Designing for Informal Mindfulness: Exploring How Interactive Technology Can Support Mindful Awareness in Everyday Life

Laura Koekkoek
Utrecht University
Utrecht
The Netherlands
l.m.koekkoek1@students.uu.nl

Marit Bentvelzen
Utrecht University
Utrecht
The Netherlands
m.bentvelzen@uu.nl

Informal mindfulness, the practice of bringing mindful awareness to everyday activities, has been associated with a range of well-being benefits, yet most technologies focus on *formal* practices (e.g., meditation). We explore how interactive technology can support *informal* mindfulness. We conducted interviews with informal mindfulness practitioners (n=12) and used the findings to design a tangible prototype, the *Mindfulness Ball*. We then evaluated it in a day-long in-the-wild study with 12 participants, followed by exit interviews. Our findings show that the Mindfulness Ball can support informal mindfulness through low-threshold, embodied interactions that prompt brief moments of awareness during daily activities. Participants reported increased awareness that sometimes lingered beyond the interaction. Engagement was shaped by embodied and curiosity-driven interaction, while prompt effectiveness depended on contextual fit. We conclude with implications for designing technologies that better support informal mindfulness in everyday life.

1. INTRODUCTION

Many people experience stress, with recent research reporting high levels across populations (Piao, Xie, and Managi 2024). Mindfulness-based interventions can help address these challenges by reducing stress, anxiety, and depression, while supporting psychological well-being (Lomas et al. 2019).

Mindfulness is commonly defined as a non-judgmental awareness of present-moment experience (Kabat-Zinn 2013). It can be cultivated through formal practices, such as structured meditation exercises, as well as through informal practices that integrate awareness into everyday activities like eating, walking, or cleaning (Birtwell et al. 2019; Lukoff et al. 2020). As interest in mindfulness has grown, researchers have increasingly explored how interactive technologies can support its practice (Terzimehić et al. 2019). However, existing systems primarily focus on formal practices, especially guided meditation (Lukoff et al. 2020).

This emphasis on formal practice overlooks the potential of informal mindfulness, which may be more strongly associated with psychological well-being and psychological flexibility than formal practice alone (Birtwell et al. 2019). Consequently, little is known about how interactive technologies can support mindfulness in everyday, informal contexts.

To address this gap, we explore the following research question: *How can interactive technologies support informal mindfulness practices?*

2. RELATED WORK

2.1. Mindfulness

Mindfulness is commonly defined as paying attention to the present moment in a purposeful and non-judgmental way (Kabat-Zinn 2013). Mindfulness practice has been associated with a range of benefits, including reductions in anxiety (Peterson and Pbert 1992; Miller, Fletcher, and Kabat-Zinn 1995), depressive symptoms (Ramel et al. 2004), rumination (Ramel et al. 2004; Lykins and Baer 2009), stress (Carmody and Baer 2008), and chronic pain (Kabat-Zinn 1982). It has also been linked to improvements in brain and immune function (Davidson et al. 2003), attention (Jha, Krompinger,

© Koekkoek et al. Published by BCS Learning and Development Ltd.

and Baime 2007; Chiesa, Calati, and Serretti 2011), and emotional regulation (Hamilton, Kitzman, and Guyotte 2006). Furthermore, evidence suggests a dose-response relationship, with benefits increasing as the frequency of practice increases (Bostock et al. 2019).

2.2. Mindfulness in HCI

Given the potential benefits of mindfulness, HCI researchers have explored various ways of supporting mindfulness practice through technology. Examples include the Soma Mat and Breathing Light, which promote meditative physical introspection through heat and breathing-based feedback and can be used to support practices such as guided meditation and body scanning (Ståhl et al. 2016); the Mindfulness Sphere, which visualizes a user's heartbeat to encourage attention to bodily sensations (Thieme et al. 2013); ZenVR, a virtual reality system for learning meditation practices (Feinberg et al. 2022); and the AEON app, which supports novice meditators in practicing thought distancing (Chittaro and Vianello 2014).

Designing technology for mindfulness can be challenging because common HCI design principles may conflict with mindfulness principles. Features such as progress tracking, gamification, and social comparison can promote an achievement-oriented mindset that conflicts with the process-oriented nature of mindfulness (Lukoff et al. 2020). Previous work has also identified tensions between user control and acceptance and between richness and minimalism (Terzimehić et al. 2019). Another challenge is balancing self-tracking with a non-judgmental attitude (Zhu, Hedman, and H. Li 2016; Parsons et al. 2019). While technology can help people become more aware of their behaviour, it should avoid encouraging them to judge it as ”good” or ”bad” (Parsons et al. 2019). Research has also pointed to a tension between providing technological support and helping users develop their own mindfulness practice (Terzimehić et al. 2019; Feinberg et al. 2022).

Several design recommendations have been proposed to address these challenges. These include aligning technological features with mindfulness principles (Lukoff et al. 2020), creating embodied and adaptive experiences (Sliwinski, Katsikitis, and Jones 2017), and supporting awareness without labelling behaviour as ”right” or ”wrong” (Parsons et al. 2019).

