

CHAPTER 4

THE TEMPORALITY OF MUSIC LISTENING

Creators of the temporal arts—music, cinema and dance—devote a great deal of energy and imagination to elaborating the way the structure of their works unfold in time. Given that such forms can span several minutes, tens of minutes, and in some cases several hours, we might ask what the subjective reality of these forms is if we take into account the limits of human memory. The way we pose the question of form is already full of presuppositions concerning what form is, what it can be, and what role it plays in the temporal arts.

The theoretical approaches to musical form can be classed into about three categories, albeit with fuzzy boundaries between them. A first category considers form “out of time;” it includes what Philippe Lalitte calls “architectonic” and “organicism” theories.¹ These approaches are classic in several Western traditions of music analysis. The architectonic approach involves descriptions in terms of motives, phrases, periods, and sections, the former ones embedded within the latter. The organicist approach conceives form as “a living organism that develops from a core structure that takes root in the tonal organization,”² represented in some theories of this type in terms of hierarchies of harmonic relations that extend up to the whole work, even if this work lasts an hour and a half, as in the case of a Mahler symphony. Memory and the temporal aspects of the listening process, that is, the phenomenological and psychological aspects, are not often taken into account by these approaches. Indeed, one might say that they presuppose that memory is infinite and exhaustive. In their defense, we should recognize that with a few exceptions, their aim is not to describe the “experience” of the form, but rather, at a more or less “objective” (or neutral) level, the structure of the musical object being studied.

A second approach to musical form essentially consists of denying its psychological existence. A radical example of this approach is the concatenationist theory of Jerrold Levinson, who considers that musical experience exists only in the moment, and that the global experience of a work is the concatenation of successive moments: “*Musical form* is centrally a matter of cogency of succession, moment to moment and part to part.”³ This concept is not without links to Karlheinz Stockhausen’s notion of *Momentform* as it was embodied, for example, in his piece *Kontakte* for electronic sounds, piano and percussion:

Each moment, whether a state or a process, is individual and self-regulated, and able to sustain an independent existence. The musical events do not take a fixed course between a determined beginning and an inevitable ending, and the moments are not merely consequents of what precedes them and antecedents of what follows; rather the concentration on the Now—on every Now—as if it were a vertical slice dominating over any horizontal conception of time and reaching into timelessness, which I call eternity: an eternity which does not begin at the end of time, but is attainable at every moment.⁴

A striking aspect of this conception of form is the absence of memory, or perhaps the denial of its implication in the accumulation of musical information, in the inference of temporal trajectories and in the comparison of things

¹ Philippe Lalitte, “Conditions de possibilité d’une rhétorique formelle perçue” [Possible conditions of a formal perceived rhetoric], *Intellectica*, vol. 48-49, 2008, p. 103-114. These two terms are, following the distinction proposed by Lawrence M. Zbikowski, between “atomistic” and “chain-of-being” theories (*Conceptualizing Music: Cognitive Structure, Theory, and Analysis*, Oxford, Oxford University Press, 2002, p. 310).

² “... un organisme vivant qui se développe à partir d’une structure-noyau qui prend racine dans l’organisation tonale.” Lalitte, “Conditions de possibilité d’une rhétorique formelle perçue,” p. 3. [my translation]

³ Jerrold Levinson, *Music in the Moment*, Ithaca, Cornell University Press, 1997, p. 14. [Author’s emphasis]

⁴ Karlheinz Stockhausen; cited in Karl Heinrich Wörner, *Karlheinz Stockhausen: Werk-Wollen, 1950-1962*, Köln-Rodenkirchen, P. J. Tonger, 1963. English version: *Stockhausen: Life and Work*, translated from the German by Bill Hopkins, Berkeley, University of California Press, 1973, p. 46-47. [Author’s emphasis]

heard at a given moment with those heard in the not-too-distant past of the piece. At the same time, Levinson seems to accept that the past might influence the present through a “[...] tacit, unconscious correlation of present passages or bits with earlier ones, rather than explicit, conscious grasp of relationships of the broad-span sort.”⁵ As such, although he adopts a concatenationist position in opposition to the explicit consideration of large-scale architectonicism or organicism, he nonetheless admits that the processes that resemble those of memory can operate implicitly. One might conclude that the distinction he effectively tries to make is between implicit and explicit apprehension of form.

A third approach considers that form exists “in time.” In this conception, large-scale form is the shape of lived experience through time and its resonating reminiscences, rather than an out-of-time structure that one can apprehend entirely.⁶ This is the conception of musical form of composers such as Roger Reynolds who considers that the work of the composer is to shape experience with sound.⁷ The temporal component of experience is thus crucial. This approach evokes the emerging domain of cognitive dynamics, of which Mari Riess Jones is one of the pioneers through her reflections on time and processing constrained by time during music and everyday listening.⁸ A central part of this approach is the interaction between two types of processes over time: perceptual organization, attention, the storage and retrieval of memories, and the generation of expectancies on the one hand, and the emotional, affective, and aesthetic reactions on the other. Because such processes are dynamic, their study requires the use of methods that are sensitive to temporal evolution in order to address the perceptual, cognitive, and emotional issues of musical listening and the psychological experience that results from them. This also suggests the importance of using real, whole pieces of music in natural listening situations.

Many important questions about the experiential dynamics during music listening still need to be posed and addressed. What are the relative contributions of perceptual and cognitive processes in listening to music of different styles? How do the processes of perceptual processing, attentional dynamics, and the play between memory and perception contribute to musical apprehension—or comprehension—and emotional and aesthetic reactions to music as it evolves in time? What is the nature of what remains when the music has ended? What are the time constants of various aspects of memory in musical experience, i.e., do certain memories degrade faster than others? What are the contributions of musical structure and the interpretation in a performance on the temporal form of a listener's experience?

The project presented in this chapter was developed to address some of these issues by way of a long piece of contemporary music composed by Reynolds especially for the project. This work is entitled *The Angel of Death*. It was conceived according to formal properties that allowed for the study of certain dynamic listening processes, that is, those that evolve over time, all the while completely fulfilling the artistic aims of the composer. In collaboration with him, the decision was made to focus on two aspects of the listening experience: one related to the perceptual processing of the musical structure over time, more specifically the feeling of resemblance of materials that are repetitions or variations of the thematic materials already heard in the piece; the other related to the emotional force or intensity felt by the listener as a function of the musical structure and its sonic properties. These aspects of the perceptions and reactions of the listeners were measured in a continuous fashion in a concert hall. Other experiments were conducted in the laboratory with the aim of studying the perception of musical similarity, the perceptual structure of the thematic materials and the interaction in memory of thematic materials and their transformations or variations. This project raises questions concerning the nature of musical form, the role of familiarity and recognition in music listening, and the temporal evolution of emotions evoked by the music.

⁵ Levinson, *Music in the Moment*, p. ix.

⁶ Lalitte qualifies this approach to form as “energetic” or “kinetic” (“Conditions de possibilité d’une rhétorique formelle perçue”). In musicology, this approach is represented by the work of Boris Vladimirovitch Assafiev (*Музыкальная форма как процесс*, 2 volumes, Moscow, State Musical Editions, 1930-1947; Leningrad, Muzgiz, 1971. English version: *Musical Form as Process*, translated from the Russian by James Robert Tull, 3 volumes, Columbus, Ohio State University, 1976) and of Ernst Kurth (*Musikpsychologie [Music Psychology]*, Berlin, Hesse, 1931), to cite only these two.

⁷ Roger Reynolds, “A perspective on form and experience,” *Contemporary Music Review*, vol. 2, no. 1, 1987, p. 277-308.

⁸ Mari Riess Jones, “Time, our lost dimension: Toward a new theory of perception, attention and memory,” *Psychological Review*, vol. 83, no. 5, 1976, p. 323-335; Mari Riess Jones & William Yee, “Attending to auditory events: The role of temporal organization,” in Stephen McAdams & Emmanuel Bigand (Eds.), *Thinking in Sound: The Cognitive Psychology of Human Audition*, Oxford, Oxford University Press, 1993, pp. 69-112. Au sujet du domaine de la dynamique cognitive, voir Lawrence M. Ward, *Dynamical Cognitive Science*, Cambridge, MIT Press, 2002.

THE PROJECT: *THE ANGEL OF DEATH*⁹

Art allows for a relation with the external world that gives free reign to the creative potential specific to the human species. Artistic creation distinguishes itself in this way from numerous cognitive activities traditionally studied in the domain of the cognitive sciences. Artistic creation, and more specifically musical creation, is not, however, free of all constraints. Music is a form of free expression, partly symbolic and partly founded directly on sound, which is nonetheless constrained by a system of norms—of plausibilities—, and this, even if these norms seem to exist solely to be subtly surpassed and modified. The “supervised liberty” that characterizes musical creation teaches us something fundamental about the plasticity of human cognitive function. Indeed, musical systems continue to evolve and to be modified over the course of human history. This evolution, in its turn, requires cognitive systems that produce and understand the musical systems and that allow listeners to adapt themselves to these new organizations permanently. This adaptation does not always happen without resistance. The impassioned debates generated throughout the 20th century by the emergence of what is called “modern” and “contemporary” music bears witness to the importance of the social and aesthetic stakes raised by a question that is, in the end, essentially cognitive and artistic in nature. However, this confrontation of the cognitive and the artistic is rarely addressed in explicit fashion and in direct collaboration.

The composer Reynolds and I met at IRCAM at the beginning of the 1980s and we began a collaboration that led to the integration of psychoacoustic results concerning auditory segregation (see Fig. 1.10) in the composition of his work *Archipelago*, composed in 1982 and 1983; he applied independent vibratos to the even and odd harmonics of melodies played by several instruments, thereby splitting them into two new “virtual” sound sources and made them travel independently through space over an array of loudspeakers. In 1993, we began a series of exchanges that led us to a project born of our desire to collaborate around the creation of a specific musical work. The artistic object¹⁰—a chamber concerto for piano—was conceived in order to provide to the psychologists a unique access to the process of musical creation itself. The goal was to explore the perception and cognition of the contemporary musical forms and materials in their relations to the intentions and aims of the composer. The form, the materials, and the composition of the work became the subjects of a scientific study on the perception and reception of the music, as well as on its emotional and aesthetic impact. The scientific enterprise was present during the whole creative process and gave rise to a unique set of experiments at the world and North American premiers of the piece. In an experiment conducted for the first time in real time, listeners recorded certain aspects of their perception, memory, and emotional reactions to the music, all the while experiencing this music for the first time in a concert.

This project involved an interdisciplinary collaboration over a period of six years. The fruits of this utopian gathering of arts and sciences encompasses the conception and perception of musical materials, their transformations by score-based compositional techniques and by computer-processing of the sound samples, as well as the musical form conceived as a dynamic experience through time. Reynolds proposed the original form of the work to Emmanuel Bigand and me at the end of 1997. The discussion between the three of us that followed at UCSD, joined by Gerald Balzano, concerned both the way the form of the work would allow the study of the influence of large-scale form on perception during listening to the work and the question of what kinds of experiments could be conceived to test hypotheses on this type of “situated” perception. The primary thematic materials, conceived in versions for piano and for chamber orchestra, were characterized, composed, and orchestrated in 1998 and at the beginning of 1999. The orchestral versions of the materials were recorded at UCSD in the Spring of 1999 with the Sonor Ensemble conducted

⁹. This chapter summarizes a project that involved three teams: the Perception et Cognition Musicales team at the Sciences et Technologie de la Musique research unit (UMR STMS) at IRCAM-Centre Pompidou in Paris and the French Centre national de la recherche scientifique (CNRS), a second team assembled by Reynolds in the Music Department of the University of California, San Diego (UCSD), and a third team around Emmanuel Bigand at the Laboratoire d'étude de l'apprentissage et du développement (LEAD) a joint laboratory of the CNRS and the Université de Bourgogne in Dijon. The music-analytic, musicological and psychological results of the project were published in large part in an e-book I co-edited with Marc Battier (*Creation and Perception of a Contemporary Musical Work: The Angel of Death by Roger Reynolds*, Paris, Ircam-Centre Pompidou, 2005), which includes the republication of articles in a special issue of the scientific journal *Music Perception* (vol. 22, no. 2, 2004) dedicated to the perceptual part of the project. In the present chapter, I draw freely from the writings of my composer (Roger Reynolds) and musicology (Philippe Lalitte and François Madurell) colleagues when I need to relate certain compositional or musicological points.

¹⁰. IRCAM-Centre Pompidou commissioned the work *The Angel of Death* for piano, chamber orchestra and computer-processed sounds from Reynolds. The world premier took place in the Agora Festival at IRCAM-Centre Pompidou in Paris in June 2001 with the pianist Jean-Marie Cottet and the Ensemble Court-Circuit conducted by Pierre-André Valade. The North American premier took place in the Time Forms Festival at UCSD in April 2002 with the pianist Gloria Cheng and the Sonor Ensemble conducted by Harvery Sollberger.

by Harvey Sollberger. The piano versions were recorded at IRCAM in May 2000 by the pianist Jean-Marie Cottet. These recordings became not only the basis for psychological experiments on the thematic materials, but also the source materials for the layer of computer-processed sounds, created with the assistance of the computer music designer Frédéric Voisin at IRCAM in 2000 and 2001. The score was finalized in Spring 2001.

The general objective of the project, aside from the central goal of creating a musical work, was to bring objective elements of reflection to the questions raised by musical creation within an approach to research that unites the methods and theoretical frameworks of the cognitive sciences and social sciences. The study of contemporary musical creation presents an essential theoretical and methodological advantage: to be able to conceive of scientific research in direct interaction with a composer. However, composers don't compose music "in general," they compose specific pieces. Therefore, the project necessarily had to focus on a single work, although this work was conceived in coherence with the general objectives of the project itself, which was simultaneously artistic and scientific. In the framework of this interactive project, the goal of the psychologists was thus to analyze:

- 1) the process of invention and problem-solving in musical composition;
- 2) the perceptual processing and memorization of musical materials and the variations and transformations applied to them;
- 3) the integration of the materials and their transformations into the composition itself;
- 4) the experience during listening to the whole piece in a concert situation, this last point being affected by the integration of the materials.

This ambitious project necessitated the implication of people with a diverse set of skills, including musicologists, psychologists, and technicians, in addition to the composer of the work.¹¹ Each category of collaborators brought their own set of concepts, vocabulary, presumptions, and thought processes, which we had to confront and reconcile over the course of the project.

The whole project has already been described in detail elsewhere.¹² Here, I will focus primarily on the aspects that are directly related to the temporality of music listening and propose a reflection on its implications for music theory and musicology.

STRUCTURE OF THE WORK AND THE THEMATIC MATERIALS

The compositional process adopted by Reynolds evolved over several decades and led him to an elaborated conception of each aspect of a work.¹³ According to the composer, this process is related to the fact that his father was an architect and also to the fact that he had finished his studies in physical engineering before starting his university-level music training. He considers that the use of the imagination, the creation of sketches and graphics, textual description, and the association with extramusical elements are as much a part of "composition" as writing the final score itself. The distinctive sign of his compositional method is to work with a formal diagram on which he conceives the entire detailed structure of the work, before starting to determine the inner details. However, as Lalitte remarks, Reynolds does not view the formal plan as a rigid framework that must necessarily be filled, but rather as a conceptual structure that allows his intuitive and subjective impulses to be optimized.¹⁴

The two halves of the work

Reynolds first conceived the plan of *The Angel of Death* in two main parts, each lasting about 17 minutes in their final form. They constitute the same "landscape of opportunity" traversed in two distinct ways. The Section part (S hereafter) presents the materials in a way that maximizes the identity of the sections and the moments at which the structural landmarks articulate themselves in the listener's mind. In the Domain part (D hereafter), the listener must

¹¹. See Philippe Lalitte, "Compulsory figures," in McAdams & Battier (Eds.), *Creation and Perception of a Contemporary Musical Work*; Roger Reynolds, "Compositional strategies in *The Angel of Death* for piano, chamber orchestra and computer processed sound," in McAdams & Battier (Eds.), *Creation and Perception of a Contemporary Musical Work*.

¹². See McAdams & Battier (Eds.), *Creation and Perception of a Contemporary Musical Work*.

¹³. Roger Reynolds, *Form and Method: Composing Music*, edited by Stephen McAdams, New York, Routledge, 2002. For an analysis of the unique position occupied by Reynolds' œuvre, see Lalitte, "Compulsory figures."

¹⁴. Philippe Lalitte & François Madurell, "Retrospective reflections," in McAdams & Battier (Eds.), *Creation and Perception of a Contemporary Musical Work*.

understand the elements as sources of influence radiating from the central element of each theme, rather than as clearly delineated sections. Therefore, the D part is by nature more continuous and organic, and its internal boundaries are less notable. These two ideals are represented graphically in Figure 4.1 by squares and ovals, respectively. The parts are vertically aligned to reveal the temporal correspondences between them (T1 = theme 1, TR1→3 = transition between the materials of T1 and T3, COMB2/4 = combination of the materials of T2 and T4, *RepStrat* = repetitive strata; these elements are explained below). The grey rectangles represent the central sections of the thematic materials.

The basic materials comprise the five “thematic elements” (T1 to T5). It should be noted that the notion of thematic element for Reynolds largely surpasses in duration and in content the traditional notion of musical theme. These materials, called “themes” to lighten the text, are in fact short compositions each having its proper form: beginning, definition of its terrain, evolution, and end. They are complete musical textures and not musical themes with a single melodic-rhythmic line.¹⁵ Each theme has a central subsection that Reynolds calls the “core element” (indicated by the grey squares in Fig. 4.1). The themes are presented in their entirety in the S part. In the D part, only the core element appears in its initial form, the rest being a greater or lesser transformation of the other subsections of the theme.

Other sections include the “regions”¹⁶ of combination of materials of different themes (COMB2/4 for the materials of T2 and T4), as well as the regions of transition between the materials of one theme and those of another (TR1→3 for the materials of T1 and T3). In addition to the thematic materials and their direct derivatives (COMB and TR), there are three nonthematic elements that appear in very similar form in the two parts. One is a very extended, centrally positioned section called *Other*. This passage is a concatenation of cyclic ostinati that are expressly out of phase in order give a global impression of constant change, but without direction: always the same, always different, and going nowhere. It is a unique event that in no way participates in the rest of the work. The other element is a series of rhythmic and more directional ostinati organized in repetitive strata (labeled *RepStrat* in Fig. 4.1). Additionally, an *Interlude* for piano, rhetorically similar to the core element of T5, manifests itself just before this theme in both parts and serves as a kind of premonition of the *Epilog*, also play by piano at the end of the work. There are two large structural silences, one of 11 seconds between COMB2/4 and *Other*, that gives listeners a moment of reflection to integrate everything that has preceded it and to prepare them for the marked difference of *Other*, and the other is an equilibrating silence of 9 seconds between T4 and *RepStrat*.

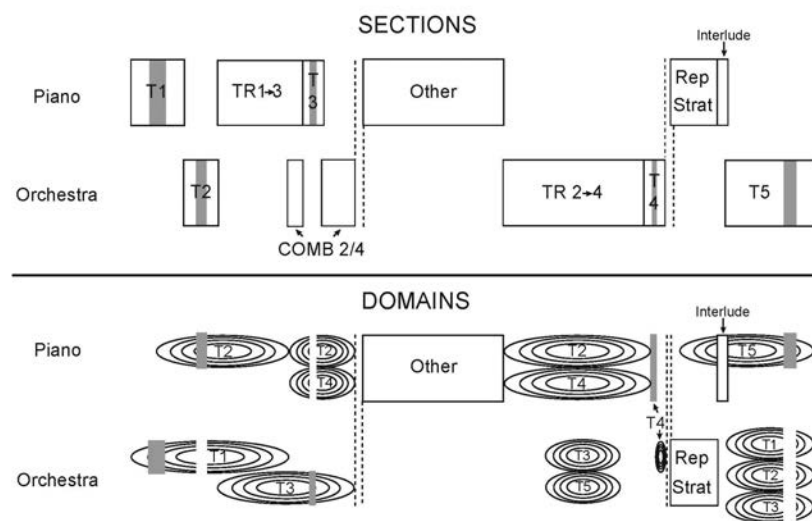


Figure 4.1. Schematic diagram of the structure of the two main parts of *The Angel of Death*.

¹⁵ Reynolds, “Compositional strategies in *The Angel of Death*.”

¹⁶ Reynolds uses the term “region” to designate the different sections of the form. I thus employ this term to maintain coherence with his writings.

The two parts have similar global temporal structures in the sense that the core elements of the themes, as well as *Other*, *RepStrat* and *Interlude*, occur at identical moments in both parts. This temporal structure is revealed by the superposition of the two parts in Figure 4.1. Around these temporal pillars, the materials are developed differently within each part. In S, the boundaries between themes, the TR and COMB regions, as well as the other regions, are clearly demarcated. Two of the combinations (COMB3/5 and COMB1/2/3) are present in D but not in S. In the D part, the materials overlap and interpenetrate more, giving a more organic and diffuse sense to the musical flow. Note, for example, that the clear delimitation of T1, T2, TR1→3 and T3 in the S part are lost with the overlap of the materials of T1 to T3 in the corresponding region of the D part. This distinction is one of the composer's essential aesthetic objectives.

The piano and orchestra each present certain materials in each part, thus creating a stratified structure. Furthermore, the materials played by the piano in one part (for example, T1, TR1→3, *RepStrat* in S and T2, COMB2/4, TR2→4, T5 in D) are incarnated by the orchestra in the other part. Thus, even though the core elements of the themes come back at the same moments in the two parts, they change instrumentation from one to the other. The only exceptions to this rule are that *Other* and *Interlude* remain in the piano in both parts.

Although the instrumentation suggests that the work is a sort of concerto for piano and chamber orchestra, Lalitte remarks that the relation between the soloist and the orchestra does not follow the traditional scheme of a concerto in which the soloist leads in dialogue with the orchestra, which must respond.¹⁷ The order of presentation of the thematic materials alternates between the two instrumentations, and the materials were composed without tying them to a specific instrumentation, but taking into account the compositional constraints specific to the two realizations.¹⁸ However, the formal structure of the work is more complex than a simple alternation: in addition to the presence of regions dedicated solely to the piano (*Other* and *Interlude*), the two parts of the work present specific manifestations of the concerto genre. In S, the alternation between strata of the piano and the instrumental ensemble represents a constant variation of the equilibrium between a domination by the piano culminating in the *Other* section, then a reversal in which the orchestra subsequently takes over with the previously mentioned exception of *Other* and *Interlude*. Another relational logic is created in the D part where the zones of influence of the piano and orchestra are less defined temporally and some are more nested in others; the writing creates the overlap and favors fusion and heterogeneity. As such, even if the two strata still exist, the relation between the piano and ensemble is much more deeply connected. Lalitte proposes that this difference in the relation between soloist and ensemble has consequences for the reception of the piece.¹⁹ In S, the soloist has to focus the audience's attention in order to be the point of reference, whereas in D the soloist is no longer the principle referent. To the contrary, the pianist can acquire a much stronger power of attraction when appearing alone in *Other* and *Interlude*.

The materials change strongly between S and D with the exceptions already mentioned above (*Other*, *Interlude*, *RepStrat*, and the core elements). *RepStrat* and the core elements only undergo a change in instrumentation, and *Other* is transformed in the second half of the work by an electroacoustic elaboration, but remains recognizable per se. Lalitte is of the opinion that it is these elements as carriers of invariance that subtend the formal coherence of the piece.²⁰ As far as the core elements are concerned, they fill both an expressive function and function as prototypes for the elaboration of the subsections of the themes. They must possess strong identities to be able to adapt to the transformation procedures. As such, the composer states that the formal design increases the tendency of the listeners to pay conscious attention to their memory processes: the formal structure stratifies and personalizes the listeners' experience. Reynolds calls this kind of form "revelatory" and considers that it is profoundly different from "communicative" forms. The design of the revelatory form invites the listener to a meaningful interaction, not by way of a common message addressed to all, but in inciting them to benefit individually and at the highest possible level of aesthetic experience.²¹

¹⁷ Lalitte, "Compulsory figures."

