Exploring the potential of personalized VR bodily learning systems

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Abstract

Remote learning, also known as web-based learning or eLearning, provides opportunities for skill development and knowledge transfer without the need for teachers and learners to be co-located. This mode of education became essential during the Covid-19 pandemic lockdowns in 2020 and 2021. It is a model which largely relies on video conferencing software. But because of the desktop metaphor that has been foundational in the design of mainstream technology since the 1970s, these solutions are optimized for sharing information that is best recorded and interpreted on paper, i.e. flat, 2D interfaces. Meanwhile, individuals who wish to remotely access resources for bodily disciplines such as dance or martial arts currently must rely on these offerings as well. While it is not impossible to learn and teach bodily practices through these modalities, bodily knowledge ultimately lives in and is shared through the body, of which language and 2D visuals only provide an approximate translation. This thesis argues that there is ample opportunity in human computer interaction design to create new models of remote learning specifically for bodily practices, and makes use of virtual reality (VR) as one of the potential technological bases to ideate new fit-for-purpose models. As a maturing technology which still has not been widely adopted, VR

allows some breathing room from the legacy language and symbolism that current remote learning models are built upon. And most importantly, it affords more physical interactions, making it a suitable candidate for body-first design explorations.

Taking a practitioner-as-researcher approach, this thesis **1) seeks to understand the current practices of how bodily disciplinary knowledge is acquired and shared in situ.** The first study consists of one-on-one interviews with dance teachers and students. After thematic analysis of the collective responses, potential designs are explored which ultimately results in three interventions to be tested: *Dance Tools*, *Energy Beast* and *Star-Stuff: a way for the universe to know itself*, the last of which was used in collaboration with its creator. The second and third studies engage somatic connoisseurs to observe the way these tools are integrated into the process of communicating bodily knowledge. The first study was done with a group of soma design researchers, who were taught a staff-spinning technique, and the second study was done in a series of teacher-student pairs from a variety of bodily disciplines. The findings from these studies ultimately produce insights towards answering the main question of this thesis, **2) how can practice of bodily disciplines be supported with VR interventions?**

Following a series of thematic analyses and first-person practitioner reflections, the thesis then argues how the standardized VR design aim of realism is not the most appropriate for bodily teaching and learning contexts, and how in some cases, less realism is more learning. It proposes three alternative design values: *Authenticity*, where the spirit of the practice is amplified instead

of the realism of it; *Subjectivity*, the independent configuration of things and users within the environment to account for differences in individual perspectives rather than a singular objective environment; and *Modularity*, which calls for simplicity and versatility of features and hardware to empower users to personalize the intervention to suit their own purposes instead of an assumed configuration. Lastly, this thesis introduces a new methodology for self-reflective design, *splitting yourself*, which involves the development of two somaesthetic repertoires so practitioner-researchers may separate these identities and engage them in discourse, potentially producing more nuanced insights compared to previous forms of self-reflection through a singular subjectivity.

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Chapter 1

Introduction

1.1 Problem Definition and Motivation

The recent democratisation of virtual reality (VR) technologies suggests that a point has been reached where they could be a viable technical intervention to support bodily practice at home. After all, VR training systems have a history of use in high-risk fields (79; 29), as well as physiotherapy rehabilitation for patients (91; 63). But when it comes to remote learning, 2D pre-recorded videos and videoconferencing technologies are still the convention; the widespread lockdown restrictions placed as a response to the Covid-19 epidemic have made this indisputable. While these solutions can still be helpful, especially for non-embodied knowledge like language or history, they leave much to be desired for those who wish to remotely learn or teach activities such as performance arts or sports (57). This is because the spatial complexities of movement make some physical techniques difficult to learn and teach through a flat surface. In group practice, the social en-

vironment is further defined by the software being used, which can limit practitioners if not developed with physical practice in mind. Furthermore, the vast differences in individuals' learning variables, such as their physical qualities, mental outlook, or training environment; call for adaptations, making the nature of bodily learning highly personalized. Even in a private session with an instructor, the ability to discern crucial details of what the other is doing, or feeling is limited when observed through a computer screen.

To address the shortcomings of current models, this thesis investigates the design, deployment, and study of VR prototypes that support bodily practice, especially in remote settings. Contemporary applications of somaesthetics suggest that a "body-centric" approach to design might offer a promising methodology to explore this challenge (87). In doing so, this research would explore the processes of bodily learning and how they may be supported in a remote, home-based setting with VR technologies.

1.2 Research Questions

The aim of this research is to study the sharing of embodied knowledge in scenarios where it is impractical (or even perhaps less desirable) for practitioners to meet in person. The following questions are considered:

RQ 1

How are bodily disciplines practiced, learned, and taught?

1a

How does this process change in remote settings, such as those created from the Covid-19 pandemic?

These RQs are investigated through Chapters 3 and 4 using grounded theory methods, first-person reflection, and a dive into the theoretical background of practices encountered during this research. They aim to understand how bodily discipline practice is enacted across different styles and lineages to inform intervention designs.

RQ 2

How might VR be used to improve bodily teaching and learning?

This RQ is mainly addressed in Chapter 6 in which soma design researchers are engaged to ideate ways in which movement can be communicated and taught in an assymmetrical scenario.

2a

Especially in remote settings?

This RQ is primarily faced in Chapters 7 and 8 where the design and development of the interventions created throughout this work are detailed, as well as the testing of them by practitioners.

2b

What information about bodily practices is essential for designers to know when creating VR interventions?

Design conventions from Chapter 5 are reviewed and alternative design values are proposed. This RQ is addressed in Chapter 9.

RQ 3

What is an effective methodology to query bodily practice in the

absence of other practitioners?

Indicative of the socially isolated early days of this work, Chapter 10 describes the strategies used to articulate somaesthetic insights derived from practice-based psychology and role-playing.

1.3 Research Areas

As an interdisciplinary project comprised of even more interdisciplinary fields, it is easy to oversimplify exactly where this thesis is situated. But a rough listing of the main topics would include human-computer interaction (HCI), computer-supported cooperative work (CSCW), sports and exercise sciences, and performing arts.

Human-computer interaction (HCI) can be defined simply as "intersection between psychology and the social sciences, on the one hand, and computer science and technology," generally with the goal of studying, improving, and expanding the relationship between people and technologies (38; 56). Computer-supported cooperative work (CSCW) is a related discipline about the "study of how people work together using computing and communication technologies" (135). "Work" in this instance is not meant to refer solely to occupational settings, but any collaborative setting. Like HCI, it is a broad topic involving computer science, management information systems, and anthropology (74). It is unclear as to whether HCI and CSCW are completely separate fields, but they can be distinguished by describing HCI as human-computer interaction and CSCW as group interaction using computers.

Sports and exercise sciences are a diverse field concerned with understanding and enhancing human athletic performance. They are largely made up of natural sciences such as kinesology, biomechanics, psychiatry, and psychology, though they can also include social sciences such as economics, political science, and women's studies. Sports and exercise science research has been historically positivist, although a paradigm shift has emerged in the past few years as academics in this field note that positivist parameters are insufficient for completely explaining the "cell to society" (18) contextual factors of physical activity (37; 78; 19). This thesis pays particular attention, but is not limited to sports andragogy and heutagogy. Sports andragogy is an applied discipline about the learning, teaching, and educating of adult movement, sport, play, and exercise. Sports heutagogy is concerned with the same, but in a self-learning context.

Performing arts can be loosely defined as activities which use the body for creative expression, and "attends to the lived experience of the artists in the moment" (93) As the name implies, performing arts can be done for an audience, and is often an indication of a society's cultural wealth (42). Note that instead of "performing arts," this thesis uses the term "bodily disciplines" instead to deemphasize the audience aspect and instead focuses on their kinesetheic elements. The term is also used to acknowledge that the focus of practice is not limited to performance, but may transverse into sport, recreation, and beyond. The term "discipline" refers to the fact that these activities tend to be specialist areas of study which can take years for the practitioner to cultivate.

Dance, martial arts, and circus arts fall under this umbrella term.

1.4 Research Influences

1.4.1 Horizon CDT

This project is supported by the Horizon Centre for Doctoral Training, under the research theme for 2019, "Creating Our Lives in Data." PhD students within the Horizon CDT program are interdisciplinary and typically have four years to complete their research. They are also paired with an industry partner so that project outcomes are both scholarly and practice-based.

1.4.2 Industry Partner, Robert Clark

Dance, a socially and culturally prevalent family of bodily disciplines, has several pre-existing repertoires of movement, yet still encourages a generous amount of kinaesthetic creativity, or "the active use of the body through abstract movements to explore possible futures" (171). This attribute is not only useful in artistic expression, but also in the design of interactive systems (60; 86), making it a sensible choice as the vehicle for this research. Work was done in collaboration with Robert Clark, a professional dance choreographer and teacher [1], as the domain expert and industry partner.

1.4.3 Covid-19 Pandemic Lockdowns

[1] More information about Rob Clark and his work can be found on his website: http://www.robert-clark.org.uk

Pandemic-related closures were enacted across the UK about five months into this PhD, significantly shaping the research activities that took place afterwards. Visiting and observing several dance practices in person was the original plan for the first exploratory study, but this had to be changed into a series of online interviews. There had also been early talks with this project's third supervisor on organizing a study involving the testing of VR prototypes with several athletes at the University of Loughborough for a larger sample size, but this was abandoned since the first UK lockdown in March 2020 as it became logistically inviable. As a result the research as a whole shifted from mixed methods to purely qualitative research.

This project would always have some first person research activities, but they became central when access to other practitioners and researchers was largely cut off at the formative stages of the project. Even in the months after lockdown, many colleagues were still working from home and a feeling of belonging to a research community and being able to spontaneously share ideas through "water cooler talk" did not occur consistently until May 2022 during the placement at KTH Royal Institute of Technology, likely because Sweden did not have a national lockdown. Though the social isolation in the UK resulted in the delayed development of certain research skills, it also forced some creative solutions, which will be detailed in Chapter 10.

The sudden reliance on online education proved to be vindicating in that it quickly exposed what was already suspected: that video conferences were still the go-to model for synchronous remote learning. Hearing about everyone's complaints and praises

for it became a simple matter of going online, and this research was suddenly very easy to justify not only to academics, but to laypeople. But it also came with its own setbacks, namely that there was an explosion of work in remote learning and the first literature review became quickly outdated, requiring another significant survey. But this is fairly common in computer science, and ultimately a welcome sign of progress.

1.5 Contributions

1.5.1 Main Contributions of This Work

The contributions of this thesis include:

1. A conceptual framework of personalized bodily practice. This framework addresses RQ 1 and will be unpacked in-depth in Chapter 9.

2. Three suggested design values; namely authenticity, subjectivity, and modularity. Addressing RQ 2, these three design values are offered as an alternative to the current, default design aim of realism within VR. This contribution will also be explored in detail in Chapter 9.

3. The methodology of splitting oneself as an extension of existing first person and practice-led methods in HCI. An answer to RQ 3, the creation and utilization of this methodology will be explained in Chapter 10.

1.5.2 Publications not Included in the Thesis

The following list includes papers featuring research which was not directly part of this thesis, but still influenced the research process. Note that the author's name shows as "Christine Li" as these works were published prior to the author's official name change through the University of Nottingham:

1. Paul Tennent, Kristina Höök, Steve Benford, Vasiliki Tsaknaki, Anna Ståhl, Claudia Dauden Roquet, Charles Windlin, Pedro Sanches, Joe Marshall, Christine Li, Juan Pablo Martinez Avila, Miquel Alfaras, Muhammad Umair, and Feng Zhou. 2021. Articulating Soma Experiences using Trajectories. In *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems* (CHI '21). Association for Computing Machinery, New York, NY, USA, Article 268, 1–16.

2. Kristina Höök, Steve Benford, Paul Tennent, Vasiliki Tsaknaki, Miquel Alfaras, Juan Martinez Avila, Christine Li, Joseph Marshall, Claudia Daudén Roquet, Pedro Sanches, Anna Ståhl, Muhammad Umair, Charles Windlin, and Feng Zhou. 2021. Unpacking Non-Dualistic Design: The Soma Design Case. *ACM Trans. Comput.-Hum. Interact.* 28, 6, Article 40 (December 2021), 36 pages.

3. Joe Marshall, Paul Tennent, Christine Li, Claudia Núñez Pacheco, Rachael Garrett, Vasiliki Tsaknaki, Kristina Höök, Praminda Caleb-Solly, and Steven David Benford. 2023. Collision Design. In *Extended Abstracts of the 2023 CHI Conference on Human Factors in Computing Systems* (CHI EA '23). Association for Computing Machinery, New York, NY, USA, Article

411, 1–9.

Chapter 2

Narrator Introductions

Designing for bodily experiences is notoriously problematic as they tend to be ineffable and exist beyond the realm of written or spoken language. Being able to precisely and completely define, dissect, and model aesthetic experiences has been a greater philosophical issue. Recognizing that bodily experiences must be *lived* and *felt* to be truly known, HCI researchers have increasingly turned to first person methods as interests shift from designing for ergonomics to designing for experiences. This allows designers to draw on their own lived experiences to shape their creations and ideas. Soma design specifically is built on deep, first person accounts of experience and provides multiple tools for articulating them (87) and was selected to provide the theoretical framework for exploring the topic of remote training for bodily disciplines.

As HCI drives towards the novel design of embodied interactions and technologies, perspectives from other fields with a much longer history of articulating and designing body-centric experiences are

drawn in by necessity. Interdisciplinary research teams consisting of researchers and artists have been the standard in performance-led research for decades (28). To go one step further, the presence of artist-practitioners have gained visibility as well (173; 44).

Being both a researcher and a movement practitioner, the author drew from both of these areas for interdisciplinary work. However, the severest waves of the Covid-19 pandemic to date overlapped with about half of the duration of this project. This meant that during the national lockdowns in the UK, the author had to stop engaging in her somatic practices as normal, as studios closed and social gatherings were no longer a safe option. This provided an opportunity to push the magnitude of self-reflection and self-observation to an extreme for the past four years, ultimately resulting in the deliberate splitting of and dialogue between the author's practitioner and researcher roles. An in-depth description of this proposed methodology and its creation, justifications, benefits, and drawbacks can be found in Splitting Yourself: A New Methodology for Self-Reflective Design.

2.1 Practitioner Positionality

I'm an able-bodied, neurodiverse, Asian American woman in her early thirties living in the UK. I've been deeply engaged as a student of movement disciplines since my late teens when I took up karate and kobudo, continuing until the pandemic. Since moving to the UK, I also started training in HEMA[1] and aerial arts. In 2019, I began modeling and flow arts. They keep me sane, they're where

[1] Historical European martial arts

I meet most of my friends, and they make me better. Unfortunately, I've relocated several times because life happens. Instructors and training peers have come and go as well. Regrettably, the only way I could continue practicing at the quality of experience I wanted meant finding a new place to train locally, more often than not requiring me to adopt a new school or style. And while I am grateful for still having access to these resources, it's a shame to not be able to realistically keep practicing with the group of practice buddies left behind, or the grandmaster who lives countries away, despite the tons of communications tech available.

Figure 2.1: The author as a practitioner on static trapeze during a studio photoshoot. Unedited photo by Simon Richardson.

While aspects of my personal practice are undoubtedly dance adjacent, I don't consider myself a dancer in the sense that I have taken part in consistent dance-specific training for this to have impacted my self-identity. The dance world is a place I have visited at times with curiosity and fastidiousness, but at the end of the day, it's still foreign to me. But still, I am a mover, both geographically and bodily, who would benefit from having more remote learning

options!

2.2 Researcher Background

Figure 2.2: The author as a researcher giving a talk to Games Development students at Access Creative College Bristol. Photo by Dominick Mortier.

Because the problem this research seeks to address affects all embodied disciplines to some degree, the author's unfamiliarity with dance served as a means to make tacit knowledge explicit during the earlier, exploratory stages of the project, which is discussed further in Theoretical Background of Bodily Practice. It was the hope that some of the design insights which followed may be discipline agnostic, or at least the discipline-specific limitations may be easily flagged for anyone interested in undertaking future work.

2.2.1 The Soma Design Methodology

Because somaesthetic design is the chosen methodology of this work, a brief description of its philosophical underpinnings is provided here.

Mind-body dualism, a central philosophical tradition in Western culture (154; 182; 151), describes the mind and body as separate entities. The mind is often assumed to be where a person's soul or being exists, and the body is simply the fleshy vehicle which carries the self. Shushterman argues that this assumption originates from religious belief during the Middle Ages in Europe where the body was thought to be base and sinful, and the mind was divine (162; 180). The relevance of dualism in this research may seem opaque initially, but when one considers how it has persisted into the modern era, it becomes more clear. Assumptions from mind-body dualism carry an inherent set of values which seep into the design of technologies. Common devices such as computers and phones are screen-centric, engaging the user's mind while the body is left with extremely limited interactions. Höök (87) makes the argument that as a result, these devices literally shape the bodies of their users, often in detrimental ways. The body is treated as a mere afterthought, or at best a crude vehicle for operating these devices.

Somaesthetics (162) is a discipline meant to counter mind-body dualism, bringing the body back into the equation of the self. Here, the body is not considered an object which houses one's being, but a living, perceiving subject whose physical morphology and interactions with the world make it intertwined with one's being. Somaesthetics prioritizes attention to bodily experience and cultivating one's perception and aesthetic appreciation, providing many benefits to somatic inquiry and research.

Soma design further translates somaesthetics into a process for design. It includes tools that have been developed to help articu-

late somatic experience for reflection, such as body maps (114; 43) and soma trajectories (174) which step away from words, recognizing the strained relationship between language and felt experience. Artifacts and experiences created from the soma design playbook encourage the user to be attentive to their bodies as a key mode of interaction and as a result are often unusual in their form factor compared to mainstream devices. Examples include a large, air-suspended mobile instrument which is played through touch with bare skin (23), wings which help the wearer better "remember and re-experience neglected body parts," specifically the shoulder blades, with shape-changing materials (179), and a device resembling an anatomical heart that provides haptic feedback of the user's real heart beats (16; 17). Though it has been historically used for slow and gentle experiences, there are few cases of soma design also being used for thrilling or exciting activities, such as an interactive wooden dummy for martial arts training (116). Regardless of the activity that designers are intervening with, soma design as a methodology is about cultivating self-awareness and self-knowledge through bodily experiences, making it appropriate for a project such as this, where the aim is to inquire the nature of bodily practices and imagine potential interactions that would support them.

2.3 Thesis Structure

This section provides an overview of the contents of this thesis.

Understanding Bodily Practices: To provide scope, the thesis opens with establishing a working definition of bodily disciplines and

provides an overview of the most prominent practices used for this research in Chapter 3. Using dance as a subject of focus and supplemented by Calyx's experiences, an understanding of the process by which somatic knowledge can be acquired and shared is then co-constructed through conversations with dance choreographers, teachers, performers, and students in Chapter 4.

Intervening with Bodily Practices: The second part of this thesis gives an overview of interventions in the context of bodily discipline practices. Related work in HCI and bodily disciplines, as well as the current state of remote practice of bodily disciplines is explored in Chapter 5. Chapter 6 details a workshop in which soma design researchers test ideas in a series of mock remote lessons using a VR toolkit. Calyx shares a self-reflexive account as the teacher. 7 details the design and development of the interventions studied. In Chapter 8, a series of test sessions with practitioners of various bodily disciplines using the VR intervention prototypes is reported.

Reflecting on Augmented Bodily Practices: The third and final part of the thesis examines potential future of remote bodily practice as well as first person methods in interaction design. Chapter 9 synthesizes the findings from the chapters above and three discussion points are provided explaining how realism of VR is a suboptimal design aim when applied to bodily practice, and how (un)realism of experience can be advantageous. Chapter 10 reveals a methodology to help practitioner-researchers with self-reflective work. Finally, Chapter 11 provides a summary of the thesis, revisits the research questions, and lists its contributions.

Part I

Understanding Bodily Practices

Chapter 3

Theoretical Background of Bodily Practice

This chapter provides a working definition for "bodily disciplines" within this project, then perspectives from pedagogy and skill acquisition literature on practice are added. Top level descriptions of the bodily disciplines encountered in this work follow, along with relevant corresponding terminologies and abbreviations. One should note that extensive and complete descriptions of the bodily disciplines, skill acquisition, and physical pedagogy is beyond the scope of this work. But given that this research is exploratory and practice-led, it is crucial to have a general understanding of their specific factors of practice such as embodied actions, histories, training spaces, and communities.

3.1 Attributes of Bodily Disciplines

As discussed in 1.3, "performing arts" might be a more well-known

term for the area this research is concerned with. But the term "bodily disciplines" is used instead to shift focus to the somatic aspects. It also acknowledges that one may practice not just for performance, but other reasons such as self-cultivation, sport, or as a hobby. This is an especially important distinction as the reason for training will literally shape the movements of practice (107; 90). "Discipline" refers to the fact that these activities tend to be specialist areas of study which can take years for the practitioner to cultivate. A set of criteria for bodily disciplines within the scope of this research is provided. A bodily discipline should:

1. consist of knowledge that must be taught and learned primarily through the body. Subjects consisting mainly of theoretical knowledge do not count.
2. be associated with or contribute to a certain cultural identity or phenomenon.
3. use the body as the focal point of expression. For instance, painting is an embodied discipline but the body is a tool, and is not the medium itself.
4. involve a creative component.

This is by no means an all-encompassing, rigid definition and is simply provided for clarity while reading the text.

3.2 From a Skill Acquisition Perspective

A common central concern of practitioners is progression and mastery of their chosen discipline. To design interventions which

help develop this, it is imperative to understand skill acquisition and expertise. Coaching science is one topic which can lend insights.

Traditionally, the study of expert performance has worked under the assumption that all practitioners learning a skill must adhere to an optimal movement pattern, treating deviations from this template as noise which hinders performance and should be reduced with practice (105). An article frequently cited in academia and popular culture (76) by Ericsson et al. (59) defined an expert as someone who has completed at least 10 years of well-distributed "deliberate practice," that is, practice where a qualified teacher provides one-on-one instruction, as well as guidance on how the individual should conduct solo practice between lessons. Using classical musician training as the vehicle for inquiry, Ericsson et al. (59) set out to debunk the myth that elite performance is the result of innate, qualitative talents not found in normal adults, and to find the most favorable conditions for "improving the reproducible objective performance in domains of expertise," i.e., to reduce variations from the expert model by making movements and behaviors automatic.

While creating awareness of skill accessibility is justified, many have pointed out that this learning approach dismisses the effects of the performance environment on the individual, as well as adaptive movements due to age, anthropometric attributes, disabilities, injuries, etc. (157). This idealization of a movement template has cascaded into some problematic standards for different fields of expertise, as exemplified by body dysmorphia and eating disorders observed in ballerinas (137; 15).

A growing body of ecologically-based work on skill acquisition shows that although foundational movement patterns should be learned by beginners, variance in motor movements, even among expert performers, is unavoidable, since individuals can have a multitude of functional adaptations to successfully complete a task (49; 157). Attempting to eliminate these variances can result in exhausting, discouraging practice for an otherwise enthusiastic learner, and could make performance worse by interfering with existing adaptive skilled behaviors and increasing the risk of injury (83).

Dynamical systems theory (DST), which has been used to develop training protocols for athletic skills such as agility (83), is a promising alternative framework (49; 157). It rejects the notion of a single ideal movement pattern, stating that functional movements and behaviors emerge from the convergence of three key factors: 1) task constraints, such as rules, boundaries, or instructions; 2) organismic constraints, such as height, sex, emotions, genes, or cognition; and 3) environmental constraints, such as weather or gravity. By manipulating these constraints thoughtfully in training scenarios, the execution of a skill is more likely to be successful – that is, expertise is characterized by *adaptability*. DST also highlights the link between perceptual information and skilled behaviors, sometimes referred to as perception-action coupling (61); what separates experts from novices is their ability to attune to the correct environmental cues that indicate the best actions and reactions. Novice fighters, for instance, may instinctively look at their opponent's limbs or hands in anticipation of an attack, though these cues generally do not provide enough time to

react appropriately. By contrast, experienced fighters will know to look for movement in the shoulders as a more timely informational cue. VR can be used to create unique constraints, such as a virtual staff which changes size and weight distribution as the user continues to spin and balance it. Ultimately, the author found this to be a more ethical and holistic perspective on gaining expertise in a bodily discipline, which has guided the research activity that followed.

3.3 From a Pedagogical Perspective

Because the interventions would effectively be teaching and learning tools, it is crucial to understand some of the current work on physical pedagogy. Though andragogy (adult education) and heutergogy (self-education) would technically be more appropriate terms, pedagogy (child education) is used here as much of the body of work on adult education is still labeled pedagogy, which appears to have taken on a working definition of education in general.

Through Calyx's experiences, two differing teaching approaches were noticed across her bodily discipline practices. On one end is the traditional, teacher-centric method where teaching is mostly done by demonstration and learning is done through mimicry. On the other end is a contemporary, student-centric method of teaching which rejects hierarchies and practitioners are encouraged to collaborate and invent their own movements and ideas. This dichotomy has been observed in scholarly work on bodily practices, as well as HCI and dance (145). Deferring to etymology, Butter-

worth (33) refers to traditional methods as didactic, with Greek roots translating as "to teach" while the contemporary methods are called democratic or "people + power." This has also appeared in HCI research as the pedagogical strategies of different dance learning systems showed through; Raheb et al. (145) categorized traditional and contemporary systems as "demonstrative" or "generative," respectively.

The basis of traditional "demonstration-reproduction" teaching styles may have a biological basis in the tendency for observers to copy movements of observed others, sometimes referred to as embodied simulation (72) or mimetic learning (196). This is important especially in children as they learn to develop their sense of otherness, social understanding, and empathy. Although Gallese (72) specifies that this is "not necessarily the result of a willed and conscious cognitive effort," it is suggested that this allows movement knowledge to be accessed (80), forming the basic principle behind mimetic learning or learning through imitation. This approach has a central position in practices where the goal is to perfectly replicate an idealized version of the material (69). Foster (69) has described this style of teaching as objective-focused, with the intent of producing "trained bodies" which have learned to copy movements from the demonstrated ideal perfectly. The classical musician training which Ericsson et al. (59) studied could be categorized as using this pedagogical model.

There is no clear origin of democratic pedagogical models, but they appear to have risen up over time as due to changing educational philosophies and societal shifts which made way for more democratic learning. These alternative approaches became especially

more common after the American cognitive revolution (53) of the mid-20th century, where the field of psychology faced significant changes and neuroscience was emerging (127), getting society closer to a more complex understanding of phenomena such as motivation, memory, and indeed, skill acquisition. In bodily practices such as dance, this means that practitioners are exposed not just to physical practice, but to processes like choreography so that they can take ownership of their compositions and gain a strong understanding of their discipline. For instance, Laban Notation (52) assumes that all dancers are creators and is used as a way to bring theory back into tertiary (pre-professional) dance education. Contemporary styles of teaching also tend to encourage inclusivity. For another dance example, considering the language used in instruction (202) such as "walk slowly" assumes all dancers use two feet, whereas "traverse slowly" includes dancers who rely on other forms of locomotion.

Of course, pedagogical models in real life are more diverse and mixed than these two extremes, and this has been discussed in research as well. Combining historical investigation and personal reflection, Butterworth (33) proposed a paradigm for learning and teaching called the Didactic-Democratic Spectrum in a call for practitioners to avoid taking for granted the ways in which they have been taught, and instead "further develop good practice in relation to professional practice, pedagogy and research in ways that

may not yet have permeated all dance education contexts to date."

3.4 Predominant Bodily Disciplines of This Research

Because this research is practice-based, it is necessary to introduce the practices involved in this work. This section gives a high-level description of the main bodily disciplines encountered in this document. Note that all but dance are practiced by the author through Calyx. As described in Narrator Introductions, an unfamiliar practice was included to help make explicit what normally might have stayed tacit knowledge to the author if all of the disciplines used for study were already familiar (115). This strategy also helped to highlight commonalities and differences between bodily practices, which became helpful when designing interventions that were meant to be usable across different disciplines (Chapter 7.) Note that these categorizations are not mutually exclusive. For example, the Afro-Brazilian martial art of capoiera is combat disguised as dance. Estimated to have been developed around the 16th century during colonial Brazil, this style of "battle-dance" was developed by African slaves when they were forbidden to learn how to fight, and was used not only for combat but as a form of creative movement and spirituality.

3.4.1 Dance

Figure 3.1: A performance of MASS by industry partner and dance choreographer Robert Clark. Photo by @camillagreenwellphotography on Instagram.

Dance is a universal (96) human (and non-human (98; 136)) activity which can carry social, cultural, artistic, and personal significance. As such, it can include but is not limited to: social dance such as at weddings or nightclubs, folk dance which reflects the identity of a community, or professional dance as seen in stage productions and compositions (see Figure 3.1.) Fundamental elements of dance include movement such as steps or postures, and music. Rhythm and timing of movements can be used to create a harmonious expression with sound. Out of the bodily disciplines listed here, none appear to have been given as much scholarly attention as dance, in HCI and elsewhere (201) based on the searches conducted here.

Because of the vast stylistic range and origin of dances, the environments and people one might practice with vary massively. But the participants involved with this research predominantly

Figure 3.2: An online, one-to-one footwork practice between dance teacher Robert Clark and the author in their respective homes. This session was held in Microsoft Teams during the second national Covid-19 lockdown in the UK.

practiced in studio or studio-like environments with large, empty spaces and sometimes with mirrors on the walls for visual feedback, with one or few instructors and several classmates, which is accepted as a common learning environment for dance (200). Those who practiced remotely, especially during the Covid-19 lockdowns in their respective countries, also made use of the space in their homes. In the practical sessions with the industry partner, dance was learned one-on-one through Microsoft Teams (Figure 3.2.) Because the author was a beginner, these sessions consisted of fundamentals such as establishing a common vocabulary between the instructor and the student, diagnostic movements so the instructor could gauge the student's current physical abilities, and sensitizing exercises. Dance improvisation exercises to improve flow and fluidity were also added as a response to Calyx's desire to improve her Circus Arts practice.

3.4.2 Martial Arts

Like with dance, martial arts is an umbrella term for the various traditions of combat training and techniques. Often having deep historical and cultural roots, different styles and systems have been developed over centuries and tend to be linked with particular traditions and philosophies. Practitioners may have any number of motives including physical fitness, self-defense, mental discipline, or spiritual development (124; Witkowski et al.). The two main branches of martial arts referenced within this work are historical European martial arts (HEMA) and karate.

HEMA describes the study and practice of combat systems from historical periods across Europe. These are primarily weapon systems like longsword, sword and buckler, rapier, dagger, and polearms, though unarmed techniques may also appear. They also cover different combat contexts, such as battlefield fighting as opposed to private duels, which is reflected in the design of the weapons and the physicality of the techniques. Practitioners often rely on historical source material, such as manuals, manuscripts, and treatises written by medieval and Renaissance masters. This shapes the way knowledge transfer occurs. Unlike more well-known martial arts which tend to be taught didactically, HEMA is a modern revival of traditions, where practitioners often must recreate the techniques found in the primary source documents in a process of interpretation and experimentation (88). Perhaps the earliest form of asynchronous remote learning materials, the depictions of techniques can be difficult to interpret, especially the documents which predated perspective drawing (101). Differences in historical and modern language (194), as well as the inclusion of medieval Latin in some cases (181) contribute further

to this confusion, which can lead to fervent debate between practitioners about techniques. Practitioners may conduct research into historical contexts and how this shaped the embodiment of the practice, such as the use of leather-soled shoes in several European countries during the 15th century (129) resulting in slippery conditions, which some have used to justify small steps in footwork to avoid losing balance. This tendency to not only participate in the physical practice but also research results in practitioners contributing to academic discourse (89).

Figure 3.3: A pair of HEMA practitioners spar during a group class. By Kristine Konsmo, shared with permission.

Calyx's main HEMA practice is that of *Kunst des Fechtens* (KDF), translated from German as "the art of fighting." It refers to traditions of German-speaking regions of medieval and Renaissance Europe. Her club focuses on the use of longswords and daggers. However, she occasionally visits other HEMA clubs and study groups, and therefore has intermittently practiced other weapons,

including historical rapier and saber. Training is typically held in a hired gymnasium, ideally with tall ceilings and lots of empty space due to the comparatively long reach of the weapons compared to unarmed fighting, or outdoors at a park. The learning context is mainly focused on historical combat settings, though competitive sparring with protective gear (Figure 3.3) is also common as HEMA tournaments grow in popularity (186).

Figure 3.4: A karate sensei performing a kata for solo practice. By Chad Eagan, shared with permission.

Karate, translated from Japanese as "empty hand," is a group of martial art styles which originated in Okinawa as a form of unarmed self-defense. The exact origin of karate is difficult to pin down, but it has influences from Chinese martial arts as Okinawa served as a port between China and Japan (121). Karate gained recognition outside of Okinawa after World War I when it was introduced to Japan (70), revised, and standardized by the Japanese government for public health and school programs (100). The globalization of karate increased further after World War II with the

American occupation of Japan and the prominence of martial artists in Hollywood films (107), with a swell of Western *karateka* (karate practitioners) and tournaments in the 1970s and 1980s as an indication of the American zeitgeist. This resulted in further changes to karate to cater to the preference of spectators (107).

Today, Japanese karate and Okinawan karate [1] are practiced globally for a number of personal factors such as health, feelings of self-efficacy, or thrill (124). Karate is Calyx's first serious bodily practice, and it has influenced much of her other practices in terms of her approach to training, with a tendency to execute basic techniques with many repetitions to polish the movement, as well as needing to understand the reasoning behind all movements. The styles she has practiced feature mixed techniques of strikes, grapples, and throws. Training is typically done in a group class at a *dojo*, translated from Japanese as "place of the way," which are typically dedicated training spaces consisting of empty areas and some equipment such as striking pads, practice dummies, and punching bags. Social configurations can consist of solo, partnered, and group arrangements depending on the exercise and number of students in attendance.

3.4.3 Circus Arts

Circus arts encompass several performance disciplines which, as the name implies, are associated with circus shows. Traditionally circus acts involved wild animals such as lion taming, but con-

[1] Though Okinawa is currently a prefecture of Japan, usage of the term "Okinawan karate" is maintained as they can differ dramatically in training practices from Japanese styles, reflecting the cultural, historical, and linguistic differences between the two.

cerns for animal welfare have resulted in a shift away from this (128). Circus artists were also made to perform the same act for several years, with little say in the creative process as they were "captured bodies" (150) kept to execute skills masterfully, resulting in the artists feeling imprisoned (106). Though these scenarios still unfortunately exist, there is growing favor of the third wave of circus (109). Like the third wave of HCI (24), the contemporary circus movement takes a humanistic approach, with acts having more connection with the audience. It is also pushing towards empowerment of the artists so that creative fulfillment is prioritized over skill mastery and machine-like consistency. The two branches of circus arts used within this work are aerial arts and object manipulation.

Aerial arts involve air-suspended apparatuses such as aerial hoop or lyra, static trapeze, or aerial silks (Figure 3.5.) Previously kept within the professional realm, aerial arts have been growing as a hobby (120), partially due to the fact that practitioners experience improved fitness and mental health (142). Aerial pole, which was originally found not in the circus but in strip clubs, has also crossed into recreational fitness (132) and even professional sport, though Jensen and Thing (90) express concern about how the hegemonic masculinity of the field of sport might strip aerial pole of its gender non-conforming qualities as it gets "sportified" and standardized gender ideals are reinforced.

Figure 3.5: Left: Calyx hangs inverted on an aerial hoop. Right: An aerial silks student learns the figurehead trick. By John Wilson, shared with permission.

Aerial training is highly technical to ensure that practitioners are safe in their usage of the apparatuses, including learning how to properly climb, wrap, and perform drops and spins in the air. Aerial performance also has some similarities to dance. For instance, performances are often choreographed to music, with the aerialist combining their athleticism with creative expression. Calyx samples several aerial apparatuses as part of group classes, but she primarily uses aerial hoop and aerial pole.

Figure 3.6: Calyx practicing a toss and catch trick with a staff during a solo practice session at home.

Another branch of circus arts is object manipulation, sometimes referred to as flow arts, which refers to the skillful manipulation of objects. Juggling is a famous example of an object manipulation act that has a strong association with the circus (141). They are often performed in a visually captivating and rhythmic manner. The author's main experience has been in staff spinning and sword spinning. It should be noted that staff spinning is the only bodily discipline which Calyx has learned almost exclusively online, both asynchronously through demonstration videos, and through live remote classes via Zoom. For this reason, it has been practiced in the author's back yard (see Figure 3.6) or other available spaces that were not formally dedicated for this purpose, and the community consists mostly of people she has not met in person. Staff and sword spinning were the main disciplines prac-

ticed through the Covid-19 lockdowns along with improvisational dance, while the rest were generally not engaged. Little scholarly work on object manipulation in general has been done, but from Calyx's observations, formal, colocated classes are not as common and instead practice is done solo or in informal skill share sessions and group "flow" gatherings.

3.4.4 Modeling

Figure 3.7: A model posing at an underwater studio, with a photographer in the foreground capturing pictures. By Halo Haynes and Robin Smith, shared with permission.

Modeling involves posing for photographs or videos. Perhaps the most well-known form of this practice is commercial modeling, which is done for the purpose of promoting certain products, services, or lifestyles, such as clothing in the case of fashion modeling. The rise of image and video-based social media platforms such as Instagram and TikTok have prompted companies to invest heavily in their online marketing strategies (92; 36). However, modeling is a diverse field and can also be done purely for artistic or recreational purposes as is the case here, especially since these social media platforms have somewhat democratized the ability to

Figure 3.8: Calyx modeling in a greenscreen studio for a fantasy-themed shoot, dressed in costume and drawing a longbow.

promote one's own work to a massive audience. Practice is done either in a studio (See Figure 3.7) or on location with a photographer or videographer, though other people such as a makeup artist, stylist, or other models may also be involved.

Inspired by various forms of gameful character-based role play, including tabletop role-playing games (TTRPGs) (169) and live action role-play (LARP) (118), Calyx mostly takes a narrative-based approach to her modeling. Themes may also be influenced by her other bodily practices (see Figure 3.8.) Though she is self-taught, some comparisons could be drawn to Method acting, an immersive dramatic approach where actors draw on personal experiences and emotions to portray a character more authentically (97). As a result this requires several tricks for putting on the character on camera, such as imagining what motivations or background they might have and how that would influence their behavior and embodiment. The character-based approach is not the only one models use to pose, and in fact appears to be rather uncommon outside

of the cosplay community. Through Calyx's observation, different models have their own preferred ways of posing, such as having a repertoire of pre-determined poses, freestyling with or without music akin to improvisational dance, or creating specific shapes using the body given external factors such as the landscape or lighting, the last of which often requires the model to see what is in the camera's viewfinder to more effectively compose themselves, or direction from the photographer.

3.5 Summary

This chapter provided a working definition and criteria for bodily practices within the scope of this research. An abbreviated background of teaching and learning bodily disciplines from skill acquisition literature and pedagogical literature was explored. Lastly, basic overviews of the predominant bodily disciplines used for this project, as well as their factors of practice such as training space and community were provided to contextualize the research.

Chapter 4

Interviews with Dance Practitioners

This chapter presents a set of interviews with professional and recreational dancers and dance teachers. The aim was to understand the processes of dance practice, especially looking at the seemingly contradictory notion of using predefined movement vocabulary while simultaneously developing the practitioner's personalized movement style as found in Theoretical Background of Bodily Practice. The findings are the used to form an empirical foundation informing the designs of the VR interventions to follow.

4.1 Method

4.1.1 Participants

Thirteen dance practitioners with 7 to 21 years of experience (M=14.8,

SD=5.1) were recruited to take part in semi-structured one-on-one interviews; seven of whom were approached independently, four of whom either currently or previously collaborated with the Mixed Reality Lab at the University of Nottingham, and three through chain-referral sampling. Countries of practice represented include the UK, USA, Canada, Poland, and Sweden. Between them was a variety of dance backgrounds and styles, though contemporary dance was heavily represented (see Table 1). All participants who were dance instructors reported teaching a wide variety of students in terms of age and (dis)abilities. The participants received no financial compensation. The study was done in accordance with ethics procedures and approved by the University of Nottingham School of Computer Science Ethics Committee. Ethics forms supplied to the participants can be found in Appendix A.

Table 4.1: The dance styles which participants reported reasonable confidence in discussing for the study.

	Self-Reported Preferred Dance Styles
P1	contemporary
P2	physical theater, movement theater, contemporary
P3	ballet, contemporary
P4	belly dance, historical reenactment dance
P5	contemporary
P6	hip hop, belly dance, fusion
P7	swing dance
P8	contemporary, jazz
P9	ballet
P10	ballet, jazz, contemporary
P11	jazz, tap, hip hop, contemporary
P12	ballroom
P13	ballet, contemporary

4.1.2 Procedure

A series of semi-structured interviews were conducted, focusing

on the processes and mechanisms of bodily practice in a dance setting. The interviews took on a somewhat spontaneous, conversational (46) form as Calyx would draw upon her experiences to relate to the stories that the participants shared. This provided an avenue of abstraction from dance-specific settings to movement and bodily practices as a whole.

Interviews were conducted online through Microsoft Teams, Skype, or Zoom as preferred by the interviewee and lasted between 28 minutes and 1 hour 46 minutes. Sample transcripts of the interviews can be found in Appendix B.

Though exact subject matter varied noticeably between participants, the conversations were guided by the following topics:

- Their dance background. This often included explanations as to how they were introduced to dance, where they learned, what kind of dance styles they learned and taught, and what they do now, and what drives them to practice.
- Detailing the demographics that the participant typically works with or prefers to work with.
- Unpacking their methods, struggles, solutions, approaches, and philosophies working with different bodies and abilities.
- Unpacking the practicalities of sharing or developing embodied knowledge through dance sessions. This included anything from co-located to remote sessions, or synchronous and asynchronous sessions.
- Their experiences with remote dance practice, if any.

4.1.3 Data

During each interview, an audio-visual recording of the meeting was captured using the teleconferencing software's built-in record features. The videos were uploaded to Microsoft Streams for auto-transcription. The resulting corpus of data was then manually proofread by the researcher and formatted, during which time initial notes on the data were recorded.