2.3. Formal vs. informal mindfulness

Within mindfulness, a distinction is commonly made between formal and informal practice. Formal practice refers to structured exercises such as sitting meditation and body scans, whereas informal practice involves bringing mindful awareness to everyday activities (Birtwell et al. 2019). Informal mindfulness is often considered more accessible because it can be integrated into existing daily routines (J. Li, Cochrane, and Leshed 2024). Moreover, the frequency of informal mindfulness practice has been found to be more strongly related to well-being and psychological flexibility than the frequency of formal practice (Birtwell et al. 2019).

While HCI research has explored various ways of supporting mindfulness through technology, much of this work focuses on formal mindfulness practices. As a result, less is known about how technology can support informal mindfulness in everyday life.

3. METHOD

To understand how people practice informal mindfulness, we conducted semi-structured interviews with 12 participants experienced with informal mindfulness. The study was allowed to proceed by Utrecht University's Research Institute of Information and Computing Sciences on the basis of an Ethics and Privacy Quick Scan. Participants ranged in age 30-64 years (M = 50.08, SD = 12.18), and had between 3-35 years of mindfulness experience. Interviews were conducted online and lasted 37 minutes on average. Two interview participants also took part in the final prototype evaluation.

The interviews began with a brief introduction and informed consent for recording, followed by an inquiry into participants' informal mindfulness practices, motivations, challenges, and views on technological support (see Appendix A for the protocol). Interviews were transcribed verbatim and analyzed using thematic analysis (Braun and Clarke 2006). After familiarising themselves with the data, the first author open-coded a representative 10% sample. Through iterative discussions with the last author, an initial coding tree was developed and refined, then applied by the first author to the remaining transcripts. A broader thematic analysis (Blandford, Furniss, and Makri 2016) was subsequently conducted to identify recurrent themes.

3.1. Key insights

3.1.1. Informal mindfulness practices

Participants reported practicing informal mindfulness during a wide range of activities, most commonly *walking* (n=9), *eating or drinking* (n=6), and *household chores* (n=5). Most participants (n=7) indicated that only brief moments of mindfulness were sufficient.

Participants described several motivations for practicing informal mindfulness, with *relaxation* being mentioned most frequently (n=6). Many participants relied on *sensory experiences* as anchors for their attention (n=8). Common techniques included using reminders and intentionally removing potential distractions.

Participants also described several challenges. The most frequently mentioned barriers were *mind wandering* (n=10), *distractions from digital devices* (n=7), and having a *busy schedule* (n=7). Despite these challenges, participants associated informal mindfulness with positive outcomes, including feeling more *relaxed*, experiencing *less stress*, and increased *feelings of joy*.

3.1.2. Opportunities for technological support
Participants identified several ways in which technology could support informal mindfulness practice. One frequently mentioned idea was providing *activity suggestions* to inspire practice. Participants also discussed the use of reminders, including *visual* (n=6), *haptic* (n=5), and *auditory* (n=4) reminders. Regardless of the modality, participants agreed that reminders should be *subtle* and *unobtrusive*.

A common concern (n=5) was that technology itself can be *distracting*. Some participants therefore preferred the idea of a single-purpose device that would minimize distractions. Regardless of form, participants emphasized that any system should be simple and intuitive to use.

3.2. Design Requirements

Based on the interview findings and literature, we formulated five design requirements for the prototype: DR1) Align with key mindfulness principles, DR2) Provide subtle, sensory cues, DR3) Feel intuitive and simple to use, DR4) Provide activity suggestions, and DR5) Minimize digital distractions.

4. DESIGN PROCESS

4.1. Concept development and selection

Based on the design requirements, we developed three concepts: *The Mindfulness Dice*, *The Mindfulness Ball*, and *The Mindful Drawing Board*. All three concepts were designed as tangible objects that provide subtle reminders and mindfulness prompts. The Mindfulness Dice displays a mindfulness prompt or activity suggestion when rolled, the Mindfulness Ball displays a prompt when shaken, and the Mindful Drawing Board reveals a prompt as the user follows text with a stylus.

To select one concept for further development, we conducted an online survey with 12 participants to evaluate the three concepts. Participants viewed a storyboard for each concept and answered Likert-scale and open-ended questions about it. After evaluating all three concepts, they were asked to rank the concepts from most to least preferred.

Overall, participants preferred the *Mindfulness Ball*. They considered it the least obtrusive concept, the best fit for informal mindfulness, and the one they would be most likely to use. Participants particularly appreciated its visual design and the larger variety of prompts it could provide compared to the Mindfulness Dice. Based on these findings, we chose to further develop the Mindfulness Ball.

4.2. The Mindfulness Ball

The final prototype (Figure 1) was designed to address the five design requirements identified from the interviews and literature. The prototype is a spherical object inspired by the Magic 8-ball. Its shape encourages a simple and intuitive interaction: the user picks up and shakes the ball. The ball was 3D printed in white and light grey to create a calm and non-distracting appearance.

