

## 8 | Pierre Boulez and the Redefinition of Serialism

CATHERINE LOSADA

Writing from Buenos Aires to John Cage in 1954, Pierre Boulez stated:

I am keeping as much of my time as possible for writing *Le Marteau sans maître* . . . I am trying to go further and deeper, and also to widen my outlook. With the two cappella choral pieces I wrote last year, it is one of the works that has given me the most trouble. I am trying to rid myself of my thumbprints and taboos; I am trying to have an ever more complex vision – less visible and more worked out in depth – I am trying to expand the series, and expand the serial principle to the maximum of its possibilities. (Nattiez 1993: 149)

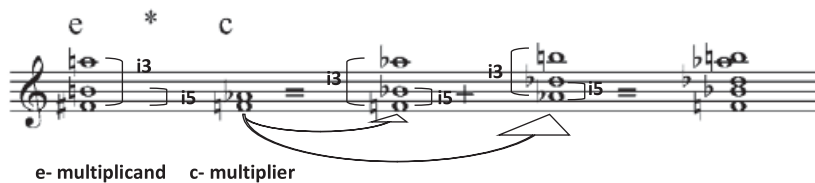
The decade of the 1950s, in fact, witnessed a great transformation in the compositional practice of Pierre Boulez. The usual narratives of serialism during this decade have tended to dwell on Boulez's experiments with multiple serialism in *Structure Ia* (1951), where the composer applied the operations common to twelve-tone music in a one-to-one mapping of other parameters such as duration, articulation, and dynamics. The practice of multiple serialism represented a significant contrast with the more conventional form of serialism that Boulez had successfully practised since 1945. It did, in fact, expand the serial principle by extending it to other parameters, thus breaking with familiar formal structures and opening up possibilities for common structural underpinnings between various parameters (Decroupet 1995a), but this experiment was tremendously short-lived. Boulez presented radical deviations from a straightforward application of multiple serialism as soon as the second and third movements of that work, *Structures Ib* and *Ic* (1952) (Boulez 2004). Although this technique appeared in other works, such as *Polyphonie X* (1951) and (briefly) *Structures II* (1956–61), it was eventually abandoned.

The desire to expand the serial principle, however, did not end with it. The ensuing works, like *Le Marteau sans maître* (1952–5), *Pli selon pli* (1957–62/89), and the Third Piano Sonata (1955–7/63), which brought Boulez to the pinnacle of his reputation within the European circle of composers, are those that truly redefined serialism. Yet, with the exception of *Le Marteau*, which is often presented as an extension or loosening of serial practice, illustrating Boulez's much cited references to a dialectic

between freedom and control (cf. Boulez 1991d; Goldman 2011: 39), narratives of twentieth-century serialism rarely discuss their serial practice (Salem 2018). In what follows, I will discuss how Boulez's redefinition of serialism took place and its motivations, as well as its musical implications and ramifications. Ultimately, the chapter shows how, through this redefinition, serialism remained an important element of Boulez's compositional technique until the end of his career. Furthermore, Boulez's serialism was an essential forerunner of future trends, rather than a culmination of an abandoned practice.

In the quotation that opens this chapter, Boulez talks of expanding the series, as well as the serial principle. It might be useful to examine both of these ideas in turn. The works he refers to are *Oubli signal lapidé* (1952–3) and *Le Marteau sans maître* (O'Hagan 2007: 35; cf. Campbell 2016). In *Le Marteau*, Boulez develops three distinct serial techniques (Decroupet 2005; cf. Koblyakov 1990; Mosch 1990; Haas 1990; Piencikowski 1980 and 2000), all of which expand the series by generating *blocs sonores* (Boulez 1991e: 128; Decroupet 1995b: 120; cf. Salem 2018), vertical collections of notes of variable size that can function as the basis for pitch organisation. This desire to organise various parameters (notes, durations, articulations, dynamics) in groups, and thus free up possibilities in terms of texture, timbre, and temporality, was the primary motivation for the deviations from straightforward application of multiple serialism (which were achieved chiefly through grouping notes based on their equivalence in smaller modular spaces) in the second and third movements of *Structures I*.

