

Mindfulness in the digital workplace: an explorative study of the compatibility of mindfulness and technology

Sammy J. S. Wrede, Tobias Esch, Maren M. Michaelsen

Angaben zur Veröffentlichung / Publication details:

Wrede, Sammy J. S., Tobias Esch, and Maren M. Michaelsen. 2025. "Mindfulness in the digital workplace: an explorative study of the compatibility of mindfulness and technology." *BMC Digital Health* 3: 45. <https://doi.org/10.1186/s44247-025-00186-0>.

RESEARCH

Open Access



Mindfulness in the digital workplace: an explorative study of the compatibility of mindfulness and technology

Sammy J. S. Wrede^{1*}, Tobias Esch² and Maren M. Michaelsen²

Abstract

Background Mindfulness has made its way into the business context. Simultaneously, several options for digitally encouraging mindfulness have been proposed in recent years, with opposing opinions questioning the compatibility of mindfulness and technology, claiming it is a paradox. This study aims to examine the compatibility of mindfulness and technology, i.e., how mindfulness and digitalization interact as compatible or incongruous phenomena in the digital working context.

Methods Semistructured interviews with 15 experts, all specializing in technology and mindfulness in the workplace, were conducted to generate hypotheses of digital mindfulness at work. Qualitative content analysis as well as content analysis via extraction were utilized in this study to explore mutual relationships.

Results Information about workplace mindfulness, digitalization, technology and digital stress was synthesized. The themes “Mindful by Workplace-Design” (a) and “Working Mindfully in a Digital Cooperation” (b) resulted in suggested modifications for digital workplaces. The compatibility of the two phenomena escalated at the “Tipping Point” (c), reached beyond the use of mindfulness apps, i.e., when wearables are added.

Conclusions The results point out the limits of digital mindfulness, as well as opportunities for the cooperation of mindfulness and technology. For employers, this study provides guidance for shaping mindful digital workplaces and mindful work cultures.

Keywords Workplace mindfulness, Digital mindfulness, Technology, Digitalization, New work, Qualitative research

Introduction

On the occasion of arising mindfulness and technology linkages, this study explores their fundamental compatibility. The research question is grounded in the prevailing consensus across disciplines, wherein concerns about incompatibility suggest that one can neither be mindful within a digital work environment nor use technology in a mindful manner. When do these concerns become relevant? Before addressing the intersection between mindfulness and technology in the workplace, current research on digital work and occupational health is stated to emphasize the necessity of this investigation.

*Correspondence:

Sammy J. S. Wrede
sammy.wrede@uni-wh.de

¹Department of Human Medicine, Faculty of Health, Chair of Occupational Medicine and Corporate Health Management, Witten/Herdecke University, Witten, Germany

²Department of Human Medicine, Faculty of Health, Institute for Integrative Health Care and Health Promotion, Witten/Herdecke University, Witten, Germany



© The Author(s) 2025. **Open Access** This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit <http://creativecommons.org/licenses/by/4.0/>.

Digital working context

The nature of office work is changing. Simple, repetitive tasks are increasingly automated, while demand rises for specialized knowledge and the ability to manage complex, continuously evolving processes. In European contexts, “Work 4.0” describes the restructuring of employment systems driven by digital innovation [1]. This transformation also promotes mobile work, flexible workplaces, and adaptable working hours [2]. The expansion of digital and mobile collaboration systems enables companies to operate more flexibly. However, this flexibility concurrently leads to digital stress [3].

Technological progress fosters faster operations, greater abstraction, increased flexibility, and stronger personalization in all areas of life [4]. The restructuring of social life around digital communication and media infrastructures is encapsulated in digitalization processes [5]. “Digitization” refers to the process of converting information into machine-readable formats, whereas “digitalization” accounts for its consequences [6]. Digitization encompasses data processing, communication, and integration [7]. Various developments highlight the potential adverse effects of digitalization, including technostress, privacy erosion, problematic and addictive use of technologies, loss of control over technology-mediated decisions, and blurring of work-life boundaries across technologies like work applications, social media, artificial intelligence, and fitness trackers [8].

Occupational stress, health and disease

Among working adults in Germany, work (46%) and high personal expectations (43%) are the main reported stress factors [9]. Excessive workload and role ambiguity emerge as major workplace stressors, whereas sophisticated technology characteristics predominantly predict workplace stressors [10]. “Digital stress” (syn. “technostress”) describes strain from struggling to adapt to new technological demands, resulting in stress-related symptoms [3]. Techno-stressors are associated with adverse health and work outcomes [11]. Furthermore, research indicates that adverse work environments are closely linked to mental health issues such as depression [12] as well as to an elevated risk of cardiovascular diseases [13].

The WHO recognizes burnout as a syndrome of chronic work-related stress that has not been managed effectively [14]. The onset of burnout is determined by a number of stressors, while the risk of burnout is reduced when individuals perceive their work as meaningful and appreciate the culture at their workplace [15]. Workplaces are characterized by their organizational culture that, on the one hand, is difficult to change and, on the other hand, is inevitably affected by environmental conditions, which implies deeply rooted values and

assumptions that are often not conscious to employees and employers themselves [16]. Employee-oriented practices – i.e., giving employees opportunities to participate, offering social support, showing appreciation, etc. – brings about positive outcomes [17]. In this way, workplace culture impacts the (mental) health of employees [18]. New work concepts advocate human-centered approaches, emphasizing workplace culture as an ecosystem – a living organism rather than a mechanistic organization [19].

Measures of organizational development, occupational health promotion and management are proposed to prevent detrimental conditions such as (digital) workplace stress [20]. As such, mindfulness-based interventions have the potential to counter the harmful effects of psychosocial stress, thereby reducing the burden of curative costs, and the inability to work for both employees and employers in the long run [21].

Mindfulness

Mindfulness-based practices, such as “forest bathing” (Shinrin-Yoku), are recognized for their health benefits, including stress reduction, reduced anxiety and depression, as well as improved immune function [22]. Nature as a natural habitat lends itself to mindfulness practice and rebalancing, but both business and technology seem to be more antithetical to mindfulness. Nevertheless, mindfulness has found its way from (ancient) religion and natural habitats into science and business, showing positive effects in workplace settings [21, 23].

Mindfulness, according to Kabat-Zinn [24], is a specific form of attention that is intentional, relates to the present moment, and is nonjudgmental. Formal mindfulness practice increasingly influences informal mindfulness [25]. Informal mindfulness describes habits of mindful behavior or internalized attitudes, such as increasing attention in the present moment, that are becoming more prevalent in everyday activities [26]. Meditation is an example of one practice for formally training mindfulness. It is rooted in many spiritual traditions and practiced for both spiritual and secular reasons. Practitioners aim to maintain or regain inner balance through reflection and contemplation; grc. *medomai* [27]. Advanced practitioners pursue meditation as a state of being that can be described as the coming together of concentration and an awareness of mental and physical/environmental oneness; skr. *yo-ga* = “union” [28].

Mindfulness as a health-promoting approach can be explained through the stress response. For example, instead of surrendering to a stressor in a “reactive” way, the human body can be conditioned for a physiologically manifested “relaxation response” through the mental practice of mindfulness, allowing one to face stressful situations in a healthier way [29–31]. *Mindfulness-based*

stress reduction, a commonly applied behavioral intervention in many therapeutic and professional settings, is based on the practice of mindfulness as the central therapeutic principle [32]. The core element of this program's mindfulness practice is the seven basic attitudes that are consciously developed and trained during meditation: (1) nonjudgment, (2) patience, (3) keeping the beginner's mind, (4) trust, (5) nongrasping, (6) acceptance, and (7) letting go [33]. Mindfulness-informed approaches utilize other forms of therapy aside from mindfulness-based approaches. While mindfulness-based programs focus on learning and improving mindfulness primarily through formal mental exercises, mindfulness-informed programs focus on promoting relaxation, acceptance, or communication by encouraging informal mindfulness, e.g., through physical exercises such as yoga asanas [21]. One such mindfulness-informed approach is offered by the *BERN* concept (*Mind-body medical stress reduction*): stress-reducing behavior (Behavior), sufficient movement (Exercise), regular inner reflection and relaxation (Relaxation), and mindful enjoyment of healthy nutrition (Nutrition) [34, 35]. Beyond the intrapersonal perspective, collective mindfulness, i.e., the increase in mindfulness among a group of individuals such as colleagues, can bring about societal benefits by allowing for a transition from an "ego-system" to a collaborative "eco-system" [36].

Objective: compatibility of mindfulness and technology at work

Mindfulness interventions have increasingly been applied in work contexts and have demonstrated efficacy in reducing stress among participants [21, 23]. Whilst mindfulness is increasingly discussed as a necessary counterpart to digitalization, no up-to-date research exists on how exactly mindfulness meshes with cutting-edge technology. Mindfulness may serve to find appropriate ways to deal with expanding technology [21, 37]. There is a growing body of research on digitally supported mindfulness training as well [38–40], but the question remains: to what extent can (the latest) technologies facilitate mindfulness in the workplace?

One challenge of many trainings is the lack of transfer to everyday life independent of guided training, as participants find it difficult to maintain practice without guidance [41]. Mobile applications can solve this well and potentially increase the sustainability of a training even beyond and apart from the duration of a course; they can be flexibly integrated into employees' daily work and leisure time. Because apps are not tied to a specific location, the digital component is a practical way for decentralized working models to reach employees independently of location and time. Adding nuance to smartphone-enabled self-monitoring, digital mindfulness enhances productivity as well [42]. Mindfulness interventions

delivered by technology have been found to be effective, but an exploration of novel approaches to mindfulness training that combine the latest technological advances with proven meditation practices is needed [43]. The ambivalent relationship between information technology and mindfulness in organizations has been explored, but new technologies (e.g., bio-/neurofeedback devices) have entered the market since [44].

