

# Virtual environments for creative work in collaborative music-making

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**Abstract** Virtual environments are beginning to allow musicians to perform collaboratively in real time at a distance, coordinating on timing and conceptualization. The development of virtual spaces for collaboration necessitates more clearly specified theorizing about the nature of physical copresence in music-making: how the available communicative cues are likely to affect the nature of visually mediated rehearsal and performance. Pilot data for a project carried out at the New School for Social Research demonstrate some important factors relevant to designing remote spaces for musical collaboration, and suggest that virtual environments for musical collaboration could actually enhance the feeling of being together that creative musical expression requires.

## 1 Introduction

Music-making is a quintessentially creative activity, both in rehearsal and in performance. In rehearsal, the performer creates an interpretation of a piece, improvising upon some starting point—in Western classical and popular music, from a musical score (within a range of acceptable variability), and in jazz, from an underlying harmonic structure. In performance, creativity manifests itself in how the performance moves

and breathes in that particular setting and moment. Collaborative music-making, where two or more performers rehearse and perform together, involves the same kinds of creativity in rehearsal and performance, but adds a large set of additional complexities. In rehearsal, collaborative musicians engage in a creative process of coming up with a joint interpretation or set of potential improvisations; in performance, they initiate and react to their partner's variations in pacing, flow, and mood, co-constructing the particular performance dynamically. This is true even when musical partners are following a score. No two performances are ever alike, and it is creative deviation that makes a performance sing.

Musical collaborators' feelings of copresence—of breathing together, of being able to anticipate each other's moves, of feeling both independent and like one being—are essential for this creative process to occur. And yet in ordinary musical settings there can be multiple impediments to this copresence. Physical constraints can get in the way; if partners cannot see each other, because of their placement in an ensemble or because their instruments are blocking the view, feelings of copresence can be diminished. Partners' level of knowledge about what the other is experiencing, or attentional limitations on their own performance (e.g., needing to fixate on a score), can make it hard or impossible to coordinate creatively.

Virtual reality allows us to imagine new forms of copresence that have the potential to enhance creativity in rehearsal and in performance. Freed from the constraints of the physical world, one could imagine being surrounded by one's cellist partner's bowing, seeing a visualization of the trumpet soloist's improvisation, or feeling one's singer partner's breathing in a

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way that is physically impossible in real world settings. Enhanced access to cues could be useful both in rehearsal and performance.

At present, this sort of technology has not been fully developed. Broadband technology is only beginning to allow sufficient bandwidth to allow fully two-way communication with imperceptible lag (see, e.g., Barbosa 2003; Gu et al. 2005; Jung et al. 2000; Konstantas et al. 1998, 1999, for discussion of technical specifications for remote musical coordination). Beyond this, there is a vast amount of additional knowledge needed to understand what kinds of visualizations or sensory representations will actually enhance creative rehearsal and performance, and for which kinds of performers and musical styles. Systematic research on the visual and auditory cues that musicians use to coordinate in rehearsal and performance is underway (e.g., Blank and Davidson 2006; Himberg 2006), but at present far too little is still known. We have nothing like a systematic database or taxonomy of different kinds of musical coordination which would allow us to precisely specify how, for example, the cues that orchestra members use in coordinating with conductors and each other differ from the cues in rock bands, jazz ensembles, or string quartets.

This paper describes the beginnings of a line of research that will form the building blocks for understanding virtual environments for creative work in musical collaboration, allowing us to better understand which aspects of physical copresence are worth enhancing in a virtual environment and which are not. The work starts by looking at low-level forms of virtuality that are technically feasible today: remote video and remote audio connections.

Obviously these are only the tip of the iceberg as far as what virtual environments will allow, but understanding what happens here is an essential first step. The virtual space that is created even with remote video is—at least in the minds of the musicians using it—already at a substantial remove from the true physical copresence that musicians expect. Understanding what happens when visual cues are presented to musicians in a non-physically-copresent way is the first step towards far more elaborate virtual musical spaces.

## 2 Remote copresence in chamber music

In recent years musicians have created rehearsals and performances where two or more participants are separated in space and time, sometimes even across continents (e.g., Konstantas et al. 1997, 1998, 1999; Jung et al. 2000; see Barbosa 2003, for discussion of

system requirements for different kinds of collaborative musical tasks). Thus far bandwidth limitations remain such that the performances are not fully two-way in the way that live performances with physically copresent musicians are; typically a second party must follow a first party's lead because of notable signal delay. But such limitations are on their way to being reduced or eliminated so that musicians in different physical environments will be able to collaborate with no perceptible time delay. Consider, for example, the October 2002 Interactive Cross-Continental Jazz performance between Montreal, Canada and Palo Alto, CA, where the delay was at times reduced to 50 ms; this reportedly felt to the musicians "almost like being on the same stage" (see <http://www.ultravideo.mcgill.edu/overview/>).

The stage is thus set for the beginnings of far more elaborate virtual environments for collaborative musical performance. The sine qua non is that any such environment must allow signals to be passed so quickly that true two-way reactivity can occur. In order to build such environments, however, we will need to theorize the nature of musical collaboration far more clearly.

