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MUSIC RESEARCH AND PSYCHOACOUSTICS

THE RELATED DOMAINS OF PSYCHOACOUSTICS AND MUSIC research also had a pivotal ideological position in 1984 within IRCAM, and they were propounded by the musicians' group as the way forward for musical composition. The musicians' meetings were initiated in urgent response to a massive planning document for the future of IRCAM, written by the incumbent Scientific Director at the start of '84, which hardly mentioned music or music research at all. That autumn he left IRCAM and his plans were never realized; but internal conflict between the scientific side and those who saw themselves as upholding IRCAM's musical ideals appeared to be chronic. As the musicians' meetings developed, they worked on defining two levels of future music research: the main research themes, and the social organization of research, for which they proposed new collaborative teams reminiscent of Boulez's Bauhaus model. This was a bid for more autonomy, power, and resources for music research, which the group felt to be under threat. By insisting on the centrality of IRCAM's future and long-term orientation, its musical goals and social organization, the group embodied a fundamentalist return to Boulez's original vision.

Central to the musicians' group engagement with music research and psychoacoustics in 1984 were interrelated concerns with timbre and with musical form. This must be understood in the context of historical developments arising from the impasses of musical modernism earlier in the century and their contemporary legacy.

The functional tonal music system upon which baroque, classical, and romantic music was based centered on manipulations of pitch, while timbre was a relatively neglected parameter of composition. With the gradual dissolution of functional tonality in late romanticism and early modernism, composers showed increased awareness of timbre, whether in Debussy's exploration of tone color or Varèse's extension of the range of sound materials. However, Schoenberg was the first to theorize timbre as a major musical parameter with his 1911 concept of *Klangfarbenmelodie*: a "melody" defined by successive changes of timbre rather than

pitch. Webern, in his pointillist works, pursued this by experimenting with timbral contrasts as a structuring device.

As we saw in chapter 2 [see original publication], the main thrust of the postwar avant-garde under the ideology of total serialism was the scientific extension of serialism to control all musical parameters, including timbre. But attempts to control timbre in this way by electronic synthesis, such as those by Stockhausen, produced poor, monotonous results. This was not the only postwar expression of an interest in timbre. Perhaps in reaction to the rationalist excesses of total serialism, during the '60s an eclectic range of composers – from the Poles Lutoslawski and Penderecki of the *Klangfarbenschule*, to Xenakis, Berio, and indeed Stockhausen – evinced a looser, sometimes mystical concern with sound color. At the same time Schaeffer was taking further the idea of timbre as a structural dimension with his aim of constructing a *solfège* of timbres for *musique concrète*. But it was the failure of early electronic synthesis in the service of total serialism, and of the acoustic analyses informing it, that led to efforts by scientists such as Risset to gain better analyses of timbre. I noted before how important computer technology became in allowing a new kind of feedback between timbral analysis and digital synthesis, with the idea that, in theory, digital synthesis could produce any timbre, given appropriate information.

This generation of researchers came to believe that physical descriptions alone could not explain the perceptually or musically meaningful aspects of timbre, so psychoacoustical research was deemed necessary to find the most perceptually important dimensions. These analyses helped to achieve a more organic range of synthesized timbres, revealing at the same time the extraordinary complexity of timbre for both analysis and synthesis – something that we will see continues to pose problems for computer music.

Some psychoacoustic research was employed, however, in a harsher critique of total serialism. Composers and researchers hostile to serialism and concerned with the audience's bewildered incomprehension of this music turned to perception studies to explain it. They argued that serialism transgressed the perceptual limits of the listener and was too complex and fragmented to be musically meaningful. In some cases, the scientific refutation of serialism was allied to a postmodern call for a return to tonality. This research did not simply criticize serialism as music, then, but offered a scientific critique based on purported universals of human perception.

