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Sleep, Knowledge, Technology. An Introduction

Hannah Ahlheim, Dariuš Zifonun & Nicole Zillien [*]

Abstract: »*Schlaf, Wissen, Technologie. Eine Einleitung«.* This article conceptualizes sleep as a social fact. Far from being a simple biological necessity, sleep is imbued with meaning. We argue that in the "knowledge society," science and technology play a key role in producing the social meaning of sleep and in grating validity to certain styles of "sleep knowledge." Paradoxically, in their search for "valid" knowledge, actors turn to science while at the same time science often offers provisional and contested knowledge. In particular, the modern sleep laboratory and mobile self-tracking technologies prove to be epistemically productive. They open up arenas for (experimental) practices that contribute to producing, applying, and legitimizing sleep knowledge. The article traces the historical processes that led to the invention of the modern sleep lab and current mobile technologies and sheds light on the questions of how knowledge about sleep and its disorders is produced, which sleep knowledge people view as valid, and how this attribution of validity is legitimized. Furthermore, the boundaries between sleep lab and society at large are permeable. Scientific knowledge leaves the lab and enters the social stage, which is why the scientific ideal of objectivity directly encounters the prevailing social and subjective knowledge. In addition to providing the conceptual outline for this HSR Special Issue on "Sleep, Knowledge, Technology," the article provides synopses of its nine thematic contributions.

Keywords: Sleep, knowledge, technology, sleep laboratory, mobile self-tracking, experiment.

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1. Sleep in the "Knowledge Society"

Having neglected sleep for a long time, historians, social scientists, and anthropologists have only recently begun to elaborate that this "biological necessity" is strongly shaped historically, culturally, and socially: sleep habits and sleep disturbances vary, sometimes considerably, across centuries, social classes, and cultures. Nevertheless, sleep is all too often described as a physiological phenomenon – an "apparently a-sociological phenomenon of unconsciousness" (Taylor 1993, 463) or "social nothingness" (Aubert and White 1959, 325) – and is thus understood as quite limited in its susceptibility to being shaped by social and cultural factors (Marinache 2015, 17). To move beyond this narrow view, the sociologist Brian Taylor replaces the common notion of "being asleep" with the more sociologically amenable one of "doing sleeping" – opening up a new perspective on sleep and sleeping. In the context of the "knowledge society," the concept of sleep no longer assumes that it simply takes place but instead is "made" with recourse to scientific knowledge and techniques (Stehr 2001; Weingart 2003; Vogel 2004; Raphael 2013). A significant contribution in this context was the establishment of sleep laboratories in the 1970s and the spread of new technologies for measuring sleep, which has enabled the systematic, interdisciplinary production of knowledge about sleep and sleeping and has influenced ideas about the malleability of sleep decisively. For mundane practices, this conception of sleep as something that is "made," and thus formable and optimizable, is accompanied by the need to fully understand the desired conscious and efficient use of sleep. This requirement is however difficult to fulfil – not least because the nature of the scientific knowledge required is always provisional, fragile, and contested.

In this HSR Special Issue, we address this topic by exploring the production, application, and legitimation of knowledge about sleep. We analyze the ways in which scientists, experts, and laypersons as well as mere sleepers are "doing sleep" by means of producing, developing, changing, and applying knowledge about it. Practices involved in scrutinizing, measuring, defining, quantifying, visualizing, governing, and optimizing the slumbering body not only reveal but also produce and determine the phenomenon of sleep itself.

Our focus illuminates practices undertaken while studying sleep in the laboratory and with the help of self-tracking. While "sleep laboratories" were considered rather unusual places for research until the 1980s, today they are part of everyday life in hospitals and research institutions. Awareness of the relevance of sleep in medicine and scientific research has been growing continuously since the 1970s. Devices have had to be developed and adapted, while scientists and physicians have defined areas of application, looked for test subjects, tested measurement techniques, and applied for funds. With

the measurement and description techniques that have been developed, new disease patterns have emerged and ideas about "healthy" sleep have changed, and today sleep disorders have been recognized as illnesses that are worthy of treatment and can be diagnosed according to standardized guidelines. Yet neither the technological devices themselves nor the knowledge indicating how to use or interpret them have remained within the walls of the scientific laboratory. As early as the 1970s, motion sensors were used that could be worn around the wrist, making it possible to carry out outpatient examinations of sleep-lab subjects. Portable laboratory instruments such as the "Marburg suitcase" developed in 1981 have made it possible to measure respiration, oxygen saturation, snoring noises, pulse rates, eyelid openings and movement, and sleep positions, and even produce electroencephalographs (EEGs) in the bedroom at home (Kluge 2014). These developments can be regarded as precursors of today's technologies for digital self-tracking of sleep.