4.1.4 Analysis Method

The concepts of coding and sorting are most closely associated with grounded theory, introduced by Glaser and Strauss (77). Instead of the traditional method of forming a hypothesis and subsequently testing it, a researcher will collect data and form a theory around it, i.e., the theory is grounded in the data. The approach used for this study is adapted from grounded theory in that the data from the interviews have been coded and grouped into larger themes, but it does not follow the exact precepts set out by Glaser and Strauss. Braun and Clarke's guide to thematic analysis (31), a method meant for finding and analyzing themes from patterns in qualitative data, is applied here.

Once interviews were proofread and formatted adequately, transcripts were uploaded onto the Obsidian note-taking and knowledge management software. Next, each interview was read through and concepts of interest were manually coded along the way. These concepts were distinguished with a new note file within Obsidian, creating a unique code. Each interview was procedurally read through and coded this way until completion, with recurring con-

cepts containing backlinks to all participant files where the code occurs. When the entire dataset was coded, similar codes were merged, and broadly related codes were clustered together into one folder, serving as candidate themes (31). This was presented to two other researchers from the Mixed Reality Lab in an online invited data review session via Microsoft Teams, where the group unpacked these clusters through discussion. Following this meeting, the clusters were reorganized further and arranged into the themes highlighted below.

4.2 Findings

The following section outlines and elucidates each of the core themes that were constructed from the interviews, coding and data review session.

4.2.1 Themes

Theme 1: Normativity

In seeking to understand the characteristics of practitioners to inform intervention design, some complicated tensions in dance culture and tradition became a common point of discussion.

High Expectations

Some of the interviews revealed exceptionally high standards of athletic prowess.

A choreographer, P3, on selecting dancers:

> *P3: "They'll always be able physically to pretty much do everything I want them to do... And you know, we're working with the most able of able-bodied people."*

A professional dancer, P13, on applying for work:

> *P13: "...you can also get into situations where you're like, part of being able to get the job that you have is that you are able to do all those things. That's part of the criteria. That's why you're doing auditions. Doing that stuff, especially in ballet where you have, umm, set material where you have very clear vocabulary. It's like you need to be able to do a double tour, two spins in the air... to be able to do this part of the role."*

Note that discussions of these high expectations of athletic capability have been mainly present in the conversations involving professional practitioners who are employed in the industry. They did not cover the expectations of amateur dance, but still, this has a heavy impact on all practitioners due to the societal view of dancer identity as explored in the following subthemes.

Body Standards

Very specific body standards in some groups and schools appear to be a consequence of the aforementioned standards for athletic prowess:

> *P4: "One of the issues that [I] see in dance in general is... that people see through media, through television,*

through theater, through computers, people doing very complex stuff which the vast majority of people can't achieve. I mean, they probably could if they did years and years of training, but not once a week... And its become less and less inclusive and more and more exclusive."

This leaks into the aesthetics of practitioners' bodies:

P10: "It's constant, that sort of comments about your body, like every single dancer will have had that if they do ballet... it's completely wrong, but basically in the classical... genre... it's all about making lines... they wouldn't even let us do press ups 'cause they didn't want our shoulders to be large... I mean if you had any of these things naturally that maybe you couldn't change– so if a girl has bigger breasts, she just wouldn't be considered."

P9 recounts their competition days, describing how dancers from the ages of nine to teenage years would receive criticism from judges about their bodies:

P9: "[You'd] get a tape back of the judges, criticizing every single thing that's going on in your show. So if you lost, you're going to hear even more like, the negative thoughts that they've had and they would comment on your body... Sometimes the kid has just a, you know, they talk about banana back where your back is super

> *arched and they would say, like, 'That kid doesn't have a future in dance.' It's like, oh my God."*

In some dance styles, especially in more traditional models such as ballet, dancers' bodies are judged in ways that may be problematic. This is explored in detail in work by Langdon and Petracca (103) where they found that sense of dancer identity was not related to number of years of practice, but instead was negatively correlated with body appreciation. A literature review by Serquiz and Duarte (159) stated that public opinion of the ideal dancer body can be considered a risk factor for the development of eating disorders, and "Body Dissatisfaction (CI) is categorically present in the daily life of dance practitioners."

Imposter Syndrome

Imposter syndrome is a psychological pattern where an individual doubts their abilities or accomplishments and have a persistent fear of being exposed as a fraud. Even when presented with evidence of their competence, those experiencing imposter syndrome will attribute their success to external factors such as luck (40). Those with high expectations placed on them, such as professional dancers, may experience imposter syndrome as the expectations can drive perfectionist tendencies which can make the individual feel inadequate.

> *P1: "... I think traditionally [dance culture] is seen as, 'This is the dancing body. The dancing body looks like this. The dancing body should be able to do this this and this.'"*

> *P11: "It's amazing when someone is drunk [flails head and shoulders] and just going at it. You put the same person the next day into a dance class and they are like stiff as a board because now they are finally* dancing, *like 'the real thing.'"*

People who practice dance are even afraid to self-identify as the perceived dance identity is put on a pedestal. P2, who teaches both movement theater and dance, discussed how her movement classes get higher attendance than their dance classes, even though the content is largely the same. When asked her thoughts on why this might be, she responded:

> *P2: "Yeah, I think it's the fact[??] that, 'I'm not a dancer.' Children and teenagers do that a lot: 'I'm not a dancer.' even if they've had dance experience in the past, 'I'm not a dancer.'"*

Because of certain traditions and societal expectations, dancers are expected to be and do certain things. This results in practitioners denying themselves the identity. As seen when Calyx introduces herself in Practitioner Positionality, she doesn't consider herself a "dancer" per se - despite the fact she does practice dance.

Being a Body

Despite the advanced athletic prowess of professional dancers, some participants noted that training can be incomplete despite certification. A former competitive dancer, P9, explains why they

think they weren't taught how to choreograph in dance school:

> *P9: "You're often– for competition, you're very much you become a tool. You're just a tool for the teacher to get a trophy to put on school [inaudible] stuff... They treat it more as the activity and exerting the energy is the satisfaction when it isn't.'*

P10 on auditions:

> *P10: "It's just [an] industry that people are pretty disposable, so anyone with any opinions or anything... it just gets into, do you have the right color hair or are you the right exact right height I'm looking for? Is your body shape like this? And they can be really picky with all of that superficial stuff because they're everyone's talented enough and there's very few people that are way above that would definitely get work. It's a real luck of the draw thing, and often they don't even tell the dancers why they're getting the jobs.'*

The normative dancer is treated as a body or a tool for a choreographer in movement design. This can be problematic for practitioners who wish to practice first and foremost for themselves, rather than being objectified to express someone else's message or story.

Theme 1 Summary

Aspects of the dance world appear to be strict, exacting, and homogenizing. When designing interventions to support dance prac-

tice, one must keep in mind that certain varieties of dance are only enabled by the fact that the dancers look and move the same way. If building movement practice systems for this purpose, the creators must keep in mind that their intervention will only cater to a particular classification of dancer as some forms of practice are exclusive.

However, there are parts of the dance world that are meant to be the antithesis of this normativity by embracing individuality, as seen in the next theme, providing an alternative angle of investigation.

Theme 2: Individualizing Movement

The normative dancer represents a small portion of practitioners, and indeed humans. Some dancers and choreographers have been exploring work which deliberately breaks out of this specific concept of what a dancer should do and what the dancing body should look like. This theme explores the counter-cultural views of dance, and how this influences practice.

Dance is Innate

Despite the issues arising from imposter syndrome as discussed above, participants say that dance is for everyone, it is part of being human, and an important element of it is individuality.

P4 on the evolutionary psychology of dance:

> *P4: "Dance going back is a big signaler of sexual attractiveness, of intellect and and so on and is very much a*

> *social function. And I think when we strip that away from people by making it exclusive, we lose a lot of the* individuality *and what people bring to dance that becomes possibly less creative in a broader sense. It might be amazing in an artistic sense, but in an individual* interactive *sense, it becomes less so."*

P11 describes how Black Americans were denied access to dance, which in new styles to get around the restrictions rather than accepting a cessation of dance:

> *P11: "We had the whole history of, well, African Americans just being denied to step out into the theaters. But they were dancing. You can't deny it... it was part of their religion... we reached the point where we have uh, a lot of styles branching out of it. How even a hip hop has branched out of jazz, right?"*

P11 on attempts to suppress and heavily restrict dance in the Middle Ages in Europe because of sensibilities in what was considered proper:

> *P11: "...you can't really take that away from people, but it was kind of converted into something that separated people more and then afterwards it started growing back again into something that we have today."*

So if everyone is meant to dance, it is necessary for designers to support emerging and personal dance practices of cultures and

individuals that arise through the inevitable evolution of dance disciplines and styles.

Bodies are Different

A place to start answering this question is acknowledging that although practitioners (broadly) share biomechanics, "every student is different and everybody is different" as P6 puts it.

P1 brings up a point about instructors' use of language in classes, describing how some avoid naming body parts for fear that they would exclude students. To get around this, P1 decides that instead of avoiding the naming of body parts, she offers it as one of a few options, and also makes use of visualizations and metaphors in the hope that students will find that at least one option applies to their own body:

> *P1: "I try not to be frightened of body parts because we all have bodies, but it's about offering options... Thinking about the* ***length of our spine****, and again I know for some people the spine and maybe if there's depending on your condition... I've seen some described...* ***like a waterfall that goes upwards****... I basically try not to be frightened of anything. But that doesn't mean I'm not because I'm human."*

While discussing their personal practice, participants demonstrated familiarity with their capabilities and limitations:

> *P10: "I always liked doing sports but I was never good at anything that was, umm, too fast [laughs] like I would*

> *enjoy it. I, but I (was) just never talented. Anything like fast twitch muscles... even the dance styles that I did were that were like fast... jazz and so I was never good but I was always really flexible."*

> *P9: "... what I ended up being really good at which is I think where my style worked was floor work. I'm very good with my lower body. My legs and feet are have a much better sense of control and guidance on those than I do with my arms."*

An individual's bodily capabilities and limitations are strong determining factors for what and how practice is done. In these examples, some may decide to stick with what one is good at, though they should not be barred the choice to overcome their personal limitations. Regardless, this still influences practice. Scholarly work proposes ways to accommodate different bodies in dance class Zitomer (202), and there are dance companies which champion the diversity of its performers and students (6). It is critical for designers to recognise the lack of homogeneity in bodies and design systems that do not contain too much implicit bias from pedagogical hegemony as covered in Theme 1: Normativity.

Beyond Techniques

If dancers' role in industry tend to be described as "tools" (33) this implies an incomplete dance practice. But then one must ask, what is missing?

Going back to the example of the drunk dancer mentioned in Theme 1: Normativity, P11 shares her opinion that simply being able to

match the shapes and movements in a class is not dance:

> *P11: "[The drunk dancer] had so much power and they they were amazing on the dance floor the night before, but when they put them in a class, everyone was kinda, you know, scared because now it's important how we look and* that's not dance."

The above quote hints that going beyond mechanically performing the movements brings one closer to actually performing dance. One way to do this is having a relationship to the practice material. P1, who is both a dancer and a choreographer, explains with excitement how they choreograph:

> *P1: "I knew in the back of my brain that I was interested in body language and I was interested in body language and so the nuances of that, and interpretation andhow it's perceived."*

P3, another choreographer, shows again that being interested in a topic and wanting to share it through performance is fulfilling:

> *P3: "I'm much more interested in niche areas, so not in presenting fairy tales on stage but in kind of like, what's really going on and finding different ways of expressing what's really going on in the human condition at the moment... [Mainstream choreographer] is more sorta like neoclassical kind of ballet...well, ballet-contemporary mix I suppose. And whilst it's great fun*

> *to do, I felt like I had a different voice to offer in terms of the dance world and so I just wanted to go down my route."*

These examples show that for the study participants, dance shouldn't simply be movement, but movement with expression, and dancers "need to surrender to the situation and they need to become generous" in P3's words, whether that be a drunken person ecstatically dancing without inhibition, or a professional dancer knowing the story behind a choreographic work.

Storytelling

Participants expressed how drastically an intention or quality can change movement and characterize the dancers in the story of the performance.

P13 likens dancers to actors, explaining that they use a variety of non-verbal elements to tell a story:

> *P13: "...you've got dynamics, so the the force and speed and the quality of movement that the dancers chooses to do in a given movement. The movement can be, you know, presenting to an audience. [sweeps arm across body] But I can present to an audience smoothly slowly [sweeps arm across body slower] I can present with a power [beats chest while sweeping arm across body more dynamically] a pompous from my chest and show– and now I'm giving two different characters."*

P11 on working with personas in dance:

> *P11: "...it always helped me to understand the character especially well with ballet. It was easy because it was just my teacher who would be like, 'Look up your character because you are supposed to act like...' uh, for the most part it was princess who was in love, you know? ... And it was really easily done, but uh, when I moved into Charleston and into modern dance, particularly modern dance, you kind of have to... invent this yourself so, I got really interested in what Martha Graham kind of... well, introduced into the world of dance, how every movement is supposed to carry meaning."*

In the case of reenactment dance, P4 explains that the historical context allows for playfulness between performers, adding another layer to enhance the performance:

> *P4: "So if we're doing Regency or Victorian, we look at the social context... this is often the only time you get to interact with a man. So when you're putting up your hand and you're circling round, you have the opportunity to meet eyes and to flirt a little bit - or avert your eyes if you find anyone unpleasant so you can change things..."*

Relating to the material helps with the presentation of the movements to the audience, because dance isn't just the production of moves, it is what is being said with the moves. This can turn into a type of storytelling, turning dancers into characters, though this can either be explicit or implied. Designers need to ensure

that practice tools do not make assumptions about (or worse, impose) a persona or narrative. Instead, tools should facilitate users in their process of persona creation and adoption.

Theme 2 Summary

It is the view of some participants that all humans are meant to dance. Designers looking to create inclusive tools for bodily practice must accommodate this inherent diversity through considering a range of abilities and by facilitating users in their meaning making processes. Encompassing this in an intervention will require more than a single, one-size-fits-all approach. The question then becomes how bodily teaching can be adjusted to accommodate this diversity in practice.

Theme 3: Dual Approaches

Because of the tensions between classical dance culture and modern dance counter-culture as explored in Theme 1: Normativity and Theme 2: Individualizing Movement, two types of movement became noticeable throughout the interviews, which will be referred to as "codified" and "exploratory." Exact definitions of these words vary between contexts. But within this thesis, codified technique refers to pre-defined moves or rulesets, while exploratory technique refers to intuitive generation of movements. It is important to note that these definitions are extremes within a vacuum– in application, it is very unlikely that a codified approach will have complete absence of exploratory techniques or activities, and vice versa.

Preferences

Some participants made their personal preferences, usually from a student perspective, very clear, such as P10:

> *P10: "I really, really liked the technique of ballet, like the rigidity of it, almost that there is a right and wrong. And and there's things to work towards. I found some of the concepts in other styles of dance is a bit too fluid, maybe? I just– I liked the positions, I liked– you had to know what you were aiming for and just working towards things and seeing your technique improve."*

P10 did admit that their preference was not as common and that "a lot of kids hate it," especially as they gained more teaching experience:

> *P10: "...what I recognize was not everyone is like obsessed with ballet technique like I am. [laughs] They wanna do it for fitness, but they also want to come actually feel like they're able to express themselves"*

In contrast to ballet, P7 discusses how imperfectionism in swing is embraced as freedom:

> *P7: "...it really is kind of putting yourself out there and just experimenting and just yeah, if things go wrong and I think, 'Well, that's fine. I'll just join in on the next count.' You know? But yeah, the entire sort of concept of swing is because that jazz music and that's*

old age was, you know, or like the freedom of dancing and just like pure joy, basically and just responding to music and just get—distilling the essence of like the fun and carefree dynamic sort of mood of the music and just filtering it out to to music."

Mirrors also had a polarizing effect on the study participants which seemed to be determined by the distinction between codified and exploratory movements. P12, a former competitive ballroom dancer, believed that effective solo practice was near impossible without a mirror as one could not ensure that the moves were technically correct:

P12: "The main problem is that you need a mirror... because otherwise you do not know if what you're doing is actually good. OK, I can be doing stuff for hours and hours and I could be doing it wrong because I do not see any or hear any feedback. Problem with recordings is that you cannot correct yourself in a live time."

P11 acknowledges that mirrors are ubiquitous in dance, to the point where she believes they create problems in practice and prevent dancers from sensing and experiencing movement:

P11: "I feel like a lot of modern dancers suffer from... suffer as the prisoners of the mirror, I would say. They're kind of losing the way that the dance is supposed to feel like...They're just straightening the arms, but they are not feeling their arms, they're just looking if they look

> *good. And instead, if they wouldn't have the mirror, they would push all the way until they feel every single muscle tense in their in their hand, and then it is really straight for for the dancer then you are really reaching, not when it looks like you're reaching. So yeah, it's huge problem."*

Both codified and exploratory approaches have their appeal, focusing on different fundamental aspects of dance. Codified focuses on learning a clearly defined movement vocabulary, while exploratory allows for raw expression and creativity. The implication of this is that intervention designs need to be able to support both codified and exploratory approaches to dance teaching and learning. For instance, a virtual mirror can be helpful for self-correction, but it cannot be the only form of feedback the user receives.

Health and Safety

Codified technique becomes non-negotiable when safety is involved:

> *P2: "I might teach them, like in terms of, 'I want you to all fall to the ground.' At this point I'm going to teach you how I want you to fall to the ground, because clearly there's a technique to that to not hurting yourself."*

> *P2: "...I've basically learned through ballet and doing– how to fall in ballet. I know where all the soft spots of my body are and now I know how to fall in never hurt myself."*

Having an appropriate training environment to ensure proper technique is done is also a factor:

> *P10: "I mean if you're on a carpet and you're doing a ballet class, your muscles aren't working against any resistance of a slippy floor, so you can be pretty disengaged, and your glutes. And then your knees are twisting just to turn out the feet rather than you squeezing your legs out into that turned out position. So it can be pretty dangerous."*

Technique is important when it helps keep people safe, as mentioned in Circus Arts with regards to aerial apparatus usage. Interventions must be careful not to obscure technique and subsequently introduce additional safety concerns.

Words, Not Sentences

As discussed in Theme 1: Normativity, dancers may get an incomplete education where they mainly develop physical and athletic prowess, as well as pre-defined movement vocabulary, without being taught how to choreograph. A metaphor for this could be learning the phonetics of words without their meaning so the learner cannot intentionally form meaningful sentences. Participants explained how movement design is a discrete skill from codified technique, and only learning technique can result in practitioners being stuck in movements they have drilled previously.

> *P2: "...generally speaking I find it actually more interesting to work with movement with non-dancers be-*

cause they don't fall back on established technique. You know if I've got a ballet dancer in my class, then they'll probably make what I'm giving them quite balletic."

P9: "I think hip hop is an exemplary style for, umm, for teaching dance. It was the only one that ever actually did try to teach you how to tie things together–because the moves are so discrete... that it has to be taught to you, how to use it with other moves, which I feel like that's brilliant! You can't just stand there and pop and be like [repeatedly chest pops]"

Acquisition of technique alone does not necessarily result in creativity, just like how learning individual words but not knowing how to string them together is just sound. Even if pronunciation is perfect, the ability to say anything personal and meaningful is significantly reduced.

Creative-Led

On the opposite spectrum of codified technique development is exploratory technique development, a more deductive approach where students are given an environment to explore their movements and their relationship with the space and other students (if present) with the intention that they will pick up more general principles such as space, weight, gravity, etc.

P8, a teacher, explains the benefit of focusing on creative skill development:

P8: "I think technique can also really be formed in a

> *modern class... where you're improvising and where you're creating and you're working together. Um, I see the students that have more of a background in that, having a greater understanding of things like.....umm, technical technical things like, uh, weight and moving with gravity and flow and... their connection with their head and their tail and their connection with others in space... and so I think that those are just as well cultivated in a creative practice as they are in a codified practice, if not more so."*

P1, who works with disabled and mixed-ability students that would be considered non-normative in classical dance, shares a similar view on technique development:

> *P1: "...the way I see technique is very much exploring how your body functions and how you make use of that. How first of all, how do you find out about it and how you maximize your potential?"*

As explored in the previous subtheme, learning movement codes alone results in practitioners feeling stuck, not knowing what to do with their bodies. This approach appears to more directly give students a chance to learn movement design and flow. This implies that interventions should support creativity and improvisation if they are to support learners beyond technical expertise.

Too Much at Once

The exploratory technique and tools are not without their weak-

nesses. Even P8 who advocates this approach explains that if students are given an environment that is too open, it is overwhelming and the purpose of the activity is unclear:

> *P8: "I had an improv class in college that I really didn't like because they were, like you know, the teacher would be like, 'Oh, that was a, you know, a good choice to make.' which, like what does that mean!? [laughs] ...So you need to be given the tools... you can use different body parts. You can use different levels in space. You can move in different directions. Like, let's dance on this plane... I think in cultivating an improv practice, I think that shared [spoken] vocabulary is really important of body, space, and time so that you know what you're working with, right?"*

P10 feels lost when being taught with an exploratory approach:

> *P8: "...some of the dance I did, I just thought, 'How do I even get better at this?' Almost just seems that it's like you just meant to do it and I have found it a bit hard sometimes to let go of."*

Despite the benefits of exploratory practice, instructors must still provide an "entry point" or structure to activities using this approach. Otherwise the practice is too unfocused and students are unable to understand what they are doing. One intervention idea is to support this framing - to close off some of the possibilities of a completely open world and offer the user that entry point.

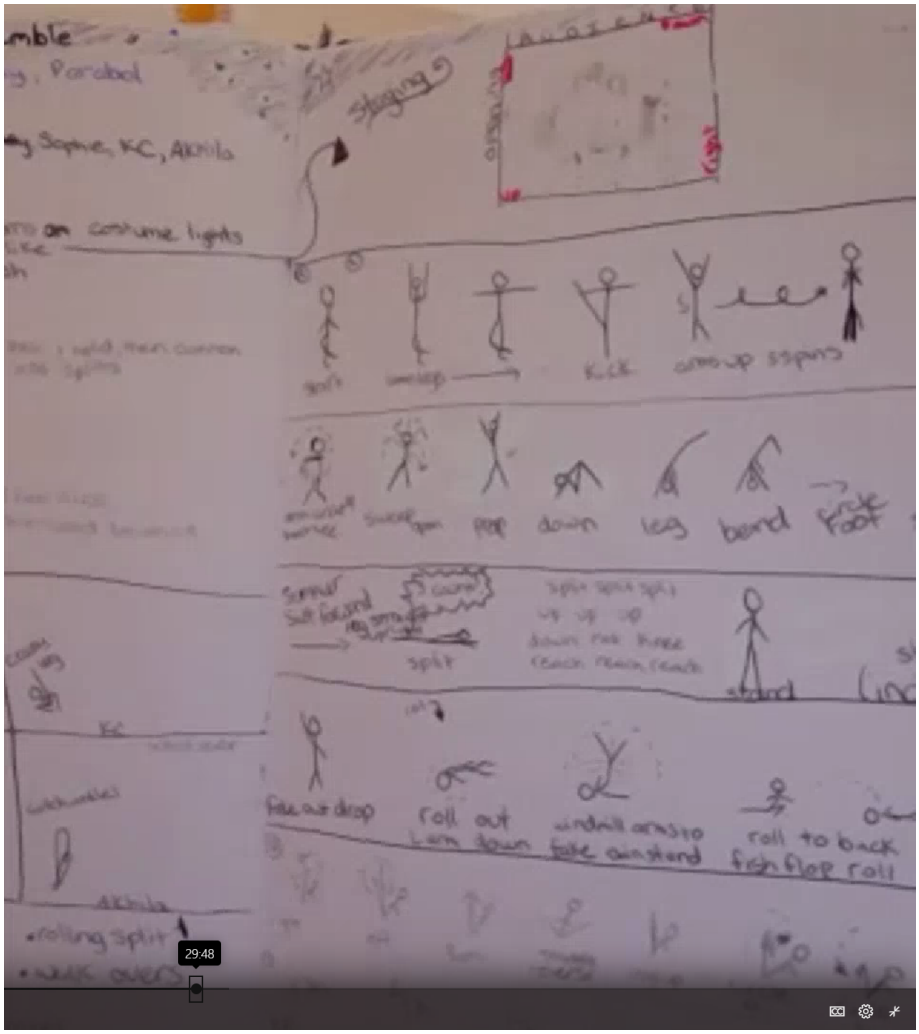

Figure 4.1: A screenshot of the interview with P6 featuring their "movement notebook," used to document choreography and movement design. The page in the image includes stick figures representing moves in a sequence and a top-down view of the stage. This is an example of mixing codified and exploratory methods.

Approaching Each Other

As mentioned earlier, it is rare for an approach to be exclusively codified or exclusively exploratory. In fact, the interviews revealed that practice can move from one to the other. For instance, when asked about their choreographic process, P6 states they start intuitively and then edit what they have done, even documenting the choreography using a "movement notebook" (see Figure 4.1):

> *P6: "I'll turn on some music, I'll close my eyes, I'll just start dancing around like a fool and we usually record myself. Then I go back and I watch the recording and I say, '...that that was juicy, I really like that movement.' 'Eww! That? No, I lost the flow... We're going to ditch that.' 'Ooh this one over here. There's something to this, I'm going to go back to that movement and see where I can shift that energy and see if I can put it into something that's a little bit more fluid,' for example."*

During an improvisational activity, P11 names recognized moves that resemble what their students did:

> *P11: "...I would say from time to time when I noticed someone did a movement that was similar to a named a step, or any kind of movement that existed and had a name in any of the techniques I know, I would go, 'Hey, do you know what you just did? It was fouetté!' Or, 'Do you know that this has a name? It's chaîné!' So the kid would be so excited that they– it doesn't matter if they did it right, it just resembled something they would be so excited that they discovered something that actually existed and it would keep them going and they would keep perfecting this one move because it was theirs."*

Codified and exploratory skill development look very different, especially for beginners who are starting out their journey of embodied practice. But as skill develops, some content of their practice may incorporate more of the other style. More specifically,

dancers who started out with a codified practice will eventually become familiar enough with the "movement codes" to the point where they become second-nature, taking cognitive load off of the mechanics of the movement and freeing up their attention to emote, express, or add their own artistic flair. Conversely, beginners of an exploratory practice will develop a broader understanding of, as P8 puts it, "elements of dance" such as shifting weight, use of space, or head-tail connection. This understanding prepares them for more codified practice where movements can be designed, edited, and perfected.

Combining Styles of Movement

Following the conclusion of the last subtheme, it is then perhaps unsurprising that students are encouraged to try different styles of movement.

P6 recognizes there are traditions which oppose this, but emphasizes the benefits of having different perspectives:

> *P6: "I want my students to be well-rounded and there is the really, really strong tradition in both dance and circus that the student only trains with one master forever and they never do anything else from that, and I call bullshit on it... each teacher has a different and unique perspective, the same way each student has a different and unique body, and there may be things that make sense to me in my body that don't make sense to you in your body... Train with everyone. No one owns movement."*

P9 explains that learning different dance styles will expand one's repertoire, allowing them to choose preferred moves:

> *P9: "Any additional stuff you learn more than one style of dance... you will become a better dancer as a whole and you will find your own style because you're going to find moves from other dance styles that you will just like doing."*

P11 talks about street dancers getting broader skill development from very different styles of dance:

> *P11: "...our teacher decided that the best dancer is the one that knows many, many styles. It was fun because the boys who are really into be b-boying and popping, they notice that after taking ballet classes, they significantly improved... in the street dances."*

Having a healthy variety of styles and teachers appears to be beneficial for skill development, thus implying that designers should consider creating interventions which are flexible to different styles of movement. This can also help practitioners discover their strengths, weaknesses, and preferences, allowing them to personalize their practice with the intervention I.

Dance Evolves

Participants detailed how dance styles are not static, but change over time:

> *P9: " .. I think what would be nice is to be able to teach people to history of dance... when you tell someone where hip hop comes from and you learn that it's entirely that it's adopted from street styles, but then that immediately goes, 'Oh, so there's no rules.' ... a whole style of dance just came from the streets from people communicating to one another is a clear sign that dance evolves, and it's not just something that was written by some French guy in this 1500s and everyone has to follow it for the next 1000 years."*

This continues to be the case today. P6 describes combining their movement instincts with pre-defined styles of dance to create a snake-inspired style, a fusion of contortion, belly dance, and hip hop:

> *P6: "This style of movement has always been in my body, if that makes any sense. Like I've always felt a personal inclination towards slithery slinky wiggily movements, very, very much ever since I was a young child... I've always felt it and when I got more into contortion, I saw a very, like, I don't know how to describe it, but I just saw. I just saw the similarities in movement... it was just as clear as the sky is blue, you know?"*

As people are exposed to new ideas, approaches, conditions, along with a better familiarity with themselves and their own bodies, they develop a deeper understanding of movement. As a result,

new forms of dance are created. As mentioned above, interventions need to be careful not to conform too rigidly to particular styles and instead should be able to adapt to evolving practices.

Theme 3 Summary

Two broad approaches to dance practice were derived from the discussions about the various activities the practitioners experienced, both from student/performer and teacher/choreographer perspectives: codified and explorative. Though participants did not make explicit the mixing of approaches, some made explicit the mixing of dance styles and teachers. In a well-rounded practice, even those who stay with one style can incorporate elements of the opposite teaching approach as their skill level progresses. A lack of opportunity to do so results in an incomplete practice, as seen with the normative dance school format where the emphasis is on executing movements from a pre-existing vocabulary. But when combined, along with an advanced understanding of movement and oneself, whether explicit and technical or tacit and intuitive, this can result in new movement vocabularies and dance styles. It seems prudent to account for flexible and evolving practice to support a user's skill development journey over a long period of time in the design of any interventions.

Theme 4: Practice Adapts

There is a multitude of approaches and activities, which do not stay static. In this theme we discuss the mechanisms which determine how practice can differ.

Gauging

The teachers in the study reported a necessary responsiveness and adaptability to their students:

> *P6: "...it's very useful for me to familiarize myself with the students that I have in class and what type of movement their bodies are working with... And then when I have new students, I always take note, 'OK, this is somebody whose body I'm not familiar with.,' and then when I get into the classroom, I would usually focus my attention on the movements of the new student."*

Another reinforced the idea that having information about students prior to the class is helpful, but there is no substitute for actually watching them:

> *P1: "[written] information... is limited in terms of its usefulness... So for example, epilepsy... would be really, really important to know just from its safety point of view... But also again... the only way I'm gonna learn more is by meeting them... how everybody engages with me, with the group, with the task."*

P5 sets tasks according to their expectations of the piece:

> *P5: "...because I won't have prior knowledge with students... I'll have ideas when I come in and I'll set tasks to see what their creative response is like and what their tendencies and desires are, so not dissimilar to a kind of audition process..."*

P4 describes an unpleasant class with a teacher who failed to connect with the class by not adjusting the teaching to what P4 felt they needed:

> *P4: "I mean one time we did some dancing with a very pretentious dancer... insisted on teaching us all the fancy hand movements before we got the mechanics of the dance... [laughs] It was a disaster. We didn't do the display in the end, it was just impossible."*

The teacher has to work with the people who are there, so they must gauge students to determine how this will shape the class. Interventions must be sufficiently adaptable to be able to cope with spontaneous adjustments - and perhaps even support the process of gauging.

Mental Blocks

As P8 puts it, dance is "first and foremost is about community." Like any social scenario, individuals may have mental blocks which stifles their bodily practice.

> *P2: "...if I'm asking them to crawl along the floor, for example, in this supernatural way, then they've got to commit to that supernatural way of doing it. They can't just crawl along the floor with embarrassment."*

> *P11: "The moment when you start thinking you look stupid, you start to look stupid."*

Participants described some methods to help students relax. P4 and P11 uses silliness to release tension:

> *P4: "And at first people who are learning it, you know, they just go mechanically through the process, but when they realize that we're acting like complete buffoons all the time, they start to join in. And because nobody is offended because it's all fun, you know we will play along."*

> *P11: "When you're focusing that you are in a class when– or if someone is expecting something from you this is when you stop dancing and you start repeating after the teacher... I would always do the warmup but start with something really silly like you know, trying to act as a pigeon [bobs head] on the street... the silliest you can imagine, the better it is... if you do a stupid movement, nobody is going to bat an eye because everyone just did something... this is when you kind of release all the mental tension and then you're able to finally focus on your body."*

Alternatively, one choreographer tries to create a safe environment through verbal communication:

> *P6: "So I will generally talk like really, just try to make them feel safe and comfortable and that they can be expressive in my company and with everyone else's company. And I suppose when that doesn't happen, there*

isn't a... it's almost like the ice hasn't broken in the room."

The interviews describe that comfort leads to better dancing. Methods teachers or choreographers use to help students or performers get out of their heads and into their bodies can include silliness or talking– things that help build connections with the people in the room so there is less social awkwardness, therefore less fear of moving.

Bodily Identity

There is a recognition for individuality in practitioners that is inalienable.

P9, who says that even with their experiences training in ballet, they believe that people cannot dance exactly the same way despite normative expectations:

P9: "What's impossible is being stuck to the rulebook. It'll never happen... Your body is going to dictate how you dance, just inherently. If you're a larger dancer, you're going to dance very different way than if you were petite. Like you– it's just how things are going to be, and I think that's what needs to be taught more."

Beyond physical traits, P8 and p13 describe an ephemeral element which makes each practitioner unique:

P8: "Part of our movement, part of our own movement style, is born inside of us. Like I think you could watch

a video of me dancing now with all the experience that I've had throughout my life and see a video of me dancing at 8 and know that I'm the same mover, like, I think that there's something that we have that just doesn't go away, no matter how much you iron it out... even if you look at a company that's supposed to look at the same right? Uh, yes, at first glance they're all going to look exactly the same, but I think you can always see like a twinkle of someone's self coming through."

p13: "... we talk about aura. We talk about personality. We talk about– in Sweden, Swedish we talk about, we say it's utstrålning... It's the radiance. How you're projecting. What you're feeling. What you're thinking."

In addition to movement style, aura, and utstrålning, participants used terms for similar concepts such as presence, flair, or essence. One example of this is P9's description of always feeling an inclination towards "slithery slinky wiggily movements" in their body. This reportedly can be sculpted, cultivated, reduced, but never trained out entirely. An adaptive, creative practice can help individuals discover and develop aspects of their bodily identity, which requires less focus on mechanically following movements and more on being attuned to one's body. When this occurs, a practitioner's personal style can be cultivated.

Space

In interviews where online classes became a topic of discussion, space limitations were a common cause of frustration:

> *P2: "I mean, I've just sort of given up [except] for Pilates because Pilates is doable online... and I don't get frustrated with it. It's so annoying to do dance class in my living room. And now there's a Christmas tree in there. So goodness knows how it'd work."*

p13:

> *p13: "I was in my little apartment, you know? For –like the big thing is, you don't have space, you know? I'm trying to do these things that were designed to be like on a big stage and you have to like kind of rehearse it in your little room."*

This affected the way classes were taught. Some teachers made adjustments to the class content:

> *P10: "The first Zoom ballet class I did was at the start of the pandemic... that was difficult to begin with actually, umm I made a barre. We mainly just did a barre because people don't have space at home to do center work."*

Confusion and awkwardness arose as many mechanisms and expectations to practice were disrupted or no longer applied, so adjustments had to be made. Space pointedly and literally shaped movement and practice content, thus any designed intervention expecting to be used at home must take into consideration that home spaces - even just in terms of scale - are rather different to

those of a studio. To add further complexity, home spaces are often captured, introducing a health and safety issue I. Understanding that there is an infinite configuration of home spaces and designing to work with and around this will be critical for interventions that support remote-learning. Though such interventions could be used in a studio setting just as easily.

Burdens of Remote Practice

When practice goes from co-located to remote, participants reported frustration at the lessened communication options:

> *P11: "They can't see! You're standing on your– on your head to just figure out how to place camera so they can see you. And this is just it feels so... it felt like I wasn't doing my job properly with them, even though I was, you know, trying to everything in my power, but it was still not enough and I felt ashamed that they have to take part in my classes like this."*

This results in students taking on a heavier burden. p13 talks about the extra emotional labor required in an online practice:

> *p13: "you're completely alone... if you're learning something with a very big group, it's very easy just to be in the flow, you know? Even if you're having like the most tired day or completely out of it, you can just kind of go with everybody else's energy... Compared to, if you're completely alone, you just have to be there and you have to try to learn and you're gonna do it and you're gonna*

> *get frustrated and you're gonna get things wrong and you don't have that, like, distraction and you don't have something like helps you push. It's just all you."*

P8 describes how communication was reduced, there was less discussion and less detail on what they were doing. But when students managed to take on more, it proved beneficial to their skill development:

> *P8: "... they had to take more responsibility for how they were learning, and I think that was hard for them. And like a huge challenge. But I think it was really helpful in getting them out of their own heads a little bit and just letting it– like doing the thing and letting it happen... there was something gained in having to fill in the gaps for themselves and trusting their bodies to do it... generally– some of them didn't [laughs] – they came back into the studio with like a better understanding of their own bodies moving in 3D space, and that was really surprising to me."*

Embodied practice with a big range of people means that instructors need to be adaptive. But when classes are taken online, their power to do so is substantially decreased as communication, both verbal and non-verbal, become complicated. Trying to maintain the same expectations of an in-person class is counter-productive and discouraging. So instead of building things for pre-existing expectations, it may be worth thinking about developing new expectations to get the most out of VR interventions.

Theme 4 Summary

From the conversations it is apparent that dance practice is about relationships: between students and instructors, dancers and choreographers, and within oneself; P8 goes so far as to say that dance doesn't exist "outside of the community in a real living way." Figure 4.2 is a sketch based on patterns identified from this theme, showing the generalized dynamics of these relationships in a group class setting when the entire system is functional.

From reviewing the above subthemes, one can see that dance sessions are incredibly complex socio-somatic spaces which require attentiveness from all parties involved. Teachers gauge students to decipher their tendencies, desires, and needs. They help students get over mental blocks that may be preventing them from getting the full benefit of the class by making a comfortable environment so that students can get out of their minds and into their bodies. An important aspect of this is also recognizing that each practitioner has their own bodily identity, aura, essence, etc., and this needs to be accounted for in practice. Certain aspects may be cultivated or reduced depending on the desired outcome of practice, but ignoring this element can lead to practitioners feeling dehumanized.

Space was generally not a focus of the interviews unless the topic of online classes came up, in which case complaints about the significant reduction in practice area was the norm. Space requirements of the "normal" practice exceeded the available space in the participants' homes, indicating that training space has been largely taken for granted until unusual circumstances of the Covid-

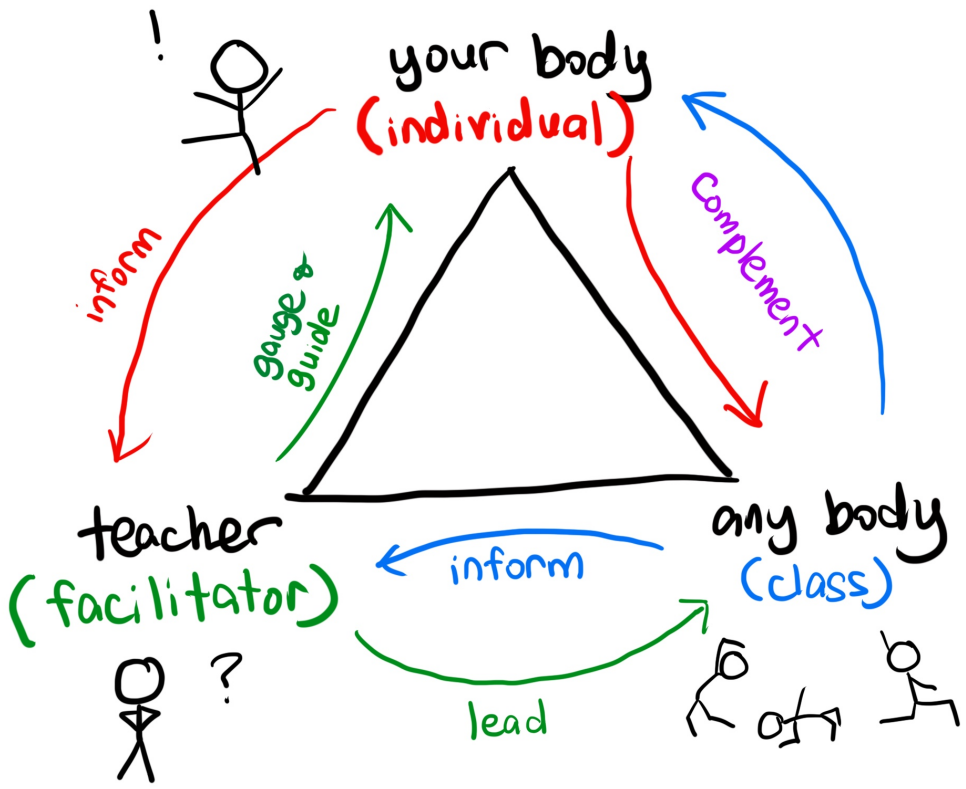

Figure 4.2: A sketch showing generalized relationship dynamics of co-located practice based on the interviews.

19 pandemic displaced practitioners. From this, it is apparent that the adaptive techniques employed in practice are not only determined by the people within the system, but also the environment(s) in which it takes place. The significant reduction of space required practitioners to literally reshape their practice, from the transposing movements to relying on relatively static activities. Lastly, the narrowing of avenues for communication down to the 2D audio-visual blurred some of the relationships between practitioners, resulting in some loss of the sense of community. This distancing placed a greater responsibility on students, reduced communication between individuals, and tested the adaptive capabilities of dance practice in new ways which were frustrating and surprising for many participants, though some were discour-

aged from online dance practice entirely.

4.2.2 Practitioner's Account

The following section consists of Calyx's answers to the guiding questions used for the semi-structured interviews previously presented, as well as her reflections on the findings from this study overall.

