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STUDYING THE ABILITY TO USE SPORT WATCHES WHEN RUNNING - INSIGHTS FROM A SMALL PILOT STUDY

Research in Progress

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Abstract

Digitalization is a phenomenon that seems to affect all aspects of contemporary society. The sports domain is by no means excluded from this development. In sports, the sport watch might be one of the most iconic symbols in how digitalization has enhanced, changed and developed how physical activities are experienced and measured. Despite the massive adoption of sport watches among runners and other athletes, few studies have explored how sports watches are used in the specific activity they are designed for. The study presented in this research in progress paper is small and should be viewed as a small attempt to outline an approach to study digital technology use in sports activities.

Keywords: wearable technologies, sport watch, running, digitalization, interaction in the wild.

1 Introduction

Computerization and now days digitalization are phenomenon that affect all aspects of contemporary society. More importantly, digitalization is a method used by different types of actors in order to confront, transform, change, and improve practices by the design and adoption of new digital tools, applications and services with a profound effect on the designated target. Such development has a long tradition of scientific inquiry, especially when different types of mobile technologies are introduced, and challenge established practices. Studies in the late 90s explored how mobile devices (at the time named PDAs/Handheld computers) created new possibilities but also introduced problems of making place or taking up space in service work (Kristoffersen & Ljungberg, 1999). Studies of the advent of computer technologies in police vehicles highlighted the challenges of making use of such technologies while driving but not be *dead on arrival* (Marcus & Gasperini, 2006). The use of mobile phones in various situations is an ever-developing field of inquiry. A study of mobile phone use while driving uncovered how drivers adapt the use of the mobile phone talk in relation to the traffic situation (Esbjornsson, Juhlin, Weilenmann, 2007). Studies of how digital technologies affect established practices has a long tradition in the IS-community (Goodhue & Thompson, 1995), and such insights often transform into important recommendations that affect the development of new policies, procedures and digital services.

The sports industry is by no means isolated from these developments and the domain is firmly affected in various ways (Xiao et al. 2017). A good example of this development is the advent and adoption of sport watch use by both professional and recreational runners. The emergence of the sportwatch follows the shift in the broader society where the watch has developed from a technology for collective organization (town-square clock) to a distributed device for individuals that now combines a variety of software applications that empower its owner (Gregg & Kneese, 2019). We have also witnessed a shift at the track and field arena where coaches were in charge of timing to a situation where timing has become a task also for the athlete. The sports watch has become a natural part of many runners' equipment (Nurkka 2013). In a study with 2,000 runners, 60% used a sport watch (Janssen, Scheerder, Thibaut & Brombacher 2017). The use of "athletic wearable" is a growing phenomenon and a growing market (Luczak, Burch, Lewis, Chander & Ball 2020).

From a technical point of view, sport watches seem to have accurate and correct functionalities in terms of GPS and heart rate monitoring. In recent studies (Johansson, Adolph, Swart & Lambert, 2020) assessment of several different "GPS sport watches" shows that the margin of error is negligiblefor the purpose for running. The precision of heart rate measurement (HRM) is another function that has become increasingly popular (Janssen, Walravens, Thibaut & Cheerder 2020). Studies show that there is a certain margin of error for different "wrist-worn-sensor-based-devices" (Shcherbinas et al, 2017). However, according to the authors, heart rate measurement is still useful for training purposes but not be used for medical purposes.

Sport watches with GPS and HRM functionalities are increasingly popular and are nowadays a very common device among runners. Despite the emergence of a variety of devices dedicated to fulfilling various needs for measuring all possible aspects of physical activities, the sport watch seems to be a preferred device. According to some studies, arguments are brought forward claiming that sport watches are more user-friendly than other devices (Seuter, Pfeiffer, Bauer, Zentgraf & Kray, 2017). There are few studies that focus on the use and interaction of sport watches users, especially with the focus on use during the actual physical activity.

This paper outlines an approach that explores how the use of a sport watch is perceived while running. In addition, a small set of data is presented indicating the relation between the running speed and the efforts needed when interacting with a sport watch.

2 The use of digital applications for running

Janssen et al. (2017) conducted a survey with 2172 participants from Marathon Eindhoven to investigate the extent to which running applications and running watches are used. In parallel with examining factors related to running such as frequency of running, numbers of races, running as a primary sport, they also examined socio-demographic factors such as gender, age, level of education among these runners. The purpose of this was to create insights in order to be able to identify distinct characteristics of runners who use running applications and running watches. However, in that study, they did not investigate how the watch was used during running but instead focused on what technologies were used. In the survey, roughly 60% of the runners use a dedicated running watch. Older and more experienced runners seem to have a greater tendency to use a dedicated runningwatch, while younger and less experienced runners have a lower tendency to use a watch, but instead use running applications on a mobile phone (Janssen et al. 2017).

