Schoenberg, Serialism and Cognition: Whose Fault if No One Listens?

Philip Ball

Address for correspondence:
18 Hillcourt Road
East Dulwich
London SE22 0PE
p.ball@btinternet.com

Abstract

Atonal compositions based on the twelve-tone method devised by Arnold Schoenberg remain, in some cases a century after they were written, largely unpopular with music audiences. Research in music cognition may now offer some clues to why this is. Schoenberg's method of atonal composition actively undermines some of the basic cognitive principles that allow our brains to turn notes into music. Unless twelve-tone music is granted other aids to cognition, it may thus fail to create a cognitively coherent auditory experience, but becomes a mere collection of sounds.

Introduction

In 1958 the American composer Milton Babbitt wrote an article in the music magazine *High Fidelity* that still provokes fury today.[1] His title said it all: 'Who Cares If You Listen?' Responding to widespread accusations that modern classical music was incomprehensible to, and disliked by, the great majority of the music-loving public, Babbitt argued that not only should modern composers be unconcerned at this animosity but they should welcome it. If the public had no interest in this new music, he said, the composer should stop worrying, making compromises and indulging in exhibitionism to attract an audience, and simply get on with 'his' craft – or perhaps, he might have been tempted to say, his science.

In the 1950s, classical composition was dominated by the form of atonalism developed at the start of the century by the Austrian composer Arnold Schoenberg and his followers in the so-called Second Viennese School, most notably Anton Webern and Alban Berg. Schoenberg devised a prescriptive system, described below, for composing music that lacked a tonic centre around which the melodies and harmonies were rooted: it gave equal status to all the notes of the chromatic scale. Within the academic spheres of music composition, Schoenberg's 'serialist' or 'twelve-tone' technique came to be seen as the only respectable way to write music, to the extent that any attempts to compose within the old tonal tradition were widely regarded as recidivist, decadent and vulgar. Babbitt was one of a group of composers, including the influential Pierre Boulez in Paris, who extended Schoenberg's serialist constraints on the way pitch was organized to embrace

other musical parameters such as rhythm and dynamics, leading to a mode of composition called total serialism in which tightly prescribed rules dominated the composer's practice.

The result was a kind of music that, to many listeners, sounded fragmented, bleak and inaccessible. In contrast to the experiments in chromaticism, dissonance and rhythmic irregularities practiced by composers such as Richard Wagner, Serge Prokofiev, Igor Stravinsky and Béla Bartók, which were at first greeted with bafflement and even outrage by the musical public but have now contributed much-loved pieces to the standard Western repertoire, the atonalism of Schoenberg and his followers continues to be deemed 'difficult' by many concert-goers. Some of these works, such as Berg's opera *Lulu*, are considered by many critics to be masterpieces of modernism. But many are rarely performed, and are still regarded as commercially risky by concert programmers unless leavened with more popular pieces from the older tonal repertoire.

Whence this resistance? Babbitt put it down to conservatism and ignorance. Those charges were, and still are, repeated by champions of serialism. In his *High Fidelity* article Babbitt acknowledged that the ways in which pitch and other musical parameters were used in extreme atonalism 'makes ever heavier demands upon the training of the listener's perceptual capacities.' This, however, was granted not in recognition of the difficulties with which a listener was confronted, but as the prelude to an impatient criticism of the poverty of intellectual resources that audiences brought to this complex new music. Because they are so bad at remembering precise values of pitch, register, dynamics, duration and timbre, said Babbitt, most listeners ended up 'falsifying' the intentions of the composer.

Why on earth should the public *expect* to understand this advanced art form, Babbitt asked, any more than they would understand advanced mathematics? Mathematicians and physicists can go about their recondite business without facing accusations that they are somehow elitist and are shirking their social responsibility. Why not musicians?

And so, he concluded,

> I dare suggest that the composer would do himself and his music an immediate and eventual service by total, resolute, and voluntary withdrawal from this public world to one of private performance and electronic media, with its very real possibility of complete elimination of the public and social aspects of musical composition.[1]

Many people were outraged by Babbitt's remarks because they considered them to be an arrogant dereliction of the musician's duty to *communicate*. Such accusations are easily enough refuted if one takes the perfectly defensible position that the artist has no obligation whatsoever to communicate, but only to follow his or her impulses and instincts. The issue then simply becomes that of whether or not you like the kind of music Babbitt was advocating. Many didn't and still don't; then go elsewhere, Babbitt seemed to say.

It is not wholly unfair to suggest that there is a strongly conservative streak in the

audiences of classical music. While undoubtedly some concert-goers have eclectic and experimental tastes, others will still consider Bartók forbidding and post-war atonalism unlistenable. The schedules of any major concert venue, or at the sales statistics of recordings of classical music, will confirm the suspicion that the public taste remains firmly rooted in tonality. For example, none of the 50 top-selling composers through the UK music retailer HMV in 2003-2008 composed in an atonal style. At London's Royal Festival Hall, 'contemporary classical music' – including just about anything atonal – is split off from the main programmes of the resident London Philharmonic and the Philharmonia Orchestras and assigned to the London Sinfonietta, as if to imply that it forms virtually a separate genre. Even during the 1950s, at the height of serialism's popularity among composers, just ten tonal composers (Bach, Handel, Haydn, Mozart, Beethoven, Schubert, Chopin, Wagner, Brahms and Debussy) were responsible for 39% of all music performed in the then-current repertoire.[2]

This cannot all be attributed wholly to the conservatism of classical audiences. The return to tonality evident in the music of Steve Reich, John Adams and Philip Glass has been greeted with an enthusiasm that Boulez has never been afforded. Dissonance abounds in the works of young contemporary composers such as Thomas Adès and James MacMillan, yet audiences will give them more of a chance than arch-serialists such as Babbitt or Luciano Berio.

The half-century of research on music cognition since Babbitt published his article now provides material for a more informed and fruitful debate of the position he espoused. It enables us to ask whether there are more deep-rooted, cognitive reasons for the cool reception this 'modern' music has received.

In exploring that question here, I imply that calling something 'music' does not make it so. Debating the question 'is it music?' is as arid as the equivalent debate over art in general, and I am uninterested in looking for definitions. Rather, I examine the issue of what patterns of sound are and are not cognitively transparent. As we come to understand more about what it is that enables the human mind to 'think musically', we might reasonably wonder whether sound can be considered to become music in the degree to which it allows us to do this. I show that Western atonal music has, to varying extent, tried systematically to eliminate the characteristics that traditionally render the music of most cultures comprehensible. My contention is that Schoenberg's atonalism need in itself be by no means an inaccessible system for composing music, but that unless composers working in that tradition recognize the fundamental cognitive needs and limitations of the listener, they risk not so much making music as arranging notes. The two are not the same thing.

The perceptual origins of tonality

Western tonal music – which includes just about all Western music from the early Renaissance to the late nineteenth century – is music that has a key, and therefore an associated scale and tonic. In effect, this means that, out of the twelve notes in the chromatic scale*, some are privileged over others. Since the early sixteenth century this

privileging has generally been governed by the use of diatonic scales – the major and minor (Figure 1). These scales select seven from the full gamut of twelve chromatic notes, and structure the composition around this subset. To put it crudely, the scale tells you which notes in a particular key 'sound right': in the key of C major, say, they are all the white notes of the piano.

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*I should more properly talk here of *pitch classes* rather than notes, to acknowledge the equivalence of notes in different octaves. That is to say, there are twelve pitch classes in Western scales, which repeat in successive octaves. Furthermore, I am referring here to *equal-tempered* diatonic scales. In other forms of temperament, such as the Pythagorean and just intonations used in early music, there are more than twelve pitch classes, because each key may have its own unique set of pitches. In these temperaments, for example, the sharp and corresponding flat notes, such as D# and E*b*, do not have the same pitch, which they do on a modern piano keyboard. However, the arguments about tonal hierarchies of pitch are not specific to the intonation system: they apply to tonal music regardless of the precise tuning of the notes.

This certainly does not mean that the diatonic notes are the only ones that may be used in a tonal composition, however. There are *no* intrinsically 'wrong' notes in the key of C (even if we set aside the possibility of modulating, within a C major composition, to other keys). In Bach's C major fugue from Book I of *The Well Tempered Clavier*, for example, no single pitch class is excluded: all the notes in the chromatic scale are used within barely a page and a half of manuscript.

If that is so, then what is it that really distinguishes tonality from atonality? The perceptual rules we use for establishing the tonality when we listen to a piece of music are not ones that derive from any musical theory; they are purely statistical. That is to say, we learn by acculturation which notes to 'expect'. These are rules that we begin learning at birth, or possibly before[3], and have mostly mastered by the age of five – by this age, children can identify the difference between 'in key' and 'out of key' (diatonic/non-diatonic) notes in simple tonal melodies[4-6].

