52. The Complex Dynamics of Improvisation

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This essay provides some general observations about the field of improvisation studies and surveys important theoretical and empirical work on the subject. It makes a distinction between referent-based and referent-free musical improvisation, placing particular emphasis on the specific issues that surround the latter, and highlighting recent research that has arisen to address them. Whether referent-based or referent-free, improvisation appears to involve a continual tension between stabilization through communication and past experience and instability through fluctuations and surprise. While many issues persist about how to frame and explore musical improvisation, there is broad agreement that improvisation involves novel output (for the individual, but only optionally for society) created in nondeterministic, real-time situations by individuals and collectives involving certain affordances and constraints. The critical questions involve how we chose to frame these improvisatory dynamics: either as information processing struggling to keep pace with the cognitive demands of the moment, or as an ecologically sensitive engagement with one's sonic and social world.

52.1 The Study of Improvisation

The study of improvisation, paraphrasing *Howard Gardner*'s view of cognitive science, has a relatively short history but a very long past [52.1]. All instances of human music making, from the most ancient to the most avant-garde, arguably involve at least some degree of improvisation, if by this we mean making musical decisions in the course of performance. Until the advent of sound recording, however, musical improvisation was extremely difficult to document, and therefore to study systematically.

Oral teachings, and to a lesser extent written treatises on the subject, can be found in a variety of musical traditions: from Western classical music (at least until the time of Beethoven), to folk and art music traditions of the non-Western world (especially in south, west and southeast Asia, but also throughout much of Africa and Latin America), to more contemporary popular music styles, with jazz serving as an important locus of activity. The thrust of these treatments, however, tends to be either prescriptive or anecdotal. General comparisons between various improvising traditions were sometimes made, but relatively little scholarship attempted to offer a more systematic or synthetic view of improvisation, with [52.2] being an important exception.

Audio recording provided researchers with the ability to capture and rehear a performance, allowing for microanalysis of sonic details and for comparative studies, often either involving a single musician improvising on different occasions [52.3] or different individuals improvising on the same underlying musical structure [52.4]. This methodology allowed for more nuanced descriptions of musical improvisation, but the inherent complexities of the transcription and analysis process, whether done by a human or by a machine, are nontrivial. *Peter Winkler* in [52.5] highlights many of the insurmountable challenges inherent to any attempt to reduce music as sound to music as notation. He likens a transcription to a blueprint drawn after the building is built, and cautions us not to mistake the blueprint for the building.

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Beginning around the 1960s, the growth of both jazz studies and ethnomusicology as academic fields precipitated an increase in research on musical improvisation, with some of the most influential texts also emerging from nonmusic-related fields [52.6–8]. At roughly the same time, a musical practice specifically described as *improvised music* or *free improvisation* emerged that borrows from a panoply of musical approaches and at times seems unencumbered by any overt idiomatic constraints. This practice was originally championed by an eclectic group of primarily American and European artists with backgrounds in modern jazz and contemporary classical music. It now involves musicians emanating from around the world and draws on an even wider spectrum of influences, including electronic, experimental, and intermedia arts. This essay will provide some general observations about the field of improvisation studies and survey important theoretical and empirical work on the subject. It makes a distinction between referent-based and referent-free musical improvisation, placing particular emphasis on the specific issues that surround the latter, and highlights recent research that has arisen to address them. The scope of the research being surveyed is primarily limited to work published in English.

52.2 The Field of Improvisation Studies

In [52.9], *Bruno Nettl* argues that improvisation is *an art neglected in scholarship*. In [52.10] *Derek Bailey* observes that improvisation is both the most widely practiced of all musical activities and the least acknowledged and understood. Despite this apparent neglect, the academic field of improvisation studies has grown considerably in recent decades, with the publication of numerous scholarly books and articles on the subject, and with the emergence of academic journals, conferences, and graduate programs with improvisation as a central focus. The appearance of the journal *Critical Studies in Improvisation/Études critiques en improvisation* in 2004, the formation of the International Society for Improvised Music in 2006, and the forthcoming publication of the two-volume *Oxford Handbook of Critical Improvisation Studies* are all watershed marks for the field's increasing prominence.