In 2020, a study was done on participants from Marathon Eindhoven 2016 with 3727 runners (Janssen et al, 2020). The purpose of the study was to create insights to map the value provided by the sport watch to the runner. The study specifically focused on which data fields are used during running and what the athlete does with such information. Based on the collected data, the study resulted in a characterization of four different running groups with specific attributes concerning the use of a running watch, running application by telephone and the data fields used. The study outlined the following groups; everyday runners, socially competitive runners, individually competing runners and dedicated runners. 60% of the runners in the study did actively use a running watch. The most common data fields for the runners were distance (90%), time (96%), speed (85.5%) and heart rate (68.2) while only 5.4% checked other data fields. The group with individually competing runners are those who make the most use of the data fields in the running activity (Janssen et al. 2020). The study also showed that 77% evaluate the running session after the session , 56% look at the information overtime, and 22% uses the data to adjust future training sessions.

In a study by Nurkka (2013) the role of customization was explored. In a study of 100 runners that used sport watches a stunning majority of 99% had in a variety of ways made customizations to their sport watches. Nurkka's (2013) results show that a vast majority (82%) modify which data fields are displayed during training. The runners claimed that a sense of better control and increased efficiency were key drivers. The study suggests that it is common among runners to be interested in modifying the appearance of data fields on the sport watch in order to make the device more user-friendly for the specific user.

Seuter et al. (2017) presents a study with 22 participants, exploring how the running stride is affected when using a sport watch, mobile phone with a running application and smart glasses. The study was done in a laboratory setting focusing on the impact of technology use on the running step. This study builds upon previous research indicating that the walking speed changes when interacting with a mobile device (Kane, Wobbrock, Smith 2008). The results in the study by Seuter et al (2017) showt hat the sport watch is the device that is easiest to interact with while running. Although the watch wasthe device that was easiest to interact with, it still affected the running motion.

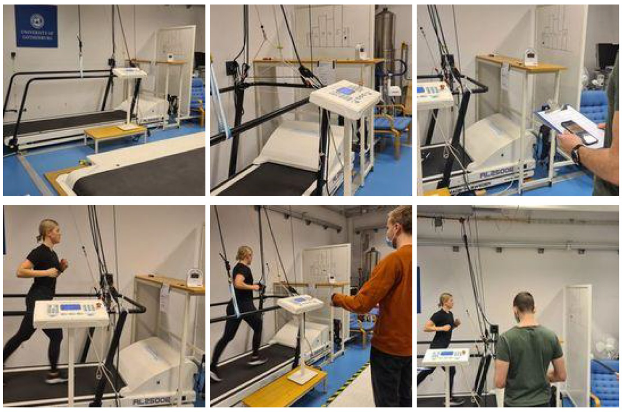
In a study by Jensen and Mueller (2014), they explore the ability of smart devices to provide feedback to a runner regarding the running motion that is done. They suggest that there should be a variety of feedback generated by the watch depending on the runner´s motion and steps. One example that they mention is that the watch should vibrate when the runner's arms make an unnecessary or too strong wave movement. Such feedback would allow the runner to improve the running economy. The authors outline insights regarding sport watch interaction design. An important aspect in such design concerns the modalities that should be used when informing the runner about factual information and behaviorally oriented information. One example here is the difference between communicating duration versus communicating that the runner should improve the running posture. In the first case, the watch should communicate via a generated voice whereas in the other case, small vibrations might be used.

3 Method

This paper outlines tentative results from an experiment that studies the use of smartwatch while running. The study was done in a laboratory setting during the spring 2021 (ie during the corona pandemic). The purpose of this study was two-fold, 1) to develop methodology and 2) collect a first set of data to explore the use of sport watches while running. In contrast to previous studies, the aim here is focused on the sport watch itself rather than focusing on the impact on the stride, speed or running posture.

The specific objective of the study was to learn about how the running speed influenced the ability to use the sports watch. The concept of use is multifaceted and covers a range of actions and interaction with technology. In the experiment presented here, use is focused on the explicit action of reading the data presented by the watch on its graphical user interface. The experiment was designed based on the underlying assumption that at a higher running speed, the runners would experience a higher cognitive load while trying to read data presented on the sports watch.

Four participants were included, and they were selected based on their running capacity, that is, the speeds they run 10k (kilometer). The group, despite its small size, aimed at having a distribution between recreational runners and more elite runners. The group consisted of two recreational runners with a 10k time of about 55 minutes and two elite runners with a 10k time on 30 minutes. All runners had previous experiences of running with a sportwatch. The sport watch used had a color screen of 30,4 mm in diameter, 240 x 240 pixels in resolution, and a total weight of just below 40g.



