"Speech is Silver, Silence is Golden " Analyzing Micro-communication Strategies between Visually Impaired Runners and their Guides

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Figure 1: Interaction analysis of visually impaired runner and sighted guide running in the park

ABSTRACT

Running and jogging are popular activities for many visually impaired individuals thanks to the relatively low entry barriers. Research in HCI and beyond has focused primarily on leveraging technology to enable visually impaired people to run independently. However, depending on their residual vision and personal preferences, many chose to run with a sighted guide. This study presents a comprehensive analysis of the partnership between visually impaired runners and sighted guides. Using a combination of interaction and thematic analysis on video and interview data from 6 pairs of runners and guides, we unpack the complexity and directionality of three layers of vocal communication (directive, contextual, and recreational) and distinguish between intentional and unintentional corporeal communication. Building on the understanding of the importance of synchrony we also present some exploratory data looking at physiological synchrony between 2 pairs of runners with different level of experience and articulate recommendations for the HCI community.

*Both authors contributed equally to this research.

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KEYWORDS

Visually impaired, running, guide, blind, sport, synchrony, interdependence

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1 INTRODUCTION

Engaging in sporting and other physical activities has been shown to deliver significant benefits to individuals at physical, psychological and social level [28]. During the COVID-19 pandemic being able to exercise and remain active was highlighted as important to only to one's physical but also mental health [5].Unfortunately, for many individuals with visual impairment being able to access sporting activities on a regular basis is extremely challenging due to a combination of high cost, lack of facilities, limited support, and low-confidence [37, 43, 55]. Compared to most other sports, running and jogging enjoy particular popularity amongst visually impaired athletes due to the fact that, at least at entry level, they do not require special equipment or facilities [39]. Associations supporting visually impaired runners, as well as hosting and promoting inclusive running events, both competitive and non, are also growing in number which showcases the increasing interest towards the sport [39].

To date the several researcher in HCI and beyond have explored how technology can better support visually impaired runners including providing haptic or auditory feedback to help people remain in their lane when jogging on a 400m track [72], exploring the use of drones to provide a guiding system that can be localised and followed based on the sound of its rotors or through a tethered leash [2, 8], creating portable systems that provide route information during a marathon [90], as well as implementing computer vision algorithms for portable cameras to support obstacle avoidance when running outdoors [61]. However, all these studies focus on scenarios where the visually impaired person is running alone [2, 8, 61, 72, 90], which does not necessarily aligns with the reality of people lives, nor their desires [9, 14, 51, 57, 84]. Moreover, in these contexts technological failures can create significant difficulties for users with negative consequences ranging from discomfort and annoyance to harm [32, 51].

Although research on technological systems tend to be focused on independent running, many visually impaired people, especially those who have limited or no residual vision, prefer to run with a sighted human guide or a guide dog [40, 53, 72, 75]. In many cases, assistance from a guide is not only preferred because it provides more security and clearer instructions, making the runner feel safer [72], but also because of the inherent value of the relationship between the runner and the guide [40]. Allen-Collinson et al [4] illustrates the importance of the process of guides and runners Listening-out to non-linguistic indicators such as each other's step, breathing and other body auxiliaries such as watches or bell, as well as the surrounding soundscape. This process helps to gather information about the environment, the pace of the other person, and their performance. Equally important is also for the pair to tune-into verbal conversation to communicate important information such as turns or steps, but also to provide a *contextual picture* of the environment that enriches the running experience [4]. Beyond auditory clues, runners and guides also communicate in an embodied manner using a tether that each person holds with one hand as they run side-by-side [75]. Guides are trained to use the tether to give instructions to the runner about turns, obstacles to avoid or required stops supplementing, and in some case substituting verbal instructions [40]. Overall, studies examining the multifaceted nature of the relationship between runners and sighted guides unveil a complex interdependent dynamic where communication, trust, synchrony, and mutual support are essential for success [4, 23, 40, 75].

The intricacies of mixed ability collaboration have been explored by scholars in both HCI and CSCW, highlighting how access occurs as a result of a joint actions that take place within specific relationships and situations [15, 19, 80, 87]. The relational and power dynamics between the involved parties have been shown to affect the willingness to ask for assistance, even when the so called help is in fact legally warranted accommodation, leading to disabled people having to engage in draining hidden work to meet the requirements of an inaccessible environment [14, 20, 27, 56]. Much of the collaborative work that enables accessibility takes place in the moment, but preparation and rehearsal are also useful to facilitate in-situ interactions and reduce the burden for everyone involved [19, 47]. Finally, post-interaction feedback can help to improve future experiences and give disabled people a greater sense of control [47, 87]. Researchers have called for better technological systems able to support mixed ability collaboration, particularly focusing on the need to enhance users' contextual awareness of their respective actions [15, 27, 71, 84, 86], and focusing on providing information that leverage a shared common ground rather than prioritizing the sense-making modalities of non-disabled individuals (e.g., translating visual information into sound) [15, 80, 84, 86].

To date, although studies have started to explore the experiences of visually impaired runners and their guides this has been primarily done using interviews and ethnographic approaches focusing on individual perspectives [4, 23, 40, 75]. Therefore, there has been limited research seeking to unpack the specific interdependent embodied dynamics that occur between runners and guides with different level of expertise while they run. Moreover, there is a lack of overlap between phenomenological studies focused on understanding partnerships between visually impaired runners and guides [4, 23, 40, 75] and HCI studies exploring mixed-ability collaboration as well as the role of technology to support visually impaired runners [2, 8, 72, 90].

Following a similar approach to the one adopted by Vincenzi et al [84] we leverage interaction analysis [7] to understand how visually impaired people and their guides work together interdependently within the context of their running sessions, unpacking how they share information and adapt to each other in action, and identifying the key aspects of this unique collaborative relationship. Our goal is not to use technology to substitute guides and make runners more *independent* , but to explore if and how technology could help to support the existing relationship within its current dynamics.

Our research approach was guided by the following questions

(1) How do visually impaired people and guides communicate with each other during running?
(2) What are the key elements that characterise that interdependent collaboration between visually impaired runners and guides?
(3) How can technology support the interdependent collaboration of visually impaired runners and guides?

To this end we collaborated with Go Achilles! an organization in Tokyo working to support people with and without disabilities at all levels with an interest in running together, weather competitively or for leisure. We attended events initially as volunteers to build a relationship with the groups and over a period of 3 months we recruited six pairs of visually impaired runners and sighted guides. We conducted semi-structured interviews with participants and collected video footage of running sessions using body cameras worn by a member of the research team who would follow the pair during their practice. As participants often mentioned how synchrony was a crucial aspect of running together, we attempted to further explore this aspect by collecting data using smart wristbands featuring accelerometers and sensors measuring electrodermal and heart activity, from two pairs of participants during a single session.

Our analysis highlight how the interdependent relationship between visually impaired runners and guides is mediated by multi-layered communication that involves both vocal and corporeal exchanges. The directionality of these exchanges defines the actions of each individual. Moreover, while vocal communication is primarily intentional, corporeal communication can occur as a result of embodied reactions, such as a sighted guide tensing up when falling out-of-step with the visually impaired runner, which are detected and interpreted by the other person depending on the context. Based on these results we highlight how technology can help augment this relationship by increasing contextual awareness of one's surroundings as well as respective states and actions during the run, but also by enabling training opportunities before running and mechanisms for feedback and reflection following a run.