What the key of a piece of tonal music determines is not 'which notes may be used', but the *probabilities* of the various notes it contains: the chance that any note in the music, picked at random, will belong to a specific pitch class. A composition in the key of C major is more likely to contain a G, say, than an F# or a C#. The *probability distributions* of notes encode how many times each note occurs in a piece, or equivalently, the relative probability that a note chosen at random will belong to a particular pitch class. These distributions are easy to deduce simply by counting up notes. For Western classical music, they turn out to be remarkably stable across many periods and styles[7] (Figure 2).

It is not obvious, however, that we will *judge* the status of notes this way – that the salience of notes in musical practice must conform to that in our subjective impression. Carol Krumhansl and her coworkers have conducted exhaustive listening tests to find out if this is the case.[8] In a typical study, they establish a tonal context – a sense of key – by

playing a chord, a scale, or a short sequence of chords of the sort that might end a song (called a cadence). They then immediately play their subjects a note in the chromatic scale and ask them how well it seemed to 'fit' the context. The results are remarkably consistent, regardless of the extent of the listeners' musical training (Figure 3). Krumhansl calls this subjective evaluation of the 'rightness' of notes the *tonal hierarchy*.

The tonal hierarchy tells us what we would intuitively expect. The common notes – the peaks in the distribution – are all in the diatonic (here the major) scale, and the troughs are all chromatic notes outside the scale. The latter are all used more or less equally rarely. The notes of the major triad chord (the tonic, third and fifth of the scale: **1-3-5**, or here C-E-G) are the most frequently used. The tonic note **1** is the most salient of all: it is the note that centres the melody. In this distribution we can identify a *hierarchy* of note status with five levels: the tonic, tonic plus fifth, the major triad, the diatonic scale, and the chromatic scale (Figure 4). Although it is normally applied only to Western music, the word 'tonal' is appropriate for any music that recognizes a hierarchy in which note use is favoured to different degrees. That is true of the music of most cultures.

This differentiation of notes is a cognitive crutch: it helps us interpret and remember a tune. The notes higher in a hierarchy offer landmarks that anchor the melody, so that we don't just hear it as a string of so many equivalent notes. Music theorists say that notes higher in this hierarchy are more *stable*, by which they mean that they seem less likely to move off somewhere else. The tonic, being the most stable of all, is where many melodies come to rest. This is true of just about any children's song, and of most popular tunes or hymns, from 'Happy Birthday' to 'We Wish You a Merry Christmas' to the Beatles' 'I Wanna Hold Your Hand'.

The notion that some notes are more stable than others can be turned on its head to say that some are more *active*, tending to 'push' the melody off elsewhere. We can think of the pitch space as a topographic landscape in which more stable notes correspond to the valleys (Figure 5). A melody is then like a stream of water that seeks the low ground. From any point, it will tend to run towards the nearest depression: the nearest note of greater stability. More-stable notes exert a pull on nearby less-stable ones. In C, an F is pulled down towards E, but also up towards G. An A gravitates down towards G, but a B tends to rise up to C. Chromatic ('out-of-scale') notes are particularly unstable and are likely to move quickly onto more stable ones: an F# to a G, an E*b* to a D or an E. Such notes are generally just 'passing tones', of brief duration.

These attractions filter down through the hierarchy: ultimately, everything is drawn to the tonic. So a tune may come to rest temporarily on the relatively stable third or fifth, but still feels a pull to the tonic, which might be reached either in a series of small steps or in a leap, as at the end of 'Auld Lang Syne', which jumps up from a fifth to the tonic on the last two syllables.

Krumhansl's tonal hierarchy is very similar to the actual distribution of notes (see inset, Figure 3). But what is cause here, and what is effect? What, ultimately, makes us decide that a G is a better fit in the key of C than is an F#? Do we make that judgement based on

what we've learnt from exposure to music, or is it determined by innate mental factors, influenced for example by considerations of consonance, which composers have then simply put into practice? A correlation analysis of the tonal hierarchy against measures of consonance and actual tonal distributions in Western classical music of the eighteenth and nineteenth centuries suggests that learning of statistical probabilities is far more important than intrinsic consonance.[9] This implies that we should be able to learn new ideas about 'rightness' if we hear them often enough.

Although Krumhansl's methods have been criticized[10, 11], her point that statistical learning guides or even governs our perception and expectation of the notes that make up a melody is widely accepted. The implication is that we form a mental image of the tonal hierarchy, and refer to it constantly to develop anticipations and judgements about a tune, whether we are listening to a nursery rhyme or a Bach cantata. When we hear a piece of music, we begin immediately trying to match it to a particular tonal hierarchy – in other words, to locate the key and tonic. Even people who have no musical training or specialized knowledge, and who may not even know what a key is, will typically deduce a tonal centre within a few seconds of the music starting.[12] A general sense of tonality, which entails an ability to sing a song without constantly wandering out of key, develops in most people by the age of five or six without any formal training.[5, 13-15] By seven, many children can detect a key change – a switch to a different tonal hierarchy – in the middle of a familiar song.[15]

If music was simply a matter of following gravity-like attractions from note to note, there would be nothing for the composer to do: a melody would be as inevitable as the path of water rushing down a mountainside. The key to music is that these pulls can be resisted. It is the job of the musician to know when and how to do so. If there were no underlying tendencies, no implications within each note of which one will follow, we would be indifferent to the outcome, and all melodies would sound like the same random meandering. The effect of a tune is determined by whether it follows the attractions or resists them. This is one of the fundamental principles of how music exerts its *emotional* power: it is a question of whether or not the music meets our expectations of what it will do next.[11,16] The tonal hierarchy and the different stabilities of musical notes create a context of expectation and anticipation, which the composer or performer manipulates to make music come alive and convey something akin to meaning. If the melody moves from a note of lesser to greater stability, we sense a reduction of tension, as though some constraint has been relaxed. In short, the tonal hierarchy provides the tonal composer with a framework for creating a sense of purpose, meaning and intentionality in music.

Enter serialism

In the finale of his Second String Quartet, written in 1907, Arnold Schoenberg made the dramatic gesture of omitting any key signature. It was an admission that his music had finally reached the point where assigning a key had no meaning, because it said nothing about the notes that the composition included: they weren't structured around any scale. So there was no longer a tonic note; the music was *atonal*.

We can now see more clearly what this notion implies. It is not the abandonment of a key signature per se that matters. Others, such as Erik Satie, had previously omitted an initial indication of key, finding it more convenient simply to annotate the various accidentals (sharps and flats) as they occurred. And conversely, Schoenberg could have written his finale with a key signature but merely applied the necessary accidentals where needed. The reason this music can be considered atonal is not because it formally dispenses with a tonic, but because it does so in *perceptual* terms: if we listen with an ear attuned to tonal music, we can't make out where the piece is rooted. To put it another way, the tonal hierarchy of Figure 3 no longer applies – it is not a good guide to what notes we should expect to hear. Yet just about everyone in Western culture, both in the early twentieth century and today, grows up hearing and learning this tonal hierarchy, and so will instinctively try to apply it to atonal music. This is why many find such music baffling: they have no conceptual tool for navigating it.

Cross-cultural studies have shown that new tonal hierarchies can be learnt rather quickly, and can then help us make sense of music from unfamiliar cultures and styles.[17-20] But the point about Schoenberg's atonality is not that it has a different tonal hierarchy; it is that this music has *none*.

That is quite deliberate. Schoenberg designed his atonal music explicitly to make it so. He recognized how strong our urge is to identify a tonic, and assumed that we generally do this on the basis of note statistics: we assign the most common note as the tonic. (The way we assign a key is in fact not quite as simple as this – it draws also on what we have learnt about the unequal interval step sizes of the diatonic scales.) 'The emphasis given to a tone by a premature repetition is capable of heightening it to the rank of a tonic', Schoenberg wrote.[21] In order to remove all traces of tonality, it is not enough simply to use plenty of chromatic notes outside the diatonic scale; we have to ensure that no note is played more often than any other.

This is the objective of Schoenberg's serial or twelve-tone scheme. It requires the composer to begin by creating a *tone row* in which every note (again, one should really say pitch class) in the chromatic scale is arranged in a particular sequence (Figure 6). This is the raw material of the composition: the sequence specifies the order in which notes may be used. The twelve-tone row must be sounded in its entirety before it may repeat. In this way, no tone can acquire any more significance than any other, and so there is no possibility of a sense of a tonic note emerging even by chance. The hierarchy is flattened by fiat.

This might sound like a highly constrained way to compose. But Schoenberg permitted various permutations of the tone row too, related to the original one by symmetry operations: the order of notes may be reversed (a retrograde row), or it may be inverted, as if in a mirror plane through the first note. Or reversals and inversions may be combined (Figure 6). Moreover, each note can be sounded in any octave, and individual notes can be repeated before the next one sounded. In Schoenberg's original scheme, the composer was also free to choose rhythm, dynamics and so on, although later total serialists precluded these options.