A final factor in this history concerns another major problem in twentieth-century composition: the absence of any coherent approach to musical form since the advent of modernism. This refers to the high-level organization of musical sound horizontally, through time, but also vertically, as with tonal harmony. Classical musical form had continued into late romanticism, but with the break from tonality around the turn of the century came the question of new forms to match the new musical systems of atonality and then serialism. Boulez in 1951 chided Schoenberg for the "contradiction" of retaining classical form despite his invention of serialism, and Boulez's view – that musical modernism must seek new forms to suit new sound materials – became orthodox. Yet over the century no sustained modernist approach to form emerged, so that the problem of new musical forms has remained central to debates around modernism and its limits and has been high on the compositional agenda.

More recently two important developments have occurred, both dependent on the computer. The first links issues of form with timbre and time. We have seen that throughout the century composers have considered whether timbral change can structure music in time. Computer synthesis offers ways to further this, since unlike *musique concrète* and electronic synthesis, every component of a digitally simulated timbre is built up completely from scratch so that the timbre is no longer inviolate but, in theory, infinitely malleable. The technology has therefore come to be seen as a means of taking two such simulated timbral objects and, through an analysis of their components, building a "bridge" or "transition" between them. According to this approach, timbral objects need no longer remain discrete, but may be transformed, melted into one another, thereby creating unprecedented possibilities for structural movement by timbral change. Hence, while at the micro level each partial in the timbre is rapidly evolving in time, at the macro level the transitions construct higher-level musical time – a "timbral syntax."

One possibility of timbral transition, then, is that the microtemporal processes within the timbre and the formal macroprocesses constructed by timbral syntax could be related. The composer could derive macromusical forms from microtimbral processes – generate the whole from the seed – or vice versa, and so create unity. This is a highly sophisticated version of the notion of unifying micro and macro that we saw in chapter 6 [see original publication] was a rhetoric widespread within IRCAM and that continues the organicism of the tradition of German romanticism as reinterpreted by Schoenberg. In 1984 this approach was the pinnacle to which IRCAM's musicians' group vanguard in various ways aspired: an organicism doubly consecrated through its mediation by the latest, most astute scientific analyses and by the unique musical possibilities of advanced computer technologies. Since in 1984 the Chant and Formes programs were considered by many in the group to come closest to offering tools to pursue these ideas, the destinies of the Chant/Formes group and that of the vanguard were closely entwined.

The second development around musical form has involved a different level of computer applications. The work of writers such as Meyer (1956) indicates the parallels that have been developed in the past between information theory and music analysis. In disciplines related to computer science we can trace a development from information theory through cognitive science to artificial intelligence, a kind of applied cognitive modeling with the computer both as analytic tool and means of simulation. AI is based on the analysis of forms of knowledge to extract their essential content and logic or "rules," which are then redescribed as a structure of inference and written as an "intelligent" computer program, such as an "expert system," that represents a simulation of that knowledge system. Similarly, in music there has been a development from music analysis as a purely analytic field to one that, employing the computer and in conjunction with the rise of cognitive music studies and AI, aims to provide both computer analyses of musical structure and also computerized models of "musical knowledge" or "rules" as aids to composition. The computer has therefore come to be seen as a tool for analyzing the deep structures or "cognitive rules" characteristic of certain musics, but equally for simulating these rules – and indeed for generating entirely new abstract structures as frameworks for composition.

There are two observations to be made. First, we can see in these developments, due to the mediation of the computer as both analytic tool and simulator, a subtle but profound elision between analysis and composition: the two are close to becoming as one. Thus, at IRCAM in 1984 the main psychoacoustician, HM, constantly entertained the desire to compose since he saw his cognitive analytical work as generating compositional ideas, yet other composers' use of his research disappointed him.[1]

Second, the computer's ability to produce elegant abstract models has meant that its generation of new conceptual schemes for music, in particular mathematical and cognitive structural models, has become quite autonomous from the analysis of extant musics. This lay, for example, behind the AI-influenced approach of IRCAM's Formes program, with its generalized and abstract, hierarchical ordering of objects and events in time.

