Self-Reflecting and Mindfulness: Cultivating Curiosity and Decentering Situated in Everyday Life

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Abstract. Research on the use of mobile to promote mindfulness states is still relatively nascent, especially when exploring how such states can be cultivated in everyday life, outside of meditation-based approaches. In this study we investigate the design of a mobile app that seeks to cultivate mindfulness states situated in everyday life. Using reminders to prompt self-reflection and breathing exercises to prompt body awareness, we sought to address the overarching question – how can we design towards mindfulness situated in everyday living and how might it change what we mean by mindfulness? Our findings suggest that mobile-based approaches can promote curiosity and decentering through self-reflection, and that the valence and likelihood of experiencing certain mental events may influence how self-reflection is experienced, which in turn influences curiosity and decentering factors of mindfulness states.

Keywords: Mindfulness · Situated context · Self-reflection · Curiosity · Decentering · Emotional health · Persuasive design · Mobile learning

1 Introduction

Traditionally, mindfulness focuses on complete freedom from suffering and cultivating positive qualities of the mind characterized by a state of altruistic omniscience. Westernized adoption of mindfulness is largely removed from the spiritual origins and focused on the therapeutic benefits – happiness and wellness. Despite these differences, both share a characterization of mindfulness as a transient state of non-appraisal in which mental experiences and sensory information are meta-cognitively monitored without evaluation or interpretation [1, 2]. Furthermore, both share a view of mindfulness training as a cultivation of dispositional traits that eventually will impact all aspects of one's everyday life [3].

Building on the momentum of the quantified-self and persuasive technology movement is the opportunity to use mobile devices to support mindfulness as a practice that is situated in everyday life. Mobility is increasingly being understood as the mediation of one's relationship with situated contexts such as location and those around us [4].

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In this study we investigate the design of a mobile app that seeks to activate and support mindfulness states situated throughout a person's everyday life. Using reminders to prompt self-reflection and breathing exercises to prompt body awareness, we sought to address the overarching question – how can we design towards mindfulness situated in everyday living and how might it change what we mean by mindfulness? Specifically we sought to explore how self-reflection throughout one's day serves as a mediating process that influences the way one experiences curiosity and decentering – two factors commonly used to operationalize a mindfulness state [5].

2   Related Work

2.1   Mindfulness States

Mindfulness can be understood both as a dispositional trait and as a temporary state that can be induced. The two perspectives are interlinked in that consistent induction of mindfulness states may lead to long-term changes in mindfulness as a dispositional trait [6]. When understanding mindfulness as a state, two factors of curiosity and decentering are often used to operationalize the construct [5]. Lau et al. [5] characterize curiosity as present-moment awareness with an investigative interest, while decentering is defined as reflecting a shift from identifying personally with thoughts and feelings to relating to one's experience of a wider field of awareness. In other words, decentering is about seeing one's thoughts and feelings as passing mental events in the mind rather than reflections of reality [7].

There is debate as to how such states can be cultivated that stem largely from one's interpretation of what a mindfulness state actually is. For instance, as we mentioned, the curiosity factor of a mindfulness state is characterized as being present-moment aware-ness with an investigative interest. There however are differences in the extent to which such awareness is unencumbered by language or conception. For instance, Buddha's earliest teachings describe mindfulness as a form of moment-to-moment application of bare attention that does not linguistically or conceptually elaborate one's observed experience [8]. This may stand in contrast to approaches to mindfulness that see aware-ness as a form of dealing with the narratives themselves such as therapeutic interventions that advocate for forms of managing the interpretations (e.g., acceptance) we assign through mindfulness-like approaches [3, 9]. Furthermore, ongoing work on under-standing the neurological underpinnings of mindfulness indicate that early stage mind-fulness practitioners may experience top-down attentional control processes (i.e., conceptual), while more experienced practitioners are able to attenuate in a more non-conceptual experiential manner [10].