The cognition of serialism

Serial atonalism purposely sets us adrift from any locus to which expectations of 'the next note' can be pinned. To many listeners, this simply provokes irritation, exasperation or boredom – the music seems incomprehensible, and they feel the composer is just being obtuse. To others, the effect is pleasantly arousing: like any other confusion of our expectations, it stimulates careful listening and invokes a sense of tension. Such tension can never be resolved in the ways that it is for tonal music – there is 'no way home' to a stable tonic centre – but atonalism can perform a delicious juggling act, offering little hints of structure and logic that keep our attention alive.

Krumhansl *et al*. have tested listeners' responses to serial compositions using the same methods that were used to establish the tonal hierarchy.[22] They played the subjects tone rows or excerpts from serial compositions to establish a context, and then asked them to assess the fittingness of each note in turn from the chromatic scale. The responses varied hugely, and it is hard to discern any general rules in how the listeners try to organize what they hear. In general, however, they showed signs of searching (fruitlessly) for hints of structure based on their expectations from tonal music. (Interestingly, listeners with more training in atonalism show the opposite behaviour: having learnt to expect no tonal root, their responses seemed governed by an expectation that the music would avoid any hint of it.)

This seems to lend some support to the assertion of composer Paul Hindemith that trying to avoid tonality is, for most listeners, 'as promising as attempts at avoiding the effects of gravitation.' The result, he said, is like 'those sickeningly wonderful merry-go-rounds on fair grounds and in amusement parks, in which the pleasure-seeking visitor is tossed around simultaneously in circles, and up and down, and sideways.' He concluded that future generations 'will probably never understand why music ever went into competition with so powerful an adversary.'[23]

Yet Schoenberg's method does not by itself guarantee to eliminate all trace of tonality. Consider the tone row in Figure 7, which obeys Schoenberg's rules. It starts with the ascending major scale of C, and ends with a descending pentatonic (five-tone) scale on F#. (Such pentatonic scales are common in non-Western music, for example that of East Asia.) So this tone row will create two *local* sensations of tonality, in C and F#. Here we would be finding a sense of key not on the basis of overall note statistics (which remain 'flat' – there is still no tonal hierarchy), but because of our learnt associations of groups of notes with diatonic scales and with certain pitch steps. In other words, we are persuaded for a brief moment to 'hear with tonal ears': to imagine a tonal hierarchy where there is in fact none.

If one were to choose tone rows at random, one would quite often find little groupings like this (albeit generally less extreme) that give a momentary sense of tonality. Some twelve-tone composers, including Stravinsky in his later works and indeed even Schoenberg himself, used rows that create, apparently by design, momentary tonal effects

in this way*. But musicologists David Huron and Paul von Hippel have looked at the statistics of Schoenberg's tone rows, and find that on average they have fewer local groups of notes that give a hint of tonality than a random selection would provide.[24] In other words, it seems that Schoenberg preferentially selected those rows that banish tonality most effectively. For this reason, Huron argues that serial composition should not be regarded as 'atonal' at all. Rather, the system is deliberately *contratonal*: not casually ignoring tonality, but taking great pains to eliminate all trace of it. It seems that Schoenberg did this unconsciously – there is no sign he was aware that the twelve-tone method needed something more to achieve his contratonal objective.

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*Both Schoenberg and Alban Berg in fact manipulated tone rows ingeniously to reconstruct 'tonal' effects such as cadences. Berg even managed to recreate the opening of the Prelude to Wagner's *Tristan und Isolde* in his *Lyric Suite*, and part of a Bach chorale in his Violin Concerto. This seems bizarre for composers who are allegedly trying to escape tonality, especially as it is so hard to do. But it seems that Schoenberg's school was keen to show that there was a link between twelve-tone music and the earlier, especially Germanic tradition – that the former was somehow validated as an extension and generalization of the latter. In many ways Schoenberg was no revolutionary but a staunch traditionalist.

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Gluing a tune together

Traditional tonal music does not by any means attain its comprehensibility solely from the tonal hierarchy. There are many other cognitive mechanisms at play that weave sequences of notes into coherent streams (while keeping these streams distinct from one another), and which create a tense of trajectory and intention in music.[7, 11, 25, 26] These mechanisms stem from the tendency of the human mind to seek meaningful associations between groups of stimuli: does *this* belong with *that*? The default position is that it probably does, unless there's good reason to think otherwise: we are pattern-seekers.

The key mechanisms by which such associations are identified were proposed by the German-based Gestalt psychologists in the late nineteenth and early twentieth centuries, centred around Max Wertheimer, Christian von Ehrenfels, Wolfgang Köhler and Kurt Koffka,. They argued that the mind possesses holistic organizing tendencies that make perceived experience more than the sum of its parts. By grouping and separating the patches into discrete objects, we make the world an intelligible place. We form continuous objects from fragments, for example if more distant objects are broken up by intervening ones. And we learn to assume continuity: to expect, say, that when an aeroplane passes behind a cloud, it will appear on the other side.

The gestalt principles are most easily understood in the visual realm. We might group objects by similarity, or proximity, or by the presumption of smooth contour ('good continuation') (Figure 8). Our comprehension of these visual associations requires no conscious effort: in cognitive terms, we can *parse* the stimuli very readily. In other words, the gestalt principles operate 'out of sight', as it were. All of these visual

principles have sonic analogues, and this means that music is only indirectly related to the acoustic signals generated by the performers. What we 'hear' is an *interpretation*, a best guess in which our brains seek to simplify the complicated soundscape by unconsciously applying the gestalt principles, which have been found from experience to do a fairly reliable job of turning the sound into a hypothesis about the processes that created it.

The principle of good continuation, for instance, is one of the governing factors in the cognition of melody. It is widely recognized that the contour of a melodic theme determines how easy it is to process. Melodies that advance in small pitch steps tend to be perceived as continuous, while large pitch jumps threaten to break this continuity. This is reflected in the fact that the probability of pitch steps in the music of most cultures has a universal tendency to decrease as the steps get larger (Figure 9).[7] In C major, there is a stronger probability that, say, a C will be followed by the D above it than by an F. (This explains why the peak for D in Figure 2 is higher than that in Figure 3 – Krumhansl's method doesn't really take into account expectations of *melodic trajectory*.) There is a correspondingly stronger probability that a G will be followed by an A or F than by a C. As with predicting the weather day to day, we are most likely to forecast correctly the next note in a melody by assuming that it will be similar to the last one. To what extent this preference for smooth melodic lines is an intrinsic organizing characteristic of auditory cognition, and to what extent it is statistically learnt, is not clear. But either way, it conditions our expectations about what melodies will do, and seems to represent a basic cognitive aspect of music processing.

Smoothness of melodic contour can be maintained irrespective of systems of tonality, as indeed the tone rows in Figure 7 imply. So there is nothing in Schoenberg's method that explicitly excludes it. Berg's *Lyric Suite* (1925-6), for example, makes use of predominantly small pitch steps in its melodic lines. But because Schoenberg insisted on the principle of octave equivalence – a pitch class in the tone row can be sounded in any octave – his rules promoted the notion that smooth contour need not matter. In other words, it was the absolute *pitch class* of each note that was important, not its distance in pitch from the preceding note. As a result, many atonal compositions have a jagged, disjointed pitch profile. In the later *total serialist* approach, which prescribes the choice of register (or, in some cases, assigns this at random) as well as pitch class, smooth melodic contours may indeed be more or less banished (Figure 10). It is for this reason – and *not* because of the high degree of chromaticism or musical dissonance – that detractors of Schoenberg's music are right in a sense to say that it typically has no 'tune'.

Schoenberg's school never seemed sure quite how to handle the notion of melody. Alban Berg claimed that melody formed that basis of twelve-tone music just as much as it did any other music. But it's not clear what he meant by 'melody', a word that he uses almost synonymously with 'theme'. Schoenberg himself searched for ways of constructing atonal melodies from his twelve-note alphabets, but without reaching any strong conclusions. Anton Webern seemed happy to renounce melody in favour of shorter *motifs* that could be woven together like those of a Bach fugue.

The extract in Figure 10*a* also makes clear what happened to rhythm in total serialist compositions: namely, that it was fractured to the point of invisibility. Rhythmic regularity is another of the cognitive aids on which tonal music has traditionally relied: gestalt-based processing looks for some kind of rhythmic continuity, such as what we might recognize in musical terms as a sense of metre. Even the striking irregular rhythms in Stravinsky's *Rite of Spring* jolt our expectations because they are created by the uneven emphasis of notes or chords spaced *evenly* in time (Figure 11*a*) – that is to say, they occur within a regular metrical pulse. The effect is disconcerting and, for many listeners, enlivening, precisely because of this interplay between the regular and the irregular: we are given the material to develop expectations, even if these are then manipulated and violated. The same is true even when Stravinsky uses complicated changes of metre (Figure 11*b*), because again there remains an underlying grid on which the lurching stresses are arrayed: the crochet timings are identical even if the stresses vary. As a result, the pattern is disjointed but nonetheless comprehensible.