Of the techniques used in *Le Marteau*, the most far-reaching, in the sense that it influenced subsequent methods of pitch generation for the remainder of Boulez's career, was the technique of pitch-class multiplication. As Figure 8.1 shows, pitch-class multiplication consists of a process where two sets are combined to form a larger set, by replicating the intervals of one set (figured from a chosen anchor note), over each of the



**Figure 8.1** Pitch-class multiplication as described by Boulez.  $e^*c$  ( $ec$ ) results from realising each one of the ordered pitch-class intervals that occur above the bass in  $e$  (the multiplicand) over each pitch-class of  $c$  (the multiplier)

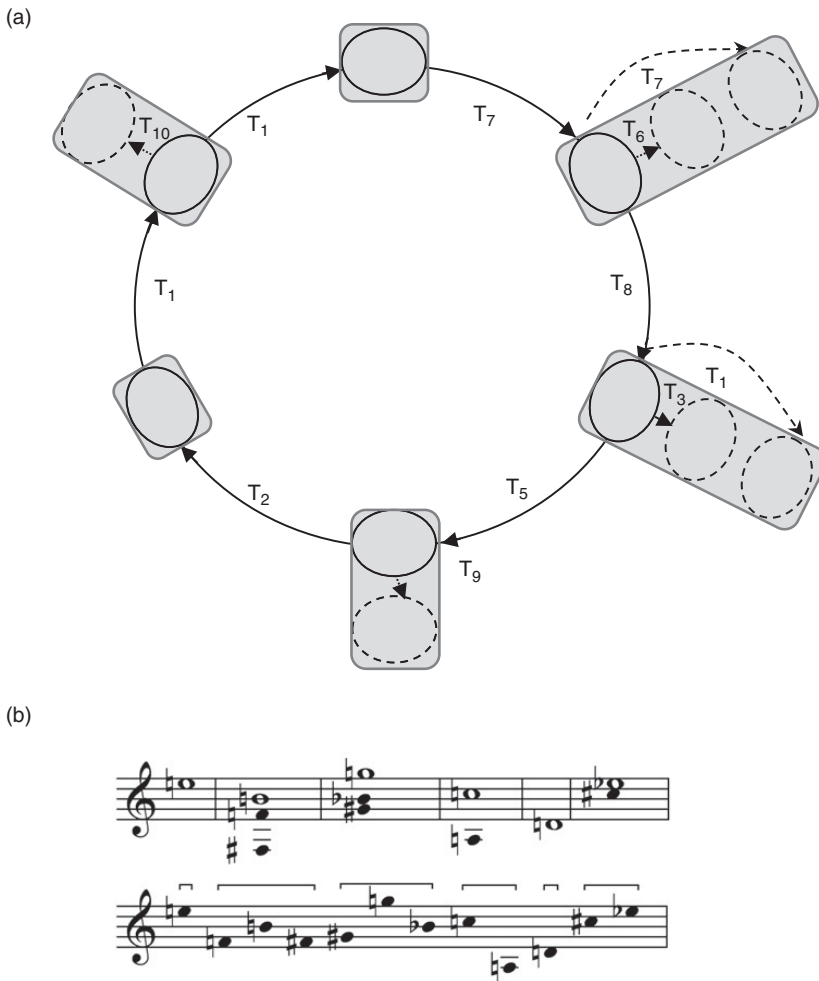
notes of the other set. Initially, Boulez incorporated this technique in the larger context of a multiplication table. These tables expand the series in a very literal sense. Each system of the table contains several embellished series, that is, partitions of the series transposed systematically by the intervals of the row itself and embellished by the intervals within the partitions themselves. Figure 8.2, from 'Séquence' (Third Piano Sonata), illustrates the multiplication table as an embellishment of the series most clearly (Decroupet 2006). The partitioned twelve-tone series appears at the top of the example. Each note of the row recurs at the top left of each of the twelve sequences of six chords that make up the pre-compositional sketch. Each of these sequences of chords consists of the partitioned row transposed to start on successive notes of the row and embellished (depending on which of the six systems it is on), by the intervals within each of the six partitions. For instance, in the last system of the table, the partitioned row is transposed to start on E $\flat$  and C $\sharp$  (the notes of the last of the partition of the row, taken in order from top to bottom). Each of these transposed rows is embellished by a transposition of the same at the interval between E $\flat$  and C $\sharp$  (two semitones down). Similar tables were used for works such as

Figure 8.2 Annotated reproduction of pre-compositional table for 'Séquence', from Third Piano Sonata. Paul Sacher Foundation, Pierre Boulez Collection (Mappe H, Dossier 2 f,1)

*Structures II* (1956–61), *Doubles* (1958), and *Domaines* (1961–68) (Koblyakov 1990: 32; Losada 2014; Losada 2017; Losada 2019a; Losada 2019b).

