“Contradiction pushes me to improvise”: Performer Expressivity and Engagement in Distanced Performance Paradigms

Performing arts communities have been hit hard by the recent pandemic, leading to shifts in performance venues and resulting changes in expressivity and interaction. To investigate how social distancing has influenced performers in their practice, engagement, and social conditions, and how they adapted to these changes technologically and psychologically, we interviewed 25 professional performers who have engaged in both live and online performance. We found that performers treated online performance as akin to a movie-recording situation where time is limited, and audience interaction is absent. Instead of avoiding distanced venues, performers adapted to the limitations, inventing improvisation strategies in distraction-filled situations, using time and technical limitations as creative constraints, and sometimes even making new technological strategies part of their new direction for continual practice. To understand how a distanced performance affects the practice of a dancer in live performance, we created a performance where the dancer performs at 9am at one location while the robot she interacts with interacts with her at 9pm halfway across the world. The intervention showed that the performer altered her rehearsal strategies to work with the distanced technology, and adapted to the live interaction with a distanced audience by using her own imagination. This study provides insights that guide us in the design of interactive technology for distant performance to account for the adapting strategies performers are already taking to overcome limitations of time, location, and hardship.

CCS Concepts: • **Applied computing → Performing arts; • Collaborative and social computing → Collaborative and social computing devices**

KEYWORDS: collaborative dance, online dance. lighting design, real-time dance performance.

1 INTRODUCTION

Performing arts communities have been deeply impacted by the prevalence of Covid-19, which leads to decline in revenue and shifts in performance format and experience [28]. Restrictions in gatherings have led to the transition of performing arts from in-person to online [28]. While virtual arts experiences are gradually replacing in-person offerings, technologies and devices play an increasingly crucial role in providing better performing experience both for performers and audiences. Zoom, Facebook, Instagram, and other web-based resources have been the online concert choices for musicians, dancers and bands [17].

This paper looks at how the pandemic has influenced the performance community in terms of performer expressivity and engagement in distanced performance paradigms based on a qualitative study. In the interviews we inquire the performers about how the pandemic influenced their life and performing practice and how they perceive distanced performance as a possible approach. We found that the performing online was reshaped by technology because the online platform determines how the performance is presented and how performers can interact with the audience. The deferral in time brought by the technical aspect also affects the performing experience. In terms of interaction with the

audience, the sense of being watched and physical touch were lacking during the performance, leading to less engaging experiences.

To understand the findings in the context of a real remote performance and understand the performer's workflow and interpretation of the audience and technology, we then create a remote performance that allows the performer to interact with a telepresence robot in a remote performance venue. To better understand performers' engagement and improvisation strategies and audience interpretations in distanced performance, we conducted a survey of 20 audience members in this intervention.

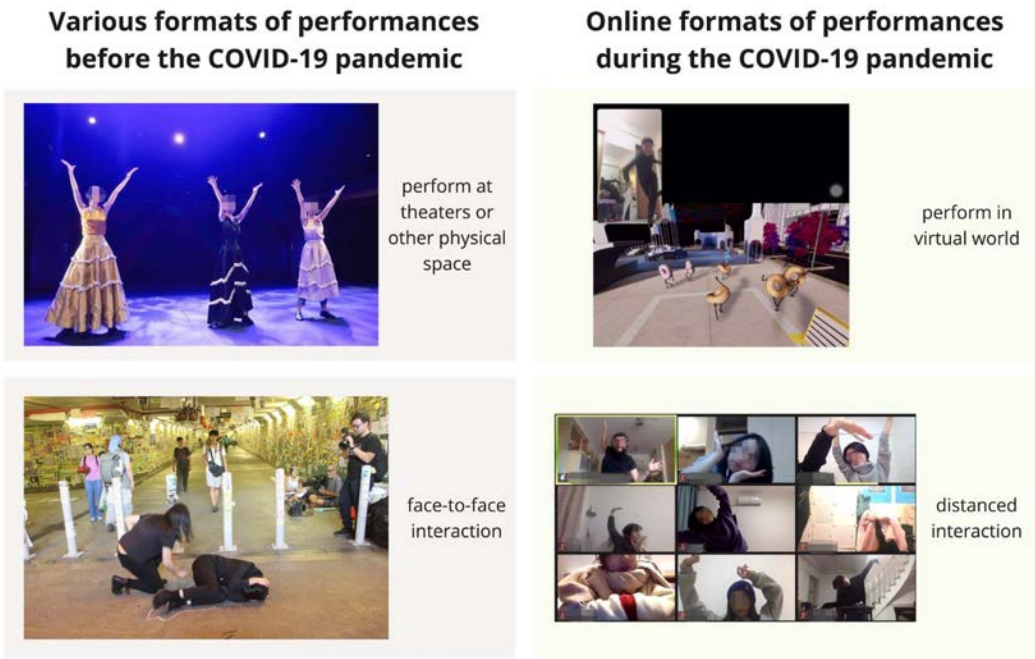

Fig. 1. Summary of the shifts of arts performances before / during the Covid-19 pandemic restrictions, with selected figures showing the performers interviewed in their practice. (Upper Left) Performing live in a local theater with reduced audiences during Covid-19 (P16). (Upper Right) Live performance in a virtual environment with other dancers using motion capture (P10), (Bottom Left) A conceptual performance with live audiences in socially distant format during Covid-19 lockdown (P23). (Bottom Right) Online performance workshop conducted in Zoom during Covid-19 lockdown (P13).

The contributions of this work are thus, an interview-based study and research through design that identified i) the practices and experiences of online performance forced by isolation, and how this has impacted performers' living and performing practices, ii) design implications that allow for active performer-audience interaction in online performance, and iii) how performers improvise and engage with audiences in future interactive remote performance systems.

2 BACKGROUND

To better understand the background of performer communities in this new normal situation, this section first illustrates the literature on pre-Covid-19 dance and performance research in HCI including interactive technologies and strategies in dance performances. Then, we summarize the adopting technological tools and shifts applied to mitigate the pandemic crisis in performing art, and the impacts of the Covid-19 in creative industries and performance art including social policies and individuals' reactions.

2.1 Covid-19's Impacts on Performance Art

Studies of social impacts of the recent lockdown found that people in isolation endured negative shifts in their emotion, behavior and cognitive function due to social isolation and loneliness [11]. Creative tools and activities can serve to increase interpersonal communication and connection and alleviate some of the negative effects of social distancing. In particular, Schwender et al. [20] showed that social dance interventions can advance participants' body-awareness and sense of self. Moreover, individuals have the chance to improve their aesthetic standard, interpretation, and psychological diathesis while watching performing arts [25]. With reference to the Covid-19's social impacts on human daily life [13], social distancing has led to the cancellation and decline of physical art performances venues. The performing format and interaction mode in art performances also went through great changes and have relied on online platforms [21]. For instance, several arts performances, dance class and participatory dance performances can only be broadcast live via social media platforms or other online channels. The positive effects of performance and the negative effects of their cancellation imply that careful studies of emerging online format performance is needed.

2.2 Interactive technologies and strategies in dance performances

The combination of emerging digital technologies and live performances reshape dance practices and can increase the connections and interactions between performers and audiences . Audience engagement has always been a significant priority in performance production [7]. Mixed design strategies have been applied to engage audiences in interactive performances [5], so that audiences can gain a better understanding of complex, layered and conceptual works [12]. However, application of performance technologies in dance performance has influenced its choreography and the whole production, since more rehearsal time and processes are needed for integrating these interactive technologies into dance performance [15]. Recent studies have focused on applying interactive or reactive multimedia technology into dance performances and productions. Motion capture has been used to generate digital interaction between audiences and performers [14]. This has led to creation of interactive dance works using live motion capture systems [9,14,29], which can generate fine movement artifacts for subsequent analyses [14]. Another direction of research has explored the application of

digital technology in virtual dance. One study found that the combination of virtual reality and motion capture technology creates an immersive experience which enables them to engage with dance performances from different angles and positions and strengthens the sense of tension [27].

The application of such interactive technologies has also developed studies on movement improvisation in live dance performances [4,18,22]. Although improvisational artistry is involved in all live performances, technologies bring uncertainty and new challenges to the production of live performances since performers should make changes according to the performing environment [4]. For instance, Choreography is a novel interactive system which explores the impacts of avatar characteristics of motion capture systems on movement improvisation [18]. Since the interpretive abilities of technology are separated from humans' awareness [16], dancers need to apply strategies to handle degrees of openness in improvisation [19].

2.3 Dance and performance research in HCI

In the HCI realm, studies have analyzed the tension and interaction between dancers and participants through an interactive installation [26], finding that dance performance is a mechanism which can encourage participants to actively engage with the interactive installation and experience tensions during the facilitative process. After that, mobile technologies have further been explored by a study using the Radical Choreographic Object (RCO) to investigate audiences' participation in dance performances using gesture-based interactions, finding that that participants transfer their interaction modes and feelings from obeying it to re-interpreting and re-appropriating it [1]. This suggests that audiences can become active agents of online performance situations, providing an interactive experience for both performers and viewers.

3 RESEARCH METHODOLOGY

To better understand performer expressivity and engagement and explore the performer-audience-connection in distanced performances, we conducted semi-structured interviews with 25 experienced performers via Zoom (14), Tencent Meet (3), and in person (8).