While improvisation has often been studied in discipline-specific ways (e.g., in music, theater, dance, or visual arts), only recently have researchers embarked on more multi- and interdisciplinary work, at times spurred on by developments in the cognitive and neurological sciences, or by an interest in understanding improvisation across experience. Improvisation studies as an academic field tends to draw on many of the same theories that influence other scholarly work in the arts and humanities, such as critical theory, cultural studies, and science and technology studies. Researchers in the field have become more politically and socially engaged on the whole. Work on improvisation now extends well beyond the arts into fields such as education, philosophy, sociology, anthropology, literature, law, postcolonial studies, gender studies, human-computer relations, sports, and medicine, to name only a few.

Improvisation has also become a hot topic in management studies and organizational design, along with other business-related fields. Two special journal issues dedicated to this topic are [52.11, 12]. The former offers primarily a favorable assessment of employing the *jazz metaphor* to understand and generate creativity in the business realm, while the latter provides a more critical view of the underlying ethics and profit-driven motivations of attempting to *aestheticize* neoliberal economics.

What exactly is meant by the term *improvisation* across this variety of work can be remarkably diverse, and at times frustratingly vague. Certainly improvisation involves numerous different types of creativity (another term that defies easy definition). In the arts alone, whether it is theater, dance, comedy, painting or music, improvisation undoubtedly draws on different sets of abilities and experiences, and it offers different demands and rewards. Therefore, the metaphorical comparisons frequently made to improvising music from within other fields and pursuits can illuminate, but also obfuscate.

52.3 Challenges in Defining Improvisation

Definitions of musical improvisation tend to be vague, overgeneralized, or beholden to conventional notions of musical practice. For example, improvisation is often described as composing music on the spur of the moment, or as performing music spontaneously without the aid of manuscript, sketches, or memory. These

types of definitions tend to downplay the extensive practice and experience that seasoned improvisers bring to performance, and the ways in which memory (both declarative and procedural) and often some form of notation (perhaps functioning as an *aide memoire*) are still involved when one learns how to improvise.

Improvisation, according to *Bruce Benson* [52.13], does not fit the binary opposition of composition and performance that underpins how we tend to think about music making. He insists that we view improvisation along a continuum of musical practices running through various gradations of interpretive performance towards a type of stream-of-consciousness playing. Improvisation, however, can also be understood as qualitatively different from conventional notions of composition and performance, involving very different cognitive processes and reflecting different aesthetics, even a different ontology. Might improvisation challenge traditional notions that music necessarily involves a linear process leading from *compositional* activity to *performance* activity? Might it even get us to rethink conventional ideas about cognition that subscribe to a linear progression from sensation to thinking to action?

Jeff Pressing, whose work on the cognitive modeling of musical improvisation was some of the earliest and most influential on the subject, defines improvisation as *the simultaneous design and execution of musical ideas* [52.14], a formulation that seems both to call on and exceed the conventions of composition and performance. Writing in philosophy and aesthetics about musical improvisation is limited, but often argues that improvisation and composition are driven by unique mechanisms and expressive goals and therefore should not be assessed uniformly. In general, these treatments highlight the cumulative conception and irreversible temporality of improvisation; one can make reference to what has already occurred, but any *editing* must happen retrospectively.

Ed Sarath, for instance, asserts in [52.15] that improvisers experience time in an inner-directed manner in which the present is heightened and the past and future are perceptually subordinated. These observations underscore his conviction that improvisation demands a distinct *aesthetics of spontaneity*. *Ted Gioia* in [52.16] formulates an *aesthetics of imperfection* that cautions against making judgments about musical improvisation using the same formalist criteria that we use to judge notated composition. *Philip Alperson* in [52.17] frames his arguments through an *aesthetics of action*, insisting that, while improvisation affords access to the *composer's mind at the moment of creation*, it should not be viewed as a performative token of a compositional *megatype* or model.