¹⁸ On this subject, see Stephen McAdams, "Problem-solving strategies in music composition: A case study," *Music Perception*, vol. 21, no. 3, 2004, p. 391-429; François Madurell, "The Angel of Death: Timelessness of the Pianistic Gesture," in McAdams & Battier (Eds.), *Creation and Perception of a Contemporary Musical Work*.

¹⁹ Lalitte, "Compulsory figures."

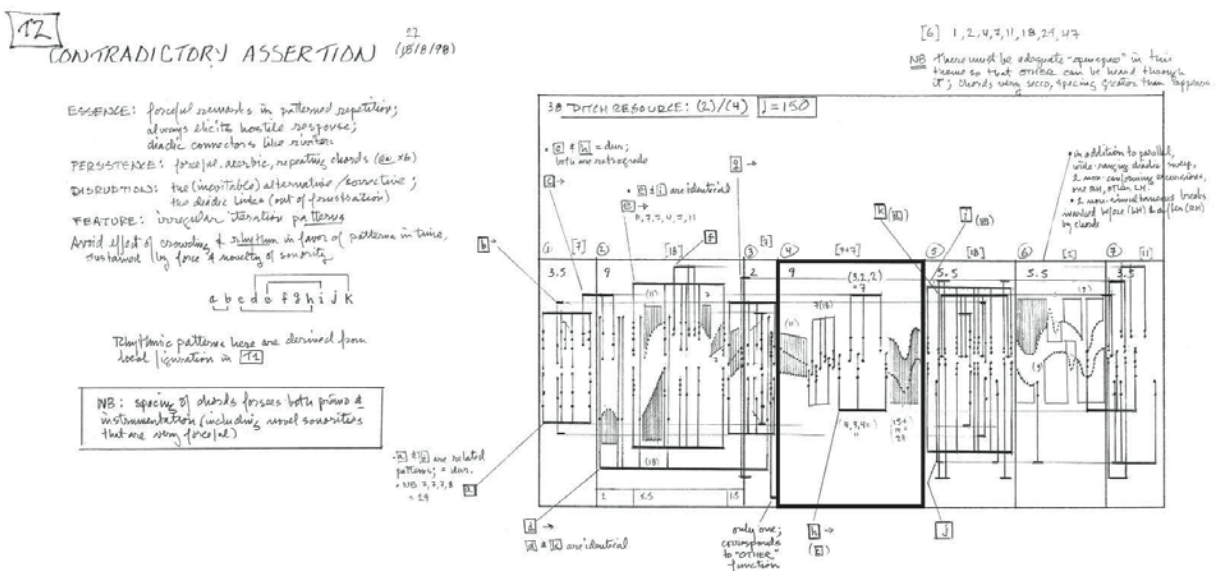
²⁰ *Ibid.*

²¹ Reynolds, "A perspective on form and experience," p. 306.

The thematic materials

The five thematic elements last from 23.5 to 99.5 seconds. The term “theme” may lead to confusion here as mentioned briefly above. Lalitte insists on the fact that in the present context, these elements are not simple melodic-rhythmic themes with a purely linear character, but are veritable compositions, each following its own trajectory and including a beginning or introduction, a middle or phase of evolution, and an end, the role of which can be assimilated to that of cadence or mechanism of closure.²² In other words, the principle functions that contribute to the creation of the form remain stable at this local level. The themes are composed with subsections, each with its own characteristic content, notably in the S part. This type of restricted time scale facilitates the establishment of reference points for the listeners.

The thematic elements have evocative titles that characterize them linguistically (Theme 1: *Equilibrium in extremis*, Theme 2: *Contradictory assertion*, Theme 3: *Tremulous uncertainty*, Theme 4: *Jagged rips*, and Theme 5: *Interior line*). Each theme includes from four to nine subsections that are planned in advance in detail (see Figs. 4.2 and 4.3). In these figures, the subsections are delimited by the rectangles and their temporal proportions are drawn from a logarithmic series. The annotations specify the character, the palette of pitches (or pitch resource in the composer's words), the durations of the subsections in seconds, and the tempo. The internal proportions of the durations, the pitch resource, the textural character, the formal shaping, the rhythmic vocabulary, and the instrumentation are all established in categorical fashion. Reynolds considers that it is crucial for the thematic elements to be strongly and distinctly characterized so that the structure can be heard and that the themes can adopt the roles of “characters” in the dramaturgy of the piece.²³



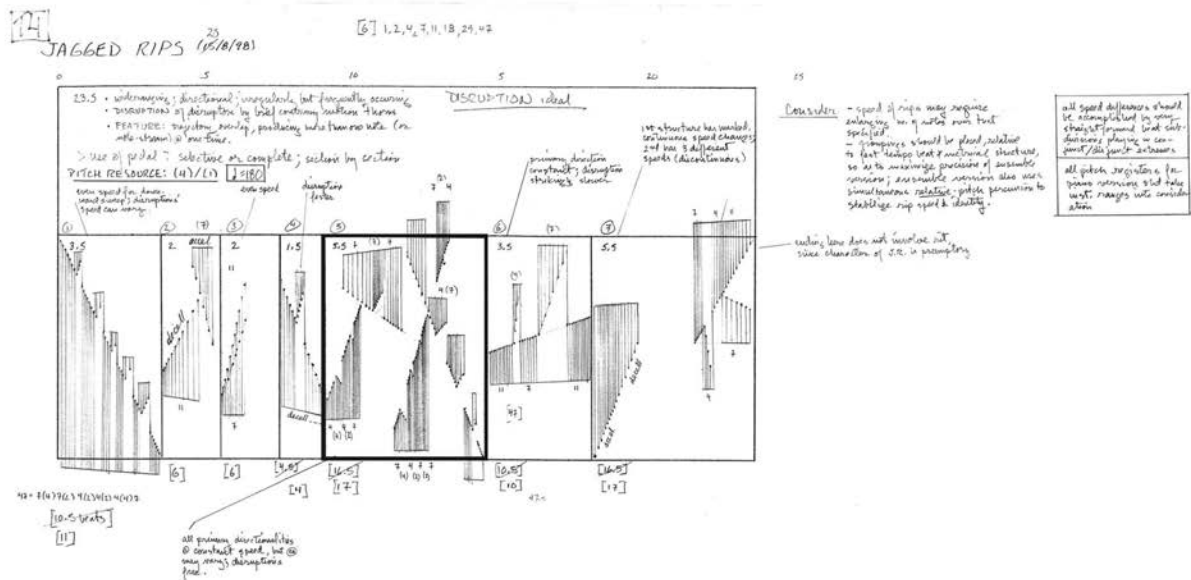


Figure 4.3. Textural diagram created by the composer for Theme 4: *Jagged rips*.

The musical materials play a central role in *The Angel of Death* in that they occupy a perceptual and cognitive function in relation to the form of the work and are the subject of great conceptual effort on the part of the composer to define and refine their nature and the distinctions among them. Given that they were conceived, composed, and recorded at the beginning of the project, we had the possibility to explore them experimentally and to analyze them before the whole work was composed. The recording of these principle components of the work at the beginning of the project was also required for artistic purposes—their use as a basis for the computer layer: after edits and assemblages, they were to become the source materials to be processed by computer algorithms to obtain the ten computer images that compose the electroacoustic layer of the piece.

In his article on his compositional strategies for *The Angel of Death*, Reynolds describes the palette of resources that were pre-established: pitches, number series, and proportions that then form the thematic materials.²⁴ He presents the series of 18 disjoint pitches that is subsequently elaborated in a series of 56 conjoint pitches, the two sets being used in several transpositions. He also describes the different ways that the numbers are used as norms that underlie the feeling that the listener will have over time of what is probable in the universe of the piece. As Lalitte remarks, this sense of the probable is necessary in order to grasp and be affected by what happens over the course of the piece.²⁵ The logarithmic series are used as proportions, a characteristic of Reynolds' music analyzed by Lalitte, who shows their unique and essential contribution to Reynolds' temporal and textural aesthetic.²⁶

The themes were conceived in pianistic terms, drawing from the history of pianistic gestures,²⁷ but they also had to be translatable into parallel orchestral versions.²⁸ All of the thematic materials were composed for both instrumentations in order to fulfill the bipartite conception of the works' form. To find an equilibrium between the resemblance among the subsections of a given theme and the need for variation across the subsections to render the theme musically convincing created a range of perceptual possibilities in terms of both intra- and inter-thematic similarity relations. Two experimental studies were conducted to explore the perceptual structure of the themes and the similarity relations among the subsections.

Sandrine Vieillard, Olivier Houix, Roger Reynolds, and I conducted experiments in which listeners were asked first to group together the subsections of the themes that had a musical family resemblance and then to describe the

²⁴ *Ibid.*

²⁵ Lalitte, "Compulsory figures."

²⁶ *Ibid.*

²⁷ See Madurell, "The Angel of Death: Timelessness of the pianistic gesture."

²⁸ See Reynolds, "Compositional strategies in *The Angel of Death*."

similarities among the elements in each group.²⁹ The data were analyzed to create a tree diagram that represents the relative similarities of the 34 subsections of the five themes, with a separate diagram for each instrumentation. The intra- and inter-theme relations basically depend on musical surface relations, such as melodic and rhythmic texture, articulation, gestural properties, and timbre. Timbre plays a particularly important role when one compares the similarity relations between the two instrumentations. Most notably, instrumentation, timbre, and the kind of timbral change (smooth or disjoint) strongly affected the classifications for the orchestra version. In addition to the basic perceptual properties, the similarity relations are also evaluated on the basis of the mood evoked by the subsections, particularly for the orchestral versions. The similarity relations among subsections from different themes create interesting possibilities for the ambiguity of thematic identity. However, the analysis of the perceptual data showed that the composer avoided such potential pitfalls in the juxtaposition of thematic materials in the derived regions (TR, COMB) of the work.

Philippe Lalitte, Emmanuel Bigand, Bénédicte Poulin-Charronnat, Charles Delbé, Daniel D'Adamo, and I have shown that the strong rhetorical structure constituted by the sequencing of subsections, in interaction with the perceptual properties of the musical surface, give rise to unity in spite of the musical variability within each theme.³⁰ We studied two things:

1) how listeners follow the musical progression of each theme by indicating their perception of functional boundaries at subsections with a task involving segmentation during listening;

2) how they perceive the temporal implications of the subsections, that is, does a given subsection precede or succeed another one rhetorically?

In the first phase, the listeners listened to the whole themes three times and had to make a different evaluation each time. In the second listening, their task was to push a button each time they discerned a change in musical idea. These segmentations corresponded for some to the discontinuities in the musical surface, but for others, the segmentations were strongly influenced by the rhetorical structure of the themes. In the second phase, the listeners heard pairs of excerpts taken from the themes (one or more consecutive subsections). The two excerpts either came from the same theme or from different themes. Listeners first had to decide if the excerpts belonged to the same theme. If they judged them to be from the same theme, they then had to say which of the two came first in the theme. The listeners (especially the nonmusicians) had more difficulty with the second task. When they succeeded, the judgments of belongingness to the same theme were based on surface similarities, and the temporal orientation depended on having previously heard the whole theme. The listeners seemed to grasp the rhetorical structure during the segmentation task, but had difficulty in judging the belongingness. This result suggests that the musical structure is easy to follow in time, all the while being difficult to represent in an abstract fashion. Such a representation would have allowed listeners to judge precisely the temporal articulation of the parts presented outside of their temporal context.

Score-based transformation of materials

One of the main ideas in Reynolds' aesthetics is to rethink the basic principles of Western variation. Lalitte affirms that the variation procedures employed in *The Angel of Death* are rather unusual for Reynolds. He distinguishes three types of variation: by heterogenization (change of instrumentation and writing techniques between the S and D parts), by continuous transformation (TR et COMB) and by derivation (*RepStrat*, the *Interlude* and the *Epilog* for piano found at the very end of the work).³¹ Several of these techniques represent new tools for transformation that are not typical of Reynolds' previous work, but represent new directions in his compositional evolution.

²⁹. Stephen McAdams, Sandrine Vieillard, Olivier Houix & Roger Reynolds, "Perception of musical similarity among contemporary thematic materials in two instrumentations," *Music Perception*, vol. 22, no. 2, 2004, p. 207-238; reprinted with demonstrations of the experiments in McAdams and Battier (Eds.), *Creation and Perception of a Contemporary Musical Work*.

³⁰. Philippe Lalitte, Emmanuel Bigand, Bénédicte Poulin-Charronnat, Stephen McAdams, Charles Delbé & Daniel D'Adamo, "The perceptual structure of thematic materials in *The Angel of Death*," *Music Perception*, vol. 22, no. 2, 2004, p. 265-296; reprinted with demonstrations of the experiments in McAdams & Battier (Eds.), *Creation and Perception of a Contemporary Musical Work*.

³¹. Lalitte, "Other(s)."

Heterogenization

According to Lalitte, heterogenization is created by the changes in instrumentation and writing technique that differentiate S and D.³² Reynolds has described the problems inherent in the conception of the materials for two instrumentations, as well as the way in which the materials were transformed between the two parts of the piece.³³

Two instrumentations. I examined the process of conception of the materials for two instrumentations in a series of interviews with the composer.³⁴ He clearly possesses acquired knowledge, very often explicit, of the performance constraints of the piano and the orchestral instruments: what they can and can't do, individually and collectively. He also masters the range of their timbral and articulation qualities. This knowledge allowed him to adapt what was initially conceived as pianistic gestures to an orchestral realization. It also led him to adapt his writing style in order to achieve the complex sequencing of instruments in extended pianistic gestures over several octaves, which surpasses the range of individual orchestral instruments. This adaptation made use of quicker tempi than he would normally have used, simpler subdivisions of the beat allowing precision in the relay overlaps between instruments related to the metric structure, and the gestural reinforcement for creating timbral continuity in certain passages that traverse several registers passing from one instrument to another. The conception of the pianistic textures clearly draws from intimate knowledge of the ergonomics of the piano. Reynolds, who is a pianist, states that he started with the piano as an unconscious point of departure, using the image of the body playing the piano to impose certain constraints on the conception of thematic textures such as those in Figures 4.2 and 4.3. However, he already had the fact that the materials needed to be adapted to the orchestra in mind, thus producing two sets of constraints in their formulation. Indeed, their instrumental "plausibility" was always in the background when he created the textural diagrams. Finally, it is also clear that Reynolds possesses another domain of knowledge, one less conscious and transmittable by verbalization, concerning the timbral effects of the different instruments in various registers, as well as the judicious use of timbre in combining and sequencing the instruments. This knowledge served to imagine the perceptual effects of orchestration in terms of the fusion of sounds coming from different instruments and the composite timbres that emerge, as well as in terms of the segregation of sounds into auditory streams and the segmentation of melodic lines into motives on the basis of timbral discontinuities. It seems that there is a whole domain related to orchestration that involves procedural knowledge,³⁵ in which most composers have difficulty expressing what they know and how they use it when orchestration decisions are made.

The change in the instrumentation of the themes between the two halves inevitably influences the degree of homogeneity of the material. When the themes are presented in the orchestra, the timbre and the balance of dynamics and texture modify the morphology and consequently the identity of the material compared to the more homogeneous piano version. To test the effect of instrumentation change on the recognition of the subsections of the themes, Bénédicte Poulin-Charronnat, Emmanuel Bigand, Philippe Lalitte, François Madurell, Sandrine Vieillard, and I studied how timbre is coded in memory by the listener for materials drawn both from *The Angel of Death* and a symphonic poem by Franz Liszt, in order to shed light on a possible difference between memory processes in nontonal and tonal music.³⁶ In the first learning phase, extracts of the themes (nine for piano and nine for orchestra) were presented to four groups of listeners (two groups for each instrumentation), and they had to memorize them. Then, in a recognition phase, the nine learned excerpts were presented along with nine new ones, and the listener had to decide for each one if they had heard it in the learning phase or not. These 18 excerpts were either in the same instrumentation as the learning phase or in the other instrumentation. Thus, one of the groups heard the piano during learning and the piano during recognition, another piano and then orchestra, and vice versa for two other groups having the orchestra in the learning phase. At the beginning of the recognition phase, we informed the listeners that if the instrumentation changed between the two phases, they should ignore the change. Each of these four groups was composed of half professional musicians familiar with contemporary music and half nonmusicians.

³². *Ibid.*

³³. Reynolds, "Compositional strategies in *The Angel of Death*."

³⁴. See McAdams, "Problem-solving strategies in music composition."

³⁵. Procedural knowledge is employed in the completion of a task and cannot be easily expressed by the individual because it is unconscious, implicit, and tacit. This type of knowledge can be distinguished from declarative knowledge, which can be expressed with language. It is the difference between knowing *how* and knowing *what*.

³⁶. Bénédicte Poulin-Charronnat, Emmanuel Bigand, Philippe Lalitte, François Madurell, Sandrine Vieillard & Stephen McAdams, "Effects of a change in instrumentation on the recognition of musical materials," *Music Perception*, vol. 22, no. 2, 2004, p. 239-263; reprinted with demonstrations of the experiments in McAdams & Battier (Eds.), *Creation and Perception of a Contemporary Musical Work*.

The percentage of correct recognitions as a function of the correspondence between the instrumentation in the two phases, the instrumentation in the learning phase, and musical training is shown in Figure 4.4 (left panel). First, note that when the timbre doesn't change, musicians are better than nonmusicians. However, if the timbre changes, the performance of the musicians is not different from chance (50%) and that of nonmusicians is significantly above chance (although only slightly so): nonmusicians seem to have been less perturbed by the timbre change than were musicians. The capacity to recognize excerpts of contemporary music is thus moderate and the perceptual identity of the excerpts is strongly affected by the change in instrumentation. For contemporary music, it thus seems difficult to memorize abstract features (such as melodic contour or rhythm, for example), which would contribute to stable memory traces if there is also a change in timbre. Musicians stored the surface features more easily than nonmusicians, but this advantage worked against them when the timbre changed in an unexpected way. Timbre would seem to be an integral part of the memory trace in musicians.

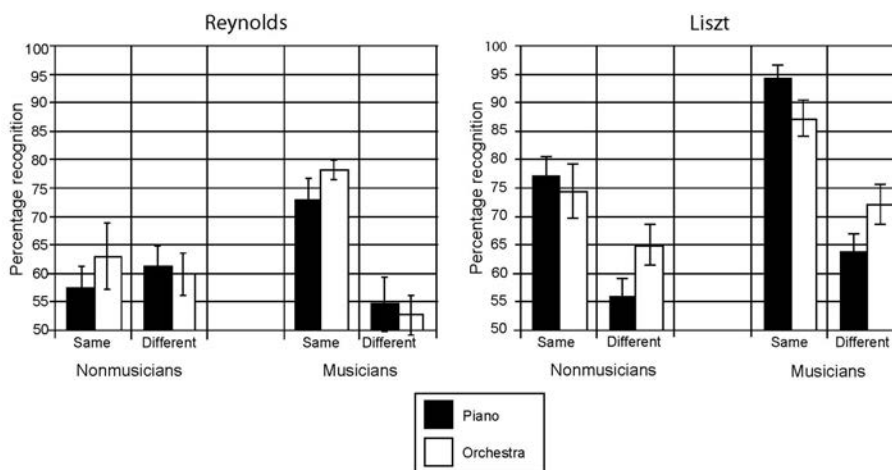


Figure 4.4. Recognition of the materials in *The Angel of Death* by Roger Reynolds (left panel) and in *Les Préludes* by Franz Liszt (right panel).³⁷

To know whether this effect is specific to contemporary music, we redid the same experiment with 18 excerpts from the third symphonic poem *Les Préludes* by Liszt, in versions for orchestra and piano four hands, both by the composer. The results are presented in Figure 4.4 in the right panel. Globally, performance improved compared to the experiment with nontonal music for both musicians and nonmusicians. For the tonal music, the negative effect of timbre change on recognition is parallel for both groups.

Nevertheless, a very interesting asymmetry appears only for tonal music. Going from orchestra to piano has a less strong negative effect than going from piano to orchestra (compare the black bars to the white bars in the Different category in the right panel of Fig. 4.4). This result suggests that it is easier to learn the orchestral version and then recognize a “reduced” version in terms of timbral diversity than to learn the piano version and then be confronted by a more timbrally “elaborated” version. The surface features seem to have less influence in the memorizing of tonal music than is the case with nontonal music. In the tonal music, the abstract features such as melodic themes, meter, and harmonic progressions provide global information that includes the surface features and offers an economical way to represent the musical excerpts in memory.

Timbre thus seems to be an integral part of the memory code, being intimately linked to the processing of pitch and rhythm. The recognition of a thematic subsection is less good when the instrumentation changes than when it remains constant, and this holds for musician and nonmusician listeners. Although this result underscores the fundamental role of timbre as a bearer of form in music, especially in contemporary music, it also suggests that a musical variation involving timbre can pose interesting challenges for listeners.

³⁷. This figure is derived from figures in Poulin-Charronnat, Bigand, Lalitte, Madurell, Vieillard & McAdams (*ibid.*, p. 248, Fig. 1 and p. 255, Fig. 3 © Regents of the University of California 2004, adaptation authorized by the University of California Press).

Composition of S and D. The modification of writing technique between S and D is another factor of change in the degree of homogeneity. Although the formal ideal of S is composed of circumscribed and clearly delimited zones, that of D is a calling into question of the sectional identities. The writing of S has a tendency to be more homogeneous than that of D where the temporal expansion and the temporal proximity of the thematic materials creates overlaps, thus favoring fusion and heterogeneity of texture (see Fig. 4.1). The relation between the core element and its theme is very different depending on whether it is in S or in D. In S, the thematic coherence is reinforced at each subsection that approaches the core, as Lalitte *et al.* showed with respect to the perception of the structure of the thematic materials.³⁸ However, in D, the field of characteristics, strong at its center, gradually loses its cohesive force the further it is from the core. Generally, D was composed as a free variation, even though it was constrained by the metric framework established by the writing of S, which the composer imposed on himself in the realization of D. Only the most salient elements of the themes were reused. As Figure 4.5 shows, certain subsections were eliminated, keeping the same sequential order.³⁹

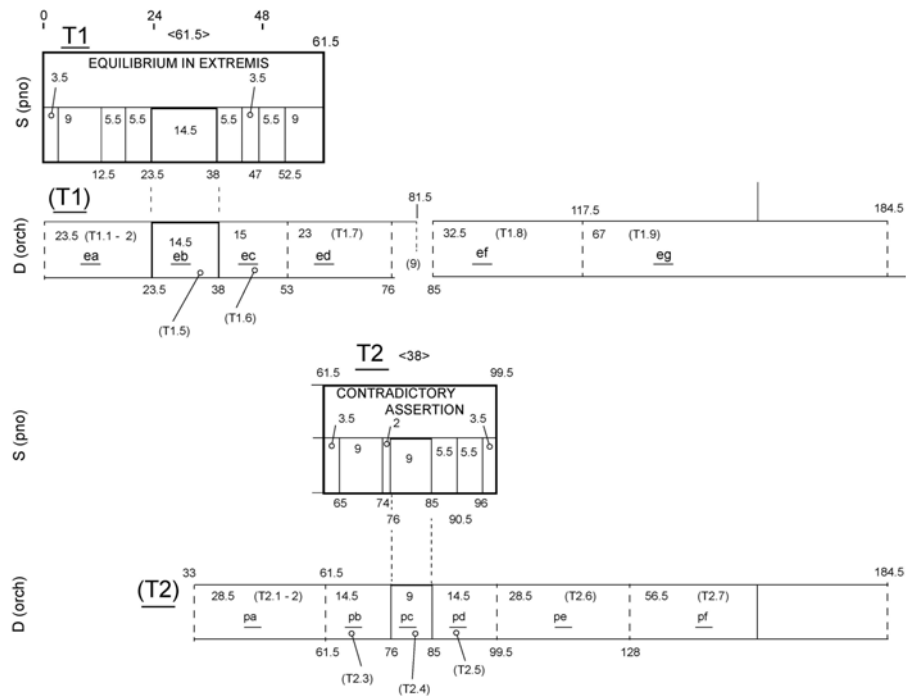


Figure 4.5. Diagrams taken from the final formal plan showing the temporal structure of themes T1 and T2 in S (top) and D (bottom).⁴⁰

Lalitte suggests that if one adds the effect of instrumentation and the change of writing technique, the themes presented by the piano in S (T1 and T3) are, in theory, those that undergo the greatest heterogenization.⁴¹ The passage from D to S and vice versa seems less crucial for the other themes (T2, T4, T5). The core elements are meant to contribute to the conservation of the identity of the themes between S and D. Their durations and placement in D

³⁸. Lalitte, Bigand, Poulin-Charronnat, McAdams, Delbé & D'Adamo, "The perceptual structure of thematic materials in *The Angel of Death*."

