Chapter 4
De-instrumentalizing HCI: Social Psychology, Rapport Formation, and Interactions with Artificial Social Agents

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Abstract Decisions in designing artificial social interactants to reproduce culturally-specific forms of human sociality evince a range of conceptions of the norms and cognitive processes involved in the human social interactions themselves. Regarding the use of machine learning (ML) in such systems, decisions whether or not to use this approach implicitly presents questions on the nature of the interpersonal adaptation that takes place and indicate a range of conceptions of the values which structure these interactions. In the design of virtual performers of musical free improvisation, several designers assume that the experience of equal partnership between improvisers can only be afforded through deployment of ML in such systems. By contrast, tests of agents not based in ML reveal that human beings experience illusions of "adaptation" in interactions with systems which lack any adaptive capacity. Such results suggest that HCI research with artificial social interactants may be used to raise new questions about the nature of human interaction and interpersonal adaptation in the formation of relationships over time.

4.1 Technological Re-embodiments of Human Practice

At its core, artificial intelligence (AI) research aims to create technologies which either match or surpass the natural or acquired cognitive capacities for creativity and productivity which human beings readily exhibit in a variety of activities. Inevitably, developing machines to engage in human practices involves creating computational representations of how fluent and skillful practitioners sense, feel, think, and act in response to the world and other human beings. For most AI researchers, designing

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a system that does accounting, drives a car, or engages in a customer service interaction necessitates identifying objective standards by which those practices are normally executed and developing a computational description of them.

Nevertheless, as numerous critics of science and technology research have suggested (Friedman and Nissenbaum 1996; Nissenbaum 2001; Edwards 1997; Lewis 2000; Helmreich 2001; Forsythe 2002; Suchman 2006; Seaver 2012; Wilf 2013a, b; Burrell 2016; Seyfert and Roberge 2016), AI systems often reproduce at least a portion of the designer's subjective interpretation of both the tasks themselves and the culturally-specific values and principles that shape them. If one designs a machine to do what a human does, then one is inescapably also invested in a project of producing a representation of the cultures that provide meaningful contexts for human action. Moreover, like any other representation of culture (e.g., an ethnographic text, film, or novel), there exists at least a small gulf between how an AI system characterizes human action and the actual actions of human practitioners per se.

As a subfield of AI, much the same is true for machine learning (ML). Like AI, ML research includes projects dealing with reproductions of actual human behavior as well as those that aim to transcend it. Similarly, in the effort to simulate or outperform human capacities for learning, adaptation, or even improvisation, ML is a technical project that often necessitates an investigation of how human beings process their experiences of interacting with the world and successively shift their behavior through further experience. In the context of human computer interaction (HCI) with an artificial social agent, ML functions not only as a component in simulating adaptive human sociality, but as a means of posing questions and hypotheses about how human beings form rapport and adapt to one another over time. Even if HCI researchers do not frame their work as an investigation of social psychology, their work may nevertheless have significant implications for the study of human consciousness in social interaction.

With these perspectives in mind, this chapter analyzes the relationship between ML research in the context of HCI along with the culture, phenomenologies, and processes of social behavior implicitly investigated and characterized in the creation of such technologies. In light of recent efforts to move the field of HCI beyond its strict focus on functionality and ease of use (Bødker 2006; Harrison et al. 2007), this chapter focuses on three questions regarding the relationship between ML and human culture:

1. How does a designer's attempt to encode the human values that shape particular activities influence (1) their choice of whether to use ML, and (2) the decision to use certain ML techniques rather than others?
2. To what degree is ML effective in performing the kind of interpersonal adaptation processes a designer seeks to simulate? In which culturally-specific domains of human action is ML necessary? How do these differences reflect cultural variations and individual discrepancies in how subjects understand the norms of a given cultural milieu?
3. How can human experiences with ML technologies be used to better understand processes of interpersonal adaptation and rapport formation? Similarly, how can

human experiences with such systems be used to investigate the ways cultural values affect the form and degree of interpersonal adaptation expected over subsequent interactions?

To address these questions, this chapter surveys numerous stances on the necessity of ML techniques for designers of artificial social agents that engage in a form of social interaction unique to a particular musical practice. Specifically, this chapter looks at the design and design rationale of a range of virtual performers of free improvisation, a form of experimental music in which the performance is not the realization of a musical score, but results from the impromptu social and musical interactions between players. Far beyond simply reproducing the sonic surface of this artistic practice, designers of these systems seek to ensure that these artificial social interactants embody the values which shape how artists engaged in this musical form coexist with one another. In the process of pursuing this goal, these designers offer a range of perspectives on the efficacy of ML methods as a means of simulating the kinds of interactions these performers engage in and adhering to the principles that define this form of music as a culturally-specific mode of face-to-face interaction.

For a variety of reasons, several designers working in this area assume that ML constitutes an effective means of encoding the socio-political ideals at the center of this musical practice. However, tests of such systems with actively performing free improvisers suggest that ML constitutes, at best, just one of many possible ways of programming an artificial social interactant to function as an ideal human interlocutor in this domain. Surprisingly, tests of systems not designed using ML techniques reveal that performers, and perhaps human beings more generally, are often to prone to experiencing these non-adaptive systems as "adaptive" even though the system has no such capacity encoded.

This illusion has two likely explanations. On the one hand, the sensation of adaptation may result from the well-documented psychological phenomenon known as the effect of "mere exposure" (Zajonc 1968), or the principle that increased contact with a given stimulus corresponds with more positive evaluations of it over time. On the other, the impression of adaptation may arise from a dynamic feedback loop resulting as the human participant's adjustment to the non-adaptive system elicits a different side of the system's behavior (Hsu and Sosnick 2009). As a result of their own contributions to the interaction and the system's reactions to this novel input, the human player may be led to believe that the system has "adapted" despite the absence of any real computational means for the system to do so (i.e., ML).

Overall, I argue that even where its efficacy is doubtful or contested, the use of ML in the design of artificial social interactants offers a means of examining the social psychology of rapport formation and how human beings develop intimate knowledge of their interlocutors over a series of interactions. As will be discussed in greater detail, recent empirical work (Hsu and Sosnick 2009; Banerji 2012; Linson et al. 2015) suggests that ML may not be necessary for achieving the kinds of interactions that free improvisers prefer to engage in. In turn, this data raises questions about the nature of the interpersonal adaptation between players which theorists of free improvisation claim is central to musical interaction in this practice (Waterman 2008; Young 2010; Beins 2011).

More importantly, such experiences also suggest a degree of ambiguity in the notion of "rapport formation" and may have implications for the theorization of this aspect of human interaction in the field of social psychology (Cappella 1990; Tickle-Degnen and Rosenthal 1990; F. Bernieri and Gillis 1995; F. J. Bernieri et al. 1996; Grahe and Bernieri 1999; Lakin and Chartrand 2003). At face value, the idea of rapport formation suggests that a dynamic process of interpersonal adaptation and learning takes place between human beings. By contrast, the fact that improvisers report that they experience "adaptation" in interactions with systems which lack any meaningful capacity for adaptation over time suggests that "rapport formation" may actually be at least partially the result of relatively static processes.

Therefore, beyond "implications for design" (Dourish 2006), the shortcomings of ML in this or other domains of simulated human interaction may offer a source of data about the nature of rapport formation and interpersonal adaptation which may not be available through other methodologies. Additionally, the limitations of ML offer a counterpoint to debates about how an algorithm would depict culturally-specific principles and cognitive processes of interpersonal adaptation. Though numerous designers assume that ML is necessary for living up to specific human values, empirical studies show that this issue is far more complicated and raise several questions about the concept of "rapport."

Finally, though many perspectives in HCI argue that a focus on the study of user culture poses a risk of derailing HCI research from the goal of refining the fit between human tendency and system design (Crabtree et al. 2009), this interpretation underestimates what the study of culture and sociality still offers to design. Whether one is interested in researching culture or social behavior for their own sake or interested in refining a system to the needs of a human population, the study of how people conduct themselves and pursue various goals remains essential. If HCI is committed to the creation of technologies that intuitively complement the ways and means of real human users, then any data which uncovers aspects of the sociality or culture of a technology's human interactants is likely to prove useful for this original, pragmatic goal of HCI research.