In general, these different aesthetics may be explainable through differences between online and offline cognition, especially when viewed from both the vantage point of the individual and from a social cognitive perspective. Online cognition is concerned with *immediate input* from our local environment and is often used to describe an interactor's point of view, whereas offline cognition involves more *careful considerations*, such as lengthy editorial decisions or future planning, and it frequently describes an observer's – rather than an interactor's – point of view. Improvisation has certainly been disparaged in settings that place a greater value on offline cognition and/or that view an activity's intrinsic value from a *universalizing* perspective of observation over interaction.

My personal favorite illustration of the oft-noted differences between composition and improvisation comes from a chance meeting between Frederic Rzewski and Steve Lacy. In this frequently recounted tale, Rzewski asked Lacy to describe in 15 s the difference between composition and improvisation. Lacy replied [52.10, p. 141]:

> *In fifteen seconds, the difference between composition and improvisation is that in composition you have all the time you want to decide what to say in fifteen seconds, while in improvisation you have fifteen seconds.*

Lacy's formulation of the answer, according to the story, lasted exactly 15 s.

The pithiness of this statement and the timeliness of its delivery belies its profundity. On the one hand, Lacy improvised his verbal response to a question about improvisation given the constraints of time and context. If he had been provided a full minute, or 10 min, or 2 h for his response, or if he was speaking to a different audience, or perhaps in French, he would, undoubtedly, have improvised a different answer. In this way, his particular response is both in-the-moment and context-dependent; it is spontaneous, yet also made to conform to the expectations and demands of the moment.

Moreover, Lacy had likely given some previous thought to the general issue, and perhaps he had even offered similar albeit differently phrased responses on the subject in the past. So, in what ways was his statement improvised, worked out, or some combination of these? Would his remark have been less effective if he had not delivered it within the provided 15 s window of time? Should we view his response as *spontaneous*, or is it better viewed as *fluent*, in the same way that fluent speakers do not necessarily intend the construction of their sentences ahead of time? What if his response had been musical rather than linguistic? How would we judge its spontaneity or fluency then?

A priori definitions of creativity are certainly ill advised, but a posteriori definitions are likely unavoidable. *P.N. Johnson-Laird* [52.18] provides a helpful acronym for exploring creative activity, NONCE, according to which the outcome of a creative process is novel (N) for the person producing the result but only optionally novel (O) for society at large, and it is the result of a nondeterministic process (N) that is guided by constraints (C) and is based on existing elements (E).

52.4 Some Contemporary Research Directions

On the whole, researchers in the fields of music psychology and music cognition have focused the majority of their attention on how listeners perceive and process music. These approaches tend to use recorded or computer-generated music examples for their consistency. When researchers have explored the complexities of music performance, they most often do so by looking at the performance of notated music, again for the experimental control it provides. Studying in vivo improvisation from the perspective of the performer or listener remains a challenging proposition, and most writing on the subject remains theoretical, with much of it emanating from practicing musicians or from academics who also improvise.

The most widely accepted approaches to the study of improvisation in cognitive psychology theorize that improvisers deal with the *cognitive constraints* of the moment by drawing on a *model* [52.19], a *blueprint* or *skeleton* [52.20], or a *referent* [52.14] stored in long-term memory. Depending on the specific musical tradition, the relationship between a given improvisation and its model or referent may be more or less fixed, with free improvisation perhaps providing something of a boundary case for this approach, since many of its practitioners disavow the idea that the music is based on a model.

While it is undoubtedly true that real-time creative processes such as improvisation place great demands on cognitive resources, the brain is only one node in a complex nonlinear feedback system. Notably fewer authors, however, have approached the topic from the vantage point of social or ecological psychology [52.21, 22]. In other words, the question of *how does one improvise?* tends to elicit cognitivist or computational models concerned with individual *information processing* and *signal generation* instead of ecological inquiries that explore how one's perception, action, and sonic and social worlds may be intertwined or entangled. I will have more to say about this topic at the end of the essay.

