbian principles to the idealized ritornello movement would leave us solely with the ritornello. There, the ritornello is clearly the most stable section and, it seems, the only thing worth remembering. Of course, in reality our memory does not work quite as formulaic and it is more dependent on the passing of time than a simple deletion of all singular connections, whenever their occurrence, would suggest. Yet, the simplified graph for BWV 1046/1 offers some insight into ritornello structure and the limitations of graphing temporal successions of motives as I have done it in the previous figures.

The apparent stability of the ritornello, obvious in the idealized example of Figure 3, is reflected in the real example of Figure 5 by the stretch of paradigms

IncA - CadA - IncB - CadB,

all connected in order and occurring thus at least twice, in the opening and the closing

[2] In BWV 1046/1, the first twelve measures are conventionally considered to be ritornello material. Scholarly opinion is generally in agreement on this notion; for example, see Dreyfus or Geck, *op. cit.* Since we currently evaluate the success of different modifications of the graphs on the characterization of the ritornello, we will assume the identity of the ritornello as sections A and B known.

[3] The original presentation of Hebb's ideas can be found in his *The Organization of Behavior: A Neuropsychological Theory* [New York: Wiley, 1949]. A recent appraisal of Hebb's role in the neurosciences is R. E. Brown and P. M. Milner's "The Legacy of Donald O. Hebb: More Than the Hebb Synapse" [*Nature Neuroscience Reviews* 4 (2003): 1013-1019].

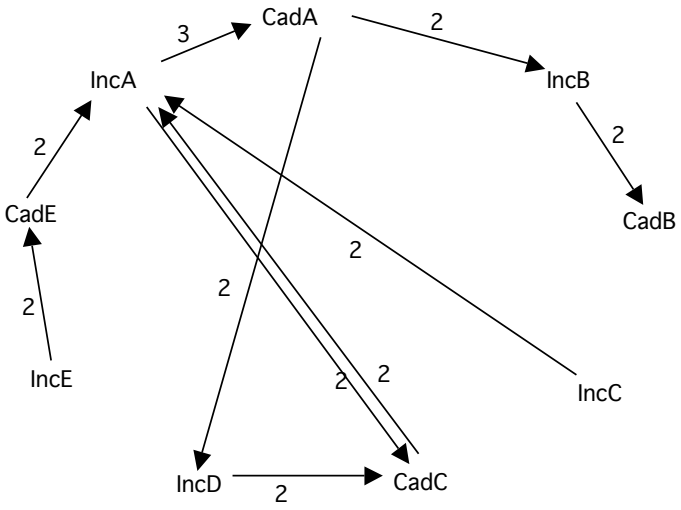

Figure 5: Hebbian Simplification of Successions in BWV 1046/1

ritornello. However, the graph does not reveal anything about the paradigms's order of appearance. Section A and section B could have been presented apart from each other and the connection between CadA and IncB could have been established at a third instance, separately from the other two connections. Granted, it is not likely for such a complicated process to happen twice (and a third time for the establishment of section A). However, the grouping of the sequence of paradigms into a ritornello based on the graph would not be acceptable without further, larger-scale clarification of successions. The movement would need a second listening and a second round of graphing, where the focus is now not on successions of paradigms but on successions of successions of paradigms. While this may be an analytical possibility worthy of pursuit, it is not open to the listener who attends usually just one performance and has to identify and order paradigms at first hearing. If one is interested in a listener's perspective, one should tailor one's analytical method to the means available to the listener.

Let us now turn to a closer look at mutually canceling successions. Given that they raise confusion when interpreted by the listener in the act of remembrance, we might exclude them on the grounds that recall only operates with unequivocally unidirectional successions.

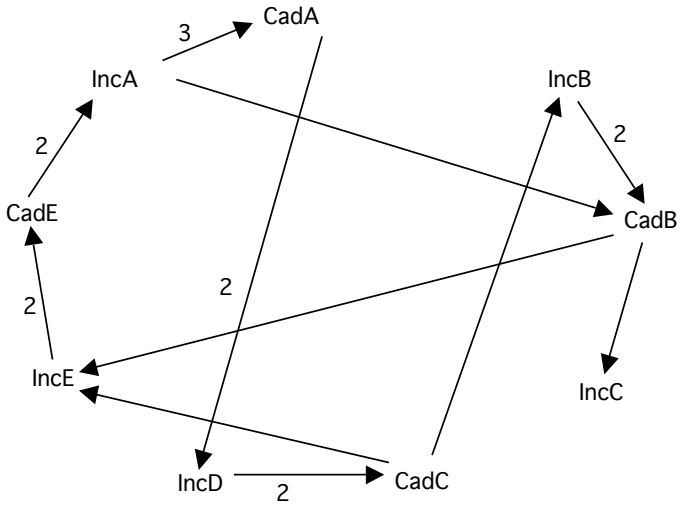

Figure 6: Unidirectional Successions in BWV 1046/1

Figure 6 is a simplification of the information on temporal successions provided in Figure 4, having deleted all bidirectional successions.

Proceeding to an examination of the sections commonly considered the ritornello (A and B), we can assign to either section a separate cycle of ritornello-episode interactions (similar to the cycles in Figure 3 that lead from the ritornello to the various episodes). Section A derives its power as a ritornello from interaction with sections D (observed at the end of the above discussion of the movement's beginning) and E. Section E is the most likely to precede section A in its guise as ritornello. Section D has a somewhat more ambiguous relationship, given that IncD both introduces IncA and follows CadA twice. Still, we can establish a preferred cycle of ritornello-episode succession for section A:

IncA - CadA - IncD - CadC - IncE - CadE - IncA - CadA.

Similarly, section B has an episodic equivalent in section C. Here, the cycle is as follows:[4]

IncB - CadB - IncC - (IncA -) CadC - IncB - CadB.

[4]In cases where the actual occurrences of neighboring paradigms (such as IncC and CadC) are separated by incursion of another paradigm (such as in the common sequence IncC-IncA-CadC), I suggest that remembrance will preferably reconstruct the succession from IncC through CadC, regarding IncA as distracting material. This assumed, the interspersion of IncA does not threaten the identification of section C as episode.

Both cycles of ritornello-episode interaction share CadC, and the cycle involving section B has at least a tendency to lead towards the cycle involving section A (note the alternate connections from CadC and CadB to IncE), thus confirming A as a gravitational center of the complete ritornello structure.

If we apply to Figure 6 the same Hebbian premise as to Figure 5, we arrive at a sparse structure in which sections B and C are isolated, while sections D and E are still defined in their episodic character through direct association with the ritornello section A. (The graph has not been prepared; the reader is invited to make his or her own sketch by deleting all single connections in Figure 6.) Although we might consider Section B a part of the ritornello based on evidence in harmony (returning to the tonic) and texture (returning to the full texture of the beginning), its isolated position with respect to both episodic and other ritornello material make it a more problematic part of the movement's structure than could be gathered from studying the score. Yet, its strong presence in the recalled initial moments of the movement in Figure 1 provides ample evidence that section B, by likelihood of recall, is not distinguished from the structurally clear ritornello of section A. Therefore, the arguments that led to the simplified version and its elucidation of structure cannot be transferred into the domain of arguments for or against a certain listening practice.

The outlined confusions and observations, while perhaps having been overdramatized to make a point, do not harken well for a general definition of ritornello and episode based on the graphs and tables examined. The figures are a representation of temporal succession of motives in the movement congruent with that of any score. The modifications according neuropsychological theories like Hebb's did not change the methodology, they only interpreted the results. While discarding *Fortspinnung* material and avoiding ambiguous motivic successions, we are still fundamentally involved with a representation that could be derived from the neutral level according to Nattiez-style semiotics. Under the influence of memory, not all successions of material are equal, and the criteria for more and less important syntagms, *vulgo* memorable and forgettable motives, still need establishing. The filter of the esthesic level, our listening and memory formation process, has so far only helped paring down the material. It has not been involved in the structuring of the material into a coherent, memorable whole.

Paradigmatic representations of ritornello structure as in Table 2 have a central flaw: they do not simply present paradigms but a concatenation, or superposition, of types of paradigmatic relations. The first type of relation operates on the scale of sections, ordering the parts of each section (incipit, cadence, and other not explicitly memorable material) into a succession of motives. The second type of paradigmatic relation governs the scale of the complete ritornello movement, ordering its parts (ritornellos and episodes) such that after completed listening the ritornello structure of the movement is represented and ready for remembrance in the listener's mind. Neither paradigmatic relation creates "ritornello structure" (the graphable component of structure) or "ritornello process" (the changing opinion about structure formed in the process of listening) by itself. Rather, both paradigmatic relations, by determining the succession of paradigms on their temporal scales, conspire to inform the listener's mind as she proceeds through the movement. Only gradually does a representation of the structure emerge from calibrations between the two scales and their constituent parts in the ritornello process.

Therefore, we should not attempt to elucidate movement structure *through* section structure as we did above. Rather, we need to determine how the paradigmatic relations of these two scales interact during listening. To this goal, paradigmatic analysis and Saussure-based music semiotics cannot contribute.

6.0 PEIRCE - BEYOND LINGUISTICS

The problems of analysis outlined in the previous chapter convince me that semiology, at least in the guise of paradigmatic analysis usually applied to music, does not provide a terminology variable enough to accomodate the manifold ways of signification possible in mnemonic processes. In Saussure, the primary signification relation exists between the signifier (a language expression) and the signified (an object). This binary definition of the sign relationship, transferred onto the time axis, would allow for discrete semiosis only, that is, plain connections between sign and object of a lexical nature. A sign becoming associated to an object (say, by preceding it and being fixed in memory as a precedent sign) could only have one possible meaning; changes of meaning or double meanings would not be easy to explain and the dependence of meaning on the temporal situation that we can observe in our daily lives would necessitate terminological contortions. Hence, even though my approach owes its music-analytical precedents to Saussure's semiology, I will adopt the terminology of another branch of semiotics that is more capable of dealing with extended temporal processes; this version was introduced first by the American philosopher Charles Sanders Peirce.

According to Peirce, a sign is "something that signifies something else [the object] to someone in some way."[1] The way in which the sign signifies to someone Peirce calls the interpretant; in the words of Turino, the interpretant is "the *effect* created by bringing the

[1]Peirce's semiotic work appeared over a number of years in several papers, most of which are compiled in *Collected Papers of Charles Sanders Peirce* [ed. Charles Hartshorne and Paul Weiss, Bristol, U.K.: Thoemmes, 1998]. The present application of Peirce's terminology is based on the introduction given in Thomas Turino's "Signs of Imagination, Identity, and Experience: A Peircian Semiotic Theory for Music" [*Ethnomusicology* 43 (1999): 221-255]; in the present quotation (222), Italics were omitted because in the source the whole definition was italicized.
During the writing and revision of this section, Professor Jonathan Sterne's explanation of Peircian semiotics in the concurrently taken class "Music and Communication" was of great help.

sign and object together in the mind of a perceiver."[2] In more pedestrian terminology, the interpretant is the meaning of the sign with respect to object and perceiver.

The introduction of the interpretant into the signification process (which amounts ultimately to an objectification of meaning) catalyzes an interesting phenomenon quite unthinkable in the Saussurean model, semiotic chaining: Due to the fact that an interpretant may itself become a sign in another step of signification leading to the involvement of another sign and the production of a new interpretant, and due to the second fact that this process may theoretically continue *ad infinitum*, semiosis may indeed involve more than just the relation between a sign and its signified object, a plain, lexical, Saussurean meaning. In Peircean semiotics, signs may acquire multiple meanings throughout the signification process and this process has the temporal extent which we required earlier. The idea of chaining opens to analysis extended processes that may include, for example, sets of historical events, the decisions of individual members in a society, successions of musical events (my focus later in this paper), or indeed any kind of intersection between these and other sets of objects. The temporal extension of many cultural practices (one may think of rituals or ceremonies, or of the transmission of cultural traits by teaching) and the encompassing of many divergent or even contradictory impulses in one cultural action now become accessible to semiotic description through a continuous process of signification, semiotic chains.