In contrast, extreme serialism of the sort practised in Boulez's *Structures Ia* takes pains to eliminate any sense of a grid. The events seem to be independent of one another, and we have no basis for formulating any expectations at all about when they will occur. As a result, the music can seem rhythmically formless – just a collection of isolated events. Again, I want to emphasize that Schoenberg's twelve-tone technique did not in itself enforce this – it said nothing about how rhythm was to be used. In a piece such as Berg's *Lyric Suite* the rhythms and dynamics seem to share much in common with those of tonal music, no doubt contributing to the sense that this is music with a clear and audible logic.

As an organizing principle in serialism, surely the most obvious candidate is the tone row itself. Won't we hear it as a kind of tune simply because we hear it again and again? Apparently not – because we *don't* really hear the tone row again and again. For one thing, in the absence of guidance from a tonal hierarchy or melodic contour, it becomes just a series of twelve notes – which is rather too many for the human brain easily to recall in sequence[27] (just try memorizing a random series of a dozen numbers). Furthermore, the brain simply does not encode sequences of notes in permutational form, but rather, uses hierarchical structures as *aides memoires*. For example, Diana Deutsch has found that the phrase in Figure 12*a* is more easily remembered if structured as in Figure 12*b* than in Figure12*c*, even though they contain exactly the same sequences of notes, because the pauses in the first example divide the sequence into groups of notes with identical contours (sometimes called parallelism, because the successive melodic contours stay parallel to one another).[28, 29] In other words, there is a transparent hierarchy in the pitch grouping patterns in the former case. In a very real sense, there is *less information* to recall in that instance, because the repeating pattern makes it possible to condense the information of the whole sequence into a more concise form. Instead of having to remember that 'C# follows the first D, and then D follows that…', we need simply recall that there are four repeating motifs, each consisting of a semitone step down and then back up, on each note of the G major chord. (There is an additional element here to aid memory: the starting notes in Figure 12*b*, but not in Figure 12*c*, are on the notes of the major triad, which is another structure we have already encoded in our brains in the tonal hierarchy.) In the same way, the sequence 123123123123 has an obvious structure

that 121322311322 does not: it is algorithmically compressible. Serial composition does not lend itself to this kind of hierarchical structuring: the tone rows do not, for a start, 'sit' on a tonal hierarchy, and the serial idiom does not tend to arrange rows into fragments that share similar contours.

The situation is made worse by Schoenberg's assumption of octave equivalence. We do not remember melodies according to the pitch class of the component notes, but according to the contour – the series of pitch intervals. Musically untrained adults asked to sing back an unfamiliar melody might not get a single note right, yet will capture the basic contour. And familiar tunes remain recognizable when the melodic contour is 'compressed', as if reducing the vertical scale on a mountain range.[30, 31] Conversely, if the notes of a well-known melody are played in randomly selected octaves, so that the pitch classes are retained but the melodic contour is completely altered, the tune generally becomes very hard to identify (Figure 13).[32, 33]

And once the tone row is rearranged by the manipulations permitted by Schoenberg's scheme, it becomes extremely hard to recognize as bearing any relation to the parent sequence. Schoenberg appeared optimistically to imagine otherwise, drawing an analogy with vision: 'Just as our mind always recognizes, for instance, a knife, a bottle, or a watch, regardless of its position, even so a musical creator's mind can operate in the imagination in every possible position, regardless of their direction, regardless of the way in which a mirror might show the mutual relations, which remain a given quantity.'[34] According to music psychologist Diana Deutsch, Schoenberg's assumptions of 'perceptual equivalence under transposition, retrogression, inversion, and octave displacement are fundamental to the theory of twelve-tone composition.'[35]

But tests show that sequences of notes altered in this way are rarely recognized as equivalent.[35-38] We don't encode melodies in ways that facilitate it. For one thing, the various transformations are apt to alter the melodic contour, which, as indicated above, supplies our initial, crude mnemonic device. But more generally, the fact that we do not encode melodies as mere sequences of pitch classes, which makes the tone row hard to perceive even in its unaltered form, creates even greater cognitive barriers under permutation. It's one thing to *know* that one sequence of notes is an inversion of another, but quite another to *hear* it.

Fred Lerdahl lists several reason, in addition to these, why tone rows are 'cognitively opaque'[39], including the unsystematic way they incorporate consonance and dissonance, and the lack of shared 'pitch alphabets'[30] between different serial works (in comparison to the common use of, for example, arpeggios and ascending or descending diatonic scales in tonal music).

Actually, it is not clear that Schoenberg ever really intended the permutations of a tone row to be heard by the listener. They were simply a *compositional principle*, a way of creating building blocks for assembling into music.* Notice that in the quote above he speaks only of the 'musical creator's mind', not the listener's. The tone row was not a

musical idea so much as a set of musical atoms. Composition began only after the tone row had been selected.

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*Schoenberg seems somewhat ambivalent about this. He claimed that 'consciously used, the motif [tone row] should produce unity, relationship, coherence, logic, comprehensibility and fluency.'[40] But even this doesn't explicitly suggest that these things are to be experienced by the audience, as opposed to the composer.

The music theorist Allen Forte has claimed that serial music is organized according to so-called pitch-class sets, which are small groups of notes (more properly, of pitch classes, taking no account of octave) that recur in clusters either simultaneously (in chords) or sequentially (in melody).[41] Rather like the tone row itself, these sets are transformed in the composition according to various symmetry operations, such as inversions or cyclic permutations. The problem with this rather mathematical analysis is that it focuses only on the musical score and again takes no account of whether the sets are actually perceived. There is no indication that they are, and good reason to suppose, on the above considerations, that they are not.[30] Indeed, the typical 'deep embedding' of pitch-class sets in the musical structure (Figure 14) makes it highly unlikely that even experts can hear them, at least without prior study. So whether or not pitch-class set theory elucidates any formal structure in atonal music, in all probability it says nothing about how that music is heard – nothing, indeed, about it *as music*.

Lerdahl's accusation of 'cognitive opacity' in atonal music extends beyond the character of the tone row to issues of larger-scale structure. One of the central tenets of the 'generative theory of tonal music' developed by Lerdahl and linguist Ray Jackendoff is that music has a hierarchical structure analogous (but not identical to) the embedded form of linguistic constructions, with an associated syntax that governs the arrangement of component parts.[39, 42, 43] This structure, according to Jackendoff and Lerdahl, can be revealed through a gradual simplification and stripping down of the 'musical surface' called pitch reduction, removing less important notes and retaining just the skeleton – a process inspired by Heinrich Schenker's method of musicological analysis introduced in the first half of the twentieth century.[44] But Jackendoff and Lerdahl suggest that atonal music may contain little in the way of grammatical and syntactic structure. There is no atonal equivalent of a grammatical form such as a cadence, for example, and indeed no reason why any particular chord should follow or precede another, beyond (in serial composition) the constraints of the tone row. When the generative theory of Jackendoff and Lerdahl is applied to atonal music, it elicits structures that are 'perceptually fragile' – that is, it is hard to identify the start and end of phrases – and 'of limited hierarchical depth': they are all surface, with little recursive branching.[38] Tests on music students and specialists seem to bear this out[45]: the subjects were unable to identify accurately which of two pitch reductions of pieces of atonal piano music best matched the original pieces, indicating that any hierarchical structure was not clearly perceived. This implies is that, although serialism certainly has governing rules (and typically applies them inflexibly), they are not of the kind that permit a well-formed musical grammar. Syntactically speaking, this music is shallow.

That may be significant for the way we respond to it. One of the reasons why music commands our attention may be that our mechanisms for linguistic processing might be marshalled to give a perceptible logic to complex music.[46] Our ability to develop musical grammar means that we are not doomed to remain at the level of nursery rhymes (which, it must be said, already have a simple syntax). But music without a clear grammatical framework may struggle to amount to more than a linear series of notes and motifs, lacking in depth.[39] And again, when the 'rules' of the music are not cognitively transparent – whether at the level of pitch relations or of larger-scale hierarchical and syntactic structure – it becomes harder to develop meaningful expectations, and so a major channel of emotional expression is denied.[11, 16]

As serialism came to be imposed on ever more of the composer's degrees of freedom – as it moved towards total serialism – it concerned itself ever less with what a listener heard and became increasingly a glass-bead game for arranging notes. This is illustrated by Pierre Boulez's *Le Marteau sans Maître* (1954), a composition that sets the surrealist poems of René Char for an alto voice and six instruments. Widely acclaimed when it was first performed, it nevertheless posed a puzzle: Boulez indicated that it was a serial piece, but no one could work out how. It was not until 1977 that the theorist Lev Koblyakov figured out the unconventional serial process Boulez had used.[47] In other words, for over 20 years no one could deduce, let alone hear, the organizational 'structure' of this masterpiece. This doesn't mean that *Le Marteau* is wholly unlistenable: the unusual sonorities are, for a time, diverting in their own way. But it shows that there is no intelligible organization of pitch (and, one might add, of rhythm either). One can hardly blame audiences for suspecting that what is left is musically rather sparse.