3.1 Data Acquisition and Analysis

We recruited experienced performers in both local areas and those from locations around the world whenever available. We chose only interviewees who have experience performing in at least one online (or otherwise socially distant through technology) performance during the Covid-19 pandemic times alongside a previously extensive practice that includes at least two live performances in their careers (frequently up to 10 or more). Institutional research protocols were approved and followed strictly during the interview process. We found performers by direct messaging and posts on social media platforms (WeChat, WhatsApp, and Instagram). Each interview lasted between 30-45

minutes. Interviews were conducted in English or Chinese, and recorded in audio form. The Chinese interviews were transcribed into English after removing the information that refers to personal and identifiable data. In total, 25 participants (3 male, 22 female) were interviewed (Table 1). 7 performers were interviewed in-person due to availability [24].

Table 1. Summary of interviewees' information

ID	Gender	Occupation	Area of Practice	Online Tech/Approach Mentioned
P1	F	Performer	cantonese opera, performance technology	video, Zoom, streaming
P2	F	Dancer	chinese dance, ballet	distanced live, streaming, youtube, bilibili
P3	F	Dancer	professional dance practice	distanced live, youtube
P4	F	Dancer, performer	dance instructor	Zoom, distanced live, commercial online performance
P5	M	Dancer	modern dance	video, distanced live, social media platforms, online courses
P6	F	Dancer	classical dance, dance instructor	Zoom, distanced live, teaching dance on social media platform
P7	F	Performer	performance art. dance teacher	video, Zoom, distanced live, online teaching, youtube
P8	F	Performer	chinese dance	video, virtual platforms
P9	F	Performer	participatory performance	distanced live, Zoom
P10	F	Dancer, performer	ballroom dance, virtual performance tech	VR, virtual platforms, Zoom, motion capture, AR
P11	M	Performer	performance art, behavioral art	performance recording, Zoom, distanced live, streaming
P12	F	Dancer	ballet, latin	audience engagement, distanced live performance, streaming
P13	F	Performer	theatrical performance, applied drama	Zoom, online workshop, distanced live performance
P14	F	Dancer	contemporary dance	video, VR, distanced live, motion capture, streaming
P15	F	Performer	theatrical performance	distanced live, online workshop, Zoom
P16	F	Performer	musical theater	video, youtube, streaming

P17	F	Dancer	chinese dance	online workshop, video
P18	M	Dancer	swing dance performance	video, online workshop, streaming
P19	F	Dancer	swing dance performance	video, online workshop, distanced performance
P20	F	Dancer, performer	contemporary dance	video, distanced performance, Zoom
P21	F	Performer	live performance, performance art	distanced live, social media platforms, streaming
P22	F	Performer	performance art, behavioral art	VR, 360 and immersive methods, video, virtual platforms
P23	F	Performer	online performance	distanced live, Zoom, online teaching, youtube
P24	F	Dancer	performance art, dance teaching	video, Zoom, distanced live, virtual platforms, bilibili, youtube
P25	F	Dancer	contemporary dance, teaching	distanced live, Zoom teaching

3.2 Interview Procedure

During each semi-structured interview, interviewees were asked to briefly introduce their artistic research directions and performance experiences. Then, the interviews included questions about their practices and experiences in performing online, the effect of shifts caused by social distancing on their practice, their perspectives on how people are performing during quarantine times, the difference between conducting performance online or in a physical place, and how they expressed themselves in online performance.

3.3 Data collection and analysis

We applied coding to process and analyze the transcriptions. First, we conducted nine interviews and obtained the possible codes based on literature review and early data. One researcher took notes during the interviews and transcribed data into text. All researchers conducted the interviews and two researchers classified codes based on different themes [23]. Finally, all three researchers analyzed the codes together.

4 FINDINGS

Our interviews revealed four aspects in which performers were affected by the paradigm of distanced performance: a new adaptation with technologies designed for distanced communication, alteration in performers' interpretation and expectation of audiences, adaption to policy measures on distancing, and changes in the community of practice in terms of content and collaboration.

Contradiction pushes me to improvise

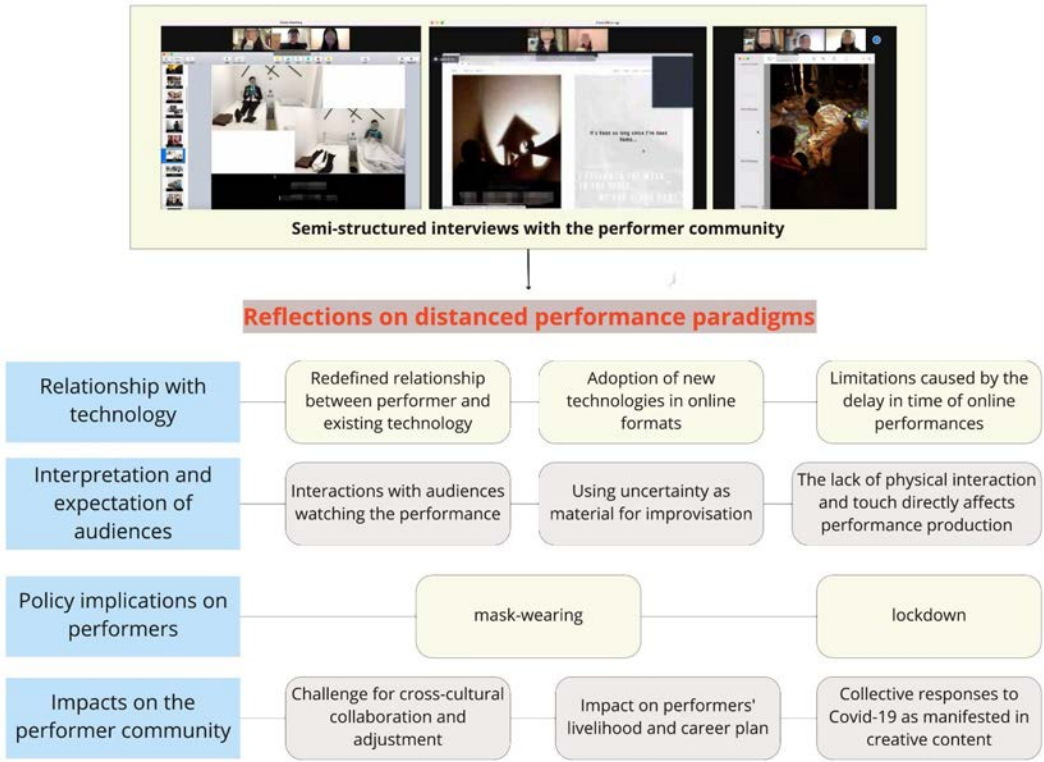

Fig. 2. Research methodology and key findings. (Up) Screen captures from semi-structured interviews conducted in Zoom, (Bottom) Diagramming the key findings.

4.1 Performer's relationship with technology

4.1.1 Redefined relationship between performer and existing technology.

With the professional performers interviewed, online performances occur most often on platforms like Youtube and Zoom, where action takes place in front of a web camera. Interviewees pointed to the similarities between conducting streamed performance in virtual platforms and being recorded in movie shoots (e.g. P4, P10, P18, P19, P22, P25) noting that they both occur asynchronously. This led performers to also take up unfamiliar technologies like video recording (P22) and web broadcasts (P18, P19). "*Due to the epidemic I had some inspirations and started to apply film making skills into my work, including the use of cameras and perspectives*" (P24). Performing in Zoom requires performers to serve as movie directors (P3, P10, P23, P24), and they can do recordings repeatedly in multiple takes until satisfactory (P18, P19), unlike live performances. However, performers also indicated that video recording capabilities applied to distanced performance also have space limitations since their movements were limited by their rooms and the perspectives of the cameras. "*I cannot do a full range of movements in the small studio I stream from, and cameras cannot pick up my movements when I'm on the ground*" (P23). Moreover, performers are often reluctant to

take up purely online work (P14, P21, P22), noting the limits on their expressive ability: "*The recording is not the actual work because I have presence and intuition in my own live work*" (P11).

The online performance pushed our participants to rethink their relationship with audiences and how technology enables the relationship: "*We're closer to rethinking what technology is in our life and also how we as a human being as a species should carry on*" (P5). In live performance, they can directly see the audience and the "*concentration was mostly on human behaviors and reactions*" (P2). In the online context, the performance is represented through an abstraction layer instead of being directly watched. P1 notes that "*Zoom meeting setting defines who we are*" and how performance is presented. They "*became more intimate with technical devices*," namely the camera, and "*less intimate with audiences*" (P1). Once the camera becomes the only media that connects the performers and the audiences, "*it dominates the performance*" as well: "*The camera determines the perspective of the audience, the space that I can dance is also limited*" (P3). Another participant felt that there were no significant differences in performing between online and offline, but "*the quality of performance in terms of detail differs in live show and online performance."* (P4) One performer incorporated remote texting itself into her performance practice, creating a work that uses audience texting to add interactivity to her work in an effort to overcome the lack of intimacy in online performance (P9).

In summary, we found that professional performers perceived the single-watching lens of online performance to be less intimate and more dominating than live performances where audiences are individuated, but have come to adapt to the existing technology.

