

DTI 6997 – Digital Transformation and Innovation Research Project

**Persuasive system design for runners using smart
sport training technologies**

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Foreword

I initially had hoped to focus on the Fogg Behavioral Model for sports tracking technology for runners. This meant that I would need to understand runners' motivations and abilities while interacting with persuasive technology. What were the use and user specific context and design features that improve persuasive messaging effectiveness? Unfortunately, I couldn't find an extensive reference for context of motivations and abilities for this niche. I therefore shifted towards creating the framework for Persuasive system design for runners using smart sport training technologies.

Abstract

The goal of this paper is to understand the persuasive technologies used for smart sport training by runners. The Persuasive Systems Design (PSD) by Oinas-Kukkonen & Harjumaa (2009) was used as the framework, and its components were identified. This takes in consideration the analysis of the persuasion context (intent, event, strategy), design of system qualities, and intended behaviour changes.

This work explores and consolidates findings from 35 works. It provides different perspectives from this multidisciplinary field such as psychology, technology, social sciences, sport sciences, etc. The hope is that this framework will help advance the understanding of persuasive technologies design for smart sport training for runners.

Introduction

Running is one of the most popular recreational activities and it continues to grow (Clermont et al., 2020). Researchers have credited the sport of amateur running's growth to its: accessibility, low barrier to entry, integration as part of countries' health improvement programs (Knaving et al., 2015), health-related focus, recreational nature, motives, and experiences (Janssen et al., 2017).

Due to the benefits of running, training programs aimed at generating interest in this sport is growing in popularity (Clermont et al., 2020; Knaving et al., 2015); even marketing and human-computer interaction (HCI) designs have evolved towards generating interest in running and promoting a healthy lifestyle (Knaving et al., 2015)(p.1).

Technological advancements have allowed runners to wear and gather data while running (Carlén & Maivorsdotter, 2017; Lunney et al., 2016). This can be described as the digitisation of running. Lunney (2016) elaborates that these advancements have also allowed consumers to monitor their fitness and track their activity seamlessly, regardless of which device they use.

Persuasive system design for runners using smart sport training technologies

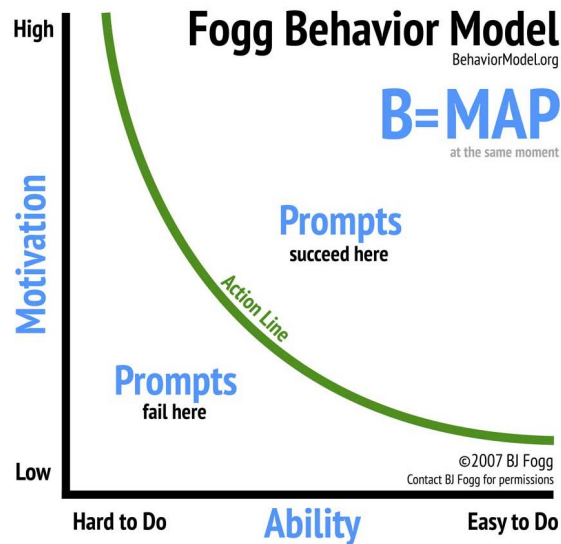
There's a lot of growth in this area. Smartphone use is increasing, making it more accessible for runners to use health and fitness apps (Dallinga et al., 2015; Lunney et al., 2016). The market of wearable fitness technology has grown tremendously both in fitness trends across the world and as a multi-billion dollar industry; with over 75% of runners using fitness wearables consistently to achieve their goals (Clermont et al., 2020)(p.1). The number of potential wearable fitness users is growing (Canhoto & Arp, 2017). The Online Fitness Communities (OFC), which support runners adopting technologies, has a userbase that also has been growing quickly (Stragier et al., 2018). There is now also a better selection of devices that runners can use if they don't have access to a trainer or a coach (Janssen et al., 2017).

Although fitness wearables devices are popular, adoption has been difficult and they are notoriously abandoned (Blanson Henkemans et al., 2015; Lazar et al., 2015); even as they become more affordable (Canhoto & Arp, 2017). Runners may start running enthusiastically, but many fail to continue often due to the lack of motivation and feedback (Stragier et al., 2018). Between 30% and 50% of individuals stop using their devices or apps after 6 months (Canhoto & Arp, 2017; Michaelis et al., 2016). This can have a negative impact on the user's experience and the user's peers. Abandonment can also be a missed opportunity for organizations' viability and for improving public health. Better adoption rates could also lead to lower rates of electronic waste and reduce negative environmental impacts (Lazar et al., 2015).

Despite the growing interest in fitness health wearables, personal informatics (Fritz et al., 2014), and the growth of market and platform integrations, there is still a gap with theory in regards to technological adoption (Lunney et al., 2016). Although most authors have recommendations for improving Smart Sport Training technologies (SSTT) (particularly from marketers, researchers, designers, and engineers), there are more wearable devices every day and yet not much research has been conducted specifically for wearable fitness devices nor for non-medical use in the literature (Canhoto & Arp, 2017). What we do know is that runners who receive support and feedback in a detailed, informative, and quantified way, are more likely to continue using the technology (Stragier et al., 2018).

To help build a foundational understanding of the context for runners and SSTT, the Persuasive Systems Design (PSD) framework by Oinas-Kukkonen & Harjuma (2009) was used with relevant findings throughout the literature. The next steps after this work could include adding the Fogg Behavior Model (FBM) (Bj Fogg, 2009) within the PSD messaging strategy, since this model is a simplified systemic approach to visualize how to improve user-behaviour (to enable runners to reach their goals with the use of technology) by considering three main factors: motivations and ability (PSD user context), and triggers (PSD messages and routes).

Figure 1 - The Fogg Behavior Model has three factors: motivation, ability, and triggers (BJ Fogg, n.d.)



Methodology

The review explored and consolidated findings from 35 works providing different perspectives for this multidisciplinary field like psychology, technology, social sciences, and sport sciences. The hope is that this framework will help advance the understanding of persuasive technologies design for runners in this area of research. The review includes mostly papers from the last 14 years (2008-2021) related to persuasion, user experience design, smart sport training, wearables, runners, sports, and behaviour.

The study aligned the method to explore: **Persuasive system design for runners using smart sport training technologies.**

To improve the scope, the papers were to mostly limited to articles. The data source is entirely secondary. Most of the search was through the University of Ottawa library database (OMNI). No search terms were excluded. Articles were retained if relevant to elements of PSD.

Since the scope is very narrow, articles that focused on more general perspectives such as fitness or sports, or non-running specific wearables were also included to add additional context if the topics were otherwise scarce. With an acute awareness that the persuasive effectiveness relevance is probably weaker for general health fitness or wearable users; this work attempts to be explicit and respect these nuances. For example, if a paper discusses non-sport related individuals, the term 'user' is employed, and if the study relates to general sport users, the word 'athlete' could be used instead, etc.).

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- **Design:** An adaptation of the Persuasive system design for the context of SSTT for runners
- **Keywords outside of search:** n/a
- **Database:** University of Ottawa Library access (2021-2022)
- **Not included in the search:** seminal reference to behaviour theories

Table 1 - Keywords for annotated bibliography

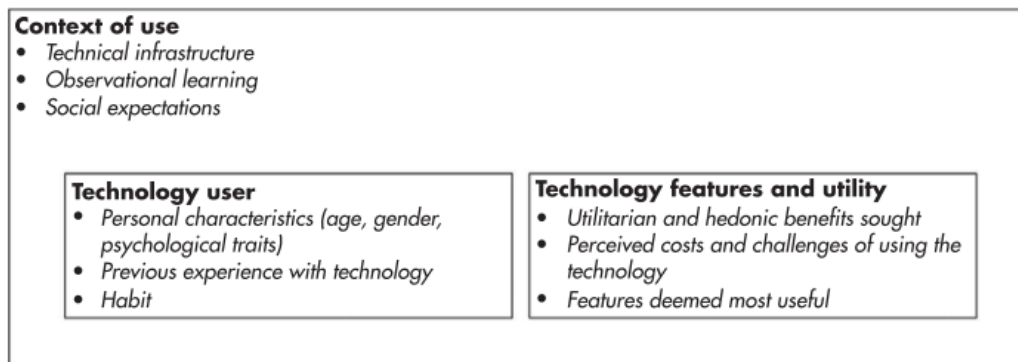
	Concept A	Concept B	Concept C	Concept D
Synonyms or associated keywords	<ul style="list-style-type: none"> • persuasive system design • persuasive techno* • persuasive design • persuas* • user experience 	<ul style="list-style-type: none"> • smart • wearable* • IOT • gps watch • device • tracking • data • personali* 	<ul style="list-style-type: none"> • runners • run* • runn* • fitness • sport* • athlet* • train* • health 	<ul style="list-style-type: none"> • behavio* • motiv* • adoption • sustained • persist*

Persuasive system design

Gamification for physical activity has often been unsystematic: They lack systemic approaches, are too reward-oriented, lacks user-centric considerations, and are pattern bound (Zuckerman & Gal-Oz, 2014)(p.1706). This limits efficacy and makes it hard to measure the behavioural impact, therefore motives should be evaluated to better understand affordances (Zuckerman & Gal-Oz, 2014).

Technological considerations are also important for adoption. Canhoto & Arp (2017) highlight that “to fully understand technology acceptance, we need to consider the features and utility of the technology, the context of usage and the user of the technology” (p. 34).

Figure 2 - Factors that might influence the adoption and use of wearables (Canhoto & Arp, 2017)



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Pintar & Erjavec (2021) share that design features with behaviour-theories have been researched, yet only about 26% of persuasive system research use them; when these theories are indeed used, the most popular one is the Transtheoretical model (TTM) (p.76).

A solution for this work is identifying behaviour-theory persuasive system for SSTT for runners. Oinas-Kukkonen & Harjumaa (2009) explain the definition of persuasive systems:

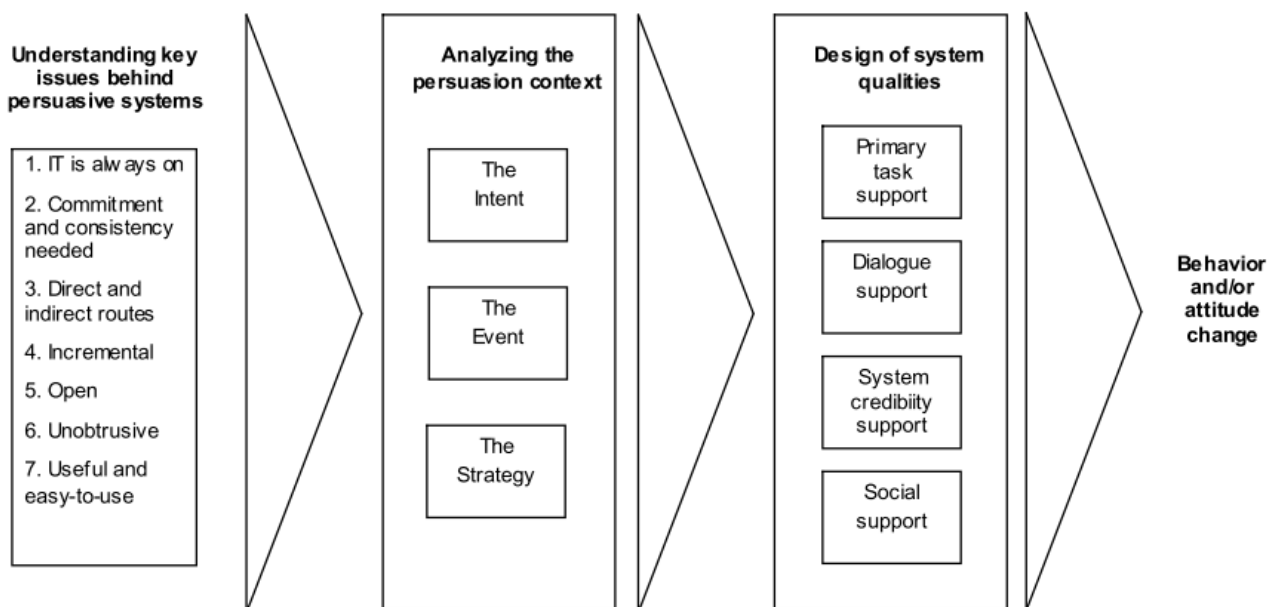
Persuasive systems may be defined as “computerized software or information systems designed to reinforce, change or shape attitudes or behaviors or both without using coercion or deception.

In this definition, there are three potential successful outcomes for a persuasive system: the voluntary reinforcement, change or shaping of attitudes and/or behaviors (p.486).