This practice creates an identity between the relationships governing local and large-scale structures, a criterion that had been important for Boulez throughout his career (Boulez 1991e: 116–17; cf. Piencikowski 1985 and 1993; Decroupet 2012 and 2016; Losada 2008, 2014, 2017 2019a, 2019b, 2019c). Figure 8.3 presents a graph that illustrates how the desire to preserve the same structure on the local and larger level explains the transpositional structure of the multiplication table as a whole. The graph in Figure 8.3a reflects the relationships embedded in the partitioned row (Figure 8.3b), stressing the transpositional relationships between the highest notes in each partition of the row, which function as anchor notes. If the nodes of the graph are filled with pitch classes, the graph represents the partitioned row (moving clockwise from the very top node, which represents the first partition of the row). If they are filled with each of the sets of the partitioned row, the graph represents a vertical or horizontal trajectory through each of the columns or systems of the multiplication table. Finally, if the nodes are filled with the partitioned row itself, the graph represents the entire left side of the multiplication table. This explains the transpositional structure of the table, which is determined by the intervals between the anchor notes. Simultaneously, each of the shaded radial subgraphs in Figure 8.3a, which reflect the intervals embedded in each of the partitions of the row, represents the transpositional relationships that govern the corresponding system of the table.

Crucially, this type of structural organisation creates important harmonic relationships, defined by common tones, common subsets, and varying degrees of chromatic saturation, which embody a hierarchical organisation. The multiplication table also expands the series in terms of density, thus permitting a degree of flexibility at the local level, where the pitch classes can be disposed of with a certain freedom and are not subject to a strict temporal disposition. Furthermore, in several of these works, multiplication tables organise parameters beyond pitch (especially duration). This practice has several advantages over the former approach to multiple serialism when applied to other dimensions. Chief amongst these advantages is the organisation into groups, which enables the composer to avoid the pointillistic sound world that emerges from having each note associated with its own dynamic, articulation, and duration marking.



**Figure 8.3a** Transformation graph modelling the partitioned row and other levels of structure in ‘Séquence’, from Third Piano Sonata

**Figure 8.3b** Partitioned row for ‘Séquence’

Reaching beyond the goal to ‘expand the series’, Boulez’s desire to ‘expand the serial principle’ transcended the development of multiplication techniques, as is reflected in his insistence that:

one must accept increasingly that not everything is determined and it would be more satisfying for the mind – less essentialist – not to create a hierarchy before commencing, but to discover this hierarchy as we go along with the work. I believe that this is not yet the case. But late Debussy is there to show us the way. A ‘work’ [in English] perpetually ‘in progress’ [in English] (dear Joyce). Thus one would be led

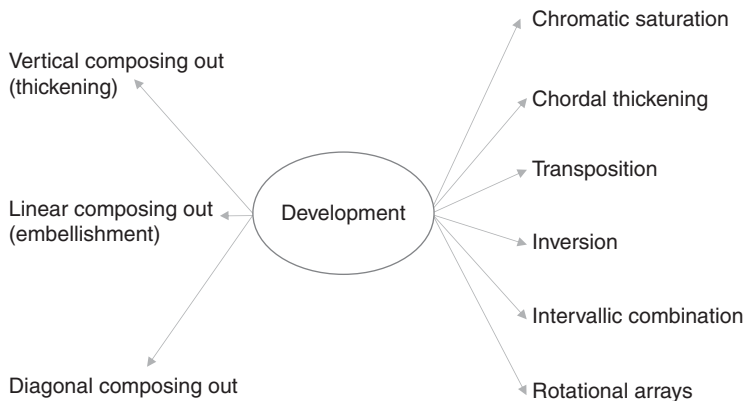
to compose without sketches, which would be very pleasant!! The sketches would be made in the course of the work and not before. I intend to integrate that into the variation principles (generative principles) which would themselves be submitted to a vertical and horizontal serial universe. (Letter from Boulez to Stockhausen, quoted in Piencikowski 2016: 99)

After the composition of *Le Marteau*, Boulez did in fact, gradually reduce his reliance on extensive pre-compositional tables of the type shown in Figure 8.2. Two crucial influences led to radical changes in his compositional approach, what I term the redefinition of serialism (Piencikowski 2016; cf. Salem 2016). These were the influence of mathematical trains of thought on his techniques of composition and the influence of music from other cultures on his approach to temporality, timbre, and texture. I will examine each of the influences in turn.