Philosophy, politics and music

The obvious question is: *why* did Schoenberg invent his twelve-tone method? Much has been made of Schoenberg's insistence on the 'liberation of the dissonance', a demand that we cease to consider some combinations of notes as cacophonous and forbidden. To this extent, Schoenberg's method seems only to be the logical endpoint of the experimentation with chromaticism and unconventional harmony that had been growing in music for almost a century. By the start of the twentieth century, composers could use just about any amount of dissonance they wanted. They wouldn't always be thanked for it – audiences rioted at the premiere of Schoenberg's Second String Quartet in Vienna in 1908, and indeed even his 1899 tonal piece *Verklärte Nacht* was controversial when it premiered in 1902. But there was far more receptivity to new sounds in the early twentieth century than is credited by the endless (and often misleading) recounting of the riot at the premiere of the *Rite of Spring*. In *Verklarte Nacht* one can hear the sound of conventional Western tonality in its anguished death-throes: music on the brink of falling apart. So what led Schoenberg to reject tonality so forcefully in his compositions – not just to avoid it, but to take explicit steps wholly to expunge it?

The fact is that Schoenberg created serialism not so much in order to do something new as to avoid doing something old. For all the talk of liberation, it was in fact a system

designed to *exclude*: specifically, to exclude tonality. To Schoenberg, tonality needed to be banished because it had become a tired, sentimental, clichéd reflex.

The music theorist Eduard Hanslick remarked in 1891 on the way innovation can become tired mannerism, leading to a high turnover of forms in classical music:

> Modulations, cadences, intervals and harmonious progressions become so hackneyed within fifty, nay, thirty years, that a truly original composer cannot well employ them any longer, and is thus compelled to think of a new musical phraseology.[48]

This was precisely Schoenberg's complaint. He felt that his serial technique offered a systematic alternative to diatonic tradition, as opposed to *ad hoc* chromaticism. The tone row, he said, 'unifies all elements so that their succession and relation are logically comprehensible, and which is articulated as our mental capacity requires, namely so that the parts unfold clearly and characteristically in related significance and function.'[49]

Quite aside from the alleged degeneracy of the *musical* language of tonality, some of Schoenberg's supporters, notably the sociologist and musicologist Theodor Adorno, emphasized the political connotations of serialism.[50] Adorno's Marxist critique of tonality argued that it had become the instrument of a complacent and selfish bourgeois capitalism. He felt that capitalist 'mass culture' had essentially 'confiscated art', and that to reclaim it entailed a complete rejection of the old tonal language of music.

Yet Schoenberg and Adorno never really explained where the supposed banality of tonality lay. While it is true that one can detect a certain reliance on easy affect and over-used structures in the music of Sibelius and Vaughn Williams, their complaint also seemed to be that classical conventions had been debased in popular music (Adorno loathed jazz). The serialists held the diminished seventh chord in particular contempt, whose 'shabbiness and exhaustion', said Adorno, is evident 'even to the most insensitive ear'.[51] But philosopher Roger Scruton points out how absurd it is to say that a particular *chord* can be banal, rather than the way it is used. 'What would remain of the art of painting', he asks, 'if individual shades could simply be deleted from the painter's palette by those who use them tastelessly?'[52] Scruton suspects that Schoenberg deplored the diminished seventh precisely because its ambiguous nature, devoid of any clear tonal centre, opens up for the tonal musician the liberation from the tonic that Schoenberg wished to claim for himself.

Babbitt reconsidered

Plenty of people, even if they are a small minority among Western music listeners, find satisfaction in the ascetic extremes of total serialism. Clearly they have found ways of listening that make sense to them – perhaps, for example, by focusing on the individual sonic events rather than searching for relationships between them. It is hardly meaningful to suggest that they are wrong or mistaken in their tastes. Even the more extreme serial experiments are not wholly barren. They may weave strange, disembodied effects. One can enjoy their colourful interplay of timbre, one can sense skittish little ideas in their dense flurries of notes, or enjoy the weightlessness of their open spaces. They challenge

us to find new ways to *hear*. (But one must sometimes suspect that such responses free-ride on our pre-existing musical resources, and do not seem an obvious part of the composer's skill, sensitivity or intention.)

Besides, one can hardly blame Schoenberg, or indeed Babbitt, for ignoring principles of music cognition that had yet to be discovered. But experimentation in music it must be regarded as precisely that: an experiment, which by definition may or may not work. Schoenberg's experiment did work to the extent that it led to new sonorities, new possibilities for finding form in music. It *did* liberate composers in some ways, and in the hands of artists such as Berg, Stravinsky, Messiaen, Penderecki, and Schoenberg himself, atonalism could become a vibrant force. But *a priori* innovations driven primarily by philosophical, theoretical or ideological motivations lack a tradition from which to draw. Great art succeeds not because some theory says it should but because it is embedded in a web of reference, allusion and convention – it takes what we know and changes it, sometimes radically. Artistic traditions generally have the shapes they do for reasons that are to do as much with an empirical appreciation of cognitive needs as with the exigencies of culture and history. They can't simply be invented from first principles.

How, then, might one respond to Babbitt, in the light of our current understanding of musical cognition? We might want to acknowledge that he was right to be impatient at the notion that music should be undemanding. He was right that the marketplace is not the best arbiter of what is valuable in music. And he now looks prescient in his suggestion that electronic media could free musicians and composers from the normative and homogenizing demands of commercial success – all kinds of odd sonic experiments thrive on the Internet, and our musical world is the richer for it.

Furthermore, the arguments adduced here do not imply that there is anything 'wrong' with atonal music, serial or otherwise. As I hope I have indicated, many serial works muster organizing principles outside of the tonal hierarchy and its associated syntax that lend the music transparency, emotion, even genius. But if the cognitive crutch of tonality is removed (and if the aim is to write music that can be coherently processed without a tremendous amount of theoretical preparation and repeated hearing), it seems important to recognize that this has been done, and that other cognitive mechanisms, such as the use of gestalt binding principles in melody and rhythm, are brought to bear. Babbitt's aloof dismissal fails to acknowledge the issue of cognition at all. It is not, for example, that listeners are inept at remembering pitch and duration values, but that the structure of the music actively thwarts this – sometimes for experienced listeners as much as for naïve ones. It cannot be a good thing for musicians to be erecting those cognitive barriers *without any awareness that they are doing so*.

And in ignoring public taste entirely, musicians and composers in Babbitt's milieu ran the risk of becoming increasingly dogmatic and narrow about what music *is*. The resolute rejection of tonality in the 1960s and 70s became as doctrinaire and, ultimately, as conservative as the disdain that visual artists of the 1980s displayed towards those who wanted to paint pictures. Moreover, the austere purism of some total serialists refused to acknowledge the social roles that music has long occupied in all cultures of the world. At

its worst, the attitude towards the public becomes one of sheer condescension. Even in 1998 the pianist and critic Charles Rosen could write:

> Nothing is more comic than the resentment of contemporary art, the self-righteous indignation aroused by its difficulty. I remember once being invited to lecture in Cincinnati on the music of Pierre Boulez and Elliott Carter. In the question period afterward, a woman posed what she evidently conceived not as a question but as an aggressive and defiant challenge: 'Mr Rosen, don't you think the composer has a responsibility to write music that the public can understand?' On such occasions I normally reply politely to all questions, no matter how foolish, but this time I answered that the question did not seem to me interesting but that the obvious resentment that inspired it was very significant indeed.[53]

One can perhaps forgive some of Rosen's haughtiness in the light of the fact that questions of this kind are often a coded way of asking why composers don't write music like Mozart and Beethoven any more. But taken at face value, the question is a genuine one, even if one's preferred answer is 'no'.

Music can be a great many things. But there does not seem much point in allowing it to be *anything*. Our minds use certain cognitive tools to organize sound into music. With practice, we can change the way we listen. But if we frustrate our auditory cognitive mechanisms too far, all we are left with is sound. It seems possible that some forms of total serialism become tolerable to listeners only when they become inured, and not because there is really anything to hear – nothing except notes and silence, a meandering uniformity with no means of creating tension and release, or for beginning and ending. As Roger Scruton puts it, 'When the music goes everywhere, it also goes nowhere.'[54]

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Figure 1 The major and minor diatonic scales.