Measuring heart rate variability as an evaluation method confirms the stress-reducing effects of mindfulness interventions [45]. Smartphone apps as well as heart rate variability chest straps provide the necessary technical prerequisites without compromising practicality or quality of the evaluation [46, 47]. Additionally, the process whereby electronic monitoring of a normally automatic bodily function is used by individuals training to acquire voluntary control of that function (i.e. biofeedback) shows some effects on stress parameters and symptoms [48, 49]. Wearable devices, such as biometric-measuring smart watches, hold promising innovation potential for future-oriented mindfulness training [50–52]. Coming from these insights, this study contributes to shedding light on the potential for employees and employers to date. The research question seeks to address the gap: how do mindfulness and digitalization interact as compatible or incongruous phenomena in the digital working context?

Methods

With the aim of generating hypotheses regarding the compatibility of workplace digitalization and mindfulness, qualitative research allows for the uncovering of hermeneutic structures. Semistandardized guided interviews with experts were chosen as a tool for generating these structures to look at the counter- and interplay of the two phenomena from different perspectives (Appendix I: Interview Guidelines). The methodology has already been described elsewhere [53].

Interviewing experts

The interviewed experts were recruited conveniently. The authors contacted professional connects who work with mindfulness. Drawing on the experience of working in mindfulness or information technology for a minimum of ten years was a prerequisite for the selection of the interview candidates. To satisfy the amount of data material required to answer the research question, 17 experts were contacted via email or through social platforms such as LinkedIn. Consecutive interviews were conducted until data saturation was achieved, which occurred with 15 respondents with and without management positions, including founders, managing directors, consultants, trainers, coaches, and authors, some of whom were self-employed. The interviews were held

Table 1 Sample of experts in mindfulness and/or digitalization

Mean AGE	38.75 (Missings=3)
SEX (f/m)	4/11
Mean EXPERTISE „Mindfulness“ (low=1 to high=10)	7.43
Mean EXPERTISE „Digitalization“ (low=1 to high=10)	7.36
Average COMPATIBILITY (totally mismatch = -5 to totally match=5)	2

by SJSW; she is a research associate in social and health sciences at Witten/Herdecke University with a Master's degree and trained in qualitative research methods. The participants knew the researcher mostly from occupational settings. The aim of the study was not disclosed to prevent bias, but the participants might have known the fields of research of SJSW. The interviews were recorded one-on-one via Zoom, mainly in German, as this was the native language of the experts and interviewer. Next, the relevant parts were translated into English during the analysis process. A short questionnaire was dispatched via email to the interviewees, including questions on the expert level and self-assessed compatibility of mindfulness and digitalization on scales of 1 to 10 (10 indicating high expert level, high compatibility, respectively) and sociodemographic data (Appendix II: Short Questionnaire). Table 1 provides a description of the sample.

Extraction and qualitative content analysis

The established audio material was transcribed verbatim with the use of f4, an audio transcription software. The

transcribed material was returned to the participants to obtain consent to further process the material anonymously, which was permitted by all of them. The audio transcription software also supported the interpretation process, especially with respect to coding and citing. The material was analyzed through the use of different methods. First, qualitative content analysis was used to synthesize and present the information for set categories. An iterative deductive-inductive approach with a predefined category system following the interview guidelines served as a starting point for structuring/summarizing the evaluation according to Mayring [54] for the general understanding of mindfulness in the workplace. Inductive derivation was used for the understanding of technology/digitalization (since it was not directly queried). The set was extended within the analysis process. With openness for inductive inclusion, further categories have been added. The final category system was established within the analysis process by searching for consensus in the experts' opinions on the interplaying disciplines and deriving hypotheses (see Table 2). Second, to elaborate on causal connections between mindfulness and digitalization, extraction according to Gläser&Laudel [55] was applied, as such causal chains are difficult to map in a hierarchical code system. In a hierarchical code system, such chains would quickly make the code system huge and confusing. To maintain these causal chains, keywords for the respective interesting dimensions were noted for each text passage during the respective extraction, and then the extracted material was processed. Similar to the content analysis, as an intermediate step,

Table 2 Summary of the principal results

Category	Theme	Description	H1-H5
Mindfulness	Practice	Mindfulness practice includes formal and informal practices.	H1.1
	Routine	Practice routines vary from several times a day to cyclically.	H1.2
	Implications	Mindfulness implies sensation awareness and connection with oneself and one's environment in the present moment as it is (without judgment).	H1.3
	Benefits	Improving interpersonal communication, reactivating resources, and releasing individual human potential/biopsychosocial relaxation responses are benefits of mindfulness.	H1.4
	Prevention	Mindfulness holds the potential to prevent psychosomatic stress symptoms and their negative effects.	H1.5
Mindfulness in Corporate Context		Specific challenges at work (such as many different stimuli and personalities) require mindful interventions that address behavior and conditions at work.	H2
Digital Workplace Conditions	Digitalization	A fast-paced and increasingly complex working world leads to opportunities as well as drawbacks for employees.	H3.1
	Technology	Technology includes hardware and software/nontangible products.	H3.2
	Digital Stress	Digital working contexts involve stressors and ensuing stress reactions.	H3.3
Mindful Modifications for Digital Workplaces	Mindful by Workplace-Design (a)	For a more mindful digital workplace, technological infrastructures should be designed mindfully (with less harm to physical and mental health), and digital support for formal mindfulness practice at work can be provided.	H4.1
	Working Mindfully in Digital Cooperation (b)	To be more mindful in the digital workplace, individuals should adjust their working routines and reduce digital stressors.	H4.2
Tipping Point (c)		The compatibility of mindfulness and technology tips when responsibility for sensory awareness of one's own physical body is given to digital devices or foments competitive behavior at workplaces.	H5

the results were presented in the form of a table, systematically noting the relevant information from each appropriate passage. Coding was performed solely by SJSW (single coding). Figure 1 illustrates the applied qualitative research process.

Results

Description of the sample

The mean age was 38.75 years, with the male gender being overrepresented (11/4). Three participants omitted age information. On a scale from 0 to 10, the respondents ranked their expert level as being between 7 and 8 on average in regard to mindfulness as well as digitalization. On a scale from -5 to 5, the compatibility of mindfulness and digitalization was ranked with 2 as a mean with answers ranging from -3 to 5. The study period lasted from September 2020 to March 2021. The respective interviews lasted approximately 45 min on average.

Based on the analysis of the interviews, two themes emerged that were mentioned in reference to the relationship between mindfulness and digitalization: (a) “Mindful by Workplace-Design” and (b) “Working Mindfully in a Digital Cooperation”, leading to suggested modifications for mindful digital workplaces. On the basis of the compatibility discussion, we discovered a (c) “Tipping Point” of digital mindfulness, i.e., an overuse of digital elements when practicing mindfulness. In the following, we first present how the experts understand mindfulness in general and in the corporate context and then present the two themes before elaborating on the compatibility shift.

Experts’ Understanding of mindfulness in the digital workplace

Mindfulness

Regarding how they train mindfulness, the experts listed formal and informal practices, including classical sitting meditation, breathing, mental training, and body scan. Body exercises were mentioned in this context, such as

sports, yoga and other means of physical mobility. The experts also cited other methods such as working on oneself, self-exploration, performing a “check in” throughout the day (asking oneself questions such as “Where am I right now?” and “How do I feel?”), communicating with oneself, calming oneself down, refocusing attention, creating anchors, and other exercises such as completing a 5-minute journal to express feelings and gratitude.

“One is formal exercises, that is, classical sitting meditation. I do have an area, so a sitting cushion, and I do formal practice there. I do body exercises, so mindfulness-based meditation in movement, you could say, and I do informal exercise throughout the day.” w-45-8/8/2, para. 13.

H1.1: Mindfulness practice includes formal and informal practices.

The variety of routines in mindfulness practice ranged from daily, varied inconsistently, mornings and evenings, and cyclically, and two interviewees mentioned that they were unsatisfied with their practice schedule.

“I should certainly do a lot more.” w-47-6/8/2, para. 21.

H1.2: Practice routines vary from several times a day to cyclically.

Within this study, the experts’ implications of mindfulness were closely connected to perceiving feelings/emotions for the sake of physical and mental health. According to the experts, being mindful means proactively maintaining a healthy balanced lifestyle. Mindfulness was described as an attitude to pay attention to oneself – nonjudgmental, with radical acceptance in the here and now. This could be observed to be related to one’s ability to redirect attention to the present moment

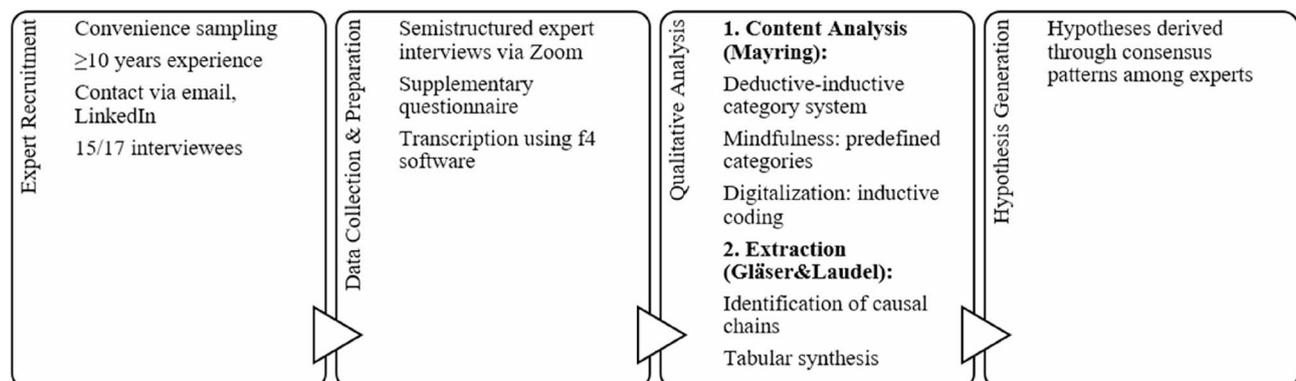


Fig. 1 Qualitative research process

and often requires conscious deceleration in everyday life to (re-)gain energy. For the experts, observing a moment for what it is means being open to inner experiences as well. One can be mindful in a state of alertness/subconsciousness.