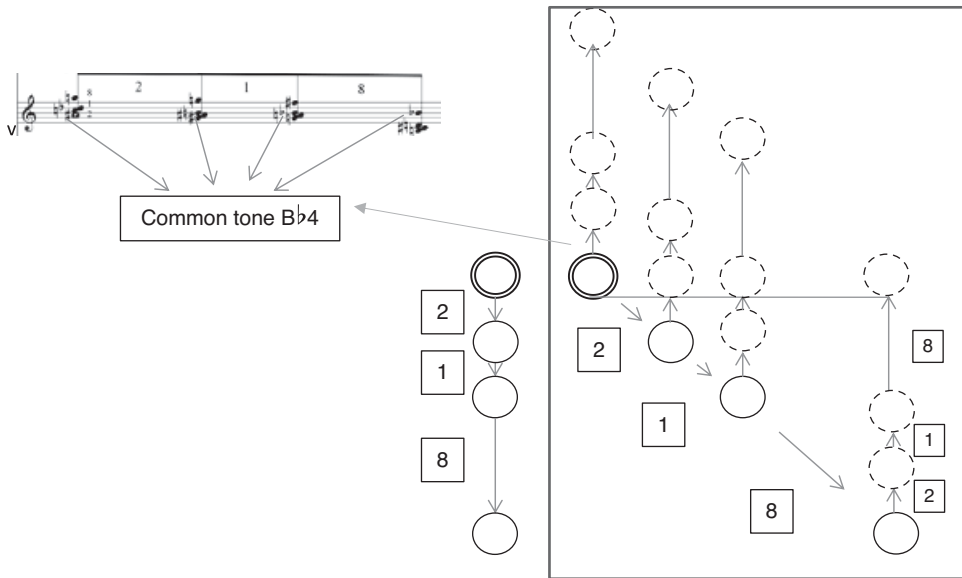
A turning point in Boulez's career was his exposure to the logical empiricism of Louis Rougier (Rougier 1956; cf. Decroupet 2003a; Nicolas 2005 and 2010; Campbell 2010; Losada 2019c), which had repercussions on his musical technique that allowed him to reach many of the goals outlined in the quotation cited immediately above. In his writings, Rougier argues that the fundamental axioms of a system, instead of apodictic or assertoric truths, in certain cases may simply be optional conventions (Rougier 1920: 199; Marion 2005: 158–59; cf. Losada 2019c). He states, furthermore, that 'a reasoning should be independent of the object upon which one reasons . . . Only the relations imposed upon these notions by the postulates and the definitions must intervene in the deduction' (Rougier 1920: 199). Crucially, 'the axiomatic method makes it possible to construct purely formal theories which are networks of relations, schemes of ready-made deductions. Consequently, the same form can be applied to various subjects, to sets of objects of a different nature, on the sole condition that these objects respect among themselves the same relations as those stated between the undefined symbols of the theory' (Rougier 1956: 1001). Rougier's ideas transformed Boulez's approach to serialism by providing him with the motivation to expand the serial principle in two fundamental, and radical, ways. In the first place, they made Boulez increasingly less reliant on a generative twelve-tone row and extensive pre-compositional sketches and more prone to reappropriate previously used materials as the basis for new works. On the other hand, they led to solidification of a practice already common to Boulez: that of applying networks of relationships, chosen from the possibilities embedded in the source material, in different contexts. This had important consequences for his harmonic language.