Both laboratories and sleep trackers offering generally accepted knowledge about an individual's sleep are part of everyday life in highly scientified and digitalized societies of the 21st century. This special issue challenges this apparently "secure" knowledge by focusing on the social and historical conditionality of sleep.

In the following, we explore the question of how knowledge about sleep is produced, what role science and knowledge play in this process, which sleep knowledge people view as valid, and how this attribution of validity is legitimized. Thus, this volume contributes to a better understanding of a society whose members (have to) draw on knowledge for orientation and decision-making in everyday life.

2. From the Birth of the Sleep Laboratory to Sleep Tracking

Since the late 19th century, a growing number of experts and scientists have produced recognized sleep knowledge in one central location: the sleep laboratory. Sleep laboratories are dedicated to the individual treatment of patients' sleep problems while at the same time aiming to produce objective sleep knowledge by establishing scientific methods, theories, technologies, and typologies.

For a long time, the analysis of sleep depended on recollected narrations of sleepers or their perceptions immediately after waking up. Only the observation of the "sleep of others" (Kroker 2007) in a laboratory-like situation seemed to make systematic research into the state of "sleep," which is inaccessible to consciousness, possible at all. In this respect, new technologies, measuring instruments, and devices have played a decisive role (Kroker 2007;

Williams 2011; Wolf-Meyer 2012; Penzel 2014, 221; Ahlheim 2018a, 2019). The discovery of REM sleep in the early 1950s is considered the "hour of birth" of sleep research: rapid eye movements during sleep, measured with the help of the electro-oculogram (EOG), resembled EEG waves indicating wakefulness; the so-called "dream sleep" was discovered. Since the 1960s, American psychologists, psychoanalysts, pharmacologists, physiologists, and neurologists in particular have joined forces to measure sleeping and dreaming subjects in the laboratory. For decades, the measuring methods developed in the 1960s formed a basis for sleep knowledge that was rarely questioned anywhere in the world (Rechtschaffen and Kales 1968).

Since the 19th century, so-called gentleman science has proven the validity of scientific knowledge through direct witness of public experiments (Porter 1995). Now, the ascription of validity depended increasingly on the use of standardized procedures and technologies as well as a quantified representation of knowledge. Personal trust was thus replaced by "trust in numbers" (Porter 1995). This also explains why, in modern times, the subjective influence of experimenters was understood as a disturbing factor and therefore had to be eliminated from the process of knowledge production through standardization, technologization, and quantification. Against this background, contemporary sociological studies analyze how sleep and sleepers become the object of scientific analysis in the sleep laboratory (Kroker 2007; Moreira 2006; Williams, Coveney, and Meadows 2015; Krause 2016). In the laboratory, sleep is determined by means of technical measurements of brain waves, respiration, heartbeat, and eye movements, categorized according to standardized rules, visualized in the form of diagrams, and evaluated in alignment with medical classifications (Krause 2016). In the 1970s and 1980s, the "discovery" of sleep apnea was of great importance with regard to this development. The effects of dangerous breathing pauses are neither directly accessible to those affected nor to outsiders; rather, they become apparent only through polysomnographic measurement. Sleep apnea thus appears as "the apotheosis of the twentieth-century practice of studying the sleep of others in the laboratory" (Kroker 2007, 398), which no longer needs the subjective perception or awareness of sleepers themselves. Thus, the relevance of technologies is emphasized, as is that of a "clinical gaze" (Foucault 1973) that transforms the patient's problem into one that physicians can solve (Krause 2016, 339; Williams, Coveney, and Meadows 2015, 1043; Schubert 2006, 104).