Both of these developments, along with the constant conceptual foraging for scientific analogies to structure composition that I described in the last chapter [see original publication], evidence a continuity with deeper characteristics of musical modernism. They should be grasped as an extreme contemporary expression of modernist theoreticism, the tendency for theory to become prior to, prescriptive of, and constitutive of compositional practice.

In this genealogy the scientific study of cognitive universals takes a central place, both psychoacoustic study of microtimbral and temporal processes and cognitive study of musical structure. We have seen a convergence from several directions of interrelated concerns with timbre and sound material, timbre and temporality, timbre and form, and timbre and perception. All were considered to be enhanced by the computer, since in theory it enables "any imaginable sound" or musical structure to be both analyzed and simulated. Yet it is also obvious that timbre becomes a rhetorical catchall subsuming many diverse preoccupations, and that "timbre," "temporality," and "perception" become generalized discursive themes. Motivated by major problems of musical modernism – the sense of sterility attached to composition techniques such as serialism based originally on the primacy of pitch, the lack of an approach to musical form, the errors of midcentury rationalism and scientism, the conceptual weakness of *musique concrète* – research on timbre and perception has been held, at IRCAM and more widely, to offer ways forward.

Overall, it is striking that the response to the deep musical and philosophical impasses that arose around early and midcentury serialist modernism has been to amend and improve the rationalism and scientism through increasingly sophisticated scientific and technological mediation. Far from rejecting the deeper epistemological character of modernism, postserialism has refined and complexified it, for example in the elision of computerized music analysis with compositional genesis. As we will see in greater depth, the discourse within which IRCAM is situated is a scientistic refinement of the classic concerns of modernism.

This legacy, with little overt hostility to serialism, lay behind the continuous reference to perception, timbre, and form by the IRCAM vanguard, for whom the study of musical perception and cognition would lay the basis for new sound materials and new musical forms. In 1984 there were, by consensus, two main psychoacousticians at IRCAM, neither employed as such: Pedagogy director RIG and junior tutor HM, both of whom had trained in cognitive music psychology.

IRCAM's psychoacoustic research at this time examined how listening organizes the physical world by differentiation and integration. The issue of aural integration can be illustrated by pitch perception, which involves the unconscious integration of many different harmonic partials (frequencies within the harmonic series) into a single sound object. This psychoacoustical phenomenon is called "fusion," and it was a theme of HM's research.

Work on harmonic fusion has fed into study of the contrasting perception of "inharmonics": those sounds, like bells, that are not based on a single harmonic series. Research has shown that we do not hear inharmonics as fused single objects; rather, we search unconsciously within them for the patterns of the harmonic series and hear them as a set of overlapping, incomplete harmonic pitches. In fact, when we perceive a pattern of higher harmonics within an inharmonic but the fundamental harmonic frequency is physically missing, the brain projects a phantom fundamental to replace the missing one, a phenomenon known as "virtual pitch." These apparent details were major interests of IRCAM's vanguard, since digital synthesis has the unique potential to construct infinite numbers of inharmonics and to change over time their "internal" structure of frequencies (or spectrum) so as to produce interesting senses of movement "within" the the sound – another kind of timbral transition, known at IRCAM as the "evolution of spectral form."Thus research on inharmonics, virtuals, fusion, and the "internal evolution" of sounds was seen as potentially valuable for composition.

The phenomenon of aural differentiation can be illustrated by RIG's studies of timbre. It is known that listeners have the capacity to differentiate relatively between pitches, so that they hear pitch intervals as relatively the same (for example a fifth, an octave) even if at absolutely different registers. RIG's work in the 1970s examined whether subjects have a similar cognitive capacity to differentiate between timbres, which are both physically and perceptually multidimensional. He focused on the "multidimensional scaling" of timbre and the notion of perceiving "timbral analogies." Subjects were asked to judge the similarity or difference between instrumental timbres (oboe and cello, clarinet and voice) sounding the same pitch. This gave a distribution of timbres according to perceived likeness and difference, though little understanding of the parameters underlying these judgments. From this, RIG drew up graphic representations of timbral perception in terms of two-dimensional and three-dimensional spatial distributions. These were meant to provide predictive maps of how to create perceptually interesting new timbres, as well as to serve as guidelines for the simulation of perceptually valid timbral transitions. The research aimed to inform both the synthesis of new sound materials and, through timbral syntax, new compositional forms. The implicit message: "where pitch was, let there be timbre."

