Watching Your Back While Riding Your Bike

Designing for Preventive Self-Care During Motorbike Commuting

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Abstract. This paper presents our early exploratory work investigating if and how motorbike riders would engage with visual cues on lower-back posture to adjust their body posture while riding and in turn prevent lower back injuries due to physical stress. The design exploration reported is part of a larger series of investigations looking into the broader notion of integrating measures for preventive self-care with existing everyday activities (e.g daily motorcycle commute) by means of digital technology. We are guided by the concept of embodied self-monitoring grounded in theories on the embodied and circumstantial nature of human actions, a construct previously used to guide design oriented research in the domain of out-of-clinic physical rehabilitation. We follow a research-through-design approach with the sketching of user experience as our primary mode of inquiry as we look to expand opportunities for interaction design in the domain of preventive self-care. We report on the outcome of in-situ enactments performed by four motorbike riders as co-explorers engaging with our interactive soft&hardware sketches while actually riding in traffic. In-situ enactments and follow-up interviews with the riders encourage us to a) further elaborate our interactive sketches for motorbike commuting and b) further investigate more broadly the design of digital technology in support of preventive self-care as an integrated part of mundane activities such as, in the case at hand, the daily motorcycle commute.

Keywords. Motorbike Riding; Embodied Self-monitoring; Constructive Design Research; Interactive Sketching

1 Introduction

"If you know bikes at all, you can tell a lot about a man by how he rides. Abdullah rode from reflex rather than concentration. His control of the bike in motion was as natural as his control of his legs in walking. He read the traffic with a mix of skill and intuition. Several times, he slowed before there was an obvious need, and avoided the hard braking that other, less instinctive riders were forced to make. Sometimes he accelerated into an invisible gap that opened magically for us, just when a collision seemed imminent." [18].

In this paper, we explore the design of digital technology aimed at mitigating the risk of lower back pain injuries caused by the physical stress experienced as part of the daily motorcycle commute through dense urban traffic. In particular, we look into the design of a system that, by making cues on the rider's back posture available seeks to enable and encourage bike riders to carry out preventive measures as an integrated part of riding.

A large number of people use motorcycles to commute in India. As per Bangalore Traffic Police, Bangalore had about 3.8 million two-wheelers (which includes both motorbikes and scooters) in March 2015. Commuting in Indian traffic involves not only negotiating dense traffic, but also traffic that is erratic with no lane-discipline, and bad road conditions (see figure 1).

Figure 1: Riding in Traffic

Motorbike commuting in such conditions is physically stressful, as the rider has to ride for longer durations by sitting in uncomfortable positions required to balance the motorbike in slow moving and erratic heavy traffic [21]. It requires the rider to continuously adjust the steering utilizing the upper body [12]. The constant adjustments of the upper body lead to high repetitive loading on the musculoskeletal system, particularly in lower back region [21]. Furthermore, research has shown that maintaining the same lean-forward posture for longer duration, while navigating the city traffic causes fatigue in lower back muscles [20]. Orthopedics and physiotherapists suggest the riders to strengthen their core back muscles to reduce the musculoskeletal strain through core strengthening exercises [1]. However, adhering to this kind of traditional exercising require that the riders take time out of their busy schedule to exercise as a distinct activity beyond, and detached from, the daily commute. Realising this challenge, therapists suggest that the riders perform back stretching exercises while sitting on the bike either during a break or immediately before or after riding (see figure 2).

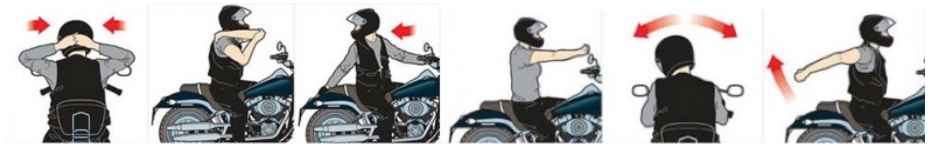

Figure 2: Recommended Preventive Self-care Exercises for the Motorbike Riders[1]

We see this as an example of a general move in the field of physiotherapy towards a more individualized approach (for e.g. [14,15,16]) aiming to better integrate exercising as part of existing everyday activities. Saving time, one could imagine that riders, for example, would do the stretching exercises while holding still at traffic lights. However, as we observe in Indian city traffic most bike riders do not make a complete stop at traffic lights, but instead push the bikes using their feet to get in position (see figure 1).