4.2 Delimitations and Scope

While third-wave HCI research raises numerous new questions and retheorizes several old issues in HCI such as the fit between user and system or the proper role of technology in everyday life (Bødker 2006; Harrison et al. 2007), this chapter deals with only a selection of the issues foregrounded by the third-wave perspective. Though the third-wave has foregrounded issues such as embodiment (Bardzell and Bardzell 2011), emotion (Boehner et al. 2007), and the proliferation of interactive technologies beyond the workplace, this chapter focuses on the inscription and encoding of cultural values in interactive systems (Sengers et al. 2004; Fuchsberger et al. 2012) as well as a phenomenological perspective on how users experience technologies (Harrison et al. 2007).

Regarding phenomenology, the present discussion focuses on an account of human experience of technology without respect to whether what one is experiencing is "real" or not. In order to do so, this chapter takes after Edmund Husserl's articulation of the concept of "bracketing" or "epoché" in his classic work *Ideas* (Husserl 1913/2012: 56–60). For Husserl, bracketing describes a basic conceptual commitment of phenomenology in which one attunes to human experience without necessarily being concerned with whether those experiences are grounded in an empirically verifiable reality. For example, this would be an account of one's experience of hearing a "dog barking" irrespective of the fact it may either be an actual canine vocalization or another auditory stimulus which nevertheless evokes the illusion of a bark.

For this discussion (and perhaps for third-wave HCI more generally), the principal relevance of bracketing is that it is of utmost importance to examine how reality (or technology) is experienced by an individual without necessarily being burdened by the issue of whether that experience is evidence of a scientific fact or an utter hallucination. Regardless of their "reality," the perceptions arising from encounters with humanlike technologies are often felt to be "real" even when one is aware of the illusion of these sensations. This is not to assert that such hallucinations possess veracity, nor is it to assert that it does not matter whether a system is designed using ML or not. Rather, it is to recognize that human beings live by many illusions and that it is quite likely that such illusions play a role in human encounters with humanlike technologies like an artificial social interactant. This is especially significant given that ML-driven HCI applications aim to effectuate an illusion that the human interactant is "in fact" engaging with another member of their species.

While this chapter addresses work at the intersection of HCI and ML, the principle focus will be agents that are built with the explicit goal of simulating forms of social interaction which human beings regularly engage in. This area of HCI and ML work includes research into the development of interactive conversational agents which produce a sense of realness and humanness in how they interact with a human being in terms of linguistic competence, sound production, and perception (Eklund 2002; Maatman et al. 2005; Morrissey and Kirakowski 2013). It also includes forms of "artificial life" (Langton 1997) in which machines perform as if they were human beings (e.g., artificial general intelligence, social robotics, videogame characters, etc.). With this focus in mind, other areas of research taking place at the intersection of ML and HCI are less relevant. This includes the domain of "interactive machine learning" (Fails and Olsen Jr 2003; Fiebrink et al. 2011; Amershi et al. 2014), in which users are enabled to correct the process by which ML parses and analyzes information.

Although interactive ML (or IML) research overlaps with the present discussion's concern with the simulation of face-to-face human interaction, current work in IML does not seek to reproduce human interactions through speech, gesture, gaze, and other embodied communication in real time. Instead, current IML research largely focuses on reproducing an interaction between a supervisor and a subordinate. Just as a higher-level worker might train an assistant to analyze or parse certain types of incoming information, IML partially resembles this professional mode of human interaction. Even so, the modality of this form of HCI is relatively artificial when compared with conversation or the kind of social interaction through music discussed here. Eye contact, gesture, or intonation (to say nothing of speech itself) have yet to be used as a mode of interaction for IML research, where visualization of the ML protocol has been the primary sensory output relayed to the user for their critique.

Still, an interaction between a human user and an interactive ML system, insofar as it simulates a supervisor-worker dyad, remains relevant because it resembles a real form of social interaction in business or other organizational contexts. More importantly, like any type of human sociality, values such as autonomy, responsibility, transparency, or personal integrity form much of the psychological infrastructure of an interaction between two workers. Similarly, it is quite likely that IML applications, particularly where they simulate work-related human interactions, are inflected by the same values and expectations that shape interpersonal relations in organizations even though the "worker" in that case is a nonhuman user technology. Or, considering the more experientially-oriented angle of third-wave HCI, it is possible that an interaction with an IML system may remind users of similar interactions they have had with co-workers as they mentor them in how to deal with certain kinds of information.

4.3 Encoding Egalitarianism

Since George Lewis' *Voyager* (1993, 1999, 2000), researchers in computer music have developed a variety of interactive virtual musicians built for performers of musical free improvisation to play with as if these systems were just another human improviser (Blackwell and Bentley 2002; Assayag and Dubnov 2004; Hsu 2005; Casal and Morelli 2007; Yee-King 2007; Young 2008; Bown 2011; Carey 2012; Linson et al. 2015). Based on each designer's experience with and conception of this musical practice, these systems are constructed with the goal of reproducing the same kind of inspiring, challenging, and spontaneous social interactions through sound that human performers of free improvisation hope to engage in with one another. In order to create the experience of playing with another free improviser, these virtual performers are designed to process live acoustic input from the human player and respond in real time. Thus, in the ideal, these artificial improvisers recreate the sensory and interactive experience of making music with a real improvising partner.

Before turning to the issue of ML, there are a number of ways that these systems are built to encode and mechanically re-embody the social values that shape how improvisers engage with one another. Specifically, as is discussed across a wide range of literature on this practice (Spellman 1966; Kofsky 1970; Bailey 1980/1993; Stanyek 1999; Steinbeck 2010; Lange 2011; Carles and Comolli 1971/2015; Corbett 2016; Rodriguez 2016), free improvisation purports to liberate musicians from the typical interpersonal hierarchies which define many forms of music-making (e.g., composer and performer, conductor or bandleader and ensemble, soloist and accompanist, critic and performer, etc.). Instead, performers of free improvisation assemble themselves in a flat, nonhierarchical, egalitarian arrangement in which no player serves as leader and no composition is used as a guide for how sonic events will take place in the performance. Additionally, free improvisers seek to avoid relying upon any traditional structures for musical performance (i.e., pulse, harmony, form, genre, style, convention, etc.) in order to prevent the implicit hierarchies that often result when some individuals are more proficient in certain culturally-specific musical structures (e.g., jazz, Indian classical music, baroque music, etc.). By eliminating such structures, improvisers aim to create a situation in which the only determinant of what takes place in performance is the dynamic interaction of the personalities of the improvisers themselves (Blackwell and Young 2004). Nevertheless, for all that they may strive to avoid such constraints, recent critiques have duly noted the limitations of these emancipatory pursuits (Backstrom 2013; Canonne and Garnier 2015).

Although individual programming approaches of these designers vary greatly, each of these researchers agrees about some basic principles for how the lofty goal of egalitarianism should be translated into the creation of such a system. Across the board, designers concur that systems cannot reproduce an egalitarian interaction if they are built for the performer to use as an instrument. Instead they must be designed in order to allow for musicians to engage with these systems as if they were a fellow player (Rowe 1992; see also Lewis 2000). In practical terms, this means that the mode of interaction with the system should not allow the human performer to "veto" (Lewis 1999: 104) or otherwise directly control the system's sonic output in real time as one might with an instrument. Unlike numerous other interactive performance systems (see Chadabe 1997), these systems do not incorporate any kind of haptic or tactile interface which would enable the human subject to retain their position of mastery and control[1] over the mechanical musical object.

In turn, this is analogous to the way that improvisers themselves interact musically and socially. Before, during, and after they play, free improvisers habitually refrain from directing, criticizing, or instructing other musicians, irrespective of how irritated they may have been with their playing or whether they had specific desires for how the performance should have taken place (Banerji 2016). Even when disgust may seem obvious from a player's choice to stop playing (see Fischlin et al. 2013: 203–219) or play more loudly in order to drown others out, it is often unclear what these kinds of interactive actions mean or if they represent a critical judgment of one player against others. Moreover, direct expressions of criticism after performance between players is implicitly regarded as a threat to the nonhierarchical ideal (Borgo 2002; Pras et al. 2017). This reticence[2] is both a means of

[1] Again, in the case of a virtual free improviser, the designer does retain control over the system's behavior. But unlike the control exerted over a system built to function as an "instrument" (Rowe 1992), a "player" system cannot be directly controlled on a moment to moment basis.