Work on musical improvisation from within the field of ethnomusicology has corrected some of this imbalance. For instance, *Paul Berliner*'s [52.23] and *Ingrid Monson*'s [52.24] influential work on jazz improvisation highlights its dialogical nature and the culturally contingent ways that it is learned and conceptualized. *Vijay Iyer*'s work [52.25], as well as my own [52.26], also demonstrates how contemporary views of cognition as inherently embodied, situated, and distributed can shed further light on how and why musicians improvise together.

Theoretical writing on improvisation still outpaces empirical work on the subject, although this balance is beginning to shift, as more researchers analyze data drawn from, for example, video and other performance capture methods [52.27] or galvanic skin response [52.28]. By using brain imaging techniques [52.29–31] we are also beginning to identify specific neural regions that may be involved in heightened moments of improvisational creativity – sometimes referred to as a *flow* state [52.32, 33] – but this research is still in its earliest stages and questions abound with regards to how to structure experiments and how to interpret the data meaningfully.

Other recent approaches have used a variety of interview tactics [52.34] or grouping tasks [52.35] to understand the kinds of choices that improvisers either made in performance or might likely make given certain stimuli. Here again, challenges remain regarding how to frame tasks for participants and to employ measuring and recording technologies in ecologically sensitive ways that do not unduly impede or prefigure improvisational activities, as well as how to assess and account for differences in improvisational skill level.

Some recent work has shifted focus from primarily investigating performer note choice within harmonic contexts, akin to how jazz is often taught using chord-scale relationships, towards studies of intensity and timing as key factors in how musicians improvise together, and of how listeners hear and interpret improvised performances [52.36, 37]. The importance of timbre and nonlinear organizing principles in contemporary improvised music remains understudied in the literature, although fractal dimensional analysis of recorded improvisations has produced compelling results [52.26, Chap. 5 with Rolf Bader]. Another avenue of contemporary research involves developing automatic improvising systems with the intention of creating competent or even expert performances as judged by knowledge-

able human listeners [52.38]. Some of these approaches have turned to robotics as well in order to explore the important role that physical gestures often play in facilitating group interaction and in engaging listeners [52.39].

While many issues persist about how to frame and explore musical improvisation, there is broad agreement that improvisation involves novel output (again, for the individual, but only optionally for society) created in nondeterministic, real-time situations by individuals and collectives involving certain affordances and constraints. The following two sections will attempt to clarify these ideas within the domain of referent-based and referent-free musical improvisation.

52.5 Referent-Based Improvisation

Jeff Pressing, an improvising pianist himself, was one of the first psychologists to put forward a convincing cognitive model of improvisation, and he continued to refine his work on the subject until his untimely death. In brief, his model in [52.40] characterizes improvisation as a heterarchical process involving motor, psychological, and cultural aspects (which differentiates it from other models that emphasize only rule-based procedures, such as *Johnson-Laird*'s [52.18]; see [52.41] for an analysis of these competing theories).

It is first important to make a distinction between the various timescales involved in improvisation. For the purposes of this discussion, I will divide them into *short-term*, *intermediate*, and *long-term*. On the short-term scale of a second or less, Pressing argued that embodied patterns and learned gestures of procedural memory constitute the bulk of the grist for the improviser's mill. Improvising at this timescale, according to him, involves a nonlinear cycle of motoric function and cognitive feedback and feedforward. In reviewing the physiological and neurological literature, Pressing concluded that improvisers have the biological capacity to react to unexpected changes, and hence to one's own or one another's new ideas, about twice a second. He argued that the performance of experienced improvisers on short-term timescales can be quite nuanced and flexible, but it is also largely automatized.

On an intermediate timescale, lasting from a few seconds to the length of a full performance, Pressing argued that most improvised music utilizes an underlying scheme or formal image to facilitate the generation and editing of improvised behavior. Pressing called this a referent. His most succinct description of a referent was [52.40, p. 52]:

> *a set of cognitive, perceptual, or emotional structures (constraints) that guide and aid in the production of musical material.*

In other words, having a referent allows improvisers the possibility to prepare before the performance and a means during the performance to anticipate future developments. It provides *material* for variation or development, and since a referent can be shared, it reduces the need for detailed attention to all of the component parts of a given performance.