Peirce distiguishes between three principal modes of signification, firstness, secondness, and thirdness.[3] Firstness describes a signifier whose signified is not precisely defined and whose meaning, thus, has yet to be determined; the sign can still mean anything conceivable, barring, of course, limitations of perception and logic. Secondness represents the coalescence of several firstness-signs into a compound experience, an event; an example would be the space-time event as defined in relativistic physics; the coordinates of the event in the three spatial and one temporal dimensions, as signifiers, coalesce to signify the event itself. Thirdness is the lingual and lexical representation of the sign in a word (hence, signs of thirdness are the equivalents of the Saussurean, lexical sign). These varied modes are, of course, subject to chaining: the interpretant of a sign becomes a sign itself in another significa-

[2] *Ibid.*; Italics original.

[3] Turino, "Signs," 231; however, my rendering of Peirce's terms here has been heavily influenced by Jonathan Sterne's explanation (see above, note 1 on page 39).

tion relation. Peirce assumes that each higher category encompasses the respective lower one(s); the interpretants of firstness and secondness signs function as signs of secondness and thirdness, respectively.[4] A sign of secondness is equally a sign of firstness; events are both compound signs and themselves unfixed signifiers. A sign of thirdness (that is, a word or concept) is both a compound sign (of the phonetic values and the associated meaning), and a signifier that may come to signify a separate and different signified (for example, when a word is dissociated from its accustomed meaning and used as a metaphor).

By applying these three basic modes of signification to signs themselves, to the sign-object relationship, and to the interpretant, Peirce arrives at a highly structured philosophical view of perception, signification, and thought-expression, respectively, where each of these means of interacting with one's environment has its own firstness, secondness, and thirdness categories. It suffices for my exercise to mention the most commonly used, second of these trichotomies, that of icon, index, and symbol. Iconic sign-object relations imply that sign and object are connected because they share the same contingent reference space: an iconic sign has the same general features as the object to which it refers. Indexical signification implies a causal or coincidental relationship between sign and object: the sign and its reference are connected through temporal co-occurence (which, to remind ourselves, is David Hume's interpretation of causality). The third, symbolic relation is purely conventional: a succession of phonemes or letters is associated with a particular concept.

Peirce's structured (though not primitively structuralist) exposition of semiosis allows a wider range of objects to be considered significant and averts some troubles of the Saussurean approach. For example, signs may now have multiple meanings. Although the Saussurean model did not exclude this possibility explicitly (there are, after all, several meanings listed for many words in, say, the *Oxford English Dictionary*), the implication was that the discrepancies were historically (diachronically) or culturally (synchronically) caused and that they implied (and necessitated) the existence of a root signification (that is, a primary association of sound and object) from which the modern meanings derived. While this may very well be the case in most languages, musical signs (however one would wish to define these as a category) are notoriously difficult to fix. Turino points to the multiplicity of

[4] *Ibid.*, 232.

meanings assignable to an object through repeated indexical signification.[5] A specifically musicological advantage of applying Peirce's semiotic theory is the possibility to account for emotional responses to music as part of the signification process; Turino interprets emotions as "rhemes," interpretants in the mode of firstness (as immediate results of signification, not consciously tied to a particular event).[6] If firstness, secondness, and thirdness can be cast in a temporal veil, even the listener's emotional response could eventually be factored into an understanding of music.

More to the point of music-historical inquiries, Peircian semiotics unravels the problems of a popular model of communication that, if not explicitly, also finds its way into musicological arguments: music is often seen as message that codes for meaning and transmits this between its sender (the composer) and its receiver (the listener). Of course, this bears more than a passing resemblance to Nattiez's poietic, neutral, and esthesic levels of signification. If we assume this model for the transmission of musical meaning, then encoding and decoding have to observe a certain fidelity, which in nineteenth- and twentieth-century musicology was ascertained by the claim of privileged modes of encoding (authentic composition by a privileged sender, the genius-composer) and decoding (by an experienced analyst or a competent listener); the message was, of course, the ill-defined musical work. Today, we hold that the will of the composer is no longer the only, or even major, influence on the significative potential of music; and understanding music through the musical work, while still a means of conceptualization in musicology, has become much less restricted to a class of cognoscenti. Certainly, musical meaning is not restricted to well-educated, acculturated listeners but open to all.

We are now armed with a terminology for signification that goes beyond the binary model of signifier and signified with just a single kind of signifier-signified relation. One vexing conceptual problem in the analysis of temporal succession in music is the relation between musical references and time, and between the present act of remembrance and the past act of listening which provided the references for memory. To clear the way for an inspection of how these references are put to use in time (the actual process of memory

[5] Turino, "Signs," 235.
[6] *Ibid.*, 238.

and meaning formation), we will have to identify of what general semiotic kind references are. Only thereafter can we examine how these references are manipulated by the actions of memory and which other signification processes play a role in memory formation.

7.0 SIGNIFICATION AND TIME

To approach music (or any temporally extended happenstance) as a temporal phenomenon influenced by memory, we need to define the nature of the units which are manipulated by memory. This involves both their description and the characterization of their reference space. Considering the semiotic bias exhibited in this inquiry, we should consider them signs, with distinct referents and modes of signification (modeled on Peircean semiotics). Considering that they are signs, they will signify something, an object (or a set of objects) we call the reference space of temporal succession. Our present quest will thus be directed towards a feasible signification process for the creation of the temporal construct upon which we base meaning. In the reference space created by this basic signification process, three conditions ought to pertain: (i) we ought to be able to distinguish signs from each other and from their referents; (ii) we ought to be able to identify and differentiate between iconic, indexical, and symbolic signification relations acting upon those primary signs; and (iii) given our desire to analyze temporal successions, we ought to be able to distinguish between before and after, to establish the order of temporal instances unequivocally.

An innocent adaptation of the third requirement, and the old adage that music is an art happening in time, may suggest time as the primary reference space of temporal signification in music. Time is usually considered by us to be an irreversible, continuous process. Ideally, irreversibility (or unidirectionality) ought to allow the designation of before and after. However, once we try to define signification in this particular continuum, the two concepts of time and sign will collide. As we shall see, time has only a very limited influence on temporal signification and only very specific ways of signification are capable of providing the constituent units of memorization, the substrate of remembrance.

The central problem for the identification of the reference space with time itself is time's

nature as a continuum. Once we assume a continuous reference space, the distinction between iconic and indexical signification becomes blurred. An icon, we remember, is a signification relation where sign and object share the same reference space. Sign and object coexisting in time are thus, undeniably, iconically bound. Yet, given that they coexist temporally, we might with the same justification consider them indexically signifying. And if we separated them, assigning to the sign a particular time and to the object another, they would cease to share the reference space, being neither indexical nor iconic. As we required distinction between signification relations, and as time as reference space wreaks havoc to this distinction (at least if applied naïvely), we seem to be better off without a temporal continuum rather than with it, regardless of our interest in temporal succession. Our reference space needs to be discrete.[1]

Discreteness as fundamental feature of the reference space implies that iconic signification did not create the reference space in which it signifies; iconic sign-object relations act only upon signs and objects already provided by previous signification relations. Iconicity, thus, does not create the initial segment of a (temporal) semiotic chain.

Having precluded iconicity as provider of the reference space, we turn to indexicality. Discreteness does not preclude indexical signification, which relies on the co-occurrence of sign and object, that is, their simultaneity. Yet, the perception of simultaneity is being created only once both events have happened and have been perceived. The two events conceptualized as having happened "at the same time" have, in fact, been perceived at different temporal instances; their simultaneity resulted from a mental process that associates the two events with the same temporal marker (usually chosen from one of either event's temporal occurrences). In a strict sense, rather than having happened or even having been perceived simultaneously, the two simultaneous events are actually *remembered* as having happened simultaneously.[2]

[1] It bears well to remember that all concepts we employ in the language description of music (as well as any signification process rendered in language) are discrete at heart. Note, melody, and piece all refer to temporally bounded concepts. The same may be said of more general terms such as "the Baroque period." As regards diachronic concepts, like genre, or the concept of time periods as such, their applicability is implicitly connected to an extended time, too. We may be able to define "genre" such that it applies to all types of human musical actions known to us, but even then the concept would fail to include pre-human times. In short, any concept has a temporally limited period of applicability, and it will eventually fall out of fashion.

[2] Curiously, what applies to simultaneity also applies to its lack, to temporal distance. Temporal distance

The very process whose workings we wish to observe already needs to be employed to furnish indexical signification. Indexicality, thus, is an equally unlikely candidate for the creation of memory's constituent units.

At this point, we might ask what we imagine the constituent units of temporal succession to be. The signification relations creating memories mediate between two kinds of signs, things happening (for example, a ritornello being played and conceptualized as such) and instances when the things happen (which allow temporal ordering). Both of these kinds of signs are part of the reference space and both need to be signified by the fundamental signification relation providing the reference space. Neither indexicality nor iconicity have been shown to work; both are already too dependent on fundamental, temporally ordered input, too dependent on the existence of references that are (always?) already there. The least problematic solution to signification may thus be the plain, idiosyncratic declaration of certain input as instances or happenstances. This process of labeling is purely linguistic in that it does not need to fulfill any conditions to be effective. Of course, we might prefer labels that are sensible with respect to what we know already, but previous knowledge is not required. The labels need to be lingually viable (that is, one ought to be able to put them in speech) because they would otherwise prove unwieldy to discuss in a speech-based rendition like this.[3] The labeling process, though not dependent on a previously established vocabulary, is, in terms of the distinction made by Peirce, one of symbolic signification.

As the reader has probably noticed, there is some friction between the Peircean definition of symbolic signification and its present widening to designate the process of creating a reference space of temporal signification. Peircean semiotics limits symbols to lexical signs, words which have an agreed-upon, stable meaning. Yet, the labeling process taking place

becomes effective only between already established references; remembrance of the earlier instance must become active simultaneously with (or after) the later one. Thus, temporal distance is itself a product of remembrance.

[3]It is in fact here that the linguocentric bias of musicology characterized by Charles Seeger comes minimally and unavoidably into play ["Systematic Musicology: Viewpoints, Orientations, and Methods," *Journal of the American Musicological Society* 4 (1951): 240-248]. Support for the role of language in understanding and conceptualizing music is lent by recent neurological research by Aniruddh D. Patel, suggesting that language and music are perceived differently but share what he terms the feature of structural integration of new information thanks to a shared ability to integrate this information based on syntactic prediction ["Syntactic Processing in Language and Music: Different Cognitive Operations, Similar Neural Resources?" *Music Perception* 16 (1998): 27-42].

within a remembering person's mind is not unlike that. The meaning of the instance or happening as labeled changes when it is taken up into other signification processes, but this does not refute the initial validity of an arbitrarily assigned label. The label may get displaced, but its initial service as marker for the external item, be it a temporal instance or an extended event, does not loose importance. Nor does the condition that the label be lingually viable (expressable in terms of speech) imply that it necessarily needs to be expressed or, in fact, is at all expressed. Most likely, it gets replaced by a different label, more appropriate to whichever standards the perceiver wishes to apply. The original labeling is thus forgotten. However, this does not exclude the possibility that the original label can be lingually expressed. This specific characteristic of symbolic labels as they are applied in our case I shall call "referentiality." Referentiality designates not the actual but the possible lingual rendering of a sign.

Based on the previous discussion we are now able to assert that our reference space, the stage on which other signification relations play their part in memory formation, is best defined as a symbolic construct, parsed into instances and thus discrete. This realization bears two implications: (i) Other than through suggesting direction, that is, a notion of before and after and the fact that the two are not interchangeable, the unidirectional continuum time does not contribute to the reference space and, thus, to meaning formation. Simultaneity and temporal distance, as well as all happenstances in the reference space, are results of signification immanent to the perceiver. (ii) The referents of the labels for happenstances and temporal instances must themselves have been constructed (at some earlier point) through reference; in effect, they are links in a semiotic chain. Labels and referents are thus temporally divided by virtue of happening at different times. The reference space within which temporal meaning formation takes place is discontinuous by virtue of the process of meaning formation itself. All entities serving as signs and objects are capable of serving as such by virtue of their resulting from a prior signification process. In a sense, the process of temporal signification creates the unique reference space in which it can most easily function. The substrate and the result of meaning formation is the same.