4.1.2 Adoption of new technologies in online formats.

In addition to adoption of online streaming and video recording, some performers also took up entirely new media that were previously unexplored in their practice (P4, P6, P11, P15, P18, P19, P22). For example, a performer who works with live behavioral, concept performances was pushed to experiment with interactive video: "*I decided to move to the opposite medium to my work to challenge myself in these times*" (P22). She also notes the extreme differences between the media, noting that in live performances, audiences can move around and see what they'd like from various perspectives, but in her new media of video, "*the audience cannot control the director's decisions, so I end up having additional power to frame what audiences experience*" (P22). The online meeting format encourages this type of framing as a way for performers to creatively limit what audiences *can* see, contrary to live performance, in which the audience themselves chooses what they *want* to see. In reaction to this, P22 has explored the use of 360 video to allow audiences to see a more immersive view of the performance, recognizing that even immersive perspectives cannot substitute for liveness: "*Going to a venue has an association of quality experience due to expectation and commitment by the audience; this cannot be shown even immersively*" (P22).

Contradiction pushes me to improvise

In one case, the performer participated in an online group exhibition that used the virtual web-based exhibition not only as a way to show the creative artifacts, but also showed the process behind what the performer was experimenting with before the virtual exhibition itself as a screen capture of the live process meeting. In this way the performing artist can show his process virtually, as a proxy for showing the actual live performance itself: "*showing the process together with the other artists was for me, the performance itself, it's not the same as my performance, but it's something completely different*" (P11). In his case, he adapted to the lack of live audiences: "*to myself no matter if there is an audience present or not, I already know the situation and mental state I want to be in and am not aware of the audience directly*." Thus this transition to an online static format can potentially be made easier by the type of mental framing of P11.

As opposed to simply adapting to the online format, certain performers have also explored innovations in performance technology as part of their new renewed focus or practice (P1, P7, P10, P21, P24). For example, despite beginning her career in ballroom and contemporary practices, P10 has spent the duration of the pandemic era on technological performances, working with motion capture, dancing with recorded video in VR, avatar dancing, virtual performance using Tilt Brush in VR, etc. "*I see Covid as an opportunity for innovation, doing things that I didn't get to explore before*" (P10). Case in point is her last work to be proposed for live performance, which was interrupted by the Covid-19 outbreak. In that piece, 16 people were to be stuck in a square space, viewable by the audience from above. When that work had to be moved online in video format, she was initially distraught: "*Looking from above is only one viewpoint live, but ironically was much more immersive than the many viewpoints of the movie*." However in looking for ways of overcoming the limitations of single-viewpoints in a video, she became absorbed in immersive distanced performances, in which she has produced work for a recent residency and as her company's practice. In particular she has adapted to the online format, figuring out how to "*monitor how everyone moves*" when rehearsing in Zoom and multitasking to "*manage spaces of everyone who participates*" in online works. She finds her previous experience as a movie director especially helpful in this new online regime, and often asks her students and dancers to imagine the scenario in order to "*design the perspective taking process*" for immersive works. She has understood the advantages of online performance, such as being able to situate the performance in a place that is more related to the topic than the theater could be (dancing next to a lake as part of the story as opposed to an artificial lake in live theater, for example); and running the performance at any feasible time without fixed venues. In short, she has taken distanced performance as an emerging and integrated part of her practice.

The same can be said of P24, who up until Covid-19 was teaching and performing contemporary and pair dance. Since the pandemic lockdown she has been doing online performances and online residencies exclusively, with one work that uses projection and puppet play on a layered Zoom screen to show collaborative performance with a participant from a different country: "*In doing what I want to do for my practice, I have*

found that there's always a new way to be creative, so the new constraints are just sources of inspiration for new ways of connecting performers together" (P24).

In summary, performers have experimented with new technology that were previously not part of their practice, as well as technology recently employed to provide greater immersiveness and expressivity in distanced work. Some have made these technologies a core part of their practice going forward, creating a community for such practice.

4.1.3 Limitations caused by the delay in time of online performances.

Participants mentioned time delay as another main situation brought about by online performances. "*There must be some kind of delay in terms of the technical aspect so you're always seeing something that is different from intended*"(P1). Participants were often frustrated by the delay in online performance when performing online to instruct the students (P1, P4, P10, P23). "*It often leads to unsatisfactory teaching results when many students learn the wrong rhythm due to the delay*."(P4) One participant generalized this delay idea into every aspect of delay when dealing with Covid-19 lockdowns, including delays in venue openings, delays in developing one's own practice, etc. She termed this general idea of delay associated with Covid-19 "*deferral, or a desire for something to eventually happen*" (P1). Instead of seeing "deferral" as a negative element of the lockdown, she took it as an opportunity, and "*would like to develop it further in [her] later life*" (P1). Delays as manifest in the "deferral" concept of pushing things back that can occur now to later points within a single performance, in a scheduled show, in a point in one's career illustrates the way performers attempt to deal with Covid-19 situations by adapting a metaphor that can capture their emotional state. On the other hand, it pushes the artist to think about how this kind of frustration can be "*transformed into another layer of meaning*" (P1) relating the temporal deferral in the micro scale of the delay in online performance to one's own performance practice, where subscriptions and scheduled shows have been canceled: "*The online performance has a delay that is like a metaphor for how our lives have been altered*." She notes that the online situation has "*changed the way we spend time together*," but finds it to be "*an opportunity to adapt*" (P1).

The notion of time seems especially relevant in the online regime. For one performer, it seems that the amount of time available is especially pressing in formats that require recording and streaming, as in distanced performance, whereas live performance do not appear to have such constraints. "*Acting in movies and online only lasts briefly, but live performances can last forever*" (P21). She equates the current online performance with her previous experience as an actress, noting that they both involve time constraints of when her part of the stream ends or when the director tells cut. The "*timelessness of the performance,*" on the other hand, is reflected in her live works during Covid-19 times, when she created an 8 hour performance where visitors can visit her in a cage and freely make eye contact. Further illustrating this contrast, she notes that "*live performances can be personal because the audience is part of it, but in a movie, who watches it? I cannot tell*" (P21). But as the online constraints impose their restrictions, she is looking for ways to adapt: "*I continue to search for a performance that lasts forever and is about the self*."

Contradiction pushes me to improvise

In summary, performers found the delay in time of online performances to be both a source of hindrance, and a constraint that can lead to creative adaptations. They find the time constraints of the online format especially stifling compared to live performances.

4.2 Performer's interpretation and expectation regarding audience interactions

4.2.1 Interactions with audiences watching the performance

The online performance redefines how performers interact with audiences. Previously in live performance, performers were being watched in person by audiences and they "*could immediately get audiences' feedback"* (P2) and could have *"emotional communication and feedback*" (P3). "*This real-time feedback triggers energy in me*" (P2). Through this process, a dialogue loop was constructed between the performers and audiences. "*When I was doing the live performance, the fact that I'm being watched motivates me and energizes me. And I enjoy the process of transforming this energy into my dance as a response to the audience.*" (P2) One performer said "*it was the audiences' cheer [in live performance] that really opened up for me to respond through dance patterns*." (P8) Another noted that it's really the "*interaction with space that the audience occupies*" that provides the material for one's creative choices (P14).

In contrast, in online performance, audiences' gaze can not be perceived by the performers, "*especially when they turn off their camera, I feel like I'm performing to myself, and that feels awkward*" (P4). Due to the lack of interaction, "*online performance is like making a movie*." (P4). The performance was well prepared beforehand, the performers "*just present it to the audiences online*" (P8). "*There is no communication in between.*" (P7) Another noted that "*I have to do everything by myself, and I got no response from the audience, which is discouraging*." (P6) The lack of feeling of being watched is the primary concern on the topic of realism of the performance: "*The performance doesn't feel real because I think that performance is meant to be watched*" (P6). The perspectives and adaptations brought up by audiences are so strong that for one performer, "*the interaction with the audience is the ultimate source of creativity*" (P14). For some performers, this need for an audience is so strong that they never gave up on live performance even when online venues prospered, preferring to do their art in-person whenever possible (P7, P16, P21, P22).

In other cases, however, even the need for audience interaction is an adaptation to be overcome by performance practice in the pandemic era. For example, despite working exclusively in-person for his work before Covid-19, P11 feels that "*if [he is] clear about the topic and what [he wants] the outcome to be, not all performance art needs to be for live audiences*." He feels that he is not aware of the audience because "*the topic is more important to the flow*." He appears to compartmentalize performances without audiences as "*a new thing,*" but that even this type of "*showing together is the performance itself*" (P11). This perspective also resonates to some extent with the performers who prefer live interaction, because they speak of actively trying other methods like video and immersive documentation that do not have audience participation (P21, P22).

In summary, the online format forces performers to adapt a single-lens, asynchronous approach in regards to the audience, creating a situation where they feel like they are performing to one abstract viewer like a camera lens as opposed to a collective interaction as it is found onstage.