Composer AV's project in 1984, described in the next chapter [see original publication], was an attempt to put some of this psychoacoustical work on timbral transition into compositional practice. In the following dialogue, HM, who was involved in the project, discussed the aims as well as problems that arose. But the exchange also conveys well the strategy whereby issues of perception are brought in as a hopeful way out of what has been, essentially, an aesthetic failure. The failure was an attempt to create a musically meaningful "interpolation" between two distinct timbres by synthesizing glissandi (slides) between their component frequencies.

Rather than reconsider whether such an aim is unmusical, HM preferred to think of the aim – a key principle of the music vanguard as informed by psychoacoustics – as correct, but the method used as perceptually at "too low a level." The answer, for him, was therefore not to think of a new musical aim but to be more scientific.

> *HM:* In his first visit in '82, AV wanted to work on timbral transition – from an oboe to a soprano voice sound – and we did that using Chant on the PDP10 with MC's help. Then he wanted transitions from very complicated inharmonic sounds like a gong or tam-tam into a soprano. But the problem is: even at the level of physical modeling, there's no similarity at all between those two things. I wrote him some [software] instruments that would allow him to take any given set of frequencies and have them interpolated in some bizarre fashion with another. It was a total failure. All we got is this large glissando which was not at all satisfactory for timbral transformation. So we started to think of other ways. . . .
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> We learned that it's not just to do with the frequency dimension. It's much more complicated. I've been playing a lot recently with this notion of the coherence of the behavior of sound objects, and what coherence means in one case is totally different from another case. So for that to be successful you'd have to be making the interpolations at a much higher level of behavior of the elements, because simply thinking at an acoustic level is not satisfactory. We did get some partially satisfactory results, based on a notion I came up with of a sort of pivot – a period of time in which things decompose and recompose into other objects. That was much better; we'd totally disintegrate one sound and then have it re-form over a specified time into the other sound.
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> *GB:* What you seem to be saying about timbral transformation is that the idea of interpolation as a continuous process is contradicted by realizing how precise are the coherences of timbres as discrete objects? . . .
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> *HM:* I wouldn't say it's contradicted: I think it *is* contradicted at the level we were dealing with it. But that's like trying to talk about social organization at the level of molecules – we were trying to deal with it at too low a level. It implies having a much better knowledge about what we mean by coherence in each case; so that when transformation takes place, it's at a *perceptually relevant* level, so that coherence is maintained, or incoherence if that's desired, at a level that's *believable* to the ear.
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> *GB:* So you're still convinced of the idea that there could be a syntax of timbral transformations that could in itself be some kind of syntactic language?
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> *HM:* Yes, I think so.

The absences in IRCAM's psychoacoustics are also significant. As well as being central to the *stage*, psychoacoustics was the subject of IRCAM's main public lecture series in 1984 called "Perception and Composition." Both courses dealt with timbre, inharmonics, and so on, but neither dealt at any length with rhythm as a musical dimension. Only the public lectures had a session called "Rhythm and

Time Perception," which looked at issues of time, memory, and duration rather than rhythmic issues of pulsation, beat, repetition – phenomena associated aesthetically with jazz and popular musics. Musical time in total serialism is conceived in terms of calculated durations that construct extremely complex and irregular rhythmic structures. RIG, who gave the lecture and who we have seen was keen on jazz, nonetheless spent all his time on a critique of this serialist approach and its lack of perceptual validity. He talked with relish, as follows.

