MTO A JOURNAL OF THE SOCIETY FOR MUSIC THEORY

György Ligeti's Chamber Concerto in the Light of the Article ". . . how time passes . . ." by Karlheinz Stockhausen

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KEYWORDS: Ligeti, Stockhausen, Chamber Concerto, integral serialism, time in music

ABSTRACT: This study examines György Ligeti's Chamber Concerto for 13 instruments, written in 1969–70, in light of Karlheinz Stockhausen's 1957 article ". . . how time passes . . . " In this famous article, Stockhausen establishes relationships between the components of musical writing: durations, tempi, rhythms, pitches, and registers. He describes the solutions he imagines for composing time against the backdrop of integral serialism and the advent of electronic music. By comparing this article with Ligeti's score, one recognizes a realization of the concepts introduced by Stockhausen, such as "field-sizes," "duration-formants," use of proportions, and tempo/pitch "mediations." This study sheds light on Ligeti's choices regarding the establishment of metronomic and *senza tempo* strata, the serial treatment of tempi in the second movement, and the freedoms granted to the performers. This comparative approach puts into perspective existing analyses of the Chamber Concerto that focus primarily on the organization of pitches and the realization of textures.

DOI: 10.30535/mto.31.1.2

Received December 2023

Volume 31, Number 1, March 2025

Introduction

[0.1] Ligeti's Chamber Concerto for 13 Instruments was written during 1969–70 for the ensemble *die reihe* conducted by composer Friedrich Cerha. It was premiered on October 1, 1970, at the Berlin Festival. This piece is significant in Ligeti's repertoire in that it contains many of the aesthetic features of his style, including the micropolyphony developed in the late 1950s and early 1960s, and the pattern-meccanico style (Clendinning 1993). The work also evokes Ligeti's Hungarian period, through the use of melodic figures that emerge from the instrumental texture and the use of a chromatic language and formal sophistication reminiscent of Bartók. In this sense, the Chamber Concerto is a work of synthesis and a turning point in Ligeti's artistic life (Searby 1989). Like his Second String Quartet (1968), this piece uses techniques from the distant past such as the canon, and a form that recalls the Allegro/Andante/Scherzo/Allegro of the Classical-era Symphony

(Beffa 2016, 198),[1] while also reflecting Ligeti's more recent experience in the electronic music studios of WDR in Cologne, and the legacy of the Darmstadt school. In this article, I will investigate how the Chamber Concerto relates to this method of musical thought: to integral serialism, and early electronic music, through Stockhausen's famous article on musical time ". . . wie die Zeit vergeht . . ." (". . . how time passes . . ."). (Stockhausen 1957a). I will focus mainly on the rhythmic and temporal conception of the Chamber Concerto, and how the ideas conveyed in Stockhausen's article can shed light on Ligeti's compositional work.

[0.2] Among the numerous analyses of the Chamber Concerto is that of Pierre Michel, who highlights the canonical processes of the first movement (1985, 208–20). Michael Jarrell (2016) completed a study of pitches in all four movements. In addition, analyses by Jane Dawson (1986), Jane Piper Clendinning (1989), Marie Delcambre-Monpoël (1999), and Muriel Joubert (2001) reveal several significant organizational aspects (including pitch structures, use of melodies, formal principles using the golden ratio, and the Fibonacci sequence). These include charts and graphs providing an overview of each movement (Dawson 1986; Clendinning 1989, 137–166; Delcambre-Monpoël 1999, 113–118; Joubert 2001, 59–62). Additionally, Hans-Peter Kyburz (1990) demonstrates the preponderance of factor 11 in forming the number of measures in a corpus of pieces by Ligeti from the 1960s and early 1970s. Miguel Roig-Francolí (1995) describes the link between pitch organization and formal structures of the first movement. These analyses provide an understanding of the piece's pitch structures and major organizational principles, but do not offer an overview of the different temporal strata Ligeti has set up. Nor do they explain choices that at first glance seem peculiar, such as tempo changes, fermata durations, or certain freedoms granted to the instrumentalists. Finally, Ligeti himself presented on his own work on several occasions in interviews and for concert program notes. His highly visual presentations reveal some of his compositional devices, such as polyrhythm or polymeter, albeit without much detail.[2]

[0.3] In this study, I will relate the Chamber Concerto to Stockhausen's article ". . . how time passes . . . ," written in September/October 1956 and published the following year in the journal *die Reihe*. It is well known that the encounter with Karlheinz Stockhausen was decisive in Ligeti's personal and creative development. First, he was impressed by the electroacoustic piece *Gesang der Jünglinge*, which he heard on the radio in Budapest on November 7, 1956 (Gallot 2010, 42). Fleeing Hungary and the repression of the revolution by the Red Army, he went first to Vienna. He arrived in Cologne on February 1, 1957, taking advantage of a scholarship to study in the WDR electronic music studios (Kerékfy 2019, 103–14). He then stayed at Stockhausen's home in Cologne for six weeks. Stockhausen showed him several works in progress, most notably *Gruppen* for three orchestras and his pieces *Klavierstücke I–IV*. About this time, Ligeti would later write, "the explanation of [Stockhausen's] way of working was one of the strongest impulses in the field of composition" (1994, 17–18). Ligeti's arrival in Cologne coincided approximately with the publishing of the article ". . . how time passes . . . ." It is easy to imagine that the ideas expressed in the article figured prominently in their discussions.

[0.4] However, Ligeti was soon critical of the ideas related to integral serialism represented by the work of Boulez and Stockhausen. He criticized this method for its dogmatic nature, embodied in a "totalitarian" concern for unity.[3] His criticism was first expressed in his analysis of Part Ia of Pierre Boulez's *Structures* for two pianos, published in *die Reihe* (Ligeti 1958, 1960b). Ligeti concluded that the aridity of the work stems from an "ascetic and extreme" attitude (1960b, 62). This analysis was written in March and April 1957, shortly after he arrived in Cologne. In his retrospective note, Ligeti ([1994] 2001, 83–84) revealed that Stockhausen was an important intermediary in this work, having lent him a journal containing the series of pitches used by Boulez. Stockhausen also proofread the German grammar in drafts of Ligeti's article (Feldman et al. 1952, 167–74). Later, Ligeti's criticism of total serialism became even more explicit in his article on the evolution of musical form (1960a; 1964), echoing Iannis Xenakis (1955). His main argument is that the proliferation of serial scales tends to foster a globalizing and simplifying perception. In his 1971 "Interview with Myself," Ligeti returned to his ambiguous relationship with integral serialism and the composers interested in the practice, declaring that "unity remained fixed at the level of commentary, a verbal description of the composition" ([1971] 1983, 129). Finally, Ligeti's

detachment from the pointillist serial aesthetic is also expressed in his first instrumental compositions exploring the idea of continuum, such as *Apparitions* (1959) and *Atmosphères* (1961).