They continue by stating that shaping outcome is maybe more effective than changing it, that many goals can be used for persuasion, and that “Persuasive systems may utilize either computer-human persuasion or computer-mediated persuasion” (p.486).

By identifying relevant components of SSTT and runners, and populating them into a persuasive design system, this work enables researchers to provide recommendations, based on both the requirements and design of system qualities. This would support SSTT users towards behaviour and/or attitude change for runners.

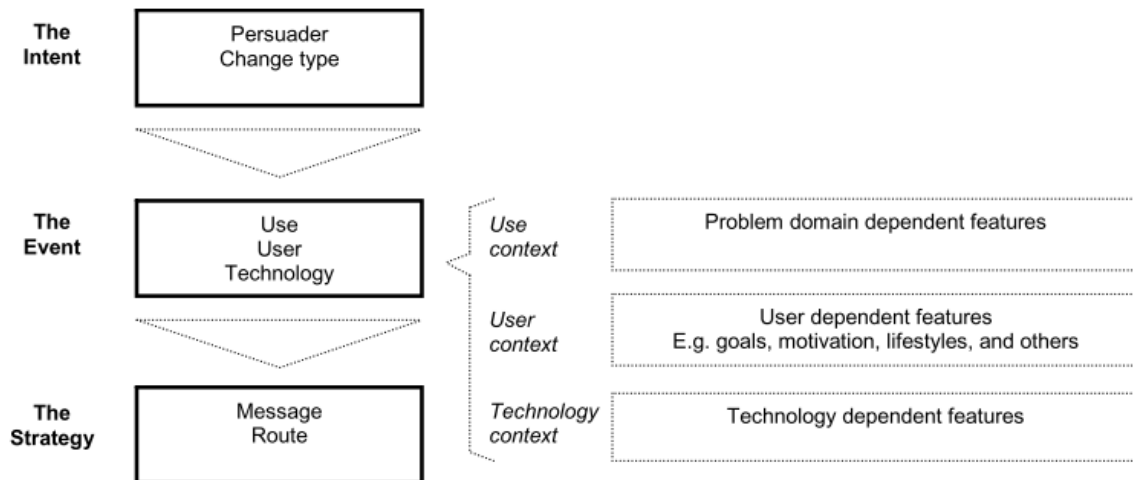
Figure 3 - Phases in Persuasive System Development (Oinas-Kukkonen & Harjumaa, 2009)



Analyzing the persuasion context

Following the PSD framework; the intent, event, and strategy need to be identified to analyse the persuasion context and inform the design of system qualities.

Figure 4 – Analyzing the persuasion context (Oinas-Kukkonen & Harjumaa, 2009)



The intent

According to Oinas-Kukkonen & Harjumaa (2009), there are three sources of intentions: “Those who create or produce the interactive technology (endogenous), (...) those who give access to or distribute the interactive technology to others (exogenous) (...), and the very person adopting or using the interactive technology (autogenous)” (p.489).

For this work, the endogenous intent is from the designers, engineers, and researchers that create SSTT. The exogenous intent is varied, and the autogenous intent is mainly runners, but could also include supporters such as coaches, peers, or kins.

Change type

Oinas-Kkukonen & Harjumaa (2009) explain the types of changes for the intent:

One-time behavior change may be achieved more easily, permanent change is much more difficult. A central feature of analyzing the intent is to consider the change type, in particular whether the persuasion aims at attitude and/or behavior change.

One-time behavior change may be achieved more easily, whereas permanent behavior change is much more difficult. An attitude change that directs behavior may be the most difficult to achieve. Attitudes can vary in many ways. They may be based on emotions, beliefs, or past

experiences and behaviors, and they may be internally consistent or ambivalent (...). Attitude change means that a person's evaluation is modified from one value to another. (...) attitudes do not always predict or determine behavior. (p.489-490)

They continue by stating that: changing behaviour is possible if the attitude isn't aligned, behaviour can lead to attitude change, attitudes can predict behaviour, and primary beliefs and intention behaviour should be considered for change as well (p.490). This should be done without coercion or deception (p.486).

The event

Use and technology context

Runners – The users

Defining user segments for runners in the context of technological adoption is as convoluted as defining wearables; the literature doesn't have a standardized typology (Kuru, 2016)(p.849). As mentioned earlier, the low-barriers to this activity means that runners run in different variations: distances, frequencies, events, group-sizes, and terrains.

By group-size: Runners may run alone, in groups, or both, (Carlén & Maivorsdotter, 2017). Although some may enjoy running in groups, others prefer to be lone runners (Canhoto & Arp, 2017).

By distance: Carlén & Maivorsdotter (2017) describes long-distance running as “running more than 10 km in training sessions and competitions, regardless of terrain (e.g. trail running/off-road, asphalt/cities, etc.)” and “ultra-runners, who train and compete in distances beyond the 26.2 mile marathon mark” (p.19).

By competitive level: (Kuru, 2016) highlights the difficulty of categorizing runners by competitive levels. Their first example refers to categorization made by previous studies: athletes run in races and have a chance to win, runners train regularly and participate in races without the intent to win, and joggers run or race irregularly (Smith, 1998). Elite runners are also considered as athletes by Smith (1998), and referenced by Carlén & Maivorsdotter (2017); they invest a significant amount of time training (Sperlich & Holmberg, 2017). We can imply that the term sub-elite (Knaving et al., 2015) is a competitive tier slightly below it. Another competitive categorization could be the serious runners (Clermont et al., 2020) that are quasi-professional, and the fun runners (Kuru, 2016) who are leisurely.

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By frequency: The weekly running frequency, noted by Kuru (2016), inspired Clermont et al. (2019) to label runners who ran less than four days a week as recreational, and those who ran more as competitive.

By event participation: Opting to categorize users by events instead, other researchers label runners who already run regularly and participate in races as advanced amateur runners (Knaving et al., 2015).

By support or affiliation: Unorganized runners either don't have professional trainers or coaches, club runners run in running clubs (Janssen et al., 2017).

Janssen et al. (2017) (p.2) share that “substantial guidance is necessary to maintain sensible and sustainable sports participation among novice and less experienced runners”. The use of SSTT could help runners achieve this goal.

Smart Sport Training Technologies

There are many interpretations, and definitions throughout the literature, that are similar for defining wearable devices, or online communities, that are used by runners to track their activity.

According to Rajšp & Fister (2020), “Smart Sport Training (SST) is a type of sports training, which utilizes the use of wearables, sensors, and Internet of Things (IoT) devices, and or intelligent data analysis methods and tools to improve training performance and/or reduce workload, while maintaining the same or better training performance” (p.1). This definition seems to include the use of **Wearable Fitness Technologies (WFT)** and **Online Fitness Communities (OFC/OFCs)**. To differentiate the technologies (which includes WFT and OFC) from the training, **Smart Sport Training Technologies (SSTT)** will be used as all the applied technologies and definitions holistically.

WFT devices (Lunney et al., 2016) are described by many as wearable consumer electronics technology, including GPS running watches, mobile phones, dedicated devices using device-independent apps, and heart rate monitors (Canhoto & Arp, 2017; Clermont et al., 2020; Rupp et al., 2016; Stragier et al., 2016). WFT use sensors and log users' physical activities once a session starts. The devices are also internet connectable, can work with application programming interfaces (API) and generally collect, store and transmit information (Canhoto & Arp, 2017).

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WFT devices are usually worn on the wrist (Rupp et al., 2016) and sometimes on a continual basis (Lunney et al., 2016; Michaelis et al., 2016; Rupp et al., 2016). They are also usually gathering data on physical activity (Lunney et al., 2016; Stragier et al., 2016) in an automated manner, with the possibility of providing motivation (Michaelis et al., 2016). Within WFT, the main difference between the Activity Tracking Technology, and Sports Tracking Technology is that the latter is specialized to help runners evaluate their performance and enable them to improve their training accordingly while also retaining recordkeeping capabilities (Kuru, 2016).

Many WFT devices are complimented with software for the platforms, the device, or apps (Ledger, 2014; Stragier et al., 2016). The user doesn't see a clear distinction between WFT and the software; the user considers them as an ecosystem that is meant to support them (Canhoto & Arp, 2017). This user perspective is an important interpretation that supports this work: the user experience (UX) is indeed holistic and multi-faceted, and not limited to simply hardware components. Additionally, WFT and apps can be complemented, or incorporated, with OFCs; these mainly allow to collect, aggregate, inform, and display data while also providing social features (Stragier et al., 2018).

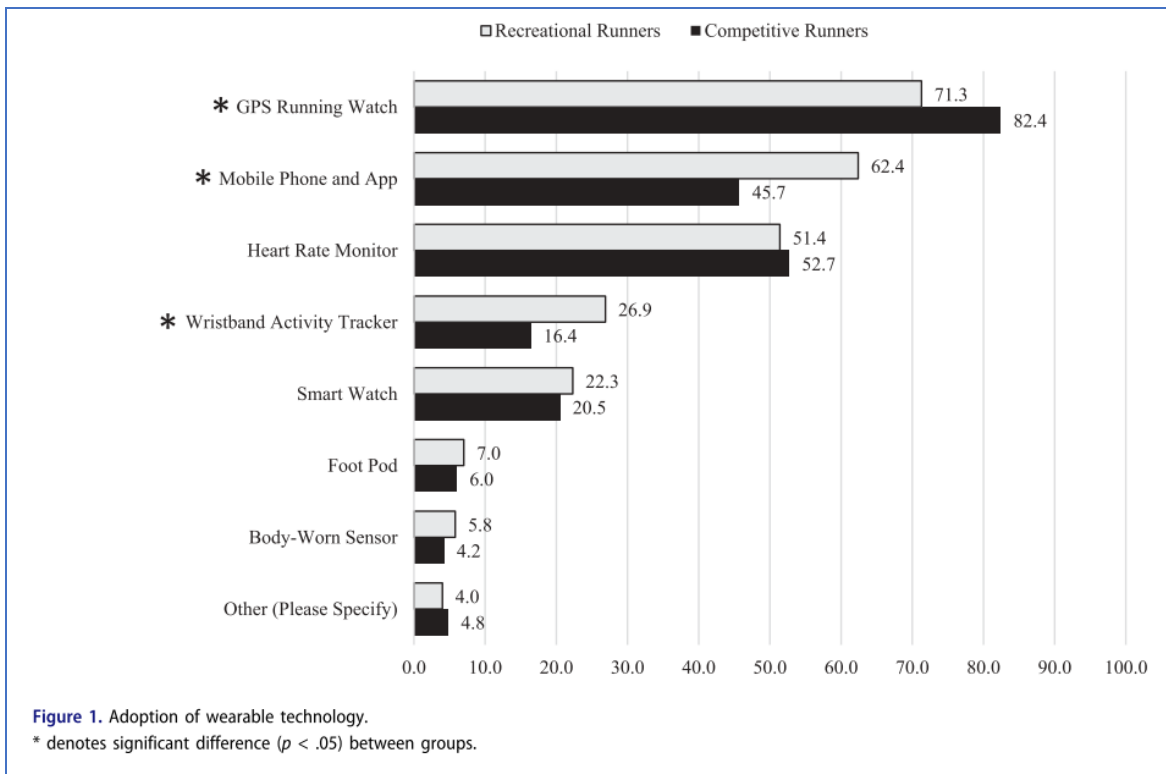
Use of SSTT varies greatly. Here are some examples by Clermont et al (2020):

Most recreational and competitive runners used more than one type of wearable technology. The most common type of device for both groups was the GPS-enabled sport watch, but this fact was significantly more common in competitive runners than recreational runners. (p.3)

(...) mobile phones and apps, as well as wristband activity trackers, were significantly more common in recreational runners and these results are relatively consistent with previous literature. (...) even though most runners preferred GPS-enabled sport watches, the use of mobile phones with running apps was more prevalent in half-marathon participants compared to full marathon runners. (p.5)

Kuru (2016) mentions that "these systems focus on making people self-aware by giving personal information (i.e., their physical activity level) and motivate them to have better behavior (i.e., to get active)" (p.847). They fit the description from Oinas-Kukkonen & Harjuma (2009) as being persuasive as computer-human and computer-mediated (p.491).

Figure 5 - Adoption of wearable technology (Clermont et al., 2020)



User intentions

Users' intentions for adopting technology can and should be studied; Canhoto and Arp (2017) state that, as an early adoption model, the Unified theory of technology acceptance and use of technology (UTAUT) (Venkatesh et al., 2003) focuses on user needs and understanding user intent variables. Venkatesh et al. (2003) mentions that UTAUT can explain up to 70% of user intention. User intention can then possibly inform the strategy and design of system of qualities for SSTT.

