



**TURUN
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SLEEP TRACKING

Health Advisor, Stressor, or Both?

Shan Feng



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ABSTRACT

Adequate sleep is essential for overall health and well-being. Despite advances in understanding sleep and the development of sleep-tracking technologies, insufficient and poor-quality sleep remain widespread issues worldwide. This situation raises questions about whether these advancements have contributed to improved sleep. Owing to the growing awareness of sleep health, sleep tracking has attracted increasing interest from both society and the scholarly community.

Sleep tracking, a form of self-tracking, refers to the practice of using technological tools to monitor, record, and measure an individual's sleep. Compared to self-tracking, research on sleep tracking has received relatively limited attention and has undergone less rigorous empirical investigation. Nevertheless, prior research has suggested that sleep-tracking technology can increase users' awareness of their sleep, support behavioral changes, and promote overall health and well-being. Despite these benefits, users still face challenges when using sleep-tracking technologies. Therefore, a more granular analysis is needed to uncover the underlying reasons for users' behavior in the context of sleep tracking. In addition, the effectiveness of sleep-tracking technology in improving sleep often falls short of users' expectations, further highlighting the need to explore how individuals respond to these technologies. Although prior studies have examined the challenges and barriers associated with sleep tracking, the potential stressors and their adverse effects warrant further investigation.

Against this backdrop, this dissertation seeks to understand how users interact with both sleep-tracking technologies and the data they generate, addressing the main research question (RQ): *How do people engage with sleep-tracking technology?* To answer this question, this dissertation is guided by three sub-RQs: (1) *Why and how do people use sleep-tracking technology?* (2) *How do configurations of technology affordances and psychological outcomes influence advice-compliance behavior in sleep tracking?* and (3) *What are the potential stressors associated with sleep tracking, and how do they impact health anxiety?*

This dissertation comprises six articles: two literature reviews (Articles I and VI) and four empirical studies (Articles II–V). The first systematic literature review (Article I) inspires this dissertation and generates its sub-RQs. The empirical research (Articles II–V) adopts a mixed-methods approach, combining 38 semi-structured interviews with Oura smart ring users and 324 survey responses from general sleep-tracking users. The data were examined using thematic analysis,

structural equation modeling, and fuzzy-set qualitative comparative analysis. A Q-sorting test was employed to develop and validate the measurement items for the new constructs that were included in the survey. The final integrative literature review (Article VI) synthesizes current research on sleep tracking and proposes future research agendas in this field.

The key findings of this dissertation shed light on how people engage with sleep-tracking technology. Overall, the findings across six articles reveal that sleep tracking can be understood from a sociotechnical perspective, embodies a duality as both advisor and stressor, and involves complex and asymmetric relationships between its antecedents and outcomes. Specifically, Article II demonstrates that feature-enabled technology affordances can both satisfy and frustrate users' basic psychological needs in the context of sleep tracking. Moreover, the satisfaction of autonomy and competence needs plays an important role in sleep tracking, whereas relatedness needs are less central. In addition, Article III identifies several configurations of technology affordances and psychological outcomes that contribute to high and low levels of advice-compliance behavior. The findings highlight that obtaining sleep-related guidance and triggering behavioral changes are an important pair of affordances associated with advice-compliance behavior. Finally, Articles IV and V identify, develop, and validate the measurement items for eight potential stressors associated with sleep tracking. The results indicate that invasion, unreliability, pursuit of perfect data, and vague guidance have direct and positive effects on health anxiety, while complexity, inaccuracy, and data-perception discrepancy have indirect effects on health anxiety.

Accordingly, this dissertation contributes to both theoretical understanding and practical applications. Theoretically, it advances sleep-tracking knowledge by conceptualizing sleep tracking as a sociotechnical practice and clarifying the pathways that influence sleep-tracking outcomes from the information systems perspective. This dissertation also enriches and expands the sociotechnical perspective and existing theories to better fit the sleep-tracking context. Practically, the findings offer insights for designing a user-centered sleep-tracking technology by enhancing detection accuracy, implementing transparency mechanisms, providing personalized feedback, offering nonintrusive notifications, and rethinking social features and comparative metrics. This dissertation also guides users to engage more proactively, remain attentive to their own feelings and perceptions, and avoid overreliance on technology.

Finally, this dissertation acknowledges several limitations and proposes agendas for future research on sleep tracking. Researchers should strive for a balance between qualitative and quantitative approaches, strengthen theoretical foundations, and promote interdisciplinary collaboration. Moreover, researchers are encouraged to explore individual differences, the evolution of technology, user-centered design, stakeholder roles, and the broader impacts of sleep tracking, including behavioral changes and potential adverse effects.

KEYWORDS: Sleep tracking, user needs, technology affordance, stressor, advice-compliance behavior, health anxiety

TURUN YLIOPISTO

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TIIVISTELMÄ

Riittävä uni on välttämätöntä kokonaisvaltaiselle terveydelle ja hyvinvoinnille. Vaikka unen tutkimus ja unenseurannan teknologiat ovat kehittyneet, riittämätön ja heikkolaatuinen uni ovat edelleen laajalle levinneitä ongelmia maailmanlaajuisesti. Tämä tilanne herättää kysymyksen siitä, ovatko nämä edistysaskeleet todella parantaneet unta. Kasvavan uniterveyden tietoisuuden myötä unenseuranta on saanut yhä enemmän huomiota sekä yhteiskunnassa että tutkimusyhteisössä.

Unenseuranta, joka on yksi itsensä mittaamisen (self-tracking) muoto, viittaa käytäntöön, jossa teknologisia välineitä käytetään yksilön unen seuraamiseen, tallentamiseen ja mittaamiseen. Verrattuna itsensä mittaamiseen unenseurannan tutkimus on saanut suhteellisen vähän huomiota ja sitä on tarkasteltu vähemmän systemaattisen empiirisen tutkimuksen kautta. Siitä huolimatta aiemmat tutkimukset ovat osoittaneet, että unenseurannan teknologiat voivat lisätä käyttäjien tietoisuutta unestaan, tukea käyttäytymisen muutoksia sekä edistää terveyttä ja hyvinvointia. Näistä hyödyistä huolimatta käyttäjät kohtaavat edelleen haasteita unenseurannan teknologioiden käytössä. Tämän vuoksi tarvitaan tarkempaa analyysia käyttäjien käyttäytymisen taustalla olevien syiden ymmärtämiseksi unenseurannan kontekstissa. Lisäksi unenseurannan teknologioiden tehokkuus unen parantamisessa jää usein käyttäjien odotuksia heikommaksi, mikä korostaa tarvetta tutkia, miten yksilöt reagoivat näihin teknologioihin. Vaikka aiemmissa tutkimuksissa on tarkasteltu unenseurannan haasteita ja esteitä, mahdolliset stressitekijät ja niiden kielteiset vaikutukset edellyttävät edelleen syvempää tutkimusta.

Tässä taustassa tämä väitöskirja pyrkii ymmärtämään, miten käyttäjät ovat vuorovaikutuksessa sekä unenseurannan teknologioiden että niiden tuottaman datan kanssa ja vastaa pääasialliseen tutkimuskysymykseen (RQ): *Miten ihmiset käyttävät ja kokevat unenseurannan teknologiaa?* Tämän kysymyksen tarkastelua varten väitöskirjaa ohjaavat kolme alatutkimuskysymystä: (1) *Miksi ja miten ihmiset käyttävät unenseurannan teknologiaa?* (2) *Miten teknologisten affordanssien ja psykologisten seurausten yhdistelmät vaikuttavat ohjeiden noudattamiskäyttäytymiseen unenseurannassa?* ja (3) *Mitkä ovat unenseurannan mahdolliset stressitekijät, ja miten ne vaikuttavat terveysahdistukseen?*

Väitöskirja koostuu kuudesta artikkelista: kahdesta kirjallisuuskatsauksesta (Artikkelit I ja VI) ja neljästä empiirisestä artikkelista (Artikkelit II–V). Ensimmäinen systemaattinen kirjallisuuskatsaus (Artikkeli I) inspiroi väitöskirjaa ja muodostaa sen alatutkimuskysymykset. Empiirisissä tutkimuksissa (Artikkelit II–V)

käytetään monimenetelmällistä lähestymistapaa, jossa yhdistyvät 38 puolistrukturoitua haastattelua Oura-älysoikeuden käyttäjien kanssa sekä 324 kyselyvastausta unenseurannan yleisiltä käyttäjiltä. Aineisto analysoitiin teemaattisen analyysin, rakenneyhtälömallinnuksen ja epäselvien joukkojen vertailevan laadullisen analyysin (fsQCA) avulla. Q-lajittelutestiä käytettiin uusien mittarien kehittämiseen ja validointiin. Lopuksi integroiva kirjallisuuskatsaus (Artikkeli VI) kokoaa yhteen unenseurannan tutkimuksen ja ehdottaa tulevia tutkimuslinjoja.

Väitöskirjan keskeiset löydökset valottavat sitä, miten ihmiset suhtautuvat unenseurannan teknologiaan. Kuuden artikkelin tulokset osoittavat, että unenseuranta voidaan ymmärtää sosioteknisestä näkökulmasta, jossa ilmenee kaksijakoisuus neuvonantajana ja stressitekijänä sekä monimutkaisia ja epäsymmetrisiä suhteita taustatekijöiden ja seurausten välillä. Artikkeli II osoittaa, että ominaisuuksiin perustuvat teknologiset affordanssit voivat sekä tyydyttää että turhauttaa käyttäjien psykologisia perustarpeita. Autonomian ja pätevyyden tarpeiden tyydyttäminen on erityisen keskeistä, kun taas yhteenkuuluvuuden tarve on vähemmän merkityksellinen. Artikkeli III tunnistaa useita teknologisten affordanssien ja psykologisten seurausten yhdistelmiä, jotka johtavat korkeaan tai matalaan ohjeiden noudattamiskäyttäytymiseen, ja korostaa, että uniohjauksen saaminen yhdessä käyttäytymismuutoksen käynnistämisen kanssa muodostaa tärkeän affordanssiparin. Artikkelit IV ja V tunnistavat, kehittävät ja validoivat mittarit kahdeksalle unenseurannan yhteydessä mahdollisesti esiintyvälle stressitekijälle. Tulokset osoittavat, että tunkeilevyys, epäluotettavuus, täydellisten mittaustulosten tavoittelu ja epämääräiset ohjeet lisäävät terveysahdistusta suoraan, kun taas monimutkaisuus, epätarkkuus ja datan ja kokemuksen ristiriita vaikuttavat terveysahdistukseen epäsuorasti.

Tämän mukaisesti väitöskirja edistää sekä teoreettista ymmärrystä että käytännön sovelluksia. Teoreettisesti se syventää unenseurannan tutkimusta käsitteellistämällä unenseurannan sosioteknisenä käytäntönä ja selkiyttämällä mekanismeja, jotka vaikuttavat sen tuloksiin informaatiojärjestelmätieteen näkökulmasta. Väitöskirja myös rikastaa ja laajentaa sosioteknistä näkökulmaa ja olemassa olevia teorioita unenseurannan kontekstiin. Käytännön tasolla löydökset tarjoavat näemyksiä käyttäjälähtöisten unenseurannan teknologioiden suunnitteluun parantamalla mittaustarkkuutta, lisäämällä läpinäkyvyyttä, tarjoamalla yksilöllistä palautetta, kehittämällä hienovaraisia ilmoitusmekanismeja sekä uudelleenarvioimalla sosiaalisia ominaisuuksia ja vertailumittareita. Väitöskirja rohkaisee myös käyttäjiä olemaan aktiivisempia, kuuntelemaan omia tunteitään ja välttämään liiallista riippuvuutta teknologiasta.

Lopuksi väitöskirja tunnistaa useita rajoitteita ja esittää tulevia tutkimuslinjoja. Jatkossa tutkimuksen tulisi tasapainottaa laadullisia ja määrällisiä menetelmiä, vahvistaa teoreettisia perustuksia ja edistää monitieteistä yhteistyötä. Tutkijoita kannustetaan tarkastelemaan yksilöllisiä eroja, teknologian kehitystä, käyttäjälähtöistä suunnittelua, sidosryhmien rooleja sekä unenseurannan laajempia vaikutuksia, mukaan lukien käyttäytymisen muutokset ja mahdolliset haitalliset vaikutukset.

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My connection with Finland began in 2016, when I joined the double master's programme of Business Intelligence and Knowledge Management (BIKMA) between Finland and China. That year became a turning point in my life. I was deeply impressed by the diversity of cultures among my classmates, the harmony of the academic environment, and a lifestyle closely connected to nature. When the time came to consider doctoral studies, it felt natural to apply in Finland and to return here once again. Luckily, in May 2019, I returned to Finland and joined the Information Systems (IS) Science unit at the Turku School of Economics (TSE) as a doctoral researcher.

During my doctoral journey, I have received invaluable guidance from my supervisors, enjoyed countless inspiring discussions with colleagues, and exchanged ideas in seminars organized by our unit. I have also had the opportunity to attend conferences and seminars in Newcastle (UK), Kristiansand (Norway), Kilpisjärvi (Finland), Heerlen (the Netherlands), and Kuala Lumpur (Malaysia). Each of these experiences brought new insights, friendships, and perspectives that enriched my research and personal growth. Beyond academia, I have also gathered countless happy and unforgettable memories in Finland. I have caught the aurora dance above a frozen lake, listened to owls calling in the quiet forest night, picked mushrooms hidden in the autumn forests, and waited under wide skies for comets and falling stars. This entire journey has been made possible and meaningful by the many people who have supported, encouraged, and accompanied me along the way, to whom I would like to express my sincere gratitude.

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List of Original Publications

This dissertation is based on the following original publications, which are referred to in the text by their Roman numerals:

- I Feng, S., Mäntymäki, M., Dhir, A., & Salmela, H. (2021). How self-tracking and the quantified self promote health and well-being: Systematic review. *Journal of Medical Internet Research*, 23(9), e25171.
<https://doi.org/10.2196/25171>
- II Feng, S., & Mäntymäki, M. (2025). Sleep tracking with a smart ring: A needs–affordances–features perspective. *Proceedings of the Pacific Asia Conference on Information Systems*.
<https://aisel.aisnet.org/pacis2025/hci/hci/7>
- III Feng, S., & Mäntymäki, M. Advice-compliance behavior in sleep tracking: A configurational analysis of technology affordances and psychological outcomes. [Manuscript submitted for publication].
- IV Feng, S., Mäntymäki, M., & Salmela, H. (2023). Sleep tracking as a stressor: Experiences from smart ring users. *Proceedings of the European Conference on Information Systems*.
https://aisel.aisnet.org/ecis2023_rp/369
- V Feng, S., & Mäntymäki, M. (2024). Stressors of sleep tracking: Instrument development and validation. In R. van de Wetering et al. (Eds.), *Disruptive innovation in a digitally connected healthy world. I3E 2024: Lecture notes in computer science* (vol. 14907, pp. 344–357), Springer.
https://doi.org/10.1007/978-3-031-72234-9_29
- VI Feng, S., Mäntymäki, M., & Pappas, I. O. (2026). Sleep tracking: An integrative review, conceptual framework, and future research agendas. *Behaviour & Information Technology*. 1-31.
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1 Introduction

The purpose of Chapter 1 is to provide an overview of this dissertation. The chapter begins by introducing the research background (Section 1.1), followed by a discussion of the identified research gaps and motivation (Section 1.2). It then proposes the main research question (RQ) and sub-RQs (Section 1.3). Finally, this chapter outlines the connection between the articles in this dissertation (Section 1.4) and describes its overall structure (Section 1.5).

1.1 Research background

Sleep is one of the most important pillars of a healthy lifestyle (Choe et al., 2011; Walker, 2017). However, owing to the complex brain activity involved, it remains one of the least understood aspects of human life. Before the advent of sleep-tracking technology, sleep was primarily understood subjectively in terms of bedtime, wake time, and total duration. In the mid-20th century, breakthroughs in polysomnography (PSG) and electroencephalogram (EEG) revealed sleep as a structured process with distinct stages. These advancements contributed to the discovery of the rapid eye movement stage by Nathaniel Kleitman, regarded as the father of sleep research, and his student Eugene Aserinsky (University of Chicago, 1999). Building on these fundamental understandings of sleep, the development of actigraphy in the early 1970s enabled the convenient tracking of sleep with a wrist device.

Today, various types of sleep-tracking technologies are available on the market. These technologies include mobile applications (e.g., Sleep Cycle), wearable devices including smartwatches (e.g., Apple Watch), smart rings (e.g., Oura), smart bands (e.g., Whoop), and headbands (e.g., Muse), as well as non-wearable devices (e.g., Withings sleep pad). Reflecting this trend, the global market size of sleep-tracking devices (including sleep applications, wearable devices, and non-wearable sleep devices) was estimated to reach \$24.68 billion in 2024 and is expected to grow to \$196.44 billion by 2037 (Research Nester, 2024).

However, it remains uncertain whether the enhanced understanding of sleep and advancements in sleep technologies have led to improved sleep. A recent worldwide survey involving 13,000 people across 17 countries found that 40% of people experience fewer than three nights of quality sleep per week (ResMed, 2024).

Although the U.S. Centers for Disease Control and Prevention recommends that adults get at least seven hours of sleep per night (CDC, 2024), the proportion of people sleeping seven hours or fewer per night remains high, with variations across countries ranging from 32% to 54% (YouGov, 2024).

This widespread sleep insufficiency is concerning. Prior research has found that sleep-related disorders and insufficient sleep have been linked to a range of adverse outcomes, including physical health issues, such as obesity, cardiovascular disease, and diabetes (e.g., Grandner, 2017; Khandelwal et al., 2017; Taheri et al., 2004; Tobaldini et al., 2017), as well as mental health issues, such as stress, psychiatric symptoms, depression, and anxiety disorders (e.g., Grandner, 2017; Staner, 2003; Tsuno et al., 2005). Moreover, poor sleep is also associated with an increased risk of accidents and injuries, such as vehicular crashes and work-related injuries (e.g., Grandner, 2017; Luyster et al., 2012). Therefore, the growing public awareness of the importance of sleep has significantly driven the demand for tools to understand and manage sleep.

The rise of sleep-tracking technologies is a response to this demand. Medical-grade sleep-tracking technologies provide more accurate sleep detection via brain waves and other biometric data. For example, the PSG has become the “gold standard” method for diagnosing sleep disorders. In contrast, consumer-grade sleep-tracking technologies rely on proxy measures captured through multiple hardware sensors. Consumer-grade sleep-tracking technologies collect data such as heart rate, heart rate variability, blood oxygen, body temperature, and movement. These data are then algorithmically synthesized to infer and interpret sleep patterns. Hence, compared to medical-grade sleep-tracking technologies, consumer-grade sleep-tracking technologies offer a more accessible but less accurate approach (Goldstein, 2020).

Beyond its growing popularity among consumers and in public discourse, sleep tracking has attracted increasing attention from the academic community. The existing research has examined the sleep-tracking phenomenon from a multidisciplinary perspective. For example, some studies have developed new sleep-tracking technologies and algorithms for sleep detection (e.g., Gamel & Talaat, 2024; Han et al., 2024). Other research has focused on evaluating the accuracy of consumer sleep-tracking technologies in comparison to the gold standard for sleep—that is, PSG (e.g., Berryhill et al., 2020; Tuominen et al., 2019). In addition, a growing body of research has explored user experiences with sleep-tracking technologies, identifying various factors from individual and technological perspectives that influence users’ engagement and usage behaviors (e.g., Attie & Meyer-Waarden, 2023; Kaitz et al., 2023; Kuosmanen, Visuri, Kheirinejad, et al., 2022). Some studies have also investigated whether sleep-tracking technologies can promote better sleep and overall health (e.g., Attie & Meyer-Waarden, 2023; Devine et al., 2024;

Shaforostov et al., 2024). Although specific studies have demonstrated positive outcomes, others have highlighted potential risks, such as stress (Kuosmanen, Visuri, Kheirinejad, et al., 2022) and sleep-related anxiety associated with orthosomnia (Baron et al., 2017). Despite their promise, current sleep-tracking technologies face significant challenges and barriers to effective use (Liang & Ploderer, 2016; W. Liu et al., 2015).

In the field of information systems (IS), although research on sleep tracking remains in its early stages, a substantial body of research has investigated the broader self-tracking movement. Prior research has investigated the adoption and post-adoption of self-tracking technology (e.g., Choi & Kim, 2024; Gimpel et al., 2019; Kari et al., 2016), with most research focusing on fitness tracking (e.g., Abouzahra & Ghasemaghahi, 2022; Attig & Franke, 2019; James et al., 2019). Previous research has explored factors influencing the initial adoption (e.g., Krey et al., 2019; Pfeiffer et al., 2016), continued use (e.g., Beldad & Hegner, 2018; Huang & Ren, 2020), intermittent discontinued use (e.g., Shen et al., 2018, 2020), and abandonment (e.g., Attig & Franke, 2020; Dhir et al., 2024) of fitness tracking technologies. Moreover, research has investigated the impact of self-tracking technologies across various contexts, such as individual daily life (e.g., Rieder, Lehrer, et al., 2020; Y. Zhang et al., 2025), organizational settings (e.g., Messer & Lukas, 2023; Mettler & Wulf, 2019), and clinical settings (e.g., Gabriels & Moerenhout, 2018; Y. Kim et al., 2016). This body of research has demonstrated the potential of self-tracking technologies to facilitate behavioral changes (Lehrer et al., 2021; K. Rönkkö, 2018) and enhance well-being (Giddens et al., 2017; Gimpel et al., 2021), providing valuable insights into the sleep-tracking phenomenon.

Sleep tracking has emerged as a rapidly growing focus in the broader self-tracking movement. With the growing importance of sleep tracking in health management and the persistent challenges and barriers to its effective use, there is a need for further investigation to understand how people engage with sleep-tracking technologies.

1.2 Research gaps and motivation

As sleep tracking is fundamentally a form of self-tracking, this dissertation refined the broader research gaps of self-tracking and positioned them within the specific context of sleep tracking. This dissertation first identified research gaps through an overview of self-tracking. Considering the nature of sleep and the central concerns in sleep tracking, this dissertation further specifies these gaps in the context of sleep tracking. Finally, three research gaps emerged that motivated this dissertation. Figure 1 illustrates the overview of research gaps ranging from self-tracking to sleep

tracking. This refinement strengthens the research motivation by linking general insights from self-tracking to the particular characteristics of sleep tracking.

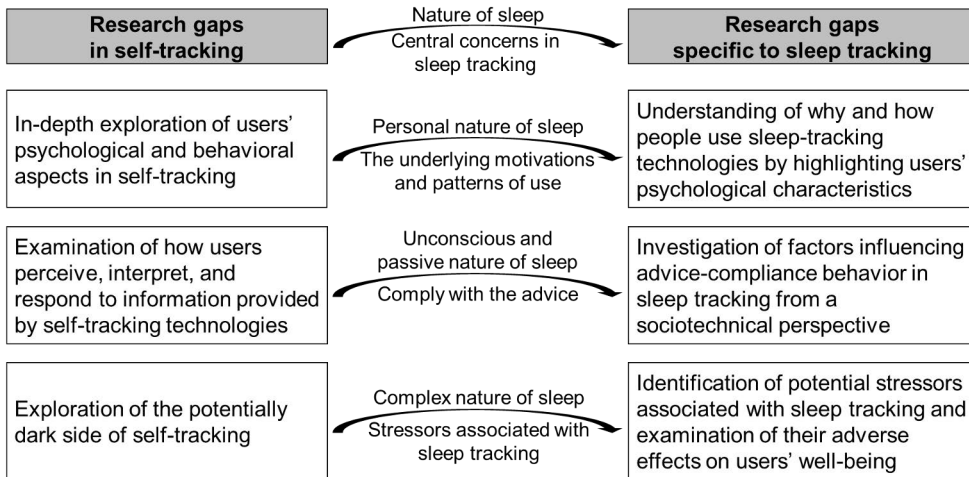


Figure 1. Overview of research gaps from self-tracking to sleep tracking

First, numerous studies on self-tracking have examined the factors influencing users' cognition, emotion, and behavior from individual and technological perspectives. From a user perspective, prior research has demonstrated that factors such as motivation (Shin & Biocca, 2017; Suh, 2018), user goals (James et al., 2022), perceived benefits and risks of use (Chuah, 2019), and psychological barriers (Javdan et al., 2023) impact the use of self-tracking technologies. From a technological perspective, technology-related factors, such as technical features (James et al., 2019; K. Rönkkö, 2018) and functionalities (J. Hu & He, 2020; Huang & Ren, 2020), have been found to contribute to behavioral change through the use of self-tracking technologies. In the context of sleep tracking, prior studies have explored usage behavior (Attie & Meyer-Waarden, 2023; Leblanc et al., 2022), continuance intentions (Kaitz et al., 2023), and compliance with sleep-tracking technologies (Matsangas et al., 2024; Nolasco et al., 2023).

However, current research has not yet fully captured the multifaceted nature of the self-tracking phenomenon, underscoring the need for a deeper exploration of users' psychological and behavioral aspects vis-à-vis self-tracking. In particular, in the context of sleep tracking, the underlying motivations and patterns of use remain underexplored. Moreover, given that sleep and sleep tracking are highly individualistic activities (Liu et al., 2015; Lyall, 2021), people may derive different experiences from the same sleep-tracking practices owing to their unique characteristics. The personal nature of sleep makes the research on sleep-tracking

motivations and use patterns more critical and complex. Future research should investigate people's diverse experiences with sleep-tracking technology to better understand why and how people use this technology. Thus, it is essential to highlight users' psychological characteristics, such as need satisfaction and frustration, when addressing why and how people use sleep-tracking technologies.

Second, self-tracking technology provides users with various types of information, including biophysiological and performance data, interpretive insights regarding their performance, and feedback or advice to promote health. Previous research has conceptualized a four-stage process to describe how users respond to their performance data, including review, react, reflect, and respond (Constantiou et al., 2023). Prior research has also demonstrated that feedback from these technologies significantly influenced users' sustained use of fitness technology (Soltani, Tuunanen, et al., 2024), while compliance with this feedback critically determined the outcomes of long-term use (Agyei et al., 2023; Dadgar & Joshi, 2018).

However, given the critical role of users' responses, dedicated research is required to explore how people perceive, interpret, and respond to the information that the self-tracking technology provides. Owing to the unconscious and passive nature of sleep (Ravichandran et al., 2017), users' compliance with the advice generated by sleep-tracking technologies is essential for achieving improvements in sleep quality and overall health. Additionally, prior research has suggested that complying with the advice provided by self-tracking technologies can facilitate sustained use (Dadgar & Joshi, 2018) and contribute to achieving the desired health outcomes (Agyei et al., 2023). Although compliance has been examined in sleep-tracking research, it has primarily been measured in terms of wearing rates (Matsangas et al., 2024; Nolasco et al., 2023). Thus, there remains a pressing need for research to explore the factors influencing advice-compliance behavior from a sociotechnical perspective in the context of sleep tracking.

Third, given the extensive body of research exploring the dark side of information technology (IT) (e.g., Califf & Sarker, 2020; Maier et al., 2015; Tarafdar et al., 2013), self-tracking technologies may pose similar risks. The existing studies have identified stressors associated with wearable devices, including strains related to users' emotions, cognition, and behavior, as well as users' coping mechanisms (Rieder, Vuckic, et al., 2020). Dependence on self-tracking technology has been observed, particularly in gamified activity tracking, with variations across individuals (Attig & Franke, 2019). In the context of sleep tracking, prior research has suggested that the effectiveness of sleep-tracking technologies in improving sleep is not as high as expected (S. Zhang et al., 2019), and some users have expressed doubts about their efficacy (Quante et al., 2019). In some cases, sleep-

tracking technologies have been reported to induce stress, frustration, and anxiety (Baron et al., 2017; Kuosmanen, Visuri, Kheirinejad, et al., 2022).

However, most research on sleep tracking has explored the challenges and barriers of sleep-tracking technologies (Liang & Ploderer, 2016, 2020; W. Liu et al., 2015; Ravichandran et al., 2017), which may act as potential stressors leading to adverse outcomes. The dark side of sleep tracking, particularly the stressors associated with sleep-tracking technologies, is complex because sleep is intertwined with multiple aspects of contextual and lifestyle factors (Buysse et al., 1989; Shochat, 2012). Building on the complex nature of sleep, it is necessary to identify the potential stressors associated with sleep tracking from a comprehensive perspective and to examine their adverse effects on users' well-being.

1.3 Research questions

To address the gaps in the existing research and gain a deeper understanding of the sleep-tracking phenomenon, this dissertation explores how people engage with sleep-tracking technology in their daily lives. Accordingly, the main RQ is as follows: *How do people engage with sleep-tracking technology?*

Engagement conceptualizes the integration of user and technology attributes to explain how their interaction moves technology use beyond mere functionality, resulting in pleasurable user experiences (O'Brien & Toms, 2008). In the context of self-tracking, engagement with self-tracking technology refers to users' interactions with both the technology and the performance data that it generates (Constantiou et al., 2023). Instead of highlighting users' characteristics or perceptions of technology, the engagement perspective focuses on the interaction between users and technology (Constantiou et al., 2023).

This dissertation examines users' engagement with sleep-tracking technology by focusing on the interaction between users and the technology. To provide a more nuanced analysis, this dissertation investigates the main RQ through three foundational and interrelated aspects: (1) why and how people use sleep-tracking technology; (2) users' post-adoption behavior: reactions to the information provided by sleep-tracking technology, particularly advice-compliance behavior; and (3) users' negative experiences: sleep-tracking stressors and health anxiety. The following sub-RQs reflect these three aspects:

Sub-RQ1: Why and how do people use sleep-tracking technology?

Sub-RQ2: How do configurations of technology affordances and psychological outcomes influence advice-compliance behavior in sleep tracking?