The assertion that the substrate/result of temporal signification, or meaning formation, is a symbolic reference space with potential verbal references to each member has consequences.

Given that we search for ways of signification responsible for meaning *formation*, not for its presentation or preservation, it follows that symbolic signification does not contribute to temporal meaning formation and, by extension, to the process of remembrance. The units of memory are (at least according to our definition of the reference space) symbolic but they do not create meaning, they only preserve and confer it.[4] Referentiality (the potential of an object to be referenced by a word) is a convenient result of temporal signification but not what drives it. Indexical or iconic signification are more likely candidates for this honor. To infer how memories are formed, we cannot rely on linguistic concepts alone but need to appeal to neuroscience.[5]

To reiterate the two major results of the previous discussion, time and symbolic signification do not play a role in the memory formation process as such. However, both supply basic notions, the former of process, the latter of unit; furthermore, symbolic signification will figure significantly in the storage of concepts outside the memorization process. First, though, we shall scrutinize remembrance of word lists because here we are supplied with data and theoretical underpinning. Only then will we proceed to point out the differences to the musical case.

[4]It follows that symbolic references are incapable of changing their meaning; the changes of meaning we observe in everyday language use are due to meaning formation using the old referent.

[5]In a sense, we are by the nature of our approach, by its linguocentrism, never quite allowed to witness the processual aspect of memory formation; the best we can achieve is the detection of a minuscule difference at a significant place within the mnemonic structure; the difference suggests that memorization has taken place.

8.0 MEMORY

8.1 THE STANDARD VIEW OF WORD LIST MEMORY

Having laid a terminological and analytical foundation with our excursion into semiotics, let us now proceed to a closer examination of the characteristics of memory. Musicological treatments of the topic are now common and surveys of the basic theories are available to musicologists.[1] I will first review the current state of research with a focus on something similar to melodies in structure: word lists and the features of their recall from memory.[2] In the description of methodology and results, I will make frequent reference to some technical terms which I have italicized where they are defined. The reader may also be cautioned that neuropsychology has a weakness for acronyms, a trait I have adopted in a few cases.

Let me first describe a typical experimental setup (the reader may refer to the timeline

[1] A general survey is given by Bob Snyder's *Music and Memory: An Introduction* [Cambridge, Mass.: MIT Press, 2000]. More specific reference to neuropsychological theories can be found in the articles of Candance Bower, *op. cit.*, and in William L. Berz's "Working Memory in Music: A Theoretical Model" [*Music Perception* 12 (1995): 353-364]. All of these expository or theoretical accounts deal with memory as a multi-store system, a memory model I describe below but circumvent in lieu of what I think is a more acute and experimentally correct description.

[2] The material for this section is based to a large degree on my memories (indeed!) of a course in neuropsychological models of memory taught in Fall 2000 at Brandeis University by Michael J. Kahana. Reference will be made to the course material in its present incarnation (for similar course taught in Fall 2003), "Foundations of Human Memory" [course material for Npsy 137b, Brandeis University, 2002, available at http://memlab1.ccs.brandeis.edu/~kahana/Courses/Npsy137/, last accessed 15 November 2003]. Quite obviously, the present version is a work in progress; the third chapter ("The 'Modal' Model") has the most complete exposition of facts I use for my argument, while Chapters 6 ("Association") and 7 ("Sequence Memory") contain other pertinent information.
Specialist literature central to my argument includes another source co-authored by Mr. Kahana with Marc W. Howard: "Contextual Variability and Serial Position Effects in Free Recall" [*Journal of Experimental Psychology: Learning, Memory and Cognition* 25 (1999): 923-941]. In addition to Kahana's "Foundations," the following two sources provide a non-specialist introduction to recent advances in neuroscience: *Conversations in the Cognitive Neurosciences*, ed. Michael S. Gazzaniga [Cambridge, Mass.: MIT Press, 1997]; and Rodolfo R. Llinas, *The I of the Vortex: From Neurons to Self* [Cambridge, Mass.: MIT Press, 2001].

Table 3: Timeline of a Typical Free-Recall Experiment

Instructions	
Rehearsal	Item 1
	IPI
	Item 2
	IPI
	...
	IPI
	Last Item
	RI
Recall	Item A
	Item B
	...

in Table 3 for a succinct list; times passes from top to bottom). After initial instructions, the experimental subject is presented with a list of semantically unrelated words (the *items*) at a specific presentation rate. During this process of *rehearsal*, the items are separated by a constant temporal distance, the *inter-presentation interval* (IPI). After the last item, the *retention interval* (RI) ensues which is often longer than the IPIs. Thereafter, the subject writes down the items as they come to her mind (*free recall*), or the experimental supervisor gives a cue item and the subject is asked to recall another item from the list (*cued* or *conditional recall*).[3] In either case, the researcher is free to vary the conditions of rehearsal by asking the subject to take note of particular item features (such as similar sounds or semantic meanings) or by filling the IPIs and/or the RI with tasks that are ostensibly not related to the objective of the recall task, namely the remembrance of the word list.

Regardless of the quirks of the individual experiment, the results in examinations of free recall are usually represented graphically as a function of an item's position in the list. Of course, one trial (or even several trials with the same person) does not yield statistically meaningful data. Hence, recall tasks are usually averaged over many trials until general patterns become discernible. Figure 7 shows a prototypical *serial position curve* (SPC),[4] where the probability of an item being recalled by the subject is plotted against list position. We can see that the highest likelihood for recall rests with the last few items, a feature of memorization called *recency*. Perhaps surprisingly, the first few items are also slightly more prevalent in memory (*primacy*). I offered a somewhat haphazard analogy of recency and primacy with melody remembrance in the third chapter as impetus for my desire to

[3] In my extrapolation from the results of these experiments and their interpretations by neuropychologists, I will start from the vantage point of free-recall tasks because I consider them to be closest to the way in which musical structure is recalled. However, cued recall cannot be divided from free recall because the only conceptual difference consists in the researcher's control over presentation of the cue item: either it is supplied by the researcher (in cued recall) or by the subject (in free recall). The differences and similarities will become more obvious once we examine recall tasks and their influence on memorization later on.

[4] Given that the data collected in an experiment usually serve different purposes than a general explanation, the trends I describe here are often difficult to discern in figures representing actual experimental results. Therefore, I have chosen not to represent real data but rather idealized ones. Qualitatively, all curves in this paper are based on actual graphs and I give the source graph and the quantity or situation chosen in a footnote. This serial position curve is adapted from Kahana, "Foundations," 32; here, I re-produce qualitatively only the graph for immediate, un-distracted recall.
The reader will notice a similarity between the way in which we remember melodic sections (with the incipit and cadence particularly well retained) and graphs like Figure 7 with high likelihood of remembrance at the beginning and the end of the list. Noticing this similarity in my own recollections of ritornellos encouraged me to undertake the research leading to this paper.

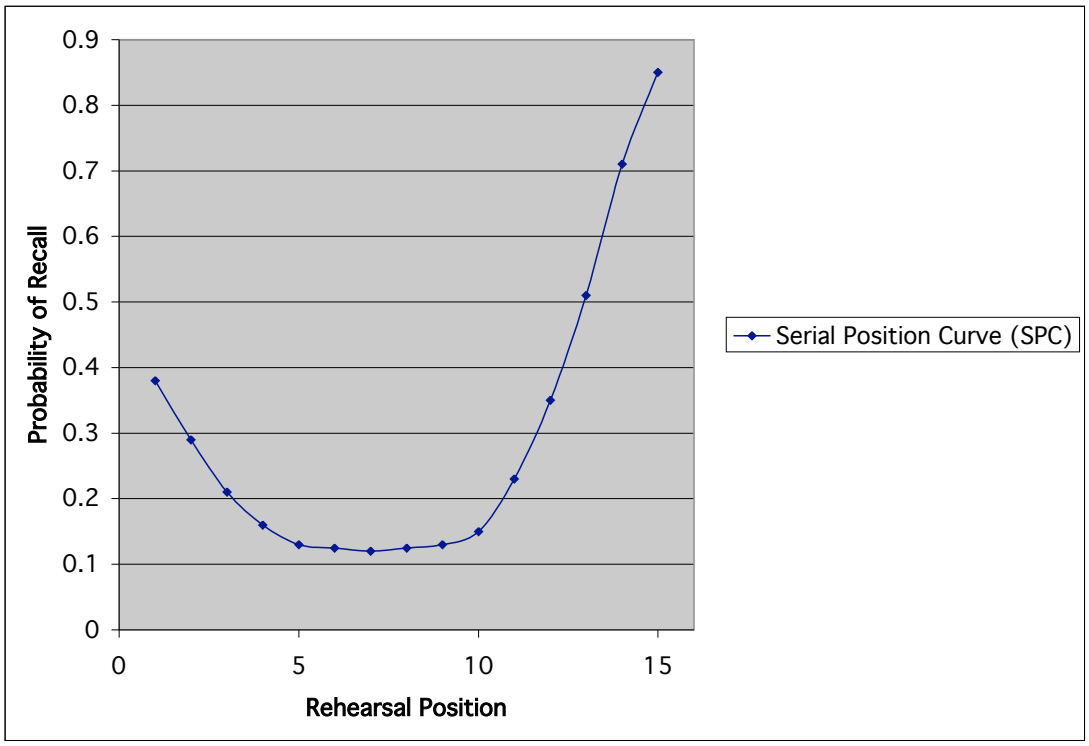

Figure 7: Serial Position Curve: No Distractor Tasks

connect music and neuropsychology. As we shall see, these two measures are not quite as unproblematic as one would hope. But before I present more acute measures of mnemonic activity, let me review shortly an explanatory attempt that reasons for data like those given in Figure 7 quite well and has gained some traction in popular and musicological discussions of memory: the multi-store model.

In the 1960s and early 1970s, when serial position data were formally presented for the first time,[5] neuropsychologists developed memory mechanisms to account for these data.[6] The most famous class of models to emerge from serial position experiments in the late 60s and 70s was called *multi-store models*.[7] Multi-store models are based on the assumption that memory consists of several different stores with different capacities, different abilities to retain items, and different ways to remember them. The most successful single model of this type has the acronym SAM (for "Search of Associative Memory") and it was developed in the late 1970s by Robert M. Shiffrin and Jeroen G. W. Raaijmakers.[8] In principle, SAM supposes three stores: the smallest (the sensory store) accepts any appropriate input, does not retain any items for longer than a few milliseconds, and transfers them immediately to the next two levels, *short-term memory* (STM) and *long-term memory* (LTM).[9] STM has a capacity of approximately four to ten items. Once it is filled and new items keep being entered, old items get expelled randomly either to LTM or they are lost, that is, forgotten. Recall from STM simply involves remembering the whole current content with approximately equal probability. As this is assumed to happen at the beginning of the recall period, STM is supposed to be mainly responsible for the strong recency effect observed in free recall.

LTM has an unlimited capacity and retains items indefinitely. In LTM, each possible

[5]For example, through Benjamin B. Murdock's "The Serial Position Curve in Free Recall" [*Journal of Experimental Psychology* 64 (1962): 482-488].

[6]Today, these models are usually cast in terms of a computer simulation that will (or not) yield resultant serial position curves similar to the ones observed *in vivo*.

[7]The first precise description of such a model was given in Robert C. Atkinson and Robert M. Shiffrin's "Human Memory: A Proposed System and Its Control Processes" [in *The Psychology of Learning and Motivation* 2: 89-105, ed. K. W. Spence and J. T. Spence, New York: Academic Press, 1968].

[8]"Search of Assocative Memory" [*Psychological Review* 88 (1981): 93-134]. The reader should note that my description of SAM is quite simplified and skips over many randomizing steps included in the model to make the results as similar to experimental data as possible.