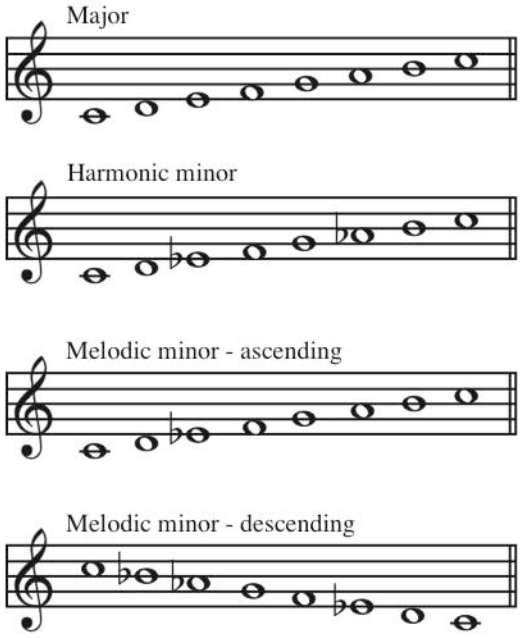


Figure 2 The frequency of occurrence of pitch classes for major-key Western tonal music of the eighteenth to early twentieth centuries. The sample (all transposed to C major) consists of: songs by Schubert and Schumann, arias by Mozart and Mendelssohn, lieder by Richard Strauss and cantatas by Johann Adolf Hasse. The width of the band spans the range of values for each of these groups.

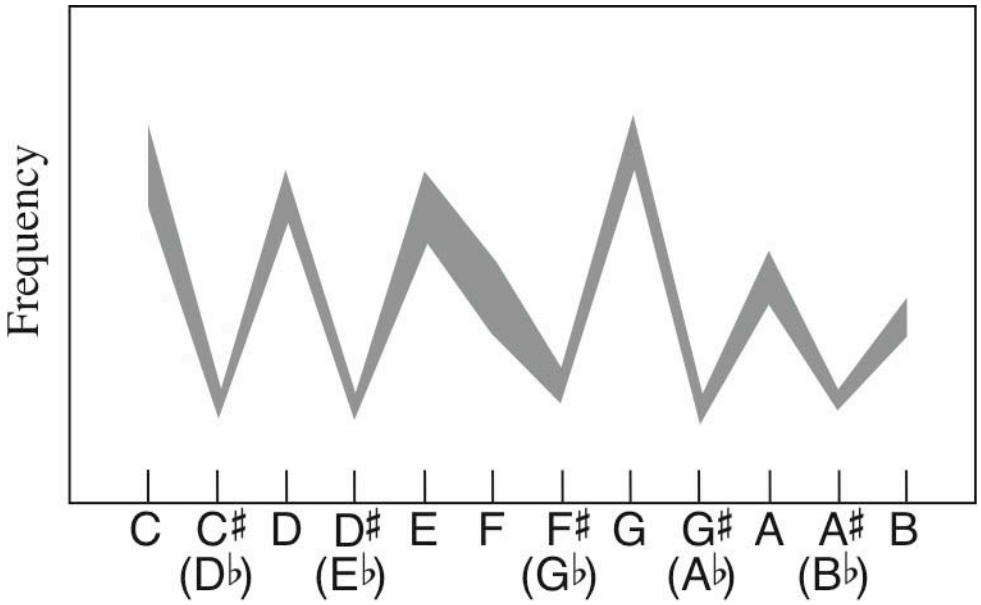


Figure 3 The ‘tonal hierarchy’: how people rate the ‘fittingness’ of notes within the context of C major. *Inset*: Comparison with the actual note frequency distribution for Western tonal music.

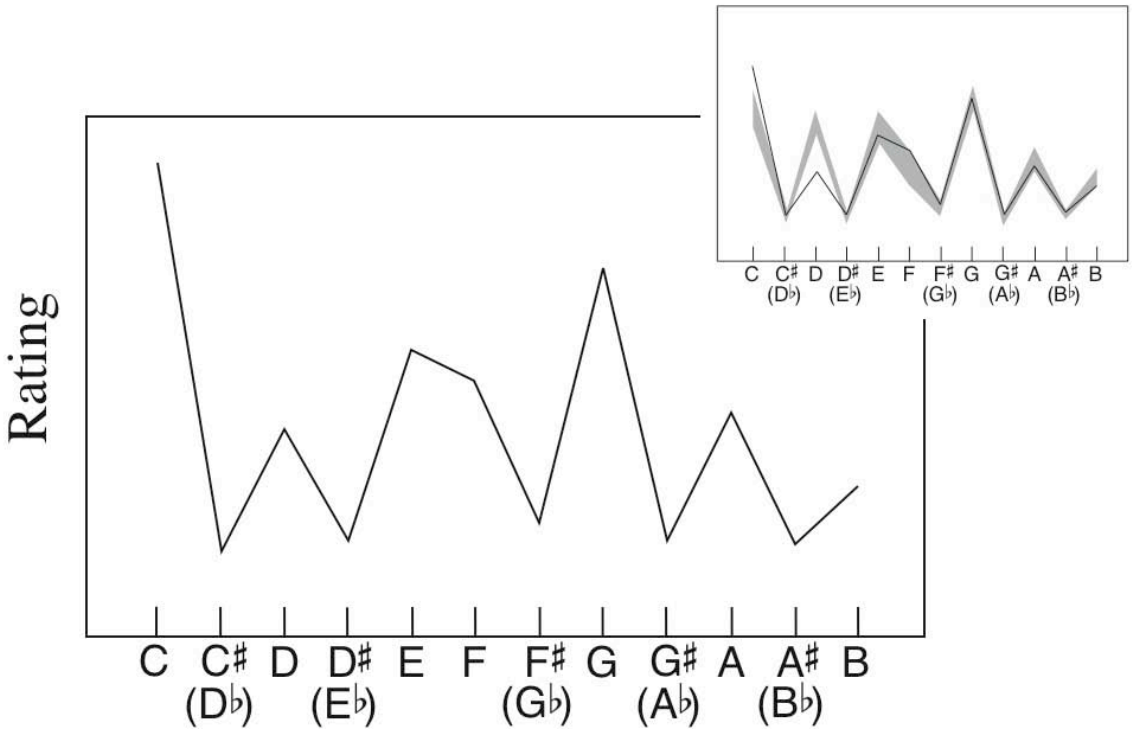
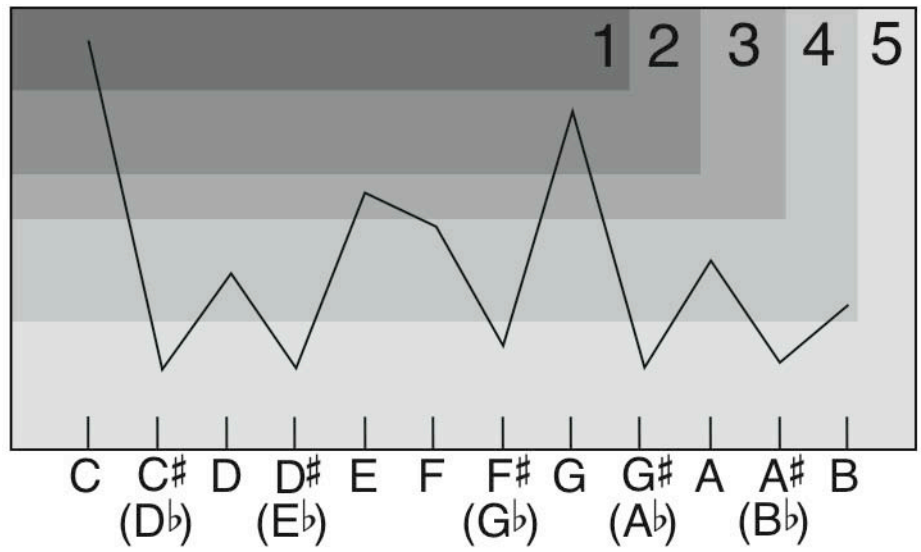


Figure 4 The hierarchy of notes in the major scale.



1: Tonic	C											
2: Plus fifth	C							G				
3: Triad	C				E			G				
4: Scale	C		D		E	F		G		A		B
5: Chromatic	C	C♯	D	D♯	E	F	F♯	G	G♯	A	A♯	B

Figure 5 Note stabilities, and the ‘tendencies’ of melodic movement. Solid lines show stronger tendencies, dotted lines show weaker ones.