Our work makes three contributions to HCI:

- We show how guided running is a deeply collaborative act that mediated by an interdependent multi-layered communication featuring both vocal and corporeal exchanges
- We highlight the importance of three key concepts that shape interdependent communication during guided running: directionality, synchrony, and silence.
- We present potential avenues for technology to support the mixed-ability collaborative relationship between visually impaired runners and sighted guides for training purposes, in-situ augmentation, and post-run reflection

2 RELATED WORK

In this section we first provide a brief overview of the practice of guided running, we then present key insights from phenomenological studies focused on understanding interdependent relationships between visually impaired individuals and sighted guides during walking and running, as well as HCI research focused on the role of technology is supporting mixed ability collaboration towards access.

2.1 Guided Running for Visually Impaired People

Guided running for visually impaired athletes has been part of the Paralympic Games since their first edition in 1960 [25]. In the Paralympic Games and other official competitions organized by the International Paralympic Committee (IPC) there are specific rules specifying which runners are allowed to compete with a guide - only those with the most severe visual impairments, how many guides can a visually impaired runner have within a race - one if the race is 800m or less and two for longer races, how runners and guides are going to be connected to each other - via elbow lead or tether, the maximum allowed distance between them - no more than 0.5 meters, and how they are allowed to cross the finishing line - the visually impaired runner must always cross first [3, 41, 62]. However, outside these official competitions, visually impaired athletes and their guides use different strategies depending on their individual preferences and specific circumstances [75].

For individuals the decision to run with a guide or alone is often shaped by a variety of factors including the degree of visual impairment, the degree of self-confidence, the familiarity with the environment, the availability of a guide, and the desire for social interaction [10, 26, 42, 75]. Guides participating in official competitions are expected to undergo recognised training and receive adequate certification, but outside registered competitions many guides are simply family members and friends of a visually impaired person, members of the same inclusive running club, or volunteers who joined local organization [10, 39, 40]. The training received by sighted guides in these scenarios is informal and not as rigorous and many pairs of guides and runners around the world have not received any training at all, but simply learned together through practice [39, 40, 73].

Visually impaired runners and guides often move side-by-side, but it is also possible for the guide to run in front or behind the visually impaired person [52]. Pairs can run without any form of physical connection, with the guide staying close to the visually impaired person and giving verbal instructions about turns, track lines, or obstacles, as well as using analog or digital sound emitting devices to give the runner continuous auditory feedback [4, 52, 75]. Most commonly pairs keep connected to each other either directly - loosely holding hands or using the elbow-guide technique where the visually impaired runner holds the elbow of the guide keeping their thumb on the outside, or via a tether [10, 52, 75]. As holding on to the guide's elbow or hand can interfere with the runner's arm swing many visually impaired people prefer to use a tether when running [10, 52, 67, 75, 89]. The material of tethers used in guided running can vary depending on individual preferences, but these are usually pieces of rope or string that runners and guides will both hold with their inside hand or wrap around their elbows [40, 52, 75]. In order to maintain physical distance without interfering with the guiding process, during the COVID-19 pandemic, some pairs of runner leveraged other tools, including longer carbon fiber sticks [40], but these are significantly less common. Regardless of whether they keep in contact directly or using a tether or a stick, during the run would provide haptic feedback, as well as voice commands, to indicate the following basics instructions:

- Turn left or right: The voice command usually precedes the haptic feedback. When the visually impaired runner is placed on the outside of the turn, the guide simply uses the arm or the tether to indicate the sharpness of the turn. If the visually impaired runner is placed inside the turn, the guide will step slightly in front of them to better use their arm or the tether to indicate the sharpness of the turn
- Steer left or right on the path: The voice command usually precedes the haptic feedback and should indicate the reason for steering (i.e. obstacles or people coming). Haptic feedback is similar to the one given for turns, but the tension applied to the tether or the movement of the arm are less pronounced
- Slow down: The voice command generally precedes the haptic feedback and the guide should provide a reason for slowing down (i.e. narrow path, or presence of people). The guide will hold the tether or the arm slightly back to reinforce the feedback. Depending on the circumstances, the guide might then step in front of the runner to provide more effective guidance and help shield the person from incoming people or obstacles.
- Stop: Depending on the urgency the haptic feedback can proceed the verbal command. For sudden stops the guide will lift their arm or tether up, raising the arm of the runner to indicate a alt. For regular stops the guide will give the vocal command firs and slow to a stop holding the tether or keeping their arm still to give feedback to the runner.

As a general rule of thumb it is recommended that guides are faster than visually impaired runners to ensure that they can comfortably keep in-step with the person and that they do not interfere with the pace of the runner, but in more informal settings this does not always occur [10, 39, 52, 54, 70]. Finally, although technical aspects of how to run and communicate are important, research and testimonies from professional and amateurs runners and their guides stress our trust, enjoyment and partnership are the most important aspects of the runner-guide experience [4, 10, 39, 40, 75]. In the following section we look more specific at the interdependent relationships between sighted guides and runners unfold in action and how pairs negotiate communication strategies to harmoniously move together.

2.2 Understanding Interdependent Relationships in Guided Walking and Running

The partnerships shaped by the interdependent relationships between sighted people and visually impaired people working together towards collaborative access have been explored by multiple researchers in a variety of situations including play, work, everyday mobility, and sport [4, 12, 14, 15, 19, 27, 40, 59, 77, 84].

Weather this takes place while walking or running, sighted guiding is one of the examples of mixed ability pairs of working together to collaboratively completing a task, in this case moving from a starting point to an end one, at their selected speed and pace [15, 19, 66, 84]. However, interdependent walking or running involving visually impaired people and sighted guides is not just a means to collaboratively achieve a specific goal, but also a goal in itself that creates and deepens relationships between people [10, 31, 40, 49, 84]. Simply put, sighted guiding might be chosen by walkers and runners with mixed visual abilities, not necessarily as a sole or preferable way to engage in an activity because is safer, faster, or more functional, but just because it is more enjoyable [4, 39, 40, 59].

Understanding this aspect of interdependent collaboration during walking or running is fundamental to unpack the complexities of communication occurring between the visually impaired person and their sighted guide. Vincenzi et al [84] illustrates how mixed-ability pairs co-constitute space in which to move together using a variety of strategies from embodied actions to simple voice commands, and attention to multi-sensory clues. Their analysis also show how unexpected and unexplained pauses in the communication, verbal or embodied, causes ruptures to these shared spaces which often create unnecessary challenges for the visually impaired person [84]. Bennett et al 2020 [15] highlights how in these mundane acts of care frequently shaped by uneven power dynamics as the sighted guide is the one sensing the surrounding and giving the visually impaired person the capacity to act which is otherwise limited by existing environmental barriers. In primarily functional terms this unbalanced power dynamic is undoubtedly true as sighted is a prioritised ability in a largely inaccessible world [20]. Yet, the visually impaired ramblers interviewed by MacPhearson [58] explained how they cared for their sighted guides by purposefully asking for visual descriptions of various landscapes as a way to enable their companions to share their experiences, even though they did not need those descriptions to enjoy the countryside. In this case the verbal communication occurring between the two is an act of care of the visually impaired person to the sighted guide with whom they share a intercorporeal experience [58].

