“I Could See Your Heart Rate Creeping Up”: A Trioethnographic Study of Shared Real-Time Exertion Data in Road Cycling

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Abstract

Prior SportsHCI work highlights the potential of interactive systems to support collaborative physical activity, yet little is known about athletes’ long-term, in-situ experiences with such collaborative sports technologies. To address this gap, we investigate how sharing real-time exertion data shapes the experience of collaborative road cycling. In a year-long trioethnography, we collected post-ride reflections and recorded conversations and examined them within ongoing reflexive analysis. Our findings show that shared exertion data functions both as a coordination resource and a socially meaningful signal that shapes self-presentation, social comparisons, and the support we give and receive. We discuss implications for the design of collaborative sports technologies that account for the nuanced, evolving, and emotional athlete experience around shared exertion data. Ultimately, we aim to advance understanding of how to leverage shared real-time exertion data to improve the athlete experience.

CCS Concepts

• **Human-centered computing** → **Ethnographic studies**.

Keywords

Shared real-time exertion data, Road cycling, Heart rate, Collaborative Sport, Collaborative physical activity, Trioethnography, Triautoethnography, Ethnography.

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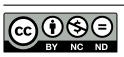
1 Introduction

SportsHCI and related research has long recognized the importance of supporting people doing physical activity together [2, 25, 44, 59, 76]. A growing body of work explores how interactive systems can enhance physical activity through social interactions, such as social exergames [54] and shared feedback [46, 58]. In this space, technologies that support real-time interaction during sport [1, 62, 84] show great promise for helping athletes to remain connected [40], be responsive [28], and provide motivation for team members [67]. We refer to this group of technologies as *collaborative sports technologies* to emphasize their real-time support for working together toward a mutual goal rather than competing with each other.

The sport of road cycling offers a compelling case for studying collaborative sports technology because road cycling is highly social and often features a mutual goal. Such mutual goals can include maintaining a pace that keeps the group together, jointly navigating road hazards, and holding conversations [38, 52, 78]. Road cycling typically involves riders traveling at higher speeds than leisure or commuter cyclists, and road cyclists typically ride in close proximity (Figure 1a) to take advantage of drafting in the slipstream [8, 53, 73]. (Please see subsection 2.3 for a brief overview of key cycling terms. For a detailed exposition we refer the reader to Franz et al.’s [33] contextual design study of road cyclists’ experiences riding in groups). In these tightly packed groups, small changes in pace or body position on the part of one cyclist can impact the cyclists around them [53]. In competition, cyclists can leverage this effect to disadvantage opponents, but in *collaborative cycling*, drafting is used to help other riders, often with the mutual goal of supporting riders of different fitness levels in staying together.

Despite the fact that most road cyclists leverage sophisticated commercial technologies that display their own exertion data, today’s state-of-the-art commercial technologies cannot display one rider’s exertion data alongside exertion data from a fellow rider. Franz et al. studied how group road cyclists coordinate pacing and manage effort together during rides and found that, although cyclists rely heavily on cycling computers, these devices do not support sharing any real-time exertion data [33]. Findings from other cycling studies suggest that shared real-time exertion data may hold the potential to foster social conversation [1] and pacing coordination [83]. However, much of that research on real-time exertion data sharing in cycling has been conducted in controlled environments [40] and within short-term studies [2]. This situation points to an important gap in collaborative sports technology research: studying the long-term, in-situ experience with shared real-time exertion data.

The potential benefits of shared real-time exertion data have been examined outside of cycling, where prior work suggests it can increase motivation [86], accountability [59], and social connection [55]. But people’s experiences with sharing exertion data are nuanced and include the risk of experiencing unwanted social comparisons or competitive feelings [59], or feeling surveilled in the wrong context [16]. Such context is also emphasized in recent work in data donation, which has highlighted that people’s comfort



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engaging in collaborative interpretation of their data varies across individuals [37].

To guide future design of collaborative sports technologies, the field needs to move toward a fine-grained understanding of athletes' nuanced, long-term experience in sharing real-time exertion data. This need is highlighted by two of the Grand Challenges in SportsHCI as identified by Elvitigala et al. [27]. They call out the need to study interactive technology for the longitudinal nature of sport and to better understand the multifaceted, emotional side of the athlete experience.

To investigate the multifaceted experience of sharing real-time exertion data in road cycling, we employ an autoethnographic approach. We take guidance from previous cycling autoethnographies in which authors have documented their own experiences commuting by bicycle [61], racing bicycles [19], or trying cycling as a new sport [51]. The autoethnographic approach is increasingly utilized in HCI to examine deeply personal, embodied, emotional, and often marginalized lived experiences that are difficult to document as an external observer. For instance, recent SportsHCI work has explored the connection between digital performance metrics and embodied perception to make sense of physical effort and guide performance [81]. More broadly, recent work has used autoethnography to explore the hidden emotional and cognitive costs of videoconferencing for a person who stutters [85], how self-tracking could help manage Long COVID by limiting physical activity [41], and the accessibility barriers a person with a mobility disability faces when navigating interactive seat plans for public events [79].

Sharing exertion data during collaborative cycling is indeed a personal, embodied, and emotional experience; furthermore, it is a collaborative experience. Therefore, we conducted a collaborative autoethnography—specifically a trioethnograhy [3, 22, 43, 70]. In this study, the three researchers are also the research subjects. The three of us, Wesly, Lincoln, and Kristy, documented our experiences sharing real-time heart rate and power data over the course of one year to investigate the following research question:

What are athletes' experiences around shared real-time heart rate (HR) and power over prolonged use in collaborative, co-located road cycling?

Because existing commercial cycling computers do not offer the ability to view more than one person's HR and power [33], we developed a prototype that runs on a commercial cycling computer commonly used by cyclists (Figure 1b and c). This prototype augments the existing training and mapping features of the cycling computer with a partner's data fields. We rode with this prototype, embedding it into our training routines and social rides, and we collected a corpus of post-ride reflections and recorded conversations. We engaged in reflexive dialogue grounded in the collected data during biweekly meetings where we critically examined our own embodied, emotional, and social experiences as they unfolded across various rides. We interrogated not only what we did during rides, but how we felt and how we made sense of those experiences over time and in relation to one another.

Our findings reveal how shared real-time HR and power data reshape the experience of collaborative cycling. They reveal how shared exertion data becomes entangled with how we present ourselves, how we read one another, and how we support each other. We surface the dual nature of shared HR as both a tool that enables connection and support, while also, in some situations, introducing threats to our presentation of self and, consequently, our sense of belonging. **We make the following novel contributions to the field of SportsHCI: 1) We offer a grounded account of how road cyclists engage with shared real-time exertion data over time, showing that it serves as both a coordination tool and a socially charged signal; 2) We articulate design considerations for building collaborative sports technologies that support the social dynamics around shared real-time exertion data in road cycling.** Ultimately, the aim of this line of research is to advance understanding of how to leverage shared real-time exertion data to improve the athlete experience.

2 Background and Related Work

We situate our research on collaborative real-time exertion data sharing at the intersection of embodied self-tracking and collaborative sports technologies. Section 2.1 on embodied self-tracking highlights findings on how data mediate the understanding of the self. Section 2.2 sheds light on how shared real-time exertion data has been shown to be socially negotiated in sports. Finally, we provide background on cycling dynamics and terminology in Section 2.3.