[0.5] The Chamber Concerto was composed more than ten years after Ligeti and Stockhausen first met. This was the composer's second collaboration with *die reihe*, an ensemble founded by Friedrich Cerha and Kurt Schwertsik in 1958 after they attended the Darmstädter Ferienkurse (Cerha 1999). Cerha first met Ligeti when the latter arrived in Vienna in 1956, but it was also in Darmstadt in 1958 that they consolidated their friendship with numerous discussions (Eisenschenk 2003; Ligeti 1987, 3–5). Their first collaboration was the creation of *Aventures* for voice and ensemble, premiered in 1962. The ensemble *die reihe*, which shares its name with the journal in which Stockhausen's article was published, was formed in the spirit of the Darmstadt school.(4) On the other hand, the journal *die Reihe* was highly influential among composers of the 1950s and 1960s and represented a showcase for research associated with integral serialism, information theory, and electronic music as conceived in the electronic music studios of Cologne (Grant 2001). As for *die reihe*, it focused on avant-garde composers such as Boulez, Pousseur, Nono, and Stockhausen, as well as the composers who inspired them, including Varèse, Schoenberg, Berg, and Webern (Cerha 1999, 6). The composition of the Chamber Concerto was established in the context of this common heritage.

1. How time passes

[1.1] Stockhausen's article ". . . how time passes . . ." (1959) is his most famous text, and the most discussed article published in *die Reihe* (Grant 2001, 135). Published in 1957, this visionary essay on musical time is a diary of the composer's thinking. The article lies at the crossroads between the physical sciences (especially quantum field theory), psychoacoustics, information theory,(5) integral serialism, and electronic music. The article was conceived as a response to the problems faced by serial composers in the mid-1950s, namely the increasing complexity of serial scales, which led to unpredictable results (Essl 1989). This text is closely related to the composition of several pieces by Stockhausen, including *Gruppen* (1957b), *Zeitmaße* (1956),(6) and *Klavierstücke XI* (1956). The article moves from the elementary concept of "phase" to the idea of "field," both considered as timespans.(7) Its starting point is a perceptual fact. A "phase," delimited by two points of an oscillating signal (the correct term would be a "period"), is perceived as duration when its ratio is less than or equal to 1/16th of a second (≤ 16 Hz) and as pitch when it is greater than 1/16th of a second (≥ 16 Hz). In this way, Stockhausen assimilates pitches to micro-phases of duration. He also notes how one can perceive a one-second duration to be different from a two-second duration, but it is difficult to differentiate an eleven-second duration from a twelve-second duration. Consequently, he states that we perceive primarily in terms of proportion since 1:2 is bigger than 11:12 (Stockhausen 1959, 11). In this sense, the main argument of the article is that proportions are the basis for the perception for pitches and durations. This observation prompts Stockhausen to unify musical components that observe the same ratio.(8)

[1.2] After its publication, the article was widely disseminated. The first published responses to the article consisted of isolating the concepts used in the article from their musical context and confronting them with definitions from physics and psychoacoustics. The physicists John Backus (1962) and Adriaan D. Fokker (1962) demonstrate the terminological inaccuracies, contradictions, errors, and liberties taken by Stockhausen. For example, the definition of phase introduced by the composer at the very beginning of the article departs significantly from the physical concept (Stockhausen 1959, 10; Backus 1962, 166–169; Fokker 1962, 62–72). The author uses the term "phase" to denote a timespan formed by the points of oscillation, whereas "phase" typically indicates the relative position of the sound signal to time. Similarly, the use of the terms "quantum" and "formant" are scientifically incorrect. Christopher Koenigsberg (1991) summarizes this controversy and details the article's contributions in relation to scientific concepts. It concludes that Stockhausen's text is that of a musician rather than a scientist. In addition, the historical approach developed by Etienne Darbellay (1988) and Laurenz Lütteken (1998) puts into perspective the use of ratios to justify the link between pitch and duration by invoking the thirteenth- and fifteenth-century composers Franco of Cologne and Franchino Gaffurio who used similar procedures.

[1.3] The second part of the article (Stockhausen 1959, 30–40) is of particular interest to this study, as Stockhausen introduces the concept of "field-sizes" (*Feldgröße*). In this concept inspired by quantum field theory and information theory, time is interpreted as a field whose measurement or size is not absolute. In this regard, Stockhausen draws inspiration from Henri Bergson's philosophy, which contrasts time experienced as quantity and time experienced as quality (Bergson [1889] 2013, 72–109). Similarly, Stockhausen distinguishes time that can be measured (*Zeitquantum*) and experienced time (*Zeitfeld*: time-field) (1959, 37). Thus, the term "time-field" refers to a fairly long timespan whose appraisal is mainly qualitative. Indeed, Stockhausen seems particularly interested in transposing concepts inherited from quantum field theory to music, as evidenced by his use of the terms "quantum," "field-size," and "degrees of freedom." Quantum field theory, which includes results from special relativity and quantum mechanics, revolutionized the perception of time in the first half of the twentieth century.(9) In this theoretical framework, time is seen as an adjustable parameter and not as an observable quantity, which implies that "each object has its own time" (Léon 2022, 162). Stockhausen draws inspiration from this concept when he imagines a "synchronization of simultaneous *proper times*," and a "serialization of successive proper times" (1959, 37). I will compare this idea to the second movement of Ligeti's Chamber Concerto, where a different tempo is assigned to each instrumentalist. The description of independent rhythmical and temporal strata proposed in Stockhausen's article—sometimes metronomic with different tempi, sometimes *senza tempo* (Stockhausen 1959, 32–34)—illustrate this "temporal pluralism" (Bachelard 1932, 23) leading to "temporal superimpositions" (Bachelard 2022, 141–62).

[1.4] Ligeti twice referred to ". . . how time passes . . ." in his writings. The first citation is in his article on the evolution of musical form, where he summarizes the main contributions: the "punctual" and "statistical field" opposition, the superimposition of heterogeneous structures or "layered composition," the simultaneity of different meters, the freedom given to performers, and the use of proportions (1960a). In 1971, Ligeti returned to Stockhausen's article in his "Interview with Myself." Here Ligeti addresses important questions about perception, arguing as follows:

> Unlike Stockhausen, however, I felt that even when pitches on the one hand and duration values on the other were governed by the same quantitative regulation—a logarithmic progression, say—the analogy between the two series existed only on the level of verbal description. There was no musically effective analogy, since our nervous system reacts to ratios of pitches and of durations in fundamentally different ways, and the two fields, which certainly do belong to a shared context physically, bear no contextual correspondence psychologically, in the data of our perception. . . . When I hear a fifth, however, I feel a certain acoustical quality, my sensory perceptions convey no impression of speed, and the ratio of 3:2 (the physical definition of a fifth) plays no part in my understanding. Meanwhile I am accepting without question simple duration ratios as recognizable quantitative elements within a speed range accessible to my perceptions. A simultaneous combination of triplet and duplet, for example, appears directly to my understanding as a time factor of 3:2, without the help of a measuring apparatus. By contrast, it is hardly necessary to point out that those physical speeds which are perceived by my ears in the form of pitches lie (as far as my nervous system is concerned) not in the physical realm of speed, but in an area of the mind in which perceptions are qualitative, not quantitative. (Ligeti [1971] 1983, 129–30)

[1.5] In this section, I have highlighted the rich and ambiguous relationship between Ligeti and Stockhausen, and the promising context for associating the article ". . . how time passes . . ." with the Chamber Concerto. In the following sections, I examine the extent to which Stockhausen's descriptions can be applied to Ligeti's music. I thus relate Stockhausen's quotations to Ligeti's compositional choices. In this comparative study, I focus first on the notion of field-size presented in the second part of Stockhausen's article. Then, I describe in more detail ideas from the first part of the text that relate to the Chamber Concerto, such as the use of proportions, the construction of duration-formants, and tempo/pitch relationships.