Several times a day, the device provides a subtle visual reminder by briefly displaying the text ”shake me” on its screen. When shaken, the ball displays a mindfulness prompt. These prompts either suggest everyday activities that can be done mindfully (e.g., ”Try doing one small household task with full attention”) or encourage awareness of present-moment experiences (e.g., “Notice if there is tension somewhere in your body”). The prompts are phrased to encourage awareness without judgment or a focus on performance. After displaying a prompt, the screen turns off again. This brief interaction was designed to fit easily into daily life while minimizing digital distractions through the use of a single-purpose device.

A high-fidelity prototype was developed for the evaluation. The outer shell was 3D printed using an existing Magic 8-ball design[1]. The prototype contained an Arduino Uno, a tilt sensor, a 16x2 LCD display, and a battery pack. When the ball is shaken, the tilt sensor detects the movement and triggers the display of a randomly selected mindfulness prompt.

5. EVALUATION

5.1. Method

We evaluated the prototype with 12 participants. Participants were between 23 and 62 years old (M = 41.08, SD = 17.84) and reported varying levels

[1] https://www.instructables.com/Magic-8-Ball-Open-Source-Customizable-Fun-and-Easy/

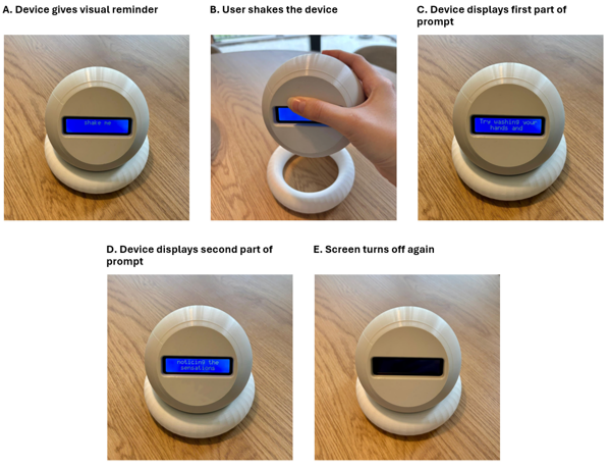

Figure 1: *Interaction flow: the Mindfulness Ball first provides a visual reminder (A: "shake me"), after which the user can shake the ball (B) to receive a mindfulness prompt (C: "Try washing your hands and", D: "noticing the sensations"). After this, the screen turns off again (E).*

of mindfulness experience. Participants completed a short survey before using the prototype for one day. Afterwards, the prompt log was retrieved from the prototype and used during a semi-structured interview about their experiences with the device. The interviews were transcribed and analyzed using thematic analysis (Braun and Clarke 2006). Following familiarization with the data, the first author iteratively coded the transcripts to identify recurring themes. See Appendix B for the survey and interview protocol.

5.2. Findings

Participants were generally positive about the Mindfulness Ball, describing it as simple, low-threshold, unobtrusive, fun, and playful. This was also reflected in the ratings. Participants rated the prototype as minimally intrusive (M = 1.33, SD = 0.54), while giving high ratings for fit with daily routine (M = 4.25, SD = 0.84) and prompt usefulness (M = 4.08, SD = 0.90) (Figure 2). Together, these findings suggest that the Mindfulness Ball was perceived as a low-threshold intervention that could be incorporated into everyday life.

Participants often interacted with the device on their own initiative rather than waiting for a reminder. Prompt logs showed that participants triggered an average of 13.5 prompts per day (SD = 7.94). Several participants (n=6) said they were motivated by curiosity and picked up the ball to see what new prompt it would provide:

> *"Sometimes it was out of curiosity. Especially later on, because it was different every time, so after a while I just got curious: 'Oh, what will it say now?'"* (P5)

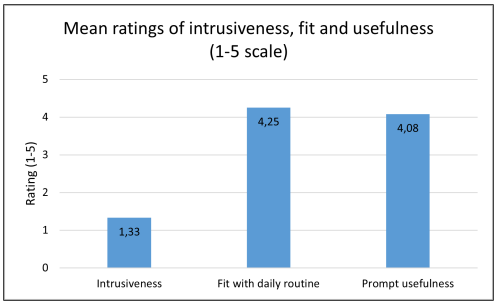

Figure 2: *Bar chart of mean ratings of intrusiveness, fit with daily routine and prompt usefulness on a 5-point scale (1 = low, 5 = high).*

In general, participants perceived the reminders as subtle and unobtrusive. As one participant described:

> *"It's more like an invitation, that's how I saw it."* (P8)

However, this subtlety also reduced noticeability. Half of the participants (n=6) reported missing at least one reminder during the evaluation, and eight participants suggested supplementing the visual cue with an additional sensory modality such as sound or vibration. This highlights a design tension between maintaining unobtrusiveness and ensuring reminders are noticed:

> *"Perhaps a sound or some sort of vibration feature would make it stand out a bit more."* (P3)

Overall, participants responded positively to the prompts, describing them as clear, engaging, and occasionally surprising. In particular, participants appreciated prompts that were concrete, brief, and easy to incorporate into ongoing activities:

> *"They were also things that didn't take long at all. So, I found them quite manageable within a short time, which is nice, because it lowers the threshold for doing them."* (P3)

