Ligeti's Etude pour piano No. 11 ‘En Suspens’: Multidimensional Analysis and Insight into the Composition Process

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Abstract

This study aimed at deciphering the inner logics of György Ligeti's Piano Etude No. 11 and its relations with form. Two parameters were derived from pitch-class set theory and used for statistical analyses: the sum ∑ of the six components (ic1 to ic6) of the interval vector, which measures the complexity of a chord, and the ratio (ic1 + ic2 + ic6)/∑, which measures its dissonance. The results have shown that the music is polyphonic and constructed from two complementary guidonian hexachords. The melodies generated from two short motifs, phrase structures, rhythms, average dissonance and complexity of harmony all vary between the parts and contribute internally to the tripartite form and progression. Polyrhythms result from the superposition of cyclic rhythms whose periods are coprime integers. The relations between hidden cyclic patterns of sound and pitch are reminiscent of the medieval motets. The outcome is complex but coherent.

Keywords: music analysis; musical form; piano etude; pitch-class set theory; polyrhythm

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1. Introduction

György Ligeti (1923–2006) is one of the most original and creative composers of the second half of the 20th century. Excellent monographs on his life and work have been published in several languages, in particular English (Steinitz, 2003; Floros, 2014; Boukobza, 2019, pp. 257–258). The last years of Ligeti's life were partly occupied by the composition of his *Etudes pour piano*, in the tradition of those by Scarlatti, Schumann, Chopin and Debussy. The first (1985), second

(1988–1994) and third (1995–2001) books contain respectively six, eight and four Etudes (Ligeti, 1988; Ligeti, 1994; Ligeti, 2001a). They are considered as a major set of 20th century compositions for the piano. A recent monograph summarizes much of what is known so far about them (Boukobza, 2019).

Ligeti's writings inform us of his interests, influences and main researches during the composition of his Etudes. He wrote them as studies of both pianistic virtuosity and music composition, starting from simple central ideas and going from simplicity to extreme complexity (Ligeti, 2013, p. 290). His influences have included jazz, the music of sub-Saharan Africa, the *Ars subtilior* movement of the 14th century and the *Studies for Player Piano* by Conlon Nancarrow (1948–1992). They inspired him to develop complex melodic and polyrhythmic structures, and experiment the possibility of creating illusory melodic and rhythmic patterns by the combination of several voices (Ligeti, 2013, pp. 127–129 and 287–290). In parallel, Ligeti searched for new ways of thinking harmonically that would depend neither on total chromaticism nor diatonicism (Ligeti, 2013, pp. 123–125). He found that systems of complementary scales enabled him to construct new harmonic configurations that were neither tonal nor atonal but in-between (Ligeti, 2013, p. 298). Ligeti was deeply interested in the theory of musical form. He strongly advocated the view that form goes beyond the simple relations of the parts between them and with the whole. The way in which the parts function internally and act within the whole, has an important role (Ligeti, 2001b, pp. 147–162).

Ligeti's piano Etudes have been recorded by such exceptional artists as Pierre-Laurent Aimard (1997), Toros Can (2002), Idil Biret (2003), Fredrik Ullen (2006) and several others since then. Aimard has worked directly with Ligeti, two of the Etudes are dedicated to him (Nos. 10 and 12), he has premiered many of them, and his recordings of the Etudes are considered as an excellent rendition and a reference for their interpretation (Bleek, 2019; Boukobza, 2019, pp. 239–249).

Etude No. 11, entitled *En Suspens*, occupies the middle position in the second book of Etudes and it functions as a transitory point of rest in this cycle of pieces. It was written in 1994 after the other Etudes of the second book and the *Concerto pour piano et orchestre* (1988). Therefore, one can assume that many of the musical concepts and ideas that Ligeti had developed in his previous compositions for piano would be included in Etude No. 11. This Etude has been the subject of partial analyses (Chang, 2007, pp. 140–145; Baik, 2009; Can, 2011; Pace, 2012; Beffa, 2016; Marin, 2017; Boukobza, pp. 150–152) and proposed as a case study in post-tonal theory (Straus, 2016, pp. 154–155). However, the results of these analyses are generally reported at a macroscopic level and do not explain the detailed inner mechanisms of the piece. They privilege specific aspects, for example the spatio-temporal structure of the piece (Chang, 2007) or the separate voices of its polyphonic structure (Marin, 2017). The goal of the present work was to decipher the internal logics of Etude No. 11 and its relations to form, and thus gain insight into the composition process. Towards this goal, I performed a

thorough multidimensional analysis of Etude No. 11, in particular of its scalar material, melodic material, harmony and rhythm. I explored how the interactions between these different musical elements contribute to the character, form and complexity of the piece while keeping coherence. The results and conclusions of this analysis could interest pianists, composers, music analysts and historians.

2. Materials and methods

The Schott editions of Ligeti's *Etudes pour piano* and *Concerto pour piano et orchestre* were used in this work (Ligeti, 1985; Ligeti, 1988; Ligeti, 1994; Ligeti, 2001a). Etude No. 11 can be purchased separately. Its performances guided the analysis in several instances. In the text below, the pitches of a chord are listed from the lowest to the highest without separation, e.g. $E_4B_4A\flat_5D\flat_6$. The pitches of a melody are separated with hyphens, e.g. $D\flat_6$-$E\flat_5$-$D\flat_6$-$B\flat_5$-$A\flat_5$-$G\flat_5$. In the tables, however, the pitches of chords are also separated with hyphens for simplicity.

The analysis of Etude No. 11 is complicated by the two different time signatures of the bar: 6/4 for the upper staff and 12/8 for the lower staff or staves. The position of notes in the score was indicated by a couple of integers (x, y) where x is the bar number and y is the beat number, each beat with the time value of a crotchet (quarter note), e.g. beat (9, 4) for beat 4 of bar 9. The interval of time between beats y and z of bar x was noted (x, y–z).

Chords written on different staves are rarely struck simultaneously because of the polymetre of the bar. To enable a detailed harmonic analysis, each bar was divided into twelve sub-beats, each with the time value of a quaver (8th note). The chords whose notes are struck on the same sub-beat, were named *in-phase* chords; those whose notes are struck on different sub-beats but whose time lengths overlap, were named *out-of-phase* chords.

The *in-phase* and *out-of-phase* chords were analyzed according to Pitch Class (PC) Set method (Forte, 1973; Walter, 2001). Chords whose normal forms are related by a transposition, have the same function. The consonant intervals correspond to components ic3, ic4 and ic5 of the interval-content vector (ic-vector); and the dissonant intervals to ic1, ic2 and ic6 (Schoenberg, 1978, pp. 18–22). For statistical analyses, the set of ic-vectors was considered as a subset of $\mathbf{N}^6$ with the corresponding law of addition (**N**, natural numbers). In general, the sum of ic-vectors is not an ic-vector; however, an example where it is an ic-vector is described in the Discussion section. In this work, the complexity $\sum$ of a sextuple is defined as the sum of its six components; the harmonic complexity $\sum_H$ of a pc-set (or chord) is defined as the complexity of its ic-vector. $\sum_H$ depends only on the number n of pitch classes in the pc-set and is equal to $n(n–1)/2$ (Forte, 1973, p. 19). The complexity of a sum of ic-vectors is equal to the sum of their individual harmonic complexities.

3. Results

3.1. Overall organization

The score is 35 bars long. Most of the score is written on two staves. It is written on three staves in bars 16–17 and 28–33 and the two lower staves are then linked together. The upper and lower staves have different key and time signatures. The upper staff corresponds to the right hand and the lower staff or staves to the left hand, without ambiguity. The overlaps or crossings of hands are indicated by changes of clefs in the corresponding staves (the words hand and staff are used indifferently in the following).

The score can be divided into parts and phrases. Part 1 comprises bars 1–17; Part 2, bars 18–26; and Part 3, bars 27–35. Part 1 can be further divided into four phrases. Each of them ends with a minim and a rest in the upper staff and is exactly 25 crotchets long. The right hand plays the same notes in the third and fourth phrases as in the first and second ones, but transposed downward by an octave. Therefore the four phrases of Part 1 form two phrase-groups. Part 2 comprises two phrases covering bars 18–20 and 21–26, respectively. Each phrase ends with a dotted minim in both staves. Part 3 also comprises two phrases, covering bars 27–30 and 31–35, but without clear separation between them. In Parts 2 and 3, the key signatures are exchanged between the left and right hands at the junction between the first and second phrases. Parts 1 and 2 are polyphonies of two voices, each voice comprising mainly dyadic chords and more rarely monads or triads. Part 3 is constructed similarly, except that each main voice is accompanied by an ornamental voice, for a total of four voices.