The reappropriation of previously composed materials became an essential feature of Boulez's compositional process (cf. Tissier 2012; Salem 2014, 2016, and 2019). On the one hand, he developed a tendency continually to revise works, as I will discuss shortly. In many cases, however, the practice of reusing materials did not have a strong aesthetic basis, since the material stemmed from unpublished works, and recognition of the source materials was not the goal. Instead, it reflected a gradual diminishment in the importance placed on the nature of the source materials and a proportional increase in the emphasis on proliferation of materials, through techniques of development based on relationships embedded in the material itself. As a result, from this point on in his career, his works gradually moved further away from an underlying twelve-tone basis. Simultaneously, a number of techniques of development, roughly summarised in Figure 8.4, became standard to his compositional process (Losada 2019b). Although many of them (transposition, inversion) stem directly from serial procedures, what distinguishes them is how they replicate the relationships embedded in the materials itself, their application in the vertical and harmonic dimensions simultaneously, as well as repeated application in a single dimension as the material proliferates in the course of the compositional process. Combined with the other techniques (intervallic combination, chordal thickening, chromatic saturation), they enabled different ways of generating crucial harmonic links between foreground and middle-ground events, creating a method of composing out that Boulez described as inhabiting the diagonal dimension and opening up a new realm of possibilities for hierarchical structure (Losada 2019d).

To illustrate, Figure 8.5 explains the basic principle that generates several pages of material from *Éclat* (1965) from the opening chord of his



**Figure 8.4** Summary of serial developmental techniques



**Figure 8.5** The consequence of transposing a chord by the retrograde of embedded pitch intervals (in registral space) is a common tone in pitch space

unpublished work *Don* (first version 1960, for piano and voice). In this example the intervallic structure of the opening chord of *Don* (the last chord in the progression), determines the transpositional relationships in the progression. The transpositions retrograde the series of intervals (defined in register) embedded in the chord. The technique is a type of pitch-space multiplication and is also akin to a rotational array. The result of this scheme is a common tone,  $B\flat_4$ , that is a significant element of the harmonic content of the piece, creating a hierarchical structure. On the musical surface, the various chords are deployed with flexibility in terms of ordering. Even when deployed horizontally they are often perceived as stretched-out simultaneities.

The above example illustrates the conceptual similarities between the technique and multiplication and rotational arrays. In fact, rotational arrays, and arrays built on the simultaneous transposition of a series by the intervals of the series and their inversion, underlie virtually all of Boulez's works written after 1971 (Dal Molin 2006, 2007, 2009, and 2016; Goldman 2011; Tissier 2012; O'Hagan 2021). These encapsulate many of the same structural relationships embedded in multiplication tables, including isomorphic relationships at various levels of structure and an emphasis on common tones. They also generate harmonic sonorities that share large, common subsets



embellished by additional notes, thus permitting continuity in the musical language in a non-dodecaphonic context (Losada 2021).

These are the technical underpinnings of Boulez's redefinition of serialism. They allowed Boulez to realise the goal of composing without extensive pre-compositional sketches, instead creating the sketches along the way. Although hierarchy is essential to his conception, it is not determined in advance: it is achieved through variation principles (generative principles) that work in both the horizontal and vertical realm. His satisfaction with the potential of these techniques can be seen in the following comment in a letter to Stockhausen from late 1957: 'now that we have a basic technique that is sufficiently broad and solid, we must work madly on the poetics' (Karlheinz Stockhausen Collection, Paul Sacher Stiftung). This outlook explains why Boulez essentially stops writing theoretical texts on music for about a decade after 1965 (Goldman 2011: 39). Having solidified his compositional technique, Boulez was ready to focus on the aesthetic realm. This aesthetic component accompanied the transformation of this compositional approach and had far-reaching influence in several fields of inquiry. It derived from a multitude of influences, many of which, like the ideas of John Cage, affected most mainstream European composers of the time. I would like to focus, however, on those that were important to Boulez as an individual. These are encapsulated in the concept of the 'rhizome' and the influence of music from other cultures.

The rhizome relates to the creative alternative to organicism embedded in Rougier's logical empiricism (see Losada 2019a). Rougier states that 'there exist an unlimited number of equivalent notions and propositions that can be chosen as primaries, without any being imposed by right of nature' (Rougier 1956: 1001). As has been noted by many authors, Boulez's works from this time period can be grouped into families of works that share common materials. The nature of the relationship between the different works, however, varies widely. While some works share common materials with others without any audible link between them (for example, the Third Piano Sonata and *Domaines*, which are based on pre-compositional tables derived from retrograde inversive related rows), others have clear musical links. Some works are re-compositions or revisions of others (for example, *Figures Doubles Prismes* (1963/8) compared to *Doubles* (1958)), while others constitute expansions of movements, smaller sections, or materials from another work (for example, *Domaines* for clarinet and instrumental ensemble compared to *Domaines* for solo clarinet, or *Éclat*, with respect to the first version of *Don*, for voice and piano). In Boulez's practice, from here on, even works that share a common pre-compositional basis typically exploit