Taking the suggestions by the physiotherapists even further we want to explore if and how part of the most basic lower-back strengthening exercises could be integrated with the activity of actually riding the bike. Grounded in related research on the design for physical rehabilitation [2,3,4,5,6] we speculate that presenting the riders with an opportunity to perform preventive self-care as part of riding will lead to a higher degree of adherence. In particular, guided by the theoretical construct of 'embodied-self-monitoring' [2, 4], we explore if and how, digital technology could help bring forward opportunities for the riders to perform basic adjustments to their ride posture while riding. As a first principle, our design to support in-situ body posture adjustment obviously has to take second place to the primary task of navigating the motorbike safely through dense traffic. Hence, basic adjustment of posture involves simple stretching and activation of the muscles of the lower back while leaving the hands free for the most crucial task of steering.

Without having any clear preconceived constraints to our design, other than the before mentioned first principle, and general therapist input on relevant basic adjustments, we set out to explore and narrow in on the kind of experience and interaction a system like this should enable. We did so by engaging in a process of co-exploration with riders experiencing our interactive sketch while riding. In terms of a broader research framing, the work reported is part of a series of research-through-design studies guided by the overall vision of mobile&pervasive digital technologies designed to encourage and enable people in turning mundane activities of everyday life into opportunities for preventive self-care.

2 Design exploration

We take a construction oriented research-through-design approach [13]. In particular, we engage in a process of sketching where interactive soft&hardware sketches act as our main vehicle for inquiry as the key facilitator of in-situ co-exploration with

[1] From: http://www.bmf.co.uk/news/show/7-tips-to-reduce-motorcycle-pain

actual riders and while riding. Hence, we seek to engage stakeholders in a dialogue, and process of co-exploration, anchored in actual, however brief and sketchy, first hand experience.

In line with Buxton [8] we emphasize the evocative nature of sketching throughout this process and how what we look for in the collaboration with the riders are suggestions and openings for further design rather than conclusive statements on usability and particularities of our sketch. Informed by initial observations of motorcycle rides and guided by the theoretical construct of embodied self-monitoring, we started to envision, through scenarios, how data on back postures could be made available to encourage acts of preventive self-care while riding. In parallel, and as a fully entangled part of the envisioning process, we started work on the interactive ReRide soft&hardware sketch that would allow us to engage four riders as in-situ co-explorers.

2.1 Adding cues on back posture to the experience of motorbike riding

To get an initial report on the world of motorbike commuting in dense traffic one of the authors wore a GoPro camera on his helmet to video-record a ride from work to home. Inspection of the video soon turned our attention to the ways the rider, like Abdullah, constantly engage with a range of cues as he weaves in and out of traffic. The most easy to identify cues at play had to do with the presence and movement of nearby vehicles, the condition of the road, and of course the movements of the motorcycle experienced through the rider's direct bodily interaction with the bike.

What if data on Abdullah's body posture were made available alongside the many other cues that he experiences from the environment and the bike as he skillfully moves through traffic? How would Abdullah experience this? Could taking in visual cues on his back posture and adjusting his back accordingly be fully worked-in as part of Abdullah's driving?

Looking further to the rider's interaction with the bike we notice how cues from the environment, in many cases experienced as direct bodily interaction with the bike, is combined with visual cues taken in by the occasional glance at the dashboard with its selection of standard gauges (speedometer, tachometer oil pressure, fuel level, etc.) availing data on the state of the motor cycle. This seems to suggest a presentation of cues designed for continuous presence in the rider's field of view but at the same time, most important, designed with a low demand for attention along the lines of the design for glanceability [10], as we aim for a minimum of interference with the primary task of navigating the bike safely through traffic. In a first attempt, this made us look for ways to piggyback on the dashboard design and placement as well as the rider's familiarity with the reading-at glance of the standard gauges. In effect, this in fact opened a much broader space of opportunity for design as it, in general, encouraged us to expand the kind of information made available on a motorbike to encompass not only data on the state of the bike but also data on the condition of the rider.