In mainstream jazz, for instance, a *standard* song form can provide a shared template of melodic, rhythmic, and harmonic information, and a means by which performers can synchronize or orient their performances with respect to those of the other musicians. But Pressing's notion of a referent was quite open-ended. It could be abstract or sublime, such as [52.14, p. 346]:

> *a mood, a picture, an emotion, a physical process, a story ... virtually any coherent image which allows the improviser a sense of engagement and continuity.*

A referent, in other words, is essentially anything that can provide shared musical *seeds* from which an improvisation can grow.

At the longest timescale, Pressing theorized about one's *knowledge base*, which includes the *passive expertise* an individual has about a music style and music culture, as well as the more personal history of one's own compositional choices and predilections. Pressing acknowledged that some improvisation could be referent-free on the intermediate timescale, but he insisted that all improvisation involves certain constraints at the short-term and long-term timescales, since embodied patterns and enculturated knowledge are always present in improvised performance.

Pressing's model is representational and reductionist by nature, but it offers considerable complexity in proposing that improvisers are constantly representing musical structure in parallel, via motor, musical, acoustic, and other ways. His model draws distinctions between improvisational features (e.g., loudness), objects (e.g., a motif), and processes (e.g., sequencing a motif), but it is primarily centered on the level of the musical event. A musical event, for Pressing, might involve an isolated feature, object, or process, but more often it will include all of them.

According to Pressing's model, improvisers first produce a set of musical events (E1). Then each subsequent set of events (E2, E3, E4) – at whatever time grain – takes into account the referent (R) that an improviser has stored in long-term memory (LTM), as well as each previous E – with increased weight given to E instances immediately prior. In ensemble settings, improvisers are also constantly taking account of and representing what the other musicians may have just done. All of this information makes arriving at an optimum solution likely too time consuming and resource intensive, but improvisers, according to Pressing, need only find a good solution, not the best. Pressing views these compounding and constraining factors as providing the potential for unique outputs and novel interactions between musicians. Experienced improvisers, according to him, tend to have a richer knowledge of the referent, an improved motor control and flexibility with their instruments, and an improved cognitive representation with more detail at a smaller grain size about the musical events produced by themselves and others, all of which allows for a mentally nimbler and more responsive performance.

52.6 Referent-Free Improvisation

What, then, of performances that do not, by their own admission, involve a referent? A variety of descriptive terms have circulated at various times and in various locales to describe post-1960 musical improvisation, each with its own group of adherents and each with its own semantic shortcomings. The preferred terms tend to highlight the creative or progressive stance of the performers and the cutting-edge or inclusive nature of the music itself: for example, free or free-form, avant-garde, creative, experimental, contemporary or new, collective, spontaneous, and so on. Stylistic references (e.g., jazz, classical, rock, world, or electronic) are variously included or excluded, as are cultural or national identity markers (e.g., Great Black Music, British Free Improvisation, or Japan Noise). In certain cases in which these specifying linguistic markers are not included, terms may still be indelibly associated with specific individuals or locations: for instance, conduction (Butch Morris), sound painting (Walter Thompson), chance or aleatoric music (John Cage), harmolodics (Ornette Coleman), intuitive music (Stockhausen), reductionism (Berlin), and onkyokei (Tokyo), etc.

The scholarly literature on improvisation also varies considerably on the question of how to interpret the notion of *freedom* in this music. Some authors explain freedom in purely musical terms, as varying degrees of liberation from functional harmony, metered time, and traditionally accepted performance roles and playing techniques [52.42, 43]. For others, defining free improvisation in strictly musical terms misses its most remarkable characteristic – the ability to explore and negotiate disparate perspectives and worldviews [52.44].