2. *"Field-sizes"*

[2.1] To justify the concept of "field-size" (*Feldgröße*), Stockhausen demonstrates that the more complex the musical notation, the more inaccurate the interpretation at the temporal level. Using rhythmic examples of varying complexity, he shows that inaccuracies create timespans that, when repeated, lead to greater or lesser fields of variation. Thus, Stockhausen argues that "the factors of dubiety depend progressively on the method of notation" (1959, 30). One recognizes here the inspiration of the principle of uncertainty or indeterminacy in quantum mechanics described by the physicist Werner Heisenberg (1927). This principle states that "it is impossible to know both the position and the velocity of an object" (Léon 2022, 155); the more known its position, the less is known about its velocity, and vice versa. Stockhausen seems to have adapted this idea to the pair of complexity of musical writing and precision of musical interpretation.(10) In quantum physics, the continuity between time and space that we observe in our tangible world is no longer respected. In Euclidean space, the motion of an object is necessarily continuous, whereas on the quantum scale, an object can jump from one state to another. An object is thus no longer described by absolute characteristics such as speed, position in space, etc., but by the probabilities that it can be in certain states (Tong 2015, 2). Stockhausen has apparently applied these principles to the parametric description of a musical event inherited from post-serial techniques (pitch, duration, rhythm, tempo, proportion, etc.). If musical events obeyed the laws of quantum physics, they would no longer be characterized by absolute parameters but rather by the probabilities that they would be found with certain characteristics. Thus, for each parameter of a musical event, Stockhausen considers a field (field-harmony, field-intensity, time-field, field of modes of attack, or field-proportions, etc.). The degree of variation of these fields would constitute "field-sizes." A "field" could thus be defined as the set of probabilities that a parameter will be found with certain characteristics. In Stockhausen's text, a field-size is defined by the temporal dispersion between the absolute time of the score and the relative time of the interpretation. A field-size is mainly introduced as the result of interactions between temporal strata according to certain proportions. The notion of field-size could then be defined as the degree to which events of a time-span deviate from perceptible numeric ratios, where the word "size" would refer to some method of measuring the degree of "scatter," which could then be potentially serialized.(11) The term field-size would therefore apply to the interactions between strata and not to the strata themselves.

[2.2] Stockhausen's musical descriptions of the concept of field-size are of particular interest to this study, as they are echoed in Ligeti's Chamber Concerto. In the following quotation, Stockhausen focuses on the grace note, which, played "as fast as possible" and grouped as a stratum, has variable duration:

> There was the small note, for one, written independently of the other measured-time values—the 'grace note'. If its tempo was "as fast as possible," and if it were not only single but came in groups of various sizes, either before, over or after a measured time-duration, then these groups of grace notes would take over the functions of a second time-stratum "fading in" to the measured durations. (1959, 34)

Here, Stockhausen also emphasizes the interaction between a musical stratum comprised of grace notes and another stratum based on measured durations. In the Chamber Concerto, if one equates passages composed according to a metronomic indication and passages composed of groups of grace notes to independent strata, one could observe movements I and IV as writing in the form of two strata, sometimes successive, sometimes simultaneous.(12) In the Chamber Concerto, Ligeti describes these grace note passages as cadenzas, marking them *senza tempo* and indicating that they should be played as quickly as possible, independently of the other instruments; only the initial attack is metrically determined (Chamber Concerto, Mvt. I, m. 19). In movement I, the first appearance of a *senza tempo* stratum is at rehearsal mark E, with groups of grace notes played first by the piano and celesta, and then by the violins. This stratum emerges from the metronomic stratum at rehearsal mark D and settles beneath another metronomic stratum at letter F. Aurally, strata made up of groups of grace notes are easily confused with metronomic strata, as the latter are often composed of rhythmic superimpositions that blur the sensation of pulsations, as in the beginning of movement I. Metronomic strata can also include groups of very fast measured notes quite similar to the realization of grace note groups, as at the beginning of the fourth movement. **Examples 1** and **2** show the two strata on a time axis for movements I and IV. The metronomic

stratum (black arrows) is made up of all the durations where the conductor beats time. Furthermore, the *senza tempo* stratum is composed of groups of grace notes (gray arrows), and passages with fermatas of either held sounds or silences (dotted arrows). In both movements, the two strata alternate, and the metronomic stratum comprises greater total duration than the *senza tempo* stratum. The temporal indeterminacy of the "field-sizes" in Stockhausen's text seems to be achieved through approximate durations for *senza tempo* passages, e.g., "ca. $3^{1/2}$ " at letter E of movement I, but also by bracketing the rests that complete the measures when a group of grace notes ends on a metronomic stratum (**Example 3**).

[2.3] In the following quotation, Stockhausen considers another way of obscuring the metronomic perception of time. He proposes superimposing several strata with different constant tempi. This passage refers specifically to *Gruppen* (1957b):

> When discussing the development of the time-spectrum in the sphere of serial fundamental durations, we have already met the problem of what would happen when several groups of instruments—if possible, separated in space—played simultaneously in different constant tempi. Here there is obviously a relation between the durations of the *tempo-strata* and the definition of the field-proportions: the longer two orchestras play in different tempi, the more probable it is that the time-strata will get out of step, be displaced. Even apart from the fact that such displacements require a corresponding control of field-harmony, field-intensity, field-density, etc., the method of time-composition must aim at regulating such *field-times*. Clearly, the flow of time can no longer be imagined as "quantified"; displacement can come about gradually and continuously within particular time-fields, and the associated field-sizes can not be thought of as a sort of discrete succession (the time-alterations "flow," as it were, continuously past an "acoustical window," like a motion-picture). (1959, 31, emphasis original)

Stockhausen describes a blurred perception of time resulting from a phase shift between strata. However, Stockhausen seems more interested in the temporal dispersions created by the interaction between strata than in the strict shift caused by different tempi. For Stockhausen, these temporal dispersions are a way of constituting a continuous perception of time.(13) When considered alongside the Chamber Concerto, this quotation recalls the polytempi of movement II (letters C to P); see **Example 4**. Here, Ligeti creates a kind of reservoir within which eight instruments of the ensemble (all except the strings) are successively assigned a different tempo at each measure.(14) From letter C onwards, Ligeti asks the conductor to give a tempo of ♩= 92 to the clarinet, while the other instruments continue at the previous tempo (Chamber Concerto, 34). The conductor then gives the bass clarinet a tempo of ♩= 84, while the clarinet continues with a tempo of 92, and so on. The *senza tempo* passages at letters L and N, each lasting around 13 to 15 seconds, form acoustic windows in which each of the instrumentalists must keep their tempo without "being influenced by the other players" (Chamber Concerto, 38–42).