3.2 Scalar material

The precise nature of the scalar material in Etude No. 11 has taken a long time to emerge. The upper and lower staves have different key signatures, one with no alteration and the other one with five flats. For some authors, the absence of alteration in one of the key signatures implies a C-major mode whereas the five flats in the other one imply a D♭-major mode, since the absence of accidentals eliminates the minor modes (Baik, 2009, p. 51; Gottlieb, Neveux, Rignol & Thinat, 2001, p. 101). Other authors mention that: (i) the C pitch of the D♭-major scale and the F pitch of the C-major scale are missing in the whole piece, (ii) the two scales are hexatonic and (iii) they are related by a tritone transposition (Marin, 2017; Boukobza, 2019, p. 150). In the present work, I made the alternative assumption that the F♯ pitch and not the F pitch is missing in one of the scales. In this assumption, both scales are hexatonic, one derived from D♭ major and the other one from G major with their leading tones omitted. They are devoid of tritone intervals, deduced from one another by transposition of a tritone and complementary (Fig. 1A). This assumption opened new perspectives in the analysis of Etude No. 11.

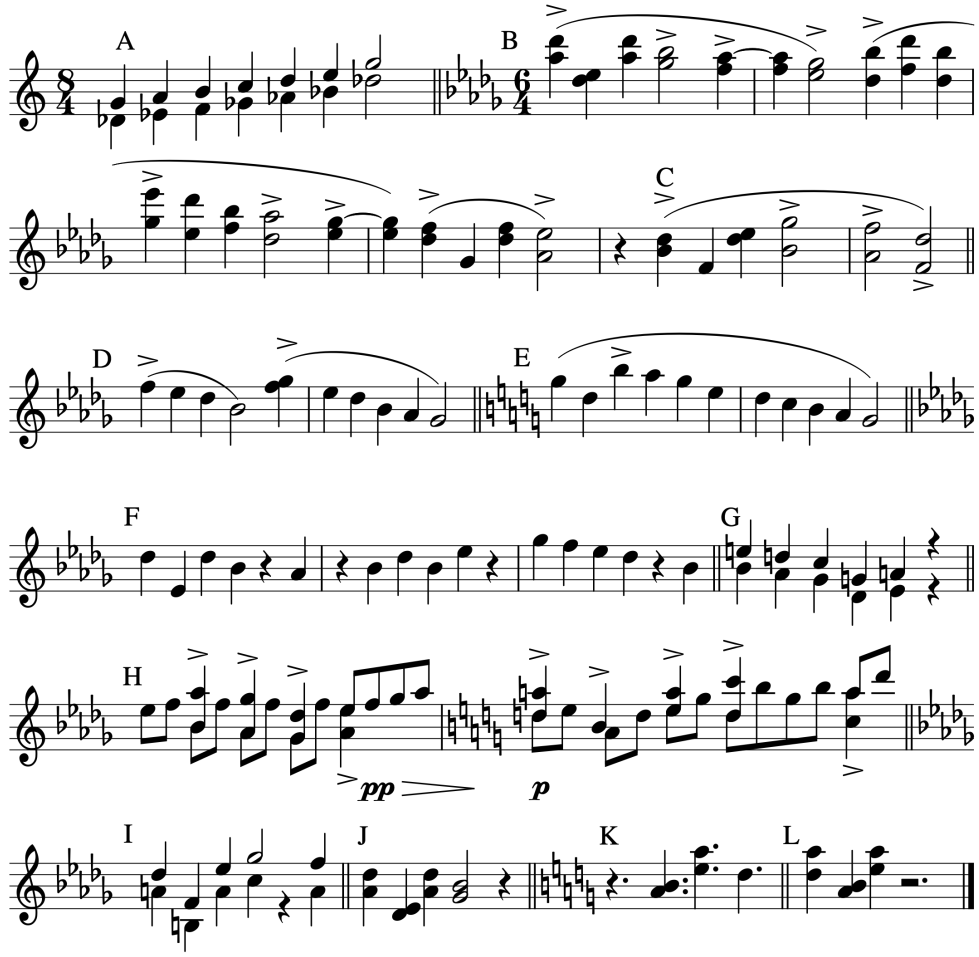

Figure 1. Melodic motifs in the upper staff of Etude No. 11. The music examples may have been transposed by one or several octaves for clarity. A) The two hexatonic scales used in the score. B–F) Melodic lines present in bars 1–4 (B), 5–6 (C), 18–19 (D), 23–24 (E), 27-29 (F). G) Comparison of motifs present in bars 22 (top voice) and 29–30 (bottom voice). H) Upper staff of bars 30–31. I) Comparison of motifs present in bars 5 (top voice) and 31 (bottom voice). J–L) Comparison of motifs present in the upper staff of bars 1 and 9 (J), the lower staff of bar 9 (K) and the upper staff of bar 31 (L).

3.3. Melodic material

The main melodic line is played by the right hand in Etude No. 11. This assertion is supported by several properties of the score. In Part 1, the melody of the right hand in bars 1–9 is exactly transposed by one octave in bars 9–17 while the accompaniment by the left hand is modified. The first phrase ends with a half-cadence and the second phrase with a deceptive cadence in the right hand. The dynamics and rhythmic density of the right hand are higher than those of the left

hand and more elaborate. In Parts 1 and 2, the slurs delimitate longer musical segments and the harmony is more complex in the right hand than in the left hand.

The melodic lines of Etude No. 11 are constructed by combinations of two motifs. Motif 1 comprises: i) a down skip, ii) an up skip, and iii) one or several down steps. The intervals of the skips are variable. Motif 2 is a descending hexatonic scale, often containing the characteristic step of minor third, either D♭-B♭ or G-E.

The melody of Part 1 is constructed mainly from Motif 1. This motif and variations with one additional anterior or posterior upskip are played at the beginning of the first and second phrases by the right hand (Figs. 1B and 1C). The accompaniment by the left hand appears erratic at first sight. However, by allowing an anacrusis of two notes at the beginning of Part 1, the musical line of the left hand rearranges in three-and-a-half meaningful phrases. Each phrase spans exactly three bars and can be described as the succession of two segments of five and four notes (Fig. 2A). Moreover, the melodic line that corresponds to the top notes of the dyads, has three noticeable features: (i) skips are predominant, (ii) successive steps are avoided, (iii) the five-note segment of each phrase has its highest or lowest pitch on the central note. The melody of the left hand also includes three symmetrical patterns. The pentachord D_4-B_4-C_5-G_4-A_4 in bars 1–2 and the pentachord A_2-G_2-C_3-B_2-D_2 in bars 10–12 are in retrograde relation and bracket the three-and-a-half phrases just described (Fig. 2A). A motif in dotted quavers in bar 12 is present in a quasi-inverted form in bars 13–14; the centre of inversion is located between C and C# (Figs. 2B and 2C). A descending *glissando* in bar 16 mirrors an ascending *glissando* in bar 15. These symmetries give meaning to the corresponding patterns.

The melody of Part 2 is constructed mainly from Motif 2 but with an important contribution by Motif 1. The right hand plays Motif 2 twice at the beginning of the first phrase (bars 18–19, Fig. 1D) and again at the beginning of the second phrase (bar 21). It plays three combinations of Motifs 1 and 2 in the remainder of Part 2 (bars 21–26; see Fig. 1E). The melodic line of the left hand has the same structure in Part 2 as in Part 1 (compare Figs. 2A and 2D). It is organized in three phrases of exactly three bars each. In each phrase, the five-note segment is a descending scale, in sharp contrast with the corresponding segment of Part 1, which was mainly composed of skips. The four-note segment is made of skips, except in the third phrase where it is a descending scale. The right and left hands play descending scales in imitation in several regions of Part 2. The same descending scale of four notes, played either by the right hand or by the left hand, brackets Part 2 (Figs 1D and 2D).