Furthermore, the experts described some consequences of being mindful. The interviews revealed that connection and self-distance can lead to being one with the environment. A regular habit of introspection and awareness in the presence appears to result in this conscious handling of oneself, fellow human beings and one's environment in general.

“For me, mindfulness is a specific form of attention. It is characterized above all by the fact that it focuses on the current moment without judgment. It is first of all about perceiving only what is right now and to connect consciously with the qualitative nuances of this experience.” w-25-9/5/2, para. 5.

H1.3: Mindfulness implies sensation awareness and connection with oneself and one's environment in the present moment as it is (without judgment).

The interviewees reported benefits to communication, creativity, and focus. The effects of mindfulness training routines were positively depicted as “freedom from self” (m-44-7/8/4, para 4), liberation, calming down, mental stillness, and space between stimulus and response. For long-term effects, the experts also named the rebuild of synapses, better self-management, and the potential of being mindful and successful at the same time.

“Being available all the time and feeling this pressure to have ten things on my mind all the time - I have the feeling that this has a lasting effect on the body, more or less, as if you never sleep. And, for me, mindfulness is already the chance, like sleep, to get off the wheel during the day, to lower the pulse and, in principle, also to lower the head a bit. It's like being in a car at full throttle all the time. Then the tires are [burning] and if you just manage to slow down the speed a bit in between, the tires cool down again and you just have a longer running time.” m-30-7/9/-2, para. 28.

H1.4: Improving interpersonal communication, reactivating resources, and releasing individual human potential/biopsychosocial relaxation responses are benefits of mindfulness.

The experts also reported that mindfulness comes with preventive effects if noticing warning signals and conscious interruption of destructive patterns is part of it.

Negative effects, which they experienced (from work) without the practice and why they think mindfulness practice is needed are: being stressed out, taking stress out on others, intrusive thoughts from unpleasant memories or of imagined future scenarios, emotional outbursts, “monkey mind” (w-47-6/8/2, para. 29), “meeting hopping” (w-32-8/8/5, para. 13), multitasking, fatigue syndrome, sleep problems, symptoms of burnout, and being on autopilot almost all the time.

“So, in the past I've only had an outburst of emotion (laughs) to a great extent and only then realized that there was an emotion there. And now I have become much more aware, even if it is quite less emotion so very small traces of emotion in a conversation [...] ‘Oh, there is something, an emotion.’” m-40-8/7/3, para. 4.

H1.5: Mindfulness holds the potential to prevent psychosomatic stress symptoms and their negative effects.

Mindfulness in the corporate context

By analyzing the description of the experts' understanding of mindfulness, mindfulness within the working context is illuminated. The experts mostly referred to workplaces, where teamwork and collaboration are aspirational. The challenge of being mindful in a corporate context was traced back to the amount of interactions and different personalities (stimuli) in workplaces. Additionally, experts noticed that uninterrupted focus is needed to accomplish tasks, which can be improved upon by means of mindfully respected social queues (door closed/headphones on). Moreover, speaking from the experts' experiences, mindfulness can help decision making and reflection on processes.

It can be observed that the employer is in a position to encourage mindfulness successfully with training. From the experience of the interviewees, this should involve less spirituality with the subject. Healthy ergonomics, encouraged productivity and creativity could be manifested through mindfulness. The experts also stated that mindful leadership and “leading by example” are driving forces for increased mindfulness at work. The issue that digital leadership skills are currently sought, e.g., trust in employees and paving the way for social exchange despite physical distance, was broached.

Examples of integrated mindful interventions at work named by the interviewees were 1 min to “mentally arrive” at work/to meetings, break and movement times (especially in home office), mindful meeting (45 min. appointments, first 5 min. of which are for tuning in), mindful break, and meditation at work (remove barriers, create space). The following quotation depicts one

example of digitally supported mindfulness in a corporate context.

"[...] you can switch on your Mindfulness-App and you can stay in your office, that could be one way, you could say there is a room available from three o'clock to three thirty or one o'clock to one thirty, when anybody wants to practice mindfulness they can go there and in that room you know that you're not going to be disturbed and everybody is there for the same purpose." m-57-9/9/3, para. 26.

H2: Specific challenges at work (such as many different stimuli and personalities) require mindful interventions that address behavior and conditions at work.

The relationship between mindfulness and workplace digitalization

Digital workplace conditions

Beginning with a description of the digital workplace, the relationship between mindfulness and digitalization in workplaces is analyzed. On the one hand, the understanding of digitalization at work in the study's sample was characterized by the constant pressure to perform, the fast-paced environment, and an increasing complexity of tasks and interactions. The experts mentioned that automation within digital transformation leads to human substitution. The experts also stated that work processes are changing, which results from product cycles becoming shorter and a multitude of communication channels existing. Simultaneously, boundaries between work and private life are becoming increasingly blurred. On the other hand, the advantages of digitization were emphasized by experts. They mention that work becomes more independent of time and place as collaboration/keeping in contact over spatial distance in real time is possible. Furthermore, technology can save ways, provides immediate access to knowledge and training is possible to pursue digitally. However, the experts noted that this "zapping" (w-47-6/8/2, para. 31) is performed at a rate for which humans are not designed.

"One is that technology offers an extremely wide range of possibilities in terms of flexibility, which means that mindfulness is perhaps easier to implement. And the other is that it also makes me available everywhere, if I don't organize it well, and perhaps focused moments are more difficult to implement." m-35-7/8/3, para. 25.

H3.1: A fast-paced and increasingly complex working world leads to opportunities as well as drawbacks for employees.

Technology within digitalization was delineated as devices, messaging platforms and social media. Furthermore, the experts named e-learning platforms, webinars, apps, smartwatches/wearables, and notifications.

"Apart from all these tools, Zoom, Teams, Adobe Connect, Skype and whatever else was flying at me, I had to deal with it. At the beginning I also had this irritation [...] I'm talking to you, you're sitting somewhere in Germany, yes, you have the feeling that you're sitting together, but nevertheless there's still a marginal distance." m-44-7/8/4, para. 8.

H3.2: Technology includes hardware and software/nontangible products.

The interviews revealed that all of these environmental conditions can lead to digital stress, which results in individual stress reactions such as excessive demands or isolation, "digital hamster wheel" (w-32-8/8/5, para. 13), lack of self-control ability, limited recovery processes, stress due to inconsistent tools, addictions, and misunderstandings of facial expressions/body language.

"So, there is hardly any silence anymore, there is hardly any rest, there are hardly any breaks. Everything we consume on a daily basis is timed shorter and shorter, and that of course has an influence on our, shall we say, brain." m-36-8/9/-3, para. 24.

One extreme intervention mentioned to escape from technology is undergoing digital detoxing, a period of time during which a person refrains from using electronic devices such as smartphones or computers, which is regarded as an opportunity to reduce stress and focus on social interaction in the physical world. However, there are more options to counteract the negative stress effects encouraged by digital working conditions.

Mindful by Workplace-Design (condition-related)

"It's a bit like the direction of "Ethics by Design" is it here quasi "Mindful by Design" [...]." w-47-6/8/2, para. 33.

Within this theme, considerations are being stated regarding how to design digital workplace conditions for workers to be more mindful. One opportunity created by technological progress includes digital support for meditation. Further disclosed technological implications to be more mindful at work could turn out to be blockers (emails, calendar appointments), reminders (drinking, exercise, stress/heart rate variability), and pop-ups/alerts (Meditated today already?). Notifications and

trackers (e.g., for the time remaining in social networks) can help to inhibit harmful behavior. The experts stated that a human-friendly design should counteract the slot machine principle, which aims for dopamine release. From the experts' perspective, sales maximization should not be at the expense of mental disorders. They state that the attention span in the age of digital marketing has already decreased. Conditions to target more mindfully designed technology include low stimulus and reducing addiction potential ("less but better"). One example mentioned was the usage of vibration instead of sound for advanced learners in meditation apps. Insight Timer was named as an app that provides subtle signals for orientation during meditation. Self-control can be supported by technology, in the experts' opinions, whereas data security seems to be a challenge at the organizational level.

More sophisticated technical solutions come with artificial intelligence (AI), on-demand coaches, virtual agents, and chat bots for the relief of employee workload, e.g., in customer support. Some experts mentioned that such support at work could enable more time for mindfulness and that digital solutions at work free spaces could focus on essentials (such as creativity, compassion, synthesizing information, and innovation).

"So, really technical solutions that create your, I'll call it now, digital retreats. Then digital solutions, AI solutions that just take work off your plate. That can certainly also help people, that you simply provide on-demand coaches. The industrial psychologist doesn't have to come and ask you into his room, but you can have a Zoom conference with them and they can briefly advise you on your problems. As one example." m-37-3/9/2, para. 34.