[2] While peer criticism is not seen in this way by participants of other egalitarian social projects (Chaudron 1984; Snyder and Fessler 2014), improvisers view criticism as a kind of speech act that instantly nullifies equality by placing the speaker in a position of authority with regard to the actions of the addressee.

respecting the equal status of fellow players as much as it is a performance of an ethos of openness to a “diversity” of practices within free improvisation (Bailey 1980/1993: 83).

Similarly, improvisers do not interact through any sort of visual cues between performers (Lewis 2007), as has been occasionally suggested (Andersen and Brooks 2003). Though moments of gaze between performers do occur, it is not entirely clear what meaning they carry nor what impact they have on how the interaction progresses. In sum, researchers in computer music concur that if these systems are to interact with human performers of free improvisation as their equals, then (1) there should be no mechanism that allows direct control of their behavior, and (2) it is not necessary for them to be able to respond to gestural cues.

4.3.1 Is ML Necessary for the Experience of Equal Partnership?

Beyond these points of agreement, however, designers differ significantly on the question of whether ML is essential for allowing systems to produce interactions that yield an experience of equal partnership and agency in the collective outcome of the performance. At the computational and interactive levels, these designers take divergent approaches to encoding egalitarianism in the behavioral capacities of these systems. By no means do they all assume that ML or any other adaptive systems technique (i.e., genetic co-evolution) is the best means of encoding this social ideal. For example, about free improvisation generally, George Lewis writes that “the possibility of internalizing alternative value systems is implicit from the start” (Lewis 1999: 102). For most proponents of ML methods, Lewis’ description of free improvisation would immediately suggest that it is imperative that a designer incorporate ML if they aim to encode the values that these musicians strive to live by. After all, what else would be implied by the term “internalizing”? Curiously, however, Lewis’ system *Voyager* (2000) does not incorporate ML or any other adaptive systems technique.

4.3.1.1 Yes

While Lewis and other designers do not use ML techniques in the design of their systems (Hsu 2010; Linson et al. 2015), several other researchers in this domain assume that a capacity for iterative adaptation to the human player in real time is a necessary part of the successful design of such a system. Implicitly, this line of thinking limns several crucial assertions these researchers make about the social psychology of free improvisation and how it is shaped by values like egalitarianism and multiculturalism. Specifically, the use of ML or other adaptive techniques assumes that in order to properly engage in an egalitarian style of social interaction, two players participating in a collective free improvisation must both make an effort to adapt to one another as they make music together. Broadly, then, the use of ML in such systems assumes (1) that the human player wants to feel that the other improviser is learning about their habits and tendencies in interaction and (2) that this ongoing interpersonal learning process is essential for yielding the experience of authentically egalitarian social interaction.

However, the use of ML implicitly poses a hypothesis about what happens in the psyche of the human improviser and how they experience musical interaction with another. Because improvisers generally seek to preserve an equity of status between performers, designers of ML-based virtual free improvisers assume that the human improviser is forming a memory of how the other plays and tends to react in order to draw on these memories later on. Overall, the application of ML in this domain also assumes that if one player (whether human or machine) fails to engage in this process of adaptation while the other makes efforts in this direction, the player that maintains their original manner of interaction has acted autocratically or egotistically, thereby disrupting the equity of status between participants.

For designers using ML or other adaptive techniques like genetic co-evolution (Eiben and Smith 2003; Casal and Morelli 2007) or particle swarm optimization (Kennedy and Eberhart 1995; Blackwell and Bentley 2002) in the creation of these artificial performers, the principal objective behind deploying these methods is to allow the system to have a better knowledge of the habits and tendencies of its human interlocutor. While adaptive techniques can be used to allow the system to simulate the sympathetic and cooperative interactive style of a human player, they can also enable the system to exhibit defiant or oppositional playing. Though many players prefer more supportive styles of interaction, other players find that this interactive attitude lacks the kind of drama and tension they prefer to produce in performance (Banerji 2016). For example, Oliver Bown's *Zamyatin* system (Bown 2011, 2015) uses information learned about the human performer to create both oppositional and sympathetic responses to their playing. Likewise, Michael Young's *NN Music* (Young 2008) acquires information about the player's current performance "state" (i.e., the average and standard deviation of various timbral characteristics) in order to develop a catalog of their playing tendencies. Nevertheless, this index is not necessarily used to create sympathetic behaviors and can also be used to simulate the intentional, audible divergence many players value in musical interaction (Banerji 2016).

Although it uses neither ML nor any other adaptive systems technique, Ben Carey's *_derivations* system (Carey 2012) builds a "memory" of its interactions with a specific performer by making a running catalog of phrases produced by the human player for later use as the basis of the system's improvisatory output. If an incoming phrase from the human player is similar[3] to a phrase currently stored in the system's database, the system calls up this phrase and uses it as base material for

[3] Similarity is judged by an analytical comparison of incoming and stores phrases on the basis of their loudness, pitch content, spectral centroid (or "brightness"), noisiness (or ratio of tone to noise) as well as the mean and range for these values in a given phrase.

improvisatory exploration (e.g., by manipulating the pitch or rhythmic content of the phrase). This evokes a sensation that the system has the kind of knowledge of the human player that might develop from repeatedly working with the same duo partner over time. At the same time, it avoids reproducing a type of personality which is too prone to cooperation and fails to generate the sense of interpersonal contrast that many improvisers value.

In the same vein, Gerard Assayag's *OMAX* project (Assayag and Dubnov 2004; Cont et al. 2006; Assayag et al. 2010) at IRCAM (Institut de Recherche et Coordination Acoustique/Musique), exclusively frames the use of ML around the goal of simulating a sense of "style learning" (see Pachet 2003; Assayag et al. 2006) between human and machine. That is, the system learns the player's "style"[4] in terms of their tendencies in the use of pitch and rhythm over time. Again, this assumes that because the human being tries to learn the style of the computer, the computer must also make an effort to learn the style of the human. However, while "style learning" may imply that the system will tend to exhibit a spirit of collaboration, OMAX is designed to exploit what it learns to react both sympathetically and antagonistically.

In the end, the purpose of deploying ML in this domain is not necessarily to bring the system to adapt to every move the player makes, but rather to build its capacity for acquiring knowledge about the player in order to try and predict their actions (Assayag et al. 2010). This predictive capacity is used not only to create responses which closely resemble the human performer's actions but responses which deviate and contrast with their suggestions as well. Similar in approach to Assayag's OMAX project, Nicholas Collins' *Improvagent* system (Collins 2008) tries to both predict the responses of the human player and also to understand the consequences of its own actions in terms of the player's response. The system assesses its own ability to predict the player's actions by comparing its predictions with the actual outcomes of the player's behavior. If there is a discrepancy between the player's actions and the system's prediction, the method of prediction is adjusted accordingly.

However, for all that there may be an intuitive association between ML and the kind of adaptation implied by certain notions of egalitarianism as a logical choice for realizing these ideals in musical interaction, it is unclear as to whether ML succeeds convincingly. This is mainly due to a consistent trend in which designers of these systems do not test them with active performers of free improvisation. As a result, the efficacy of ML as a means of embodying the sensation of nonhierarchical interaction is not known. Still, for David Plans Casal (2008), the use of an adaptive system proved to be one that he himself found frustrating as a performer collaborating with the system. In his experience, the system's constant tendency to try and improve its responses to his playing resulted in a vexing situation in which the system failed to continue in one direction for long enough in order to create a sustained musical idea.

[4] As Eitan Wilf notes (2013b), this is a very specific notion of the term "style" which essentially predetermines what can and cannot even count as style.