The melody of the top voice at the beginning of Part 3 is nearly identical to that at the beginning of Part 1 until it skips from $E♭_6$ to $G♭_6$ at the beginning of the third bar (Figs. 1B and 1F). It then continues with a descending scale and ends with a motif that is a tritone transposition of a motif in Part 2 (Fig. 1G). The descending

scale is played as 7th dyads, except where the hexatonic scale does not allow such an interval (bars 29–30). The motifs of the top voice at the beginning of the second phrases of Part 3 and Part 1 are approximately related by a tritone transposition (Fig. 1I). In the upper staff of bars 30 and 31, two illusory melodic patterns in quavers, $G♭_5$-F_5-$D♭_5$-F_5-$E♭_5$ and C_6-B_5-G_5-B_5-A_5, are composed of notes from both main voice and accompaniment; they are related by transposition of a tritone and clearly recognizable on audition (Fig. 1H). In bars 33–34, the right hand plays A_5-C_6-E_6-G_6, which is an arpeggiated minor 7th chord, and then G_6-A_6-B_6-D_7, which is an arpeggiated Mu chord (a major triad with added 2nd). These ascending *arpeggi* are played mostly as 9th dyads and mirror the descending scale of bars 29–30. Additional melodic similarities are present in bars 1, 9 and 31 (compare Figs. 1J, 1K and 1L).

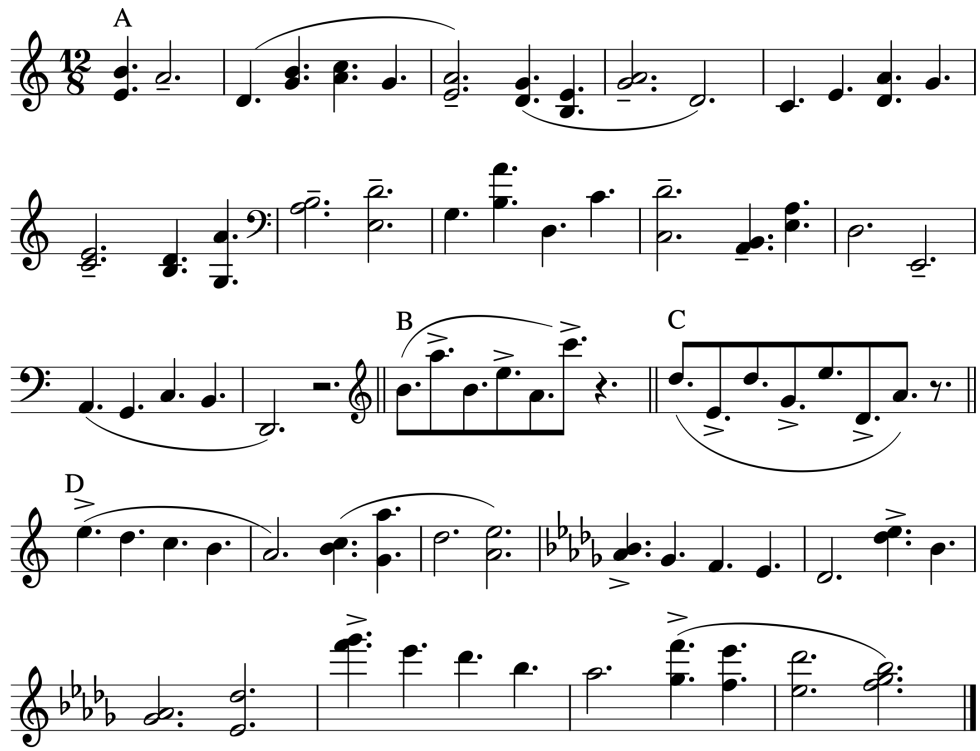

Figure 2. Melodic motifs in the lower staff of Etude No. 11. The music examples may have been transposed by one or several octaves for clarity. A) Motifs present in bars 1–12; an anacrusis of three dotted crotchets has been introduced and the slurs have been modified to emphasize two repeated motifs of five and four notes. B–C) Motifs present in bars 12 (B) and 13–14 (C). D) Motifs present in bars 18–26; the slurs emphasize two repeated motifs of five and four notes.

In conclusion, the melodic materials of the three parts derive from both Motifs 1 and 2 and are strongly interrelated, with emphasis on Motif 1 in Parts 1 and 3,

and emphasis on Motif 2 in Part 2. The melodies of the left hand have similar constructions in Parts 1 and 2 but with a contrast between skips in Part 1 and steps in Part 2. Additional melodic similarities create a network of relations and coherence between the different phrases and parts.

3.4. Registers

In most of Part 1, the two voices play in different registers. The two voices overlap briefly in bars 5, 6, 8 and 16. The two hands cross widely in bars 12–14 and this crossing gives the illusion of a third voice. In Part 2, the two voices share rather similar registers. They overlap in bars 18–20, 22 and 24, and this overlap briefly creates the illusion of a compound melody in bars 18 and 24. In most of Part 3, the two voices have different registers. However, they extensively overlap in bars 33 and 34 and it becomes difficult to differentiate them. They separate again at the end of bar 34 and this separation of register contributes to signal the end of the piece. The pitches of the piece go from A_0 to A_7, i.e. nearly the full span of the modern piano. There is a gradient of pitches towards the lower end of the register in Part 1. By contrast, there are gradients of pitches towards the higher end of the register in both Parts 2 and 3. The extreme pitches at the end of the parts function as delimiters since all three parts start in the medium register. Most of Ligeti's Etudes end in extreme registers and dynamics like *En Suspens*, with consequences on timbre and harmony since the overtones of a pitch are audible or not according to the register.

3.5. Segmental analysis

Melodic segments have often an intrinsic harmony that can be used to create relations between them or harmonize them. The melody of the right hand in Parts 1 and 2 of Etude No. 11 is segmented by slurs. The melody of the left hand is structured by alternating segments of five and four notes, as described above (Figs. 2A and 2D). Two melodic lines exist for each hand, corresponding to the top and bottom notes of their constitutive dyads. The pc-set classes of fifty five segments in Part 1, Part 2 and the beginning of Part 3 are reported in Table 1.

The whole hexachord (Forte number 6-32) is used in four segments of the right hand. It corresponds to a minor 11th chord (Persichetti, 1961, 82–85). The pentachord subsets of the hexachord belong to three set classes. Set classes 5-35 and 5-23 are widely used, in eight and seven segments, respectively. Set class 5-35 corresponds to the maximally-even pentatonic scale. Set class 5-27, which corresponds to a major or minor 9th chord, is used only once and in its minor form. The tetrachord subsets belong to seven set classes. The set classes 4-26, 4-23 and 4-22 are widely used, four, seven and nine times respectively. Set class 4-26 corresponds to a major added-6th or minor 7th chord; 4-23, to a 7th suspension 4 chord; and 4-22 to a major added-2nd or -4th (Mu) chord. Set class 4-20, which correspond to a major 7th chord, is not used at all. Set classes 4-14, 4-11 and 4-10,

which correspond to clusters, are used at most twice. The trichord subsets are used in segments at the end of phrases. Thus, the tetrachords that have known functions in jazz, are favored whereas those that correspond to clusters, are avoided. The major 7th tetrachord and major 9th pentachord are totally avoided (see Paragraph 3.9).

Table 1. Segmental properties of Etude No. 11

Hand	Bars	Forte number
RHt	1–9	5-35, 5-35, 3-2 / 4-11, 6-32, 4-14/
RHb	1–9	5-23, 4-11, 3-9 / 4-26, 6-32, 4-23/
LHt	1–12	5-23, 4-23 / 4-26, 3-7 / 4-23, 4-23 / 5-23
LHb	1–12	4-23, 3-11 / 4-22, 4-22 / 4-14, 3-9 / none
RHt	18–26	4-22, 5-35, 5-23 / 4-26, 5-35, 6-32, 5-35, 3-2/
RHb	18–26	none, 6-32, 5-35 / 4-22, 4-22, 6-32, 5-23, 3-6/
LHt	18–26	5-23, 4-22 / 5-27, 4-23 / 5-35, 4-22/
LHb	18–26	none, 4-22 / 5-23, 4-26 / 5-35, 3-2/
RHt	27–28	4-23, 3-7
RHb	27–28	4-22, 3-7

RHt and LHt, top melodic lines of the right hand and left hand, respectively; RHb and LHb, bottom lines of the right and left hands; (/), end of phrases. The segments of the right hand are delimited by the slurs of the score, except for measures 27-28. The segments of the left hand are alternately five and four notes long and presented in Fig. 2A and 2D.