The idea of intercorporeality between visually impaired runners and sighted guides was also articulated by Allen-Collinson [4] who outlined the practice of listening-out for auditory clues an tuning-in conversation to convey key information to each other. Once again these processes are mutual as sighted guides might be in charge of looking out for obstacles and navigating a path, but a visually impaired runner helping their sighted guide to improve their performance will be paying attention to the other person's breathing, foot fall, and posture to know when to increase or decrease the rhythm [4]. Similarly, runners and guides interviewed in the UK, Netherlands and the US [10, 39, 40] spoke of running together as a mutual act of care and a partnership of equals rather than a hierarchical relationship. One distinctive, and seemingly oxymoronic aspect of it, is the fact that, when the relationship is successful, runners and guides feel that the other person's presence can be either the most prominent aspect of a run, as when the two spend the time venting about their problems during a jog [39], or completely invisible, as when synchrony is so perfect that one feels like is running alone [39].

2.3 Technology in mixed-ability collaborative access

Although we found that the majority of the literature focusing on technological interventions to support visually impaired runners does not consider scenarios featuring the mixed-ability collaboration with a sighted guide [2, 8, 61, 90], researchers in HCI and CSWC have spent considerable effort investigating how technology can support these forms of collaborations, facilitating access to activities in the context of work [20, 27, 56, 71, 87], transport [46, 47], gaming [36], and everyday life [19, 80]. Bennet et al 2020 [15] articulates how these collaborative acts are shaped by people's desires to accomplish a particular task, but also their mutual concern for each other, as well as a natural inclination to harmonise actions. These motivations drive people to establish, implicitly or explicitly, some common ground around what information is useful to make sense of the situation in a particular moment, and how can be best shared [15, 19, 80]. Accessibility scholars have argued that AI systems trained to recognise not merely the features of the surrounding environments, but the actions of both actors withing their contextual meaning for the specific pair of individuals, could yield significantly more value than conventional assistive systems which merely transpose information from one sensorial channel to the other [15, 84, 86, 87].

The relationship between the parties involved in these collaborative access dynamics and the context in which they take place are both crucial to understand the potential role of technological interventions. Physical barriers and ableist social norms already generate a power differential between non-disabled people who generally conceptualised as those who provide help, and disabled people who are the recipients of help [14, 15, 18, 84, 88]. Furthermore, contextual dynamics which already exist in workplaces, families and other social circles can compound this asymmetry. Thus, it it not unusual for disabled people to express preferences towards more transactional exchanges where help is provided in exchange for compensation or as part of a service, rather than having to ask for support to those with whom they have a pre-existing relationship [14, 18, 20, 46, 87]. Technology can, and already does to an extent, facilitate this process, for example trough applications such as Be My Eyes or Viz Social, SNS and even as part of larger transport applications like Uber or Ola [14, 18, 46, 51]. However, the quality of help that can be obtained is inconsistent, both when it comes to asynchronous advice provided to forums and social media, to in-situ assistance provided in person or via an application [14, 18, 46, 51].

This issue is not necessarily limited to transactional forms of support either, deaf professionals in Wang et al [86] explained how hearing colleagues can be terrible at adjusting their practices when interacting with them, with attempts to communicate in more accessible manners making collaboration even more complicated. Much of these misunderstandings originate from lack of awareness about the need and capacities of disabled people amongst their non-disabled peers. In turn this can lead to the disabled person choosing to adjust their own behavior to facilitate interactions for their non-disabled collaborators who is unfamiliar with accessibility norms [20, 27, 86, 87]. Moreover, Mack et al [56] highlights that even when rules about accessibility have been established and agreed upon, they can be challenging to implement and uphold due to the lack of familiarity or the complexity that emerge in the presence of conflicting needs. Yuan et al [88] proposes how technology could be leveraged to provide knowledge on how to assists, supplying advice to non-disabled people engaged in mixed ability collaboration about which information are valuable to their disabled companions in a particular situation at a specific time. Overall, as seen in this short summary, there are significant overlaps that shape the opportunities for technology to play a role in facilitating mixed-ability collaboration. However, the specific needs are shaped by the contextual relationship and the specific activities in which people are engaged in. In our study, we focused on the activity of running and seek to unpack the existing collaboration dynamic between visually impaired runners and sighted guides, to highlight where technology could empower both.

3 METHODS

3.1 Settings & Approach

The study was conducted in coordination with volunteer organizations HandsOn Tokyo and the local branch of Go Achilles! an international organization supporting people with with mixed abilities, primarily but not only people with mixed visual abilities, interested in running together. One Sunday each month, the two groups organize a joint event to connect local volunteers with opportunities to guide visually impaired joggers on their routes in one of the main parks in the city. The local branch of the international organization features both runners and guides who exercise on a regular basis, and the volunteer organization provides an entry point for new guides. Each session runs for approximately three hours, and consists of guide training, group warm-up, and the activity itself.

Guide training is a group activity led by an expert blind runner and guide, in which volunteers are given an initial set of instructions for guiding visually impaired runners. Such instructions are categorized as follows: 1. verbal cues for movement (i.e. "stop", "turn right", "turn left", "step up", etc.) 2. verbal indications about the environment (i.e. "on your left", "be careful", etc.), and nonverbal guide instructions (i.e. "match the steps of the runner", "allow the runner to set pace"). Following an initial set of instructions, guides are encouraged to practice. Volunteers pair up and are handed blindfolds. One partner is instructed to wear the blindfold while the other practices guiding them on a jog through the park. This activity provides some basic training for volunteers who want to learn how to guide visually impaired runners, enables guides to understand how verbal and non verbal instructions are issued and received during a run, and allows guides to familiarize themselves with the route they will use as they guide joggers through the park.

Guides and runners then engage in a warm-up activity, consisting of group stretches and mobility exercises led by one of the participants. Following the warm-up, volunteers introduce themselves and guides and runners are matched based on numbers and perceived skill level (expected running time for a loop of the park which is approximately 2km). Each pair then begins their route through the park. Throughout the activity, pairs are encouraged to return to the rest area set up at location where they started for a break or replenishment.

The park where the activity takes place is a public park which is central and well maintained. The terrain is flat and the main path used by the runners is wide and paved, providing a regular running surface. The park is extremely popular with other joggers and families and often features local events, meaning that while the paths are wide, but they can also be busy. Only service vehicles are allowed in the park making the traffic almost exclusively pedestrian except for a dedicated area where bicycles are allowed. The route followed by the runners in the study does not cross the bicycle path.