Sub-RQ3: What are the potential stressors associated with sleep tracking, and how do they impact health anxiety?

1.4 Positioning of the articles

This dissertation comprises six articles, of which five have been published and one has been submitted for review. Specifically, two journal papers (Articles I and VI) and three conference papers (Articles II, IV, and V) have been published. The remaining article (Article III) has been submitted for journal review.

The role of each article in relation to the sub-RQs and the overall dissertation is illustrated in Figure 2. Article I clarifies the current state of research on self-tracking and the quantified self, thereby helping to determine the overall research direction of this dissertation. Based on the insights gained from this initial review, this dissertation narrows its focus to sleep tracking, which is further explored through the three key aspects outlined earlier. Articles II–V are empirical studies that collectively address three sub-RQs. Specifically, Article II focuses on sub-RQ1, Article III on sub-RQ2, and Articles IV and V on sub-RQ3. Finally, Article VI comprises an integrative literature review on sleep tracking, synthesizing insights from the existing body of sleep-tracking research and proposing future research agendas in this field.



Figure 2. The contribution of each publication to the dissertation

To provide a more granular analysis of the RQs, each article outlines specific guiding questions. Table 1 presents the underlying six articles and summarizes the RQ(s) of each article.

Table 1. The underlying six articles and the research question(s) in each article

Research questions in the dissertation		Article	The research question(s) in the article
Systematic literature review		Article I	What is the current state of research on self-tracking and the quantified self in the domain of health and well-being?
Empirical studies	Sub-RQ1: Why and how do people use sleep-tracking technology?	Article II	(1) What basic physiological needs satisfaction and frustration do users experience when sleep tracking with a smart ring? (2) How do the features of a sleep-tracking smart ring afford user behaviors and influence needs satisfaction and frustration?
	Sub-RQ2: How do configurations of technology affordances and psychological outcomes influence advice-compliance behavior in sleep tracking?	Article III	(1) What are the technology affordances of sleep-tracking technology, and what psychological outcomes emerge from its use? (2) How do different configurations of technology affordances and psychological outcomes contribute to high and low levels of advice-compliance behavior?
	Sub-RQ3: What are the potential stressors associated with sleep tracking, and how do they impact health anxiety?	Article IV	What potential stressors do users attribute to sleep tracking executed through a smart ring?
Article V		(1) What are the valid measurement scales for stressors? (2) What is the association between stressors of sleep tracking and health anxiety?	
Integrative literature review		Article VI	(1) What is the current state of research on sleep tracking from a human-computer interaction perspective? (2) What are the key agendas for future investigation?

Article I presents a systematic literature review (SLR) that establishes a foundational understanding of self-tracking and the quantified self in the domain of health and well-being. This article categorizes the existing literature into three stakeholder clusters: end users, patients and people with illnesses, and healthcare professionals and caregivers. It then synthesizes the main research themes within each cluster. Finally, the review identifies several gaps and proposes directions for future research on self-tracking. Guided by the current state of self-tracking research and recognizing the growing importance of sleep tracking, this dissertation narrows its focus specifically to sleep tracking and identifies three distinct research gaps within this emerging field. Based on these gaps, the main RQ and three sub-RQs are defined.

Article II draws on interviews with 38 Oura ring users to explore users’ experiences of satisfying and frustrating their basic psychological needs, as outlined

in self-determination theory (SDT; Ryan & Deci, 2017a). The needs–affordances–features (NAF) perspective (Karahanna et al., 2018) is employed to theorize how specific features of sleep-tracking smart rings afford user behaviors and influence needs satisfaction and frustration. By mapping the relationships between user needs, technology affordances, and features, this article elucidates why and how people use sleep-tracking smart rings. The findings have practical implications for improving the design of features and guiding users in the more effective use of these technologies.

Article III employs a mixed-methods approach, combining interviews with 38 Oura ring users and a survey of 324 general sleep-tracking users. This study examines how configurations of technology affordances and psychological outcomes influence users' advice-compliance behavior. Affordance refers to the potential actions that arise from the relationship between users and technology (Strong et al., 2014; Volkoff & Strong, 2017). The qualitative study in this article identifies the four technology affordances of sleep tracking and the three psychological outcomes that emerge from its use. The quantitative study then expands its scope to cover general sleep-tracking technology, revealing several configurations of technology affordances and psychological outcomes that contribute to high and low levels of advice-compliance behavior through a survey. The findings contribute to a deeper understanding of the factors that influence users' compliance with advice and provide suggestions for designers.

Articles IV and V constitute a set of related papers. Article IV analyzes interviews with 38 Oura ring users to identify potential stressors associated with sleep tracking. Adopting the person–technology (P–T) fit model (Ayyagari et al., 2011), this study interprets these stressors by examining the misfits and gaps between individuals' values and abilities and technologies' supplies and demands (i.e., what they provide and require). Building on Article IV, Article V develops measurement instruments for sleep-tracking stressors and investigates their impact on health anxiety through a questionnaire survey with 324 sleep-tracking users. Together, Articles IV and V clarify the potential sleep-tracking stressors, establish measurement items for quantifying them, and examine their impact on health anxiety.

The final article, Article VI, presents an integrative literature review (ILR) that summarizes the existing research on sleep tracking. Guided by the human–computer interaction (HCI) framework (Zhang & Li, 2005), this article provides an integrated understanding of the research on sleep tracking and summarizes the future research directions proposed by the literature. By integrating the insights from Article VI with the findings of this dissertation, this dissertation offers agendas for future research in this field. The overall conceptual research framework, as shown in Figure 3, outlines the key components and relationships that structure this dissertation.

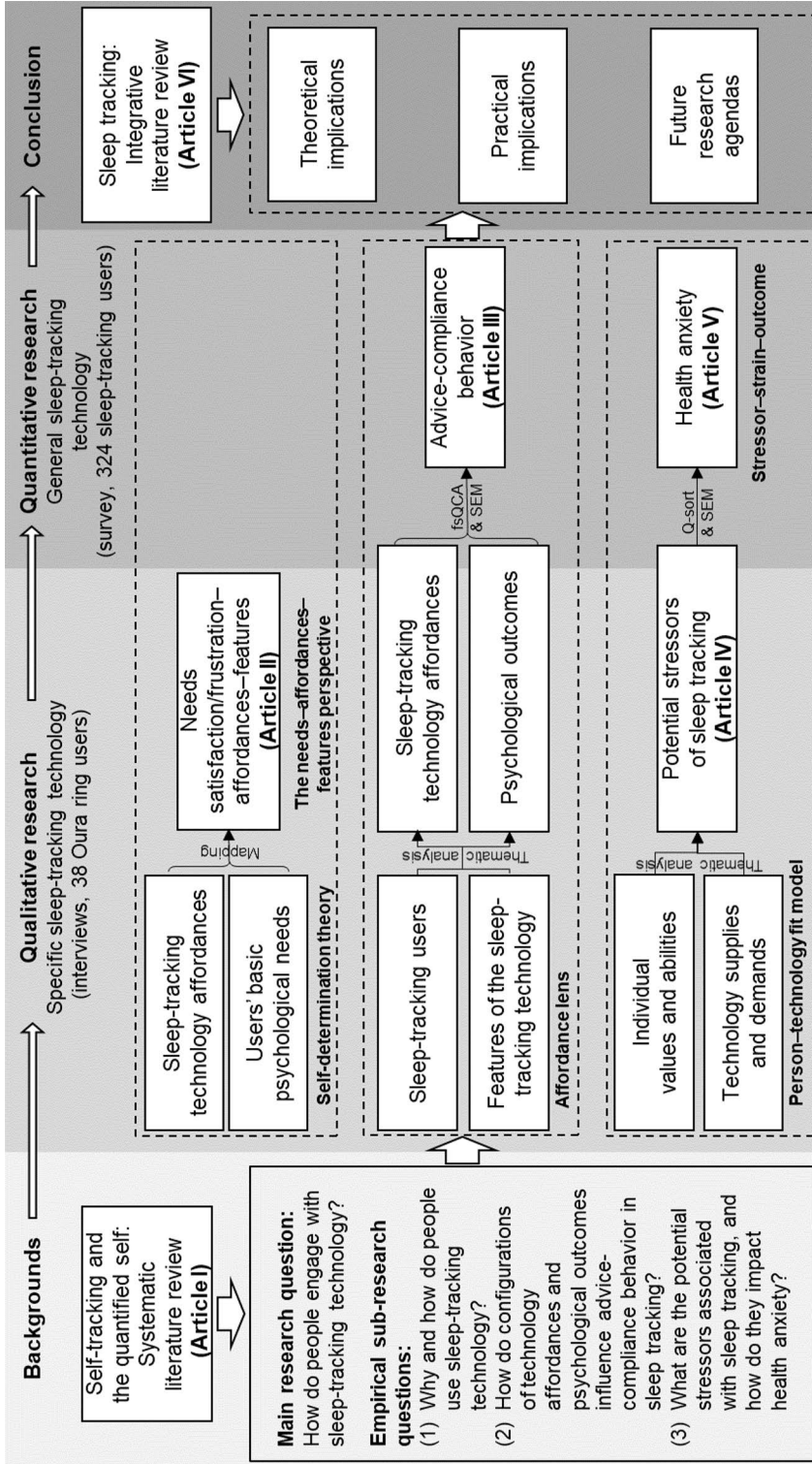


Figure 3. The overall conceptual research framework

1.5 Structure of the dissertation

This dissertation consists of seven chapters. Chapter 1 provides a brief introduction to the research background, identifies research gaps and motivation, outlines the RQs, explains the relationship between the included articles, and presents an overview of the dissertation's structure.

Chapter 2 reviews prior research on self-tracking and sleep tracking. This chapter begins by defining and delineating the scope of both concepts, followed by a comprehensive review of the antecedents and consequences associated with self-tracking and sleep tracking.

Chapter 3 presents the theoretical background of this dissertation. This chapter first introduces the sociotechnical perspective as the basis for selecting theories, followed by a detailed discussion of the theoretical lenses employed in each article. Each theory is introduced through its foundational concepts, relevant prior research, and the justification for its application within this dissertation.

Chapter 4 outlines the methodology of this dissertation. A mixed-methods design was employed to address the RQs in this dissertation. Following the discussion of the philosophical underpinnings, this chapter details the literature review and the mixed-methods process, including data collection and data analysis. Finally, this chapter describes the validation procedures implemented to ensure the rigor and credibility of the study.

Chapter 5 provides detailed summaries of each article (Articles I–VI). As this is an article-based dissertation, the findings of each article are presented individually. To facilitate understanding, this chapter introduces the significance of the research, the research methods, and the main findings of each article. In addition, the empirical research articles elaborate on the theoretical and practical implications of each article.

Chapter 6 synthesizes the findings from the six articles included in this dissertation to address the RQs. By integrating insights across the studies, this chapter provides a comprehensive understanding of the overall research on sleep tracking and answers the main RQ and the three sub-RQs in turn.

Chapter 7 discusses the theoretical and practical implications derived from the findings of the dissertation. Finally, this chapter identifies the limitations of this dissertation and proposes agendas for future research on sleep tracking.

2 Prior Research

Chapter 2 reviews prior research on self-tracking and sleep tracking. This chapter first introduces the definitions and scope of self-tracking (Section 2.1.1) and sleep tracking (Section 2.2.1), followed by a review of the existing research on their antecedents and consequences (Sections 2.1.2 and 2.2.2).

2.1 Self-tracking

2.1.1 Definition and scope

Self-tracking “involves practices in which people knowingly and purposively collect information about themselves, which they then review and consider applying in their lives” (Lupton, 2016). Several terms are commonly used to describe similar practices, including personal informatics, lifelogging, and the quantified self. Although these concepts are related, they differ in focus and emphasis. Personal informatics, a term commonly used in HCI research (Lupton, 2016), refers to a type of system that helps people collect and reflect on personal information (I. Li et al., 2010). In contrast, lifelogging refers to the practice of collecting personal information over time through wearable computing devices or other computerized and automated methods (Lupton, 2016). The purpose of lifelogging, unlike that of personal informatics, is not necessarily self-improvement. Lifelogging may serve simply as a means of documentation. Meanwhile, the quantified self, coined by Wolf and Kelly in 2007, refers to the digital self-tracking phenomenon or movements, highlighting the underlying ethos and apparatus that support such practices (Lupton, 2016).

Currently, self-tracking technologies have been developed to monitor a wide range of personal information (Lupton, 2016). These technologies track health-related data, such as fitness, weight, sleep, and diet, as well as other aspects of daily life, including social interactions, financial status, and household energy consumption. Moreover, self-tracking technologies are used in various contexts, including individuals’ daily lives, workplaces, and educational environments. Despite the diversity of self-tracking technologies, most are designed to support

users' health and well-being in their daily lives (e.g., Behne et al., 2020; Feng et al., 2021; Moya & Pallud, 2017).

Alongside the rapid development of self-tracking technologies, research interest in this area has grown significantly. Prior research has examined self-tracking practices across a range of health-related domains, such as physical activity (Lin et al., 2024; Zhou et al., 2022), stress (Lentferink et al., 2022), diet (Zečević et al., 2021), menstrual cycle (Hong et al., 2024), and weight loss (Lehto & Oinas-Kukkonen, 2015). This body of research highlights the expanding role of self-tracking in personal health management and behavioral interventions. To date, research has accumulated valuable insights into the antecedents and consequences of self-tracking (e.g., Attig & Franke, 2019; James et al., 2022; Rockmann & Gewald, 2019; Suh, 2018).

2.1.2 Antecedents and consequences of self-tracking

This dissertation synthesizes prior research on the antecedents and consequences of self-tracking into five categories: user engagement, use, continued use, impacts on health and well-being, and the dark side of self-tracking.

(1) *User engagement in self-tracking.* Several studies have examined user engagement by exploring factors that influence user experience (Wannheden et al., 2021), data-related practices (Constantiou et al., 2023; Ivanov et al., 2015), dependency (Attig & Franke, 2019), and compliance with self-tracking technologies (e.g., Agyei et al., 2023; Rieder et al., 2021; Wittkowski et al., 2020). Prior research has suggested that technology affordances can fulfill users' basic psychological needs and then influence engagement with fitness-tracking technologies (Zhou et al., 2022). Complementing the view of user needs, user experiences with healthcare self-monitoring tools have been elaborated across four spheres through needs satisfaction and frustration experiences, including interface, task, behavior, and life (Wannheden et al., 2021).

Regarding data-related practices, users respond to their performance data through a four-stage process: review, react, reflect, and respond (Constantiou et al., 2023). Users also share their tracked health records with others, and this sharing behavior is influenced by factors such as health motivation, perceived health status, severity, and age (Ivanov et al., 2015). Notably, users may also develop dependency on wearable activity-tracking technologies. Prior research has suggested that individuals with high intrinsic motivation regarding physical activity show lower dependency (Attig & Franke, 2019).

Compliance has attracted increasing research attention owing to its critical role in determining the outcomes of long-term tracking (Ekpezue et al., 2023). Compliance generally refers to "the target acting in accordance with an influence attempt from

the source” (Payan & McFarland, 2005, p. 72). Compliance changes, as defined by Oinas-Kukkonen (2013), emphasize momentary behavioral changes in response to behavior change support systems. In the context of wearable activity-tracking technologies, the actualized affordances can trigger changes in compliance, particularly among users who seek personal insights (Rieder, Lehrer, et al., 2020). Moreover, the self-efficacy and contexts of wearable technology use also influence users’ compliance behavior (Rieder et al., 2021).

Prior research has also highlighted compliance behavior, whereby users take action in accordance with technological interventions and cues. For instance, the use of wearable technology has been shown to enhance compliance with physician-prescribed therapy measures (Wittkowski et al., 2020). Moreover, compliance behavior can support sustained self-management activities among patients using information and communication technologies (ICTs) (Dadgar & Joshi, 2018) and contribute to achieving goals, such as losing weight, when compliance is maintained with intervention tasks from a weight loss app (Agyei et al., 2023). To capture compliance in practice, some metrics have been applied to quantify compliance with technology, such as data collection rate (the transmission of data to a wearable device) (Mekhael et al., 2023), overall usage rate (Chung et al., 2019), and wearing rate (Hartman et al., 2018).

(2) *Use of self-tracking technology.* The use of self-tracking technology has been discussed in prior research (Abouzahra & Ghasemaghaei, 2022; James et al., 2022; Rockmann & Gewald, 2019). Prior research has identified several factors that influence the self-tracking use of technology, including user needs (James et al., 2022; Soltani, Tuunanen, et al., 2024) and user goals (Abouzahra & Ghasemaghaei, 2022; James et al., 2022; Rockmann & Gewald, 2019). Previous research has suggested that users’ psychological, interpersonal, and physical goals influence their usage behavior through the satisfaction and frustration of basic psychological needs (James et al., 2022). Moreover, previous research has reported that users’ mastery and performance goals in the fitness app context influence their use of motivational affordances, such as self-monitoring, exercise guidance, rewards, and social comparison (Rockmann & Gewald, 2019). Similarly, an affordance network has been proposed to explain the effective use of activity wearable devices by achieving three key goals: activity improvement, activity planning, and activity monitoring (Abouzahra & Ghasemaghaei, 2022).

(3) *Continued use of self-tracking technology.* A growing body of research has emphasized the importance of the continuance intention to use (e.g., Bélanger et al., 2021; Chuah, 2019; Tsai et al., 2022) and continued use (e.g., Beldad & Hegner, 2018; Huang & Ren, 2020; Paré et al., 2018) of self-tracking technologies. Prior research has suggested that the perceived benefits positively influence the intention to continue using self-tracking technologies (Bélanger et al., 2021; Chuah, 2019).

Perceived utility and hedonic value can directly impact continuance intention (Tsai et al., 2022) or indirectly influence continuance intention through users' gratification (Shin & Biocca, 2017), inspiration (Chuah, 2019), and well-being (Chuah, 2019). Moreover, the effects of motivation and user needs on continued usage have also been explored (James et al., 2022; Suh, 2018). For instance, research has found that utilitarian and eudaimonic motivations have a positive influence on the intention to continue using quantified-self technology, while hedonic motivation shows no significant effect (Suh, 2018). The satisfaction of basic psychological needs, including autonomy, competence, and relatedness, has been shown to significantly influence continuance intention in the context of fitness technologies, whereas need frustration negatively affects it (James et al., 2022). Research focusing on competence needs has indicated that competence satisfaction has a positive influence on continuance intention to use fitness apps (Rockmann, 2019).

To better understand how users persist with self-tracking technologies, prior research has examined factors influencing continuance use (e.g., Beldad & Hegner, 2018; Huang & Ren, 2020; Paré et al., 2018), habitual use (Stragier et al., 2016), and sustained use (Soltani, Tuunanen, et al., 2024; A. K. C. Wong et al., 2024). Studies have demonstrated that user perceptions are positively associated with continued use of self-tracking technologies, including user satisfaction (Madhumitha & Lekshmi, 2022; Paré et al., 2018), perceived ease of use (Beldad & Hegner, 2018; Huang & Ren, 2020; Paré et al., 2018), perceived usefulness (Beldad & Hegner, 2018; Cho et al., 2020; Huang & Ren, 2020; Jaana & Paré, 2020; Paré et al., 2018), and perceived enjoyment (Huang & Ren, 2020). In an online fitness community, habitual usage behaviors are often driven by users' self-regulatory motivation, social motivation, and perceived usefulness (Stragier et al., 2016). Previous research has found that factors such as motivational feedback, satisfied needs, and frustrated needs are associated with sustained usage (Soltani, Tuunanen, et al., 2024). Among special user groups, such as older adults, support from technology, health experts, peers, and family can promote the sustained use of wearable monitoring devices (A. K. C. Wong et al., 2024).

(4) *Impacts on health and well-being.* Recent studies have examined the impact of self-tracking technology on health and well-being (e.g., Hong et al., 2024; James et al., 2022; Ravichandran et al., 2017). In particular, prior research has reported that self-tracking technologies can enhance users' health consciousness (Hong et al., 2024; Ravichandran et al., 2017; Stiglbauer et al., 2019) and lead to positive psychological outcomes (James et al., 2019, 2022). Specifically, self-tracking technologies enable users to gain a better understanding of their health status (Hong et al., 2024; Ravichandran et al., 2017) and increase their health awareness (Stiglbauer et al., 2019). Increased health awareness is important because health consciousness serves as a key determinant in maintaining health-related behaviors

(Shin & Biocca, 2017). Beyond health awareness, self-tracking technologies have also been linked to subjective vitality—a positive feeling of aliveness and energy (James et al., 2019, 2022). In the fitness-tracking context, the satisfaction of basic psychological needs (James et al., 2022) and intrinsic and extrinsic motivation to exercise (James et al., 2019) positively influence users' subjective vitality.

Prior research has also examined the effects of using self-tracking technologies on health-related behaviors. Features such as feedback (Hermsen et al., 2016; K. Rönkkö, 2018), data sharing (K. Rönkkö, 2018), and rewards (Plangger et al., 2022) have a positive influence on users' lifestyle changes. In the activity-tracking context, wearable devices potentially enhance physical activity levels (e.g., Brickwood et al., 2019; Hartman et al., 2018; Maher et al., 2017; Razon et al., 2019), while gamified design elements strongly stimulate behavioral change outcomes, such as higher step counts (Grech et al., 2024). Similarly, the experiences of pleasure and enthusiasm while using mobile fitness apps have been reported to positively impact users' fitness intentions (Xu et al., 2023).

Beyond health-related behaviors, self-tracking technologies have a positive impact on users' health and well-being (Giddens et al., 2017; Gimpel et al., 2021; Razon et al., 2019). Enhancements of autonomy affordance and goal performance have a positive influence on users' subjective well-being (Gimpel et al., 2021), while the breadth of feature use can also positively impact users' well-being (Giddens et al., 2017). Moreover, survey evidence revealed that the majority of respondents (63.5%) reported a positive impact of Fitbit on their health (Razon et al., 2019).

(5) *The dark side of self-tracking.* Self-tracking is not without its drawbacks. Several dark sides have been identified in prior research (Dhir et al., 2024; Kari et al., 2016; Rieder, Vuckic, et al., 2020). Technostress caused by wearable technologies can lead to emotional, cognitive, and behavioral strains (Rieder, Vuckic, et al., 2020). These strains stem from technological issues, including inaccuracy, unreliability, complexity, and inflexibility, as well as concerns related to transparency and evaluation, such as over-transparency, overdependence, and discrepancies between feelings and data (Rieder, Vuckic, et al., 2020). Critical negative experiences, such as difficulty of use, unreliable data, lack of improvement, and unclear goals, can directly result in technology rejection (Kari et al., 2016). Moreover, prior research has reported multiple pathways leading to the discontinuance of wearables, showing how various contextual factors and critical incidents combined to influence users' decisions to stop using these technologies (Dhir et al., 2024).

Currently, wearable devices face high rates of abandonment and discontinuance, accompanied by different barriers and challenges. From the technological perspective, issues related to inaccuracy (Attig & Franke, 2020; Harrison et al., 2015; Hong et al., 2024; Javdan et al., 2023), data uselessness (Attig & Franke, 2020,

2023), and aesthetics (Harrison et al., 2015) have been identified as key factors contributing to discontinued use. On the user side, the barriers and challenges include forgetting to update or follow the technology (Hong et al., 2024), feelings of enslavement to wearable devices (Javdan et al., 2023), lack of technological literacy (Hong et al., 2024; A. K. C. Wong et al., 2024), and forgetfulness issues, particularly among older adults (A. K. C. Wong et al., 2024).

2.2 Sleep tracking

2.2.1 Definition and scope

Drawing on Lupton's (2016) definition of self-tracking, sleep tracking can be defined as the practice of using technological tools to monitor, record, and measure an individual's sleep (Feng et al., 2022). Sleep-tracking technology enables users to manage their sleep by leveraging quantified sleep and health data to identify factors that positively or negatively influence their sleep and to provide personalized recommendations for improvement.

Unlike fitness tracking, which is a focus research area in the context of self-tracking, sleep tracking possesses several distinctive characteristics. First, sleep is an unconscious and passive behavior (Ravichandran et al., 2017), making it fundamentally different from physical activities that users can intentionally control. Second, owing to its complex nature, sleep is entangled with numerous factors, such as the external environment, daily-use technologies, and users' lifestyles (Shochat, 2012). The above two characteristics contribute to a third: sleep patterns cannot be tracked manually (Ravichandran et al., 2017). Instead, they can be inferred only from biological signals, such as heart rate, heart rate variability, or movement (Liang & Ploderer, 2020). Fourth, individuals have limited control over their sleep. They cannot consciously decide when to fall asleep or how to improve their sleep quality in the moment. This limited control stands in contrast to fitness tracking, where individuals are able to choose when, how, and how much to exercise. Finally, the relationship between users and sleep-tracking technology tends to be more interdependent than with fitness-tracking technology. While users may become less reliant on fitness-tracking technology as they automatically improve their activity or form a habit (Attig & Franke, 2020), sleep-tracking users often remain dependent on the technology for objective measurements and personalized recommendations.

Various disciplines are currently examining sleep tracking (e.g., Berryhill et al., 2020; Gamel & Talaat, 2024; Kuosmanen, Visuri, Kheirinejad, et al., 2022). For instance, medical studies have examined the validity and accuracy of sleep-tracking technologies by comparing them with diagnostic tools such as PSG (e.g., Berryhill et al., 2020; Tuominen et al., 2019). Meanwhile, studies in computer and engineering

have focused on designing new technologies and algorithms for sleep detection and enhancement (e.g., Gamel & Talaat, 2024; Han et al., 2024). Research in the fields of HCI and IS has focused on the human aspects of interacting with sleep-tracking technologies, examining how these interactions influence users' behaviors and health outcomes (e.g., Kuosmanen, Visuri, Kheirinejad, et al., 2022; Liang & Ploderer, 2016). Although this body of research has provided valuable insights, a deeper understanding of how sleep-tracking technologies are used and their impact on users' daily lives remains necessary.

2.2.2 Antecedents and consequences of sleep tracking

This dissertation synthesizes prior research on the antecedents and consequences of sleep tracking into four categories: user engagement, use and continued use, impacts on health and well-being, and the dark side of sleep tracking.

(1) *User engagement in sleep tracking.* Prior research has explored user engagement with sleep-tracking technologies (Aji et al., 2022; Kuosmanen, Visuri, Kheirinejad, et al., 2022). For example, previous research has shown that integrating wearable devices with digital behavioral therapy for insomnia enhances user engagement compared to digital therapy alone (Aji et al., 2022). A survey also examined user engagement and classified participants as either daily or rare users based on how frequently they self-reported their sleep in applications, with nearly 80% being identified as daily users (Kuosmanen, Visuri, Kheirinejad, et al., 2022).

Prior research has also explored user compliance with sleep-tracking technologies, with most studies focusing on long-term compliance with wearable devices in real-world settings. For example, a study conducted among military personnel demonstrated a decreasing trend in compliance with Oura rings over 210 days, with the higher-ranking individuals exhibiting better compliance than the subordinate military members (Matsangas et al., 2024). In contrast, a month-long study calculated an adherence score based on users' non-wear time and usage distribution, finding that the participants maintained a high participation rate and contributed sufficient data for meaningful analysis (Nolasco et al., 2023).

(2) *Use and continued use of sleep-tracking technology.* Although prior research has primarily examined usage behaviors in the broader context of self-tracking, studies specifically examining sleep tracking remain limited. Several studies have begun to explore usage behaviors vis-à-vis sleep-tracking technologies. Previous research has found that perceived usefulness and perceived ease of use positively influence the intention to use and real use of sleep-tracking applications (Attie & Meyer-Waarden, 2023). Furthermore, four dimensions of usability have been shown to impact users' intention to use personal sleep monitoring devices: performance expectancy, effort expectancy, social influence, and facilitating conditions (Leblanc

et al., 2022). In addition, individuals with chronic insomnia expressed a willingness to continue using sleep health ITs owing to their acceptability, ease of use, and usefulness (Kaitz et al., 2023).

(3) *Impacts on health and well-being.* Similar to broader research on self-tracking, recent studies have examined the influence of sleep tracking on health and well-being. Specifically, current research has explored how sleep-tracking technologies impact users' health-related cognition and behavior. For example, prior research has shown that sleep-tracking users can develop a greater awareness of their sleep patterns (Griffiths et al., 2022; Karasneh et al., 2022; Liang & Ploderer, 2016) and improve their sleep hygiene (Karasneh et al., 2022; Ravichandran et al., 2017). These technologies also support a better understanding of common sleep misconceptions (Ojalvo et al., 2023) and the potential causes of poor sleep (Lau & Carney, 2025).

Building on this increased awareness, behavioral change has emerged as a key outcome associated with the use of sleep-tracking technology. Prior research has found that sleep-tracking technology can positively influence users to proactively change their behavior to improve sleep quality (Griffiths et al., 2022; Kuosmanen, Visuri, Kheirinejad, et al., 2022; Ravichandran et al., 2017). These technologies promote the adoption of healthy sleep hygiene practices and discourage behaviors that negatively affect sleep. For example, sleep-tracking users may reduce screen time before bed (Griffiths et al., 2022), establish a fixed sleep routine (Kuosmanen, Visuri, Kheirinejad, et al., 2022), avoid eating late and consuming too much caffeine or alcohol (Griffiths et al., 2022; Kuosmanen, Visuri, Kheirinejad, et al., 2022), increase activity level (Griffiths et al., 2022; Kuosmanen, Visuri, Kheirinejad, et al., 2022), and manage sleep disorders or related chronic conditions (Ravichandran et al., 2017). In addition, prior research has suggested that the perceived usefulness of mobile health apps for sleep tracking has a positive influence on real use, which in turn impacts users' perceived well-being (Attie & Meyer-Waarden, 2023). Ultimately, when effectively adopted, these behavioral changes can contribute to improving users' health and well-being.