3.5. Harmony of the separate right and left hands

The harmonic analysis of Etude No. 11 is complicated by two factors: the two complementary hexatonic scales and the different time signatures (6/4 and 12/8) for the upper and lower staves. It may be performed at two different levels, the *intra*-harmony within each staff and the *inter*-harmony created by combining the two staves and therefore scales. Analysis of the *intra*-harmonies allows one to independently characterize each of the two main voices of the polyphony. Analysis of the *inter*-harmony should consider both the *in-phase* chords, which are struck on the same sub-beat (i.e. quaver), and the *out-of-phase* (or latent) chords, whose notes are struck on different sub-beats but whose time lengths overlap. Here, a statistical approach was used to understand how consonance and dissonance contribute to shape the overall form of Etude No. 11 (see Methods).

In a first step, I analyzed separately the chords played by each hand and computed their interval content vectors (ic-vectors). I then computed the sum of these ic-vectors for the different parts or phrase-groups (Table 2). There is no tritone (ic6 = 0), which is consistent with the hexatonic scales used. In the first phrase-group of Part 1 (bars 1–9) and upper staff, there are no minor 2nd or major 7th (ic1 = 0), and only few major 2nd or minor 7th (ic2 = 4). The dissonant intervals (ic1 + ic2 + ic6) account for 12% of the 33 intervals. In the lower staff, the dissonant intervals account for 40 % of all intervals. Therefore, the right hand

plays more consonant dyads than the left hand in the first phrase-group. In the second phrase-group (bars 9–17), the right hand plays the same chords as in the first phrase-group, transposed downward by an octave, whereas the left hand plays different chords. Therefore, the second phrase-group appears as a harmonic variation of the first one. In the lower staff of the second phrase group, the dissonant intervals account for 17 % of all intervals. Overall, harsh dissonances are avoided in the chords played by either the right or the left hand in Part 1.

In Part 2 (bars 18–26), the dissonant intervals account for 60 % of all intervals for the right hand, and 79 % for the left hand. Thus harsh dissonances are favoured in the chords played by either the right or the left hand. In Part 3, I limited myself to the accented chords. In the first phrase (bars 27–30), the dissonant intervals account for 44 % of all intervals for the right hand and 33 % for the left hand. In the second phrase (bars 31–35), they account for 47 % of all intervals for the right hand and 31 % for the left hand. Therefore, there is a minority of dissonant intervals in Part 3 and no significant difference in the dissonance contents of its first and second phrases. In conclusion, when the right and left hands are considered separately, they play consonant chords in Part 1, highly dissonant chords in Part 2, and chords of intermediate consonance in Part 3.

Table 2. Statistics of the chords played by the right and left hands

Bars	Hand	Chord #	Sum of ic-vectors	∑	ic1+ic2+ic6 (%)
1–8	RH	33	(0,4,13,8,8,0)	33	12
1–8	LH	15	(0,6,2,2,5,0)	15	40
9–17	LH	6	(0,1,0,1,4,0)	6	17
18–26	RH	32	(7,17,4,2,10,0)	40	60
18–26	LH	12	(4,7,0,1,2,0)	14	79
27–30	RH	18	(1,7,5,0,5,0)	18	44
27–30	LH	18	(0,9,6,5,6,0)	26	33
31–35	RH	20	(2,15,5,2,12,0)	36	47
31–35	LH	20	(2,9,7,5,13,0)	36	31

For bars 27–35, only the accented chords have been considered. Chord #, number of chords analyzed, excluding the monads; Sum of ic-vectors, vector obtained by adding the ic-vectors of the analyzed chords; ∑, total number of intervals for the analyzed chords, obtained by adding the six components of the vector in column 4 (see Methods).

3.6. Harmony of the in-phase chords

In a second step, I analyzed the chords that are played *in-phase* by the right and left hands and therefore correspond to *inter*-harmony (Tables 3–5). For Part 1, the sum of the ic-vectors is equal to (5,10,17,16,9,8) for the 19 *in-phase* chords. The consonant intervals (ic3 + ic4 + ic5) are in majority (65 % for 65 intervals). For Part 2, the vectorial sum is equal to (24,14,8,8,7,6) for the 15 *in-phase* chords. The dissonant intervals are in majority (66 % for 67 intervals). For Part 3, the vectorial

sum is equal to (13,24,33,34,26,16) for the 18 *in-phase* and accented chords. The consonant intervals are again in majority (64 % for 146 intervals). Therefore, the trend that I found by separately analyzing the right and left hands, is confirmed by an analysis of the *in-phase* chords. There is a harmonic contrast between Parts 1 and 3, which are rather consonant, and Part 2, which is highly dissonant, at least for the *in-phase* chords. Tables 3–5 show that the majority of the *in-phase* chords (13/19) in Part 1 and accented *in-phase* chords (17/18) in Part 3 belong to a tertian harmony (Persichetti, 1961, pp. 66–92). In contrast, only one of the 15 *in-phase* chords of Part 2 belongs to this type of harmony.

Table 3. Properties of the *in-phase* chords for bars 1–17

Position	Chord	IC-Vector	Forte #	Function
(1, 1)	E4-B4/A♭5-D♭6	012120	4-26	Minor 7th
(2, 4)	G4/D♭5-B♭5	002001	3-10	Diminished
(3, 4)	B3-E4/D♭5-A♭5	012120	4-26	Minor 7th
(5, 4)	G4/D♭5-E♭5	010101	3-8	Augmented 6th
(8, 1)	B3-A4/G♭4 -E♭5	012111	4-27	Dominant 7th
(8, 4)	C4/E♭4-G♭4	002001	3-10	Diminished
(8, 6)*	C3-D4/B♭3-F4	021120	4-22	Major 9th (-7th)
(9, 3)*	A2-B2/A♭4-D♭5	121110	4-11	Major 9th (-5th)
(9, 4)	E3-A3/D♭4-E♭4	111111	4-z29	none
(11, 1)	G2/F4-D♭5	010101	3-8	Augmented 6th
(11, 4)	B2/E♭4-D♭5	020100	3-6	none
(12, 4)	B4/D♭4-F4	010101	3-8	Augmented 6th
(14, 1)	D7/B♭3-G♭4	000300	3-12	Augmented
(15, 2)	E1/E♭4-G♭4	111000	3-2	none
(15, 3)	D2/D♭4-F4	101100	3-3	none
(15, 4)	C3/A♭3-E♭4	001110	3-11	Major
(16, 3)	A5/G♭3-E♭4	002001	3-10	Diminished
(16, 5)	C4/F3-D♭4	100110	3-4	none
(16, 6)	D3/E♭3-G♭3	101100	3-3	none
(17, 1)	E2/A♭2	000100	na	Major 3rd
(17, 2)*	D2-A2/B♭2-F3	101220	4-20	Major 7th
(17, 4)	A1-E2	000010	na	Perfect 5th

The positions of the chords are given by the couple (bar, beat) and their functions according to (Schoenberg 1983). (/) Separates the notes that are played by the left and right hands; (*) Chords that are not in phase but were included in the table for the discussion on the transitions between phrases and parts; na, not applicable.

3.7 Harmony of the out-of-phase chords

The above harmonic analysis was only partially satisfactory because it involved only the *in-phase* chords. Are the *out-of-phase* chords a way of hiding or

smoothing highly dissonant chords or intervals? I therefore analyzed the totality of the chords, either *in-phase* or *out-of-phase* in two representative portions of the piece, the first phrase-group of Part 1 and the entire Part 2. Ninety-eight chords were analyzed for bars 1–9. The sum of the ic-vectors was equal to (53,67,119,106,55,59), with a large majority of consonant intervals (61 % of 459 intervals). One hundred and eight chords were analyzed for bars 18–26. The vectorial sum was equal to (142,111,52,75,62,50), with a large majority of dissonant intervals (62 % of 492 intervals). Therefore, the analysis of the combined *in-* and *out-of-phase* chords was consistent with the analyses of the separate hands or *in-phase* chords. The *out-of-phase* chords, which function through resonance, do not appreciably blur the consonant or dissonant character of harmony in Etude No. 11.