Picture 1. Treadmill in the lab environment.

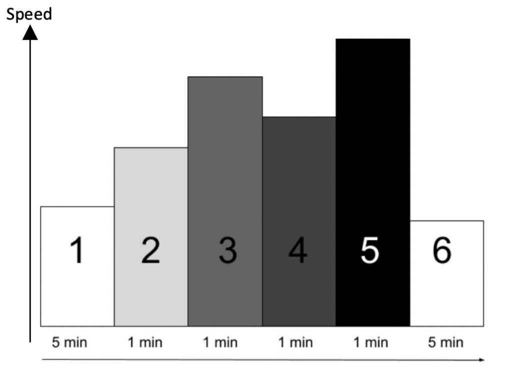


Figure 1. Intervals and the speed.

In the experiment, the runners were exposed to different speeds while running on a treadmill (picture 1). The speed was set in relation to their self-reported time for a 10k run. This means that the recreational runners had a lower speed, but similar speed-profile (figure 1) compared to the runners that belonged to the elite segment. The experiment was designed to collect observations at different running speeds.

Procedure

The arrangement consisted of each respondent running on a treadmill with a running watch on the wrist. The respondents were instructed that at every full minute, according to the watch on their wrist, report the heart rate. The task only required the respondent to look at the clock to keep track of time and at the right time report the heart rate data displayed on the clock.

This is a simple interaction with the clock and also the most common when running, i.e. to look at the clock to take part of information from a data field. The experiment was designed to be able to give results about how well the respondents could keep track of time and read data from the clock at different speeds.

The time indication was checked by starting a timer clock at the same time as the clock was started. The heart rate was checked by connecting the running watch with an application from the same manufacturer so that the observer could monitor the heart rate value from another device.

To investigate the interaction at different speeds, running was divided into six different speed intervals, where the respondent reported the heart rate at all speeds except the first interval, as that interval was considered as warm-up. The different speed intervals were clearly communicated to the respondent using a graphical illustration in front of the treadmill.

At each report from the respondent, an observer noted the pulse reported and which pulse was displayed on the control device, in parallel with an observer noting how many seconds the respondents report deviated. This was noted in two separate but identical protocols. After completing the treadmill, the respondent had the task of completing a questionnaire to provide self-reported subjective information about the perceived physical effort and the strain when interactingwith the clock in the different speed intervals.

The physical effort was measured using Borg's 17-point rating of perceived exertion scale (Borg, 1982) and filled in by the respondent for each interval. The Borg-scale run from 6 – "*zero exertion*", to 15 – "*you can talk but not in full sentences*" and up to 20 – "*Maximum exertion*" where each increase in step corresponds to a perceived increase in exertion.

The perceived stress of the interaction was measured with a questionnaire consisting of NASA Raw TLX (Hart, 2006) scales using the three dimensions performance, mental demand, temporal demand. These dimensions were selected in order to fit the purpose of the experiment. The dimensions were measured using a 21 step scale from 0 (very low), 10 (medium) up to 20 (very high) where the respondents answered three questions "how well did you accomplish the different tasks?", "how mentally demanding was it to maintain the running speed while looking at the watch?" and "to what extent did the running speed affect your ability to look at the watch?".

Analysis

The collected data from the experiment consisted of four questionnaires with the data from the perceived efforts according to the Borg-scale, four questionnaires with data from the NASA Raw TLX questionnaire and four forms with the observer's field notes. Due to the small sample size, no statistical analysis was performed, but rather a more explicit summary of collected values in order to visualize patterns. The field notes were compared and analyzed in a simplified thematic analysis.

4 Results

The results from the experiment are presented in five data sets. Each data set present the participants value (measured or self-reported) for each interval. The different intervals are associated with a specific speed, where speed 3 were the second highest speed and speed 5 were the highest speed (see figure 1).

DATASET 1 - Precision of reporting time (deviation in seconds): measured

Interval	2	3	4	5	6
Participant 1	0	+1	0	+1	0
Participant 2	0	0	-1	0	-1
Participant 3	+3	0	0	0	0
Participant 4	0	0	+10	0	+2

Table 1. Precision of reporting time.

Data set 1 shows that the participants had a good precision when doing the task of reporting at the predefined points in time while running. Only a few very small deviations were identified. As shown, participant 4 had a significant deviation during interval 4.

DATASET 2 - Perceived effort using the Borg-scale (6-20) : self-reported

Interval	2	3	4	5	6
Participant 1	13	17	16	18	12
Participant 2	12	13	14	15	11
Participant 3	14	16	15	18	13
Participant 4	10	14	13	16	8

Table 2. Percieved effort.