2.1 Autoethnographic Findings on Embodied Self-Tracking

To capture the intimate, sensory, and emotional complexities of interacting with data about one's own body, often referred to as self-tracking, researchers frequently employ methodologies such as autoethnography and collaborative autoethnography [18, 41, 48, 68]. For example, Homewood et al. [41] documented using HR and step data to deliberately limit activity while living with Long COVID. Similarly, an autoethnographic study on managing Polycystic Ovary Syndrome (PCOS) highlighted the need for holistic, long-term tracking across multiple devices to navigate unpredictable symptoms [48]. In a duoethnography, researchers examined how the designs of some self-tracking devices embed normative, gendered assumptions about health and the body, which can inadvertently provoke feelings of shame or social exposure [17].

Taken together, these studies show that understanding the self through self-tracking data is a highly subjective and nuanced process that can yield great insights [68]. At the same time, some studies have observed a risk of trusting the numbers over one's embodied sensations [41], and some researchers argue for balancing quantified metrics with what Coşkun and Karahanoğlu describe as the "qualified self," situating numbers within the shifting realities of lived experiences [20].

Across this body of work, a consistent pattern emerges: people do not simply use self-tracking data as objective input; they actively negotiate it within the context of their lived experiences. These studies also demonstrate that data can shift how people understand their bodies [41, 42]. Our study takes the novel step of examining a collaborative autoethnographic perspective of what happens when this data becomes mutually visible in real time.

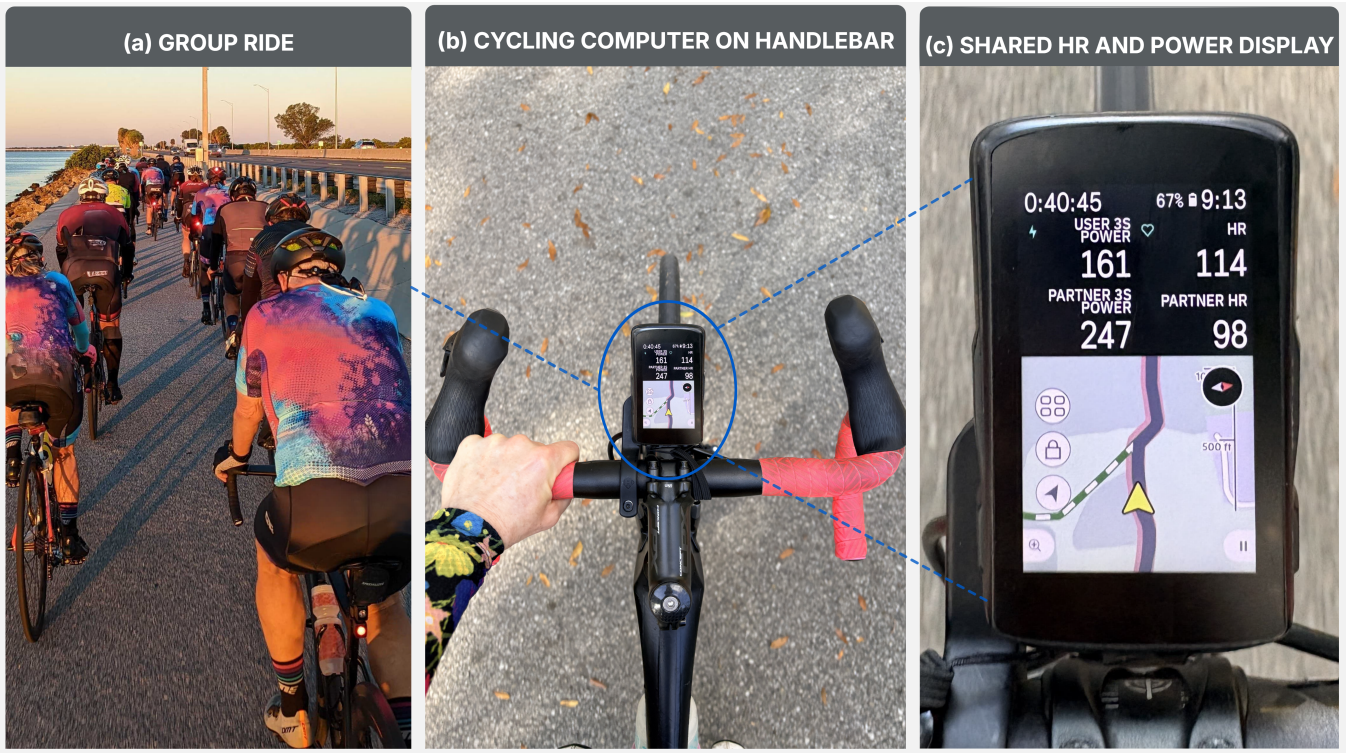


Figure 1: Overview of a group road ride and our collaborative data-sharing interface. (a) A group road ride where cyclists ride in close proximity with one another. (b) A handlebar-mounted cycling computer displaying live exertion data while riding. (c) A close-up of the user's configuration showing shared HR (in beats per minute) and power (in watts) for both the user and their partner along with the map.

2.2 Collaborative Exertion Data Sharing during Physical Activity

When data is shared, collaborative physical activity research shows that it can actively shape how people coordinate and experience exertion together, even at a distance. For instance, Jang et al. [46] demonstrate that shared haptic feedback can allow partners to synchronize actions and develop a sense of interpersonal connection during joint activity. Similarly, Høeg et al. [44] show that embedding social interaction into physical activity creates a shared experience, where participants respond to each other in real time rather than engaging independently.

While these studies show the importance of supporting social interaction during physical activity, they do not center on exertion data as the medium of coordination. Popular commercial platforms such as Strava[1] display exertion data after the fact, enabling users to share data with others after activities are completed [77]. Systems such as "Track Your Friends" support awareness of others' activity through shared location and activity metrics [5]. However, these systems support asynchronous interaction rather than moment-to-moment coordination.

A smaller body of work examines real-time sharing of exertion data during synchronous, co-located activity such as road cycling. Early explorations illustrate how making exertion information visible to a partner can reshape interaction during physical activity. For instance, Walmink et al.'s "Open Heart Helmet" [83] displayed HR on the back of a rider's helmet, allowing others behind that rider to interpret exertion and provide feedback during their ride. "Race By Hearts" [75] introduced a mobile application that shares real-time HR between participants. The system encouraged participants to push their limits and compete. This dynamic also surfaced tensions such as discouragement and pressure when fitness levels were mismatched. More recent work extends these ideas. Agharazidermani et al. [2] developed a mobile phone app that allows cyclists to view each other's HR during outdoor rides. In their study, pairs of cyclists who had not shared exertion data with each other previously engaged in a ride together with the mobile phone mounted to their handlebars displaying shared data. They noted how the shared real time exertion data allowed riders to adjust their pace relative to their partner's in real time, and suggested that it may have fostered more social dialogue. These studies, conducted in controlled environments or over the course of a single session of interaction, leave open the question of how cyclists experience shared real-time exertion data over time in-situ across a variety of rides. This is the gap we address.