Table 4. Properties of the *in-phase* chords for bars 18–26

Position	Chord	IC-Vector	Forte #	Function
(18, 1)	E5/F5	100000	na	Minor 2nd
(18, 4)	C5/B♭4	010000	na	Major 2nd
(19, 1)	A4/E♭5	000001	na	Tritone
(19, 4)	B4-C5/A♭4	101100	3-3	none
(20, 1)	D5/D♭5-A♭5	100011	3-5	Viennese trichord
(20, 4)	A4-E5/B♭4-A♭5	210111	4-5	none
(21, 1)	A♭4-B♭4/B5-C6	221100	4-2	none
(21, 4)	F4/E5	100000	na	Major 7th
(22, 1)	D♭4/E5-C6	101100	3-3	none
(22, 4)	D♭5-E♭5/D5-C6	321000	4-1	none
(23, 4)	E♭4-D♭5/C6-B6	221100	4-2	none
(24, 1)	F6-G♭6/G5-E6	321000	4-1	none
(24, 4)	D♭6/C5-B5	210000	3-1	none
(25, 4)	G♭5-F6/B6-A7	111111	4-z15	none
(26, 4)	F5-G♭5-B♭5/C6-G6-B6	421242	6-z6	none

See legend to Table 3.

3.8. Harmonic complexity

The harmonic density of a chord, measured as the number of its pitch classes, is a very rough parameter. I have therefore introduced a new parameter, the harmonic complexity of a chord, which is defined as the sum of its six ic-vector components (Methods). I deduced the average harmonic complexities of the *in-phase* chords in the three parts of the score from the vectorial sums that are given in Paragraph 3.6. The average harmonic complexity is equal to 65/19 = 3.4 for the 19 *in-phase* chords of Part 1; it is equal to 67/15 = 4.5 for the 15 *in-phase* chords of Part 2; finally, it is equal to 146/18 = 8.1 for the 18 accented and *in-phase* chords of Part 3. Thus, the average harmonic complexity increases from Part 1 to Part 2 (from 3.4

to 4.5), and sharply from Part 2 to Part 3 (from 4.5 to 8.1).

Table 5. Properties of the in-phase chords for bars 27–35

Position	Chord	IC-Vector	Forte #	Function
(27, 1)	E4-B4/A♭5-D♭6	012120	4-26	Minor 7th
(27, 4)	C4-G4-A4/E♭5-B♭5	123121	5-25	Seven-sixth chord
(28, 4)	E3-G4/D♭5-B♭5	004002	4-28	Diminished 7th
(28, 5)	C4-A4/G♭5-E♭6	004002	4-28	Diminished 7th
(29, 1)	E4-C5/A♭5-G♭6	020301	4-24	Augmented 7th
(29, 4)	G4-A4/E♭5-D♭6	020202	4-25	Dominant 7th flat 5
(30, 4)	A2-E3/G♭4-D♭5	012120	4-26	Minor 7th
(30, 5)	B2-G3/A♭4-E♭5	101310	4-19	Minor major 7th
(31, 1)	B♭3-F4/D5-A5	101220	4-20	Major 7th
(31, 4)	F3-B♭3-A♭4/D5-C6	032221	5-34	Dominant 9th
(32, 4)	D♭3-A♭3-F4/B5-E6	113221	5-32	Dominant 7th sharp 9
(32, 5)	G♭2-D♭3-B♭3/G5-A5-D6	313431	6-z19	Major 5th+Suspended
(33, 1)	F3-E♭4/A4-B5	020202	4-25	Dominant 7th flat 5
(33, 4)	B♭4-A♭5/D5-E6	020202	4-25	Dominant 7th flat 5
(34, 4)	E♭6-A♭6/C6-D7	111111	4-z29	none
(34, 5)	C5-E5-B5/D♭6-A♭6-E♭7	323430	6-14	Major 7th+Suspended
(35, 1)	F♯5-C♯6/D6-A6-E7	122230	5-27	Major 9th
(35, 4)	B4-F♯5/D♯6-A♯6-C♯7	122230	5-27	Major 9th

See legend to Table 3. Only the chords that are accented in both hands have been considered.

3.9. Transitions

Since the scales of the upper and lower staves have no seventh degree, leading to a tonic, I analyzed the initial and final chords of the different phrases, and the chords that are present in the transitions where the two staves exchange their scales. I found that the initial and final chords of the phrases in Parts 1 and 3 are obtained as subsets of a major 9th chord (Fig. 3A).

In Part 1, the initial chord $E_4B_4A♭_5D♭_6$ [beat (1, 1)] of the first phrase-group can be considered either as a major added-6th chord or as a minor 7th chord. The latter corresponds to a major 9th chord with the root omitted. The final chord $C_3D_4B♭_3F_4$ [beat (8, 6)] of this phrase-group corresponds to a major 9th chord with the 7th degree omitted. The initial chord $A_2B_2A♭_4D♭_5$ [beat (9, 3)] of the second phrase-group corresponds to a major 9th chord with the 5th degree omitted. The penultimate chord $D_2A_2B♭_2F_3$ [beat (17, 2)] of this phrase-group correspond to a major 9th chord with its 9th degree omitted, and therefore to a major 7th chord. The last chord of the first phrase $C_4A♭_4E♭_5$ [beat (4, 5)] and the last chord of the third phrase $C_1A♭_3E♭_4$ [beat (13, 2)] are identical major triads and would be dominant chords if the piece was written in D♭ major. The last chord of the fourth

phrase A_1E_2 [beat (17, 4)] is a perfect 5th and ends Part 1.

In Part 3, the initial chord $E_4B_4A♭_5D♭_6$ [beat (27, 1)] of the first phrase is identical to the initial chord of Part 1 [beat (1, 1)]. The transitional chord $B♭_3F_4D_5A_5$ [beat (31, 1)] between the first and second phrases is identical to the penultimate chord $D_2A_2B♭_2F_3$ [beat (17, 2)] of the fourth phrase in Part 1, except that the two hands are permuted. The final chord of Part 3 is an authentic major 9th chord [beat (35, 4)].