1) What's your somatic background? Briefly describe the discipline(s). How did you come into practice, and how long have you been practicing?

I've done various styles of Japanese and Okinawan martial arts, starting in 2008 at the beginning of college when I signed up for karate classes, until 2020 when the pandemic hit. For brevity I'll just give a general group description, but the three styles of karate I practiced, *Shindo Jinen Ryu, Shorin Ryu,* and *Goju Ryu*, each have their own lineages and stylistic differences, which is an entire essay unto itself. But in general, my unarmed combat training tended to be multidisciplinary, involving strikes, locks, and throws. Kobudo, or weapons, the "sister" arts to karate, were mainly bo staff and sai. I did kenjutsu or Japanese sword fighting via my first dojo as well. For the first few years, I was on my university team, though I didn't enjoy sport karate as much as recreational or self-defense classes.

I'm still practicing martial arts now, albeit a different one, HEMA, which I picked up in 2017. We have to resort to surviving manuscripts which are centuries old, which is still a strange feeling for me compared to my previous stuff. *Shorin Ryu*, one of the oldest styles of

karate, which was officially founded after World War I. So my HEMA experiences have been less "Hai, sensei![1]" and more of a book club where everyone is trying to figure out what the hell these ancient texts are saying. This isn't to blame the artists, They're beautiful and valuable from a historical perspective, but for a modern student there can be a lot of ambiguity. I've never seen HEMA practitioners so relieved looking at a manuscript as I have when it features illustrations of fencers' butt cracks, so we can actually confirm which leg is forward and which leg is back in the stance. The style I train in is *Kunst des Fechtens* (KDF), a 15th century German style and I'm most comfortable with longsword and rondel dagger. I've also done a bit of Renaissance era HEMA with rapier, smallsword, and saber during my three month placement at KTH, though the Stockholm HEMA club that hosted me was manuscript agnostic so I got to sample a lot.

In 2017, I also started aerial pole fitness. A few years later, I picked up aerial hoop, and a bit of trapeze and aerial silks. Though pole is perhaps most commonly known from pole dancing, my classes were predominantly focused on skillwork rather than dance, so I can execute a series of techniques one at a time, but it's not performative, and I can't improvise a choreography. This is also true of the other aerial apparatuses, my training is really focused on technique, strengthening, and conditioning. Sometimes a phrase of moves to get the hang of flowing between shapes and to work on endurance.

Modeling is one I picked up accidentally. In 2019, I wanted to

[1] Japanese for "Yes, teacher." It is customary in traditional karate schools to use some Japanese terminology, especially when addressing others.

get some professional photos of a costume I made and hired a photographer. She asked if I'd consider modeling as a hobby, because I seemed natural. I believe this actually was due to my karate background because the photographer was a model herself, I was able to follow her clear directions and demonstrations easily. What sealed the deal and gave me enough confidence to try this thing was when other photographers and creatives reached out to me for collaborative art projects after the photographer and I posted the images from our shoot, and I haven't stopped since. Genres include character/narrative, editorial, fine art, glamour, and conceptual, or some mix of these. I'm also trained in underwater modeling, which is a whole other ball game because of the physics.

2) Why have you picked these disciplines?

I picked karate shortly after moving away from my parents over to college. They're rather traditional Chinese immigrants and wanted me to exist at a desk and focus on scholarly excellence, whereas all I wanted to do was move and play. The idea of learning a martial art felt like a way to be free, to reclaim autonomy over myself, mind and body. Also, I was 17 and had a very romanticized idea of martial artists; I just wanted to be a badass.

Why HEMA? You can learn how to use a big steel sword with your friends and hit each other. There's not much more to say.

Funnily enough, I started aerial arts because I wanted to be better at karate. I needed strength and conditioning, but I loathe gym routines. They're repetitive and I just can't stay focused. I knew that aerialists are incredible athletes, so I thought that would be

better than nothing. Indeed, it ended up being far better than nothing. My locks in karate became vice-like from the strength I built up being up in the air and holding on for dear life. My coordination and proprioception were much better as well, probably because you have to think about how to move around while inverted or in other unusual orientations, also while spinning which can be very disorienting. There's a joke that an instructor will show you something whilst you're on the ground, and once you turn upside down, the information has dumped out. Currently the main reason why I do aerial arts is because they're often thrilling, like being a kid swinging on monkey bars, and they keep my brain focused on the present.

Modeling in general is something I continue to do because it allows me to share an idea or feeling through a visual and kinesthetic medium, which I find so much easier to do than through words. I have dabbled in catalogue style shoots, which is what people outside of this world seem to assume I do, probably because of media portrayals and being bombarded by advertising, but I didn't find it creatively fulfilling because I was essentially a living mannequin with nothing to say. It doesn't help that they tend to be more picky about what you look like, which doesn't feel nice. So instead I just do things I'm interested in. I really fell in love with character and narrative modeling. There's nothing like taking a character from my imagination and making them real. I come up with a concept, then do some experimenting on how I might embody them through costume design and styling, then facial expressions, poses and body language, and location. The entire process is fun, it's the best thing and reminds me a lot of

generating a character sheet for a tabletop game or a LARP[2].

3. Describe the people and environments you practice with. Are you in person or remote? What interventions are used for remote sessions, if any?

For martial arts and aerial arts, it's a fairly standard setup with one or two teachers, maybe an assistant teacher (usually an advanced student) and other classmates who are also there to train. In my experience, pretty much everything is done in person, at a dedicated space. I tried a couple of karate classes on Zoom and Google Meet, which was nice because they let me train with my dojos back in California, but it was also to see if things would feel any different from the first time I tried this in 2012 after moving away from my first dojo. It still fell flat for me. During the pandemic, I also tried arranging the space in my house to be more suitable for embodied practice, but it was frustratingly small and everything felt cramped, having all my stuff around made my anxiety worse and it was just strange being in this space. Aerial stuff was out of the question as I didn't have my own rig at the time. I pretty much gave up on my practices during lockdown and switched to mobility training and staff spinning. The latter is something I continue to practice because I don't have a class near me to do this, and the teacher I like to train with has been doing remote classes since 2016, so she's very good at altering her teaching style for Zoom.

With modeling there tends to be more of a variety and configurations of groups, but at bare minimum, I'll be with a photographer.

[2]Live Action Role Play, a form of role playing game where players embody their characters in a fictional setting, most often in costume and with props appropriate to their character.

For group shoots, it's common for there to be multiple models and multiple photographers, so we switch off, and sometimes models will stick together for duos, trios, and group shots. If I'm lucky, there may also be a designer, and a hair and makeup artist. I know lots of people managed to successfully do remote photography and modeling by tethering a camera to their computer and using some software which lets you remotely control someone else's camera and see what's on the viewfinder, but I haven't done this myself so I don't know the exact details. I've seen some amazing results from it, though.

4. As a learner, what are some things that you find helpful or unhelpful?

I get the most out of practice when the teacher breaks down things and presents little bits at a time. If you try to show me a whole kata[3] or phrase of new aerial tricks, I won't remember even half of it. It'll just feel discouraging.

Context of movement or pose is also necessary for me to do the thing convincingly. This is somewhat a given in martial arts because everything is meant to be purposeful, so I can generally follow along without issues, or at least understand what I'm supposed to be doing even if my body hasn't caught up yet. But for aesthetic things, this can get confusing if the directions are vague. It's best when I get direction that's very literal. This is true for me even in modeling, which is perhaps the opposite of martial arts in that it's all aesthetic and not functional. Rather than "just freestyle" which simply makes me freeze with confusion, "jelly-

[3] Japanese for "form," a set of choreographed moves.

fish" works great. "Soften your hands" does somewhat make sense, but it doesn't tell me the shape I should be making for the camera, whereas "pretend you're holding a hotdog" is pretty straightforward.

For unhelpful things, when a teacher talks way, way too much compared to how much time we get to actually try the thing we're learning. I try my hardest to keep listening, but I really can't focus and after a bit, I physically cannot hear them anymore.

If there's a culture of competitiveness or one-upmanship, that's also something I don't flourish well in. It brings out this vicious perfectionist in me which I don't like, and it detracts from my practice because I just become focused on being better than everyone else, which makes me pay too much attention to what other people are doing instead of what I'm doing. If I am paying attention to myself, it's because I'm punishing myself for mistakes I might've made. It's stressful. It's not why I train. I'm trying to just have fun while learning cool things. After a few years on my university karate team, I had to stop because I wasn't getting that anymore. At times I thought about maybe one day entering pole sport competitions, or HEMA tournaments, and I know good sportsmanship exists, but I'm still reluctant.

5. How can you tell if you've gotten better?

Usually I have to see to believe, like watching video feedback of me doing a move and comparing it to an earlier one. Or if someone comments on my progress. It's really hard to tell internally, since improvement is really gradual and I can't feel the changes in how I'm performing something in my body over a great period

of time, unless it's an especially memorable, discrete thing like getting a new move on the aerial hoop down.

I did recently get a rare experience where I slowly realized, "Oh damn, I guess I have leveled up." during a Northern Lights tour in Norway. Professional photos for all the tourists were part of the package, so it was the first time I was the only one extremely familiar with being in front of a camera. The biggest differences I noticed weren't necessarily in the way the photos came out, but in the way I sort of freestyled, and in the types of questions I asked the photographer, like if he could shoot in RAW[4]. I also asked him if I could look at the photo of the person right before me to see what shapes the Northern Lights were making. Then I looked to the treeline to see where my arm should go, and struck the pose to make it look like I was casting a spell. I noticed the other tourists, who had previously just taken the direction the photographer provided, copied my poses right afterwards, which is something I used to do when I was not comfortable with getting my picture taken.

6. Do you feel you've developed your own style?

For pretty much everything I've done, no, I don't think I have. The classes I tend to go to are generally technical and I've focused on honing these building blocks. But I can't say I've spent much time learning how to choreograph. Stringing moves together in martial arts might be different because if I'm sparring, I'm responding to my opponent, but I don't know if I have artistry in that yet.

The exception to this is modeling. It's the only movement discipline

[4] An image file format which contains uncompressed data with minimal processing. It is a choice for more advanced photographers as RAW allows for more control over the editing process.

I can comfortably say I have something approaching a personal style, maybe because my practice isn't structured classes where I lean on an instructor to tell me what's right or wrong, but just photography sessions where we're having a play and we have to determine for ourselves what we like, and over time I've developed a clear idea of my own aesthetic.

5. Do you consider yourself a martial artist/aerialist/model etc?

For me this is pretty much the same as the last question. I don't feel like a martial artist nor an aerial artist because I don't feel like I've practiced enough artistry to distinguish how my style might be different from someone else's. But I'm comfortable identifying as a model, maybe because it's unusual to say "I do modeling" or possibly because there's a sense of ownership about what I'm choosing to create.

Researcher Response

Though the subject matter of Calyx's responses was decidedly not dance, her experiences share many commonalities with the study participants.

As one might expect, models are subjected to societal standards and ideals on their appearance due to "being bombarded by advertising," just as P4, P9, and P10 described for dancers in Theme 1: Normativity, regardless of actual skill in either context. Calyx also expressed frustration at being "a living mannequin with nothing to say" in catalogue style photoshoots, indicating that models can also be seen as tools the way classical dancers (33) and traditional circus artists (106; 150) are (Chapter 3.) She reports

a preference for projects which give her creative license, in line with P1 and P3 reporting better fulfilment from indulging their interests in Theme 2: Individualizing Movement.

What is especially noticable in Calyx, likely due to the diversity of bodily disciplines she discussed, is the way her practices influence each other like in the subtheme **Combining Styles of Movement** of Theme 3: Dual Approaches. This combined with having chances to regularly explore and discover a personal style has likely allowed Calyx to more comfortably identify as a model as in the **Bodily Identity** subtheme within Theme 4: Practice Adapts. From a skill acquisition perspective, expertise is also displayed during her retelling of the Northern Lights photoshoot, specifically adapting her poses (157) to the shapes of the lights in the sky.

By contrast, it is intriguing how Calyx reports that karate is the basis for her movement background, yet she claims to not have artistry, so one can assume she does not identify as a martial artist. This is in spite of the fact that it is the bodily discipline in which she has the most years of experience compared to the others, consistent with the reluctance to identify as dancers in Theme 4: Practice Adapts, as well as work from Langdon and Petracca (103) showing that dancer identity is not correlated with amount experience. It is possible that Calyx has imposter syndrome about her martial arts practice due to the exacting standards of Japanese karate, especially in sport karate as described

in Theoretical Background of Bodily Practice.

4.2.3 Reflections

This study was performed to construct an understanding of the practical mechanisms and processes of sharing embodied practice by speaking with dance practitioners. Somewhat unexpectedly, what followed were discussions which heavily included the societal and political factors that helped shape the world of dance today, along with the tensions and differences. One can imagine a heavily codified practice requiring the highest fidelity representations of the participants' bodies, whereas in an exploratory practice, practitioners may not need to see their bodies at all. Technical literacy and economic factors which determine access to technology could also be considered. If the most financially successful dance schools are the primary consumers of such interventions, then following the line of thought that P9 discussed, the codified and competitive would have more influence over what the new world of VR bodily practice will look like.

This project does not have the scope to address these tensions directly, but these findings serve as important reminders: embodied practice disciplines are not monoliths. To make interventions relevant for practitioners, designers should acknowledge that they will need to accommodate not only preexisting processes, but also cultural baggage, and how that may affect the outcomes of usage. That is, an intervention is incorporated into an embodied practice culture; an embodied practice is not simply applied to an intervention. Ignoring this will result unintentional outcomes.

Dance sessions require strong communication and attentiveness between practitioners and oneself. Like most other forms of embodied knowledge, practice is traditionally done in person, and the sudden shift to online practice during the 2020 lockdowns in response to Covid-19 was a difficult transition for the participants. This is, at least based on the interviews, likely due to the loss of 3D spatial information, elimination of non-audiovisual forms of expression or feedback, additional steps needed to enable communication (such as having to mute/unmute) and loss of usable practice area. This great disruption to practice created a strain and loss of connection.

Despite this somewhat bleak outlook on the current video call model, the findings also indicate that remote practice is not doomed to be inferior to in-person practice. It is simply that webcams and computer monitors were not optimized for bodily interaction. Of course, the current limitations of telecommunications make it difficult to meet all the interpersonal demands of embodied practice. But dance practice is also rather malleable. As P13 describes, the adaptive mechanisms used in online practice already existed in dance, and the Covid-19 lockdowns "turned it up to 11," stretching and testing their limits. For instance, one limit materialized as greater cognitive strain and emotional labor on the students due to the reduced scope of support that the instructor can provide, also reflected in previous work (50). This creates an opportunity to intervene with remote practice by lifting some of this burden. VR interventions are a good candidate for making up some of this loss of information by reintroducing the 3D and sense of touch (with the inclusion of haptics.)

There is a temptation to build interventions which aim to match the co-located experience as closely as possible. But this study shows that it is not necessary, and in fact is a potentially more problematic approach given the current limitations of VR. When the participants placed the same expectations and standards on remote practice as they did on co-located practice, frustration and shame sprung up. By contrast, P8's students who managed to trust themselves to "fill in the gaps" when delivery of instruction was low fidelity show that faithfully porting the co-located experience to VR is not necessary, and in fact a reduction of unnecessary information in a VE can be used to the user's advantage. Finding a new balance of expectations on what to communicate, how, using what tools, etc. will be crucial to building a more supportive model of remote embodied practice.

4.3 Summary

This exploratory study investigated the mechanisms and influences of dance sessions from thirteen one-on-one discussions with dance practitioners. Here, four themes across the conversational semi-structured interviews were constructed from the dataset: Normativity, Individualizing Movement, Dual Approaches, and Practice Adapts. These were supplemented by the researcher's first person accounts as Calyx. Cross-examination of these themes showed that designers should acknowledge that they will need to accommodate societal and cultural factors of practice to keep their

interventions relevant for practitioners.

4.3.1 Design Takeaways

Study 1 provided the following design insights:

- Certain varieties of dance are only enabled by the fact that the dancers look and move the same way, making them exclusive by nature. Designers should be mindful that an intervention built for these styles of movement will only cater to a particular classification of practitioner.
- Designers looking to create inclusive tools for bodily practice must consider a large range of somatic abilities, as well thinking of ways to support practitioners in their own meaning making processes.
- Cultivating expertise of a bodily discipline can take years. Interventions that are designed to support a practitioner's journey would need to future-proof itself by allowing for flexible and evolving practice over time.
- Teachers constantly attend to their students and adjust the session as they gauge student performance. Interventions should be sufficiently adaptable to be able to cope with spontaneous adjustments. To go further, teaching interventions could also help with gauging.

Part II

Intervening with Bodily Practices

Chapter 5

Related Work

This chapter provides a brief overview of VR and its use as a training tool, then introduces a selection of research where VR systems for bodily practice are studied. Lastly, this chapter situates this project within established research on the current state of remote bodily learning.

5.1 Virtual Reality for Bodily Practice

Virtual reality (VR) has captured the imagination of technologists for several decades now, ever since Sutherland (170) introduced the concept of an "ultimate display" which could immerse users completely in an artificial reality that would be indistinguishable from physical reality. Perhaps the most commonly referenced pop culture equivalent is the *Star Trek* holodeck, which can manipulate physical matter and even be lethal for its users, blurring the lines between what is real and what is not (68). VR could be described as a digital environment designed to make users perceive

that they are in a virtual world through simulated sensory inputs (184), though this description is certainly not definitive. Frameworks to further refine VR discourse have since been proposed, such as the iconic Milgram et al. (126) reality-virtuality continuum which defines augmented reality (AR) as the real world augmented with virtual content and a virtual world with some real world objects as augmented virtuality. Though this continuum originally applied only to visual displays, it is still used heavily to frame mixed reality (MR) research artefacts (166).

Because of its capability to transport users to another setting, and the fact that it can include embodied interactions, one can imagine the appeal of using VR for practice. Immersive experiences can evoke the feeling of presence or "being there" (152), making VR an enticing option for embodied training while keeping trainees in a safe environment devoid of the associated occupational risks. It has been used as a cost-effective and low-risk training intervention for occupations which involve scenarios that are high-risk and limited-attempt, like firefighters (29), military personnel (79), and surgeons (165). It is believed that the virtual environment (VE) engrosses users in the skills and tasks to be practiced, and a convincing experience in a VE is said to indicate positive transfer of skills (199; 167).

VR has also been used in sports and exercise science for athletic training, often being used to evaluate perception-based athletic skills such as "reading the game" (62) and anticipating situations (10; 183). Research on VR interventions as diagnostic tools for martial arts follows this trend, perhaps due to their prominence as sports rather than performance arts. As a result, VR inter-

ventions for martial arts tend to be framed as instruments for coaches and athletes, specifically to objectively measure and evaluate performance (47; 138). For instance, Petri et al. (138) built an intervention on the Oculus Rift DK2 which presented a virtual karate opponent to expert karate athletes. The virtual opponent would attack the participants as a means to train and measure the user's reaction time for sparring. A similar study by Polechoński and Langer (140) used an unspecified VR application on the Oculus Quest 2 to test the reaction time of mixed martial arts (MMA) fighters, though they found that performance was significantly better outside of the virtual environment. However these studies did not investigate the integration of the interventions into practice, but instead explored the technological possibilities of VR when applied to martial arts performance testing. Research that does discuss adding VR to the pedagogical models of martial arts practice is mostly speculative (143; 125).

Yang and Kim (197) introduced a VR system with a first-person interaction mode they call the "ghost" metaphor where the teacher's movements are juxtaposed onto the student's perspective. This was created for training scenarios where students needed to learn "exact motions, which are often required in sports and the arts." The system, named "Just Follow Me" (JFM) was evaluated in a lab setting over two days. Participants were given a series of calligraphy learning tasks and JFM was found to have produced effects that were as good as or better than the real world, and the authors argued this was due to less cognitive load on the student by providing them more direct proprioceptive information from the instructor. Another VR bodily learning system for tai chi by

Chua et al. (41) used a similar strategy, but they found that this produced no better learning results compared to real life training. This contradiction could be due to the activities chosen for testing. East Asian calligraphy predominantly engages the dominant arm (131) whereas tai chi requires engagement of the entire body (102), making it overwhelming for participants of the latter group to keep up with the ghost instructor. The findings reported by Chua et al. (41) about participants mainly watching the hands on the demonstrative body hint at this possibility of cognitive overload. The model of juxtaposing the demonstrator body over the user's (learner's) body was revisited more recently by Hoang et al. (82), with their creation of Onebody, a posture guidance system which ran on the Microsoft Kinect and Oculus Rift. Designed to guide learners through mimicry, the authors reported it would be appropriate for contexts such as martial arts, yoga, or dance. They too held controlled experiments and compared the performances between first-person perspective and the standard third-person perspective, reporting that there was a "significant advantage" using the former to replicate postures. They did however note that Onebody only handled poses well and not movement, so it did not help participants train the transitions between postures.

There is a wealth of dance-support research (145; 201) as the third wave of HCI (34) continues rolling in, though just a fraction of it involves VR as a resource for practice. Still, there are valuable insights to take away from the collective work that can be considered for VR-based interventions; in a literature review of 77 papers on computational support for dance from the last two decades,

Zhou et al. (201) reaffirmed that planning a dance project is an idiosyncratic process which makes it challenging to generalize designs across multiple projects. They advised that future works should be adaptable in methods and tools; project-specific implementations are unlikely to be generalizable without further consideration and modifications. Additionally, a cross-examination of recent Dance Interactive Learning Systems (DILS) (145) found that most of these systems were usability tested during workshops or in laboratory environments rather than the dance studios or home settings they were designed for, providing a gap for further inquiry.

Senecal et al. (158) reported the design and creation of a VR application on the HTC Vive for salsa dance practice, where the user's performance is motion captured and analyzed using a six point skeleton. The user could interact with the virtual partner using the controllers and "can control the salsa dance pattern's transitions similarly to real dance situation," though users could only assume the leader role. Study participants were given eight exercises which mirrored that of real life scenarios, and it was found that the participants with no dance experience improved in skill, though the authors admit that this conclusion was far from definite, as some of the non-dancer participants had "minor dance experience or extensive experience with virtual reality applications" which was not included in their analysis. Despite these limitations, the ability to produce some skill improvement in a form of partner dance is promising, as it is theoretically more difficult to emulate than forms of solo dance, or more generally any practice where physical contact is not a factor.

The work on bodily learning appears to be dominated by dance. Circus arts make the occasional appearance in HCI research, such as the use of an aerial hoop for full-body interaction design (112), but none where the application was learning and teaching could be found. One instance of aerial arts appearing in VR was accounted for by Piitulainen et al. (139) as online communities recreated night club scenes in social VR platforms, though again this was not explicitly a learning context. Scholarly literature of "in situ" lockdown bodily practice using VR was not forthcoming, despite there being an increase in headset usage and sales (22), although there was one dance school[1] held exclusively within *VRChat* which cropped up since the pandemic began (5).

Work on VR as a new pedagogical resource for bodily discipline practice is scant, but growing. And on the industry side, several consumer-ready VR products have been released throughout the duration of this research, such as the Oculus Quest 2[2] or the HTC Vive XR Elite [3]. Although VR is still maturing, this indicates that it is emerging as a potentially viable technology to support practitioners in remote practices, and warrants further research.

5.2 Current State of Remote Bodily Learning

Despite the overall momentum in the field of HCI to design for the likes of martial arts and dance, this relationship would seem to be fairly one-sided, as absorption of newer technologies into

[1] https://www.vrdance.org
[2] Now Meta Quest 2: https://www.meta.com/gb/quest/products/quest-2/
[3] https://www.vive.com/uk/product/vive-xr-elite/overview/

standard practice and pedagogical models was rare prior to the Covid-19 pandemic. There was very little work on remote learning of bodily disciplines in actual practice settings. This is due to a highly skeptical view of technology, where practitioners are doubtful that the digitization of bodily activities can properly support the vast complexities of somatic knowledge (35; 200). It can also be due to a perceived clash in the traditions of certain disciplines, where technology is thought to get in the way of the "naturalistic" setting of the practice (117; 125). Since several countries enacted lockdowns, the closures of group classes forced many to press forward regardless of their skepticism. What resulted was an uptick in studies on the topic, albeit most are specifically about dance. But they generally describe how practitioners adapted in creative ways, how attitudes towards technology in bodily practice shifted, and how the technologies shaped their practices.

Responding to the sudden prevalence of remote learning during the pandemic, Dimitrakopoulou (55) conducted two experiments on asynchronous remote learning by copying a video. She reports that copying has a "central position" in dance education, especially in the professional model, citing Foster (69) she reports as mainly being used by the professional model where the emphasis is on creating trained "bodies" (the objectified sense of the body is implied here) which have learned exactly what the teacher as the "demonstrative body" has shown them. In the first experiment, Dimitrakopoulou (55) asked dancers to copy a video of a completed dance work, noting that it consisted not only of movement patterns, but also aspects such as costumes, lighting, music, and camera angle. Interestingly, all of them paid attention to the move-

ment and not to any of the other aspects, and considered a good copy to be one that matches the original movements closely. The author notes that this task "failed creating a safe space for students to 'fail' without fear." The second experiment involved students watching a video where the instructor explains and breaks down the movements of choreography. Not only were students able to copy the choreography more successfully, but they also felt more comfortable and free to express their own interpretations of the work due to the deeper level of understanding that the material helped provide them. But overall, all of the students and the author preferred in-person learning over distance learning, explaining that there are particular details missing, and thus student feedback is less individualized. Additionally, the fact that video is a visual medium brings up the concern that it creates the same effects as mirrors, where students become highly self-critical and competitive when "everyone is trying to become the demonstrative or the ideal body." The author concludes that a digital body is a "half body' with a lack of the senses, and information between practitioners is lost because "there is no common place," comparing it to a game of telephone.

Mabingo and Ssemaganda (117) looked into how dance students and teachers coped with remote learning using less developed technological infrastructure in African environments such as Uganda. They found that apps offering asynchronous learning and archival such as Whatsapp were more reliable than Zoom and other live video call solutions, which were expensive and required stable Internet connection. Though students lamented how material that would have been simple to learn face-to-face became diffi-

cult. On learning indigenous dance, one student noted, "The atmosphere of doing with others makes something happen automatically in the body. You pick the energy, feel the groove, and dive in the movements; they just come naturally." and the authors then described how the "absence of collective bodies...meant that the pedagogy founded on the organic relational interface between individuality and communality was undermined." Despite this, the participants displayed a large degree of pedagogical flexibility which reincorporated some of the communal aspects of Indigenous knowledge sharing through dance. Students noticed that each had their own strengths, such as rhythm or theory, and would rely on each other to support the teacher in transferring knowledge, especially when the teacher did not always have Internet access, which created a connection through communal learning. Although some felt that core values of Indigenous dance practice were still not obtained during lockdown, such as the sharing of a space as a community and feeling "that you are with real people and creating experiences together."

In a self-study, Singapore-based dance teacher Zeitner (200) reflects on how pedagogical practices changed during the pandemic as his class shifted from in-person to Zoom and Microsoft Teams. He admits to emotional and cognitive challenges of teaching dance improvisation online and attributed this to his belief that a face-to-face setting is a requirement for this practice. What he found was that his students put in a surprising amount of effort to engage with the class material and showcase their progress, especially in their efforts crossing artistic disciplines into music, video editing, and film making. However, Li et al. (111) reported that

students were concerned about the extra workload that Zoom introduced, and were unsure they had the digital skills to complete their coursework may hamper their sense of self-efficacy. The differences between these two studies could be that Zeitner (200)'s class was for tertiary dance education, where the students were preparing for a career in dance, while Li et al. (111)'s survey respondents were not all dance majors, and some were new to dance entirely.

The move to learning martial arts through Zoom workshops or online classes generally left practitioners feeling ambivalent, according to a study by Meyer (125) which consisted of 306 participants across several, mostly Western countries. Styles which required more contact between opponents, such as sparring-heavy styles like HEMA or grappling styles like judo were heavily disrupted. By contrast, styles which were reliant (or could be largely reduced to) forms had better chances of online adaptation. Practitioners changed their training to focus more on solo work, including solo weapons practice which some predominantly unarmed styles had largely forgotten, as well as history and theory. Though online training was not seen to fully replace in-person training, instructors shared their intentions to continue developing digital formats of training, indicating that it is a helpful supplement to enriching one's martial arts practice. Despite this, Meyer drives home his point that martial arts are ultimately an embodied activity and the current video call model is insufficient for this, though he speculates that VR could return this "authentic physicality" to online practice with the introduction of haptic training devices such as smart target dummies. Adoption is a different matter,

however, as Meyer notes that traditional martial arts is reluctant to accept new technologies, prioritizing authenticity instead.

In a sharing of auto-ethnographic accounts of setting up online aikido classes as teachers based in Greece, Kantzara and Loos (95) argue that regular contact and online classes provided a crucial sense of community, empowered their students, and pushed them to invent new training strategies. They attribute these to the openness and flexibility in course design, as well as communication with students. Though far from perfect, the authors report that training online helped their community by making them more resilient against the precarious pandemic situation.

Overall, it appears that practitioners encountered a critical stress point where the previous pedagogical models needed to change to accommodate social isolation. This meant that teachers had to stay flexible in delivery of content, such as helping students navigate their unique practice spaces. This also largely meant that students had increased responsibilities in terms of providing peer support, teaching themselves (and sometimes the instructor) new digital skills, and independent thinking (164; 20). Making use of what was available to them, this consisted of mainstream technologies like video calling software, social media, and messaging apps. Workloads of both teachers and learners had increased, largely due to the fact that not all practitioners could use the tools in ways that would serve them best. While this expanded the skillset of some, Davis and Phillips (50) point out that the teachers who were committed to providing quality teaching had a tendency to work extra long hours, and the energy they needed to adapt to remote learning resulted in them "struggling,

tired and fatigued." Davis and Phillips (50) quite rightly say that it is not enough to simply accept the circumstances and move on. Despite the fact that practitioners managed to adapt to remote practice, it arguably says more about the lengths humans will go for movement, community, and creativity than the suitability of current technology in remote learning. There is still much weight that fit-for-purpose technological interventions could bear.

5.3 Summary

This chapter provided an overview of VR for simulation training, especially in bodily discipline practices, where there was a tendency for it to be used as a diagnostic tool or mimetic learning tool. This chapter then visited the current state of affairs for remote learning of bodily practices, much of which sprung up as a result of the Covid-19 lockdowns. Practitioners who continued practice were generally able to adapt to remote practice, though the technologies they turned to were more accessible such as messaging apps or video conferencing software. However, some lamented that these solutions still lacked some crucial factors of in-person practice, especially those which were imbued with deep cultural meaning and traditions. Aspects such as the communal sense of being together in one space or not being able to make physical contact were missed. This is quite a contrast in the focus of the VR research reviewed here, and provides an opportunity to shift attention to these open problems.

Chapter 6

VR and Soma Design Workshop

Designing interventions from Theoretical Background of Bodily Practice and Interviews with Dance Practitioners alone would have only provided part of the picture. As frequently discussed in the previous chapters, much of the phenomena this project is interested in cannot simply be written or verbalized to equivalent effect of first person experience. To that end, a design workshop was organized to explore the practical and mundane elements of somatic learning, and how certain prototyping items provided for the session could be used to approximate interventions with this process. This would help further inform the intervention designs that would be studied with movement practitioners in the final empirical phases of this work.

6.1 Method

This study centered around a two-hour workshop where participants taught each other movements in a mock remote session, using a selection of design tools to aid their communication.

Because felt experiences are notoriously complex and difficult to communicate, somaesthetic design (shortened to soma design) was used for this study because it focuses on the personal, felt experiences with a product or system through the first-person perspective. Designers can examine and improve on connections between sensation, feeling, emotion, subjective understanding and values" (87), making it an especially appropriate design approach for ideating interventions meant for bodily disciplines.

6.1.1 Recruitment, Participants, and Safeguarding

Due to the specific requirement of needing people experienced in soma design, recruitment was kept within the Interaction Design Lab at KTH Royal Institute of Technology, where the workshop was held; only researchers and academics were involved. Awareness of the study was raised through word of mouth and posting on the lab's internal Slack server.

Six people attended the two-hour workshop, including the author as a researcher-as-participant. Participants will be referred to as P1-P5; Calyx will be referred to as P0. All participants have provided their preferred pronouns and were postgraduate level students proficient in soma design research. The participants received no financial compensation.

Duty of accountability and care to all participants was observed in

accordance to the University of Nottingham Code of Research Conduct and Research Ethics. Because soma design workshops can be strenuous, combined with the fact that some of the participants had little or no prior experiences with VR, a nearby room was booked on the same day which served as a dedicated rest area with seating, tissues, cushions, snacks, and anti-nausea medicine. At the beginning of the workshop, all participants were informed that they may come and go at any point without having to provide explanation, and that they may request the researcher's assistance whenever needed.

6.1.2 Design Toolbox

Because video-based interventions are already widely used in non-VR interactions, there was a concern that providing perfect view of the other as part of the design toolbox would stifle creativity with remote communication strategies. So instead of providing video, the asymmetry of the teacher/student experience was pushed to a more extreme form where the student could only see the virtual world, and the teacher could see the student, but not the virtual world.

- Soma Shapes: A subset of the Soma Bits (190) as a modular kit for quick prototyping of embodied experiences, these comprised of six shapes of foam and cotton textile fabric that can be placed on the body. Though Windlin et al. (191) present the shapes with specific names and suggested somaesthetic qualities (see Figure 6.1,) the author was not familiar with these at the time of the study and the shapes were used in-

Figure 6.1: A diagram of the different soma shapes are provided by the designer: stones, spine, shell, accordion, moebius, and outline. Photo used with permission from Windlin et al. (191).

tuitively.

- SomaPlay VR application: A plain, minimalist space resembling a martial arts dojo. Included were multiple display modes for the controllers (see Figure 6.2.) This app was made in the Unity game engine and ran on the Oculus Quest 2 VR headset.

- Props and/or supplies: These items included wooden dowels, aerial pole dance shoes, and various arts and craft supplies.

- Body Maps, colored markers, and colored pencils: Body maps are visual documents, often paper, containing outlines of humanoid figures which are meant to be filled in with an individual's notes and drawings (see Figure 6.8.) They provide a way for designers to document somatic experiences and com-

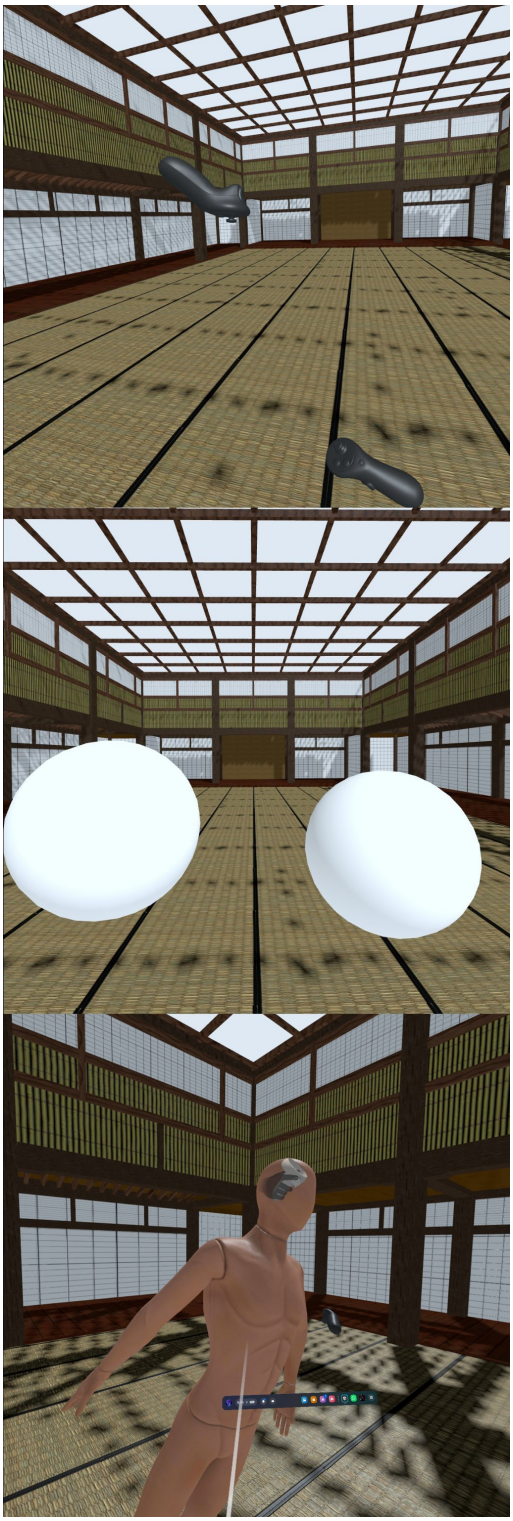

Figure 6.2: Top to bottom: Controllers as:
1) default
2) spheres
3) life-sized, humanoid dummy in one hand and a controller in the other

Figure 6.3: The makeshift VR staff: a wooden dowel with an Oculus Quest 2 controller taped onto each end. The motion trackers in the controllers were used as a proxy for the orientation of the staff, which the student could see in the VE.

plex motions which may be otherwise difficult to verbalize (43).

6.1.3 Workshop Structure

This two-hour workshop was planned with the following structure:

- Sensitize: Each person chooses their own familiar movement, and spends a few minutes honing in on it
- Calibrate: Group fills out and discusses body maps, and shares chosen movements
- Nominate: Group picks one of the movements to learn

Figure 6.4: The workshop in progress. A participant wearing the Meta Quest 2 headset is learning an object manipulation trick, the figure-8 spin. Other participants provide instruction or design suggestions.

- Session: Teacher(s) and student skill share, others design
- Repeat Nominate - Session until all willing participants have had a turn to teach/learn their desired movements
- Reflect: Group fills out and shares body maps

Roles and rules were given for the group activities. Note that other than the student, the roles were not fixed and participants would move between them of their own accord.:

- Student: Person learning the movement within the VR system.
- Teachers: Provide instruction and guidance to the student.
- Designers: Witness the interactions and manipulate the resources in the workshop room to ideate and create additional items to support the lesson.

- Computers: Any interaction with the student had to be mediated through the intervention. Because this workshop only provided design pieces rather than one single, complete intervention, Wizard of Oz (WOz) technique (155) was used to test ideas. For example touch could only be done through "haptics" features, a low-fidelity version was approximated by pressing soma shapes into the student's body rather than the teacher touching them directly.

6.1.4 Data

Because the studied phenomenon take place in the spoken, unspoken, felt, kinaesthetic, private, and shared; a combination of three qualitative data sources were used to articulate the experiences in the workshop. Firstly, video recordings were taken through two cameras on opposite sides of the room. Participants also marked up body maps at the beginning and end of the workshop. And the week following, microphenomenologically inspired interviews were conducted by two researchers who received accreditation for this specific method. Three of the participants returned for these interviews. For two of the interviews, audio-visual recordings were captured. For one interview, an audio recording was captured and uploaded to the Otter.ai speech-to-text transcription software. All data was uploaded to the university's OneDrive folder dedicated to this project. Sample transcripts of the workshop clips and interviews can be found in Ap-

pendix B.

6.1.5 Analysis Method

Once the entire corpus of data had undergone an initial round of transcription, a data session with members of the Mixed Reality Lab was organized. Seven other researchers attended this session and were provided an overview of the study and research aims. Afterwards, a selection of relevant clips and quotes, as well as the participants' body maps, were presented to the group for open discussion. This was followed by a one-on-one remote data session with a researcher from the University of Oulu whose work focuses on collaborative activities in VR.

Since this workshop produced rich data, a combination of methods was used to process what had occurred:

- Ethnographic Mapping: Because the aim of this study was to see how participants might use the provided VR tools to assist in communicating embodied knowledge, i.e., the "machinery of interaction" (45) supported by these tools, an ethnomethodological approach was adopted to visualize the unfolding of these sessions. Activity maps (45; 11; 66), were drawn to find any noteworthy patterns from the sequentiality of interaction within and across the sessions (see Figure 6.5). These maps were drawn using transcriptions of the workshop footage.

- Thematic Analysis: This method returned from Interviews with Dance Practitioners as a means to construct themes relevant to the design of remote learning VR tools. Data be-

came familiar through transcribing the audio from the workshop recordings, which were further coded in Excel by speaker/actor and role. Because it was found that nearly all computer actions were performed or directed by the teacher, the computer role was consolidated into teacher non-verbal codes. The contents of each cell in Excel was then written down on a paper sticky note, with colors and shape of sticky note indicating the session and actor of each quote. Designers' lines were not transcribed at this point, as it was decided the focus for this study should be on the student/teacher interactions. The interviews and body maps were consulted for guidance on focus points, then each sticky note was grouped by content. These content stacks were further grouped into broader topics, candidate themes, and ultimately the themes reported below.

- Practitioner Account: Although the researcher designed this study with the assumption that P0 would be one of the students, the group requested she teach them her warm-up movement, a figure-8 spin with a staff, which took up the majority of the allocated time (for more background on staff spinning as a bodily discipline, see Circus Arts.) As a result, P0 assumed a much more proactive role throughout the workshop as she acted as an instructor. Though the approach of the session started more didactic and became increasingly democratic (33) as the learned participants could provide instruction as well, P0's starting point as teacher directly shaped the sessions and influenced the experiences for the participants. It is especially important, then, to provide a first per-

son account from this teacher perspective to contextualize the way the sessions were conducted. To help make this explicit, this account is written by Calyx and this methodology is discussed in detail in Splitting Yourself: A New Methodology for Self-Reflective Design.