[2.4] Stockhausen further proposes that fields can be characterized by the manner in which their individual rhythmic layers vary their tempi independently.

> Now, if the single time-quanta of the formants are no longer in a constant relation to each other, but speed up or slow down, moreover in various degrees, then the formant-rhythm becomes more or less diffuse. Different field-sizes result, according to the number of *variable tempi in the formants*, and according to the degree of their alterations, in which the original harmonic phase-relationships can no longer be traced back to a scale of discrete time-quanta. For example: a first duration-formant has a constant tempo, a second is "as fast as possible," a third speeds up and a fourth slows down, and all are to be played simultaneously; and only the fundamental duration of such a time-spectrum is exactly measured as a single value. (1959, 32, emphasis original)

The notion of "time-quanta" refers here to measurable durations associated with formants derived from the division of a fundamental duration.(15) By translating the idea of a harmonic spectrum from the frequency domain into the time domain, Stockhausen creates a harmonic spectrum of durations (1959, 17). A "formant," in Stockhausen's usage, is a harmonic division of a fundamental

duration.[16] If a whole note is taken as the fundamental duration, the "formants" will be two half notes, a triplet of half notes, four quarter notes, etc. (**Example 5**). Applying the idea of "formants" to the macrostructure of a piece, he is interested in the relationships that strata have with each other. As before, Stockhausen proposes here to superimpose strata with different temporal profiles to blur metronomic perception. He focuses on the temporal dispersions resulting from interactions between strata.

[2.5] This last quotation from the article resonates with the passage from rehearsal marks I to N in the third movement of the Chamber Concerto. In this movement, Ligeti establishes several *pattern-meccanico* strata (Clendinning 1993), in which the type of attack and pitch remain constant, but the rhythms are shifted.[17] A first stratum corresponds to a fixed metronome at ♩= 60 (Letter I). A second begins with the tempo ♩= 80 (letter J) while some players (horn, trombone, piano and double bass) are asked to remain at ♩= 60. This new stratum slows down to form a new layer at 60 (letter L) while some instrumentalists are asked to remain ♩= 80 (piccolo, clarinet 2). Then, in the same way, a new layer is formed and decelerates to ♩= 40 (letter M). These strata constitute three different metronomic layers (**Example 6**). Added to this is the *senza tempo* stratum composed of "repeated notes, medium-fast, staccatissimo leggiero" (Chamber Concerto, 67). If this last stratum is equated to the "as fast as possible" stratum mentioned in ". . . how time passes . . ." one only lacks an accelerating stratum to fully satisfy Stockhausen's description.

[2.6] In the second part of his essay, Stockhausen describes another type of "field-size," focusing on performers' actions. Here again, Stockhausen transposes concepts from quantum physics to the musical domain.[18] In quantum physics, the moment at which phenomena occur cannot be reliably predicted, whereas the quantity of action involved is deterministically predictable (Léon 2022, 313). A consequence of this idea on the psychology of individual actions is expressed by the philosopher Gaston Bachelard. Bachelard is interested, for example, in the significance of physical and mental hesitations (or "reverse impulses"), which he says "accidentalize time; they break the continuity of temporal evolution" (Bachelard 2022, 118). This idea resembles Stockhausen's interest in the actions of performers as creators of temporalities that evade measurement. He describes, for example, the time it takes performers to prepare themselves to execute a musical action, depending on the nature of the attack requested (1959, 34–35). He also comments on the groups of grace notes, whose execution time depends on their interpretation (34), and of durations determined by the respiratory capacities of wind instrumentalists (35). Here, Stockhausen conceives physical and physiological capacities of the performers as "degrees of freedom" (37–38). In his 1978 interview with Peter Várnai, Ligeti also addresses the concept of freedom. He declares, about the Chamber Concerto that "the difference between exact notation and such freedom of interpretation is minimal" (Várnai et al. 1983, 62–63). In the Chamber Concerto, Ligeti systematically carries out the descriptions in Stockhausen's article around these "degrees of freedom." Thus, one finds grace notes *senza tempo*, to be played as quickly as possible (Mvt. I, III and IV); assigning a different tempo to each instrumentalist (Mvt. II, III); durations based on the instrumentalists' execution times (the piano cadenza at m. 30 in Mvt. IV); and passages in which wind instrumentalists are asked to sustain as long as their respiratory capacity permits (Mvt. I and II, oboe at m. 53 in Mvt. IV).

[2.7] Stockhausen is also interested in the "field-sizes" associated with silences. He mentions that "the field-size of a rest would result from the fact that it is in the nature of a struck note to stop sounding, while the preparation of the next sound takes more time. Such preparation can be either mental (where the musical notation is more or less esoteric), or practical (as when movements are necessary in the course of the various preparations of resonating bodies, mechanical 'registrations,' etc.)" (1959, 34). Here, Stockhausen considers the silence that comes at the end of a sound's resonance, and that of the performer's mental and physical preparation for the next sound. The "field-sizes" related to silence are therefore linked to room reverberation and the performer's preparation time. In the Chamber Concerto, Ligeti seems to stage these passages of silence: by asking the conductor to continue beating time between the third and fourth movements (11 beats at ♩= 40), Ligeti shifts the audience's attention to the conductor's gestures, and at the same time prepares them for what is to come. We could then link this passage to a metronomic stratum as defined by Stockhausen, in the sense that the conductor articulates time with his gestures. On the

other hand, the long final silence of the fourth movement is consistent with one that typically accompanies the end of a piece. However, this silence, noted *senza tempo* ca. 15 seconds, seems excessively long for a piece lasting around 20 minutes.