[1] https://www.strava.com

2.3 Cycling Dynamics and Nomenclature

Road cycling is a social sport shaped through ongoing interaction between riders, environment, infrastructure, and technology [51]. Road cyclists ride in close proximity, often only a few centimeters apart in any given direction as illustrated in Figure 1a. Groups of elite riders can sustain 50+ km/h. For context, the autoethnographers in this study live in a flat area and a typical low-intensity social ride may average around 28 km/h while their faster group rides may average around 34 km/h. Training and social rides in our local community can last between 2 to more than 5+ hours in duration.

Through thousands of hours riding in groups, road cyclists develop habits, emotional strategies, and tacit skills which are all brought to bear simultaneously with the social interaction between riders [52]. Select terms that will be needed to understand the quotes provided in this paper are as follows:

- ***Drafting:*** **Riding closely behind another cyclist**[2]. This practice reduces aerodynamic drag and lowers the effort on the trailing rider. Importantly, a rider can increase the draft they provide by sitting up taller, and conversely, they can decrease the draft by making themselves lower or "more aero".
- ***Pace control:*** **The regulation of speed and effort.** The cyclist(s) at the front of the group can explicitly agree to modify pace (e.g., "Let's ease up a bit,") or can implicitly coordinate pace through their bike positioning, typically to match the abilities of the group and keep riders together. Pace can be determined by training goals, pre-determined speed objectives, in-the-moment mood, and many other factors.
- ***Being dropped or "sitting up"***[3]**: Becoming separated from the group when unable to sustain the group's pace.** Even when a weaker rider is drafting optimally, the pace could require the rider to expend too much energy over time. In that case, the rider will not be able to stay with the group.

Over time riding with others, a cyclist can infer others' exertion levels through subtle body cues such as posture and pedaling style. However, in the absence of shared real-time exertion data, it is common for a cyclist to ask a training partner, "What's your HR?" or "How's this power?". Our study investigates what happens within this rich context of road cycling when shared real-time exertion data is made available to experienced cyclists.

3 Methodology

Through this study, we sought to investigate athletes' experiences around shared real-time HR and power over prolonged use in collaborative, co-located road cycling. This section details our research methodology. First, we outline our motivation, the design, and the trioethnographic process we employed over the one-year period (Section 3.1). Next, we describe how we identified the theoretical framing used for our analysis (Section 3.2). In Section 3.3, we provide positionality statements for each of the three researchers to help contextualize the findings based on our lived experiences. Subsequently, in Section 3.4, we provide details on our data collection methods. We then conclude this section with our data analysis procedures (Section 3.5).

Table 1: Corpus Summary

Dataset Component	Value
Study duration	13 months
Autoethnographers	3
Shortest ride	~ 16 km (10 miles)
Longest ride	~128 km (80 miles)
Recorded meeting hours	25 hours
Ride transcripts and reflections	219 pages

Note. The autoethnographers rode together more frequently than the corpus reported. However, we reported only on the approximately 30 unique rides in which shared physiological data were used and documented according to the study protocol. We excluded rides when logistical constraints prevented data sharing or when we intentionally chose not to share data because doing so would have imposed additional emotional or interpersonal strain or burden.

3.1 Overarching Autoethnographic Approach

Ethnography is a research method that originated in the field of anthropology [4, Chapt 1], and involves a researcher deeply embedded with those being studied. In autoethnograpy, which is increasingly adopted in HCI [47], the researcher is simultaneously the one doing the observing and the one being studied. Autoethnography is especially well-suited for studying how one interacts with data about one's own body, where meaning-making, interpretation, and lived experience are central yet difficult to externalize [15].

In studies with two or more autoethnographers, termed collaborative autoethnographies, the researchers employ the dialogical relationship between themselves to examine experiences and assumptions, generating insights through often contrasting viewpoints [49, 71]. Two types of collaborative autoethnography are duoethnography, which includes two ethnographers [17], and trioethnography, which we employ here, with three ethnographers [43].

In designing the details of our method, we drew upon several autoethnographic studies of cycling. For example, one autoethnographer examines the deep-seated fear, paranoia, and anxiety associated with cycling in heavy traffic [18]. Autoethnography has also been used to explore mental toughness in extreme cycling endurance events and reveal how unexpected emotional triggers such as anger can be used to overcome exhaustion [19]. Another autoethnography documents one's transition from novice commuter to competitive cyclist while detailing the challenges associated with assuming a new cycling identity [52]. We took guidance from these prior works as we norm-set for our reflexive dialogue meetings. For example, we explicitly welcomed the expression of difficult or controversial emotions and we acknowledged the multi-sensory

[2]This definition is simplified because technically, depending on wind direction, the maximum draft may be achieved beside another rider rather than behind them. Wherever one rider's body blocks the wind for another rider, draft is provided.
[3]Most riders differentiate these two, where "being dropped" indicates that even when trying their hardest, a rider cannot stay with the group. In contrast, "sitting up" refers to separating from the group proactively when a rider deems the pace too fast.

nature of cycling with others as something to be embraced and not oversimplified. We also drew heavily upon recent collaborative ethnographies from HCI literature to inform our method. In particular, a recent trioethnography on use of generative AI for research [22] shaped our mechanism for recurring meetings and a shared, cloud-based note-taking document.

In an autoethnography of this length, methodological decisions often need to be modified as new information arises. That was the case for us. Our initial study design included rides with external participants. Early in the study, however, we determined that these rides provided only snapshot experiences that did not reflect our typical training relationships. We therefore refined the study to focus on the longitudinal experiences of the three autoethnographers. External riders remained part of the riding context, but the present analysis focuses on the autoethnographers' experiences. For the few findings in the results section in which outside riders are featured, we make that distinction clear.

3.2 Identifying a Theoretical Framing

We did not embark on this study with a theoretical framing in mind, nor did we know for certain that we would want one. Many autoethnographies do not employ theory to guide their analysis (e.g., [47]). However, we suspected that we may wish to employ theor(y/ies) to aid in our analysis given the size of the corpus we intended to collect and the potentially contrasting experiences we anticipated making sense of. Nevertheless, we waited until after the bulk of data collection was complete to discuss candidate theories from sports sociology, sports psychology, and related domains. We compiled this list based on our collective experience as well as consultations with expert colleagues. Our list included, in addition to the theories expanded on in the sections below, Bourdieu's Theory of Capital, Habitus, and Field [11], Social Identity Theory [80], Foucauldian perspective [32], Intersectionality Theory [14], and Self-Determination Theory [69]. We collaboratively weighed each theory according to how strongly we felt that it helped explain and contextualize our lived experiences. Simply put, we asked ourselves, "Do I identify with what this theory posits?" Ultimately, we felt that our experiences aligned strongly with Social Comparison Theory [30], Presentation of Self Theory [65], and Social Support Theory [7]. We chose to utilize all three of these theoretical lenses because we felt each one brought a distinct viewpoint that helped us make sense of our experiences as we analyzed our data and organized the findings.