This suggests that concise and actionable prompts may facilitate engagement with informal mindfulness practices. However, participants also emphasized the importance of contextual relevance. Prompts that did not fit the user's immediate situation were frequently ignored, postponed, or experienced as frustrating:

> *"Sometimes it gave me a prompt, like 'go for a mindful walk'. But then it said that just when I'd been outside, so I was almost tempted to say: 'That's not very helpful, I've just been outside.'"* (P1)

Furthermore, most participants (n=9) reported increased awareness during use of the Mindfulness

Ball. For some, these effects extended beyond direct interaction with the device and carried over to other everyday activities:

> *"I do think something stuck with me, because it reminds you that you can do things a certain way. For example, I was tearing up some paper at one point and then I thought to myself: 'Oh, that's a nice sound, what am I hearing here?' So maybe it does have an effect to take in things more calmly every now and then, without being on autopilot."* (P8)

Several participants also reported repeating mindfulness exercises independently later in the day without interacting with the device again:

> *"And there was one I deliberately chose to do a few times. I enjoyed it so much and found it so effective that I thought: 'Well, I don't need the Mindfulness Ball for this; I can bring myself to stand still for a moment every now and then, to see how my posture feels.'"* (P2)

This suggests that the influence of the prompts was not restricted to moments of interaction with the device itself. Beyond increased awareness, participants described feeling more relaxed and taking more intentional breaks throughout the day:

> *"What I also noticed it did was: it made me pause for a moment, because otherwise I would just keep going all day. And taking a moment like that helps you to take a break, instead of just rushing through your day."* (P2)

These effects were not experienced uniformly across participants. Some felt that the prompts were too brief to noticeably influence their awareness, while one participant noted that sustained mindfulness could sometimes feel uncomfortable:

> *"If I am constantly aware of everything, it's not always a good thing. In fact, it makes me feel tense if I'm mindful all day long."* (P9)

Taken together, this shows that while the Mindfulness Ball supported awareness, reflection, and moments of pause for many participants, the perceived benefits depended on individual preferences and on how mindfulness practices were integrated into everyday routines.

6. DISCUSSION

Our findings suggest that the Mindfulness Ball supported informal mindfulness through more than the prompts alone. Participants described how the physical interaction itself increased awareness, how curiosity motivated repeated engagement, and how contextual and personal factors shaped their experiences with the device.

6.1. Embodied Interaction Fosters Awareness

The act of picking up and shaking the Mindfulness Ball appeared to contribute to participants' awareness. Rather than simply receiving a reminder, participants performed a deliberate physical action before engaging with a prompt. This is consistent with previous work on embodied and mindful interactions, which suggests that embodied interaction styles can promote mindful engagement (Van Rheden and Hengeveld 2016) and help direct attention towards bodily sensations (Höök, Ståhl, et al. 2015; Höök, Jonsson, et al. 2016).

One possible explanation is that the interaction briefly interrupted participants' ongoing activities and shifted their attention towards the present moment. Previous research similarly found that introducing small frictions into interactions can interrupt automatic behaviour and encourage more attentive engagement (Cox et al. 2016). This interpretation also aligns with embodied perspectives on cognition, which emphasize that cognition is influenced by bodily actions and interactions with the environment (Wilson 2002; Lee-Cultura and Giannakos 2020).

These findings indicate that simple physical interactions can support informal mindfulness practices. At the same time, participants appreciated that the interaction remained easy and low-threshold. Future systems should therefore consider how to introduce physical engagement without making interactions unnecessarily demanding.

6.2. Curiosity-Driven Interaction

Curiosity played an important role in how participants engaged with the Mindfulness Ball. Rather than only interacting after receiving reminders, participants often picked up the device voluntarily to see which prompt would appear next. This behaviour can be understood in terms of intrinsic motivation, which refers to engaging in an activity because it is interesting or enjoyable rather than because of external rewards or pressure (Ryan and Deci 2000). Curiosity is one form of intrinsic motivation and is closely related to exploratory behaviour (Oudeyer, Gottlieb, and Lopes 2016).

Previous research has shown that curiosity can be encouraged through novelty, surprise, and uncertainty (Tieben, Bekker, and Schouten 2011; Oudeyer, Gottlieb, and Lopes 2016). In this study, the variation between prompts and uncertainty about the next interaction may have contributed to repeated engagement with the device. This is consistent with research suggesting that curiosity is maintained when people continue to encounter opportunities for discovery (Poli et al. 2024).

Designing for curiosity may provide a way to encourage engagement with mindfulness technologies.

6.3. Ways Forward

While the findings of the current study suggest that the effects of the prompts extended beyond the interaction itself, it remains unclear whether these effects persist in the long term, as the evaluation lasted only one day. This is particularly relevant given that HCI research has primarily focused on supporting state mindfulness, while paying less attention to long-term, trait mindfulness (Terzimehić et al. 2019). At the same time, previous research suggests that repeated experiences of state mindfulness can contribute to trait mindfulness over time (Kiken et al. 2015), especially when mindfulness is integrated into daily activities rather than limited to formal practice (Lukoff et al. 2020). Future research should therefore examine whether the increase in awareness observed in this study is sustained over longer periods of use.