Janssen et al. (2017) explain that "every runner, from beginner to experienced, has their reasons for going the distance. Some run to clear their minds, other to lose weight or become fitter and some train to participate in races" (p.815). As mentioned earlier, runners expect and hope that their SSTT will help them in some way. There are many socio-demographic and socio economic factors that influence the acquisition and type of SSTT, such as income, education, genders, age, sport-frequency, etc. (Janssen et al., 2017)(p.3).

User context

Kuru (2016) enlightens us about the runner's context:

As with all types of technology, the experience of interacting with [SSTT] is dynamic, and it is affected by many factors, including time, context, goals, emotion, behavior, and attitudes. Additionally, people's expectations change with new technology, because new functions and features need to be made sense of and taken into account relative to goals for product use. (p.848)

Needs

As mentioned previously by Clermont et al. (2020), "over 75% of runners use wearable technology and/or running-related apps for training optimization and distance recording on a consistent basis" (p.1). They distinguish that "competitive runners were more interested in tracking personalized data and running form/biomechanical data, whereas recreational runners were more interested in using wearable technology as motivation to run" (p.3).

Goals

Oinas-Kukkonen & Harjumaa (2009) share insight on goals and their relation to PSD:

(a) the highest and most difficult goals produce the highest levels of effort and performance; (b) specific, difficult goals consistently lead to higher performance than urging people to do their best; (c) when goals are self-set, people with high self-efficacy set higher goals than do people with lower self-efficacy; and (d) people with high self-efficacy are also more committed to the assigned goals and to finding and using better task strategies to attain the goals as well as to responding more positively to negative feedback.

Thus, when users have the opportunity to set a goal, they will use their preexisting knowledge and earlier experience more effectively to achieve their goals. Overall, persuasive systems should encourage users to set goals and to discover ways for achieving them in a systematic and effective way. It should be noted, however, that goal specificity in itself does not necessarily lead to high performance. (p.490)

Use of technology by goal-orientation

Canhoto & Arp (2017) notes that the use of technology varies by goals-orientation for fitness users; “general fitness goals (e.g. moving more) was associated with sustained and stable use; specific fitness goals (e.g. prepare for marathon) was associated with loyalty but changing patterns of use; and nutrition related goals (e.g. lose weight) was associated with product switching and irregular use” (p.47). The goal of SSTT users influences behaviour; users are more likely to pursue intrinsic goals (satisfying to pursue) instead of extrinsic ones (stressful and unsatisfactory) (Canhoto & Arp, 2017)(p.51).

More specifically for runners, most (81.5%) are motivated by meeting their SSTT goals, about 60% changed their training to improve their performance, and 36.2% were influenced by looking at their data (Clermont et al., 2020)(p.3). Their main reasons for adopting SSTT is to track personalized training data (Clermont et al., 2020) and receive feedback (Stragier et al., 2018).

It’s critical that SSTT share progressive and informative feedback for runners achieving their goal (Kuru, 2016) (p.1). Since runner’s technology engagement is linked to their running engagement, runners expect the technology to stay focused on running (Kuru, 2016)(p.1).

Motivation of runners

Ryan and Deci (2000) posit that user’s motivation, both intrinsic and extrinsic, and their desire to attain their goals leads to successful adoption. They also maintain that humans are inherently motivated, but vulnerable to becoming passive. The method by Ryan and Deci (2000) breaks-down user needs into three components that need to be fulfilled for an individual to be fully motivated: competence, relatedness, and autonomy. They conclude that conditions that promote autonomy, and respect competence increases human motivation, whereas controlling behaviours have the opposite effect.

Although runners may start with a high motivation for their training, they often fail to sustain their activities and eventually stop (Stragier et al., 2018) (p.815). Janssen et al. (2017) note that there are many motives for runners, and that motives vary by running experience (Janssen et al., 2017)(p.2). Knaving et al. (2015) add that the advanced amateur runners usually have high intrinsic motivations, followed by extrinsic motivations, with very low amotivation.

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Figure 6 - Average results and standard deviation on the Sports Motivation Scale (Likert) – Advanced amateur runners (Knaving et al., 2015)

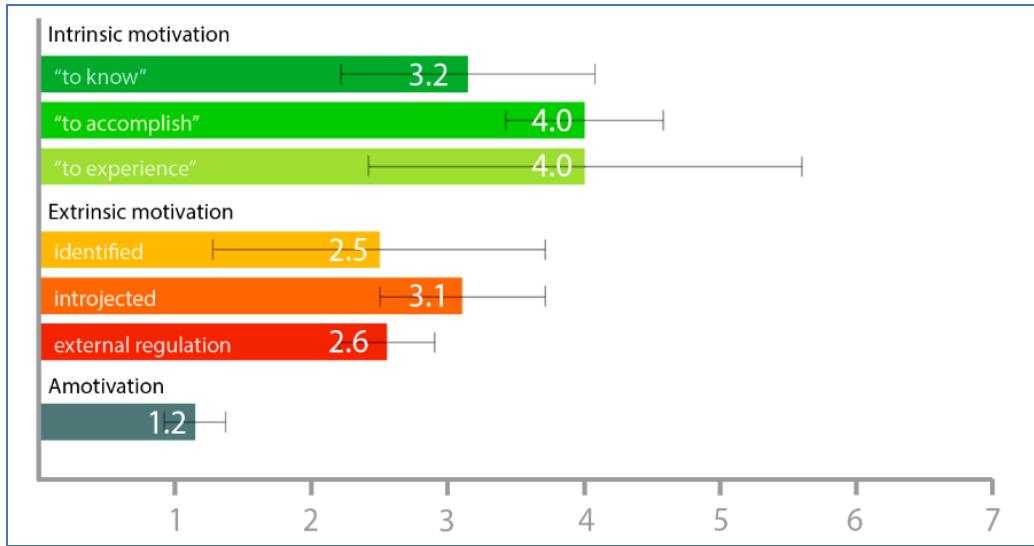
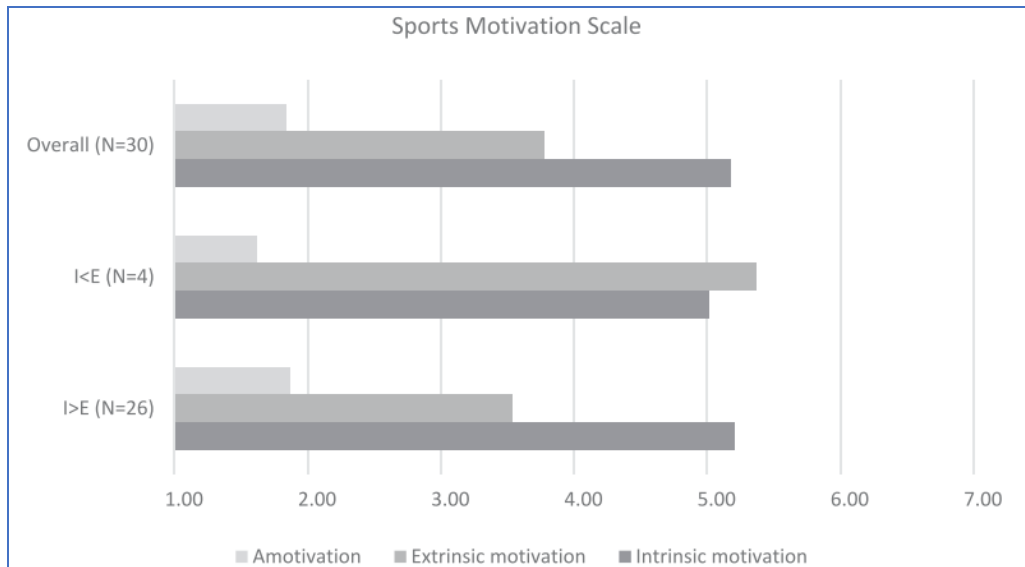


Figure 7 - Sports motivation scale for serious runners (Kuru, 2016)



Stragier et al. (2016) add that “self-regulatory motives are the primary motive for novice user” (p.40). When runners are low in intrinsic motivation, especially for the externally motivated, and don’t have enough social support or feedback, they are more likely to stop their activities (Stragier et al., 2018)(p.815). The following motives follow the Motivations of marathoners scale (Stragier et al., 2018)(p.819-820).

Table 2 - Running motivation items (based on the Motivations of marathoners scale) (Stragier et al., 2018)

			β
Physical motives	Weight control	To keep my weight under control	0.91
		To lose weight	0.94
		To look leaner	0.89
	General health orientation	To improve my health	0.80
		To become more fit	0.71
		To stay in physical condition	0.90
Social motives	Affiliation	To meet people	0.84
		To socialise with other runners	0.98
	Recognition	To earn respect of peers	0.86
		To make my family or friends proud of me	0.81
		To make people look up to me	0.90
		To get compliments from others	0.84
Achievement motives	Competition	To see how high I can place in races	0.80
		To get a faster time than my friends	0.80
		To beat someone I've never beaten before	0.80
	Personal goal achievement	To compete with myself	0.77
		To push myself beyond my current limits	0.56
Psychological motives	Psychological coping	To improve my mood	0.62
		To concentrate on my thoughts	0.67
	Life meaning	To add a sense of meaning to life	0.87
		To make my life more purposeful	0.87
		To make myself feel whole	0.79
	Self-esteem	To improve my self-esteem	0.88
		To feel more confident about myself	0.90

*All beta's (β) are significant at $p < .001$.

Physical motives (weight concern, general health orientation)

Users who are inexperienced (Dallinga et al., 2015)(p.7), and motivated by weight management are more likely to use apps and online fitness communities (Stragier et al., 2018)(p.815). Inactive individuals might also share these characteristics (Dallinga et al., 2015).

Social motives (recognition, affiliation)

Social motives include peer pressure (short term for motive and adoption), social expectations, or influences (Canhoto & Arp, 2017). For general fitness, participants who felt they were connected to the right community were more motivated and had or better experience (Fritz et al., 2014). Runners with social motivations are prone to sharing activities (Stragier et al., 2018) such as comparing performances for external motivation and sustained use of OFCs (Kuru, 2016)(Stragier et al., 2016), which leads to a perceived usefulness for experienced users (Stragier et al., 2016)(p.40). Stragier et al. (2018) share that

“runners with low to medium abilities were more motivated by social affiliation” (p.816) and that female runners are usually more affiliation-oriented.

Achievement motives (competition, personal goals achievement)

Runners with high ability are primarily motivated by altruism, competition and past participation, whereas the low-to-medium ability runners are more focused on health goals (Stragier et al., 2018)(p.823). Clermont et al. (2020) note:

For more competitive runners, it appears that information related to running dynamics is needed to maintain their interest and usage of wearable technology, whereas recreational runners need more motivational features that help them adhere to their running program. (p.8)

Stragier et al. (2018) add that “OFC users are more achievement-oriented than non-OFC users, especially regarding the attainment of personal goals” (p.823) and that typically male runners are more competition-oriented.

Psychological motives (life meaning, self-esteem and psychological coping).

Knaving et al. (2015) state that “events add more meaning to everyday training sessions, but most participants saw the invigorating nature of regular running as the main advantage of the sport” (p.8). Similarly, recreational runners and long-distance runners that used SSTT apps in general felt better both physically and mentally (energetic, better diet, sustained sport behaviour, self-esteem, etc.) (Dallinga et al., 2015) (p.5-6).