Members of our research team began to join sessions run by both organizations in spring 2023. Some of us are regular, albeit non competitive runners, and we have experience practicing sports, inclusive and non, but we had no experience of guided running before. Moreover, although some of us have lived experience of disability, we have no lived experience of visual impairment, meaning we have a limited understanding of the specific experiences of visually impaired runners. Our interest in mixed ability sporting experience sparked conversations with runners and group organizers throughout the regular meetings and during these discussions we asked about the possibility of conducting research to better understand the relationship between runners and guides. Members of both groups were familiar with us and our backgrounds as designers, HCI, and accessibility researchers, but in our conversations we explained our interest was primarily in understanding communication dynamics between runners and guides as they naturally occur. Although we did have an interest in considering the potential role of technology in augmenting that communication , this would be secondary to the result of other observations and subject to further debate with runners and guides themselves. Throughout our research we tried to remain mindful of our positionality and refer to the judgement of runners and guides when interpreting the results, including asking for clarification when classifying interactions from videos and discussing our final framework for communication to ensure that our interpretation matched the experiences of runners and guides. The study protocol was approved by the Keio Graduate School of Media Design Ethics committee

3.2 Participants

Participants were recruited from the Go Achilles! and HandsOn Tokyo organizations during the sessions carried out in June, July and August 2023. After warm-up and before guides and runners were matched together during each of these sessions we introduced our study explained our goal and data collection methods, including interviews and video recordings, specifying that participants could approach us if they were interested in taking part. We also asked any runner and guide who did not want to be captured in any of the videos to approach us to ensured that they would not be accidentally captured in videos or photo taken on the day. If interested, potential participants were explained additional details of the study including data storage and handling and asked to provide verbal consent before the started the running session with the member of the research team.

In total 12 participants (6 pairs of runners and guides) agreed to take part in the research. Participants' demographics including age, degree of visual impairment, and experience as guides or runners are listed in Table 1. Participants, both runners and guides, were asked to provide information about any disability or other condition, beyond visual impairment, that would influence their experience of running and/or guiding. No other personal information was collected.

3.3 Data Collection

Pairs were recruited at the start of the event, on a volunteer basis. The jogging session was video recorded by a member of the research team wearing a body cam who would follow the pair during their usual run. The purpose of the videos was to capture patterns of micro-communication between individuals as they occurred without interfering with runners forms or action. After pairs completed their runs and during breaks in between laps, we conducted interviews with identified pairs of blind joggers and their guides. Interview questions focused on methods of verbal and nonverbal communication between guides and runners when facing various scenarios including managing unexpected situations (such as navigating around obstacles, handling crowds, and suddenly stopping). Additional interview topics included preferences in guide behavior and priorities when running with or training new guides, and differences when running with familiar and unfamiliar partners. Interviews were conducted primarily by the first and second author English or Japanese depending on interviewees preferences. Interviews were audio recorded with the permission of participants and subsequently transcribed. Japanese interviews were translated in English before analysis.

3.4 Data Analysis

Data corpus consisted of video recordings from four cameras recording joggers and their guides on their route, and interview transcripts from four pairs of joggers and guides. Videos from the body cameras worn by the researchers following the pairs were initially analyzed by author XX using interaction and thematic analysis to identify critical exchanges, behaviors, and moments between visually impaired joggers and their guide counterparts [45, 64, 65]. This analysis strategies was chosen as it is generally suitable for in-the-wild ethnographic studies, including sport ethnography, and enables interpretation of both nonverbal and verbal interpersonal interactions and unpacking of interdependent dynamics [64, 84]. Salient interactions identified by author XX were then discussed and reviewed with author XX. Audio recordings from participants interviews were transcribed and translated from Japanese to English. Transcripts were analysed using inductive thematic analysis with an open coding approach focused on understanding individual experiences of communication [17, 21, 48] . Initial coding for video and transcribed data was conducted by the first author and codes were discussed and reviewed with the second and third author. Codes and salient interactions identified from interviews and videos were discussed amongst all authors to develop a model for a framework of communication between runners and guides, this framework was also discussed with participants and other runners and guides who attend the events but did not participate in the study until a consensus on interpretation was reached.

Table 1: Participants' demographics

ID	Age (years)	Sight level	Experience Guiding/Running	Experience Together
P1	70	No residual vision	Runs regularly since 2004	Occasionally run together
G1	58	Sighted	Guide since 2015	Occasionally run together
P2	46	No residual vision	Runs regularly since 2008	Run together only twice
G2	39	Sighted	Novice (less than 3 months)	Run together only twice
P3	63	No residual vision	Runs regularly since 2017	Occasionally run together
G3	50	Sighted	2 Years	Occasionally run together
P4	65	No residual vision	Runs regularly since 2006	3 years including competitions
G4	72	Sighted	7 Years	3 years including competitions
P5	59	Hands motion	Runs regularly since 2008	First time
G5	58	Sighted	First time	First time
P6	69	No residual vision	Runs regularly since 2014	10 years
G6	64	Sighted	Since 2009	10 years

4 RESULTS

The framework that we conceptualised based on our analysis divides communication in two main modalities: Vocal and Corporeal. We deliberately use the these terms rather than relying on more common terms such as verbal and non-verbal as we wish to highlight that vocal communication encompasses any information transmitted via voice production mechanisms and received via auditory channels, which includes more than words but excludes gestures with specific verbal associations [6], and corporeal refers to all forms of communications that are expressed through the physical body primarily through movements and perceived primarily via tactile and proprioceptive channels [33, 83]. Vocal communication is articulated on three levels: Directive, Contextual, and Recreational, whereas Corporeal communication can be classified as intentional or unintentional. Finally, we present the concept of Silence in guided running as a form of communication in itself indicating companionship and mutual understanding [30]. It is worth noting that different forms of communication both Vocal and Corporeal are often concurrent and bi-directional and that there was often a certain degree of overlapping between strategies observed in situ. Yet in our analysis we highlight were directionality was more pronounced and the purposes for which each strategy was used. Our communication framework is intended to provide guidance in the phenomenological interpretation of exchanges between visually impaired runners and guides, rather than representing a mutually-exclusive classification system. An overview of the communication framework is shown in Figure2

4.1 Vocal Communication

4.1.1 Directive. Directive vocal communication was observed amongst all pairs at several points and represents the most basic form of functional exchange of information between runners and guides. Directive communication was sometime explicit such as when a guide issues a command such as *"Start"*, *"Stop"*, *"Left turn coming in 5 meters"*. But could also be a more general alert such as *"There are children further up the road"* indicating that more specific commands might follow if there are sudden obstacles on the road. Direct vocal communication was leveraged more often by guides, but we observed runners using it as well, in particular with more inexperienced guides, such as P2 telling the guide after a few minutes *"Let's go faster"* or P5 pointing out *"Didn't we miss a left turn?"*.

Directive vocal communication is essential to convey basic information about the path, surrounding environment or the state of one of the runners, including injuries. Safety is its primary purpose and both runners and guides stressed that it should be as clear as possible at all time. Although guides are the ones primarily responsible for it, visually impaired runners often also contribute with their own insights, for example flagging if they hear a faster person coming from behind them. One of the most difficult aspects that defines this particular kinds of communication is that runners and guides need to agree on what level of essential information to feel safe at all time, and when an excessive amount of information might simply become confusing and overwhelming. Trust in each other was what defined these limits within the specific contextual relationships with the need for more detailed explanation characterizing early exchanges, whereas long-term partners could rely on the most minimal exchanges.