In addition, the impact of long-term use on user engagement remains unclear. Previous research has shown that engagement with interactive systems can decline over time as the novelty effect wears off (Koch et al. 2018). Similarly, repeated reminders may eventually lead to habituation, resulting in reduced responsiveness among users (Anderson et al. 2017). Future research should therefore investigate how mindfulness technologies can maintain engagement over time, for example through variation in prompts or interaction.

Finally, participants responded differently to the prompts, suggesting that a one-size-fits-all approach may not be sufficient. Previous work has highlighted the importance of adaptive and personalized experiences in mindfulness technologies (Sliwinski, Katsikitis, and Jones 2017). At the same time, personalization presents a challenge in this context. Whereas it is standard practice in HCI to tailor technologies to the user and give them control, mindfulness emphasizes acceptance. This tension has been described as a question of "coherence in design": the extent to which a system's features align with the underlying principles of mindfulness (Lukoff et al. 2020). Future research should therefore examine how personalization can be applied in a way that remains consistent with mindfulness principles.

6.4. Limitations

This study has several limitations. First, mindfulness was assessed qualitatively through interviews rather than with a validated quantitative instrument. This approach was chosen because the study focused on participants' experiences with the prototype in an everyday context. Existing measures of state mindfulness, such as the Toronto Mindfulness Scale (Lau et al. 2006), were primarily developed for short, controlled mindfulness sessions. As participants in the current study interacted with the prototype multiple times throughout a normal day, the suitability of such measures was unclear. In addition, previous work has questioned whether mindfulness can be reliably measured using self-report questionnaires (Grossman 2008). While interviews provided rich insights into participants' experiences, they make it difficult to compare findings between participants or determine the extent of observed effects.

Second, participants used the prototype for only one day. While this allowed us to study its use in a natural setting, it remains unclear whether the observed effects persist over time or how interactions with the device may change with repeated use.

Finally, the prototype was highly sensitive, causing prompts to be triggered unintentionally. In some cases, participants adapted their interaction with the device as a result. For example, one participant started tapping the prototype rather than shaking it. This may have influenced how the prototype was experienced during the evaluation.

7. CONCLUSION

While existing mindfulness technologies primarily focus on formal mindfulness, this study explored how interactive technology can support informal mindfulness. The findings suggest that technology can support informal mindfulness through low-threshold interactions that encourage brief moments of awareness during everyday activities. During the prototype evaluation, most participants reported increased awareness, which sometimes extended beyond moments of interaction. This appeared to be supported by simple and intuitive interaction, concrete prompts, and embodied interaction that interrupted automatic behaviour and shifted attention.

The findings further suggest that context plays an important role in how mindfulness prompts are experienced, and that curiosity can encourage self-initiated interaction. At the same time, the study highlights challenges related to reminder design and individual differences. Taken together, these findings provide insight into how interactive technologies can be designed to support informal mindfulness in daily life.

REFERENCES

Anderson, Bonnie Brinton et al. (2017). "It All Blurs Together: How the Effects of Habituation Generalize Across System Notifications and Security Warnings". In: *Information Systems and Neuroscience*. Ed. by Fred D. Davis et al. Vol. 16. Series Title: Lecture Notes in Information Systems and Organisation. Cham: Springer International Publishing, pp. 43–49. ISBN: 978-3-319-41401-0 978-3-319-41402-7.

Birtwell, Kelly et al. (Jan. 2019). "An Exploration of Formal and Informal Mindfulness Practice and Associations with Wellbeing". In: *Mindfulness* 10.1, pp. 89–99. ISSN: 1868-8527, 1868-8535.

Blandford, Ann, Dominic Furniss, and Stephann Makri (2016). *Qualitative HCI Research: Going Behind the Scenes*. Synthesis Lectures on Human-Centered Informatics. Cham: Springer International Publishing. ISBN: 978-3-031-01089-7 978-3-031-02217-3.

Bostock, Sophie et al. (Feb. 2019). "Mindfulness on-the-go: Effects of a mindfulness meditation app on work stress and well-being." In: *Journal of Occupational Health Psychology* 24.1, pp. 127–138. ISSN: 1939-1307, 1076-8998.

Braun, Virginia and Victoria Clarke (Jan. 2006). "Using thematic analysis in psychology". In: *Qualitative Research in Psychology* 3.2, pp. 77–101. ISSN: 1478-0887, 1478-0895.

Carmody, James and Ruth A. Baer (Feb. 2008). "Relationships between mindfulness practice and levels of mindfulness, medical and psychological symptoms and well-being in a mindfulness-based stress reduction program". In: *Journal of Behavioral Medicine* 31.1, pp. 23–33. ISSN: 0160-7715, 1573-3521.

Chiesa, Alberto, Raffaella Calati, and Alessandro Serretti (Apr. 2011). "Does mindfulness training improve cognitive abilities? A systematic review of neuropsychological findings". In: *Clinical Psychology Review* 31.3, pp. 449–464. ISSN: 02727358.