3.2.1 Social Comparison Theory. Social Comparison Theory (SCT) posits that individuals evaluate their abilities, traits, and emotions by comparing themselves to others [30, 74]. These comparisons may be upward, toward individuals perceived as superior, or downward, toward those perceived as inferior [21, 30]. In sports psychology, this theory has been used to explain how athletes interpret their own fitness and regulate effort in competitive and collaborative environments [23, 64, 88]. As will become clear in the results, social comparisons amongst the autoethnographers were responsible for many emotional experiences, some of which affirmed the usefulness of shared real-time exertion data, and others that made us question the contexts in which we were willing to share.

3.2.2 Self-Presentation Theory. The concept of presentation of self originates in Erving Goffman's framework, which conceptualizes social interactions as performances [65]. According to this dramaturgical idea, individuals attempt to actively manage how others perceive them by electing to show certain aspects of themselves while concealing others [35]. Athletes may regulate effort, appearance, and communication to project competence and manage others' image of them [24, 39]. As our results will show, this phenomenon was highly relevant for one of the autoethnographers.

3.2.3 Social Support Theory. Social Support Theory (SST) posits that social relationships provide critical resources that help people cope with stress, sustain motivation, and achieve goals [7]. Support is typically conceptualized across four dimensions: emotional (encouragement or empathy), informational (advice or guidance), tangible/instrumental (practical assistance), and companionship (shared experience). These forms of support can play important roles in shaping physical activity [29, 34] and long-term adherence [60], as individuals are more likely to do well when they feel supported by others [66].

Importantly, the nature of social support evolves with context and relationships. Support may initially emerge as instrumental, but can transition into emotional as relationships deepen. As the results section will show, the autoethnographers discovered that shared real-time exertion data over time helped them to provide social support to weaker riders (the experiences of Wesly and Lincoln) and to feel supported and cared for by others (the experiences of Kristy).

3.3 Statement of Intent and Positionality

As researchers and participants in this trioethnography, our observations are situated and embodied accounts shaped by our histories, fitness levels, interpersonal relationships, and identities as cyclists.

3.3.1 ***Wesly.*** I identify as a cisgender Black man, born and raised in the Caribbean in his 30s. I relocated to the United States (U.S.) as a teenager. My relationship with cycling began around three years old, and continued through adolescence. During this period, cycling was not framed as a sport but as an everyday activity similar to fútbol in my childhood. It was accessible, informal, and integrated into daily life.

After moving to the U.S., I stepped away from cycling for a period. My re-entry into cycling was initially motivated by weight loss and transportation. Although I briefly commuted by bike, concerns about road safety led me to only continue riding recreationally on trails once or twice per week over the following years. As my interest in cycling grew, I began joining local group rides and later competed in local and regional time trial races and triathlons. This progression led to qualification for the World Triathlon Multisport Championships following earlier participation at national championship events in the first half of the 2020's.

In contrast to my childhood years in the Caribbean, in the U.S. I am frequently one of the few Black riders in group rides and, at times, positioned as an "other" within those spaces. These experiences have shaped how I engage with others within cycling. In group rides where I am known, there is often an expectation that I

will perform at a high level. This expectation contributes to a competitive posture and informs how I interpret both my own fitness and that of others. When sharing HR data, I am often positioned as the stronger rider and I feel the need to regulate pace and effort in response to my partner's exertion level. While this pattern reflects my training history and current fitness, it also introduces social expectations that shape my role within collaborative riding.

As an HCI researcher with a strong interest in physiological data visualization, my interpretations are further shaped by an analytical sensitivity to how data is represented, interpreted, and acted upon. My lived experience as a cyclist combined with my awareness of race, access, and visibility in sport informs how I attend to issues of comparison and the social implications of shared real-time exertion data.

3.3.2 ***Lincoln.*** I identify as a cisgender East Asian man, born in China and raised in the Midwestern U.S. and Canada. I grew up actively riding a bicycle for transportation and recreation. I started cycling as a sport during my senior year of high school in Canada when I stopped playing American football competitively. My cycling journey started with road cycling, where I quickly found myself riding in groups and competitions. Cycling became a large part of my life, as I worked in bike shops, raced competitively, and my friend group consisted almost exclusively of cyclists.

As someone of Asian descent, I was often a visible minority in cycling, which in North America is predominantly white and male. However, I felt that the cycling community in both Canada and the U.S. was more inclusive than the general population, and I experienced fewer overt racist incidents in cycling compared to football and other sports. I did not experience my visible minority status as an active presence in cycling interactions, unless directly commented on by myself or one of the few other East Asians cyclists on a ride.

I am in my 30s. Shortly before the start of this study, I began training seriously with a professional coach. The start of this autoethnography coincided with a significant improvement in my cycling fitness. I have found myself among the fastest riders in my local community, and over the course of this study, I often worried about how my shared real-time exertion data may affect others, specifically whether my HR and power data would be demotivating to those I normally ride with.

My professional background is in communications, with a focus on non-verbal communication through constructed imagery. Specifically, I study how people use clothing to communicate their identities. The combination of my lived experiences as a cyclist and my research interest have informed the ways in which I have interpreted and analyzed data for this trioethnography.

3.3.3 ***Kristy.*** I identify as a cisgender white woman, born and raised in the southeastern U.S. I am in my 40s and am raising two teenage children. I grew up in a rural area and began cycling casually in my late 20s when I moved to a city with bike infrastructure. In my late 30s I took up road cycling and was mentored by the members of my local cycling club. I attribute their encouragement and nurturing over the years as a primary factor in my becoming a cyclist. I have now raced at local, national, and international-level events in a variety of cycling disciplines including road cycling.

On average I train 6 days per week on the bike. I have a professional cycling coach. My nutrition and strength regimens center around cycling performance as the goal. Nevertheless, in part because of my sex, age, and petite body size, I produce fewer watts than most of the cyclists I ride with and I am often the slowest cyclist on any given group ride. Additionally, I have been the only woman on group road rides many times. On the other hand, I am known for organizing rides that are well attended. This juxtaposition—being the "weakest" rider while being the social organizer of many group rides—is sometimes a significant emotional lift for me. The emotional stakes feel particularly high given the fact that my entire local friend group is composed of cyclists. A sense of belonging as a cyclist is central to my current conception of my identity.

My professional disciplinary background is in computer science, and I study how people collaborate with the help of novel interactive technologies. My strongest interest lies in how to support people who might otherwise be left behind in achieving their goals. The combination of my lived experience and my research interests have informed the ways in which I have interpreted and analyzed the data from this trioethnography, especially prominent in the ways sense of belonging and confidence (or lack thereof) tend to arise prominently within my observations.

3.4 Data collection

The trioethnographic process described earlier spanned one year. Following each ride, we individually documented our experiences before participating in recorded biweekly reflexive dialogue sessions. Data collection consisted of ethnographic journals, early-stage in-the-wild audio recordings, and recorded collaborative reflections.

3.4.1 Ethnographic Journaling. We each maintained written pre-ride and post-ride reflection diaries. The mechanism for doing so differed for each person. Wesly used post ride dictations using his phone's recorder. He also used written notes immediately after each ride using a note taker on his phone. Lincoln most frequently used written notes following a structured format, recording details of the ride such as weather conditions, type of ride (workout or group ride), highlighted dialogue, and other things he noticed during the ride. Kristy used a combination of dictated notes on her phone along with typed notes inside Training Peaks[4], the software she uses to track her training and communicate with her coach. She used the "private notes" field in this platform to journal after rides so that her reflections were only visible to her, not her coach.