³⁹. On this subject, see Reynolds, "Compositional strategies in *The Angel of Death*."

⁴⁰. © Roger Reynolds 2001, reproduced with the kind permission of the composer. The durations are indicated for each subsection. For the D part, the core element is identical to that of the S part, except for a change in instrumentation. The other subsections of D are derived from the indicated thematic subsections (for example, T2.5 is derived from subsection 5 of theme 2). Note that the materials of subsections T1.3 and T1.4 do not appear in D.

⁴¹. Lalitte, "Other(s)."

remain the same as in S. Furthermore, the other strata are interrupted when the core elements appear to avoid them being masked by competing materials.

I examined the strategies used by Reynolds to solve the problem of creating a similar temporal structure, but constituted in two different ways by the same thematic materials.⁴² One of them is based on an architectonic and spatial conception of the global form and on the detailed planning within this representation, as one can see in Figure 4.5 for the T1 and T2 regions. The horizontal dimension represents time, as in a score, and the two instrumental factions were conceived as strata (piano and orchestra). A spatial reasoning was used by superimposing the S and D parts in the formal plan to align temporally certain of their components. Musical landmarks were used to create common pillars that provide moments of similarity; they were also useful for imagining different variation and transformation processes by which the thematic subsections could be deployed in way that was informed by the ideal of larger-scale textures and atmospheres that each section was supposed to transmit. This kind of formal plan, relatively ubiquitous in Reynolds' compositional method, serves as a sort of self-imposed limit around which local decisions are made at the moment of writing. Another limitation that he imposed on himself, arising in part from the temporal constraints related to the impending rehearsals and concert, involved the imposition of a spatial, metric, and tempo framework in the score of D. This score had to have the same structure of measures on each corresponding page of S. These pragmatic decisions certainly had an impact on the final result, but the adaptive capacity of the composer simply allowed him to integrate them into the compositional process.

Continuous transformation

Another type of transformation realized with instrumental writing is found in the derived regions (TR and COMB). Reynolds has explained the conception of these two types of musical development in terms of long “trajectories” that go from a predominance of one material to that of another for the Transition ideal, and of a “mosaic structure” woven of highly characterized and distinctive excerpts drawing from two or three themes for the Combination ideal.⁴³ Lalitte reminds us that TR and COMB are intermediary regions that “comment” upon the thematic materials and advance the action.⁴⁴

As applied in *The Angel of Death*, the transition is a directional process. For example, TR1→3 is constituted of two superimposed strata, corresponding to elements from T1 and T3, with a preponderance of T1 at the beginning and of T3 at the end (Fig. 4.6).

Reynolds writes that in the TR1→3 region, he used an alternation between adapted citations from the source themes. However, for the first 15 seconds (upper layer), a passage in trills was conceived, based on the harmonic content of T1, in order to provide a sort of meaningful and desirable pause after the aggressivity of the contradictory character of T2. Starting in measure 69 of the score, there is an alternation of mood between the trembling figuration of T3 and the harmonic declamatory nature of T1. The material of T1 is transformed at certain points by ostinati and arpeggios. At other moments, it is expanded, imposing a new rhythmic character. Arriving at measure 91, the world of T3 has completely overcome the weakening incursions of T1. In the voice of the composer:

What is clear is that when I was working on S, I decided that the transition sections were going to involve new material, which is to say textures that didn't exist literally in any of the themes, and also harmonic structures that didn't exist there... But even this newness of course was always indebted to or derived from [the themes]. But I'm making this distinction because when I got to D, everything that happens there is literally out of the themes. So in a way, the domain section is purer than the sectional structure. To go back to sectional, it seemed to me that it was important that the transitions have the character of what I think of as transitions in—let's say—Beethoven. You can see that the detailed plan of transition 1 to 3 [Figure 7] almost gets like the descriptions of the themes. There's a detailed textural and sort of narrative commentary about what's going to happen here. (12 June 2001, Paris).⁴⁵

⁴². McAdams, “Problem-solving strategies in music composition.”

⁴³. Reynolds, “Compositional strategies in *The Angel of Death*.”

⁴⁴. Lalitte, “Other(s).”

⁴⁵. Reynolds, “Compositional strategies in *The Angel of Death*.”

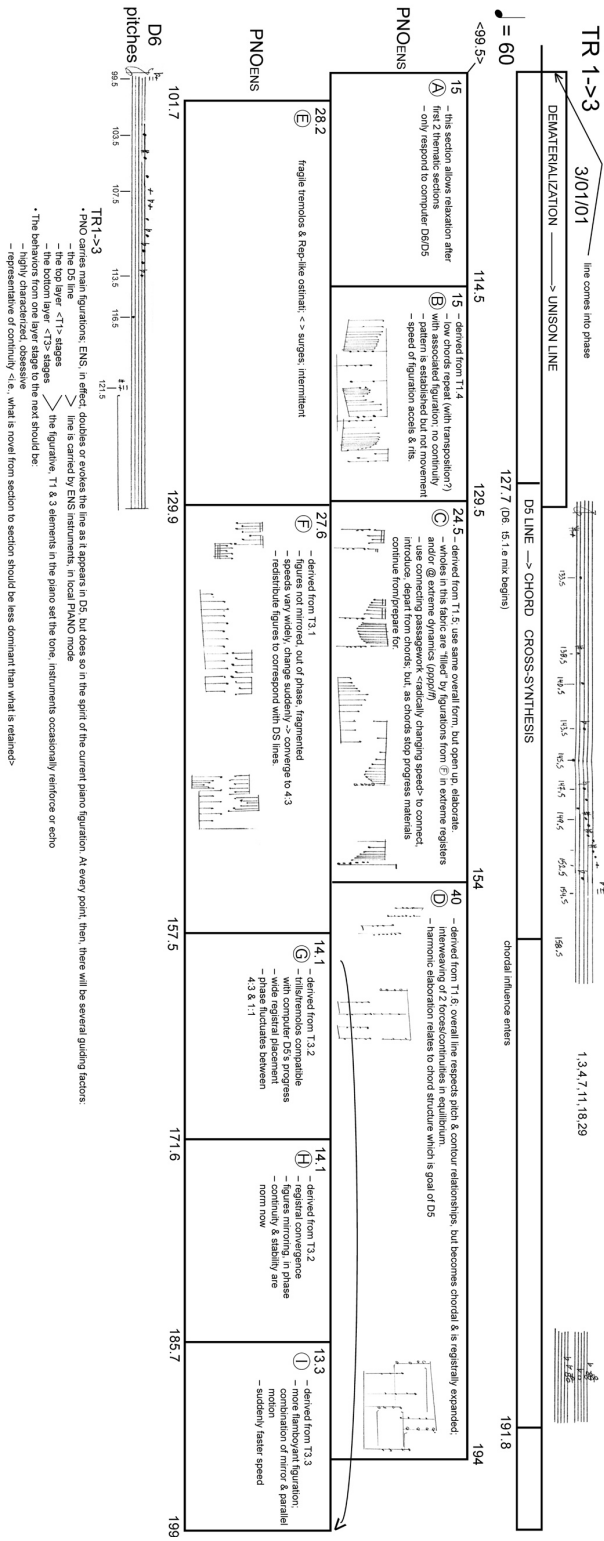


Figure 4.6. Textural diagram for the region TR1→3.⁴⁶

46. © Roger Reynolds 2001, reproduced with the kind permission of the composer.

The combination notion, Lalitte emphasizes, corresponds to a recombination of thematic materials.⁴⁷ It is a sort of mixture having an intermediary function in which the identity of thematic fragments is shaken by the unforeseeable interactions. For example, the COMB2/4 texture, (measures 88 to 115) is an imbrication of chords borrowed from T2 and of jagged gestures coming from T4. However, this mixture is not static; starting from a discontinuous texture, this region evolves toward rhythmic convergences of repeated notes. Like T2, which is a sort of contradiction to the directionality of T1, this region begins its intervention before the end of TR1→3 and disturbs the trajectory of the transition. After its interruption by T3, the density of the region intensifies and creates a first climax that is abruptly interrupted by the silence preceding the *Other* region.

Derivation

According to Lalitte, variation by derivation can be defined as the exploitation of short theme fragments to form completely new materials.⁴⁸ The regions that employ this kind of variation, *RepStrat*, the *Interlude*, and the *Epilog*, do not have a transition or development function, but rather a role of reinforcing or attenuating the dramatic tension. *RepStrat* starts after the 9-second silence that follows T4, then stops abruptly and leaves room for the calm of the *Interlude* for solo piano. The texture of *RepStrat* comprises three ostinatic strata with accented notes having similar rhythmic values (superimposition of 16th notes, quintuplets, and sextuplets), giving a general impression of rapidity, velocity, and discontinuity. This region is played by piano in S and by orchestra in D.

Lalitte also explains the special relation between the *Interlude*, the core element of T5, and the *Epilog*, as well as their formal functions in the work. Originally, the piece was to end with the electroacoustic image S7.⁴⁹ However, it was during the elaboration of this image that Reynolds had the idea of expressing a kind of trajectory “that would lead from auditory hallucination to reality.”⁵⁰ As the computer image unfolds, the recorded material undergoes less and less processing, creating a natural transition to the *Epilog* played by the pianist to conclude the piece. The *Epilog* has a double conclusive function. While bringing the piece to a close, it completes the S7 image. Indeed, this image recapitulates the main thematic materials with the notable exception of T5, which was heard just before. With its evanescent chords, that sound like a reminder of the atmosphere of the core element of T5, the *Epilog* gives the sensation of accomplishment. The *Interlude*, which has similar material to the *Epilog*, plays the role of a “decompression chamber” after the tension accumulated in the *RepStrat* region and the preparation for the entry of the “interior line” (T5). In the second part of the piece, these two moments of interior reflection, the *Interlude* and the *Epilog*, form what Lalitte conceives as a bridge that frames the culminating point of the dramaturgy: the last appearance of T5 (with the D9 image) followed by the recapitulative image S7.

Lalitte feels that the three types of variation—by heterogenization (S and D), by continuous transformation (TR and COMB) and by derivation (*RepStrat*, *Interlude*, and *Epilog*)—do not have the same transformative power.⁵¹ If variation by heterogenization reverses the instrumentation, removes a few subsections, and blurs the boundaries, it still conserves the core elements intact and preserves a good part of the identity of the themes. The variation by continuous transformation gnaws a bit more at the identity of the thematic materials. Only the most salient features are retained to be processed by cross-fading or superimposition. The identities tend to fuse. Finally, the variation by derivation only conserves the most “abstract” properties of the themes, such as the palette of pitches, a rhythm or a harmonic density. The degree of transformation is such that it drastically abolishes the original identity.

The two versions of the piece

The two parts can be played in both orders (S–D or D–S). However, just before the end of the first part played, the electroacoustic part begins, linking the two instrumental parts by a solo transition section, modulating and commenting the second instrumental part. Then a solo electroacoustic section in the form of a coda that begins just before the end of the second part summarizes everything (Fig. 4.7). When the computer coda concludes, the pianist plays the brief *Epilog*. In the mind of the composer, this computer section is a complex structure, assembled in modular fashion, but that can be disassembled and studied in several ways.

⁴⁷ Lalitte, “Other(s).”

⁴⁸ *Ibid.*

⁴⁹ *Ibid.* The computer images (D1, D2, S4, D5, D6, S7, S8, D9, D10 and S11) are discussed below.

⁵⁰ Roger Reynolds; cited in Lalitte, “Other(s).”

⁵¹ Lalitte, “Other(s).”

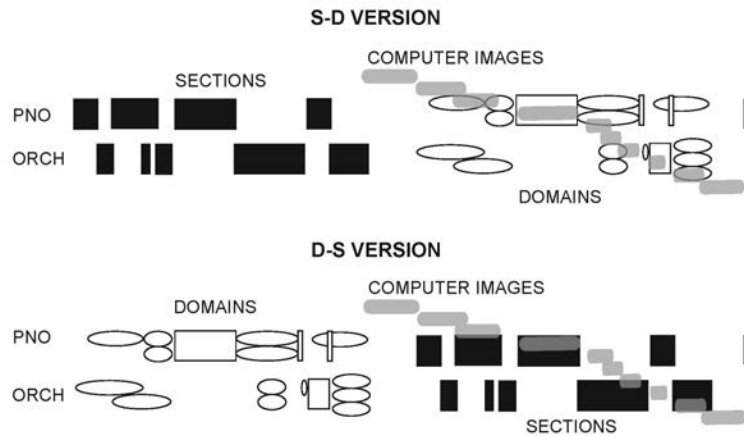


Figure 4.7. Diagram of the structure of the two versions of the piece.

The composer's focus on musical form as an experience that is temporal and multidimensional at several levels was omnipresent in the development of the metric and spatial parallelism of the S and D parts. The various components that had to be dealt with simultaneously in their construction led to changes in the nature of certain regions in order to equilibrate their relative weights in the memory of the listener, as well as to the dramatic trajectory passing from one region to another. In his article on the compositional strategies used for *The Angel of Death*, Reynolds reveals with remarkable clarity the processes of decision-making and problem-solving that are brought into play in the shaping of the musical detail within the larger-scale structural plan in order that they might give rise to the desired experience over time and in memory.⁵²

Madurell explains the critical importance of the perceptual approach, so often absent in music analysis in general, for an understanding of the dynamic aspects of form.⁵³ He even goes so far as to emphasize the error of conceiving of experienced musical form in terms of spatial plans on paper (although such representations are nonetheless useful to consider the conception of the form and to understand the relations within a form from an analytic point of view, as several aspects of this project have shown). The resistance to this more dynamic conception of form in several analytical circles, and in particular its tight link with the methods of experimental psychology, is often subtended by a scepticism concerning the reductionist nature of many studies in music psychology. Although the spatial reasoning on form can be intimately related to the endemic use of spatial metaphors in much human reasoning, one can still question the real role of such metaphors in the way in which one listens and in which one commits to memory the form in the course of a true musical experience. As such, although Reynolds uses such spatial representations as tools for composition, he always keeps in mind the perceptual and cognitive limits implied by listening in time.

Lalitte proposes that in *The Angel of Death* Reynolds created a dramatic situation reversal that upsets the course of events, a reversal structure that must necessarily include a *peripeteia* and a recognition in the sense of Aristotle: a reversal that leads from ignorance to knowledge.⁵⁴ He recalls that for Aristotle, the finest example of recognition is accompanied by a *peripeteia*. These two ingredients of the reversal structure are clearly present in the large-scale structure of *The Angel of Death*. The piece comprises two halves (S and D) that correspond to two opposed types of writing and in which the instrumentation of the themes is reversed (piano in one half, the ensemble in the other). According to Lalitte, the passage from S to D or from D to S, depending on the version chosen by the conductor, constitutes a *peripeteia*, a change of value. In both cases, the computer part, which integrates fragments of thematic materials, starts a bit before the end of the first part and intervenes over the course of the second part. The appearance and the recognition of this new character (insofar as the electroacoustic material provokes recognition phenomena)

⁵². Reynolds, "Compositional strategies in *The Angel of Death*."

⁵³. François Madurell, "Toward a dynamic conception of musical form," in McAdams & Battier (Eds.), *Creation and Perception of a Contemporary Musical Work*.

⁵⁴. The *peripeteia*, according to Aristotle's *Poetics* is "the reversal of the situation, a change by which the action veers round to its opposite, subject always to our rule of probability or necessity", and recognition is "a change from ignorance to knowledge, producing love or hate between the persons destined by the poet for good or bad fortune." See Lalitte, "Other(s)."

triggers a true situation reversal. This reversal brings not only an element of surprise, because the ensemble stops for a while to make room for the electroacoustic sounds, but it also changes the perspective in that the electroacoustic part, by making the sounds travel around the listeners, imports a spatial dimension uncoupled from the physical world of the instruments.

Lalitte notes that the two halves of *The Angel of Death* are temporally asymmetric.⁵⁵ Indeed, even though S and D have identical global proportions, the second half of the piece is longer due to the two computer images that frame it (D10 and S7). Lalitte makes the following observation:

[C]ontrary to [other works by Reynolds], in which the breaking point is located at the highest moment of tension, in *The Angel of Death* this corresponds to the tension found “in the trough of the wave.” When the piano and the instrumental ensemble fall silent and allow the electroacoustics to be heard, the dynamics, the density, the tangibility of the extremely soft sound of the computer layer confers upon the resulting tension an introverted quality, a feeling of surprise at a world of sound that has sprung from nowhere.⁵⁶

The electroacoustic part

The presence of recorded thematic materials that are transformed by computer processing is characteristic of many of Reynolds’ works. *The Angel of Death* employs several types of processing that he has already used in the past, including analysis/resynthesis, filtering, “editorial” algorithms (cutting and reassembling with temporal resequencing), time stretching and compression, and spatialization, but he uses these techniques in a new way and with specific aesthetic aims. In particular, the transformational approaches of the computer images, as they are described by Reynolds,⁵⁷ are of two types, in conformity with the various levels of dichotomy present in the piece (piano vs. orchestra, S vs. D, S–D vs. D–S, and so on). The computer images, in the composer’s conception, are derived from the S and D ideals: the D-type images are organic and sculpted on a larger scale, arising from a basic singular process, whereas the S-type images are mosaics, employing a panoply of strategies and processing techniques and having a distinctive temporal design.

The electroacoustic stratum is composed of ten of these images, which are generally considerably longer than the themes (between 47 and 161 seconds; see Tab. 4.1 and Fig. 4.8). The digital materials are also spatialized over a six-channel sound system. Some images, like the first one (D1), which links the first and second instrumental parts, is entirely derived from a single theme. Others draw their base materials from several themes. The five themes, recorded beforehand in versions for piano and an ensemble of 16 instruments, are all used at one moment or another in the electroacoustic stratum. They incorporate transformation techniques that are qualitatively and procedurally different from those employed in the purely instrumental parts of the work.

The problem to be resolved to compose the electroacoustic part was to coordinate and integrate this part with the instrumental material in its two versions (S and D), as well as to conceive of the instrumental strata so that they can stand on their own or be harmonized with the electroacoustic stratum.⁵⁸

The problem with the global coordination was resolved by conceiving of the electroacoustic part as discrete images, the beginnings of which are aligned with specific moments in the instrumental score. Then, each image was conceived according to a certain textural continuity that didn’t require synchronization with a specific moment with the instrumental component, more segmented in S and more organic in D, but structured temporally in both cases. Finally, a graphic diagram superimposing the structure of the electroacoustic part with the already-designed S and D parts was used as a conceptual aid (see Fig. 4.8).

The problem of integrating the electroacoustic and instrumental layers was resolved in part by the fact that they share common source materials: the subsections of the thematic materials in their piano and orchestra versions served as points of departure for the development of the TR and COMB regions. In the composer’s conception, this approach provided a family relation between the components that overlapped temporally. Additionally, the computer images were composed first, and Reynolds could use them as reference points from which the S and D parts could be composed (in that order). During interviews with the composer, it became clear that to clearly imagine the interaction between materials and textures and the types of density/complexity being aimed for was the basis upon which the moment-to-moment compositional decisions were made thereafter. This parallel approach allowed him to optimize

⁵⁵. *Ibid.*

⁵⁶. *Ibid.*

⁵⁷. Reynolds, “Compositional strategies in *The Angel of Death*.”

⁵⁸. McAdams, “Problem-solving strategies in music composition.”

the mutual constraints imposed by the electroacoustics and the S and D parts. The instrumental parts were composed to be played both along with and in interaction with the electroacoustic part. This inner listening, which must necessarily play an essential role in music composition, is another domain to which direct access during composition is difficult without interfering with the process itself.

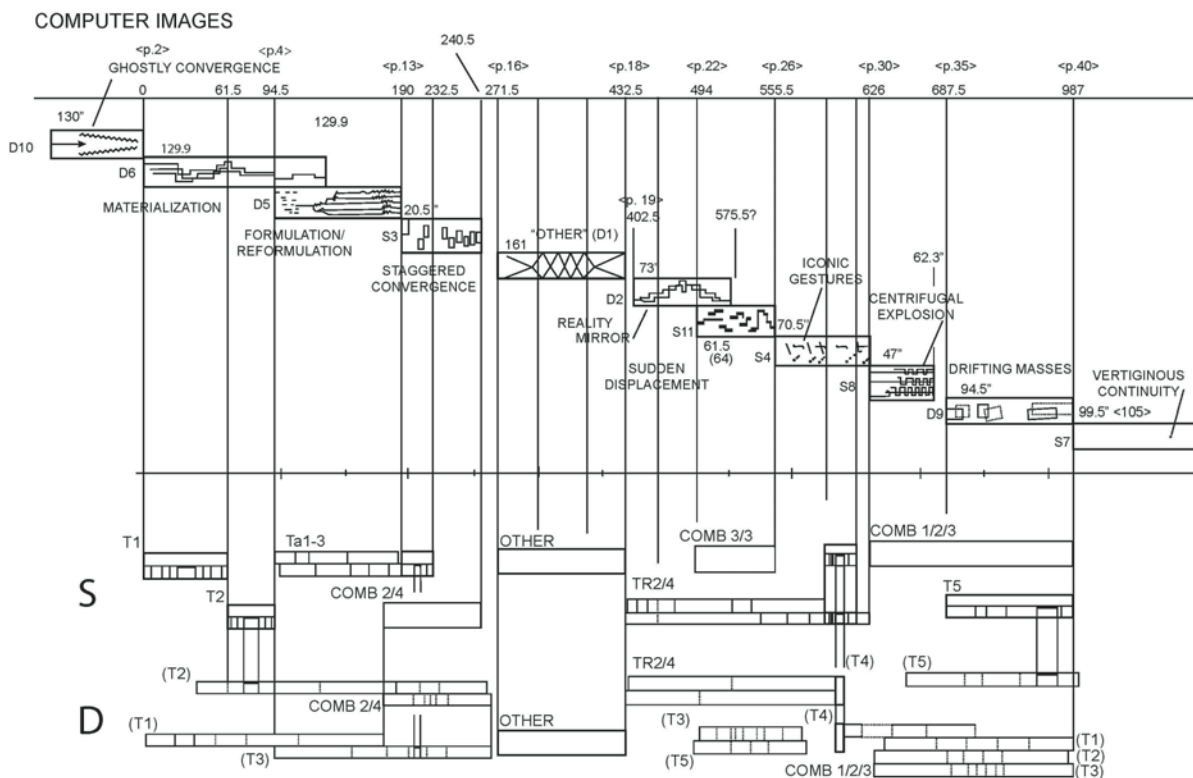


Figure 4.8. Initial formal diagram showing the temporal alignment of the computer images with the S and D parts.⁵⁹

The electroacoustics play a dramaturgical role in *The Angel of Death*. The addition of the computer part to a piece is never an aim in itself for Reynolds. According to Lalitte,

the use of electroacoustics is not there to set the music off, or as a cover-up. Its presence is always justified structurally, temporally, harmonically and/or timbrally. It always plays a major role in the dramatics of the work. In this theater for the ear, the electroacoustic part constitutes a character, a persona in its own right.⁶⁰

The electroacoustics in Reynolds' work always has a strong implication in the formal design and temporality of the piece. Whether it is through the editorial techniques of temporal recomposition (cutting and reassembly) or the techniques of time stretching applied to recorded materials, the electroacoustics modulates, constrains or transforms the experience of time.