3. Proportions in the formal structure

[3.1] The previous sections showed that passages from the Chamber Concerto could correspond to realizations containing different field-size relationships associated with interactions between a metronomic stratum and a grace note stratum, between strata with different constant tempi, or with different temporal profiles, instrumentalist capabilities, or silences. In the following section, I distinguish between those parts of the Chamber Concerto that are metronomically determined (metronomic strata) and those that describe the temporal dispersions associated with the concept of field-size (*senza tempo* strata). If the main argument of Stockhausen's essay—in which the different time intervals are related to proportions—is observed, one needs to ask whether these strata are established according to particular ratios. Moreover, Stockhausen is particularly interested in the mutual relationship between strata: "a scale of field-sizes is regulated, not by the absolute sizes of the time-fields, but by the proportions of one time-field to another" (1959, 31). In the Chamber Concerto, Ligeti is cautious to respect the proportions between measured and *senza tempo* passages in movement IV, as he writes in the footnote of the first page: "if a tempo faster than ♩= 80 is taken at the beginning, the later tempos (changes of metronome marking) must be correspondingly faster, so that the tempo proportions remain the same. This also applies to the *senza tempo* passages, whose durations are measured in seconds; these passages will be shorter in proportion" (Chamber Concerto, 87).

[3.2] To determine the relationship between the strata, I have counted the absolute durations of each stratum, even though this seems to contradict Stockhausen's idea of unquantifiable time. Two strata were considered: the metronomic stratum, in which sound events are organized within a quantified time frame, and the *senza tempo* stratum. In the metronomic stratum, I count the moments when the conductor beats time, including empty measures such as at the end of the third movement, with one exception: the polytempi section of the second movement (rehearsal letters C–P) is considered as part of the *senza tempo* stratum. For the *senza tempo* stratum, I consider: the passages with grace notes,[(19)] held notes or rests with fermatas and an approximate time indication (e.g. rehearsal E, Mvt. I); the passage in mm. 39–41 of the first movement where the instrumentalists must hold the note according to their breathing capacity; the passage composed of multiple tempi in the second movement (letters C–P); and the ones composed of repeated notes in the third movement (letters C–G).[(20)] A few of the techniques used in my calculations are worth mentioning. I used a mean value when a duration indication lies between two values. Additionally, I calculated the *rallentando* passages according to a tempo equivalent to the average of the start and finish tempo. Finally, I have selected an average duration from several recordings for the slow passages and fermatas at the end of movements and passages where the duration depends on the instrumentalist (mm. 30 and 53, Mvt. IV) (Boulez 1983a, Wurtz 2013, Ceccherini 2015).

[3.3] **Example 7** shows the durations measured in seconds for each of the metronomic (M.) and *senza tempo* (s.t.) strata for each page of the score. Looking at the relationship between the two strata, a ratio of around 2:1 can be observed for the third and fourth movements (193/97.9 for Mvt. III and 155.7/78.5 for Mvt. IV).[(21)] The second movement ratio is approximately 1:1 (162.6/158.9), if one considers the tempo succession part as a *senza tempo* stratum. Finally, for the first movement, the ratio between the two strata corresponds approximately to the golden ratio (220.6/136.9 = 1.611). The duration of silent passages is also significant. If the moment of silence at the end of movement III had been part of the *senza tempo* stratum, one would not have obtained the 2:1 ratio. The opposite is true of the fifteen seconds of *senza tempo* silence at the end of movement IV.

[3.4] At this stage, several questions remain. Although certain proportions have been recognized in the formal structure, such as the 2:1 ratio, the use of the golden ratio,[(22)] and the Fibonacci sequence,[(23)] Ligeti never demonstrates perfect rigor in their use. It is known, however, that Ligeti had previously employed the Fibonacci sequence to construct the formal plan of the piece *Apparitions* (1959).[(24)] Several hypotheses follow from this regarding the formal structure of the

Chamber Concerto: Ligeti may have used these structures unconsciously, worked from a pre-established plan to which he roughly adheres, or added a degree of inaccuracy.[25] It is also interesting to note that the time indications at the end of each movement are overestimated, whether one takes into account the duration based on the table at Example 7 or the durations of most recordings.

4. Duration-formants

[4.1] In his article, Stockhausen describes "formant" structures as blocks that can be filtered in the manner of a harmonic spectrum in the pitch domain (1959, 27–29). This way, Stockhausen builds up different families of formant spectra by "omitting durations or *tying* them" (29, emphasis original). At the end, he creates rhythmic aggregates that he likens to "time noises" (*Zeitgeräusche*). The process described by Stockhausen is similar to that applied by Ligeti from E to H and from I to N in movement III. Indeed, each instrument seems to play a formant based on the harmonic division of one second as a fundamental duration, with varying degrees of omission or ligature to create polyrhythms. For example, from mm. 32–34, each string instrument plays a particular formant. The double bass plays Stockhausen's formant 3 regularly, then the cello plays formant 4 (some notes of which are tied), creating a stream of eighth notes shifted by a sixteenth note. Violin 2 plays formant 5 regularly while the viola plays formant 6, some notes of which are tied and some omitted, and finally the violin 1 plays formant 7, the notes of which are tied in pairs (**Example 8**). This same kind of process can be found at letter I, but with some rhythmic strata that slow down (from K to M). Furthermore, tempo changes enable Ligeti to make the texture more complex by applying simple ratios between layers, where "one can change the unit by changing tempo" (Boulez 1963, 56). Indeed, one could consider that the layer with ♩= 80 goes 3:2 faster than the layer with ♩= 60, so an eighth note at ♩= 80 would become a triplet for the layer at 60. These proportional tempo changes further link this passage to the quotation just presented, since Stockhausen uses the example of formant structures to justify changes in tempo and speed of the strata. For example, the rhythmic structures at the beginning of the movement I (mm. 1–19) can be interpreted as a superimposition of three or more duration-formants of the fundamental duration of one second with durations sometimes omitted or tied together. In another way, the superimposition of rhythmic structures, such as duration-formants, is explored throughout the Chamber Concerto to generate a harmonic blur, approaching the idea of *Bewegungsfarbe* (sound color in motion), as described by Ligeti (1981, 297–324).

5. Tempo-pitch relationships

[5.1] Let us compare the pitch/tempo relationship in ". . . how time passes . . ." with the layering of individual tempi of the second movement (from C to K) of the Chamber Concerto. In the first half of the article, Stockhausen mediates pitches and tempi by applying a duodecimal logarithmic scale between tempi 𝅝 = 60 and 𝅝 = 120 and taking as references A4 (440 Hz) and the tempo 𝅝 = 60. He then assigns the notes of the chromatic scale to different tempi (1959, 20–21). He obtains the following pairs (note/metronomic indication): A4/60, A♯4/63.6, B4/67.4, C4/71.4, C♯4/75.6, D4/80.1, D♯4/84.1, E4/89.9, F4/95.2, F♯4/100.9, G4/106.9, and G♯4/113.3.[26] Conversely, by applying this principle to the tempi chosen by Ligeti in the second movement, one finds approximately the same range of pitches presented harmonically at the beginning of the movement. Let us take the tempo ♩ = 92 introduced in letter C of the second movement and apply a cross-multiplication, knowing that a tempo of 60 corresponds to A4. For the tempo ♩= 92, the resulting frequency is (92x440)/60 = 674.67, which corresponds to the note E4 + 1/4 tone. The table in **Example 9** lists the eight tempi for each instrument, from letters C to K, with their corresponding frequencies and pitches (with eighth-tone accuracy), the time signatures, the number of beats, and the duration of each intervention.