In spite of this apparent scientific progress, however, a linear narration of technologization, standardization, and quantification is too simple. Subjective assessments have remained relevant and have even gained new momentum in sleep research: Today, sleep research regularly resorts to the subjective evaluation of one's own sleep quality, grafting a social process on to measurement technology in the sleep lab. Indeed, individual assessments and experiences play a major role in the interpretation of sleep data.

Accordingly, the standardized laboratory research that produces an "artificial product" of sleep profiles also countenances subjective forms of knowledge, so that knowledge production can be understood as an interplay between objectifying technology and subjective assessment. This understanding of the sleep laboratory can be linked to the tradition of laboratory research and studies of work (Knorr Cetina 1995; Bergmann 2008). From this perspective, knowledge of sleep is produced in a (self-)experimental procedure that involves situated practices as well as established bodies of knowledge and at the same time proves to be suitable for everyday life in light of the continuous linkage to subjective experiences. Against this background, the arrangements that accommodate sleep measurement can also be understood as "experimental systems" (Rheinberger 1997) which aim at the production of new knowledge in an interplay of technologies, researchers, skills, and the laboratory environment, even as these systems themselves become objects of investigation. From such a pragmatist perspective, the analytical focus is on all actors and elements involved in the production of knowledge (Clarke 2005; Star and Griesemer 1989). Sleep knowledge thus emerges in the "cooperative system" (Soeffner 1991, 368) of the sleep laboratory. Patients and their relatives, physicians and researchers, nursing staff, hospital management, technology manufacturers, and others together constitute the personnel of the corresponding "social world" (Strauss 1978; Clarke and Star 2008). In this social world, however, not only are sleep problems solved, but also what is to be understood by sleep at all is negotiated.

The knowledge, data, and new norms generated in the sleep laboratory soon however left the specific, technically equipped space of knowledge production, as the measurement methods themselves also proved to be "mobile." The "techniques" of the sleep laboratory have conquered the private bedroom in the form of respirators or sleep trackers. In general, self-tracking technologies (for sleep) have been spreading rapidly since the beginning of the 21st century (Williams, Coveney, and Meadows 2015). Numerous publications are now devoted to the digital recording, storage, processing, and transmission of personal data arising from the body, behavior, and the environment in general (cf., e.g., Duttweiler et al. 2016; Lupton 2016; Mämecke, Passoth, and Wehner 2018; Selke 2016; Zillien 2020). Individual studies also focus specifically on sleep measurement (Williams, Coveney, and Meadows 2015; Meißner 2016). A distinction is made between smartphone apps that measure sleep using motion sensors and microphones; technologies worn on the body such as watches, wristbands, or headbands; and sensors positioned between the mattress and sheets, for example, which, like laboratory technologies, can record brain waves, body temperature, muscle tension, and eye movements (Liu, Ploderer, and Hoang 2015; Williams, Coveney, and Meadows 2015). Among other things, it has been shown that measuring one's own sleep does more than contribute to our understanding and treatment of acute sleep

disorders – this practice, which involves analyzing everyday sleep patterns, also aims to "understand the impact our sleep has on how we feel and function" (Williams, Coveney, and Meadows 2015, 1047). The production of sleep knowledge has therefore changed its "place" since the end of the 20th century, leaving the specific sphere of the laboratory and penetrating everyday society.

3. Sleep, Knowledge, Technology

With this spread of knowledge and technology, sleep has increasingly become the object of formation. The idea of being able to shape sleep is also linked to the idea of "optimizability," which requires the sleeping individual to use sleep as a "resource" consciously, efficiently, and "correctly" (Ahlheim 2018b; Crary 2013). The contributions in this special issue investigate which kinds of knowledge are capable of producing certainty and how these bodies of knowledge circulate beyond the boundaries of the laboratory and enter everyday life.