[9]Because the sensory store does not retain the items after forwarding them to STM, it is usually considered to have no influence whatsoever on experimentally measurable variables like retention time or probability of recall.

pairing of items is assigned a *strength* value which is usually a function of the time the items spent together in STM. In recall, a new item is chosen based on the highest associational strength to a previously recalled item. It follows that items that per chance stayed in STM together longer will have a higher likelihood of being associated in memory and being recalled together. This mechanism explains the choice of SAM's acronym, for "Search of Associative Memory." Association between items in recall is thus strongly (but not exclusively) dependent on their temporal proximity in rehearsal.

SAM assumes that STM is recalled first and thus explains the recency effect. The primacy effect relies on slightly higher associative strengths of the first few list items. These items are privileged because they were taken up into an empty short-term store and, thus, were not under the immediate danger of being expelled. Therefore, they have stayed slightly longer with one another in STM, which leads to slightly higher associative strengths for them. Their recall is thus slightly more likely than that of items following in their step. Thereby, SAM gives a plausible explanation for the shape of the serial position curve in free recall.

SAM explains basic results of recall experiments extremely well. Moreover, it can be adapted to other memory tasks like recognition. The use of multi-store models for neuropsychological accounts of memory is thus obvious and their importance has even been acknowledged by public usage; terms like "short-term memory" have become common currency. It might thus seem tempting to adopt recency and primacy (as defined through models like SAM) and apply them to things musicological. From the neuropsychological point of view, though, several problems with multi-store models emerge: They are not aesthetically pleasing because they use two different recall mechanisms for what ideally ought to be one holistic phenomenon. They do not provide a quantifiable measure of association (neither recency nor primacy are quite sufficient). Most importantly for an experimental science, under certain conditions the predictions of models like SAM are not borne out by experimental data. As we shall see, these different experiments, while challenging the multi-store model, will provide us with more tangible if still metaphorical connections to the problems encountered in music analysis.

8.2 DISTRACTOR TASKS: SEVERAL PROBLEMS AND A DIFFERENT REPRESENTATION

When talking about the general setup of free recall experiments, I mentioned the possibility of introducing unrelated tasks into the IPIs or into the RI, so-called *distractor* tasks. In a test of word list memory, a suitable distractor might be a task involving difficult calculations by the subject.

If such a distractor task is posed in the RI, memory performance changes significantly as can be seen, for illustration, in Figure 8 (on page 56).[10] Recency vanishes completely while primacy is retained. Primacy is a persistent feature of free recall, even when the end-of-list distractor is extended. At first view, the clear division of the recency phenomenon from the remainder of the list, and the researcher's ability to control its appearance by specific changes of experimental conditions, lends support to the multi-store model; there seems to exist a close correlation between the activity of a limited-capacity STM and the observed recency effect. The remainder of the serial position curve seems to be governed by LTM.

The problems of the multi-store model and the theories about memory on which it is based become apparent when distractor tasks in the RI and IPIs are set into relation with one another. Previously we only had a pronounced distractor in the RI, leading to a vanishing recency effect. Let us assume the experimental conditions that lead to Figure 8, where we had a much longer distractor-filled RI than IPI. If we now introduce distractor tasks in the IPIs and increase their length, the shape of the serial position curve approaches again that of Figure 7. The recency effect re-appears. Items already thought forgotten make a miraculous re-appearance once the experimental conditions are changed.

In retrospect, the recency effect is strongest when the IPIs and the RI are of equal length and it vanishes as the RI becomes much longer than the IPIs.[11] We may thus think of recall

[10] Adapted from Kahana, "Foundations," 32 and 35; here, only the graphs for extended end-of-list distractor tasks were reproduced.

[11] The explicit presence of a distractor plays an obvious role. In regular experiments, the RI is usually longer than the IPIs and, yet, recency is observed. However, distractor tasks provide a means of control over what the subject is engaged in during rehearsal and recall. In the regular setup, the subject's mind is likely actively engaged in rehearsing the items, while a distractor task precludes that.
Another means of establishing control over the subject's private rehearsal processes is so-called overt rehearsal, in which the subject is asked to repeat aloud the items as they come to his mind during the RI.

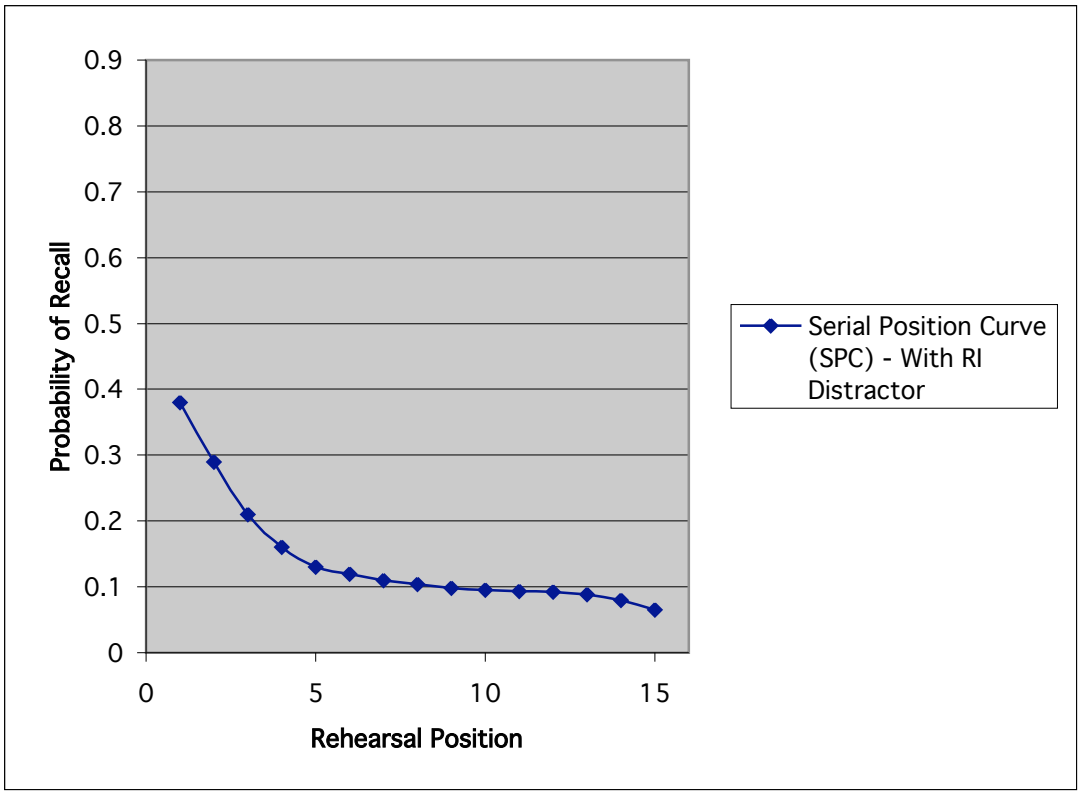

Figure 8: Serial Position Curve: RI Distractor

operating similarly on different time scales as long as the relative lengths of the IPIs and the RI are the same; this feature has been dubbed *scale invariance* and it seems to be a consistent feature of free recall.[12] Assuming scale invariance, we can differentiate between two basically different types of recall applicable to memorization on all time scales: (i) Recall undivided from rehearsal through either a distractor task or long separation; this type will usually have similar-length IPI and RI and exhibit a strong recency effect. (ii) Recall that is dissociated from rehearsal through a distractor in the RI and generally a much longer RI than IPI; this type will exhibit little or no recency.

The reappearance of recency in rehearsal periods with longer IPIs has been dubbed *long-term recency.*[13] It agrees with scale invariance but problematizes the assumptions leading to multi-store models like SAM. SAM relies on the non-associative retention of items in the short term store until recall is initiated, explaining recency by the uncalibrated emptying of STM. Since the distractor task in the RI should displace any items from the original memorized list and effectively empty STM, recency should vanish, which SAM predicts correctly. However, SAM cannot account for the reappearance of recency when the IPIs are also filled with distractors and their length approaches that of the RI. In effect, SAM and related models rely on the independence of the formation of mnemonic inter-item associations from the RI's duration. At least seen through the spectacles of a recall process divided into temporally separate regions, one in which recency obtains and another in which associations obtain, the multi-store model fails to account for long-term recency.

The solution to the apparent dilemma does not lie in a radically new model but, first, in a different representation of the data such that inter-item association and recency are examinable separately. Excepting the split between recency and pre-recency regions (which depends on the experimental setup), temporally proximate items have proximate recall probabilities; perhaps, a different graphic representation of the data could point us to the probability of recall as a function of temporal proximity. In the same vein, the importance of recency in recall begs for a representation of recency alone, without the possible interference of primacy and, especially, inter-item association. Howard and Kahana suggest representa-

[12] Kahana, "Foundations," 48.
[13] Kahana, "Contextual Variability," 925.

tions of the data that fit these requirements by introducing two new measures.[14]

The measure of *conditional response probability* (CRP) indicates the likelihood of an item's recall given that another item has just been recalled. Figure 9 shows a typical distribution, with the lag to the possible next item as dependent variable (on the horizontal axis) and the just recalled item in the center, at lag zero. We can see that close list positions are more likely to be recalled together (a variant of recency may apply) and that recall of future list positions is much more likely than recall of past items.[15] This phenomenon has been termed *lag-recency* by Kahana. Overall, the CRP curves give a resonably clear account of the strength of inter-item associations and their dependence on temporal proximity. The only unusual feature of the CRP is its bias towards recalling items following in the list.

The recall probabilities for end-of-list items can be measured more acutely through the *probability of first recall* (PFR), the likelihood of any list item being recalled first. Figure 10 shows a typical PFR curve in which, unsurprisingly, the highest probability rests with the last presented (that is, the most recent) item.[16] Inter-item associations do not play a role because the curve records the subject's recall probability to only one recalled item, in particular, the first one which cannot explicitly be associated with a previously recalled item.

Because we can think of free recall as an initial random (though recency-driven) recall followed by conditional recall, the CRP- and PFR-curves represent the experimental data, distracted or undistracted, as well as the serial position curves in Figures 7 and 8 above.[17] Figures 11 and 12 show the effects of extensive RI distractors on the CRP and PFR representations.[18] Distractors, depending on their length, have the same implications as described

[14] "Contextual Variability," 924.

[15] Figure 9 has been adapted from Figure 3.5 (Avg) of Kahana, "Foundations," 43; in cumulative accounts like Kahana's, forward conditional recall has a probability roughly twice as high as backward recall.

[16] Figure 10 is adapted from Howard and Kahana, "Contextual Variability," 925, Figure 1. In my representation, the general tendency towards recency evident in all recall curves for a specific item has been emphasized; the actual experimental results are obviously much more varied. Interestingly, and perhaps significantly for our enterprise, the experimental recency curves shown in Howard and Kahana's article (extending as they do over the whole time range of rehearsal) show some evidence of hierarchy and parsing, especially the 'bumps' in the PFR curves at the recency end; these 'bumps' exhibit the bathtub-shape of the regular serial position curve on a smaller scale (just over two to five items). The higher recall probabilities of the recent items seem to be more pliant to the disturbances. For a clearer (less 'bumpy') representation of the PFR prepared by Kahana himself, see "Foundations," 47.

[17] Howard and Kahana, "Contextual Variability," 937.

[18] My Figure 11, the PFR, is adapted from Kahana, "Foundations," 47. Figure 12, showing the CRP, was taken from the same source, 48, left half of Figure 3.9.