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Table 3 - Differences between app users and non-app users in Running physical activity (RPA), perceived health and lifestyle, and self-image (Dallinga et al., 2015)

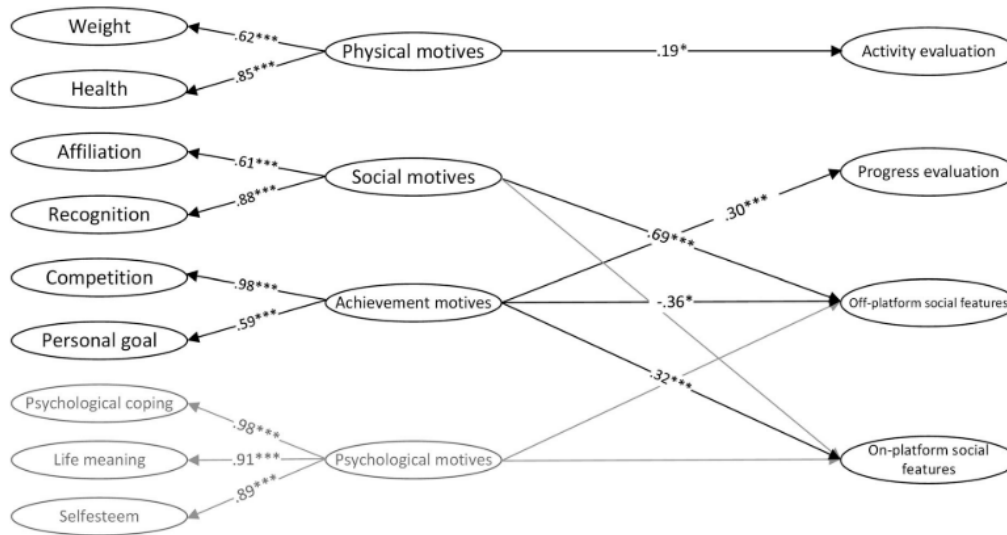
		16 km		Chi ²	P	6.4 km		Chi ²	P
		App use	No app use			App use	No app use		
		N (%)	N (%)			N (%)	N (%)		
RPA	Decreased/same	624 (23.7)	821 (31.1)	55.49	< 0.001	467 (39.1)	369 (30.9)	17.22	< 0.001
	Increased	689 (26.1)	504 (19.1)			246 (20.6)	112 (9.4)		
Perceived health	Not healthier	497 (18.2)	722 (27.5)	72.71	< 0.001	294 (23.5)	268 (21.4)	18.36	< 0.001
	Healthier	863 (31.6)	646 (23.7)			443 (35.4)	246 (19.7)		
Smoking behaviour ^a	More/equal	164 (43.3)	111 (29.3)	0.11	0.814	91 (52.3)	52 (29.9)	2.16	0.208
	Less	64 (16.9)	40 (10.6)			24 (13.8)	7 (4.0)		
Alcohol consumption ^b	More/equal	901 (41.5)	897 (41.3)	1.63	0.211	441 (54.4)	296 (36.5)	0.28	0.619
	Less	201 (9.3)	173 (8.0)			46 (5.7)	27 (3.3)		
Eat healthier	Agree	496 (18.4)	420 (15.6)	10.71	0.001	221 (18.0)	129 (10.5)	3.76	0.052
	Disagree	843 (31.3)	932 (34.6)			502 (40.8)	377 (30.7)		
Feel more energetic	Agree	923 (34.3)	731 (27.2)	65.17	< 0.001	467 (38.1)	281 (22.9)	9.95	0.002
	Disagree	412 (15.3)	623 (23.2)			255 (20.8)	223 (18.2)		
Chance of maintaining sport behaviour	Agree	949 (35.3)	868 (32.3)	13.30	< 0.001	538 (44.0)	339 (27.7)	7.33	0.007
	Disagree	389 (14.5)	481 (17.9)			183 (15.0)	163 (13.3)		
I know that performing sport is not my thing	Agree	21 (0.8)	28 (1.0)	0.97	0.387	12 (1.0)	14 (1.1)	1.82	0.226
	Disagree	1313 (49.1)	1316 (49.1)			711 (58.0)	488 (39.8)		
Feel better about myself	Agree	859 (32.0)	646 (24.1)	74.19	< 0.0001	492 (40.1)	257 (21.0)	37.60	< 0.0001
	Disagree	475 (17.7)	703 (26.2)			229 (18.7)	248 (20.2)		
Feel more like an athlete	Agree	605 (22.5)	422 (15.7)	55.40	< 0.0001	343 (28.0)	168 (13.7)	24.68	< 0.0001
	Disagree	731 (27.2)	926 (34.5)			377 (30.8)	335 (27.4)		
Changed lifestyle	Agree	913 (34.1)	796 (29.7)	25.01	< 0.0001	502 (40.9)	302 (24.6)	12.76	< 0.001
	Disagree	421 (15.7)	550 (20.5)			220 (17.9)	204 (16.6)		
Stimulating others to perform sport	Agree	657 (24.5)	566 (21.1)	14.65	< 0.001	384 (31.3)	217 (17.7)	12.02	0.001
	Disagree	676 (25.2)	784 (29.2)			339 (27.6)	287 (23.4)		
Losing weight	Agree	543 (20.2)	399 (14.8)	36.72	< 0.0001	270 (22.0)	125 (10.2)	21.61	< 0.0001
	Disagree	794 (29.5)	955 (35.5)			453 (36.9)	380 (30.9)		
Feel tired more often	Agree	97 (3.6)	84 (3.1)	1.17	0.282	52 (4.3)	38 (3.1)	0.08	0.824
	Disagree	1237 (46.1)	1266 (47.2)			668 (54.7)	463 (37.9)		

^aThe participants who did not smoke were excluded
^bThe participants who did not drink alcohol were excluded

Emotions are short term, sensitive, stimulated within certain context, and might help inform the persuasion process; this state is triggered by beliefs about cognitive physiological, social and behavioral aspects (Ahmad et al., 2020)(p.225). There are six basic emotions that can be measured on an emotional scale with valence and level of arousals; it's also known that happier states lead to higher motivation and can influence a behavioural shift (Ahmad et al., 2020)(p.226). Mood on the other hand, lasts for extended periods of time (weeks to months) and often unrelated to what triggered the mood (Ahmad et al., 2020)(p.225).

Interestingly for OFCs, runners have no relation for psychological motivations, hinting that similar outcomes are more likely felt rather than this motive itself (Stragier et al., 2018)(p.824).

Figure 8 – Running motivations and OFC affordances structural model (Stragier et al., 2018)



Abilities

Injuries

Although running does have health benefit, it can have negative impacts like injuries and overtraining. Overuse injuries are the most common with 50%-79% yearly incidence (Clermont et al., 2020)(p.1).

Environmental

Runners are continually exposed to different environments. Unfavourable weather temperatures and injuries are major demotivators for runners (Kuru, 2016)(p.851). Elites have particularly high levels of psycho-biological stress from travelling, and physical stress from varying oxygen, temperature, and elemental factors (Sperlich & Holmberg, 2017).

Genetics

Pickering & Kiely (2019 inform:

Genetic variation exerts an influence on every aspect of elite athlete performance, including training adaptation, injury risk, ergogenic aid use, post-exercise recovery, athletic development and, at some point, potentially the identification of elite athletes. (p.9)

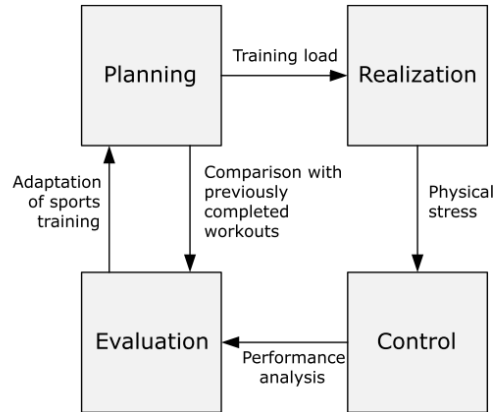
Additionally, (...) skill acquisition, psychological traits and post-exercise fatigue, along with tangential factors that may impact athletic performance and preparation (...). (p.13)

Persuasive system design for runners using smart sport training technologies

Training cycle, events, and competitions

SSTT have been studied in all phases of training (Rajšp & Fister, 2020).

Figure 9 - The four phases of sports training (Rajšp & Fister, 2020)



Runners who train regularly have microcycles (tapering, blocks of training) and macrocycles (dedicated longer period of varying intensity) (Sperlich & Holmberg, 2017)(p.1). Overtraining syndrome is possible, with runners becoming more prone to injury, illness, negative mood and performance reduction (Main & Grove, 2009)(p.1). Saw et al. (2016) agree with them, noting that drastic increased training and chronic training load led to higher overtraining, while acute decrease helped improve well-being (p.1). Performance and well-being during competitions can be affected by external factors (weather, competitors, etc.) (Saw et al., 2016) (p.2).

Table 4 - Factor loadings, inter-factor correlations, and internal consistency values for the six training distress factors (Main & Grove, 2009)

	Subscale and item					
	DEP	VIG	SYM	SLE	STR	FAT
Depression (DEP)	1.00	-0.194	-0.228	-0.394	0.437	-0.208
- miserable	0.747	-0.153	-0.121	-0.053	0.035	0.136
- unhappy	0.738	-0.067	-0.017	0.039	-0.030	-0.106
- bitter	0.721	-0.083	0.107	-0.003	-0.015	-0.125
- downhearted	0.703	-0.034	-0.028	-0.033	0.085	0.028
- depressed	0.636	-0.018	-0.004	-0.125	0.073	0.057
Vigour (VIG)	-0.194	1.00	0.041	0.110	-0.259	0.182
- energetic	-0.044	0.781	0.031	-0.005	0.037	0.095
- lively	-0.006	0.774	0.039	0.024	-0.016	-0.035
- active	-0.033	0.755	-0.026	-0.055	0.025	-0.097
- alert	0.052	0.494	-0.074	0.056	-0.092	0.179
Physical symptoms (SYM)	-0.228	0.041	1.00	0.247	-0.181	0.321
- muscle soreness	-0.070	0.047	-0.790	0.021	-0.045	-0.079
- heavy arms or legs	0.014	0.027	-0.787	0.014	0.035	-0.016
- stiff/sore joints	0.026	-0.047	-0.672	-0.091	0.010	0.006
Sleep disturbances (SLE)	-0.394	0.110	0.247	1.00	-0.273	0.207
- difficulty falling asleep	-0.041	0.033	0.036	-0.947	0.010	-0.041
- restless sleep	-0.043	0.005	-0.062	-0.738	0.016	-0.092
- insomnia	0.132	-0.028	-0.020	-0.636	-0.029	0.114
Stress (STR)	0.437	-0.259	-0.181	-0.273	1.00	-0.311
- stressed	-0.105	-0.031	-0.004	0.012	0.776	0.054
- could not cope	0.033	-0.019	0.108	-0.091	0.636	-0.094
- difficulties piling up	0.165	-0.123	-0.090	0.051	0.539	0.040
- nervous	0.112	0.111	-0.052	-0.008	0.411	-0.071
Fatigue (FAT)	-0.208	0.182	0.321	0.207	-0.311	1.00
- tired	0.036	0.007	-0.053	0.005	-0.053	-0.785
- sleepy	-0.009	-0.112	-0.041	-0.075	0.109	-0.647
- worn-out	0.165	-0.054	-0.219	-0.012	0.113	-0.502
Cronbach's alpha	0.86	0.80	0.80	0.82	0.72	0.78

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Table 5 - Typical patterns of subjective measures to acute changes in training load and chronic training (Saw et al., 2016)

	Acute		Chronic	n
	Increased training load	Decreased training load	Ongoing training	
POMS				
Total mood disturbance	↓↓	↑↑	?	27
Tension	?	↑↑	-	27
Depression	?-	--	--	28
Anger	?	↑↑	?	28
Confusion	--	--	---	27
Vigour	↓↓↓	↑↑	?	29
Fatigue	↓↓↓	↑↑↑	?	30
Recovery-Stress index	↓↓	↑↑↑	↓	7
Stress				
General stress	--	↑↑	↓↓↓	10
Emotional stress	--	?	--	11
Social stress	--	↑↑	↓↓	11
Conflicts/pressure	---	---	↓↓↓	11
Fatigue	↓↓↓	↑↑	↓↓	11
Lack of energy	---	--	↓↓↓	11
Physical symptoms	↓↓	↑↑	--	11
Injury	↓↓	↑↑↑	?-	11
Emotional exhaustion	--	--	--	11
Disturbed breaks	---	---	---	11
Recovery				
Social recovery	↓↓	↑↑	↓↓	10
Physical recovery	--	---	---	11
General well-being	↓↓	↑↑↑	↓↓	11
Sleep quality	---	--	--	11
Success	---	---	↓↓	11
Being in shape	↓↓↓	↑↑↑	↓↓	11
Personal accomplishment	---	---	↓↓	11
Self-efficacy	---	---	--	11
Self-regulation	---	---	↓↓↓	11
SFMS				
Overtraining score	↓	↑	--	4
DALDA				
Sources of stress	---	---	-	4
Symptoms of stress	↓↓↓	↑↑↑	↓	5
STAI				
State anxiety			-	1
CSAI-2				
Cognitive anxiety			-	1
Somatic anxiety			?	1
Self-confidence			?	1
PSS	?	↑		1
MTDS				
Total score			↓	1
All subscales				0
DSC				
DSC			-	1
STPI				
Anxiety			?	1
Anger			-	1
Mood				
All subscales			-	1

Typical patterns rated as improve (↑), decline (↓), conflicting findings (?), or no change (-). Three symbols indicates strong evidence, two symbols for moderate evidence and one symbol for limited evidence. Shading highlights strong (dark grey) and moderate (light grey) associations. n refers to number of contributing studies.
POMS, Profile of Mood States; RESTQ-S, Recovery Stress Questionnaire for Athletes; SFMS, Societe Francaise de Medecine du Sport; DALDA, Daily Analyses of Life Demands of Athletes; CSAI-2, Competitive State Anxiety Inventory-2; PSS, Perceived Stress Scale; MTDS, Multi-Component Training Distress Scale; DSC, Derogatis Symptom Checklist; STPI, State-Trait Personality Inventory.