Many authors have interpreted free improvisation, and free jazz in particular, as a sociopolitical response to the appropriation and exploitation of African-American music styles [52.45–47]. They focus considerable attention on the birth of the practice during the Civil Rights Movement in the United States and on the music's place within the context of an emerging postcolonial world. Other authors have allied themselves with Marxist or neo-Marxist critiques of hegemonic culture and have focused on free improvisation's implied critique of capitalism and its related market- and property-based economy. For instance, *Eddie Prévost*, a pioneering English improvising percussionist, argues in [52.48] that free improvisation is least susceptible to commodification and that it is, therefore, primarily the domain of those who have felt stifled or excluded. Still others view collective improvisation as a fruitful site for generating social bonds, often across cultural and class divides, or argue for its promising therapeutic uses [52.49].

Given this range of opinion and approaches, how is it that musicians attempting to leave all compositional aspects undecided until the very moment of performance can produce coherent music together in real time? Opinions about free improvisation vary widely, according to *Derek Bailey* in [52.10, p. 85]:

> *They range from the view that free playing is the simplest thing in the world requiring no explanation, to the view that it is complicated beyond discussion. There are those for whom it is an activity requiring no instrumental skill, no musical ability and no musical knowledge of any kind,* he asserts*, and others who believe it can only be reached by employing a highly sophisticated, personal technique of virtuosic proportions.*

If there is a shared bond between these diverse performers, it may be a fascination with both the surprising musical occurrences and interpersonal possibilities inherent to an improvisatory method in which the content

and form of the music at the intermediate timescale are radically underdetermined. In other words, improvised music of this kind explores matters from the microscopic level of expressive detail to the macroscopic level of collective coordination and emergent form, all without an explicit reliance on a shared model or referent. Self-imposed and shared stylistic constraints do often play a generative role in the development of the music, but in referent-free improvisation there is no explicit precommitment to what will happen once the performance begins.

Even with these ideals in mind, it is clear that artists bring to any given performance a lifetime of musical engagement, experimentation, and expectation that is evident at both short-term and long-term timescales. Free improvisation is not a *pure* form of improvisation, or a type of ex nihilo creation, as some of its adherents occasionally suggest. Embodied patterns and learned gestures provide the foundations of this approach on short-term timescales, and across longer timescales free improvisation involves the development of a personal experiential knowledge base (and, some argue, necessitates developing an identifiable *voice* or style) as much as any other practice. Calling the music *nonidiomatic*, as *Bailey* does in [52.10], runs the risk of denying culturally shared sensibilities and understandings, which certainly come into play when the musical backgrounds of the performers and listeners are similar.

It should be noted that a considerable amount of music that is grouped under the broad heading *free improvisation* is not referent-free in the way that I am using the term here, perhaps highlighting that this binary between referent-based and referent-free improvisation is ultimately untenable. For instance, in settings in which musicians have played together before or those in which they are simply aware ahead of time of the body of recorded work that the other musicians have produced (which is to say almost every professional improvised music encounter), these previous experiences often serve as a type of pseudoreferent for the current situation.

Mike Heffley [52.50] highlights three kinds of freedom in improvised music: freedom-from-form, freedom-to-form, and freedom-in-form. Freedom-from-form describes the reactive process of stretching, challenging, and breaking rules and conventions that were once embraced as laws. Freedom-to-form is a proactive step in which rules, patterns, and conventions from other musical traditions, and those of idiosyncratic origin, are embraced as temporary and mutable structures or designs. Freedom-in-form, for *Heffley* [52.50, pp. 279–80], signifies the consummate stage as well as the point at which the process has gone full circle:

> *One path is chosen from among all possible, and its route, uncharted from without, has nonetheless imprinted its own order on the improvising body as a law unto itself . . . that will come in its turn to be so challenged and changed.*

Somewhat analogously, many improvisers confront at various points in their musical careers the seeming paradox that one's instrument can be a means, a subject, and a barrier to expression. In other words, does one choose to use one's instrument to express something musical beyond the instrumental (e.g., singing a song with a saxophone)? Does one follow the more instrumental impulse to explore the sonic possibilities inherent to one's instrument (e.g., keyclicks, slap tonguing, and multiphonics on a saxophone)? Or does one's instrument potentially dictate too much of the content of what one improvises (e.g., can one play the saxophone without thinking saxophonically?).