4.2.2 Using uncertainty as material for improvisation

The ability to improvise during performances creates a sense of agency for both the performer and the audience [4]. Due to the lack of live audiences providing *"energy for performance*,"(P2) online performance creates a situation where "*we play to the camera with a previously determined routine*" instead of improvising (P4). "*Improvising doesn't make sense in the online video, because the whole production needs fickle, unpredictable audiences for us to react to*" (P18). This is consistent with the view that in online performance, the performer does not have a model of the individual viewer, but rather can only focus on a single abstract viewer (such as webcam or video camera), as we saw in the previous section. Thus she cannot find ways of improvising with the audience since she cannot know what the audience is feeling "*out there*." (P6)

Interestingly, we found that performers also take this constraint itself as an opportunity to improvise: "*During our livestream, the audience is not ideal [and we] need to refocus, but the contradiction pushes me to improvise, … it's like being constantly distracted online."* (P1) In short, even though performers don't see the audience online well, especially with video-off conference calls, they find the reduced information load to be not necessarily a hindrance, but rather a creative constraint. In P1's case, she uses the distractions from random audiences on zoom as a way to improvise her practice during the performance: *"I learned how to distract [myself] away from the distractions online*." The distractions and multitasking required in online performances make it improvisational just to be able to "*monitor how everyone is moving and respond to them appropriately*" (P10). For (P7), "*I'm appreciative of being able to perform in person again*," because working in zoom has been *"exhausting because I cannot adapt to my audience*." Her practice has been to improvise her participatory performances without rehearsal, because she wants to change her actions based on the surprises that audiences bring her. This is only possible in the live space with an engaged audience.

In summary, professional performers found it difficult to improvise online without full vision of responsive audiences, but some have used these constraints as creative opportunities to adapt.

4.2.3 The lack of physical interaction and touch directly affects performance production.

The physical interaction between performers and audiences are lacking in the online performance. One participant said the most concern was "*the fact that humans cannot touch each other*" (P1), in which the "*temperature*" is lacking in the performing experience. "*People would come close to look at and touch the makeup on my face after the performance*" (P1). However, in online performance, "as a performer I need to think how to reach the audience." Similar to how another performer said "*there was always a*

screen, a separation between the performers and the audiences" (P3). Previously in the live performance, "*I often walk into the auditorium and invite the audience to join the dance by taking their hands*" (P2). The intimate touch and bodily interaction "*is an important part of my performing experience*"(P2) that can incentivize the participant to create different improvisations and provoke inspiration "*for my next choreography creation*" (P1). The lack of touch also negatively impacted the preparation for the performance: "*We tried to do online rehearsals with partners from other regions, so there was no physical contact or pulling movement between actors, it was hard to imagine how actors pulled each other in different spaces…*" (P13)

One performer sees herself as a "*body researcher*" (P5): to perform is "*to study your own body through body language and to learn about others' bodies through somatic interaction.*"(P5) The lack of physical connection would be "*a missing part in the process of my art creation*" (P6) in the online performing context. However even the inability to touch and feel the temperature of someone has been used by performers as creative constraints. For example, (P9) uses emojis and touch-based visual feedback in her text to the audience during the performance to "*simulate being touched, not by your hands but by your mind,*" while P10 experiments with telepresence and motion capture to simulate interaction with remote audiences. P1 notes that even though she cannot feel the audience individually, the rhythm of the audience online as they come and go, turning on and off, gives her a sense of being physically present like being touched by music.

In summary, physical touch is a limitation of online performance, reducing engagement and improvisation. However this constraint can also lead to creative solutions using different avenues of communication like sound, touch-feedback, and somatics.

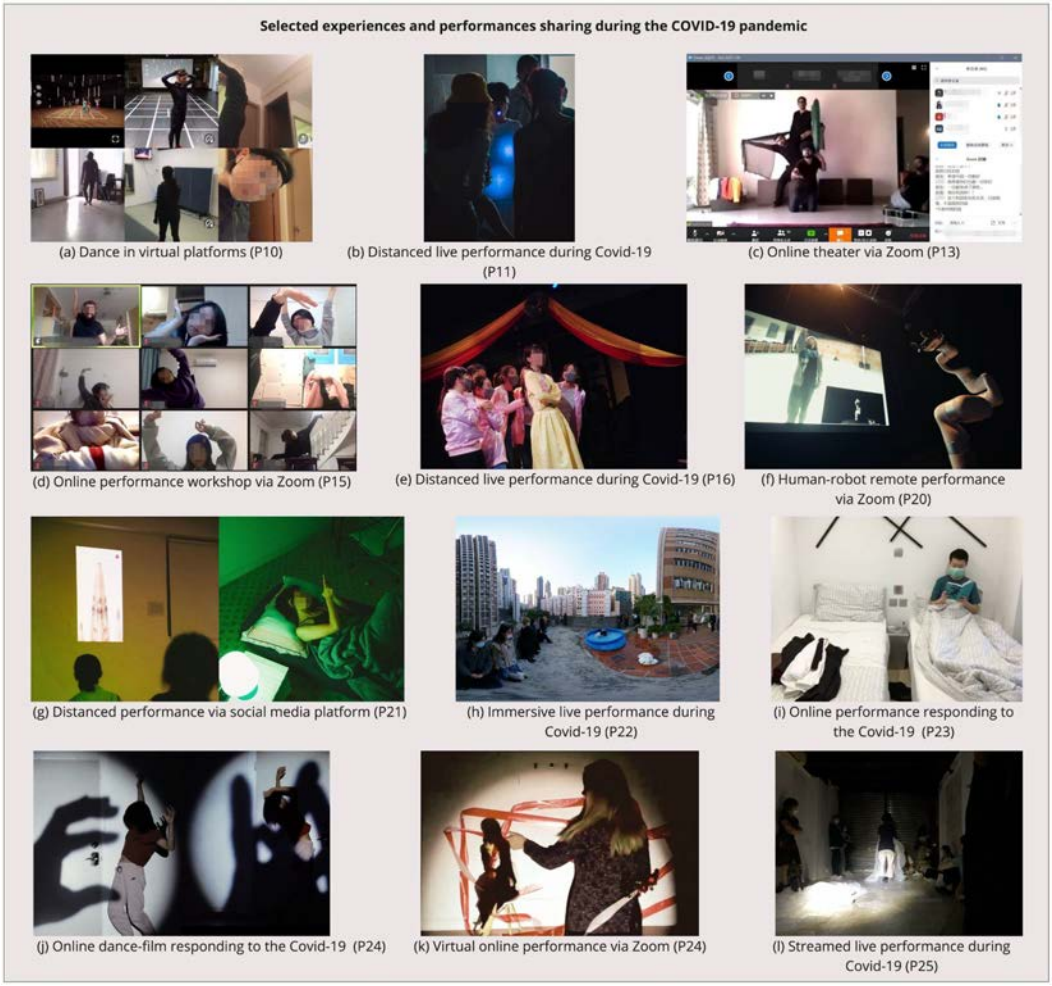

Fig. 3. Dance practices of professional performers engaged during the interview. Photos are used with permission from the interviewees. (a) Live performance in a virtual environment with other dancers using motion capture (P10). (b) Distanced performance with the mask-wearing policy during Covid-19 pandemic (P11), (c) Online theater conducted in Zoom during Covid-19 lockdown (P13). (d) Online performance workshop conducted in Zoom during Covid-19 lockdown (P15), (e) Distanced performance with reduced audiences during Covid-19 (P16), (f) A human-robot remote performance conducted in Zoom during Covid-19 lockdown, (g) A distanced performance in which audience members can text the artist at will via the Signal app, while she is going to sleep at a distanced venue nearby (P21), (h) Live behavioral performance documented using 360 video and immersive methods during Covid-19 pandemic (P22), (i) Online performance related to self-isolation in hotels and home quarantine during Covid-19 lockdown (P23), (j) A online dance film produced during Covid-19 lockdown (P24), (k) A virtual online performance conducted in Zoom (P24), (l) A streamed distanced live performance during Covid-19 (P25).

4.3 Implications of social distancing and safety policies for performers

Contradiction pushes me to improvise

4.3.1 Impact of mask-wearing

During the pandemic, wearing masks in public places is a compulsory requirement. This makes it difficult for performers to do on-stage actions and interact with audiences. In our interviews, several performers mentioned that "*performing with a mask on face makes her feel a lack of oxygen*" (P10) and that "*the performer has to frequently take the mask off to breathe*" (P25). In addition to the performers' discomfort caused by wearing masks, they also took steps to minimize the impact of wearing a mask on the audience's viewing experience. For example, one performer (P12) chose to wear a transparent mask in her offline performance even though turning can lead to the mask falling off. Besides, in performers' eyes, wearing masks not only makes them "*look like dead faces*" (P10) but also changes the way they sense the audience, because audience members are also wearing masks and not showing emotion. The performer cannot see the audience's smile but can only see whether the audience is happy or not through their eyes. In this case, she "*imagines that they are always smiling*" (P12). Moreover, one interviewee (P15) said that "*In the past, though I could not see all the audience due to lighting reasons, I could still see the first few rows of the audience. That created a sense of interaction. Now [online], I feel that the audience are expressionless.*"

In summary, the government's mandatory requirement on mask-wearing obstructs the performers' presentation of their facial expressions, as well as their perception of the audience's own expressions.