Chittaro, Luca and Andrea Vianello (Mar. 2014). "Computer-supported mindfulness: Evaluation of a mobile thought distancing application on naive meditators". In: *International Journal of Human-Computer Studies* 72.3, pp. 337–348. ISSN: 10715819.

Cox, Anna L. et al. (May 7, 2016). "Design Frictions for Mindful Interactions: The Case for Microboundaries". In: *Proceedings of the 2016 CHI Conference Extended Abstracts on Human Factors in Computing Systems*. CHI'16: CHI Conference on Human Factors in Computing Systems. San Jose California USA: ACM, pp. 1389–1397. ISBN: 978-1-4503-4082-3.

Davidson, Richard J. et al. (July 2003). "Alterations in Brain and Immune Function Produced by Mindfulness Meditation". In: *Psychosomatic Medicine* 65.4, pp. 564–570. ISSN: 0033-3174.

Feinberg, Rachel R. et al. (Apr. 29, 2022). "ZenVR: Design Evaluation of a Virtual Reality Learning System for Meditation". In: *CHI Conference on Human Factors in Computing Systems*. CHI '22: CHI Conference on Human Factors in Computing Systems. New Orleans LA USA: ACM, pp. 1–15. ISBN: 978-1-4503-9157-3.

Grossman, Paul (Apr. 2008). "On measuring mindfulness in psychosomatic and psychological research". In: *Journal of Psychosomatic Research* 64.4, pp. 405–408. ISSN: 00223999.

Hamilton, Nancy A., Heather Kitzman, and Stephanie Guyotte (June 2006). "Enhancing Health and Emotion: Mindfulness as a Missing Link Between Cognitive Therapy and Positive Psychology". In: *Journal of Cognitive Psychotherapy* 20.2, pp. 123–134. ISSN: 0889-8391, 1938-887X.

Höök, Kristina, Martin P. Jonsson, et al. (May 7, 2016). "Somaesthetic Appreciation Design". In: *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems*. CHI'16: CHI Conference on Human Factors in Computing Systems. San Jose California USA: ACM, pp. 3131–3142. ISBN: 978-1-4503-3362-7.

Höök, Kristina, Anna Ståhl, et al. (June 25, 2015). "Somaesthetic design". In: *Interactions* 22.4, pp. 26–33. ISSN: 1072-5520, 1558-3449.

Jha, A. P., J. Krompinger, and M. J. Baime (June 1, 2007). "Mindfulness training modifies subsystems of attention". In: *Cognitive, Affective, & Behavioral Neuroscience* 7.2, pp. 109–119. ISSN: 1530-7026, 1531-135X.

Kabat-Zinn, Jon (Apr. 1982). "An outpatient program in behavioral medicine for chronic pain patients based on the practice of mindfulness meditation: Theoretical considerations and preliminary results". In: *General Hospital Psychiatry* 4.1, pp. 33–47. ISSN: 01638343.

– (2013). *Full Catastrophe Living (Revised Edition): Using the Wisdom of Your Body and Mind to Face Stress, Pain, and Illness*. Westminster: Random House Publishing Group. 1 p. ISBN: 978-0-345-53972-4.

Kiken, Laura G. et al. (July 2015). "From a state to a trait: Trajectories of state mindfulness in meditation during intervention predict changes in trait mindfulness". In: *Personality and Individual Differences* 81, pp. 41–46. ISSN: 01918869.

Koch, Michael et al. (2018). "The Novelty Effect in Large Display Deployments – Experiences and Lessons-Learned for Evaluating Prototypes". In: ISSN: 2510-2591.

Lau, Mark A. et al. (Dec. 2006). "The toronto mindfulness scale: Development and validation". In: *Journal of Clinical Psychology* 62.12, pp. 1445–1467. ISSN: 00219762, 10974679.

Lee-Cultura, Serena and Michail Giannakos (2020). "Embodied Interaction and Spatial Skills: A Systematic Review of Empirical Studies". In: *Interacting with Computers* 32.4, pp. 331–366.

Li, Jingjin, Karen Anne Cochrane, and Gilly Leshed (Nov. 7, 2024). "Beyond Meditation: Understanding Everyday Mindfulness Practices and Technology Use Among Experienced Practitioners". In: *Proceedings of the ACM on Human-Computer Interaction* 8 (CSCW2), pp. 1–29. ISSN: 2573-0142.

Lomas, Tim et al. (July 15, 2019). "A Systematic Review and Meta-analysis of the Impact of Mindfulness-Based Interventions on the Well-Being of Healthcare Professionals". In: *Mindfulness* 10.7, pp. 1193–1216. ISSN: 1868-8527, 1868-8535.

Lukoff, Kai et al. (July 3, 2020). "From Ancient Contemplative Practice to the App Store: Designing a Digital Container for Mindfulness". In: *Proceedings of the 2020 ACM Designing Interactive Systems Conference*. DIS '20: Designing Interactive Systems Conference 2020. Eindhoven Netherlands: ACM, pp. 1551–1564. ISBN: 978-1-4503-6974-9.