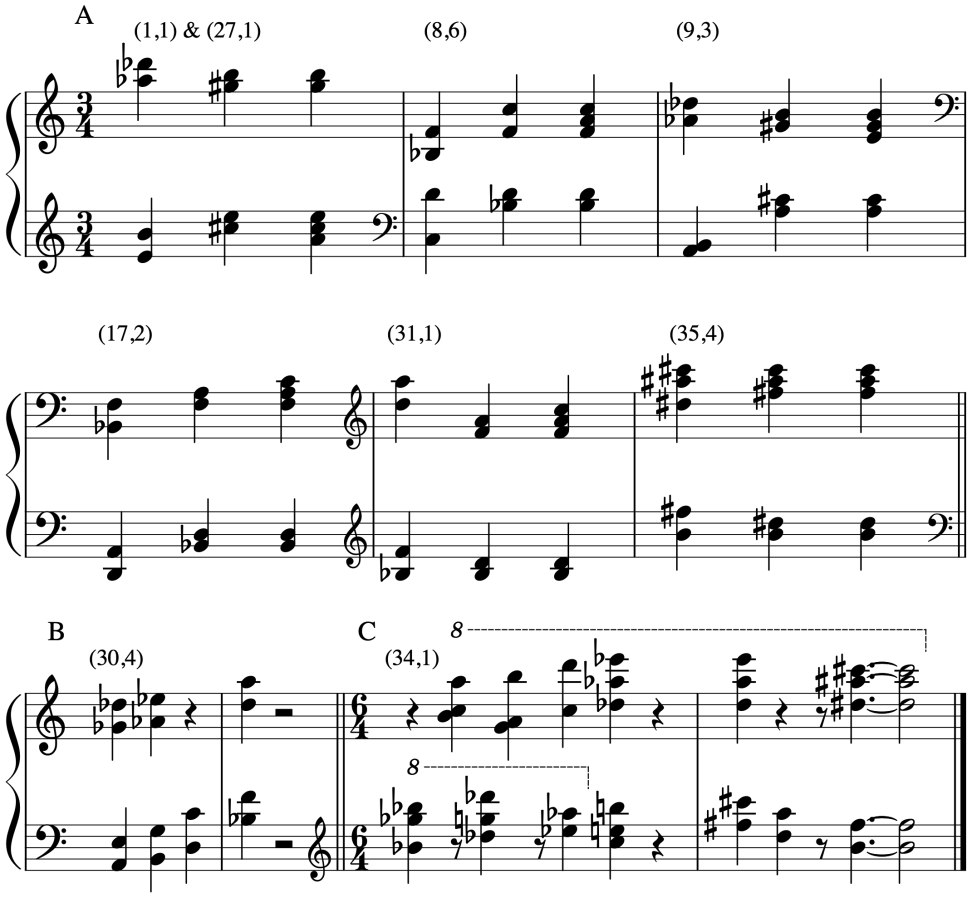

Figure 3. Initial and final chords of phrases. A) For each chord, the figure indicates the coordinates of the chord in the score, its original disposition, its tertian equivalent and the major 9th chord from which it may derive. B) Chords at the junction between the first and second phrases of Part 3. The tertian equivalents of the four chords are F♯AC♯E, A♭C♭E♭G, CD, and B♭DFA, respectively. C) Final chords of the score. Only the relevant parts of the bars are represented.

The transition between the first and second phrase-groups in Part 1, and the transition between the first and second phrases in Part 3 are worth analyzing. The final chord [beat (8, 6)] of the first phrase-group in Part 1 and the initial chord [beat

(9, 3)] of the second phrase-group are two derivatives of a major 9th chord, with either the 7th or the 5th degree omitted (Fig. 3A). Therefore, they generate a smooth transition. There is no exchange of scales between the hands in Part 1.

The transition between the first and second phrases of Part 3 is trickier (Fig. 3B and legend). The last three *in-phase* and accented chords of the first phrase are the following: $A_2E_3G♭_4D♭_5$ [beat (30, 4)] is a minor 7th chord; $B_2G_3A♭_4E♭_5$ [beat (30, 5)] is a minor-major 7th chord; $B♭_3F_4D_5A_5$ [beat (31, 1)] is a major 7th chord. The right hand proceeds through a succession of three parallel perfect fifths: $G♭_4D♭_5$-$A♭_4E♭_5$-D_5A_5. The left hand plays the following chords: A_2E_3 is a perfect 5th; B_2G_3 is an augmented 5th/minor 6th; D_3C_4 is an augmented 6th/minor 7th; and $B♭_3F_4$ is a perfect 5th. Thus, we observe a smooth transition from a minor 7th chord to a major 7th chord and from one hexatonic scale to the other one. The arrival on the final chord of the piece is somewhat similar (Fig. 3C). The main voice of the right hand plays a succession of four parallel major 9th, A_5B_6-C_6D_7-$D♭_6E♭_7$-D_6E_7 [beats (34, 3) to (35, 1)], then a minor 7th, $D♯_6C♯_7$ [beat (35, 4)]. The main voice of the left hand plays a succession of four parallel perfect 5th, E_5B_5-$F♯_5C♯_6$-D_5A_5-$B_4F♯_5$ [beats (34, 5) to (35, 4)]. The chords of both hands resolve in a major 9th chord. Overall, the major 7th chord is only present at the end of part 1 and in the transition between the two phrases of Part 3. The major 9th chord is only present at the end of Part 3 (Tables 3-5). These two chords do not correspond to any of the melodic segments analyzed (Paragraph 3.4). Thus, they seem reserved for special transition functions in the score.

3.10. Rhythm

Previous works had recognized the existence of cyclic rhythms in Etude No. 11 but without analyzing the interactions between them and with the melody (Marin, 2017; Boukobza, 2019, pp. 151-152). Here, I have divided the rhythms into two classes for a precise analysis: short-range and long-range. The short-range rhythms result from the different time signatures of the upper and lower staves, 6/4 and 12/8 respectively. Several long-range rhythms can be recognized in the different parts. Part 1 comprises four phrases of exactly 25 crotchets each, as described above. On the upper staff, each phrase comprises three uneven length segments, delimited by slurs. The rhythmic grouping is by crotchets (1) and minims (2): 1112̲2̲2̲; 1111112̲2̲; 1112̲1. The last crotchet is a rest separating the phrases (Figs. 4A and 4B). Since the numbers 25 and 6 (or 25 and 24 = 4x6) are coprime, each phrase and therefore each cycle of the corresponding rhythm start on a different beat of the bar, with an increment of one crotchet per cycle.

On the lower staff, the rhythmic grouping is by dotted crotchets (1) and dotted minims (2): (12)111121122, where the dotted crotchet and dotted minim in parentheses are only present in bar 1 at the beginning of the piece. This rhythm is different from the one previously described (Marin, 2017; Boukobza, 2019, pp. 151-152). It is strictly repeated three and a half times between the two symmetrical

melodic patterns in bars 1–2 and 10–12 (Paragraph 3.3). The rhythm is subsequently varied with dotted quavers and a *glissando* but is still recognizable until the end of its fifth cycle in bar 16. Since this cyclic rhythm is 12 dotted crotchets (18 crotchets or three bars) long, each cycle starts on the same beat of the bar, i.e. on the fourth dotted crotchet. The new cyclic rhythm that I propose here, has the advantage over the previously published ones that it rearranges the melodic line of the lower staff in a meaningful, repeating structure (Paragraph 3.3).

The cyclic rhythms of the right and left hands have periods of 25 and 18 crotchets, respectively. Since these two numbers are coprime, the combined long-range rhythm of the left and right hands varies in the different phrases of Part 1. A regular and preconceived pattern of accent marks contributes to the complexity of the rhythm. For the right hand, they are on the first note of every group of three crotchets and on every minim (underlined in the above pattern). For the left hand, there is no accent mark, except in bars 12–14 (Figs. 2B and 2C). In most of Part 1, there is a two versus three polyrhythm (left hand versus right hand). However, the dotted crotchets of the left hand are split into two dotted quavers in bars 12 to 14 and every second dotted quaver is accented. This split generates a four versus three polyrhythm (left hand versus right hand).

The long-range cyclic rhythm of the right hand and phrases are 50 quavers long in Part 1 whereas the short-range cyclic rhythm of the left hand is 3 quavers long. Consequently, their combined rhythm varies in the different phrases since the numbers 50 and 3 are coprime. The first dotted crotchet of the left hand occurs at the beginning of phrase 1, one quaver after the beginning of phrase 2, two quavers after the beginning of phrase 3 and again at the beginning of phrase 4. Overall, the short-range and long-range cyclic rhythms at work in Part 1 have different frequencies and the arithmetic relations between their periods, based on coprime numbers, generate variations and diversity in the combined polyrhythm.

Part 2 comprises two phrases of unequal length, encompassing bars 18–20 and 21–26 respectively. The lower staff has the following rhythmic pattern of dotted crotchets (1) and dotted minims (2): 111121122. This pattern occurs once in the first phrase and twice in the second phrase, and is exactly three bars long. I observed that the left hand has fully identical long-range rhythms in Parts 1 and 2. Accents are present in both right and left hands of Part 2. They modify the first note of descending scales or reinforce dissonant chords.