Still according to Lalitte, Reynolds' desire was to form an electroacoustic part that is perceptually distinct from the instrumental part.⁶¹ The world of supernatural forces suggested by the electroacoustic part forms a parallel current that coexists with the "real" world of the instrumental music. The electroacoustic part introduces a counterweight to

⁵⁹. © Roger Reynolds 2001, reproduced with the kind permission of the composer. The notation <p.1> indicates that the computer image is synchronized with the instrumental component on page 1 of the score. The S and D parts have identical numbering. The S3 image was removed in the end by the composer.

⁶⁰. Philippe Lalitte, "Drama and temporality of the electroacoustics in Roger Reynolds' *The Angel of Death*," in McAdams & Battier (Eds.), *Creation and Perception of a Contemporary Musical Work*.

⁶¹. *Ibid.*

the instrumental part; it is sometimes immersed in the instrumental ensemble, and from time to time emerges from the ensemble or even dominates it. This parallel world is not, however, totally independent. The electroacoustic materials form many relations with the instrumental part by the fact that their source materials are recordings of these same instruments. The links that unite these two worlds are related as much to timbre, compositional writing, temporality, and themes, as they are to performance.

#	Name	Duration	Source materials	Processing techniques
D10	Ghostly Expansion	2'10"	T3.2	Time stretching, spectral transposition
D6	Dematerialization	2'10"	T5.1	Time stretching, filtering, spectral transposition
D5	Formulation/Reformulation	1'40"	T5.1	Cross-synthesis, time stretching, editorial algorithms
D1	Other	2'41"	Other (nonthematic material)	Filtering (plus spectral transposition and editorial algorithms for superimposed orchestral elements)
D2	Reality Mirror	1'15"	T1.6	Time stretching
S11	Sudden Displacement	1'05"	T3.1, T3.2, T5.4, T3.3, T3.4	Spectral transposition
S4	Iconic Gesture	1'10"	T2, T4	Superimposition, filtering, editorial algorithms, spectral transposition, time stretching
S8	Centrifugal Explosion	0'47"	T1.3, T1.2, T2.6, T4.1, T4.5	Editorial algorithms
D9	Shifting Masses	1'40"	T5.5	Analysis/resynthesis
S7	Vertiginous Continuity	1'40"	T2.4, T3.3, T2.2, T2.4, T2.5, T2.6, T1.9, T4.5-6, T1.1-3, T4.1, T4.7	Editorial algorithms, spectral transposition, time stretching/compression, multiplication and superimposition, filtering

Table 4.1. The ten computer images, their instrumental sources, and the computer processing techniques.⁶²

Given that the sources for the electroacoustic part of *The Angel of Death* come exclusively from the instrumental parts recorded by the musicians, it is not only the thematic material itself that is processed digitally, but also the interpretation of this material. Lalitte remarks that in this case, the digital processing takes on a new dimension; it becomes reinterpretation of the instrumental gestures by infusing them with various temporal or timbral alterations.⁶³ As Reynolds emphasizes, “the performer’s interpretive contribution can now itself become a composer’s resource.”⁶⁴ This is a new form of variation that Lalitte qualifies as “interpretive modulation.”⁶⁵ Conserving a common basis between the sounds played live and the sounds diffused over loudspeakers thus preserves the unity while playing on the ambiguity of sound streams, timbres, transformations, and spatial positions.

The order of the computer images was determined by taking into account the relations between the thematic materials included in these images and the materials played in the instrumental part (see Tab. 4.1 and Fig. 4.8). Lalitte summarizes the functions of images in the following way.⁶⁶ The first group (D10/D6/D5) comprises relatively long images with a calm atmosphere. The source materials come from T3 and T5. The computer part thus plays a priming role by preceding the appearance of these two themes in the second half of the piece, but also a role of recalling these materials already encountered in the first half. Then comes the D1 image, *Other*, with computer processing and the

⁶². This table is an expanded version of the one used by Lalitte (“Drama and temporality of the electroacoustics in Roger Reynolds’ *The Angel of Death*”).

⁶³. Lalitte, “Drama and temporality of the electroacoustics in Roger Reynolds’ *The Angel of Death*.”

⁶⁴. Reynolds, “A perspective on form and experience,” p. 286.

⁶⁵. Lalitte, “Drama and temporality of the electroacoustics in Roger Reynolds’ *The Angel of Death*.”

⁶⁶. *Ibid.*

superposition of brief instants drawn from the themes. D1 is isolated with respect to the other images, preceded by a pause and played solo by the electroacoustics. All of these factors, as well as its strong identity, give this passage great power of recall. A group of three short images (D1, S11, and S4) follow *Other*. Even though they have different atmospheres, these three images have in common the idea of acceleration and deceleration and are superimposed on the TR2→4 region (plus COMB3/5 in D), which is strongly characterized. The multiplicity of source materials, the digital processing (time stretching, filtering, transposition, filtering, etc.), as well as the spatialization effects (gyrations), permeate this extended passage with a sort of psychological pressure that leads irrefutably to T4. A process of accumulation of ostinati common to the S8 image and *RepStrat* leads to the calm of the *Interlude*. The D9 image, which occurs conjointly with T5, places the listener in an atmosphere of quietude uncoupled from the concrete world. The source material of D9 being the core element of T5 (T5.5), this image seems to have been conceived both as an anticipation and a recall of the “chorale” that this core element evokes. The last S7 image arrives in a soloistic, dematerialized, and reflective coda. Consisting of ten segments including source materials that belong to the first four themes, S7 has a clearly recapitulative function. In a certain way, the image evokes the life of the work that passes before the ears of the listeners just before its end.

If one considers the most global temporal scale, the most important dramaturgic factor of *The Angel of Death* is the moment at which the computer part begins:

This is a veritable reversal of the situation that does not only contain an element of surprise, but above all changes our entire perspective on the piece. ... In this theater for the ear, the electroacoustics constitute a character in their own right, playing a predominant role in the dramatics of the piece. The electroacoustic part is a metaphor representing the Angel, bringing with it a ghostly, unreal, inhuman world. Nevertheless, this parallel world, which possesses its own strata, weaves numerous links with the real world of instruments.⁶⁷

Indeed, the constitution of the computer images conserves the distinction between S and D: the S images are composed of heterogeneous materials and function according to principles of sequential alternation and temporal concentration, whereas the D images, of a homogeneous material, exploit stratification and time stretching. The relation between the electroacoustics and the instrumental part can be one of integration or segregation, domination or submission, as well as intensification or perturbation. In all these cases, the electroacoustics acts like a prism on the instrumental part in changing the listener's perception of a given passage as a function of the version of the piece (S–D or D–S).

At the appearance of the electroacoustic part, the network of thematic relations becomes denser and gives rise to a greater richness of possible interpretations. Some elements are anticipated, but others recur and can give rise to memory processes of priming or refreshing, even if these elements are fragmented and transformed. The processing by transposition, by filtering or by stretching, contraction or temporal reformulation brings a greater degree of transformation than the simple piano/orchestra inversion, and these techniques are employed especially as an expressive resource. According to Lalitte, all of these properties lead the electroacoustic part to determine which way the action is going and to have the profoundest effect on how listeners will experience time.⁶⁸

PERCEPTION OF THE WORK IN REAL TIME

The structure of *The Angel of Death* raises several interesting issues concerning the processing through time of the materials and the form that establish the basis of our exploratory hypotheses.⁶⁹ The composer conceived the S and D parts with very different characters and posed the hypothesis that the more abrupt changes in material in S would give a clearer sectional character than would the overlapping and interpenetrating deployment of similar thematic materials in D. Furthermore, given that the two versions of the piece differ in the order of the two parts, questions concerning the influence of previous listening to one part on the perception of the other can be addressed, or, in other words, does the large-scale context affect the perception and recognition of musical materials and the emotional reactions they induce in listeners? Also, because the computer layer always accompanies the second part, comparing the same part (S or D) in the two versions (S in S–D vs. S in D–S, for example) would allow us to study the influence of this layer

⁶⁷. *Ibid.*

⁶⁸. *Ibid.*

⁶⁹. See McAdams, “Problem-solving strategies in music composition.”

on the instrumental material (although this comparison would be confounded with the order of this part in the piece). Finally, at the Paris and La Jolla premiers, the two versions (S–D and D–S) were played, but in different orders, so that the longer-term influences of previous listening to the music could be studied (although this factor would also be confounded with the differences in interpretation of the two ensembles and the cultural milieu of the listeners).

In order to address these issues, two scales were used along which listeners could continuously rate their impressions while listening. One concerned the perception of musical materials and structures (familiarity or resemblance of what is currently being heard compared to everything that has been heard since the beginning of the piece). The other concerned the emotional responses of listeners (the force or intensity of emotions felt in response to the music). This kind of experimental task, continuous self-evaluation by the listeners of their experience during listening, requires a double implication on their parts. They must listen to and experience the music, and at the same time they must track and translate their experience onto a specific dimension.

The device for measuring the responses of 128 people in real time in a concert hall included the same number of boxes with sliding cursors, the position of which was translated into numerical data along the scale being tested (see Fig. 4.9).

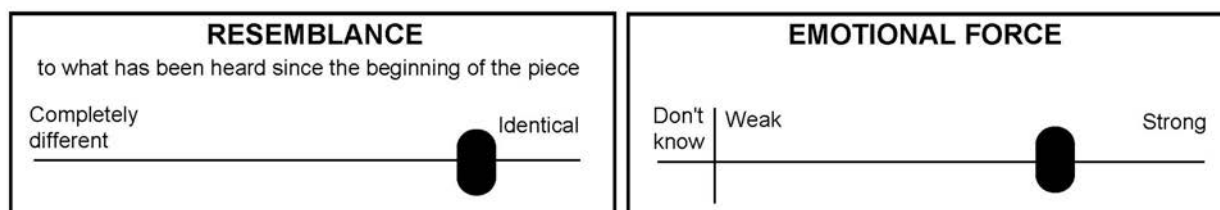


Figure 4.9. Two types of continuous response boxes.

For each listener, this method gives a temporal profile of their ratings over time, which we can represent graphically as a function of time (see Fig. 4.10). However, not all of the profiles are useful for our purpose, which is to link the responses to the structure of the music being heard. Indeed, we are seeking responses that remain more or less active during listening to the piece, like the “skyscraper” profiles at the top of Figure 4.10. We remove the profiles that don't change for several minutes in a row (see the bottom of Figure 4.10), because we don't know if this is really their response or if they had forgotten to respond for a time. In the case of a doubt like this, we do not include them in the analysis. Curiously, there were more flatliners in the Parisian audience than in the Californian audience!

The two behavioral measures—perceptual resemblance and emotional force—result from perceptual, cognitive, and affective operations that are very different. I will examine the issues related to this two scales separately.

Resemblance and recognition

First of all, this project studied the perception of musical similarity, that is, the recognition of associations between original musical materials and variations or transformations of these materials during listening to the piece. How does the feeling of resemblance or recognition that evolves during listening create the “comprehension” of the musical work? The feeling of resemblance, of having heard something similar, is an element with which composers play intuitively through the presentation and development of themes, but also at a more global level with the structuring of musical sections on the basis of texture, harmony, register, and instrumentation. Such processes contribute not only to the feeling of change from one section to another within a piece, but also to associative relations across the piece that are established by recognition.

In the field that studies the perception of musical structure and structural relations, most of the work has focused on comparisons made outside of a musical context, using, for example, experimental paradigms of melodic recognition or discrimination⁷⁰ or judgments of musical similarity in pairs of excerpts.⁷¹ Few studies have been conducted on

⁷⁰. See Lucinda A. DeWitt & Robert G. Crowder, “Recognition of novel melodies after brief delays,” *Music Perception*, vol. 3, no. 3, 1986, p. 259-274; W. Jay Dowling & James C. Bartlett, “The importance of interval information in long-term memory for Melodies,” *Psychomusicology*, vol. 1, no. 1, 1981, p. 30-49.

⁷¹. See Daniel Matzkin, *Perception de similarité de mélodies tonales et non tonales: étude pluridisciplinaire* [Perception of the similarity of tonal and atonal melodies: A pluridisciplinary study], doctoral thesis, Paris, École des Hautes Études en Sciences Sociales, 2001; Stephen McAdams

complete musical works. Among these, several have used segmentation tasks (at times with descriptions of the form afterward) in order to explore the processing of larger-scale musical structures.⁷² Globally, the results show effects of change in texture, tempo, density, register, and instrumentation or of pauses at the boundaries between sections. However, a study by Mondher Ayari and me revealed understanding at a more detailed level of the modal organization in improvised Arabic music, at least in Arab listeners who possessed the cultural schemas necessary for this music.⁷³

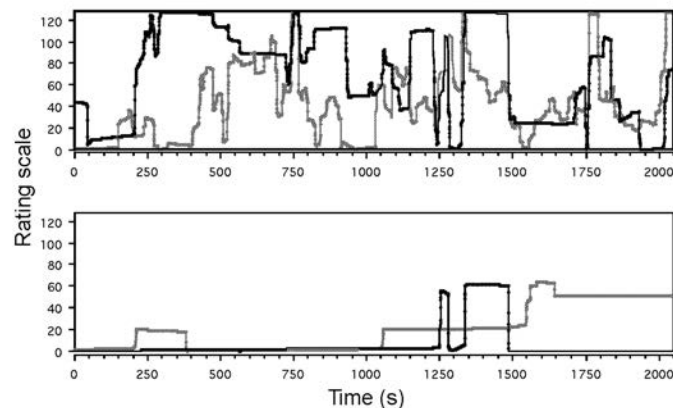


Figure 4.10. Examples of temporal profiles recorded during listening to *The Angel of Death*.

Two other studies, the first conducted by W. Jay Dowling, Seyeul Kwak, and Melinda Andrews and the second by Dowling, Barbara Tillmann, and Dan Ayers, used an adaptation of a technique called the “running memory paradigm” to study the fluctuating nature of memories over time of a musical “event.”⁷⁴ An evolution in melody recognition depends on change over time in the efficiency of different types of recovery cues for memorized melodic excerpts: the results show a decrease in recognition for certain comparisons and increases for others.

It is relevant here to evoke the theory of episodic memory of Endel Tulving⁷⁵ and the fact that the recovery strategy for memories changes between short-term and long-term memory. The traces of past events are stored in memory by a process of encoding. Memory is probed when a recovery cue is present. The information of this cue is combined with information from the trace to form what Tulving calls “ecphoric” information. The recoding with the ecphoric information can change the memory trace and this information provides the basis for the response of the memory system to the probe. The efficiency of various cues that provoke the recall changes over time, suggesting a critical role of recoding in the dynamics of memory operations in a continuous activity such as reading or listening to music.

Taking into account these processes of interaction between memory coding and perception leads us to conceive of an evolutive sense of the resemblance we feel over time in a musical work when several themes are presented

& Daniel Matzkin, “The roots of musical variation in perceptual similarity and invariance,” in Isabelle Peretz & Robert J. Zatorre (Eds.), *The Cognitive Neuroscience of Music*, Oxford, Oxford University Press, 2003, p. 79-94.

⁷² See Rita Aiello, “Can listening to music be experimentally studied?” in Rita Aiello & John Sloboda (Eds.), *Musical Perceptions*, New York, Oxford University Press, 1994, p. 273-282; William L. Berz & Anthony E. Kelly, “Perceptions of more complete musical compositions: An exploratory study,” *Psychology of Music*, vol. 26, no. 2, 1998, p. 175-185; Eric F. Clarke & Carol L. Krumhansl, “Perceiving musical time,” *Music Perception*, vol. 7, no. 3, 1990, p. 213-252; Irène Deliège, “Approche perceptive de formes contemporaines,” in Stephen McAdams & Irène Deliège (Eds.), *La musique et les sciences cognitives*, Liège, Pierre Mardaga, 1989, p. 305-326; Mitchell Karno & Vladimir J. Konečni, “The effects of structural interventions in the first movement of Mozart’s *Symphony in G Minor*, K. 550 on aesthetic preference,” *Music Perception*, vol. 10, no. 1, 1992, p. 63-72; Lucy Pollard-Gott, “Emergence of thematic concepts in repeated listening to music,” *Cognitive Psychology*, vol. 15, no. 1, 1983, p. 66-94.

⁷³ Mondher Ayari & Stephen McAdams, “Aural analysis of Arabic improvised instrumental music (taqsim),” *Music Perception*, vol. 21, no. 2, 2003, p. 159-216.

⁷⁴ W. Jay Dowling, Seyeul Kwak & Melinda W. Andrews, “The time course of recognition of novel melodies,” *Perception and Psychophysics*, vol. 57, no. 2, 1995, p. 136-149; W. Jay Dowling, Barbara Tillmann & Dan F. Ayers, “Memory and the experience of hearing music,” *Music Perception*, vol. 19, no. 2, 2002, p. 249-276. The “running memory” paradigm was used for the first time in a recognition task by Roger N. Shepard & Martha Teghtsoonian, “Retention of information under conditions approaching a steady state,” *Journal of Experimental Psychology*, vol. 62, no. 3, 1961, p. 302-309.

⁷⁵ See Endel Tulving, *Elements of Episodic Memory*, Oxford, Oxford University Press, 1983.

repeatedly or with various kinds of transformations or variations. Their temporal organization creates a fluctuating sense of the association of the present with what has been heard in the recent or more distant past. In this direction, Carol Krumhansl has used continuous measures of memorability to explore the role that musical *topoi* play in the experience of the music of Mozart and Beethoven; she has shown that the *topoi* are crucial for the definition of musical form.⁷⁶

The resemblance rating scale

The aim of this experiment was to explore the dynamic process of perception of musical similarity and recognition of musical materials in a real musical context. The resemblance scale depends solely on different levels of memory processing.⁷⁷ For example, a segment can be familiar because the surface features (texture, timbre, pitch scale or any feature that one can extract from a musical sound or visual experience) are common with another segment in memory. Furthermore, higher-level processing could be implicated in the memorizing of relations between the parts of a piece over larger timespans. This latter kind of processing would be implicated in the recognition of certain kinds of transition or contours of change—in fact, anything that changes over time. Because there are different levels of processing, different time scales could be involved in the feeling of resemblance with materials encountered earlier in the piece.

The data from such an experiment are very rich, and we had to focus the analyses on a few specific issues, including:

- ◆ the correspondence between the temporal response profiles and the global structure of the piece (as presented in Figs. 4.1 and 4.7);
- ◆ the recognition of musical materials (with or without change in instrumentation) in different musical contexts (S or D parts);
- ◆ the effect of large-scale musical form on instantaneous theme perception.

Correspondence between response profiles and the structure of the piece

Figure 4.11 presents the average profile of active listeners during the La Jolla concert. The structure of the piece is superimposed on these profiles for comparison. The S–D version (top) was played first, and the D–S version (bottom) was played last. The structure conceived by the composer is indicated for the three layers (piano, orchestra, electroacoustics), and the vertical lines mark the beginning of the sections. Note that the instantaneous resemblance ratings have a global tendency to increase over the whole piece, as well as over the whole concert (the two versions being played in the same concert). The average resemblance is higher in the second version heard, by 10 points on a scale of 128 for the California concert and by 22 points for the Paris concert. This difference is only 2 points for the experiments in the laboratory with recordings of the Paris concert in which different groups heard the two versions. There is clearly a global increase in the listeners' familiarity with the style and sonic universe of the composer. In the average profile, there are notable changes (increasing and decreasing) on several section boundaries. These most probably correspond to the recognition of returning material (increases in the profile) or the arrival of new material from another theme (decreases in the profile). During the *Other* region, the profile increases nearly linearly over the whole duration during the first presentation, and it reaches its maximum more quickly and stays there for the electroacoustic version in the second part of the piece; the listeners thus acquired a fairly clear memory representation of this texture, which is a bit unique in the piece. The *Interlude* and *Epilog* for piano have an average resemblance that accumulates over the listening to both versions in the same concert, demonstrating the emblematic status of these two elements and their strong association in memory. Globally, it seems that the reactions to section boundaries are stronger in the S part than in D, which corresponds to the aesthetic intentions of the composer. The most robust reactions to novelty over the two versions are the beginnings of *Other*, TR2→4, T5 and D10 in the first half, and of

⁷⁶ Carol L. Krumhansl, "Topic in music: An empirical study of memorability, openness, and emotion in Mozart's *String Quintet in C Major* and Beethoven's *String Quartet in A Minor*," *Music Perception*, vol. 16, no. 1, 1998, p. 119-134. On the subject of musical *topoi*, see Leonard G. Ratner, *Classic Music: Expression, Form, and Style*, New York, Schirmer, 1980; Victor Kofi Agawu, *Playing with Signs: A Semiotic Interpretation of Classic Music*, Princeton, Princeton University Press, 1991.

⁷⁷ The original scale used at the Paris premier varied between "completely new" at one end and "very familiar" at the other, the notion of familiarity being related exclusively to materials heard since the beginning of the piece. We modified this scale by using the notion of resemblance at the La Jolla premier, because some Parisian listeners seemed to use familiarity as referring to everything they had heard before during their life.

S11 and S7 in the second. The most robust recognitions of material already heard over the versions are situated exclusively in the second half at the return of T1, D1 (*Other*), the *Interlude*, and the *Epilog*.