(4) *The dark side of sleep tracking.* Despite these positive impacts on health and well-being, the dark side of sleep tracking has been recognized in prior research (Griffiths et al., 2022; Jahrami et al., 2024; Kuosmanen, Visuri, Kheirinejad, et al., 2022; Nagele & Hough, 2024). Tracking one's sleep may lead to stress and physical discomfort, particularly when users receive negative feedback, engage in competition with others, and experience discrepancies between the tracked data and their own perceptions (Kuosmanen, Visuri, Kheirinejad, et al., 2022). Similarly, an autoethnographic study reported that data-perception discrepancy can induce frustration, while competitive elements may also contribute to stress and further negatively affect sleep perception (Nagele & Hough, 2024). Moreover, several cases

of orthosomnia have been identified in a clinical setting (Baron et al., 2017). Individuals experiencing orthosomnia become preoccupied with improving or perfecting their sleep data from wearable devices, which can, in turn, lead to a worsening of their sleep quality. Based on the diagnostic criteria for identifying orthosomnia, prior research has reported a rising prevalence of this condition among users of sleep-tracking technology (Jahrami et al., 2024).

Although the body of research on the dark side of sleep tracking is still being developed, the existing studies have identified a range of barriers and challenges that underscore its potential negative impacts. Users' sleep may remain unimproved owing to the various limitations inherent in sleep-tracking technologies. These include technical issues related to batteries, sleep detection, data loss, and data export (Kuosmanen, Visuri, Risto, et al., 2022; W. Liu et al., 2015); the inability to identify the underlying causes of sleep problems (Liang & Ploderer, 2016); a lack of actionable recommendations for improvement (Liang & Ploderer, 2016); limited support for data interpretation (W. Liu et al., 2015); and opaque sleep algorithms (Liang & Ploderer, 2020). In addition, user-related factors may hinder the effectiveness of sleep-tracking technology. These include insufficient knowledge about sleep (Liang & Ploderer, 2016, 2020), difficulties maintaining consistent tracking behaviors (W. Liu et al., 2015), low levels of trust in the technology (W. Liu et al., 2015), challenges in managing and interpreting the data (W. Liu et al., 2015), inconsistency between data and perception (Ravichandran et al., 2017), and overemphasis on sleep stages (Ravichandran et al., 2017).

3 Theoretical Background

Chapter 3 introduces the theoretical background of this dissertation. This chapter begins by outlining the basis for selecting the theories (Section 3.1). Subsequently, this chapter introduces and discusses the theoretical lenses applied in each empirical article (Sections 3.2–3.4).

3.1 Sociotechnical perspective as the basis for selecting theories

The sociotechnical perspective (Bostrom & Heinen, 1977) provides the overarching lens for this dissertation and serves as the basis for selecting theories to explore sleep tracking. The sociotechnical perspective (Bostrom & Heinen, 1977) views a system as comprising two independent yet interacting components: the social and the technical. The social component involves individual attributes, interpersonal relationships, and authority structures, while the technical component encompasses technology, tasks, and processes (Bostrom & Heinen, 1977). Crucially, the outcomes of the system were determined by both social and technical components, with neither deserving a privileged position (Beath et al., 2013). Building on this foundation, this dissertation employs multiple theories that align with the sociotechnical perspective. Each theory contributes to understanding specific topics of sleep tracking, focusing on the interplay between users and technologies in this context while also bringing new insights into the overall sociotechnical perspective.

Three factors support the adoption of the sociotechnical perspective as the basis for selecting theories in sleep-tracking research. First, the sociotechnical perspective offers a holistic view to explore sleep tracking by integrating both social and technical perspectives rather than isolating one side from the other. Second, sleep is an inherently personal activity (Liu et al., 2015; Lyall, 2021) and is complex in relation to contextual and lifestyle factors (Buysse et al., 1989; Shochat, 2012). Meanwhile, sleep tracking as a form of self-tracking represents a voluntary and non-mandated activity that is initiated and maintained by users rather than enforced externally (Dhir et al., 2024). The characteristics of sleep and sleep tracking underscore the need for selected theories that capture both social and technical components, as emphasized by the sociotechnical perspective. Finally, within the IS

research, the sociotechnical perspective aligns closely with the foundational principle of IS research, emphasizing the necessity of considering both human and technological components in research on IT-enabled change (Beath et al., 2013). Accordingly, the sociotechnical perspective provides a strong theoretical foundation for understanding sleep tracking within the IS field. Overall, the sociotechnical perspective is particularly well suited for examining user engagement with sleep-tracking technologies in IS research.

This dissertation employs five theories across Articles II–V to address the RQs from both the social and technical perspectives. Specifically, Article II selected SDT (Ryan & Deci, 2017a) and the NAF perspective (Karahanna et al., 2018), which together emphasize the social component of user needs and the technical components of technological features. Article III adopted the affordance lens (Volkoff & Strong, 2017) to theorize wearable technology affordances, which arise from the relationships between goal-oriented users and technical features. Article IV employed the P–T fit model (Ayyagari et al., 2011) to identify the potential sleep-tracking stressors arising from the misfits or gaps between users and sleep-tracking technologies. Building on this, Article V applies the stress–strain–outcome (SSO) (Koeske & Koeske, 1993) to further investigate the impact of these identified stressors on health anxiety. Table 2 presents the alignment of these theories with the sociotechnical perspective (Bostrom & Heinen, 1977).

Table 2. Alignment of theories with the sociotechnical perspective

Article	Theory	How they fit with the sociotechnical perspective
Article II	Self-determination theory	Focuses on the social component, specifically users' basic psychological needs.
	Needs–affordances–features perspective	Bridges the social and technical components by showing how technological features enable affordances that satisfy individual needs.
Article III	Affordance lens	Integrates the social and technical components by using the affordance, which arises from the relationships between goal-oriented users and technical features (Volkoff & Strong, 2017).
Article IV	Person–technology fit model	Explores stressors by identifying the misfits or gaps between the social component (users' abilities and values) and the technical component (technological demands and supplies).
Article V	Stressor–strain–outcome	Further examines the impact of stressors (the misfits or gaps between users and technologies) based on the findings of Article IV.

3.2 Self-determination theory

SDT is a well-established psychological theory that offers a comprehensive account of human motivation and personality, emphasizing the evolving inner resources that support personality development and behavioral self-regulation (Ryan & Deci, 2000). SDT defines needs as “innate psychological nutriments that are essential for ongoing psychological growth, integrity, and well-being (Deci & Ryan, 2000, p. 229).” SDT is a meta-theory comprising six mini-theories, each with a distinct emphasis on motivation and psychological integration (Ryan & Deci, 2017b). The basic psychological needs theory is one of the mini-theories within SDT, focusing on three basic psychological needs (autonomy, competence, and relatedness) and concerning how the satisfaction and frustration of these needs relate to well-being and ill-being (Ryan & Deci, 2017a).

Within the basic psychological needs theory, autonomy refers to the need to self-regulate one’s experiences and behaviors, reflecting a sense of initiative and ownership over one’s actions (Ryan & Deci, 2017, 2020). In contrast, autonomy frustration arises when individuals feel pressured or controlled by either external forces or internal demands (Chen et al., 2015). Competence is a psychological need that refers to a feeling of mastery or a sense of being able to succeed and grow (Ryan & Deci, 2020). When this need is thwarted, competence frustration emerges, characterized by feelings of failure and doubts about one’s efficacy (Chen et al., 2015). Relatedness, the third core psychological need, involves feelings connected to others and experiencing a sense of belonging (Ryan & Deci, 2020). Relatedness frustration, conversely, refers to experiences of social exclusion, isolation, or loneliness (Chen et al., 2015). In summary, the basic psychological needs theory emphasizes that fulfilling basic psychological needs is vital to fostering development, integrity, and well-being. Conversely, when these needs are thwarted, leading to need frustration, individuals are more likely to experience increased ill-being and diminished functioning (Ryan & Deci, 2017a).

Prior research has examined the satisfaction and frustration of three basic psychological needs in the context of self-tracking (e.g., James et al., 2022; Soltani, Honigsberg, et al., 2024; Wannheden et al., 2021). Previous research has shown that users’ goals of using fitness technology can influence needs satisfaction and frustration (James et al., 2022). Moreover, the feedback provided by fitness-tracking technology has been linked to the satisfaction or frustration of specific needs (Soltani, Tuunanen, et al., 2024). When the effects of user needs on adoption and post-adoption behavior have been explored, need satisfaction has been found to positively influence subjective vitality and the intention to continue using fitness technology (James et al., 2022). In contrast, need frustration has the opposite effect (James et al., 2022). However, some studies have reported that no significant relationship exists between needs satisfaction and the sustained usage of fitness technology, and

unexpectedly, there is a positive effect of frustration of competence and relatedness on sustained usage (Soltani, Tuunanen, et al., 2024). This discrepancy may reflect the fact that the experience of need satisfaction and frustration can vary across individuals, depending on time, context, and social interaction (Ryan & Deci, 2017a). Supporting this view, evidence from digital health research has demonstrated that the same self-tracking experiences may evoke both need satisfaction and frustration owing to individual differences (Wannheden et al., 2021). Nonetheless, needs satisfaction and frustration are not static, and prolonged tracking often leads to decreased need satisfaction (Kerner & Goodyear, 2017).

The SDT is appropriate for exploring why people use sleep-tracking smart rings. In contrast to Maslow's hierarchy of needs (1943), which conceptualizes human needs hierarchy levels and primarily focuses on need satisfaction, the SDT offers a more dynamic and explanatory perspective of human motivation. First, as a psychological theory, SDT focuses on the nature, structure, and functioning of individuals in action (Ryan & Deci, 2017b), making it well suited to explaining user behaviors in the context of sleep-tracking technology. Second, including both need satisfaction and frustration allows for a more nuanced understanding of the sleep-tracking phenomenon, particularly given the inherently complex nature of sleep. Third, SDT emphasizes that needs satisfaction and frustration can differ across individuals, depending on temporal, contextual, and social factors (Ryan & Deci, 2017a), which is valuable for capturing the diverse experiences of users.

3.3 Affordance theory

The concept of affordance originates from ecological psychologist James J. Gibson (1979), who defined affordances as “what [the environment] offers the animal, what it provides or furnishes, either for good or ill (p. 127).” Norman (2002) introduced affordances into the field of HCI, defining them as “the perceived and actual properties of the thing, primarily those fundamental properties that determine just how the thing could possibly be used” (p. 9). Although Norman emphasized the perceived and actual properties of objects, independent of the actor, Gibson's original concept highlighted that affordances arise from the relationship between the object and the actor.

3.3.1 Affordance lens

IS researchers have mainly followed Gibson's affordance theory to study technology use from a sociotechnical perspective (e.g., Benbunan-Fich, 2019; Markus & Silver, 2008; Strong et al., 2014). In this context, affordances are defined as “the potential for behaviors associated with achieving an immediate concrete outcome and arising

from the relation between an artifact and a goal-oriented actor or actors” (Volkoff & Strong, 2017, p. 4). IS researchers have emphasized that affordances can be determined by both features of technical objects and the characteristics of the actor(s) engaging with them (Markus & Silver, 2008). Thus, affordance theory (Volkoff & Strong, 2017) provides a sociotechnical perspective from which to understand the sleep-tracking phenomenon in this dissertation.

Building on the affordance theoretical framework proposed by Bernhard et al. (2013), recent review studies have synthesized IS affordance into four key dimensions: affordance existence, affordance perceptions, affordance actualization, and affordance effects. These dimensions correspond to the cognitive process, recognition process, behavior, and immediate concrete outcomes of technology use (Pedrola et al., 2023; Pozzi et al., 2014; H. Wang et al., 2018). In the context of self-tracking, recent research on affordance has focused on identifying the existence of affordances that are relevant to these technologies (e.g., Benbunan-Fich, 2019; Elmholdt et al., 2021; Rockmann & Maier, 2019; Suh, 2018). An affordance network has been developed to show how different affordances support various goals (Abouzahra & Ghasemaghahi, 2022). Research has examined how perceived informational and motivational affordances shape users’ engagement with Fitbit activity-tracking devices (Jarrahi et al., 2018). Further studies have highlighted the role of actualized affordance in the context of self-tracking (Gimpel et al., 2021; Rieder, Lehrer, et al., 2020). Regarding affordance effects, most prior research has examined the impact of affordances on users’ intention to use and behavior (A. Li et al., 2024; Ma et al., 2023; Rieder, Lehrer, et al., 2020; Suh, 2018; J. Zhang & Lowry, 2016). It is important to recognize that no single set of affordances applies to all technologies. New affordances are needed to adapt to evolving technologies (Jarrahi et al., 2018; Markus & Silver, 2008).

This dissertation employs the affordance lens to theorize the aggregated dimension of the technology affordances of sleep-tracking technologies. Unlike the user-centric theories, such as the technology acceptance model (Davis, 1985), which primarily emphasize the users’ perceptions and intentions, or technology-centric theories, such as the task–technology fit theory (Goodhue & Thompson, 1995), which focus on technology and task characteristics, the affordance lens is valuable for capturing action possibilities and interactions. Specifically, first, the affordance lens emphasizes the relational role of affordances, which helps explain the interaction between users and sleep-tracking technology. Second, the affordances shift the focus from what the technology has (e.g., the features) to what it enables users to do, thereby emphasizing the active role of users during the interaction process. Third, the affordance lens provides a novel perspective for further research on the outcomes of users’ interactions with sleep-tracking technology, such as the effects of the combination of affordances.

3.3.2 Needs–affordances–features perspective

The NAF perspective, developed by Karahanna et al. (2018), provides a framework for understanding users' engagement with technology. Karahanna et al. (2018) mapped psychological needs to affordances and features, explaining how users' needs motivate their use of technology while the features of the technology enable affordances that can satisfy these needs. Figure 4 illustrates the logic of the NAF perspective. In their study, Karahanna et al. (2018) focused specifically on social media. They drew on SDT (Deci & Ryan, 1985, 2000) and psychological ownership theory (Pierce et al., 1991) to identify psychological needs within this context. The corresponding social media affordances were identified through a comprehensive literature review.

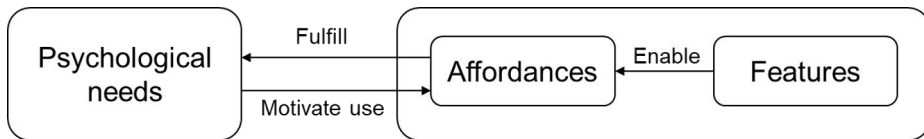


Figure 4. The logic of the needs–affordances–features perspective (Karahanna et al., 2018)

Karahanna et al. (2018) encouraged researchers to apply the NAF perspective to various types of technologies, exploring how different affordances may fulfill diverse psychological needs. Echoing this call, subsequent studies have applied the NAF perspective in different contexts. At the individual level, relevant studies encompass research on online social networks (Vaghefi et al., 2023; Xiao et al., 2025), online knowledge communities (Jiao et al., 2021), and social media (Kishore et al., 2022). At the organizational level, prior studies have examined the use of business intelligence tools (Abhari et al., 2020) and the use of technology for open decision-making (Pan et al., 2024). The NAF perspective has also been adopted to understand the use of AI-enabled technologies, such as the metaverse (Zuo & Shen, 2024), educational virtual reality (Adžgauskaitė et al., 2020), and technology anthropomorphism (Zheng & Jarvenpaa, 2021). Most studies have used the NAF perspective to map psychological needs, affordances, and features identified through qualitative interviews and to understand the use of specific technology (e.g., Pan et al., 2024; Vaghefi et al., 2023; Zuo & Shen, 2024). Other studies have employed the NAF framework to develop research models and empirically evaluate the relationships between these variables (Jiao et al., 2021; Xiao et al., 2025). Overall, the NAF perspective has provided a comprehensive view to capture the relationship among users' psychological needs, affordances, and features, thereby enabling a deeper understanding of user experience across different technologies.

This dissertation employed the NAF perspective to map users' basic psychological needs and sleep-tracking technology affordances, thereby enabling an understanding of how people use sleep-tracking smart rings. The NAF perspective offers particular value for several reasons. First, it focuses on basic psychological needs and provides a foundation for explaining the underlying mechanisms that drive user engagement with sleep-tracking technology. Second, by emphasizing technology affordances, the NAF provides a more useful and flexible perspective for interpreting features (Karahanna et al., 2018). Affordances can be actualized through various features, making them more reflective of real-life usage scenarios, wherein users may rely on different features to achieve similar goals.

3.4 Theories of stress

Stress is commonly understood as “a state of worry or mental tension caused by a difficult situation” (World Health Organization, 2023). With the rapid advancement of technology, increasing attention has been paid to technology-induced stress, commonly referred to as technostress. Craig Brod, a clinical psychologist, defined technostress as “a modern disease of adaptation caused by an inability to cope with the new computer technologies in a healthy manner” (1984, p. 16). In the IS field, technostress is the stress experienced by “individuals due to the use of information and communication technologies” (Ragu-Nathan et al., 2008, p. 418).

Although technostress has been widely examined in organizational settings (e.g., Califf & Sarker, 2020; Maier et al., 2019), it is also increasingly recognized as a relevant issue in individual technology use contexts (e.g., Benlian et al., 2020; Rieder, Vuckic, et al., 2020; Weinert et al., 2015). However, limited research has investigated technostress in the context of self-tracking, especially in relation to sleep tracking. Previous research has identified several barriers and challenges associated with the use of sleep-tracking technology, such as perceived difficulty in adopting sleep hygiene recommendations, the mismatch between score and user perception, and the lack of accuracy (e.g., Liang & Ploderer, 2016; Quante et al., 2019; Ravichandran et al., 2017). These findings provide a valuable foundation for exploring technostress in the context of sleep tracking. Although a few recent studies have begun to address this topic (Kuosmanen, Visuri, Kheirinejad, et al., 2022; Nagele & Hough, 2024), research in this area remains limited.

To gain a deeper understanding of the technostress associated with sleep-tracking technology, this dissertation employs two stress theories to explore stressors in the context of sleep tracking: the P–T fit model (Ayyagari et al., 2011) and the SSO framework (Koeske & Koeske, 1993).

3.4.1 Person–technology fit model

Drawing on the person–environment fit model of stress (Edwards et al., 1998), Ayyagari et al. (2011) extended it to the technological environment and proposed the P–T fit model, as shown in Figure 5. This model explains stress as arising from a misfit or gap between an individual and their technological environment (Ayyagari et al., 2011). The P–T fit model consists of two main dimensions for evaluating stress: abilities–demands (A–D) and supplies–values (S–V). The A–D dimension reflects that stressors may arise from a misfit or gap between the demands imposed by the technology and the individual’s abilities (such as skills, knowledge, time, and energy) (Ayyagari et al., 2011; Edwards, 1996; Edwards et al., 1998). In contrast, the S–V dimension evaluates stress by capturing a misfit or gap between what the technology supplies and the individual’s values (preferences, interests, and goals) (Ayyagari et al., 2011; Edwards, 1996; Edwards et al., 1998).

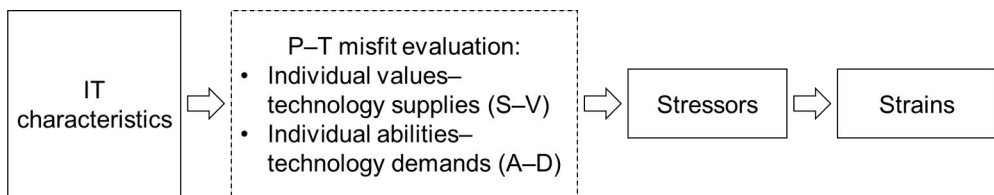


Figure 5. Person–technology fit model (Ayyagari et al., 2011)

Prior research has employed the P–T fit model to identify stresses by evaluating the discrepancy between person and technology across the aforementioned dimensions. For example, Ayyagari et al. (2011) identified several stressors by examining P–T misfits in the context of ICTs, while Al-Fudail and Mellar (2008) applied the model to identify stressors in the context of technology-supported teaching. Building on the relationship between IT characteristics, stressors, and strains within the P–T fit model, previous researchers have employed qualitative methods to explore distinct patterns of stressors in social networking services (SNSs) (Salo et al., 2019) and to explain work outcomes (e.g., work exhaustion) among software professionals (Tomer & Kumar, 2023). In addition, this model has been applied in quantitative research to support the building of research models in various technological contexts, including ICTs (Ayyagari et al., 2011), smart home assistants (Benlian et al., 2020), students’ academic use of mobile devices (Qi, 2019), and excessive mobile app texting (Al-Abdullatif et al., 2020). The P–T fit has also been conceptualized as a variable influencing the experience of stress (Tarafdar et al., 2023). Overall, researchers have broadly adopted the P–T fit model in stress-related research.

The P–T fit model is a well-suited approach to exploring the stressors associated with sleep-tracking technology. First, it identifies stressors from both the individual and technological perspectives, offering a comprehensive view of user–technology interaction. The P–T fit model aligns with the transactional model of stress and coping, which conceptualizes stress as emerging from the interaction between environmental stimuli and individual appraisal (Lazarus, 1966; Lazarus & Folkman, 1984). Second, whereas the transactional model of stress and coping (Lazarus, 1966; Lazarus & Folkman, 1984) emphasizes cognitive appraisal and coping processes in response to stress, the P–T fit model offers clearer criteria for identifying stress through its two key dimensions: abilities–demands and supplies–values.

3.4.2 Stressor–strain–outcome framework

The SSO framework, proposed by Koeske and Koeske (1993), uses three components to illustrate the process of stress. In the SSO framework, stressors refer to “environmental stimuli (objective events) that are perceived and interpreted by the actor as troublesome and potentially disruptive” (Koeske & Koeske, 1993, p. 111). The stressors then lead to strain, which disrupts the individual’s concentration, physiology, and emotions. Over time, the strain can produce a prolonged impact on behavior and psychology, which are referred to as outcomes.

The SSO framework has been widely applied in IS research on stress, particularly in the context of SNS (e.g., Fakhfakh & Bouaziz, 2023; Fu et al., 2020; Guo et al., 2020). Prior studies have shown that stressors arising from SNS can lead to psychological strain, such as exhaustion (Fu et al., 2020; Yu et al., 2018) and fatigue (Dhir et al., 2019; Guo et al., 2020; Pang, 2021). The strain that results from the stressors, in turn, influences various user behaviors and emotional responses, including discontinuance behavior (Fakhfakh & Bouaziz, 2023; Fu et al., 2020), avoidance behavior (Guo et al., 2020), and social anxiety (Pang, 2021). This strain has also been linked to reduced performance outcomes, affecting, for example, job performance (Fakhfakh & Bouaziz, 2023; Yu et al., 2018) and academic performance (Dhir et al., 2019). Beyond the SNS context, the SSO framework has been adopted in other technology contexts, such as intelligent customer service in pharmaceutical e-commerce (Jia et al., 2025); generative AI, such as ChatGPT (Duong et al., 2025); and compulsory e-education (V. Lee et al., 2022). Collectively, prior studies have highlighted the explanatory power of the SSO framework in capturing the psychological and behavioral outcomes of technology-induced stress.

Compared to theories of stress, such as the transactional model of stress and coping (Lazarus, 1966; Lazarus & Folkman, 1984) and the P–T fit theory (Ayyagari et al., 2011), the SSO framework provides a robust theoretical basis for explaining the causal relationships through which potential stressors lead to users’ strain and,

subsequently, to their behavioral and emotional outcomes. By offering a structured lens to link stressors with their outcomes, the SSO framework serves as a strong foundation for developing the research model and theorizing the pathways through which sleep-tracking stressors contribute to health-related outcomes, such as health anxiety.

4 Methodology

Chapter 4 mainly introduces the methodological approach adopted in this dissertation. First, this chapter discusses the philosophical underpinnings that inform the research design (Section 4.1). Next, this chapter describes the research methods employed in each article, including two types of literature reviews (Section 4.2) and the mixed-methods approach used in the empirical studies (Section 4.3). Finally, this chapter presents the validation strategies applied in the studies to ensure the rigor and credibility of the research (Section 4.4).

4.1 Philosophical underpinnings

Research philosophy refers to “a system of beliefs and assumptions about the development of knowledge” (Saunders et al., 2023). The core of research philosophy is the paradigm, which represents a specific combination of these assumptions that offers a coherent stance on knowledge and the nature of the world. Kuhn (1970) described paradigms as universally recognized scientific achievements that provide model problems and solutions to a community of practitioners over time (p. viii). In the context of social science, Mingers (2001) defined a paradigm as a construct that encompasses a set of assumptions covering ontology, epistemology, axiology, and methodology. In particular, ontology concerns the nature of reality, epistemology refers to the nature of knowledge, axiology addresses the role of the values and ethics underlying the research process, and methodology outlines the principles and procedures guiding how research is conducted (Mingers, 2001; Saunders et al., 2023; Venkatesh et al., 2023).

Building on Chua’s (1986) framework of assumptions in social science research, Orlikowski and Baroud (1991) classified the research paradigms in IS research into positivism, interpretivism, and critical realism, with each reflecting a distinct set of ontological, epistemological, axiological, and methodological assumptions. Positivism is commonly linked to quantitative research, while interpretivism is associated with qualitative research (Johnson & Gray, 2010). However, a heated debate emerged around the so-called “incompatibility thesis” (e.g., Goles & Hirschheim, 2000; Howe, 1988; Smith & Heshusius, 1986; Weber, 2004), which argues that research paradigms such as positivism and interpretivism are

fundamentally opposed and cannot be mixed. Nevertheless, more recent scholars have shifted beyond the paradigm incompatibility debate toward paradigm pluralism, viewing multiple paradigmatic perspectives as coexisting within a field (e.g., Landry & Banville, 1992; Teddlie & Tashakkori, 2010; Venkatesh et al., 2023). In the IS field, pragmatism has been proposed as an alternative paradigmatic stance that encourages a more balanced stream of research (Goles & Hirschheim, 2000) and constructs a bridge between conflicting paradigms (Wicks & Freeman, 1998).

With the growing discussion on paradigm pluralism (e.g., Landry & Banville, 1992; Teddlie & Tashakkori, 2010; Venkatesh et al., 2023), IS researchers tend to adopt various paradigms. Consequently, mixed-methods research often draws upon multiple paradigms to explore complex RQs. In relation to mixed-methods research, two primary paradigmatic stances guide mixed-methods research: the alternative paradigm stance and the dialectic stance. The alternative paradigm advocates for using a single paradigm to provide a philosophical underpinning for mixed-methods research, including pragmatism, critical realism, and transformative emancipatory (Greene & Hall, 2010; Teddlie & Tashakkori, 2010; Venkatesh et al., 2023). In contrast, dialectical stance researchers embrace the intentional use of multiple paradigms in a single inquiry, thereby gaining deeper insights through their dialectical thinking (Teddlie & Tashakkori, 2010; Venkatesh et al., 2023).

This dissertation follows the alternative paradigm stance to guide the mixed-methods research. From the overall perspective, this dissertation adopts a pragmatic approach. Pragmatism is a philosophical tradition that originated around 1870 in the United States (Goles & Hirschheim, 2000) and is grounded in Charles Sanders Peirce's pragmatic maxim: "Consider what effects, which might conceivably have practical bearings, we conceive the object of our conception to have. Then, our conception of these effects is the whole of our conception of the object" (1878, p. 295). Pragmatists emphasize the principle of usefulness, focusing on producing designed and anticipated results by selecting the most appropriate philosophical or methodological approach for a given research problem while avoiding the use of metaphysical concepts (Goles & Hirschheim, 2000). In line with this view, pragmatist researchers recognize the coexistence of a single and multiple realities, whereby the single reality exists independently of our mind and multiple realities are constructed and reconstructed through social constructions (Venkatesh et al., 2023). Moreover, pragmatism emphasizes the centrality of RQs and highlights that the selected methods and paradigms should fit these questions (Teddlie & Tashakkori, 2010; Venkatesh et al., 2013, 2023). Thus, pragmatism research is a problem-solving and action-focused inquiry process (Greene & Hall, 2010).

The selection of the study design of this dissertation is consistent with one of the pragmatists' assumptions: Pragmatism rejects the notion of forced incompatibility between research paradigms (Venkatesh et al., 2023). Informed by pragmatism, this

dissertation employs a mixed-methods approach, drawing on assumptions from both positivism and interpretivism to better address the RQs. The qualitative interviews focus primarily on identifying the relevant factors associated with the three sub-RQs. Through users' self-reported experiences, this study explores how they interact with sleep-tracking technology in their daily lives. This qualitative study is guided by the interpretivist assumption that reality is socially constructed. Users may develop different understandings of sleep tracking based on their unique contexts and experiences. Building on the findings of the qualitative study, the subsequent quantitative survey aims to examine the relationships between these factors and the key outcomes of interest. This study is grounded in the positivist assumption that an objective reality exists and can be observed and measured.

In line with the principle of pragmatism, this dissertation prioritizes the RQs over adherence to a single methodological tradition (Johnson & Onwuegbuzie, 2004; Venkatesh et al., 2013, 2023). This dissertation is structured around one main RQ to explore how people engage with sleep-tracking technology. To explore user engagement with sleep-tracking technology, this dissertation further unfolds the main RQ into three sub-RQs. These sub-RQs explore (1) why and how people use sleep-tracking technology; (2) users' post-adoption behavior, specifically advice-compliance behavior; and (3) users' negative experiences associated with sleep-tracking stressors and health anxiety. A single methodology is not sufficient to comprehensively address the main RQs and some of the sub-RQs. Therefore, this dissertation combines qualitative interviews with a quantitative survey to address the aforementioned RQs.