4.3.1.2 Maybe Not

While several designers have chosen to use ML and related techniques in order to build systems which uphold values central to free improvisation as a socio-cultural practice, Lewis and others have created systems which do not assume that ML is a necessity in working towards the enactment of the principles of egalitarianism or multiculturalism. In essence, this means that across this range of designers, two fundamentally distinct notions of egalitarianism are at work. The first, which assumes ML is essential, interprets egalitarianism as an ethico-political ideal which requires that improvisers engage in a process of mutual adaptation to one another's playing and improvisatory tendencies. According to this view, the production of a flat, nonhierarchical social structure, or "leveling" (Woodburn 1982; Boehm 1993), is best achieved through the efforts of each member to assimilate to the group.

Contrasting with this assimilationist or integrationist interpretation, however, those who design interactive virtual free improvisers which are not based in ML or related adaptive techniques make a design decision that implicitly suggests their belief that such interpretations of egalitarianism are questionable. Systems like those of George Lewis (2000), Adam Linson et al. (2015), or William Hsu (2010) which do not use adaptive techniques suggest a second, alternate interpretation of egalitarianism that is rooted far more in a sense of autonomy than it is in cooperation or coalescence. For such designers (as well as the actual improvisers whose views of the situation they may reflect), adaptation to the other is incongruent with the nonhierarchical ideal because it introduces a sense of hierarchy as one player makes an effort to yield to the other. In this perspective, it is far better to maintain a sense of independence in terms of one's own playing protocol in relating to the group than it is to acquiesce to or accommodate the stylistic tendencies of others.

The meaning of these varying attitudes towards the use of ML in the creation of synthetic musicianship extends far beyond the use of these techniques to simulate human behavior or create a convincing artistic result. Rather, these differing stances on the need to integrate ML bespeak the diversity of interpretations of what "egalitarianism" is as a moral or political value in a context far removed from the immediate context of HCI. Design decisions in the creation of these virtual musicians indicate the presence of two distinct concepts of what it means to occupy a status equal to one's interlocutor and what might be required to preserve the flatness of the distribution of power between two individuals in a real time social encounter. For those that adopt ML methods in pursuit of creating a free improviser from computing machinery that performs in an egalitarian manner, their choices suggest an assumption that the experience of equality is only possible through the gradual adaptation of one social interactant to the other and vice versa. Failure to do so is regarded as a setback to realizing the nonhierarchical ideal. Conversely, for those who do not use ML in these systems, such design choices suggest an interpretation of egalitarianism in which adaptation is regarded as capitulation. In this view, disuse of ML represents and performs a rendering of egalitarianism built upon the sense that all are equal if no one feels compelled or expected to lose their autonomous sense of self and conform to the rest of the group.

Crucially, however, none of these claims are made explicit in the written documentation of these systems in published literature. Rather, it is only implicitly that such design decisions refer to egalitarianism at all from the fact that these systems aim to emulate how improvisers socially interact through sound in performance and that the discourse around free improvisation pervasively emphasizes the notion that the practice is predicated upon egalitarian principles. Returning to the third-wave HCI concern for analyzing how systems encode values, it is imperative that designers articulate how they interpret particular cultural values when they attempt to encode them in interactive systems. Doing so would not only reduce any ambiguities in this issue but also allow their systems to be understood as they should be: hypotheses on the nature of these values themselves expressed in the language of computation and the experience of embodied interaction with virtual social agents.

4.4 The ML You Never Asked for: Illusions of Adaptation in the Absence of ML

But regardless of the diversity of interpretations of egalitarianism implied in the range of attitudes about the utility of ML in this domain of arts technology, it is debatable as to whether ML is necessary for achieving the sense of adaptation and rapport that an improviser may desire. This is not a programmatic statement suggesting that the use of ML should not be investigated in this research domain nor is it to suggest that "the implication is not to design" (Baumer and Silberman 2011). Whether or not ML is effective in satisfying an improviser's expectation or desire for a sense of adaptation over time, creating — and more importantly, rigorous testing of such systems with human interactants — is likely to provide important data which enables a more detailed understanding of how improvisers form rapport. More generally, research in this area also contributes to the ongoing social psychological investigation of what "rapport" really consists of in human relationships and how it develops over time (Cappella 1990; Tickle-Degnen and Rosenthal 1990; F. Bernieri and Gillis 1995; Grahe and Bernieri 1999; Cassell et al. 2007; Gratch et al. 2007; Huang et al. 2011).

In the context of virtual performers of free improvisation, recent empirical work suggests that ML may not be necessary for human beings to experience a particular system as adaptive. Such results are rather paradoxical since it is reasonable to assume that a system using ML would be more likely to produce the sensation of adaptation to the human interactant than a system using no such technique. Yet in several cases, researchers have noted that human interactants report that they have nevertheless experienced a sense (or really, an illusion) of adaptation and evolution in the behavior of systems which are in no way based in ML or any other kind of adaptive systems technique. For example, after designing his *Odessa* system, Adam Linson tested this virtual free improviser with a group of eight performers (Linson et al. 2015). In each test, a single human improviser and the Odessa system performed a series of three "duets." Curiously, Linson notes that despite the fact that his system uses neither ML nor any other adaptive systems technique, improvisers felt that the system's behavior seemed to have adapted to theirs over the course of the three takes.

Similarly, as part of my own research in this domain of computer music, I have tested a virtual free improviser of my own design, *Maxine* (Banerji 2010, 2012, 2016), with over 90 improvisers in Berlin, San Francisco, and Chicago. Like Odessa, Maxine is not based in ML nor does it use any other type of adaptive systems technique. Within this larger project to test this system with improvisers, I conducted a small experiment in which I asked eight improvisers in the San Francisco Bay Area to play a series of 10 short takes with Maxine in a studio setting at the Center for New Music and Audio Technologies (CNMAT) in the fall of 2010. After each take, the improviser was asked to complete a simple numerical evaluation of the system according to four criteria[5] and also provide an open-ended written commentary on their experience of that piece. Though the purpose[6] of these tests was not directly related to the present discussion, the qualitative data collected in this experiment resonate with Linson's observations of a perceived sense of adaptation despite the absence of any computational architecture which would directly contribute to such an experience. Specifically, several participants of this experiment noted that the system was "better" over the course of the experiment, using this term several times to describe the improvement of one take over the next.[7] For example, for the first take, all but one player had negative comments about their duo with the system. For the next take, however, five of eight participants reported a strongly positive difference.

Outside the context of this experiment, I have also noticed that players have frequently commented on the "improvement" of the system after their first experiences of it. I find such comments perplexing given the fact that the changes I have made to the system's original design in 2009 are so minimal as to be inconsequential[8] in a

[5] These criteria were (1) the degree to which the system inspired you to respond to its playing, (2) satisfaction with unexpected or surprising responses from the system, (3) the overall sense that the interaction was meaningful, and (4) whether the system's responses seemed relevant or random.

[6] The main question for this experiment focused on the issue of whether or not the active listening of another improviser increases or decreases an improviser's level of aesthetic or social-interactional satisfaction of the experience of playing music. In order to investigate this question, in a random selection of the 10 takes, the system was set to listen to a prerecorded track (and therefore, not listen to the sonic events of the current take) whereas in the remainder of takes the system listened to the combination of itself and the human performer, this being the way the system was originally designed to receive input in a performance setting. (For further discussion, see Banerji 2012.)

[7] To be clear, the quantitative data from the experiment does not necessarily suggest a clear sense of evolution in the player's experience across the set of 10 takes. However, the quantitatively-graded criteria do not directly correspond with positive or negative sentiments about the system's interactivity as an experience. With the exception of one criterion ("meaningfulness"), the criteria evaluated refer to the player's observations about the interaction overall and do not inherently convey judgments about the aesthetic value of the experience.