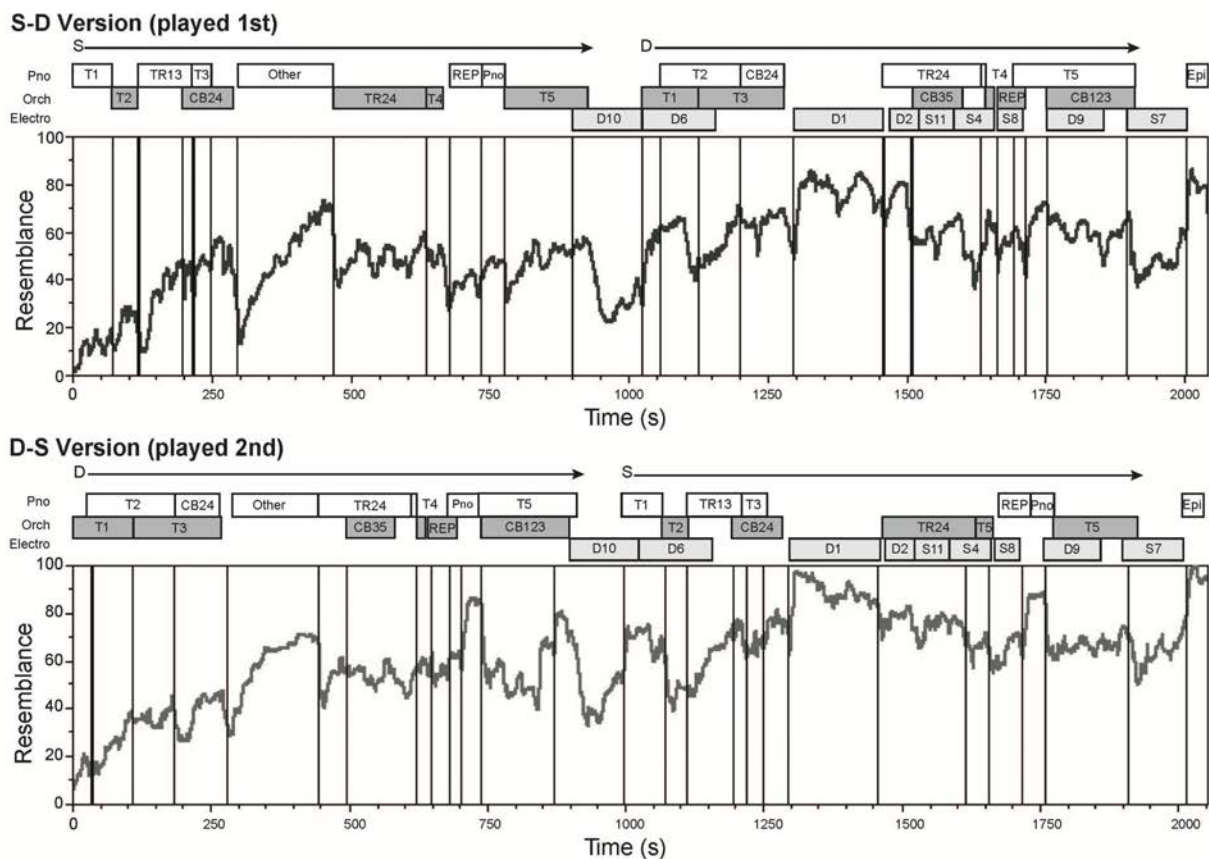
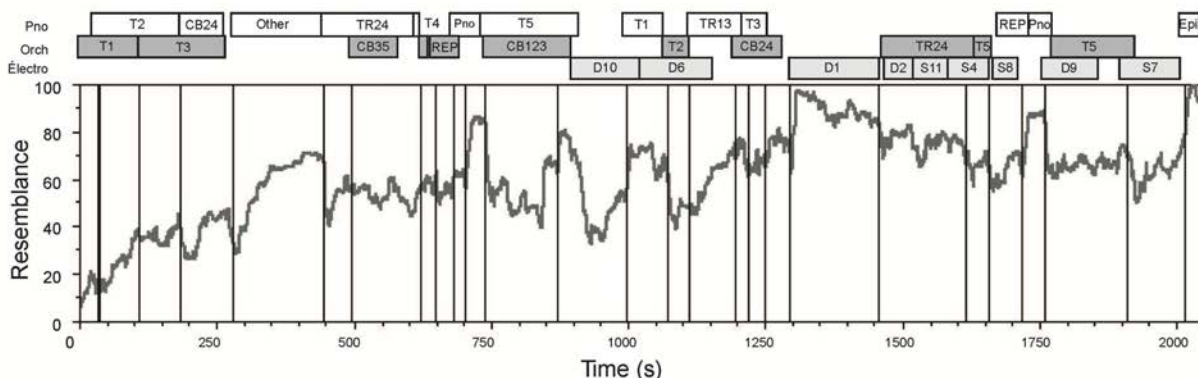


Figure 4.11. Average resemblance profiles for the La Jolla concert.⁷⁸

Examining the same version (D–S in Fig. 4.12) played in Paris and San Diego allows us to compare the joint effect of the interpretations by the two ensembles (Court-Circuit and Sonor) and of the populations of listeners (Parisian and Californian). Abstracting from the fact that the same version was played first in Paris and second in La Jolla, we can note several similar features in the average profiles: the global progressive increase from the beginning to the end of *Other*, a reaction to novelty at the entry of TR2/4 in D, recognition of the *Interlude* (curious for the Parisian version, because this material is mostly associated with the core element of T5, which has not yet been heard—maybe it’s a link with the harmonic field and mysterious atmosphere of *Other*?), an increase near the end of T5, and then a decrease when this theme yields to the subtle and progressive entry of the electroacoustic bridge D10 (the somewhat disquieting and menacing entry of the angel), an increase at the entry of the full version of T1 in S, a decrease at the entry of T2, a strong increase at the return of *Other* in its electroacoustic version, and then the clearly demarcated recognitions of the *Interlude* and *Epilog*.

⁷⁸ This figure is derived from figures in Stephen McAdams, Bradley W. Vines, Sandrine Vieillard, Bennett K. Smith & Roger Reynolds, “Influences of large-scale form on continuous ratings in response to a contemporary piece in a live concert setting,” *Music Perception*, vol. 22, no. 2, 2004, p. 297-350, p. 314, Fig. 3 and p. 315, Fig. 4 © Regents of the University of California 2004, adaptation authorized by the University of California Press). The article is reprinted with demonstrations of the experiments in McAdams & Battier (Eds.), *Creation and Perception of a Contemporary Musical Work*. In this figure, CB=COMB, REP=RepStrat, Pno=Interlude and Epi=Epilog.

La Jolla - D-S Version (played 2nd)



Paris - D-S Version (played 1st)

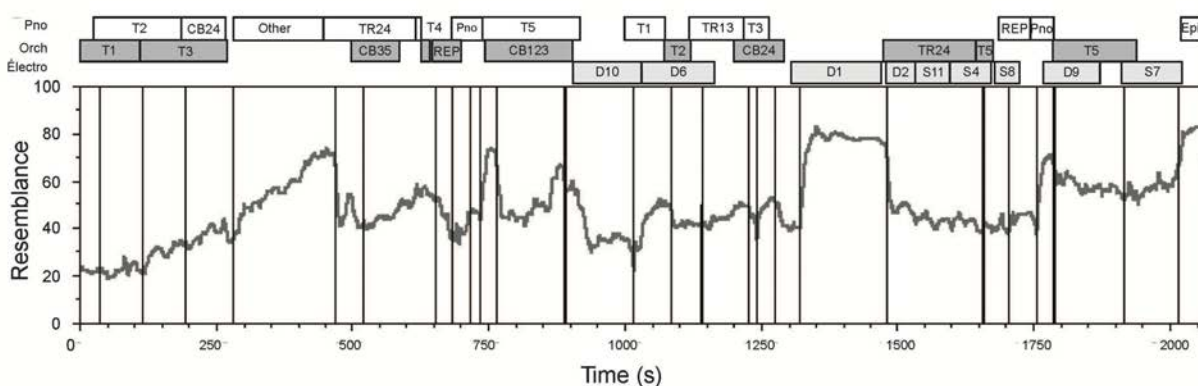


Figure 4.12. Average resemblance profiles for the D-S version in La Jolla (top) and Paris (bottom).⁷⁹

The two curves can be differentiated in terms of the more defined structural response at a local level in the interpretation by Sonor compared to that of Court-Circuit: the curve is more jagged, suggesting more synchronization in the listeners' responses to elements within the large sections.⁸⁰ This difference may be related to the listeners' culture (Parisian vs. Californian), to the interpretation (more marked contrasts by Sonor than by Court-Circuit), or a combination of these two factors.

Recognition of thematic materials in the context of the whole work

This experimental paradigm allows us to explore the role of musical context in the recognition of materials. The results obtained by Poulin-Charronnat and collaborators, in a study mentioned above, revealed the difficulty listeners have recognizing the materials if the instrumentation changes over fairly short durations and outside of the musical context of the complete work.⁸¹ Are the materials memorized in a more abstract way within the musical context, which would allow the listeners to recognize more easily the material in another instrumentation? Remember that the core elements are presented in their entirety in both parts of the piece. Are they recognized with a different instrumentation 17 minutes later in a different surrounding context and after being exposed to intervening material that is quite diverse, certain elements of which might reinforce their memory trace whereas others might interfere with this trace?

⁷⁹. This figure is derived from McAdams, Vines, Vieillard, Smith & Reynolds (*ibid.*, p. 315, Fig. 4 © Regents of the University of California 2004, adaptation authorized by the University of California Press).

⁸⁰. The responses were slightly more defined in laboratory experiments in Paris than in live concerts, but they were always less structured in the French interpretation than in the American one.

⁸¹. Poulin-Charronnat, Bigand, Lalitte, Madurell, Vieillard & McAdams, "Effects of a change in instrumentation on the recognition of musical materials."

If we consider the average resemblance ratings taken over the time period corresponding to the core element of each theme in the two halves for the S–D version, the averages are higher in the second half for four of the five themes (with the exception of T3 which decreases slightly). However, as mentioned previously, the resemblance profiles had a tendency to increase progressively over the whole piece, reflecting a progressive and general familiarization with the style of the composer. How then can we estimate the resemblance of the core element in the two halves independently of a global change of familiarity that influences the instantaneous resemblance ratings?

To perform an appropriate analysis, we need to estimate the resemblance for the region around the core element between the two halves of the piece in order to correct the measure of resemblance during the core element itself. Figure 4.13 shows how this measure of “emergence” of the core element from its surroundings is done. The thick grey line is the average of the individual curves. The question to which this measure responds is the following: does the average resemblance of the core element increase more than the surrounding materials in its second appearance? As such, for each listener, we use the average of their profile during the core element (the central square in Fig. 4.13) and the average of the profile during the 5 seconds before and after the core (the noncore squares in Fig. 4.13). We compare the noncore average to the core average. The more the core average is greater than the noncore average, the more the core has emerged compared to the surrounding material.

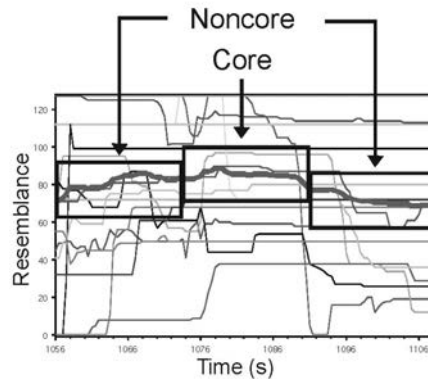


Figure 4.13. Calculation of a measure of core emergence.

We hypothesize that the noncore and core averages in the first half should be equivalent because the listeners have not yet heard the core. Then, we presume that the resemblance increases globally in the second part, but, if the core is recognized as such, its average should be greater than that of the periods on either side. Figure 4.14 presents the results predicted if the core element emerges from its musical environment in terms of explicit recognition. The averages in the temporal region of the core and those around it should be equivalent in the first half. The noncore average should increase due to the augmented global familiarity, but the core average should increase even more if it is recognized during its second appearance.

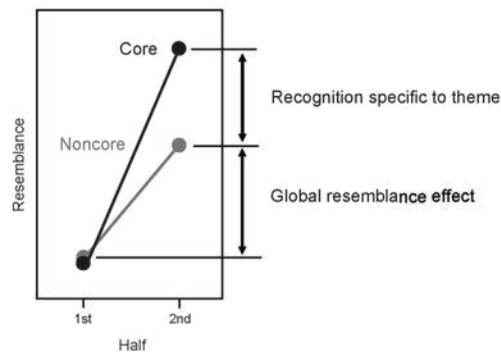


Figure 4.14. Predicted results if the core element emerges from its musical environment in terms of explicit recognition.

In analyzing the profiles for the two versions in the two concerts, it seems that a significant emergence of the core element in the second half only occurred for T1 and T5 in the S–D version in Paris and weakly for T3 in the S–D version in La Jolla. So, even though some core elements seem to be implicitly recognized according to this measure (only 3 out of 20), the recognition is not systematic for all themes in all performances, thus confirming the general difficulty revealed in the study by Poulin-Charronnat and collaborators of explicitly recognizing thematic materials presented in different instrumentations.⁸² It is not clear at this stage whether this result represents an incapacity to recognize materials after a change in timbre, even in a musical context, or if there is simply no additional increase within a musical context that is already rich in connections and associations.

Effects of large-scale form on structural perception

Another question is to know whether listeners respond with changes in their resemblance ratings at structural boundaries conceived by the composer. It is at these boundaries that listeners encounter either new material, in which case their ratings should decrease, or returning material that is more or less transformed, in which case the ratings should increase as a function of how similar the newly occurring material is to materials already heard. In order to study this question, we focused our analysis on ten structural boundaries that are common to both S and D parts (Fig. 4.15): the entry of T2, the beginning of TR1→3 in D and the T3 in S, COMB2/4, *Other*, TR2→4, T4, *RepStrat*, *Interlude*, the end of the *Interlude* that adjoins the materials of T5, and the electroacoustic solo that begins just before the end of T5 (D10 for the first half and S7 for the second). According to the artistic intentions of the composer, we expect that this structural perception will be more marked for S than for D.

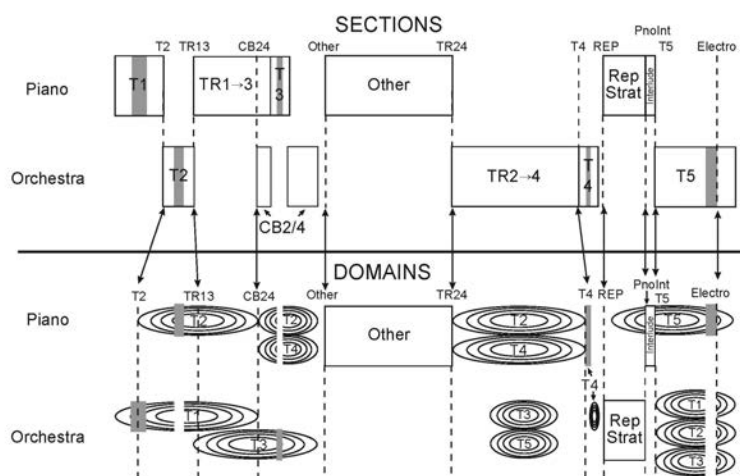


Figure 4.15. Moments in the score at which the perception of structural boundaries were analyzed.⁸³

To perform this analysis, we use a transformation of the resemblance profile that is called the “first derivative.” It is derived by calculating the slope of the profile, which represents how fast listeners are changing their ratings at each instant. Given that the responses often change in a stepwise manner—an abrupt change upward or downward followed by a plateau—the derivative of the profile produces peaks at the moment of sudden change, and the height of the peaks corresponds to the steepness of the slope at that point. In Figure 4.15, the first seven moments where such changes are found are indicated by arrows. Since we want to reveal the boundaries where the state of resemblance changes, we are interested in the amount of change and not necessarily in its direction; the interesting number is thus the absolute value of the derivative, which combines increases and decreases. Additionally, we need to filter the result of this calculation to remove small, insignificant changes and only keep the larger ones; to this end, a threshold is set

⁸² *Ibid.*

⁸³ This figure is adapted from McAdams, Vines, Vieillard, Smith & Reynolds, “Influences of large-scale form on continuous ratings,” p. 305, Fig. 1 © Regents of the University of California 2004, adaptation authorized by the University of California Press.

and peaks below that are filtered out. The result of this transformation is represented in the lower panel of Figure 4.16. It is clear that this listener perceived 23 boundaries where a notable change in the materials occurred.

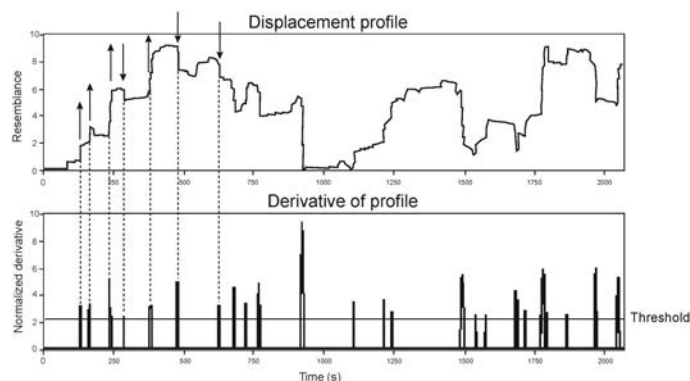


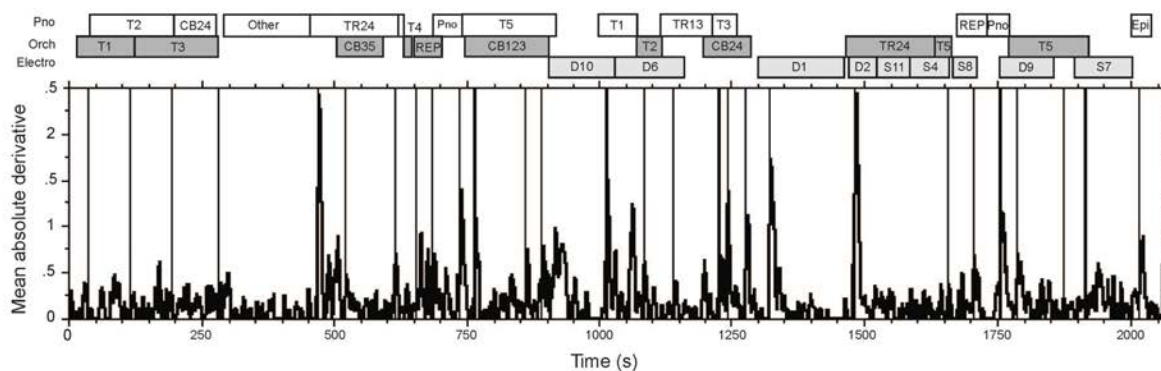
Figure 4.16. The resemblance profile of one person listening to *The Angel of Death* (top) and the filtered absolute value of the derivative (bottom).

When we compute the average of the profile derivatives of all listeners, we obtain a representation of the audience reaction taken collectively. In Figure 4.17, this average profile derivative is shown with the structure of *The Angel of Death* for both versions at the Paris concert. The response strength at a boundary is proportional to the height of the peak at a given moment. Again, the section boundaries are indicated by the vertical lines in order to show the correspondence between the responses and the musical structure. Most of the large peaks occur at section boundaries as conceived by the composer. What interests us is the difference in resemblance as a function of the section boundaries. The analyses show that, in line with the composer's aim, the responses at boundaries are stronger in the S part than in the D part in the S–D version in Paris and in both versions in La Jolla. The strength of the responses linked to the structure is generally higher for the La Jolla concert than for the Paris concert. We can see what seems like differences between the corresponding parts in the two versions, for example, D in D–S and S–D. The question that arises concerns the origin of these differences. Are they due to nuances in interpretation, to the effect of the electroacoustic part or to the influence of the large-scale form on perception?

To address this question, we needed to precisely quantify the perceived boundary strength based on the profile derivatives: is the average derivative after the boundary significantly greater than that before the boundary (indicating a change in state just after the boundary)? For each listener, we calculate the average derivative over the 5 seconds after the boundary in question and subtract from this value the average over the 5 seconds before the boundary (see Fig. 4.18). We call this measure the “boundary strength,” because the greater it is, the more the responses increase just after the boundary. In the case shown here, it is clear that many changes in the profiles occur just after the boundary, even though some listeners seem to anticipate it a bit. Next, we analyze the nine boundaries indicated in Figure 4.15. The influence of the large-scale form on the instantaneous resemblance ratings can be studied by testing the effect of part (S vs. D) and the position of the part in a given version (for example, D in S–D vs. D in D–S) in the concerts in Paris and La Jolla.

The two versions heard in the two concerts show a significant effect of the tested boundaries. The strongest boundaries include *Other*, TR2→4, *Interlude*, and T5. For the performances of the work, only the D–S versions produce a significant interaction between the part and the tested boundary, indicating that the relative strengths between the tested boundaries diverge between S and D in this version. For D–S played in Paris, the divergence concerns COMB2/4 and *Other* (with a positive significant strength for S and nearly zero strength for D) and the electroacoustic part (with a positive strength for D). For D–S play in La Jolla, the boundary strength of *Other* is higher for S, whereas that of the electroacoustic part is higher for D (the entry of D10 between the two parts evoked more reactions than that of S7 at the end). The number of significant boundaries in the D–S version was higher than that of S–D, and similarly there were more of them in S than in D.

D-S Version



S-D Version

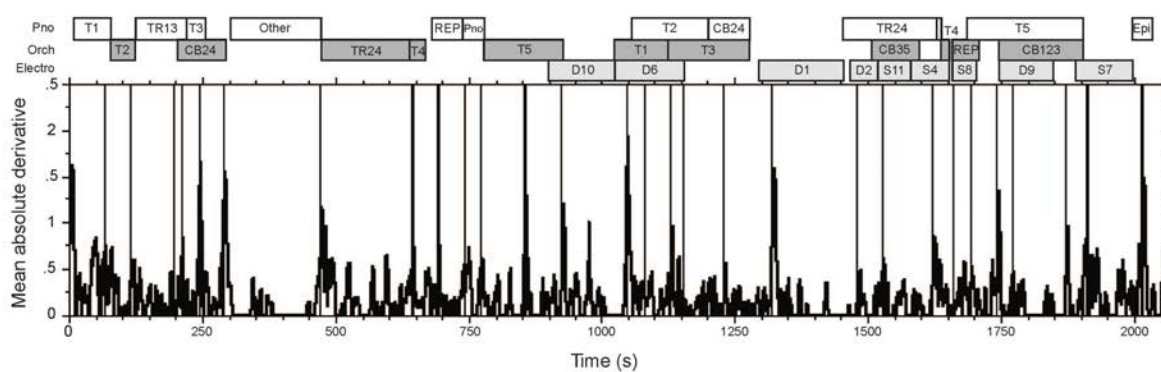


Figure 4.17. Average absolute derivative of the resemblance profiles for the two versions of *The Angel of Death*.⁸⁴

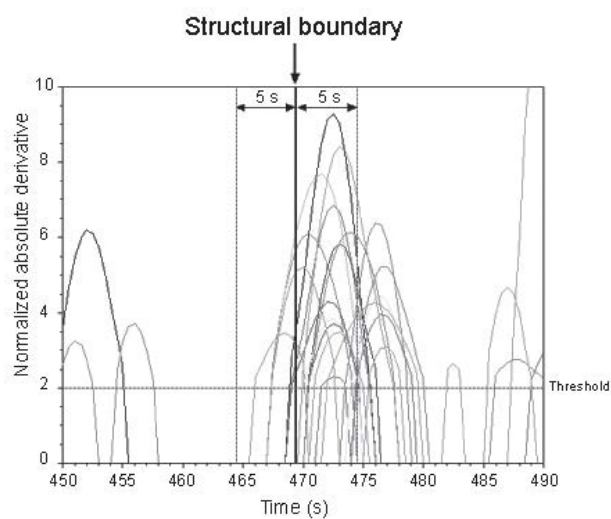


Figure 4.18. Example of individual profile derivatives at a section boundary.

⁸⁴ This figure is adapted from McAdams, Vines, Vieillard, Smith & Reynolds (*ibid.*, p. 320, Fig. 5 © Regents of the University of California 2004, adaptation authorized by the University of California Press).

The effects of the position of a part and the order of appearance of a given version in the concert were tested across concerts and versions. The analyses show that the S and D parts had equivalent strengths over the set of ten boundaries when they occurred in the first position (P1: see the (a) graph in Fig. 4.19). However, the strength increases in second position (P2) for the boundaries in S and decreases for those in D. One might conclude from this analysis that the boundaries in S are more salient after having heard D, whereas the boundaries in D are less salient after having heard S. As graphs (b) and (c) in Figure 4.19 indicate, the position interacts in a complex way with the part in its effect on boundary strength. There is a tendency for S to have higher boundary strengths in second position (version D–S) and for D to have higher boundary strengths in first position (D–S version also). This result suggests potential effects of the large-scale form, or of the cumulative experience with the materials and the style of the composer, on the perceptual analysis of the musical structure at the sectional level. Curiously, it was the D–S version that was preferred by the majority of listeners at both concerts. The association of these two effects leads us to hypothesize that the listeners prefer a version in which the musical structure becomes clearer perceptually to a version in which it becomes less clear.