Culture

Social identity for runners is linked and affected by training, preparing for runs, and the struggles of running (Carlén & Maivorsdotter, 2017). This could maybe explain why users become uncomfortable when they want, but cannot plan a run (Kuru, 2016)(p.851). Runners identify are also impacted by events (failure and glory), travels, feelings of escape, time/space/zones, and healthy lifestyle (Carlén & Maivorsdotter, 2017)(p.30).

Proficiency

Sports tracking technology use and experience varies (Canhoto & Arp, 2017; Kuru, 2016). Janssen et al. (2017) share that “apps are more likely to be used by younger, less experienced and involved runners. Hence, apps have the potential to target this group of novice, less trained, and unorganized runners. In contrast, sports watches are more likely to be used by a different group of runners, older and more experienced runners with higher involvement” (p.1-2). Stragier et al. (2018) also recall that “solitary runners tend to use apps more often than members of a running club, who are more likely to use sports watches” (p.1).

Table 6 - Probability of event runners’ usage of apps and sports watches for different consumer profiles (Janssen et al., 2017)

Socio-demographic			Running-Related				Psychographic				Probability	
Gender	Age	Education	Training frequency	Organizational Context	Main sport	Events	Ease practice	Perceived Advantage	Individual Quitting	Social Quitting	Usage of apps	Usage of sports watches
Male	46 years & older	High	3x/w & more	Clubs	Yes	5x/y & more	High	High	Low	Low	0.10	0.76
Male	46 years & older	High	3x/w & more	Clubs	Yes	5x/y & more	Low	High	High	Low	0.13	0.78
Male	46 years & older	High	3x/w & more	Individual	Yes	2-4x/y	Low	High	High	Low	0.26	0.60
Male	36-45 years	High	2x/w	Small group	Yes	5x/y & more	High	High	Low	Low	0.38	0.51
Male	36-45 years	High	2x/w	Individual	Yes	2-4x/y	Low	High	High	Low	0.54	0.41
Female	36-45 years	High	1x/w & less	Small group	No	2-4x/y	Low	Low	High	High	0.59	0.21
Female	36-45 years	High	2x/w	Small group	No	2-4x/y	Low	Low	High	High	0.62	0.32
Male	36-45 years	High	2x/w	Individual	No	1x/y	High	High	Low	Low	0.64	0.32
Female	36-45 years	Low/middle	2x/w	Individual	No	1x/y	Low	High	High	High	0.75	0.28

The strategy

Knaving et al. (2015) capture the difficulty of SSTT persuasive context perfectly:

Can technology help the runner smeared in his own spit during the last mile of a marathon?
 How do we support the runner with interactive systems when they are nervously pacing around the room trying to decide what to do with their time when they are injured? Can we present means to ease the frustrations of families when their lives are starting to be organized according to training programs? What support can we provide when a race is not going as planned? This seems like the biggest downfall of current technology offering. It only focuses on flow. (p.2)

Route

Oinas-Kukkonen & Harjuma (2009) elaborate the key persuasion strategies with routes:

An individual who carefully evaluates the content of the persuasive message may be approached by the direct route, whereas an individual who is less thoughtful and uses simple cues or stereotypes for evaluating the information may be persuaded through the indirect route.

Direct and indirect processes may act simultaneously, and both strategies may be supported through numerous software system features. Direct persuasion has turned out to be the more enduring of the two. However, in the era of information overflow, people are often forced to use indirect cues more often than before, because of the abundance of information to be handled. When an individual sees relevant cues, heuristics are triggered. These may also be called cognitive shorthands, shortcuts, or rules of thumb.

Heuristics are normally derived from experience and may have some empirical validity.

Heuristics are often socially shared, but in practice a heuristic is available only if there is a stored representation of it in one's memory. (p.488)

The message

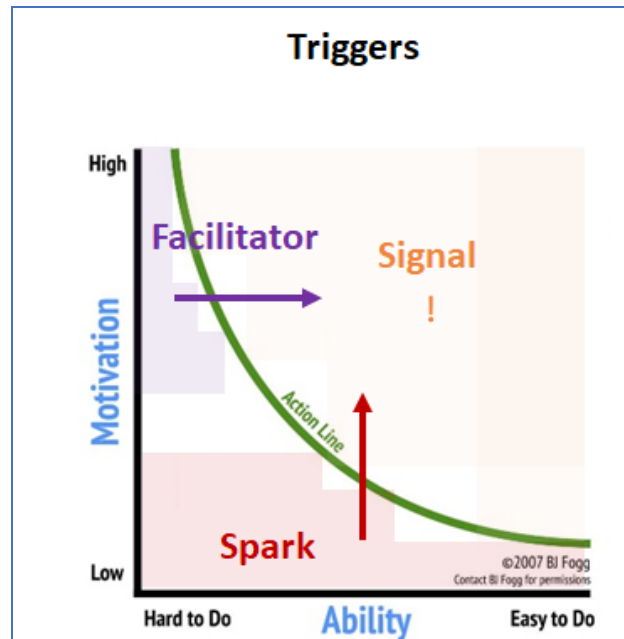
Facilitators, sparks, and signals

By aligning the FBM and preferred routes based on user state, it's evident that the FBM works quite well to inform which type of preferred routes of persuasion to use.

Table 7 - FBM contextual elements of persuasive design triggers

User state	Triggers (FBM)	Preferred route (Oinas-Kukkonen & Harjuma, 2009)
Low motivation/high ability	Spark	Prefers heuristics or indirect persuasion
High motivation/low ability	Facilitator	
High motivation/high ability	Signal	Prefer or open to direct persuasion (cognitive, convincing arguments with logic, reason, and intelligence)

Figure 10 - The Fogg Behavior Model with added trigger overlays (BJ Fogg, n.d.)
(overlay modification by Maxime Gauthier-Kwan)



Blanson Henkemans et al. (2015) distinguish the different types of persuasion: “macro level persuasion has an overall persuasive intent” and “micro level persuasion (microsuasion) aims at persuading the user to continue interaction with technology. This contributes to stimulating use until the desired behavioural change is reached” (p.1).

Knaving et al. (2015) describe flow strikingly like a user state with high motivation and high ability:

Flow may be attained when the feedback is perceived as immediate, the goals are clearly understood, and challenges and skills are identified as balanced. When people are in a flow state, they have a sense of control and find the activity intrinsically rewarding. Flow during marathon running has been shown to positively influence future running motivation, although it has not been directly linked to race performance. (p.2)

They also highlight that it’s “impossible to successfully design assuming a constant state of flow” (p.9). This reinforces that a combination of sparks, facilitators, and signals is key for persuasive messaging for runners.

Designers should start with microsuasion to create interest in SSTT; by first creating a running habit, then monitoring progress, and finally progress-tracking might follow (Stragier et al., 2018) (p.824). The messaging should also be “providing a meaningful rationale for an uninteresting behavior, along with

Persuasive system design for runners using smart sport training technologies

supports for autonomy and relatedness, promoted its internalization and integration” (Ryan & Deci, 2000)(p.74); Rupp et al. (2016) agree that design should integrate self-determined features (p.1437).

Triggers could perhaps benefit from using emotions, since emotions are stimulated by context, actions or objects for a short period (Ahmad et al., 2020)(p.225). The use of fear for motivation could be explored as a motivator if runners welcome or are motivated by this approach for their goal-orientation (Kim & Cho, 2016). Kim & Cho (2016) distinguish that simply focusing on high-efficacy messages is better, but there could be experimentation with high-threat/high-efficacy message combination, or low-threat/high-efficacy depending on the user fear control responses.

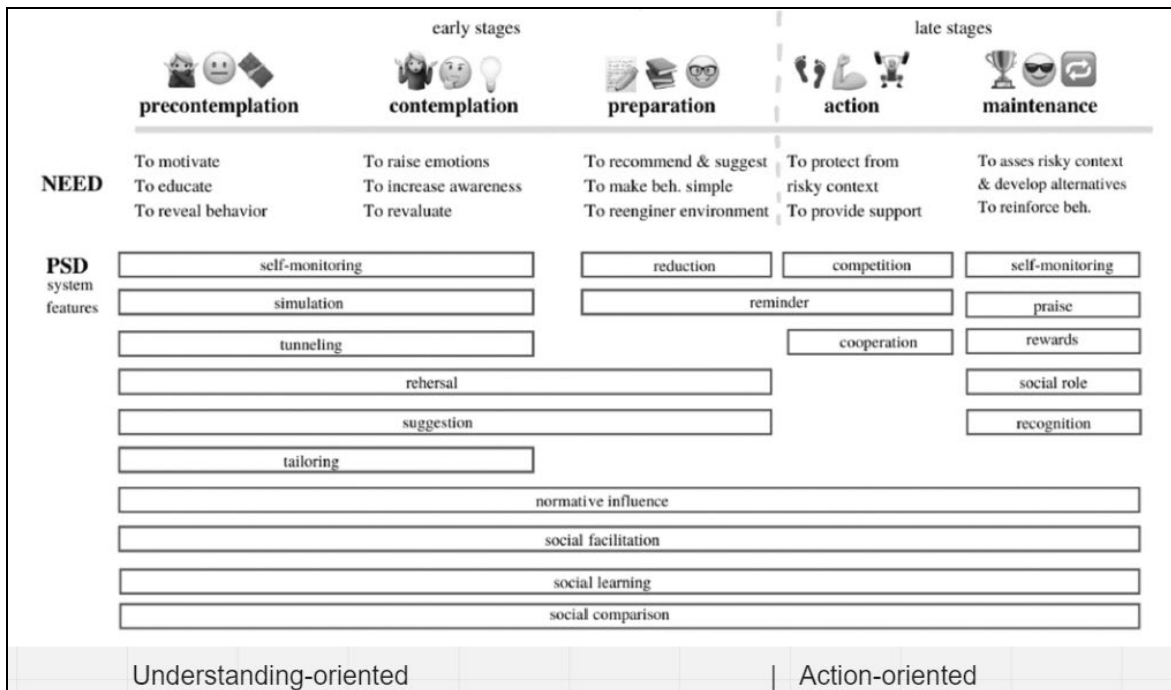
Persuasion by runner’s experience, stages, and expertise

Designers should also adapt the macro level persuasion since user needs change from the first weeks of use; the SSTT should evolve with the user (Fritz et al., 2014) (p.496). The Transtheoretical model (TTM) Framework for designing for behavioural change with the use of persuasive technology by Pintar & Erjavec (2021) identifies this user evolution (needs, system features and user stages) quite well. By overlapping the TTM framework with the Overview of running experience by Kuru (2016), it becomes evident that these PSD system features and design functionalities should be fully integrated in the design of system qualities and influence the choice of messaging.

For example, a person new to running that uses SSTT for the first time would benefit from persuasive messages related to the TTM precontemplation stage, while also considering the running experience assessment of needs, and receiving data highlighting distance and total time for activities.