Lykins, Emily L. B. and Ruth A. Baer (Aug. 2009). "Psychological Functioning in a Sample of Long-Term Practitioners of Mindfulness Meditation". In: *Journal of Cognitive Psychotherapy* 23.3, pp. 226–241. ISSN: 0889-8391, 1938-887X.

Miller, John J., Ken Fletcher, and Jon Kabat-Zinn (May 1995). "Three-year follow-up and clinical implications of a mindfulness meditation-based stress reduction intervention in the treatment of anxiety disorders". In: *General Hospital Psychiatry* 17.3, pp. 192–200. ISSN: 01638343.

Oudeyer, P.-Y., J. Gottlieb, and M. Lopes (2016). "Intrinsic motivation, curiosity, and learning". In: *Progress in Brain Research*. Vol. 229. Elsevier, pp. 257–284. ISBN: 978-0-444-63701-7.

Parsons, Christine E. et al. (Jan. 2019). "Designing technology tools to support engagement in mindfulness-based interventions: an analysis of teacher and student experiences". In: *DIGITAL HEALTH* 5, p. 2055207619868550. ISSN: 2055-2076, 2055-2076.

Peterson, L. G. and L. Pbert (July 1, 1992). "Effectiveness of a meditation-based stress reduction program in the treatment of anxiety disorders". In: *American Journal of Psychiatry* 149.7, pp. 936–943. ISSN: 0002-953X, 1535-7228.

Piao, Xiangdan, Jun Xie, and Shunsuke Managi (Dec. 23, 2024). "Continuous worsening of population emotional stress globally: universality and variations". In: *BMC Public Health* 24.1, p. 3576. ISSN: 1471-2458.

Poli, Federico et al. (2024). "Curiosity and the Dynamics of Optimal Exploration". In: *Trends in Cognitive Sciences* 28.5, pp. 441–453.

Ramel, Wiveka et al. (Aug. 2004). "The Effects of Mindfulness Meditation on Cognitive Processes and Affect in Patients with Past Depression". In: *Cognitive Therapy and Research* 28.4, pp. 433–455. ISSN: 0147-5916, 1573-2819.

Ryan, Richard M. and Edward L. Deci (Jan. 2000). "Intrinsic and Extrinsic Motivations: Classic Definitions and New Directions". In: *Contemporary Educational Psychology* 25.1, pp. 54–67. ISSN: 0361476X.

Sliwinski, Jacek, Mary Katsikitis, and Christian Martyn Jones (Oct. 2017). "A Review of Interactive Technologies as Support Tools for the Cultivation of Mindfulness". In: *Mindfulness* 8.5, pp. 1150–1159. ISSN: 1868-8527, 1868-8535.

Ståhl, Anna et al. (May 7, 2016). "The Soma Mat and Breathing Light". In: *Proceedings of the 2016 CHI Conference Extended Abstracts on Human Factors in Computing Systems*. CHI'16: CHI Conference on Human Factors in Computing Systems. San Jose California USA: ACM, pp. 305–308. ISBN: 978-1-4503-4082-3.

Terzimehić, Naa et al. (May 2, 2019). "A Review & Analysis of Mindfulness Research in HCI: Framing Current Lines of Research and Future Opportunities". In: *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems*. CHI '19: CHI Conference on Human Factors in Computing Systems. Glasgow Scotland Uk: ACM, pp. 1–13. ISBN: 978-1-4503-5970-2.

Thieme, Anja et al. (Apr. 27, 2013). "Design to promote mindfulness practice and sense of self for vulnerable women in secure hospital services". In: *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. CHI '13: CHI Conference on Human Factors in Computing Systems. Paris France: ACM, pp. 2647–2656. ISBN: 978-1-4503-1899-0.

Tieben, Rob, Tilde Bekker, and Ben Schouten (2011). "Curiosity and Interaction: making people curious through interactive systems". In: Proceedings of HCI 2011 The 25th BCS Conference on Human Computer Interaction.

Van Rheden, Vincent and Bart Hengeveld (Feb. 14, 2016). "Engagement Through Embodiment: A Case For Mindful Interaction". In: *Proceedings of the TEI '16: Tenth International Conference on Tangible, Embedded, and Embodied Interaction*. TEI '16: Tenth International Conference on Tangible, Embedded, and Embodied Interaction. Eindhoven Netherlands: ACM, pp. 349–356. ISBN: 978-1-4503-3582-9.

Wilson, Margaret (Dec. 2002). “Six views of embodied cognition”. In: *Psychonomic Bulletin & Review* 9.4, pp. 625–636. ISSN: 1069-9384, 1531-5320.

Zhu, Bin, Anders Hedman, and Haibo Li (2016). “Design digital mindfulness for personal wellbeing”. In: *Proceedings of the 28th Australian Conference on Computer-Human Interaction - OzCHI ’16*. the 28th Australian Conference. Launceston, Tasmania, Australia: ACM Press, pp. 626–627. ISBN: 978-1-4503-4618-4.