The dynamics in ensemble situations are even more complex. Clément Canonne argues that collective free improvisation offers a paradigmatic case of the coordination problems which are present, to some degree, in every form of group improvisation. He devises a mathematical model in [52.51] using dynamical systems theory that extends, rather than contradicts, the important work of Pressing on referent-based improvisation. Briefly, on short timescales Canonne agrees with Pressing that clusters of musical events are primarily determined by previous training and embodied patterns. Cognitive limitations play a role (one can't decide too much at the same time), but so does a desire to remain flexible (one does not want to decide too much at the same time). At the intermediate timescale, which may range from many seconds to many minutes, referent-free improvisers must work to create sonic *identities* in the absence of material provided by a shared referent. Sonic identities include processes or features that are developed or explored for a short time, only to give way to new emergent *identities* via some process of gradual or abrupt transition [52.52]. How these transitions arrive and are effected by the ensemble provides some of the more fascinating moments in referent-free improvised performance (see [52.53] for a taxonomy of transition types and [52.26] for a detailed performance analysis using this taxonomy).

In [52.54], *Canonne* adopts the notion of a *focal point* from game theory to explore how potential transitional moments in the music exert various forms of salience on the performance and for the musicians. At these moments, musicians are collectively trying to single out one of many possible trajectories, or to arrive at a convergence of expectations (although, admittedly, wonderful music can also happen, from the listeners

perspective, when the expectations of the performers remain divergent). In empirical studies involving musicians with different musical backgrounds and levels of experience with referent-free improvisation, Canonne found that experienced improvisers most often take advantage of sonic disruptions to signal transitional moments or to singularize musical ideas, turning them into focal points that ensure the vivacity of the musicians' coordination. His data show that seasoned free improvisers were also more skilled than their counterparts in jazz and classical music not only at determining the salience of the sonic environment for themselves, but also in anticipating the salience that sonic events will have for others, often taking into account particular instrumental constraints and affordances, or, when relevant, their shared history of improvising together.

Team reasoning strategies and skills are likely of particular importance to referent-free improvisation settings, since without a shared referent there is little musical *scaffolding* with which to solve group coordination problems. Canonne's dynamical systems model also demonstrates that referent-free improvisation can be self organizing, particularly in situations with a small number of musicians (< 5) who can sufficiently take advantage of their virtuosity, their leadership qualities, and their team reasoning.

Whether improvising in a referent-based or referent-free setting, one's *knowledge base* appears to encompass the embodied (overlearned motoric practices), personal (conceptual, aesthetic, ideological), and culturally shared (tacit understandings) elements that allow for the coherent unfolding of a musical performance. *Canonne*'s most recent empirical work [52.35] highlights how experienced improvisers come to share an implicit mental model of the practice of referent-free improvisation; a type of higher-level knowledge or metastructure that is task-specific instead of piece-specific. He and coauthor Aucoutourier asked experienced improvisers to sort short audio examples of free improvisation into groupings based on their *pragmatic similarity*; in other words, how they would react to the sounds in a performance setting. The authors analyzed these responses and found that the degree of similarity with which participants grouped sounds predicted with better-than-random accuracy their degree of musical familiarity.

In other words, musicians who played together tended to think about improvised music in the same way. The authors conclude that shared mental metamodels such as these may play a key role in the success of referent-free improvisation by allowing more confident *mind reading* of the intentions of fellow improvisers, more frequent cognitive consensus in the course of a performance, and swifter repair of *communication errors* when there is cognitive divergence among the improvisers. They note, however, that the normalizing force of familiarity is not always desired and is therefore frequently countered when musicians opt to play in unfamiliar situations with unfamiliar collaborators (e.g., Derek Bailey's Music Improvisation Company was founded on the idea of having musicians improvise together who had never shared the stage before).