3.4.2 Biweekly dialogic reflections. The primary source of data for this study consisted of recorded and transcribed biweekly reflexive dialogue sessions among the three autoethnographers held on Zoom or in person. We would each report from our recent rides, often reading or summarizing our journal entries. We would sometimes pull up logged ride data from the platforms we use such as TrainingPeaks[4], Strava[1], RideWithGPS[5], and Wahoo[6] that included maps, HR profile, and temperature to aid our recollection of how the experience unfolded. This process would lead to questions and

[4]https://www.trainingpeaks.com
[5]https://ridewithgps.com
[6]https://www.wahoofitness.com

probes from the other authors, resulting in rich back-and-forth dialogue that spanned a variety of topics and often deepened from week to week on a particular topic that recurred. Because these transcripts are a central gathering point for discussion of journals and other ride data, they are the basis for the qualitative analysis described in Section 3.5.

3.5 Data Analysis

As part of this longitudinal autoethnography, some level of data analysis was ongoing throughout the entire process as we made notes of commonalities and contrasts that emerged within our reflexive dialogues. However, as we reached the end of data collection, we prepared the corpus consisting of all transcripts and notes from all of our prior meetings. The three autoethnographers took separate approaches to memoing the corpus individually and then met numerous times to collaboratively refine our themes and agree on how to report our findings. Kristy read and memoed the dataset in relation to the selected theoretical frameworks (Section 3.2). She grouped moments that reflected different forms of support, comparison, and self-presentation. In parallel, Lincoln memoed the transcripts in a more bottom-up approach by identifying recurring patterns, notable moments, and cataloging practical dynamics that emerged across rides. Wesly took a higher-level synthesis approach and identified high-level patterns by focusing on points of convergence and divergence in our experiences.

Following these independent analyses, we engaged in a series of dialogic sessions to synthesize our findings. During these discussions, we compared interpretations and discussed differences of viewpoint. We intentionally retained contrasting cases as particularly important to report. We compiled similar and contrasting points of view to create theory-informed groupings.

4 Results

In this section, we report the results of this trioethnographic process and subsequent qualitative analysis of the corpus we collected. As described in Section 3.2, we identified three theoretical frameworks that we felt helped to explain the experiences we had with sharing our data in real time during cycling. We structure this results section around those three theoretical lenses. In the subsections that follow, all quotes are extracted from either in-the-wild audio recordings during rides, or from the reflexive dialogue transcripts among the three autoethnographers. The reader will also note that in the following quotes, the autoethnographers refer to each other's *absolute* HR values rather than normalized metrics such as HR zone or percent of maximum HR. Although we recognize that HR zones vary widely across individuals, those differences were part of our tacit models of each other, so using absolute HR values became a natural part of our everyday communication. We conjecture that our comfort using absolute HR values is due to sports technology historically offering them as a default, and we critique this practice later in design considerations (Section 5.5).

4.1 Social Comparison: Calibrating to Each Other

Social Comparison Theory posits that people evaluate their own abilities, traits, and emotions by comparing themselves to others [30]. Social comparison happens in many aspects of cycling, including the brands of bicycles we ride, the types of clothing we wear, and even how tall our socks are[7]. Reflecting over a year of riding, we noticed how social comparisons related to our effort on the bike seemed to change in the presence of shared exertion data.

Without shared real-time exertion data, we compare ourselves to each other during group rides by observing cues such as body language. If someone looks more tired than us, we infer that they are (or have been) exerting themselves more. With shared HR and power, rather than wondering "how am I doing relative to others," we could see it.

4.1.1 Understanding Effort Through Shared Data. Although we had both HR and power data available, we most often discussed HR because it is a more stable (albeit somewhat laggy) variable than power. It also captures an internal state of exertion. However, power was a helpful additional data point to support our interpretation of each other's effort from shared HR data. We primarily used our partner's HR to infer their effort level in real time. Kristy reflected on a ride with Wesly:

> "I remember rolling out and saying that my HR was immediately higher than yours and thinking, I'm so glad he's [Wesly] finally seeing the difference in how hard it is for me compared to him."

In this case, Kristy felt relieved that Wesly might form a better understanding of her own effort relative to his on the same rides. Contextualizing our fitness relative to others was a recurring theme. After a period of indoor training, Wesly described returning to group riding and struggling:

> "At some point, I kind of questioned [my fitness]. Am I really that unfit or is everybody really, really fit?"

Inferring others' effort in real time from shared exertion data sometimes led us to question each other's reasons for riding how we did. For example, one of the first rides with shared exertion data between Wesly and Kristy was a moderately paced social ride. When trying to make sense of Wesly's effort on the front of the group and how long he remained on the front instead of coming back into the draft, Kristy said,

> "So you stayed on the front, even when your HR was in the 170s and I thought, gosh... 150s was kind of hard for him typically but maybe I'm just remembering that wrong. But if I'm remembering it right, he's really working hard up there."

4.1.2 Longitudinal Calibration Over Time. As we rode together with shared exertion data repeatedly, our familiarity with each other's data became more refined. HR values began to carry personalized meaning, shaped by past rides and accumulated understanding.

Kristy built a mental model of how her HR compares to Lincoln's when they are riding in a group with other riders:

> "[Lincoln's] HR will often be similar to mine in the back. So I might be sitting at 165 [bpm] in the back or

[7]The reader may be warned that sock height can be a particularly triggering topic for road cyclists and is best approached with caution.

> in the middle, and he gets on the front and he's sitting at 165 [bpm] on the front."

This exchange between Lincoln and Kristy illustrates how an understanding of each other's HR and effort was built over time. Lincoln:

> "I remember seeing your HR creep up as you were riding [in] the group and you weren't even at the front yet, but your HR was already above 170... And so I was really glad to see that you were aware of that too. And then you pulled[8] for 30 seconds before you [moved to the back]."

Kristy responded,

> "I remember even telling you, and I said, 'I couldn't get my snack out of my pocket.' ...if I can't get my snack out of my pocket, my HR goes up 10 to 15 beats per minute instantly..."

Over time, we developed an internal sense of what "typical" for each other was. This growing familiarity reduced the need for constant interpretation of the shared data. As Lincoln noted in a later ride:

> "Your HR was in the zone and we were both hitting the targets... having done quite a few of these paired [rides] back-to-back, it felt like I was learning your HR a lot more."

4.1.3 Tensions with Social Comparison from Shared Data. We noted important tensions in social comparisons based on shared exertion data when the two riders had different fitness levels. In the early stages of the study, Lincoln rode with an experienced runner who was new to cycling. She was surprised by the disparity between their HRs and asked,

> "Are you a robot? Are you even alive? Why is your HR so low?"

Concerned that this difference might discourage her, Lincoln attempted to mitigate the potential negative impact of her social comparison. He explained that multiple factors could influence HR. Reflecting on this interaction, he explained:

> "I was more concerned about [the participant] rather than my own HR because I knew there was such a high discrepancy between our fitness levels, and I was really concerned that there would be a negative impact… So I found myself trying to reassure her."