6.2 Findings

6.2.1 Activity Maps

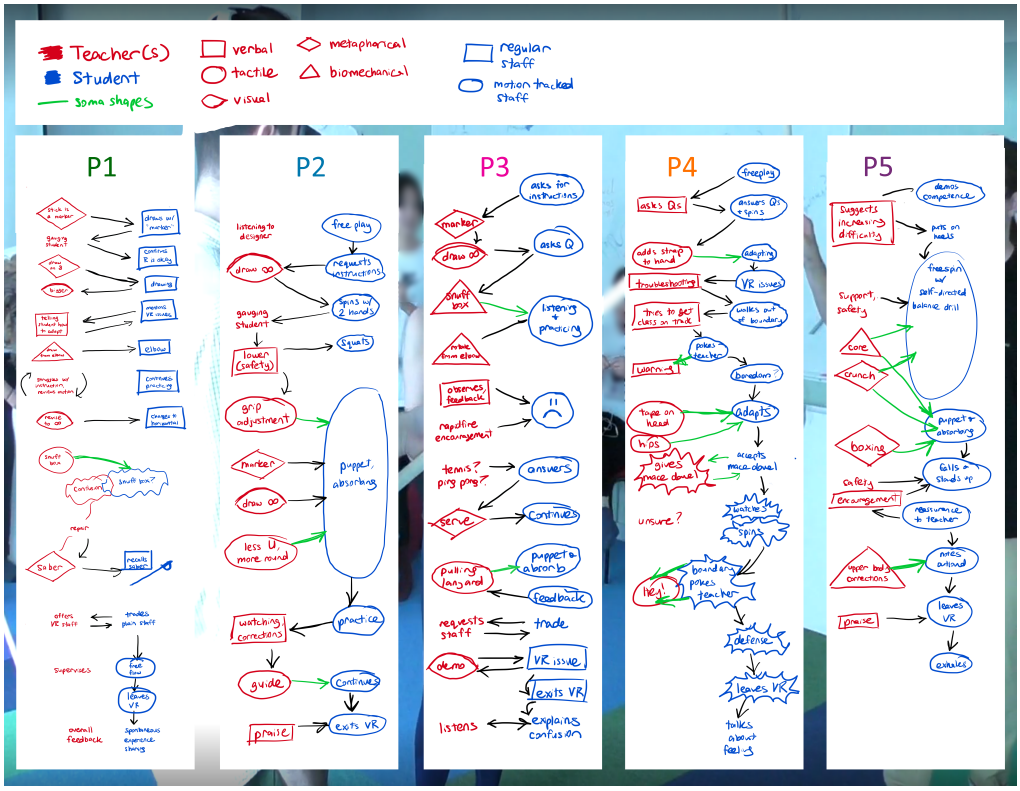

Figure 6.5: A side-by-side view of activity maps from each session.

Figure 6.5 shows a flowchart of interactions between teachers and student. Each of the five activity maps is presented in chronological order, from top to bottom and left to right. As seen in the

legend at the top of the image, feedback modalities are coded by shape.

Note that although all participants were present in the room and could anticipate the class content by watching the sessions before theirs, this did not drastically change things for those who did not already know the figure-8 spin as they still asked for the instructions anyway. And despite starting off roughly the same, the experiences that followed were not identical to each other.

Figure 6.6: Two different types of sliding weight staves to make the staff spinning task more difficult for P4, an advanced student are presented to the group.
Top: P2 created a version with soma shapes, a cardboard tube, and a roll of tape.
Bottom: P0 offers a staff created by P3 comprised of clay blocks and zip ties.

This difference is even more evident with the two students who already knew the figure-8 spin, P4 and P5. New strategies and tools were designed to make the task more appropriate for their advanced level, such as the creation of a staff with sliding weight for P4 to test his adaptability (Figure 6.6) and P5's desire to work

on her balance by wearing six-inch high heel shoes (Figure 6.7) designed for aerial pole (for further background on this bodily discipline, see Circus Arts.) These students displayed what in skill acquisition is called "virtuosity" in the task, so uncertainty was reintroduced to the task to allow them to express full range of abilities (71), even to a point beyond what they knew they could do.

A generalized sequentiality of interaction of the sessions could be identified as follows: a beginning phase of the marker metaphor and the teachers familiarizing themselves with the student's current abilities, a middle phase of teachers providing feedback and, if needed, troubleshooting variations of feedback based on the student's response, followed by an ending where the student decides to terminate the session by removing the headset. At times different participants would chime in to instruct the student, resulting in the session having a democratic approach (see From a Pedagogical Perspective.) Modalities that the teachers used for instructive communication throughout the workshop remained within the verbal, tactile, visual, metaphorical, and biomechanical.

Despite the similarities of overall teaching process and strategy, the execution of each session branched off in their own ways, especially as more information about the student was gathered, resulting in unique sessions co-constructed and personalized via communication between the student and teachers. It seems then, that because of needs, preferences, and interpersonal dynamics that vary between individuals, personalized bodily learning ne-

Figure 6.7: P5 stands up and wobbles just after putting on the aerial pole heels.

cessitates live, flexible, and creative adaptations.

6.2.2 Themes

Two themes pertinent to the design of VR tools for bodily learning were developed from the data: Theme: Imperfect VR is still Useful and Theme: Configurable Conditions.

Theme: Imperfect VR is still Useful

Throughout the workshop, there were instances when the VR room did not behave as it was designed. One common complaint was the two spheres not moving in real time to the controller movement. Because the spheres were being used to visually indicate the staff's position in the virtual environment, students were quick to alert the teachers to a problem when it arose. While at times this disrupted the learning, there were thresholds of bro-

kenness where it was still usable:

> P1: "*One of them repeatedly gets stuck somewhere... So I only see one moving.*"
>
> P0: "*That's okay. You only need to see one for this.*"
>
> (Workshop Clip 3)

Because P1 was made to expect there would be two spheres showing the movement of the controllers, he sees immediately that the VE is not responding the way it should, and believes this might be a problem. This is unsurprising as he is new to the figure-8 spin. The teacher, P0, knows the visualization exercise she is about to give him only requires one point of reference, and reassures him that the VE is providing him enough information for the task he is about to do, despite the fact that it isn't behaving as intended.

In the next session, a similar problem arises, but since P2 was present for the first instance of this issue, he asks for a similar adaptation:

> P2: "*Can I just use the other ball cause the other one froze?*"
>
> P0: "*Yeah sure, that's fine.*"
>
> (Workshop Clip 3)

Even when both of the spheres disappear from view entirely, P4 finds another indicator in the environment as a guide:

> P3: "*Ah he can't see it (the sphere.)*"

> P0: "*Can you not see it?*"
>
> P4: "...*What's more interesting is I can see the shadows on the ground... and it makes more sense to follow those.*"
>
> (Workshop Clip 4)

In this situation, the P0 is asking P4 to advance to the next progression of the technique. But P3 notices something is off, and they check in with P4 to see if his VE is still helping him. P4 describes what he is and isn't seeing, and that despite the spheres not showing for him, he found something else in the environment that still gives him the feedback he needs.

P1 takes it a step further and discredits what he sees, instead using the spheres as an approximate visual aid without letting them affect his flow:

> P1: "*I had to... I guess* ***force myself to relax and not care about just the visual input*** *of the VR headset because I know it was faulty. I could see the orbs, you know jittering and some– sometimes one would lose connection and would float far away and come back. So it was not a one-to-one with the orbs and the stuff, but rather me feeling the movement. And then I could get some visual aid, spatially, but uh also had to, to be able* ***to perform the movement I had to relax and not compensate for all the jitters*** *because they were not real right? There's a difference there between the seeing and the felt, uh, experience.*"

(Interview, P1, emphasis added)

Here, it is evident that P1 recognizes different approaches one may take when learning a movement: the way it looks from the outside, and the way it feels on the inside. He describes how the unrealistic jitters of the virtual spheres pushed him to focus on the latter, inwards towards the feeling of the movement because the outside was unreliable. It is unclear if this is something he would have done without VR, but it is clear that the imperfectness of the visuals prompted him to this course of action.

Theme Summary

In some instances when the visuals provided by the virtual environment did not work as intended, participants did not let the designerly intention of the tool's function limit their practical uses for it. Some of this was supported by the teacher's knowledge of what was essential, but once the students knew enough of the training requirements for the technique they were learning, they could decide for themselves what was still functional enough for the task at hand.

Theme: Configurable Conditions

As described in 7.2.2, the VR app was not built to imitate the real world learning environment. Rather, it was meant to be a canvas on which to ideate learning experiences and features.

For P5, the absence of others in the VE made it easier for her to ignore the social pressures of performing a movement in front of

people:

> P5: "*I typically, I will got stage... stage scare a lot. So it's nice to kind of like, trick yourself. Like you're alone in the in the VR room. Only a teacher is there and this like, you can only hear her voice or his. She's like, not there as well. She will only touch you, but it's* ***not a human touch****.*"
>
> (Interview, P5, emphasis added)

Even with haptic feedback being applied live by a person on the other end, P5 found the fact that it wasn't direct touch helpful, in that it distanced her enough to not be afraid of the performative aspect of practicing with others. Even though P5 was an advanced student, it is possible her stage fright would have had a negative impact on her practice had she not had her space alone in the virtual room.

P1 also thought of the VR room as a way to make his presence (or at least, his perception of his presence) flexible for each moment:

> P1: '*So in a way I think* ***VR was kind of interesting as a kind of semi-blindfold****. Because a blindfold would have worked, but then I would've lost...*"
>
> INTERVIEWER: "*All of it.*"
>
> P1: "*The dojo was* ***good enough to provide a room, good enough to keep balance*** *in the room. But removing most of the objects in the room? I think that's kinda neat actually. The perception of the dojo.*"

(Interview, P1, emphasis added)

Here, P1 explains how the simplistic VR dojo gave him enough of an environment for practice, but allowed him to focus on his internal processes, e.g., the balance of the stick in hand, the weight of staff with controllers compared to without controllers, rather than external processes, e.g., how the move looked, or copying a demonstrated movement pattern.

P2 describes how he enjoyed the fact that the spheres in the VE didn't match the size of the controllers in the real environment:

> P2: *"I'm wondering if it was made easier, maybe because they (the spheres) were a lot bigger compared to the actual VR controllers. I'm not sure why, like maybe it's because they... Like, were so... Like,* ***big and bright but still kind of light compared to their size that it felt more comfortable as I swing it****– swing it around... that makes it– made the whole experience of swinging them around more comfortable, you think, and* ***it felt easier than if they had been smaller.****"*
>
> (Interview, P2, emphasis added)

In this quote, P2 shares how the feeling of spinning the staff was made easier and enjoyable by having the spheres in the VE appear larger than their real world counterparts, the Quest 2 controllers. While the spheres were programmed to be larger for visibility purposes, as a byproduct this also altered the very perception of the training tool itself. In P2's case, this alteration proved beneficial by making it more pleasurable to practice spinning.

Theme Summary

Participants used the unrealistic aspects of VR to aid their practice, and they decided for themselves what worked for them. Based on the participants' accounts, this flexible, individual reality is formed by a combination of what they take find useful from virtual world and the real world.

6.2.3 Practitioner's Account

Body Map

The following quotes are transcribed from the workshop footage, when the group is sharing their body maps at the very beginning and end.

Before: "...I'm also waking up and I'm really drowsy and I think this is fuzzy. (motions around head) Uh, yeah I haven't really woken up in my body yet, um, with the exception of, this arm I think I slightly injured over the weekend. Slightly. It's not terrible, it'll probably take like a couple days (to heal.) But it's a little, like, stuck. And this hand I was using for twirling, like P3 said like a nunchuck. Uh also it feels like for some reason my body keeps turning. Like my hips keep going to one side they won't go to the other side."

After: "I think because we just did (waves hands) I was doing a lot of the figure-8 stuff, so my body has a very slight figure-8 infinity sign sway to it. Umm, this upper half, whereas before it was very like (uses hands to make claw gesture around head and brings hands forcefully downwards), pulling me down, now I'm a lot more

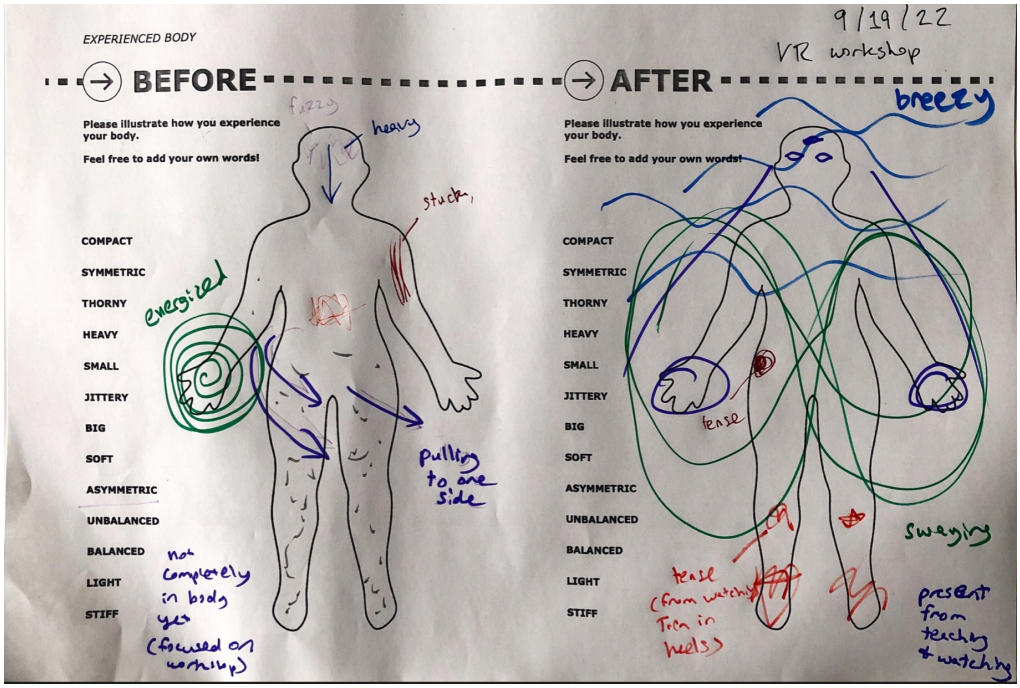

Figure 6.8: Calyx's body map.
BEFORE: "fuzzy, heavy, stuck, energized, pulling to one side, not completely in body yet (focused on workshop)"
AFTER: "breezy, tense, swaying, tense (from watching P5 in heels), present from teaching and watching"

relaxed because I've been moving around. My (chuckles) my feet and calves are tense because I was watching you (P5) in the heels and I was just going (grimaces) arghhh!"

Reflections

It might have been the stress of running the workshop and making sure everything was going smoothly, but I was prepared to turn off my brain and follow along with whatever instruction I was given. So it was a bit of a jolt when (P3) said he wanted to learn the staff spin. Others voiced their agreement rather quickly, and while my shyness meter was blowing up, I didn't want to let them down either. I was shy because even though I was pretty familiar with the spin, I'm not familiar with teaching. I'm always a student, likely

because I keep switching between so many activities, so I've not managed to master anything. The only time I had done anything like teaching before was when I practiced karate and the sensei would ask me to take some kohai[1] to the side and demonstrate kata as they followed along. But I wasn't expected to say or do anything much beyond my normal solo practice, I only needed to show them. And here, in a situation of my own design, I was denied the ability to show anything as the student was in VR and couldn't see anything in the physical room.

So after a millisecond of panic, I did the only other thing that came to mind, and I parroted the instructions my staff spinning teacher provided when I took her class: pretend one tip of the staff is a giant marker, draw a giant eight with your stick and arm all in one line, then perform the motion from your elbow instead of your shoulder, then finally perform the motion only from your wrist. And you have a figure-8 spin! In retrospect, this was totally masking, as I didn't know how to be a teacher so I just imitated one while I dissociated, and I don't have any somatic memory from those beginning moments. Fortunately, these instructions were enough to get us started. Two of the students who never did this before got most of the way there on these canned instructions alone. Once the session found its rhythm, and my brain settled into "teacher mode," I could critically observe how they were moving. Recognizing what was wrong and right was easy, because the spin is mechanical and technical, you can only really do it that one way, so there's a clear vision of what it should look and feel like. The difficulty for me as a novice teacher was telling this to the

[1] A term denoting a junior or less experienced student, commonly used in Japanese martial arts

student. It was like I was transferring this vision from my body, to my head, to their body. Finding the right kind of feedback was tricky since I couldn't fall back on simply demonstrating it to them. I'd catch myself repeating the same instructions while instinctively moving my body to demonstrate, which obviously wasn't helpful. So I kept struggling with this translation and sharing process. Do I use metaphors, do I talk about the different planes and lines of the movement, do I break down the biomechanics? Frankly I struggle to explain it fully in any of these terms, but I know how it's supposed to feel, and I was frustrated I couldn't simply mind meld[2] this feeling into them. Have you ever played a game of Taboo where your teammates were very close, but just couldn't get what you were trying to say? It reminds me of that kind of feeling. Or– and this might sound wrong, and I realize this comes off as objectifying the other participants, but when there were long periods of me giving instruction and the student didn't say anything in response but only changed their movement, it kind of felt like a form of puppeteering, except the information transfer was indirect, and I had to figure out the right commands. Most of the time when I couldn't find the words, I'd manipulate their bodies directly using the Soma Shapes. But I felt like a very inexperienced puppet master. The right commands were also different for each individual. With (P1), I was quite lucky because I had taken HEMA classes from him, so I was more familiar with his movement repertoire. When I wanted him to incorporate body movement after progressing far enough into the basic figure-8, I only needed to remind him of downward cuts from using a saber, and I could immediately see the correct changes in his spins. Other situations were a bit more difficult. The

[2] A term from *Star Trek* referencing a telepathic link between individuals.

marker metaphor did not seem to work for (P3) and it took some trial and error before we found the feedback that did work, which in this case, was pulling the tip of the staff in the movement pattern it needed to go. Kinesthetic feedback made more sense to him, and I was really glad to have my "graduated" students and participants who already knew the technique there to give feedback from different angles.

Because she already knew the basic figure-8, (P5's) session was really interesting because she opted to wear my six-inch pole heels while spinning to test her balance. Here I felt that I provided more of a support or peer role and less of an instructional role, since I had not done this myself. I actually don't think I could even do it as well as she did. Obviously I knew the spin, and I knew what wearing the heels felt like, but not off a pole, on this carpet, while spinning a staff, so I could only guess what it might feel like. My feedback mostly relied on external cues, such as when I noticed that she wasn't engaging her core very strongly, and that this might help stabilize her. And unlike the other sessions, it didn't feel strange that I wasn't in the room with her, rather it was good that I could leave her alone to concentrate on her balance, and just appear when needed, because it's annoying to try and balance when something in your vision is moving around. One last memorable moment was how I stopped myself right before I went to touch (P5's) stomach and lower back with Soma Shapes, but suddenly felt that I needed to ask. I didn't want her to be startled and fall, but it also didn't seem fair that I could engage with her directly while she couldn't do the same to me, so I felt like I had to get her permission first. Weirdly I didn't encounter this with the other

participants. Perhaps it's because (P5) and I only met that same day, and I had already done soma workshops with the others, or maybe it's a sign of my ingrained sexism, but it might be worth pointing out.

Researcher Response

It is apparent from the practitioner's account that teaching is a separate set of skills from learning and performing, which is consistent with the pedagogical literature (160; 108). While P0 knew when the student was doing something wrong or right because of her empirical experience (122), she didn't always know how to proceed. It is these instances where the other participants who also knew the figure-8 spin could chime in and offer alternative instructions for the student, such as P4's inquiry of whether P3 played ping pong, and explaining that the wrist movement he was trying to learn is similar to a serve. In this way, some parts of the workshop sessions could be compared to the social dynamics of club practices, study groups, or open gym/studio sessions, where peer feedback is a shared responsibility amongst the members and roles may be less prescriptive than formal classes with the teacher-student dynamic (see From a Pedagogical Perspective.)

In her body map, P0 reported tension in her calves and feet from watching P5 practice balancing on one foot while wearing heels. This could be kinesthetic empathy (146; 149), described as vicariously experiencing another body, often referred to in the context of watching dance performances. This may be a contributing factor to P0's sudden inclination to ask P5's permission to touch her before giving tactile feedback via the Soma Shapes, as she was lit-

erally putting herself in her shoes. The possibility of touching somebody without signalling it or asking for consent in advance is problematic. It is possible P0's familiarity with the others, especially P1 having trained with them before, gave created a social dynamic which implied consent to touch that was not established with P5.

6.3 Summary

This chapter describes the design and outcomes of a workshop which explored how people might communicate bodily movement and knowledge remotely through a soma design lens, using a minimalist VR room, Soma Shapes, and foraged props and supplies. Following a combination of analysis methods, it was found that 1) sessions unfolded in different ways despite the teacher using the same starting instructions due to student individuality, 2a) imperfect VR experiences could still serve practical purposes in learning, 2b) participants configured their own training scenarios from a combination of chosen elements from the virtual and real world, 3) empirical experience is not a substitute for teaching skills, but peer support can still create a helpful learning environment, especially with multiple peers bringing their own perspectives.

6.3.1 Design Takeaways

As seen in the collection of activity maps and body maps between the students, there is a need for responsiveness and creativity with learning sessions. The themes also show that simplicity

and versatility are powerful attributes of the tools which helped participants learn during the workshop. Modular interventions show promise, such as a toolbox rather than a specific, purpose-made experience. The next chapter details the design and development of interventions, which are meant to reflect this goal.

Chapter 7

Intervention Design and Development

Creating the interventions was a non-linear, intuitive, and meandering process, as design often can be (189; 54). Sources of inspiration included the first two studies, online dance sessions with the industry partner, and the author's personal practice as Calyx.

7.1 Equipment and Software

To build, test, and study the interventions, the university provided a Meta Quest 2 VR headset (marketed as the Oculus Quest 2 when the project began) and a pair of corresponding Quest 2 controllers, as well as a development laptop. All applications were built using Unity, a game engine and development platform. Accompanying scripts for interactive features within the applica-

tions were written in C# using Microsoft Visual Studio.

7.2 Intervention Prototypes

The following section describes the intervention prototypes developed throughout the course of this project.

7.2.1 *Energy Beast*

Inspiration and Guiding Principles

Because it is often expensive and impractical to have regular one-on-one lessons with a teacher, even online, it quickly became apparent that self-learning is an important skill to cultivate in its own right in remote practice. An online dance session with the industry partner focusing on the author's particular struggle with developing the skill in improvisation and freestyling inspired a solo practice intervention, *Energy Beast*, offering the user a pseudo-sentient dance partner in the form of a mass of energy which can subtly follow or lead depending on the user's interpretations.

This idea came from an exercise the industry partner offered where one imagines "energy" activating certain parts of the body as it flows through the dancer. Additionally, a few participants from Interviews with Dance Practitioners described activities involving the visualization of energies– especially a ball of energy– used as an imaginary apparatus or prop which helps develop bodily awareness, targeted muscular activation, transitioning between movements, and flow. For instance, P6 used this technique to generate choreography. Conversations with duet-dancers outside of

the study also brought up the idea of dancing with another person's "energy."

Energy Beast was meant to take the idea of energy as the essence of another, or at least of another's movement, and make an artifical version of it to see how it may influence solo practice. Thus the intervention provides an alternative prompter if a teacher is not available, or if the student simply wishes to practice alone. It was also intended to be a solo practitioner's stepping stone option if the practitioner is at a stage in their practice where it is overwhelming to both imagine the ball of energy, i.e., to lead themselves, and react to it, as was the case for Calyx.

Design Process and Decisions

The purpose of *Energy Beast* is to support a practitioner's solo practice by turning the energy ball into a pseudo-sentient dance partner. A simple sketch was drawn (See: Figure 7.1) to quickly visualize how the experience might look, which acted as a reference during development. The energy beast was envisioned to be able to change location, colors, effects, mass, etc., based on the music and the movements of the user.

Because this VR interpretation takes an internalized process and makes it external, *Energy Beast* was predicted to produce qualities in movement that would not be identical had the practitioner done the exercise through visualization. Though with full-body tracking, it would be possible to have the ball of energy trace the user's body, more closely mirroring the internal aspect of the original practice that inspired it. But creating faithful recreations of

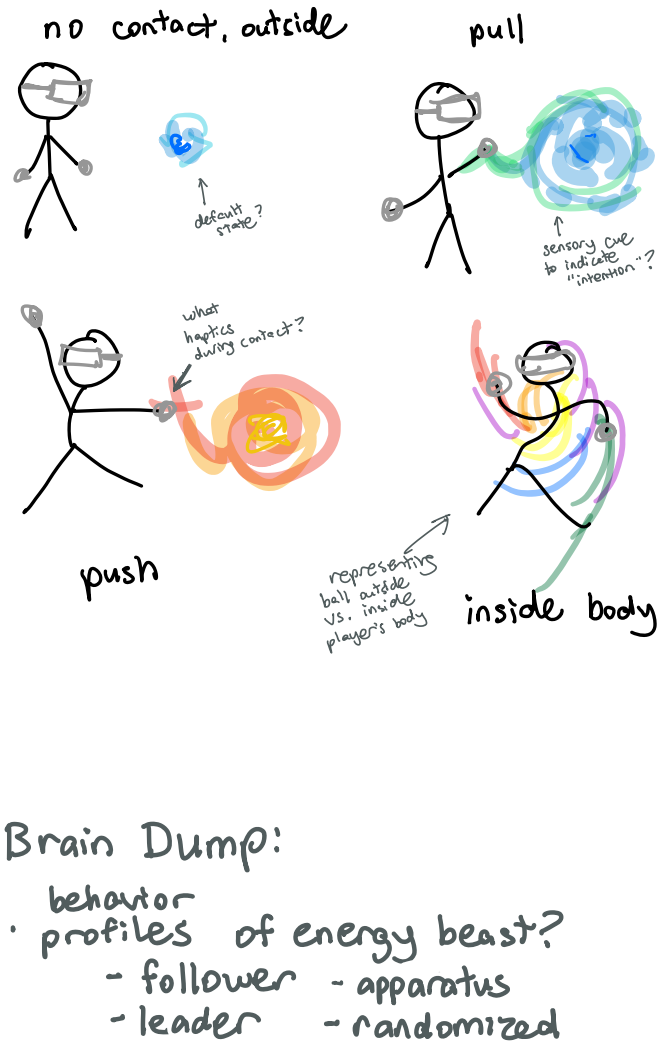

Figure 7.1: A page of an Energy Beast design sketch showing potential interactions between a practitioner and the beast.

co-located activities to VR was not considered crucial for remote learning, so the "energy beast" as a separate, external entity was deemed acceptable.

The energy beast's behaviors are set by the user's headset, following it around slowly so that it always moves around the space to return to the user's view. Using the headset's built-in hand tracking, the space taken up by energy beast also expands and contracts depending on the distance between the user's hands (See: Figure 7.2). The energy beast's particle behavior, size, and distance from the user is set to randomly oscillate within a specific range. More complex behaviors for the energy beast were originally planned, such as explicit cueing signals to the user. But after exploring Unity's VFX Graph[1] and testing the effects through improvisational dance, it turned out that the simple behaviors mentioned above were enough to make it seem alive, or at least alive enough to dance with the user. The particles' reactivity to sound was also scrapped as the desired music to dance to changed almost daily, and simply muting the headset and playing the music elsewhere proved convincing enough.

[1] https://unity.com/visual-effect-graph

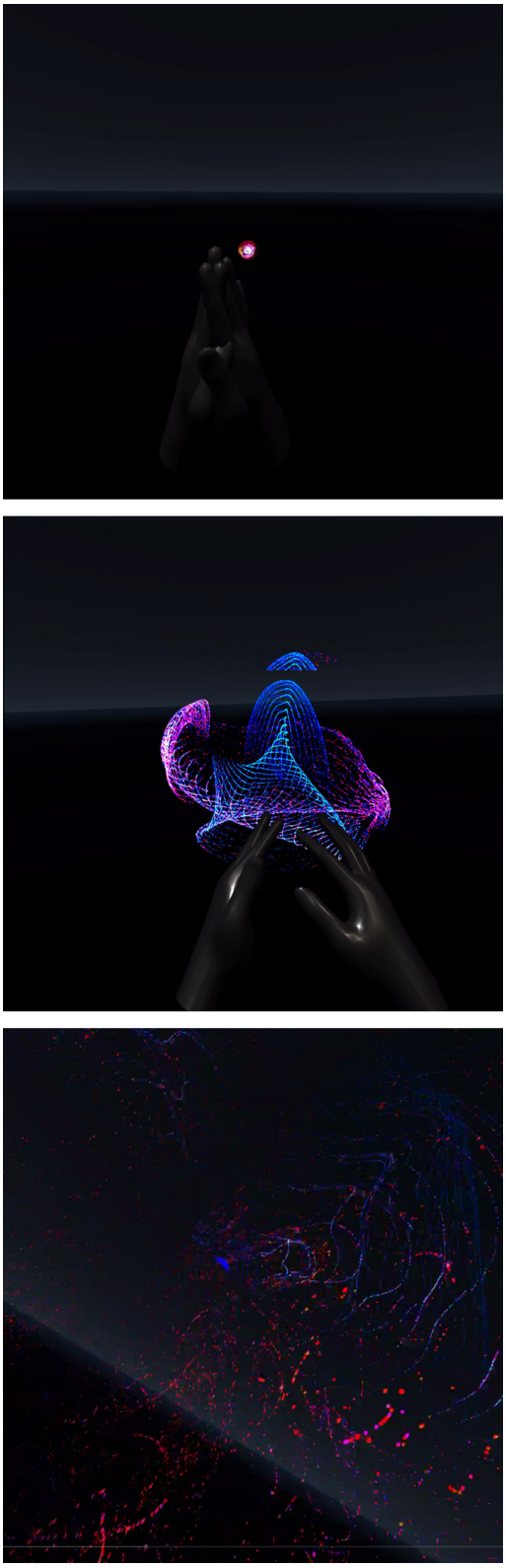

Figure 7.2: From top to bottom: the energy beast's size changing from tiny to enveloping the user, depending on the proximity between the user's hands.

7.2.2 Dance Tools

Inspiration and Guiding Principles

The VR toolkit used in the VR and Soma Design Workshop was meant to be a barebones experience which the designers could use to build upon. However, during the study it was found that the experience itself was not only sufficient for the practice scenario, but the simplicity of the VE helped participants focus on just the crucial parts of the learning. Having the VE be an environment which was open to being shaped for the needs of each student made sense given participants in Interviews with Dance Practitioners explained how adaptability and versatility were essential for teaching, especially when their class had students of varying abilities. Therefore, the same general idea of a minimalist room with simple, building block features where the user could determine their purpose was retained for the intervention design. As its rather unimaginative name suggests, *Dance Tools* was built with a similar ethos to a studio gym, with items such as resistance bands, yoga blocks and exercise mats which are simplistic in their nature thus can be used several different ways for several different activities and exercises.

Design Process and Decisions

During VR and Soma Design Workshop, nearly all participants noted that the virtual room was a dojo and made references to *The Matrix*, and in some cases colored participants' styles of movement to be more combative. To be less suggestive of a specific activity, this was changed to a plain studio with wood floors (Fig-

Figure 7.3: Default studio environment.

ure 7.3.) Though it was technically designed as a dance studio, it is common for other bodily disciplines to be practiced in them as well, though this may reflect the real-world disparity of dance schools appearing to have more prevalence and commercial success than martial arts schools. The ability for users to swap environments was also added later on, with an outer space skybox (Figure 7.4) as an "outdoors" alternative to the indoor studio which was not obtainable in situ. Other environments were added such as a night club and a ship which wavered side to side, but these made the application impractically slow and were cut.

Dance Tools required use of the Quest 2 controllers. Like the VR toolkit, the controllers' rendering could be swapped between an accurate virtual version of them or plain spheres. Because the figure-8 staff spinning move was often described with a drawing metaphor, additional trails feature (Figure 7.5) was added so users could see the lines drawn by the controllers' movements.

This concept was implemented in the form of several 3D geomet-

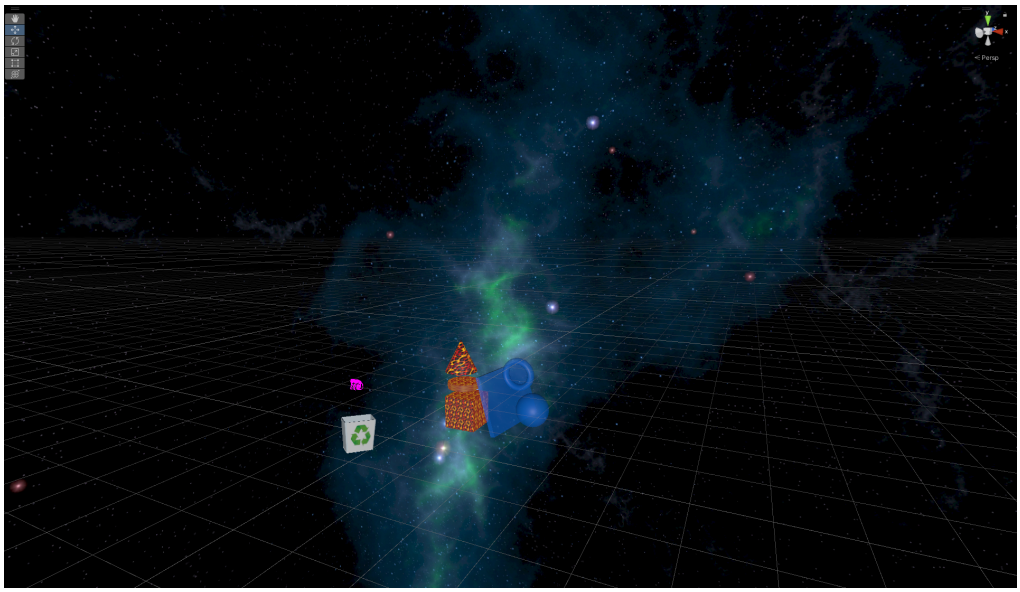

Figure 7.4: Alternative space environment.

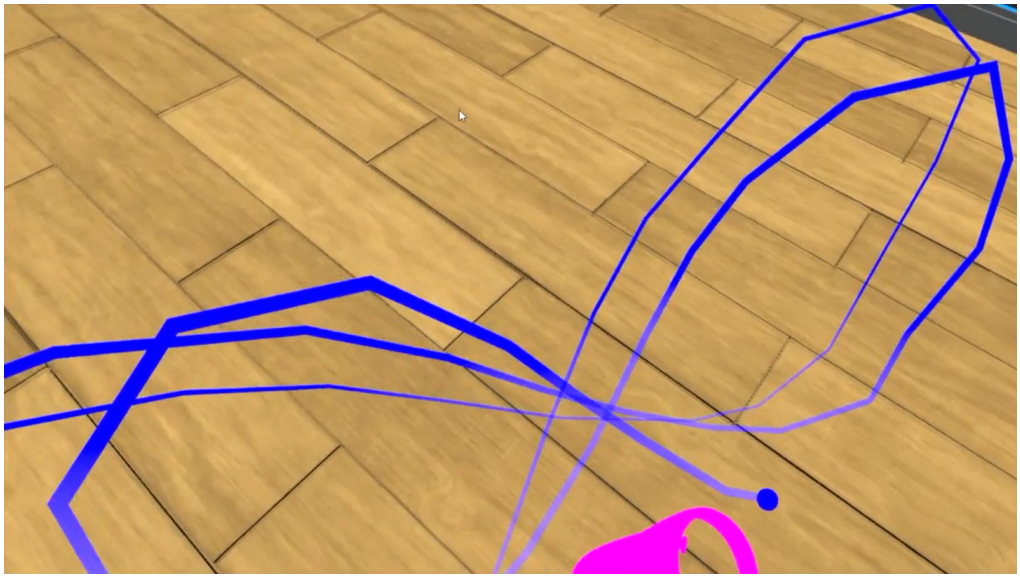

Figure 7.5: Study 3 participant using the trails feature to check the figure-8 pattern they were instructed to create while learning a dance.

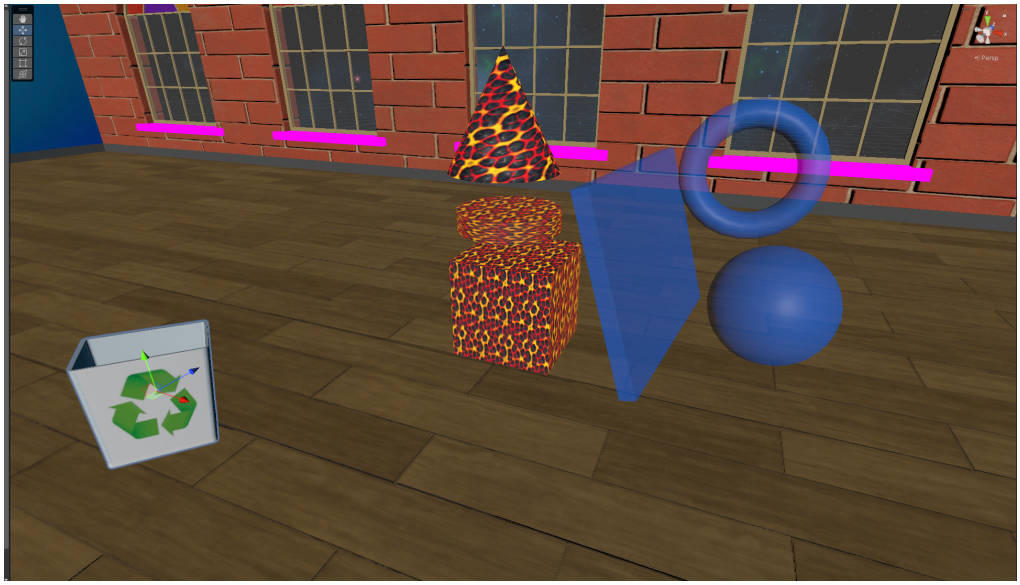

Figure 7.6: Blocks for guiding movement. Semi-transparent blue indicates the guides, and the lava texture indicate obstacles. A recycling bin for deleting unneeded blocks is on the lower left.

ric shapes generated within arm's reach of the user (Figure 7.6.) These shapes, which were called blocks, could be grabbed and placed anywhere in the VE. They were fully adjustable in size and dimensions. Grabbing a block would generate a new clone so that the user could have as many blocks as they needed. The two colors of blocks were added to further specify their uses: a set of semi-transparent blue blocks, called guides, and opaque blocks with lava texture and a burning flesh sound effect if the user came in contact with them, called obstacles. Lastly, a recycling bin placed on the floor nearby would stand ready to delete any blocks the user no longer wanted, making a chomping sound as it deleted items. These were added from the author's conversations with her personal network of bodily practitioners, noticing that a common strategy in learning consisted of using basic lines or shapes, real or imaginary, to guide movement. For instance, one of her sword instructors described a drill where cuts must be done as

parallel to an angled box or wall as possible, without hitting it, to practice precision in movement. In Figure 7.7, a fencing student from Study 3 has resized the torus block and placed it in front of her to act as a target for another precision drill.

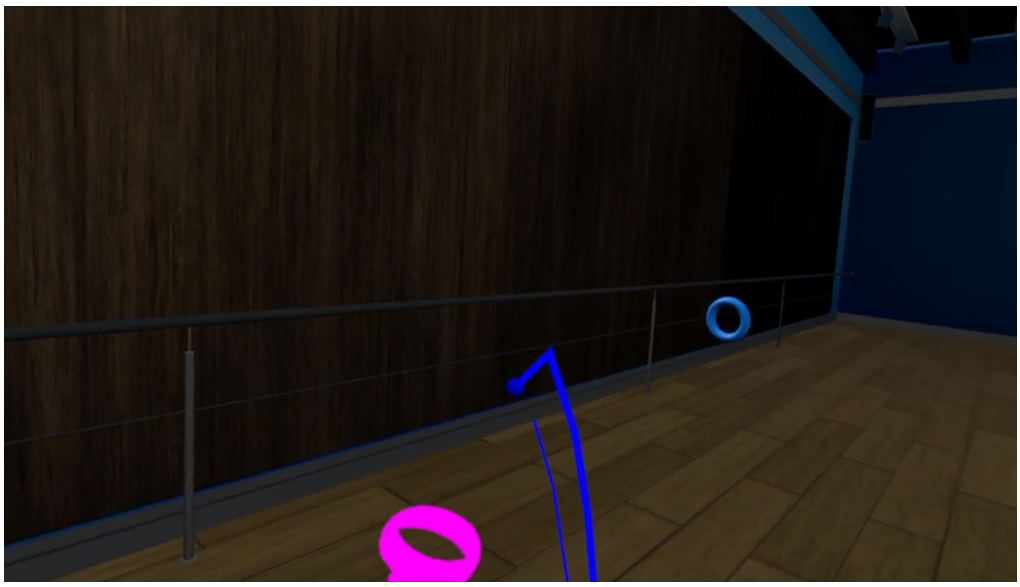

Figure 7.7: A shrunken torus block placed in front of the user, in this case a fencer, as a small target to develop aim. The trails feature is also toggled on.

7.2.3 *Star-Stuff: a way for the universe to know itself* by John Desnoyers-Stewart

Sensitizing oneself to touch and the information which it conveys, such as directionality, amount of pressure, and muscle tension or relaxation is a crucial skill in many duet forms of bodily practices. This can be trained through contact exercises, and their prevalence across several martial arts and dance is perhaps indicative of their effectiveness. Not least, they were something the author had seen repeatedly through personal practice and research-related workshops. Okinawan karate and various forms of kung fu share the "sticky hands" touch sensitivity and reflex

drills, where partners maintain contact with their forearms and protect themselves while trying to attack their partner. [2] This can be practiced with pre-assigned push-pull cyclical movements, or free-sparring. Advanced practitioners may perform this drill blindfolded so they may attend to the tactile sensations even more closely. Weapons systems in HEMA also refer to "binding," describing situations where weapons are in contact for longer than a moment, which is crucial for reading the opponent's intentions and provides information to the fighter about how to react. And of course, contact improvisation is used in dance as an exploratory activity. After attending enough soma design workshops which incorporated contact improvisation exercises, questions emerged about how well this type of exercise could translate into VR. Especially since the Quest 2 provided very limited and simplistic haptic feedback out of the box, there was an interest in seeing if other forms of virtual "touch," such as through visual feedback (156) could be effective not just for co-presence, but for co-practice.

Star-Stuff was not created by the author, but by another practitioner-researcher, John Desnoyers-Stewart, who agreed to let his work be used in a collaborative research effort. It was chosen as it already had three fundamental components the author envisioned for contact exercise interventions: telepresence between two users, abstracted representations of users' bodies, and feedback upon the users' virtual bodies making contact. Like the purpose-made interventions of this project, *Star-Stuff* was made in Unity and can be operated with an Oculus Quest 2, either with controllers or with hand-tracking. As a two-player experience, users are placed

[2] There are stylistic differences in the way these are practiced. This is a generalized description for brevity.