The interviews also revealed that mindfulness can be supported through apps in general. As advantages of meditation apps, the experts pointed out a low hurdle to starting mindfulness practices due to location/time independence. Apps as a tool are able to create access, as the application holds the potential to spread information and to build a community across distances. Apps sometimes also offer gamification for motivation and digital success triggers as rewards. Another specific mindful digital workplace intervention suggested was a meditation plug-in in team software (e.g., Headspace plug-in in Microsoft Teams). This intervention would be one way to be more user-friendly/customer-oriented and balance innovations that are potentially causing information overload, which appear to lead to digital stress. The data revealed further considerations in terms of digital support for meditation, such as neurofeedback, a form of biofeedback in which subjects respond to a display of their own brainwaves or other electrical activity of the nervous system. These

innovations have also been found to be effective [38, 39]. In addition, auditory considerations such as binaural beats that can bring humans in flow and "altered states (of being)" were recommended (m-57-9/9/3, para. 28).

"So accordingly, technology would be a bit of the catalyst more or less or is it factually to introduce more people to the subject." m-30-7/9/-2, para. 32.

H4.1: For a more mindful digital workplace, technological infrastructures should be designed mindfully (with less harm to physical and mental health), and digital support for formal mindfulness practice at work can be provided (a).

Working mindfully in digital Cooperation (behavior-related)

Within this theme, mindful behavioral strategies to compensate for digital workplace stress are explored. The experts mentioned that mindfulness helps coping with stress and building resilience for psychological health, as accelerating workloads might require the ability to surrender and balance work-life. According to the experts, intrapersonal approaches, such as handling the "inner team," [56] recognizing stimulus and reaction, could encourage coping with digital stress at work. Moreover, avoiding egocentricity while practicing self-discipline allows employees to cooperate mindfully and balance the ego and other. Likewise, empathy was listed as an essential skill empowered by mindfulness.

What kind of mindful and digital considerations can help one cope better with digital working conditions? To provide some applicable recommendations, the data revealed the following mindful modifications at digital workplaces:

- switching off notifications.
- going into social exchange proactively by doing virtual coffee rounds or similar activities.
- implementing moving breaks.
- setting reminders to eat/drink,
- adapting behavior (e.g., work routes, work mode, establish connection/staging closeness in home office).
- trusting in employees.
- cognitive restructuring.
- looking forward.
- meditating with apps.
- adjusting meeting structures.
- block mails during certain times (e.g., silent work, stop multitasking).

"[...], that we reduce the time down to 45-minute appointments. Yes, and really allow these change-over times into the new virtual space together [...]."

There is the rule that the first five minutes of a meeting are there for everyone to get up again, open the window, go to the bathroom or something or have a drink, whatever. [...] So once tool equipment, but just clearly through integrations. I mean, things like the hint that you need something to drink or something like that or now really need to make a break.” w-32-8/8/5, para. 27.

H4.2: To be more mindful in the digital workplace, individuals should adjust their working routines and reduce digital stressors (b).

To summarize the experts' statements, mindful digitalization would mean aligning the expectations of leaders and addressing the influence of a fast-paced work environment. Within the interview analysis, it became clear that this is a balancing act, as it is at times referred to as a “double-edged sword” (e.g., m-30-7/9/-2, para. 30), “fine line” (e.g., m-42-8/5/3, para. 24), or “dilemma” (e.g., m-?-7/5/3, para. 18). However, if workplaces succeed in creating cooperation between the two supposed opposites without pressure, employers have the chance to profit in the experts' opinion. The interviewees said that this might be supported through the management of change and development in the organization. Apparently, creating mindfulness at work often requires a change in perspective.

“And mindfulness is, that is also the dilemma, that mindfulness is just so to speak freely interpretable. Thus, how mindfulness will be integrated into the digital process will arise. I would say, that would be a typical approach of mindfulness, not to want to do it, but to let it arise. And there are good chances [...] namely, that digitalization brings many other new constraints, to which mindfulness can be a constructive cooperation or alliance. Yes, and that's actually the basic idea [...] that we try to create alliances here [...] with the balance between these supposed opposites. And that's the special thing about mindfulness, that it's not just an exercise concept, it's more of a philosophical concept. How do I get balance into systems, how do I balance systems? So and with mindfulness practices the chance to balance is relatively greater in my experience than with others.” m-?-7/5/3, para. 18.

Experts' attitudes towards the compatibility of mindfulness and Technology– Tipping point

Finally, the point where the compatibility of the two phenomena changes in the experts' opinion is determined. While the prior paragraphs described a mindfulness-supporting digital workplace and ways to deal mindfully

with digitalization, the next paragraphs include emotions towards and opinions about the compatibility of mindfulness and technology. To assess the excessiveness of technology for mindfulness, meditation apps were utilized to initiate digitally supported mindfulness practices. This was extended upon by using wearables to measure biomarkers such as heart rate variability. In this step, the self-reported compatibility of mindfulness and technology as rated within the questionnaire was notable. Three representative arguments are presented here, which included two extremes (-3/5) and one average score (2) as ranks for compatibility.

Surprisingly, the ranking with the lowest compatibility (-3) showed a change within their argumentation. The ability to use an app to practice mindfulness, as well as the appraisal tips, in regard to the digital support of fitness trackers for mindfulness were highlighted. When the interviewees elaborated on their thoughts, they came to the conclusion that technology and mindfulness actually contradict each other. The interviewee pointed out that mindfulness is hindered if someone relies on technology for information rather than access to the emotions of their own physical body. Nevertheless, digital support seems to be helpful to get started and to access emotions if someone is unfamiliar with mindfulness.

“There could possibly, could of course also be the cases where that might make sense at the beginning, that you say, I have such bad access to myself, which I can totally understand, because it was my own experience. So, for a long time I didn't have any access at all to my emotions and I couldn't categorize them at all, so maybe it's helpful sometimes, but I would also say very much off the cuff and from my gut feeling, actually, I find that it contradicts itself.” m -36-8/9/-3, para. 54.

The person who rated with an average position (2) does not practice mindfulness with an app and emphasized that this does not belong together in their opinion. The interviewee sees themselves as tech-savvy, but as they were introduced to mindfulness foreclosed from any mobile connection and electronic devices in a monastery, they want to keep this experience consciously offline. As the interview led to wearables as digital support for mindfulness, the interviewee depicted the experience of a “Fitband buzzing on the wrist” as annoying rather than supportive, especially referring to the function of receiving messages and notifications for appointments. The interviewee was well aware of examples of the use of this technology but came to the conclusion that this is not for them. In addition to the fact that the positioning of the person with the lowest and average compatibility on the

scale differs greatly, the extracted statements draw a similar picture.

“So this constant buzzing on the arm drives me crazy, has already driven me crazy before my mindfulness experiences. [...] for me it was nothing, these that this Fitband, or how it was called yes, because afterwards how many steps I have made - I never looked at it. [...] I think that even without the app I have a good feeling for myself whether I have moved enough today or not. So, I just feel that myself, I don't think I need the app for that. And that's why I don't see these advantages for me personally at the moment. But I know that many others totally swear by it and also find it totally important.” w-47-6/8/2, para. 39.

Finally, the highest compatibility (5) of mindfulness and technology was reported by someone who characterizes themselves as a “big fan of technologies like this” (w-32-8/8/5, para. 28). They love mindfulness apps, especially those including gamification. They appreciate feedback by technology and use fitness trackers for workouts as well as mindfulness practice. The interviewee pointed out the affinity for this of peers/leaders as well. The interviewee named the risks of these applications and excessive use of technology, especially as it can create pressure, competition and provoke high performance, only then being a paradox with mindfulness.

“That's why I think it's perhaps a paradox at first. And you also have to be careful how far you push this and not that this again becomes a competition and high-performance. Yes, again, so that we all only compare ourselves and who is better, faster, higher, further. Then, we are suddenly again in the same logic in mindfulness. [...] I think this way, the one about routines, about tracking, about social pressure, also a bit about sharing. You and I would have to tell each other every day where we meditated. That makes a difference, and you can share that well in networks and apps and chats and so on. That helps people enormously. So, when I experience this in coaching sessions and so on, these are usually mechanisms that fire you up. They at least give you the kick to go through with it for two or three weeks. And then it sometimes works out easier on its own. Sometimes not, unfortunately, you fall behind. But most of the time it works out better. And I think it's good for the time being. But then, we should also look in any case: Do we keep the balance and in the end also see the pure quality of mindfulness? And not just this again: Who is better here from both of

us today in the chat? Who meditated more during the hour?” w-32-8/8/5, para. 36.

In Fig. 2, some more representative statements are illustrated on the scale.

In summary, most of the interviewees did not reject the idea of using an app to practice mindfulness, as this makes it much easier, especially for beginners who need some guidance. The technology facilitates the scalability of mindfulness-based interventions. The independence of time and place, lower costs, the possibility of social exchange through this application, and the diversity of bundled offerings (progressive muscle relaxation, meditation, yoga, trance, etc.) at work were mentioned as advantages compared to interventions in physical presence. Individual needs can also be addressed better via apps than in group settings. Technology can provide access to stress physiology and emotion indicators (processing) via key performance indicators (KPIs), e.g., heart rate variability and pedometers. Benefits, such as alternative ways of learning to sense the physical body, starting by situating oneself mindfully, becoming and staying motivated, and triggering success, were reported. This enhances self-empowerment (gaining insight through biometric information) in some of the experts' opinions. Permanently collecting data such as biomarkers with wearables was embraced by few of the experts and was seen rather critically by most experts. Wearables offer some means of support for self-exploration through their functions. Nevertheless, the experts were critical about self-control, for instance, regarding the Quantified Self, a community that uses recording, analyzing and evaluating personal and environmental data via hardware and software solutions, as one extreme representative [57].

“I think that these self-control abilities are above all an area of action of mindfulness and I think that we do not necessarily activate it [through measuring biometric data via wearables], but rather passivate it, would be my assumption.” m-42-8/5/3, para. 26.