Social comparison with unexpected consequences can also arise when we see erroneous or noisy data from our riding partner. For example, after riding together for many months with shared HR and power and building the aforementioned longitudinal understanding, Lincoln and Kristy went on a ride where Lincoln's HR monitor malfunctioned and showed his HR consistently below 100 bpm despite hills and warm weather which would normally push HR higher. Kristy's HR was, as expected, significantly higher. Kristy's words were,

> "Oh my god, I am so much less fit than him, how is he ever going to stay with me for [an upcoming event]."

and

> "I am not going to look at the [shared exertion data] for the entire rest of this ride".

Then, about four hours later, when Lincoln mentioned that his HR monitor had failed and was consistently reading below 100, Kristy shared,

> "It was huge emotionally for me. I can't believe even with the whole background I have knowing his HR compared to mine that I would have been fooled by an erroneous reading and had such an emotional response to it."

4.2 Presentation of Self: Shaping One's Own Visibility and Exposure

Presentation of Self Theory posits that we treat social life as performance, presenting a curated version of self to the the world [65]. In cycling, people present versions of themselves intentionally for various reasons; for example, they might smile and talk to appear less exerted if they are trying to ride with more fit people[9]. We found that shared exertion data interacted in interesting ways with our own attempts to curate our image as cyclists within our collaborative rides.

4.2.1 Exposure of Hidden Effort. Sharing our data exposed aspects of our own effort that otherwise would have remained hidden. In some cases, this visibility brought difficult feelings. Kristy described her usual attempts to mask her exertion on social rides,

> "I try to talk more, I try to smile more, I try to make it seem like I'm okay… like I'm not struggling."

In contrast, Kristy reflected on an experience sharing data with another rider (not among the autoethnographers) early in this study,

> "I did feel embarrassed that my HR was high and I knew it was due to the heat, humidity, and my training fatigue. There is no reason I wouldn't have been in zone two at that effort level normally, my power was so easily within my zone two, but my HR was high. So I was embarrassed because I thought, well, he's going to think that I'm way less fit now than when he rode with me years ago."

In contrast to these difficult moments, we observed a helpful side of exposing hidden effort. For example, on a group ride that was far too fast for her (and on which she was the only woman rider), Kristy described making the decision to "sit up" and let the group go on without her. If he had not known how exerted Kristy had been up to the point she sat up, Lincoln may have tried to convince her to stay with the group. But since they were sharing data, she noted,

> "It actually was very validating to me to have the numbers bear that out and to know that Lincoln knew that. So when I told him, hey, I'm gonna sit up, go have fun, he didn't try to argue with me. He didn't say, come on, you can just, if you hold on for two more minutes, it'll get easier, because he knew it was not getting easier for me."

[8] "Pulling" in cycling refers to riding in front of the group where the wind resistance is greatest, while others draft behind

[9] They also might feign exhaustion when they actually feel fine, though that tactic is typically reserved for competition.

Lincoln confirmed when reflecting on the same ride,

> "I could see your heart rate creeping up and then your power would spike as we got to the top before we go down. And then your heart rate ... would sit high, and then it would drop like maybe half a minute later....I felt like, wow, this is a long time without your HR coming back down. And even when it came back down, it was not down to the 150s or 140s. It was going from 170 to 165."

In this quote Lincoln demonstrates an awareness of Kristy's sustainable HR versus values that she could not sustain for the many remaining hours of the ride. This awareness had been built longitudinally over many shared rides. He used this knowledge to recognize that sitting up was the right choice for Kristy in that particular ride.

4.2.2 Identity, Vulnerability, and Evaluation. Our attempts to curate our image were particularly shaken in moments where we were unsure how others were reading our data. As Wesly reflected:

> "I don't know how they're interpreting what they're seeing… are they thinking I'm struggling? Are they thinking I shouldn't be here?"

We observed that our shared HR and power data spoke not only to our exertion in a moment, but we felt it was tied to our sense of belonging and competence within the group. In the preceding "fast ride" example, the autoethnographers were not in control of the ride pace. Unable to change pace, the variable that had to change was group membership (specifically, through Kristy's departure). In some contexts it is the opposite: staying together is the expectation and the pace is modified to achieve that goal. Shared real-time exertion data directly facilitated that goal. Wesly noted that being able to see Kristy's HR on a ride with fewer cyclists for which she was the ride organizer, allowed him to communicate with other members of the group in novel ways. Wesly reflected,

> "I remember I tapped [ride group member] on the shoulder and told him to slow down... because I could see Kristy's HR and I knew [we were] going too hard."

In this instance, while HR may have exposed vulnerability from Kristy's point of view, it enabled intervention from Wesly's point of view. The data provided a basis for action. These moments illustrate a dual dynamic: on one hand, exposure and validation, on the other vulnerability.

4.3 Social Support: Acting on Our Shared Data

Social Support Theory highlights how people provide each other various forms of support—emotional, informational, tangible / instrumental, and companionship-based—and this support contributes to a person's well-being and resilience [89]. We observed that shared exertion data fundamentally reshaped how we provided support to each other, how we interpreted the support given, and even how we knew support was not needed.

4.3.1 Giving Support: Data-Driven Adjustments. One of the most immediate impacts of shared HR was the ability to provide targeted, real-time support. Many of the preceding quotes pertaining to social comparison and presentation of self illustrate how we provided instrumental support to each other through controlling the pace of a ride. For example, Lincoln described adjusting behavior based on observed HR:

> "And I noticed that the ride leader's HR just climbed up. And then even when [their] power numbers came down, [their] HR didn't decrease. And so when I rotate to the front, I tried to tone it down a little bit while still having a decent speed."

Within a group environment where proactively providing support through pacing control is often not obvious to others, shared exertion data brought an attunement to us in noticing the ways we were being supported or could provide support. Kristy mused on how Lincoln sometimes tries to give her a better draft by making himself taller.

> "Lincoln has this telltale sit up really high because he thinks that'll help me more."

Lincoln mentioned making in-the-moment adjustments based on shared exertion data from his partner,

> "Do I need to sit up a little bit more? Can I lean down a little bit more?"

These adjustments were also visible to riders outside the sharing dyad. On this ride, only Lincoln and Kristy were connected through the shared HR prototype. Wesly was riding with the group but was not connected to the system and therefore could not view either rider's data. Nevertheless, through hours of riding together, he inferred that they were sharing from Lincoln's riding behavior alone. Wesly noted:

> "That's when I figured you guys were sharing... I didn't know if you guys were sharing ...But when you stood up, I was like, 'oh yeah, he is definitely trying to shelter you [Kristy]."

4.3.2 Support Needed? Sometimes it Isn't Clear. In some cases, we hesitated to modify pace or other aspects of the ride because elevated HR was difficult to make sense of. This ambiguity made intervention a calculated decision rather than an automatic response. As Lincoln reflected when unfamiliar with a rider's typical HR:

> "I didn't know if [they] were actually struggling or if that's just where [their] HR sits when [they]'re riding hard."

Kristy also reflected that sometimes a rider unfamiliar with her HR might think she needs support when she does not,

> "there is ... a fear [that] we are reducing someone to a number... I'm actually fine, but someone thinks I'm not fine because they're looking at my numbers, and they think they need to do something... actually, they don't."