"When I run with someone new for the first time, my biggest worry is whether they'll be able to communicate the necessary things to me at the right times. Therefore, I believe it is very important that we practice the communications properly before we actually start running together." - P3

"What I try to be careful not to do is to not overload the runners with more information than what is needed as, there are people who start to get nervous just from hearing everything. So I try to mention only the information that matters, as I said, the bare minimum. Right turn, left turn, and so on." - G6

4.1.2 Contextual. Vocal contextual communication refers to exchanges aimed at providing additional information about the surrounding environment which are not going to necessarily require the pair to take an immediate action. Runners and guides explained to us how contextual communication could vary quite extensively in booth quantity and content depending on the purpose of the run. If the pair was out for a leisurely jog in which performance was

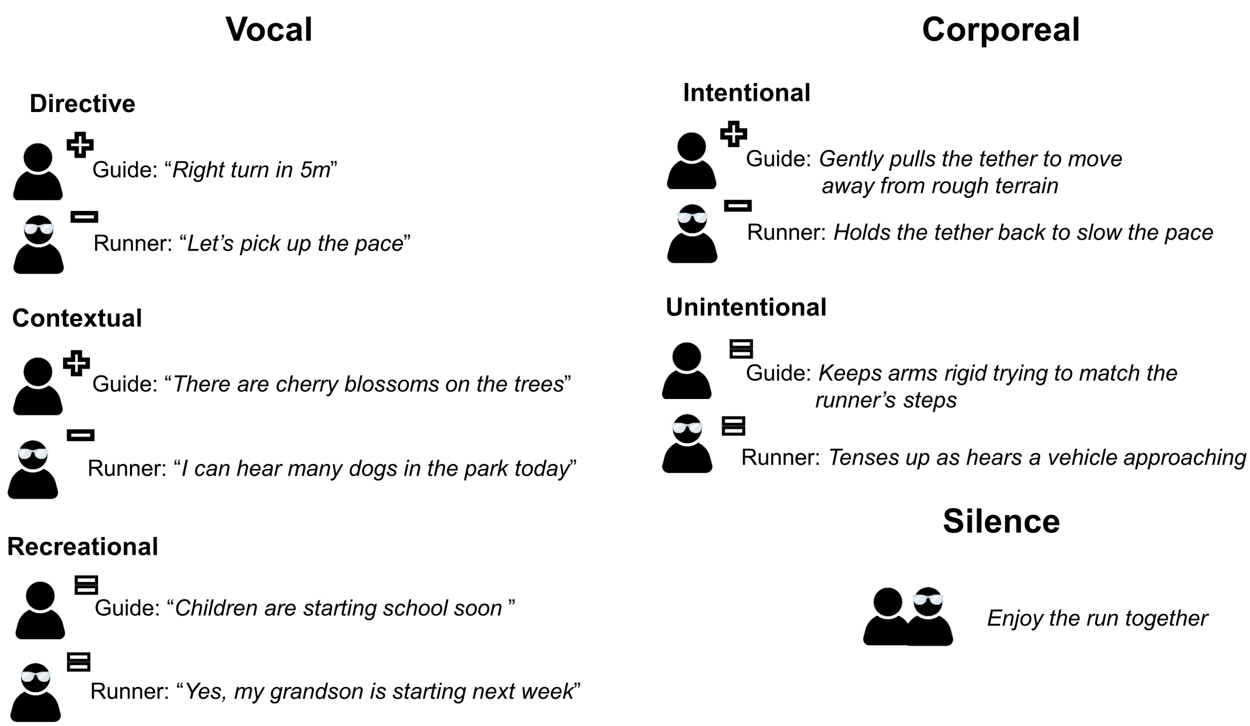

Figure 2: Overview of communication framework including Vocal, Corporeal and Silence each featuring sample indicative utterances from runners and guides

not a concern, contextual communication was often quite rich and similar in nature to what Allen-Collinson et al 2023 [4] described as *"painting of a picture via evocative verbal descriptions"*. However, Allen-Collinson et al 2023 [4] seem to attribute this communication almost exclusively to the guide, whereas during our observations we witnessed how visually impaired runners also contributed to this, leveraging their own sensory experiences (*"It is really hot today and I can hear a lot of cicadas from all the trees around, I could not even hear if the dog park was busy" - P1*). In this manner the evocative representation becomes richer for both people, as each draws the other attention to particular aspects of the environment.

One interesting point that we noticed was that contextual communication was also leveraged extensively to interact with the other pairs of runners that were jogging in the park. As shown in Figure X as the pair is approaching other runners from the same group they would generally alert the other person *"I can see [name of the runner] and [name of the guide] there, we'll pass by them in a few meters" - G4.* As the two pairs would approach each other the guide and runner who were overtaking from behind will say their name and a short greeting or a funny observation, the other pair would then reciprocate as they were been overtaken. These exchanges, even if brief were considered very important as many people reiterated how they enjoyed the Sunday morning sessions organised by Go Achilles! because they felt part of a larger community. The bond between a runner and their guide might be the most functionally important during the run itself, but it was not the only meaningful one.

"This group has become part of my life now. I can refresh myself with these meetups, and it has become part of my daily life. Everyone here is my friend and I actually met my wife at this club (laughs)" - P1.

Runners and guides such as P4, G4, P5, P6, and G6 who had experience running in marathons and other competitive events also illustrated to us how the vocal contextual communication takes a completely different meaning in this scenario. During competitive events contextual talk is much more sparse and generally relates to key information concerning the pace the pair is keeping, the distance covered or remaining, as well as information about other competitors.

4.1.3 Recreational. Recreational communication was most common amongst pair who knew each other well, or pairs who felt individually more confident about their abilities, even if they had limited experience running together . Overall, recreational vocal communication was leveraged as frequently by runners and guides, and if the guide was nervous due to their limited experience, it was almost entirely carried out by the visually impaired runner. Recreational communication was largely unrelated to the run itself and could revolve around any topic of common interests from favorite books, family matters, travel experience or favorite foods. Interestingly, recreational communication could be frivolous in its

Figure 3: A pair of runners passing two walkers from the same organization on the path

content but engaging in it could also become a functional act as it gave the runner additional information about the guide's position.

"Well, all the guides are pretty much good. But for me I like having a conversation. A good guide will respond to me. Just saying "yes" is okay, but conversations are fun aren't they? And it is also very helpful because it lets me know where my guide is. I can know, "oh sounds like we are about to move left a bit or right a bit." Communication is the best for me." - P3

"Conversations are really the best thing. Everyone here likes to run, but what really helps to make the experience fun is being able to talk about the things that we like and make friends. Once you are comfortable about safety then you can enjoy the relationship - G3

The quote from G3 highlights how novice guides were unlikely to be engaging in recreational conversation with their runner as they tried to remain "focused on the job" and were concerned that distractions might compromise their ability to ensure safety. Runners generally understood this and were understanding of the difficulties faced by novice guides. Many tried as best as they could to make their guides feel comfortable, reminding them not to worry too much, the shared understanding was that everyone who would join the session was doing their best and tried to look out for each other. Being safe was of course important, but the goal was to have fun together and excessive worries should not ruin the experience.