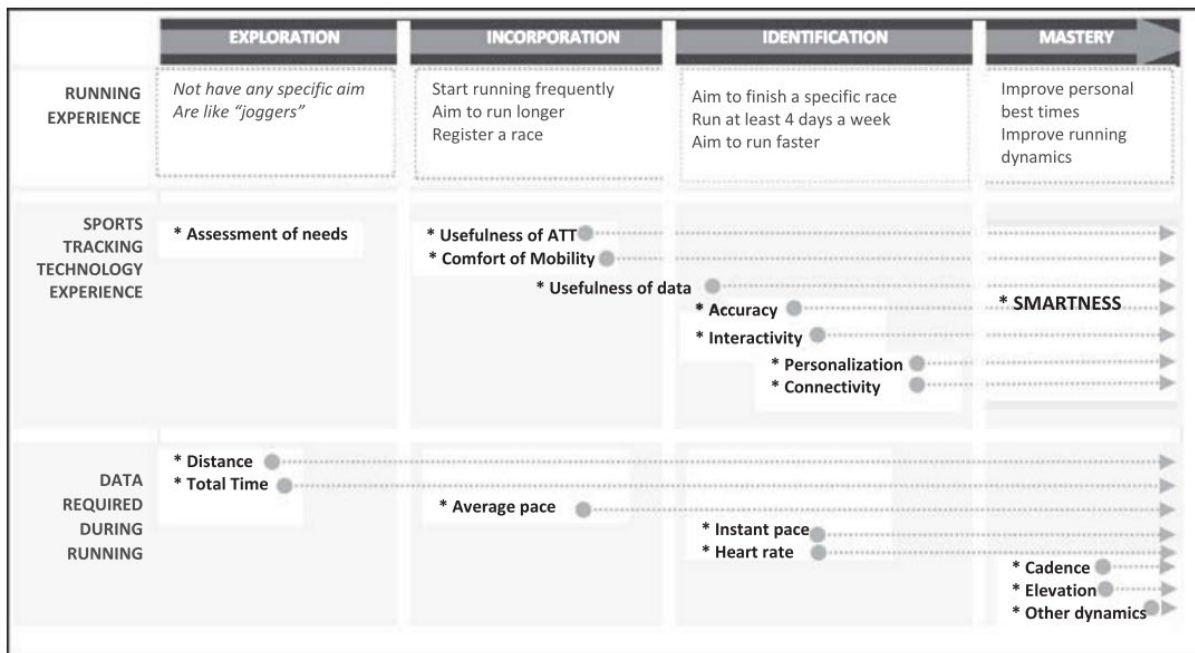
Persuasive system design for runners using smart sport training technologies

Figure 11 – TTM Framework for designing behavioural change with the use of persuasive technology



[Orientations were added annotations based on the work: understanding-orientation, and action-oriented]

Figure 12 – Overview of running experience (runner's aptitudes and progression) (Kuru, 2016)



"(1) exploration, the phase in which the user explores both the possible technologies and the self; (2) incorporation, in which the STT is gradually incorporated into the life of the runner; (3) identification, in which the runner feels emotional attachment to both running and the STT; and (4) mastery, in which the runner masters both running and the STT" (Kuru, 2016)(p.852).

Design of system qualities

Oinas-Kukkonen & Harjumaa (2009) state that “a system’s persuasiveness is mostly about system qualities” (p.491). Stragier et al. (2018) support this by elaborating:

‘Affordance’ refers to the perceived utility of a technology and its technological properties (...). The technological capabilities of a technology provide users with functionalities or features that allow them to interact with the technology in a meaningful way and as such, create value and take advantage of these features” (Stragier et al., 2018)(p.817).

How to improve the system with user’s preferences

While Blanson Henkemans et al. (2015) suggest a cognitive engineering, Pintar & Erjavec (2021) instead focus on suggestions for developing products for behavioural change:

- (1) pick a target group and conduct user research to find out in which stage of change the users are;
- (2) try to understand users’ emotions;
- (3) link the PSD features according to the TTM stage;
- (4) give extra attention to simulation, rehearsal, and normative influence. (p.82)

As previously mentioned, Kuru (2016) provides an Overview of running experience that informs how and when to best employ certain design and informative features.

Figure 13 - Summary suggestions (Kuru, 2016)



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“The blue circle indicates the suggestions for supporting runners with STT psychologically, derived from the “running experience” divisions, and the green circle indicates how the STT should behave to achieve this” (Kuru, 2016)(p.856).

SSTT are too often focused on technical parts rather than the whole experience (Kim & Cho, 2016) (p.2). The user experience happens before, during, and after interacting with the product, “covering all aspects of the experience such as physical, emotional, sensual, cognitive, and aesthetic” (Kuru, 2016)(p.848). During all steps of interaction, users feel interest, pleasure, joy and disappointment (Ahmad et al., 2020). It’s only logical that emotions should be considered for design qualities for user, system, and interaction controls (Ahmad et al., 2020).

Table 8 - Coding and categorization of emotions stimulation factors for each interaction stages (Ahmad et al., 2020)

Theme	Category	Open-Code		
		Pre	During	Post
User control	Individual Awareness	Self-satisfaction	Self-satisfaction	Self-satisfaction
			Consciousness value	Consciousness value
	Personality	Interest Knowledge Skill Relatedness	Interest Knowledge Skill Relatedness	Interest Knowledge Skill Relatedness
System control	Interface design	Interface attractiveness	Interface attractiveness	Interface attractiveness
			Layout	Layout
	Persuasive function	Persuasive function	Persuasive function	Persuasive function
	Content presentation	Information quality	Information quality	Information quality
			Data representation	Data representation
			Multimedia	Multimedia
	System Quality	Reliability Usefulness	Reliability Usefulness	Reliability Usefulness
	Usability	Learnability	Learnability	Learnability
			Ease of use	Ease of use Ease of access
	Interaction control	Task	Feedback Action Expectation	Feedback Action Expectation

User’s preference comparison

Clermont et al. (2020) summarize Kuru’s (2016) findings on user preference:

Runners identified collecting personal data as the most important function of tracking technology, but interactivity, usefulness, connectivity and personalization were all important characteristics in ensuring long-term use. (...) simple metrics, such as distance and total time, were sufficient for beginner runners; however, runners who wished to improve performance and running dynamics also desired the ability to monitor cadence, elevation, and other, unspecified, advanced metrics. (p.1)

Clermont et al. (2020) also specify that “On average, runners believed that distance, speed, and time were the three most important metrics related to injury prevention” (p.3).

1. Primary task support

Reduction

Unusable technology hinders motivational needs (Rupp et al., 2016) while lowering barriers for users like minimizing maintenance is beneficial (Lazar et al., 2015). While a message might be timely, users should be able to occasionally ignore messages when they are too busy (Consolvo et al., 2009)(p.408).

SSTTs collect large amounts of data. To help with reduction, data should be abstracted (Consolvo et al., 2009; Stragier et al., 2018), summarized for analysis, and simple to share the results either on OFC or other social platforms (Stragier et al., 2018). Data should also be unobtrusive (Consolvo et al., 2009)(p.408), transparent and easy to consult information (Rupp et al., 2016)(p.1437), visually insightful (Stragier et al., 2018), and with clear graphics (Kuru, 2016)(p.857). Data visualization and interaction should be used to inform the user before, during, and after the run (Kuru, 2016). Data should be fast, easy, and seamless to consult regardless of system output (Kuru, 2016). Clermont et al. (2020) highlight the importance of this stating that “90% of respondents looked at their wearable technology data after every run and 75% preferred to view their data both in real-time during their run as well as in the form of a summarized report after the run” (p.7).

In terms of use, mobility and availability are perceived easier to use while perceived ease of use directly determines usage behaviour (Lunney et al., 2016).

Tunneling

Information-related characteristics of SSTT with personalized data are critical to sustained use (Clermont et al., 2020). Designers should focus on providing feedback and monitoring early on, and then transition towards progress tracking in the longer term (Stragier et al., 2018).

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As discussed previously, using the FBM for messaging will help with use guidance and opportunities. Designers should be very careful to consider techniques for the fragility of user state while running (state of association and dissociation), especially when the user is uncomfortable (Knaving et al., 2015). Knaving et al. (2015) further suggest to “minimize distraction for in-run communication. Use non-intrusive interfaces that can be ignored when the runner is in an associative state” (p.9).

In regards to the TTM framework, it's best to ensure that runners don't skip stages since it leads to higher risks of relapse and regression, therefore SSTT should encourage progressive and patient guidance (Pintar & Erjavec, 2021). Ideally, future SSTT should be able to predict the needs before the runners become aware of them (Kuru, 2016).

Featuring novel biological data is motivating and helps to reach goals (Lazar et al., 2015; Rupp et al., 2016).

Tailoring

SSTT have to target specific needs of runners, with heavy efforts in tailoring and personalization to maximize healthy sustained use and training benefits (Janssen et al., 2017). The solution is to highlight the perceived advantages (features) to the runners based on their running profile (ability, involvement, etc.)

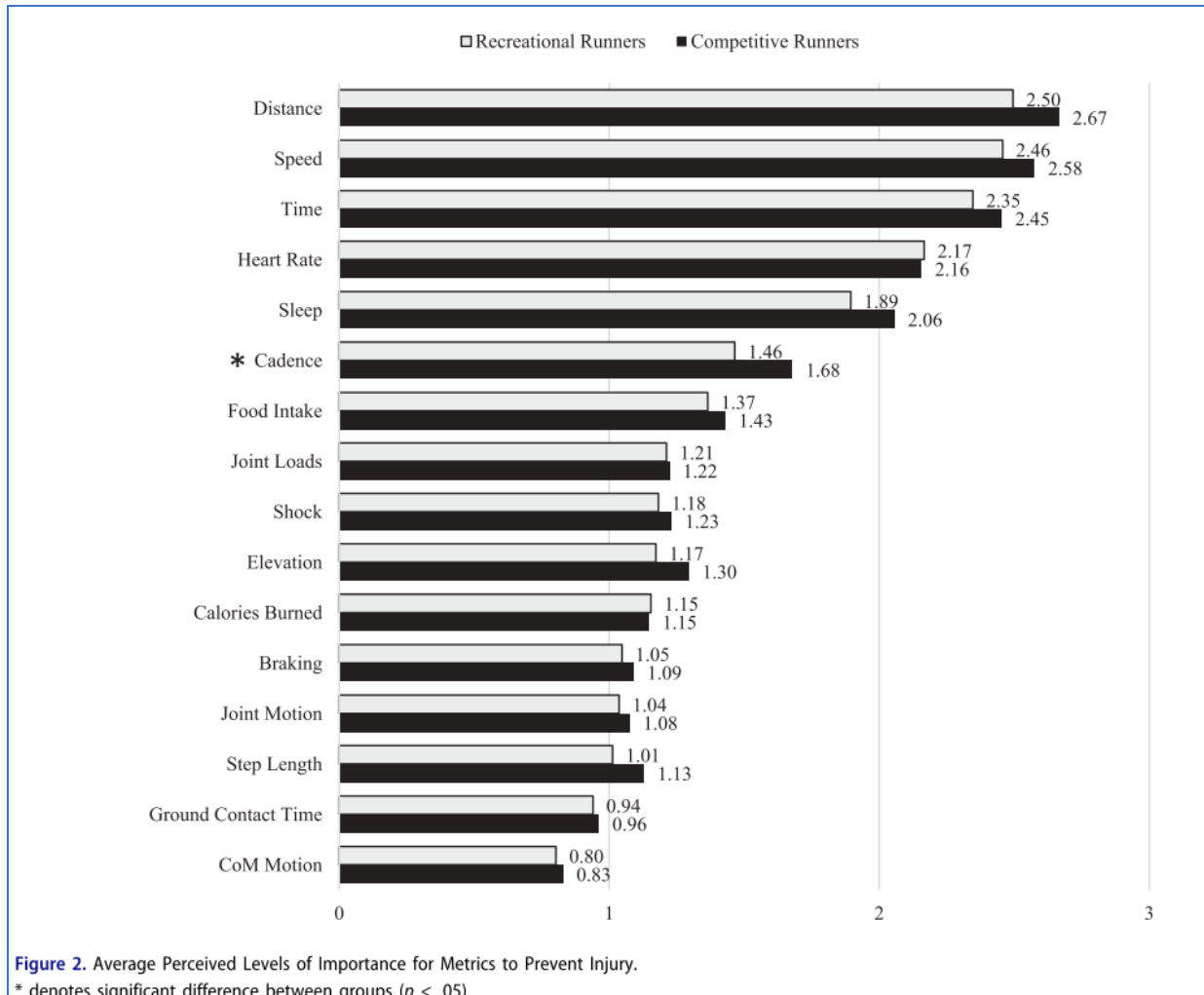
For example, when designing for recreational, beginner, and novice runners, design could focus on app development because users are less invested in the sport; while designing for competitive and club runners could focus more on dedicated devices (Clermont et al., 2020; Dallinga et al., 2015; Janssen et al., 2017) since they prefer using them for “tracking personalized data related to training and running biomechanics” (Clermont et al., 2020)(p.3).

SSTT sports programs should be customized to running, and tuned the type of running; this would allow better monitoring of athletes and their well-being (Saw et al., 2016). This could include learning from multiple target zones (speeds, heart rates, interval training), and would increase the accuracy towards better goal setting or challenges (de Oliveira & Oliver, 2008).

Sustainable use does not only benefits the users but could help reduce electronic waste. Canhoto & Arp (2017) explain that “consumers blame the technology for the unsatisfactory outcome, whereas the issue may be their expectations” (p.48). Better data-collection will help personalize marketing (Lunney et al., 2016). Marketers should showcase the challenges of running (habit forming, inconvenient weather), to

ensure that user’s perception have more realistic expectations of use; the technologies we see today are presented in the context of situations where running is easy and fun.