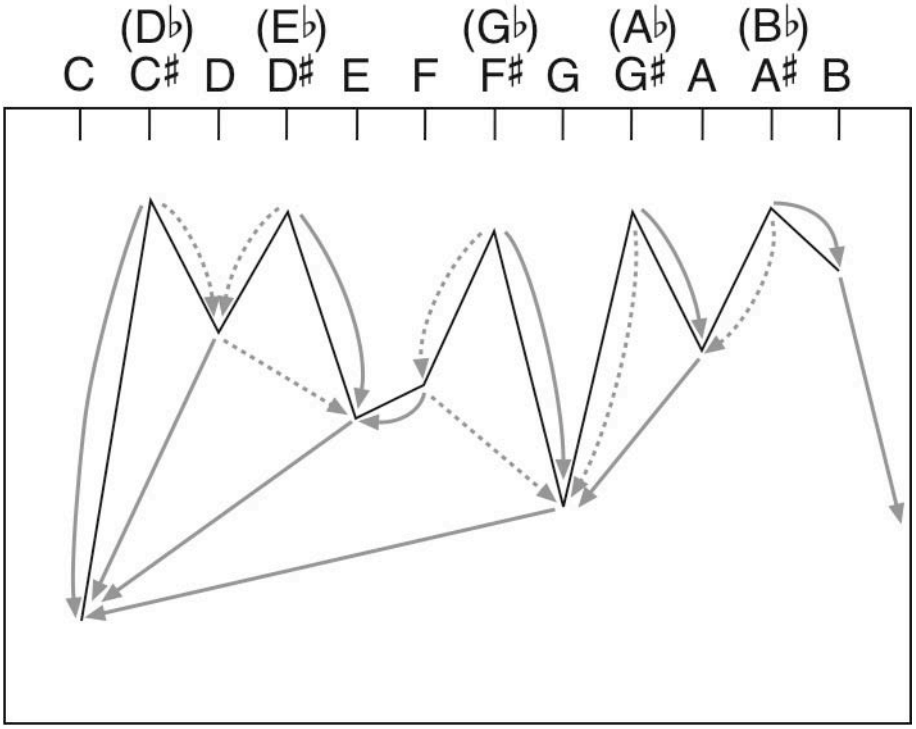


Figure 6 A twelve-tone row and its permitted permutations.

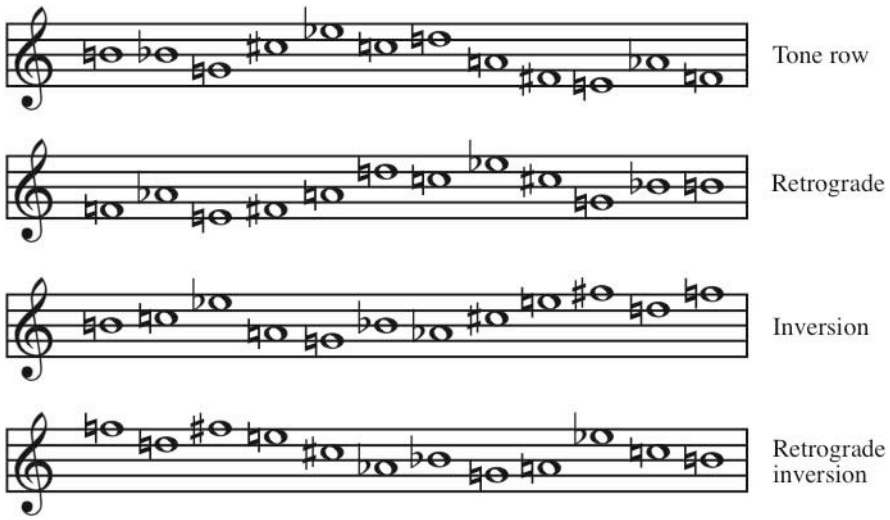


Figure 7 A tone row that creates two local sensations of tonality.

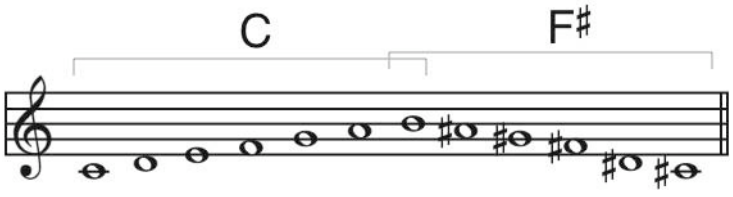


Figure 8 The gestalt principles of similarity (*a*), proximity (*b*) and good continuation (*c*).

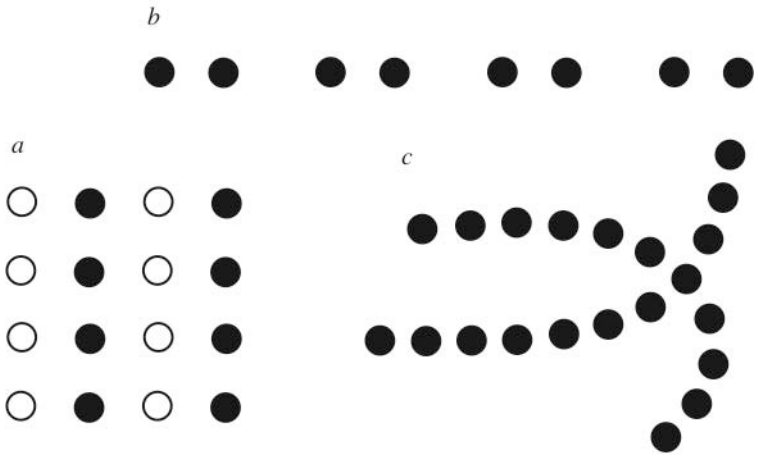


Figure 9 The distribution of pitch intervals for Western (*a*) and non-Western (*b*) music.

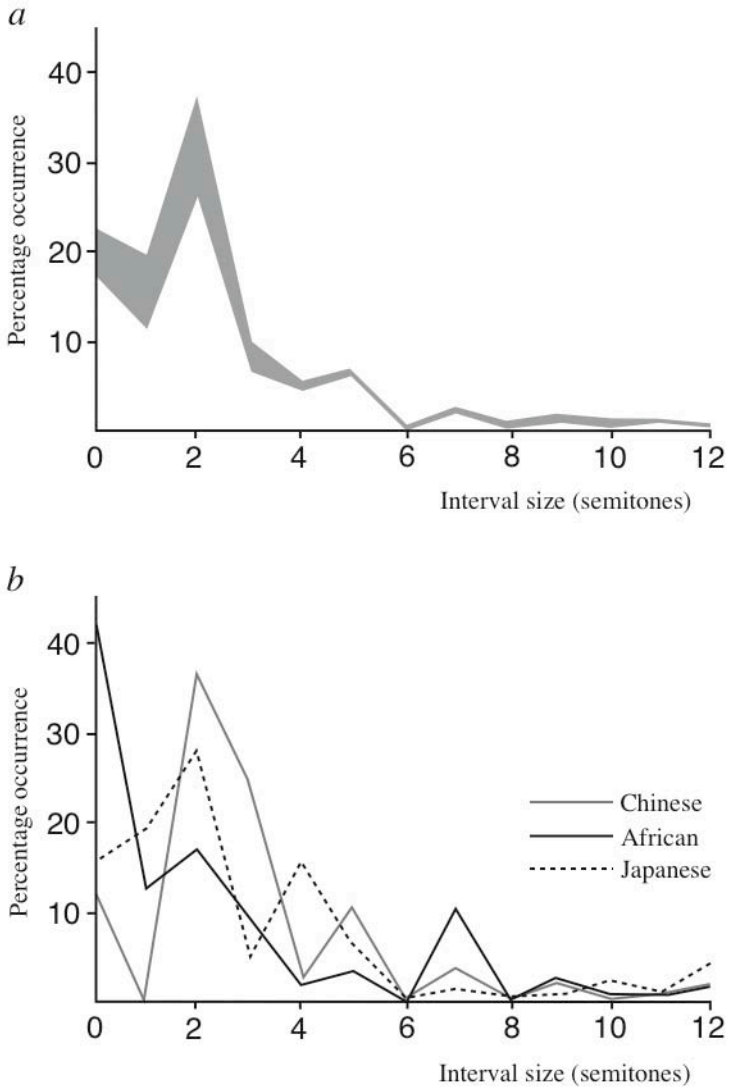


Figure 10 *a*, Extract from Pierre Boulez's *Structures Ia* (1952). *b*, Extract from Boulez's *Piano Sonata No. 1* (1951), second movement.