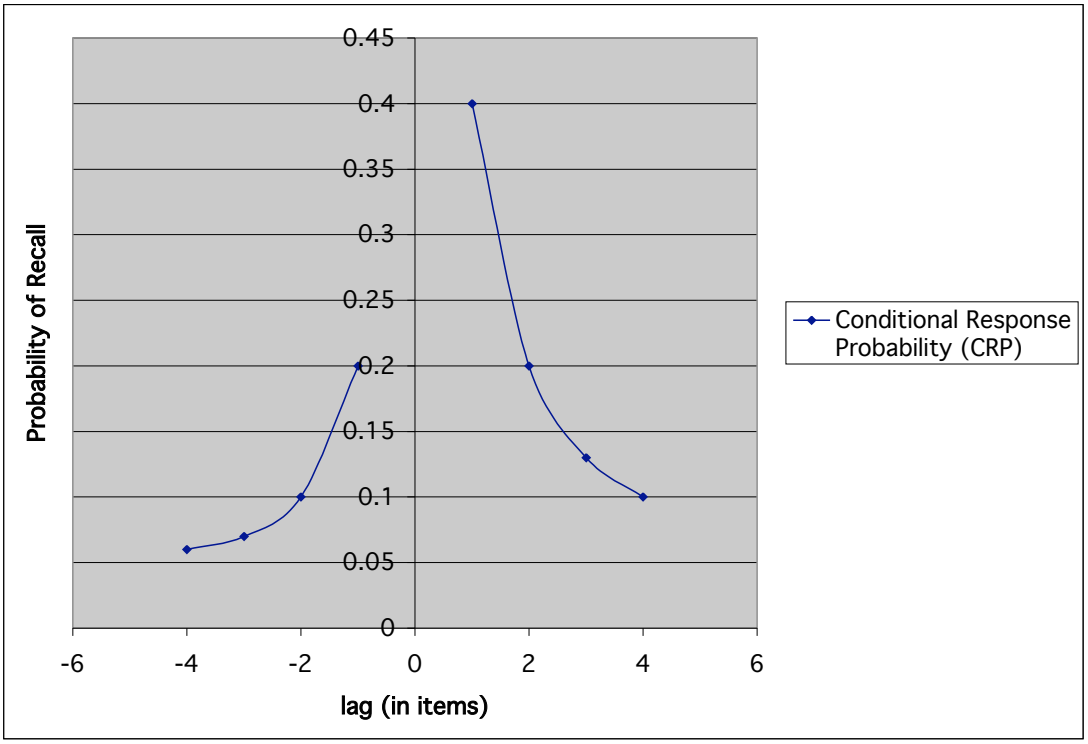

Figure 9: Conditional Response Probability (CRP): No RI Distractor

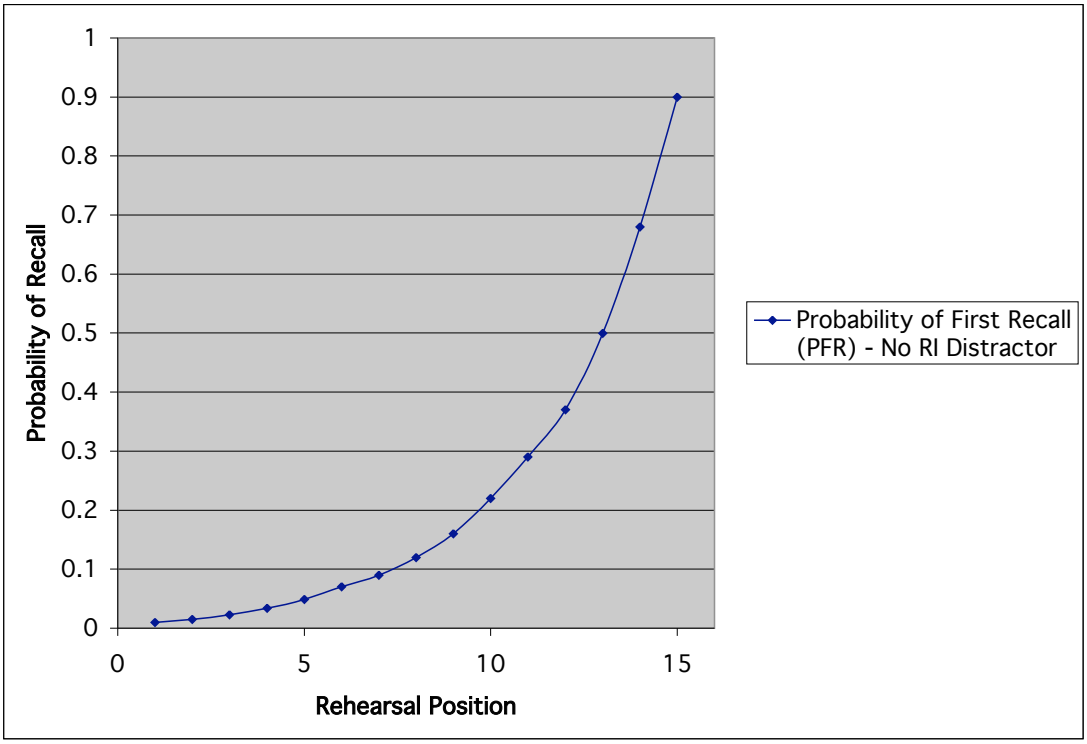

Figure 10: Probability of First Recall (PFR): No RI Distractor

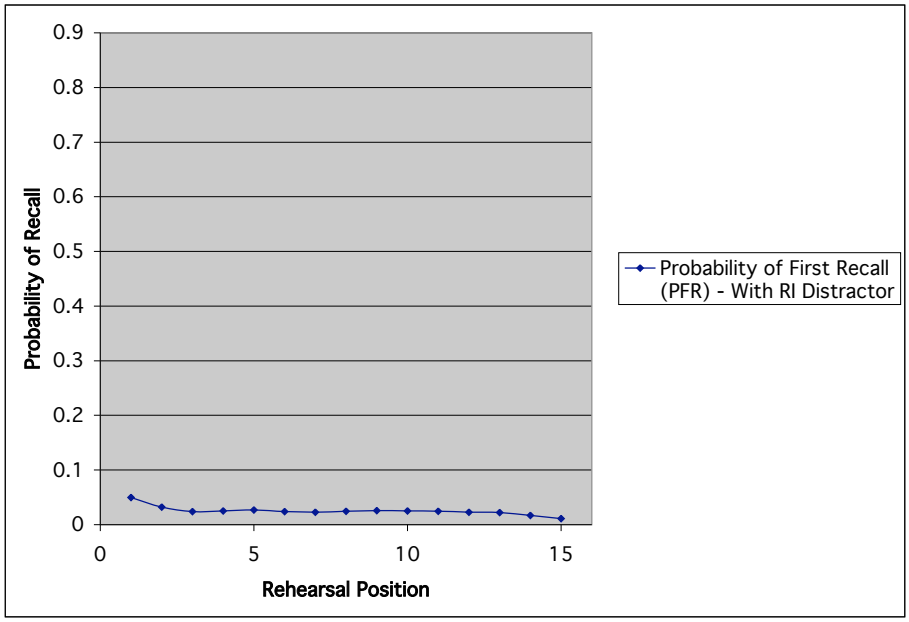

Figure 11: Probability of First Recall (PFR): RI Distractor

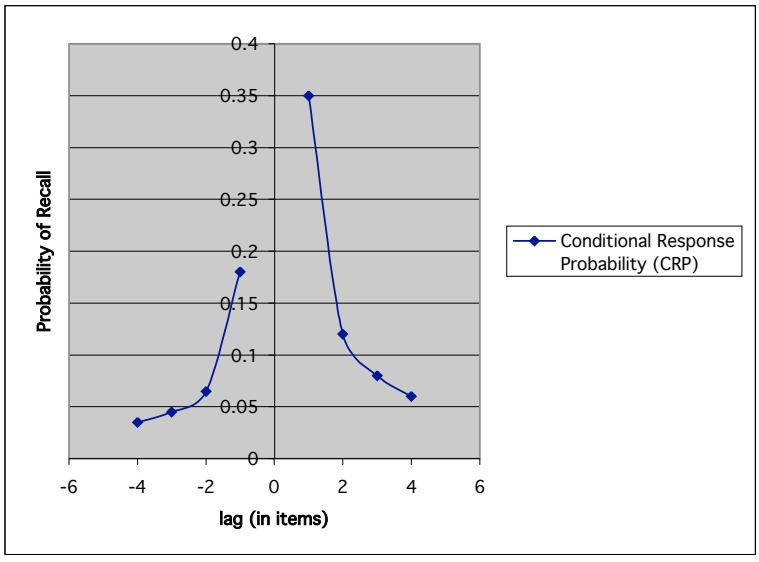

Figure 12: Conditional Response Probability (CRP): RI Distractor

earlier. The effect of a strong RI distractor task on the recollection of recency items (as represented in the PFR curve) is even clearer than in Figure 8: the graph becomes almost flat. On the other hand, the lag-recency effect, our representation of associations, is not affected qualitatively presence of a distractor or, more generally, the dissociation of recall from rehearsal. This reflects the unchanging nature of inter-item associations in memorization with respect to the specific recall task; regardless of the relative length of the RI distractor, the list is conceived of and stored as one unit, its subunits being associated with one another in the same contiguous way.

Nothing of what has been said so far excludes the possibility that contiguity and recency are functional at different time scales.[19] This option poses at once the question how recency and contiguity interact when memories are formed and stored at different temporal scales. For example, a particular musical motive may be the beginning of a phrase but the phrase intermediate between two others. Is this motive going to be recalled with a higher probability because of its rehearsal position in the phrase or with a lower probability due to the phrase's position in the tub between a primacy-phrase and a recency-phrase? Or, to twist the question around and place responsibility on the situation of the recall task, which task would yield the former result, and which the latter? The question bears out in neuropsychological terms the concern raised earlier with regards to paradigmatic analysis: not all syntagms of one paradigm are remembered equal.[20] I suggest in the following chapter that a close examination of the neuroscientific methodology from a semiotic perspective might suggest a peculiar interpretation of the underlying mechanism[21] of free recall, an interpretation that

[19] One theory of memory, invented to remedy the shortcomings of the two-store model, has more explicit references to what is called 'levels of processing.' The proponents suggest that certain memories are stored better because they are processed by 'higher' faculties of the human mind, which might be associated with temporal scales. An exposition is given in F. I. M. Craik and E. Tulving, "Depth of Processing and the Retention of Words in Episodic Memory" [*Journal of Experimental Psychology* 104 (1975): 268-294]. For my project, I found Kahana's more explicit examination of word lists and their temporal behavior more useful.

[20] The remark about 'bumps' in the PFR curves of "Contextual Variability," 925, Figure 1, in note 16 on page 58, may reflect precisely this plasticity of memory, its ability to hierarchize the incoming data and reference them such that a necessary but not superfluous amount of information is accessible at any point in time.

[21] One ought to mention that Howard and Kahana, in "A Distributed Representation of Temporal Context" [*Journal of Mathematical Psychology* 46 (2002): 269-299], provide their own memory model that accounts for long-term lag-recency *and* provides a simple explanation for the asymmetry of the lag-recency effect. I have decided to cast my suggested theory in a less technical guise but their Temporal Context Model might, with some more thought, also be applied to analyzing musical structure.

will ultimately make the neuropsychological findings applicable to musicological and music-analytical problems.

9.0 TOWARDS A THEORY OF PARSING AND PARSIMONY

9.1 PRELIMINARIES

After the previous broad survey of neuropsychological descriptions of memory, let me now turn to the philosophical reasoning that, in my opinion, would make these descriptions a viable support for musicological research. To facilitiate my working-together of neuropsychological and semiotic ideas in a musicological mould, let me first recount the salient points recovered from either field.

In Semiotics:

- For the purpose of the description of music in lingual terms, all signs can be analyzed as referential, that is, potentially symbolic.
- All signs of a referential character have clear positive/negative connotations, i.e., when applied, certain objects are deigned to fall under them, others not.
- Iconic and indexical signs play likely no role in the creation of referential signs (though they may play a role in the creation of these signs' references, namely memories).

In Neuroscience:

- Each instance of engaging memory may be divided into three sections: instructions, rehearsal, and recall.
- Instructions consist of referential signs, to be applied in the rehearsal process.
- Recall data may be analyzed as a composition of two different effects operative through memory: recency (higher likelihood of remembrance for recent items) and contiguity (higher likelihood of remembrance for items close to the current temporal position, with

a distinct forward bias). These effects can be observed at different temporal scales independently (scale invariance).