"For guides, don't be afraid. No one wants to fall or get hurt. Things like falling of course happen. But It's better if we just enjoy and have fun running together. I want to run a lot for competition and things like that, so it is best if we enjoy and have fun so we can run a lot. " - P2.

4.2 Corporeal Communication

4.2.1 Intentional. Intentional corporeal communication was very similar in nature to directive vocal communication meaning that It was primarily leveraged to convey functional information concerning the run. In many circumstance corporeal communication was accompanied by vocal direct communication such as the case for starts, stops, and turn where the guide would move their body and use the tether to indicate the sharpness of a turn or to navigate around obstacles that would require substantial steer from the predefined path. However, in other cases intentional corporeal communication could be used in more subtle ways such as to gently nudge a runner away from a small rough patch on the pavement, without the need to interrupt other forms of vocal communication, such as contextual or recreational, in which the pair was engaged.

"Some are just little things. Like If the path has been repaved. There could be little 5mm gaps and things. I tend to guide them away from these things, you don't need to explain everything if you know each other" - G1

As pointed out by G1, trust was the element that generally determined the extent in which a guide would pair intentional corporeal communication with directive verbal communication or not. Pairs which were familiar with each other and had established a mutual understanding seemed to have more intentional corporeal communication which was unaccompanied by direct verbal commands.

On the other hand, when familiarity was limited corporeal communication was always linked to more explicit verbal instructions to motivate it.

Direct corporeal communication was almost exclusively leveraged by guides and we witnessed only two occasions in which the runner used it. In one case, P2 noticed his shoes getting untied, probably from the clicking sound of the lace hitting the pavement, he gently tugged the tether and said *"Shoe"*, indicating that the pair had to stop for him to be able to tie it. Another occasion was when P2 was keen on increasing the pace in a particular stretch of the park and simply moved slightly ahead of the guide, generating tension in the tether so that the pair could increase the speed.

4.2.2 Unintentional. Unintentional corporeal communication could be generated for both runners and guides an we found it to be more commonly associated with pairs that had a limited degree of experience running together. Novice guides were the ones found to be most commonly delivering these kinds of unintended information with their bodies, usually in the form of tension in their arms, resulting in a mechanical movement, or awkward motions when they realised they had fallen out of sync with the runner and were trying to once again match their step. What we observed from video analysis was that when the guide posture became too rigid it would often affect the movement of the runner meaning that unintentional corporeal communication could become a circular pattern that a pair would struggled to get out of until they were able to return in sync with each other.

" When someone is very nervous, the rope feels very heavy, and I can feel that very clearly. I mean obviously the person has to move their arms so you would feel the tension on the rope, this can make it difficult to run and it becomes a problem for both - P6"

When runners or guide would notice themselves or the other person falling in these patterns of unintentional communication which affected the running experience, the tendency was to try to repair the disruption in a subtle manner, without resorting to vocal communication. However, if the situation persisted one would generally give clearer instructions to the other ("But when the pace just does not match up, I also tend to tell them as it can be unpleasant for both" - P1). A certain degree of disruption from unintentional communication was generally expected, particularly from novice guides or between pairs with limited familiarity, but the degree of tolerance towards it was heavily influenced by the context of the run as well. More competitive pairs pointed out that in a leisurely 5-10 km jog falling out of sync was not necessarily an issue, but as the distance and tiredness increased it could add to the existing strain. As fatigue started to pile up, visually impaired runners also noticed how they were more likely to lose form, altering the pace of the guide and breaking up the synchrony. These challenges were the ones that would test which partnerships would endure well under strain and which ones would struggle.

"When it comes to that point [around 30 km], how should I say it, your true unfiltered side starts showing and you are either there for each other or not. But if it's 5-10 km, even with mistakes it'll end on friendly terms." - G6

4.3 Silence

As we observed pairs jogging on the park, we started to notice periods where runners and guides did not engage in either vocal or corporeal communication, they simply run side by side with the tether loosely bobbing between the two. Participants explained that this happened when not just their bodies, but their minds where in perfect synchrony which allowed them to feel completely free and unrestricted in their movement as they enjoyed the run in a companionable silence.

"Maybe the best thing that I can remember was a while back, it felt like I was running on my own. I was connected from here with my guide but the rope was completely free and I could move naturally. It's like running side by side without needing to be connected. You can move alone but know you are together" - P4

Prolonged periods of silence were observed only between the pairs P4-G4 and P6-G6 as it required not just confidence in one's ability to run or guide, but also complete trust that the other person was able to sense changes in the environment, react to them and resume active communication, vocal or corporeal as needed. Together with recreational vocal communication, silence was considered one of the most rewarding parts of running together as it indicated a level of intimacy within the pair signaling to the other that they were both simply there to enjoy the moment and could forget about any other thought that might be affecting them during or before the run.

"You know how you have a lot of things you worry about or think about in life. And when you go for a run and you are relaxed together with your guide maybe your worries don't magically disappear, but you are able to separate yourself a bit from those emotions. Even when you're thinking about the same heavy and negative things, I feel like if you run and you can feel free, you can get a bit more relaxed in your mind." - P6

5 MEASURING SYNCHRONY

Throughout our observations and interviews it became apparent to us that one of the key elements that defined the partnerships between runners and guide was their ability to feel in synchrony with each other, seamlessly sharing an intercorporeal space that encompassed both of them. Synchrony of movement was of course important as seen when illustrating the disruptive effects caused by unintentional corporeal communication. However, feeling in synchrony did not stop at the ability of runners and guides to match each other step and arm movement, but also understanding the degree of details required when using directive vocal commands or adjusting the intensity of intentional corporeal gestures, being able to create a shared multi sensory representation of the surrounding via contextual communication, and feeling when recreational communication was welcome or silence was preferred. These findings matched the observations of mixed-ability collaboration reported by HCI researchers in other contexts where partners utilised both auditory and haptic cues to support shared sense making and mutual understanding of each other actions to accomplish a specific task [15, 19, 86, 88]. What we also observed within our study was how this deep sense of connection was built overtime and represented a testament to the strength of the partnership of the runner and the guide. As the bond between partners seemed to run much deeper than their visible motion patterns we became fascinated with the idea of exploring to what extent it would connect to their embodied experiences. This decision was motivated by a serious of considerations. Firstly, assessing the synchrony of steps leveraging accelerometers is relatively easy, unobtrusive and inexpensive, which allowed us to quickly integrate it within the study at short notice. Sensors able to detect biometrics parameters such as Electrodermal Activity and heart variability are often included in wrist-worn and hand worn devices, and these data is also often used to analyse physiological state during sporting activities for a variety of purposes from individual performance to team work [16, 79]. Secondly, our team had experience deploying and analysing data from these on-body sensors in a variety of situations, which increased our confidence in being able to employ them effectively within a relatively short time frame. Finally, we believed that attempting to introduce a relatively simple and low-profile technology which had a form factor that many participants would be familiar with, could be more easily accepted by participants but would also allow us to explore if technology could be potentially deployed in a context where is currently scarcely present and where collaboration is solely mediated by human actors.