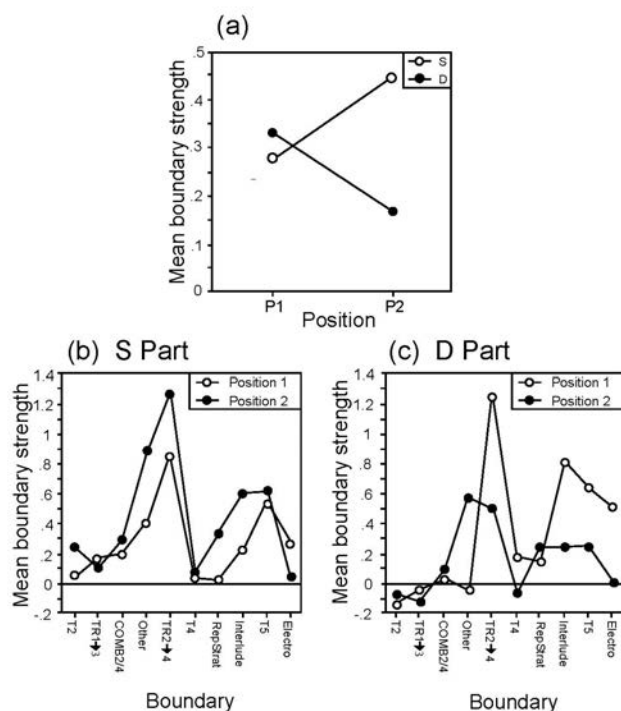


Figure 4.19. Average boundary strength: (a) as a function of the position in the piece for the S and D parts (all boundaries taken together) and as a function of the boundary tested for the S (b) and D (c) parts.⁸⁵

The resemblance scale seems to capture reactions to familiarity, resemblance, and recognition at several temporal scales. Some reactions to change in materials, texture, and the sound palette across the section boundaries are related to local differences between what is being heard and what is in working memory. These reactions demonstrate the vigilance of the listeners toward a change when it is detectable. The direction of these reactions reflects longer-term memory processes implicated in the recognition of thematic materials that return (increasing ratings) or of completely new materials (decreasing ratings). The first part and first version heard show greater decreases in the profiles, which indicates the detection of new material. There are also more prominent increases in the second part and the second version heard, which indicates the recognition of materials already heard. These characteristics of the average profiles testify to the continuous effort of the listeners to rate what they are hearing, which is of course reassuring.

⁸⁵ This figure is adapted from McAdams, Vines, Vieillard, Smith & Reynolds (*ibid.*, p. 322, Fig. 7 © Regents of the University of California 2004, adaptation authorized by the University of California Press).

However, there is an interesting interaction between the reaction to change and recognition that is evident in the average profile. At several places, there is a sudden, brief descent at a section boundary at which listeners detect a short-term change in the musical surface, but which is rapidly followed by a marked increase when they realize that the material has been heard before. Looking at Figures 4.11 and 4.12, the first occurrence of *Other* in S–D (Fig. 4.11) and in D–S (Fig. 4.12) gives a profile that increases progressively, whereas the second occurrence in S–D (part D in Fig. 4.12) or the third occurrence in the second version heard (D–S part D in Fig. 4.11) produces a profile that descends rapidly and then increases rapidly once the material has been recognized. The *Interlude* shows a similar pattern of results. There is also a cumulative effect of resemblance across the two parts of the piece and across the two versions heard in the same concert. This accumulation perhaps reflects a more abstract feeling of familiarity with the style of the composer who the majority of the listeners certainly didn't know at the beginning. There are thus apparently several types and levels of musical similarity that come into play in these ratings.⁸⁶

Another factor emerging from these comparisons is that the effect of position seems mainly related to having already heard the materials in the first part or the first version and less to the presence of the electroacoustic part that always accompanies the second part. Reynolds was not surprised to observe that the electroacoustic part does not interfere with the perceptual and structural experience of one part or the other. He had the impression that a listener would not likely remark the exact and detailed form of the computer images because their ideas are usually spread over a great timespan, and because their subtler details are often obscured by—or mixed with—the instrumental layers with more defined forms. The moments at which the electroacoustic part most affects the resemblance ratings are when they function as solo (D10, D1 and S7), as explicit support for the instrumental layers, or as intensification near the end of a section that was already characterized by the instrumental materials.

The boundary strength measures were derived from the resemblance profiles at moments corresponding objectively to analogous section boundaries in the S and D parts. This use of the derivative of the continuous rating profiles provides a tool for the study of the dynamics of perception and recognition. Many structural boundaries provoked sudden changes in the profiles, which in turn appear as peaks in the profile derivative. These peaks indicate that the listeners are sensitive to certain aspects of the macrostructural organization of the piece as conceived by the composer, and this in spite of the absence of previous experience of the audience with contemporary music in general or with Reynolds' music in particular. The peaks are clearly linked, in several cases, with discontinuities in the material, or they correspond to medium- to long-duration pauses (see Fig. 4.17 and Tab. 4.2). Some examples are the beginning of *Other* (in S), *RepStrat*, *Interlude*, and the core element of T5. The implicit detection of boundaries also reflects the return of emblematic materials that have a structural importance, as with *Other* and the *Interlude* in the second part, and the beginning of the *Epilog* for piano at the end of the piece. This result is remarkable in the sense that these materials are not particularly powerful or dramatic, but they acquire for the listener a certain “weight” through their recognition. The absence of such changes at other boundaries (notably in T2 and TR1→3 in D and COMB2/4 and T4 in both S and D) reflect the relative continuity of the musical discourse, even if these materials were conceived in a sectional manner by the composer.

A surprising result is the absence of perceptual boundaries (peaks in the profile derivative) at T2 and at TR1→3 in the S part. These two regions are characterized objectively by changes in instrumentation and texture, and they are preceded by pauses (*fermati*). It is likely that in a segmentation task a boundary would be placed at these moments.⁸⁷ Nevertheless, in a certain sense the pauses (partially filled by resonances of the preceding materials) seem to minimize the discontinuity, and there is a relative rhetorical continuity across the breach. Other interesting cases include *Other* in the D part, TR2→4 and T5 in both parts, and D10. These boundaries only have a weak qualitative discontinuity in the materials (Tab. 4.2), but are perceived strongly as moments of change. They are all very distinct in musical character at their beginnings, and all of them, with the exception of *Other*, provoke increases in resemblance ratings when they are heard for the second time. This last result demonstrates the role of dynamic memory processes in macrostructural perception in the absence of strong discontinuities on the musical surface. Considered together, these results suggest that this technique is sensitive to the structural properties at different levels of abstraction of the sound

⁸⁶ On this subject, see McAdams & Matzkin, “The roots of musical variation in perceptual similarity and invariance.”

⁸⁷ See Clarke & Krumhansl, “Perceiving musical time”; Deliège, “Approche perceptive de formes contemporaines.”

event, including temporal and qualitative discontinuities, structural markers such as repetition and return, and several rhetorical functions such as continuity, development, and digression.⁸⁸

Table 4.2. Characterization of the musical changes at section boundaries.⁸⁹

Boundary	S	D
T2	I, MT, P qualitative discontinuity + pause	I qualitative continuity
TR1→3	I, MT, D, P qualitative discontinuity + pause	– strong qualitative continuity
COMB2/4	I qualitative continuity	– strong qualitative continuity
<i>Other</i>	I, MT, TD, D, P strong qualitative discontinuity	I, P weak qualitative discontinuity + pause
TR2→4	I weak qualitative discontinuity	I weak qualitative discontinuity
T4	– strong qualitative continuity	– strong qualitative continuity
<i>RepStrat</i>	I, MT, D, P qualitative discontinuity + pause	MT, D, P qualitative discontinuity + pause
<i>Interlude</i>	I, MT, TD, D qualitative discontinuity	I, MT, TD, D qualitative discontinuity
T5	I, P weak qualitative discontinuity + pause	I, P weak qualitative discontinuity + pause
Electro(D10)	– qualitative continuity, electroacoustic part increases progressively	I weak discontinuity in instrumental part, electroacoustic part increases progressively
Electro(S7)	– qualitative continuity	I, MT weak qualitative discontinuity

These data are very rich, and several aspects of them could be presented at greater length. However, I will focus the rest of this exposé on what they indicate with respect to the effect of large-scale form on the dynamic processes of perception and memory.

The effects of large-scale structure on the perception of boundary strength

Large-scale structure creates several significant effects (effects due to part, to position and to the order of presentation of versions) on local boundary strength, that is, on the detection of qualitative discontinuities and on the reaction to them. On average, boundary strength is affected by the part and the position. The boundaries are stronger in the S part than in D, and in the D–S version than in S–D. Additionally, these two factors interact. Independently of the order of presentation of the versions, the S and D parts have equivalent boundary strengths in first position, but this strength increases in second position for S and decreases in the same position for D (Fig. 4.21). This asymmetry suggests differences in the memory processing of the two ways of developing the thematic materials in the two parts. This asymmetric relation is supported again by differences in the influence of the memory trace in each part on the perceived boundary strength in the second part of the two versions. The more continuous flow of D in first position had less effect on S in second position than the clear sectional presentation of S in first position had on D in second position. The S part had more effect on itself across the two versions heard, which suggests a clearer and more persistent memory coding of the materials in their realization in S than in D.

These results on boundary strength raise the question of knowing why more boundaries and stronger ones appear in D–S than in S–D. One might expect that the more didactic and marked presentation of S clarifies the structure based

⁸⁸. See Lalitte, Bigand, Poulin-Charronnat, McAdams, Delbé & D’Adamo, “The perceptual structure of thematic materials in *The Angel of Death*.”

⁸⁹. The boundaries are those indicated in Figure 4.15. I=Instrumentation, MT=musical texture, TD=temporal density, D=dynamics, P=existence of a pause or silence. The D10 image begins just at the end of the core element of T5 in the first part and the S7 image starts 3.5 measures after the end of this core element in the second part; as such the nature of the change of the electroacoustic elements depends on the position rather than the part.

on the materials in a more elaborate fashion than would the more diffuse character of D. As such, a more precise and durable memory trace would be established for S, which could then interact with the musical information that arrives over a longer timespan. This idea has implications for the formation of representations in memory and the priming strength of representations constructed beforehand as a function of their nature (D vs. S) on the rest of the piece.⁹⁰

A plausible explanation would be that listeners don't expect the boundaries to arrive as quickly in the first part of S–D and that they haven't yet acquired enough familiarity with the style. They don't give as much weight to the idea of a change in S–D as they do in D–S. However, similar results are produced for S–D when this version is heard in second position in the concert, in which case the listeners would have acquired such stylistic experience. In D–S, the change occurs with a more unusual and decisive event in the second part (S), which clarifies and makes more explicit the materials presented in a more fluid form in the first part (D). Our brains always seek to find order in the perceptual stimuli.⁹¹ If a listener experiences a music that is ambiguous (D) for a certain time, then when a perceptible order is introduced, it is likely that their attention would increase and that they profit from the earlier presentation of the thematic materials for the processing of new materials and of the structure, even though it might be diffuse, thus consolidating them in memory. When S comes first, a clear representation of the materials accumulated in memory is subsequently perturbed by a more varied, interactive, and less clear presentation of the materials. The continuous discourse in the D part lends itself neither to segmentation nor to categorization or recognition.

The evolution of emotional response in The Angel of Death

The study of emotional responses to music is currently a booming field⁹² and includes the characterization of emotions felt during music listening, attempts to precisely situate the aspects of musical structure that generate them, the specification of the nature of the major dimensions of emotional experience (such as arousal or valence: the positive or negative aspect) and the way that they unfold through time.⁹³ It is the evolution of emotions over time that mainly interests us in the study of the piece by Reynolds, as well as the study of the effects of large-scale form on emotional experience over the course of the piece.

Krumhansl used continuous ratings of emotion, openness, and memorability of works by Mozart and Beethoven, with the aim of studying the relation between the musical structure and the intonation units in the theory of the temporality of language discourse by Wallace Chafe.⁹⁴ She found that new ideas were introduced at points of weak tension and neutral tempo, and that the musical tension tended to increase up to a peak produced just before the end of a segment. John Sloboda and Andreas Lehmann used continuous response techniques to explore the way in which the intensity of a simple emotion is affected by performance decisions during the interpretation of relatively short pieces.⁹⁵ Their results show the effects of musical structure and of variations in interpretation on the emotionality profiles: the peaks and valleys of emotional experience are associated with structural characteristics of the music.⁹⁶

⁹⁰ For a similar discussion on priming in the electroacoustic transformations of the musical materials in *The Angel of Death*, see Sandrine Vieillard, Emmanuel Bigand, François Madurell & Stephen McAdams, "Implicit memory relations between original and transformed versions of contemporary musical materials," in McAdams & Battier (Eds.), *Creation and Perception of a Contemporary Musical Work*.

⁹¹ See John A. Michon, "The making of the present: A tutorial review," in Jean Requin (Ed.), *Attention and Performance VII*, Hillsdale, NJ, Lawrence Erlbaum Associates, 1978, p. 89-111.

⁹² See Patrick N. Juslin & John Sloboda (Eds.), *Handbook of Music and Emotion: Theory, Research, Applications*, Oxford, Oxford University Press, 2010.

⁹³ On this subject, see Emmanuel Bigand, Sandrine Vieillard, François Madurell, Jeremy Marozeau & Alice Daquet, "Multidimensional scaling of emotional responses to music: The effect of musical expertise and of the duration of the excerpts," *Cognition and Emotion*, vol. 19, no. 8, 2005, p. 1113-1139; Simone Dalla Bella, Isabelle Peretz, Luc Rousseau & Nathalie Gosselin, "A developmental study of the affective value of tempo and mode in music," *Cognition*, vol. 80, no. 3, 2001, p. B1-B10; Emery Schubert, "Continuous measurement of self-report emotional response to music," in Patrick N. Juslin & John Sloboda (Eds.), *Music and Emotion: Theory and Research*, Oxford, Oxford University Press, 2001, p. 393-414.

⁹⁴ Krumhansl, "Topic in music"; Wallace Chafe, *Discourse, Consciousness, and Time: The Flow and Displacement of Conscious Experience in Speaking and Writing*, Chicago, Chicago University Press, 1994.

⁹⁵ John Sloboda & Andreas C. Lehmann, "Tracking performance correlates of changes in perceived intensity of emotion during different interpretations of a Chopin piano prelude," *Music Perception*, vol. 19, no. 1, 2001, p. 87-120.

⁹⁶ For previous studies arriving at the same conclusion, see Carol L. Krumhansl, "A perceptual analysis of Mozart's *Piano Sonata K. 282*: Segmentation, tension, and musical ideas," *Music Perception*, vol. 13, no. 3, 1996, p. 401-432; Caroline Palmer, "Anatomy of a performance: Sources of musical expression," *Music Perception*, vol. 13, no. 3, 1996, p. 433-453; Jaak Panksepp, "The emotional source of 'chills' induced by music," *Music Perception*, vol. 13, no. 2, 1995, p. 171-208; John Sloboda, "Music structure and emotional response: Some empirical findings," *Psychology of Music*, vol. 19, no. 2, 1991, p. 110-120.

Bradley Vines, Regina Nuzzo, and Daniel Levitin used continuous ratings of musical tension as a measure of musical emotion.⁹⁷ They focused on the derivatives of response profiles to characterize what they called affective speed and acceleration and their dynamic relation to musical tension and release. Their interpretation of the data sought to show that affective energy is stored and released when musical tension increases or decreases, creating an arc structure of musical tension and release, which recalls the respiration of the music and the changing emotive dynamics proposed as essential components of musical meaning by Leonard Meyer.⁹⁸

Listeners participating in the concert experiments with *The Angel of Death* had to continuously rate the intensity of their emotional response to the music and to indicate it with a slider that varied between “weak” and “strong.” There was also a zone in which the listener could place the cursor when they didn’t feel anything. The recorded emotional force profiles involve very different processes than the ratings of resemblance. They refer to momentary emotional responses and not to memory traces, even though memory may potentially affect the emotion. The emotional responses are related to physiological mechanisms,⁹⁹ and they can have valence, a tendency to induce attraction or repulsion. Nevertheless, and following from an experiment conducted by Emery Schubert¹⁰⁰ and the instructions given to listeners, it is likely that the one-dimensional scale of emotional force we used probes the arousal component or level of activation of emotion rather than the valence component. We selected a one-dimensional emotional force scale, because we were interested more in the evolution of the intensity of the emotional reaction over time and its relation to the musical structure than in the categories of emotional experience that might be evoked and that would be susceptible to large variation from one listener to another.

The average emotional force profiles are presented for two versions of the piece in the two concerts in Figures 4.20 (S–D version) and 4.21 (D–S version).¹⁰¹ There is less variation in the average profiles for emotional force than for resemblance. The profiles vary over about half of the scale and are centered in the middle. Due to the fact that the data were normalized to have the same range of variation for each listener, this limited variation indicates that there is a great deal of uncorrelated difference between listeners and that only the moments at which they are synchronized will be evident in the average profiles. There are, however, moments at which great emotional force is elicited, in decreasing order, by the electroacoustic solos, the COMB2/4 region in the second half in spite of small decreases caused by *Other*, the *Interlude*, the core element of T5 (just before the entry of the electroacoustic part), and the *Epilog*. Note that this was the aesthetic impact desired by the composer for the *Interlude*, the T5 core element, and the *Epilog*.¹⁰²

The average profiles can be considered as a hierarchical series of embedded arcs, the dips often, but not always, corresponding to section boundaries (for example, the beginnings of *Other*, TR2→4, T4, T5, and D10 and S7). An example of this hierarchical structure is visible in Figure 4.21 for the profile of D–S played in La Jolla. A series of four smaller arcs create a more englobing arc that ends at the beginning of TR2→4. The embedded arcs include T1 up to the first third of T2, the remaining two-thirds of T2 up to the first third of COMB2/4, the remaining part of COMB2/4, and *Other*. Some of these arcs have an even more detailed inner structure. The following group of four or five arcs ends at the beginning of D10, and so on. Seen in this way, the four interpretations seem to be composed of five or six large sections producing an emotional arc that ascends and then descends, within which are embedded from one to five smaller arcs. This characterization of the form of the emotional experience interested Reynolds at the beginning of the project. It should be emphasized that although the thematic elements play a strong role in the evolution of the feeling of familiarity and resemblance, the strong sections in terms of the elicitation of emotional response are the derived sections: the transitions (TR), combinations (COMB), and electroacoustic solos (D10 and S7).

The following analyses focus on the comparisons between the concerts (different orders of presentation of the two versions) and between the parts (S and D), depending on whether they were heard in the first or second position in the piece.

⁹⁷ Bradley W. Vines, Regina L. Nuzzo & Daniel J. Levitin, “Analyzing temporal dynamics in music: Differential calculus, physics, and functional data analysis techniques,” *Music Perception*, vol. 23, no. 2, 2005, p. 137-152.

⁹⁸ Leonard B. Meyer, *Emotion and Meaning in Music*, Chicago, University of Chicago Press, 1956.

⁹⁹ See Elaine Hatfield, John T. Cacioppo & Richard L. Rapson, *Emotional Contagion*, New York, Cambridge University Press, 1994; Carol L. Krumhansl, “An exploratory study of musical emotions and psychophysiology,” *Canadian Journal of Experimental Psychology*, vol. 51, no. 4, 1997, p. 336-352.

¹⁰⁰ See Emery Schubert, “Continuous measurement of self-report emotional response to music.”

¹⁰¹ The thin curve indicates that the corresponding version was played first in the concert and the thick curve that it was played second.

¹⁰² See Reynolds, “Compositional strategies in *The Angel of Death*.”

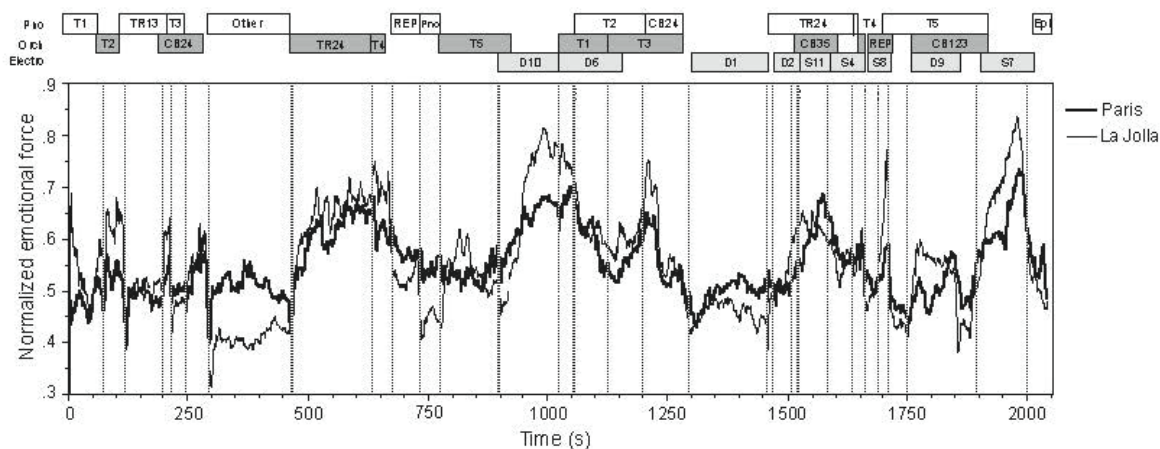


Figure 4.20. Average emotional force profiles for the S-D version played in Paris (thick curve) and La Jolla (thin curve).¹⁰³

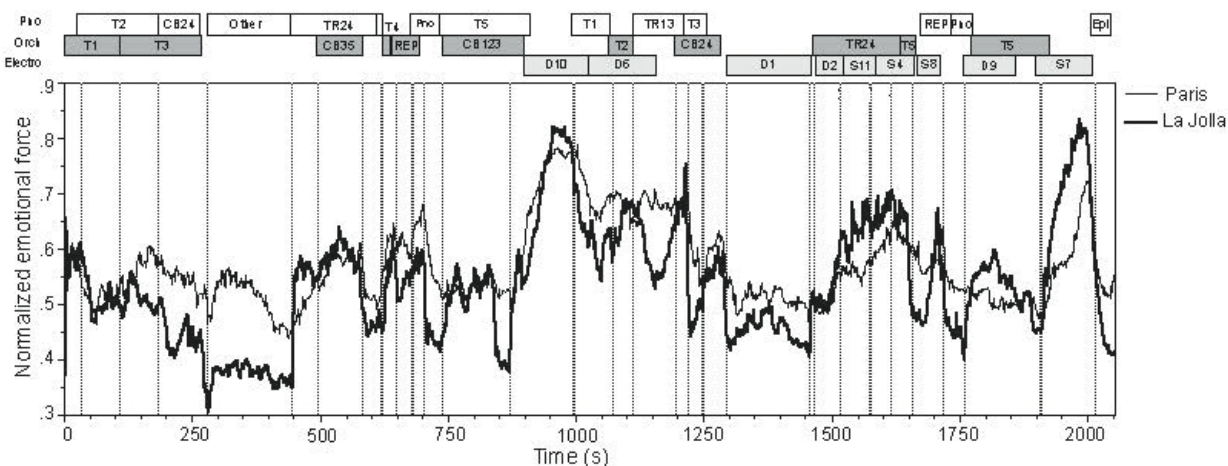


Figure 4.21. Average emotional force profiles for the D-S version played in La Jolla (thick curve) and Paris (thin curve).¹⁰⁴

Comparison between the concerts

Globally, the average profiles are very similar between the two interpretations performed by two different ensembles. The changes in the profiles from the La Jolla concert are larger and more abrupt than those from Paris, which suggests a great synchrony of response for the former group. This result might be explained by a greater sensitivity of the listeners or a greater emotional variation in the interpretation by Sonor, or both. Some aspects distinguish the two interpretations: a more subtle, refined, and blended sound for the Court-Circuit ensemble in Paris, and a more dynamic and contrasted sound that makes the inner voices emerge more in La Jolla, due to the larger hall, with the increased space allowing the electroacoustic part to be played at higher levels.