Figure 14 - Average perceived levels of importance for metrics to prevent injury (Clermont et al., 2020)



Personalization

“Despite the potential complexity of a personalised training process, perhaps the simplest message—that all athletes need to be treated differently—is the most important.” (Pickering & Kiely, 2019)(p.15)

Janssen et al. (2017) remark that a higher proportion of runners are now running alone instead of with clubs (p.2); they share that “personalized guidance and support is losing ground, often resulting in drop-out due to injuries or demotivation. Substantial guidance is necessary to maintain sensible and sustainable sports participation among novice and less experienced runners” (p.2). To avoid runners skipping (TTM) stages or regressing, designers should adopt an adaptive and personalize approach to improve behaviour change (Pintar & Erjavec, 2021) and have technology evolve with the runner’s

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mastery of the sport and technology (Kuru, 2016). Ahmad et al. (2020) suggest to also have a deep understanding of the user's emotions to create impactful application (p.226).

Having accurate data based on past performances helps to personalize training (Clermont et al., 2020; de Oliveira & Oliver, 2008; Janssen et al., 2017), motivation (Clermont et al., 2020; Janssen et al., 2017; Lazar et al., 2015), goal perception, (Clermont et al., 2020)(p.8)(Janssen et al., 2020)(p.14), improve performance and prevent injury (Clermont et al., 2020)(p.8).

With additional context on the runners, designers can customize the persuasiveness of the user interface by choosing personalized visuals (Ibrahim et al., 2013) to influence both short-term and long-term persuasion. Creating an environment that caters to runners motivations is more likely to sustain the behaviour and motivate them (Stragier et al., 2018)(p. 824); for example a personalization could perhaps allow users to turn off features that aren't interesting to them to improve their experience (Stragier et al., 2018; Zuckerman & Gal-Oz, 2014).

Figure 15 - The refined framework of persuasive visual web design (Ibrahim et al., 2013)

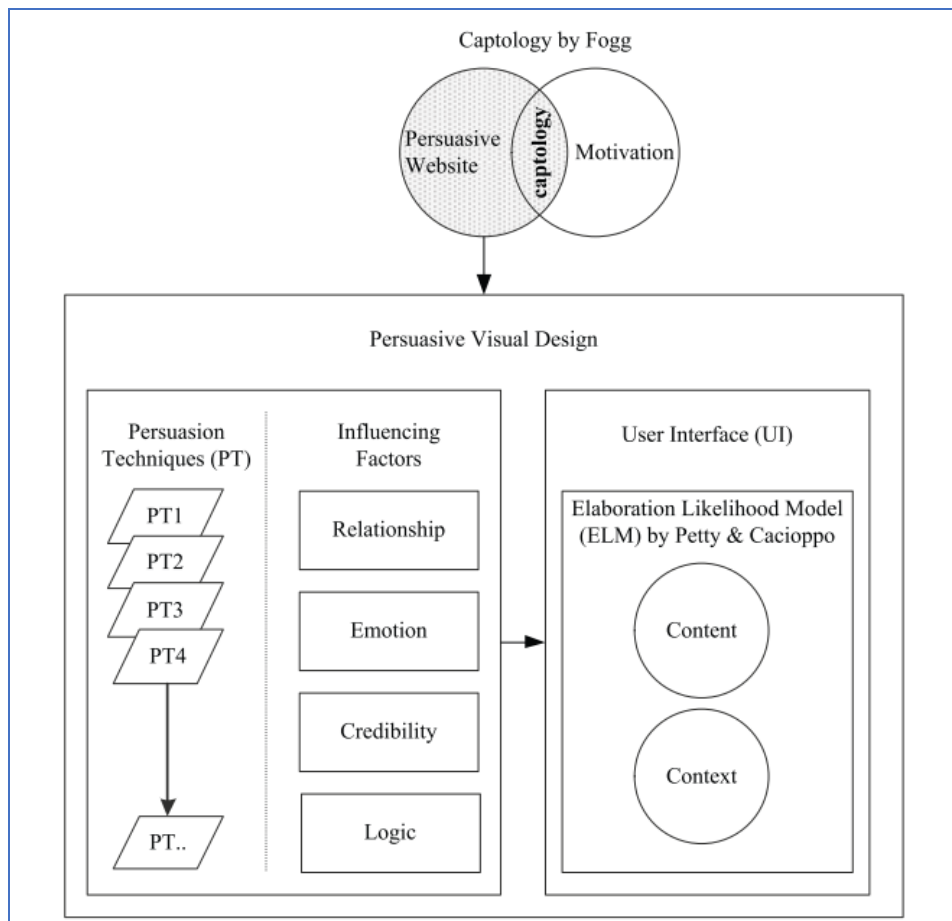
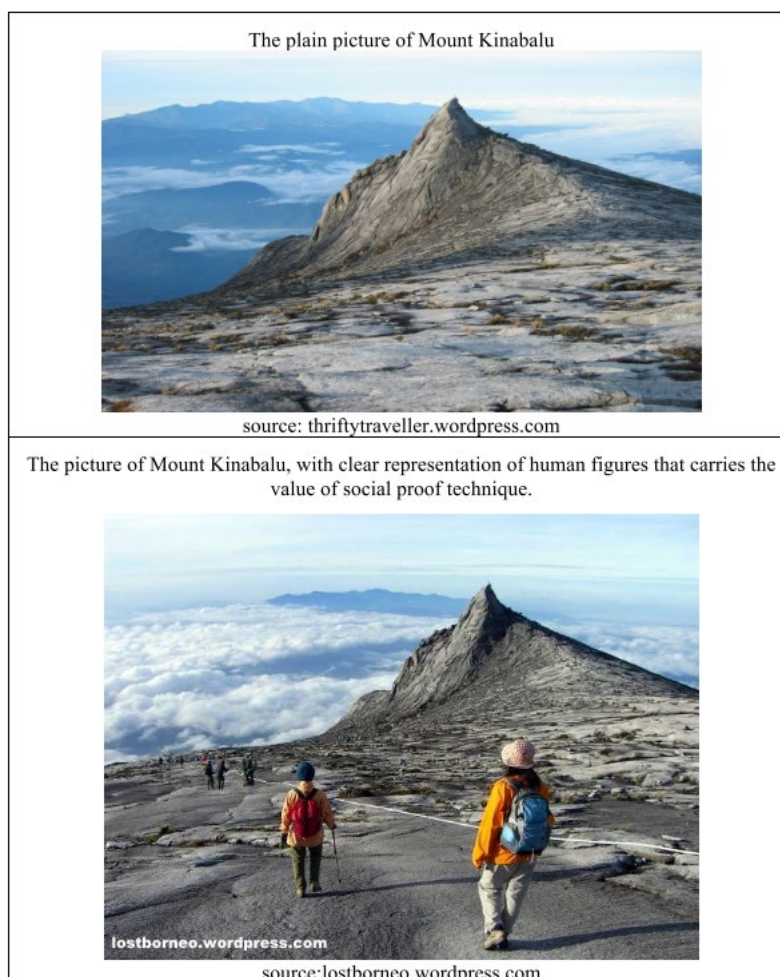


Figure 16 - Example of non-persuasive and persuasive images (Ibrahim et al., 2013)



Clermont et al. (2020) and Kuru (2016) agree that personalization is important for SSTT. Kuru (2016) elaborates:

Personalized information and interactions offer a more engaging experience with the system. Personalized views of data keep people from becoming bored. Prompts or incentives that have been tailored to an individual keep people motivated to work toward their goals. Other forms of personalized interactions can include incentives or inspirational information. A design for personalization is not static; it needs to be tailored periodically to stay in tune with a user's changing goals. For example, the system can tailor the advice that is given, based on improvement and shifting goals. (p.856-857)

Self-monitoring

In general, effective designs should allow for continuous measurement, goal-setting and real-time feedback (Zuckerman & Gal-Oz, 2014). Knaving et al. (2015) suggest to:

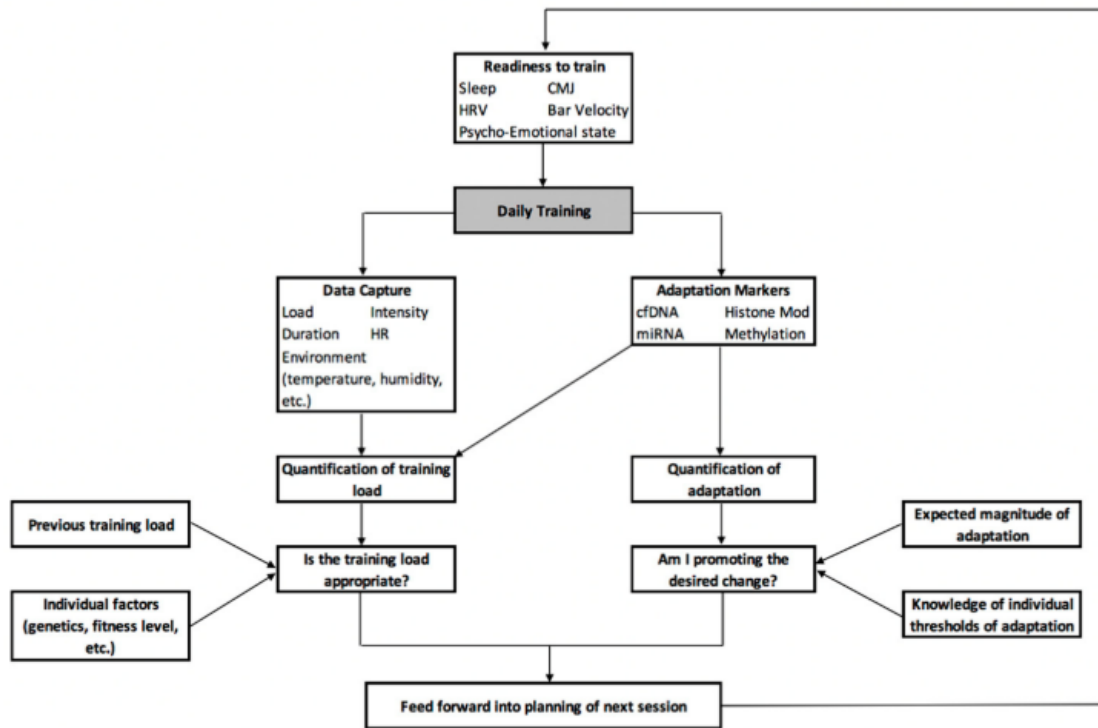
Allow users to define personal and social goals as part of their running experience. Facilitating internalization of motivation (...) [and] build systems that strengthen the runners' internal motivations rather than attempting to design technology that only supports separable goals. (p.8)

The design should be explicit about supporting behaviour maintenance to keep users motivated (Fritz et al., 2014)(p.494). Stragier et al. (2018) support this, they mention that "physical motivations for running are positively associated with the use of one category of self-regulatory features, namely the checking of relevant parameters after completion of an activity" (p.822). SSTT should not only provide an after run summary, but also be able to provide immediate information during the run (Clermont et al., 2020) (p.8). Overall, information should be comprehensive, offer details beyond the running activity, and avoid hiding the SSTT recording capabilities (Consolvo et al., 2009)(p.410). Pickering & Kiely (2019) agree on data collection and elaborate:

A major challenge will be to get athletes to accurately and consistently collect data—such as sleep metrics and HRV—away from the training field, with ease of use and lack of perceived invasiveness important factors for technology developers to consider in this regard. Nevertheless, despite these challenges, the development of a personalised training process appears to hold promise in the optimisation of athlete performance. (p.15)

Saw et al. (2016) mention that athlete mood disturbance, perceived stress and recovery, and symptoms of stress should also be monitored (p.3) using subscales that are sport specific, such as running (and that do not mistake symptoms of causalities)(p.10). Capturing data regularly and having a baseline is beneficial for the user (Fritz et al., 2014; Saw et al., 2016). To enable adjustments, Saw et al. (2016) suggest daily monitoring of sport-specific multi-component training distress scale, weekly monitoring such as for mood states, and training microcycles (p.10). Self-monitoring is promising, but could further benefit from comprehensive monitoring from non-sport related scales and 24/7 feedback (Sperlich & Holmberg, 2017).

Figure 17 - A framework for the implementation of various emerging technologies to enhance daily training practice (Pickering & Kiely, 2019).



Simulation

Kuru (2016) share that “for the technology to help with personal improvement or avoiding injuries, the technology must be smart enough to give advice or suggest possible alternatives by analyzing runners’ data” (p.855).

Rehearsal

Observational learning was a significant factor for device acquisition and applications (Canhoto & Arp, 2017) (p.51).

2. Dialogue support

Praise, and Rewards

One of the recommendations by Consolvo et al. (2009) include the use of positive reinforcement. They suggest to “reward the user for performing the desired behavior and attaining [their] goal. When the desired behavior is not performed, the user should not receive a reward nor a punishment, but [their] interest should be sustained” (p.409).