Previous studies had shown that physiological synchrony between individuals who engaged in particular activities together could be linked to the sense of connection people feel with each other [11, 13, 82] as well as the depth of their relationship [50, 74]. We shared this idea with the participants who were curious to see if it would be possible to assess differences between new and established pairs. As a result, during the last session in August 2023 we recruited two pairs of participants P6/G6 (Pair 1) and P3/G3 (Pair 2) who had respectively significant and limited experience running together. The pairs were asked to wear a sensing wristband (See Section 5.1) on their outside arm, the one not holding the tether during a lap of the park.

5.1 Hardware

Custom made sensing devices worn by participants on their wrist featured an optical plethysmograph (PPG) and two Ag/AgCl electrodes for Electrodermal Activity (EDA) measurement on the fingers. EDA is measured with a Wheatstone bridge and a 16-bit ADC at 10Hz, PPG is measured at 200 Hz with 12-bit resolution. Acceleration of the wrist is measured on 3 axes at 50Hz. The devices are battery powered and the data is transmitted wirelessly in real time to the investigator's PC nearby where it is recorded and stored.

5.2 Data Analysis

Since the data was recorded from jogging participants in over 30 degrees C heat in a humid subtropical climate, the recorded data contains artifacts. Due to this we had to discard the EDA data, as in each pair one of the recordings was deemed abnormal and considering the climate where the recordings were made, we cannot be confident about the data quality. Surprisingly though the other recording in each pair looks rather typical for an EDA recording with this setup. Since we focused on assessing the time-synchrony of the physical motion and physiological states of the subjects, we cropped the recordings to the same length. Due to a hardware malfunction, the last few minutes of one of the subjects in the first pair was lost, leaving us with the initial 9 minutes. Thus, we cropped the end of each recording to this length.

5.3 Results

5.3.1 Acceleration. To analyze the synchrony of the movement in each pair we used dynamic time warping (DTW) method[35]. DTW is a measure of synchrony which involves the minimization of the distance between data points of two time series using a matrix and then evaluating how the resulting diagonal line compares to an ideal diagonal. These distance scores reveal how far the diagonal is from the ideal line, with a shorter distance indicating a stronger level of synchronization.

Here we focus on the movements of a relatively large amplitude related to the arm swaying, since the participants must move at a similar pace. With this in mind, the data was low-pass filtered (Butterworth, 2nd order, cut-off at 3.5Hz) and down-sampled the data by a factor of 5 (order 8, type I Chebyshev filter), as it eliminated micro-movements and left us enough information on each sway. In addition, since the exact position and orientation of the device on the wrist could not always be assured, rather than using each acceleration axis independently we calculated the total length of the acceleration vector and used it as a scalar value. This allows us to focus on total acceleration that the device is experiencing but loses the directionality. Thus, eliminating the problem with precise device positioning, while preserving each hand swing. Additionally, to account for the individual differences between the two individuals and their swing movements (some may swing more than the others), we normalized the data prior to the analysis. As the result, DTW distance for the Pair 1 is 344.324, normalized distance: 0.06886, for the Pair 2 the corresponding metrics are 342.416 and 0.06848.

These results show that both pair exhibited a high degree of movement synchrony in their arms during the run. Values were similar amongst both pairs, with Pair 1 slightly outperforming Pair 2. Figure 4 shows a graph that overlays acceleration profile of runner and guide for Pair 1.

5.3.2 Heart Rate Variability. For the PPG analysis, we relied on the neurokit2 package [60]. We used Elgendi et al 2013 [29] method for the PPG data cleaning and beat detection. On this dataset it produced more accurate beat detection than the alternatives. Data was split into 2-minute windows with 50% overlap, giving us a minute-by-minute picture. The resulting heart rate and it's variability metrics were normalized and compared within each pair using dynamic time warping (DTW) [35]. and correlation scores. However, both pairs have shown almost identical results except for Low Frequency High Frequency (LFHF) score. The correlation score for the minute-by-minute heart rate are 0.6386 and 0.6209, DTW normalized distances are 0.10938 and 0.085 for the first and second pair respectively. The root mean square of successive differences between normal heartbeats (RMSSD) correlation score is 0.4 and 0.367 and DTW normalized distances 0.13431 and 0.17054. Similar relationship holds for other commonly used HRV metrics except the LF/HF ratio: in the first pair the correlation score is 0.615 and normalized DTW path is 0.10591, while in the second these metrics were 0.222 and 0.17335, which is notably different.

The LF/HF ratio has been previously described as an indicative measure of the sympathetic to parasympathetic autonomic balance,

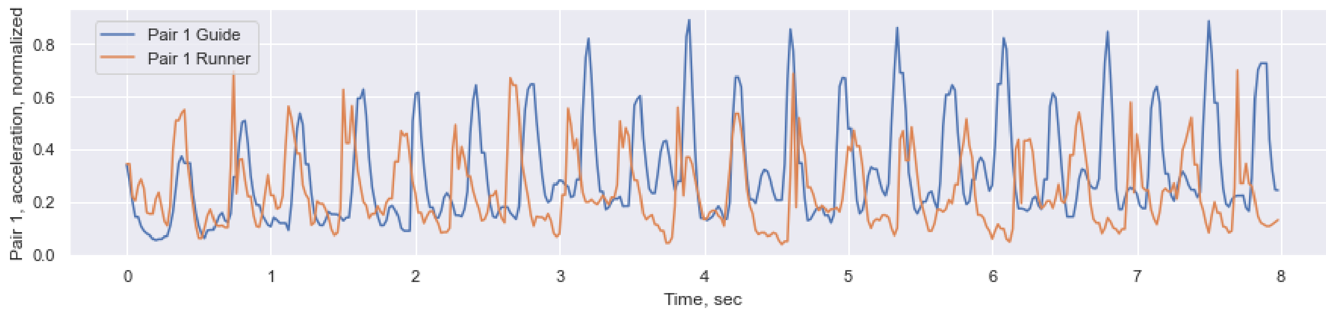

Figure 4: Graph showing the normalised acceleration profiles from Pair 1

which is in turn linked to both exercise performance [22] and emotional or physical stress [85]. Moreover, previous studies has shown that it can be used as a measure for interpersonal connection in reaching a joint state of flow amongst both dancers [24] and musicians [76]. It should be stressed that our results to date are based on a limited amount of data in relation to both number of participants and length of running activity, which makes it difficult to draw definitive conclusions. However, what our findings indicate is that while both pairs are able to move in synchrony during their run, Pair 1 also exhibit a deeper level of physiological synchrony which could be considered the sign of a stronger sense of connection that affects their physical and emotional state.

6 DISCUSSION

In our study we have drawn from a variety of data sources and methodological approach to understand the interdependent relationship between visually impaired runners and sighted guides in-situ and unpack the communication strategies that these pair employ to share and interpret functional information, develop a sense of connection, and co-construct an intercorporeal partnership. Our findings show how pairs engage in both vocal and corporeal exchanges to relate with each other and the space around them as they run together. Trust and companionship are key features that define this partnership, as well as the ability to reach a state of synchrony and create "Silence", described as moment in which both runners and guides simultaneously feel completely free yet fully supported by the other. In the following sub-sections we leverage these results to identify spaces in which technology could offer support to visually impaired runners and sighted guides to facilitate mixed-ability collaboration, not only in-situ, but also before and after a run. In doing this we both build and expand on the broader corpus of research on the topic.