Overall, the following questions are guiding our research: Which measurement methods, which norms, standards, and modes of representation emerge, prevail, and spread beyond the laboratory? What is the significance of "measurement" for the idea of "good" sleep? How, to what extent, and in which places do the measurement techniques and apparatuses used shape and change the (everyday) image of the sleeping person? At which points and through which practices are "validity" and "objectivity" produced or recognized, and by whom? When, where, and why does scientific knowledge appear as "precarious" and contingent? In answering these questions, the nine thematic contributions to the three sections of this volume adopt distinct perspectives. They analyze practices in the spatial arrangement of the sleep laboratory (3.1), locate sleep in its respective cultural contexts (3.2), and study sleep-tracking devices (3.3).

3.1 Ethnographic Studies of the Current Sleep Laboratory

As mentioned before, the contemporary sleep laboratory is a key site of sleep knowledge. First, the laboratory is the site of the production of scientific knowledge about sleep. Here, experiments take place, technology is developed, numbers are produced, visual images of sleep emerge, categories are established. At the lab, the "structure of sleep" was discovered and, since then, its functions have been investigated, its pathologies have been scrutinized, and remedies for these pathologies have been found. Secondly and equally important, the laboratory is the place where scientific sleep knowledge is put to the test, confronts other types of knowledge, and leaves

the sphere of scientific investigation. Sleep knowledge starts its journey (back) into society at large as persons with difficulties sleeping visit the laboratory in search for help.

While the two contributions to this section of this issue adopt distinct theoretical and methodological perspectives and focus on distinct aspects of the lived experience of the sleep laboratory, they not only approach the lab from a shared ethnographic perspective, but they also share an interest in the transformations that take place at the lab.

Far from what the scientific-technical name suggests, the sleep laboratory is a place charged with intense affects and emotions. In her article, "Sleeping with Strangers – Techno-Intimacies and Side-Affects in a German Sleep Lab," *Julia Vorhölter* shows how the very technologies that are supposed to produce "objective" knowledge of an individual's sleep are involved in what Vorhölter refers to as "techno-intimacy." The proximity between bodies, minds, and technology and their co-dependency in producing sleep knowledge turn the diagnosis and therapy of sleep disorders into a messy enterprise. Moreover, Vorhölter suggests that we treat the entire socio-spatial arrangement of the sleep laboratory as an "intimate space." Dynamics of closeness and distance between bodies and technologies give rise to feelings of anxiety, anger, and uncertainty but also empathy and care in the process through which these emotions are managed. Vorhölter shows convincingly, however, that unwanted and disruptive encounters between bodies, minds, and technologies cannot be controlled effectively or consciously. They result in "side-affects" that shape the sleep lab and should be regarded as integral parts of its fabric as well as precondition for the production of sleep knowledge.

While Vorhölter's contribution is informed by affect theory, *Dariuš Zifonun, Svenja Reinhardt,* and *Sebastian Weste* in their contribution draw on role theory and practice theory. In "Rescaling the Patient. The Diagnosis of Sleep Related Problems in the Sleep Laboratory," they situate the sleep laboratory in its medical context. The production of sleep knowledge takes place in a medical setting that frames sleep-related practices. This contribution argues that this medical context is interactively made relevant in the ways those present at the lab collaboratively produce their respective roles. By following the typical arc of work during a diagnostic polysomnography (PSG) procedure, from hospital entry to discharge, the authors focus on the practices involved in producing the patient role. They engage critically with the notion that the patient is a docile object of biopolitics who is subjected to an encompassing "bodification." Indeed, "the body" itself appears to be the result of a constant flow of negotiations that relate "the body" to "the person" of the patient. The article shows how, in separate phases of the diagnostic process, a "rescaling" of the patient is performed that shifts the patient along a scale from being a "full" person to being "merely" a body.

Taken together, the two contributions in this section underscore the importance of "practices of classification, comparison, evaluation, and quantification" (Heintz 2021, 6) at the sleep lab. They also show that the meanings of sleep that emerge from these socio-technological practices are shifting, uneven, fuzzy, and contested. From a comparative perspective, the contributions highlight that "knowing the sleep patient" emerges from peculiar affective, discursive, and interactive practices and is confined to the laboratory while other kinds of sleep knowledge more easily flow between knowledge domains. In particular, "digital bodies" produced by sleep technology populate the laboratory as well as the private bedroom and the internet.