different properties embedded in the materials themselves, creating a multidirectional (non-organic) network of relationships between different works and sections within individual works. This approach, embedded in the concept of the rhizome, was far-reaching in its influence. It appears in Boulez's sketches from the late 1950s and early 1960s. It was adopted and developed by the philosophers Gilles Deleuze and Félix Guattari in the 1970s (Campbell 2010: 143–5), indicating that they may have taken this idea from Boulez.

As Luisa Bassetto and Rosângela Pereira de Tugny have stated, the music of other cultures was another crucial aesthetic influence on Boulez, transforming his approach to texture, timbre, and timing, in addition to the question of what constitutes the work itself (Bassetto 2003 and 2014; Pereira de Tugny 1998 and 2006). This influence was not superficial, nor did it consist of a straightforward appropriation or imitation. As I argue in a recent article (Losada 2021), Boulez's interactions with the 'other' illustrate Gianmario Borio's penetrating assessment of how artists like Boulez were forerunners of post-colonial thinking (Borio 2009; Borio 2013a). In Boulez's music, elements inspired by music from other cultures impress themselves indelibly into the creative procedures and are fundamental to his redefinition of serialism. In my view, this interaction is an example of 'productive reception' in the sense presented by Maria Moog-Grünwald (Moog-Grünwald 1993) and shows elements of 'critical listening positionality' described by Dylan Robinson (Robinson 2020), though it is important to note that Robinson (and others) would probably consider this extraction to be problematic. From my standpoint, however, as a person whose identity can only be described as resulting from the confluence of many different cultures, these interactions between different cultures do not seem problematic when they invert established schemes of dominance and invoke a change in the way we listen to and conceive of the work of art, reflecting a deep understanding of the musical and cultural contexts.

Boulez, highly critical of composers writing music primarily based on exoticism, sets his approach in relief, by emphasising what he admired about Debussy, and specifically how Debussy permitted elements from the music of other cultures to transform his musical language without imitating or making direct reference (and thus exploiting) the original context (Boulez 1967: 6; Boulez 1984: 142–3; Boulez 1991i). Boulez also clarifies how he uses instruments from other cultures in order to destabilise dominant hierarchies (Boulez 1984: 140).

In order to grasp the depth and quality of this influence on the music of Boulez, it is important to understand some crucial aspects of the composer's professional trajectory (cf. Losada 2021b). In 1946, after completing

his studies with Messiaen in the Paris conservatory, and having started to achieve recognition through some of his compositions, like the *Sonatina*, Boulez expressed an interest in being an ethnomusicologist (Bassetto 2014). In fact, he planned a research trip to Cambodia, with the Guimet Museum, but this trip was never realised owing to the start of the Indo-China War. However, Boulez realised many transcriptions of music from the Far East and Africa during this time.

Boulez acknowledged the influence of the music from other cultures on his approach to temporality. This is manifest in the way texture and timbre interact with timing to create an exploration of musical space. In the first place, it affected his sense of timing within the works, imbuing them with a greater degree of flexibility. On the other hand, it affected his conception of what constitutes a work of art in itself. Both of these ideas, and the acknowledgement of the influences from the Far East, are embedded in the following quote from Boulez:

Regarding the time conception and the cyclic works which apparently have neither beginning nor end – in India and Japan a performance lasts a very long time, people come and go, listen or not as they please – I would say that on the creative level I live in a kind of plasma which enables me to change my location by moving from front to rear. I remain in the same material and project my thoughts in several directions at once. I now have a flexible material that permits these shifts in time and these diversions. Because of this I have made several versions of *Pli selon pli* and am thinking of extending *Éclat*. (Boulez 1967: 8)

In the realm of timbre, Boulez mentions that the xylorimba refers to the African balafon, the vibraphone to the Balinese gamelan, and the guitar to the koto from Japan (Boulez 1986d: 341).