“However, a permanent use of such technologies to measure physiological parameters would lead this concept ad absurdum. In my opinion, the training of one's own perception and trust in the same are those aspects that are promoted by mindfulness. If a technical device takes over this task permanently— and not only for the beginning of getting to know one's own organism – mindfulness would get a goal orientation, which contradicts it from my point of view. In this case one would rather speak of self-optimization than of mindfulness training.” w – 25 – 9/5/2, para. 36.

“The limit, of course, is where it becomes an addiction” w-45-8/8/2, para. 35.

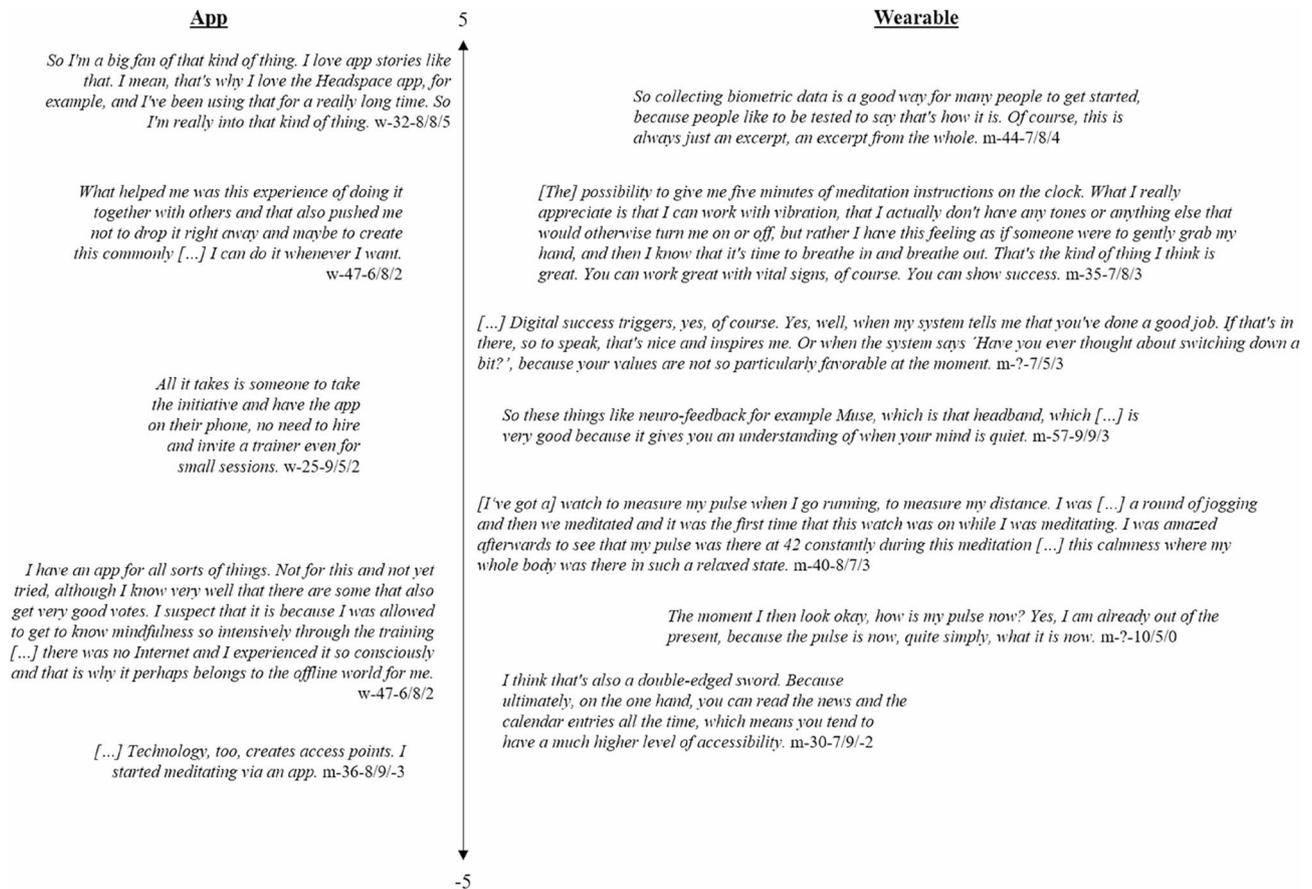


Fig. 2 Experts' attitude towards the usage of apps and wearables for mindfulness training

The “Tipping Point”, where the compatibility shifts, may be reached when participants begin neglecting sensations of their physical body and relying on technology instead. This contradicts the experts' comprehension of mindful vigilance and maturity, promoting comparison with others rather than with oneself. Self-observation through technology could diminish self-awareness and result in an intraindividual obsession.

H5: The compatibility of mindfulness and technology tips when responsibility for sensory awareness of one's own physical body is given to digital devices or foments competitive behavior at workplaces (c).

Figure 3 illustrates the previous paragraphs: the compatibility shift for the individual.

Discussion

This work generated some hypotheses on the compatibility of mindfulness and technology at work by analyzing interviews with experts according to qualitative research standards.

Principal results and comparison with prior work

Mindfulness is practiced formally and informally, from several times a day to cyclically, and described as

sensation awareness, consciousness and connection with oneself and one's environment in the present moment as it is (without judgment) (Table 2, H1.1-H1.3). The alignment from the implications of mindfulness, given by the interviewees in a nutshell, with the definitions from literature presented in the introduction, speaks for the theoretical contribution of this work as well as the study sample's expert level.

Due to the biopsychosocial relaxation response that is triggered by mindfulness practice, resources can be reactivated and individual human potential released (Table 2, H1.4) [31]. Furthermore, interpersonal communication has been reported to improve, so mindfulness seems to be beneficial, albeit challenging, to implement at work. It was stated that practicing mindfulness prevents psychosomatic stress symptoms and their negative effects (Table 2, H1.5). By declaring the experts' comprehension of mindfulness in the corporate context, the basis for further analysis was established. Because of many different stimuli and personalities, mindfulness in the workplace entails specific challenges, requiring mindful interventions that address behavior and conditions at work in cooperation with digital technologies (Table 2, H2).

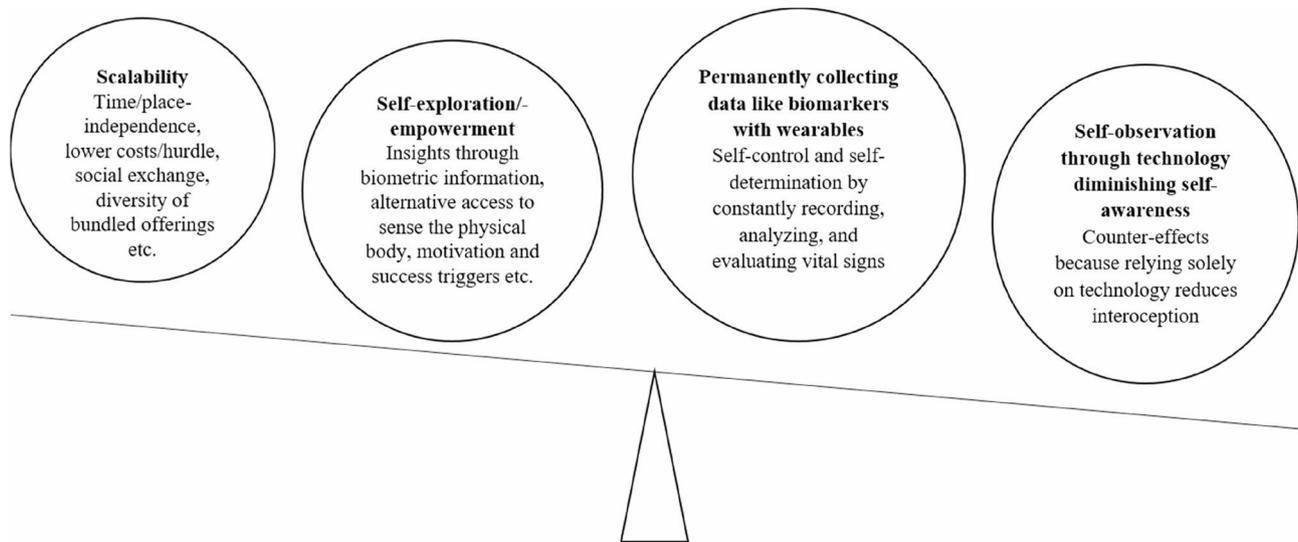


Fig. 3 Tipping point of the compatibility of mindfulness and technology for the individual

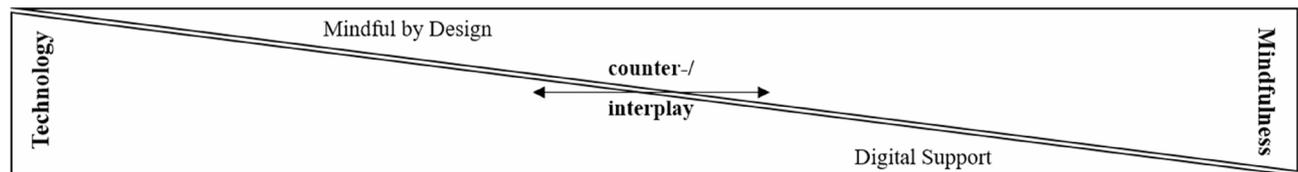


Fig. 4 Interactions of mindfulness and technology at work

In times of advancing digitalization, the so-called *VUCA* world as a term describes critical corresponding characteristics such as Volatility, Uncertainty, Complexity, and Ambiguity [58]. This leads to a Pressured, “Always on”, Information-overloaded, and Distracted (*PAID*) reality for individuals at work [59]. The experts’ statements supported these theoretical constructs of digitalization (Table 2, H3.1).

Technology has been broken down by experts into hardware and nontangible software, including social media, which can be enablers as well as stressors, amplifying stress reactions in digital contexts (Table 2, H3.2 + H3.3). Current research on digital stress confirms the stressful side effects for the individual caused by digitalization in the workplace [60–62].