Data set 2 shows that the perceived effort is increasing along with the increased speed of running. The data also indicates that interval 5 had a significant impact on the participants' perceived efforts, with high to very high numbers being reported. The data also indicates that the perceived effort seems to marginally decrease when shifting (between intervall 3 and 4) from higher running speed (in interval 3) to a slower running speed (in interval 4).

DATASET 3 - Perceived Mental demand (0-20, NASA RAW LTX)) : self-reported

How mentally demanding was it to maintain the running speed while looking at the watch?

Intervall	2	3	4	5	6
Participant 1	4	7	8	17	10
Participant 2	2	3	3	5	2
Participant 3	4	7	6	10	4
Participant 4	5	11	9	13	1

Table 3. Percieved mental demand.

Data set 3 shows that the perceived mental demand follows the increase and decrease of the running speed. The data indicates that interval 3 and interval 5 (the two intervals with highest speed) had an impact on the mental demand. Participant 1 reported a relatively higher number for interval 5 compared to the other participants.

DATASET 4 - Perceived Temporal demand (0-20, NASA RAW LTX)) : self-reported

To what extent did the running speed affect your ability to look at the watch?

Intervall	2	3	4	5	6
Participant 1	2	11	13	14	8
Participant 2	3	7	8	10	4
Participant 3	4	10	8	19	3
Participant 4	3	14	10	18	1

Table 4. Percieved temporal demand.

Data set 4 shows that the perceived temporal demand is increasing in relation to the increased speed. The data shows that the temporal demand is only decreasing to a small extent when the participants shift from a higher running speed to a period of lower running speed.

DATASET 5 - Perceived Performance (0-20, NASA RAW LTX)) : self-reported

What is your assessment of how well you accomplished the different tasks?

Intervall	2	3	4	5	6
Participant 1	14	10	9	7	3
Participant 2	20	20	20	20	20
Participant 3	19	18	19	18	19
Participant 4	19	18	17	16	20

Table 5. Percieved performance.

Data set 5 illustrates the perceived performance does not significantly follow the shift in speed. There are minor shifts in assessments between the episodes of higher speeds and lower speeds. The data illustrate that two of the participants report data that are difficult to interpret, where participant 1 significantly reports very low numbers and participant 2 reports the same maximum number.

5 Discussion

The study presented in this paper is a first attempt to develop an approach to study sports technologies in use in a specific athletic activity. A set of data points has been selected in order to explore the perceptions of the demands on using a sports watch while running. The data sets are limited and only cover a group of four runners. Nevertheless, the study indicates that interacting with technology while running is not simple nor without impact.

The results suggest that a) an increased speed makes it more demanding to look at the watch and b) maintaining speed is demanding when looking at the watch. These two insights might be viewed as common sense, but nevertheless important since they open up for a discussion regarding how the use of digital technologies affect the sports activity. In previous studies of mobile technologies, making place for technologies is an often overlooked aspect (Kristoffersen & Ljungberg, 1999) when introducing new technology, designing technology that does not negatively harm the practice (Marcus, & Gasperini, 2006) is another aspect that seem difficult to accommodate when new technical features becomes available.

The tentative result of the study presented in this paper is particularly interesting in relation to the results presented by Seuter and colleagues (Seuter et al, 2017) where they show that the use of a sportwatch affect the athlete’s running stride. The tentative results presented here highlight how the increased pacing is affecting the ability to use the sport watch. The results from the the two studies seem to suggest that there is potentially a reciprocal relationship between the the impact by the sportwatch on the running stride and the impact by an increased frequency of strides on the ability to use the sportwatch. In order to fully explore that relationship, perhaps from a task-technology fit perspective (Goodhue & Thompson, 1995), additional studies are necessary.

The study presented in this paper has limitations and a clear weakness is the sample size. In the results it is clear that some of the self-reported data points (*see dataset 5*) seem to lack in validity since two of the participants' self-assessment did not correspond in a meaningful way to the activity. Since the study is small, clearly, more data is needed in order to fully confirm the reliability of the results.

In addition to the tentative results, this study contributes with a small initial draft of an approach to study sports technology in use by combining measures for physical effort (the Borg-scale) with the mental load (NASA Raw LTX). Few studies have had an explicit objective to study sports technology during specific athletic activities, with the study by Seuter et al (2017) as one of the few exceptions.

6 Conclusion

This research in progress paper has presented insights from a small pilot study on the use of sports technology. The study has explored how runners perceive a simple interaction with a sport watch while running. The study was done in a laboratory setting (during the corona pandemic). The results from the study are tentative and due to the small sample size, few distinct claims should be made. Nevertheless, the study indicates that the speed of running has an impact on the ability to interact with technology. There is a need for more studies in order to develop these claims and in order to formulate implications for the design of digital technologies for running.

Disclosure statement

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