In addition, pragmatism enables researchers to select the method that is best suited to addressing their RQs (Morgan, 2007). Guided by the main RQs, this dissertation adopts a mixed-methods approach, combining qualitative interviews and a quantitative survey. First, this dissertation comprises a qualitative interview study involving 38 Oura ring users. The interview questions were related to sleep-tracking users' experiences. This study identifies users' experiences of needs satisfaction and frustration, technology affordances, psychological outcomes resulting from the use of sleep-tracking technology, and potential stressors associated with sleep tracking. Building on these qualitative insights, a quantitative survey study with a broader sample of general sleep-tracking users is conducted. This study examines the configurations of technology affordances and psychological outcomes in relation to advice-compliance behavior as well as the relationship between sleep-tracking stressors and health anxiety. Overall, this dissertation employed qualitative data to address sub-RQ1 and combined qualitative and quantitative data to answer sub-RQ2 and sub-RQ3.

Finally, pragmatists believe that research should be useful to people rather than relying on metaphysical concepts to accurately represent reality (Feilzer, 2010). By

synthesizing the findings from both qualitative and quantitative studies, this dissertation offers practical suggestions for sleep-tracking designers and users to enhance the functionality of these technologies and the effectiveness of their use. This approach is also consistent with the knowledge creation process in pragmatism research (Venkatesh et al., 2023). Figure 6 illustrates the pragmatist view of knowledge creation that guides this dissertation.

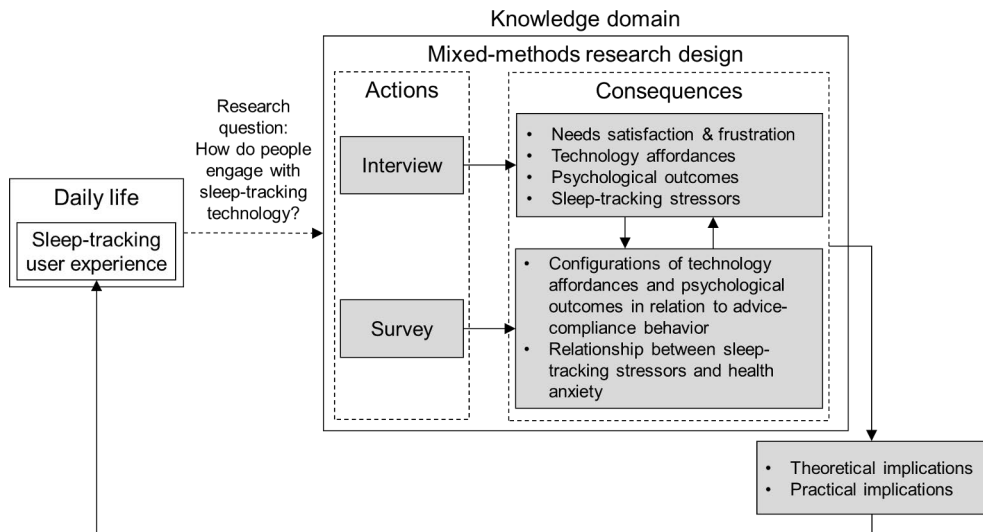


Figure 6. A pragmatist view of knowledge creation in this dissertation (adapted from Venkatesh et al., 2023)

4.2 Literature review

4.2.1 Choice of review type

Literature reviews play a vital role in academic research. According to Cooper (1988), a literature review serves three purposes: to (1) integrate previous studies to enhance generalizability, resolve conflict, or bridge the gap between theories or disciplines; (2) critically evaluate prior studies; and (3) identify central issues within the field. Similarly, Pare (2015) outlined four key purposes of a literature review: to (1) summarize prior knowledge, (2) aggregate or integrate data, (3) build an explanation, and (4) conduct a critical assessment. Notably, the classification of the literature review should not only emphasize the central foci (e.g., research outcomes, research methods, theories, and practices or applications) and goals of reviews (e.g., integration, criticism, and identification of central issues) but should also consider

the perspective of the reviewers, coverage of the review, organization of the review, and intended audience of the review (Cooper, 1988).

A variety of literature review types are available to serve different research purposes. The choice of literature review type mainly depends on the research goal. From a goal-oriented perspective, reviews can be grouped into three main categories: systematic, semi-systematic, and integrative (Snyder, 2019). A more fine-grained classification outlined nine review types: narrative, descriptive, scoping/mapping, meta-analysis, qualitative systematic, umbrella, theoretical, realist, and critical (Paré et al., 2015).

To determine the appropriate type of review, it is important to clarify the goals before initiating the review project (Paré & Kitsiou, 2020, p. 172). For instance, a narrative review is appropriate for summarizing a specific topic but does not aim to generalize or accumulate knowledge from the literature (Paré & Kitsiou, 2020). In contrast, an SLR is designed to aggregate, critique, and synthesize literature that fits predefined criteria, following a transparent and rigorous process (Paré & Kitsiou, 2020). Conversely, an ILR is appropriate for reviewing, critiquing, and synthesizing current knowledge in an integrated manner, such as through a model or conceptual framework, thereby enabling the development of new frameworks and perspectives (Torraco, 2005, 2016).

Each type of review is a unique vehicle for synthesizing existing knowledge. Cronin and George (2023) proposed a decision-making process that demonstrates the selection of a synthesized vehicle (i.e., review type), as shown in Figure 7. In Figure 7, adjudication refers to a way to organize knowledge by eliminating errors and establishing “settled science” on a given topic. In contrast, redirection refers to a way to organize knowledge by structuring existing knowledge to promote new and emerging research (Cronin & George, 2023). The term “community of practice” refers to discrete groups of researchers who study the same topics using different paradigms, conceptual languages, research traditions, and metatheoretical analyses (Cronin & George, 2023). While knowledge-synthesis vehicles can both adjudicate and redirect, one is typically selected as the primary objective of the review (Cronin & George, 2023).

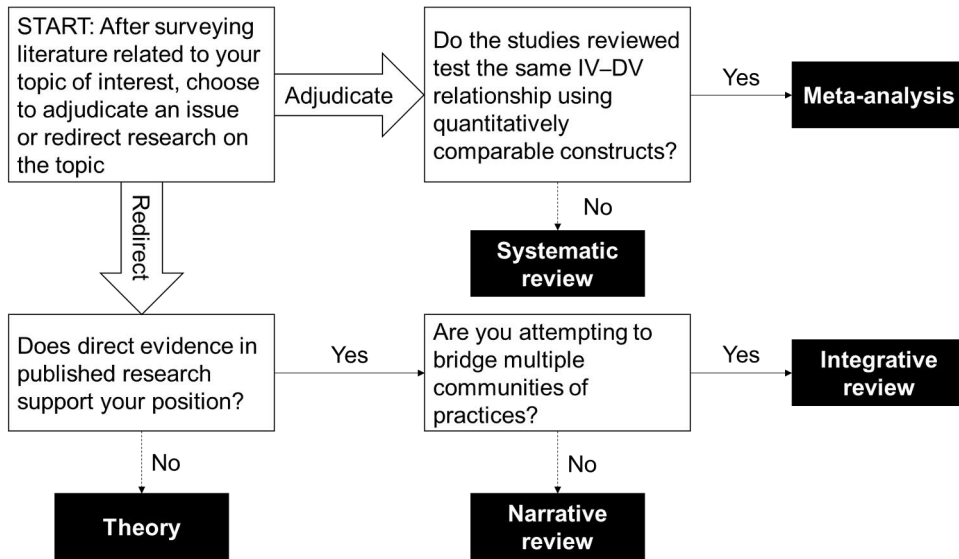


Figure 7. The choice of synthesis vehicle (Cronin & George, 2023)

This dissertation includes two literature reviews: an SLR in Article I and an ILR in Article VI. Article I aims to explore the current state of research on self-tracking and the quantified self in the domain of health and well-being. The purpose of this article is to adjudicate an issue by synthesizing existing findings and evaluating the literature to establish “settled science” on the topic of self-tracking and the quantified self. Moreover, the reviewed studies varied in their independent and dependent variables. Based on the choice of synthesis vehicle proposed by Cronin and George (2023), the SLR is a particularly well-suited synthesis vehicle for Article I. An SLR enables researchers to synthesize a large body of information, map out areas of uncertainty, and uncover gaps in the literature (Petticrew & Roberts, 2006). By following a systematic, transparent, and rigorous review process (Higgins & Green, 2008), the SLR also enhances the replicability and credibility of the findings (Tranfield et al., 2003).

Article VI aims to explore the current state of the research on sleep tracking and propose key agendas for future investigation. The purpose of this article is to redirect research by synthesizing knowledge on sleep tracking from a diverse set of literature to develop a model or framework and propose agendas for further inquiry. Based on the choice of synthesis vehicle (Cronin & George, 2023), the ILR is an appropriate method for Article VI. The ILR enables researchers to study a topic that spans multiple research designs and methodologies (Cronin & George, 2023). Guided by a model or conceptual framework, the ILR reviews, critiques, and synthesizes

existing findings into an integrative structure (Torraco, 2005, 2016), thereby generating new insights and identifying agendas for future research.

4.2.2 Systematic literature review

Article I followed a well-established eight-step review protocol (Okoli & Schabram, 2010) to conduct an SLR (see Figure 8). Eight steps were organized into three stages: planning the review, conducting the review, and reporting the review (Okoli & Schabram, 2010).

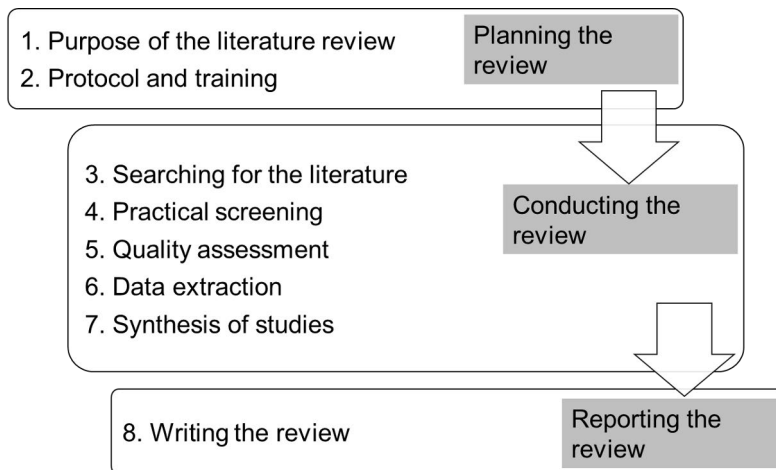


Figure 8. Systematic literature review process

The first stage comprises two steps: defining the purpose of the literature review and establishing the protocol and training. The purpose of this SLR is to identify the current state of the research on self-tracking and the quantified self in the domain of health and well-being. The second step involves establishing the protocol and conducting training. The reviewed articles were retrieved from five databases: Scopus, Web of Science (WoS), PubMed, Taylor & Francis, and the Association for Information Systems eLibrary (AIS eLibrary). For the search strategy, the following criteria were applied: (1) topics (title, abstract, and keywords) contain “self-track*,” “self track*,” “quantified self,” “quantified-self,” “self quantif*,” and “self-quantif*”; (2) journal and conference papers; and (3) English-language publications. Table 3 summarizes the inclusion and exclusion criteria, and Table 4 outlines the quality appraisal criteria.

Table 3. Inclusion and exclusion criteria used for the systematic literature review

Inclusion criteria		Exclusion criteria	
IC1	Studies with the main topic (title/abstract/keywords) containing self-tracking or the quantified self	EC1	Studies with matching titles and digital object identifiers
IC2	Studies published in a peer-reviewed journal or for a scientific conference	EC2	Studies whose main topic is not self-tracking or the quantified self (digitized self-tracking and self-quantification via mobile devices, apps, and platforms; ignore diary and video recordings)
IC3	Studies published in English	EC3	Studies for which the purpose of the paper is not improving health and well-being
IC4	Studies with title/keywords/abstract-based screening	EC4	Studies that are not empirical (literature reviews, conceptual papers, technical papers, or editorials)
IC5	Studies with full-text-based screening	EC5	Studies in which the primary empirical subjects are not human, such as products, services, or markets
IC6	Studies with humans as primary empirical research subjects	EC6	Studies based on quality assessment
IC7	Studies based on citation chaining	-	-

Table 4. Quality appraisal criteria used for the systematic literature review

Quality appraisal criteria	
1	The empirical study adopts a qualitative, quantitative, or mixed-methods approach. The possible answers are mixed-methods approach (+2) and quantitative or qualitative research (+1).
2	The study is a fully structured article divided into four basic sections: introduction, methods, results, and discussion. The answers are Yes (+1) and No (+0).
3	The study unequivocally describes the research process in sufficient detail. A quantitative study shows the questionnaire items, a qualitative study involves the coding and categorization process, and an experimental study provides the details of the experiment. The answers are Yes (+2), Partially (+1), and No (+0).
4	The study clearly documents the research implications (contributions or implications) and limitations. The answers are Yes (+2), Partially (+1), and No (+0).
5	The study was published in a reliable and recognized publication. (1) Based on Journal Citation Reports (JCR: an annual publication that provides information about academic journals with impact factor data.): journal in the top 25% (Q1 +1.5), in the 25%–50% group (Q2 +1), in the 50%–100% group (Q3 or Q4 +0.5), and no JCR ranking (+0). (2) Conference ranking based on CORE (conference ranking portal): CORE A* or A (+1.5), CORE B (+1), CORE C (+0.5), and no CORE ranking (+0).

The second stage involves conducting the review. Figure 9 shows the inclusion and exclusion procedure. The search was carried out in February 2020. Two authors in Article I conducted the review process, maintaining continuous communication

and exchanging information. Finally, 67 empirical studies were included in the final sample, with 42 journal papers and 25 conference papers.

The third stage involves reporting the review. To ensure a clear and logical classification, Article I employed the concept matrix (Webster & Watson, 2002). A classification scheme was developed to structure the current research on self-tracking and the quantified self in the domain of health and well-being.

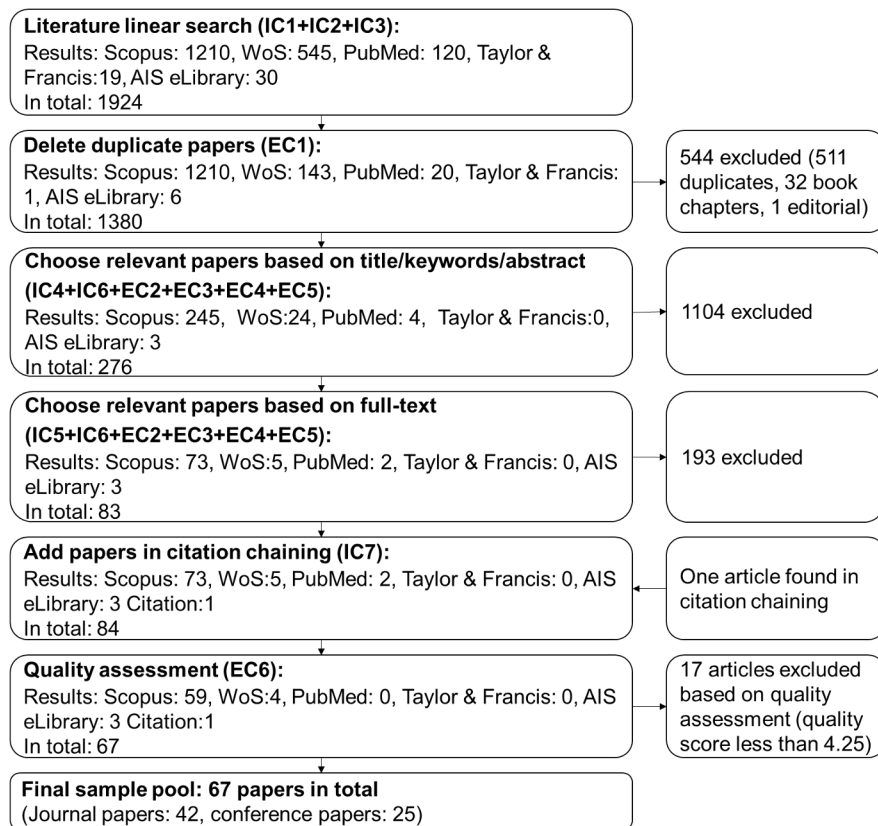


Figure 9. Inclusion and exclusion procedure for systematic literature review

4.2.3 Integrative literature review

Article VI followed Torracco's (2005, 2016) guideline, which provides a three-phase checklist for conducting an ILR: (1) prepare to write the integrative literature review, (2) organize the integrative literature review, and (3) compose the integrative literature review.

The first phase involves articulating the purpose of the ILR. This review focuses on users' interactions with sleep-tracking technology and aims to generate new

insights by exploring and synthesizing the state of the art. An ILR is well suited for this purpose, as it allows for the integration of knowledge from existing studies into a model or conceptual framework while also providing critical analysis that can generate new insights into this topic. To guide the analysis and synthesis of the research on sleep tracking, the HCI framework (Zhang & Li, 2005) was adopted for this review.

In the second phase, to ensure a rigorous review process, this article executed the article search process by following the steps of an SLR (Okoli, 2015; Snyder, 2019; Tranfield et al., 2003). The articles were obtained from five databases: Scopus, WoS, PsycINFO, AIS eLibrary, and the Association for Computing Machinery Digital Library (ACM Digital Library). The following criteria were applied for the search strategy: (1) topics (title, abstract, and keywords) contain “sleep track*,” “sleep monitor*,” “sleep sens*,” “sleep technolog*,” “sleep app*,” and “sleep device*,” (2) journal and conference papers, and (3) English-language publications. Table 5 presents the inclusion and exclusion criteria, while Table 6 outlines the quality appraisal criteria.

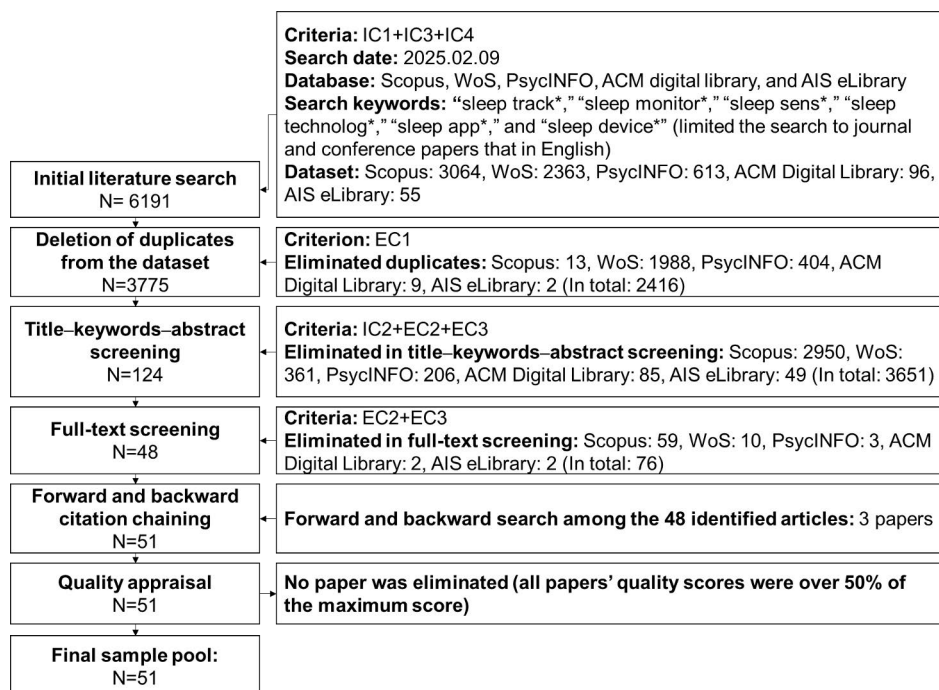
Table 5. Article selection and quality appraisal criteria for the integrative literature review

Inclusion criteria		Exclusion criteria	
IC1	The study is a full paper published in a scholarly journal or a conference with refereed practice.	EC1	It is duplicated.
IC2	The study contains empirical research.	EC2	The main topic (title/abstract/keywords) does not contain users' interactions with sleep-tracking technology (e.g., manual sleep tracking, sleep assessment, sleep therapy, and animal sleep tracking).
IC3	The main topic (title/abstract/keywords) contains one or more of the search terms “sleep track*,” “sleep monitor*,” “sleep sens*,” “sleep technolog*,” “sleep app*,” and “sleep device*.”	EC3	Studies in which the research subjects are not sleep-tracking users (excluded topics include sleep-tracking technology validation, accuracy assessment, design science about new technology, biomedical research, and so on).
IC4	The study is published in English.	-	-

Table 6. Quality appraisal criteria for the integrative literature review

Quality appraisal criteria	
1	The study is a fully structured article that includes four basic sections: introduction, methods, results, and discussion. The answers are Yes (+2) and No (+0).
2	The study describes the research process unequivocally and in sufficient detail. For example, a survey study reports the survey instrument, a qualitative study reports the coding and categorization process, and an experimental study reports the detailed procedures of the experiment. The answers are Yes (+2), Partially (+1), and No (+0).
3	The study was published in a reliable and recognized publication journal and conference: (1) Journal ranking based on JCR: Q1 (+2), Q2 (+1.5), Q3 (+1), Q4 (+0.5), and no JCR ranking (+0). (2) Conference ranking based on CORE: A* (+2), or A (+1.5), B (+1), C (+0.5), and no ranking (+0).

The search was conducted in February 2025. Two authors of Article VI carried out the review process and maintained an open discussion throughout. Figure 10 illustrates the article selection and review process for the ILR. A total of 51 empirical studies, comprising 33 journal articles and 18 conference papers, were included. Drawing on the five components of the HCI framework (Zhang & Li, 2005), this review extracted and organized current research on sleep tracking into a framework that focuses on user interactions with sleep-tracking technologies.

**Figure 10.** The article selection and review process for the integrative literature review

The final phase entailed composing the ILR. To clearly present the identified themes and their categorizations, the concept matrix (Webster & Watson, 2002) was employed. Based on the synthesizing framework for sleep tracking and the critical analysis of the findings, several future research agendas were proposed, considering both research design and research content.

4.3 Mixed-methods approach to empirical studies

4.3.1 Ethical considerations

This dissertation employed a mixed-methods approach, combining qualitative and quantitative research methods. As the research involves real people and collects their personal data and user experiences, it is crucial to evaluate potential ethical considerations carefully.

To ensure that the research processes were ethically robust, this dissertation implemented several measures to minimize potential physical, mental, economic, or social harm to participants. Ethical measures were applied throughout both the data collection and data management processes. The data collection process involved obtaining informed consent, using appropriate tools and platforms, and providing participants with compensation. The data management process involved secure data storage, the anonymization of identifiable information, and a clear definition of the data lifespan. Details are shown in Table 7.

Table 7. Ethics of data collection and data management

	Qualitative research	Quantitative research	
Data collection	<p>Semi-structured interview (Articles II–IV)</p> <p>(1) Informed consent: (a) Informed consent was prepared for informants. (b) Informants recruited from the Oura Facebook group signed an informed consent form; informants recruited from the authors' social networks were asked for their permission, which was obtained either verbally or via email. (c) Informants were provided with basic information about the study and agreed to participate in it. (d) Informants understood that they could withdraw their consent at any time.</p> <p>(2) Tools: Interviews were recorded using Zoom or an audio recorder. The interviews were transcribed using the Otter app and rechecked by the researcher.</p> <p>(3) Compensation: Informants recruited from the Finnish Oura Facebook group will receive a 20-euro S-group gift card as a voucher.</p>	<p>Q-sorting test (Articles III and V)</p> <p>(1) Informed consent: (a) Participants were provided with basic information about the study and agreed to participate. (b) Participants understood that they could withdraw their consent at any time.</p> <p>(2) Platform: This study used the Proven By Users platform (https://provenbyusers.com/) to design the Q-sorting test and collect data.</p>	<p>Survey questionnaires (Articles III and V)</p> <p>(1) Informed consent: (a) Participants were provided with basic information about the study and agreed to participate by responding to the first question in the questionnaire: "I have understood and will move forward to the survey. Yes/No". (b) Participants understood that they could withdraw their consent at any time.</p> <p>(2) Platform and tools: (a) This study used the Webropol electronic survey tool (https://webropol.fi/) to design the questionnaire. (b) Data were collected through the Prolific platform (https://www.prolific.com/), which supervised both participants and researchers.</p> <p>(3) Compensation: All participants were paid at a rate of 8.00 USD per hour for each task.</p>
	Data management	<p>(1) Data storage: The transcriptions were pseudonymized and archived confidentially on a university laptop and Google Drive.</p> <p>(2) Anonymization: Pseudonyms (code/number names) were assigned to informants and used in all research notes and documents.</p> <p>(3) Data lifespan: The records and transcriptions will be destroyed in six months, when the research ends.</p>	<p>(1) Data storage: The data were pseudonymized and archived confidentially on a university laptop.</p> <p>(2) Anonymization: The Q-sorting test was conducted anonymously.</p> <p>(3) Data lifespan: The records and transcriptions will be destroyed in six months, when the research ends.</p>

4.3.2 Data collection

(1) *Semi-structured interview*. The interview effectively captures the user experience in an authentic context (Turner et al., 2017). Additionally, the semi-structured interview incorporates predetermined questions while allowing opportunities for further exploration, enabling researchers to obtain both retrospective and real-time responses (Gioia et al., 2013). Given the personal (Liu et al., 2015; Lyall, 2021), unconscious (Ravichandran et al., 2017), passive (Ravichandran et al., 2017), and complex (Buysse et al., 1989; Shochat, 2012) nature of sleep, this dissertation employed semi-structured interviews to explore user experiences with sleep-tracking technology, focusing specifically on user needs, the affordances of sleep tracking, the psychological outcomes that emerge from its use, and the stressors associated with sleep tracking (Articles II, III, and IV).

The Oura ring users were selected as the object of the semi-structured interviews. The Oura ring is a wearable smart ring designed to provide a holistic picture of users' health, with a particular emphasis on sleep, readiness, and activity. The device was developed by Oura Health, a company founded in 2013 and headquartered in Finland. The selection of the Oura ring as the focus of these studies was based on several key considerations. First, the Oura ring is considered a valid device for sleep tracking. It provides accurate sleep-tracking data, with a 79% accuracy rate compared to the 83% accuracy of clinical PSG (Oura Team, 2022). Second, the Oura ring is well suited for sleep tracking owing to its unobtrusive and user-friendly design. Unlike many activity-tracking technologies that continuously increase activity goals once previous targets are met, the Oura ring offers personalized recommendations based on the user's daily activity levels and prior sleep patterns without imposing rigid or escalating goals. Third, several prior studies have selected the Oura ring as a research object in sleep-tracking studies (e.g., Koskimäki et al., 2018; Kuosmanen, Visuri, Kheirinejad, et al., 2022; Nagele & Hough, 2024), identifying it as one of the most suitable tools for long-term sleep tracking (Kuosmanen, Visuri, Kheirinejad, et al., 2022). Overall, owing to its reliability and user acceptance, the Oura ring is a strong candidate for sleep-tracking research.

Prior to the semi-structured interview being conducted, an interview protocol was developed. The protocol consisted of four main parts: (a) background questions, (b) use habits, (c) evaluation of the positive and negative sides of the ring, and (d) personal stories, experiences, and critical incidents. The details of the questions are provided in Appendix 1.

The semi-structured interviews were conducted online, via telephone, and face-to-face in April 2021 and September 2022. These time frames were selected to capture user experiences with the second and third generations of the Oura ring,

as the third generation was released in November 2021. The informants were recruited through the authors' networks and a Finnish Oura users' Facebook group. They were informed about the interview procedures and gave their consent to participate in the interview. All informants were required to have more than two weeks of use experience, as this is the minimum period for Oura to establish a baseline for insightful interpretation and guidance.

In total, 38 Oura ring users participated in the interviews, with those recruited from the Facebook group receiving a 20-euro gift card as compensation. The sample included 24 females and 14 males. Half of the informants fell within the age range of 25 to 44 years. Additionally, 86.84% of the informants had more than six months of experience using the Oura ring. Table 8 shows the informants' demographic information. Each interview lasted between 23 and 58 minutes and was audio-recorded with permission. Altogether, the interviews generated 1,393 minutes of voice recordings and 138,285 words of transcripts.

Table 8. Informants' demographic information

Item	Category	Frequency	Percent (%)
Gender	Female	24	63.16
	Male	14	36.84
Age	25–44	22	57.89
	45–65	13	34.21
	over 65	3	7.89
Education background	Master's/PhD degree	31	81.58
	Bachelor's degree	6	15.79
	Vocational education/polytechnic training	1	2.63
Employment	Employed	32	84.21
	Unemployed	1	2.63
	Student	1	2.63
	Entrepreneur/self-employed	2	5.26
	Retired	2	5.26
Length of use	Less than half a year	5	13.16
	0.5–1 year	11	28.95
	1–2 years	11	28.95
	2–4 years	8	21.05
	More than 4 years	3	7.89
Use with other self-tracking technologies	Yes	24	63.16
	No	14	36.84

(2) *Q-sorting approach*. To gain a deeper understanding of how sleep-tracking technology influences users' behavior and well-being, a survey was designed to explore these effects. Appropriate measurement items should be prepared for each construct. However, suitable measures are not always available in the existing literature. Therefore, for this dissertation, a Q-sorting test was conducted to develop and validate the measurement items for the new constructs.

This dissertation followed the three-stage Q-sorting exercise outlined by Moore and Benbasat (1991) to develop new measurement scales, including (a) item development, (b) Q-sorting, and (c) pilot testing. The sorting process was conducted using the Proven By Users platform. First, potential measurement items were developed for these new constructs based on insights from the interviews, the authors' firsthand user experiences with sleep-tracking technology, and their observation of sleep-tracking virtual groups on social media. In Article III, nine candidate items were developed to measure the affordance of triggering behavioral changes. In Article V, the identified stressors—data-perception discrepancy, pursuit of perfect data, and vague guidance—required new measurement items. In total, 12 candidate items for these three stressors were established.