3.2   Studying Sleep in Context

The second section of this special issue addresses questions pertaining to how, at what point, and to what extent knowledge of sleep depends on the context in which it is produced, represented, perceived, or practiced. In a broader sense, the three case studies are concerned with the same cultural domain, as they all address Western-industrialized societies in the 20th century (Germany, the US, Norway). They focus, however, on different historical situations, social spaces, and geo-graphical/climatic areas as they reveal the impact of social norms and cultural influences on scientific concepts as well as popular notions of sleep.

In their article, "Masters of Time. Chrono-Biologizing Sleep in the 20th Century," *Hannah Ahlheim* and *Jonathan Holst* draw attention to the fact that, in an industrialized and rationalized society, the question whether the human being could master sleep and sleeping time has become increasingly relevant. Scientists from multiple fields set out to discover the principles of basic body rhythms (Hussey 2022), debating the effects of "cosmic forces," the influence of light and temperature, and the power of will and habits. In the course of the 20th century, the idea that a "sleep mechanism" inside the body regulates the "alternating phases" of sleep and wakefulness gained momentum. During the 1960s, the new discipline of chronobiology scientifically defined the concept of a "body clock," which today is an essential component of sleep knowledge worldwide. Ahlheim and Holst show that experts have found highly diverse, even contradictory, answers to questions related to the how, why, and when of sleep, depending on the context in which they lived and technologies they worked with. By conceptualizing experimental spaces not as "neutral instances of verification" but as "epistemically productive," the article aims to point out that the science of sleep did not follow a linear path towards a biological truth, but rather contributed to the sometimes contingent "making" of scientific concepts that generate reliability only within a specific historical context.

Mina Lunzer's article, "Sleep as Movement. Sleep as Stillness. Objects of 'Sleep' at the Scientific Exhibition 'Dreamstage' (1977)," shows how closely intertwined concepts of sleep are not only with technologies but also with certain spaces and audiences. Taking the disturbed reactions from the public after visiting the "Dreamstage" exhibition as the starting point, Lunzer elaborates on the distortions that arise when specific modes of sleep representation shift to another context, serving a different purpose. She attributes the dissonance perceived by the audience to the fact that two contradictory representations of sleep collided and merged in the exhibition: The representation of sleep as a "moving" object and its perception as a state of "stillness." Lunzer connects these two modes of sleep representation with certain techniques used to make sleep visible. Technologies arising in the laboratory have represented sleep as an ongoing process, through continuously changing and moving curves as well as artistic photographic work that sets sleep in motion through a serial arrangement of stills. While these approaches have presented a "living" sleep in motion, the non-moving real living sleeper, who was also part of the exhibition, appeared as a rather scary "dead" object. Lunzer thus draws attention to the fact that certain techniques for representing sleep and making sleep into an "object" always interact with aesthetic norms and ethical-moral charges which change when transferred to another time, place, or space.

While *Julie Mewes's* ethnographic study, "Matters of Sleep. Sleep timing devices towards a 'sleep of any time,'" remains in the broader cultural realm of Western societies, it shifts our gaze to a very different geographical and historical context: the Arctic, today. Choosing a praxeologically informed approach, Mewes investigates the use and effects of sleep-timing devices in the everyday life of hospital staff in northern Norway. She reveals the importance of material "matters of sleep" and describes individual "day-to-day strategies" for managing sleep in a context shaped by regular shift work as well as the extreme conditions of the arctic or midsummer night. By conceiving sleep as a practice "enacted with and through socio-technological arrangements in time," Mewes wants to "overcome prevalent simplifying conceptualizations of sleep as a body function." She concludes that both of her subjects try to establish "sleep of any time," using any of multiple devices designed to induce or prevent sleep. One sleep-research subject, Anne, masters her endogenous bodily needs by aligning her time for sleep as closely to a "normal" rhythm as possible with the help of exogenous factors, for example by letting the "light" fade on her way to bed, switching off one light bulb after the other. Another subject, Britt, manages her sleep timing by shoveling snow, feeding her cat, or painting her sailboat, totally disregarding the prevalent norms of supposedly "healthy" sleep and minimizing her sleeping hours. In both cases, the result is a highly individualized sleep rhythm that is inextricably linked to a social and cultural context. Sleep, based on the insights generated in all three

contributions to this section, is never and maybe not even mainly a preset bodily function; it is instead a shifting and complex product of a particular context. The same is true for knowledge about sleep: What seems to be "certain" at a specific time or in a specific space can become strange, scary, and even precarious when transferred to another surrounding or to another historical situation.