- Dissociation between the three sections of memory engagement (either through temporal distance or through actively induced distraction) or between their items leads to the breaking of scale invariance in rehearsal, and/or to the loss of recency in recall.

The following discussion attempts to forge a connection between the two fields. Music does not play a role in the argument *per se*; hence, I will mention it only if it adds a peculiar perspective. Actually applying some of my results to the *First Brandenburg Concerto* will be relegated to the next chapter.

As a *leitfaden* through the argument, let me pose the problems we shall have to address:

- How do the referential signs in the instructions become functional? What do they denote?
- Which common types of recall tasks/situations cause dissociation where?
- How can the presence of dissociation explain the absence of recency?
- What influence on memorization and remembrance has dissociation between either instructions and rehearsal or rehearsal and recall?
- Can we associate any features of memory with the semiotically defined icon and index signs?

9.2 ANALYZING RECALL TASKS

In a plain neurospsychology experiment, the precepts of memorization seem clear: the basic units supposed to be remembered are words and they are presented in and referred to as a list. The words and their constituent sounds (the phonemes) need to be distinguished by the subject from other sounds that are not part of the required units of remembrance. These precepts are not self-evident; they need to be conveyed by a series of instructions from the researcher to the subject, instructions that we may cumulatively refer to as the "recall task." Analysis reveals that such tasks specify several levels of memorization as well as several time scales; based on this information (in neuroscience experiments provided immediately prior to the experiment) the subject stores and remembers the list.

A typical recall task might read: "At the initiation sign (or alternatively, after completion of the distractor task), please write down those words in the studied list (read aloud) that you remember." The task contains several temporal markers that make quite clear which stretches of time and time scales are involved:

1. Reference to the studied *list* limits the subject's active efforts at memorization to the time period between the beginning of rehearsal and the initiation of recall and only to items that appear in the presented list.
2. Reference to the items as *words* demarcates the sounds constituting word expression (phonemes) from other, ambient sounds that are part of what the subject perceives but not words.

As it were, these two time scales seem to form absolute, referentially fixed scale boundaries. Attention is diverted from anything happening at a smaller scale than words and at a larger scale than the list, and any reference to list or items is assumed to be clear, with unequivocal verbal references at either scale. Note that both scales are referentially defined independently from one another. Of course, both indicators imply the existence of smaller parts, both memorable and not; these are words and non-words for Observation 2 and memorable and forgettable parts of the list for Observation 1. As we shall see below, neither the list nor the constituent words are in fact unequivocally referential before the start of the experiment. Their referentiality arises only in the storage process (for the words) and the remembrance process (for the list as a remembered whole).

Apart from the scalar indicators, the above recall task also suggests what is and what is not memorable about the various temporal markers noted. The instructions to ignore anything outside the list and anything other than words are ensconced in the definitions of scale above. Continuing in the enumeration,

3. The primary objective of remembrance is the words as parts of the *list* (the sample task could well have left out reference to the "words in the studied list" and simply requested remembrance of the "list" without changing the experimental outcome).
4. Any distractor if presented between the initiation of list presentation and the initiation of recall is to be ignored in the list remembrance.

Both these propositions influence the association of referential objects between the two levels, that is, how the words become the list, in my opinion the actual process of memory formation. Observation 3 opposes clearly the list as marked for remembrance to the words as unmarked, thereby clarifying the hierarchy of the two scales, while Observation 4 points to the influences on remembrance by items which could be considered memorable but are explicitly designated forgettable. Interaction of all four of these aspects of the recall task will help to create the peculiar pattern we observe in the results of word list recall.

Having clarified which levels participate in a recall situation, we need to examine the motivations for recalling the information provided in rehearsal in a certain way deemed parsimonious by the subject. These motivations are caused by the relation between instructions and rehearsal. Parsimony undoubtedly leads to loss of information; paradoxically, this loss may be a sign of mnemonic success worth risking if the remembered, replicated version of the object fulfills the requirements of the recall situation. Whether the loss of information is a catalyst or an obstacle to remembrance depends on the task with which the listener is posed. (In fact, in the nature of recall tasks, a difference between musical remembrance and word list recall will emerge. As promised above, I will only point out these differences and postpone a discussion of music until the neuroscience has been dealt with.) Obviously, a subject or listener will try to store at any time scale only what seems important with respect to the task. Here, differentiations of importance between items emerge that will allow the association (in memorization) of groups of items with the list level (as memorable items) and others as remaining at the word level (as unmemorable).

The recall tasks posed in an experimental situation differ quite drastically from what a subject might encounter when listening to music. Usually, experimental tasks, provided directly before the rehearsal of items (the real experiment), reference a clear temporal field for the putative sources of remembrance (the list). Thus, a strong connection is established between the memorable and the bounded period in which it is supposed to happen. In terms of the experiment being performed, the focus on the memorable units is understandable. The results of the experiment are lists of remembered words. If the subject remembers the entire list (whatever that may be) but does not clearly distinguish the words (for example, by mixing-up the spelling), the researcher will not be able to collect the data she was looking

for, namely the recall probabilities of each distinct word. Loss of information on the word level would be disastrous; loss of information on the list level is admissible. In fact, it is the measured entity. The instructions ordain a clear recall of items and a rough recall of the list (even though the list is stil the primary focus).

In music, common recall tasks are, of course, self-posed. No instruction period *per se* precedes rehearsal. The rehearsal period (that is, the performance or replay of the piece) is clear, but the items (for example, motives, or sections, depending on the analytical desires of the listener) are not clearly marked. No reference to prior knowledge of the piece's vocabulary, its motives, can be assumed. A test of memory, as in Figure 1, results in an approximate rendering of the melody as a whole but not in the exact repetition of the individual motives. Loss of information is if not welcome then at least accepted at the item-(or word-)level but deemed problematic if it affects the whole.

9.3 MEMORY FORMATION

After this short excursion into music, we return to the remembrance of word lists as a well-studied model. The stakes and the levels of memorization are now clear; it remains for us to determine how memories are defined. Since we agreed that what we can designate and discuss in memory, musical or otherwise, are referential entities, our attention shifts towards the identification and, possibly, the creation of referentials. We commence with the constitution of the words in the listening/rehearsal process.

As noted, the recall task defines a minimal level of units for remembrance, here words. Immediately, we are posed with the question of what happens such that words, and not phonemes, are considered the basic level of memorization. The decision is obviously not made before the instructions because the subject cannot foresee the requirements of the recall task. Once the recall task is known, however, and the importance of words as memorable constituent units in the to-be-remembered list is clear, memory starts parsing the sounds received through the subject's ears into words and ambient sounds. In the second step of the memorization process, the phonemes of each word are conceptualized as one instance. List recall requires not knowledge of the words but only of their occurrence in the list.

Temporally, a word may extend over the time to speak its phonemes or read its letters; conceptually, as a word in a list, it becomes *one* instance in time. Hence, the instantized words are sufficient to assure memorization according to the indications of the recall task. Evidence for this is the variable nature of item recall: the subject may either call items out aloud (recalling combinations of phonemes) or write them down (recalling combinations of letters). Both the phoneme- and the letter-combinations employed in recall were not created in rehearsal but referential knowledge imported from the subject's past.

Referring back to the discussion of ways of signification in Chapter 7, we realize that this creation of one parsimonious sign (the word as instance) for an extended, many-valued object is an example of creating simultaneity and, thus, at least partly due to indexical signification. Memory does not need to store the word *per se* because it has already been stored when it was learned (for example, in kindergarten) or when it was last used. Currently, only an indexical reference is necessary. Just why the created parsimony results in loss of information (forgetting the phonemes) but allows to re-create them (or the letters representing the same word in writing) when recall is requested can be more easily observed and discussed on the larger scale of list recall.

In list recall, the objects of mnemonic desire are the items, the words. Accepting the notion that even remembrance of the first item in the list needs to be triggered by the recall of another, prior item, we look to the recall instructions for guidance in figuring out the trigger item because the instructions are the only sources available to the subject in the context of the experiment. The instructions provide two possible trigger times: the beginning of the rehearsal process and its end (referenced by Observations 1 and 3 above; given that the distractor is not to be considered a viable item, the last memorable one thus appears before it). If no distractor is presented, the most recent item has a higher likelihood of recall, and if recalled, it becomes the trigger for the next step in remembrance. With a distractor, the penultimate item (the last on the list) has a relatively lower likelihood than the first item because the separation from the temporal trigger is larger. The first item has a higher probability of becoming the first in the recall list and, thus, of its temporal position becoming the next trigger.

In the case of distraction, thus, the remembering subject is forced to jump backward to

a past item, skipping the items in between by force of the recall task which defines the list and not any of the items as objective of remembrance. Contrary to the backward jumps required to distinguish the words and code their positions (which induced the forgetting of the words' actual phonemic composition), this one does not result in the elimination of the list's content. The objective of list recall forces the preservation of some (but not all) of its content in active memory. Recall of the first item only when list recall is requested would not be a successful execution of the task. Indexical signification to just one item as stand-in is not enough; on the word-to-list transition, a different type of remembrance comes into play.

After the first recalled item, this item (or rather, its temporal instance) is used as hook for the next. The procedure is a search for maximum proximate likelihood; the CRP curve (Figure 9) tells us that the immediately following item is the most likely one to be recalled. Hence, the direction of recall here is forward while in indexical signification it is generally backward.[1] In principle, this search-and-recall procedure continues until either all items are recalled (a very unlikely proposition) or (more likely) until remembrance hits an obstruction, this being either the putative RI distractor (if recall started close to the end of the list) or an unmemorable item. Of the latter kind there are two, those already excluded in the memorization of the items' temporal positions (for example, ambient noises) and those excluded in the present attempt at list-level parsimony.

Instructions provided good anchors for deciding upon exclusion during rehearsal (the subject is assumed to be familiar with the sound and usage of words even if not necessarily with the particular words themselves). For recall, there are no indicators about desirable and undesirable items in the list. After a point in time has been established as temporal marker, forward recall is likely favoring the subsequent item to be recalled next. However, this regime does not hold throughout recall.[2] With increasing distance from the start of forward recall, its acuity wanes. It behaves like the declining positive-lag region of the CRP,

[1] Of course, in the situation of a free recall experiment, repeated recall of words in the same remembered list is not desired; therefore, a possible return to previously recalled items in the process of remembrance is not evident in the recall data. The experimental technique of overt rehearsal allows for examining such repeated recalls.

[2] If forward recall would proceed unceasingly, and unerringly, recall would likely reproduce the complete list of items.

which has a clear forward bias only for recall of the first positive-lag item. With the second positive-lag item already, there is a concurrence between choosing preceding against following items; probabilities of recall are (roughly) equal. Which direction is chosen depends on the whim of the moment. This possible confusion implies that the items recalled in a stretch of forward recall are tied, through this process, to the first item in the row, which was reached by a backward jump.

Should thus at some point the process of forward recall break (by running into already recalled items) and a new item from earlier in the list become the next kernel, the list segment of forward recalled items is separated from either of its neighboring elements by a break and it has one item most likely to be recalled first, namely the first item in the segment.[3] The complete list is thus parsed and there exists the possibility of parsimonious reference to only the first item of each segment without loosing the subsequent items of each segment entirely.

In terms of the Peircean trichotomy invoked earlier, we might think that the pure potentiality of firstness signs (and iconic signification) is more likely to be represented by the seemingly random backward jumps. However, while they may seem random, the jumps are directional and they connect one temporal reference system, forward recall along the course of time, to another, namely that of past referentials. An item becoming the first in a small chain automatically acquires the nature of a referential; it will be the most likely of all symbolically referenced items in that segment. The creation of simultaneity between past and current courses of time in the moment of reference points to backward recall as indexical signification. Forward recall, on the other hand, does not imply any meaning (in the sense of inter-temporal connections) for the items being recalled. Their potential independent meaning is still to be determined while their current meaning derives from the small segment of items of which they are part and parcel. Hence, I shall classify forward recall under iconic signification.