4.3.2 Impact of the lockdown

The government's lockdown policy usually results in negative impacts on performers' livelihood. Many performers we interviewed had the experience of scheduled performances being canceled or postponed: "*It is a hard time for livelihood*" (P24, P25). Among the affected performances, some were permanently canceled while others switched to online formats. "*During the pandemic, I don't know when the performance will be suddenly canceled. I would feel sorry that a long-prepared performance cannot be presented in front of the audience* (P17)." What's more, the random nature of these scheduling changes make it difficult for performers to plan their careers and livelihood around them (P25). In addition, "*offline performance exchanges and artistic collaborations between schools have decreased*" (P17).

One manifestation of the lockdown are social distancing mandates: "*the number of audience watching performance offline is strictly limited*" (P17). One of our interviewees who teaches dance said that "*before the pandemic, I had 6 to 12 students in one class, which is convenient for students to get to know each other and to socialize. But now under the social-distancing regulation, I can only have one-to-one class*" (P14). There are also psychological impacts of social distancing on performance. For instance, one interviewee mentioned that in her offline performance, "*when getting close to the audience, I felt under pressure when I saw one parent holding her small child back from me*" (P16). This implies that social-distancing has negatively impacted the interaction between performer and audience, leading to psychological burdens for performers.

On the other hand, we observed some surprisingly positive impacts of the lockdown. For instance, the new online schedules are often asynchronous, meaning that "*performances can be done at any time*" (P10). Along with the relaxation of time limits, lockdown also "*gives one more time to work on himself and think about how to make a breakthrough*" (P11). Besides, lockdown provided new social opportunities for performers to "*work with friends to try new things in a small group*" (P25). Almost half of the performers interviewed mentioned additional time to innovate and refine their practice as an advantage of the pandemic lockdown era (P1, P4, P7, P10, P11, P12, P14, P18, P19, P21, P23, P24, P25).

In summary, the lockdown reduces performers' offline performance opportunities and practice-based exchanges while enabling them to find time for personal learning.

4.4 Impact of Covid-19 on the performance community

4.4.1 Challenges for cross-cultural collaboration and adjustment

The creative and cultural industries were significantly disrupted by Covid-19 [30]. Several interviewees noted that they encountered difficulties in conducting international collaboration via virtual platforms due to time and location differences: *"Due to travel ban, mandatory quarantine and such policies limit transnational collaboration, we have no choice but to collaborate online. When we conduct online meetings, I am really confused about how to share my thoughts vividly"* (P15). However, some interviewees with multi-cultural background, overseas studying, working or living experiences also noted that the Covid-19 pandemic brings new inspirations and artistic concepts in distanced collaboration, promoting cross-cultural communication and adjustment: *"Everything went online during the pandemic period, so I had more opportunities and time to contact friends from different countries and cultures online, and then we used video concepts to create art and performance."* (P16) Also, *"I did more collaborations with artists from other countries and regions since people had to switch to the online approach, which did not require more effort or time"* (P13).

In adapting to distanced performance venues, performers used online, recorded, and immersive strategies: "*I was basically dancing by myself amid the pandemic, so I started to consider how to create new work from a different perspective like projection*" (P24). But rather than merely using these new techniques to overcome problems, performers have adapted these new strategies as part of their own practice going forward, internalizing these interactions into future developments that use these technologies and adaptations as their own future performance practice direction (also 4.1.2). P23 even mentioned that performers will still apply such distanced approaches in future performance after Covid-19: "*Everyone applied online solutions amid the epidemic, which leads our community already adapted to such approaches. Even if the situation goes better, I believe that we will still use such online approaches"* (P23).

4.4.2 Impact on performers' livelihood and career plan.

Those in the creative sector, especially freelancers, are disproportionately affected by Covid-19 [8]. Of our interviewees, 22 were independent performing artists, making these negative impacts particularly pronounced: "*As a struggling artist, I have to find the performance opportunities to stay living, so random interruption makes livelihood even more difficult*" (P25). Over half of the interviewees noted that they had to stop physical performance and find tentative possibilities or occupations since the shortage of funds, the cancellation of physical performance, the closure of theaters, art centers and organizations, etc: "*During the epidemic, the majority of my colleagues changed careers and only few people can persist in it*" (P15).

They were aware that performing online is more competitive than performing at physical venues, since it is difficult for online audience to focused on the entire performance and interact with performers via screens: "*Online audiences can turn off their screens and drop out of the show at any time, so it is more competitive for artists*" (P24). Therefore, several interviewees directly mentioned that they need more support from local governments and art institutions: "*we would like to receive more financial and venue support*" (P16). There also appeared to be increased anxiety and peer pressure in the performer community, forcing them to consider new approaches in career planning. Several performers mentioned that the focus in their career planning transferred from live performance to dance teaching (P2, P4, P7, P14, P18, P19, P24, P23, P25).

4.4.3 Collective responses to Covid-19 as manifested in creative content.

Our interviewees also mentioned that Covid-19 brings similar experiences for the community of performers, e.g., "*the only commonality between performers is that we're all at home so covid is the commonality*" (P11). Several interviewees noted that they would add personal reflections into their artistic creation and performance theme as the responses to the Covid-19 pandemic and its impacts on the public: "*My mental health is very poor amid the pandemic and there are a lot of struggles I want to express through my work*" (P24).

However, on the contrary, P13 mentions that performers may *avoid* discussing and responding to the Covid-19 pandemic theme due to their negativity (self-isolation, policy limitations, etc.): *"Theater is an amazing venue since a theater has its own motivation and energy, it will tell you what the audience wants. When we were doing 'Playback Theatre' on the theme of Covid-19, our audiences avoided discussing this topic... From the artist's perspective, we want to tell a story that audiences have experienced. So the Covid-19 experience may be a valuable material in future art creation, but contemporaries would want to avoid it"* (P13). This is echoed: *"I personally don't want to mention this topic, since it was a painful experience for me"* (P14). Thus, the content of the performer's creations has also been influenced by their experience in the pandemic.

5 REMOTE PERFORMANCE

While the interviews probed performer workflows and expectations, they did not inform us what performers actually do in the course of a typical online performance and

preparation process in terms of real problems solved and moment-to-moment adaptations to the task. To understand how the performer's expressive abilities and collaboration with a distanced performance system may be affected in a real distanced performance situation that includes a live distanced audience, we created a Zoom-based performance (Fig. 4) that presented a dance artist and a robotic arm telepresence separated by two locations in the world and 12 hours of time difference.

Based on the interviews with performers above, we wanted to create a physical manifestation of the process to examine some of the issues alluded to in the interview studies that could not be fully understood without a virtual performance occuring. As such we engaged a dancer from the interview (P20) to perform on Zoom at 9am local dancer's time, with a robotic arm collaborating with her at 9pm local performance venue time. The dancer's image is projected in the 9pm venue for a live audience (~25 people) along with the physical presence of the robot. Our focus in this performance is on the way the dance artist interprets the rehearsal and performance process and how the online live audience may affect her perception of the interaction.

Fig. 4. A distanced human-robot performance taking place at 9am in the dancer's location and 9pm at the viewing and robot's location across the world. (Left) Dancer (P20) engaging with the robot arm during rehearsal. (Middle) Rehearsal process at the studio of the dancer at 9am and the theater at the same time at 9pm as seen in Zoom. (Right) Live performance with dancer and robotic telepresence co-performing the story and dancing at the same time.

5.1 Design and Implementation

The remote performance was designed from the performer's point of view to facilitate her expressivity and collaboration. The previous considerations on lack of improvisation within online venues (P1, P2, P4, P6, P7, etc.) led to our introduction of live audience engagement at the 9pm location. Because performers shunned the individual Zoom-like audience we decided to create one large live audience following social distancing guidelines that is seen as a whole in Zoom. Due to the performer's lack of a perceptual model for what the audience is doing out there (P6), we decided to minimize the amount of information the performer needs to multitask with (P1), creating one audience instead of separate ones gazing randomly and distractingly at the performer.

The consideration of lack of touch and presence (P1, P3, P5, P9) became the basis for the robotic arm intervention in our performance. Taking inspiration from P2's taking of the

audience's hand and P10's exploration with telepresence, we created a system that attempts to capture the way the performer can feel the audience's presence using the robot arm. Although the performer still cannot physically touch the audience, the robot art serves as a surrogate for seeing how she can affect a live audience by her telepresence. We also acknowledge that such a telepresence does not fix the touch sensation problem, and instead engage with the performer to understand how she may work with the remote presence system in forming a mental model of how the touch-like interactions would occur throughout the rehearsal and performance process. We also designed the intervention to reduce the performer's impression of dancing in front of a movie camera as found in the discussions (P1, P21, P 22), in favor of collaborative interaction that forces the performer to see what her surrogate is doing in real time, thus avoiding the "performing for recording" paradigm encountered by the interviewees (P10, P11, P22).

There are other variables which reflect the limitations faced by the remote performers that we did not attempt to design for, but rather wanted to reflect in the performance to further study how they can be dealt with in vivo. The limitations due to delay in time due to time differences (P1, P4, P21) were reflected in our simultaneous performance in the two remote locations despite timing difficulties on both sides in both rehearsal and performance day. The mask-wearing limitation (P10, P12, P15, P25) was followed both at the performance and the audience locations despite difficulties during the rehearsal. The mask-wearing was relaxed for the dancer during the performance due to the lack of oxygen supply (P10) during draining continuous dance sequences. Finally the intervention engages the community of our performer, providing her relief from the Covid-19 shutdown that occupied her practice, as referred to by those who created new adaptations involving their communities (P13, P15, P16, P22, P25).