3.3 Studies of Sleep-Tracking Practices

The final section in this special issue focuses on the diffusion, use, and impact of contemporary digital sleep technologies. In particular, the tracking of sleep through smartwatches, wristbands, and rings has found its way into everyday life, but the diffusion of self-tracking technologies has since the beginning been accompanied by a critical debate. In this sense, for example, the self-tracker is considered the paradigmatic social figure in a society that prizes self-optimization (Bröckling 2020, 9; 2016). At the same time, self-tracking represents an everyday practice that can be seen as typical of a "society as laboratory" (Krohn and Weyer 1990) and thus promises, among other things, new possibilities for generating knowledge. The empirical studies in this special issue reflect all these perspectives.

The first article in this section, "Redefining Rest: A Taxonomy of Contemporary Digital Sleep Technologies" by *Ben Lyall* and *Bjørn Nansen*, systematically introduces the various material artifacts and practices associated with digital sleep technologies. Within a theoretical framework of mediatization, the authors develop a taxonomy that systematizes the myriad consumer technologies, products, and media currently emerging in the sleep industry. The taxonomy reflects the extent to which digital sleep technologies construct multiple meanings of sleep through their mediatization, distinguishing five domains: the instrumentalization of sleep data; augmentation of bedroom material; routinization of the sleep atmosphere; the hacking of sleep rhythms; and, finally, the modulation of neurological states. In each case, sleep is problematized, and the corresponding problem is then addressed with "digital solutions." Digital technologies are considered indispensable for the production of good sleep, even if the scientific knowledge inscribed therein is uncertain. Furthermore, the diffusion of digital technologies is an expression of the crisis of as well the growing commercialization and commodification of sleep. The authors conclude that marketing and media coverage are thus generating a broad discussion about how (rather than whether) digital technologies improve sleep.

The sociological analysis "Sleep Experiments. Knowledge Production through Self-Tracking," by *Nicole Zillien*, *Nico Wettmann*, and *Frederik Peper*, understands knowledge production through self-tracking as an experimental practice. The paper begins with the assumption that scientific knowledge

rarely provides unambiguous instructions and therefore leads to uncertainty in everyday life. Against this background, the authors assume that expertized sleep trackers reduce uncertainties by turning everyday life into an experiment, investigating it through digital means and thus reducing uncertainties step by step. The empirical findings are based on a digital ethnographic analysis of online forums, blogs, and subreddits as well as online video footage on sleep tracking. The study shows that such a form of self-tracking can be characterized by, first, a willingness to tinker and tune, second, a specific temporality, and third, a successive expansion of self-tracking arrangements. Along with their empirical analysis, the authors claim that self-experimental use of digital sleep-tracking technologies on the part of users can lead to insights that relate to science while also reducing uncertainty in everyday life.

A much more critical stance with regard to the implications of sleep tracking is taken by *Diletta De Cristofaro* and *Simona Chiodo*. Their article, "Quantified Sleep: Self-Tracking Technologies and the Reshaping of 21st-Century Subjectivity," is the joint work of a cultural theorist who studies contemporary representations of sleep and a philosopher who works on the implications of new technologies. They assume that the recent increase in sleep tracking should be interpreted as an expression of a virulent sleep crisis. The empirical analysis refers to self-trackers' blogs about sleep, sleep-tracking technologies' marketing information, and the functionalities of these devices and apps. Using this material, the authors claim that the pursuit of self-improvement lies at the heart of sleep tracking. Accordingly, it is assumed that self-tracking permanently increases the pressure to perform, which is considered problematic from both an epistemological and an ethical perspective.