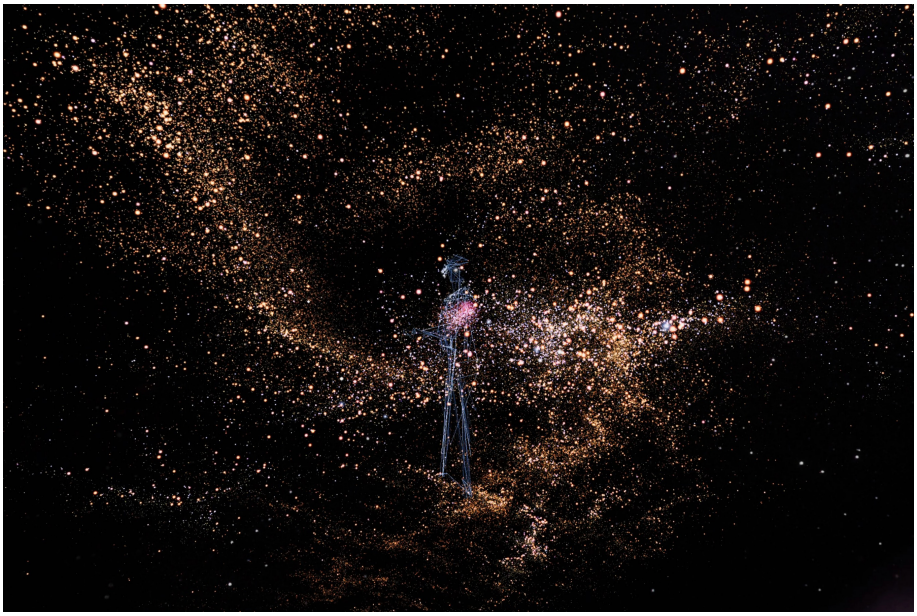

Figure 7.8: First person view looking at another player, standing amongst the stars. Screenshot by John Desnoyers-Stewart CC BY-SA 4.0.

in outer space with constellation-like humanoid avatars devoid of unique features, with particles of "star-stuff" being emitted from their chest. The particles gently waft away depending on the users' movements, eventually shaping itself into a galaxy. People sharing a virtual room start off three meters apart, and they may only engage with each other through movement. If they come together, brighter particles are emitted from the points of contact, and the music swells.

Because it was originally designed as an art installation, there was a question as to how the original design values may affect the experience as a remote learning intervention. It is specifically a meditative and playful experience, made to create a sense of familiarity between anonymous users by displaying them with the same constellation-like avatars, to "evoke a sense of oneness...to see their fundamental sameness as 'being made of star-stuff"' (54), which may not be applicable to many practice objectives. Still, the

Figure 7.9: Two users touching virtual hands in Star-Stuff. Photo by Julia Read, 2021 CC BY-SA 4.0.

experience showed promise for this project's use case as Desnoyers-Stewart (54) described a parallel, Covid-safe installation where users would interact remotely and were reported to act "as if they were touching, keeping their hands in close contact without passing through the virtual body, moving them together side-to-side" despite not having physical contact (see Figure 7.9.)

7.3 Summary

This chapter provided a details about the inspiration and design processes of the three interventions that were created during this project: *Energy Beast*, which is meant to help with solo improvisational practice, *Dance Tools*, which contains fundamental elements that the user can configure for their practice, and *Star-Stuff, a way for the universe to know itsef* by artist-researcher John Desnoyers-Stewart, who created it as an art installation but this project has repurposed as a two-person remote learning in-

tervention for study. The next chapter will detail the final study, where bodily practitioners across several disciplines test the above interventions and are interviewed on their experiences afterwards.

Chapter 8

Practice Sessions with VR Interventions

Following up on the dancer interviews, a VR soma design workshop, and first person *researcher-as-practitioner* reflections, prototype interventions were designed and developed. In this study, these efforts culminated in a series of testing sessions where practitioners across different bodily disciplines had the opportunity to test one or more of these interventions for remote learning scenarios.

8.1 Method

8.1.1 Recruitment, Participants, and Safeguarding

The scope of bodily practices was opened up beyond dance to see how the interventions would fare across a sampling of different activities and skill sets. Participants were recruited from the

author's network of practitioners. The dancers interviewed in Interviews with Dance Practitioners who expressed interest in trying the interventions were also given the opportunity to participate again. Countries of practice represented include the UK, Poland, Canada, and the US. The participants received no financial compensation. An overview of the participants' bodily disciplines and experience can be seen in Table 8.1.

Prospective participants were invited to refer a partner to the study, as the sessions were meant to be done in pairs for either a teacher-student session or a peer-to-peer session. Those who did not have a partner consented to being matched with another by the researcher after stating their preferences for role and scenario in the consent form.

Prior to each session, the Oculus Quest 2 headset and controllers were sanitized with alcohol wipes. The researcher set up and tested the boundaries of each space to avoid obstructions, as well as any props to be used for the activity if they were modified for VR use. However, this did require frequent communication between the participants and the researcher, not to mention researcher-assisted adjustments throughout the sessions, as the Oculus Quest 2 was not fit for purpose in some cases, such as the lack of body tracking beyond the head and hands which required makeshift solutions such as elastic bands. Due to the exertive nature of the study, participants were informed that they were free to start, break, and end the session as they needed. Remedial snacks and water were also provided. The study was performed in accordance with the University of Nottingham School of Computer Science Ethics Committee procedures. Ethics forms supplied to the

Individuals				
Group	**Participant**	**Role for Study**	**Somatic Disciplines**	**Experience**
G1	P1	teacher	aikido, karate, katori, judo	19 years
	P2	learner	karate	20 years
G2	P3	solo practitioner	classical ballet, contemporary postmodern, jazz, hip hop	20 years
	X	X	X	X
G3	P4	teacher	Aerialist and instructor	10 years
	P5	learner	Aerial Irish dancing as a teenager	1 year aerial
G4	P6	teacher	Jazz, disco, contemporary, pole, cheerleading aerial circus	dance from a young age unspecified 5 years
	P7	learner	rock climbing aerial circus	2 years 8-10 months
G5	P8	peer	climbing HEMA	6 years 7-8 years
	P9	peer	HEMA rapier	3 years
G6	P10	teacher	Ballet, jazz, modern, tap dance, gymnastics + acrobatics street dance, aerial silks and fan veils	19 years combined
	P11	learner	BJJ modeling horseback riding/archery	2 years 10 years 15 years
G7	P12	teacher	aikido HEMA fencing horse riding, Puro tango, pole dance	6 years aikido 10 years fencing unspecified
	P13	learner	softball archery electro swing/shuffle HEMA fencing	7 years, sporadic, 6 months, 6 years

Table 8.1: A breakdown of the groups in the study, including information about the individuals and their bodily practices.

participants can be found in Appendix A.

8.1.2 Procedure

Each group was instructed to organize themselves and hold a practice session in their chosen bodily discipline using the VR tools provided. Due to various technical issues, combined with the fact that *Dance Tools* was not built with multi-user support, these sessions were conducted as mock-remote, where the teacher could only view the student from a fixed point of view, often through a window or door frame acting as a screen, and thus were only able to directly interact with the student through auditory means or by WOz haptics, though it should be noted that none of the participants opted to use the latter.

Test sessions were conducted one group at a time. Due to logis-

tical restraints and the geographic spread between groups, each session was held in a different location. These consisted of home settings or communal training spaces, depending on what was appropriate.

Prior to the start of each practice session, participants were introduced to the equipment and interventions. This allowed the teacher, who was most often not going to be in the VE during training, to familiarize themselves with the practice space. In some cases, participants also used this time to ask each other what they would like to work on, as that helped them make a decision as to which intervention(s) to use. Brief and simplified overviews of each intervention are given below, but in-depth descriptions of their design and development can be found in Intervention Prototypes.

- *Dance Tools* (Figure 8.1) is a virtual dance studio containing simple, versatile features such as configurable and cloneable shapes, as well as controller movement tracking. For groups that chose this intervention, students conducted their practice in the VE, while the teacher watched from a third person perspective and through the student's perspective by streaming the Quest 2 view to a laptop.

- *Star-Stuff: a way for the universe to know itself* (Figure 8.2 was originally designed as a hybrid interactive art installation. Up to two users are placed in outer space, with their bodies rendered as constellations and star particles coming from their center of mass, their arrangement dictated by their movements. Although it displays an abstract form of

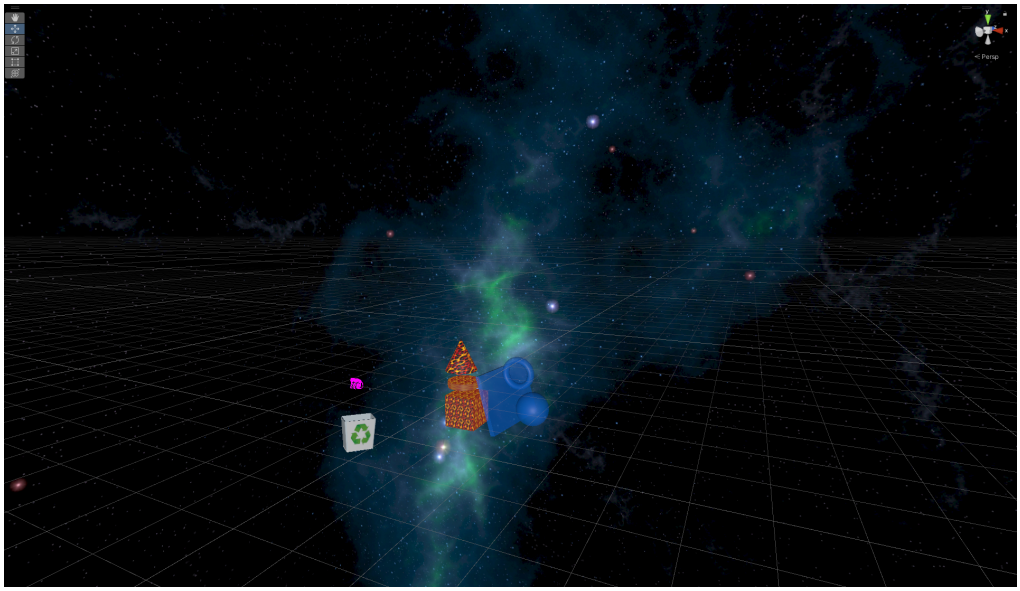

Figure 8.1: The *Dance Tools* outer space environment with blocks that the user can grab, resize, clone, and place anywhere in the area.

a normative humanoid body, body tracking is limited to the head and hands, so this intervention extrapolates the rest of the users' bodies. While this was originally meant to be offered as a symmetrical experience to contrast the asymmetrical option of *Dance Tools*, server issues sometimes made this not possible, in which case the protocol of having the student in VR and the teacher at the computer for the duration of the session was followed.

- *Energy Beast* (Figure 8.3 is a solo experience designed to support improvisational dance wherein the user is partnered with a ball of particles. Called the energy beast, this cluster of particles shifts in size, shape, and color. It may follow or lead the dancer; its movements are meant to be ambiguous and up to interpretation. Note that this intervention was not originally offered to each group as it was designed for Calyx's solo practice in her endeavors to develop flow, transitions,

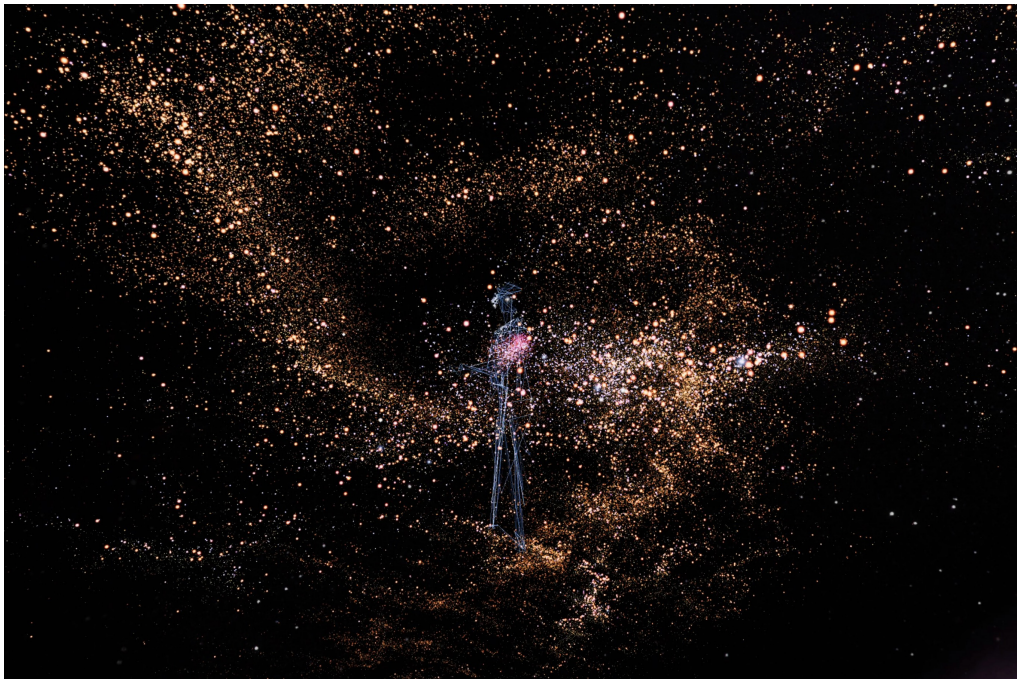

Figure 8.2: A user in *Star-Stuff* standing amongst the stars. The system tracks the user's head and hands, while the rest of the body is approximated by the application.

and free-styling skills. However, one of the partners from group G2 could not make it on the day of their scheduled session, so P3 was offered the opportunity to try *Energy Beast* in a solo session.

Once the participants felt ready and chose at least one intervention (see Table 8.2), the equipment was prepared. In the martial

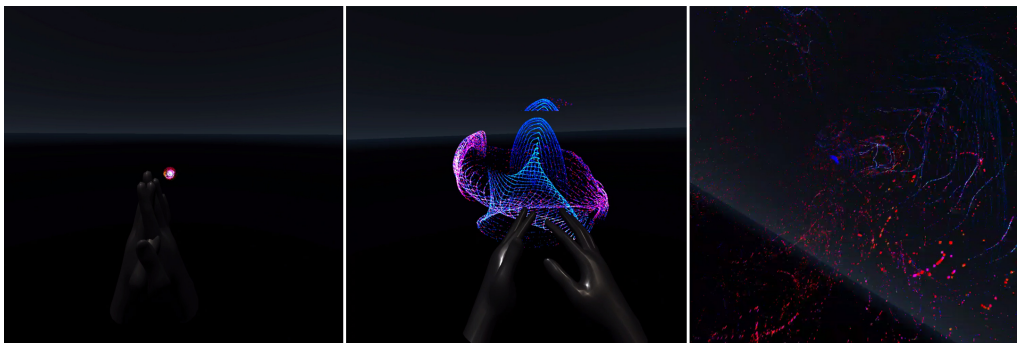

Figure 8.3: The user perspective in *Energy Beast*, containing a ball of energy which is designed to give the impression that it is alive and moves with the user in improvisational dance.

arts sessions, this meant that controllers would be attached to the training swords for motion tracking and participants would determine the best placement for them. For the circus session, rigging for the aerial hoop was checked by one of the participants who is a professional instructor at a local circus school, and a crash mat was placed directly below the hoop; this is a standard safety procedure to minimize the chance of injury.

Participants who used the Oculus Quest 2 VR headsets were assisted with fitting and general use if requested. In asymmetrical scenarios, the teacher was provided a desk with a view of the student from afar and a live view of the VE. A Meta Messenger call would also be set up to allow voice communication between parties, on the study laptop for the teacher and on the headset for the student, but this proved inconsistent and participants had to be redirected to speaking up to each other from a distance. During the sessions, the researcher assumed a passive role and only interfered if a participant asked a question directed at her or asked for assistance. After each session, a group conversation was held. Depending on availability, they were conducted in person immediately after the session with each group, or at a later date online recorded by Microsoft Teams. Post-session interviews lasted between eight minutes and one hour. Sample transcripts of a practice session and interview can be found in Appendix B.

Because participants tended to be enthusiastic about their bodily disciplines, the nature of these were conversational (46). This meant that Calyx would interject comments when relating her own practice experiences to what participants shared (see Chapter 10.) As for the researcher role, follow-up questions were asked

Table 8.2: Groups in study 3 and systems used

Sessions						
Group	Energy Beast	Dance Tools	Star-Stuff	Practice	Activity	Additional Equipment
G1		X		martial arts, katori	basic draw, cuts, basic sheathe	bokken w/ controllers
G2	X	X	X	dance	improvisation, drills	X
G3		X		circus, aerial hoop	skill work, technical	aerial rig, hoop, crash mat
G4		X	X	dance	introduction	X
G5			X	martial arts, rapier	sparring	pair of rapiers w/ controllers
G6		X	X	dance	introduction	X
G7		X		martial arts, smallsword	drills	smallsword w/ controllers

either as responses to what participants had shared, or to probe specific moments from the session that the researcher noticed, overall guiding the direction of conversation to prevent it from straying too far from the session itself.

8.1.3 Data

In all sessions, one camera was pointed at each participant to capture audio-visual recordings. Whenever possible, the participants' views in VR were streamed using the Meta Quest Cast to a Computer feature or Unity's Game View, though this was not always consistent due to Wi-Fi issues or limitations. These streams were screen captured with either Movavi Screen Recorder or the built in Windows 10 screen capture feature. A single camera was used to record data for each group's interview if conducted in person. If it was held online, the meeting was recorded with Microsoft Teams. All videos were then uploaded to the university's

dedicated OneDrive folder for this project for processing.

8.1.4 Analysis Method

The first five participant testing sessions were transcribed manually and in chronological order. It was at this point where a pattern between the representation of the body and the familiarity of movements was recognized. A few sketches were drawn iteratively to articulate this relationship (Figure 8.4.)

The last three sessions were transcribed using the UoN Automated Transcription Service and the Microsoft Streams autotranscription feature. These transcripts were read through to find more instances of the virtual body-movement familiarity relationship. Prospective instances prompted revisiting the raw video footage for further detail and verification of their relevance.

Verified instances were then added as points on a graph, the refined version of the initial sketches.. A list of these points, drawn from either participant quotes or the researcher's observations, was collated to substantiate the sketch by providing further detailed record of each instance.

8.2 Findings

8.2.1 Usefulness of Body Representation

This chart (Figure 8.4) is a visual representation of the relationship between the user's body as represented in the VE and how they felt during the practice, with each number correlating to the

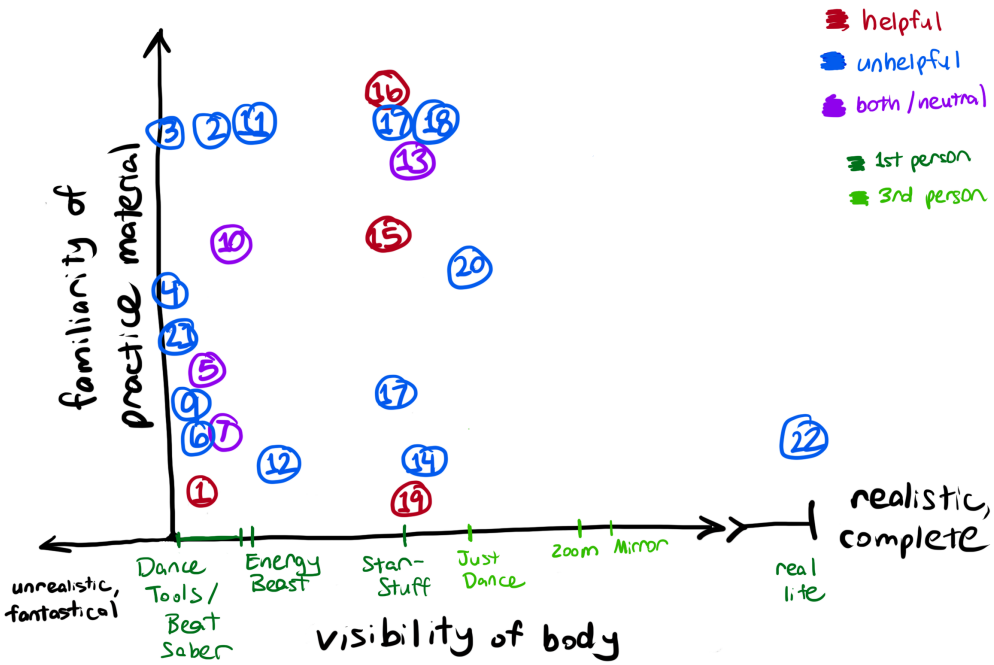

Figure 8.4: A graph representing the instances participants talked about the representation of their body and how this impacted the practice. The x-axis represents the visibility of the user's body, and the y-axis represents the user's familiarity with the practice material. Numbers on the chart correspond to the numbered items in the text of this section.

numbered items on the list below. It is limited to empirical evidence generated from testing the intervention prototypes for this study, as well as participants' recollections of their own empirical experiences. Speculative features and designs were frequently brought up by the participants in the interviews and they often guessed at how beneficial these would be, but these instances are not included. Emphases are added for clarity.

Dance Tools

- 1) G1, INTERVIEW, P2: "*A lot of the positioning [P1] was telling me what to do was where the tip (of the sword) was. And this was really useful to know because* ***I couldn't see my hands****. But these two sensors (controllers) were moving at different rates. So he'd be like, 'flip the tip' or like, 'higher on the tip' 'lower on the tip' whatever. But like, the tip would be moving at a different rate from where it is and I'd be like, 'I don't know where it is actually, right now...*"'

  P1: "*Mmm. You didn't know where your body was.*"

  P2: '...*When it was (accurate), it was fine, when it wasn't it was kinda like,* ***I actually don't know whether I was doing this correctly or not.***"

- 2) G2 RESEARCHER OBSERVATION: P3 places a series of virtual rings on the ground and jumps with controllers tracking his feet

  P3, INTERVIEW: "*I was testing my jumps and even spacing between it. One thing* ***I didn't have when I was training*** *all the time in that space was having* ***objects that won't hurt me****? [laughs] um, because with the digital ones, I could set*

Figure 8.5: P5 performing a birdie roll in the aerial hoop under P4's instruction while using *Dance Tools* and wearing the Oculus Quest 2 HMD.

a ring and if my feet were being tracked, which they were, ***I could estimate if I'd gone in that ring perfectly****, I'm not gonna roll an ankle or something."*

- 3) G3, RESEARCHER OBSERVATION: P4 prompted by P5 to try a birdie roll (Figure 8.5) in VR, upon performing it she expressed and vocalizes thrill even though it's a beginner move and she is an expert

- 4) P5, INTERVIEW: "*It was, like, incredibly free...* ***it was so much more fun than doing it not in VR*** *I found because, like I was just in space, and you kind of watch all of space flip... and it doesn't really feel like you were attached to anything... it was a very different experience to just doing the roll where I could see what I was doing. Because* ***I couldn't see where my body was or what was going on, it literally just felt like I was doing a flip in space...****"*

- 5) P5, INTERVIEW: "*There were way fewer distractions, like it, I think that was really really helpful. And I think going into it I was worried I was gonna bash into stuff or I*

would be scared that I'm gonna hit the rigging or something like that, but I found that far less in the VR— it just disconnected— ***the only thing I was thinking about was my body which helped a lot.*** *I couldn't see my body so it felt a bit awkward, trying to work out where I should go, but that was the* ***only thing I could focus on was how it felt.***"

- 6) P7, INTERVIEW: "*Being able to see the trails was immediately useful to me. Umm, cause a lot of it—I wasn't really clear on what—partially what was being described to me sort of in a way that wasn't clear to me but umm realizing what (P6) meant when she said do a semi-circle and do, you know 45 degrees and stuff. And just seeing the trails in the air after I'd done them made me realize where I had gone wrong and made it easier to correct.*"

- 7) P7, INTERVIEW: "*...I didn't need to worry about my feet at all. I couldn't see them. I was just doing what I felt was probably okay. And it almost kind of, I wasn't overthinking my foot placement...I think one of the things it did do was it increased my motion sickness. Like trying to find a point of reference...*"

- 8) P7, INTERVIEW: "*(not seeing feet) might've been more of an issue if I had to learn something with specific foot placement. I don't think I would've been able to do that without you (P4) showing me a box step and then me just doing it a bunch of times, and then looking at my feet until I've got it.*"

- 9) P7, INTERVIEW: "*I think one thing that really helped not seeing my body at all was the— I have been kind of self-*

conscious about dance before, and like, oh mine doesn't look as good as (P4's) and I've definitely had some like minor to moderate self-esteem and mental health issues to do with that. And although it– it's quite a femme dance, and stuff and like obviously circumstances are like I'm doing this silly dance in front of someone who doesn't know me that well (the researcher). But because I was in a void, because I couldn't see anyone else, like, that factor limited though it was, I think that was just completely gone. I wasn't worried about my body shape or how I looked."

- 10) G7, RESEARCHER OBSERVATION, student is thrown off because she thinks the focus is on accuracy and the system is failing to provide this, but the teacher is looking for consistency, which the system is able to display:

  P12: "*Okay so, try to do cavazione*[1]."

  P13 "*It's not perfectly smooth so sometimes with quick movements, you see [demonstrates movement w/ trails on] it sometimes it follows.*"

  P12 "*Yeah but that's not cavazione, that's feint.*"

  P13 "*But cavazione is mięcie*[2]."

  ...

  P12 "*Okay, so I need you to keep the circle level, so you come back the same way.*"

  P13 "*Kay.*" *[moves smallsword in circles instead of U shape]* "*Boop. Boop. boop. Oh yeah like this okay. So like this, boop.*

[1] An Italian fencing term used to denote a move where the fencer disengages their blade from their opponent's

[2] Polish for "cut"

I get it."

Energy Beast

- 11) G2, INTERVIEW: "*(Energy Beast uses) the one-to-one that Oculus gives so it's like, you can see every single movement of your fingers... so you're a little more conscious with what you're doing with your hands... I wanted to do more expression with my hands. Especially in ballet is very formal and rigid choices, you have to stick to specific poses and transition between them, in this one I was like, 'Nah nah nah." It motivated me to do more contemporary mixing inside of that. Almost like I was controlling the sphere and having a discussion with it."*

- 112 CALYX, CONVERSATION WITH G3, responding to P7 on the topic of self-consciousness in dance: "*I was so self-conscious, even if I weren't in front of a mirror, I could still see my body in the peripheral, right? And that was enough to make me go like, 'I don't want to dance, at all.' ... (Energy Beast) really helped me a lot actually. I would actually forget... I wouldn't even think about the way I looked and I would just be present with this thing of energy."*

Star-Stuff

- 13) P3, INTERVIEW: "*The constellation hands kind of blurred what's actually going on with your hands, so I thought less*

about positioning and the formal posture with my hands... what mattered more was the guiding motion that I was doing for my hands..."

- 14) P3, INTERVIEW: "*At first I just saw one little star and was like, 'Ooh, hello!' [laughs] and it followed my hand... it took me a bit to realize that the star stuff was coming from my body... that's when I was being a little silly and was kinda [rolls hands into stomach] digging it out from me. To like spread it out more."*

- 15) P8, INTERVIEW: "*So first of all, there has to be a a visible blade, right? We did not have that...in my experience any blade weapon, like any any martial art based around the weapons would suffer from that all greatly."*

- 16) P10, SESSION: "*I'm kind of trying to figure out what what I can actually show in here because* ***I can't really monitor the movement very well.*** *I mean, I can monitor like the ways of... I'm afraid we* ***can't really do technique...***"

- 17) G6, SESSION, P10 instructing P11 with familiar metaphors
  P10: "*So we are going to straighten all the way up to the sky... And if you try and reach to the very stars that are unreachable above you... Yeah, And we are going to cross our arms, hug very closely like the dearest friend that you have."*

- 18) G6, SESSION, P10 teaching P11 how to do a plié[3]
  P10: "*So we kind of bend our legs down as we go down. You can even look a little bit down at your hands and we're going*

[3] A fundamental movement in classical ballet, a French term meaning "to bend"

to open and look at the sky and straighten our legs. Yeah, perfect. I can actually see that and... we are up, up, up, up, up, up, up... Yeah, perfect. ***I can see you're bending your knees and all the right spots.*** *"*

- 19) G6, SESSION, deciding to switch to *Dance Tools*

  P11: "*I can't even tell if you're facing me.*"

  P10: "*OK, because I put my arms while my hands on my shoulders and I was basically rotating them the same way that we were rotating our hips at some point.*"

  P11: "*So I I think I saw like on the level of your shoulders. So you're probably holding them and you are like moving at the elbows.*"

  P10: "*So the bottom line is we need more sensors. there's no accuracy right now.*"

Just Dance by Ubisoft

- 20) P3, INTERVIEW: "*The common link would be how disassociated you are to the task, it has the joycon or whatever single object in your hand, it's* ***never gonna be accurate****. Also the game doesn't penalize you for failing, it just continues on. So even though there's high scores and it asks you to achieve x many stars to potentially unlock other things, there's still* ***suspension of disbelief****.*"

Beat Saber by Beat Games

- 21) P7, INTERVIEW: "*...I'm sure I look like a maniac when like, the out of the headset... but, when I'm in that moment, I'm doing a lot of really wild moves and I feel really cool doing it, even though I objectively have seen a video of me doing it, and I know I don't look cool.. But like, it feels good... And like, that's I think to me the most positive aspect of doing this, it just totally removed the fear factor of being seen doing dance stuff. It wasn't my body so I don't care if anyone saw me.*"

In Situ

- 22) P7, INTERVIEW: "*When I learn dance I spend a lot of time looking at my own feet, and looking at where I'm going and my arms and stuff. The ones I struggle with most are the ones where I have to do a spin or something, or look at [P4] or something, cause I would always be looking at just what I was doing.*"

The collection of data here indicates that the participants paid much attention to their virtual embodiment and whether that improved or worsened the learning experience for them. This implies that avatar design should be approached thoughtfully when creating interventions for bodily practice. Further discussion on this topic can be found in Study Insights: Fidelity of User Bodies.

8.2.2 Intervention Feedback

Participants were forthcoming about their frustrations and im-

provements they would have liked to be included. Additionally, there were some technical limitations of using the Oculus Quest 2 for purposes it wasn't built for which came up during the test sessions. For the scope of this study, imperfect experiences were inevitable and the interventions themselves were rather flawed for actual practice, however they were valuable in that they helped make explicit the design priorities of bodily practice by providing a tangible starting point as "conversation objects" (178). They also shed light on the original design intentions of the Oculus Quest 2 and brought up questions of current assumptions of home VR technology. These field notes were compiled when participants gave feedback about the system. For clarity, they have been organized in the following groups: **System and Hardware**, **Environment and UI**, **People**, and **Review**.

System and Hardware

This subject reflects on aspects of the hardware that the participants highlighted as problematic and suggests changes which would significantly improve the experience - particularly focusing on the experience of tracking, tracked objects, and tracker objects.

G1 and G7: a lighter motion tracker to not affect weight of sword

G3: headset registers as out of bounds when floor level is mapped correctly but user climbs up onto the hoop

P4 and P5: multiple, small motion trackers that can be attached to the aerial hoop

P8 and P9: tactile feedback of partner or opponent's sword, feeling of steel over plastic or foam emphasized

G5: a less "space hungry" setup where the sword peripheral is short (but correctly balanced) as having the real length of the swords tracked significantly lengthened their wingspan, greatly increasing the space requirements for virtual sparring

Environment and UI

This topic reflects on issues around the environment and interaction modalities to consider suggestions that would improve the experience.

P4 and P5: being able to see the hoop and turn this off and on

P4: teacher draws an arrow shooting through in the direction the student needs to go so they can follow the pathway, possibly from a recording

P5: being able to see the teacher, turn this off and on

P5: seeing a video while on the hoop in the top corner where you can always see the instructor, automatically adjusts orientation to match viewer while they're inverting

P8: visible sword

P12: having the spheres change colors, so you can hit the ones that are blue and green, have someone change their color and then you can't touch them, as a reaction training

P4: other environments students can choose from

P6: dropping in an image into the VE and drawing on it

P8: simulated response to getting hit in VR, like wounds showing on avatar or feedback

P10: no permanent lava shapes or hazard objects

P10: a mirror or VR body clone

G6: customizable particles: fewer-more, change colors, turn off, they were giving P11 sensory overload as they currently were

People

This topic reflects on the social organization of the systems and people that are part of those systems.

P1: multiplayer scenario, teacher in the room holding up targets, akin to pad work in situ

P7: group class scenario with adjustable presence to accommodate practitioners who are more shy or have social anxiety

P8: more complete representation or mocap of fencing partner

P9: having AI spawn an opponent that performs techniques against you, you have to react to it to train reflexes and decision making

Review

Finally, this section reflects on practitioners' need for review - that is how they might "look back" at what they have done and use this to progress in their disciplines.

P7: instant replay function of trails

P4: recordings of each aerial trick, and being able to name the recordings yourself instead of prescribing to conventional names

P9: record the session for trainer to review in VR so they can walk around watching the session

8.2.3 Practitioner Account

While Calyx was not a participant in this study, she had used some of the interventions for practice. Her reflections are provided below.

On *Dance Tools*

One study group included one of my circus teachers and a classmate. While I gave them the chance to do a dance session, an aerial rig was available and quite frankly, none of us could pass up the chance of combining VR and aerial practice. (P5) was in an outer space environment because (P4) said that "aerialists love space, and you can't get more space than space." It seemed like the finale of (P5's) test session was doing a birdie roll (Figure 8.5,) which is pretty simple normally, but seemed a little terrifying to do while wearing a thing strapped to your head. Her reaction was absolute gold, though, and right afterwards she told (P4) and me that we have to try it for ourselves. When I tried it, I immediately got what she was talking about because you couldn't see your body or the hoop at all, it was completely disembodied. So it was scary but thrilling to just let your head fall forward and flip all the way 360, with the stars whooshing in your vision. It really makes

me wonder what it would feel like to try it in other environments. I get bored super easily, the birdie roll was exciting at first when I learned it but you get used to it and the novelty fades. It really annoys me but this is probably why I quit a lot of new hobbies too, I hit a plateau and it stops feeling fun, when what I'd really like to do is persevere through and actually master something instead of be a jack-of-all-trades. Most likely I'd need to try this more to actually know, but from that experience I can imagine this would be an awesome way to inject novelty back into things that you have to keep practicing repeatedly.

On *Energy Beast*

Trying to dance freestyle makes me cringe. It is one of the most uncomfortable things ever. At best, I'll go through a sequence of moves I've already been taught. At worst, I freeze. The only time it has ever been okay for me is when I have someone leading me, like Rob (Clark), but he's very busy so I couldn't train with him regularly. But it's nice to not have to worry about what I need to do, since I'm only reacting. That's why I made *Energy Beast*, just to have something I can kinda move with so I'm not stuck in my own head feeling anxious about what to do. At times when I'm feeling restless and don't have a particular thing I need to be doing in that moment, I'll use it and put on whatever music matches my mood or is already in my head. I think my most recent session was a longing mood, and it seemed like I kept trying to chase the ball of energy. Sometimes the particles would extend out, like it was wanting to be in the same space as me. Other times it would move away like it had become shy. A few times the controller lost track of

one or both of my hands, so it shrank to the smallest it could go and gave the impression that it was turning away or keeping distance. And it's different each time I try it, I think it depends on my mood and what I've been thinking about, or what I've been through on the day, that colors the way I interact with the ball of energy in there. I'm certainly not going to do any dance performances because of it, but in terms of helping me to come out of my shell and get me to just freestyle dance, it has worked like a charm.

Researcher Response

In terms of *Dance Tools*, Calyx was able to directly engage at the practitioners' level by performing a birdie roll herself following encouragement from P5. This allowed her to relate on an experiential level to P5's description of the experience later during the group conversation, providing the researcher a much clearer understanding of how the lack of embodiment in the space environment proved to be beneficial in this particular exercise. The topic of somaesthetic articulation from practitioner to researcher using this methodology is explored further in Benefits and Drawbacks of Chapter 10.

Calyx's need to have direction to reduce cognitive load in improvisational movement could be due to the fact that, based on her descriptions (4.2.2,) her practices heavily focus on learning and polishing single discrete techniques. The result of her being uncomfortable with freestyling movement, even though she has a developed movement vocabulary, echos what P9 from Interviews with Dance Practitioners says about how even well-trained dancers will be confounded when told to improvise because flow and chore-

ography are a separate set of skills from technique.

8.3 Summary

In this final empirical study, series of sessions were held with several practitioners across a dance, martial arts, and circus arts. Paired up by discipline, each group tested at least one of the three interventions, then were invited to discuss their experiences afterward.

8.3.1 Design Takeaways

This study provided the following design insights:

- Virtual embodiment can affect the quality of practice, so avatar design needs careful consideration.
- System and Hardware: tracking, tracked objects, and tracker objects are particularly crucial in augmented bodily practice.
- Environment and UI: allowing users to toggle certain objects off and on accommodates changing needs and focuses during practice.
- People: Features to support direct interaction between users, such as being able to hold up striking pads for each other, can carry over some useful aspects of the tools used in situ practice. Controlling how much the user or other users appear present can help with social anxiety during practice.

Review: Features which allow users to record and review their performances can be helpful feedback, allowing the practitioner

to inspect their performances from a third person perspective so that they may improve.

Part III

Reflecting on Augmented Bodily Practices

Chapter 9

⟨Un⟩Realism of Virtual Experience

9.1 Introduction

Replicating "realism" has been a prevalent end goal of virtual reality development. If one follows the history of VR, this makes sense; Sutherland's influential paper introduced the concept of an "ultimate display" which could completely immerse users in a synthetic reality and could even manipulate physical matter (170). In the decades that followed, much of the work done in virtual simulation training was created for the purposes of more cost-effective and low-risk military training, where many of these interventions needed users to believe to some degree that the simulation was real in order to maintain the desired level of psychological fidelity (12). And two of the three dimensions in Milgram and Kishino's taxonomic framework for classifying MR displays (126), Reproduction Fidelity and Extent of Presence Metaphor,

are respectively exocentric and egocentric indicators of reality. It is also much easier to develop features for the external senses which are objective, controllable, and measurable compared to the rather subjective internal senses; one could measure the amount of auditory output by decibels, but equilibrioception varies by the individual, making it easier to design for an objective reality and thus perpetuating the standard.

Whether intentional or grandfathered in, both academia and industry have placed much emphasis on realism as a dominant design aim, with concepts such as presence, immersion, and fidelity used as defining characteristics, if not evaluative measures, as seen in the earlier literature review (Chapter 5.) Within HCI research there have already been arguments against continuing to use reality as a conceptual model for VR because of the constraints on designers (119), but commercially this standard persists.

The interventions used in this project were not designed to be ultra realistic, indeed they were designed to be deliberately quite abstract, partly through the limitations of the technology but also to reflect the necessry flexibility guidelines determined through Interviews with Dance Practitioners and VR and Soma Design Workshop. Some features which were meant to accurately reflect elements of the real world, such as the movement of the controllers or the representation of the user's body, were in fact missing or unreliable. While the various technical challenges certainly presented problems - which may well be overcome as the technology matures - there were many surprising instances or glimmers where participants found the seams and blurring between virtuality and reality to actually be helpful for their prac-

tice sessions in ways in ways not possible in traditional or remote video training sessions.

9.2 Chapter Overview

This chapter consists of the following sections:

- Introduction: Revisiting the history of VR and realism as a design standard, and how this research suggests an alternative conceptual model of VR.
- Attentional Emphasis and De-emphasis: When it comes to creating a VE for bodily practice, less is more.
- To See or Not to See: The level of fidelity of elements within the VE has a non-linear effect on practice.
- Personalization: A design framework on the relationship between movement and area of focus is proposed. The argument is then made that it would be better to acknowledge that users will shape the system to their own practice, and future VR technologies should empower them to do so.

9.3 Attentional Emphasis and De-emphasis

9.3.1 Study Insights

Theme: Imperfect VR is still Useful showed how the participants made use of elements in the VE even if they were not following the designer's intentions. P1 described how the minimalist VE

gave them "enough of a room to keep balance," while the jittering movements of the spheres representing the controllers taped to each end of the staff prompted them to go inwards and focus on the feeling of the figure-8 spin, after which they displayed improvement in the execution of the skill in terms of fluidity and speed of movement, as well as ease and relaxation in the body. In trying to learn the same skill, P2 described how the spheres were "big and bright" which he claimed enhanced his enjoyment of the staff spinning; these "big and bright" spheres captured his attention such that they added motivation to the practice.

In Practice Sessions with VR Interventions, P1 spent his time in *Dance Tools* building a training dummy out of the shapes provided, only to not use them when teaching P2 in their session. When asked why he made this decision, he described how he did not want to overwhelm P2 with too many things, as she was only being introduced to the general movements and the targets would have been appropriate after she developed a certain level of skill first. Additionally, P2 talked about how the shapes were distracting because they weren't being used, and though they were already to the side, wished that they were not there.

The pair of aerialists of G3 shared how removing the body and the aerial hoop from view helped shift attention from outwards to inwards. Namely, P5 was able to attune to the sensations of the aerial tricks rather than looking at her limbs and the apparatus. P4 described this pushing away of the external appearance to focus on felt sensations as being a necessary part of development after the student has acquired a broad idea of the positions and movements.

It can be seen from these studies that attention is a precious resource that the practitioner must consciously decide on where to place it for their practice to be productive, and it does not take much to draw attention away or scatter it. While some participants who were less familiar with VR initially displayed some excitement from its novelty, the way they used VR was more pragmatic to the needs of practice. Even when more features in the VE were available, participants stuck with what worked for their needs, changing only if the features no longer served them.