### 2.1 Levels of coordination

A key part of traditional chamber and jazz collaborative performance is that the performers must coordinate the timing and expressivity of their performances at the millisecond level. Simply coordinating competently enough that there is nothing obviously wrong—no mistimed attacks, no notes held longer by one party than the other, no obvious differences of opinion about what the right tempo should be or how exactly a phrase should slow down or speed up—is no mean feat, as skilled soloists who attempt to collaborate for the first time quickly discover. Musicians following a score have a script to follow that dictates a good deal about what they should do, sometimes including precise metronomic tempo markings and expressive timing cues. Musicians improvising without a score, say on the basis of a jazz chord progression, have a less detailed and more implicit "script" to follow. But with or without a score, how exactly the script gets enacted by particular performers varies across performers, and even within a performer on different occasions. This is why musicians rehearse a piece again and again before deeming the performance ready for the world. Coordination isn't an all or none phenomenon—performers can be more or less tightly coordinated on timing, dynamics, expressive features, and conceptualizations.

Beyond this, collaborative musicians strive to achieve a fuller sense of copresence or mind-meld, such that the coordination and give-and-take feels effortless and organic, and the pair or group operates as one entity. To use Shütz's (1951) characterization, they strive to achieve a "mutual tuning-in relationship by which the 'I' and the 'Thou' are experienced by both participants as a 'We' in vivid presence." Some performers are better at this than others, and some combinations of performers are better at this than others. Although the vocabulary for talking about this is impoverished, and not every musician feels comfortable discussing the issues, an almost mystical discourse has arisen among musicians who do talk about the shared mental space they work at creating. They talk of getting into the magic zone or getting into "chamber space," and they share their peak experiences, stumbling for words, as if describing food or sex. The give-and-take of high-level collaborative performance, where different partners "drive" (take the initiative) at different points, has the quality of transcendent play.

Of course, such a high-level feeling of copresence is not unique to collaborative musicians. Participants in other joint actions—pairs of ice dancers, actors performing a scene, tennis doubles partners—have related notions of being "in the zone." They also, in various ways, can distinguish between carrying out a joint activity competently enough that it works and entering a kind of shared space in which they achieve what feels like real mind-meld.

Little in current scholarly theorizing quite gets at distinguishing joint action at this very high level from ordinary joint action. The work on "flow" (Csikszentmihalyi 1992; Csikszentmihalyi and Csikszentmihalyi 1988) focuses on how individuals feel a sense of connectedness with and transcendence in the tasks they engage in, but does not focus on pairs' coordination. Theorizing on joint action and copresence (e.g., Blascovich 2002; Clark 1996) does not distinguish between competent and masterful coordination. In any case, far more needs to be understood from a scientific perspective about the basics of musical coordination, let alone the most transcendent levels.

### 3 Cues in collaborative musical performance

Predicting how musicians will coordinate in virtual environments, and what sorts of spaces will afford what sorts of coordination, requires greater understanding of the cues that musicians pass back and forth when they are physically copresent. Although the music that

performers create is acoustic, visual cues are also available, and these cues have been proposed to be all-important (Schütz 1951):

"...making music together occurs in a true face-to-face relationship—inasmuch as the participants are sharing not only a section of time but also a sector of space. The other's facial expressions, his gestures in handling his instrument, in short all the activities of performing, gear into the outer world and can be grasped by the partner in immediacy. Even if performed without communicative intent, these activities are interpreted by him as indications of what the other is going to do and therefore as suggestions or even commands for his own behavior. Any chamber musician knows how disturbing an arrangement that prevents the coperformers from seeing each other can be" (p. 91).

Collaborative musicians are indeed trained to watch for each other's signals—to breathe together, literally and metaphorically. But just how crucial are visual cues for competent or masterful performance? Just how crucial is actual physical copresence, as opposed to merely being able to see the other's visual cues (for example, via remote video)? Just how harmed will coperformers be by not being able to see each other at all?

From musicians' perspective, visual cues ought to be particularly useful only in some circumstances. One could imagine that audio cues could partially or fully substitute—for example, a singer's inbreath may be just as audible as visible. Visual cues won't be particularly useful if the musicians are unfamiliar enough with the music that their attention is fully engrossed in reading a score, keeping track of where they are in the chord progression, or mastering their (solo) technique. Visual cues might also not be particularly important for a collaborating pair who have performed together so often that they can predict each other's stylistic moves from prior knowledge, or who have rehearsed a particular piece so well that the precise timing is prestored.

The section that follows lays out cues that are available to musicians when they can see each other in the same physical space, and explores how these cues will vary in video-mediated and audio-mediated settings.

#### 3.1 Cues for physically copresent musicians

As collaborative cues will vary for particular settings and styles of music, let us consider as an initial test case a classical chamber setting with two collaborating musicians, a pianist and a singer. (This can form the basis for comparisons with other settings and styles. It