While H1-H3 serve to describe the experts’ understanding of the themes, H4.1/2 and H5 present the main hypotheses of the study and present new findings. The interactions of mindfulness and technology elaborated through the analysis are illustrated on a continuum in Fig. 4.

“Calm Technology” arose as an approach in information technology to appease distraction deriving from ubiquitous technology [63]. This type of information technology is designed to occur in the user’s periphery rather than constantly at the center of attention to minimize the perceptible invasiveness of technology. Inspired

by this, “Mindful by Workplace Design” was established as one main theme of the two interplaying phenomena.

On the one hand, technology implements mindfulness when digital workplace conditions are designed mindfully – designing technological infrastructures at workplaces with less harm to physical and mental health (Table 2, H4.1). On the other hand, mindfulness uses technology with the aim of supporting mindfulness training and providing digital support for mindfulness practice (Table 2, H4.1). Technical solutions, such as mindful plug-ins for software used in daily business or digitally supported mindfulness trainings, were mentioned as examples of emerging digitally supported, mindfulness-based interventions at work. Quantitative studies confirm that wearables can be an asset for workplace stress management [64]. Engagement strategies in web-based mindfulness programs comprise reminders to use the program. Other features may be suitable for encouraging adherence to interventions, and a facilitator-led component may result in higher retention [65]. In the university setting, the use of apps for mindfulness training was confirmed; however, adherence was not improved through the use of weekly text message reminders [66]. Simultaneously, in terms of stress and mindfulness, studies that used inactive control conditions yielded larger effects [67].

“Working Mindfully in Digital Cooperation” stated mindful adjustments that compensate for digital stress

– adjusting working routines and reducing digital stressors to make room for essential skills (e.g., creativity and empathy) and foster innovation (Table 2, H4.2).

Measures in health promotion, prevention, and rehabilitation that influence the behavior of the individual (behavioral prevention) are theoretically separated from those that address living and working conditions (material prevention, e.g., ergonomic office equipment or a mindful technological infrastructure) [68]. While one of our hypotheses predominantly addressed conditions (Mindful by Design (a)), the other addressed behavior (Working Mindfully (b)). Notably, the distinction of these approaches is not entirely clear. The transition is blurry, for instance, when meditation apps are implemented by employers, as this would be considered a behavioral as well as material prevention. Both aforementioned approaches are considered to prevent digital stress in the workplace and encourage mindfulness among workers. The results section “Working Mindfully in Digital Cooperation” lists mindful adjustments in digital work routines for employees and employers.

Technology can be a catalyst for mindfulness-based interventions [69]. Conversely, digitalization entails new constraints to which mindfulness can be an alliance. Balancing technological innovation with mindfulness goes along with occupational concepts such as “agility,” [70] “culture of error,” [71] or “antifragility” [72–74] that emphasize how to stay in motion and get along or even grow with changing settings such as digital working conditions. A fixed mindset assumes that human abilities are innate and immutable, whereas a growth mindset suggests that qualities can improve through practice and learning (intelligence is static vs. can be developed) [75]. Trial and error as a problem-solving method of learning (observing if it works, and if it doesn’t try a new method) encompasses that essentially all organisms use to learn new behaviors. Mindful attitudes appease the appraisal of this process as “bad” (nonjudgmental). Workplaces faced with challenges arising from digital progress would therefore benefit from tailored instructions that promote mindfulness and a growth mindset. When these attitudes are exemplified in the workplace, they might become anchored in the organizational culture [76]. The paradox of mindfulness and technology in the workplace pinpoints an individual/organizational positioning with one’s mindset.

The extraction of the “Tipping Point” (c) is another result of this study – i.e., giving responsibility for sensory awareness of one’s own physical body to digital devices, fomenting competitive behavior at workplaces (Table 2, H5). “Self-monitoring” is a dimension of digital mindfulness that can be objectively defined, systematically measured, and practically supported by digital tools and technologies [42]. This approach broaches the issue of

self-determination by using assistive technology as a matter of technology assessment and ethical discourse [77]. Excessive use of technology trackers can bear destructive consequences inter- and intraindividually.

We believe this study is the first to investigate the two sides of mindfulness and technology as compatible and incongruous phenomena in the digital working context to date. Current developments within digitalization and the potential for innovation, such as digital solutions aiming for the support of mindfulness in the digital workplace, were the content of the study. New technologies of one decade increasingly become commonplace by the next, so that technology continually throws up challenges in the workplace to the nature of work (ability). The mixed linkages in the current literature were illuminated within this exploration of the fundamental compatibility of mindfulness and technology. This work serves as a basis for further research on mindful design and digital support for mindfulness as interventions integrated into the workplace. The findings provide the foundation for action guidelines and occupational regulations with the intention of mindful organizational modifications. Nevertheless, further (quantitative) research on mindful implications to cope with digital stress and correlations of digitally supported, mindfulness-based interventions at extended digital workplaces is needed.

Limitations

We discovered inconsistencies among experts’ argumentation, especially when studying the “Tipping Point” of the compatibility of mindfulness and technology.

First, the awareness of the workplace setting did not seem to be appropriately present when the shift of the compatibility was extracted (see Fig. 3). At that time, it was unclear how exactly the digital workplace the experts were referring to looks, i.e., digital devices, ergonomic nature, etc.; individual perceptions were paramount, and the inter-individual issue of data security was not considered [8]. It appears that most software used in office environments is regarded as being part of the experts’ notion of digital technologies, which reduces the contribution of this research to areas outside of the office environment.

Second, the self-reported compatibility on a scale did not exactly fit the arguments extracted from the text material (see Fig. 2). As the disclosures were captured at different times (interview/questionnaire), the differences might be due to ad hoc assessment and exploration within the scientific analysis.

Third, the level of expertise in the two fields of mindfulness and technology was distributed equally. Nevertheless, mindfulness practices and routines varied and were not consistent among the experts, which can be traced back to some of the experts who were included in this study because of their expertise in digitalization

(Table 2, H1.1 + H1.2). The mean age was 39 years, which represents the average age of the working population. However, the female gender was underrepresented (see Table 1); thus, this must be mentioned as a limitation.

Most experts are consultants who offer mindfulness training, which is why the results have to be interpreted with regard to a possible presence of bias involved (e.g., selling one's own approach as advantageous over the use of apps, which would replace the same service). In general, qualitative research cannot be stated as representative because of the influence of the individuals, even though measures were taken to ensure intersubjectivity and comparability (e.g., interview guidelines and analysis methods according to qualitative research standards). As a justification of the applied research design, mindfulness and stress are very much connected to individual perception, which would not be satisfied with more standardized research methods. In particular, the determination of the "Tipping Point" would have been less sensitive using prescribed response options.

Conclusions

Within the scope of this study, the interactions and compatibility of mindfulness and digitalization/technology have been explored. By looking at these components, some hypotheses about the counter- and interplay were established. The complementing perspectives resulted in "Mindful by Workplace-Design" and "Working Mindfully in a Digital Cooperation," which led to a number of suggested modifications for mindfulness in the digital workplace for employees and employers. Workplace conditions as well as workers' behavior can be addressed with interventions compensating for digital stress (e.g., moving breaks, cognitive restructuring, social exchange, control digital notifications or even use digital support for mindfulness practice). As an additional insight into the underlying hermeneutic structures, the "Tipping Point" of compatibility has been extracted, which seems to be reached when self-observation through technology diminishes self-awareness. At that point, responsibility for sensory awareness of one's own physical body is given to digital devices, and in the organizational setting, competitive behavior might be fomented. Eventually, this work raises awareness for the mindful handling of technology and states benefits in digitalization, such as making use of technology for more mindfulness and reduced stress for the individual at the workplace. As an added value to current research, this study evaluates the limits for digitally supported, mindfulness-based interventions at present, i.e. the permanent use of and reliance on the technology.

Abbreviations

AI	Artificial intelligence
BERN	Behavior, Exercise, Relaxation, Nutrition (Mind-body medical stress reduction concept)
KPI	Key Performance Indicator
PAID	Pressured, Always on, Information-overloaded, Distracted
VUCA	Volatility, Uncertainty, Complexity, Ambiguity
WHO	World Health Organization

Supplementary Information

The online version contains supplementary material available at <https://doi.org/10.1186/s44247-025-00186-0>.

Supplementary Material 1.

Supplementary Material 2.

Supplementary Material 3.

Supplementary Material 4.

Acknowledgements

The authors thank the experts for making themselves available for the interview without any compensation.

Authors' contributions

SJSW was responsible for the conception as well as the methodology, project administration and wrote the original article in consultation with MMM. MMM responsibilities included validation and supervision. SJSW conducted the interviews, dealt with data curation as well as the analysis and the visualization. TE reviewed, improved, and approved the manuscript. All co-authors have made a substantial contribution to the design, data collection and analysis of the research and the drafting of the manuscript and have reviewed and accepted the contents of the manuscript prior to its submission.

Funding

Open Access funding enabled and organized by Projekt DEAL.

Data availability

Data is provided within the manuscript or supplementary information files.

Declarations

Ethics approval and consent to participate

The study was positively approved by the Ethics Committee of the University of Witten/Herdecke under reference number 233/2019, i.e. it was checked for compliance with the Declaration of Helsinki on Medical Research Involving Human Subjects as well as with the applicable data protection regulations. Informed consent to participate was obtained from all individual participants included in the study (see Appendix II).

Consent for publication

Informed consent for publication was obtained from all individual participants included in the study (see Appendix II).

Competing interests

The authors declare no competing interests.