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Gamification for users new to physical activity might increase motivation, whereas it might decrease motivation for those who are experienced in physical activity (Alahäivälä & Oinas-Kukkonen, 2016).

Reminders

Fritz et al. (2014) encourage to remind users of their long-term goals (Fritz et al., 2014). Consolvo et al. (2009) have two recommendations for reminders:

Use data to display information to encourage the user to reflect on [their] behaviors by showing the user what [they have] done and how those behaviors relate to [their] goal. (p.408)

Provide reasonable and accessible information about the user's past behavior as it relates to [their] goals. Historical data should accommodate changes in lifestyle goals over time and provide for the portability of data across devices. (p.410)

Suggestion

Lazar et al. (2015) provide a few insights. Lack of prompts or overly passive devices led to demotivation for users. They suggest lowering the barriers for users by encouraging routine. To increase user motivation, they suggest considering providing proactive feedback.

Similarity

Appealing to identify lowers the barriers for users, employing user language increases user motivation, and appealing to the user's identity of self, improves use (Lazar et al., 2015).

Liking

Comfort is a very important aspect for WFT (Canhoto & Arp, 2017; Clermont et al., 2020; Consolvo et al., 2009; Kuru, 2016; Michaelis et al., 2016), whereas ugly and obtrusive devices demotivate (Lazar et al., 2015).

Canhoto & Arp (2017) share that "increasing visibility of wearables is important for expanding adoption of the product, designing distinctive devices that consumers feel proud to wear, and which are also ergonomic and comfortable, so that the consumers do not feel compelled to take it off" (p.47). Consolvo et al. (2009) add that if "the display and any accompanying devices function as a personal object(s) that may be used over time, they need to be inquisitive and sustain interest. The physical and virtual aspects of the technology must be comfortable and attractive to support the user's personal style" (p.409).

SSTT should encourage hedonic needs and promote feelings of independence and being in control (Canhoto & Arp, 2017) (p.35). Ahmad et al. (2020) share that pleasant feel and positive thoughts about

the system, system qualities, content presentation, interface design, for interaction stages with the technologies led to positive or negative emotions (p.233); designers should learn about these to improve the persuasion framework. Lastly, Knaving et al. (2015) recommend that “for everyday running, design must support thinking, exploration, and relaxation” (p.8).

Social role

As previously discussed, the SSTT “should act like a personal coach” (Kuru, 2016)(p.856) especially for runners who don’t have access to professionals (Janssen et al., 2017). Coaching users provides concrete motivation (Lazar et al., 2015).

3. System credibility support

Trustworthiness

Accurate data is a critical factor for SSTT (Clermont et al., 2020; Janssen et al., 2017; Kuru, 2016; Lunney et al., 2016) to create meaningful outputs (Clermont et al., 2020; Janssen et al., 2017; Kuru, 2016) and provide reliability (Lunney et al., 2016). Accurate data also supports working mechanisms and personalization (Janssen et al., 2017)(p.14).

Janssen et al. (2017) suggest that “since runners do not trust incomplete or inaccurate data, (...) [the system should be adjustable to let them] remove flawed data, using a more user-centered approach” (p.16). Michaelis et al. (2016) add that:

usability issues such as experiencing issues syncing or setting up their device and having poor battery life as well as wearability factors such as having a device that people can easily damage or a device that is uncomfortable [sic] to wear were more determinantal [sic] to the user’s experience than whether it actually displayed accurate data. (p.1077)

Expertise

Both Oinas-Kukkonen & Harjumaa (2009)(p.494), and Blanson Henkemans et al. (2015)(p.3) agree that expertise such as a knowledge base is an important aspects of PSD.

Surface credibility

Affective quality and relative advantage are perceived useful (Lunney et al., 2016). Ahmad et al. (2020) add that the “findings suggest that people decide to adopt a system when they feel pleasant or having positive thought about the system” (p.233).

Real-world feel

None recalled, more research required.

Authority

None recalled, more research required.

Third-party endorsement

Users that trust a brand based on reputation have an overall better experience and intention to use the product (Rupp et al., 2016)(p.1437).

Verifiability

Michaelis et al. (2016) recommend that designers and researchers use online reviews for low-cost evaluation of product concerns (p.1077). Canhoto & Arp (2017) warn that “developers should not risk launching inferior versions of their products, as negative word of mouth is likely to have a detrimental effect on sales. This is even more important for those users that value peer interaction (...) for instance running groups” (p.47).

4. Social support

Social learning

Users that observe peers adopting new technologies decreases perceived risk (Canhoto & Arp, 2017).

Social comparison

Stragier et al. (2018) share:

social features have the potential to foster an OFC user’s need for relatedness and competence, by connecting [them] to (online) peers and affording reception of feedback from others, including motivating messages and endorsement for achieved goals. (p.817)

OFCs should also encourage discussion, analysis, and interactions with rich media for sense of belonging and knowledge sharing (and for lone runners to signal their presence) (Carlén & Maivorsdotter, 2017)(p.25), while permitting runners to manipulate their data to reflect suitable behaviour (Consolvo et al., 2009) (p.409).

Normative influence

Social factors aren’t negligible for user behavior. As Canhoto and Arp (2017) recognized, social influence is a strong factor for adopting technology (de Oliveira & Oliver, 2008). App users encourage others to run; this factor can be multiplied by using social elements and social media (Dallinga et al., 2015)(p.7).

Athletes with achievement or goals prefer to discuss on OFCs, while other goals are preferred to be discussed elsewhere; a flexible/easy-to-share system would permit this personalization (Stragier et al., 2018).

Stragier et al. (2016) highlight an example with Strava, an OFC:

Self-regulation again, which also has a strong impact on the perceived usefulness of Strava for both novice and more experienced users, appears a crucial feature for making OFC use habitual. Perceived usefulness is only impacting habitual Strava use for more experienced users as it might take time for users to recognize the effect of OFC use on their exercise behavior. Once they do, this adds significantly to habitual Strava use, as our results indicate. (p.40)

Social facilitation

Previous research suggests that social features on OFCs can create a more engaging environment for recreational athletes to commit to and experience their exercising behaviour (Stragier et al., 2018)(p.817-818). Stragier et al. (2018) continue by stating that “OFCs afford both self- regulation and sociability, and that these affordances are relevant for runners because they support the fulfilment of competence, autonomy and belongingness needs” (p.818).

Designers should provide social features for socially motivated users (Carlén & Maivorsdotter, 2017; Rupp et al., 2016)(p.1434). These features are in fact more effective for non-OFC use (Stragier et al., 2018). Sharing features should allow for rich-media (like image and videos) uploads to social platforms for providing additional context on activities (Carlén & Maivorsdotter, 2017). Since the presentation of self is important, the technology needs to also support impression management (Consolvo et al., 2009).

Cooperation

Knaving et al. (2015) share a few guidelines for cooperation:

Manage supporter connection and engagement to ensure that they have the opportunity to provide well-timed feedback. (...) If a run is perfect all the time, support would be unnecessary. (...) When designing for runner support, do not prioritize flow over other constraints. (...) Provide means for supporters to know when the runner is in a dissociative state [/] needs support the most.

OFC should allow to plan running events (Carlén & Maivorsdotter, 2017)(p.25).

Competition

Stragier et al. (2018) share that “social gamification features, such as leaderboards, can also enhance one’s sense of competence and relatedness by creating a competitive environment with online peers” (p.817). During competitive events, features should have festive social elements when racing (Knaving et al., 2015).

Recognition

Designs should support users connecting with their friends and family to observe and encourage user progress (Rupp et al., 2016)(p.1434). Consolvo et al. (2009) suggest that features should also consider how they represent the user:

Present and collect the data, which is personal in nature, such that the user is comfortable in the event that others may intentionally or otherwise become aware of it. Because the data needs to be available whenever and wherever the user needs it, it is likely to be something that [one] wears/carries, resides in a shared/common space, or uses while in the presence of others. The technology should not make the user uncomfortable in those situations. (p.408)

Behaviour and/or attitude change

There are four ways users can deal with the behaviour: change the behaviour (ideal), ignore data, rationalize the dissonance, and change their knowledge (Consolvo et al., 2009). Consolvo et al. (2009) note that it “is important for technology designers to recognize that lifestyle behavior change is a long-term endeavor that pervades everyday life, including the social world. If done poorly, the technology is likely to be abandoned; therefore a principled approach for its design is needed” (p.414).

Oinas-Kukkonen & Harjumaa (2009) state that “persuasion-in-full occurs only when attitude change takes place. Changing a previous attitude is harder than originating or reinforcing an attitude. Furthermore, if a user’s existing attitudes are based on [their] personal experience (sometimes learned through a long socialization process), they are harder to change. In proportion, if a user’s existing attitudes are recently learned from other people, they are easier to change” (p.489).

Overall, the persuasive system should ideally help runner improve their behavior, and if applicable or persistent, their attitude, towards a sustained use SSTT and running towards their goals.

Gaps in research

The main gap for this area of research is the niche of this topic: persuasive system design for smart sport training technologies for runners. The literature either focuses mostly on WFT or OFC, but not often on the technologies' ecosystem as a whole. The research is also sparse in terms of approach for runners: either being specific to a type of runner (which requires a more popularly accepted taxonomy for research definition and comparison) or demographics (countries and culture). The design of system qualities is often limited to specific functionalities or themes instead of a holistic approach. This encourages the necessity to validate this proposed framework both in theory and in application, specifically for runners, and making it more robust.

Within the literature, there are also mentions of gaps. Rajšp & Fister (2020) who did the systematic literature review of intelligent data analysis methods for smart sport training criticizes:

If researchers are going to avoid using existing datasets, they should try to ensure publishing as much of their private datasets as possible. A notable mention, although not used in any of the identified studies, is also the data generation methods (...), which could in the future allow easier verification and generation of data. According to our literature review, this research area is still very young, and has experienced increasing and persistent interest among researchers.

Although assumed, app designs often lack the identification of behavioural change theories integration and the evaluation of the impact by behaviour determinants (Dallinga et al., 2015) (p.7). Blanson Henkemans et al. (2015) agree, noting that designers usually rely on previous experience for design decisions instead of theory-based design (p.1).

Canhoto & Arp (2017) note that "different countries may not only have different demographic profiles of users, but will also have different cultural contexts and norms which are highly consequential for technology adoption and use" (p.50). There's also a gap in understanding user's emotions, which would be key for interaction design and persuasiveness (Ahmad et al., 2020) (p.226).

For researching sustained use, there needs to be more done on users that are either not willing to use (Lazar et al., 2015)(p.637) or have abandoned their devices, in order to understand why they did so (Clermont et al., 2020; Lazar et al., 2015). Research is not clear if a user upgrading device counts as abandonment, that term could be improved and explored (Canhoto & Arp, 2017).

Anecdotally, some features from the design system qualities that are missing in this work (real-world feel and authority) has been witnessed many times in SSTT; it would just be a matter of finding more literature to formally incorporate them within the framework. The same could be done for user context.

Very few articles touched on ethics and moral decisions. Although it's lightly inferred in the PSD, it would be nice to have it explicitly recognized for future design directions and deliberations. These technologies have a direct impact on physical and mental health as well as social factors. As the technology continues to evolve and smartness to increase, especially for the autonomous coaching portion, it's clear that there are ethical dilemma that could conflict between utilitarianism (Canhoto & Arp, 2017)(p.47), human well-being, and human rights (e.g. privacy and data (Sperlich & Holmberg, 2017)(p.2)).

Conclusion

This study has created a framework for understanding the Persuasive System Design (PSD) for runners using Smart Sport Training Technologies (SSTT). All elements of the PSD were identified including the analysis of the persuasion context and design of system qualities that would lead to a change in behaviour or attitude by runners using the technologies. The hope is that this PSD will help designers understand and improve sustained use of the technology, which consequently will help runners achieving their goals.

This adapted PSD framework can be used to inform future behaviour theory-based design of SSTT, alongside the Transtheoretical model (TTM) and Overview of running experience.

There are few suggestions next steps for research:

1. Validate and refine each PSD element
2. Refine the TTM and Overview of running experience for SSTT
3. Create and apply the Fogg Behavior Model (FBM) or another message strategy for SSTT for runners. This will help determine the messaging associated to the motives and abilities in specific contexts.

In terms of immediate applications, mobile apps are a great gateway trying new technologies, and adopting wearable fitness technology specific devices (Canhoto & Arp, 2017). Until or unless body-worn sensors become more popular (Clermont et al., 2020), the biggest persuasive impact for current users,

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would be designers focusing on the most popular devices. Alternatively, designers could focus on improving current and emerging technology with these findings.

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