[5.2] If I now compare the row calculated from tempo/pitch "mediations" (**Example 10a**) with the pitches contained in the chord at the beginning of the movement (sorted in the same order) (**Example 10b** and **Example 11**), one recognizes the main pitches with an eighth-tone accuracy,

except for E+1/4 instead of E and B−1/8 instead of A♯. These discrepancies could be explained by the fact that Ligeti applies another system, which consists in forming regular intervals of tempo units. Joubert (2001, 77) observes a distance of eight tempo units (92-84-76) between the letters C and E, twenty units between the letters F and H (100-80-60), and six units between the letters J and K (54-60-66). This can also be explained by the conductor's need to sufficiently differentiate the tempi (especially between 60 and 63.5 if the system introduced in Stockhausen's article is employed).(27) It is interesting to point out that the use of a decimal number to indicate tempo was commented on ironically by Ligeti.(28)

6. Discussion on perception

[6.1] This final comparison between Stockhausen's text and Ligeti's work raises the obvious question regarding whether notated elements, such as the tempo/pitch relationships, the constitution of strata, and the relationships between strata, can be perceived. For example, the *senza tempo* strata are relatively easy to identify on the score, owing to fermatas or groups of grace notes, but often impossible to identify when listening. The fact that the strata overlap, that they are sometimes composed of similar textures (for example in mm. 9–10 in movement IV, where the rhythmic parts of the oboe and clarinets merge with the *senza tempo* part played by the flute, piano, and violins), and that they are fragmented or composed of silence makes their perception particularly difficult. Furthermore, several phenomena can alter our perception of durations, such as timbre (McAdams 2019) or the emotions that music evokes (Droit-Volet et al. 2013).

[6.2] Movement III seems like a good case study for the analysis of perception, since it is primarily made up of successive distinct passages. Throughout this movement, Ligeti seems to pursue a common goal: to "erase any sense of pulsation" (Toop 1990, 82). The changes in orchestral textures in letters C, J and N, as well as the entry of contrasting playing modes—for example, such as in letters E, F and I with the pizzicato (letter E) followed by the Bartók pizz. of the double bass (letter F), or the staccato notes in the extreme low register of the trombone and horn with the pizz. (letter I)—are important perceptual markers (formal boundaries). There are contrasting elements between, on the one hand, parts with accents or *sforzandi* (as at the beginning of the movement and at the letter N, or the polyrhythms at the letters E and I), and on the other hand, the repeated note parts *staccatissimo leggiero* at letters C and H, which can constitute two distinct strata for the listener. However, at the perceptual level, the textures written between *senza tempo* and metronomic strata are sometimes very similar, as at letter G, where the repeated notes on the keyboards can be interpreted as a *senza tempo* stratum. Overall, the writing of proportions and durations in movement III is based on perceptual principles, such as the addition of contrasting elements that renew listening, or durations that create a sense of expectation, as in the section beginning at J, where the material gradually dissolves. In this part, the expectation is resolved by a return to a passage with accents at N.

[6.3] Inspiration from Stockhausen's text and experience of earlier works may have helped Ligeti to develop temporal structures based on perception. Assuming that Ligeti made conscious use of Stockhausen's ideas, what were his intentions? Was he primarily concerned with unity in the sense of integral serialism (which he seems to reject in his writings), or was he more interested in formal balance? In this sense, it seems that Ligeti uses both theoretical elements, the perception of which does not seem to be an objective in itself, and techniques based on perceptual phenomena. It is interesting to compare these observations on temporal structure with the pitch structures used in the Chamber Concerto, such as canonical procedures where the canons are not directly perceptible.

7. Other correspondences

[7.1] Other descriptions in ". . . how time passes . . ." resonate with the Chamber Concerto and, more generally, with Ligeti's works of the late 1950s and 1960s. For example, when Stockhausen discusses polyrhythmic voice composition and the superimposition of series, he comments: "It is also possible, in the process, to take the parts so far from their original function as 'voices'—i.e., their 'register' [*Lage*]—that they become merely inextricable threads in a network, and this network

must be audible only as such, and not as a superposition of parts" (1959, 15). This description resembles Ligeti's definition of micropolyphony: "a (orchestral) texture or voice of such complexity that the individual voices are impossible to hear, producing a constant transformation of the general timbre" (Ligeti 2002, 263), which he illustrates with numerous visual associations, such as the colored threads of a textile, of which only the resulting hue can be perceived, or modeling clay mixed together (Ligeti 1973, 20), or the superimposition of photos whose result is no longer identical to the individual pictures (Eichel, 25:00–30:00). Ligeti describes the Chamber Concerto as "the surface of a stretch of water, where everything takes place below the surface" (Várnai et al. 1983, 64). These descriptions refer especially to the instrumental lines at the beginning of the first movement and the poly-tempi part of the second movement.

Conclusion

[8.1] By comparing ". . . how time passes . . ." with the Chamber Concerto, it appears that Stockhausen's legacy in Ligeti's music was significantly more important than Ligeti admitted in his interviews. When Ligeti recalled his stay in Cologne, he referred mainly to the teachings of Gottfried Michael Koenig and little to those of Stockhausen. However, Ligeti considered the latter to be the "teachers of his second period of apprenticeship" (Ligeti 1994, 19). There were obvious reasons for him not to be too closely associated with Stockhausen, so as to develop his own identity as a composer. This way, such a high level of inspiration from ". . . how time passes . . ." in the Chamber Concerto could be a hidden homage to Stockhausen or at least a nod to his friend Friedrich Cerha, who conducted the piece and shared the same background as the Darmstadt school. Moreover, Ligeti has always shown an independent spirit. This is reflected, for example, in the way he negatively defines himself with "I am not" rather than "I am."[(29)] In "György Ligeti and the Rhetoric of Autonomy," Charles Wilson (2004) shows how paradoxical this approach can be, and how the assertion of independence ultimately contains so many hidden affiliations. This may be one reason why Ligeti delivered his most severe criticism of ". . . how time passes . . ." just after the premiere of the Chamber Concerto in 1971; it is analogous to how he was critical of postmodernism when his style most clearly followed its path (Ligeti 1983b). Finally, Ligeti may have hesitated to credit Stockhausen's influence given his awareness of how Stockhausen's thought was shaped by unacknowledged collaborators in the WDR studio (Iverson 2017; Cline 2019).