Received: 3 July 2024 / Accepted: 24 June 2025

Published online: 19 August 2025

References

1. Widuckel W. Arbeit 4.0 und transformation der mitbestimmung. In: Bader V, Kaiser S, editors. Arbeit in der data society. Wiesbaden: Springer Fachmedien Wiesbaden; 2020. pp. 17–34. <https://doi.org/10.1007/978-3-658-32276-2>.
2. Spath D, Bauer W. Working environments 4.0: how we will live and work tomorrow = arbeitswelten 4.0: Wie Wir Morgen arbeiten und leben. Stuttgart: Fraunhofer; 2012.

3. Gimpel H, Bayer S, Lanzl J, Regal C, Schäfer R, Schoch M. Digitale arbeit während der COVID-19-Pandemie: eine studie zu Den auswirkungen der pandemie auf arbeit und stress in Deutschland. Augsburg: Fraunhofer-Institut für Angewandte Informationstechnik FIT Projektgruppe Wirtschaftsinformatik; 2020.
4. Traum A, Müller C, Hummert H, Nerdinger FW, Digitalisierung. Die perspektive des arbeitenden individuums. Rostock: Universität Rostock, Seniorprofessur Wirtschafts- und Organisationspsychologie; Universitätsbibliothek; 2017.
5. Brennen JS, Kreiss D. Digitalization. In: Jensen KB, Rothenbuhler EW, Pooley JD, Craig RT, editors. The international encyclopedia of communication theory and philosophy. Wiley; 2016. pp. 1–11. <https://doi.org/10.1002/9781118766804.wbiect111>.
6. Ritter T, Pedersen CL. Digitization capability and the digitalization of business models in business-to-business firms: past, present, and future. *Ind Mark Manage*. 2020;86:180–90. <https://doi.org/10.1016/j.indmarm.2019.11.019>.
7. Müller-Brehm J, Otto P, Puntschuh M. Informationen zur politischen Bildung/izpb– Digitalisierung. 2020.
8. Turel O, Matt C, Trenz M, Cheung CM, D'Arcy* J, Qahri-Saremi* H, Tarafdar* M. Panel report: the dark side of the digitization of the individual. *INTR*. 2019;29:274–88. <https://doi.org/10.1108/INTR-04-2019-541>.
9. Statista. Stress - Größte Stressfaktoren in Deutschland nach Geschlecht 2016| Statista. 01.07.2021. <https://de.statista.com/statistik/daten/studie/282578/umfrage/umfrage-zu-den-groessten-stressfaktoren-im-alltag-nach-geschlecht/>. Accessed 1 Jul 2021.
10. Ayyagari. Grover, purvis. Technostress: technological antecedents and implications. *MIS Q*. 2011;35:831. <https://doi.org/10.2307/41409963>.
11. Borle P, Reichel K, Niebuhr F, Voelter-Mahlknecht S. How are Techno-Stressors associated with mental health and work outcomes?? A systematic review of occupational exposure to information and communication technologies within the technostress model. *Int J Environ Res Public Health*. 2021. <https://doi.org/10.3390/ijerph18168673>.
12. Theorell T, Hammarström A, Aronsson G, Träskman Bendz L, Grape T, Hogstedt C, et al. A systematic review including meta-analysis of work environment and depressive symptoms. *BMC Public Health*. 2015. <https://doi.org/10.1186/s12889-015-1954-4>.
13. Theorell T, Jood K, Järholm LS, Vingård E, Perk J, Östergren PO, Hall C. A systematic review of studies in the contributions of the work environment to ischaemic heart disease development. *Eur J Public Health*. 2016;26:470–7. <https://doi.org/10.1093/eurpub/ckw025>.
14. World Health Organization (WHO). Burn-out an occupational phenomenon: International Classification of Diseases. 08.09.2022. <https://www.who.int/news/item/28-05-2019-burn-out-an-occupational-phenomenon-international-classification-of-diseases>. Accessed 15 Sep 2022.
15. Listopad IW, Esch T, Michaelsen MM. An empirical investigation of the relationship between spirituality, work culture, and burnout: the need for an extended health and disease model. *Front Psychol*. 2021;12:723884. <https://doi.org/10.3389/fpsyg.2021.723884>.
16. Schein EH. Organizational culture and leadership. 3rd ed. San Francisco: Jossey-Bass; 2004.
17. Matyssek AK. Führung und gesundheit: Ein Praktischer ratgeber Zur förderung der psychosozialen gesundheit Im betrieb: [Tipps, Selbst-Check, Leitfaden. 3rd ed. Norderstedt: Books on Demand; 2012.
18. Ricker S, Hauser F. Arbeitsplatzkultur und gesundheit– ganzheitliche gestaltung der organisationalen beziehungen Zur Stärkung der Psychischen gesundheit von mitarbeitern. In: Badura B, Ducki A, Schröder H, Klose J, Meyer M, editors. Fehlzeiten-Report 2016. Berlin, Heidelberg: Springer Berlin Heidelberg; 2016. pp. 107–19. https://doi.org/10.1007/978-3-662-49413-4_9.
19. Laloux F. Reinventing organizations: Ein Leitfaden Zur gestaltung Sinnstiftender formen der zusammenarbeit. München: Verlag Franz Vahlen; 2015.
20. Gimpel H, Berger M, Lanzl J, Regal C, Schäfer R, Schmidt M, Schmidt T. Präventionsmaßnahmen der digitalen arbeit: Ein strukturierter katalog an Präventionsmaßnahmen Zur vermeidung von digitalem stress. Augsburg: Fraunhofer FIT; 2021.
21. Michaelsen MM, Graser J, Onescheit M, Tuma M, Pieper D, Werdecker L, Esch T. iga.Report 45: Wirksamkeit von Achtsamkeitstrainings im Arbeitskontext. 2021. https://www.iga-info.de/fileadmin/redakteur/eroeffentlichungen/iga_Reporte/Dokumente/iga.Report_45_Achtsamkeitstechniken.pdf. Accessed 3 Jan 2022.
22. Oh B, Lee KJ, Zaslavski C, Yeung A, Rosenthal D, Larkey L, Back M. Health and well-being benefits of spending time in forests: systematic review. *Environ Health Prev Med*. 2017. <https://doi.org/10.1186/s12199-017-0677-9>.
23. Vonderlin R, Biermann M, Bohus M, Lyssenko L. Mindfulness-Based programs in the workplace: a Meta-Analysis of randomized controlled trials. *Mindfulness*. 2020;11:1579–98. <https://doi.org/10.1007/s12671-020-01328-3>.
24. Kabat-Zinn J. Mindfulness-based interventions in context: past, present, and future. *Clin Psychol Sci Pract*. 2003;10:144–56. <https://doi.org/10.1093/clipsy.pg016>.
25. Crane C, Crane RS, Eames C, Fennell MJV, Silvertson S, Williams JMG, Barnhofer T. The effects of amount of home meditation practice in mindfulness based cognitive therapy on hazard of relapse to depression in the staying well after depression trial. *Behav Res Ther*. 2014;63:17–24. <https://doi.org/10.1016/j.brat.2014.08.015>.
26. Birtwell K, Williams K, van Marwijk H, Armitage CJ, Sheffield D. An exploration of formal and informal mindfulness practice and associations with wellbeing. *Mindfulness*. 2019;10:89–99. <https://doi.org/10.1007/s12671-018-0951-y>.
27. DeWiki. DeWiki > Meditation. 05.04.2022. <https://dewiki.de/Lexikon/Meditation>. Accessed 5 Apr 2022.
28. Wikipedia Y. 2021. <https://en.wikipedia.org/w/index.php?title=Yoga&oldid=105658829>. Accessed 23 Nov 2021.
29. Benson H, Beary JF, Carol MP. The relaxation response. *Psychiatry*. 1974;37:37–46. <https://doi.org/10.1080/00332747.1974.11023785>.
30. Esch T, Fricchione GL, Stefano GB. The therapeutic use of the relaxation response in stress-related diseases. *Med Sci Monit*. 2003;9:RA23–34.
31. Esch T, Stefano GB. The neurobiology of stress management. *Neuroendocrinol Lett*. 2010;31:19–39.
32. Michalak J, Heidenreich T, Williams JMG, Achtsamkeit. Göttingen: Hogrefe; 2012.
33. Kabat-Zinn J. *Gesund durch meditation: Das Große Buch der selbstheilung*. 10th ed. München: Barth; 2003.
34. Esch T. Der Nutzen von Selbstheilungspotenzialen in der professionellen gesundheitsfürsorge am beispiel der Mind-Body-Medizin. *Bundesgesundheitsbl*. 2020;63:577–85. <https://doi.org/10.1007/s00103-020-03133-8>.
35. Esch T, Stefano GB. The BERN framework of mind-body medicine: integrating self-care, health promotion, resilience, and applied neuroscience. *Front Integr Neurosci*. 2022;16:913573. <https://doi.org/10.3389/fnint.2022.913573>.
36. Scharmer CO, Theory U. Leading from the future as it emerges: the social technology of presencing. Oakland, CA: Berrett-Koehler Publishers Inc; 2016.
37. Thatcher JB, Wright RT, Sun H, Zagenczyk TJ, Klein R. Mindfulness in information technology use: definitions, distinctions, and a new measure. *MIS Q*. 2018;42:831–47. <https://doi.org/10.25300/MISQ/2018/11881>.
38. Balconi M, Fronda G, Crivelli D. Effects of technology-mediated mindfulness practice on stress: Psychophysiological and self-report measures. *Stress*. 2019;22:200–9. <https://doi.org/10.1080/10253890.2018.1531845>.
39. Crivelli D, Fronda G, Venturella I, Balconi M. Supporting mindfulness practices with Brain-Sensing devices. *Cogn Electrophysiological Evidences Mindfulness*. 2019;10:301–11. <https://doi.org/10.1007/s12671-018-0975-3>.
40. Bhayee S, Tomaszewski P, Lee DH, Moffat G, Pino L, Moreno S, Farb NAS. Attentional and affective consequences of technology supported mindfulness training: a randomised, active control, efficacy trial. *BMC Psychol*. 2016;4:60. <https://doi.org/10.1186/s40359-016-0168-6>.
41. Matusiewicz D, Kaiser L, editors. *Digitales betriebliches gesundheitsmanagement*. Wiesbaden: Springer Fachmedien Wiesbaden; 2018.
42. Abhari K, Klase M, Koobchehr F, Olivares F, Pesavento M, Sosa L, Vaghefi I. Toward a theory of digital mindfulness: A case of Smartphone-Based Self-monitoring. In: Nah FF-H, Siau K, editors. *HCI IN BUSINESS, GOVERNMENT AND ORGANIZATIONS: 8th international*. [S.l.]: SPRINGER NATURE; 2021. pp. 549–61. https://doi.org/10.1007/978-3-030-77750-0_35.
43. Fish J, Brimson J, Lynch S. Mindfulness interventions delivered by technology without facilitator involvement: what research exists and what are the clinical outcomes?? *Mindfulness*. 2016;7:1011–23. <https://doi.org/10.1007/s12671-016-0548-2>.
44. Valorinta M. Information technology and mindfulness in organizations. *Ind Corp Change*. 2009;18:963–97. <https://doi.org/10.1093/icc/dtp027>.
45. Gerber B, Scriba J, Geissler A, Reckling H, Fischer M, Karl D, et al. Pilotstudie zu subjektiv und objektiv messbarer stressreduktion Im alltag Einer universitären anästhesieabteilung durch Ein interventionsprogramm Nach Mindfulness-Based stress reduction (MBSR). *Anaesthetist*. 2020;69:623–31. <https://doi.org/10.1007/s00101-020-00802-w>.
46. May RW, Bamber M, Seibert GS, Sanchez-Gonzalez MA, Leonard JT, Salsbury RA, Fincham FD. Understanding the physiology of mindfulness: aortic hemodynamics and heart rate variability. *Stress*. 2016;19:168–74. <https://doi.org/10.3109/10253890.2016.1146669>.