The second stage was the sorting process, which involved two rounds. In the first round, the participants were asked to sort the listed items into groups based on their understanding and to define the groups. In the second round, the participants were asked to sort the items into predefined groups provided by the researchers. In Article III, eight participants took part in this Q-sorting process, with three in the first round and five in the second. In Article V, nine participants joined the two-round Q-sorting process, with four in the first round and five in the second. A diverse group of participants was selected to capture a broad range of perceptions, including IS PhD candidates, sleep-tracking users, senior IS researchers, and administration staff.

In the final stage of the Q-sorting exercise, a pilot test was conducted in March 2024 to evaluate the validity and reliability of the newly developed measurement items and the full questionnaire. For the pilot test, 63 sleep-tracking wearable users were recruited through the online research platform called Prolific. Among the participants, 46 were male, 84.13% were between the ages of 18 and 40, and 77.78% had been tracking their sleep for more than six months.

(3) *Survey*. The survey was employed for Articles III and V. To ensure data quality, this study applied three means: (a) screening participants with a high reputation on the Prolific platform, (b) conducting a screening survey before the main survey, and (c) including attention checks in the main questionnaire. First, participants with an approval rate of over 90% and fluency in English were invited to complete the screening survey. Second, only those who provided photographic proof of their primary wearable device were invited to participate in the main

survey. Third, two attention-check questions were embedded in the main survey to identify and exclude inattentive participants.

The main questionnaire consists of three parts: informed consent, basic demographic questions, and the items measuring each construct. This dissertation adopted measurement items from existing scales and Q-sorting tests to empirically measure the constructs identified through interviews. The questionnaire is in English, with all constructs measured on a seven-point Likert scale ranging from “strongly disagree” to “strongly agree.” The survey instrument items for each construct are presented in Appendix 2. The electronic questionnaire was designed using Webropol, while participant recruitment was conducted through Prolific.

A pilot study was conducted within the Q-sorting test to assess the validity and reliability of all constructs before the main survey was carried out. Based on the feedback from the pilot test, several items were refined to improve clarity and precision.

Following these adjustments, the main study was conducted between April and May 2024 in the Nordic countries and the UK via Prolific. A total of 340 participants responded to the main survey invitation. After participants who did not currently use wearable devices ($n = 4$), withdrew consent ($n = 1$), and failed the attention check ($n = 11$) were excluded, the final sample consisted of 324 valid responses. Among the participants, 58.02% were females, and 247 were based in the UK. The majority of the participants (88.27%) had more than six months of experience using sleep-tracking wearables. Table 9 presents the demographic profile of the final survey sample.

Table 9. Demographic profile of the final survey sample

Item	Category	Frequency	Percent (%)
Gender	Male	132	40.74
	Female	188	58.02
	Non-binary	3	0.93
	Prefer not to say	1	0.31
Age	18–25	37	11.42
	26–35	103	31.79
	36–45	98	30.25
	46–55	55	16.98
	56–60	17	5.25
	Over 61 years	14	4.32
Educational background	Lower than upper secondary school (high school) or vocational education	7	2.16
	Upper secondary school (high school) or vocational education	101	31.17
	Bachelor's degree	137	42.28
	Master's degree	65	20.06
	Doctoral degree	14	4.32
Country	UK	247	76.23
	Nordic	77	23.77
Length of ownership	Less than half a year	38	11.73
	0.5–1 year	48	14.81
	1–2 years	81	25
	2–4 years	95	29.32
	More than 4 years	62	19.14
Frequency	Multiple times per hour	71	21.91
	Once per hour	38	11.73
	Multiple times per day	164	50.62
	Once per day	33	10.19
	Multiple times per week	13	4.01
	Once per week	4	1.23
	Less than once per week	1	0.31
Proficiency	Novice user	11	3.4
	Intermediate	154	47.53
	Advanced	118	36.42
	Expert	41	12.65

4.3.3 Data analysis

(1) *Thematic analysis*. Thematic analysis was employed to interpret the interview transcripts in Articles II, III, and IV. This dissertation followed the six-stage process of thematic analysis outlined by Braun and Clarke (2006). The NVivo software was used to support the organization and management of the data.

In the first stage of thematic analysis, the authors of Articles II, III, and IV repeatedly read the interview transcripts to familiarize themselves with the data. During this process, notes were taken to capture observations, emerging ideas, and potential discussion points for the author team.

The second stage involved generating initial codes. Guided by the RQs in each article, initial codes were identified to support subsequent analysis. In Article II, 14 initial codes related to user need satisfaction and frustration were generated with 384 labeled quotes. In Article III, 23 initial codes comprising 546 labeled quotes were identified to represent instances of users' experiences arising from their interactions with sleep-tracking technologies. Article IV aimed to identify the instances of P–T misfits or gaps associated with sleep tracking, resulting in 18 initial codes with 139 labeled quotes.

The third stage focused on searching for themes. At this stage, the authors began organizing the initial codes into candidate themes. In Article II, based on basic psychological needs (Ryan & Deci, 2017a), the initial codes were categorized into predefined themes of satisfaction and frustration of autonomy, competence, and relatedness. In Article III, guided by the affordances lens, the initial codes were grouped under technology affordances and psychological outcomes. In Article IV, the initial codes were organized into potential stressors of sleep tracking.

During the fourth stage, which focused on checking coherence and refining themes, the analysis examined the relationships among quotes, initial codes, subthemes, and themes. This stage ensured that all components were meaningful and well aligned.

The fifth stage entailed defining and naming themes. Several theoretical frameworks were applied to support the explanation and definition of the themes. In Article II, the theory of basic psychological needs (Ryan & Deci, 2017) was used to define the themes, while the NAF perspective (Karahanna et al., 2018) was used to help advance the understanding of the themes by mapping needs, affordances, and features. In Article III, subthemes were theorized into technology affordances and psychological outcomes. In Article IV, stressors related to sleep tracking were identified and defined, with the P–T fit model (Ayyagari et al., 2011) supporting the interpretation of the stressors.

In the final stage, a comprehensive thematic analysis report was produced in Articles II, III, and IV, accompanied by a figure illustrating the coding process

from initial codes to subthemes and themes. Appendix 3 provides a detailed overview of the coding processes in Articles II, III, and IV, along with the initial codes, subthemes, and themes.

(2) *Q-sorting analysis*. Articles III and V used a Q-sorting exercise (Moore & Benbasat, 1991) to establish new measurement items for new constructs. Two round Q-sorting exercises were employed to test the candidate items for these constructs. The first round aimed to ensure construct validity by having the participants group and label the candidate items, which were then compared to the intended meanings of the constructs. In Article III, nine candidate items for triggering behavioral changes were grouped along with the four technology affordances for first-round Q-sorting. In Article V, 12 candidate items were sorted into three stressors. Following this initial round, the ambiguous items were refined, and irrelevant items were removed.

The second round of Q-sorting was conducted to further assess construct validity. In Article III, the overall placement ratio of items within the target constructs was 91.30%, with the lowest score for one construct (i.e., triggering behavioral changes) being 83.30%. The average Cohen's kappa was 79.88%. In Article V, the average agreement ratio across all the participants was 96.40%, and the average Cohen's kappa was 89.36%. As the average Cohen's kappa values exceeded the recommended threshold of 65% (Moore & Benbasat, 1991), these results supported the agreement in item categorization and thus reinforced construct validity.

Finally, the pilot study was conducted with 63 sleep-tracking wearable users recruited via Prolific to test the internal consistency of the newly developed constructs. The Cronbach's alphas for triggering behavioral changes, data-perception discrepancy, pursuit of perfect data, and vague guidance all exceeded the accepted threshold of 0.7, indicating good internal consistency reliability (Hair et al., 2011).

(3) *Fuzzy-set qualitative comparative analysis*. Fuzzy-set qualitative comparative analysis (fsQCA) was employed to analyze the data in Article III. The QCA is an asymmetric case-oriented method that examines how different combinations of causal conditions relate to an outcome of interest (Ragin, 1987). There are three main variations of the QCA approaches: crisp-set QCA (csQCA), multi-value QCA (mvQCA), and fuzzy-set QCA (fsQCA). CsQCA is the first variation of QCA, designed to analyze binary data (i.e., 0 or 1). MvQCA extends this approach to analyze variables with more than two categories. In contrast, fsQCA allows for partial membership scores ranging from 0 to 1, offering a more realistic representation of social phenomena. This flexibility addresses the limitations of both csQCA and mvQCA, which are restricted to binary or multi-value data, respectively.

As a set-theoretical analysis approach, fsQCA represents each case as a combination of causal conditions (Ragin, 2008). Unlike variance-based methods that focus on the net effects of individual variables, fsQCA considers all cases and uncovers complex and asymmetric relationships between an outcome of interest and its antecedents (Pappas & Woodside, 2021). The purpose of Article III is to explore how different configurations of technology affordances and psychological outcomes influence behavioral outcomes (i.e., advice-compliance behavior). Therefore, fsQCA is a well-suited analytical method.

The fsQCA procedure in Article III was conducted in accordance with established guidelines for data calibration and analysis (Pappas & Woodside, 2021). After the reliability and validity of the constructs were ensured (see Section 4.4.2), all measures were converted into fuzzy sets, with values ranging from 0 to 1. On this scale, a case with a value of 1 is considered fully within a set, a value of 0.5 represents a crossover value, and a score of 0 indicates that the case is fully outside the set (Ragin, 2008). In Article III, all conditions were measured using a seven-point Likert scale. Therefore, a direct method of data calibration was applied, setting the thresholds for full membership, the crossover point, and full nonmembership at 6, 4, and 2, respectively (Ordanini et al., 2014; Pappas & Woodside, 2021). Additionally, 0.001 was added to the crossover value (0.5) to avoid the dropping of cases (Fiss, 2011; Pappas & Woodside, 2021).

This study employed fsQCA 4.1 software to analyze the necessary conditions and sufficient conditions. Quantifying sleep-related data affordance, pursuing perfect results, and raising awareness of sleep health were identified as necessary conditions for a high level of advice-compliance behavior, as their consistency and coverage value met or exceeded 0.9 and 0.5, respectively (Hossain et al., 2022; Pappas et al., 2020; Schneider & Wagemann, 2012). Similarly, the affordance of quantifying sleep-related health was recognized as a necessary condition for a low level of advice-compliance behavior.

Following the analysis of the necessary conditions, a truth table was generated to assess sufficient conditions. Given the large sample size in Article III (324 participants), a frequency cutoff of 3 was applied in accordance with the recommendations for large-sample studies (i.e., over 50 cases) (Fiss, 2011; Pappas & Woodside, 2021). In addition, the lowest raw consistency was set at 0.8, as recommended by Fiss (2011). To prevent configurations that appear as subsets in both outcomes and the negation outcomes, the proportional reduction in inconsistency was set at 0.65 for high advice-compliance behavior and 0.75 for low advice-compliance behavior (Greckhamer, 2016). The results were presented across complex, parsimonious, and intermediate solutions.

Finally, this article found two solutions that contribute to a high level of advice-compliance behavior. The overall solution consistency is 0.864, exceeding

the minimum threshold of 0.75, which indicates a strong degree of reliability (Pappas & Woodside, 2021). The overall coverage is 0.643, suggesting that the solutions explain 64.3% of the high level of advice-compliance behavior. In addition, this study identified four solutions that contribute to a low level of advice-compliance behavior. The overall solution consistency is 0.946, indicating a strong degree of reliability. The overall solution coverage is 0.473, explaining 47.3% of the low level of advice-compliance behavior.

(4) *Structural equation modeling*. Two statistical approaches are commonly used for estimating structural equation modeling (SEM): covariance-based SEM (CB-SEM) and partial least squares (PLS-SEM). PLS-SEM is particularly suitable when the primary objective is to predict key target constructs or identify key “driver” constructs (Hair et al., 2017, p.23). Furthermore, PLS-SEM is well suited for studies with small sample sizes (Hair et al., 2017, p. 23), making it an appropriate choice for the post hoc analysis in Article III and for examining the relationship between stressors and health anxiety in Article V. The data were analyzed using SmartPLS 4 software.

Article III employed PLS-SEM in its post hoc analysis. The post hoc analysis aims to evaluate the effects of technology affordances and psychological outcomes on advice-compliance behavior. After the validity and reliability of the constructs were confirmed (see Section 4.4.2), the goodness of model fit was assessed based on the standardized root mean square residual (SRMR). The result of SRMR was 0.061, which was lower than the recommended threshold of 0.08 (L. Hu & Bentler, 1999), indicating a good model fit. Following this, a bootstrapping algorithm was applied to assess the research model. Finally, the model explained 42.5% of advice-compliance behavior. In detail, triggering behavioral changes ($\beta = 0.309^{***}$), pursuing perfect results ($\beta = 0.281^{***}$), and raising awareness of sleep health ($\beta = 0.192^{**}$) all positively influence advice-compliance behavior, while limiting attention to sleep tracking ($\beta = -0.095^{***}$) has a negative effect.

Article V employed PLS-SEM to explore the relationship between stressors and health anxiety. After the validity and reliability of the constructs were confirmed (see Section 4.4.2), the result of SRMR in Article V was 0.055, indicating an acceptable model fit (L. Hu & Bentler, 1999). Subsequently, the impact of seven potential stressors on health anxiety was tested using a bootstrapping algorithm. The R^2 of health anxiety indicated that the model explains 26.3% of health anxiety (Chin, 1998). Specifically, invasion ($\beta = 0.272^{***}$), unreliability ($\beta = 0.226^{***}$), pursuit of perfect data ($\beta = 0.240^{***}$), and vague guidance ($\beta = 0.159^*$) have a positive influence on health anxiety. Additionally, a post hoc analysis was conducted to examine the potential indirect effects of these stressors on health anxiety through the mediating variables: invasion, unreliability, pursuit of perfect data, and vague guidance. The results

indicate that invasion ($R^2 = 15.1\%$) fully mediates the effects of complexity ($\beta = 0.321^{***}$) and inaccuracy ($\beta = 0.182^*$); unreliability ($R^2 = 32.3\%$) fully mediates the effects of complexity ($\beta = 0.366^{***}$) and inaccuracy ($\beta = 0.193^*$); and vague guidance ($R^2 = 37.7\%$) fully mediates the effects of complexity ($\beta = 0.141^{**}$), inaccuracy ($\beta = 0.288^{***}$), and data–perception discrepancy ($\beta = 0.313^{***}$).

4.4 Validation in mixed-methods research

4.4.1 Trustworthiness of qualitative research

In this dissertation, Articles II, III, and IV employed a qualitative research method using semi-structured interviews. To ensure the trustworthiness of the findings, several measures were implemented in accordance with the four dimensions of trustworthiness proposed by Lincoln and Guba (1985): credibility, transferability, dependability, and confirmability. These dimensions are the criteria in the naturalistic paradigm (e.g., qualitative research), which are the equivalents of internal validity, external validity, reliability, and objectivity in the conventional paradigm (e.g., quantitative research), respectively (Lincoln & Guba, 1985).

First, credibility refers to the accuracy of the research process, which can represent the multiple realities of the participants (Lincoln & Guba, 1985). To enhance credibility, several measures—including prolonged engagement (scope), persistent observation (depth), triangulation, peer debriefing, negative case analysis, referential adequacy, and member checks (Lincoln & Guba, 1985)—can be employed. Second, transferability refers to the extent to which findings can be generalized to or across different types of persons, settings, and periods. A thick description of data enables readers to enhance transferability. Third, dependability refers to the stability and consistency of the research process over time. It is closely linked to credibility, as meeting the criteria for credibility often supports dependability. To achieve dependability more directly, measures such as a detailed description of the process and an audit trail can be used to decrease both instability and the changes induced by the phenomenon under study or by the design of the inquiry (Lincoln & Guba, 1985; Shenton, 2004). Finally, confirmability focuses on the degree to which the findings are objective and shaped by the respondents rather than being biased by the researchers' characteristics or preferences. The confirmability audit can strengthen both the criteria of dependability and confirmability. Table 10 presents the measures employed in this dissertation to ensure the trustworthiness of the semi-structured interview research.

Table 10. Measures to ensure the trustworthiness of the qualitative research

Dimension	Description	Measures taken (Articles II, III, and IV)
Credibility	The extent to which the research process accurately represents the multiple realities of the participants (Lincoln & Guba, 1985)	(1) Standard procedures: (a) The same interview protocol was followed with all informants. (b) Six-stage thematic analysis was employed. (2) Data triangulation: The authors of the paper incorporated information from the Oura website and the authors' firsthand experiences with Oura to reflect on the insights derived from the interviews.
Transferability	The extent to which the findings can be generalized to or across different types of persons, settings, and times	(1) Analytical methods: (a) Six-stage thematic analysis was employed to make the data analysis process transparent. (b) The coding process was presented. (2) Thick description: Quotes were used to enhance the informants' descriptions of their experiences.
Dependability	The stability and consistency of the research process over time	External Auditing: One outside expert (Article III) and a third author who was not involved in the data collection and the first stage of data analysis (Article IV) evaluated the analysis process and the results.
Confirmability	The degree to which the findings are objective and are shaped by the respondents	(1) Analytical methods: Six-stage thematic analysis was employed. (2) Confirmability auditing: Two authors discussed the findings and their observations during the data collection and analysis process. Finally, they reached a consensus on the interpretations. (3) Theory guidance: Theories have been used to guide theme identification, such as the SDT (Ryan & Deci, 2017) and the NAF perspective (Karahanna et al., 2018) in Article II, the affordance lens (Volkoff & Strong, 2017) in Article III, and the P–T fit model (Ayyagari et al., 2011) in Article IV.

4.4.2 Reliability and validity of quantitative research

(1) *Reliability and validity of measurements and constructs.* For Articles III and V of this dissertation, quantitative research methods were adopted, and data were collected through questionnaires. Before conducting the configurational analysis in Article III and testing the structural model in Article V, the reliability and validity of the measurements and constructs needed to be tested. Additionally, common method bias (CMB) and the multicollinearity issue needed to be eliminated.

In Articles III and V, the Cronbach's alpha, composite reliability (CR), and average variance extracted (AVE) for all constructs exceeded the thresholds of 0.7, 0.7, and 0.5, respectively. These results indicated that the measurement items in Articles III and V have solid internal consistency reliability and convergent validity (Hair et al., 2011). Furthermore, the results supported the solid

discriminant validity for all constructs in Articles III and V. Specifically, the square root of each construct's AVE was higher than its inter-construct correlation values, the factor loadings on their respective construct were higher than on other constructs, and the Heterotrait–Monotrait ratio of correlations remained below the recommended threshold of 0.9 (Henseler et al., 2015).

In addition, Harman's single-factor test (Podsakoff et al., 2003) and latent marker variable for partial least squares (M. Rönkkö & Ylitalo, 2011) were conducted to assess the risks of CMB in Articles III and V. The results showed that the largest variance explained by an individual factor was below the recommended 50% threshold, and no significant correlation was found between the marker variable and the research construct. These findings indicated that concerns about CMB in Articles III and V were minimized. Meanwhile, all variance inflation factor values for the constructs were lower than 3, indicating no issues with multicollinearity in the research model of Articles III and V (Hair et al., 2019).

(2) *The predictive validity of fsQCA.* Following the steps proposed by Pappas and Woodside (2021) for evaluating predictive validity, the predictive validity of the fsQCA was assessed in Article III. The raw sample was first randomly divided into two equal halves: a subsample and a holdout sample. The same analysis was conducted on the subsample using the same calibration thresholds. The resulting solutions from the subsample were then tested on the holdout sample using the XY plot function in the fsQCA software. The results showed similar consistency and coverage between the subsample and holdout sample. Therefore, all models are considered to exhibit strong predictive validity.

5 Summary of the Articles

Chapter 5 summarizes the main findings of each article included in this dissertation. Each section is dedicated to one article (Sections 5.1–5.6) and provides a concise overview of its research purpose, methods, key findings, and implications.

5.1 Article I: Systematic literature review of self-tracking and the quantified self

To provide an overview of the current research on self-tracking and the quantified self, this dissertation begins with an SLR that offers a comprehensive synthesis of existing studies. Article I aims to identify the current state of the art in self-tracking and the quantified self in the domain of health and well-being, and it outlines the study profiles, main research themes, and future research directions based on the findings.

A total of 67 empirical studies, comprising 42 journal articles and 25 conference papers, were included in Article I. The most commonly used methods were interviews and mixed-methods approaches. However, only 39 of the 67 studies explicitly reported their theoretical foundation(s), with the most commonly used theories being the technology acceptance model and SDT. Based on the subjects of the empirical research, this study categorized the current research into three stakeholder groups, encompassing a total of 11 research themes derived from the study foci: six themes related to end users, three themes under the group of patients and people with illness, and two themes in the healthcare professionals and caregivers groups.

The first stakeholder group is the end-user group. Six research themes were identified under this stakeholder: (1) *User motivation and goal setting*. Motivation is a central topic in understanding self-tracking usage, and some studies have identified various motivations (Attig & Franke, 2019; Gimpel et al., 2013; Suh, 2018). Sometimes, goals come with motivation. Motivational affordances can support users in achieving their goals (Gordon et al., 2019; Hamari et al., 2018), while the desire to achieve these goals can also serve as a key motivation for using self-tracking technology, such as a weight-loss app (Gordon et al., 2019). (2) *Usage and effects of self-tracking*. Although physical activity remains the most common

focus of self-tracking (e.g., Esmonde, 2019b; Maxwell et al., 2021), people also use it to monitor other aspects, such as sleep (e.g., Ravichandran et al., 2017; K. Rönkkö, 2018), diet (J. Kim, 2014a, 2014b), and fertility (Gambier-Ross et al., 2018). Prior research has identified different user types (e.g., Makkonen et al., 2016) and roles of self-tracking technology (e.g., Lyall & Robards, 2018). In addition, studies have explored the outcomes of self-tracking, including increased health awareness (Stiglbauer et al., 2019) and behavioral changes (K. Rönkkö, 2018). (3) *Continuance intention and long-term usage*. Several factors that affect continuance intention have been explored, including motivations (Shin & Biocca, 2017; Suh, 2018), perceived benefits (Chuah, 2019), and affective states (Rockmann et al., 2018). Long-term use has also garnered growing attention, with research highlighting the influencing factors, such as visualization and healthy states (Hardey, 2019), and exploring different use cases of self-tracking technologies (Meyer et al., 2017). (4) *Management of personal data*. People use self-tracking technology to manage personal health information (Y. Feng et al., 2017). Some users who habitually use self-tracking are more willing to disclose their data (Maltseva & Lutz, 2018). However, users may also encounter data-perception discrepancies (Yli-Kauhaluoma & Pantzar, 2018). Moreover, privacy concerns remain a central issue in self-tracking, particularly regarding data sharing (J. Chen et al., 2016; Gui et al., 2017; Zimmer et al., 2020). (5) *Rejection and discontinuance*. Prior research has also explored the abandonment and discontinuance of self-tracking technologies (Attig & Franke, 2020; Kari et al., 2016). Additionally, previous research has identified several strategies that users employ to resist datafication in fitness-tracking practices (Esmonde, 2019a). (6) *User characteristics*. Several user characteristics, including health literacy (McKinney et al., 2019), the digital divide (Régnier & Chauvel, 2018), and cognition (Baumgart, 2016, 2017; Baumgart & Holten, 2018), have been explored to understand their impact on use behavior.

The second stakeholder group comprises patients and people with illnesses, and this group discussed three themes. (1) *User experiences of patients and people with illnesses*. Given the special needs of patients and health conditions, previous research has examined the feasibility and acceptability of self-tracking technologies in clinical and illness-related conditions (Beukenhorst et al., 2020; Y. Kim et al., 2016). Research has also highlighted the potential supportive role of self-tracking technologies in managing chronic diseases (Schroeder et al., 2019), coping with disease (Mishra et al., 2019), and monitoring recovery during rehabilitation (Vogel et al., 2017). (2) *Management of patient-generated data*. Previous research has explored factors such as health motivation, severity of health problems, and age, which influence users' willingness to share data with professors (Ivanov et al., 2015). However, people with multiple chronic conditions may experience health anxiety as a result of tracking, which can lead to the reduced use of these technologies (Ancker

et al., 2015). (3) *Advantages and disadvantages of self-tracking in the clinical context*. Self-tracking technologies can help establish (Trauth & Browning, 2018) and mediate (Piras & Miele, 2017) the patient–doctor relationship by providing patients with more control and valuable health information. However, the challenges and risks, such as patient privacy issues (C. Chung et al., 2016), the heavy workload of tracking (Riggare et al., 2019), and obsessive tracking (Riggare et al., 2019), cannot be ignored.

The third stakeholder group comprises healthcare professionals and caregivers. (1) *Collaboration among patients, healthcare professionals, and caregivers*. Prior research has highlighted the important role of healthcare givers in collaboration practices with patient-generated data (C. Chung et al., 2016). In addition, caregivers, such as friends and family members, can also play a supportive role in helping patients adopt positive coping strategies, particularly in managing chronic conditions like Parkinson’s disease (Mishra et al., 2019). (2) *Changes in the roles of patients and professionals*. The adoption of self-tracking technology has reshaped the traditional roles of patients and healthcare professionals. Patients can now set personal health goals (Schroeder et al., 2019), take on the role of health managers (Gabriels & Moerenhout, 2018), and actively build a desired relationship with their healthcare providers via self-tracking technology (Piras & Miele, 2017). Meanwhile, healthcare professors and caregivers can act as patient managers, for example, by helping and training patients to interpret self-tracking data (Gabriels & Moerenhout, 2018; Piras & Miele, 2017). However, it is essential to emphasize that the contextual aspects of healthcare, as well as the involvement of healthcare professionals, should be considered in the practice of digital self-care (Gabriels & Moerenhout, 2018).

Finally, this article identified future research directions from two perspectives: directions proposed within the reviewed literature and directions derived from the synthesis and analysis of the review findings. Article I extracted three key future research directions related to self-tracking: (1) the need for a deeper exploration of the psychological and behavioral aspects of self-tracking (Attig & Franke, 2019; Chuah, 2019; Y. Feng et al., 2017; Gambier-Ross et al., 2018; Hamari et al., 2018; Makkonen et al., 2016; Sjöklint et al., 2015), (2) the need to investigate how individuals perceive and interpret the information provided by the self-tracking technologies (S. Feng et al., 2021), and (3) the need to examine the potential dark side of self-tracking technology (S. Feng et al., 2021). These directions were further refined and highlighted as critical research gaps that form the foundation of this dissertation.

5.2 Article II: Sleep tracking from a NAF perspective

Previous research has explored the factors influencing the use of sleep-tracking technologies (Attie & Meyer-Waarden, 2023; Leblanc et al., 2022) as well as their impact on users' health and well-being (Karasneh et al., 2022; Ravichandran et al., 2017). However, existing studies offer limited insight into the underlying reasons why and how people use sleep-tracking technology, particularly in terms of how sleep-tracking technologies fulfill users' needs to motivate user behavior. Against this backdrop, the NAF perspective (Karahanna et al., 2018) provides an appropriate framework for unpacking the idiosyncratic mechanisms of sleep tracking by mapping users' needs to their corresponding affordances and features.

The purpose of Article II is to explore why and how people use sleep-tracking technology. Drawing on the SDT (Ryan & Deci, 2017a), this article entailed semi-structured interviews that were conducted with 38 Oura ring users. Using thematic analysis, this article identified the satisfaction and frustration of users' basic psychological needs (autonomy, competence, and relatedness) in the context of sleep tracking. Guided by the NAF perspective (Karahanna et al., 2018), this study mapped affordances and corresponding features to the satisfaction and frustration of these needs, as shown in Figure 11. The findings explained how the features of sleep-tracking smart rings afford user behaviors to influence their needs satisfaction and frustration.

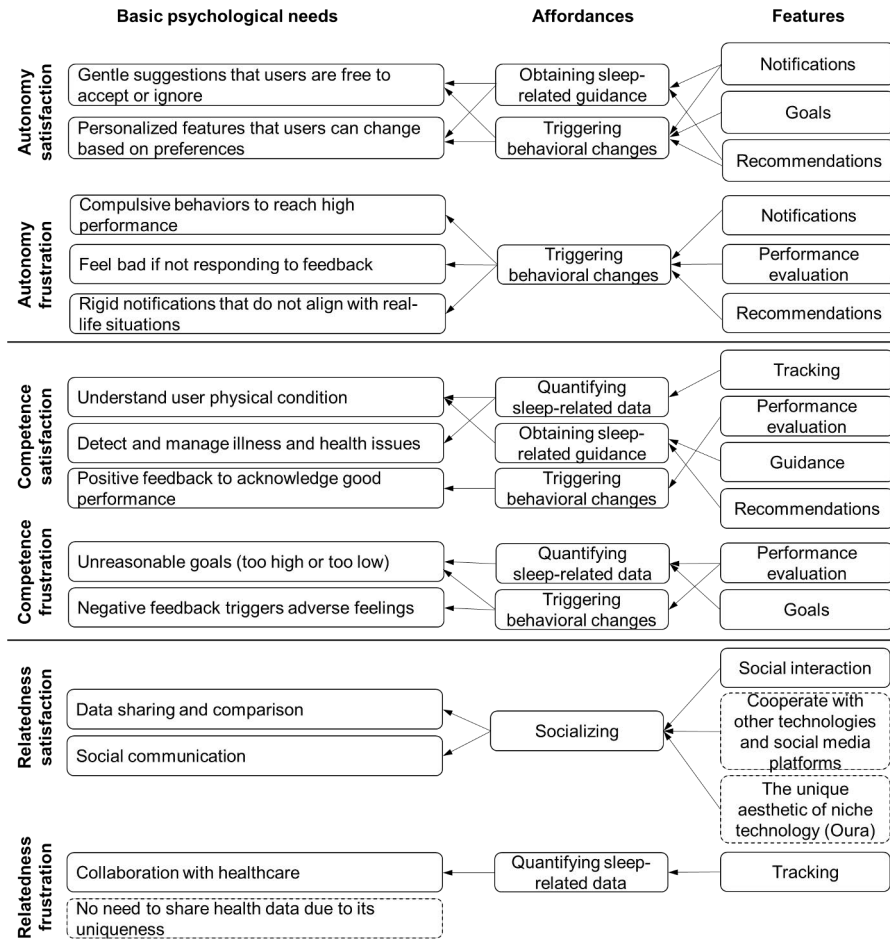


Figure 11. Basic psychological needs with related affordances and corresponding features

In the context of sleep tracking, autonomy satisfaction reflects the ability of sleep-tracking technology to enable users to self-regulate their experiences and behaviors in accordance with their own goals and values. Sleep-tracking technology can satisfy users’ autonomy needs by offering gentle suggestions that users are free to accept or ignore and personalized features such as selectable notifications, editable goals, and tailored recommendations. These features enable users to obtain sleep-related guidance and change their behavior. However, the features of notifications, performance evaluations, and recommendations aim to trigger users’ behavioral changes. This design may sacrifice users’ autonomy by creating a sense of pressure or control, leading to compulsive behaviors, negative feelings owing to inaction, and dissatisfaction with rigid notifications.