2.2 The ReRide scenario

As one of the very first steps in the process of sketching we formulated the idea of ReRide, as captured by the following scenario: *Diva commutes to her work on her motorbike daily. She has been doing so for the past 5 years, and now is in the danger of developing repetitive strain injury of her lower back. To prevent the injury she has to perform stretching exercises, but she does not have the time or the energy at the end of day to do so. She then starts using ReRide. ReRide consists of two parts: a) A belt that is worn on the lower back sensing the position of the back* (see figure 3) *and b) a display unit that displays this information real-time, next to the motorbike's speedometer. As Diva rides her bike through the traffic she gets continuous feedback of her lower-back posture and adjusts her riding position in accordance with advice from her physiotherapist on preventive exercising.*

Figure 3: ReRide Interactive Sketch. Rider with the belt. The display next to speedometer

2.3 The ReRide Interactive Sketch

In line with the open-ended nature of our early explorations we constructed a very basic interactive soft&hardware sketch using the Arduino platform. We fixed a passive resistor based flex sensor on a back support belt as the sensing unit (see figure 3). Data from the belt was input to the Arduino and in turn used to drive a LED bar display. When the rider bends their lower-back, resistance of the flex sensor increases. The Arduino board detects this increase as a change in analog input signal level and lights up a LED on the LED bar; the more the rider bends their lower-back the more number of LEDs light up on the LED bar. Our mapping of the increase in resistance in the flex sensor to the LED bars is an approximation aimed purely at exploring the basic experience of riding with the data. The data measured this way clearly lacks the precision needed if they were to be considered as 'true' measurements of the rider's lower-back posture.

The LED bar display was placed on the dashboard of the motorbike (see figure 4).

2.4 Experiencing ReRide

The interactive sketches helped us establish a dialogue with riders grounded in actual in-situ, however brief, first hand experience of what it would be like to have data on your lower-back posture available as visual cues while riding your bike. We asked four daily motorbike commuters, two men and two women, to go for rides with our ReRide sketch. One of the authors was riding pillion during this trial, with a video camera focusing on the rider and the ReRide display. Each ride lasted about 20 minutes and was followed by a brief discussion about the experience. Reiterating the intent of bringing forward our interactive sketches in the first place, we were not looking to test the particular design but rather trying to tap into riders reflections on the overall experience while aiming to get further input on where to take the general notion of making information on lower-back posture available as part of the riding experience.

Figure 4: Riding with the ReRide display positioned as part of the existing dashboard

2.5 What the Riders Did & Said

All the four riders mentioned that having access to their lower back data helped them to get a sense of their posture during the ride. One participant said, "Being able to see (data about) my posture helps, as I am usually aware of my bad posture only when it (lower back) starts to hurt." While the riders' opinions varied on how they will actually engage with the data while riding, they agreed that it added another layer of information for them to consider during the short ride with the sketch. In summing up the riders' experience of riding with ReRide we focus on two points brought forward across riders when discussing the role of lower-back cues as part of the act of riding.

"How About the Time Spent in the Same Posture?".
During the post-ride interview riders suggested that some kind of indication of the accumulated time spent in the same 'bad' back posture would help them make the decision on whether to adjust their back posture or not. Further, riders suggested that combining these accumulated back posture data with some sort of measure on time left to reach their destination would help them prioritize their decision to change posture in relation to their primary goal of reaching their destination safe and on time.

We observed several instances where preventive self-care clearly took second place to getting to the destination on time.