We observed that more information does not automatically lead to us giving or receiving better support; the conditions under which support is offered and accepted are nuanced and relational.

5 Discussion

Over the course of a year, we experienced many of the ways in which shared real-time exertion data influenced our riding, our interpersonal interactions, and our understanding of ourselves. While

we presented many of those experiences organized through the three theoretical frameworks above, these processes were deeply intertwined in our experiences. Moments of comparison often triggered concerns about self-presentation, which, in turn, influenced whether and how we gave or received support. For example, noticing a partner's elevated HR (comparison) could prompt the other to adjust their pace (support), but that decision might be moderated by how we wished to be perceived (presentation of self). Similarly, awareness of one's own visible data could shape whether support was accepted or resisted. Early interactions influenced later expectations, and repeated interactions with shared exertion data shaped both our interpretation and behavior over time.

5.1 Shared Data Facilitates (But Does Not Automatically Improve) Social Support

Across our experiences, sharing HR and power data enabled us to both provide and receive social support. Prior work shows that support only works when it fits the situation and is perceived as helpful [36, 56]. In our work, shared real-time exertion data made that support actionable in real time. For stronger riders, access to a partner's data allowed for more precise and timely adjustments to pacing and anticipating needs of other riders. For riders receiving support, shared exertion data reduced uncertainty and made support more legible which reinforced a sense of being cared for.

These findings extend prior work on social support in physical activity [1, 59], which has emphasized encouragement and companionship, and argues that social support can motivate physical activity by showing how real-time shared data can shape how users support one another in real time. Previous work has also demonstrated that shared HR can promote both social interaction and coordination during cycling. For instance, Walmink et al. [83] showed that sharing HR fosters teamwork and a sense of being "in it together," while Agharazidermani et al. [1] found that real-time shared displays helped riders maintain target intensity and increased social dialogue.

Our findings align with these observations but add important nuance. While these prior studies primarily capture short-term engagements, our longitudinal experience shows that these same mechanisms evolve into more complex social dynamics over time. Rather than simply promoting interaction, shared HR data became a resource through which we continuously developed individualized interpretations of what that data meant and adjusted support accordingly. What begins as encouragement or coordination can shift toward comparison, accountability, or even tension depending on context.

Recent HCI work has shown that the design of comparison interfaces shapes users' emotional and behavioral responses and demonstrated that identical underlying data can produce different experiences depending on how comparisons are presented [82]. Our findings extend this perspective to collaborative sport by showing that the consequences of shared HR are similarly mediated through interpretation. Over time, we learned to read our data in relation to one another's abilities, the terrain, ride objectives, and sensor reliability.

Our findings also refine how we understand the role of conversation in social support. Prior work in CyclingHCI suggests that shared exertion data may facilitate social dialogue among cyclists [1]. However, that work examined pairs encountering shared HR for the first time in a single-session study. In contrast, our findings show that over repeated rides, support does not simply manifest as increased conversation. Instead, support becomes distributed across modalities, including embodied actions such as drafting and pacing adjustments, as well as more subtle forms of emotional awareness tied to the visibility of effort.

Our findings also speak back to broader HCI discussions of social support by showing that support in collaborative sport is something that technology helps calibrate in real time. Recent HCI work has called for more conceptual clarity around what counts as support and has argued that effective support depends on fit between people's needs and circumstances [56] rather than on the mere presence of a supportive feature. That point was especially salient in our rides. We did not treat HR as an objective instruction for action. We interpreted it through terrain, prior knowledge of a partner, ride goals, and expectations of effort. In this sense, shared HR data did not determine support but, instead, made the conditions for support visible, negotiable, and, at times, contestable.

Together, our findings extend prior work by showing that, while shared HR and power data can facilitate social support, it does not guarantee it. Support emerges through ongoing interpretation, relationship dynamics, and context. The support can shift between beneficial, neutral, and even uncomfortable as we (the riders) make sense of one another's exertion over time.

5.2 To Share or Not To Share? It Depends.

Our prototype supports selective, pairwise sharing. Before or during a ride, each rider could choose whether to share HR and power data with a single riding partner. Sharing was therefore not automatically enabled for everyone in the group, and riders who were not connected to a sharing pair could not view the data. Our work shows that sharing HR and power data is a relationship-dependent decision shaped by trust and social dynamics. Prior work shows that sharing data can increase social presence and perceived understanding between collaborators [9, 50], but it does not guarantee better collaboration. On our rides, we actively decided when to share based on who we rode with, the goals of the ride, and whether the data would be interpretable or useful. With riders less familiar with HR, sharing sometimes created additional cognitive and emotional load, especially when we felt responsible for explaining or acting on their data.

The decision on whether to share data with a trusted and familiar riding partner is also influenced by the implicit awareness that grows over time when riding with shared exertion data. In Section 4.1, we noted how Lincoln's awareness of Kristy's HR increased over many rides. He went on to say,

> "[over time] it was a lot less active processing, conscious effort to think about how is this going to affect Kristy. It's almost like I had the heuristic of [how] these sorts of things are going to impact her heart rate. And so my body could adjust a little bit more naturally to it."

Indeed, Lincoln and Kristy noted that, after a while, sometimes it felt unnecessary to share data and they opted not to do so for simple

logistical reasons (the extra clicks required; device battery life). This finding adds to the conversation around what has been identified as a Grand Challenge in Cycling HCI [57], namely, reducing cyclists' reliance on technology in favor of their own embodied knowledge and the judgments that knowledge supports. Our year-long study suggests that reliance on shared exertion data may naturally decrease over time as cyclists build deep familiarity with each other's exertion patterns.

5.3 Visibility, Vulnerability, and Self-Presentation

Sharing HR also introduced new tensions around visibility and self-presentation for us. Because HR makes our effort visible, it exposed aspects of our exertion that we would have otherwise managed only through embodied cues or selective disclosure. There were moments of concern about embarrassment, about misinterpretation, and fear of being reduced to a single metric. The findings about embarrassment or being reduced to a single metric are particularly pertinent when considered in context of other aspects of the rider's identity. For example, Kristy, who is a petite female rider whose power output is less than the larger male riders who commonly attend group rides, found the visibility of her own HR amplifies her existing concerns about belonging. For Wesly, who tends to be susceptible to heat related illness, sharing his HR on hot days heightens his concerns that his physiological responses may be misinterpreted as lack of fitness.

Prior work on self-presentation shows that we regulate what we reveal to shape how others perceive us. Goffman frames social interaction as managed performance [65]. We extend this body of work by showing what happens when HR and power data enters that performance and cannot be easily withheld or reframed. Shared HR constrains impression management by forcing certain signals into the open, which further reduces the ability to strategically curate effort. This contributes a more specific account of self-presentation in data-rich, embodied settings. Our work shows that shared HR and power data transforms impression management from a largely self-managed act into a real-time, negotiated process that is shaped by context and one's own and other's interpretations.

Importantly, when HR aligned with internal experience, it validated effort and reinforced confidence. Shared HR and power data can both expose and affirm, depending on how it is interpreted within the social context of the ride.