Competence satisfaction in the sleep-tracking context refers to the extent to which the sleep-tracking technologies enable users to feel capable and effective in managing their health. Specifically, these technologies empower users to understand their physical condition and to detect and manage illness and health problems, while also providing positive feedback that encourages sustained engagement. Features such as tracking, performance evaluation, guidance, and recommendations enable users to quantify sleep-related data, obtain sleep-related guidance, and trigger behavioral changes, thereby satisfying users' competence needs. Despite this, competence frustration may also arise when users experience doubt or a feeling of failure, often triggered by unreasonable goals or negative feedback. In these cases, features related to performance evaluation and goals may contribute to competence frustration through the affordances of quantifying sleep-related data and triggering behavioral changes.

Relatedness satisfaction refers to how the sleep-tracking technologies make users feel a sense of connection. Indeed, the social interaction feature enables users to socialize by sharing and comparing data and communicating with others. This article also found that users expressed interest in cooperating with other technologies or social media platforms to actualize socializing. Furthermore, the unique aesthetic of niche technologies, such as smart rings, can serve as a conversational topic, further promoting social interaction. However, owing to the uniqueness of personal health data, most users reported not experiencing relatedness frustration, as they rarely share their data with others. Some informants may experience relatedness frustration, especially when interacting with healthcare professionals, who were often uninterested in or dismissive of the data tracked by consumer sleep-tracking technologies.

Therefore, Article II summarized three key findings that are unique to sleep tracking: (1) Personalized features and guidance-flexibility balanced suggestions can support users' autonomy satisfaction, (2) competence is a key factor in the use of sleep-tracking technologies and can be satisfied through appropriate goal settings and positive feedback, and (3) relatedness needs appear to be less central owing to the personal and private nature of health data. In terms of theoretical implications, this study extended the application of SDT and the NAF perspective by integrating need frustration into consideration within the NAF perspective, providing new insights into the sleep-tracking phenomenon by mapping needs, affordances, and features across different scenarios. In terms of practical implications, this study provided several recommendations for sleep-tracking designers. For example, designers should incorporate personalized features and gentle suggestions to support users' autonomy needs. Setting reasonable goals and implementing supportive strategies can enhance users' competence. Furthermore, designers should be cautious when providing comparative metrics with others, and collaboration with

healthcare professionals is crucial to the future development of sleep-tracking technologies.

5.3 Article III: The configurations of affordances and psychological outcomes influence advice compliance

Although sleep-tracking technology can enhance users' awareness of their sleep health (Karasneh et al., 2022; Kuosmanen, Visuri, Kheirinejad, et al., 2022), it does not always improve sleep in the desired manner (Liang & Ploderer, 2016; S. Zhang et al., 2019). In a longitudinal study, only 20% of users acted on the data and notifications provided by their sleep-tracking technology (Kuosmanen, Visuri, Kheirinejad, et al., 2022). This limited effectiveness may be attributed to users' passive and inactive responses to the advice provided by the sleep-tracking technology. However, prior research has found that various factors influence compliance behavior in self-tracking (Mekhael et al., 2023; Yang et al., 2022). In the context of non-mandated activities (Dhir et al., 2024), such as sleep tracking, factors from both the user's and technology's perspectives play a crucial role in influencing advice-compliance behavior. In addition, prior research has highlighted the importance of the potential psychological outcomes emerging from interaction with sleep-tracking technology, such as increased awareness of sleep health (Kuosmanen, Visuri, Kheirinejad, et al., 2022) and enhanced understanding of sleep patterns (Quante et al., 2019). Despite these contributions, the specific technology affordances of sleep tracking and their influence on psychological and behavioral outcomes remain underexplored.

Article III adopted the affordance lens (Gibson, 1979; Volkoff & Strong, 2017) to explore the phenomenon of sleep tracking. The purpose of this article is to explore the configurational effects of technology affordances and psychological outcomes on advice-compliance behavior in the context of sleep tracking. Article III employed a mixed-methods approach, comprising two empirical studies: Study 1 and Study 2. For Study 1, semi-structured interviews were conducted with 38 Oura ring users. Using thematic analysis, Article III identified technology affordances specific to sleep tracking and psychological outcomes that emerge from user interactions with sleep-tracking technology. Study 2 employed fsQCA to explore the effects of various configurations of technology affordances and psychological outcomes on advice-compliance behavior. Combining the findings from Study 1 and Study 2, Article III provides actionable insights for designers of sleep-tracking technology.

Study 1 is an exploratory qualitative study. This study identified four technology affordances of sleep-tracking technology and three psychological outcomes that emerge from its use. In terms of technology affordances, the first is the quantifying

sleep-related data affordance. Features such as tracking, goals, and performance evaluations support this affordance, enabling users to quantify, observe, and document their personal health data. The second affordance is obtaining sleep-related guidance. Features such as recommendations, guidance, and notifications enable this affordance by helping users acquire knowledge of the biophysiological foundations of the tracked parameters. The third technology affordance is triggering behavioral changes, which offers users the possibility to alter their behavior predictably without forbidding or forcing them. The features, such as notifications, performance evaluations, goals, and recommendations, support users in changing their bad habits and maintaining good ones, thereby promoting sustained behavioral change. The last one is the socializing affordance. It enables users to share and compare data and user experiences as well as lubricate communication with others. The social interaction features, such as the sharing button and users' circles, help users achieve their social goals.

This study identified three psychological outcomes resulting from the use of sleep-tracking technology. The first psychological outcome, pursuing perfect results, refers to users' tendency to strive for higher scores and aim to meet the goals set by the technology. The second psychological outcome is raising awareness of sleep health. Users become more attentive to their sleep and begin to understand the impact of harmful behaviors on their sleep after they use the sleep-tracking technology. Finally, limiting attention to sleep tracking describes a psychological outcome in which users allocate less attention to sleep tracking owing to disruptions caused by the technology.

Study 2 identified two solutions for a high level of advice-compliance behavior. In Solutions 1 and 2, obtaining sleep-related guidance, triggering behavioral changes, and pursuing perfect results are core factors contributing to the high level of advice-compliance behavior. In addition, this study identified four solutions for the low level of advice-compliance behavior. Among these four solutions, at least one of the technology affordances is absent: either the affordance of obtaining sleep-related guidance or the affordance of triggering behavioral changes. Table 11 presents the detailed configurations that contribute to the high and low levels of advice-compliance behavior.

Table 11. Configurations contributing to high and low levels of advice-compliance behavior

	Solutions						
	High level of advice-compliance behavior		Low level of advice-compliance behavior				
Configuration	1	2	3	4	5	6	7
Technology affordances							
Quantifying sleep-related data	●	●	●	●	●	●	●
Obtaining sleep-related guidance	●	●	●	●	●	⊗	⊗
Triggering behavioral changes	●	●	⊗	⊗	⊗	●	⊗
Socializing		●		⊗	●	⊗	⊗
Psychological outcomes							
Pursuing perfect results	●	●	⊗	⊗	⊗	⊗	●
Raising awareness of sleep health	●	●	●	●	⊗	●	●
Limiting attention to sleep tracking	⊗		⊗		●	●	●
Raw coverage	0.457	0.564	0.255	0.289	0.155	0.213	0.282
Unique coverage	0.079	0.186	0.021	0.026	0.015	0.033	0.093
Consistency	0.874	0.884	0.965	0.960	0.995	0.978	0.945
Overall solution consistency	0.864		0.946				
Overall solution coverage	0.643		0.473				
Black circle (●): presence; Circle with "X" (⊗): absence; Large circle (●, ⊗): core condition; Small circle (●, ⊗): peripheral condition; Blank space: "don't care" condition.							

In addition, the post hoc analysis examined the direct effects of four technology affordances and three psychological outcomes on advice-compliance behavior. The results show that triggering behavioral changes, pursuing perfect results, and raising awareness of sleep health have a positive influence on advice-compliance behavior. Meanwhile, limiting attention to sleep tracking has a negative influence on advice-compliance behavior.

Overall, Article III reveals the findings from a configurational perspective of technology affordances and psychological outcomes. Three key findings were identified from a configurational perspective: (1) Different combinations of technology affordances and psychological outcomes can contribute to a high level of advice-compliance behavior; (2) solutions for low levels of advice-compliance

behavior suggest that when there is a lack of affordances for obtaining sleep-related guidance or the trigger for behavioral changes, users are less likely to comply with advice; and (3) psychological outcomes are crucial when scrutinizing user behavior through the affordance lens. In addition, this study identified five key findings related to specific technology affordances and psychological outcomes: (1) The affordance of quantifying sleep-related data is the basis of sleep-tracking technology, (2) obtaining sleep-related guidance and triggering behavioral changes are crucial for supporting advice-compliance behavior, (3) socializing affordance can support complying with advice to some extent, (4) users who are pursuing perfect results and raising awareness of sleep health are prone to complying with the advice, and (5) limiting attention to sleep tracking can hinder users' compliance behavior.

In terms of theoretical implications, this study extended the application of technology affordances to sleep tracking, explored the configurations of technology affordance with psychological outcomes, and deepened the understanding of advice-compliance behavior in the context of sleep tracking. In terms of practical implications, this article offered several actionable suggestions for sleep-tracking designers, including improving the accuracy of sleep data quantification by integrating high-quality sensors and reliable algorithms, designing effective cues and prompts to nudge users toward compliance while also providing educational content, and offering supportive communities while carefully providing social comparisons.

5.4 Article IV: The stressors of sleep tracking

Current research has shown that the effects of sleep tracking are not always beneficial (Kuosmanen, Visuri, Kheirinejad, et al., 2022), and its impact on improving sleep health is not as effective as expected (S. Zhang et al., 2019). Although prior research on sleep tracking has identified various barriers and challenges that users encounter when leveraging sleep-tracking technologies to improve their sleep and health (e.g., Acosta et al., 2024; Liang & Ploderer, 2016; W. Liu et al., 2015; Ravichandran et al., 2017), the existing studies have paid limited attention to the stressors of sleep tracking. Considering the tight interplay between sleep and stress (E. Kim & Dimsdale, 2007; Staner, 2003; Tsuno et al., 2005), it is crucial to identify and investigate stress induced by sleep-tracking technology and to develop strategies to mitigate their adverse impact.

This article aims to explore the adverse effects of sleep-tracking technology by identifying the potential stressors that it may induce. To achieve this, 38 semi-structured interviews were conducted, and thematic analysis was employed to uncover the potential stressors associated with sleep-tracking smart rings. The P-T fit model (Ayyagari et al., 2011) served as the theoretical framework for interpreting the potential stressors.

This study identified eight potential stressors associated with sleep tracking. Specifically, complexity refers to a situation in which users perceive technology as technically difficult to use (Tarafdar et al., 2020). In sleep tracking, complexity as a stressor can result from difficult-to-understand parameters owing to a misfit between user knowledge/time to explore and technology demands (A–D) or from complex working mechanisms that fail to meet users’ transparency needs (S–V). As a result, users may experience emotional strain and confusion about how to effectively use the sleep-tracking technology or improve their activity and sleep quality.

Invasion describes a situation in which sleep-tracking technology invades users’ daily lives, often with negative perceptions, or becomes an integral part of everyday life (Maier et al., 2012, 2015). The notification that does not align with users’ preferences (i.e., no notification or less frequent notifications) may result in emotional strain, such as annoyance, guilt, and frustration (S–V). However, even when the technology aligns with users’ needs (S–V), this situation may lead to compulsive behaviors, such as checking data immediately after waking up if users require timely, complete, or long-term information.

Inaccuracy refers to a situation in which sleep-tracking technology fails to track data accurately (Rieder, Vuckic, et al., 2020). When the technology’s detection capability fails to meet users’ expectations for accuracy (S–V), this situation can lead to emotional strain, including feelings of unhappiness and disappointment.

Unreliability represents situations in which users are unable to engage in sleep-related behavioral interventions owing to issues with sleep-tracking technology (Califf & Sarker, 2020; Rieder, Vuckic, et al., 2020). The sleep-tracking technology, plagued by technical issues such as limited battery life, synchronization problems, and delayed notifications, may disrupt users’ usage (S–V) and lead to emotional strain.

Data–perception discrepancy refers to a situation in which users experience a disconnection between their subjective perceptions and the data (Rieder, Vuckic, et al., 2020). In other words, the data from sleep-tracking technologies cannot explain users’ perceptions (S–V). In this situation, the misfit may lead to emotional strain, including feelings of disappointment, doubt, and confusion.

Pursuit of perfect data refers to a situation in which sleep-tracking technology provides users with scores and goals, and users may feel stressed when they actively strive to achieve higher scores (Kuosmanen, Visuri, Kheirinejad, et al., 2022). The gap between users’ actual performance and the target goal set by technology (S–V) may trigger compulsive behaviors, such as engaging in extra workouts solely to achieve these goals. Moreover, a mismatch between users’ ability to perform well and consistently low feedback from the device (A–D) can further contribute to emotional strain, including frustration, sadness, depression, and anxiety.

Vague guidance describes a situation in which sleep-tracking technology cannot help users pinpoint the exact reasons for their poor performance or suggest ways to improve it while aligning with the real situation. The misfit between users' needs for clear guidance and the ambiguous feedback offered by the technology (S–V) may negatively impact users' emotions and reduce their motivation to continue using the device.

Overload with multiple self-tracking technologies refers to a situation in which users receive too much information because they have more than one self-tracking technology (Maier et al., 2015). Users may encounter conflicting data across multiple devices, leading to confusion and uncertainty. This experience reflects both A–D misfit (stems from users' inability to determine which data to trust) and S–V misfit (users' needs for professional guidance remain unmet).

Overall, Article IV revealed three interesting results regarding sleep-tracking stressors: (1) Eight potential stressors in the context of sleep tracking were identified, (2) these stressors mainly stem from the misfit or gaps in the S–V dimension, and (3) the main strain of stressors is emotional. In terms of theoretical implications, this study identified eight potential stressors in the context of sleep tracking, provided deep insight into the dark side of self-tracking, and extended the application of the P–T fit model to the context of sleep tracking. In terms of practical implications, sleep-tracking designers should be mindful of the potential challenges identified in this study. Sleep-tracking technologies can implement several improvements, including a modular design, customized features, personalized feedback, and enhanced transparency of the technology's working mechanism. Furthermore, sleep-tracking users should be aware of their own perceptions, avoid overreliance on technology, and learn to trust their own instincts and feelings.

5.5 Article V: Effects of sleep-tracking stressors on health anxiety

Previous studies have documented the adverse effects of sleep-tracking technologies (Baron et al., 2017; Kuosmanen, Visuri, Kheirinejad, et al., 2022). However, limited efforts have been made to measure potential stressors and to examine their relationship with adverse outcomes. Existing research provides valuable constructs for measuring technology-related stress in various domains, such as social network sites (Maier et al., 2015), ICT in organizations (Ragu-Nathan et al., 2008), and healthcare IT (Califf & Sarker, 2020). However, these measurement instruments do not adequately capture stressors that are specific to sleep tracking, where technologies generate continuous personal health data and algorithmic guidance. In particular, stressors related to data–perception discrepancy, pursuit of perfect data, and vague guidance remain underrepresented. Accordingly, there is a need to

develop measurement items tailored to stressors unique to the context of sleep tracking before examining their effects on adverse outcomes. Additionally, prior research on self-tracking has highlighted the potential adverse outcomes, such as health anxiety (Rosman et al., 2020). In the context of sleep tracking, users may experience high concern when they perceive bodily sensations or changes as potential indicators of a disease, which can result in increased health anxiety (Asmundson et al., 2010). Therefore, it is important to explore the relationship between sleep-tracking stressors and health anxiety.

Building on the insights from Article IV, Article V aims to answer sub-RQ3 by examining the effects of potential stressors on health anxiety. Before testing the effects, valid measurement scales for the stressors were developed. This study employed a Q-sorting approach to establish measurement items, and the SEM was used to test the proposed research model. Article V examined only seven of the eight potential stressors identified in Article IV, excluding overload with multiple self-tracking technologies. This exclusion was based on the observation that when the focus was extended from the Oura ring to a broader range of sleep-tracking technologies, only 14.20% of the sample reported using multiple self-tracking technologies.

In Article V, the measurement items for data–perception discrepancy, pursuit of perfect data, and vague guidance were developed and validated. Appendix 2 presents the new measurement instruments for these three stressors and four stressors adapted from the prior literature. Finally, this study tested the structural model. As shown in Figure 12, invasion, unreliability, pursuit of perfect data, and vague guidance have a direct and positive effect on health anxiety. In contrast, complexity, inaccuracy, and data–perception discrepancy did not have a significant effect on health anxiety.

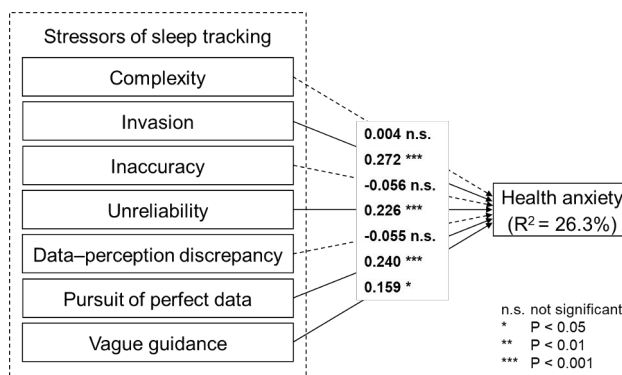


Figure 12. Structural model results

In the post hoc analysis, Article V further examined whether nonsignificant stressors indirectly influence health anxiety through these significant stressors. The results indicate that invasion, unreliability, and vague guidance are full mediators in these relationships. Specifically, the impact of complexity and inaccuracy on health anxiety is fully mediated by invasion; the impact of complexity and inaccuracy on health anxiety is fully mediated by unreliability; and the impact of complexity, inaccuracy, and data–perception discrepancy on health anxiety is fully mediated by vague guidance.

Article V highlighted three key findings: (1) To assess the sleep-tracking stressors, this study developed a set of measurement items for stressors, including three that were newly developed and four that were adapted from prior research; (2) health anxiety associated with sleep-tracking technology is directly influenced by invasion, unreliability, pursuit of perfect data, and vague guidance; and (3) the relationships among the stressors are interactive, with complexity, inaccuracy, and data–perception discrepancy indirectly influencing health anxiety through invasion, unreliability, and vague guidance. In terms of theoretical implications, this study developed validated instruments to measure sleep-tracking stressors and advanced understanding of the sources of health anxiety in the sleep-tracking context. Moreover, this study revealed the interrelationships between these stressors. In terms of practical implications, designers are encouraged to maintain a balance between providing informative guidance and avoiding intrusiveness. Designers should also ensure that the guidance is both actionable and tailored to each individual’s differences. Users, in turn, are encouraged to pay more attention to their own feelings and to take more responsibility and actions for their health.

5.6 Article VI: Integrative literature review of sleep tracking

Although prior review studies have synthesized sleep-tracking research, they have focused primarily on the technological aspects of sleep tracking. This focus highlights a growing need to investigate the role of the user and contextual factors in influencing interactions with sleep-tracking technologies. Against this backdrop, the purpose of Article VI is to explore the current state of sleep-tracking research from an HCI perspective and identify key agendas for future investigation.

For Article VI, an ILR was conducted, and 51 empirical studies were collected from five databases. Among these, 23 articles employed a qualitative research approach, while 18 used a quantitative research approach. However, most of the studies did not employ a theoretical lens, highlighting the need to develop a dominant theory in this field. Following the HCI framework (Zhang & Li, 2005), this study categorized current research into five components: user, sleep-tracking technology,

use context along with corresponding tasks, use and impacts (user-oriented outcomes), and design insights (technology-oriented outcomes).

The first component is the user, which encompasses demographics, lifestyle, habits, and psychological factors. (1) *Demographics*. Prior research has found inconsistent results regarding user demographics. While some researchers have found that demographic factors such as gender and age influence the use of sleep-tracking technology (e.g., Barnes et al., 2023; Makkonen et al., 2016; Robbins et al., 2019), others have reported no significant associations (e.g., Attie & Meyer-Waarden, 2023; Matsangas et al., 2024; Nolasco et al., 2023). (2) *Lifestyle and habits*. Scholars have found that users' lifestyles (Devine et al., 2024; Karlgren & McMillan, 2022; Nguyen et al., 2018) and habits (Robbins et al., 2019) influence the use of sleep-tracking technology, highlighting that its design should align with users' chronotypes rather than with standard sleep patterns (Karlgren & McMillan, 2022; Nguyen et al., 2018). (3) *Psychological factors*. Users' personalities (Attie & Meyer-Waarden, 2023; Nguyen et al., 2018) influence their behavior in relation to sleep-tracking technology. In addition, previous research has explored users' needs for features and users' preferences (Aji et al., 2019; Oh et al., 2022; Schwartz et al., 2024).

The second component is sleep-tracking technology, encompassing the subthemes of hardware and aesthetics, sleep-tracking features, the affordances corresponding to features, and the financial costs. (1) *Hardware and aesthetics*. Although contactless devices are easy to use (Kuosmanen, Visuri, Risto, et al., 2022), wrist-worn sleep-tracking technologies remain the most common type (S. Zhang et al., 2019). Bracelet-style devices do not disturb users' sleep (Vandenbergh & Geerts, 2015). Moreover, the credibility of the interface and device influences the overall credibility of the technology (Liang & Ploderer, 2020). (2) *Features*. Studies have classified features of sleep-tracking technology (S. Feng et al., 2023; Karasneh et al., 2022) and explored their influence on user experience (e.g., Karasneh et al., 2022; Nuo et al., 2023). Moreover, some specific features, such as feedback (Nagele & Hough, 2024) and recommendations provided by the technology (Aji et al., 2019), have been examined individually. (3) *Affordances corresponding to features*. The feature-enabled affordances that are specific to sleep tracking have been identified in prior research (Elmholdt et al., 2021; S. Feng et al., 2022). (4) *Financial costs*. The financial costs of technology may influence users' adoption and tracking behavior (Leblanc et al., 2022; Purnell et al., 2023).

The third component is related to the use context, along with corresponding tasks. Prior research has explored the sleep-tracking phenomenon in the context of (1) daily life (e.g., Attie & Meyer-Waarden, 2023; Quante et al., 2019), (2) clinics (e.g., Ojalvo et al., 2023; Purnell et al., 2023), (3) organizations (e.g., Barnes et al., 2023; Devine et al., 2024), and (4) context-specific applications (e.g., Jakowski &

Stork, 2022; Matsangas et al., 2024; J. Wang et al., 2020). Moreover, the characteristics of context and corresponding tasks in different contexts have been considered in the research on the use of sleep-tracking technology, such as social influence in daily life (Leblanc et al., 2022), patients' external context (Purnell et al., 2023), and task performance in an organization (Barnes et al., 2023).

The fourth component focuses on user-oriented outcomes, particularly the use behavior of the technology and its impact. (1) *The impact of use*. Most existing research has examined use behavior (e.g., Aji et al., 2022; Attie & Meyer-Waarden, 2023), health-related behavior (e.g., Karasneh et al., 2022; Mitsutake et al., 2016), and users' overall health and well-being (Ojalvo et al., 2023; Ravichandran et al., 2017). Research has found that sleep-tracking technology can produce positive effects, such as increasing awareness of sleep health (Kuosmanen, Visuri, Kheirinejad, et al., 2022), changing bad sleep habits (Goelma et al., 2014), and improving sleep quality (Barnes et al., 2023; Shaforostov et al., 2024). However, sleep-tracking technology can also produce adverse outcomes, such as technology-induced stress (S. Feng et al., 2023; Kuosmanen, Visuri, Kheirinejad, et al., 2022) and sleep-related anxiety associated with orthosomnia (Jahrami et al., 2024). (2) *Barriers and challenges*. Previous research has identified barriers and challenges that users experience when engaging with sleep-tracking technology, such as limited sleep knowledge (Liang & Ploderer, 2016), lack of trust in the technology (Acosta et al., 2024), technology issues (Kuosmanen, Visuri, Risto, et al., 2022), and the black-box nature of the technology algorithms (Liang & Ploderer, 2020). (3) *Segmentations and roles*. Research has also explored user segmentations based on their use patterns (Kuosmanen, Visuri, Kheirinejad, et al., 2022; Makkonen et al., 2016) and the role of sleep-tracking technology in users' lives (Nagele et al., 2022; Salmela et al., 2019).

The fifth component represents technology-oriented outcomes, namely design insights. This component emerges from accumulated evidence on user-oriented use and impacts, including design opportunities as well as feature enhancements and expansions. (1) *Design opportunities*. Designers should pay more attention to specific user groups, such as extreme sleepers (Karlgrén & McMillan, 2022), while also ensuring the integration and compatibility of sleep-tracking technologies with existing platforms (Zhang et al., 2019), wellness products (Oh et al., 2022), and health agents (Quante et al., 2019). (2) *Feature enhancement and expansion*. Previous research has also suggested enhancement and expansion of sleep-tracking features. For example, the feedback features should be improved to be personalized, educational, and actionable (Feng & Mäntymäki, 2024; Ravichandran et al., 2017; Zhang et al., 2019). In addition, new features, such as game elements, community, and subjective sleep assessment, can be added to sleep-tracking technology (Kaitz et

al., 2023; Ravichandran et al., 2017). The internal and external factors should also be considered in the context of sleep tracking (Shaforostov et al., 2024).

The five components were further grouped into antecedents and outcomes, as illustrated in Figure 13.

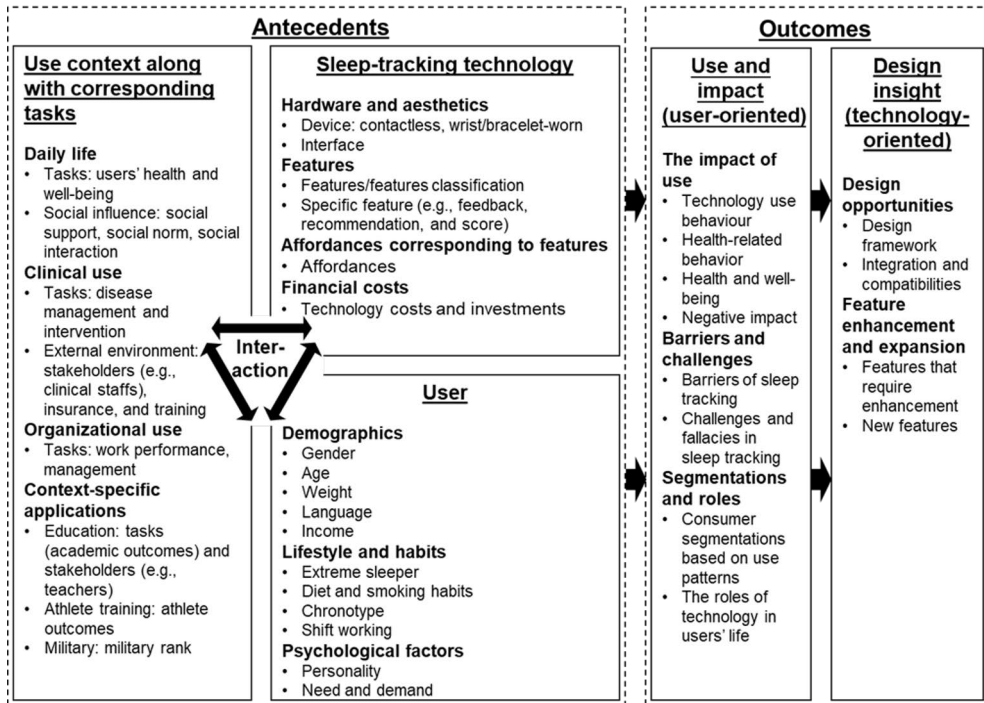


Figure 13. A synthesizing framework of research on sleep tracking

Following these five components, this article summarizes the future research directions proposed in the existing literature. Future research should investigate (1) the role of user characteristics in sleep tracking, (2) the emerging features and design innovations in sleep-tracking technology, (3) the external factors in different contexts, (4) the bright and dark sides of sleep tracking, and (5) design directions to address challenges in sleep-tracking technology.