It remains for us to re-evaluate the role of referential signification. Referentials are trivially involved in any account of signification. The structure of the recalled temporal construct is built through iconic and indexical signification, depending on how the constituent parts

[3]Unless, of course, the items in the mini-list are the last items in the large list, in which case an immediate, undissociated request for recall hugely favors them as recency items.

of the temporal structure are stressed. While iconic signification assures the recall environment's cohesion, indexical signification enables referential access to objects both inside and across the boundaries of this environment. Parsimony results from the employment or the creation of referential segments and their embedding in the currently recalled list. For example, the words of a free recall rehearsal task need not be learned anymore; the creation of their meaning, that is, a convenient way of accessing information about these successions of letters/phonemes, has already been achieved, say, in grade school. In word list recall, the indexically recalled items are thus actually the relative temporal positions of the particular words while the re-produced words are referential and the placement of these words in recall is iconic. By implication, referentials (the known phoneme- or letter-successions) influence the subject's parsing of the phoneme list heavily. Knowing the symbolic references (the words), the researcher can make predictions about the subject's phoneme list parsings. Similarly, knowledge of referentials in music, for example, prominent motives or historically conventional successions of formal parts, aids the parsing of a musical piece. Therefore, referentials are the most reliable indicators for predictions about parsing. Alas, the importance of these observations about signification and remembrance to music deserves a separate chapter. I will proceed by outlining how the above picture of recall can be aligned with the listening process in music.

10.0 REMEMBRANCE IN MUSIC

10.1 GENERAL APPLICATIONS

Having forged a connection between Peircean semiotics and the neuropsychology of memory, we are now charged with demonstrating its relevance to music. While semiotics (just like semiology) has found applications in musicology,[1] the particular brand of mnemonic semiotics suggested above requires explicit tethers to musical facts. In view of my focus on a specific piece of music (the first movement of J. S. Bach's *First Brandenburg Concerto*) and on a peculiar problem (the constitution of ritornello structure while listening to the piece), the following remarks will end with an interpretation of the results of the paradigmatic analysis earlier. However, the gained insights into musical semiotics should not be applied too narrowly. In the subsequent paragraphs, I will suggest more broadly applicable guises of the semiotic terminology before narrowing onto the semiotic recreation of ritornello structure in memory.

To reiterate, parsing clarifies the temporal dimensions and boundaries of both the rehearsal list, its segments, and the complete recall event such that temporal relations between them can become functional. In memorization, these temporal relations inform the signification of a compound temporal object through a temporal sign that may or may not be encoded as part of the object, creating parsimony.

[1] Witness Turino's "Signs," *op. cit.*, or in a less rigorous application, Steven Feld's "Aesthetics as Iconicity of Style, or 'Lift-Up-Over Sounding': Getting Into the Kaluli Groove" [*Yearbook for Traditional Music* 20 (1988): 74-113]. In this and other articles, Feld stresses the examination of indigenous musical vocabulary as a point of entry for the understanding of musical traditions alien to the researcher; by the same token, historical musicology would imply the study of emerging terminology in Western art music. Originally, this study was to include a section on the evolving usage of the words "ritornello," "cadence," "incipit" and the like; after contemplating the scale and methodological focus of this inquiry, I have relegated this line of research to a more explicitly historical study.

Musical signs are often encoded in the same compound object, for example, a motive may stand for a symphony, or the tonic pitch and the employed mode for the key development of a whole section. Equally, musical signs can signify objects not encoded in the same object, for example, the occurrence of one section may herald the coming of another. In both cases, historical knowledge (or bias), in the form of traditional and applied theoretical concepts, enables the listener's mnemonic judgments. Just as references in the instructions for word list recall enabled the subject to parse and store the list, these concepts encourage the listener to differentiate between memorable and forgettable features in music. Jacques Attali, in his book *Noise*,[2] talks about such designations at the level of large-scale musical utterances, like whole pieces or genres. Social forces determine which kind of sound is considered "music" and which is considered "noise." At the level of words and musical motives, which will be our focus, such sociological biases may be seen to operate, too, through commonly accepted definitions about what, say, a "ritornello" is. We will not delve deeply into these biases but they are acknowledged as the driving force for the binary oppositions that allow parsing and, hence, memorization.

Of the two types of musical signs distinguished above, the first (signifying in a compound) is indexical, even if the listener still listens to the same section of music. Effectively, memory unifies the segments into the one same section *post* listening. The sign refers to an already perceived object, thus allowing the intersection of two temporally distinct processes in the moment of reference, which is a requirement of indexical signification. Also, if the object is what the listener would consider an extended section, reference to the section as one thing, such as its key or key development, simultaneizes the extended temporal period, again a characteristic of indexicality.

The second kind of musical sign (signifying towards an expected future event), is iconic. Given the listener's conscious position in a section that implies another, the potential of the second section is present throughout the first. As an example we might point to the interaction between ritornellos and episodes. Once the listener is clear about currently hearing a ritornello, the upcoming section is automatically assumed to be an episode. (The

[2] *Noise: The Political Economy of Music* [trans. Brian Massumi, intr. Fredric Jameson and Susan McClary, Minneapolis: University of Minnesota Press, 1985].

same holds vice versa.) As soon as the new section begins, the iconic significance of its predecessor wanes and the listener re-situates herself within the piece's structure.

The last observation can be generalized: given that the iconic expectation was based on previous knowledge and knowledge of the current temporal position of the listener within the movement, we might assume that a similarly iconic premonition holds true for all cases when the listener can expect an event to happen in the near future but does not know the exact time. Iconic signification, then, implies a hypothesis on the listener's part about the structure of the movement, while indexical signification, when it becomes possible within the confines of the movement, replaces the hypothesis with past-oriented facts. In a sense, the listening process starts out with a completely hypothetical structure of the music in mind, this hypothetical structure (based on referential knowledge of musical conventions) influences how the musical items presented to the listener in performance are memorized, and at the end of the listening process, the structure is actualized in memory, to be remembered at will. Voluntary remembrance then triggers another, generative process that transforms the structure, now symbolically fixed (the indexical connections have become referential), into another succession of motives which, when being recalled, is transforming the indexical signs referencing the memorized structure into the iconic, processual parts of remembrance.

Indexicality and iconicity (in the sense used here) are thus two complementary processes that govern the transition of musical thoughts from their practical (audible) exposure in performance to the structural representation in the listening individual and back into a practical (and ideally, audible) rendition by the remembering listener. This receptive process, with the music listener at the nexus between a prior indexical and a subsequent iconic process (memorization and remembrance), is similar to the situation of the music producer (the composer and performer). Here, the significant pathways start with conventional knowledge of compositional history (both personal and general) being iconically crafted (through composition) into a succession from which a structure (the score) emerges indexically (if we allow for the correlation between memorization and notation).[3] In both cases, whether the structure is

[3]In performance, the connection between composer and listener, this structure is then read indexically and put into music, that is, performed, iconically. One extensive treatment of performance, both from the point of view of listeners and performers/composers, is Christopher Small's *Musicking: The Meanings of Performing and Listening* [Hanover, N.H.: University of New England Press, 1998]. Small does not develop his ideas based on neuropsychology but his general assertions about the influence of the social situation on

retained in memory through the association with verbal concepts (enabling oral transmission of knowledge) or whether it is retained in the score through association with written conceptualizations (the symbols of notation, enabling written transmission), the repositories of musical thoughts are referential entities. Their ability to preserve one concept over long periods of time (such as the term "ritornello" over several hundred years) makes them repositories but not creators of meaning. They provide the *data* which, in their amalgamation with the idiosyncratic force of the individual composer's, listener's, or performer's mnemonic faculty, become *facta*.

10.2 TOWARDS A MNEMONICALLY SOUND DESCRIPTION OF RITORNELLO PROCESS

Lest we get caught ever deeper in the theoretical web of meaning, let me turn away from the Parnassus and see whether the differentiation between iconic and indexical signs may have any bearings on the matters raised in the fifth chapter. There, we postponed judgment on the relevance of incipits and cadences for the memorization and remembrance of ritornello structure. Now, bolstered with some experience and some ideas how indexical and iconic signs may become mnemonically relevant, let us approach the subject again.

In the same manner as when analyzing recall tasks, we need to ask what the levels of the recall task in a ritornello movement are. Objective of the task is the mnemonic recovery of sections that provide a good account for the whole of the movement, both in melodic content and form. Obviously, recalling the ritornello alone, even if it were a nice melody, would not account for the special character of the form. Therefore, a mixture of ritornello- and episodic elements seems the more likely choice. Again, as in word list recall, we are confronted with a double task for memory, first the identification of the ritornello as such and second its employment in the structure. The levels involved are one basic melodic/motivic level (comparable to the list of phonemes and ambient sounds constituting the rehearsal period), another level in which sections, ritornellos and episodes, are differentiable, and the temporally

music encompass the scale I would ultimately like to reach with my model; in this paper, though, only the foundation has been laid.

most extended level, the movement as a whole. Where previouly the concept of word list recall (as opposed to sound recall or word recall) provided for a motivation to remember and to create indexical and iconic references between different time scales, here the concept of ritornello structure fulfills the same purpose. Like the other examples, ritornello structure, already in its name, suggests a connection between the small-scale section ritornello and the larger scale of the complete movement. The premise for our inquiry shall then be that *if* the listener can identify the ritornello, she will have a handle at the movement's structure.

In the light of listening as a temporally extended process, this premise might be formulated slightly differently: *once* we have a clear idea of the confines of the ritornello, we will be able to identify it in the movement. Depending on the constitution of the movement, this point in time when we can securely trust our memory enough to forget about the interaction between motives and sections and concentrate on the interaction of sections and movement arrives sooner or later. Our simpleminded ritornello from Table 1 is a relatively straightforward example.

The listener commences listening with the general knowledge of ritornello form as consisting of one repeating section with which the movement starts and ends as well as several interspersed different sections. Trivially, the first remarkable instance is the beginning of the movement; on the movement-level, the section-level, and the motive-level, the beginning provides an index, but the listener's attention is guided iconically towards the end of the current section on all three levels because this will allow him to form and confirm hypotheses about the structure.

As the music continues, iconic signification of the upcoming episode remains but attention to and memorization of the ritornello's motives wane. The central measures of the current section do not require reference to earlier music. This changes with the advent of the cadence. Here, the iconic expectation of the cadential motive is fulfilled through indexical reference to the incipit, offering the compounding of the whole stretch of music from the incipit to the cadence as one on the section-level. The incipit gets reinforced through reference, the cadence becomes potentially important as ending of the ritornello.

Notably, the cadence cannot be securely memorized as ending of the ritornello because the first episode has not been heard yet. Quite possibly, the next section of music could be

another part of the ritornello. In our example from Table 1 this is not the case.

A different incipit starts the next section. Iconic expectation shifts now to this section's completion and the putative return of the initial incipit. As the cadence of the episode is reached, iconic expectation on the motive-level becomes again an indexical compacting of the episode's incipit and cadence into another representation of the concept section. Iconic expectation on the section-level is still in limbo because the listener is still unsure about the nature of this section's formal function.

The return of the initial incipit provides the decisive jump from the scale interaction between motives and sections to that between sections and the movement. Hearing the initial motive implies

- on the motive-level, the unexpected return of a familiar motive (unexpected because the previous section was not unequivocally listened to as episodic) and thus indexical reference to its most recent occurrence,
- on the section-level, the expected return of the first section (expected because the ritornello incipit is expected to return some time after the ritornello's cadence) and thus an indexical reference to the whole first section, and
- on the movement-level, the unexpected hearing of the ritornello section, unexpected because the designation of sections was previously not completely clear.

The indexical fixing of the ritornello through double reference on the motivic and section levels provides for the clear association of the ritornello's incipit and (if the same as in the initial appearance) cadence as referential signs of the section ritornello. The ritornello's incipit is now no longer just the incipit of a section but stands for this movement's ritornello as such. Any subsequent occurrence of the motive (more strongly even when followed by the proper cadence) will suggest the section ritornello. If the indexical fixing had not happened, that is, if the episodic material had continued beyond the cadence, iconic expectation for the section ritornello would not have been transformed into indexical knowledge.