In Part 3 (bars 27–35), each hand plays two voices, the primary voice consisting of chords in crotchets and the secondary voice consisting of an embellishment of one of the chord tones, mostly written in quavers. The left and right hands follow rhythmic patterns that extend exactly on two bars, are repeated four times from bar 27 to bar 34 (Figs. 4C and 4D), and result in a continuous flow of notes. In each couple of bars, the 24 quavers of the right hand are grouped by two or four. The 24 quavers of the left hand are grouped by three except the last six ones, which are grouped by two. In bars 33 and 34, some of the groups of three

quavers are replaced by irregular divisions in four or five quavers (tuplets), or by sixth semiquavers. This creates four, five or six versus three polyrhythms (left hand versus right hand) and an acceleration of notes. Every chord of the primary voices is accented. In bars 27–30, these accents create a compound rhythmic pattern that is similar to that in Part 1 (Fig. 4).

```
RH: ●-●-●-o---o---o---●-●-●- (A)
LH: ●--o-----●--●--●--●--o--

RH: ●-●-●-o---o---●-●-●-o--- (B)
LH: ---●--●--o-----o-----●--

RH: ●-●-●-●-..●-..●-●-●-●-.. (C)
LH: ●-.●-.●-.●-.●-.●-.●-●-●-

RH: ●-●-●-●-..●-..●-●-●-●-.. (D)
LH: ●-.●-.●-.●-.●-.●-.●-●-..

RH: ●-...ø------            (E)
LH: ●-●-.ø------
```

Figure 4. Rhythmic patterns in Parts 1 and 3. RH, right hand; LH, left hand; (●-) crotchet; (●--) dotted crotchet; (o---) minim; (o-----) dotted minim; (.) rest in the main voice; (ø-) final chord. (A) Pattern of bars 1–2; (B) bars 3–4; (C) pattern repeated three times in bars 27–28, 29–30 and 31–32; (D) slightly different pattern in the last beat of bars 33–34; (E) pattern of bar 35.

3.11. Dynamics

In Part 1, the dynamics of the right hand are mostly *piano* and those of the left hand are lower or at most equal to those of the right hand. Variations of dynamics (*crescendo* or *decrescendo*) are marked only for the right hand. These dynamic marks support the following assumptions: (i) the right hand plays the melody and the left hand, an accompaniment; and (ii) harsh dissonances are avoided. In Part 2, the similar dynamics of the right and left hands, and the accents emphasize the dissonant character (see Paragraphs 3.5–3.7). In Parts 1 and 2, the *crescendi* and *decrescendi* underline the highest pitch in the different fragments of phrase and give a vocal character to the melody. Overall, the dynamic range of Parts 1 and 2 extends only between *ppp* and *mp*. In bars 27–30 of Part 3, the dynamic marks indicate that the accented chords of both right and left hands should be played *mezzo forte* and the intervening ornamental notes played *pianissimo* so as to emphasize the similarity between the first phrases of Parts 1 and 3 (see Paragraph

3.10). In bars 33–34, the right hand plays arpeggiated chords at higher and higher pitches along a *crescendo* that leads to the only *forte* dynamics of the score, and is followed by a steep *diminuendo* towards the final chord, which is played *pianissimo* and clearly indicates the end of the piece.

The transition between the first and second phrases of Part 3 is a very special moment of the score since: (i) it leads to the last phrase and coda of the score, (ii) it occurs with an exchange of the scales between the hands, and (iii) most importantly, it occurs without interruption of the musical flow. All the other transitions between phrases include either a minim and a rest as in Part 1 or a dotted minim as in Part 2 at the end of the upstream phrase. Moreover, they occur without a change in dynamics. In Part 3, the transition is emphasized by the dynamics: the last two beats of the first phrase undergo a *decrescendo* to *pianississimo* whereas the second phrase starts *piano* (Fig. 1J).

4. Discussion

4.1. Pianistic technique

Etude No. 11 is proposed to students in their eighth year of piano practice (Gottlieb et al., 2001, p. 101). What are the technical difficulties that the score may present for students at that level? The two staves have different key and time signatures. The two hands overlap or cross widely in several parts of the score and in particular they overlap in the middle of a *glissando*. In bars 15–16, the left hand plays *glissando* and *crescendo* while the right hand strikes chords *decrescendo*, which requires a good independency of the two hands. The score includes polymetres and irregular divisions of the metre (tuplets), giving rise to three versus two, four versus three and five versus three polyrhythms. Accented notes alternate between the two hands. Some chords that are expressly noted as *non-arpeggio*, exceed the span of an average hand. For example, the left hand plays E_3G_4 at beat (28, 4); $B\flat_2A\flat_3D\flat_4$, $D\flat_3A\flat_3F_4$ and $G\flat_2D\flat_3B\flat_3$ in bar 32. Ligeti indicates that the piece should be played '*avec l'élégance du swing*'. In my opinion, the 'swing' character comes from the polymetre and both hands should play strictly in rhythm. Parts 1 and 2 are of medium difficulty and worth studying for themselves. The interpreter needs large hands and a superior technique to play Part 3 and especially bars 33–34 in the right tempo.

4.2. Character of the piece

The two complementary hexatonic scales that are used in Etude No. 11 for the right and left hands, are transpositions of the hexachord C-D-E-F-G-A that was described by Guido of Arezzo in the 11th century and the seed for the diatonic scale (Reisenweaver, 2012). Ligeti used different scales for the right and left hands in other piano pieces. In Etude No. 7 *Galamb Borong* and in the 3rd movement of the *Concerto pour piano et orchestre*, Ligeti used two complementary whole tone

scales (Ligeti, 2013, p. 132). In Etude No. 1 *Désordre* and in the 5th movement of the piano concerto, Ligeti used complementary pentatonic anhemitonic and diatonic scales (Svard, 2000; Ligeti, 2013, pp. 299–300). In this way, the composer creates an illusory and shimmering harmony that comes from the equal temperament but does not belong to it any more from a sound viewpoint (Ligeti, 2013, p. 298). In Etude No. 12 *Entrelacs*, the key signatures are identical to those of Etude No. 11. However, the C and F pitches are present in both staves. Therefore, the two scales are not complementary, even if their union reconstitutes the 12 tones of the equal temperament.

The analysis of the scalar material in Etude No. 11 could explain its title *En Suspens*. The piece was first entitled *Convexe-Concave*, a title quasi-identical to that of Escher's lithography No. 56, entitled *Concave and Convexe*. It was then successively entitled *Souplesse*, *En suspension*, *Engrenage* (i.e. gears), and finally *En Suspens* (Beffa, 2016, p. 353). I propose the following explanation: the staves use scales that are derived from the D♭-major and G-major scales but are devoid of their leading tone, C and F# respectively. Therefore, phrases of music, written either on the upper or lower staff, cannot end with an authentic cadence. All the cadences are imperfect (or suspended), hence the title of the piece *En Suspens*.

The ic-vectors of the diatonic and Guido's scales differ by the ic-vector 111111 of the all-interval tetrachords (Forte, 1973, p. 18). As an aside, these tetrachords are used at least once in each of the three parts of Etudes No. 11 (Tables 3–5). The structure of Guido's scale and therefore its potential for melodies are very close to those of the diatonic scale. However, the corresponding melodies are neither tonal nor atonal but somewhere in-between for lack of leading tone. As observed in the Results section, the slur and dynamics markings give a *cantabile* character to the melodies in Parts 1 and 2 of Etude No. 11. In Part 1, this character is reinforced by the overall consonant harmony. In Part 3, the key melodic notes are accented in the upper staff and the combined rhythmic pattern of the accented chords in the upper and lower staves strongly parallels the rhythmic pattern in bars 1–2 (Fig. 2), thus recalling the melodic gesture of Part 1.

Several of Ligeti's compositions have a specified polymetre of the bar, including Etude No. 4 *Fanfare*, No. 5 *Arc en ciel*, No. 11 *En Suspens* and the 3rd and 5th movements of the *Concerto pour piano et orchestre*. Etudes Nos. 5 and 11 have similar polymetre of the bar, 3/4 (6/8) and 6/4 (12/8) respectively; they have similar indications to the interpreter: '*Andante con eleganza, with swing*' and '*Andante con moto, avec l'élégance du swing*'. These indications suggest that Ligeti used hemiola as a means of rigorously recreating the swing character of jazz. The polymetre of the bar is refined in Part 3 of Etude No. 11, since the 12 quavers of a bar are subdivided either into 3+3+3+3 or 3+3+2+2+2, in a reminiscence of the Ottoman *Aksak* rhythmic system (Cler, 1994). Part 3 of Etude No. 11 also shares a high content in 7th and 9th chords with Etude No. 5, putting it on the edge of tonal and jazz sounding.