In the S-D version (Fig. 4.20), the profiles are very similar and diverge significantly only at a few moments. These divergences are due to the stronger presence and a more dramatic use of the brass and percussion (in T2 near the

¹⁰³. This figure is derived from McAdams, Vines, Vieillard, Smith & Reynolds, "Influences of large-scale form on continuous ratings," p. 332, Fig. 8 © Regents of the University of California 2004, adaptation authorized by the University of California Press.

¹⁰⁴. This figure is derived from McAdams, Vines, Vieillard, Smith & Reynolds, "Influences of large-scale form on continuous ratings," p. 333, Fig. 9 © Regents of the University of California 2004, adaptation authorized by the University of California Press.

beginning and just before the *Interlude* in the second half), to a slower and more melodious interpretation of the T5 core element, and to the greater prominence of the S7 computer image, all in the La Jolla performance.

In the D–S version (Fig. 4.21), the profiles for the two concerts start at the same level of emotional force. They diverge just after the entry of T3 with a more reserved tension in the Parisian interpretation, compared to the franker performance in La Jolla. Next, the profile of the Californian interpretation descends in a particularly tranquil and floating *Other*. The profiles join again at the beginning of TR2→4. There is an increase in the T5 section preceding the *Interlude* in the Parisian performance due to a crescendo and a more marked dissonance, as well as a more ample and rapid descent at the entry of the *Interlude* in the Californian concert due to a longer silence preceding a softer interpretation of this *Interlude*. A descent at the end of T5 in the La Jolla concert gives another significant peak, again due to a longer silence that demarcates the beginning of the T5 core element. There are momentary divergences in TR1→3 and T3, with the Californian profile progressing toward weaker levels of emotional force. This decrease seems related to the presence of the computer image D5 that overlaps TR1→3, as well as of a silence preceding a very soft and fluid interpretation of T3 with a lot of *sostenuto* pedaling. The profiles remain quite close thereafter up to S7, where a greater increase in the Californian profile is due to the higher sound level of the electroacoustic part in this concert.

Comparison of the same part in the two versions

The correlation between the profiles of the same part in the two possible positions in the piece (for example, D in first position in D–S and in second position in S–D) is higher for the California audience than for the Parisians. The S part in the Parisian concert (Fig. 4.22, upper left graph) was rated with greater emotional force in D–S than in S–D for T1, T2, TR1→3, and the beginning of COMB2/4. Since the electroacoustic part is not very prominent in this region and blends with the instrumental strata, and since the interpretations seem very similar in this part of the piece, the higher average profile in the Parisian interpretation may be explained by an emotional reminiscence of the strong peak in the D10 electroacoustic solo immediately preceding the S part in this version. The difference between the versions is inverted after that, but is momentarily significant (statistically speaking) near the beginning and middle of TR2→4. It seems to have a stronger relation with the structure of the piece in the S–D version, with slopes in the average profile at section boundaries. For the S part in the La Jolla concert (upper right graph in Fig. 4.22), there is a completely different configuration. S–D has an average rating that is higher on TR2→4, T4, *RepStrat*, and T5 (without the electroacoustic part). The cause of this isn't clear in listening to the recordings of the two interpretations. In this region, and in the two parts and the two versions, the half without electroacoustics has a higher average emotional force. In the Californian interpretation, there is a prominent emotional peak at the end of *RepStrat* in D–S that is clearly due to the density and intensity, the levels of which increase and accelerate during the S8 computer image.

For the D part in the Parisian concert (lower left graph in Fig. 4.22), the profiles are close but uncorrelated, undulating in a small register in the middle of the scale up to T4–*StratRép*–*Interlude*–T5 where D–S is higher (again, in the electroacoustic part). For the D part in the Californian concert (lower right graph in Fig. 4.22), there are regions of marked divergence at the beginning of COMB2/4, the values being higher for S–D due to the end of the D5 computer image. Another divergence is evident at the beginning of TR2→4, D–S being higher apparently due to the particularly dramatic entry of the percussion (a screech produced by scraping the surface of the tam-tam with the end of the wood mallet). In the *RepStrat* section, the profile for S–D descends abruptly due to a longer silence preceding *RepStrat* and rapidly increases thereafter during the crescendo and increasing density of the S8 image. This creates a strong contrast afterward with the *Interlude*, hence the sudden redescent of the profile. This latter effect creates a parallel with that of the S part for the La Jolla concert mentioned above (upper right graph in Fig. 4.22). At the end of T5, the beginning of the D10 image in the D–S version of La Jolla apparently creates a stronger emotional response than the entry of the S7 image in the S–D version of the same concert.

Examining the differences between the average profiles for each concert, we obtain a glimpse of the effect of the position of the part in the piece and of the order in which the versions were heard in the concert. The S part elicits a stronger average emotional force in the S–D version than in the D–S version for both concerts, whereas the D part engenders higher ratings in the D–S version than in the S–D version. These analyses reveal that a part in first position is always rated as more evoking of emotion than in second position, and additionally, this difference increases when the first position is in the first version heard, compared with the case in which it is in the second version heard. There is thus a dominance of the position over the order of presentation, but both suggest a decrease in ratings of emotional force with repetition.

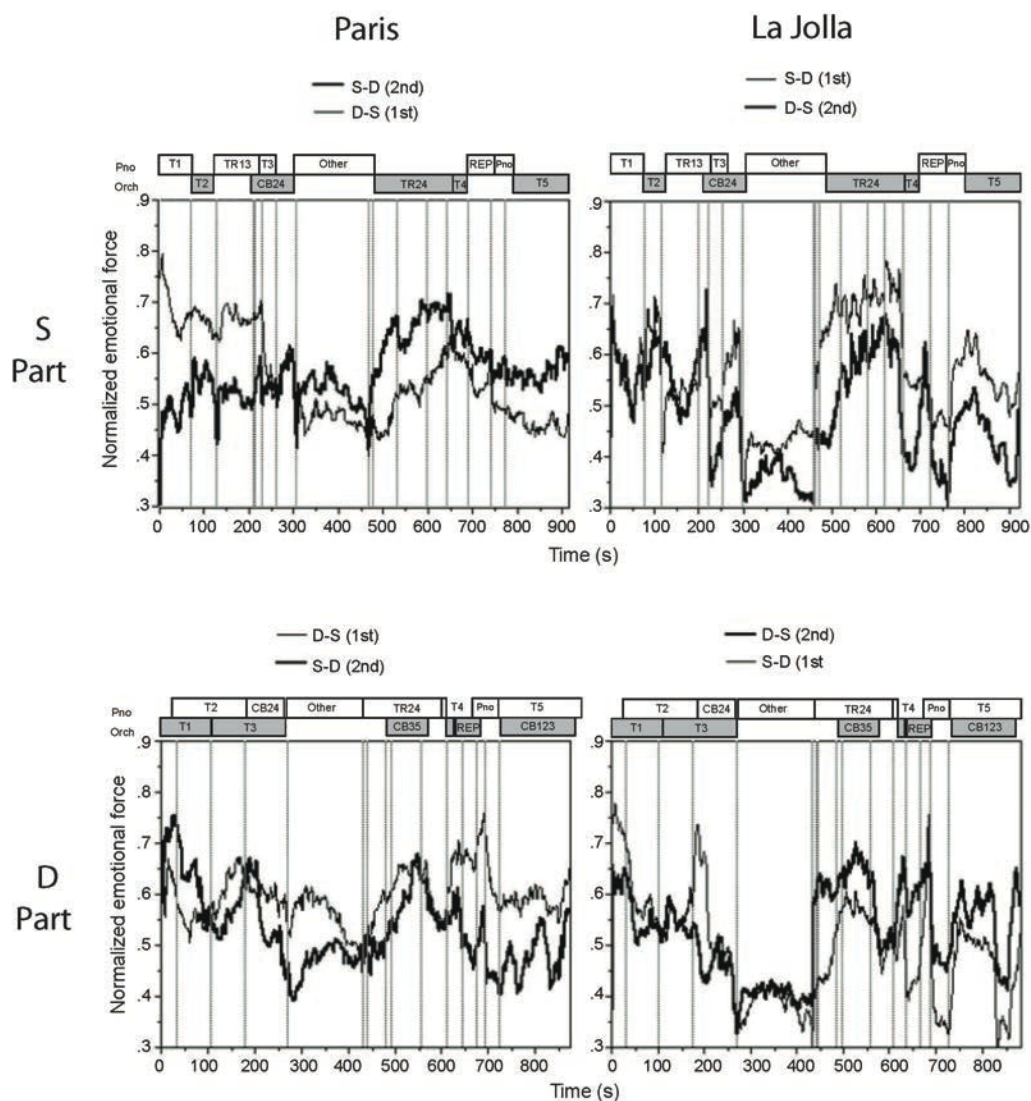


Figure 4.22. Comparison of average emotional force profiles.¹⁰⁵

Discussion

We can summarize the main results of this research as follows:

- ◆ the emotional force profiles are very similar across interpretations for a given version; in fact, there are very strong structural similarities in spite of the completely different approaches to the interpretation of the piece by the Court-Circuit and Sonor ensembles;
- ◆ the most pronounced emotional peaks are evident in the electroacoustic solos and regions derived from the materials of T2 and T4: TR2→4 and COMB2/4;
- ◆ the collective emotional force profiles have a form that can be described as a series of hierarchically embedded arcs;

¹⁰⁵. This figure is derived from McAdams, Vines, Vieillard, Smith & Reynolds (*ibid.*, pp. 336-337, Figs. 10-11 © Regents of the University of California 2004, adaptation authorized by the University of California Press).

◆ the emotional force decreases globally from the first part to the second and from the first version heard to the second, suggesting that repetition attenuates emotional response.

According to Emery Schubert, the emotional force scale mainly derives from the activation or excitation component of emotional reaction.¹⁰⁶ This observation is confirmed in part by the modeling of the acoustic origins of listeners' reactions, combining information rate (a measure of signal predictability) and energy (increased energy and information rate result in increased emotional force).¹⁰⁷ It should be noted, however, that a simple equating of emotional force and energy, as proposed by Schubert,¹⁰⁸ for example, is too simplistic, because there are clearly moments in the piece where the energy is weak and the emotional force is elevated, and vice versa. It is as much the combination of parameters in the more global trajectory of the musical discourse that seems to determine the average emotional response of the audience. Indeed, for tonal music, Krumhansl has shown that tension ratings for works by Mozart were relatively similar after having removed changes in intensity and tempo.¹⁰⁹ This would mean that the harmonic structure was quite important. Of course, in contemporary music, intensity and tempo have acquired a more important role in induced emotional experience due to the absence of harmonic structures that are strongly interiorized by listeners habituated to tonal music.

Even though the majority of the listeners, and particularly the nonmusicians of the audience, were not familiar with contemporary music in general and Reynolds' music more specifically, the music clearly affected them emotionally as evidenced by the individual emotional force profiles, which varied strongly over the whole piece. Furthermore, there is a notable relation between the average profile (representing the collective response) and the structure of the piece, in spite of the fact that the structure revealed by the data diverges in an interesting way from the structure revealed by the perceived resemblance data. One of the most striking features of the average profile is its apparent organization in a hierarchical series of embedded arc forms. The emotional force profiles reveal the importance of the electroacoustic solos (D10 and S7) and the development sections (particularly TR2→4 and COMB2/4) for the high emotional impact, as well as the reflective periods of emotional repose in *Other*, the *Interlude*, the T5 core element, and the final dénouement of the *Epilog*.

The embedded arc structure that appears in the emotional force data is analogous to the hierarchies of structure and affect (often related to cycles of musical tension and release) for tonal music, described by Fred Lerdahl in his theory of tonal pitch space.¹¹⁰ The presence of natural modulations in the emotional response suggests that there is a similar experiential dynamic in listening to nontonal contemporary music and traditional tonal music that can be an invariant of the nature of human affective response in general, from which different genres of music draw. Until recently, research on music cognition has focused on Western tonal music, but increasing attention is being paid to a diversity of musical cultures.¹¹¹ It is interesting to see the similarities across types of interpretation such as those revealed by this study. The aim is to progressively attain an increased understanding of the variants and invariants of emotion and human experience.

The composer finds completely reasonable the fact that the emotional force tended not to derive from the thematic elements themselves. He thinks that it often isn't the proposed element (the fact, the identity, the motive, the character, and the theme) that moves us, but rather what happens to the elements that we have recognized or internalized: it's the transformation, and not the identification, that leads to emotion. He says that in composing the piece, he surely thought of embedded emotional hierarchies (probably an unconscious objective). For example, the assured and linear state of T1 is followed by T2, which troubles while maintaining the level of energy; what follows is a transition from a state troubled by lighter and continuous alternations (modified interruptions) in TR1→3 toward a closure that gently rustles in T3. The idea of seeking the arcs of emotive response could be a fruitful way to examine the conception and the effect of musical experience. Future work could study how such a model of the judicious shaping of the emotional

¹⁰⁶ Schubert, "Continuous measurement of self-report emotional response to music."

¹⁰⁷ Shlomo Dubnov, Stephen McAdams & Roger Reynolds, "Structural and affective aspects of music from statistical audio Signal analysis," *Journal of the American Society for Information Science and Technology*, vol. 57, no. 11, 2006, pp. 1526-1536.

¹⁰⁸ Emery Schubert, "Measuring emotion continuously: Validity and reliability of the two-dimensional emotion space," *Australian Journal of Psychology*, vol. 51, no. 3, 1999, pp. 154-165; Schubert, "Continuous measurement of self-report emotional response to music."

¹⁰⁹ Krumhansl, "A perceptual analysis of Mozart's *Piano Sonata K. 282*."

¹¹⁰ Fred Lerdahl, *Tonal Pitch Space*, Oxford, Oxford University Press, 2001.

¹¹¹ Cf. Ayari & McAdams, "Aural analysis of Arabic improvised instrumental music (taqsim)"; Laura-Lee Balkwill & William F. Thompson, "A cross-cultural investigation of the perception of emotion in music: Psychophysical and cultural cues," *Music Perception*, vol. 17, no. 1, 1999, p. 43-64.

context can be compared across musical periods and styles, especially in terms of the temporal proportions governing the emotional sections in arc forms.

The general emotional form is relatively similar for the different interpretations (perhaps due to the presence of the composer at all rehearsals), except for a few notable differences that for the most part can be attributed to the interpretation by the conductor (the styles of Pierre-André Valade and Harvey Sollberger are quite different). Despite the variability of many factors, including the venue, the musicians, the audience, the conductor, the pieces played between the two versions of *The Angel of Death*, and the cultural context (Paris and La Jolla), the general emotional “imprint” of the composition was preserved.

However, what is striking here is the fact that the differences are a modulation of the large-scale emotional form, itself strongly linked to the musical structure. The performance in La Jolla seemed more moving to those of us who were present at both concerts. Furthermore, this rendering probably globally had a better “sound” because the Mandeville Auditorium in La Jolla is larger than the Grande Salle of the Centre Pompidou in Paris. It is possible that the larger physical and visual perspective gave a more “solid” base for the listeners to make their ratings, in addition to the fact that the distribution of the listeners was more spacious in La Jolla. The more restrained movement of the listeners in the Grande Salle may have made it so that they felt emotion was reduced in intensity. Research has shown that when emotional expression is inhibited, the experience of the emotion and the concomitant physiological changes are dampened.¹¹² The types of expressive movement that the listeners can make include rocking, adjustments of posture, and other similar movements. Another source of the difference between the concerts might be that the visual aspect contributed to the augmentation of the emotional experience. Vines and collaborators found that the fact of seeing the musician can augment the emotional experience (measured as ratings of emotional tension) during the performance.¹¹³ However, the fact that the audience in La Jolla was larger and that the listeners were more distant from the stage would suggest the inverse from what was observed in the data. Given that the difference in rated emotional force was not generalized over the whole piece, it seems more likely that the differences are due to the interpretation. Further study of the derivatives of the profiles could provide interesting information on this subject.

One of the most striking characteristics of these data concerns the effects of previous exposure to the materials (in a preceding part of the piece or a preceding version in the concert). Following from the work of Meyer,¹¹⁴ one would expect that expectations and surprise play a strong role in the emotional response, and that they can be developed with repeated exposure to the musical grammar and style. Emotional force depends partly on the position of the parts and less on the order of presentation of the versions, but both effects go in the same direction: repetition slightly diminishes the emotional force. As such, one might ask whether the change is due to something like a sense of satiation. Even though the role of satiation in emotional response has rarely been studied, Daniel Berlyne addressed from a theoretical point of view its role in preference and taste.¹¹⁵ According to him, the evolution of preference with exposure depends on the initial level of the activation potential of the stimulation (probably associated with excitation in the present case), but also on the complexity (contemporary music) and novelty (first concert) as they are initially perceived. The basic idea is that appreciation diminishes with an elevated level of familiarity. This can be related to the notion of psychological complexity.¹¹⁶ Individuals prefer stimuli with a level of complexity that corresponds to their optimal level of psychological complexity, which depends on experience (and learning) and increases with experience. Although such considerations can be relevant for several listenings to the same piece, it is difficult to imagine that they operate across the two parts of the piece or the two versions in the same concert. Given the high complexity of the music and the demands of attention and vigilance required by the continuous rating task (over a period of 35 minutes), it may be that the experimental situation had played a role in the relative decrease of emotional force with repeated exposure. This interpretation is in agreement with Schubert’s suggestion that habituation can lead to a reduction in emotional force, due to the gradual increase in the activation threshold of “emotional nodes,” in a network

¹¹². On this subject, see Hatfield, Cacioppo & Rapson, *Emotional Contagion*, p. 58.

¹¹³. Bradley W. Vines, Marcelo M. Wanderley, Carol L. Krumhansl, Regina L. Nuzzo & Daniel J. Levitin, “Performance gestures of musicians: What structural and emotional information do they convey?” in Antonio Camurri & Gualtiero Volpe (Eds.), *Gesture-Based Communication in Human-Computer Interaction*, Berlin, Springer, 2003, p. 468-478.

¹¹⁴. Meyer, *Emotion and Meaning in Music*.

¹¹⁵. Daniel E. Berlyne, “Novelty, complexity and hedonic value,” *Perception and Psychophysics*, vol. 8, no. 5, 1970, p. 279-286.

¹¹⁶. William N. Dember & Robert W. Earl, “Analysis of exploratory, manipulatory, and curiosity behaviors,” *Psychological Review*, vol. 64, no. 2, 1957, p. 91-96.

of the kind proposed by Colin Martindale to explain the appreciation of negative emotions in aesthetic contexts.¹¹⁷ The idea that repetition decreases emotional force is perhaps not so problematic at the stage of a first encounter with a work. One might hope, nevertheless, that over time, when one starts to integrate all of the aspects of a work (and especially for a fascinating interpretation), that the experience of emotional force influenced at the outset by the feeling of novelty can be renewed and even amplified. In particular, it would be interesting to study the effects on the continuous ratings of repeated listenings over several days. These effects will probably be relevant for a musical style having the inherent complexity of *The Angel of Death*.

Multidimensional experience of musical form

How might one integrate this research on the recognition and perception of musical similarity of materials with that on the force of emotional reactions to explain their implicit contribution to the experience of musical form? These two aspects of musical experience that we have attempted to probe continuously over time are related to memory and affective processes. The large-scale formal relations that can be compared in the two versions of the work had very different effects on the responses along these two dimensions. Changes in resemblance ratings were related to section boundaries and changes in thematic materials. Emotional force ratings were not tightly linked to sections, but a global and coherent contour emerged in response to the music, which was coherent over interpretations, ensembles, conductors, and concert halls. The piece itself seemed to have an emotional “imprint” in a similar sense to the way Clifford Madsen conceives of responses to music.¹¹⁸

Compared to emotional force profiles, the resemblance profiles show a greater effect of previous exposure (effects of position in the piece and order of listening to versions), which interacts strongly with the nature of the materials that the listeners rate (S and D parts) and suggests a memory dynamic that is very different for the two types of ratings. We should consider the observation concerning the differences in resemblance profiles and boundary strength between the S and D parts and between the S–D and D–S versions in relation to the general preference of listeners, as well as the composer, for the D–S version, as indicated in the end-of-concert questionnaires. What aspect of structural and perceptual analysis of the work could have contributed to such a preference? Reynolds initially thought that S–D would be the more aesthetically satisfying version, because the listeners would have heard the materials very clearly at the beginning in S and because D would have been more transparent due to the distribution of materials between the piano and orchestra piano, making this part more manageable in its relation with the electroacoustic part in the second half.¹¹⁹ However, the musical reality led him to think that the “oceanic obscurity” of D provided a more striking opening and that the TR2→4 region played by the piano in D was more persuasive in first position than would be the orchestral analog in S. The logical and strategic advantages of S–D were thus surpassed in his opinion by the persistent emotion tightness of D–S and by the more satisfying arrangement of materials progressing toward structural clarity rather than moving away from it. This clarity was demonstrated by the differential effect of large-scale form on the S and D parts, D–S having the strongest perceived boundaries, especially for S in the second half. Therefore, the movement from a diffuse structural fluidity toward clear structural perception can be inherently more satisfying intellectually and aesthetically in terms of its dynamic contribution to the global experience.

A question that comes to mind in considering the diverse and varied dimensions of psychological experience when listening to music concerns the relation between these dimensions over time. We have measured two aspects among many others that we could have measured. Let's examine how emotional force depends on a surprise effect (decreasing resemblance or sudden contrast). If the emotional force grows when resemblance decreases, that would support the classic hypothesis formulated by Meyer in *Emotion and Meaning in Music* according to which the violation of musical expectations plays an important role in the formation of emotional responses. One would expect a negative correlation between the two. In fact, this relation is quite weak if we test the hypothesis on the S and D parts separately. And these values only increase slightly if we examine smaller sections. The weak association between the two measures indicates that at a detailed level, the resemblance and emotional force profiles are independent.

¹¹⁷. Emery Schubert, “Enjoyment of negative emotions in music: An associative network explanation,” *Psychology of Music*, vol. 24, no. 1, 1996, p. 18-28; Colin Martindale, “The pleasures of thought: A theory of cognitive hedonics,” *Journal of Mind and Behaviour*, vol. 5, no. 1, 1984, p. 49-80.

¹¹⁸. Cf. Clifford K. Madsen, Ruth V. Brittin & Deborah A. Capperella-Sheldon. “An empirical method for measuring the aesthetic experience to music,” *Journal of Research in Music Education*, vol. 41, no. 1, 1993, pp. 57-69.

¹¹⁹. Reynolds, “Compositional strategies in *The Angel of Death*.”

Another approach to the reflection on the multidimensionality of musical experience is to examine the correspondence between the subjective structure of the piece revealed by the implicit boundaries in the resemblance profiles and by the low points in the emotional force profiles as extreme points of the arc forms (Fig. 4.23). A structure of embedded arcs is superimposed on these profiles to illustrate how the data reveal the “lived” structure implicit in the work for each of these two dimensions of musical experience: one perceptual, the other affective. The “subjective” musical structures inferred from the average profiles derived from the two rating scales correspond at times, but are different at other moments; that is, the high and low points in the profiles align at certain moments and don't at others, as shown by the arcs drawn in Figure 4.23. As such, globally, the notion that expectation and surprise affect the emotional response as proposed by Meyer doesn't seem to manifest itself very clearly in this work, at least for the large scale under consideration here.