[8.2] Several obstacles stand in the way of confirming the hypothesis that Ligeti drew inspiration from Stockhausen's text to compose his Chamber Concerto. First, Stockhausen's text, by virtue of its universalism and effort at unification, refers to many domains and establishes relationships that are sometimes far-fetched.[(30)] The numerous approximations and contradictions make the author's intentions particularly opaque (Koenigsberg 1991). Moreover, Ligeti's score never exactly matches Stockhausen's text. Comparing two different media, a text on the one hand and a score on the other, leaves room for interpretation. There is, of course, a methodological risk when taking Stockhausen's analogies at face value. The further away in time we are from the subject of study, the greater this risk seems to be. Additionally, the scientific contributions were accessible to both composers and could be interpreted in many ways.

[8.3] Finally, comparing other pieces by Ligeti and other texts by Stockhausen helps us understand the unique relationship between these two works. Ligeti's inspiration from Stockhausen's text seems to have reached its peak with the Chamber Concerto. Neither in the Cello Concerto (1966) nor in the Second String Quartet (1968) are there so many resonances between Stockhausen's essay and Ligeti's music. From the late 1970s onwards, Ligeti would be drawn to a musical syncretism freed from the influence of the Darmstadt avant-garde (Searby 1997, 9–14). One might also wonder whether other Stockhausen texts may have inspired Ligeti. Insofar as Ligeti turned away from electroacoustic and spatialized music in the 1960s, it is difficult to find any correspondences between Ligeti's music and Stockhausen's texts that immediately followed ". . . how time passes . . . ," such as "Elektronische und Instrumentale Musik" (Electronic and Instrumental Music) (1958a, 1961a) or "Musik im Raum" (Music in Space) (1958b, 1961b). On this matter of space, Carmen Pardo (1998) shows a fundamental difference between Ligeti, who creates the sensation of space, and Stockhausen, who spatializes sound sources with loudspeakers. However, a later text on

musical time, "Momentform,"[(31)] may have inspired Ligeti (Stockhausen 1963). Indeed, in this text, Stockhausen refers to works "in which no precise perspective of development can be predicted; they have always already begun and can continue in this way without limit" (1963, 195), which echoes Ligeti's commentary on his *Requiem*, where he refers to music that "has already sounded since time immemorial and will continue to sound" (Follin 1993, 21'). In the same vein, in "*Momentform*," Stockhausen imagines "forms in which concentration on the now . . . makes vertical incisions that pierce a horizontal representation of time" (1963, 195). Such an image could depict the octave chord (m. 38) that divides the first movement of the Chamber Concerto into two halves. [(32)]

[8.4] This study shows a close link between the theoretical and musical descriptions contained in Stockhausen's article ". . . how time passes . . ." and the formal and rhythmic construction of Ligeti's Chamber Concerto. One recognizes in the score some realizations of the musical descriptions by Stockhausen illustrating the concept of "field-sizes," like the interactions between metronomic and *senza tempo* strata, the superimposition of strata with different tempi, the superimposition of strata with different temporal profiles, the staging of silences, and the attention to the action of the performers. In addition, I identified several realizations related to the first part of Stockhausen's text, such as duration-formants, tempi/pitch translations, and proportional writing between strata of durations. To deepen this analysis, it would be interesting to explore the stylistic differences between Stockhausen and Ligeti in more detail by comparing Stockhausen's works such as *Zeitmaße* or *Gruppen* with Ligeti's Chamber Concerto.

[8.5] The relationship between Ligeti and Stockhausen encapsulates two opposing attitudes, like two irreconcilable yet complementary poles, summed up by the postmodernism/modernism pairing.[(33)] Stockhausen embodies radical thinking, where music is constructed according to abstract rules, and Ligeti nuanced thinking, where the primary aim is the shaping of sound (Bauer 2001, 64). But the details are more complex. In ". . . how time passes . . . ," Stockhausen shows great concern for sound rendering, perception, and performance conditions, while in the Chamber Concerto, Ligeti rigorously uses abstract constructions, including in his pitch structures and formal plans. Overall, Ligeti's use of models (plans, structures, ratios, etc.) must be understood as a kind of interpersonal relationship in which the model represents a mirror of the composer's thoughts. [(34)] This is fundamentally different from Stockhausen's use of models, which has more to do with imitating the laws of nature (Kohl 2017, 6–7).

[8.6] When Ligeti travelled to Cologne, he wished to free himself from the influence of Bartók and Schoenberg. To this end, he sought a language that could enable him to realize his musical visions. His encounter with Stockhausen and the techniques of electronic music taught by Gottfried Michael Koenig served as a catalyst. In this sense, the text ". . . how time passes . . ." seems to have left an indelible imprint on Ligeti's imagination, and its influence seems to crystallize more than ten years later in the music of the Chamber Concerto.[(35)]

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Footnotes

1. Additionally, György Kurtág refers to a "new type of scherzo" for the third movement of the Chamber Concerto (Gallot 2010, 6).
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2. Among Ligeti's presentations on the Chamber Concerto are the program text for the 1989 Wien Festival (Ligeti 1989), the documentary *György Ligeti: ein musikalisches Porträt* (1980, 25:00) directed by Manfred Eichel, and his interview with Péter Várnai (1983, 64).
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3. Having lived through two dictatorships in his youth, Ligeti had reason to distance himself from any rigorous ideology (Wilson 2004, 9).
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4. The journal *die Reihe*, totaling eight issues in the German edition, was founded by Herbert Eimert and Karlheinz Stockhausen in 1952 and published by Universal Edition.
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5. The physicist Werner Meyer-Eppler played a crucial role in Stockhausen's scientific training and his interest in information theory. Stockhausen attended Meyer-Eppler's communication seminars in Bonn from 1954 to 1956 (Kohl 2017, 3).
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6. In his analysis of Stockhausen's *Zeitmaße*, Jerome Kohl reports that the influence of this piece is particularly evident in Ligeti's Chamber Concerto, "where in all four movements we find simultaneous layers, either free or strict, as well as different metronomic tempi, and segments to be played 'as long as possible,' determined by the breath of the wind instruments, in the first and last movements" (Kohl 2017, 140).
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7. Karlheinz Essl (1989, 1) points out that "serial music resides in the mediation between the extremely small, the acoustic properties of sound, and the extremely large, the overall form of the composition."
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8. Imke Misch (1998) reveals the "groups" used in Stockhausen's *Gruppen*, which are each composed of a pitch, a proportion, a tempo and a duration.