Indeed, as found in Interviews with Dance Practitioners, practice often does not always need the practitioner to have extensive interaction with the environment at all times. Teachers who were interviewed described how they would utilize de-realization tools to take students out of reality, such as asking their students to visualize themselves as a like a "waterfall that goes upwards" as brought up by P1. P8, who taught classes online during the pandemic even noticed how due to the camera and space restrictions, her students couldn't see her entire body during demonstrations, forcing them to fill in the gaps themselves. Upon their return to in-person classes, she was surprised how they developed "a better understanding of their bodies moving in 3D space." She contrasted this with pre-online classes where her students would try and ask about every single detail of what she was doing, which arguably meant that they divided their attention too much at too many irrelevant things, even though they had more complete information compared to their online classes.

The findings in this research about how the practitioner's attention is a precious resource resonates with existing skill acquisi-

tion and motor learning work. Specifically, findings from Lappe et al. (104) emphasize the importance of parameterizing and limiting the trainee's attention at many phases of learning and training, especially for beginners when they are learning a new motor pattern. Dayan and Cohen (51) found that to maximize the benefits of neuroplasticity, a few minutes of quiet idle time in a non-disruptive environment immediately after practice allows the motor neurons to process the movements undertaken. Full immersion in the expected performance environment has an important place in training, but actually makes up only a small portion of practice.

9.3.2 Practitioner Reflection

Attention is a funny one for me because I am diagnosed with ADHD, or Attention Deficit Hyperactivty Disorder. It's typically defined as not being able to pay attention to anything. Another version, which I think is more accurate, is being unable to not pay attention to everything REF. While these two may look the same on the outside, the lived experience of the latter means that everything is demanding your attention, constantly and simultaneously. Though this comes with many advantages, it is also chronically exhausting to be in certain environments, and supposedly what causes so many side effects such as executive dysfunction (being physically unable to make a decision even though your brain is screaming at you to make a decision, any decision) or auditory processing disorder (hearing too much sound, so your brain doesn't process any of it clearly or processes it slowly) ALL THE REFS.

I don't know whether to be hopeful that these findings may lead to more VR experiences which turn the volume on the world down, or to be suspicious because of my positionality. But think it's safe to say that ironically, I pay much more attention to the topic of attention than average, and especially to environments which foster concentration. So as a bodily practitioner, I can say a few things with certainty. Firstly, the studios, dojos, and other places of physical practice are relatively minimalist environments with little clutter, except for the objects which are needed for practice, at least out of all the places I've trained. It is at best impractical, and at worst hazardous, to have space taken up by something which does not serve some function of the training. This can also include objects which are indirectly relevant to the practice in some way, such as certificates that the instructors were awarded, an inspirational quote on the wall, or a neon sign and phone tripods. Though they're not strictly part of the learning, they are meant to enhance the space for its intended purpose, to reassure students of the sensei's credibility, to encourage students at a moment their eyes are wandering, or to invite students to show off their hard work on social media. They are not meant to steal your attention and detract from practice. To repeat what my karate classmate from Study 3 said in his interview, *"a room is useful for its emptiness."*[1] Distractions are also discouraged. It is, from a sensorial point of view, soothingly quiet and much easier to focus. And, assuming the community I'm with is also good, it is where I feel the most effective at learning and refining my martial arts and aerial skills. So it makes sense that a VR system meant to help people with their training would also have

[1] This is likely a reference to Lao Tzu's classical Chinese poem, *Tao Te Ching*.

these characteristics.

9.3.3 Insights and Takeaways

With the points above laid out, there appears to be some conflict between the values driving VR technologies and the processes of bodily disciplines. On one end, where much of VR design stands, is full sensory immersion. On the other end, where bodily practice often (but not always, depending on the training protocols used) stands, sensory isolation and selective focus are prominent. As a result, the current design of commercially available VR headsets and experiences aim to saturate the user's senses with enough synthetic environmental stimuli to drown out the real stimuli, whereas bodily practitioners may actually require deliberately limited stimuli, aiding them to focus their attention and limit distractions. For many individuals such as Calyx, trying to focus on bodily practice in the idealized "real" environment would be at best full of distractions and at worst sensory overload. To quote Witmer and Singer (193), "A VE that effectively isolates users from their physical environment, thus depriving them of sensations provided by that environment, will increase the degree to which they feel immersed in the VE." At the time, this was meant to advocate the push for completely overlaying the existing senses, in turn driving VR towards the far end of the continuum proposed by Milgram et al. (126). But this quote could in fact be reinterpreted to say that *limiting* the senses can help with immersion, and that non-perfect recreations could be of value.

This is not to discourage realism as a design aim. It undoubt-

edly has tremendous benefits, for it would not have repeatedly appeared in applications such as military training, exposure therapy, and entertainment. This is just to say that designing for unrealism, detachment, and fuzziness between the real world and virtual environment is not without benefits either, at least within the application of bodily practice. Rather, it could be argued this is an opportunity to introduce another design value in the creation of VR technologies: **authenticity**, a term borrowed from (75) who argues that a "VE designer who understood observers' assumptions and priors for the real world could emphasize only features that leverage those expectations and leave out irrelevant features. The resulting VE could have lower fidelity but higher authenticity than even a real environment, since the signal-to-noise ratio for relevant world features would be much higher in this cleverly designed VE than in the real world, which is full of distractions." The VR game *Corrupt Kitchen* by Flintham et al. (67) showed that lack of high fidelity was not detrimental to the player experience as long as the game has the right "feel." *Corrupt Kitchen* created tension with time and environmental pressures even though the bodily task of cooking was simplified down to a very abstracted process. Players reported that it really did feel like a kitchen, not because of the fidelity, but because of the pressure, therefore making the game feel *authentic* to the tone of working in a kitchen.

9.4 To See or Not To See

9.4.1 Study Insights: Fidelity of User Bodies

During the interviews in Practice Sessions with VR Interventions, a relationship between the visibility of one's own body and how it influenced uptake of the learning material was mentioned by participants several times. These instances were listed and charted on a graph where body representation and familiarity of learning material are shown (Figure 8.4.) While one may think that the more tracked, the more complete, the more realistic the avatar, the more beneficial the intervention would be. But one can see that there were a considerable amount of instances where low fidelity or absent avatars were actually beneficial.

To help visualize this relationship, a graph derived from Figure 8.4 is presented in theoretical form in Figure 9.1. Again, this relationship is displayed orthogonally with the representation of the user's body as the x-axis and the familiarity of the practice material as the y-axis. Note that the left side of the graph includes an area for unrealistic or fantastical avatars. There is certainly interesting work on inhabiting a virtual body that is different from one's own, from self-representation in social VR (139) to the psychological and physiological effects of non-human avatars (195), including animal bodies (99). It was also briefly discussed in one of the interviews from this study. However, this was not a central focus of the studies conducted, though it leaves an open question for future work. The inclusion of the "unrealistic/fantastical" label in this chart is simply to show that this variable does not stop at complete disembodiment, but instead can become increasingly different from the user's real body.

In general, one would assume that any remote learning intervention would help the practitioner move up the y-axis, that is, to help

them gain familiarity of the practice material. It is important to note that this relationship is not fixed or universal, however. A relatively advanced practitioner can be given a straightforward drill, which would place them very high on the y-axis. But the same practitioner can be placed lower on the y-axis if given the same drill but asked to double their speed, and even lower still if given an estranged version, such as performing the drill while balancing on a flotation device in a swimming pool. Such an instance occurred in (175) when one of the authors gave the following account after walking on a balance beam with an actuator attached to his body: "I've been able to walk tightropes and balance beams for years, but when someone put the vibration on my foot, suddenly I was like a beginner again." This reintroduction of uncertainty for virtuosos (71) was also used in VR and Soma Design Workshop for P4 and P5 who already knew the staff spinning technique.

There may also be pedagogical differences which determine whether a certain level of avatar fidelity is helpful or unhelpful. In Interviews with Dance Practitioners, P11 discussed how a "big problem" in dance was how practitioners can be "prisoners of the mirror," (see Theme 3: Dual Approaches) and relied on visual input to correct themselves, rather than feeling their muscles engage proprioceptively, and they were therefore "losing the feeling of dance." But P12 described how a mirror was absolutely crucial for self-correcting one's technique, and if a dancer doesn't have one while practicing by themselves, they may ingrain bad habits. These conflicting views on using a mirror to correct oneself in practice is unsurprising, given P12's background in competitive

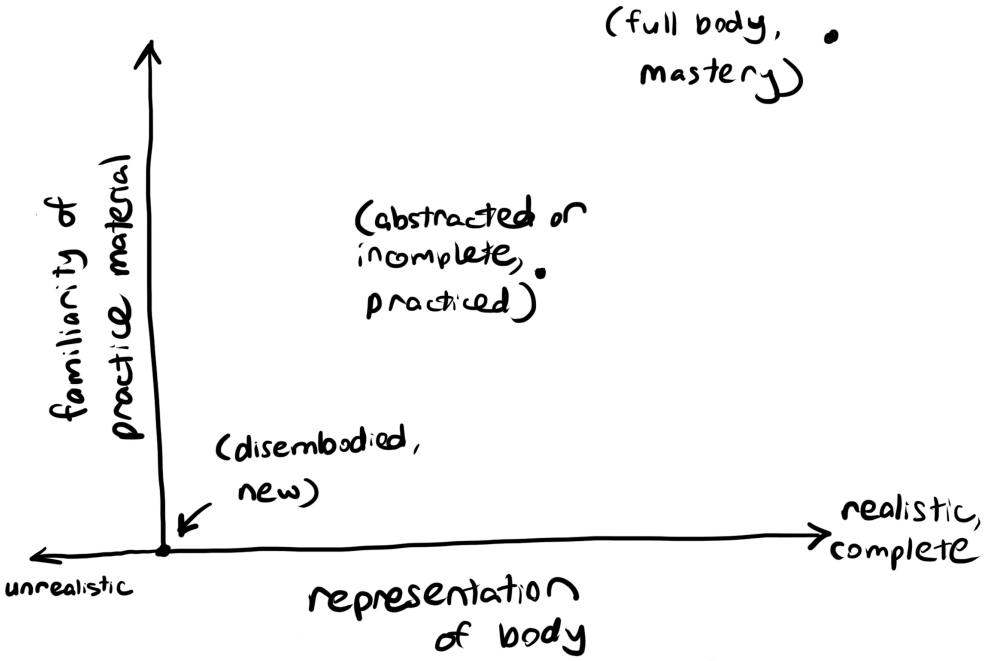

Figure 9.1: Proposed mapping to represent the theoretical relationship between user representation and practice material

ballroom dance which has very strictly defined vocabularies for movement and emphasis on external performance, while P11's background in contemporary is the antithesis of this, having dancers break conventions, innovate, and individualize.

This is indicative of a larger contrast of thought in bodily discipline training, which was discussed at length by several participants in Interviews with Dance Practitioners) and overviewed in Theoretical Background of Bodily Practice. It was found that much of this is influenced by the goals and context of training. For instance, P9, who used to be a competitive ballet dancer, described how it was more profitable for ballet schools to train their students to win competitions as it was more marketable to parents, thus changing the landscape of ballet learning to be very competition and career-focused. In Theme 1: Normativity, it was seen how standardized expectations for what dancer bodies should be

able to do created body standards that could exclude some from participation.

Mirrors are already used in current VR experiences, such as in *Asgard's Wrath 2* (73) and the default Meta Quest environment which presents users with a mirror to view their avatar. The latter case uses inverse kinematics to make the avatar seem as if it is moving naturally, but this solution lacks the exactness necessary for bodily practice. One interesting possibility as MR headsets improve would be the use of augmented virtuality (126) where it is possible to create a window back into the real world. If one were to align that window with a real physical mirror, users would be able to see themselves in the VE, which would theoretically be quite useful for this purpose.

9.4.2 Practitioner Reflection

This is tough because I agree with both the contemporary dancer and the ballroom dancer with regards to mirrors. I wouldn't eschew mirrors entirely. They are incredibly useful to have as a reference point for certain parts of practice where you just need to see yourself from a third person perspective. This is a very broad generalization but after getting the overall feeling of a brand new technique, I will occasionally look at my reflection to check in and compare it to the teacher's version and make any corrections I think I need. This has especially been the case for early stages of my karate and pole training, though much less so later on. Although I almost never used mirrors in early HEMA practice because my biggest challenge going from unarmed martial arts to armed

styles was getting used to effectively having an new limb with its own weight and balance point, and adapting to that was all by feeling. Also, I know these aren't performance arts per se, but in conditioning sessions like weightlifting or flexibility training, I'll watch my reflection the entire time as I do a few repetitions to make sure nothing is out of alignment and that I don't injure myself (see **Health and Safety** in Theme 3: Dual Approaches.)

In my pole dance studio, as soon as the doors open, there's a rush for people to go to the back and claim a pole next to the mirrors by placing their phone, water bottle, or other belongings next to it before returning to the entrance to change and pay for the class. Only three of the ten or so poles are next to the mirrors, and the lighting is better for recording yourself, so they're prime spots. Because having floor to ceiling mirrors at home isn't something that's very common, it would be great to have a clone or reflection feature in whatever VR tool you're using for practice. Just make sure that it can be toggled on and off, because in my experience it's more like a thing you use to check in with yourself rather than something you should be staring at the entire time.

That being said, I don't think designers should prioritize perfect body representation over building a platform with solid training tools and communicative features, even with limited avatars. Just like how I would find a studio with an embarrassment of equipment in it to be much more useful and versatile than a barebones studio with floor to ceiling smart mirrors on all of the walls, with an AI trained to detect when I've done a movement right or wrong. Sure, in the mirror room I'd know very quickly if something looked wrong, and depending on what it is I can easily correct it, like if

I placed my foot in the wrong spot in a karate stance. I can just place my foot where it should go.

But if it's not straightforward, like executing a head-level roundhouse kick sloppily, I'm more limited in how I can go about fixing it. Sure, I can just keep trying it over and over again, watching myself in the mirror to see if improved. But that's a much more complex problem which isn't going to be solved by seeing how I look in the mirror. Is it my balance or coordination, both of which require me to focus inwards on how the movement feels? That's going to be pretty hard to do if the room is full of mirrors. I could close my eyes but that introduces more difficulty to the kick than my current skill level might be ready for. What if it's my mobility? That's going to take conditioning over several months to develop, and while I will need the mirror to periodically check my progress, the actual conditioning doesn't require it.

Here lies a tension for the designer. As a hypothetical example, if there were an intervention which could perfectly track the movements of a user and compare them to an "expert" practitioner, then showed the differences to a user, should it be built? If so, how much tolerance in difference would the system need to allow for it to be useful? Who would determine the experts to be used as the templates for the system? Research explored in From a Skill Acquisition Perspective showed that individuals will make self-corrective adaptations to accomplish the tasks being practiced, but this does not happen if practitioners are made to follow a movement template from an idealized demonstrator body (49; 157). However, the bad habits theory still persists in popular culture and more importantly, in practice. It is not inconceiv-

able that such an intervention would be commercially successful, at least initially. But the potential of such an intervention to perpetuate these myths and exclusive bodily discipline practices raises ethical concerns about perpetuating unrealistic and unhealthy standards (see Theme 1: Normativity.)

As an aside beyond the pitfall of problematic body standards as discussed in Study Insights: Fidelity of User Bodies, some bodily disciplines are imbued with unique traditions of exclusivity as aspects of their cultural heritage and specific processes of knowledge sharing, which may create interesting dilemmas when translating them into design applications. An extreme example would be some pre-19th century styles of samurai martial arts, known as *koryū*, which are forbidden for most people. Even amongst practitioners, the most sensitive information is shared with only a select few. If somehow, a student and teacher needed to hold training remotely, security and identity verification would be a major concern. Designers should give serious consideration on the implementation here as well and work to gain a deep understanding of the communities they are creating for, then design accordingly. As seen from Interviews with Dance Practitioners, culture is critical. It is both the driver of evolution and the shaper of practice. As such systems need to either be sufficiently abstract as to not cause cultural concerns (such as *Dance Tools*) or be precise, they need to be imbued with a recognition of the culture and associated norms they are supporting.

We need to revisit the mirror thing. Especially the hypothetical system that could track all your movements and let you know what's right and wrong. At best, I might use that intervention for a small

part of practice, like if I'm learning some new movements, or if I'm preparing for a performance, but that leaves a big gap for the rest of what I need to do. The only exception to this is modeling, or I suppose any other static, motionless performance, because the mirror is pretty much WYSIWYG[2] for what the photographer would capture on camera. But in that case, it would be stupid to use VR. I'd just use a mirror. And there are plenty of times where I need to actually **not** see myself, whether it's self-consciousness getting in the way or if I'm just trying to concentrate on something else.

9.4.3 Study Insights: Access to Tools and Other People

One of the prominent issues of the Reality-Virtuality Continuum (126) is its assumption that interfaces especially towards the virtual end are blocking out the real world. However, one may wish to interact with the real world despite this. Milgram et al. (126) present the physical world as consumed rather than necessarily interacted with, which presents a problem when the intervention has a mix of physical and virtual content, not to mention users in different parts of the spectrum participating together (119). Aside from solo practice, most bodily discipline training exists as shared experiences. Additionally, the default model of VR HMDs are arguably designed with dualist assumptions (85), by encasing the eyes and providing controllers for the hands (or hand tracking); this is assumed to be enough to transport a user

[2]"What you see is what you get" refers to a type of user interface design that allows users to see a document or webpage exactly as it will appear in its final form in the editing process. In this case, Calyx is using the term metaphorically.

to a different reality even though the rest of the body is left out. Headsets such as the HTC VIVE Pro offer various trackers that make it possible for users to have full body tracking, but these are categorized as accessories and not a given. Inverse kinematics may be used to give the user a "body," but since tracking is limited to the head and hands, there can be quite significant discrepancies between the real and virtual bodies which is unhelpful for bodily practice. Because conventional VR experiences are meant to be standalone, rather objective realities, there is little to no integration of the physical world other than safety considerations such as the Oculus guardian which appears if a user gets too close to the play area boundaries.

These issues manifested themselves throughout the test sessions with practitioners in Practice Sessions with VR Interventions, due to constantly changing needs in the degree of presence of real world elements and other people throughout, thus flexibility of access and dynamic blending of real world and virtual world components becomes a requirement. Just like the level of virtual embodiment influenced uptake of the practice material, so was the representation of other elements of the physical environment, both real and virtual.

A prominent example of an instance where flexible presence of a training apparatus would have been helpful was that of G3 and their aerial hoop session. There were safety concerns with not being able to see the hoop. Using the controllers as motion trackers for the hoop, as they were used for the sword sessions, would have been unwise given their tendency to jitter or lag, as it would be more dangerous to have a hoop displaying in the wrong place

than to display no hoop at all. So the instructor stuck to moves which the student already knew but could refine further, relying on the feel of the hoop and proprioception to navigate their bodies. Although review sessions are a crucial part of training, an intervention which forces the users to scope the practice material to movements they have already learned would be very limiting as no new material could be learned. Despite this, the student reported great satisfaction and novelty in performing some tricks without seeing the hoop, as she felt as if she were floating free in space. It was later noted in the feedback that it would be helpful to be able to switch the hoop on and off. Again, with newer MR headsets, this could be done with chroma-keying, where the objects are painted a specific color and displayed through the VE as augmented virtuality. However, the only MR headsets with this capability during the time of the study were wired, which would have not been ideal for aerial practice.

Limited presence of the instructor and other individuals was also shown to be unhelpful and helpful depending on the scenario. P8 from Interviews with Dance Practitioners shared how teaching their dance students through Zoom with limited space meant that her camera gave her students an incomplete view of her, which proved to be beneficial as it forced them to "fill in the gaps for themselves" and not worry about all of the details on what she was doing. Upon their return to in-person classes, she was pleasantly surprised to find that they had greatly improved their understanding of "their own bodies moving in 3D space" even though this skill was not something they explicitly worked on. This reenforces the current notion in skill acquisition research that learn-

ing uptake is improved when attention is limited to only a few things at a time (104). This principle can easily be carried over into VR.

The social isolation that users can feel in VR can also be helpful if the student finds it stressful to practice with others around, even if it is necessary. In VR and Soma Design Workshop, P5 described how she experiences "stage fright" and found that the social pressures of performing were lessened because the instructor and classmates were not perceivably present even though P5 knew they were in the room with her. They were somewhere between there but not there– enough to supervise, without triggering her performance anxiety in a way that would negatively affect her learning. Incremental control of presence can serve to soften social difficulties associated with group practice.This has already been observed in the VRChat dance scene where users who typically do not find in situ clubbing to be appealing were happier with the various levels of detached sociality afforded to them by attending a virtual club (139). Though in collaborative settings, designers should take notice that there are quirks to not being able to see other bodies in the space, as demonstrated by the Practitioner Reflection in VR and Soma Design Workshop where Calyx describes a sudden need to make herself known to the student prior to touching her, albeit through the Soma Shapes, as the student was unable to see Calyx approaching. Features which aid users in explicitly giving consent to certain types of interactions could be implemented as part of the incremental controls over virtual presence.

It may also be useful for designers to think about how practition-

ers may need to be displayed differently to others in the VE depending on the activity. As an example, after the Japanese sword session with G1 in Practice Sessions with VR Interventions, the instructor described how he would switch between viewing the student from third person perspective to the first person, depending on what aspects of the strike he wanted to observe. In this case, one can imagine a feature which enhances the intercorporeality (172) of practice by providing the teacher an option of different views to better access the student's performance, or for a student to better absorb a teacher's demonstration. With G3, the aerial hoop session, the student found it helpful to not see her body at certain points in practice, especially when the instructor wanted to focus on certain feelings of movement, such as engagement of her quadriceps muscles to keep a firm point of contact on the hoop. However, the instructor still needed to closely watch the student, thus still required a clear and accurate visualization of the student's body. In this case, implementing a version of subjective variability (26), where the student could display herself as invisible, but the teacher could keep the student's body visible, both within the same environment, would be useful. Individual configuration of bodies in the VE would also account for hardware discrepancies between users, a situation in which Benford et al. (26) originally described the term. However, designers will want to be mindful of indexicality if users are presented with different experiences while collaborating (177).

Evidently, this dynamic weaving and unweaving of virtual and physical elements throughout a practice session is a necessary design consideration given the findings of this project. A progres-

sion of the Soma VR toolkit used in VR and Soma Design Workshop then, would be an XR toolkit which can fluidly move between reality and virtuality. Fortunately, consumer products which combine more XR capabilities into VR headsets are just starting to become available for household use. For example, Meta's Oculus Quest 3, the successor to the headset used for this work, contains a full-color passthrough camera which would allow the overlaying of virtual elements on top of a physical world view. The HTC VIVE XR Elite, which also was not available at the time the studies were conducted, offers the same. This is a promising trend for using such devices in bodily practice, and designers wishing to take advantage of features such as toggling objects to be visible or invisible, for instance, will be able to implement them. However, it remains an open question as to how camera passthrough would affect personalized bodily practice. There also does not appear to be much information about full body tracking solutions, such as more numerous and less obtrusive motion trackers to integrate the rest of the body or practice tools. Still, much progress is being made with deep-learning webcam body tracking solutions such as MediaPipe (goo), OpenPose (git) or YOLOv7 (185), which in due course could provide accurate body (and potentially object) tracking to support showing accurate body position in VR.

It is unclear where the technological limits of emulating haptics are. This might ultimately mean that some bodily disciplines will be more remotely accessible than others. For instance, consider the difference between dance styles where contact is made for the purpose of sending information between partners, compared to dance styles where kinetic energy is transferred between the

partners, such as in Lindy Hop where it is simply impossible to perform many moves alone. It would be much easier to create a remote intervention for the former than the latter. Despite all this, the limitation may not entirely be a bad thing. It could create a point where lineage splitting in dance styles and other bodily disciplines occur, where new forms of movement shaped by the technology emerge, as P9 and P11 in Interviews with Dance Practitioners speculated. This can already be seen in VRChat scenes where "half-body friendly" dance classes are available to users without full body tracking. (139)

Haptics are broadly split into force-based and awareness-based systems. Force-based haptics require something to push back - e.g. to transfer kinetic energy. Systems like the Phantom 6DOF haptic pointer (3ds), exoskeleton systems, and others have been developed, but these are unlikely to ever be consumer products. While there is some possibility around robots (such as the Mueller and Walmink (130) sword fighting robot), these are likely both too expensive and too dangerous to ever be in public or home use, at least not for the foreseeable future. On the awareness-based haptics side, most consumer VR systems have built-in vibration to their controllers and this can be extended in various ways such as haptic vests or suits (tes) that can be quite sophisticated, but can only simulate stimulation without actually transferring real force. Finally, there is the use of props, or passive haptics (even if the prop may be active or adaptable in some way) which can simulate, for instance, the weighting of a sword. These work well for objects we interact with, but less well for representing people.

Even if high fidelity haptics could be created, there will always

exist the tension between the norms of practice and technological designs. Luft et al. (116) observed in their creation of an interactive training dummy for martial arts practice that the dummy also shaped the first author in his martial arts practice through its use. So, because interactive technologies "shape our cultural expressions and... they start to shape *us*," (87) it is not beyond the realm of possibility that categories such as physical-only dance and virtual-only dance could arise, as could cultures and new norms unique to each, providing exciting opportunities for future research. Designers looking to intervene with the practice of bodily disciplines should know that it is not possible to build tools to support a practice without the tools themselves somehow shaping the practice. More specifically, they should be mindful of *how* their designs may shape practice and become woven into the evolution of bodily practices (see Theme 4: Practice Adapts.)

Haptic feedback was a much discussed feature in all of the studies, and for certain situations, was more important than the visuals. Interestingly, WOz-style haptics were offered to participants, but none of them in Practice Sessions with VR Interventions used them. This could be due to shyness or awkwardness of prodding a student, or the foreignness of using a human to emulate a computer, as the soma design researchers in VR and Soma Design Workshop did not find it strange.

P12 of Interviews with Dance Practitioners, whose specialty was ballroom dancing, discussed the importance for leaders to be able to "show your intentions" nonverbally through touch, and for followers to be able to "read" these signals. The pair of HEMA fencers in G5 of Practice Sessions with VR Interventions emphasized how

contact with an opponent's blade is rich with information and informs the fencer on what actions they should take, and learning how to read these elements are crucial for sword fighting. P9 provided an example wherein he talked about how it feels completely different to fight with LARP swords as they are commonly made of foam and therefore cannot be used the same way, since much of the steel techniques "goes to trash." P8 conceded that lack of detailed haptics in their test session would be acceptable in scenarios where learning to read the information given through the contact of an opponent's blade was not the aim of the exercise, but tested response to visual stimuli, such as reaction training or footwork. So it is imperative to have high fidelity haptics to emulate the sword of the opponent, including not only the amount of pressure, but also the direction of force and accurate material feeling of the blade. But as with the fidelity of user avatars, there are some instances where it is beneficial to strive for intentionally inhuman-feeling haptic feedback. P5 in VR and Soma Design Workshop described how she felt that the Soma Shapes provided enough social distance to make them feel like they were not a "human touch," allowing her to retain the illusion of practicing like no one was watching.

9.4.4 Practitioner Reflection

I struggle to regularly practice anything by myself. When I was headed towards *shodan*[3] in karate, one of my peers explained that much work at that point is self-reflection and solo practice, which promptly made me shrivel away at any prospects of pro-

[3] First degree black belt.

motion. It might be why I was happy to become a white belt at a new school when I moved, when some others tend to ask about retaining their rank. I used to think that this inability to maintain solo practice was a lack of discipline, or that I was too incompetent to be my own teacher, and it was a failure of character on my part. I am also in the awkward position of getting social anxiety practicing in front of others. Most of the time this is not debilitating, but it can present itself rather severely under particularly stressful and unfamiliar conditions, like the times I've had to perform kata in front of the entire class by myself. The performance scenario isn't even usually something that's explicit, there can just be moments of silence and then people's eyes wander to the few who are still trying something, or a tendency for students to keep watching the instructor even if they're working with you individually for a minute. So I find it a struggle to practice alone, but also to practice and perform in front of others. A very frustrating predicament.

The times I've felt the most growth and self-efficacy in "solo" practice were the times the teacher or a peer was present for me, but not necessarily instructing or even actively perceiving me. I just found it comforting to know they were there if I needed them, but otherwise kept me in their periphery. After receiving my ADHD diagnosis a few years later, I now understand that my struggle to regularly practice solo is likely due to executive dysfunction (153). Lo and behold, a popular strategy for coping with this is body doubling (58; 134), where another person who knows what you are doing is present, though they don't have to involve themselves in the activity. In retrospect, it's laughably predictable that I would design something like *Energy Beast* which does not have the pres-

ence and perceptive abilities of a human, but moves and cues movement from me like a dance partner. As a pseudo-sentient ball of energy, it can both be there but not really be there, and that's perfect for me.

9.4.5 Insights and Takeaways

From reviewing the practitioner test sessions of the interventions reported in VR and Soma Design Workshop and Practice Sessions with VR Interventions,it became apparent that the desired presence of certain objects or other people in the VE changed dynamically as the session unfolded, influenced by factors such as learning emphasis, exercises, and task troubleshooting. Additionally, the alteration of objects and other people within the VE depending on the needs of the individual necessitates the capacity for asymmetry in any intervention that is meant to support multiple practitioners. Because of this, a second design value is proposed: **subjectivity**, where users have independent configuration of the elements within their displayed VE.

One way to think about subjectivity is through the fidelity of user body-familiarity with practice material relationship (Figure 8.4) within the unique context of the practice and the individuals involved, which could then inform how to implement avatars, and to what degree of flexibility the system should have in rendering them. How many points of tracking should the skeleton have for an actor, compared to a fencer? Or a novice fencer to a master fencer? Or even two different fencers with the same level of experience, acknowledging that they are separate individuals with

their own learning needs and preferences?

On the high end of body fidelity, there is also the tension between the practitioners involved in this work with regards to mirrors. Some say it is impossible to do any form of solo practice without one, such the ballroom dancer in Interviews with Dance Practitioners. Whereas in the same study, one of the contemporary dance teachers as well as this project's industry partner advised caution against relying heavily on mirrors as a form of feedback. HCI designers will inevitably have to make decisions which encounter this problem.

Let's not beat around the bush: seeing how you look and whether you're following the movements correctly really just is one method of feedback, and it can't be the only one in a good regimen if you want to develop a fuller understanding of your body and your practice. It's literally superficial feedback and mastery of bodily disciplines go so much more beyond how you look.

And on a personal level, if the emphasis of my training forces me to look at myself, I will spot imperfections no matter what (see From a Skill Acquisition Perspective because I will compare myself to my teachers, or the students who have been doing this since they were three, or the Instagram star I follow. I'm just going to be really discouraged and quit. And I don't think that's right, because karate, circus, HEMA, and bodily disciplines in general are supposed to be for everybody. Not just the people who could execute everything flawlessly according to an arbitrary standard. Just as (P6) said in my chat with her from the very first set of interviews, "Nobody owns movement" and we should be honoring the

diversity of practitioners and approaches to practice. If we have the chance to make entirely new ways of training, I think it would be at best a waste, and at worst incredibly harmful and exclusive to continue paving the well-paved route of movement templates and ideals.

9.5 Personalization

9.5.1 Study Insights

In the early stages of this project, there was a question of how practice could consist of highly codified and rigid movement vocabularies, but still result in the emergence of a practitioner's personal style. Conversely, there was a question of how very open-ended and exploratory practice resulted in tangible skill development. In an attempt to reconcile these seemingly opposite approaches, i.e. the traditional and contemporary teaching approaches, the following sketch, Figure 9.2, was drawn to visualize how these approaches might connect. This was based on the findings of Interviews with Dance Practitioners in the themes Theme 3: Dual Approaches and Theme 4: Practice Adapts, as well as critical reflections from Calyx's classroom experiences across her somatic practices in martial arts and aerial arts. This sketch provided a framework from which, as Benford et al. (28) describe with regards to performance-led research, provided "sensitizing concepts" which guided analysis of the work that followed.

The graph consists of two polarities: the dimension on the **x-axis** represents where the **practitioner's attention** lies, and the range

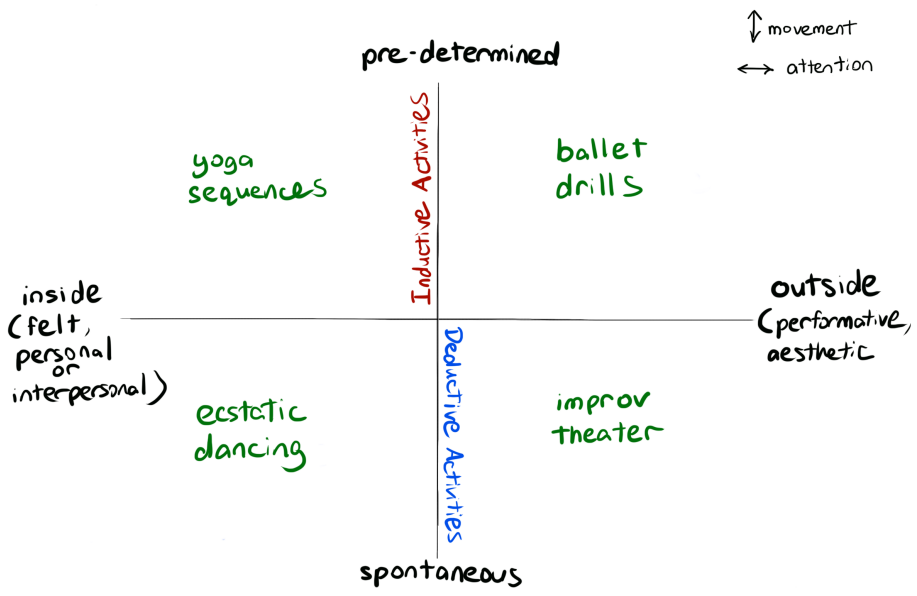

Figure 9.2: The proposed bodily practice design framework. The terms in green text are merely examples of an activity which may fit that quadrant and not meant to be all-encompassing.

goes from inwards and (inter)personal to outwards and performative; the **y-axis** represents the dimension of **movement**, which can range from pre-determined or codified, and spontaneous or instinctive. As intended, the framework includes the two seemingly opposite approaches (and everything between them) for developing personal movement and style in physical skill acquisition.

Furthermore, a horizontal bisection of the chart divides the upper half and lower half into highly codified movements and spontaneous or instinctive movements, labeled respectively as inductive and deductive activities. Inductive activities can be labeled as such if they describe the assignment of certain movements, from which the student would hopefully understand the overall principle, such as P2 of Practice Sessions with VR Interventions, the student in the Japanese sword session, who was given a specific

stance with a pre-existing name, and repeated it enough times to eventually understand the application of the technique, which in this case was threatening the opponent and keeping distance, an understanding which helped her further refine her execution of the movements. Deductive activities are labeled as such if the movements stem from general ideas, feelings, or principles, such as the visualization activity of being a waterfall moving upwards that P1 described in Interviews with Dance Practitioners. Movements can be taken from these activities and codified, which is how P6 of Interviews with Dance Practitioners described her method for creating a choreography. The inductive-deductive labeling used here is comparable to the Didactic-Democratic spectrum proposed by Butterworth (33) for tertiary dance education.

From these examples one can see that even if practice starts at a fixed position, it may lead or push practitioners around multiple parts of the model, representing the change of focus over time. This can occur within a session or in gradual shifts throughout a series of sessions.

This graph has provided a useful framework for scoping the work's design interests identified from the exploratory phases of this project:

1. inclusivity of user group
2. compatibility with most bodily disciplines
3. capable of mixing and changing pedagogical approaches

One should note that the polarities of each dimension are not mutually exclusive in actuality; a practitioner can exist in multiple

places on the framework simultaneously. For example, a hip hop dancer's movements during an improvisational session might be done without prior rehearsal, making them spontaneous, but the use of existing movement vocabulary within hip hop styles can also make them pre-determined. Rather, discrete points on the graph can be used to represent the focus or pedagogical aims of a certain activity.

With this in mind, the framework can be used to articulate the function of an intervention during one's personal practice. As seen in practice, interventions do not need to be designed to keep the session in one spot of the framework, but could guide a practitioner through traveling around the framework for a mixed practice. A lesson might define a canonical trajectory (27) - aiming to move a learner from, for example, the top right to the top left, i.e., moving from performance to introspection to get the learner to focus on how it feels to do particular actions. Whether the user trajectory actually matches this will depend on how well the design of the system and lesson work, and the particular learner, but it would certainly match intention. P3 practiced in a mixed session during Practice Sessions with VR Interventions. He used the particles in *Star-Stuff* and *Dance Tools* as prompts for improvised dancing, but used *Dance Tools* for technique work partially because "there's no movement, it's kind of asking me to make the movement in its place" and found it to be "more conducive to the training than it was to a full dance routine." This sentiment was echoed by P10 in explaining how having the particles floating around the space in *Star-Stuff* would be helpful for an open, feeling-based activity, which would end up on the lower left quad-

rant. But if it were possible to turn off the star particles in *Star-Stuff*, then the environment would be more suitable for reviewing basic technique, then putting the status of the intervention into the upper right quadrant.

9.5.2 Practitioner Reflection

The inductive and deductive labels in the framework were actually added in 2022, two years after I came up with the original framework, following a pan-stylistic rapier seminar I attended. The terms were described by a HEMA instructor who specializes in *La Verdadera Destreza*[4], or simply *destreza*, the Spanish system of swordfighting. He explained how *destreza* is a deductive system, as it stems from general principles of geometry and biomechanics, and so a practical system of sword fighting can be derived from these principles. So much of our class was talking about general concepts such the radius of a circle given our arm length plus sword length, and how we could use this to gauge the necessary distance from our opponents. In contrast, many other HEMA systems are inductive because they describe several scenarios and prescribe specific actions, which can collectively be used to eventually develop a fuller picture of the entire system. In my regular HEMA club, we typically learn pre-defined longsword techniques and memorize the names, then discuss and practice them within the context of a very specific combat scenario, such as when your sword and your opponent's sword are in a bind, also standing in a pre-defined distance and angle. Most other rapier styles are

[4]Translated from Spanish as "the true skill"

also learned this way. This was interesting in that all of the other bodily practices I had done before did not have such a clear delineation, but instead teachers would combine both approaches, explaining general principles and specific scenarios.

I would guess the reason why HEMA is more clearly separated is due to the extremely limited source materials from which to learn from (see Martial Arts.) Surviving manuscripts are incredibly rare, so they have much more influence over shaping the practice compared to, say, karate styles, where some students of the founders are still alive today. Compare two images of manuscripts from the Leeds Royal Armoury library. The first is a *destreza* manual (Figure 9.3,) which contained many images such as this, and it looked very much like geometric art. The second is from Royal Armouries Ms. I.33 and can be seen in Figure 9.4, a manuscript which contains pages upon pages of specific techniques and scenarios. I found the teacher giving a name to these differences really illuminating as to why some methods of learning just made sense to me, and why some didn't. *Destreza* is notoriously polarizing and makes up a minority of rapier fencers, from what I understand. There are common jokes amongst rapier fencers who find *destreza* confusing about how the style is just a series of demon summoning rituals because of all the circles and esoteric art in the manuscripts. But I struggle a lot more with memorizing specific moves and names. It took me years to remember all of the Japanese terms when I did karate, and now I still struggle with remembering names in German longsword. For most of my peers though, this was much easier than understanding greater, more general principles, which became clear to me very quickly if explained well, likely because

this deductive scaffolding was provided for me through my previous karate training.

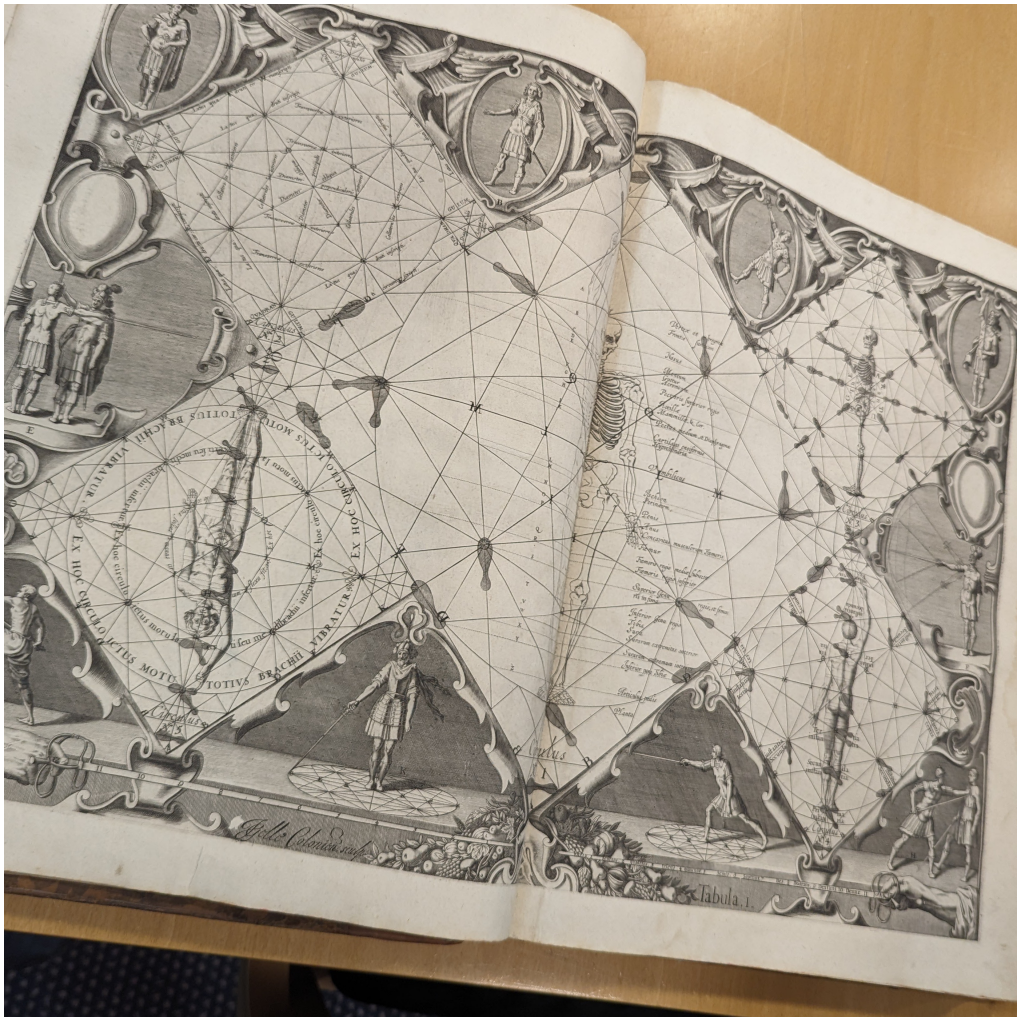

Figure 9.3: *Académie de l'espée* by Girard Thibault d'Anvers, a Dutch swordsmaster, published in 1630. The pages shown contain one example of what Thibault referred to as a "mysterious circle," where all elements of the circle are drawn in relation to the fencer's body. Photo by author, taken with permission from the Leeds Royal Armouries Museum Library.