For implementing the performance, we use a Zoom meeting to link the dancer and the performance venue on the main PC. The meeting shows the dancer, with the name and toolbars turned off. The main screen is pinned on the dancer, with a small drag and drop window to show the robot from a direct-on perspective (Fig. 4 Left). A video camera directed at the robot is connected to the PC, sending the live view to the dancer on Zoom. The dancer can hear the audio setup from the program and microphone in zoom, and thus can hear the music for the live audience during performance and rehearsal. One laptop is connected with the robotic arm for running a program that allows interactive control of different movements from the management team. A different laptop and the main PC are connected to the projection system and Zoom, respectively. The lighting of the performance venue is controlled by floor spotlights, main lights, front lights sequence and back light sequence of the whole theater. During the performance, staff is assigned to select from the preset of possible gestures for the robot arm.

Fig. 5 shows the story. At the beginning, the robot and the dancer meet each other. The dancer will make a greeting gesture with the robot and act like meeting a real person, then the robot also greets the dancer with a reaction. Next, the dancer tries to teach simple dancing steps or gestures to the robot. In response to each gesture, the

robot tries to imitate the step but cannot yet faithfully reproduce the movement. The dancer becomes disappointed and leaves the stage, while the robot asks the audience for help by standing up. With the audience's encouragement (clapping) the robot begins to practice movements, showing improvement in movement smoothness with the time.

In the next part, the dancer returns to the stage on Zoom and dances alone, while the robot watches and learns. Soon the dancer and robot become in sync, dancing together with a pre-arranged choreography to original music. Next, the robot dances alone, incorporating what he learned from the dancer with non-human steps that the human torso cannot imitate. Finally the dancer wants to lead the robot movements again, but the robot begins to have its own rebellious ideas. The dancer tries to make three simple dancing steps that are the same as the ones she teaches at the beginning, but the robot does not follow them, and instead comes up with original moves. The dancer becomes more obsessive about controlling the robot, and decides to turn off the Zoom that connects them together because she can no longer manipulate the robot. Disconnecting Zoom causes the robot to shut down as well, ending the performance.

Fig. 5. Setup diagram for the remote performance. Zoom: for interfacing with the dancer. Main PC: for entering Zoom meeting and the sound output. Video Camera: for capturing the view of the robotic arm to the main PC via hdmi. Laptop1: for controlling the robot through LAN. Laptop2: for controlling visual sequence on the floor projection. Audio Mixer: for mixing the sound from the main PC, laptop1, and microphones, so that both Zoom and the audience in the theater can hear sound from both devices. AV Panel: for capturing the audio and visual signals and switching the visuals of main and floor projection. Light Panel: for controlling the lighting.

Contradiction pushes me to improvise

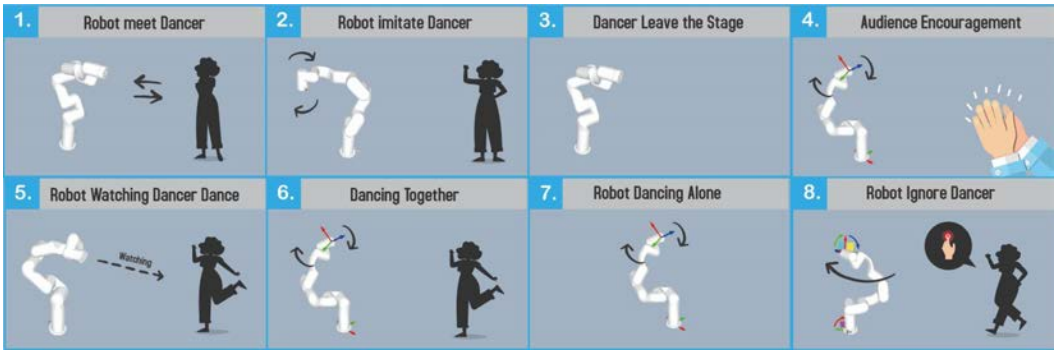

Fig.6. Storyboard for the remote performance. The robot and the dancer greet each other. The dancer tries to teach the robot how to dance and the robot tries to imitate it. The dancer feels disappointed that the robot cannot imitate the steps and leaves the stage. The robot asks the audience for encouragement, and practices how to dance to become better. The dancer shows the robot how to dance, and then dances together with the robot on the same song (5 and 6). The robot dances alone with steps that humans find difficult to imitate. The robot ignores the dancer when the dancer tries to control its movements. The frustrated dancer turns off Zoom, which leads to the robot shutting down.

5.2 Findings

5.2.1 Performance and rehearsal workflow

The idea of "deferral" was manifested in the way the performance was rehearsed, crossing a 12 hour gap with delays in the video viewing the robot causing considerable disturbance for the dancer. Because the dancer could only view the robot head-on, the fixed perspective of the camera-eye alluded to in 4.1.1 becomes an inherent limitation on the way the performer can perceive the performance. Most of the time she only has a view of the robot with whom she is dancing, and not what is happening in the different perspectives of what the robot looks like in 3D. Resonating with previous results: "*At the beginning I had a hard time feeling the robot because there's a distance and a delay, it's the same as communication with humans, we need time to build up our relationship, but with remote rehearsal it was much more difficult logistically*" (P20).

In terms of improvisation, the dancer left the parts where the robot doesn't follow her movements exactly to be improvised because she "*wanted to react to what the robot is doing in the moment*." For the part where she pre-choreographed the routine: "*I added parts to the choreography during the performance where I had to do the same dance twice*," once on her own and once with the robot, "*adding on many more elements on the second dance depending on how I feel*." However the improvisation was controlled in the sense that the first time she did the movement in the performance, the robot moves poorly so she can do anything she wanted, but the second time she did the movement, the robot is already good at movement in the story so she has to improvise something that shows she wants to control what the robot does. Some of the improvisation is also done by the staff controlling the robot movement, since he is the puppet master who interacts with the dancer directly when the dancer makes a move, showing the

personality of the robot to the live audience. "*The robot was shown not to be a mechanical device, but has a personality that I can improvise with*" (P20). This finding complements the audience-based improvisation detailed in 4.2.2. There the uncertainty lies in what the audience does, while here, it's the uncertainty of the interaction showing the personality of the robot, guiding the performer to improvise based on the uncertainty.

In regards to the rehearsal process, the distanced format made working with the technology difficult due to the limitation in the way the robot can be viewed and in the perspective of the dancer herself. "*It was hard because I only had a frontal view of the robot, it was really like brain work rather than physical work: while the robot moves to the left, which joint is rotated, and I have to use my imagination to reflect that back on to my own body in terms of which joint should be rotated and which direction I should aim*." Working with a robotic partner also forces the performer to think about what correspondences there are between human and machine, an essentially imaginative process: "*The robot has a completely different body, it doesn't have arms, it doesn't have legs, it rotates 360 degrees, so I had to imagine how to alternate the robot's joint to my joint, because robot does the movements that I never imagined before, never tried before*." Thus throughout the rehearsal, the performer had to adapt to a new interaction where she dances with a partner who does not move like her, and by imitating it, produces uncertainty in what the interaction looks like to the audience, in turn guiding the eventual improvised movements.

The cycle is a constant feedback loop: "*in the first song which is my own original choreography, when the robot movements that imitate my moves were shown to me, I began to learn from the robot movements what other things I can do with my body, so when we dance again to the same song, I decided to improvise based on what I saw from the robot… there's an exchange occurring throughout with someone totally different*." The same types of things occur in-person when the performer teaches dancing to children, for example: "*teaching the robot is like teaching to kids, no one can do exactly what I show them, because there's different interpretations by themselves, so it's always impressive to me*" (P20). In summary, due to the constraint of the online format, the performer is forced to use her imagination to collaborate with the robot partner, using mental agility to support the improvisational process.

5.2.1 Audience evaluation qualitative findings

We asked audiences for their feedback regarding their interpretation of the performer's creative intervention (n=20) to probe whether the performer's expectations and perceptions of the audience were congruent with the outcome. In particular we surveyed how audiences interpreted the interaction between the dancer and its telepresence robot partner. We distributed the questionnaire to 20 audience members (n=20, 12 male, 6 female, 2 non-binary) after showing the entire performance. RStudio was used to process, analyze, and plot the data. The audiences' short answers to survey questions about their understanding of the interaction between the performer and the robot were then coded and analyzed.

Contradiction pushes me to improvise

Several participants directly mentioned their deepest impression during the performance were the interactions between the performer and the telepresence robot (A7, A10, A11, A14, A15, A21). Audience members appeared to understand and interpret the movements of the robot based on human emotional interpretations (A4, A10, A11, A13, A16, A18, A21). For instance, participants assigned emotion to the robot movements when the performer left the screen: "*the robot was sad when the dancer was not happy with it*" (A10). Also, participants connected the delay movements of the robot with rejection of the performer's leadership, e.g., "*the robot disdainfully refused to react to the dancer*" (A19), "*the robot started to give up trying the last dance*" (A4) and "*the robot seems to have emotions*" (A14). However, it is difficult for a few audience members to imagine the robot could have personalities like a human: "*It does not have a personality, it just needs to follow the moves of the dancer*" (A18). The differences between audiences' perspectives may be due to different understanding of the technologies used: "*It looks like they are interacting, but you somehow know that it is programmed*" (A11).