2.2   Self-Reflection as a Mediating Process

In the quantified-self movement, self-monitoring is instrumental to changes in behavior. By shifting awareness to patterns of behavior one can better self-regulate either through increased motivation, deeper insights, or other persuasive aspects. While there are a variety of semantic variations in terminology, self-reflection can be considered a specialized subset of self-monitoring focused on internal mental events rather than behaviors or sensory data.

Adopting the Self-Reflection and Insight Scale (SRIS) operationalization of self-reflection we are defining self-reflection as having certain characteristics. First, while self-reflection can be seen an involuntary process as is the case with rumination that is correlated with a variety of mood disorders [11] we are viewing self-reflection as a voluntary effortful process. Second, the focus of self-reflection is understood as one that is conceptual – there is a top-down attentional focus that involves language and appraisal, rather than a focus on experiential attention. We are assuming self-reflection involves dealing with the contents of mental events (conceptualization). Third, self-reflection is being seen as free from any regulatory or problem-solving orientation. In the SRIS instrument, the second factor of insight captures one's ability to understand and make sense of their thoughts and emotions, while self-reflection seeks only to capture one's awareness of such mental events.

2.3   Designing for Self-Reflection

There are a variety of design approaches to promoting self-reflection while situated in everyday life. Reminders to self-reflect on current mental events or particular ones are a popular persuasive approach. Examples include, Mood Panda's [12] reminders to track current moods and Conscious app's [13] initial daily directive to self-reflect on and ongoing reminders to reengage effort to self-reflect on that particular directive. Another approach goes beyond tracking and attempts to provide guidance on the self-reflective process, e.g., the Mindfulness App [14] prompts users to engage in short 1-minute guided meditations. Lastly, there is an approach that does not attempt interject into the everyday experience of the user, but provides an on-demand library to help mediate one's interaction with their situated context. In the Buddhify mobile app [15], users can select from meditations categorized by goals and context (e.g., traveling or feeling sick).

3   Study Design

3.1   Theoretical Framework

Our study's goal was to obtain a rich understanding of how specific design embodiments in our tool influence curiosity and decentering through self-reflection.

In designing our tool, we laid out a conjecture map that outlined key design embodiments, their relation to mediating processes, and their relation to our target outcomes (Fig. 1). The relationship we anticipated between embodiments and mediating processes are our design conjectures, and the relation between mediating processes and outcomes are our theoretical conjectures. The objective of specifying design conjectures is to trace the observed effects back to the embodiments. This can be challenging in that each conjecture is implemented in tools and activities in ways that their operation is not isolated – in turn making the study of each of the pieces separately not possible [16]. In short, our design seeks to provide specific mental events for users to self-reflect on and explore how situating this self-reflective process in everyday life in a particular way may influence how mindfulness states are experienced.
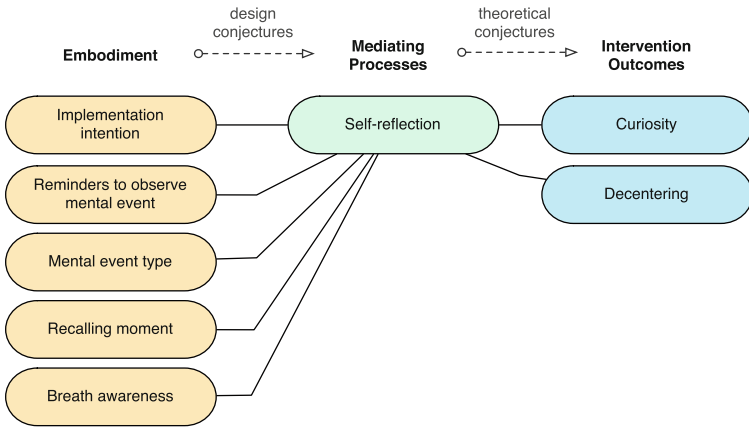
Fig. 1. Conjecture map of mobile tool design

3.2   Mobile Mindfulness App Design

The mobile app engages users in five different challenges each targeting different mental event. All of the challenges shared the same design embodiments but they differed in the specific mental event targeted (see Table 1).