Following Boulez's lead, many scholars have commented particularly on the influence of the music from the Far East (Griffiths 1978: 28; Bradshaw 1986: 159; Decroupet 2005: 44). Far fewer have commented on another crucial influence on Boulez, that related to his experiences in Latin America. The same year as Boulez's failed research trip to Cambodia, he was appointed music director of the *Compagnie Renaud Barrault*. Although Boulez did not travel to Africa or the Far East during this formative period, his position with the *Compagnie Renaud Barrault* allowed him to realise three extended tours of Latin America. These were in 1950, 1954, and 1956 (Bassetto 2003; Campbell 2016).

These Latin American tours proved to be crucial to Boulez's development as a composer, partly because of the pieces that he was working on during that time. Edward Campbell has provided crucial information

regarding these trips, which makes it possible to see the extent of the importance of this experience (Campbell 2016; Salem 2018). During the tour of 1950, Boulez worked on an abandoned project, a setting of Mallarmé's 'Un coup de dés'. During the Latin American tours of 1954 and 1956 respectively, however, Boulez worked on two pieces that carried him to very centre of the circle of European composers. As mentioned above (p. 125), during the tour of 1954 he worked on *Le Marteau*, specifically, on the 'Commentaire III de "Bourreaux de solitude"'. During the tour of 1956 he worked on the Third Sonata.

A few concrete influences can be attributed to these experiences. Campbell has noted how, in his 1954 tour, Boulez met with the brothers Augusto and Haroldo de Campos, founders of concrete poetry, in São Paulo. They spoke of Pound, Joyce, Cummings, and Mallarmé's 'Un coup de dés' (Boulez to Souvtchinsky, quoted in Campbell 2016: 11). Given this, it is interesting to note, as Campbell does, the relationship between Augusto de Campos's poems from 1953 and 1954 (for example, 'dias, dias, dias'), which explore the idea of alternative trajectories distinguished by colours, and the score for Boulez's Third Sonata, a work which was first conceived, according to a letter from Boulez to Stockhausen, around December 1954 (Losada 2018). This throws interesting light on the debate about lines of influence between European composers regarding 'open' elements in composition (O'Hagan 2017: 187). The open work, which refers both to works that lack a specific predefined trajectory, incorporating elements of choice, and to works that are subjected to perpetual recomposition and revision to the point that many remained as works in progress to the end of the composer's life, became an essential feature of Boulez's compositional approach for the remainder of his career.

Musical influences, principally affecting temporality and timbre, were important as well (O'Hagan 2007) but were always integrated into the musical language, transforming it from within, rather than invoking or imitating an extraneous context (see Losada 2021). As stated above (p. 135), Boulez explains the incorporation of instruments from other cultures as a means to destabilise dominant hierarchies, which is made possible by the profound incompatibility in the aesthetic contexts (Boulez 1984: 140). The movement Boulez was working on during his South American tour of 1954, the 'III Commentaire', incorporates clear timbral influences. The beginning of the work shines with the bright, propelling rhythm of the claves, while the end is characterised by timelessness in the repetitions of the bongos and maracas attacking simultaneously

(this texture is reminiscent of the method of playing the birimbao). In an interview with Peter O'Hagan, Boulez acknowledged other influences, like the timbral contrast between harp and flute of the music of Peru, which is essential to the timbral and spatial worlds of the 'Improvisations sur Mallarmé' in *Pli selon pli* (quoted in Campbell 2016: 23; cf. Bassetto 2003). In spite of acknowledging the influence of the Latin American music in matters of texture and rhythm in this interview with Peter O'Hagan, in other places Boulez disclaims any musical influence from Latin America, claiming that the influence was spiritual and not musical (Boulez 1967: 4). This most likely reflects the fact that the musical influences were not in the realm of pitch, nor were intended as imitation, but instead transcended into other dimensions, such as texture and temporality, which, in fact, had a more profound influence on future trends, as I will discuss in the conclusion to this essay (pp. 138–9). For example, in the interview with O'Hagan, he acknowledges the influence of the contrast between percussion and voice of the *candomblé*. This can be linked to the contrast between smooth and striated time that underlies much of his music from this time (including the examples from *Le Marteau* and *Pli selon pli* above), as well as his development of the concept of resonance, perhaps best represented in the play between resonant and non-resonant instruments that is basic to his conception of *Éclat*, which reaches beyond extending the dimension of time into that of musical space.