In summary, the audience interpreted the actions of the telepresence robot as human and emotionally reactive, providing a narrative that treats both performer and the robot as equal storytellers in the interaction.

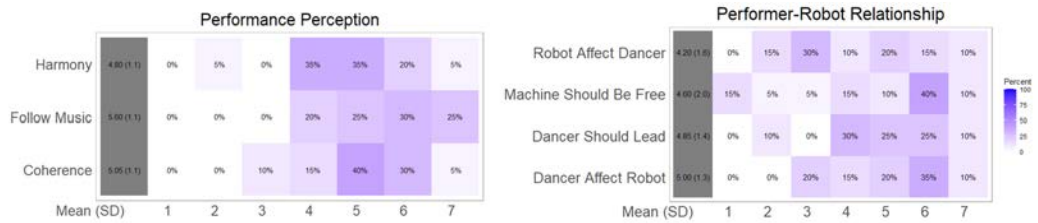

Fig. 7. Audience perception of performance and performer-robot relationship (n=20). Ratings not significantly different from each other (Coherence vs. Harmony p=0.4206, Coherence vs. Follow Music p=0.1448, Robot Affect Dancer vs. Dancer Affect Robot p=0.103, Dancer Should Lead vs. Machine Should be Free p=0.9889, Wilcoxon) but for Harmony vs. Follow Music (p=0.03703**). Questions: **Harmony** "How harmonious were the performer and the robot with each other in the dance sequences?", **Follow Music** "How well did the robot follow the music?", **Coherence** "How would you rate the amount of coherence in the interaction between the performer and the robot?", **Robot Affect Dancer** "How much does the robot's movements affect the performer's own movements?", **Dancer Affect Robot** "How much does the performer's actions affect the robot's movements?", **Dancer Should Lead** "How much do you think the performer should lead the machine in a collaborative performance?", **Machine Should Be Free** "How much do you think a machine should have its own initiative and freedom during a collaborative performance?"

5.2.1 Audience evaluation survey findings

Quantitative analysis of the audience survey (n=20) shows that the performance itself was perceived to have a high degree of harmony and coherence between dancer and robot movements, but that musicality of the robot is stronger still, perhaps due to the choreographed nature of the sound. On the side of the performer-robot interaction,

audiences particularly felt that the robot should have its own freedom during a performance, reflecting the perception of personality and emotion in the robot. They also felt strongly that the dancer's actions should affect the robot rather than the other way around. This result suggests the notion that audiences interpreted the robot as its own presence, so its collaboration with the dancer forms a narrative in which the physical presence (robot) is given emotional characteristics while the remote presence (human dancer) is perceived as the leader of the interaction.

Together, the audience evaluations showed that audiences interpreted the robot in human terms with human emotions, which is in contrast to how the performer was interpreting the robot, as a device that can imitate human motions. The different ways in which she robot can move are apparent to the performer, but the audience appears to see this as harmonious, coherent action befitting of the narrative constructed.

6 DISCUSSION

In this paper, we investigated how the performance community was affected by distanced performance formats during Covid-19 from five perspectives: the relationship between performers and technologies, performer's interpretation and expectation regarding audience interactions, policy-focused impacts on performers, challenges for the community of performers, and how performers adapt in a real distanced performance scenario. In this section, our findings are discussed in regards to the mediating role of technology in online contexts, design implications for interactive distanced technologies, and limitations of the current paradigm of study.

6.1 Rethinking the performer-audience relationship in distanced performance

Based on prior research, independent artists promoted disruptive innovation of the remote platforms based on the demand of audiences, which may achieve engaging and deeper expression [10]. The interviews showed us the intricacies of performer-audience interactions as mediated by different types of distanced technology. The transmission medium can include live streaming, zoom, video, etc. Some participants stated that their way of performing is limited to their cameras' angle, and the reproduction of their performance was manipulated by the transmission medium. The distant context requires a performer to treat the camera as a proxy for the audience. In other words, the performer must immediately interact with the camera in order for audiences to believe that the artist is performing for them. Performing body image is digitized, the 3D body movement is transformed into 2D, and the performers are physically isolated from their environment. This finding offers insights that while online context reduces much of the sense of presence, it also provides opportunities for performers to adapt to technology, and for technology to play a role in influencing the watching experience and outcome.

The result reframes the form of performing art to be impromptu, generative, experimental and unique. By exploring performers' engagement and expressivity in distanced performance paradigms, we see potential in building effective remote technologies for the performer community and better understanding policy impacts on

performers. The performer community moves beyond meaning-sharing and reframe their roles in distanced performance. They adjust to distanced technologies and audiences' perceptions to reach the performative state of online live performances in the here and now.

6.2 Policy-focused Impacts on the Community of Performers

Our findings suggest that performers' professional career, performance formats, and personal psychology have been negatively affected by the pandemic-control policies amidst Covid-19. The mask-wearing policy creates difficulty for the performer's breathing and impairs the performer's facial presentation and interaction with the audience. In terms of the lockdown, it decreases the performers' performance chances, but frees up performers from the time constraints of offline performances and gives them more room for personal development. These social policies have changed performers' career planning, working strategies, collaborative opportunities, and their psychology, which may be manifested in the creative content of the performance community. We saw that performers adapted to the online context and applied interactive technologies into their artistic creation, such as trying to design intervention based on their interpretation and expectation of audiences to overcome challenges caused by technical issues such as the delay of time, lack of physical touch, etc.

Additional research should consider policy-focused approaches to decrease pressure on performers. Since the ongoing impacts on the performance community, performers need more support and collaborative opportunities from local art institutions and governments. For example, art institutions or local governments could organize online art festivals, music concerts, sharing workshops or exhibitions related to performing art to provide more opportunities for performers. All of these findings offer useful insights regarding how social policy has influenced the performer community under pandemic and how performers have reacted to adapt to this special situation.

6.3 Design Implication

Through conducting the human-robot performance, we found that such technologies applied in distanced performance should be more interactive and participatory, since the performer is limited by remote technologies and the audience intended to interpret movements of performer and robot based on their own imagination. Therefore, designers may consider an interactive participatory system designed for online performance. Interactive formats can also be used in choreography to facilitate direct connection between performers and audiences, decrease the remote limitations caused by remote performances, and enable audiences to directly engage with the movements of dancers [3]. Within this system, the choreography could unfold according to the behaviors of the audience and the improvisation of the performers. This system may serve as the medium to connect the audience and performer, and creates a brand new experience both for audiences and performers in the context of online performance. For instance, the system can enable the performers to feel the existence of the audience and have an enhanced

sense of being watched. The key is that the system should show performers how audience interactions can be essentially random and distracting as per our interview findings (4.2).

As suggested by our findings (4.1.), remote technologies enable performers to adapt to camera-based screens, which decrease their interaction with audiences in physical venues and limit their movements. This system may mimic the watching experience in offline performance -- where the audiences control the perspective of watching with their head turning -- by controlling the camera that looks at the stage on a webpage. At the same time, the audiences can participate and influence the progress of the performance by changing the pointing angle of the camera. On the other side, the performers physically sense the existence of the audiences' gazes and react to the behaviors of the audiences with their dance patterns or improvisations. The audiences then could have another layer of behaviors when they see the reactions of the performers. Thus, a looping dialogue akin to the one between performer and robot in our intervention could be created between these two groups, which leads to a performance that all interactions are possible and all unexpections are welcomed.

In general, future interactive interfaces for expressive performance need to take into consideration adaptations of distanced performers already made to account for the lack of audience, physical touch, and spatial limitations in remote technologies.

6.4 Limitations and Future Work

While recruited experienced participants with cross-cultural collaboration experiences, they may not represent the entire performance community as a whole. The majority of our participants were from the same age ranges (25 - 35 years old) and related backgrounds (mostly Asian ethnicity). To account for this, we would recruit more performers from different age ranges and cultural backgrounds to compare Covid-19 long-term impacts on the community based on their responses and experiences (e.g. the differences between younger and elder performers). Since the interviews were conducted during Covid-19, we used Zoom and other online meeting platforms instead of in-person interviews, which has the potential to affect interviewees' answers due to lack of comfort level with opening up about topics like political policy and criticism. Additionally, the effectiveness and engagement of distanced performances can also be evaluated from the audience perspective, but we only collect results pertinent to the performer's perspective. In the human-robot performance, we can also apply the audience as separate entities in Zoom, which may provide a different perspective to understand the interaction since each audience may have its own agency.

Future research could explore the differences between performer and audience engagement in distanced and physical performances based on a workflow similar to the human-robot remote performance, and consider the impacts of different areas of practice in performing arts with cultural backgrounds. On the other hand, the differences between distanced performance conducted in different virtual platforms also need to be clarified in further development, including in the camera-based environment (Zoom and Youtube),

vs. virtual environment (collaborating with VR, 360 and other immersive technologies), etc. The interaction in the camera-based platforms is flat, since it is based on the images on screen and words on paper [2]. However, virtual and immersive methods provide users a more collaborative and participatory platform to enhance their engagement and experience [6]. Therefore, comparing the impacts and effectiveness of different platforms is an essential part in further research.