Figure 9.4: A page from *Royal Armouries Ms. I.33* by an unknown author, created around 1300. I.33 is the oldest surviving combat manual and most of the pages contain techniques meant for specific fighting scenarios using a sword and buckler. Photo by author, taken with permission from the Leeds Royal Armouries Museum Library.

Let's bring this back to technological interventions. If VR and MR interventions are to become the new models for remote learn-

ing, I would hope to not limit learning to only half of the available framework. When people ask me about my research topic, and I say, "remote physical learning in VR," I've literally lost count of how many times someone nodded their head and then started talking about about a system which demonstrates moves that you can copy, and tells you where you've done a movement wrong. For some reason the assumption about bodily learning is mimetic learning. Demonstration and copying are undoubtedly necessary, but it's not all of it. And we're not stuck with what history has left us. Right now we can make a whole lot more. It would be really nice to have a VR experience which displayed all of the fencing-related circles in proportion to my body and to my opponent, to combine the visuals learning aids with the actual training space. I know some classmates who joked about how they're not interested in attending a lecture for a sword fighting class, and I completely understand their eagerness to stop talking and actually do the thing. I have a feeling that this would help fencers who struggle to apply the general principles understand things better, since they can then *be inside the space* and see the lines their body and sword make so it feels closer to doing "doing the thing," instead of just looking at several pictures and charts, which can feel kind of detached from the activity.

The findings from the collective work show that bodily disciplines as a whole can be practiced by a great range of individuals. Indeed, the participants in all three studies varied significantly in terms of life experiences, learning needs, physical capabilities and limitations, preferences, and personalities. But work in skill acquisition, pedagogy, sports science show that personalizing the prac-

tice for the learner is necessary for effective uptake. This was also supported by findings from Interviews with Dance Practitioners. As a result of this, flexibility of teaching approaches and strategies to accommodate such a wide range of individuals is required. The capability to dynamically and spontaneously change the environment and the things within it to suit the practice should carry over into the functionality of any bodily practice intervention. The assumption of mimetic learning (see From a Pedagogical Perspective)that Calyx laments possibly reflects the prominence of games in popular culture such as *Dance Dance Revolution* where gameplay is centered around imitation. This hints at a need to break down such preconceived notions, either by showing alternatives or by developing better language to describe the tools and systems.

This is where the promise of a Soma MR toolkit becomes evident, which would be able to move across the quadrants of the framework as determined by the users. Intervention Design and Development described how *Dance Tools* came about after finding that the simplistic but versatile features in the SomaPlay prototype used in VR and Soma Design Workshop were sufficient for teaching the participants the staff spinning task, even between their different levels of experience and learning preferences. Just as a room with space and simple items such mirrors, resistance bands, foam blocks, or weights can simultaneously support yoga, pilates, HIIT, or circuit training, providing a platform with basic components allows users to shape and personalize the intervention to reflect their practice.

For adoption of such interventions, what remains is the need for

shared knowledge on how the tools work and the way they may be used. Previous work in social VR (139) has shown that users will adapt the given technology to their needs, such as the example of pole dancers placing trackers, modular pieces which are relatively small and light, in their shoes as to not interfere with their foot grip on the pole, even though the trackers were not designed for this purpose. This not only reenforces the design value of having simplistic, versatile options which empower the user to mold the intervention for their practice. But it also reenforces the idea that a sense of community is often an important part of bodily disciplines, and how the ability to share and proliferate innovative tips and ideas can allow users to maximize the use of the technology and strengthen the intervention as a whole.

9.5.3 Insights and Takeaways

Because of the aforementioned diversity in user needs and preferences in bodily practice, participants were observed to use the intervention and hardware on their own terms, rather than staying strictly with the manufacturer's original assumptions about usage. The three sword fighting groups in Practice Sessions with VR Interventions found it necessary to place controllers on their swords to track movement of their weapon in the VE. This is a similar strategy to the pole dancer placing motion trackers inside their pole shoes rather than strapping them to the ankles (139) in that the designer's intentions are ignored, and the system's capabilities are recognized instead. Those were not controllers but motion trackers. These use cases align with the argument made by Marshall and Tennent (119) that "rather than put high

level interpretations on what hardware is for, a good initial model is to look at what the hardware is capable of."

Of course, the "high level interpretations" designers place on a system will ultimately limit the user's resourcefulness. In the aerial hoop test session during Practice Sessions with VR Interventions, the headset registered as out of bounds when the wearer mounted the hoop, even though she was within the Guardian lines, revealing the assumption that the user will not go through great variations in elevation. The last proposed design value is **modularity**, which calls for the simplicity and versatility of features and hardware. When it comes to creating interventions for bodily practice, designers are urged to avoid high level assumptions and rigid systems, and instead empower users with highly capable, versatile components as defined by their own personal practice.

9.6 Summary

This chapter explored realism as a conceptual model in conventional VR design, and how it is suboptimal when applied to the practice of bodily disciplines.

The discussion points above argued that a VR experience for bodily practice need not be a singular, objective reality, but instead could house what could be considered multiple realities determined by the users' perspectives, focuses, and aims of practice. It also does not need to be the "ultimate display" à la the *Star Trek* Holodeck, a system which creates a high fidelity virtual reality indistinguishable from physical reality, and low fidelity worlds and avatars can even be advantageous if mindfully designed for the activity.

The three design values were offered as alternatives to realism:

1. **Authenticity:** amplifying the spirit or essence of the practice rather than capturing the realism of it

2. **Subjectivity:** independent configuration of elements within the environment

3. **Modularity:** simplicity and versatility of features and hardware to empower users to personalize the intervention as needed

Chapter 10

Splitting Yourself: A New Methodology for Self-Reflective Design

As this project developed, the author devised a new method as an extension of existing first person and practice-led methods: the process of explicitly splitting one's practice and researcher "selves" apart to better reflect on practice in isolation, and to better relate to other practitioners. As a reminder, Christine is the researcher self here, and Calyx is the practitioner self (Narrator Introductions.) The chapter first introduces related methods, then discusses the process and reflects on the benefits of applying this method, finally making some recommendations for others who may wish to apply the same method to their own practice-based research.

10.1 Chapter Overview

This chapter consists of the following sections:

- First Person Methods in HCI: Related first person methods for body-centric design are briefly revisited, and the methodology of splitting is introduced.
- The Process: An exposé on the splitting of the author into a practitioner part (Calyx) and researcher part (Christine) during the course of this project is given.
- Benefits and Drawbacks: Observed and anticipated pros and cons of the methodology are listed.

10.2 First Person Methods in HCI

Designing for bodily experiences is notoriously problematic as they tend to be ineffable and exist beyond the realm of written or spoken language. As a response to this open problem, first person methods have been increasingly popular in HCI research, some of which have been borrowed from other academic disciplines.

Höök (84) took an autoethnographic account of horseback riding which gleaned design considerations for HCI. Ad hoc methods have been inspired by the likes of empathetic design and autobiography. To get a "deeper emphatic understanding" of participant experiences of wearing a camera necklace for passive photography, Ljungblad (113) took self-reflective accounts before and after the study, then incorporating the accounts into the reports of the participant data. Personal narratives in particular are a well-known

tool for self-reflective research. On exploring emotion work encountered during experience centered design, Balaam et al. (21) included stories from each of the authors, which shaped the larger discussion. A similar format is used by Tennent et al. (175) about their workshop engaging soma design in sensory misalignment. The authors provided first person accounts of balance-related experiences, which were then summarized and fed into a larger discussion on combining the two frameworks.

Numerous concepts, toolkits, frameworks, and other attempts to organize the articulation of aesthetic experiences for the purposes of documentation and examination within HCI have been put forward as well. For instance, Wilde et al. (188) proposed a framework for embodied design ideation (EDI) methods for designers so that they can be communicated to peers as well as serve as an introduction to embodied design. They especially detail the power of estrangement in design, where the familiar is turned-upside down as an avenue into deep reflection. Others include making strange (115), Focusing for design (133), and soma design (87), the last of which was described in detail in Chapter 2.

Providing full, unreduced knowledge of the aesthetic experiences that the researcher would not otherwise be able to access is a major reason why HCI has turned to first person methods for designing body-centric technologies. But the proliferation of this kind of research lies in its relational quality. Writing from a first person perspective and the richness of data it confers can evoke relatable and powerful memories when the reader brings their own subjectivity to the work. Thus a somaesthetic experience is brought up not through the abstract meaning of the words themselves, but

the reader's relationship and lived experiences to the concepts behind the words.

To generate meaningful findings and reflexivity, introspection and self-reflection are crucial components of first person research. But due to the ineffable nature of somatic experiences and felt sense, this can be difficult to do alone and can often require another person to bridge the tacit and explicit. Balaam et al. (21) found it understandably difficult to open up about their memories involving emotionally-charged research projects, and they reported that another member of the team was required to help bring these experiences out through mutual collaboration (64). Even among groups of people, design considerations can be taken for granted between individuals of the same research culture. Tennent et al. (175) reported that despite the two design studios being familiar with each other's work for several years, "it was not until we designed together that the true underlying 'aesthetic axioms' (147) of the other group came to the foreground and could be understood on a deeper level." These differences were taken for granted, or perhaps even invisible, until they were made tangible when directly engaged with otherness.

What happens when otherness is not easily accessible? The Covid-19 pandemic and associated lockdowns have overlapped with the first two years of this project. This created an unprecedented degree of social isolation for the author, and the opportunity to push the magnitude of self-reflection and self-observation to an extreme for the past four years – with limited aid from an "other" to bridge the tacit into explicit. The results of this opportunity are proposed here: splitting, a methodology which involves the

practitioner-researcher separating themselves into two identities during the course of research: the practitioner self, and the researcher self, which are then engaged in discourse with each other. It should be noted that splitting as a methodology admittedly was not a conscious decision at first, rather the author was influenced by her mental health routine such that it affected self-reflections during the project. Regardless, otherness was artificially generated from within one individual by adopting two separate perspectives. Of course, it is likely that all practitioner-researchers already have two perspectives and constantly switch between them during interdisciplinary work, if they are not holding the perspectives simultaneously. What is proposed here is a deliberate split into two roles so that they may consciously hold two perspectives, then glean insights by having them interact directly with each other.

Like many of the past frameworks and toolkits proposed for first person design research, the proposed methodology here does not originate from within HCI. Rather, it is inspired by a strategy found in practice-led psychotherapy. There are numerous approaches where an individual divides aspects of themselves into separate subsystems, such as inner child work (65; 14) where a child self is identified as separate and perhaps disconnected from the present-day adult self, or voice dialogue (198) in which the therapist can interact with many subpersonalities within one person. The cognitive therapy model argues that subconsciousness can have a strong influence on feelings and behavior, and identifying these parts can bring the subconscious to the conscious (25) or in somaesthetic appreciation terms, the tacit to the explicit. From

the author's personal experience, this has certainly proved itself true when writing dialogues between her selves for mental health purposes. Allowing the previously tacit child self to materialize and vocalize resulted in surprising insights that were not apparent prior to this separation.

Talking with oneself or an imagined other is not limited to therapy, either. Those familiar with software engineering may think of rubberducking, a technique in which programmers explain a coding problem to a rubber duck (or another inanimate object) to help debug their code. Rubberducking, as a concept, was introduced as a story in The Pragmatic Programmer — a book written by Andrew Hunt and David Thomas in 1999 (176). In the story, a programmer would carry a rubber duck and explain code to it line by line. While the self is not split, it uses the same general principle of changing one's perspective, in this case to a teaching role, forcing them to articulate the intended function of the code and the current function of the code, which can help them realize what has gone wrong and what the solution might be. This is known as externalization and a similar technique, called the empty chair technique, is used in Gestalt therapy (187). Switching to Calyx's perspective for reflection throughout this thesis was often done with a similar strategy to rubberducking in terms of changing to a didactic perspective by assuming the researcher is not familiar with the practice, and using natural language rather than academic language for expression. What resulted was a constant effort in asking oneself what details might be taken for granted, and trying to make the descriptions understandable to the researcher through richness and breaking down

of component parts of felt experience as much as possible.

10.3 The Process

Shusterman roughly defines two non-exhaustive classifications of somatic disciplines: representational and experiential (161). He names the practices of make-up, forms of dress, body piercing and scarification, and body-building as examples of representational somaesthetics, while he categorizes practices such as Zen meditation, Feldenkrais, or S/M as experiential somaesthetics. These categories are certainly not exclusive, as Shusterman notes that there is an "inevitable complementarity of representations and experience...how we look influences how we feel, and vice versa." (161) For instance, one might start an exercise routine to change their appearance, only to develop an enjoyment in the experience of working out, and then will exercise to chase the aesthetic experience rather than the change in external form. Conversely, a patient may receive a physical therapy routine to treat back pain, and the strengthening of the supporting muscles results in an improvement in the patient's posture, prompting them to continue exercising to further enhance their physical appearance. This very interconnectedness with the inner and outer can provide a means for researcher-practitioners to transition between roles in interdisciplinary work.

This section is not meant to prescribe a specific procedure for replication. Instead it merely documents the processes that occurred throughout the duration of this project. Many of the strategies used here had already existed in some form of the author's

non-work life. Specifically, two of the primary sources for creating this methodology had spawned from the author's practice as a model, as well as mental health routines. Therefore, not all practitioner-researchers will find these strategies directly applicable for them. In fact, it would be counterproductive to engage in abstract traits from ideas about what a practitioner or researcher should be like, whether influenced by the procedure laid out here, in media portrayals, or elsewhere, as this would be become detatched from one's own lived experience. To develop grounded identities, they will most likely need to introspect on their own processes, both conscious and subconscious, as to how they may embody their practice and research roles, and then think on how they may deliberately separate and amplify these to further define artificial boundaries between their selves.

That being said, many analogues exist between creative bodily practices, a fact which has made the data from Interviews with Dance Practitioners applicable to other forms of practice even though the interviewees were all dancers. As a consequence, while the individual strategies applied may not be new. But the novelty of this methodology is in how it generates insights during self-reflective research between two separate perspectives within one individual. The report of processes below is meant to provide concrete examples of the work done here so that other practitioner-researchers may relate with their own personal experiences. Additions, expansions, and further development or refinement of this methodology are encouraged.

10.3.1 Developing Dual Somaesthetic Repertoires

As discussed in the practitioner's reflection in Practitioner's Account, nearly the entire process for her approach to modeling (which before that was informed by LARP and other role playing games) is stepping into the role of a character and using their imagined personal experiences to hopefully create an authentic and believable persona on camera. A comparative technique which is perhaps more well-known is Method acting (97). The main difference here is that the characters are not fictitious, but drawn from selected parts of the author's actions and personhood. Instead of the imagination, the building blocks for each identity were sourced from observations made during particular activities that pertained to each role. From there, distinctions were made explicit between the researcher and practitioner: names, cosmetic appearances, embodiment, and inhabited spaces were all considered. An extra factor that had not appeared previously but was included for the purposes of this work was writing style, and has even extended to deliberately giving Calyx her own typeface in this thesis. By defining separate somaesthetic repertoires, the practitioner-researcher is armed with several cues they can choose from, both inside and out, to help them transition to a particular mindset (and bodyset) as needed.

Names

Choosing a public-facing name is common for models, as well as other performance artists who need to portray a character (even if it's a caricature of themselves) such as drag performers, video presenters, and musicians. This provides both a layer of privacy and an opportunity for self-stylization (81; 39). Researchers may

not necessarily be concerned with either of these. And this aspect of splitting identities admittedly had no visible impact when it came to engagement with other practitioners in the studies done for this research.

Despite this, choosing separate names was vastly helpful for deskwork. It made it much easier to keep track of thoughts and reflections compared to the period of time where the same name was used for both the researcher and practitioner identities. Not to mention it made discourse with other researchers and academics much less confusing, as it became possible to discuss Calyx as if she were not the person they were speaking to directly. Practitioner-researchers looking to use this strategy likely need not pick a name to adhere to any sort of convention; other than the fact that the names are different, though this may depend on their discipline(s). What matters most is that both names feel suitable to the individual.

Appearances

This is perhaps one of the most obvious places to spot and amplify differences between the researcher and practitioner self, depending on work culture and type of practice. A painter, for instance, might have dedicated clothes which are effectively sacrificed with the expectation that they will get paint all over them. Depending on the painter's fashion sensibilities, this may also exclude these artist clothes from being worn for anything else.

Within this project, dressing for the different roles happened innately. This was greatly helped by the fact that the author's cloth-

ing was already organized by function rather than category, originally done following online advice on organizing the home in a way that was more accessible for people with ADHD. The organization was as follows:

- top drawers: basics (all)
- 2nd drawer: casual clothes (public life/researcher at work)
- left half of 3rd drawer: (private life/researcher at home)
- right half of 3rd drawer: practitioner (aerial and martial arts workout clothes)
- 4th and bottom drawer: practitioner (model/cosplay/LARP wardrobe)

Christine would most often dress simply and inconspicuously, with very muted colors, and almost never used make-up except for special occasions. At home, dressing for the visual is eschewed while dressing for tactile comfort and enjoyment is the focus. Very little thought goes into the outward appearance. Instead, softness of material, familiarity, and simplicity become the main priorities. Originally there was some overlap between the aerial hoop clothes and home clothes, which consisted of conventional athletic wear, but upon splitting the researcher and practitioner identities, they were assigned to one identity and kept separate. One may notice that the public/private life wardrobe overlaps with the researcher wardrobe. This may not always be the case for some, if for instance, the place of work enforces a dress code. Others may choose to further separate "normal" life clothes from researcher

clothes, which can potentially be a way to maintain work/life boundaries.

Because of Calyx's multiple practices, her appearances would depend on the activity. In martial arts or aerial, mobility is prioritized. This could be further specified by activity. For instance, aerial hoop often involves full coverage of the body to protect chaffing from the apparatus, while pole requires skin exposure in order to maintain contact with the apparatus, and it is not possible to perform most techniques without "grip." HEMA requires a protective fencing mask, impact-resistant gloves, and a pair of durable cargo pants with a belt so that a dagger holster may be slotted in. Black colored gear and club t-shirts are also common. Because she looked the part, the teachers and students could tell Calyx was visiting from another club, rather than a fresh beginner. As a result, she was able to attend the HEMA classes preceding G5 and G7's test sessions without being treated as such. This would sometimes involve being separated from the rest of the class so a teacher or advanced student may run the beginner through safety notes and fundamentals, depending on the makeup of the rest of the class.

Modeling outfits varied significantly and were not often repeated, but in general were much less practical, sometimes uncomfortable, complex, appropriately themed for the photoshoot, and unconventional. There is also the ritual of applying make-up (see next subsection), which can be time-consuming and, depending on how drastic the look is, can instantly impart a sense of transformation on both the outside and inside.

Priming Activity

Priming activities, which were also referred to as warm-ups or rituals, are tasks which helped the author enter a certain identity.

For the researcher identity, the priming activity took the form of making a mug of tea before starting work. The actions and sensory input that accompanies this task, such as hearing the sound of the kettle dispense water and the sensation of the tea's scent and vapor entering her nose on the walk back to the work desk quickly became associated with deskwork. After making this task an explicit part of the researcher somaesthetic repertoire, tea making became an activity in which the author could more mindfully prepare herself to think and write from the researcher perspective. This was not a drastic change in the activity itself, merely a shift in attention. This could be reenforced throughout the work session by going downstairs to refill her cup.

Much of the time, the practitioner mode was not switched on until after the warm-up activities in training in aerial and martial arts. This switch could occur much faster if certain elements remained consistent. For instance, one aerial teacher would play the same song during warm-up for three months, after which the author would find herself switched to aerial mode after hearing the first ten seconds, even outside of practice which indicates Pavlovian conditioning (148). If motivation to attend class was lacking, watching a video of someone else performing the activity on YouTube or social media would often be enough to boost motivation and anticipation for the class, switching to the practitioner

mindset. Warming up with the participants in Practice Sessions with VR Interventions, G5 and G7, proved to be helpful in not only settling into practitioner mode, but also giving the researcher a common experience which either helped bond with the participants or served as a point where interview questions could be asked from a relational perspective, with great specificity.

The modeling priming activity was often the act of changing into the appropriate styling, applying make-up, and evaluating the look with by posing in a mirror or through video recording and watching back the footage. The last step was typically done to access movement of the costume elements and overall presence of the character. If this look still did not feel "right," make-up or styling would be revisited. Test shoots would commonly be taken by the photographer as they adjust their camera's settings, and this time would be used to get a feel for the character within the shoot area, whether that be in a studio or a location; any props or elements of the location would be used as a way to think about how the character might interact with them. Music which Calyx felt suited the character would also be put on at times to help the transition. This last part in particular was very useful for understanding some of the approaches to improvisational dance and warm-up activities described by P1, P2, P5, P6, and P8 in Interviews with Dance Practitioners from a first person perspective.

Inhabited Spaces and Embodiments

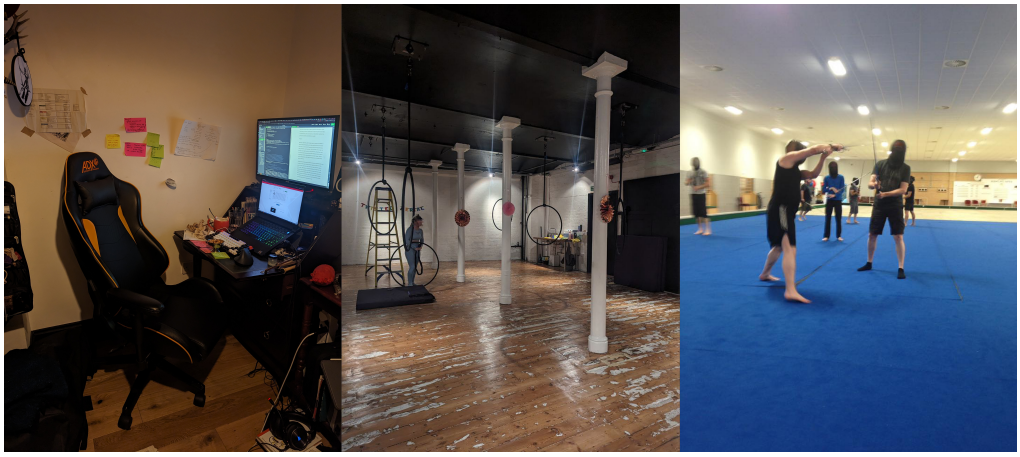

Figure 10.1: Examples of the author's spaces of research and practice. Left to right: researcher's desk, aerial hoop studio, gym studio with ongoing HEMA session.

The inhabited spaces of each activity played a large part in accessing the desired mindset, as they directly influenced the embodiments of the researcher and practitioner identities.

Much of the data processing, reading, and writing is done either on a floor or a desk as shown on the left image in Figure 10.1. The surface area of the desk is relatively small and most of the work was done on the computer or sketched onto a tablet which is kept nearby. The space tended to be littered with scraps of paper for errant thoughts or reflections relevant to the research. These were created when the author was not actively stationed at the space, but during momentary visits to the desk when a research-related thought has occurred and should not be forgotten. They may or may not have been incorporated into the work later. Overall, one can see that this researcher space is kept rather small, constrained to the corner of the room. This resulted in the researcher's embodiment having a consistently compact up quality when performing research-related activities here. If stuck in this

mode while walking, she would often retain this curled, slouched position with her head leading the rest of her body.

Figure 10.2: A view of the author's backyard where a solo sword training session had just occurred. The area of practice can be seen by the trodden ground where dirt is exposed in the center of the snow.

As seen in the same image above (Figure 10.1) on the center and right side, the areas of practice were generally much more spacious and empty, echoing what Calyx said in her practitioner reflections about how places of practice tend to be "*minimalist environments with little clutter, except for the objects which are needed*" although this isn't always the case and Calyx had to adjust her body and practice setup to the space given, as seen in Figure 10.2, where obstructions such as the aerial rig poles, stepping stones, and pond reduced the usable area for certain sword drills

when Calyx trained in her backyard. But overall, the used space is still much more than what is available in Christine's inhabited space. This also allowed for greater variability in practitioner embodiment. Taking up space and stretching limbs, transversing across the space, contracting and expanding the body, these activities meant that much more than the head and hands were being used compared to deskwork. The author also noticed a change in walking after a practice session, where she would have a more upright posture and lead with the small of her back, pushing her head up and driving the rest of her body forward in an upright position. Calyx and Christine had distinct preferences for their free space, or "kinosphere" (163).

Inhabiting the practitioner identity proved beneficial throughout the studies undertaken. Take for instance, Practice Sessions with VR Interventions, G5 and G7, both of which consisted of HEMA practitioners who had never trained with Calyx before. But the practice had preceded the research; they had seen her participate in the classes right before the test sessions were held, and so knew she was familiar with their activity. Sparring partners would not unnecessarily slow down or otherwise take it easy (as far as Calyx could tell) which is often a sign of acknowledgment of the sparring partner's abilities, depending on the club's culture. From a research standpoint, this was a boon as the participants were able to speak freely and with HEMA-specific jargon that may have not been used otherwise, effectively requiring the participant to translate their thoughts which could be understood by a layperson, which would have risked losing some nuances of the original thought. Similarly, the aerialists of G3 had practiced

with the author before in several in situ, non-research classes, and knew her current abilities. Thus, when P5 was thrilled with the experience of doing a birdie roll in the VR space environment, she was uninhibited in pushing both P4 and Calyx to try it for themselves. This may have also been helped by the fact that the author's appearance looked the part of the practitioner, as she was wearing bright teal leggings and an athletic top, both from the aerial wardrobe.

10.3.2 Donning and Doffing Identities

When assembling the somaesthetic repertoires of each, it made the elements of each identity explicit, turning the act of stepping into the chosen identity a more mindful, deliberate process. On some days, a certain strategy simply would not work, so a multi-pronged approach was useful. Changing into the researcher identity for example, taking the representative somaesthetic approach by manipulating the outer appearance and changing clothes into comfortable pajamas was not always effective if preoccupied with unrelated things, so this may have been combined with a sensory input such as choosing an especially flavorful and strongly scented tea, or sitting at the desk space for a while, i.e. manipulating the experiential somaesthetic experience.

While it was tempting to maximize time by foregoing all practice until the end of this project, it turned out to be difficult to stay grounded in the practitioner identity when deprived of the inhabited spaces and appearances. Priming activities and embodiments could theoretically have been performed at any time, but outside

of the context of practice, they were much less powerful in their effects. Requiring Calyx's input meant that practice had to continue to actively reflect and react to the findings of the work.

At times, it was difficult to switch directly between the practitioner and researcher identities, especially when tired of the work in general. It was then useful to have a period of buffer time where neither identity was equipped, and focus placed on an entirely unrelated activity to cleanse the palate, so to speak, of the previous identity.

There may not always be much time to tap into a separate self, as seen in Calyx's account from VR and Soma Design Workshop. Christine had to run the workshop, then suddenly Calyx was called upon to perform and teach. While this was doable for a two-hour period, it required a great deal of effort and there was the sense that some bleeding between the two selves occurred. The aforementioned buffer time was especially helpful to recover after the fact.

10.3.3 Conversations with Yourselves

In the initial phases of writing up the practitioner reflections and reactions to the work, there was no distinction between the two approaches. But attempts to write them in the same working document quickly proved unproductive as the work desk is not a neutral space. Indeed, it was Christine's inhabited space, and Calyx was only a guest there. As a mover by nature, the practitioner identity found it frustrating to stay seated and write for a long period of time. The work desk and its components, such as the

Overleaf project, bureau, office chair, drink coaster and mug with tea, culminated into a drastically different aesthetic from the aesthetics of the practice spaces. It was a tiny, cluttered space which was restrictive for someone who is meant to move. This often resulted in leaving the desk to do something else entirely, or if this urge was suppressed, it was still difficult to stop Christine's interference when writing.

To solicit responses, from the practitioner identity, Christine had to use her university email account and write a message to Calyx's personal email account, done in the same manner of contacting study participants or the industry partner with follow up questions. It was not until the practitioner identity had been equipped again, usually right after a class or some related activity, when the email would be answered from the phone on the way back from practice. After another break or transition period, Christine would return to the desk and integrate Calyx's answers into the thesis document, or continue the thread of conversation from the work email account. While this might seem excessive, the explicit separation and the processes developed to accomplish it helped to keep the identities separate, which led to clearer insights from both Calyx and Christine.

10.4 Benefits and Drawbacks

Like any research methodology, splitting comes with its own set of advantages and disadvantages. Most of these individual advantages and disadvantages are not unique to splitting, but the list is provided here for consideration.

Benefit: Relational Aspect

Donning the practitioner identity was useful when interacting with participants in that it reduced communication barriers. There was a tendency to use practice-specific jargon, and it was possible to have in-depth conversations about what they did. Being able to somatically relate to the participant experiences, such as performing a birdie roll with the aerialists in G3, Study 3, made it so that the researcher had direct access to these experiences as well during data analysis. A comparable concept is the different levels of researcher participation in ethnography, where in some cases high involvement in the observed group is advantageous or even necessary to obtain quality data, especially when studying sensitive topics or settings (94).

Miscommunications of experiences from participants to researchers or differences in subjectivity can result in mistranslations and inaccurate data, even in other forms of first person research were a second researcher solicits responses from the "first person." Splitting reduces this chance of miscommunication by eliminating an extra level of separation between the researcher and the articulated experience. If articulating an experience to someone else through words is like trying to transfer a somaesthetic experience, first person research is like a telepathic link. Or as humanaquarium put it, "when tensions arose between the goals of one discipline or the other there was no linguistic barrier to overcome."

But a potential pitfall of first person research is making it so personal that the resulting knowledge cannot be usefully applied to

anyone other than the original researcher. Transferability to other contexts or settings is what makes qualitative research impactful, but if otherness is not considered throughout the work, it runs the risk of becoming detached from reality and navel-gazing as critics claim. Splitting is beneficial here in that the practitioner-researcher always engages with otherness. Although Calyx carries a very similar set of insights, thoughts, and feelings as Christine's, they are not identical. As expected, the two identities agreed most of the time, but what was particularly interesting was when they disagreed. Calyx's aversion to the red lava shapes in *Dance Tools* contrasted sharply with Christine's viewpoint that they would be a fun feature to include, for instance. Calyx did not want an intervention which trained people to recognize a certain color and sound as negative, while Christine thought the perceived danger of lava and the sound of burning flesh would add a thrilling and playful aspect to the experience. It became clear that Christine was more comfortable with game design, while Calyx had experiences with drilling particular reactions to stimuli that took enormous work to unlearn later. Noticing this discrepancy brought up questions that made the crucial differences in their design priorities (and how this would influence the resulting intervention designs) obvious. The deep understanding of the somatic experience that comes from years of practice helped Höök (84) deeply appreciate the qualities of the experience. This could have been done as Christine of course, but there are other benefits. This is akin to inviting a domain expert to work with researchers who are somatically trained, providing the researchers with some first-hand experience of the domain, and collecting amateur and expert reflections as both parties engage in the somatic articula-

tion. A practitioner-researcher using the splitting methodology would essentially be doing both sides of somatic articulation, since they are both the domain expert and the somatically trained researcher.

Benefit: Work/Life Boundaries

In developing the two somaesthetic repertoires, anything that did not fall within the practitioner or researcher categories could safely be labeled as separate from work, enabling clearer boundaries for work-life balance. Additionally, needing to be Calyx often enough to provide research value meant explicitly dropping the researcher identity to do other mindful activities. This is ultimately very positive in the course of a PhD - an activity which especially in the latter stages is well known for risking burnout (110; 13; 168).

Benefit: Interest Through Imagination

The author often struggled to maintain the stillness and focus needed for the sensitizing activities more commonly seen in soma design such as body scans and Feldenkrais (87). Splitting the self acted as a way to inject interest in sensitizing and observing the self through imagination. The constant changing of roles also served to keep things interesting with variety.

Drawback: Limited Users

This methodology can only be used by practitioner-researchers, artist-researchers, or anyone taking on multiple roles in an interdisciplinary project. It can also only work if the researcher

is a practitioner in the specific area they are researching - and works particularly well if the practitioner is transdisciplinary. Calyx who has skills in martial arts, aerial arts, modelling, and now dance, would have been equally at home had the research been about any number of craft disciplines. A lifelong interest in role-play and character performance have provided the author with a relatively unique capability to apply this method. That being said, the author attributes her myriad interests to growing up with ADHD; hyperfixations and darting between novel hobbies and interests is a trait which many other individuals with ADHD share (7; 8). The author suspects that other practitioner-researchers with such traits may especially find this methodology useful, or even enjoyable, and perhaps contribute to changing the currently bleak narrative on neurodivergent individuals in academia (32; 123).

Drawback: Emotional Labor

Splitting can be laborious, which is another trait that is commonly seen in self-reflective work such as autoethnography (48; 9). For one, it can make the researcher feel vulnerable due to the amount of exposition required to effectively present the main ideas of the work. There can be reluctance in opening up, and the process of forcing oneself requires a significant amount of energy and discipline, some of which would normally be expended by another person.

It was observed during the project that switching between the two identities too rapidly can cause a sort of personality whiplash, where confusion made it difficult to settle decidedly into one role.

A similar concept, bleed, appears in LARP as a term describing the mixing of the player and the character's emotions, where "thoughts, feelings, physical state, and relationship dynamics of the player [affect] the character and vice versa." (30; 144) Additional time and space away from the work may need to be built in to create some distance for recovery before work can be taken on again.

10.5 Summary

This chapter introduced splitting, a new methodology to help practitioner-researchers with self-reflection. It involves the observation of one's own actions, thoughts, and embodiment during their practitioner and researcher activities. These are then used for the development of two separate somaesthetic repertoires, where the observed aspects of the two roles are augmented and deliberately separated. Four elements used for this particular project were 1) names, 2) appearances, 3) priming activities, and 4) inhabited spaces and embodiments. These were detailed with examples from the author's own experiences on inhabiting Christine and Calyx, along with a report on how answers from the practitioner side were solicited by the researcher. The chapter finished with a list of both observed and potential benefits and drawbacks of the methodology: **Benefits:** Relational Aspect, Work/Life Boundaries, Interest Through Imagination; **Drawback:** Limited Users, and Emotional Labor.

Chapter 11

Conclusion

11.1 Summary

VR technologies present a potential solution to the open question of effective remote learning for bodily disciplines. The findings from this research demonstrate that VR shows promise, but currently, consumer products are not quite there yet to fulfill the complex, individual, and dynamically changing needs of bodily practice. To conclude this thesis, the research questions are revisited:

RQ 1

How are bodily disciplines practiced, learned, and taught?

The exploratory Study 1, Interviews with Dance Practitioners was held to investigate how dance is learned and taught. The participants, which included teachers, career performers, choreographers, and hobbyists, were interviewed about their personal experiences with dance practice. Combined with the author's ex-

periences as a non-dance bodily practitioner through Calyx, a conceptual framework of personalized bodily practice was constructed (see: Figure 9.2). By visualizing the relationship between the practitioner's attention and the level of codification of the movement being trained using this framework, designers have a more deliberate means of creating a system which dynamically alters the practice as the student's needs arise.

1a

How does this process change in remote settings, such as those created from the Covid-19 pandemic?

In addition to a review of the current state in CSCW for bodily practices, Interviews with Dance Practitioners involved discussion of online classes if relevant to the participant. What was found in the study echoed the literature, that the remote learning model for synchronous practice was still dominated by video conferencing software such as Zoom. Although practitioners reported frustrations such as not having enough space at home, not having a clear view of the teachers or students, and increasing social barriers between classmates, the reduced stimuli and convenience of practicing at home stood out as potential boons which VR interventions could further polish. Subsequent online one-on-one dance sessions with the industry partner using Microsoft Teams provided first-hand experience with these frustrations and opportunities through an unfamiliar bodily practice for further reflection and design ideation.

RQ 2

How might VR be used to improve bodily teaching and learning?

Soma design researchers were engaged in a two-hour workshop (VR and Soma Design Workshop) to explore how bodily knowledge is communicated between individuals in an asymmetrical scenario, specifically where the learner is in VR and the teacher is viewing the student live. The author acted as a teacher role for the duration of the session, along with the other participants who had already learned the task. What was found was that individuals had differing responses to the modalities of communication which affected their uptake in learning. It was also found that the teacher needed to be highly responsive to the student by changing the difficulty of the task depending on their performance; having a variety of resources at hand, such as haptics to cue direction of movement or engagement of certain muscle groups, as well as visual guides in the VE, serve to aid in making adjustments and facilitated the practice.

2a

Especially in remote settings?

Because it is often expensive and impractical to have regular one-on-one lessons with a teacher, even online, it quickly became apparent that self-learning is an important skill to cultivate in its own right in remote practice. An online dance session with the industry partner focusing on the author's particular struggle with developing the skill in improvisation and freestyling inspired a solo practice intervention in the form of *Energy Beast* (Intervention Design and Development), which offers the user a pseudo-sentient dance partner in the form of a mass of energy which can subtly follow or lead depending on the user's interpretations. This idea came from an exercise the industry partner offered where

one imagines "energy" activating certain parts of the body as it flows through the dancer. Thus the intervention provides an alternative prompter if a teacher is not available, or if the practitioner simply wishes to practice alone.

For multi-user settings, Practice Sessions with VR Interventions saw the testing of the VR interventions, specifically in one teacher-one learner scenarios where the individuals were separate and unable to interact as they would in situ. This study was opened up from dance to other bodily disciplines, and included martial arts and aerial arts sessions, to see how well the learnings and values extracted from Interviews with Dance Practitioners and intervention design carried over. Having a limited view of one's own body proved useful in certain situations in that it reduced the amount of stimuli learners were receiving, which helped with directing attention. This was similar to what was described in Interviews with Dance Practitioners about video calls, but with VR, it could be done with a higher degree of control. However, there were also instances where elements of the physical world needed to stay in view at certain points, such as the aerial hoop. The need to toggle elements of the physical world and VE implies that MR would be better suited to remote learning, as traveling across varying levels of reality and virtuality provides the user greater control around this continuum.

2b

What information about bodily practices is essential for designers to know when creating VR interventions?

Though design guidelines were an expected outcome of this re-

search, cross-analysis of the findings made it apparent that prescribing such guidelines would be too superficial for the depth of understanding needed for supporting bodily practices. Instead, designers are invited to consider the following three values: **authenticity** in which the spirit of the practice is augmented through VR rather than the realism of the practice, which is a moot point as attempted duplication of the in-person experience would fail to convincingly recreate the physical world; **subjectivity** where individual users are allowed independent control over the displayed elements of the VE to accommodate differences in technology, roles, and priorities between users in a practice session; and **modularity** where the design of features are kept simple and versatile so that users are empowered to personalize the intervention based on the capabilities of the intervention rather than being constrained to the designer's assumptions on how the intervention should be used.

RQ 3

What is an effective methodology to query bodily practice in the absence of other practitioners?

This question arose from unprecedented social isolation as described in Covid-19 Pandemic Lockdowns. Though first person methods are prevalent in soma design, documenting one's felt experiences still often requires another person to draw out or clarify the articulations. The author's previous experiences in character modeling and role playing games, combined with her self-directed therapy routine for mental health resulted in a new methodology for self-reflective work, splitting, in which the practitioner-researcher artificially and deliberately separates the practitioner

and researcher selves to engage them directly in dialogue throughout the work (see Splitting Yourself: A New Methodology for Self-Reflective Design.) This methodology aids in bringing the tacit into explicit in the absence of others.

11.2 Future Opportunities

Further exploration of MR technologies for bodily learning: Given the upcoming consumer-grade MR headsets which support some of the features that would have been helpful for this application, specifically the toggling off and on selected elements of the environment, it would be interesting to investigate how MR-supported bodily practice opportunities might change from this point.

Follow-up on remote bodily learning for group settings: The empirical studies performed for this project consisted of solo practice or one-on-one scenarios. Descriptions of class environments in Interviews with Dance Practitioners from both the participants and Calyx hinted how group dynamics affected bodily learning, both remote and in situ. There is an opportunity to conduct further research into a larger group class or club using an intervention collaboratively to hold a practice session, as this could bear more ideas for social and communication features.

Applying the self-dividing methodology to other practices: Having now refined the dividing methodology, there are opportunities to apply it to inquiring other aspects of practice outside of remote learning, as well as other practices in general. There is also an opportunity to hold workshops hosting groups of practitioner-researchers to see how the splitting methodology could be further

refined and expanded to suit their own work.

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Appendices

Appendix A

Research Ethics

A.1 Study 1 Consent Form

University of Nottingham
UK | CHINA | MALAYSIA

Consent Form

Date: Nov. 30 - Dec. 18
Project: Dance choreographer interviews 1
School of Computer Science Ethics Reference: CS-2020-R17
Funded by: EPSRC grant EP/G037574/1

* Required

* This form will record your name, please fill your name.

Taking Part in the Study

1. I have read and understood the project information sheet dated 13/11/2020, or it has been read to me. I have been able to ask questions about the study and my questions have been answered satisfactorily. *

   ◯ Yes

   ◯ No

2. I consent voluntarily to be a participant in this study and understand that I can refuse to answer questions and I can withdraw from the study at any time, without having to give a reason. *

   ◯ Yes

   ◯ No

11/25/2020

A.2 Study 1 Consent Form

3. I understand that taking part in the study requires me to provide data and that this will involve participating in a on-on-one interview with the researcher on a recorded video or voice call. *

◯ Yes

◯ No

11/25/2020

A.3 Study 1 Consent Form

Use of My Data in the Study

4. I understand that data which can identify me will not be shared beyond the project team. *

- ◯ Yes
- ◯ No

5. I agree that the data provided by me may be used for the following purposes (check all that apply): *

- ☐ –Presentation and discussion of the project and its results in research activities (e.g., in supervision sessions, project meetings, conferences).
- ☐ –Publications and reports describing the project and its results.
- ☐ –Dissemination of the project and its results, including publication of data on web pages and databases.