47. Böckelmann I. Analyse der Herzfrequenzvariabilität (HRV) — praktische Relevanz. *Zbl Arbeitsmed.* 2012;62:275–9. <https://doi.org/10.1007/BF03346164>.
48. Brinkmann AE, Press SA, Helmert E, Hautzinger M, Khazan I, Vagedes J. Comparing effectiveness of HRV-Biofeedback and mindfulness for workplace stress reduction: A randomized controlled trial. *Appl Psychophysiol Biofeedback.* 2020;45:307–22. <https://doi.org/10.1007/s10484-020-09477-w>.
49. Lehrer PM, Gevirtz R. Heart rate variability biofeedback: how and why does it work? *Front Psychol.* 2014. <https://doi.org/10.3389/fpsyg.2014.00756>.
50. Hernando D, Roca S, Sancho J, Alesanco Á, Bailón R. Validation of the Apple watch for heart rate variability measurements during relax and mental stress in healthy subjects. *Sensors.* 2018;18:2619. <https://doi.org/10.3390/s18082619>.
51. Victorson DE, Sauer CM, Wolters L, Maletich C, Lukoff K, Sufrin N. Meta-analysis of Technology-Enabled mindfulness-Based programs for negative affect and mindful awareness. *Mindfulness.* 2020;11:1884–99. <https://doi.org/10.1007/s12671-020-01373-y>.
52. Esmailzadeh P. The role of information technology mindfulness in the post-adoption stage of using personal health devices: Cross-Sectional questionnaire study in mobile health. *JMIR Mhealth Uhealth.* 2020;8:e18122. <https://doi.org/10.2196/18122>.
53. Wrede SJS, Sobke SC, Michaelsen MM, Esch T. Implementation of mindfulness at work considering digital support: A qualitative study with a systems theory approach. *J Workplace Behav Health.* 2024;11–26. <https://doi.org/10.1080/15555240.2024.2388646>.
54. Mayring P. *Qualitative Inhaltsanalyse: Grundlagen und Techniken.* 8th ed. Weinheim, Basel: Beltz; 2003.
55. Gläser J, Laudel G. *Experteninterviews und qualitative Inhaltsanalyse Als instrumente rekonstruierender untersuchungen.* 4th ed. Wiesbaden: VS Verl. für Sozialwiss; 2010.
56. Dutine F. *Das innere Team – Reflexionsprotokoll einer Beratungssimulation.* Essen: FOM Hochschule für Oekonomie und Management; 2020.
57. Lupton D. *The quantified self.* Malden: Polity Press; 2016.
58. Bennett N, Lemoine J. *What VUCA Really Means for You.* 2014.
59. Hougaard R, Carter J, Coutts G. *MINDFUL LEADERSHIP: ACHIEVING RESULTS BY MANAGING THE MIND.* Lead Lead. 2016;2016:49–56. <https://doi.org/10.10102/ltl.20218>.
60. Pflügner K, Baumann A, Maier C. Managerial technostress: A qualitative study on causes and consequences. *SIGMIS-CPR '21: Proc 2021 Computers People Res Conf.* 2021;63–70. <https://doi.org/10.1145/3458026.3462157>.
61. Borle P, Boerner-Zobel F, Voelter-Mahlknecht S, Hasselhorn HM, Ebener M. The social and health implications of digital work intensification. Associations between exposure to information and communication technologies, health and work ability in different socio-economic strata. *Int Arch Occup Environ Health.* 2021;94:377–90. <https://doi.org/10.1007/s00420-020-01588-5>.
62. Dragano N, Riedel-Heller SG, Lunau T. Haben digitale Technologien bei der Arbeit Einfluss auf die psychische Gesundheit? [Do digital technologies at work impact mental health of employees?]. *Nervenarzt.* 2021;92:1111–20. <https://doi.org/10.1007/s00115-021-01192-z>.
63. Tugui A. *Calm technologies: A new trend for educational technologies.* *World Futures Rev.* 2011;3:64–73. <https://doi.org/10.1177/194675671100300103>.
64. Smith EN, Santoro E, Moraveji N, Susi M, Crum AJ. Integrating wearables in stress management interventions: promising evidence from a randomized trial. *Int J Stress Manage.* 2020;27:172–82. <https://doi.org/10.1037/str0000137>.
65. Winter N, Russell L, Ugalde A, White V, Livingston P. Engagement strategies to improve adherence and retention in Web-Based mindfulness programs: systematic review. *J Med Internet Res.* 2022;24:e30026. <https://doi.org/10.2196/30026>.
66. Hall BJ, Xiong P, Guo X, Sou EKL, Chou UI, Shen Z. An evaluation of a low intensity mHealth enhanced mindfulness intervention for Chinese university students: A randomized controlled trial. *Psychiatry Res.* 2018;270:394–403. <https://doi.org/10.1016/j.psychres.2018.09.060>.
67. Sommers-Spijkerman M, Austin J, Bohlmeijer E, Pots W. New evidence in the booming field of online mindfulness: an updated Meta-analysis of randomized controlled trials. *JMIR Mental Health.* 2021;8:e28168. <https://doi.org/10.2196/28168>.
68. Loss J, Bengel J. 5.1. Gesundheitsförderung, Prävention und Rehabilitation. In: *Online Lehrbuch der Medizinischen Psychologie und Medizinischen Soziologie.* <https://doi.org/10.5680/olmps000059>.
69. Mrazek AJ, Mrazek MD, Cherolini CM, Cloughesy JN, Cynman DJ, Gougis LJ, et al. The future of mindfulness training is digital, and the future is now. *Curr Opin Psychol.* 2019;28:81–6. <https://doi.org/10.1016/j.copsyc.2018.11.012>.
70. Wei C, Pitafi AH, Kanwal S, Ali A, Ren M. Improving employee agility using enterprise social media and digital fluency: moderated mediation model. *IEEE Access.* 2020;8:68799–810. <https://doi.org/10.1109/ACCESS.2020.2983480>.
71. Han J, LaMarra D, Vapiwala N. Applying lessons from social psychology to transform the culture of error disclosure. *Med Educ.* 2017;51:996–1001. <https://doi.org/10.1111/medu.13345>.
72. de Bruijn H, Größler A, Videira N. Antifragility as a design criterion for modeling dynamic systems. *Syst Res Behav Sci.* 2020;37:23–37. <https://doi.org/10.1002/sres.2574>.
73. Equihua M, Espinosa Aldama M, Gershenson C, López-Corona O, Munguía M, Pérez-Maqueo O, Ramírez-Carrillo E. Ecosystem antifragility: beyond integrity and resilience. *PeerJ.* 2020;8:e8533. <https://doi.org/10.7717/peerj.8533>.
74. Ramezani J, Camarinha-Matos LM. Approaches for resilience and antifragility in collaborative business ecosystems. *Technol Forecast Soc Chang.* 2020;151:119846. <https://doi.org/10.1016/j.techfore.2019.119846>.
75. Dweck CS. Mindsets and human nature: promoting change in the middle east, the schoolyard, the racial divide, and willpower. *Am Psychol.* 2012;67:614–22. <https://doi.org/10.1037/a0029783>.
76. Canning EA, Murphy MC, Emerson KTU, Chatman JA, Dweck CS, Kray LJ. Cultures of genius at work: organizational mindsets predict cultural norms, trust, and commitment. *Pers Soc Psychol Bull.* 2020;46:626–42. <https://doi.org/10.1177/0146167219872473>.
77. Remmers H. Environments for ageing, assistive technology and self-determination: ethical perspectives. *Inf Health Soc Care.* 2010;35:200–10. <https://doi.org/10.3109/17538157.2010.528649>.

Publisher's Note

Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.