On the basis of these observations we can now make the following mnemonically sound definition of a ritornello: a piece of music that begins with the initial motive of the movement and ends with the cadential motive of the first cadence prior to a section that keeps its

episodic character throughout. Judgments about the extent of the ritornello can thus only be made after listening to a complete episode (one defined by a distinct incipit and a cadence) and the first return of the initial motive.

Implicitly, the recurrence of the ritornello's head motive will also start signifying iconically the advent (after the next, not terribly mnemonically important cadence) of an episode. In the effort of identifying and memorizing the structure of the movement, this episode's cadence is now indexically referring to this episode's beginning. Indexical references to other episodes (such as the one preceding the previous ritornello) are less likely because the ritornello in between, by virtue of its different formal function, acts as distractor; the incipits of the now more clearly identifiable episodes are possibly remembered, the episodes as full sections not. Thereby, the ritornello, once it has been identified and defined as a section, suppresses memorization of all but the most salient parts of the episodes. The formal hierarchy between ritornello and episode, postulated at the outset as a referential convention and iconic formal expectation, has been realized in the listening process.

While we might decide to follow the plain ritornello structure of Table 1 to the end, I suggest that (as a rounding-off of this inquiry) we return once more to the First Brandenburg Concerto and observe the somewhat more complicated ritornello process taking place there. (The reader is encouraged to consult a score and Table 2.)

As usual, the first incipit (m. 1) is prefaced by the (conceptually, not actually) distracting silence of "no music." It provides the disjoined starting point iconically signifying what comes after it. This moment after the silence, the initial incipit (IncA) and the subsequent measures, comes to an abrupt end with the recognizable cadence CadA in m. 5. Given the conventions of ritornello form, this cadence partitions the melody, signifies indexically the end of the first few measures and iconically the start of a new section. The listener imports symbolic knowledge based on his experience of having listened to (or read about) ritornello form in Baroque concertos; given the conventions of the form, the next section ought to be an episode.

As the next section starts, this assumption seems at first justified. The new melodic material in m. 6 is taken to signify an episodic section of the movement. Then, however, an interference between the expected form and the actual happenstances of the music, namely

the gradual return to a fuller orchestration, throws the second incipit as beginning of the first episode into doubt. As we arrive at m. 12, CadB is reached. The fact that it is an ornamented version of m. 5 goes along with this particular kind of cadence as indexically signifying the end of *a* ritornello, but not yet the end of *the*, that is, the initial, ritornello as a memory template. The listener cannot be sure yet whether what was just heard was an episode or a ritornello. The tonal closure on the first beat of m. 13 gives a hint (F is again the tonic pitch) but the change of texture is not drastic enough to suggest episodic character for the following measures; especially the continued use of the horns stands out (in my ears) as challenging the designation of mm. 13ff. as episodic.

Insecurity about the actual role of the music persists through the next section until cadence CadC in m. 17. Comparison of the corresponding sections in Figures 2 and 1 shows a sharp drop-off of accuracy after m. 13. The initial incipit makes an appearance but is too accidental and sudden to induce the idea of a proper ritornello. We might consider m. 15 a new ritornello, but the two-measure (!) episode preceding it does not end with the cadence required; it segues into the putative ritornello. If there were closure on the motivic level this would allow us to count the preceding two measures as a separate section and, thus, assume the following IncA to be the beginning of a new ritornello, signifying on the level of sections. Unfortunately, there is no cadence preceding m. 15.

Only in m. 17 do we arrive at CadC, clearly a section ending, and only there do the two melodies in Figures 2 and 1 agree again (in the second half of the measure, the actual cadential motive). What follows is at first IncB, the return of a putative episode. Its return here signifies, if not a return of *the* ritornello (an entity as yet not clearly definable) then at least the clear episodicity of the section between the first occurrence of CadB (m. 12) and this recurrence of IncB in m. 18. In this movement, as opposed to the previously discussed ideal ritornello movement, the identification of episodic sections seems to be quite a bit easier than the recognition of the ritornello.

IncB in m. 18ff. is followed by material that is not distinctive, being borrowed from the long past *Fortspinnung* of the first segment, mm. 3-4. But this segues into CadA in m. 23. This is the first explicit indexical reference to material from the putative ritornello, i.e., the section starting the movement. (IncA in m. 15 was not introduced by a cadence.) CadA is

introduced by the previous IncB (m. 18), which was so far the only indexically referencing return of any incipit. Hence, by the end of m. 23, we may surmise that the section between the two syntagms has ritornello character. This is reinforced by the very episodic (soloist) character of mm. 24-26 (IncD). Finally, it seems that we get a grip at what is episode and what ritornello.

The episodic character of IncD harkens iconically for the return of a strong ritornello incipit. We do not have a cadential formula in the strict sense, presumably because motivic completion of this episodic section would upset the tenuous balance of power that episodes and ritornello hold at this point in the movement. The clear return of IncA in m. 27 finally tips this balance between which kind of section will have more of a grip on our mnemonic image of the movement in favor of the ritornello.

For reference, a graphic representation of the movement's structure up to m. 27 can be found in Figure 13; it follows the same procedure and conventions as Figure 4. Applying Hebbian principles (as in Figure 5) does not yield any insights into ritornello process because, at such an early stage in the movement, just after the first section clearly identifiable as episode, commonly used successions have not been established. Disregarding bidirectional successions (as in Figure 6), which helped establish cycles as a ritornello structure characteristic, gives a faint suggestion of cyclic behavior. Separating the bidirectional connection between CadA and IncB, we see that section B is already defined as episode with respect to section C. Likewise, section A interacted with IncD. However, IncA is itself an interspersion in section C, not preserving the integrity of a putative ideal ritornello. The graphic representation thus gives a rough rendering of the general characteristics, but no insight into what one might call the behavior of the individual paradigms and the sections they possibly constitute.

Observations from the ritornello process, however, have yielded at this point already a wealth of information about the paradigms participating in the movement, even though they have not yet been extensively used. Let us take stock of what knowledge the listener might have gathered about the ritornello: it starts with IncA but the occurrence of IncA does not necessarily imply the occurrence of a ritornello; it need not move immediately to CadA; CadA would accomodate prior to it either IncA or IncB; IncB is also a legitimate ritornello

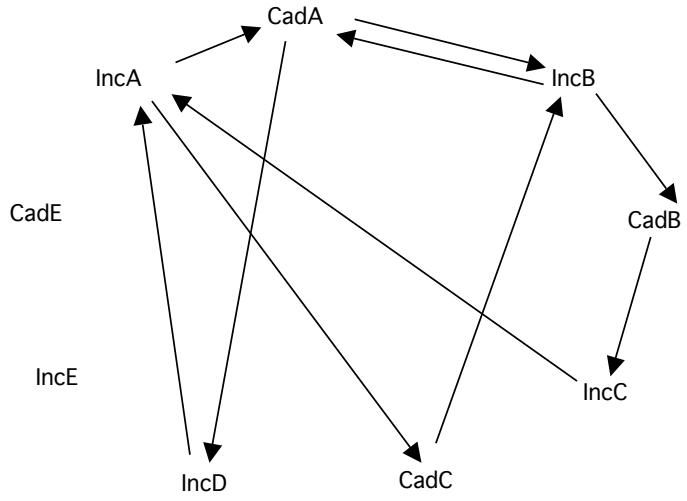

Figure 13: Successions in BWV 1046/1 until M. 27

incipit, though it is usually unconnected to section A (the complete stretch from IncA to CadA). The episodes are clear in the case of IncD but clear in retrospect only in the case of IncC through CadC. If a subject were to recall the succession of motives from memory, she might well consider letting IncD follow section A, using the first and best remembered incipit as ritornello incipit and following it up with the least ambiguous episode. The successions of sections that were easily identifiable in the idealized movement of Figure 3, with a departure-and-return strategy of the musical trace, are no longer thus easily identified in the more complicated structure represented by Figure 4. Here, the cyclical structures characterizing the generic ritornello movement seem to be more based on departure-and-return between segments than between sections. If any section did behave like a ritornello, it would have been section B.

The above discussion did not provide the clean analytical picture one might have hoped for. But in the fifth chapter the various accounts of ritornello structure, leading up to the identification of a split (or duple) ritornello, did not provide us with any evidence for the likelihood that such a structure might also emerge through active listening. The extended discussion showed that especially IncB and the whole section B take on ritornello charac-

teristics more clearly than section A, which is predestined as ritornello incipit because of its position at the beginning of the movement. The role of IncB as well as any of the other paradigms was not clear until we took the pains of examining the interaction of different time scales at each step in the sequential process of listening. Only then did the conflict between section A, ritornello by virtue of being the first group of sounds heard at the beginning of the movement, and section B, ritornello by virtue of its interactions with surrounding motivic material, clearly emerge.

While the stereotypical structure of the ideal ritornello movement indeed invites the analysis of music as structure, the duple structure of the First Brandenburg Concerto chafes against structuralization, even if it at some point succumbs to the strictures of the genre. By teasing out the institution of a fixed concept of the ritornello in the listener's mind until more than one quarter through the movement,[4] the listener is lead astray and has to involve herself more in a work that, by the unspoken laws of music, would be the domain of the composer: the generation of an easily understandable image, one that can be reproduced without fault or loss of crucial information. If the creation of (however individual) mnemonic images from auditory data is the ultimate purpose of music reception, then music such as this ritornello movement encourages and requires a creative engagement, too, one the listener ought not to shy.

[4] And much longer if we wish to unify and account for all paradigms usually considered to be part of the ritornello in the appropriate order and importance.

11.0 CONCLUSIONS

This paper was conceived of as an investigation into the promises of researching listening and the way in which we perceive temporal structure in music through it. Given that I postulated the importance of memory for listening practice, and the promise of neuropsychological results about word list memory, I needed to establish a reasonably tight connection between neuropsychology and musicology. The most amenable field, both for purposes of graphic representation of musical melodies and for the translation of different modes of memorization and remembrance into musicological vocabulary, seemed semiotics, both Saussurean and Peircean.

While Saussurean semiotics does not allow a good philosophical representation of the highly fluctuating processes of comparison involved in the assessment of music through memory, the clear, itemized description of temporal succession provided by paradigmatic analysis eases the graphic representation of the remembered musical items. Informing the order of these items are concepts that were characterized as potentially symbolic signifiers (in my terminology, referentials), as fixed in their value over time, and as clearly defining their area of applicability in the mind of the applying person. Given their non-malleable nature and bounded meaning, they were considered not part of the process of mnemonic meaning formation but means for meaning preservation outside the individual's memory.

The mnemonic components of meaning formation were found to be isomorphic to indexical and iconic means of signification. In word list memory, the two observable features of recency and contiguity were associated with indexical and iconic signs, respectively, by researching the structure and requirements of typical recall tasks, and aligning their results with the characteristics of the two types of signification in the Peircean sense.

The original cause for this inquiry, a confusion about ritornello structure in J. S. Bach's

BWV 1046/1, was not resolved but putative reasons for the confusion were provided and a different method for researching and evaluating musical memories has been developed. Instrumental is the comparison of mnemonic traces with graphical traces available, for example, in a score. The differences of the mnemonic trace, indicative of the difficulties in remembering certain features, point to issues within the music where different structural determinants (motivic structure, movement structure) conflict with one another. The resolution of these conflicts may be different in the score and in the listener's memory. The developed neurologico-semiotic corollaries of recency/indexicality and contiguity/iconicity may help in both cases but their central value lies in establishing a codependence between musicology and the neuropsychology of memory whenever musicologists examine musical memory or the listening process.

Obviously, this paper provides only a glance at the subject of memory in musical remembrance. Each section warrants exploration and would benefit from the broader treatment prevented by the scope of this paper. Nevertheless, I hope to have given the necessary broad survey of how two such disparate fields, one a science, the other a discipline of the humanities, can be associated.

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