[8] These were mainly minor tweaks in order to enable the system to start and stop at the push of a single button. Such changes had no effect on how the system would begin to play, behave during the improvisation itself, or how it would "end" pieces.

player's overall experience. This was particularly striking at a concert to celebrate the release of a duo recording of myself and Maxine (Banerji et al. 2014) which took place at CNMAT in 2014. At that event, I invited several improvisers to play with Maxine in a series of duos. Despite the fact that I had done almost nothing to improve the system since their last experiences with it, many of them congratulated me to tell me that the system was finally sounding "better." One player reported that the system had "come a long way" and "really grown up" since his initial encounter with it in 2010. Beyond this incident, it is a routine occurrence that a concertgoer who has previously seen a performance with Maxine or has previously played with it will suggest that the system now exhibits a greater sense of "maturity," that it has "improved," or that it "sounds better these days." Even though nothing about the system has changed in terms of how it processes information or responds to live input, numerous interlocutors have expressed a more positive judgment of its behavior over repeated interactions.

4.5 Sources of the Illusion of Adaptation and a Benchmark for ML in HCI

The sensation that a system with no computationally explicit capacity for adaptation has nevertheless somehow improved or adjusted to its interactants underscores the need for a phenomenological perspective in HCI. Just as Husserl insists that the study of experience must involve a suspension, or "bracketing" (Husserl 1913/2012), of analytical concern for the factual basis of such sensations, it is imperative that HCI researchers attune to what human interlocutors experience without being immediately concerned with whether those experiences have a factual basis. Regardless of what a designer (or any creative artist) intends, one must recognize that users or an audience are likely to receive or experience something that diverges from those intentions. Still, while Husserlian bracketing implies the need to ignore the factual, physical basis of experience in order to examine experience itself, the task of understanding what physical or technical facts produced those experiences (however illusory they may be) remains essential.

4.5.1 Dynamic Feedback Loops

Even when virtual free improvisers are designed with no capacity for adapting to other players over time, improvisers repeatedly experience them as adaptive for some reason or another. As odd as this collective hallucination may be, the consistency of such misperceptions about the supposedly "adaptive" behavior of a system which possesses absolutely no computational capacity for such a thing reveals quite a bit about the nature of such social interactions and the human social psychology into which ML-driven HCI fits. On one level, this illusion of adaptation is partially a result of the fact that human interactants naturally tend to gradually adapt to such systems over time. Due to the human effort to adapt to and accommodate another social interactant, the collective behavior resulting from interactions with the system (or human agent) may shift. Even though the system's protocol of translating input to output remains static, the fact that the human player has adapted to the system means that the system is now receiving input of a different kind. As a result of changes in the nature of this input, it is reasonable to expect that the system's behavior will also be different from the initial encounter between the human player and the system. In sum, because of the changes that take place through this (rather one-sided) process of adaptation, the human player is likely to experience an illusion that the system has somehow "adapted" to them.

Regardless of whether the system is actually capable of it or not, the human player's shifting approach to playing with the system conjures a different element of the system's behavior, thereby suggesting that the system might have now adapted. Reporting on a comparative test of two interactive virtual free improvisers (Hsu and Sosnick 2009), computer scientists William Hsu and Marc Sosnick suggest that one system's interactive tendencies caused two human test subjects to drastically alter their typical behavior in improvisational interaction. Because one system, *ARHS*, is built to be more sensitive to short-term changes within an improvised piece, this system seems to encourage both musicians to play with rapid transitions and "choppy" material. This change in the musicians' performance in turn causes the ARHS system to make frequent adjustments, resulting in a dynamic feedback loop (ibid, 28).

Even though neither system tested was based in any ML technique, the results of Hsu' and Sosnick's tests have implications for an investigation into how a human being might experience the evolution of their rapport with an ML-based interactive system. A human being's natural tendency to adapt to the system's behavior yields a noticeable change in the system's behavior, resulting in an illusion or at least a superficial sensory and experiential trace of adaptation. Consequently, such results suggest that it is necessary to demonstrate that the adaptation that occurs through the coupling of the human being and an ML-based system is superior to or distinct from the illusory adaptation that occurs with a non-ML system.

Notably, the human tendency to adapt in this manner is hardly unique to an interaction with a non-human social agent built to perform as if it were a human social interactant. In numerous studies of human social interaction, human beings have been shown to exhibit a tendency to adjust to the behavioral tendencies of their interlocutors, even if these adjustments are only for the purposes of facilitating communication in a specific context (Kendon 1990; Giles et al. 1991; see also Lakin and Chartrand 2003). The human adaptive behavior that Linson and Hsu describe are likely examples of sociologist Erving Goffman's classic theory of "face-work" (1955; see also 1967), or the hypothesis that human beings tend to avoid exposing themselves or others to embarrassment. In encounters with interactive virtual performers, human improvisers simply adapt to the non-human interactant in order to try to make the most of the musical occasion. The impulse to make do and cope with the shortcomings of one's musical collaborator is repeatedly referenced both by Linson's test subjects (2014) as well as in numerous ethnomusicological studies of musical interaction (Brinner 1995; Monson 1996; see also Sunardi 2011). When faced with the task of working with a musical partner whose skills are weaker than one's own, most musicians do what they can to prevent the partner's failings from being exposed to the audience by engaging in a variety of improvisatory means of dealing with their inadequacies.

4.5.2 The Exposure Effect

Aside from the general human tendency to accommodate one's interlocutors, the so-called effect of "mere exposure" (Zajonc 1968) or "familiarity principle" (see Moreland and Zajonc 1982) is another factor contributing to the almost hallucinatory judgment that a system with no capacity to adapt has nonetheless "adapted" to its partner. As proposed by Robert Zajonc, the exposure effect is a basic psychological inclination for human beings to have more positive opinions of stimuli they have previously encountered. As troubling as it may be to accept that human beings have a high proclivity to have more favorable evaluations of that with which they are already acquainted, an analysis of over 200 published experimental investigations of this phenomenon consistently indicates that both brief and repeated exposure yields more positive appraisals (Bornstein 1989).

To be certain of how or if familiarity and mere exposure effects play a role in this context, such effects would need to be studied more precisely in the context of the human experience of artificial social interactants like the virtual free improvisers at the center of the present discussion. Nevertheless, the exposure effect has been documented in numerous domains of activity including interpersonal attraction (Reis et al. 2011), musical taste (Huron 2006), and scholarly reputation (Serenko and Bontis 2011). Therefore, it is likely that the same effect is at work in the perception of adaptation in the human experience of interaction with these nonadaptive artificial socio-musical interactants. In other words, it is just as likely that one experiences a positive sensation of rapport formation over iterative interactions with a nonadaptive social agent as one would with an agent that is designed to exhibit adaptation through ML or related methods. Just as the human tendency to adapt to an interlocutor whose overall interactive processes are static still produces a sensation of "adaptation," the exposure effect presents a challenge to any researcher working with ML in the context of designing an artificial social interactant.

4.5.3 A New Benchmark for ML in Artificial Social Interactants?

Overall, the experience of adaptation with systems which do not fundamentally change their process of interacting with human interlocutors suggests the need for new benchmarks for the evaluation of such systems. That is to say, researchers designing virtual social interactants using ML must convincingly demonstrate that the adaptation that the system's human interlocutors experience exceeds the rate of improvement which would result from mere exposure. Similarly, designers might also want to critically examine whether an ML-based system results in a sense of adaptation which is superior to what would result from the interactions of a human interactant who generously accommodates the inadequacies of its nonhuman partner. Ultimately, if one wants to claim that an ML-based artificial social interactant exhibits greater levels of adaptation than one which uses no adaptive systems technique, then it must be shown that the experience of adaptation is somehow superior to that which results from the exposure effect or a dynamic feedback loop.

4.6 Inverting HCI for Social Psychology

The regularity with which improvisers feel that they are forming a rapport with a machine that has no memory of the history of their interactions presents a fascinating set of problems for the intersection of ML and HCI. Such illusions in human-machine interaction have been noted since Joseph Weizenbaum wrote of his consternation at the way human beings were gleefully bamboozled into thinking they were making real psychological progress on personal issues by talking to "Eliza," an early chatbot designed to simulate the neutral therapy style of a Rogerian psychologist (Weizenbaum 1976; see also Hofstadter 1995). These and other perplexingly gullible experiences in the human encounter with technology further corroborate Spiro Kiousis' provocative yet pragmatic suggestion that "interactivity" is less a feature inherent to the design of a system so much as it is a phenomenological dimension of how a human user frames and understands their experience with a given technology (Kiousis 2002). Systems with strong interactive capacities may nevertheless lead human interactants to regard them as static or intransigent. Conversely, systems with relatively fixed interactive approaches may be regarded by their human interactants to have exhibited a strong ability to change their behavior over time.