Campbell provides important information showing how the Latin American tours were essential to Boulez's conducting career, since they gave him a first opportunity to conduct a symphony orchestra in a comparatively safe context, which boosted his confidence (Campbell 2016: 21–2). The strides he made in the transformation of his compositional process during the same time period, indicate that the Latin American tours were essential to his development as a composer, giving him the distance and perspective necessary to truly explore new realms and break boundaries and to allow influences from the music of other cultures to re-emerge in his compositions. As Boulez wrote to Souvtchinsky on a 1956 postcard containing an image of one of the Inca ruins in Peru:

Look at this post card. It will show you the rhythm of my breath when I am alone! I am here for two days completely by myself, face to face with this. I am oxygenating myself for the future. And all previous connections will fall. The sanctuary of these places has alleviated my anxiety, and strengthened my resolution. We shall speak of it in Paris. (Boulez to Souvtchinsky, quoted in Campbell 2016: 20 (translation modified); cf. Losada 2021b)

To summarise, Boulez's redefinition of serialism consisted of developing a palette of developmental techniques that could be applied simultaneously to the horizontal and vertical dimensions and at a compositional, rather than a pre-compositional stage, which imbued them with an unprecedented degree of flexibility, as they could proliferate while the composer worked on individual passages. This perspective sees the development of newer trends in Boulez's music, not as an extension, or loosening, of the serial practice, but as developments that were made possible by his redefinition of serialism. The mathematical premises underlying his focus on techniques that developed relationships built into the material itself, resonate with those embedded in transformational theory. For this reason, the music is ideally suited to analytical techniques that invoke that theory, as embodied in the work of David Lewin (Lewin 1987; Lewin 1993). Its structure results from anchor notes and important common tone relationships that provide the basis for larger-scale harmonic structures and allowed Boulez to explore the so-called diagonal dimension, allowing for the flexibility in the treatment of musical time.

Such flexibility in the compositional approach enabled an opening up of the aesthetic realm that had important repercussions in the development of future trends. Many of Boulez's works from this time (for instance, *Éclat*) were groundbreaking in their exploration of time and space informed by the concept of resonance. The major transformation of his compositional techniques during this time period, with their harmonic structures characterised by large, common subsets embellished by additional notes, can also be seen as resulting from a broader exploration of the concept of resonance, which provides the primary inspiration for all the timbral references described above (Losada 2021). Such focus was behind Boulez's far-reaching influence on a younger generation of composers, particularly through his work at IRCAM (Institut de Recherche et de Coordination Acoustique/Musique). He had a crucial influence on subsequent developments in composition in fields. The influence of such aesthetic issues (exploration of time and space) on electronic music is straightforward enough. Scholars have also commented on the relationship between Boulez's blocks of sounds and early experiments in the electronic studio (Piencikowski 2002; Decroupet 1995a). By understanding the importance of the concept of resonance to Boulez's later works, one can also make a case of his influence on the aesthetics of spectralism, which developed at IRCAM in the 1970s. In fact, spectral composer Tristan Murail describes spectral music as an aesthetic concerned with 'sound evolving in time' (Fineberg 2000: 2; cf. Murail 2005).

Beyond the aesthetic realm, technical influences are important as well. The serial developmental techniques underlie the relationship between acoustic and electronic components in Boulez's most influential electronic works. For instance, in *Répons*, a work which propelled him again to the very forefront of composers, Boulez translates his most important serial techniques to the electronic manipulations that are embedded in the work (Gerzso 1984). In these precise technical connections the root of Boulez's motivation for founding IRCAM can be seen, a cooperation between scientists and artists to create a technology that can give voice to the artist's technical and expressive ideas. Similarly, Boulez's exploration of sound structures through repeated proliferation of his techniques of development in the vertical realm (for instance in the Third Sonata (O'Hagan 1997 and 2017) and *Doubles* (Losada 2018 and 2019b)), along with his aesthetic position that explored the boundaries between perception and non-perception, prefigured crucial developments in compositional trends that explored the boundaries between sound and noise essential to sound mass composers such as Penderecki and Ligeti (Boulez 1976: 51–2; cf. Losada 2014, 2017, 2019a, and 2019b; Decroupet 2006). This discussion shows how, far from an abandoned practice, Boulez's expansion and redefinition of serialism resulted in works and approaches that opened up new avenues for composition and continue to be relevant to composers worldwide to this day.