6. I give permission for my words to be quoted for the purposes described above. *

- ◯ Yes
- ◯ No

7. I give permission for my visual image contained in photos or video gathered during the research to be used for the purposes described above. *

- ◯ Yes
- ◯ No

11/25/2020

A.4 Study 1 Consent Form

Reuse of My Data

8. I give permission for the data that I provide to be reused for the sole purposes of future research and learning. *

◯ Yes

◯ No

9. I understand and agree that this may involve depositing my data in a data repository, which may be accessed by other researchers. *

◯ Yes

◯ No

11/25/2020

A.5 Study 1 Consent Form

Security of My Data

10. I understand that safeguards will be put in place to protect my identity and my data during the research, and if my data is kept for future use. *

◯ Yes

◯ No

11. I confirm that a written copy of these safeguards has been given to me in the University's privacy notice, and that they have been described to me and are acceptable to me. *

◯ Yes

◯ No

12. I confirm that a written copy of these safeguards has been given to me in the University's privacy notice, and that they have been described to me and are acceptable to me. *

◯ Yes

◯ No

13. I understand that no computer system is completely secure and that there is a risk that a third party could obtain a copy of my data. *

◯ Yes

◯ No

11/25/2020

A.6 Study 1 Consent Form

Copyright

14. I give permission for data gathered during this project to be used, copied, excerpted, annotated, displayed and distributed for the purposes to which I have consented. *

- ◯ Yes
- ◯ No

15. I wish to be publicly identified as the creator of the following works: audio/video recordings. *

- ◯ Yes
- ◯ No

11/25/2020

A.7 Study 1 Consent Form

Signatures

Sign as appropriate.

16. Type name as signature *

17. Date *

Format: M/d/yyyy

This content is neither created nor endorsed by Microsoft. The data you submit will be sent to the form owner.

Microsoft Forms

11/25/2020

A.8 Study 1 Information Sheet

University of Nottingham
UK | CHINA | MALAYSIA

PROJECT INFORMATION

Date: 10/11/2020
Project: Dance choreographer interviews 1
School of Computer Science Ethics Reference: CS-2020-R17
Funded by: EPSRC grant EP/G037574/1

Purpose of the research. In light of the Covid-19 pandemic and the shift away from face-to-face events, this project explores the nature of individual bodies and movements through the design of VR physical learning applications. I would like to better understand how a choreography is designed before undertaking the development of such applications.

Nature of participation. Participation in this research is entirely voluntary. Your relationship with the University of Nottingham is NOT affected by your participation.

Participant engagement The researcher will interview you via video or voice call at a mutually agreeable time. The data you provide will be a recording of this interview.

Benefits and risks of the research. Your participation will help us understand practices of dance choreography. We hope that this study will inform the design of a VR physical learning experience, which can then be studied and eventually provide guidelines for improved remote and web-based learning solutions. We foresee no risks of any kind to your participation.

Use of your data. Your data will be used in supervision sessions, project meetings and reports, in conference workshops and presentations, and in publications. ONLY pseudonymised data that cannot identify you will be made public unless you give us written consent, which you may

1

A.9 Study 1 Information Sheet

withdraw at any time.

Future use of your data. Your data may be archived and reused in future for purposes that are in the public interest, or for historical or scientific purposes. Public archives of data that CANNOT identify an individual will be stored on University of Nottingham servers using a publicly disseminated identifier. All identifiable information is stored on secure University of Nottingham servers and is accessible only to this project team.

Procedure for withdrawal from the research. You may withdraw from the study at any time and do not have to give reasons for why you no longer want to take part. If you wish to withdraw please contact Christine Li at christine.li@nottingham.ac.uk. If you receive no response from the researcher please contact the School of Computer Science's Ethics Committee.

Contact details of the ethics committee. If you wish to file a complaint or exercise your rights you can contact the Ethics Committee at the following address: cs-ethicsadmin@cs.nott.ac.uk

A.10 Study 1 Privacy Notice

PRIVACY NOTICE

The University of Nottingham is committed to protecting your personal data and informing you of your rights in relation to that data. The University will process your personal data in accordance with the General Data Protection Regulation (GDPR) and the Data Protection Act 2018 and this privacy notice is issued in accordance with GDPR Articles 13 and 14.

The University of Nottingham, University Park, Nottingham, NG7 2RD is registered as a Data Controller under the Data Protection Act 1998 (registration No. Z5654762, https://ico.org.uk/ESDWebPages/Entry/Z5654762)**.**

The University has appointed a Data Protection Officer (DPO). The DPO's postal address is:

Data Protection Officer,
Legal Services
A5, Trent Building,
University of Nottingham,
University Park,
Nottingham
NG7 2RD

The DPO can be emailed at dpo@nottingham.ac.uk

Why we collect your personal data. We collect personal data under the terms of the University's Royal Charter in our capacity as a teaching and research body to advance education and learning. Specific purposes for data collection on this occasion are to better understand the practices of dance choreography with the aim of creating a VR bodily learning experience for us to study.

The legal basis for processing your personal data under GDPR. Under the General Data Protection Regulation, the University must establish a legal basis for processing your personal data and communicate this to you. The legal basis for processing your personal data on this occasion is Article 6(1e) processing is necessary for the performance of a task carried out in the public interest.

Special category personal data In addition to the legal basis for processing your personal data, the University must meet a further basis when processing any special category data, including: personal data revealing racial or ethnic origin, political opinions, religious or philosophical beliefs,

A.11 Study 1 Privacy Notice

or trade union membership, and the processing of genetic data, biometric data for the purpose of uniquely identifying a natural person, data concerning health or data concerning a natural person's sex life or sexual orientation. The basis for processing your sensitive personal data on this occasion is Article 9(2e) processing relates to personal data which are manifestly made public by the data subject.

How long we keep your data. The University may store your data for up to 25 years and for a period of no less than 7 years after the research project finishes. The researchers who gathered or processed the data may also store the data indefinitely and reuse it in future research.

Who we share your data with Your data may be shared with researchers from other collaborating institutions and organisations who are involved in the research. Extracts of your data may be disclosed in published works that are posted online for use by the scientific community. Your data may also be stored indefinitely by members of the researcher team and/or be stored on external data repositories (e.g., the UK Data Archive) and be further processed for archiving purposes in the public interest, or for historical, scientific or statistical purposes.

How we keep your data safe. We keep your data securely and put measures in place to safeguard it. These safeguards include storage on the University of Nottingham's secure online storage system, Microsoft 365 OneDrive and Teams, both of which use SharePoint Online encryption. This involves three physically separate storage components, and 2048-bit encryption in transit. All data received from an individual is kept in two forms: one available only to the immediate project team, which may require pseudonymisation, and one available to the wider project team after it has been pseudonymised. Pseudonymisation includes transcribing the verbal content of the class and interviews as well as any relevant notes from the video and replacing participant names with suitable, unconnected names; and as necessary changing details so that they retain their relevance to the research but do not point to an individual. Extra care will be taken with potentially identifiable details if any publicly available information includes the fact that participants are also employees. Pseudonymised data is stored in separate folders from raw (identifiable) data. Only data from folders marked as pseudonymised is analysed and made available to project partners and for future analysis by this project team. Project partners are located within the UK and follow the legal requirements for safeguarding participant data. We provide the extra safeguard of keeping identifiable data within our own systems, sharing only the anonymised data. Data may also be stored on password-protected personal computers during processing, and will be encrypted at rest using filesystem encryption.

Your rights as a data subject. GDPR provides you, as a data subject, with a number of rights in relation to your personal data. Subject to some exemptions, you have the right to:

- withdraw your consent at any time where that is the legal basis of our processing, and in

such circumstances you are not obliged to provide personal data for our research.

- object to automated decision-making, to contest the decision, and to obtain human intervention from the controller.
- access (i.e., receive a copy of) your personal data that we are processing together with information about the purposes of processing, the categories of personal data concerned, recipients/categories of recipient, retention periods, safeguards for any overseas transfers, and information about your rights.
- have inaccuracies in the personal data that we hold about you rectified and, depending on the purposes for which your data is processed, to have personal incomplete data completed
- be forgotten, i.e., to have your personal data erased where it is no longer needed, you withdraw consent and there is no other legal basis for processing your personal data, or you object to the processing and there is no overriding legitimate ground for that processing.
- in certain circumstances, request that the processing of your personal data be restricted, e.g., pending verification where you are contesting its accuracy or you have objected to the processing.
- obtain a copy of your personal data which you have provided to the University in a structured, commonly used electronic form (portability), and to object to certain processing activities such as processing based on the University's or someone else's legitimate interests, processing in the public interest or for direct marketing purposes. In the case of objections based on the latter, the University is obliged to cease processing.
- complain to the Information Commissioner's Office about the way we process your personal data.

If you require advice on exercising any of the above rights, please contact the University's data protection team: data-protection@nottingham.ac.uk

A.13 Study 2 Participant Information and Consent Forms

School of Computer Science
University of Nottingham

Section B. Information to be provided to research participants

PROJECT TITLE: VR Improvisational Dance Study

1. The research
a) Aims and objectives of the research
Briefly describe what the research is about, its aims and objectives or what it seeks to achieve, and describe the context / motivation for the research (e.g., a thorny problem in computing, a new trend, a topical issue, the aims of a funded research project, completing module assessments, etc.). *The Covid-19 pandemic has skyrocketed the reliance and popularity in online classes but teaching embodied practices through the usual software like Zoom leaves much to be desired. This study will observe the* *This project explores the nature of individual bodies and movements through the design of VR physical learning applications. I would like to better understand how training is received before undertaking the development of such applications.*
b) Funder information
The research is funded by the Engineering and Physical Sciences Council research project Ubiquitous Computing for a Digital Economy EPSRC grant **EP/G037574/1** *https://gow.epsrc.ukri.org/NGBOViewGrant.aspx?GrantRef=EP/G037574/1*
c) Governance
This research has been approved by the School of Computer Science Research Ethics Committee (CS REC), ethics application ID ***insert ethics application ID once assigned*** *If any professional ethical guidelines apply, cite and insert URL, e.g., This research complies with the Association of Social Anthropologists of the UK and the Commonwealth's Ethical Guidelines for Good Research Practice, https://www.theasa.org/downloads/ethics/Ethical_guidelines.pdf (delete this text if not applicable).*

2. Taking part in the research
You will be observed during a dance improvisation session using a virtual reality intervention to help guide this activity. Audio-video recordings will be captured with cameras placed in the dance area. Additional video capture will be done within the VR headset, so that I can see what you see. Afterwards, you'll be asked to take part in an interview.

3. Risks of participation
a) Risks
There is always a risk of unauthorised access to data. Due to the nature of using virtual reality, there is a risk the experiment may induce physical discomfort, nausea (cybersickness), dizziness, or injury.

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A.14 Study 2 Participant Information and Consent Forms

b) Mitigation of risks
To avoid risk of injury, the dance area will be cleared of any obstacles or objects, and the VR headset's Guardian feature will be set up so you will have a clear visual outline of the play area. The researcher will also act as a spotter to prevent or mitigate any problems. Should you feel discomfort or nausea, you may remove the headset and notify the researcher at any time. You may wish to avoid eating a heavy meal before the study to reduce the chance of nausea.

4. Purpose of data processing
a) Data collected
We collect the following categories of data during your participation in the research: *Audio-video recordings from external cameras and within the Oculus Quest 2 VR headset, observation notes, and micro-phenomenological interview data.*
b) Specific purposes for which the data are processed
Data collected during the research that identifies you may be: • Analysed to meet the aims and objectives described in Section 1. • Reviewed and discussed in supervision sessions between researchers and their supervisors or in research meetings between members of the research team, including project partners. • If audio recordings are collected during the research, these may be transcribed and **anonymous** quotations of your spoken words may be used in scientific works, including presentations, reports and publications stored in databases and posted online, and in marketing materials that promote the research and its findings. • If visual images that identify you are collected during the research, they may be used in scientific works, including presentations, reports and publications stored in databases and posted online, and in marketing materials that promote the research and its findings; you will **not** be named if visual data is used for these purposes and you may **opt out** in Section 9b.
c) Automated decision-making and profiling
N/A
d) Legal basis for processing your data
We collect personal data under the terms of the University of Nottingham's Royal Charter and in our capacity as a teaching and research body to advance education and learning. We thus process your data on the legal basis that our research is in the public interest, we have legitimate interests and / or that you consent to data processing in freely and voluntarily participating in our research activities.

5. Storage and retention of your data
a) Data protection measures

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A.15 Study 2 Participant Information and Consent Forms

We put the following organisational and / or technical safeguards in place to protect your data and your identity to the best of our ability: i) All data stored digitally will be encrypted and password protected and all physical data will be stored in a secure location.
b) Retention period
Data protection law allows us to retain personal data for an indefinite period and use it in future for public interest, scientific or historical research purposes or statistical purposes, subject to the implementation of technical and organisational measures that safeguard your data, your legal rights and your freedoms. These safeguards include the storage measures described above to protect your data against unauthorised access, and de-identification (anonymisation or pseudonymisation) of your data wherever possible and practicable. Data that identifies or could identify you will not be made public without your consent.

6. Third party recipients, services and data transfers
a) Project partners
N/A
b) Third-party services
N/A
c) Data transfers
N/A

7. Your legal rights
Data protection rights (Data Protection Act 2018) You have the right: • To be informed about the collection and use of personal data (as per this document). • To access and receive a copy of your personal data, and other supplementary information, on request. • To object to and restrict data processing if you think we are not complying with data protection law, and to rectify inaccuracies. • To be forgotten, i.e., to have your personal data erased. • To data portability and to obtain your data in an accessible and machine-readable format if appropriate, or to transfer your data to another organisation if technically feasible. • To complain to about the way we process your personal data to our ethics committee (cs-ethicsadmin@cs.nott.ac.uk), our Data Protection Officer (dpo@nottingham.ac.uk) or the Information Commissioner's Office (https://ico.org.uk/make-a-complaint).*
Joint authorship in copyright works (Copyright, Designs and Patents Act 1988) You may, if you wish, be acknowledged and publicly identified as joint author of the *insert name for the work(s) participants are joint authors of in this research (e.g., the interview recording or video of the involvement in an experiment)*. **Affirming your right to be acknowledged as joint author may affect your anonymity.**

* Our DPO's postal address is Data Protection Officer, Legal Services, A5 Trent Building, University of Nottingham, University Park, Nottingham NG7 2RD.

(v.8 June 2022)

A.16 Study 2 Participant Information and Consent Forms

8. Your ethical rights
a) Right to withdraw
You have the right to withdraw from the research at any time without explanation. You also have the right to request that your data be deleted if you do withdraw.
b) Handling of 'mixed' data
If the data is 'mixed' data – i.e., if it involves other people (not including the researchers), e.g., a conversation or video of multi-party interaction – it cannot be deleted unless **all parties** request it. However, any mixed data involving you will be redacted wherever possible, with the exception of scientific works produced prior to your notification of withdrawal.
c) Withdrawal procedure
If you wish to withdraw, please notify **Christine Li at christine.li@nottingham.ac.uk.** If you do not receive confirmation of withdrawal from the research, please email cs-ethicsadmin@cs.nott.ac.uk

9. Consent to participate	
a) I consent to participate in the research and my signature or mark confirms the following: • I understand the aims and objectives of the research • I understand what the research requires me to do • I accept the risks of participation • I understand what data will be collected and the purposes for which the data will be used • I understand safeguards will be put in place to protect my data and my legal rights • I understand I will not be identified unless the use of identifiable data has been requested and I consent to it • I understand that I can withdraw at any time without explanation • I have been able to ask questions about the research, my participation, and my data and my questions have been answered satisfactorily • I agree to participate and my participation is voluntary	***Signature or mark:***
b) Opt out. I do not consent to use of my visual image in scientific works or materials that promote the research and its results **c) Opt in.** I wish to affirm my right to be acknowledged as joint author of original works created in this research and understand this may affect my anonymity	*Signature or mark:*

Name of participant(s)	
Date	
Witness *If participant(s) cannot sign*	*In signing I confirm the participant(s) named above have been fully informed about the research, have been able to ask questions, and consent freely.*

(v.8 June 2022)

Appendix B

Sample Transcripts

B.1 Interviews with Dance Practitioners

P: Yeah yeah I'll try to go... because I've been part of a lot of proce— processes or what it's called.

I: Or anything that sticks out to you really.

P: So yeah, I I... I guess I can start with like a general description how it usually works.

So, I mean in general there's two different versions of what's going on. I mean, either it's a piece that's already been created before and you're learning it again like it's being re restaged or it's a new creation.

So with a restated production we usually have, uh, what's it called? Uh, we have set material. All the movements are designed. Usually we're working when we can with the choreographer who created it, who still comes in and gives insight into what... uh, not

only the shape of the movement, but the intention with the movement. What, uh, how you're supposed to do the movement, which is a very important facet, and it's very difficult to create because often how a process like that would start is nowadays we film everything so everything that's been done before when it's done and it's in its final stages, it's filmed— the entire show, and when it's being restaged we have a video that we're watching and we're learning and you come in and somebody says, "OK, you're learning this part of this person here." and then, you learn the moves. Then after a while the choreographer will come and work with you and be there for maybe two weeks or a week or something and clean it and get it the way they want to do. Go away. We keep working and then maybe you'll have a final session again where they return and it gets polished right before the show. So that's usually the staging process and there's a lot of more detail around that we can go into if that seems interesting.

Uh, then you have the creation process, so if we have a piece being created from the first time, uh, and this is also a very diverse way— each choreographer approaches that differently, that's part of their art.

But in general we kinda again see two main ways of doing it, roughly, which would either be the choreographer comes in with material they've already created from before, and they've already decided everything and they teach it to the dancers.

And the other version being, you come in and the choreographer creates the material with the dancers by giving tasks, giving exercises, people suggest things and then the choreographer picks

and chooses the parts they want, edit them for their own way and then put it all together into a piece.

And of course, this is very black and white. Usually choreographers are doing a bit of both. Different choreographers do more of one technique than the other, and it switches between... but— so I've been part of all of these different types of processes throughout my career and my learning. I have learned a lot of pieces from video where you've had to try to just watch and figure out what they're doing and also where we haven't been able to talk to the choreographer. We might have just somebody who's done it before, who's remembering a bit on what they're doing, and you learn from them and you just have the video and you try to figure things out. I've done where the choreographer comes and works with you. I've done the choreographer creates something new. And then of course I've also been I've both been part of the creation process myself, and one of these working with the choreographer, getting tasks, developing stuff.

Uh, I've also been in the choreographer role where I have been the one coming up with tasks, working with dancers, putting everything together. I am also— when I work with choreography that's —I'm usually with one of these people who mix. I have material that I've created all by myself, but I have a tendency towards the creation process where I'm working with dancers and creating something because I find it's a much more interesting dialogue.

I: Yeah.

P: It creates much more new stuff.

I: Would you say that that's your favourite or preferred way of working with a choreographer, when you're in the dancer role as well, or is it more like when you're in the choreographer seat?

P: For me personally— and this varies from dancer to dancer, for me personally, I prefer being part of the creation process. I think it's much more interesting to have your own voice and be part of what's being developed and not only a tool.

I: Yeah, or a body or something.

P: Exactly, so it's still very interesting to also reset stuff and when somebody comes in with this very clear point of view, it's also very nice, but I have a slight preference towards that cooperative creation process.

I will though note once again, personal preference.

I: Of course. Yeah.

P: I do, yeah, and I do also prefer that, yes, the choreographer creates stuff with us, but it's then, they then edit it to be their way to have them, because sometimes you also work out work with choreographers where they simply tell you to do something and you do it, and then they keep it the exact same way that you just did it, and then they just— that's the piece. And for me I don't find that that's a very interesting...I mean it's, yes it'— I feel like it's halfway. It's half baked. It's like it doesn't become the choreographer's own movement. Sure, it's from their ideas, but I find it much more interesting when then they tweak it and polish it.

...

P: Yeah I did– I had to do, umm... What– during that time I got invited to an audition, an online audition, because they also did, they also started doing that now, online auditions, which is awesome experience. Uh, I had to do that and we had to learn a certain amount of material, but I had to do it in my room and it was like material for like and it's like variation(?) stuff because it's additions, it's like solo jumping and spinning and rolling on the ground and it was made for like a studio, you know? And I had to like adapt it and I had to be like, "Hey I don't have a studio because I don't have access to the studio with Internet like, I'm doing it in my apartment. I'm sorry so I've tried to adapt it as well as I can from this space."

I: How like do you have an example of what an adaptation might look like? Like what? How did you do that? I know these are hard and I know I'm going a little over time, I'm just really fascinated.

P: No, no, no worries we can go a bit over time. I don't have any other appointments. I have other things I need to do but I can pace my time.

But, umm, it's uh... it's very difficult to say because in that case I... so simple example would be– and this is very important because this is like for any dancing, so you're constantly adapting movement not only if you're doing it inside or online or visual. Every space you go to every stage, it's slightly different. They don't have the same dimensions, so dancers are always adapting their movement to whatever space they're in. Like it's just we're just talking about like, how radical it is. In this case it was extremely

big thing, because, you know, I'm trying to do a big jumping variation thing in a small room–

I: In your little apartment.

P: Exactly, but like very normal I it's very easy to reference ballet because it's a set vocabulary, even though I do more contemporary nowadays, but it's very easy. So very typical step if you're doing an exercise– we do diagonals in ballet from one side to another, and perhaps normally we would do very normal is pirouette [string of ballet terms] step. We come into the pirouette.If I'm doing this in this room, I can't do a diagonal like, normally this it's designed to be able to take me across the entire room and at the end of the exercise, if you're finished on the other side, but what I do then is I transfer it so that I'm standing on place. I can do the same technical movement moving, but I can transpose it, retranslate it into standing on space.

I: Ohh that is the same adaptation that I've done– I've– like my sensei in karate has had us do when we were in really small spaces– 'cause in Japan like they often have really tiny spaces to like, they don't have a lot to work with, so you know, they– he gave us some, like in our normal training space, it was it actually was a dance studio, but then he gave us alternatives of exercises where you only need like a cubicle because it's like so common in Japan to like just have this tiny space.

P: Yeah.

I: So yeah, transposing movements but still practicing or executing it, the movement that will–

P: Also transposing of movements and readapting is a also a very normal part of, umm, creation, movement creation. So like I have this movement that we've made this way, how does it look if I do it in reverse? How does it look if I do it– you're only doing it with your legs? How does it do if what you were doing with your legs are doing with your arms? Like, retranslation, transposing is a very normal thing within that, and especially space. That's absolutely like, "Ok, now do it traveling across the entire room." is like, okay, now we're all of a sudden doing it on this like 3 meter by like not that's excessive, but like 8– I've done things on 8x7 stages. You know like outside stages and like some sort of event stuff. And then it's movement that's actually designed for an opera stage, you know? And then you retranslate it to make it fit. And then you know it's much the– comes a point where it's like, yeah, now we have to actually also just change the choreography like we can't have like 10 people crossing at the same time, you know? We're gonna change it to five or whatever you know. So that's also a way to do it. But that's a normal part of dancer's work.

I: Cool. Again, very well put like it's not... COVID did change things radically, but like it seems like the basic coping strategies and processes used were able to be applied to the situation, I guess?

P: Yeah, it's like it's all the... we had all the techniques to deal with it, and that's why people could in a way. But it was like forcing all those techniques to the 10. You know, like pulling them up to like, really like...

B.2 VR and Soma Design Workshop

B.2.1 Sample of Workshop Transcript

CLIP 5, 14:22

P2: Mine is a bit, umm [holds up body sheet] I have more feelings in my body, but like, most of them are related to like scars on my fingers and me sleeping poorly so I try to use things that come from the workshop.

R: Oh I mean, even if it's not from the workshop, it's still part of what you're feeling. I mean I put– [points to own body sheet] most of this is not from the workshop.

P2: Okay.

15:29

R: Good?

GROUP: mhm

P5: Yep.

R: Okay, shall we share?

P1: Sure.

R: Cool.

[silence]

I'll go.

Umm, I think because we just did [waves hands] I was doing a lot of the figure 8 stuff, so my body has a very slight figure 8 infinity sign sway to it. Umm, this upper half, whereas before it was very like [uses hands to make claw gesture around head and brings hands forcefully downwards], pulling me down, now I'm a lot more relaxed because I've been moving around. My [chuckles] my feet and calves are tense because I was watching you [looks at P5] in the heels and I was just going like [grimaces] arghhh!

GROUP laughs

R: Yeah.

P3: That's cool.

R: Yeah. So that's basically me.

P5: For me, wearing the heels made me feel a bit like eliptic[?] like, my feet and my knee I think the impact was here, I feel asymmetric here because I tried to do the balancing stuff, and when switching I didn't put the same amount of effort. Also because I have an old injury here–

R: Ah yeah [nods]

P5: So I feel like, still weird, but in terms of like I think it really help me to be aware of my posture now? Because I used to do this [slouches back] the hand structure, I think I feel like after swimming or something like that. Like still feel a bit warm up here [motions to sides of head] after the exercise, so it is a nice, like, warm up, 'specially for today I guess.

[looks to P2]

P2: Uh, I have the sensation still, like you know when you've been to an amusement park, or stuff, and you feel like the roller coaster, I still feel like that but with this like, uh, infinity motion, uh, which is nice. You can really feel it. Especially like around the ankles, since I like changed my focus more on that, when you told me to focus, or or incorporate more movement. Umm....

P1: Nice.

P3: I uh, I feel like all the bits that were working together at the very start of the day have been completely disassembled.

GROUP laughs

P3: That's not necessarily a bad thing. All the—all the—all the movements are just completely [gestures with hands coming apart] –

R: You had the difficult task of teaching–

P3: – disconnected parts. I feel like uh, like one of those cartoon drawings of like an exploding jack-in-the-box with like springs and – and, and yeah, nuts and bolts like, strewn all over the floor.

P4: Yeah I think it's like most of us the- the phantom [waves hand in infinity motion] aftershadow kinda feeling. But like the wrists feel very, like, flexible? And also the core, maybe it has to do with the last bit but it sorta the—kinda put the focus on the core so it seems to be very important... for translating–

R: If you're balancing, yeah.

P4: – Well I—also when you tried to [points to lower back] to in-

fluence my core.

P1: [nods]

R: Yeah, yeah.

P4: [inaudible] the diaper or whatever that was.

[P1 and R chuckle]

P3: Balance diaper.

R: The balance diaper! The next project.

P4: Put some weight in it.

P1: Cool.

[P4 motions to P1]

P1: Thank you. Umm, because it was also really interesting to go from—because the movement I had from the start was from fencing was very angular and smooth [motions with pen in hand] and then we went into this first small circles [draws small circles with wrist] and then bigger circles. Especially with the twist, I think you showed, P3.

P3: Mmm.

P1: The flick? And kinda trying to keep doing that with the stuff, uh, really got me into it so now I feel all like springy.

P3: Mmm! [upward inflection]

P1: But I also think I feel more present and observant, uh, being in VR but I don't really trust the VR headset? Because it was

jittery, right? I had to keep the motion going anyway, uh, it's kinda interesting that, like, I shouldn't really trust my eyes. If it's outside the border it kept lagging and... so, for me that felt really, like being kind of... both observant but of course not [waves hand in front of eyes]

B.2.2 Sample of Interview Transcript

I: So, uh, let us just start by you giving a high level account of what was going on on Monday.

P1: [inaudible] On Monday we did a workshop on... I was expecting to– no, let's see. The the theme of.... You know interacting or... adding or manipulating a movement. Uh so we all figure out a movement that we do habitually. And then we went around– not everybody had a go– but to teach this movement to the rest of the group so I think we had like two of these. And um the teaching was mediated with a VR headset with certain certain like pre– premade tool you could step in. A virtual dojo where, you could see this dojo and you could track the controllers with these floating orbs. .. Joe taught a dance, and then Christine taught a specific twirl with the staff. Hmm... See Joe ta–taught the dance in situ, I don't think it was mediated the way he taught it. I think the idea was that he would show it and then give further instructions, try to mediate it. Uh, as his dance was kind of playful, that session where we involved the tools, ended up being more playful interaction, [inaudible] theme maybe follow his instruction. And the.. And then I got try out to learn the twirling of the staff while in the VR headset, and Christine had this– broken it down into

this specific set of movements which eventually graduated to the full– the full technique. The full movement. It was very cool to do because I couldn't see her at the time, I did it in VR with the staff. Tried to... Me having the staff and eventually taping the controllers to the staff so I could get the response from seeing the ends of the staff. I would say that's the highlight.

I: So what I heard was there was a workshop, with the theme of interrupting or adding or manipulating movements. And the idea was that people would bring a habitual movement and then teach that to the others in the group and the aim was to do a VR mediated exercise and in the VR environment you were in a dojo. You tracked the two controllers as floating orbs, in the end you ended up just doing two of these teaching one another stuff. Joe taught a dance, he did that in situ, not mediated in the VR, if i understood that.

P1: yeah, yeah.

I: And it was very playful and he was just, umm, fooling around with [??] and tools, and just asking the others to follow his instructions.

P1: Yeah, to be more specific maybe we started off learning and then we kinda interrupted this movement and tried to involve the VR and the other– we had the soma bits and, uh, what do you call the soft things?

I: The shapes.

P1: The shapes, soma shapes. Umm, we tried to involve them to also, in a way we also played around and kinda interrupted the

movement to see how how– how it would happen. Uh we also had the soft heels that we made previously that you could tie on your feet. Um we had a pair of high heel shoes that only fit, uh, I think a couple people but they they were involved in both of the– but both of these kinda movements that's– yeah.

I: So... Once you had done that with Joe, then the next step was that Christine was teaching, um, taught you the swirl with the staff. Um, once you got to try that you were wearing the VR headset, and you– you got to learn how to do this twirling and, um that movement was broken down by Christine into different, umm, learnings, and eventually during this exercise, you came to tape the controllers to the staff.

...

B.3 Practice Sessions with VR Interventions

B.3.1 Sample of Session Transcript

P1: Okay. So, starting with your feet together, umm, and you're holding the sword against your hip like it's a sheath, your fingers are on the, uh, side with the angles which is the curved side of the sword. Right where it meets the handle, so that would be like, the end of the sheath. You're gonna step forward with your right foot, and then at the same time you're gonna just slide that sword across, like, along your hip, and extend it out a little bit, your hand in front of you-

P2: Where am I grabbing?

P1: Just the one that's, uh—you're not grabbing the handle yet. You're just grabbing with the left hand still.

...

P2, 7:05

P2: Wait so like, I'm only holding it with my left hand.

P1: Yeah. And you're going to extend, uh, that forward, keeping it touching your hip. Right? So like it's still attached—tied to your belt, basically.

Then your right hand is gonna rest the back of your hand on the handle, like the back of your hand is touching like the—you could flip your hand over and grab the handle of the sword. Good. That's it.

P2: Okay [clooks down and up again.]

P1: And then, when you step forward with your other foot, you're gonna draw your right hand up and over your head [emphasis on certain words] and like you're unsheathing the sword and stepping forward. Then–

P2: So...

P1: So, left foot's gonna step forward, right hand turns and draws the sword....

[P2 attempts motion]

P1: ...out of the sheath, basically.

P2: [arms raised] This way. [Inquisitive]

P1: Yeah. Outta the sheath. So your left hand kinda stays by your hip.

P2: Does the left hand not drop at that point?

P1: Yeah that's fine. And then you flip the sword forward, like there's an opponent in front of you.

[P2 does motion, slowly swinging sword downwards]

P1: Cool. So just standing with the sword in front of you–

P2: Yeah.

P1: – you want the tip to be, at like, the level of your nose... Can you back up just a little bit?

[P2 backs up so she is visible through the doorframe from P1's POV again]

P1: One more step.

[P2 takes one more step backwards]

P1: Cool. The distance between your hands is about one fist distance.

[P2 adjusts hands]

P1: Good. And then, you think about the...pinky of your left hand is half on, half off. Of the bottom of the sword.

P2: My left hand?

P1: Yeah, the bottom hand. Ooh!

[P2 releases bottom hand, showing it's the right]

P1: Your hands are switched. [laughs] That's okay.

...

A: – it forward you'd be... losing ground, right? You keep the tip kinda where it is, right? And then you thrust it forward. Yeah. I know it might be a little hard for you but try and take a wider stance and bend your knees at the end of the cut. Yeah. Like, kind of like a—sh, like umm–

S: Like a shiko-dachi?

A: Like a shiko-dachi, yeah.

S: Like...this correct?

A: yeah a little lower with the blade. The-the blade can be a little lower. Yeah there you go.

S: Oh.

A: You fe—it—it stays in front of your hips a lot.

S: Okay.

A: yeah, there you go. Yeah, there you go... Cool. Do that a few more times. And then... [chuckles] if you're able, you can grab–

S: [laughs] Sometimes they like don't match [points at air]

A: Oh really?

S: yeah [laughs] and they get all glitchy it's great.

A: Okay. So now what you can do is, um, you can... you can... start in gedan, step froward cut, and then step back and touch the sword to the top of your head like the first strike.

[S goes into position]

A: Yeah. And then bring it... down to your hip, like you did before. Uh, yes, yeah, and then cut, thrust. So, up over the head, step forward, cut, and then–

S: Step, forward [inaudible]

A: And then, you can step with your other leg, and thrust. That way.

S: Do I change my, hand position?

A: That's fine too, yeah.

S: Or is it still this way?

A: It's the other way.

S: Like this.

A: Yeah.

S: Okay. I'll try it again [laughs] umm

A: So start in gedan, stpe back touch the top of your head...

S: Step back...

A: yeah touch the top of your head. Cut. Step. Thrust. There you

go. And you can just, instead of resetting to standing, after your thrust, you can step back into that overhead cut.

S: Oh, okay.

A: Yeah there you go. Step forward, Step—yeah.

...

B.3.2 Sample of Interview Transcript

P5: Biggest thing I found difficult was not being able to see [P4] because so much—especially hen I was learning our first dance, so much of that was me looking at [P4] and trying to mirror her moves. Most of the dance was mirrored. There were a few bits where we changed things up. Especially early on I was looking at N's feet, like, foot placement, where she was moving her arms and stuff. So, not having N to look at made it quite difficult, so I feel like that was probably the biggest thing. Not being able to see my own movements wasn't as much of a concern as I thought it would be. Like I could see my hands, but I couldn't see my feet. I guess I wasn't doing anything too crazy with the feet.

P4: side steps, [laughs]

P5: Doesn't really need to be.

C: Did you find when you were in there, when you were receiving instruction, were there any differences between the two scenarios, Star-Stuff and Dance Tools? In terms of your learning context, did any parts from that jump out?

P5: Being able to see the trails was immediately useful to me. Umm, cause a lot of it—I wasn't really clear on what—partially what was being described to me sort of in a way that wasn't clear to me but umm realizing what N meant when she said do a semi-circle and do, you know 45 degrees and stuff. And just seeing the trails in the air after I'd done them made me realize where I had gone wrong and made it easier to correct.

I also felt like—there were probably more things you could do. Having trails on both arms, having instant replay function, it definitely felt like that was an extremely useful tool and it made me start thinking about other things you could do when your whole body is being tracked constantly. Cause like during learning, we would record ourselves and look at it back and be like, oh I did that wrong, I did that better. But it took a bit fiddling to get them set up and stuff.

....

23;13

C: ... something that jumped out at me right away when I saw you start to give instructions was you went from sitting immediately to standing and needed to—you decided to do some of the motions as well. I'm just curious how you use that to inform your teaching.

P4: I guess it's feeling movement and also being sure of what I'm actually doing. I think it's something a lot of teachers get, where you'll be like, 'hang on, how do I do that?' [laughs] and then you'll set yourself to get it clear in your mind so that you know exactly what you're saying. I didn't come here and know what I was

gonna say, I just stood there and think 'oh yeah it's a figure of eight!' how can I describe this without showing him? And the easiest way to do that was to stand there and do it myself.

C: you had to figure out how to explain things when you knew in that scenario, he couldn't see you. How else the inputs and outputs of the situation affected the session for you guys, like I know you already said the fact that he couldn't see you, and that influenced your language for instance.

P4: Yeah, I don't think I ever usually describe this many shapes. [laughs] Cause I'm just like, oh you move your hand here.

C: You show them.

P5: Honestly remind me of [inaudible]. Like trying to describe in abstract terms what the space is like and things like that, when you started saying, 'move the semi-circle, move that' I was expecting things like 'spread!' 'stack!'

[group laughs]

C: Just to make sure I'm understanding, your typical choice is not to say the shapes, it's more through demonstration?

P4: Yeah, through demonstration and also saying it in words so [J] has—I guess almost a language to use? Erm, oh we're going to step here and then do this without me actually having to do it I guess if that makes sense.

P5: partially due to how I learn dance, you're used to teaching me and I tend to require a set of instructions, and if I break from the set of instructions, I find it difficult to get back to the set of

instructions. Like, I still have it from this first dance in my head, like, step step step, okay move out, circle circle circle, and spin spin—I would have the instructions going through my head.

P4: yeah every move would have a descriptor I guess but it wouldn't be to the same depth.

C: Okay. It was like a notation or something.

P4: Yeah, yeah.

P5: it was like a– they were certain dances from Final Fantasy, and they were discrete elements I would memorize those as [?] Dance, Bee's Knees, Bee's Knees forward, forward, forward, Bee's Knee's left left left, like I would—

P4: Rather than it being all the individual steps it would be, here is that block.

P5: Yeah cause you couldn't describe them in, like, you'd have to build it up very gradually. I don't think that would've worked for me.

C: Did you come up with the names?

P4: They're the names that are in Final Fantasy four—

P5: I think we did kind of come up with our own names for them.

P4: I cannot remember any of them [laughs]

P5: I'd have to do the dance to remember. [laughs]

P4: it did have little sections and they were named as it were.

P5: Mad Spin was one.

P4: Mad Spin, yeah.

P5: Big Kick, that was another.

C: Just to go back to what you said, [P5] about... I apologize my conversations are not very linear—

P4: It's okay!

C: you said something earlier about—you were surprised how it didn't matter as much as you thought, the fact that you couldn't see your own body? Where does the expectation of—you assume you should be seeing your body come from, and what about not seeing your body actually made it okay to deal with?

P5: Yeah, when I learn dance I spend a lot of time looking at my own feet, and looking at where I'm going and my arms and stuff. The ones I struggle with most are the ones where I have to do a spin or something, or look at [P4] or something, cause I would always be looking at just what I was doing, so the fact that the only point of reference I had to follow was this kind of floating trail, and this arm thing, it was kind of like I can kinda still see it—it almost was like I didn't need to worry about my feet at all. I couldn't see them. I was just doing what I felt was probably okay. And it almost kind of, I wasn't overthinking my foot placement—admittedly it was a simple foot movement so I don't know how much of that was, oh this is just an easy move but, umm... and then the second part I kind of expected that not seeing my body would kind of make it.. I dunno. I think one of the things it did do was it increased my motion sickness. Like trying to find a

point of reference, umm, maybe, I don't know. But—I don't know if I answered the second half of that well.

C: Correct me if I've misunderstood anything, but it felt like... needing to see your body would've been a bigger factor because in your normal practice, you're often using your vision to look for the cues for what you should be doing, in your own body.

P5: Yeah.

C: And in VR, you've found that—not seeing your feet removed some of the cognitive load of, oh where are my feet? And you had to concentrate on how the motion felt?

P5: Yeah, I think that'd be a good way of putting it. I'm not very good at intuitively knowing where my body is at a dance, I think [P4's] better at it. But yeah, it meant that because I couldn't see my feet, I wasn't really thinking about them much at all. [laughs] Umm, it might've been more of an issue if I had to learn something with specific foot placement. I don't think I would've been able to do that without you showing me a box step and then me just doing it a bunch of times, and then looking at my feet until I've got it, like, as a parallel process that I could kind of—

...

P4: I think like, using ballet again cause it's a very obvious one, you could like, say to someone that knows what first position is, and what plie is, they don't need to see it because they've already seen it before and they have that experience. Whereas [P5] might not know what first position is, so it's like alright turn out your toes, keep your feet together ankles together, and it's just a lot

more words in place of the visual you might've had.

P5: We raid in Final Fantasy all the time and we use the most complex , like between eight epeople all doing something really complicated, we used to—breaking that down to the point where they're learning it like they just know one thing. Like, high concepts or something, like okay high concepts, I've got the fire, okay, skip b, and there's three to six statements that belie hours of us like practicing and getting used to it and stuff. In that situation we'd bust out diagrams and have a white board to show stuff.

[CAT appears]

....

46:37

P4: I think speaking of diagrams, that's probably something that you can do, umm, it's like if you google again ballet, and just google stuff, there's so many images. So if you had somebody in VR, and you could just drop an image even like draw on it or something. You could circle the feet, like 'oh look, you can see how they're pointed this way' and draw a little arrow on. Even stuff like that even if you can't see the instructor, but the instructor can place other means of showing them.

C: yeah. That's one of the things that I would've liked to develop in the Dance Tools, the second thing you tried, as a networked experience so the instructor, even if you can't see them, they're in there moving elements and marking stuff and other things—

P4: you could always get one of those little art figures that they

have at HobbyCraft.

[P5 points up]

C: Oh I have those!

P4: yeah! You can always have one of those that's person-sized. And then move that!

C: I literally have a model of that.

P4: So yeah, something more technical, your hands go there! But I feel like rigging it would possibly be a nightmare. For someone to then intuitively be able to move it.

C: But conceptually I can imagine something like that in my practice being helpful like if I had to practice remotely, there were some activities I tried over lockdown that... the first classes I did were, the content was stuff I was already familiar with. Similar to ballet, in karate if you already have a foundational level of knowledge, and they give you a list of moves—

P4: [nods] You can just do them.

...