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9. In the first of his British Lectures, Stockhausen cites Albert Einstein, founder of the theory of relativity, and Werner Heisenberg, one of the founders of quantum mechanics, as influences (Stockhausen 1972, 7:20).
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10. The term *precision* here involves the notion of repeatability.
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11. The word "scatter" is borrowed from particle physics.
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12. In his analysis of the first movement, Pierre Michel notes this aspect without establishing a link to Stockhausen's text (1985, 219, translated by the author). "The first movement of the Chamber Concerto consists of mixed rhythmic writing, made up of both very precisely notated passages and more or less free sections (from the rhythmic point of view only) where the sounds must be played as quickly as possible. These two types of writing are sometimes separated (passages that are either entirely precise or entirely free), sometimes superimposed; this is a frequent preoccupation of Ligeti's: to complete the complexity of the notated parts by adding less controlled elements." Furthermore, Ligeti uses writing in groups of grace-notes in his early works, such as *Coulée* (1969) for organ, *Continuum* (1968) for harpsichord, and the *Cello Concerto* (1966), in which he alternates grace-note and metronomic parts.
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13. It is interesting to compare the last metaphor used in Stockhausen's quotation with Ligeti's description of the Chamber Concerto as a "superimposition of photos whose result is no longer identical to the individual pictures" (Eichel 1980, 25').
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14. It is interesting to compare this passage with the introduction to Gérard Grisey's *Tempus ex Machina* (1979), in which each of the six percussionists' entries adopts a new tempo, 15 units faster than the previous one, starting at ♩ = 45 and culminating at ♩ = 120.
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15. In physics, a quantum represents the smallest indivisible unit, whether of energy, motion, or mass.
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16. In acoustics, a "formant" refers to a peak of energy in the sound spectrum.
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17. This passage follows in the wake of experiments carried out in the 1960s around pattern-meccanico movements, such as *Les horloges démoniaques* in *Nouvelles Aventures* (1965), the third movement of the Second String Quartet (1968), and *Poème symphonique* for 100 metronomes (1962).
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18. In classical physics, a degree of freedom is an independent parameter in the formal description of the state of a physical system. For example, we recognize six degrees of freedom of motion for a solid body in three-dimensional space: three for translations (upward and downward, forward and backward, and side to side) and three for rotations (roll, pitch, and yaw). In quantum mechanics, the position of a particle is defined using the wave function using complex values for the various degrees of freedom (Tong 2015, 4).
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19. I do not include in the *senza tempo* stratum the groups of small notes in Mvt. I at mm. 18, 19, 57, 58, and 59, which appear to me as a kind of degradation of the metronomic stratum.
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20. Ligeti's notation also provides essential information on the duration of *senza tempo* strata by indicating their approximate end.
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21. On the 2:1 ratio, Stockhausen writes that "in the sphere of micro- and macro-phases, of pitch and duration, all proportions based on the 2 are felt to be the 'simplest,' to be regulative" (1959, 16).
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22. Roig-Francolí (1995, 263–5) and Joubert (2001, 59) describe a formal organization around the golden ratio based on the number of measures for movement I. I have identified another type of structure based on the golden ratio for this movement, taking durations into account. Overall, there are three main parts concerning the strata of movement I: a section up to about E, where only the metronomic stratum exists, a section between letters E and N, where the metronomic stratum alternates with the *senza tempo* stratum, and the section from N to the end, where the *senza tempo* and the metronomic stratum coexist. From the durations of Example 7, I found a first section based on the golden section at letter N (and not letter M as expected), corresponding to the fraction 176.2/111 = 1.58. If I divide the two members of the section into two new sections according to the golden section, I obtain approximately the start of the *senza tempo* strata at letter D, with the groups of notes *senza tempo* played by the celesta, the trombone, and the horn, and the strata at letter O (third beat of m. 47) played by the celesta and piccolo. Similarly, the division of the second segment (letters E–N) by the golden ratio sheds light on the beginning of the *senza tempo* stratum from I, second beat of m. 29.
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23. Bonichot (2017, 189–90) observes an organization around the Fibonacci sequence in *Apparitions*. This structure would justify the beginning of the metronomic stratum at letter F and the accent on E at m. 54 played by the trombone, double bass, and piano.
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24. The sketches for *Apparitions* show the Fibonacci sequence in the formal scheme, where each section is linked to a nuance and instrumentation (Gallot, 85, 180). In his interview with Peter Várnai, Ligeti states that he had used the golden section in composition of the partials of a sound, but without success (Várnai et al. 1983, 43).
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25. On proportions, Ligeti mentions in his 1978 interview with Peter Várnai: "All this was the manifestation of the constructionist phase I went through in Cologne. It was typical of me to give the exact duration of each formal section in seconds and then write on the first page of the score that both duration and metronome markings are simply approximate indications. That is what I find the ideal solution to state the proportions, but not to insist on strict observance of them. Since *Atmosphères*, I have never worked on proportions with great precision" (Várnai et al. 1983, 43–44).
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26. To obtain the equivalent tempo for A♯, the calculation would be $60x2^{(1/12)} = 63.6$, for B: $60x2^{(2/12)} = 67.4$, and so on.
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27. If Stockhausen's system were strictly adhered to by Ligeti, the following series of tempi would be obtained: 89.9, 84.5, 75.6, 100.9, 60, 80.1, 63.5 and 53.5.
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28. "I remember one of the first things that struck me in Cologne was when I saw a score (do not let us worry about who the composer was) with a metronomic indication of 52.8. There is a task for a conductor" (Várnai et al. 1983, 55).
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29. On his style: "What I actually compose is difficult to categorize: it's neither 'avant-garde' nor 'traditional,' neither tonal nor atonal. And in no way post-modern, as the ironic theatricalizing of the past is quite foreign to me" (Wilson 2004, 7). On his identity: "I was born in Transylvania and

am a Romanian national. However, I did not speak Romanian as a child, and my parents were not Transylvanian . . . My mother tongue is Hungarian, but I'm not a real Hungarian, because I'm Jewish. But since I'm not a member of a Jewish religious community, I'm an assimilated Jew. But I'm not completely assimilated either, because I'm not baptized. Today, as an adult, I live in Austria and Germany, and have long been an Austrian citizen. I'm not a real Austrian either, just a newcomer, and my German has always been tinged with a Hungarian accent" (Ligeti 1978, 236).
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30. The period of intense post-war reconstruction in Germany, as well as a bitter youth in which he lost his parents and had late access to education, may also explain Stockhausen's efforts at unification (Harvey 1975, 12–13; Stoïanova 2014, 15).
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31. Text written in 1960 for a broadcast on Westdeutscher Rundfunk (WDR).
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32. I relate this musical image to a passage from Bachelard's *L'intuition de l'instant*: "What is it that gives time its appearance of continuity? It's the fact that we can, it seems, by imposing a cut-off *wherever we like*, designate a phenomenon that illustrates the arbitrarily designated instant" (1932, 33).
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33. The opposition of the two terms has since been widely critiqued, showing that both "the antithesis and the exclusion of one of the notions by the other are obsolete, both historically and philosophically" (Bouscan 2015).
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34. "In other words, through the 'gaze' and 'mirror' of the matrix, Ligeti acknowledges that the latter "knows" him better than he knows himself" (Kyburz 1990, 133–52).
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35. The year 2023, as this article is written, seems to be a poignant epilogue to this encounter, which saw the deaths of Friedrich Cerha, Doris Stockhausen, and Mary Bauermeister, as well as the celebration of the centenary of György Ligeti's birth.
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