This section of the special issue ends with a study that examines interactions involving sleep tracking in social media. *Christine Hine*, *Robert Meadows*, and *Gary Pritchard's* article, "The interactional uses of evidenced sleep: An Exploration of Online Depictions of Sleep Tracking Data," focuses on online representations of sleep-tracking data. Comparing social media posts about the Fitbit sleep tracker as well as posts on the parent-driven discussion forum Mumsnet, they show how online social interactions produce evidence of sleep data. At the same time, however, there are also online contributions expressing mistrust and doubts regarding sleep data. New and established possibilities for producing sleep knowledge compete with and complement each other. The authors conclude that neither the interpretive self-optimization framework nor that of naïve acceptance of datafication comprehensively captures sleep-tracking practices: Rather, self-trackers embrace their own data and assign relevance to it in their online social interactions.

Accordingly, sleep tracking generates a range of implications. It can be seen as paradigmatic for a solutionist society, for a self-optimized society, for a datafied society, or for an experimental society. The social impact of digital sleep technologies ultimately depends on how the interplay between sleep,

knowledge, and technology is concretely shaped in the empirical constellation.

4.   Conclusion

Recent sociological, historical, and scientific studies describe the increasing awareness of the quality of an individual's slumber and the almost ubiquitous urge to improve one's sleep as an attempt to come to terms with the challenges of everyday life in modern, globalized, and interconnected societies. At the same time, these societies define themselves as "knowledge societies," using the rational means of scientific knowledge and expertise to address and solve problems, on the individual level as well as on the broader social level. Knowledge can serve as a means of individual optimization, helping the individual adapt to the rules of social life and the requirements of work. This is also true when it comes to sleep: More detailed, individualized knowledge seems to provide a more secure, more feasible, and, at the same time, healthier way of making sense of and managing the slumbering body and mind – that is the great promise of the ever-growing body of "sleep knowledge." The attempt to understand, to change, and to define sleep with the help of knowledge and "technology" serves as a means of gaining control over a time during which the human being seems to be unconscious and unable to act as a "master" of his/her life, body, and mind.

The contributions to this special issue contest the assurance promised by "knowledge" and ask whether the phantasy of being able to form and control one's sleep leads to more secure and "rational," more efficient and healthier, sleep practices. We address the genuine contingency of knowledge and analyze the significance of uncertainty for the everyday and individual management of (sleep) problems. Our analyses point to the fact that scientific knowledge rarely provides unambiguous instructions in either the sleep laboratory or the private bedroom. More knowledge, in one of the basic outcomes of our research, can therefore – in everyday life – produce even more uncertainty and – in the realm of science – raise more questions that can then motivate new attempts to produce certainty. The scientific practice of transforming doubt into certainty marks merely one mode of knowledge production. Thus, our study of sleep questions the modernist idealization of the univocality of knowledge and makes inroads into its inherent and ultimately irrevocable multivocality, fuzziness, and contingency, reflecting the contradictions and paradoxes that occur whenever knowledge is being produced and the ambivalences and ambiguities actors face when seeking knowledge.

The case studies presented in this special issue prove that the production and application of sleep knowledge takes place in a wide range of situations. Experts and laymen sleepers use various and varying concepts of "sleep,"

depending on historical, geographical, and social contexts but also on concrete empirical and experimental settings. Thus, the notion of a "normal," efficient, and "correct" sleep which sleepers use as a guideline for assessing and managing their every-night's sleep is based on certain practices that are shaped by the local and the material, and every definition of sleep remains "shifting" and "fuzzy."

Sociological, historical, and ethnographical approaches define their goal very different from that of scientific knowledge: In these fields, research is not necessarily meant to produce "security" or guidelines for everyday use – on the contrary. When it comes to sleep, the function of exploring, questioning, challenging, and criticizing common practices and notions might prove an important corrective: Our insights force us to think about the very foundations of the idea of a technology-driven knowledge society and, thereby, about fundamental power and decision-making structures of (post-)modernity. As much as we need reliable data and concepts as a basis for medical and psychological diagnoses or treatment, studying sleep in context reminds us that our understanding is far from being "true" for all or for good. But, maybe, knowing about the boundaries of science helps us to better understand and to withstand the challenges of the uncertainty it produces.

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