The up-skip of Motif 1 induces a tension whereas the down steps of Motif 2 induce a relaxation (Persichetti, 1961, p. 235). In Part 1, where Motif 1 is preponderant, the tension is counterbalanced by the tertian, rather consonant harmony. In Part 2, the dissonant harmony is counterbalanced by the preponderance of Motif 2. In the first phrase of Part 3, Motifs 1 and 2 are in equilibrium. Thus, the tensions and relaxations brought about by melody and harmony are well balanced in most of the score. This balance, together with the soft dynamics, gives the music its quiet and elegant character. In the second phrase of Part 3, a tension is created by the rising pitch, acceleration of notes and *crescendo* until the only *forte* dynamics of the score and it is suddenly released by the deceleration of notes, rapid *diminuendo* and final *pianissimo* chord. This last phrase has the character of a *coda*.

4.3 A subtle organization

A first level of rhythmic organization in Etude No. 11 is provided by hemiola, a three versus two polyrhythm. It results from the two different time signatures for the right and left hand, 6/4 and 12/8, is short range and runs through the whole score, except for a few beats in Part 3 (Fig. 4). Hemiola has been widely used in Western music and is a defining characteristic of African music (Temperley, 2000).

A second level of rhythmic organization is long range and reminiscent of the distinction between cyclic rhythms of sound (*talea*) and pitch (*color*) in the European music of the 14th century. Three levels of long-range organization can be distinguished in Etude No. 11: those of sound, pitch and phrase. In Part 2, the sounds of the lower staff follow a cyclic rhythm whose period equals three bars. The pitches of the lower staff have a cyclic organization in two segments of five and four notes that has also a period of three bars (Fig. 2D). Thus, sound and pitch have different but isoperiodic cyclic organizations. The music of the upper staff does not follow a cyclic organization but the lengths of the first and second phrases are equal to one and two periods of three bars respectively. Thus, Part 2 is globally organized through a time-length of three bars. In Part 3, the sounds of both upper and lower staves follow cyclic rhythms. The two rhythms are different but isoperiodic, with the same period of two bars. The pitches are not cyclically organized. The length of the phrases is equal to two periods, if one excludes the exceptional final bar. Thus, Part 3 is organized through a time length of two bars. In Part 1, the sounds and pitches of the lower staff have the same cyclic rhythm and organization as in Part 2, at least until bar 12, with a period equal to three bars (Fig. 2A). As regards the upper staff, the sounds follow a cyclic rhythm whose period is equal to 25 crochets and the phrases have the same length: the period of the sound rhythm and the length of the phrases are isometric. The pitches are not cyclically organized but the music of periods 1 and 2 is repeated, transposed downwards by one octave, in periods 3 and 4. Thus, the sound rhythms, pitch organizations and phrase lengths of the upper and lower staves are incompatible. Because the

anacrusis of two notes and the positions of the slurs hide the cyclic organizations of the lower staff, Part 1 appears organized through a time-length of 25 crotchets, i.e. just above four bars.

The organizations of the three parts of Etude No. 11 are clearly different. They are reminiscent of the medieval motets. Part 2 of Etude No. 11 could be classified as isorhythmic by reference to *Ars nova*, and Parts 1 and 3 as pan-isorhythmic by reference to *Ars subtilior* (Apel, 1972, p. 427). Given that Guido's hexachord was described in the 11th century and that the isorhythmic and pan-isorhythmic motets are inventions of the 14th century, one can assume that Ligeti was inspired by the medieval music for the composition of Etude No. 11.

4.4. Form and progression

The main melodic line is played by the right hand and strongly structures form in Etude No. 11. The musical idea of Part 1 is conveyed by two phrases of about four bars each (25 crotchets), forming a phrase-group. The first phrase starts with a clear statement of Motif 1 and ends with a chord that would be a major dominant triad in the scale of D♭ major. The second phrase appears as a repetition of the first phrase with variations and it ends on a major 9th chord, with the 7th omitted (Table 3). Both phrases share the same rhythmic pattern. The second phrase group of Part 1 has the same structure as the first one. Thus both phrase-groups have structures that are reminiscent of a musical period (Schoenberg, 1967, pp. 20–81).

The musical idea of Part 2 is conveyed by two phrases of unequal lengths, comprising three and six bars. The first phrase starts with a clear statement of Motif 2, which is immediately repeated. The second phrase repeats three times a combination of Motif 2 and Motif 1 in sequence and appears as a development of the first phrase. Thus, the phrase-group of Part 2 has a structure that is reminiscent of a sentence (Schoenberg, 1967, pp. 20–81).

The melodic structure of Part 3 is close to that of Part 1. It includes two phrases of four bars each and a concluding bar. Both phrases start with a statement of Motif 1 and share the same rhythmic pattern. A descending scale in the first phrase is mirrored by ascending arpeggiated chords in the second phrase that give the latter the character of a *coda*. The descending scale stops two crotchets before the end of the first phrase and reverses in five ascending steps, including a chromatic step, that lead to a major 7th chord, a swap of the key signatures between the staves and the beginning of the second phrase (Fig. 1H). These elements, together with a jump in dynamics (Paragraph 3.11), provide a clear articulation even though the second phrase is a continuation of the first one, without interruption. In summary, the different phrase-groups of Etude No. 11 have melodic structures that are reminiscent of the period and sentence although these two forms are classically defined in a tonal context. The local forms of the melodic lines participate in the contrast between the three different parts of Etude No. 11 and therefore to its overall form.

Sound rhythm, pitch organization, phrase length, their cyclic patterns and their subtle interactions clearly differentiate the three parts as detailed in Paragraph 4.3.

Harmony participates in form. Dissonances are avoided in Parts 1 and 3, which mostly include tertian harmonies. In contrast, harsh dissonances are favoured in Part 2, which mostly includes cluster harmonies. Thus, melody, rhythm and harmony contribute to the contrasts between the three parts of the score. The harmonic complexity of the *in-phase* chords increases significantly from Part 1 to Part 2 and then strongly from Part 2 to Part 3. Therefore, there is a gradient of harmonic complexity when going from the beginning to the end of the score, which contributes to the musical progression. Likewise, the gradients of register in the three parts and the increased frequency of notes towards the ends of Parts 1, through a long *glissando*, and Part 3 contribute to form and progression. Overall the piece has a ternary structure AA'BA".

4.5. Conclusion

From the analysis of Etude No. 11, one can deduce or confirm some traits of Ligeti's compositional method. At an early stage, the elementary materials of the piece (scale system, melodic motifs, main rhythmic patterns, etc.), their interactions and the global structure of the piece are decided or even calculated. Ligeti has qualified his Etudes as constructivist pieces (Ligeti, 2013, pp. 44 and 52). However, the composition is not automatically generated from these early decisions. The complex interactions between the different musical layers are planned to generate diversity but the composer creates additional relations between the elements of the nascent score to add meaning and coherence.

By using complementary scales, Ligeti could write a music that is neither tonal nor atonal but in-between. In fact, this strategy enabled him to use compositional techniques that belong to the pre-tonal, tonal and post-tonal musical worlds altogether. In Etude No. 11 for example, he used varying relations between sound and pitch rhythms that are reminiscent of the 14th century motets. He used contrasts between melodies, between tertian and cluster harmonies, between phrase structures, and the possibility to create tension and relaxation by disjunct and conjunct intervals that are reminiscent of tonal structures and progressions. However, he also used parametric delineators of form that act in a non-tonal and non-thematic way, and are characteristic of post-tonal music, e.g. temporal density, harmonic complexity, dynamics and register (Howland, 2015).

The multivalency of Ligeti's compositional approach gives his music a character of both familiarity and strangeness, and therefore attractiveness. In Etude No. 11, Ligeti has employed and grouped many compositional techniques in a short piano piece and shown how they can give a melodic, complex but nevertheless coherent, very pleasant and beautiful piece of music. Etude No. 11 is perhaps less spectacular than other Ligeti's Etudes but it is nevertheless technically difficult. It is a masterpiece of composition in which Ligeti's reflections, art and

genius found ways of expression. I did not invoke Ligeti's life, the development of music in the 20th century or the chaotic history of this period of time to analyze and explain Etude No. 11. Other authors have done it in a convincing manner for the whole set of Etudes (Steinitz, 2003; Floros, 2014; Beffa, 2016; Boukobza, 2019). Conversely, I hope that the work reported here provides a glimpse in Ligeti's mind as he was conceiving, composing and writing Etude No. 11.

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