Overall, Article VI presents four key findings: (1) Research on sleep tracking has been conducted across multiple disciplines, highlighting the need for more interdisciplinary collaboration; (2) current research mainly employed qualitative method approaches but lacked a clear dominant theory; (3) the majority of research investigated the sleep-tracking phenomenon in the context of daily life, with a primary focus on the impact of sleep-tracking technology on user behavior, health, and well-being; and (4) this study summarized future research directions proposed

by the literature from the perspective of five components. Finally, by synthesizing insights from prior research, this dissertation proposes agendas for future research on sleep tracking (see Section 7.4).

6 Discussion

Chapter 6 synthesizes the findings from all six articles to provide a comprehensive understanding of the overall research on sleep tracking. This chapter begins by integrating the findings from each article to address the main RQs (Section 6.1). This chapter then responds to the three sub-RQs in detail (Sections 6.2–6.4), highlighting how each article contributes to answering them. The synthesis presented in this chapter establishes the foundation for the subsequent conclusion.

6.1 User engagement in sleep tracking

In response to this growing interest and the call for further research in the area of sleep tracking (Baron et al., 2018; Cay et al., 2022; Choe et al., 2011; Hussain & Sheng, 2022), this dissertation focused on sleep tracking and addresses a timely and fundamental RQ: *How do people engage with sleep-tracking technology?*

Overall, this dissertation shows that people engage with sleep-tracking technology through complex interactions between individuals and technologies. These complex interactions go beyond simple causal explanations, such as the assumption that specific features directly influence user behavior. Instead, users engage with sleep-tracking technology in a diverse and complex way, shaped by individual differences in needs, values, and abilities, as well as by technological features, supplies, and demands. Users are motivated to engage with sleep-tracking technology to satisfy basic psychological needs for autonomy, competence, and relatedness. However, the same features that satisfy these needs for some users may lead to need frustration for others. Moreover, the configurations of technology affordances that emerge from user–technology interactions, together with the psychological outcomes, can jointly influence users’ advice-compliance behavior. Conversely, misfits or gaps between users and technology can give rise to sleep-tracking stressors that trigger emotional and behavioral strains. These stressors may, in turn, contribute to health anxiety and ultimately hinder positive engagement. Figure 14 shows the framework that synthesizes the research findings of this dissertation.

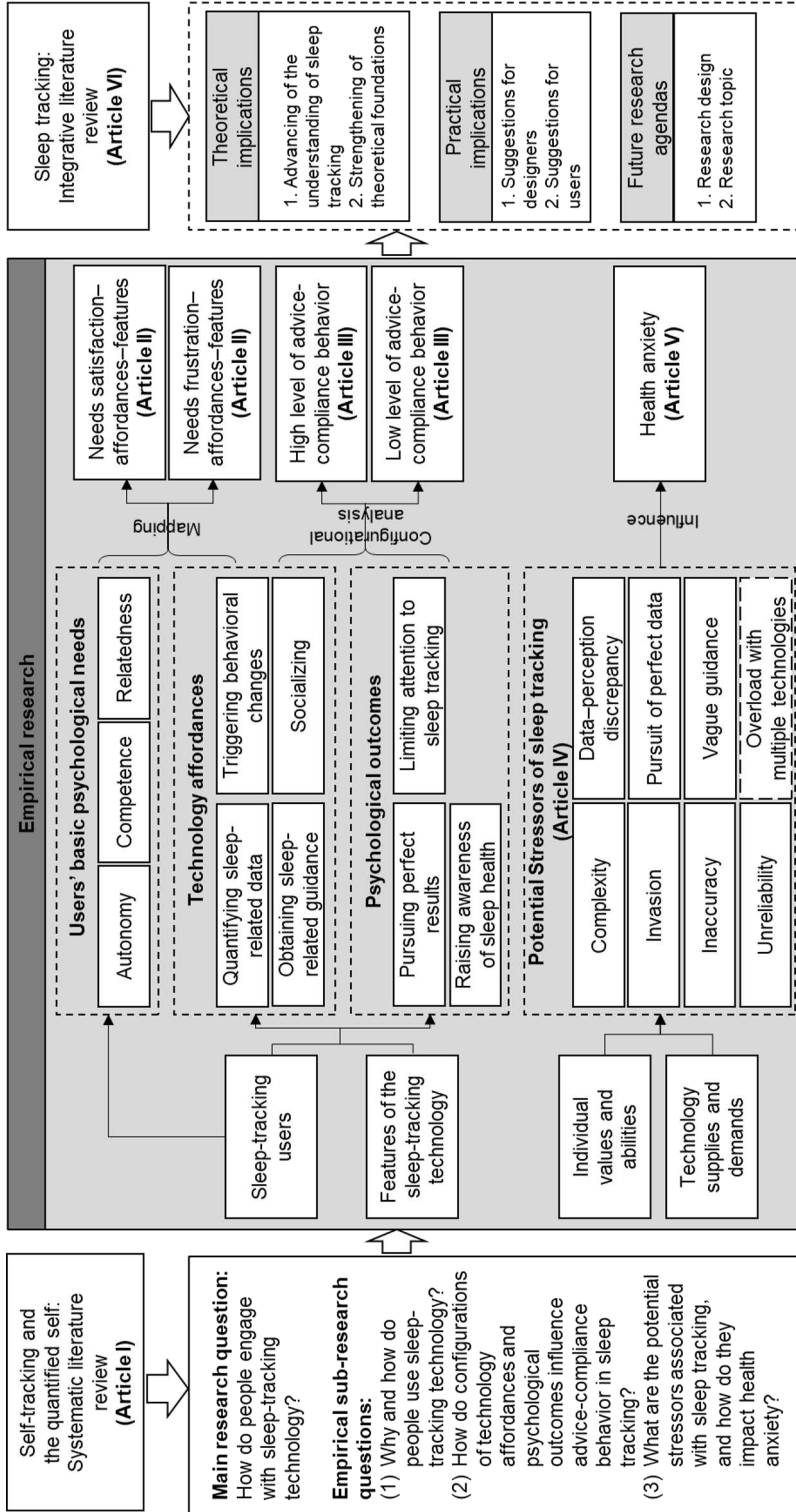


Figure 14. Framework synthesizing the findings of this dissertation

Synthesizing the findings across the individual studies, three overarching meta-findings emerge: a sociotechnical understanding of sleep tracking, the duality of sleep tracking, and the complex and asymmetric relationships in sleep tracking. First, this dissertation unpacked sleep tracking by clarifying the characteristics of the user, the technology, and the user–technology interaction in the context of sleep tracking. Guided by a sociotechnical perspective (Bostrom & Heinen, 1977), this dissertation clarified users' psychological needs satisfaction and frustration in the context of sleep tracking (Article II) and examined the psychological outcomes of using sleep-tracking technology (Article III). Moreover, this dissertation identified the technology affordances (Article III) and stressors resulting from the interactions between users and sleep-tracking technologies (Article IV). The findings extended prior studies on self-tracking, which have focused primarily on needs satisfaction (Jung & Kang, 2022; Kerner & Goodyear, 2017; Villalobos-Zúñiga et al., 2021; Zhou et al., 2022). Furthermore, this dissertation identified four technology affordances that are uniquely associated with sleep-tracking technology. These affordances capture distinctive patterns of user interaction that set sleep tracking apart from the broader self-tracking practices examined in prior research (e.g., Abouzahra & Ghasemaghaei, 2022; Benbunan-Fich, 2019). In addition, the identified potential stressors associated with sleep tracking broaden the previous research on stressors in self-tracking (e.g., Hoogstraten, 2018; Rieder, Vuckic, et al., 2020), providing an additional understanding of sleep tracking from the perspective of its adverse effects.

Second, this dissertation explored the duality of sleep tracking. Sleep-tracking technology can serve as a sleep health advisor (Article III), providing personalized health advice aimed at helping individuals increase their awareness of sleep health and improve sleep quality. However, such technology can also become a source of stress, leading to emotional and behavioral strains (Article IV) and health anxiety (Article V). The dual role of sleep tracking extends prior research by reinforcing the positive roles of sleep-tracking technologies, including teacher, informant, companion, therapist, coach, and mediator (Nagele et al., 2022), as well as the positive role of self-tracking as a tool, toy, and tutor (Lyall & Robards, 2018). This dissertation also highlights that sleep-tracking technologies can serve as a potential stressor, thereby contributing to the broader discussion on self-tracking stressors (Rieder, Vuckic, et al., 2020). Moreover, users may encounter both positive and negative experiences, as evidenced by the finding that sleep-tracking technology can both satisfy and frustrate their basic psychological needs (Article II). This finding is consistent with prior research on self-tracking, which shows that users may experience both need satisfaction and frustration (James et al., 2022; Soltani, Tuunanen, et al., 2024; Wannheden et al., 2021). Notably, the dual roles of advisor and stressor should not be viewed as contradictory, and the same applies to need

satisfaction and frustration. These experiences may occur within the same individual or at the same time, as users can experience both empowerment and strain in their interactions with sleep-tracking technologies. Building on these insights, the duality of sleep tracking underscores its complex nature, whereby positive and negative experiences are intertwined rather than mutually exclusive.

Third, this dissertation highlights that the outcomes of sleep tracking are variable and determined by individual differences, with asymmetrical relationships between the antecedents and consequences of sleep tracking. Given the complexity of sleep (Shochat, 2012) and the individual differences, this dissertation employed interviews and fsQCA to investigate these complex and asymmetric relationships in sleep tracking. In contrast to prior research that has primarily examined symmetrical causal relationships between user needs (e.g., James et al., 2022; Rockmann, 2019), technology features (e.g., J. Hu & He, 2020; Huang & Ren, 2020), and affordances (e.g., Rockmann & Maier, 2019; Suh, 2018) in relation to user behaviors, this dissertation provides a deep understanding of the complex interplay among user needs, technology affordances, and features in shaping user experiences with sleep tracking (Article II). Furthermore, unlike prior research, which has primarily employed SEM to present symmetry relationships in the context of self-tracking (e.g., Beh et al., 2021; Choi & Kim, 2024; James et al., 2022), this dissertation examined the configurational effects of technology affordances and psychological outcomes on advice-compliance behavior (Article III). This configurational approach provides multiple explanatory pathways that capture the asymmetric nature of relationships in sleep tracking. Significantly, engagement with sleep tracking is influenced by the degree of alignment between users and technologies. When alignment is achieved, sleep-tracking technology can satisfy user needs and contribute to compliance with advice (Articles II and III). However, when misfits or gaps emerge, the sleep-tracking technologies may frustrate users or create stressors (Articles II and IV).

6.2 Why and how people use sleep-tracking technology

The findings of Article II answer sub-RQ1: *Why and how do people use sleep-tracking technology?* The results revealed that users are motivated to use sleep-tracking technology to satisfy their three basic psychological needs: autonomy, competence, and relatedness. Different features of sleep-tracking technology afford users behaviors that can either satisfy or, in some cases, frustrate these needs, thereby shaping how people use and respond to the sleep-tracking technology.

First, in the context of sleep tracking, autonomy needs are satisfied when users perceive gentle suggestions and personalized features. The mapped NAF framework for autonomy needs satisfaction revealed that standardized definitions of “good sleep” cannot meet individual sleep patterns and life rhythms (Karlgrén & McMillan, 2022; Nguyen et al., 2018). The normalized goals may constrain users’ sense of autonomy (Busch et al., 2022). In this regard, these insights are supported by prior research, which suggested that the customization features and their associated affordances can help satisfy the need for autonomy (Pettersson et al., 2021; Zhou et al., 2022).

Conversely, compulsive behaviors, rigid notifications, and negative emotions resulting from the inability to respond to feedback may lead to autonomy frustration. This observation aligns with previous self-tracking research, which has indicated that unattainable tasks and pressure arising from performance evaluations can undermine users’ autonomy needs (Wanheden et al., 2021). While features such as notifications, performance evaluations, and recommendations enable the affordance of triggering behavioral changes to improve users’ sleep and health, users who comply with the advice provided by the technology may sacrifice their autonomy (Dadgar & Joshi, 2018). This finding highlights the need to strike a delicate balance between the advice provided by technology and the preservation of user autonomy.

Second, satisfying competence needs is important in sleep tracking, as it is associated with most technology affordances except socializing. As found in prior self-tracking research, competence satisfaction can arise from being aware of health data (Wanheden et al., 2021) and confidence in managing health (Soltani, Honigsberg, et al., 2024; Wanheden et al., 2021). Similarly, in the context of sleep tracking, users may experience a sense of control over their health when they receive quantified health data, illness detection information, and positive feedback from the sleep-tracking technology. Features such as informational feedback (Soltani, Tuunanen, et al., 2024), achievement and rewards (Jones et al., 2022; Rockmann, 2019), and self-monitoring (Rockmann, 2019) align with the features identified in this study that enable users’ competence satisfaction, including tracking, performance evaluation, guidance, and recommendations.

However, users may also experience competence frustration when receiving negative feedback or facing unreasonable goals. This frustration can arise from goals that are too difficult to achieve or too simplistic to offer useful value (Soltani, Honigsberg, et al., 2024; Wanheden et al., 2021). Prior research has shown that competence frustration negatively influences users’ continuance use of self-tracking technology (James et al., 2022). Accordingly, the mapped NAF framework for competence frustration highlighted the importance of setting appropriate goals and implementing supportive performance evaluation mechanisms.

Third, this study found that relatedness needs are relatively less central than autonomy and competence in terms of sleep tracking. Unlike fitness-tracking technology, wherein interaction features (Jones et al., 2022) and interactive affordances (Zhou et al., 2022) have a close relationship with relatedness satisfaction, the social interaction embedded in sleep-tracking technology may not be used as expected. Instead, users often integrate other technologies or social media platforms to satisfy their relatedness needs.

Furthermore, the relatedness frustration in sleep tracking may be less attractive, as few users would like to share and compare their sleep data with others. This observation might be explained by the fact that sleep is unique (W. Liu et al., 2015) and sleep tracking is highly individualized (Lyall, 2021). This limited role of relatedness in sleep tracking contrasts with broader self-tracking practices, wherein relatedness has been shown to play an important role in user engagement and motivation (Dijk & IJsselsteijn, 2016). Notably, users report frustration with relatedness needs only when attempting to share their sleep data with healthcare professionals. Although consumer-grade sleep-tracking technology is widely accessible, it is often less accurate than medical-grade sleep-tracking technology (Goldstein, 2020). As a result, it is challenging to convince healthcare providers to trust the data provided by consumer-grade sleep-tracking technology, thereby limiting the scope of technology use.

6.3 Users' post-adoption behavior: Advice-compliance behavior

The findings of Article III address sub-RQ2, which asked, *How do configurations of technology affordances and psychological outcomes influence advice-compliance behavior in sleep tracking?* This study identified four technology affordances and three psychological outcomes that emerge from the use of technology. Using configurational analysis, this dissertation uncovered two configurations associated with a high level of advice-compliance behavior and five configurations linked to a low level of advice-compliance behavior. The findings suggest that specific combinations of affordances and psychological outcomes can contribute to a high level of advice-compliance behavior, particularly when the affordances of obtaining sleep-related guidance and triggering behavior changes co-occur with the psychological outcome of pursuing perfect results.

From the perspective of specific technology affordance, this dissertation found that quantifying sleep-related data is a foundational affordance in sleep tracking, emphasizing the central role of self-monitoring associated with this affordance (Abouzahra & Ghasemaghaei, 2022; Ma et al., 2023). Furthermore, the affordances of obtaining sleep-related guidance and triggering behavior changes emerged as

important affordances in the context of sleep tracking. This finding aligns with prior research suggesting that reminders and notifications play an increasingly important role if users continue to use wearable devices (Ma et al., 2023). However, socializing affordance does not appear to be a central affordance influencing users' advice-compliance behavior. This finding may be attributed to the private and personal nature of sleep (e.g., Liu et al., 2015; Lyall, 2021), which users are often unwilling to share or compare with others. In contrast, social influence can significantly impact users' adoption and use behavior through social norms or expectations in general IT use (Dickinger et al., 2008; Venkatesh et al., 2003).

From the perspective of specific psychological outcomes, pursuing perfect results and raising awareness of sleep health are important factors contributing to users' advice-compliance behavior. Regarding the psychological outcomes of pursuing perfect results, although prior research indicated that data enthusiasts may retain the existing states (Rieder et al., 2020), the findings of this dissertation indicated that when rising awareness of sleep health is combined with specific technology affordances, users are more likely to comply with the advice provided by the technology. While sleep-tracking technology can indeed increase awareness of sleep health (Karasneh et al., 2022), such awareness alone is often insufficient to translate into behavioral changes (Liang & Ploderer, 2016). The findings support this point by providing several configurations in which these psychological outcomes, together with affordances, contribute to advice-compliance behavior. Additionally, this dissertation found that users who pay limited attention to sleep tracking may be less likely to comply with the advice. This finding is consistent with prior research describing passive users, who do not draw any conclusions from the tracked data but may experience neither benefits nor drawbacks from using sleep-tracking technology (Kuosmanen, Visuri, Kheirinejad, et al., 2022). Without users complying with advice, the full potential benefits of sleep-tracking technology cannot be fully realized (Ekpezu et al., 2023).

From a configurational perspective, this dissertation showed that in the context of sleep tracking, the combination of multiple technology affordances and psychological outcomes can contribute to a high level of advice-compliance behavior, even though individual affordances alone may not have a direct influence. These findings align with prior research in the activity-tracking context, which suggests that multiple affordances enable users to effectively use wearable technology to achieve their activity goals (Abouzahra & Ghasemaghahi, 2022). Compared to configurations contributing to high and low levels of advice-compliance behavior, this dissertation found that obtaining sleep-related guidance and triggering behavioral changes are an important pair of affordances associated with advice-compliance behavior. This finding supports previous research indicating that behavioral affordances can lead to compliance behavior and behavioral change

(Rieder, Lehrer, et al., 2020). Meanwhile, learning affordance is not sufficient to promote responses (Rieder, Lehrer, et al., 2020). Moreover, psychological outcomes play an important role when the affordance lens is considered in conjunction with behavioral outcomes (Buil et al., 2026; Shao et al., 2025; Sun et al., 2025; Xiao et al., 2025).

6.4 Users' negative experiences: Sleep-tracking stressors and health anxiety

The findings of Articles IV and V answer sub-RQ3: *What are the potential stressors associated with sleep tracking, and how do they impact health anxiety?* The findings identified eight potential stressors associated with sleep tracking: complexity, invasion, inaccuracy, unreliability, data–perception discrepancy, pursuit of perfect data, vague guidance, and overload with multiple self-tracking technologies. The findings demonstrated that misalignments between users and technology can contribute to negative user experiences, manifesting as emotional and behavioral strain. Furthermore, Article V examined the impact of these potential stressors on health anxiety, revealing that stressors such as invasion, unreliability, pursuit of perfect data, and vague guidance have positive effects on health anxiety. To support this analysis, Article V also developed and validated measurement scales for the identified stressors.

Although sleep-tracking technology can provide users with advice to improve their sleep health, the actual improvement does not always meet expectations (Liang & Ploderer, 2016; S. Zhang et al., 2019). In some cases, the use of sleep-tracking technology may even act as a stressor (Baron et al., 2017; Kuosmanen, Visuri, Kheirinejad, et al., 2022), potentially preventing improvements in sleep health. This dissertation identified eight potential stressors associated with sleep tracking by evaluating the misfits or gaps along the S–V and A–D dimensions of the P–T fit model (Ayyagari et al., 2011). These potential stressors are supported by previous research that highlights various barriers and challenges associated with sleep tracking from both user and technology perspectives, such as users' insufficient knowledge about sleep (Liang & Ploderer, 2016, 2020), technical issues (Kuosmanen, Visuri, Risto, et al., 2022; W. Liu et al., 2015), and inconsistencies between tracked data and users' perceptions (Ravichandran et al., 2017). These barriers and challenges support the identification of these potential stressors.

In addition, prior research has explored stressors in the broader self-tracking contexts, particularly in daily activity tracking (Rieder, Vuckic, et al., 2020) and performance-oriented sports, such as cycling and triathlon (Werner & Bischof, 2024). In the context of sleep tracking, some stressors overlap with those identified in other self-tracking contexts (Rieder, Vuckic, et al., 2020; Werner & Bischof,

2024), such as complexity, invasion, inaccuracy, unreliability, and data–perception discrepancy. However, sleep tracking also introduces stressors that are more specific to the sleep-tracking context, including pursuit of perfect data, vague guidance, and overload with multiple self-tracking technologies. The stressor related to the pursuit of perfect data aligns with the negative user experience described in the critical user archetype in sleep tracking, such as compulsive data checking and competition (Kuosmanen, Visuri, Kheirinejad, et al., 2022). Additionally, the stressors of vague guidance may stem from the inherently personal and complex nature of sleep and sleep tracking (Liu et al., 2015; Lyall, 2021). When users are unable to obtain personalized and actionable advice, their stress levels may increase. Moreover, many users in this study relied on multiple sleep-tracking technologies, resulting in information overload and increased stress.

The potential stressors identified in this dissertation may also lead to health anxiety. In particular, the intrusive features of sleep-tracking technology may disrupt users' daily routines, and constant exposure to personal health data can increase preoccupation with health, potentially contributing to health anxiety (Chae, 2015; Lagoe & Atkin, 2015). Technical issues can lead to unreliable or incomplete sleep data, which may result in misinterpretation and confusion, further increasing psychological distress. This finding aligns with prior research suggesting that unreliable healthcare IT is a key stressor contributing to negative psychological outcomes (Califf & Sarker, 2020). Moreover, users who strive to achieve optimal results often engage in compulsive behavior (Rieder, Vuckic, et al., 2020). When these expectations are unmet, health anxiety may follow. Meanwhile, the absence of clear and actionable guidance from sleep-tracking technology can also create ambiguity and uncertainty (Liang & Ploderer, 2016; W. Liu et al., 2015), which may further contribute to the development of health anxiety.

Furthermore, this dissertation found that stressors, such as complexity, inaccuracy, and data–perception discrepancy, demonstrate significant indirect effects on health anxiety. The results suggest that health anxiety may not result from one single stressor but, rather, from the compounded effect of multiple interrelated stressors acting together. This insight is particularly noteworthy, as it reveals the complex interrelationships among sleep-tracking stressors and further contributes to understanding the complexity of sleep tracking, which is deeply intertwined with users' lifestyles and contextual factors (Buysse et al., 1989; Shochat, 2012).

7 Conclusion

Chapter 7 discusses the theoretical and practical implications derived from the findings of this dissertation (Sections 7.1–7.2), highlighting how these findings contribute to the existing knowledge and inform theoretical development and practical applications. This chapter outlines the limitations of this dissertation (Section 7.3) and proposes agendas for future research on sleep tracking (Section 7.4).

7.1 Theoretical implications

Through six standalone yet interconnected articles, this dissertation presents four theoretical implications, including two associated with the understanding of sleep tracking and two related to the theoretical foundations.

7.1.1 Advancing the understanding of sleep tracking

This dissertation offers valuable theoretical insights into advancing the understanding of sleep tracking, including (1) conceptualizing sleep tracking by framing it as a sociotechnical practice and (2) contributing to the body of knowledge on sleep tracking from an IS perspective.

First, this dissertation conceptualizes sleep tracking as a sociotechnical practice, emphasizing the interactions between users and technology. Although prior research on sleep tracking has acknowledged the importance of user (e.g., Karlgren & McMillan, 2022; Nguyen et al., 2018), technological (e.g., Nuo et al., 2023; Robson et al., 2022), and contextual (e.g., Leblanc et al., 2022; Purnell et al., 2023) factors, it has often treated their effects on outcomes as straightforward antecedent–consequence relationships (e.g., Attie & Meyer-Waarden, 2023; Nguyen et al., 2018; Nuo et al., 2023), overlooking the interactive or synergistic effects that may emerge from their interrelations. This dissertation extends beyond the linear view by examining complex user–technology interactions, deepening the understanding of the sleep-tracking phenomenon as a sociotechnical practice. More specifically, Article II mapped users’ psychological needs with technology affordances and corresponding features, confirming that users’ needs can be simultaneously satisfied

or frustrated when they interact with sleep-tracking technologies. In addition, Article III investigated the joint effects of technology affordances and psychological outcomes on advice-compliance behavior, exploring multiple configurations that lead to high and low levels of advice-compliance behaviors. Articles IV and V also indicated that stressors associated with sleep-tracking technology arise from the misfits or gaps between users and their technologies.

Second, this dissertation contributes to the body of knowledge on sleep tracking by explicating the pathways of user engagement with sleep-tracking technologies through an IS research framework. By examining sleep tracking from an IS perspective, this dissertation advances the multidisciplinary discourse on sleep tracking (e.g., Gamel & Talaat, 2024; Kuosmanen, Visuri, Kheirinejad, et al., 2022; Tuominen et al., 2019) and echoes calls for multidisciplinary research on this phenomenon (e.g., Baron et al., 2018; Cay et al., 2022; Liang & Ploderer, 2016). Through an integrated examination of user needs and use patterns, advice-compliance behavior, and the potential stressors associated with sleep tracking, this dissertation advances a comprehensive understanding of sleep-tracking practices and enriches the existing literature in the domain of sleep tracking (e.g., Attie & Meyer-Waarden, 2023; Kuosmanen, Visuri, Kheirinejad, et al., 2022; Ravichandran et al., 2017). More specifically, by mapping users' psychological needs to technology affordances and features, Article II deepened the current understanding of why and how individuals use sleep-tracking technology (Attie & Meyer-Waarden, 2023; Kaitz et al., 2023; Nuo et al., 2023). Article III advanced understanding of how to realize the potential benefits of sleep-tracking technology by clarifying the patterns that contribute to advice-compliance behavior. Exploring post-adoption behavior, such as compliance with advice, is particularly important in the context of non-mandated self-tracking activities (Dhir et al., 2024), wherein users may choose to disregard the advice. Therefore, this dissertation helps explain why sleep-tracking technologies do not always lead to the intended improvement in sleep health (Liang & Ploderer, 2016; S. Zhang et al., 2019). Articles IV and V contributed to the existing research on the adverse effects of sleep-tracking technology (Jahrami et al., 2024; Kuosmanen, Visuri, Kheirinejad, et al., 2022) by outlining potential stressors along with their corresponding emotional and behavioral strains.

7.1.2 Strengthening the theoretical foundations

This dissertation offers two insights that aim to strengthen the theoretical foundations, including (1) enriching the sociotechnical perspective through a granular analysis of components' interaction and contextualizing within sleep tracking and (2) expanding the theoretical foundations used in empirical research to adapt to sleep tracking and self-tracking research.

First, this dissertation enriches the sociotechnical perspective by providing a granular analysis of the interactions between social and technical components and contextualizing them within the context of sleep tracking. Although prior research has primarily examined the characteristics of the social and technical components (Y. Liu et al., 2020; Münch et al., 2022; R. Y. M. Wong et al., 2021), this dissertation provides a fine-grained understanding of user–technology interactions by examining the affordances and stressors in the context of sleep tracking. Specifically, the affordance lens captures how users interact with sleep-tracking technology (Article III), whereas the stressors emerge from the misfits or gaps between users and technologies (Article IV). By exploring how these affordances and stressors influence users’ psychology and behavior in the context of sleep tracking (Articles III and V), this dissertation enriches the prior research on the complex interactions between social and technical components in sociotechnical systems (e.g., Dadgar & Joshi, 2018; Münch et al., 2022; Risius et al., 2024) and situates it within the context of sleep tracking.

Second, this dissertation expands the existing theoretical foundations employed by each empirical study through distinct theoretical pathways. Collectively, these extensions offer new avenues for advancing and integrating theories from related fields into the domains of sleep tracking and, more broadly, self-tracking. Specifically, Article II extended the prior research with the NAF perspective, which has focused solely on need satisfaction (e.g., Zheng & Jarvenpaa, 2021; Zuo & Shen, 2024), by incorporating the concept of need frustration. Article III enriches the current research on bundled technology affordances (Sun et al., 2025; S. Wang et al., 2023; Zhao et al., 2020) by examining the complex and asymmetric relationships among technology affordances, psychological outcomes, and advice-compliance behavior in the context of sleep tracking. Moreover, Article III emphasizes the critical role of psychological outcomes in complex and asymmetric relationships, which has also been highlighted in previous research on users’ interactions with technology (Buil et al., 2026; Shao et al., 2025; Sun et al., 2025; Xiao et al., 2025). Finally, Articles IV and V extend existing research on technostress within the self-tracking context (Hoogstraten, 2018; Rieder, Vuckic, et al., 2020) by focusing specifically on the stressors and strains associated with sleep-tracking technologies. Furthermore, this dissertation develops and validates instruments to measure the identified potential stressors, thereby enabling further quantitative research in this area.

7.2 Practical implications

Drawing on the empirical findings, this dissertation outlines seven practical implications: four aimed at guiding designers in improving sleep-tracking technology and three directed toward supporting users in effectively engaging with sleep-tracking technology.

7.2.1 Sleep-tracking designers

The empirical findings in this dissertation highlight four implications for sleep-tracking designers: (1) enhancing the detection accuracy and transparency of working mechanisms, (2) providing personalized feedback and guidance, (3) offering nonintrusive notifications enriched with educational and actionable insights, and (4) rethinking social features and comparative metrics.

First, the findings in this dissertation suggested that quantifying sleep-related data is a foundation for sleep-tracking technology, and specific sleep-tracking stressors are associated with detection inaccuracies and vague guidance. To address these concerns, sleep-tracking designers should improve the accuracy of sleep detection and ensure transparency in how the technology operates. Specifically, designers should optimize sensors and algorithms to provide users with trustworthy data. They could also expand cooperation with medical researchers to enhance data interpretability and technology reliability. Additionally, designers should improve transparency in the working mechanisms, as vague guidance may introduce stress for users. Improving the clarity of how the technology works may help users better understand and trust the data that it provides.