6.1 Technology for training

As we explained in section 3.1 at the start of each session, all guides underwent brief training to understand how to provide basic verbal (in the form of directive vocal communication) and non-verbal (in the form of intentional corporeal communication) cues to the runners. However, this was often not sufficient to make the guide feel comfortable, resulting in tenseness that was transmitted as unintentional corporeal message, or lack of directive vocal commands, both of which could contribute to the discomfort of the visually impaired runner. When this occurred runners would either bear it and hope that they guide would improve overtime (or that they would not be paired together in another session), or provide verbal feedback, which could be burdensome to them and occasionally overwhelming for the guide. These issues are somehow similar to those highlighted in other context of mixed ability collaboration where non-disabled individuals lack knowledge to understand how to assist [18, 86, 88]. Access needs can be difficult to meet, especially as people can have significantly different preferences for communication, which has been shown can overwhelm someone with limited expertise [56].

Both Branham et al [19] and Kameswaran et al 2019 [47] have highlighted how preparation can make a significant difference in the success of mixed ability exchanges, increasing the success and reducing frustrations. However, both authors have illustrated how much of the preparation is often done by the visually impaired person. In this context, we argue that technology could provide an essential form of support to sighted guides who are trying to gain both assistance knowledge (learning how to effectively help) and domain knowledge (learning what is important within the context of a run) [88]. As an example, XR technologies could offer novice guides an opportunity to practice how to guide within a safe environments, being paired with a phantom visually impaired runner with specific characteristics, preferences and access needs. Ideally, visually impaired runners would create these profiles themselves, helping guides to learn from this epistemic knowledge and ensuring that after training they can better match the needs of specific individuals. This idea of creating technologies that combine more general and situated user-generated data aligns with the suggestions of both Bennet et al 2020 [15] and Vincenzi et al [84], for in-situ collaboration, but we argue that it could also be applied in the context of training.

Good sighted guiding during a run is a complex skill to learn, as it involves several aspects and can become more complicated for those who want to work with visually impaired runners who are interested in competing. As a result, technology to support training for guides should follow a progressive skill framework that focuses first on safety, and then on other aspects which are important to the collaboration, but are not necessarily part of basic training, such as contextual vocal communication. Leveraging gamification principles to promote accessibility awareness has been proposed in the context of web development [78] , but we argue it could have a place in this context as well.

6.2 Technology for in-situ augmentation

Findings from this study unveil the complex interconnected web of communication strategies leveraged by visually impaired runners and sighted guides which encompasses both vocal and corporeal modalities. These various communication strategies are often overlapping and can, as a result, be harder to keep track of for both individuals. Accounts from runners show how novice guides might become overly focused on directive vocal and/or intentional corporeal communication forgetting to engage in other exchanges that might help them connect with their partner, making both of them feel more at ease. The difficulty in these situations are often two-folds, as highlighted by previous research on mixed collaboration [15, 71, 84, 87]. Although individuals can hear each other voices and steps and feel the tension in the , it can be challenging to understand the specific body orientation and gaze direction of the partner, which would provide key contextual information. Moreover, as seen by the presence of unintentional corporeal communication, individuals are not necessarily fully aware of what their own body is telling the other person.

A space for technological innovation in this case is to offer the possibility to augment communication by letting each person become more aware of how they are communicating, how the other person is receiving the information, but also be more explicit in contextualizing their own needs. Albeit within a different context this can be seen as an extension of the idea of Crowd work in accessibility [14, 84], combined with the idea of double empathy or interpersonal knowledge in mixed ability interaction [68, 88]. This would allow for example a novice nervous guide that they are unsure about the amount of information that the runner requires to feel safe in case of navigating a more crowded path, enabling the runner to provide reassurance if needed, but also let the guide know when the lack of vocal directions is making them feel unsafe. Haptic or auditory stimuli, could be delivered using low profile devices such as earbuds or wristbands, and leveraged to discreetly nudge people to provide cues as needed. Moreover, running tethers themselves could be augmented to help reinforce information about the other person's actions, possibly reducing the need for explicit communication. The latter aspect might be particularly important in more stressful situations were their own cognitive abilities are hindered by fatigue, such as during marathons and other long competitions. There is also the potential for augmented tethers to become invisible, similarly to the idea of haptic bracelets proposed for guided skiing [1, 38], which can help participants to feel unrestricted in their own movements are reported during episodes of silence.

Finally, our analysis of synchrony within the movements and physiological parameters of runners and guides shows that there is a space for HCI and IoT researchers to better understand how the intercorporeal experiences of runners and their guides and explore the extent to which creating technologies that allow them share these internal states with each other might help them to co-create these moments of silence enhancing their experience in the moment. Previous research have explored the effectiveness of biofeedback in promoting the physiological synchronization in dyads of people involved in a variety of tasks from musical performance [34], to meditation [44], and how, interpersonal synchrony results in greater experiences of shared flow [24, 76]. Guided running could represent a novel scenario in which to explore the potential of these technologies.

6.3 Technology for post-run feedback

In our study we were able to observe how the vocal and corporeal communication between visually impaired runners and guides is extremely complex and rich. However, we noticed remarkably few exchanges where the performance of the guide and the experience of the runner where discussed after the paired stopped. Generally this was mentioned only by pairs who had significant experience running together and who were participating in ,or planning to participate in, official competitions. Feedback was occasionally provided by visually impaired runners to guides during the run, but this was often in the form of short requests or simple corporeal gestures -such as asking to slow down, communicating earlier if a turning point was near, or gently holding the tether to adjust the pace. We argue that this is a missed opportunity to improve the skills of the guides and the experience of the runners, and one area where technology could be effectively exploited.

Kameswaram 2019 [47] illustrates how the option to provide feedback after a transactional exchange, such as the one afforded by post-ride features on Uber or Ola, helped visually impaired people feel more in control. Moreover, applications and devices that collect experience and performance indicators during physical exercise for subsequent reflection are extremely popular amongst runners and other athletes [63, 69, 81]. We hypothesise that similar features that enable pairs to give and receive feedback as well as discuss their contextual experience posthumously could be greatly beneficial as runners could share more complex information about their needs and preferences which they might refrain from doing in the moment because of the physical demands of a run, as well as for fear of overwhelming the guide. In turn, guides would have the opportunity to analyse the feedback with more calm, asking for further clarifications if needed, potentially integrating the new acquired information in technology they use for training (see Section 6.1).

7 CONCLUSIONS

In conclusion, our research sheds light on the interdependent partnership between visually impaired runners and their sighted guides. Through an interaction analysis approach we unpack communication dynamics encompassing vocal and corporeal exchanges. Our results underscores the significance of synchrony and the nuanced concept of "Silence," both of which play pivotal roles in forging a profound connection between pairs. Lastly, we propose recommendations for technology to augment, rather than replace, the existing relationship between visually impaired runners and sighted guides in the form of: (i)"Technology for training" to enable guides to practice different modes of communication in a safe environment, (ii) "Technology for in-situ augmentation" to facilitate communication awareness, helping each party become more conscious of their communication style and the needs of the other; (iii) "Technology for post-run feedback": focused enabling posthumous reflections to improve subsequent outings.

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