But while the illusions of adaptation discussed above challenge the efficacy of ML as a way of recreating the kind of rapport that emerges in a real interpersonal relationship, what implications, if any, do they have for an understanding of the mutual attunement that takes place between human beings? Regardless of the reality or fantasy of adaptation between human and machine improvisers, such illusions raise questions about the precise nature of the interpersonal process of rapport formation that takes place as social beings get to know one another over time through a series of interactions. When we feel that others have adapted to us, what has actually taken place? Has a true change in their interactive behavior occurred? Or have we simply found a more favorable impression as a result of an exposure effect or a dynamic feedback loop?

For improvising musicians, the formation of a group dynamic is both a widely discussed experience but also a normative value which defines what improvisers expect in the conduct of their peers. For example, improvising saxophonist Evan Parker, in a discussion with guitarist Derek Bailey, describes the experience of regularly playing in a group over a long period of time as one in which each participant had "accepted long ago those aspects of each other's playing that we are never going to be able to change" (Parker, qtd. in Bailey 1980/1993: 141). Likewise, percussionist Burkhard Beins characterizes adaptation and acceptance of the tendencies of one's peers as an inevitable fact of playing over and over again. Strikingly, Beins writes that "collective spaces of possibility already begin to establish themselves when the same group constellation meets for a second time after having formed some initial common experiences." Furthermore, he notes that "this phenomenon appears to take place regardless of whether those who are involved are actually are of it" (Beins 2011: 171).

Likewise, testing the virtual free improviser Maxine has prompted numerous improvisers to assert that the system's lack of memory of previous interactions is a significant barrier to their ability to feel that they are interacting with another human player. According to these players, unless I were to redesign the system to be able to acquire this kind of memory, this project is doomed to fail in the goal of reproducing the intuitive mutual understanding and rapport of human relationships. Such comments mainly arise when musicians press me to explain more about how the system works and clarify whether it can recall past events. While my goal has been to solicit their opinions of the system solely on the basis of their experience of playing with it (and not based on their evaluation of my verbal account of how it works), I have readily admitted that the system lacks any capacity to recall a previous interaction with a given performer. For several performers, this lack of memory is a major source of disappointment and immediately gives them a strong bias against the possibility that their experience playing with the system will be satisfying. For one performer, Maxine's lack of memory of previous interactions was the aspect of the system's makeup that most strongly made her feel that it would never be "lifelike." Without this sense of memory, she felt that the system lacks the basic human ability to be self-critical and improve one's abilities to work with other musicians over time in order to create more compelling performances, howsoever this may be defined.

Clearly, these musicians share a strong conviction that a process of adaptation is (1) taking place regardless of one's intentions and (2) a fundamental aspect of the successful development of a musical group engaged in this particular performance practice. But no matter how strongly these musicians may feel that such adaptation is happening, it remains a mystery as to what actually occurs that contributes to their experience of adaptation. Moreover, the fact that musicians also experience the formation of a rapport in interactions with a system whose interactive processes stay static raises the question of just how or to what degree improvisers actually adjust their approach to interaction over successive meetings to play.

If one experiences "adaptation" with an artificial social agent whose ways of interacting with input are essentially intransigent, then what does this experience suggest about the interpersonal attunement that musicians assert is both a fact and necessity in their improvisatory transactions with others? Is it possible that when musicians claim to experience adaptation with their peers that what actually takes place is similar to the illusory one-sided "adaptation" that transpires between an adaptive musician and a nonadaptive system? What, if anything, does one learn about another player's playing from improvising with them regularly both in private "sessions"[9] and concerts? What features of another's playing does one adapt to? Minute features such as rhythm or timing habits or the spectral features of their playing (e.g., tone-to-noise ratio, spectral centroid, etc.)? Or more general features such as their tendency to create form or their disinterest in doing so? And besides the possibility of taking note of how others produce such features, what does one actually do to react to them? Mimic them? Deviate from them? A combination of the two?

As it currently stands, the answers to these questions are not yet known, though recent experimental work in the behavioral science of music offers a few beginnings of an idea of what actually happens in this process of interpersonal adaptation (Canonne 2013; Wilson and MacDonald 2015). In order to answer such questions, one obvious approach would be to analyze how a group of individuals develops a particular dynamic as a result of each other's tendencies and their interplay over time. This could be done through the standard musicological means of transcribing the musical events captured in a recording and then using this data to conceptualize how the group's habits of interaction change over time. But while this approach may reveal a handful of general tendencies in how human beings habituate themselves to the quirks of their interlocutors, there is no way of knowing if a truly mutual adaptation has taken place or if this is a repetition of the unilateral self-reconfiguration in which one musician copes with the inflexibility of another player, whether human or machine. Though the resultant dynamic feedback loop may resemble a process of transformation in group dynamic due to mutual, bilateral adjustment, it is just as likely that what has actually occurred is the result of the one party's adjustment to the other. Similarly, as social psychologists have also observed, human subjects have a difficult time accurately assessing the nature of the rapport between two individuals when asked to do so from a third-person perspective in which one is not a participant of the interaction (Bernieri and Gillis 1995; Bernieri et al. 1996; Grahe and Bernieri 1999).

Therefore, in addition to the standard musicological and social-scientific methods for addressing the mystery of group dynamic formation, a comparison of players' experiences improvising with (1) systems that do not adapt versus (2) systems that do may offer a clearer picture of what actually happens to produce the sensation of rapport. Though the field of HCI traditionally instrumentalizes the testing of such

[9] When improvisers meet in private, it is rare for them to "rehearse" materials. Instead, it is far more common to play for a duration similar to that of an actual concert (ranging from 20 minutes to an hour) without break. Afterwards, some discussion may take place about the music. However, given the fact that recalling specific details of such a long duration of improvisation, in which temporal coordination (i.e., pulse) is often absent and each player is engaged in significantly independent lines of action, it is doubtful that one will have a clear recollection of specific events. Therefore, it is unlikely as well that one will have the epistemological certainty required to make a comment about what has happened and how it should have been done differently (Corbett 1994).

systems as a path towards better coupling with the human interactant, I suggest that testing offers results which transcend the canonical expectation for "implications for design" (Dourish 2006). Instead, this approach to testing could provide a better picture of how interpersonal attunement occurs and the kind of adjustments a given kind of interlocutor expects or wants from the other. For the social psychology of rapport, comparative testing of artificial social interactants which use ML versus those which do not could offer an alternative means of studying the nature of rapport itself. The illusory sensation of adaptation discussed previously raises the question of whether what we take as a shared history with an interactant is an experience containing elements which are less the result of their adaptation and perhaps partially the result of a more static interactive process. Thus research into the design and refinement of virtual social interactants (Gratch et al. 2006; Cassell et al. 2007; Huang et al. 2011) not only allows programmers to create more believable interactants, but to also address questions in the social psychology of rapport and interpersonal adaptation.

"Repurposing" (Banerji 2012) testing in this manner leads HCI away from design and towards sociocultural study. At the same time, if HCI, regardless of the paradigm one is most aligned with, remains concerned with a fit between machines and human beings, then a study of the culture and experience continues to be a resource for this goal. Likewise, this approach to testing and reconceptualization of its true value begins to suggest a whole range of applications of HCI research that reach over and above this practical agenda to examine questions of significance for the behavioral sciences or humanities (Bardzell and Bardzell 2016). While HCI can, and should, continue to focus on increasing functionality and usability, these other goals beyond design itself are what make the field's third-wave thinking have purchase for a broader realm of intellectual inquiries.