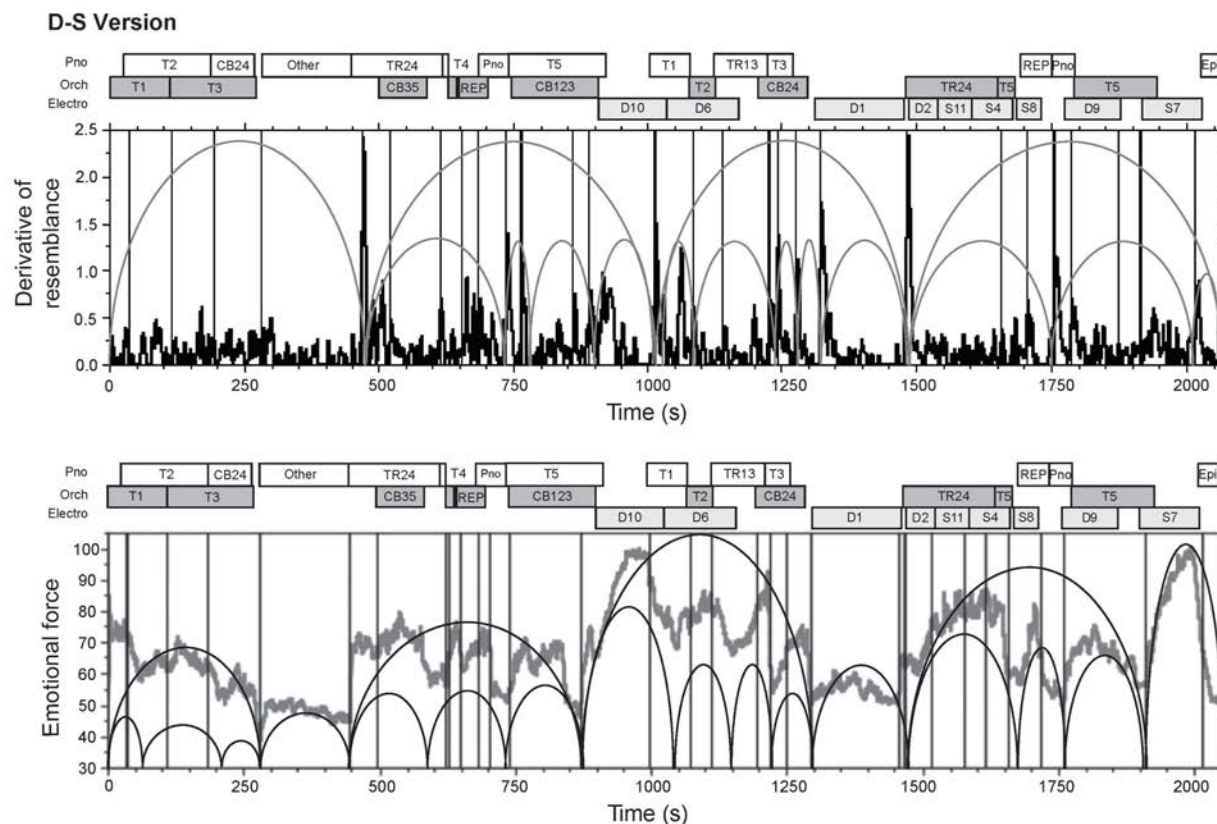


Figure 4.23. Comparisons of average profiles across listeners for the resemblance (top) and emotional force (bottom) scales.

To feel these two dimensions of experience simultaneously during music listening raises several interesting questions concerning musical form and the mental structuring of time that this kind of approach might allow us to study more systematically in the future. It is interesting to speculate on the feeling created in the listener when these different aspects of temporal experience converge and diverge over time. They can engender attentional trajectories and expectations that covary only partially and that can push and pull in different directions at the same moment. A graphic representation of the experience is presented in Figure 4.24. Each graph represents the average resemblance on the horizontal axis and average emotional force on the vertical axis. The temporal trajectories of the collective experience of the audience are traced on both dimensions over the duration of each section shown in different boxes. We thus see how the collective experience traverses the experiential space represented by these two dimensions during listening. Note that for certain sections (as with *Other-RepStrat*), the voyage in the resemblance-emotional force space is much more varied than in other sections (like *Interlude-T5*). In yet other sections (*D1-RepStrat* for the La Jolla concert), the variation in emotional force is more extended than that of resemblance (this section was in the second

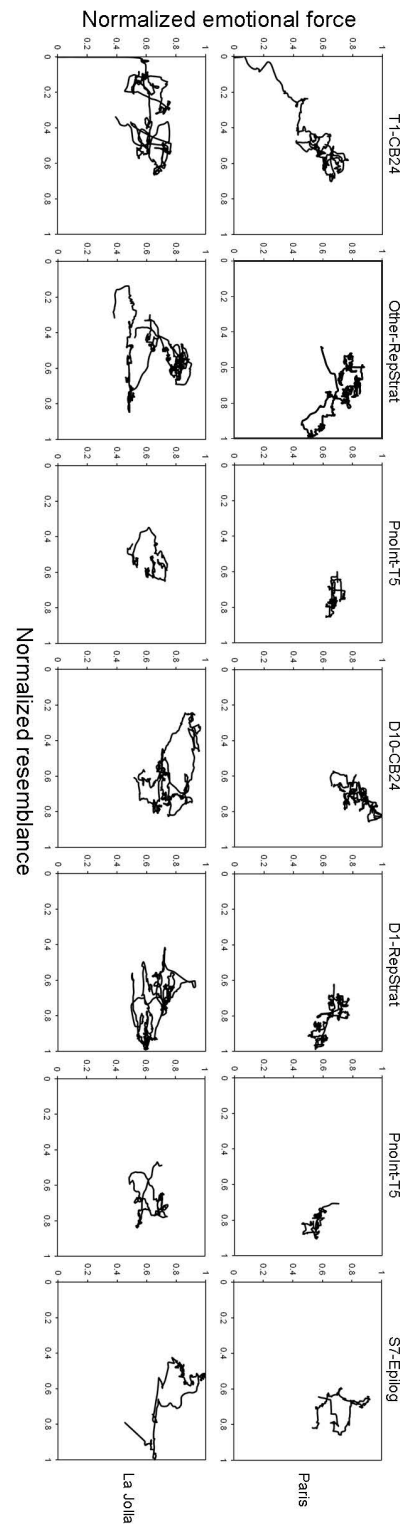


Figure 4.24. For the interpretations of the S–D version in Paris (top) and La Jolla (bottom), each graph represents one of the seven indicated parts of the piece.

half of the piece). Finally, we see that the trajectories of temporal experience vary with the interpretation, as shown by a comparison of the graphs for the Paris (top) and La Jolla (bottom) concerts. The emotional variation is greater for the California concert. As Lalitte remarked to me,¹²⁰ this result poses the question of knowing to what degree the nonconvergence of emotional experience and perception of structure (resemblance) plays on aesthetic appreciation itself. Do we prefer a work in which these two aspects converge, or rather does the partial independence create aesthetic interest? This question should certainly be studied with other works of different musical styles.

ELEMENTS OF REFLECTION

The project around *The Angel of Death* represents the combination of four main approaches: artistic creation, observation of and interviews with the composer to follow the process of musical creation, experimentation on the psychological processes at work during musical listening, and musicological analysis of the piece and its place in a historical context. The degree of interaction among these approaches was very high. The artistic approach was made concrete by the premiers of the work in Paris and La Jolla within the framework of the project. The results of the observation of the creative process include very rich written documentation and transcriptions of recordings of the interviews on the influences and decision-making processes at work during the conception and composition of the piece, as well as several musicological and psychological analyses of these elements that appear in the e-book on the project.¹²¹ These initial analyses served as landmarks to orient the in-depth musicological analyses and human experimentation that followed. The musicological analyses focused primarily on the thematic materials, as well as on their transformations in the score and through computer processing of recordings. These analyses were necessary to interpret the results of the experiments on the perception and memory of the materials.

Within this project, the psychologists explored the cognitive processing of musical structures of increasing complexity, from subsections of themes to entire themes and then to the entire work played in a concert. Since the structure of Reynolds' work is based largely on variation and transformation of the five thematic elements, the musicologists and psychologists were interested in their genesis, perception, comprehension, and memorization, as well as in the comprehension of the transformations performed on the materials.

The psychologists presumed that a listener's capacity to process the themes and their transformations would constitute a sort of "prerequisite" to be able to apprehend the complete work in a concert situation. In other words, the difficulty of grasping the perceptual identity of the themes after modification of their instrumentation, which we observed in the laboratory, would also exist in concert listening. Similarly, the results of studies on how the processes of computer transformation of materials influence listeners' memory of the themes suggests that the derived sections between themes (transition and combination regions) do not contribute to the reinforcement of the memory traces of these themes. This is contrary to what one might have thought on the basis of research in the cognitive sciences concerning integrative processes in the brain. Our results thus allow us to specify the cognitive nature of the difficulties encountered on first listening to a live contemporary piece.

The experiments on thematic materials conducted by Lalitte and his collaborators suggest that the listeners have some sense of the segmental structure of the themes and succeed locally in perceiving the similarity relations between these materials, but globally have some difficulty in understanding the temporal articulation of subsections within the themes.¹²² Listeners seem therefore to have some perception of the structure of this musical idiom over relatively short timespans. However, the integration of all of the materials over longer timespans seems to be more difficult to realize in terms of memory. The results of the concert experiments with continuous responses of resemblance and emotional force suggest an implicit influence of large-scale form on instantaneous response, and therefore on the integration of the materials and affective significance over longer timespans (on the order of several tens of minutes). The analysis of these integrative processes over the whole musical form would require a more intense collaboration involving music analysis and psychological experimentation. Beyond the implications of this work for the cognitive sciences and

¹²⁰. Philippe Lalitte, personal communication, 25 Octobre 2011.

¹²¹. McAdams & Battier (Eds.), *Creation and Perception of a Contemporary Musical Work*.

¹²². Lalitte, Bigand, Poulin-Charronnat, McAdams, Delbé & D'Adamo, "The perceptual structure of thematic materials in *The Angel of Death*."

musicology (taken in the broadest definition of the field proposed by Richard Parncutt¹²³), the present project allowed us to establish for the first time in the history of these two disciplines a systematic methodology that addresses the documentation of both possibilities and difficulties of perception encountered by listeners during the reception of a contemporary piece in concert. Lalitte summarizes the project in the following way:

In *The Angel of Death*, metaphoric worlds, moving sound imagery and multidimensional time also serve as aesthetic vectors. The archetypal images upon which the piece is built—death, fate, the fall, revival, the second chance, etc.—impregnate the spatialized sound imagery and lend their own character to the composition’s “time-writing.”

It all adds up to create a musical experience that has powerful expressiveness and unique form. Further, this is an exceptional event in the history of music and of the cognitive sciences in that a musical experiment is carried out in parallel with a set of psychological experiments in musical perception and observations concerning compositional strategy. For the composer, this involved the taking of additional risks: accepting the constraints imposed by scientific experiment, without waiving aesthetic goals or compromising artistic integrity. In a nutshell, a kind of “musical offering” to science.¹²⁴

Lalitte considers that the originality of the project around *The Angel of Death* resides in the diversity of angles of approach and in its interdisciplinary character. The engagement of the composer profoundly modified the usual conditions of the study of a work: the journal he kept and the careful monitoring of the stages of his work by the researchers from the first sketches all the way to the premier of the piece deliver to the team’s researchers the quasi-totality of the *poïesis* of the work. There is thus no need to investigate the conditions in which the piece was produced or to conduct studies that would go beyond what the composer desired to reveal. On the other hand, it was necessary to relate *The Angel of Death* to previous works and to situate the piece as much in the personal evolution of its author as in his musical environment, as did the musicologists Lalitte and Madurell¹²⁵.

Retrospectively and from a purely analytical point of view, Lalitte feels that the elements provided by Reynolds in his article in the e-book on the project answer three essential questions: the underlying system of composition (number series, proportions, architectural conceptions), the leeway the composer granted or refused himself, and the chronology of the compositional procedures.¹²⁶ The analytic field was thus largely cleared by the composer himself. It remained for the musicologists and psychologists to show the subtlety of the deployment of these principles and to explore the network of complex relations between the three actors that are represented by the piano, the orchestra, and the electroacoustic part.

The participation of the musicologists, as subjects at the beginning of the project and then as collaborators with the psychologists, strongly oriented their analytical investigations; their tendency to favor what is potentially relevant to the listener’s ear in the score was a logical consequence of this collaboration.¹²⁷ In other terms, the analytical work on the score, preceding the first full listening, was accompanied by successive mental representations, evolving as their familiarity increased with the work and its sonic realization, first with recordings of the thematic materials and then with the concert and its recording. The confrontation of memories of these representations with the real listening, first their personal listening, then that of the numerous listeners tested by the psychologists, constituted a decisive moment. The *esthesis* of *The Angel of Death* was then revealed in its grand complexity through the scientific project. The mental representations of the composer, his own perception of his work, the perception of the piece by the listeners (savvy or less so), the mental representations of the musicologists and their perception emerged progressively. These different aspects do not all lend themselves in equal fashion to scientific investigations, and they cannot therefore claim the same treatment. As Lalitte remarks:

If the experimental control was only exercised over perception, which legitimately occupies the greater position in the project, the fleeting appearance of representations in the composer’s and musicologists’ discourse gives rise to other questionings and represents a challenge that the cognitive sciences, one day perhaps, can take up.¹²⁸

¹²³. Richard Parncutt, “Systematic musicology and the history and future of Western musical scholarship,” *Journal of Interdisciplinary Music Studies*, vol. 1, no. 1, 2007, p. 1-32.

¹²⁴. Philippe Lalitte, “The unique aesthetic character of the music of Roger Reynolds,” in McAdams & Battier (Eds.), *Creation and Perception of a Contemporary Musical Work*

¹²⁵. Philippe Lalitte, “The unique aesthetic character of the music of Roger Reynolds”; Madurell, “*The Angel of Death*: Timelessness of the pianistic gesture.”

¹²⁶. Lalitte & Madurell, “Retrospective reflections.”

¹²⁷. François Madurell, “Inner hearing and direct listening: The trying conditions of score reading,” in McAdams & Battier (Eds.), *Creation and Perception of a Contemporary Musical Work*.

¹²⁸. Lalitte, “Retrospective reflections.”

From the point of view of the composer, the central and essential question raised by the project is to know the degree to which the data derived from the listeners' experiences with his work can be generalized.¹²⁹ The creative process itself is so varied, its facets manifested so differently from one person to the next, that neither the compositional process nor its presumed goals can be considered to have a generalized logic. To imagine that an immediate and widespread generalization could be possible would be to seriously misunderstand the realities of the world of concerts of contemporary music on an international scale.

If the desire to generalize the details of procedure and of stylistic coherence is condemned by the diversity of current musical languages, that does not, however, mean that the experiments reported here are without value. Reynolds feels a certain urgency that a serious and extensive study be undertaken on the relation between the way composers construct their music (including what they presume to be heard by a well-intentioned listener) and the real experience of music that listeners report. It seems appropriate to him that a profound examination of one's presumptions about contemporary musical discourse starts with asking composers what are the materials, the sonic elements, that form the basis of their musical discourse. From a global perspective, the second big question seems to him to be the following: does the experiential envelope of the entire work produce the responses that the composer imagined in the listener? Also, the fundamental point for Reynolds is not to ask oneself whether what we have found with respect to the perception of *his* music is directly relevant to the work of *other* composers, but rather to underscore the fact that two essential steps have been taken:

- 1) the types of questions posed and the way in which they were posed have been formulated and put into practice;
- 2) an initial corpus of data has been assembled and can serve as a basis for further studies.

Reynolds admitted to having felt a great deal of anxiety when embarking on the project around *The Angel of Death*, that of submitting to an objective test the presumptions and beliefs that emerged through decades of dedication and experience. He notes the following reflections:

During the 20th century, a number of the most powerful conventions developed through the course of Western music history were, in effect, set aside by composers. And these set-aside conventionalities were not superseded by comparably powerful alternatives. So it would not be surprising if the following question arose in the minds of many composers: what tools am I actually working with, and why? I have thought of myself as a "searcher" after the new, but not for the sake of rejecting tradition, or of embracing that which is novel because of its lack of connectedness to the past. From my perspective, composers write their music out of a need to interact with, and bend the world of sonic experience to immediate aesthetic purposes. But they are aware, increasingly during the last half century, of the context within which they live: enormous opportunity without an accepted or compelling base of conventionality. So they proceed, necessarily, in the presence of tenuous convictions and flickering doubt. I have grappled with this circumstance by attempting to forge a matrix of constraints within which I can be relatively confident that my elected freedoms will result in a principled (and therefore potentially graspable) outcome. It is crucial for me that the force of attractive ideas not lead me into a domain of behavior that is unrealistically remote from the realities of human perception and cognition. Thus, I have become a lay reader about perception as it applies to music.¹³⁰

Most of Reynolds' music involves forms of a fairly large scale, musical structures that last 25 minutes or more, because he is interested in the way a listener's impressions evolve through listening. He wonders how the architecture of a work can change the listener, even to a small extent. Given this aesthetic and psychological goal, the musical form must be of considerable duration to reach its optimal impact, especially if its terms are not familiar and must be, at least to a certain degree, acquired during the musical experience itself. Reynolds strongly emphasizes the fact that the aim is not that the listeners "notice" a formal structure, but rather that they live through the form. In fact, it is this artistic goal of Reynolds in particular that led me to embark on this grand project on the temporal dynamics of listening which has lasted nearly 15 years. The interdisciplinary project thus opened new perspectives for the psychology of music.

In this direction, Madurell poses one of the most important questions raised by this project and which concerns the psychological nature of musical form.¹³¹ He advances the notion of a protoform that is constructed in the mind of the listener. This process of construction is all the more crucial for contemporary music, because composers must build their own forms in harmony with their aesthetic project rather than using conventional pre-established forms.

¹²⁹ Roger Reynolds, "Epilog: Reflections on psychological testing with *The Angel of Death*," *Music Perception*, vol. 22, no. 2, 2004, p. 351-356.

¹³⁰ Reynolds, "Epilog," p. 352.

¹³¹ Madurell, "Toward a dynamic conception of musical form."

Many composers and musicologists today observe with a certain interest mixed with mistrust the research conducted by psychologists on works drawn from the contemporary repertory. This persistent resistance to the psychological approach in some musicologists is founded their feeling that it is “reductive.” The question of form, more than any other, according to Madurell, is likely to provoke reticence, because the experimental approach could seriously shake the tradition of formal analysis, by revealing an object different from the spatial projections with which musicologists usually think about musical form. He observes that one can understand the reserve of composers to submit their works to experimental investigations to verify the reality of their intentions:

[A]t the best of times the concert premier of a new composition can be difficult, and it is clear that no composer wants the additional pressure that would stem from a composition being a research subject. Nevertheless, research will be a necessary step if any knowledge is to be gained about form as a time based real-life experience, and if the needed connections are to be established between analysis and perception. [...] Roger Reynolds took this courageous step when composing *The Angel of Death*. It is possible that this experiment will usher in a new era.¹³²

Madurell distinguishes the form conceived by the composer (as found in the traces he leaves) from the one that is crystallized in the score (arising from the analysis), the one that is actualized in the first rehearsals, and finally the one lived by the listeners at the concert. He insists on the fact that one shouldn't see in his term “protoform” any pejorative connotation and should only retain the sense of “first” and “in formation.” According to him, when a work is powerless to make a protoform emerge, a lack of interest quickly settles in:

In the strictest sense of the word, the composition remains “formless” for the listener, in spite of the composer's intentions. It is highly unlikely that the listener will want to hear it a second time, even though recordings make that easy. Temporarily, such a situation would be considered as a failure. As stated earlier, this is certainly not the case with *The Angel of Death*.¹³³

Madurell states that the integration of listening processes is a necessary condition for a dynamic conception of form that would require a multidimensional representation, a first attempt of which has been outlined above.

Reynolds recounts that when he examined the results of the perceptual ratings by experimental participants, he did not find the data difficult to understand:

[...] the level of ambiguity implied in their responses (To which textural norm is an element to be related?) and the nature of the confusions or indecision (Why is a particular subsection of one theme grouped with those of another rather than with its own?) regarding my thematic materials is easily understood. I can posit reasons for the reported profiles. While this was a ratifying result, it did not yet ensure that listeners would register the form of the whole in ways that would be equivalently satisfactory. Thus, I was interested to know the degree to which the subjects of the real-time, in-concert experiments would register the existence of formal divisions that I intended to be heard (McAdams, Vines, Viellard, Smith & Reynolds, this issue). A reassuring aspect of the curves plotted from these experiments is that the majority of their significant changes (of prominent breakpoints in listener response) coincide closely with moments in the performance at which intended formal divisions in the music occurred. So, in general, the data from the experiments to date suggest that my assumptions about how people hear are viable. Further, it does not seem that the level of listener sophistication is crucial to the standard of response. On the one hand, this is a welcome perspective, but, on the other, it suggests that studies on the effects of greater familiarity (with this particular piece, with my music or that of others with similar convictions) could be important to the larger significance of the Project, as shown for some aspects of thematic perception in Lalitte et al. (this issue).¹³⁴

During the colloquium *Forme et temps : la perception au fil de l'œuvre [Form and time: Perception throughout the work]*, organized around the world premier of *The Angel of Death* in Paris, the composer Philippe Manoury asked Reynolds an essential question: “What would you have done if the data showed that your presumptions did not correspond to the experimental results?” I will close this chapter with Reynolds' response:

I will continue to look closely at the new data that arise as the psychologists probe the meanings in what they have examined. There appears to me, for example, to be a suggestion that, while listeners distinguish effectively between the material types that I have created, they are not as successful in carrying these identities with them under transformation (cf. Poulin-Charronnat et al., this issue). I speculate that the trend, viewed from a larger perspective, will be that both my materials and their transformations and combinations are more difficult for listeners to process effectively than I wish. Perhaps, then, further exploration of several questions – even in relation to the musical material already in hand – would be useful. One

¹³² *Ibid.*

¹³³ *Ibid.*

¹³⁴ Reynolds, “Epilog,” p. 353-354. In this passage, Reynolds refers to Lalitte, Bigand, Poulin-Charronnat, McAdams, Delbé & D'Adamo, “The perceptual structure of thematic materials in *The Angel of Death*.”

would be whether some ways of characterizing musical materials are more effective than others (assuming that something like a “thematic” basis is required for the composer’s approach). That is to say: what are the most salient musical characteristics from both the perspectives of musically sophisticated and musically untrained listeners ? A second, allied question would address the sense and the degree to which “initial” materials can undergo transformation without losing their identity. Both of these issues are broached within the current set of studies, but it may be important to extend them.

Should I consider simplifying the terms of my musical discourse, and, if so, how would such simplification be accomplished ? What effect might such changes in behavior have upon the nature of my engagement with the process of composition ? There is an inescapable conundrum here. The historical-social fact is that we live in a time in which the composer’s premises, the issues that engage him or her, differ markedly from the experience and capacities of the majority of serious music-listeners. This is even true if one limits the audience to be considered to those with wide experience in contemporary music. (Compare, for example, the premises inferable from the music of Elliott Carter, Helmut Lachenmann, Tōru Takemitsu, Iannis Xenakis, Morton Feldman, and Luigi Nono.) At the same time, the materials, strategies, and, therefore, prospects open to composers are of unprecedented richness. The essential ethic of the creative process will not allow one to act in violation of one’s own aesthetic sensibility. (I presume that this is self-evident and does not require elaboration.) So one is poised between the (possible) lure of modifying one’s ways so as to allow them to be better registered and more fully responded to by contemporary listeners, on the one hand, and the intellectual and emotional attractions of challenging one’s own (and other’s) taste, experience, and capacities, on the other. I would prefer to face these questions armed with more than informal, and in all probability deeply biased, positions to guide me. It is to the sort of studies reported in this special issue that I (and other musicians who share my concerns) can turn for useful perspective.

[...] The Angel Project proposes the sorts of steps that might be made in order to improve the level of informed discussion as to the ways in which music can continue to evolve in an increasingly wealthy yet problematic landscape of potential.¹³⁵

¹³⁵. Reynolds, “Epilog,” p. 354-355.