Second, this dissertation highlighted the importance of providing personalized feedback and guidance to users. Owing to individual differences in sleep patterns, users engage with sleep-tracking technology in different ways. As a result, the outcomes of technology affordances vary across users, including both psychological and behavioral outcomes. Moreover, users may experience different stressors, which are also closely related to their personal characteristics. Therefore, sleep-tracking designers need to prioritize the development of personalized feedback and guidance. Personalization plays a crucial role in satisfying users' diverse needs and avoiding adverse outcomes. Designers could enrich the raw data by allowing for more personalized data input, such as self-assessed feedback, personal preferences, sleep patterns, and lifestyle information. In addition, they could improve the technology by incorporating modular designs that support customizable features, adding advanced analysis driven by AI, and implementing adaptive feedback based on user preferences.

Third, designers should enhance notification features by providing nonintrusive, educational, and actionable insights. The findings of this dissertation indicated that compliance behavior is closely related to the affordances of obtaining sleep-related guidance and triggering behavioral changes. However, overly invasive and vague guidance can induce stress in users. Therefore, sleep-tracking designers need to strike a balance between informativeness and intrusiveness by carefully designing the form and content of notifications to ensure an optimal user experience. For example, designers could offer users multiple tailored options, present insights in a soft tone, and ensure that these insights are easy to understand. Additionally,

designers should enhance the advice provided by the technology to include more educational, actionable, and personalized information that supports meaningful interactions without overwhelming users.

Fourth, designers should reconsider social features and comparative metrics in the context of sleep tracking. The findings of this dissertation suggested that social interaction plays a less significant role in sleep tracking compared to other forms of self-tracking, such as fitness tracking. Sleep-tracking designers should be cautious when implementing socializing features, as sleep is a highly personal experience, and users may be reluctant to share their sleep data with others. Furthermore, designers should reconsider the comparative metrics in sleep tracking, as these are closely related to goal setting, performance evaluation, and the presentation of results. Designers should provide sleep goals that are both reasonable and sufficiently challenging. When evaluating performance, designers should account for individual sleep patterns and environmental contexts. Sleep results should be presented in a way that minimizes comparison with external and “ideal” sleep patterns. Instead, designers are encouraged to provide opportunities for self-comparison and long-term trends, which can be more meaningful and motivating for users.

7.2.2 Sleep-tracking users

The empirical findings in this dissertation highlight three implications for sleep-tracking users: They are encouraged to (1) take more responsibility and adopt a proactive role in managing their sleep, (2) remain attentive to their own feelings and perceptions, and (3) avoid overreliance on sleep-tracking technology.

First, the findings in this dissertation suggested that users should take more responsibility and adopt a more proactive role in managing their sleep. Although sleep-tracking technology can increase users’ awareness of their sleep health, converting this awareness into meaningful behavioral changes remains a challenge. Translating awareness into behavioral change requires users to be more actively engaged in sleep tracking, such as complying with the technology’s advice. Reflecting a shift from societal to neoliberal thinking (Lupton, 2013), sleep-tracking users should take more responsibility for their own health and actively change their behavior based on the advice provided by the technology.

Second, the findings highlight the importance of users’ own feelings and perceptions. While sleep-tracking technology provides valuable quantitative data to support users in understanding and improving their sleep, it is important that users trust their own perceptions and listen to their bodies. Given the personal nature of sleep (e.g., Liu et al., 2015; Lyall, 2021), users need to remain connected to their personal experiences when attempting to improve their sleep health. Relying solely

on the technology may undermine people's abilities to interpret their bodies' signals. Thus, sleep-tracking technology can be seen as a complement to personal health monitoring rather than as the sole source of insights.

Third, users need to avoid overreliance on technology. For instance, compliance and autonomy are a pair of swing values (Dadgar & Joshi, 2018), and users should strive to maintain a balance between these two rather than simply following the technology's recommendations. Although complying with the advice provided by sleep-tracking technology can support improvements in sleep health, it is also important for users to remain mindful of their autonomy needs and ensure that these are satisfied throughout their engagement with the technology. Additionally, overreliance on technology can introduce stress, particularly among users who pursue perfect results. While a certain level of stress may motivate users to comply with the technology's advice, excessive stress may also lead to health anxiety and negatively affect overall health.

7.3 Limitations

This dissertation has several limitations that warrant careful consideration. First, the scope and selection of the reviewed literature limit the findings derived from the literature review. This dissertation includes two literature reviews (Articles I and VI). The coverage of the reviews may be influenced by several factors, including the time span considered up to the end of the review period, the choice of databases, the selection of keywords, the focus on empirical research, and the applied inclusion and exclusion criteria. These limitations may have resulted in the omission of relevant literature, leading to gaps between the existing research streams and to a fragmented understanding of the field. Future research could expand the scope of the review articles to provide a more comprehensive view of the body of research.

Second, the generalizability of findings is limited by the selection of the focal technology and the characteristics of the recruited participants. The qualitative studies (Articles II–IV) in this dissertation focus specifically on one sleep-tracking smart ring, that is, the Oura ring, and are based on a single set of interview data. While each paper addresses different research questions and employs distinct theories, this still constrains the transferability of the findings. As a result, applying the findings to other sleep-tracking or broader self-tracking technologies requires further investigation. In addition, the sleep-tracking users recruited for the interviews (Articles II–IV) were from highly educated backgrounds. This result may be attributed to the high interest in sleep tracking among a specific user group. Future research should expand its scope to include participants with diverse backgrounds. Furthermore, the self-reported data collected from the voluntary

participants in both the qualitative and quantitative studies (Articles II–V) may reflect the viewpoints of more experienced and committed users of sleep-tracking technology. As a result, the findings may be less generalizable to casual or novice users.

Third, it is important to acknowledge the limitations inherent in the methodological approach employed in this dissertation. This dissertation used interviews (Articles II–IV), the Q-sorting approach (Articles III and V), and surveys (Articles III and V) to collect the data. The limitations arising from these methods include selection bias owing to the voluntary nature of interview participation, retrospective bias in the interviews, the subjectivity inherent in Q-sorting exercises, and the survey's cross-sectional design, which captured data at a single point in time. Integrating other research methods and research designs, such as experiments and longitudinal designs, as well as employing a mixed-methods approach, could add more value to research on sleep tracking. For instance, future research could examine users' responses to sleep-tracking technologies under varying environmental conditions through experimental approaches, explore long-term behavioral changes and sustained use through longitudinal analyses, and identify specific user and technological characteristics that influence the effective use of sleep-tracking technologies through mixed-methods approaches.

Fourth, although the selected theoretical foundations and philosophical stance offer a coherent framework and guidance for examining sleep tracking, they also limit the breadth of inquiry. Future research could integrate complementary theories and alternative philosophical perspectives to provide a more comprehensive view of the sleep-tracking phenomenon. For instance, future research could employ the stage-based model of personal informatics systems (I. Li et al., 2010) to explore users' reflections on the tracked personal information through different stages. Further research could adopt the transtheoretical model (Prochaska & Velicer, 1997) to explore the users' behavioral changes. Furthermore, this dissertation adopted the pragmatist stance, which acknowledges the coexistence of a single and multiple realities. Future research could adopt different philosophical stances to deepen the understanding of the underlying realities of sleep tracking. For example, future research could adopt a critical realist perspective on affordance theory (Volkoff & Strong, 2017) and apply the affordance actualization framework (Strong et al., 2014) to deepen understanding of the mechanisms underlying user goal achievement in sleep tracking.

Fifth, although this dissertation provides valuable insights into sleep tracking through its clearly defined RQs, theoretically grounded themes, and relevant outcomes, it is nonetheless limited in terms of its topics and scope. Future research should broaden the current focus by exploring additional factors that influence the sleep-tracking phenomenon. For example, this dissertation primarily highlights the

interactions between users and technologies, while the contextual circumstances surrounding users are not examined in depth. Future research could extend the focus beyond users and technologies to include contextual factors and investigate how environmental conditions influence users' behavior, advice compliance, and well-being. In addition, although this dissertation identified sleep-tracking stressors, future research could employ the transactional model of stress and coping (Lazarus & Folkman, 1984) to explore how people cope with sleep-tracking stressors.

7.4 Future research agendas

By integrating the insights from this dissertation with the current research status on sleep tracking, this dissertation proposes future research agendas from the perspectives of research design and research topics. Table 12 outlines the proposed future research agendas in the domain of sleep tracking.

Table 12. Agendas for future research on sleep tracking

Future research agendas		Description
Research design	Balancing qualitative with quantitative methods	<ul style="list-style-type: none"> ● Conducting quantitative research: testing the causal relationships between sleep tracking and the existing antecedents and outcomes ● Carrying out longitudinal research: exploring the long-term follow-up effects of sleep-tracking technology and how users' behavioral patterns change over time
	Strengthening theoretical foundations	<ul style="list-style-type: none"> ● Developing a dominant theory that is suitable for sleep tracking or self-tracking ● Integrating theories from various fields, such as self-determination theory, the health belief model, the models of the nature and drivers of effective use, the model of effective use for a single affordance, and stressor-strain-outcome
	Promoting interdisciplinary research	<ul style="list-style-type: none"> ● Engaging with and aligning investigations with established findings and practices from other fields
Research topics	Respect for individual differences and exploration of their impact on sleep tracking	<ul style="list-style-type: none"> ● Recognizing and understanding individual differences is a key to explaining user behaviors: diverse needs, preferences, and characteristics ● Exploring underemphasized topics: health status, health literacy, and user traits (e.g., self-control and self-efficacy) ● Examining user characteristics as antecedents and moderators
	Sleep-tracking technology evolution, user-centered design, and compatibility	<ul style="list-style-type: none"> ● Keeping up with the evolution of sleep-tracking technology: new technology and new features ● Exploring user-centered design: how to design sleep-tracking technology that adapts to the unique characteristics and needs of individual users ● Enhancing the compatibilities of sleep-tracking technology: privacy, data security, and industry standards
	The role of stakeholders and the external environment in sleep tracking	<ul style="list-style-type: none"> ● Highlighting the role of stakeholders in sleep tracking: hospitals (e.g., healthcare professionals, nurses, and caregivers), organizations (e.g., employers, departments, and companies), and education (e.g., teachers, parents, and classmates) ● Examining the influence of the external environment: support from family/hospital/organization/school, social norms, workplace culture, and peer pressure
	Impacts beyond benefits: underlying mechanisms of use, effective use, behavioral change, and potential side effects	<ul style="list-style-type: none"> ● Understanding the underlying mechanisms of sleep-tracking adoption/continued use/dropout, especially from the user and contextual perspectives ● Going beyond the use of sleep-tracking technology to its effective use ● Investigating behavioral change from a more granular analysis, with support from established behavior change-related theories ● Addressing the dark sides of sleep tracking: technostress, orthosomnia, mechanistic dehumanization in the organizational context, the outcomes of technostress (techno-eustress and techno-distress), and coping strategies

7.4.1 Research design

From the research design perspective, this dissertation proposes three future agendas, focusing on research methods, theoretical foundations, and interdisciplinary cooperation. First, future research should aim to achieve a balance between qualitative and quantitative methods. As noted in Article VI, half of the reviewed studies relied on qualitative research methods. Building on this insight, future research could adopt quantitative and mixed-methods approaches to provide a more comprehensive understanding of the sleep-tracking phenomenon. For instance, researchers could investigate causal relationships by identifying the antecedents and outcomes of sleep-tracking behaviors. Additionally, the longitudinal research design, as recommended in prior studies (Attie & Meyer-Waarden, 2023; Liang & Ploderer, 2020; Vandenberghe & Geerts, 2015), could help capture behavioral patterns over time and shed light on the long-term effects of using sleep-tracking technology.

Second, current research on sleep-tracking technology lacks a dominant theoretical foundation. Future research could focus on developing a robust theoretical basis that is specifically for sleep tracking or extending existing theories to better explain the phenomenon. Although this dissertation benefits from employing several theories from the IS field, future research could further integrate theories from other fields—for example, the persuasive systems design model (Oinas-Kukkonen & Harjumaa, 2009) and the health belief model (Rosenstock, 1960; Rosenstock et al., 1988).

Third, there is a growing call for interdisciplinary research on sleep-tracking technology (Baron et al., 2018; Cay et al., 2022; Liang & Ploderer, 2016). IS researchers should engage with and align their investigations with established findings and practices from other fields, such as medicine, HCI, and engineering. In addition, researchers should ensure interdisciplinary coherence and relevance while demonstrating respect for the rigor and contributions of other related research fields.

7.4.2 Research topic

From the perspective of research topics, this dissertation proposes four future research agendas. First, this dissertation highlights the importance of recognizing and understanding individual differences. Future research should continue to prioritize this focus. Individual differences are particularly relevant in the context of sleep tracking, as both sleep and sleep tracking are highly individualistic activities (Liu et al., 2015; Lyall, 2021). Therefore, user-related factors warrant further attention in future research. Although this dissertation considered users' needs (Article II) and individual values and abilities (Article IV), other factors, such as health status, health literacy, and user traits, were not fully explored. These factors

may play a critical role in understanding how users interact with sleep-tracking technology. Moreover, user characteristics may serve as important antecedents and moderators in understanding patterns of sleep-tracking technology use. Future research should explore user characteristics more systematically in the context of sleep tracking.

Second, in terms of sleep-tracking technology, future research should keep pace with its rapid evolution and examine how new features, such as EEG-based tracking data and AI-assisted sleep recommendations, influence user behavior. Furthermore, future research should prioritize user-centered design. This approach can better meet the diverse needs and preferences of individual users. In addition, researchers should address critical concerns related to data privacy, data security, and compatibility, especially when sleep-related data are shared across multiple self-tracking platforms or integrated into broader healthcare systems.

Third, future research should investigate the influence of stakeholders and external environments across various contexts. While this dissertation focused on individuals' use of sleep-tracking technology in their daily lives, future studies could examine its application in organizational, clinical, and educational settings. For example, future studies could investigate the role of stakeholders in implementing sleep-tracking technology and explore the potential impact of this technology on employee task performance. Furthermore, the existing research has emphasized the significant influence of the external environment on user behavior regarding wearable technology (e.g., Dhir et al., 2024). Future work should also consider both external and internal factors to gain deeper insight into the sleep-tracking phenomenon.

Fourth, future research should explore the impact of sleep-tracking technology from a more specific and nuanced perspective. Although previous studies have examined user behaviors, such as use intention (e.g., Attie & Meyer-Waarden, 2023), actual use (e.g., Attie & Meyer-Waarden, 2023; Leblanc et al., 2022), and continuance use (e.g., Kaitz et al., 2023), there is still a gap in the understanding of the underlying mechanisms of engagement behaviors from both the user and contextual perspectives. In addition, effective use deserves further attention in the context of sleep tracking. Current research has found that sleep-tracking technology does not always improve sleep health in the desired way (Liang & Ploderer, 2016; S. Zhang et al., 2019). Therefore, it is important to investigate how technology can be used to achieve the intended goals (Burton-Jones & Grange, 2013). Building on this, future research should be geared toward more granular analyses of the effects of sleep-tracking technology, including compliance behavior, the behavioral change process, and long-term impacts on users' health and well-being. While acknowledging the positive outcomes, it is equally important to examine the potential adverse effects of sleep tracking, such as technostress, orthosomnia, and

mechanistic dehumanization in the organizational context. Although this dissertation identified the potential stressors associated with sleep tracking (Article IV), further research is needed to explore the positive and negative effects of these stressors as well as coping strategies.

Abbreviations

A–D	Abilities–Demands
ACM	Association for Computing Machinery
AIS	Association for Information Systems
AVE	Average Variance Extracted
CB-SEM	Covariance-Based Structural Equation Modeling
CMB	Common Method Bias
CR	Composite Reliability
csQCA	Crisp-Set Qualitative Comparative Analysis
EEG	Electroencephalogram
fsQCA	Fuzzy-Set Qualitative Comparative Analysis
HCI	Human–Computer Interaction
ICT	Information and Communication Technology
ILR	Integrative Literature Review
IS	Information Systems
IT	Information Technology
JCR	Journal Citation Reports
mvQCA	Multi-Value Qualitative Comparative Analysis
NAF	Needs–Affordances–Features
PLS	Partial Least Squares
PSG	Polysomnography
P–T	Person–Technology
QCA	Qualitative Comparative Analysis
RQ	Research Question
SDT	Self-Determination Theory
SEM	Structural Equation Modeling
SLR	Systematic Literature Review
SNS	Social Networking Service
SSO	Stressor–Strain–Outcome
SRMR	Standardized Root Mean Square Residual
S–V	Supplies–Values
WoS	Web of Science

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Appendices

Appendix 1. The interview protocol

1. Personal background

(1) Gender

- A. Male
- B. Female
- C. Prefer not to say

(2) Age range

- A. 18–24
- B. 25–44
- C. 45–65
- D. Over 65

(3) Educational background

- A. Primary or secondary education
- B. Vocational education/polytechnic training
- C. Bachelor's degree
- D. Master's degree/PhD
- E. Other

(4) You are identified primarily as a

- A. Student
- B. Employed
- C. Entrepreneur/self-employed
- D. Retired
- E. Unemployed
- F. Other

2. Use habits (habits related to sleep tracking and the use of different features of the ring)

(1) Which generation of the Oura ring are you using? Oura Ring Generation 2/Oura Ring Generation 3?

(2) How long have you been using the Oura ring?

(3) What were your expectations before using the ring?

(4) How often do you check the Oura app? How many times a day? At what times, typically?

(5) What is your primary goal set in the app? (For example: be more present and focused, improve my athletic performance, manage stress levels, improve my health, etc.)

(6) What types of data do you like to follow and check?

(7) Do you like the notification feature in the app?

(8) Have you used meditation and breathing sessions in the app?

(9) Have you ever shared your data with others?

3. Evaluation of the positive and negative sides of the ring

(1) Compared to when you did not have the ring, how does using the Oura affect your sleep?

(2) To what extent do you think the data from the Oura ring can help you change your daily routine?

(3) In your opinion, what is the best thing about the Oura ring?

(4) Are there any aspects of the ring or its usage that you are not satisfied with or that have made you upset or frustrated?

4. Personal stories, experiences, and critical incidents

Can you share any positive or negative personal stories, experiences, or critical incidents with Oura?

Appendix 2. The survey instrument

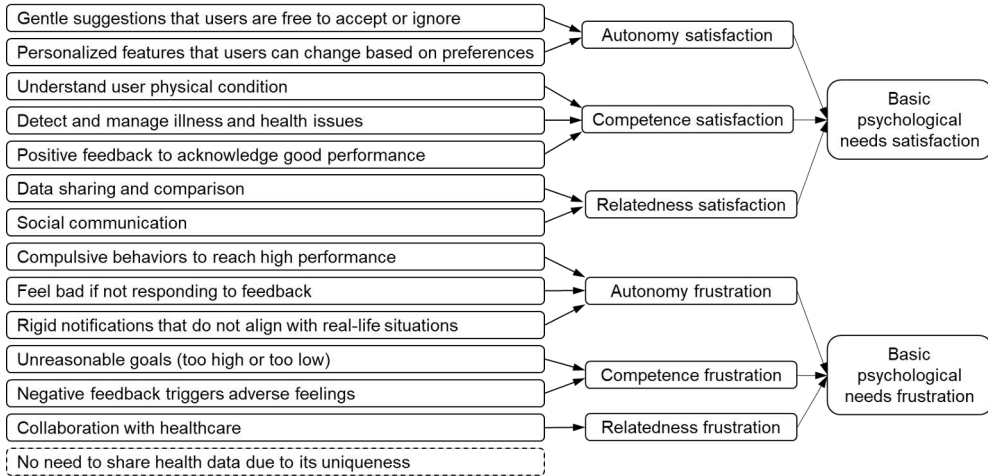
Construct	Measurement items	Reference
Technology affordances		
Quantifying sleep-related data	<p>The wearable device I currently use enables me to ...</p> <ol style="list-style-type: none"> 1. collect my sleep-related data. 2. record my sleep-related data. 3. accumulate my sleep-related data. 4. manage my sleep-related data. 5. observe patterns in my sleep-related data. 6. analyze my sleep-related data. 7. calculate my sleep score based on my sleep-related data. 8. graph my sleep-related data. 	James et al. (2019)
Obtaining sleep-related instructions	<p>The wearable device I currently use enables me to ...</p> <ol style="list-style-type: none"> 1. engage in sessions related to sleep (e.g., mindfulness, meditations, and sleep stories). 2. receive advice for improving sleep health. 3. obtain interpretations of sleep metrics. 4. receive guidance for improving sleep health. 	James et al. (2019)
Triggering behavioral changes	<p>The wearable device I currently use enables me to ...</p> <ol style="list-style-type: none"> 1. start winding down before my optimal bedtime window based on the notifications from my wearable device. 2. maintain a consistent sleep rhythm based on my chronotype (body clock) recorded from my wearable device. 3. improve my sleep habits through rewards obtained from my wearable device. 4. improve my sleep habits based on sleep-related information from my wearable device. 5. wake up at a time recommended by my wearable device. 6. go to bed at a time recommended by my wearable device. 	New construct
Socializing	<p>The wearable device I currently use enables me to ...</p> <ol style="list-style-type: none"> 1. share my sleep-related information with others. 2. compare my sleep-related information with others. 3. share my user experience on social platforms (e.g., Facebook and Reddit). 4. team up with other users via my device or its app. 5. break the ice by talking about my wearable device when meeting new people. 	James et al. (2019) and Lee et al. (2021)
Psychological outcomes		
Pursuing perfect results	<ol style="list-style-type: none"> 1. I try my best to get good sleep results from my wearable device. 2. I usually put in a great effort to get good sleep results from my wearable device. 	Feng & Mäntymäki (2024)

	3. I keep tracking my data to maintain good sleep results from my wearable device.	
Raising awareness of sleep health	<ol style="list-style-type: none"> 1. As a result of using the wearable device to track my sleep, I am conscious of my sleep health. 2. As a result of using the wearable device to track my sleep, I am reflective about my sleep health. 3. As a result of using the wearable device to track my sleep, I am aware of my sleep health. 	Twenge et al. (2007)
Limiting attention to sleep tracking	<ol style="list-style-type: none"> 1. When using my wearable device, I am “running on automatic” without much awareness of what I am doing. 2. I go through the data provided by my wearable device without being really attentive to it. 3. I check the data from my wearable device automatically without any further reactions. 4. When using my wearable device, I find myself using it without paying attention. 5. I check the data from my wearable device automatically without being aware of what I'm doing. 	Dam et al. (2010)
Behavioral outcomes		
Advice-compliance behavior	<ol style="list-style-type: none"> 1. I execute the advice prescribed by my wearable device at the right time. 2. I follow the advice given by my wearable device regularly and continuously. 3. I follow my wearable device's advice. 	Wittkowski et al. (2020)
Sleep-tracking stressors		
Complexity	<ol style="list-style-type: none"> 1. I need a long time to understand how to use my wearable device. 2. I do not find enough time to upgrade my technology skills to use my wearable device. 3. I do not know enough about my wearable device to use it satisfactorily. 4. I often find my wearable device too complex to use. 	Maier et al. (2015)
Invasion	<ol style="list-style-type: none"> 1. I have to pay a lot of attention to the notifications from my wearable device during the day and evenings. 2. I have to spend a lot of time checking the data provided by my wearable device. 3. I feel my personal life is being invaded by my wearable device. 	Maier et al. (2015)
Inaccuracy	<ol style="list-style-type: none"> 1. My wearable device produces incorrect sleep-related data. 2. There are some errors in the sleep-related data from my wearable device. 3. The sleep-related data provided by my wearable device is not accurate. 	Wixom & Todd (2005)
Unreliability	<ol style="list-style-type: none"> 1. I think that I am too often confronted with unexpected technical issues with my wearable device. 2. I think that I spent too much time trying to fix technical issues with my wearable device. 3. Technical issues with my wearable device occasionally disturb my sleep tracking. 	Fischer et al. (2021)

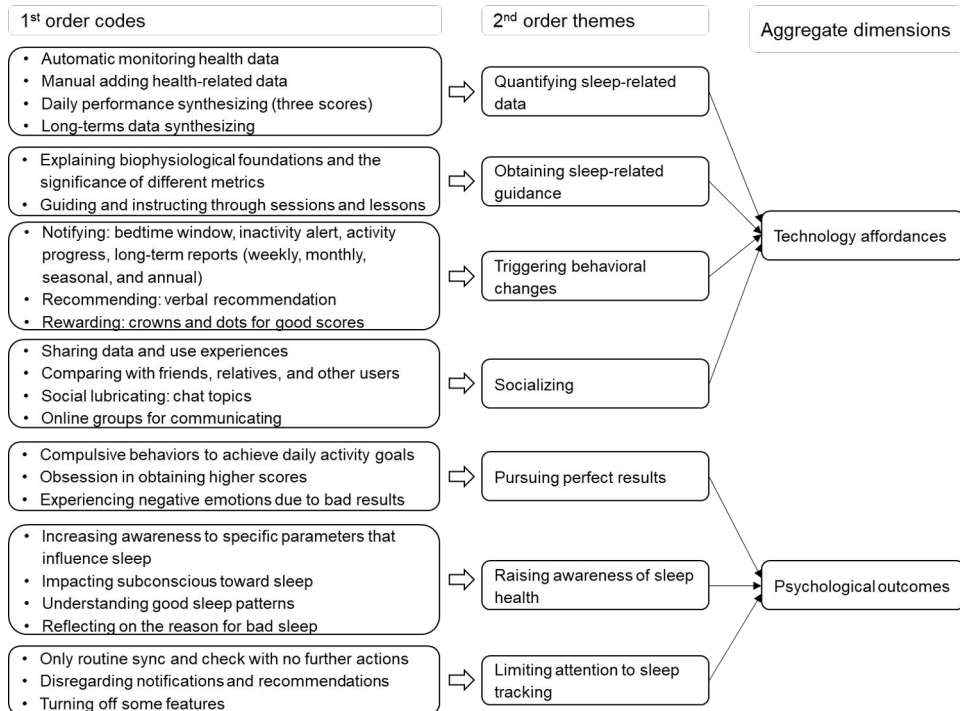
	4. I have encountered technical issues with my wearable device that have impeded my sleep tracking.	
Data–perception discrepancy	<ol style="list-style-type: none"> 1. My perception regarding my sleep does not align with the data provided by my wearable device. 2. I think the data provided by my wearable device does not match how I feel about my sleep. 3. There is a misfit between how I feel about my sleep and the data my wearable device provides. 	New construct
Pursuit of perfect data	<ol style="list-style-type: none"> 1. I try my best to get good sleep results from my wearable device. 2. I usually put in a great effort to get good sleep results from my wearable device. 3. I keep tracking my data to maintain good sleep results from my wearable device. 	New construct
Vague guidance	<ol style="list-style-type: none"> 1. My wearable device cannot provide accurate suggestions to improve my sleep. 2. The suggestions from my wearable device are not helpful in improving my sleep. 3. The suggestions from my wearable device are not suitable for the specific situations I am facing. 4. The suggestions from my wearable device often lack the detail necessary to improve my sleep. 5. My wearable device cannot provide an explanation for the poor sleep results it gave me. 	New construct
Adverse outcome		
Health anxiety	<ol style="list-style-type: none"> 1. When receiving poor results from my wearable device, I am worried about my health. 2. When receiving poor results from my wearable device, I am aware of my bodily sensations and changes. 3. When receiving poor results from my wearable device, I am afraid that I have a serious illness. 4. When receiving poor results from my wearable device, I wonder what they mean. 5. When receiving poor results from my wearable device, I imagine myself being ill. 6. When receiving poor results from my wearable device, I feel at risk of developing an illness. 7. When receiving poor results from my wearable device, I think I might have a serious illness. 	Salkovskis et al. (2002)

Appendix 3. Coding process in Articles II, III, and IV

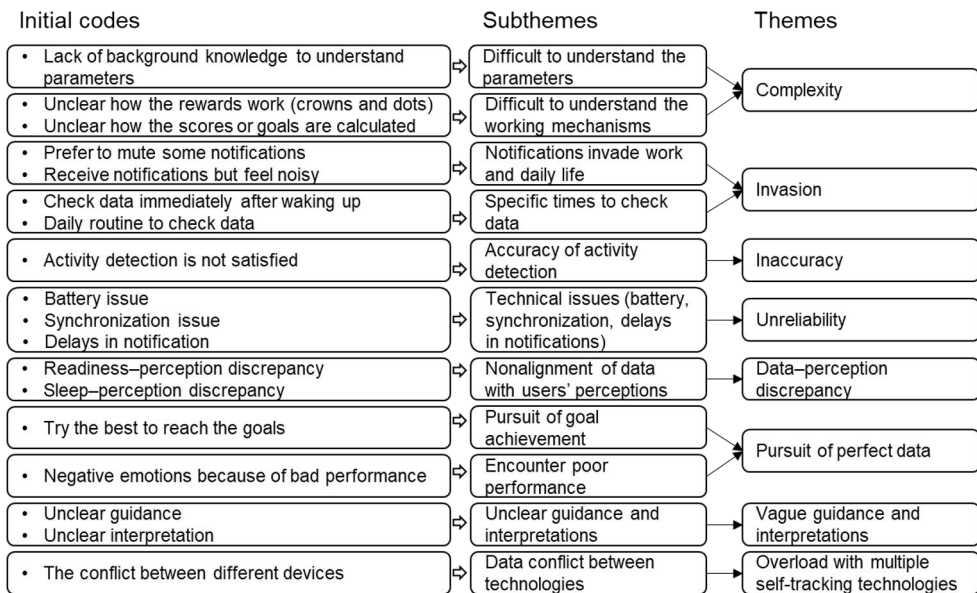
(a) Coding process for identifying satisfaction and frustration of basic psychological needs (Article II).



(b) Coding process for identifying affordances of sleep-tracking technology (Article III).



(C) Coding process for identifying potential stressors from sleep tracking (Article IV)





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