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References

Amershi S, Cakmak M, Knox WB, Kulesza T (2014) Power to the people: the role of humans in interactive machine learning. AI Mag 35(4):105–120

Andersen K, Brooks R (2003) Special guest: Rodney brooks. Studio 360: WNYC. National Public Radio, Washington, DC

Assayag G, Dubnov S (2004) Using factor oracles for machine improvisation. Soft Comput 8(9):604–610

Assayag G, Bloch G, Chemillier M, Cont A, Dubnov S (2006) Omax brothers: a dynamic topology of agents for improvization learning. In: Proceedings of the 1st ACM workshop on audio and music computing multimedia, pp 125–132

Assayag G, Bloch G, Cont A, Dubnov S (2010) Interaction with machine improvisation. In: Argamon S, Burns K, Dubnov S (eds) The structure of style. Springer, Berlin and Heidelberg, pp 219–245

Backstrom MJ (2013). The field of cultural production and the limits of freedom in improvisation. Crit Stud Improv/Études critiques en improvisation 9(1)

Bailey D (1980/1993) Improvisation: its nature and practice in music. Da Capo Press, New York

Banerji R (2010) Maxine Banerji: the mutually beneficial practices of youth development and interactive systems development. eContact! J Can Electroacoust Commun 12(3). https://econtact.ca/12_3/banerji_maxine.html

Banerji R (2012) Maxine's Turing test: a player-program as co-ethnographer of socio-aesthetic interaction in improvised music. In: Proceedings of the Artificial Intelligence and Interactive Digital Entertainment Conference (AIIDE'12)

Banerji R (2016) Balancing defiance and cooperation: the design and human critique of a virtual free improviser. In: Proceedings of the international computer music conference, pp 49–54

Banerji R, Maxine, the Astromusicologist (2014) Palmer square. pfMentum, San Diego

Bardzell J, Bardzell S (2011) Pleasure is your birthright: digitally enabled designer sex toys as a case of third-wave HCI. In: Proceedings of the SIGCHI conference on human factors in computing systems, pp 257–266

Bardzell J, Bardzell S (2016) Humanistic HCI. Interactions 23(2):20–29

Baumer EP, Silberman M (2011) When the implication is not to design (technology). In: Proceedings of the SIGCHI conference on human factors in computing systems. ACM, New York, pp 2271–2274

Beins B (2011) Entwurf und Ereignis (Scheme and Event). In: Beins B, Kesten C, Nauck G, Neumann A (eds) echtzeitmusik berlin: selbstbestimmung einer szene (self-defining a scene). Wolke Verlag, Hofheim

Bernieri F, Gillis JS (1995) The judgment of rapport: a cross-cultural comparison between Americans and Greeks. J Nonverbal Behav 19(2):115–130

Bernieri FJ, Gillis JS, Davis JM, Grahe JE (1996) Dyad rapport and the accuracy of its judgment across situations: a lens model analysis. J Pers Soc Psychol 71(1):110

Blackwell T, Bentley P (2002) Improvised music with swarms. In: Proceedings of the World conference on computational intelligence, pp 1462–1467

Blackwell T, Young M (2004) Self-organised music. Organised Sound 9(2):123–136

Bødker S (2006) When second wave HCI meets third wave challenges. In: Proceedings of the 4th Nordic conference on Human-computer interaction: changing roles. ACM, New York, pp 1–8

Boehm C (1993) Egalitarian behavior and reverse dominance hierarchy. Curr Anthropol 34(3):227–254

Boehner K, DePaula R, Dourish P, Sengers P (2007) How emotion is made and measured. Int J Hum Comput Stud 65(4):275–291

Borgo D (2002) Synergy and Surrealestate: the orderly disorder of free improvisation. Pac Rev Ethnomusicol 10:1–24

Bornstein RF (1989) Exposure and affect: overview and meta-analysis of research, 1968–1987. Psychol Bull 106(2):265–289

Bown O (2011) Experiments in modular design for the creative composition of live algorithms. Comput Music J 35(3):73–85

Bown O (2015) Player responses to a live algorithm: conceptualising computational creativity without recourse to human comparisons? In: Proceedings of the sixth international conference on computational creativity

Brinner B (1995) Knowing music, making music: Javanese gamelan and the theory of musical competence and interaction. University of Chicago Press, Chicago

Burrell J (2016) How the machine 'thinks': understanding opacity in machine learning algorithms. Big Data Soc 3(1):1–12

Canonne C (2013) Focal points in collective free improvisation. Perspect New Music 51(1):40–55

Canonne C, Garnier N (2015) Individual decisions and perceived form in collective free improvisation. J New Music Res 44(2):145–167

Cappella JN (1990) On defining conversational coordination and rapport. Psychol Inq 1(4):303–305
Carey B (2012) Designing for cumulative interactivity: the _derivations system. In: Proceedings of the international conference on new interfaces for musical expression
Carles P, Comolli J-L (2015 [1971]) Free jazz/Black power. University Press of Mississippi, Mississippi
Casal DP (2008) Time after time: short-circuiting the emotional distance between algorithm and human improvisors. In: Proceedings of the international computer music conference
Casal DP, Morelli D (2007). Remembering the future: applications of genetic co-evolution in music improvisation. In: Proceedings of the European conference on artificial life
Cassell J, Gill AJ, Tepper PA (2007) Coordination in conversation and rapport. In: Proceedings of the workshop on embodied language processing. Association for Computational Linguistics, pp 41–50
Chadabe J (1997) Interaction. In: Electric sound: the past and promise of electronic music. Prentice-Hall, Upper Saddle River, pp 286–323
Chaudron C (1984) The effects of feedback on students' composition revisions. RELC J 15(2):1–14
Collins N (2008) Reinforcement learning for live musical agents. In: Proceedings of the International Computer Music Conference (ICMC), Belfast
Cont A, Dubnov S, Assayag G (2006) A framework for anticipatory machine improvisation and style imitation. In: Proceedings of the conference on Anticipatory Behavior in Adaptive Learning Systems (ABiALS)
Corbett J (1994) Evan Parker: saxophone botany. In: Extended play: sounding off from John Cage to Dr. Funkenstein. Duke University Press, Duke, pp 201–208
Corbett J (2016) A Listener's guide to free improvisation. University of Chicago Press, Chicago
Crabtree A, Rodden T, Tolmie P, Button G (2009) Ethnography considered harmful. In: Proceedings of the SIGCHI conference on human factors in computing systems, pp 879–888
Dourish P (2006) Implications for design. In: Proceedings of the SIGCHI conference on human factors in computing systems, pp 541–550
Edwards PN (1997) The closed world: computers and the politics of discourse in Cold War America. MIT Press, Cambridge, MA
Eiben AE, Smith JE (2003) Introduction to evolutionary computing. Springer, Berlin/Heidelberg
Eklund R (2002) Ingressive speech as an indication that humans are talking to humans (and not to machines). In: Proceedings of the 7th International Conference on Spoken Language Processing (ICSLP)
Fails JA, Olsen DR Jr (2003) Interactive machine learning. In: Proceedings of the 8th international conference on Intelligent user interfaces. ACM, New York, pp 39–45
Fiebrink R, Cook PR, Trueman D (2011) Human model evaluation in interactive supervised learning. In: Proceedings of the SIGCHI conference on human factors in computing systems, pp 147–156
Fischlin D, Heble A, Lipsitz G (2013) Take two: sounds of surprise; rights, risks and responsibilities in improvised music. In: The fierce urgency of now: improvisation, rights, and the ethics of co-creation. Duke University Press, Duke, pp 203–219
Forsythe D (2002) Studying those who study us: an anthropologist in the world of artificial intelligence. Stanford University Press, Stanford
Friedman B, Nissenbaum H (1996) Bias in computer systems. ACM Trans Inf Syst (TOIS) 14(3):330–347
Fuchsberger V, Moser C, Tscheligi M (2012) Values in action (ViA): combining usability, user experience and user acceptance. In: CHI'12 extended abstracts on human factors in computing systems. ACM, New York, pp 1793–1798
Giles H, Coupland N, Coupland I (eds) (1991) Contexts of accommodation: developments in applied sociolinguistics. Cambridge University Press, Cambridge
Goffman E (1955) On face-work: an analysis of ritual elements in social interaction. Psychiatry Interpersonal Biol Process 18(3):213–231
Goffman E (1967) Interaction ritual: essays in face-to-face behavior. Anchor Books, New York