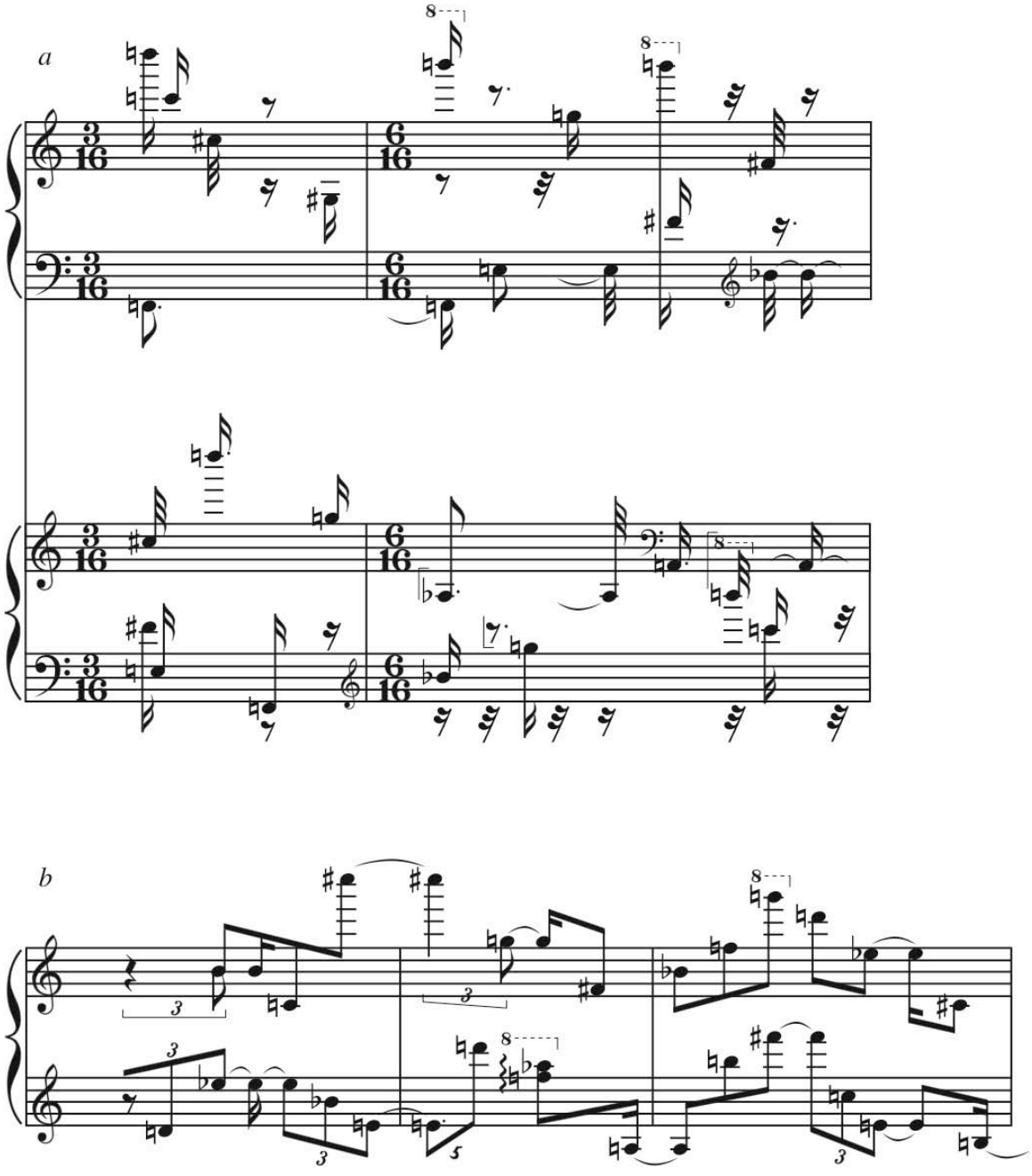


Figure 11 A steady pulse is maintained despite the erratic stresses in the 'Dance of the Adolescents' from Stravinsky's *Rite of Spring* (1912-13) (*a*). This interplay of regularity and irregularity is also evident through changes of metre in the 'Evocation of the Ancestors' (*b*).

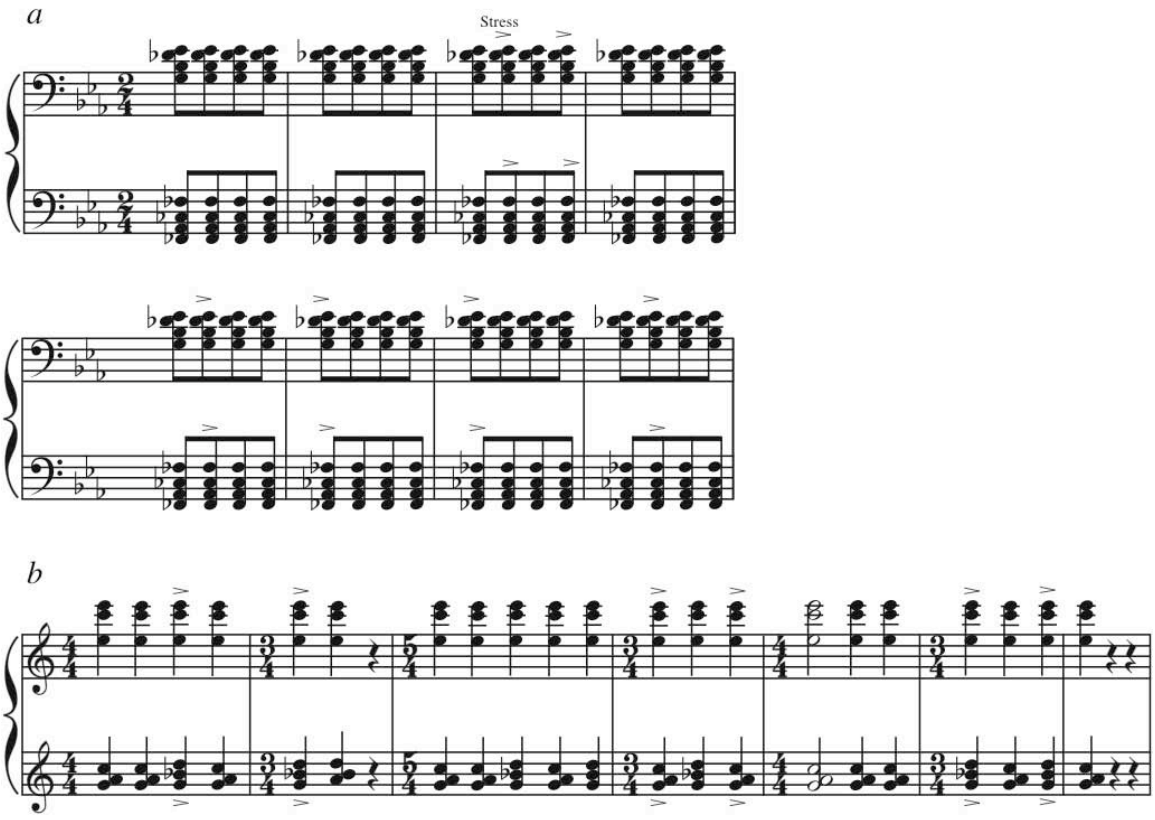


Figure 12 People can recall sequences of tones more accurately if they are grouped in ways that impose easily heard regularities, for example repetition of a pitch contour. The sequence in *a* is recalled more accurately if pauses are inserted between groups of three notes (*b*), emphasizing their identical contour. But if the pauses disrupt this repetitive structure, as in *c*, recall is considerably worse: the sequence 'makes less sense.'

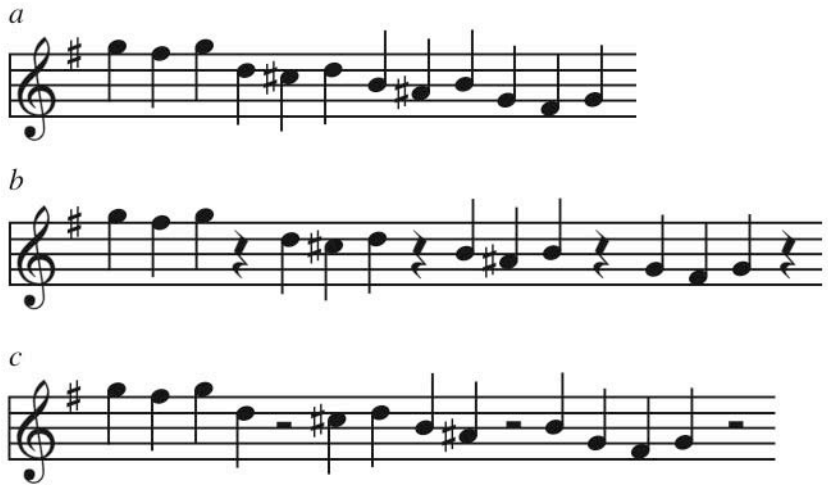


Figure 13 When familiar tunes are played with the notes assigned to random octaves, as with ‘Mary Had a Little Lamb’ here, they become impossible for most people to identify. This is because the melodic contour is severely disrupted by this octave-shifting.

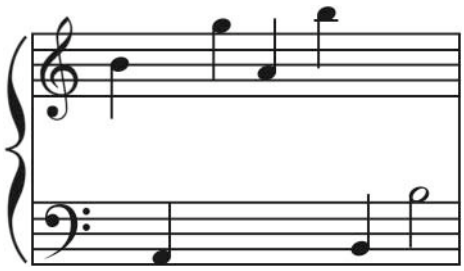


Figure 14 Some of the (three-tone) pitch class sets in Schoenberg's *Three Piano Pieces*, Op. 11 (circled). According to the theory of Allen Forte (which derives from an earlier suggestion by Milton Babbitt), atonal music is structured around such sets, which act as motifs. But as seems evident from this example – which is atonal but not serial – the pitch class sets are unlikely to occur in a way that is audible; they can be perceived only by analysis of the score.