7 CONCLUSION

Through 25 semi-structured interviews and one remote performance intervention, this work attempts to dissect the detailed process, mental framing, and social implications for performers as they adapt to the virtualization of the performance process during lockdown and Covid-19. The findings regarding treating Zoom and video conferencing software as a metaphor for movie camera gaze without rich audience interaction found in real life provides implication for how to support expressivity in online formats: we cannot continue to use software designed for meetings to do expressive work, but rather must design for ability to improvise, for telepresence, for differences in time and location, and for lack of audience engagement. Our work highlights the need for design at the personal workflow level, at the creative technology level, and at the social policy level for supporting performers in the era of distancing, to overcome mental challenges and increasing adaptation to impersonal forms of expressive communication.

REFERENCES

[1] Sarah Fdili Alaoui and Jean-Marc Matos. 2021. RCO : Investigating Social and Technological Constraints through Interactive Dance. In *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems*. Association for Computing Machinery, New York, NY, USA, 1–13. Retrieved July 6, 2021 from https://doi.org/10.1145/3411764.3445513

[2] Andy Bennett and Richard A. Peterson (Eds.). 2004. *Music scenes: local, translocal and virtual* (1st ed ed.). Vanderbilt University Press, Nashville.

[3] Bettina Bläsing and Esther Zimmermann. 2021. Dance Is More Than Meets the Eye—How Can Dance Performance Be Made Accessible for a Non-sighted Audience? *Front. Psychol.* 12, (April 2021), 643848. DOI:https://doi.org/10.3389/fpsyg.2021.643848

[4] Aili Bresnahan. 2014. Improvisational Artistry in Live Dance Performance as Embodied and Extended Agency. *Dance Res. J.* 46, 1 (April 2014), 85–94. DOI:https://doi.org/10.1017/S0149767714000035

[5] Teresa Cerratto-Pargman, Chiara Rossitto, and Louise Barkhuus. 2014. Understanding audience participation in an interactive theater performance. In *Proceedings of the 8th Nordic Conference on Human-Computer Interaction: Fun, Fast, Foundational* (NordiCHI '14), Association for Computing Machinery, New York, NY, USA, 608–617. DOI:https://doi.org/10.1145/2639189.2641213

[6] Lisa Dawley and Chris Dede. 2014. Situated Learning in Virtual Worlds and Immersive Simulations. In *Handbook of Research on Educational Communications and Technology*, J. Michael Spector, M. David Merrill, Jan Elen and M. J. Bishop (eds.). Springer, New York, NY, 723–734. DOI:https://doi.org/10.1007/978-1-4614-3185-5_58

[7] Steven Dow, Manish Mehta, Ellie Harmon, Blair MacIntyre, and Michael Mateas. 2007. Presence and engagement in an interactive drama. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. Association for Computing

Machinery, New York, NY, USA, 1475–1484. Retrieved September 7, 2021 from https://doi.org/10.1145/1240624.1240847

[8] Cornelia Dümcke. 2021. Five months under COVID-19 in the cultural sector: a German perspective. *Cult. Trends* 30, 1 (2021), 19–27. DOI:https://doi.org/10.1080/09548963.2020.1854036

[9] Sarah Fdili Alaoui, Jules Françoise, Thecla Schiphorst, Karen Studd, and Frederic Bevilacqua. 2017. Seeing, Sensing and Recognizing Laban Movement Qualities. In *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems* (CHI '17), Association for Computing Machinery, New York, NY, USA, 4009–4020. DOI:https://doi.org/10.1145/3025453.3025530

[10] Richard Frenneaux and Andy Bennett. 2021. A New Paradigm of Engagement for the Socially Distanced Artist. *Rock Music Stud.* 8, 1 (2021), 65–75. DOI:https://doi.org/10.1080/19401159.2020.1852770

[11] Louise C Hawkley and John T Cacioppo. 2003. Loneliness and pathways to disease. *Brain. Behav. Immun.* 17, 1, Supplement (February 2003), 98–105. DOI:https://doi.org/10.1016/S0889-1591(02)00073-9

[12] Stacy Hsueh, Sarah Fdili Alaoui, and Wendy E. Mackay. 2019. Understanding Kinaesthetic Creativity in Dance. In *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems*. Association for Computing Machinery, New York, NY, USA, 1–12. Retrieved June 28, 2021 from https://doi.org/10.1145/3290605.3300741

[13] Tzung-Jeng Hwang, Kiran Rabheru, Carmelle Peisah, William Reichman, and Manabu Ikeda. 2020. Loneliness and social isolation during the COVID-19 pandemic. *Int. Psychogeriatr.* 32, 10 (October 2020), 1217–1220. DOI:https://doi.org/10.1017/S1041610220000988

[14] Jodi James, Todd Ingalls, Gang Qian, Loren Olsen, Daniel Whiteley, Siew Wong, and Thanassis Rikakis. 2006. Movement-based interactive dance performance. In *Proceedings of the 14th ACM international conference on Multimedia* (MM '06), Association for Computing Machinery, New York, NY, USA, 470–480. DOI:https://doi.org/10.1145/1180639.1180733

[15] Celine Latulipe, David Wilson, Sybil Huskey, Berto Gonzalez, and Melissa Word. 2011. Temporal integration of interactive technology in dance: creative process impacts. In *Proceedings of the 8th ACM conference on Creativity and cognition* (C&C '11), Association for Computing Machinery, New York, NY, USA, 107–116. DOI:https://doi.org/10.1145/2069618.2069639

[16] RAY LC, Aaliyah Alcibar, Alejandro Baez, and Stefanie Torossian. 2020. Machine Gaze: Self-Identification Through Play With a computer Vision-Based Projection and Robotics System. *Front. Robot. AI* 7, (2020). DOI:https://doi.org/10.3389/frobt.2020.580835

[17] Ethan Sacks Ethan Sacks writes for NBCNews.com. COVID-19 strikes discordant note for the music industry. *NBC News*. Retrieved September 3, 2021 from https://www.nbcnews.com/pop-culture/music/covid-19-strikes-discordant-note-music-industry-artists-find-way-n1202571

[18] Katerina El Raheb, George Tsampounaris, Akrivi Katifori, and Yannis Ioannidis. 2018. Choreomorphy: a whole-body interaction experience for dance improvisation and visual experimentation. In *Proceedings of the 2018 International Conference on Advanced Visual Interfaces* (AVI '18), Association for Computing Machinery, New York, NY, USA, 1–9. DOI:https://doi.org/10.1145/3206505.3206507

[19] Susanne Ravn. 2020. Investigating Dance Improvisation: From Spontaneity to Agency. *Dance Res. J.* 52, 2 (August 2020), 75–87. DOI:https://doi.org/10.1017/S0149767720000182

[20] Tina M. Schwender, Sarah Spengler, Christina Oedl, and Filip Mess. 2018. Effects of Dance Interventions on Aspects of the Participants' Self: A Systematic Review. *Front. Psychol.* 9, (2018), 1130. DOI:https://doi.org/10.3389/fpsyg.2018.01130

[21] Afrizal Yudha Setiawan, Indra Bulan, and Dwiyana Habsary. 2020. Social Media as a Platform of Performing Arts Education During Covid-19 Pandemic. (2020), 6.

[22] Kent De Spain. 2012. Improvisation and intimate technologies. *Choreographic Pract.* 2, 1 (February 2012), 25–42. DOI:https://doi.org/10.1386/chor.2.25_1
[23] Anselm Strauss and Juliet Corbin. 1998. *Basics of qualitative research: Techniques and procedures for developing grounded theory, 2nd ed*. Sage Publications, Inc, Thousand Oaks, CA, US.
[24] Anselm Strauss and Juliet M. Corbin. 1997. *Grounded Theory in Practice*. SAGE.
[25] Ben Walmsley. 2021. Engagement: The new paradigm for audience research. 18, 1 (2021), 18.
[26] Sarah Webber, Mitchell Harrop, John Downs, Travis Cox, Niels Wouters, and Andrew Vande Moere. 2015. Everybody Dance Now: Tensions between Participation and Performance in Interactive Public Installations. In *Proceedings of the Annual Meeting of the Australian Special Interest Group for Computer Human Interaction* (OzCHI '15), Association for Computing Machinery, New York, NY, USA, 284–288. DOI:https://doi.org/10.1145/2838739.2838801
[27] Wu Zhen and Lian Luan. 2021. Physical World to Virtual Reality – Motion Capture Technology in Dance Creation. *J. Phys. Conf. Ser.* 1828, 1 (February 2021), 012097. DOI:https://doi.org/10.1088/1742-6596/1828/1/012097
[28] 2020. COVID-19's Pandemic's Impact on The Arts: Research Update August 31, 2021. *Americans for the Arts*. Retrieved September 4, 2021 from https://www.americansforthearts.org/node/103614
[29] How do experts observe movement? | Proceedings of the 2nd International Workshop on Movement and Computing. Retrieved September 7, 2021 from https://dl.acm.org/doi/10.1145/2790994.2791000
[30] The impact of the COVID-19 pandemic on the creative industries: A literature review and future research agenda - ScienceDirect. Retrieved January 11, 2022 from https://www.sciencedirect.com/science/article/pii/S0148296321007141