Grahe JE, Bernieri FJ (1999) The importance of nonverbal cues in judging rapport. J Nonverbal Behav 23(4):253–269
Gratch J et al (2006) Virtual Rapport. In: Gratch J, Young M, Aylett R, Ballin D, Olivier P (eds) Intelligent Virtual Agents. IVA. Springer, Berlin/Heidelberg, pp 14–27
Gratch J, Wang N, Gerten, J., Fast, E., & Duffy, R. (2007). Creating rapport with virtual agents. In: Pelachaud C, Martin J-C, André E, Chollet G, Karpouzis K, Pelé D (eds) International Workshop on Intelligent Virtual Agents. Springer, Berlin, pp 125–138
Harrison S, Tatar D, Sengers P (2007) The three paradigms of HCI. alt. chi
Helmreich S (2001) After culture: reflections on the apparition of anthropology in artificial life, a science of simulation. Cult Anthropol 16(4):612–627
Hofstadter DR (1995) The ineradicable Eliza effect and its dangers. In: Hofstadter DR (ed) Fluid concepts and creative analogies: computer models of the fundamental mechanisms of thought. Basic books, New York, pp 155–168
Hsu W (2005) Using timbre in a computer-based improvisation system. In: Proceedings of the international computer music conference
Hsu W (2010) Strategies for managing timbre and interaction in automatic improvisation systems. Leonardo Music J 20:33–39
Hsu W, Sosnick M (2009) Evaluating interactive music systems: an HCI approach. In: Proceedings of the international conference on New Interfaces in Musical Expression (NIME)
Huang L, Morency L-P, Gratch J (2011) Virtual rapport 2.0. In: Vilhjálmsson HH, Kopp S, Marsella S, Thórisson KR (eds) Proceedings of the 10th International Conference on Intelligent Virtual Agents. Springer, Berlin/Heidelberg, pp 68–79
Huron DB (2006) Sweet anticipation: music and the psychology of expectation. MIT Press, Cambridge, MA
Husserl E (1913/2012) Ideas: general introduction to pure phenomenology (WRB Gibson, Trans.). Routledge
Kendon A (1990) Conducting interaction: patterns of behavior in focused encounters. Cambridge University Press, Cambridge
Kennedy J, Eberhart R (1995) Particle swarm optimization. In: Proceedings of the IEEE conference on neural networks, pp 1942–1948
Kiousis S (2002) Interactivity: a concept explication. New Media Soc 4(3):355–383. https://doi.org/10.1177/146144480200400303
Kofsky F (1970) Black nationalism and the revolution in music. Pathfinder Press, New York
Lakin JL, Chartrand TL (2003) Using nonconscious behavioral mimicry to create affiliation and rapport. Psychol Sci 14(4):334–339
Lange BR (2011) Teaching the ethics of free improvisation. Crit Stud Improvis/Études critiques en improvisation 7(2)
Langton CG (1997) Artificial life: an overview. MIT Press, Cambridge, MA
Lewis GE (1993). Voyager (G Lewis, R Mitchell, V. I. V. I. System, Trans.). Avant, Japan
Lewis GE (1999) Interacting with latter-day musical automata. Contemp Music Rev 18(3):99–112
Lewis GE (2000) Too many notes: computers, complexity and culture inVoyager. Leonardo Music J 10:33–39
Lewis GE (2007) Mobilitas animi: improvising technologies, intending chance. Parallax 13(4):108–122
Linson A (2014) Investigating the cognitive foundations of collaborative musical free improvisation: experimental case studies using a novel application of the subsumption architecture. Doctoral thesis, The Open University
Linson A, Dobbyn C, Lewis GE, Laney R (2015) A Subsumption agent for collaborative free improvisation. Comput Music J 39(4):96–115
Maatman R, Gratch J, Marsella S (2005) Natural behavior of a listening agent. In: Intelligent virtual agents. Springer, Heidelberg, pp 25–36
Monson I (1996) Saying something: jazz improvisation and interaction. University of Chicago Press, Chicago
Moreland RL, Zajonc RB (1982) Exposure effects in person perception: familiarity, similarity, and attraction. J Exp Soc Psychol 18(5):395–415

Morrissey K, Kirakowski J (2013) ‘Realness’ in Chatbots: establishing quantifiable criteria. In: Kurosu M (ed) Proceedings of the 15th international conference on human-computer interaction. Springer, Berlin/Heidelberg, pp 87–96
Nissenbaum H (2001) How computer systems embody values. Computer 34(3):120–119
Pachet F (2003) The continuator: musical interaction with style. J New Music Res 32(3):333–341. https://doi.org/10.1076/jnmr.32.3.333.16861
Pras A, Schober MF, Spiro N (2017) What about their performance do free jazz improvisers agree upon? A case study [Original Research]. Front Psychol 8(966). https://doi.org/10.3389/fpsyg.2017.00966
Reis HT, Maniaci MR, Caprariello PA, Eastwick PW, Finkel EJ (2011) Familiarity does indeed promote attraction in live interaction. J Pers Soc Psychol 101(3):557
Rodriguez AW (2016) Harmolodic pedagogy and the challenge of omni-musicality. Jazz Perspect 9(2):173–192
Rowe R (1992) Interactive music systems: machine listening and composing. MIT Press, Cambridge, MA
Seaver N (2012) Algorithmic recommendations and synaptic functions. Limn 1(2)
Sengers P, Kaye J, Boehner K, Fairbank J, Gay G, Medynskiy Y et al (2004) Culturally embedded computing. IEEE Pervasive Comput 3(1):14–21
Serenko A, Bontis N (2011) What’s familiar is excellent: the impact of exposure effect on perceived journal quality. J Informet 5(1):219–223
Seyfert R, Roberge J (2016) Algorithmic cultures: essays on meaning, performance and new technologies. Routledge, New York
Snyder JK, Fessler DM (2014) Narcotics anonymous: anonymity, admiration, and prestige in an egalitarian community. Ethos 42(4):440–459
Spellman AB (1966) Four lives in the bebop business. Pantheon Books, New York
Stanyek J (1999) Articulating intercultural free improvisation: Evan Parker’s synergetics project. Resonance 7(2):44–47
Steinbeck P (2010) “Patience, sincerity, and consistency”: Fred Anderson’s musical and social practices. Crit Stud Improvis/Études critiques en improvisation 6(2)
Suchman L (2006) Human-machine reconfigurations: plans and situated actions. Cambridge University Press, Cambridge
Sunardi C (2011) Negotiating authority and articulating gender: performer interaction in Malang, East Java. Ethnomusicology 55(1):32–54
Tickle-Degnen L, Rosenthal R (1990) The nature of rapport and its nonverbal correlates. Psychol Inq 1(4):285–293
Waterman E (2008) Naked intimacy: eroticism, improvisation, and gender. Crit Stud Improvis/Études critiques en improvisation 4(2)
Weizenbaum J (1976) Computer power and human reason. W. H. Freeman and Company, San Francisco
Wilf E (2013a) Sociable robots, jazz music, and divination: contingency as a cultural resource for negotiating problems of intentionality. Am Ethnol 40(4):605–618
Wilf E (2013b) Toward an anthropology of computer-mediated, algorithmic forms of sociality. Curr Anthropol 54(6):716–739
Wilson GB, MacDonald RA (2015) Musical choices during group free improvisation: a qualitative psychological investigation. Psychol Music:1–15
Woodburn J (1982) Egalitarian societies. Man 17(3):431–451
Yee-King MJ (2007) An automated music improviser using a genetic algorithm driven synthesis engine. In: Giacobini M (ed) Applications of evolutionary computing (EvoWorkshops 2007) proceedings. Springer, Berlin/Heidelberg, pp 567–576
Young M (2008) NN music: improvising with a ‘living’ computer. In: Kronland-Martinet R, Ystad S, Jensen K (eds) Computer music modeling and retrieval: sense of sounds. Springer, Berlin, pp 337–350
Young M (2010) Identity and intimacy in human-computer improvisation. Leonardo Music J 20(online supplement)
Zajonc RB (1968) Attitudinal effects of mere exposure. J Pers Soc Psychol 9(2, part 2):1–27