5.4 Beyond the Individual: Collaborative Interpretation

Collectively, our findings extend prior work on wearable data [6, 10, 45, 72] and personal informatics [26, 31, 63] by shifting the focus from individual analysis [20] to collaborative interpretation. While prior studies have shown how individuals interpret their own data for sports [12], relaxation [87], and play [10], our work demonstrates that, in shared environment, shared HR and power become part of a distributed system of interactions. We build mental models of one another over time, calibrate expectations, and coordinate actions based on both data and personal cues, such as body positioning.

While our work focuses entirely on real-time data sharing, the findings add to the broader conversation in SportsHCI on asynchronous data sharing. For example, Brewer et al. have identified how elite athletes intentionally disengage from data to protect their state of mind, such as before a big competition [12]. Our study illuminates how shared real-time exertion data can influence an athlete's state of mind, such as their sense of belonging, feeling cared for, or feeling equipped to care for others. In other work on recreational cyclists, Brewer et al. found that some riders put their cycling computers out of sight or only glance at them occasionally, to "ride by feel" [13]. The findings of this trioethnography suggest that, over time, with shared exertion data, "riding by feel" may grow to include a sense of someone else's exertion as well as one's own.

5.5 Design Considerations

Our experience living with shared HR and power for one year has brought us to the unanimous conclusion that this sharing ability is empowering and desirable to include as an option within sports technologies. The tensions we uncovered suggest that designing for shared data requires careful attention not only to accuracy of data and the way it is displayed, but also to how data is interpreted and negotiated within the social context. Across our experiences, sharing HR and power data did not simply add information to the ride, it began to feel intertwined with who we are. Near the end of the study, Lincoln observed the extent to which shared HR and power had become an integral part of his experience,

> "[When we don't] connect to link our [cycling] computers together, I almost feel like I'm missing a core component of my data."

Our experiences point to numerous design considerations for future collaborative sports technologies:

- **Support in-the-moment sharing and un-sharing**. Though this work is about sharing our data with our riding partners, during some of the rides, there were instances when we wanted to withhold our data because it created pressure or unwanted interpretation. However, in our prototype, un-sharing required exiting the ride screen and closing the prototype app, a series of actions that was nearly prohibitive to do while moving at appreciable speed. While the number of functions that can be accessible at a single touch is highly limited on small devices, our findings suggest that being able to pause or stop sharing real-time exertion data at any time during a ride may be crucial to providing or receiving the types of support riders may want and need. The choice of how to achieve this functionality is a nontrivial area of investigation, made more complex by the fact that *not sharing* data is a form of information sharing in itself [12, 16].
- **Explicitly support calibration to individuals.** People's HR and power zones are highly individual. Cyclists can misinterpret absolute HR and power values because physiological baselines differs across people, especially between unfamiliar partners. When left to interpret absolute numbers, riders often assume that their partner's zones are similar to theirs unless they specifically know otherwise. Collaborative sport interfaces should allow relative displays of all metrics, both as values and in graphical ways, when feasible. A rider

should know where their partner's numbers are relative to their partner's typical numbers, not just to their own. For example, HR should have an option to be shown as percent of maximum HR, and power should have an option to be shown as percent of functional threshold power [33].

- **Ability to add sharer/sharee on the fly.** Group rides usually involve riding with multiple riding partners. However, our prototype only supports dyads. Future collaborative sports technologies should allow group sharing and the addition/removal of group members on the fly. Significant design questions are ripe for exploration when considering how to support interacting with multiple people's data on a small screen [33]. We believe a combination of multimodal approaches need to be explored for this purpose, with careful attention to their feasibility during cycling. We could imagine, for example, wearable garments that provide haptic feedback for various riding partner(s) in different parts of the garment depending on where that riding partner is situated relative to ourselves.
- **Functionality to signal qualitative state to accompany the quantitative data.** There are times when an athlete knows that if a partner interprets their data "as is" without additional context on the day, they will "get it wrong." We cannot always predict these moments. The ability to signal "I'm ok!" or "I'm not ok!" through our technology in a way that complements the quantitative values (or even displays in their place, if needed) holds the potential to significantly enrich social support in collaborative rides.
- **Annotation capability.** Throughout this year-long study, we often wanted to go back and recall specific moments on the ride. We had no way of annotating those collaborative moments during the ride but instead relied on various workarounds, other mental markers, or recordings. Research on dedicated lightweight annotation for important collaborative moments is needed.

6 Limitations and Future Work

Like any autoethnography, this study presents our own accounts, grounded in our experiences. While this methodology embraces lived experience as a form of knowledge, we make no claims that our three experiences represent the breadth of how cyclists will experience shared exertion data. In fact, quite to the contrary: the contrasts in our experiences point to the need for further research into collaborative sport technologies with a wide variety of users and in a wide variety of sports.

Our positionality also shapes and limits the work. As experienced cyclists and researchers, we bring prior knowledge and expectations on how HR is interpreted. This familiarity may have influenced how we responded to the data. Our context also constrained this study: we hold reliable jobs with steady sources of income, and we reside in a developed country. Our experiences will differ significantly from cyclists in other cultural settings. We also disclose that the three autoethnographers worked with each other closely prior to embarking on this autoethnography and throughout it, and one author is a PhD student advised by another one of the authors. We took great care to consult with external advisors and ethics experts on how to mitigate the potential risks to all three of us, and we collaboratively norm-set around our ability to opt out of the study at any time and to choose not to share in any meeting where we did not feel comfortable sharing. There were occasions where we rescheduled our reflexive dialogue meetings due to one or more of us having low emotional bandwidth. We explicitly interrogated at the outset of this study whether we felt the supervisory relationship at work translates to ride contexts, and both the supervisor and supervisee said it does not. We noted Franz et al.'s observation that the social hierarchy during group rides is "flat" [33], which corresponds to our felt experience. Despite all of these precautions, it is impossible for us to know the extent to which our professional working relationship interacted with our relationship as riders in ways that influenced the phenomena we found noteworthy throughout this study. We feel that future work should systematically examine different rider relationships (peers, mentor/mentee, etc) to examine how collaborative sports technologies may serve the needs of users in those relationships most effectively.

Finally, we have disclosed that each of us identifies as a member of a historically marginalized group. We did not approach our trioethnography with that lens at the forefront. Our experiences highlight the need to systematically examine the relationships between real-time shared exertion data and athletes' intersectional identity. The effects of sharing HR may compound for riders who occupy marginalized positions within a group. Shared data can increase visibility in ways that heighten feelings of "otherness," or in contrast, may help correct misperceptions and strengthen their sense of belonging. There are many important research questions around these dynamics.

7 Conclusion

We present a year-long trioethnographic account in which three researchers shared real-time HR and power data while road cycling across various types of rides. Our findings point to how sharing real-time exertion data can foster support among athletes and nuances where the same real-time exertion data sharing can pose potential concerns. We present design considerations for real-time exertion data sharing in cycling, and we identify numerous important directions for future work. We argue that the community is only beginning to understand how to support collaborative cycling through interactive technology, and that this research objective would be a warranted addition to the list of Grand Challenges in CyclingHCI as described by Matviienko et al. [57]. In the long term, we aim to advance understanding of how shared real-time exertion data can improve the athlete experience.

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