> Boulez was a guinea pig in an experiment in complex rhythmic perception at Bell Labs. The idea was: can a composer really hear the differences if a performer of his music plays very complex rhythms right or wrong? For example, in $^{6}/_{8}$ a 7 over 6, or 19s over 13s, and so on – such as one finds often in the music of Carter or Ferneyhough. The results? Boulez and a well-known avant-garde violinist both showed great *errors,* and in opposite directions! So this shows that the ideas of rhythmic perception of someone like Carter are *wrong*! They are impossible to realize on two levels: that of production by a player and that of perception by a listener, even a highly skilled one!

RIG ended the thirty-minute talk: "I was going to talk about another level – why one jazz drummer will have 'swing' and another won't! But I guess I'll leave that for another evening." He therefore managed only the briefest reference, amounting to an evasion, of the issue of sophisticated rhythm in other musics such as jazz; and this, on the tail of an elaborate perceptual critique of serialist rhythm that signaled his ongoing ideological battle with Boulez.

This incident highlights the specificity of the musical terrain that IRCAM's psychoacoustic research addressed and upon which it erected "universal" models of human perception. In fact, during 1984 there was one research project devoted to analyzing the "rules" of jazz improvisation, which may seem to contradict my point about the aesthetic limits and the universalizing character of IRCAM's psychoacoustics. But the project was weak, its status low, and it was bugged by illegitimacy, above all because it was seen as not sufficiently generalizable by contrast with the rest of IRCAM's psychoacoustics, which was presumed to be.[2] In his lectures, HM appeared to have a sophisticated grasp of the issue of musical-cultural differences, admitting that "our cognitive abilities are experience-based, culturally specific."Yet challenged by a student who posed the extreme cultural determinist position – "But I hear no sound, nor any music, outside a certain aesthetic and historical context: it's all in these contexts!" – HM said nothing and the issue was never elaborated. Rather, on another occasion HM opted for a different perspective that evades cultural or aesthetic specificity, this time by dissolving it into an extreme individualism: the poststructuralist idea of music as a radically "open text," HM talked of "listeners [recreating] music by their own taste structure, so there are a multiplicity of different meanings or readings in a certain music." As we have seen, this rhetoric was also at times characteristic of Boulez.

Finally, it is worth noting that RIG's experiments in timbral perception involved just nine subjects: of these, all were IRCAM workers and one was Boulez. It is on the

basis of these thin experiments employing very culturally specific subjects that RIG drew data to be interpreted in terms of universals of timbral perception and intended in turn to generate apparently aesthetically independent techniques of timbral syntax. This throws into relief the claims of the research to embody culturally independent perceptual or musical universals, and it emphasizes the ideological nature of the scientific claims to universality.

Notes

1. Interestingly, this was later modified. A friend reported of HM in 1987, "He's given up on the idea of becoming a composer. He accepts that he's a good psychoacoustician, but that doesn't mean he's a good composer or can become one."
2. The project, on computer analysis of the "rules" of jazz improvisation, involved two outsiders unpaid by IRCAM: a postgraduate who knew nothing of music and a French musicologist who had written on jazz phrasing. In May the project came before a Music Research meeting for assessment where, despite the backing of RIG, its legitimacy was continually questioned. Another director asked dubiously, "Is this *really* a music research project? How do you see it being generalized here?"
3. For the overriding purpose of maintaining the anonymity of my informants, in this section, with permission, I have not divulged the journal's name or given full references for the short quotes taken from articles.
4. MC meant here that the speakers in his room linked to the interconnected speaker system were always turned on, in order that he could overhear *stagiaires'* sounds and so judge their talent
5. Lyotard argues that the self-legitimation by the quest for truth characteristic of science until the late nineteenth century has been "delegitimized": "a process of delegitimation fueled by the demand for legitimation itself . . . an internal erosion of the legitimacy principle of knowledge" (Lyotard 1984, 39). He summarizes: "The goal is no longer truth, but performativity. . . . The State and/or company must abandon the idealist and humanist narratives of legitimation. . . . Scientists, technicians, and instruments are purchased not to find truth, but to augment power" (ibid., 46).

References

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