A. EXPLORATORY INTERVIEW PROTOCOL

A.1. Introduction

Thank you for participating in this study. The purpose of this interview is to gain a better understanding of how people currently practice informal mindfulness and how technology might support these practices.

Informal mindfulness differs from formal mindfulness. Formal mindfulness refers to structured exercises such as meditation or body scans. Informal mindfulness, on the other hand, refers to bringing conscious, non-judgmental attention to everyday activities such as eating, walking, or folding laundry.

The interview will take approximately 30–45 minutes. With your permission, the interview will be audio recorded for transcription purposes. Once the interview has been transcribed, the recording will be deleted.

A.2. Background

- How did you first become familiar with mindfulness?
- How long have you been practising mindfulness?
- How would you describe mindfulness in your own words?

A.3. Informal Mindfulness Practices

- Do you distinguish between formal and informal mindfulness?
- Can you describe a situation where you try to be mindful during a daily activity?
- What kinds of activities lend themselves best to informal mindfulness for you?
- What helps you remain aware or present in those moments?
- What tends to distract you in those moments?

A.4. Motivations and Outcomes

- What motivates you to practice mindfulness in your daily life?
- How do you generally feel before and after informal mindfulness practice?
- Have you noticed any changes or benefits over time?

A.5. Challenges

- What are the biggest challenges when trying to be mindful in daily life?
- Are there situations or contexts in which you find it particularly difficult to remain mindful?

A.6. Technology and Mindfulness

- Have you ever used technology to support mindfulness?
- How do you view the use of technology for mindfulness?
- How do you think technology could support informal mindfulness?
- If you imagine how a device, system, or app could help you be more mindful in your daily life, what would that look like?
- If you could design your own mindfulness tool, what would it do and what would it not do?

A.7. Closing

- Is there anything else you would like to share or anything I have not asked you about yet?

I would like to thank you for participating in this interview.

B. PROTOTYPE EVALUATION PROTOCOL

B.1. Pre-Interaction Survey

Participants completed a short survey prior to using the prototype.

B.1.1. Demographics
- Age
- Gender

B.1.2. Mindfulness Experience
- Overall experience with mindfulness
- Frequency of informal mindfulness practice

B.1.3. Attitudes Toward Mindfulness
Participants rated statements on a 5-point scale (1 = low, 5 = high) regarding:

- The value of mindfulness in daily life
- The potential well-being benefits of paying attention to everyday activities
- Openness to incorporating mindfulness into daily routines

B.1.4. Context and State
Participants reported:

- Their primary activity for the day (e.g., work, study, day off)
- Expected busyness
- Current stress level
- Current tiredness

B.2. Prototype Interaction

Thank you for participating in this study. Today, you will use the Mindfulness Ball as part of your normal daily activities.

The prototype occasionally displays the message "shake me" as a reminder to interact with it. You may choose to wait for these reminders, but you are also free to pick up and shake the ball whenever you want.

There are no specific tasks that you need to complete. Please use the prototype as naturally as possible throughout your day.

After the interaction period, the prompt log was retrieved from the prototype and used during the post-interaction interview.

B.3. Post-Interaction Interview

B.3.1. Introduction
Thank you again for participating in this study. I would like to ask you a few questions about your experience using the Mindfulness Ball. The interview will take approximately 20–25 minutes.

As you know, this study explores how technology can support informal mindfulness in everyday life. I am interested in your personal experience using the ball during your day. There are no right or wrong answers.

With your permission, the interview will be audio recorded for transcription purposes. Once the interview has been transcribed, the recording will be deleted.

B.3.2. Daily Context and Interaction
- Can you tell me something about what your day was like when you had the Mindfulness Ball?
- Where did you keep the ball most of the time?
- Can you walk me through moments when you picked up or shook the ball, including occasions when you interacted without first receiving a reminder?
- Were there moments when you noticed the ball but chose not to interact with it? Why?

B.3.3. Reminders and Prompts
Show participant the prompts displayed during the interaction period.

- What did you think of the reminders? How noticeable were they?
- What did you think of the prompts overall? Were there any that you found particularly pleasant or unpleasant?
- Do you remember if any prompts appeared at a particularly good or bad moment?
- Did you follow up on any of the suggestions the prompts gave you?

B.3.4. Awareness and Attention
- How, if at all, did using the ball affect your awareness or attention during the day?
- When you became more aware, what were you noticing in that moment (e.g., body sensations, thoughts, surroundings, emotions)?
- How did the prompts influence you after the interaction, if at all?
- How did you experience incorporating the ball into your daily routine?

B.3.5. Design Reflection
- What did you think about the fact that you had to pick up and shake the ball to trigger a prompt?
- What did you like most about the design?
- If you could change one thing about the ball, what would it be?
- Do you see yourself using something like this in your daily life? Why or why not?

B.3.6. Ratings on a 5-point scale (1 = low, 5 = high)
- How intrusive did the ball feel in your daily life?
- How well did it fit into your daily routine?
- How helpful did the prompts feel overall?

B.3.7. Closing
- Is there anything else you would like to share or anything I have not asked you about yet?

I would like to thank you for participating in this interview.