Theorizing about improvisational processes always runs the risk of reifying the result, or of remaining centered on the individual, whether the focus is on skill acquisition, mental representations, rule-based procedures, or on a more integrated view of cognitive schema involving the parallel processing of motor memory, auditory imagery, and audio-motor integration. Much of the early modeling of referent-based improvisation by Pressing and others remained firmly ensconced in an individualistic information-processing paradigm. Berliner's and Monson's influential work on jazz highlighted the complexity and centrality of interactional dynamics in jazz performance, but our understandings of the social dimensions of improvisational performance have often lagged. Interestingly, *Pressing*'s final writing on the subject [52.55] took a more ecological turn, highlighting how the mind, body and environment are all part of an interacting dynamical system.

52.7 Final Thoughts

A distinction has been made here between referent-based and referent-free improvisation primarily dependent on the presence or absence of shared mental models at the intermediate timescale of performance. Referent-based improvisation tends to have well-established (though not necessarily unified) traditions of aesthetic evaluation, and the cognitive schemas used tend to be overlearned so that they can be rapidly accessed and adapted to the needs of the moment. Referent-free improvisation, by contrast, may involve less-well established schemas and less shared conventions, but motor patterns still play a prominent role, and shared metamodels can evolve when musicians play together over time. In the absence of an agreed-upon referent, implicit strategies for group coordination emerge to compensate.

However, we may be best served by considering these as constructed-capabilities-in-action instead of as stored artifact, referent, or model. Improvising without a referent does not discount the importance of culture and experience, nor does it downplay one's embodied and skilled relationship with the available musical resources. Rather, it frames the process of improvising as enactive instead of representational. Knowledge does not emerge from passive perception, or from the analytical study of an agreed-upon referent; it emerges from the need to act in an environment. In this way, referent-free improvisation may offer an exciting window into exploring cognition from an ecological vantage point.

When viewed ecologically, cognition is best understood as a process coconstituted by the cognizing agent, the environment in which cognition occurs, and the activity in which the agent is participating: action, perception, and world are dynamically coupled. In this light, improvisation may be seen as a cyclical and dynamic process, with no nonarbitrary start, finish, or discrete steps (i. e., it is not a token of a compositional megatype). The improviser and the environment coevolve; they are nonlinearly coupled and together they constitute a nondecomposable system.

Improvisers engage with the world and with one another in ways that can not be fully captured by an individual- or brain-centric understanding of cognition. The brain of an improviser is, ecologically speaking, always-and-already in a body and in a niche of musical activity. Instead of having to represent a musical model or shared referent, improvisers *bring forth* a musical world from recurrent sensorimotor patterns and actions. The burden of improvised performance, in this way, shifts from storing and recalling information to detecting it, in the form of ecological invariants and affordances. In place of a computational model of mind – one that stresses the constraints of our cognitive abilities – an ecological one only requires that individuals follow the need to act in their environment, that they orient their actions so as to make the world appear – or sound – a certain way now. Cognitively speaking, this solution is efficient and cheap, and it produces reliable results under a wide variety of conditions.

Whether referent-based or referent-free, improvisation appears to involve a continual tension between stabilization through communication and past experience and instability through fluctuations and surprise [52.56]. This is likely a dynamic of all creativity in the arts and in life, but improvisation draws attention to itself *as* performance: to how it defamiliarizes the familiar. *Gary Peters* offers two related allusions in [52.57]: the improviser as a contestant in a scrapyard reality TV show in which she must fabricate something original out of the discarded materials readily at hand; and the improviser as the subject of Paul Klee's *Angelus Novus*, with her face always turned toward the wreckage of the past as she is propelled into the future by the storm of progress. In both cases, improvisation has more to do with a way of being in the world than with the content or *value* of a fixed work. The critical questions, in the end, involve how we chose to frame these improvisatory dynamics: either as information processing that struggles to keep pace with the cognitive demands of the moment, producing a type of *imperfect* art; or, as an ecologically sensitive engagement with one's sonic and social world.

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