In one such instance, the rider had to brake as he approached a parked car and hence had to bend his back to balance the bike. This was reflected by the ReRide display increasing the lit LEDs from one to two. Slowing down could have been an opportunity for him to change his back posture, straightening it. However, as he at the same time identified a gap in oncoming traffic he immediately started to speed up, again stressing his back, and the LEDs increases further from two to three. Later, he was very explicit when explaining how it is more important for him to overtake, than worry about posture when in busy traffic. He went on to mention how he would sit in the right posture, if there were no traffic. This statement however, was contradicted by our video observations showing how after seeing a clear stretch of road with no traffic, he did not slow down and sit with back straightened. Instead he accelerated till he got close to the car ahead, and 4 LEDs lit up. When he was showed this video, he commented that if he had known for how long he was sitting in a bad posture, and how he was doing on making it to his destination on time, he would have adjusted his posture. Future sketching and in-situ enactments with a modified ReRide system making available the data the rider asked for will have to show whether this is the case or not.

All together, these observations, further emphasizes to us, that any design seeking to enable preventive measures for self-care as part of riding needs to present itself as subtle and suggestive, but by no means demanding or directive, if they are to be considered relevant by the riders in the first place.

"Vibration May Help, But I Will Have to Learn to Drive With It".

Also during the post-ride interview with riders the idea of having of non-visual cues of back posture made manifest by means of haptic and audio was brought forward.

One rider in particular suggested that non-visual presentation would be helpful for her. She was quite experienced in navigating the traffic, as she was a rider for 20 years. She never looked at her speedometer, which by the way, had stopped working. However, she was a very cautious rider, anticipating bumps and potholes well in time to slow down and correct her posture immediately after she hit a speed-breaker. She kept glancing at the display before correcting her posture. During the discussion she mentioned that even though she hardly looks at the dashboard when riding, she did look this time, as she wanted to know her lower-back posture. As part of the study we did not insist that the riders look at the display, but we had explained that it displays the data about lower-back posture, which may have influenced her actions.

She mentioned how over time she would stop looking at the display, as she will develop a habit of adjusting her posture whenever she slows down. Further she mentioned that an on-body haptic feedback maybe better to develop such a habit. However, when asked if such a display would disturb her riding experience, she mentioned that it might initially, but over time she will have to learn to ride with it. We take these suggestions as an important indication that we should work on broadening the notion of 'glanceability' to make cues available by means other than visual display.

3 Concluding Remarks

We engaged in an open-ended exploration of the idea of making back posture data available as visual cues to motorbike riders in order to encourage them to do in-situ adjustments of their lower back while riding to prevent lower-back injuries.

Using our ReRide interactive soft&hardware sketch we asked four riders to go for a ride and experience first hand what it is like to engage with data on their lower-back posture while riding. In subsequent interviews we asked the riders to reflect on their experience and through this bring forward suggestions for where to take the design of a ReRide system. Overall, we got promising feedback from the riders encouraging us to further explore the design of digital technology in support of preventive basic lower-back exercising while riding. In particular, all the four riders mentioned the importance of having access to lower back information while riding, while offering suggestions for future directions the work could take. As such, our interactive sketches successfully made it possible for the riders to directly engage as co-explorers based on actual experience rather than de-contextualized speculations on what it might be like to ride with systems the like of ReRide.

The riders' experience & feedback brought forward two concrete suggestions both pointing out the need to prioritize concerns for a healthy riding position with concerns for safe and effective driving. Based on these suggestions we will start exploring how to present real-time lower-back posture data in combination with data on the duration spent in an unfavorable posture and the estimated time left to reach the destination. Further, we will explore the use of alternative modalities in the interaction with posture data looking emphasizing that such an exploration clearly need to also focus on how the riders could learn to ride with such systems, without compromising the safety and ability to navigate traffic. Beyond an immediate response to the four riders, we are currently expanding our initial design exploration to 1) Include more sensor data acquired through a Bluetooth based personal area network of pressure and movement sensors. Some wearable and some integrated with the bike. 2) Integrate data on bike and rider condition in one and the same display space. 3) Build on a cloud-based Internet-of-Things architecture (e.g. Amazon Web Services IoT) where data generated across rides and riders are accumulated, analyzed and made available for inspection to riders before and after the rides across personal devices.

Finally, our work on ReRide demonstrated to us that the theoretical construct of embodied self-monitoring can be successfully transferred as a generative design ideal in support of people turning mundane activities of everyday life into opportunities for preventive self-care.

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