Table 1. A list of challenges, properties, and sequence of interactions

Mental Event	Valence	Scope	Sequence of Interactions
Gratitude	Positive	Broad	Recall moment of gratitude in your mind
			Focus on breathing for 15 s
Conflict	Negative	Relational	Recall moment of conflict
			Focus on your breath for 15 s
Self-Compassion	Positive	Broad	Recall moment of self-compassion in your mind
			Focus on breathing for 15 s
Self-Criticism	Negative	Broad	Recall moment of self-criticism
			Focus on breathing for 15 s
Envy	Negative	Narrow	Recall moment of envy in your mind
			Focus on breathing for 15 s

Given we are viewing the self-reflective process as conceptual, the type of mental event is especially relevant. A review of mindfulness-based interventions [3, 17] and prior pilot testing led us to outline five different mental events categorized by valence and scope. Valence describes whether the mental event is likely to be linked to a positive or negative affective state. Scope describes how broad or narrow the mental event is likely to be characterized by the user. For instance, self-criticism is a broad mental event
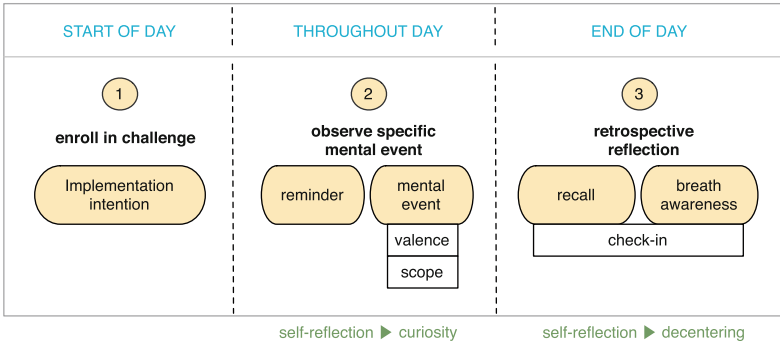
Fig. 2. The daylong life cycle of a challenge start and completion

that can encompass other events such as envy. In addition we have a relational scope that is both narrow and entails focusing on "conflict" with another person.

As illustrated in Fig. 2, a challenge is started by the user at the beginning of the day and entails setting the intention to observe a specific mental event (e.g., self-criticism) by accepting the challenge.
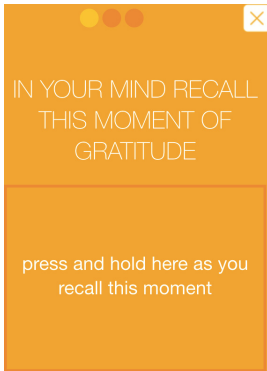

Fig. 3. Check-in. Step 1 – Recalling moment.
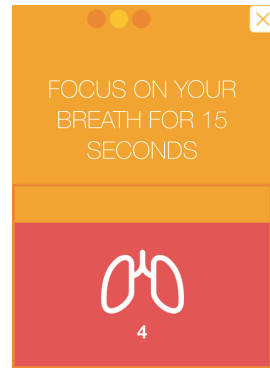

Fig. 4. Check-in. Step 2 – Focus on breath.

After accepting the challenge, users are prompted throughout the day via reminders to make an effort to observe that mental event. No action needs to be taken on part of the user when the mental event is observed. At the end of the day, the user is prompted to check-in, which consists of two-steps. First they are prompted to recall one moment where they observed the mental event (Fig. 3), and second to focus on their breath for 15 s and let that mental event recalled go as they shifted their focus (Fig. 4). The attentional shift to breath is a common attentional control exercise used in mindfulness activities to promote decentering [18]. While throughout the day the reminders seek to prompt self-reflection and curiosity on specific mental events, the end of the day interaction seeks to use the observed mental events to engage users in a decentered form of self-reflection.

3.3   Measures

Mindfulness State. Participants' achieved levels of curiosity and decentering was assessed both quantitatively and qualitatively. Quantitatively the 6-item Curiosity subscale and 7-item Decentering subscale of the Toronto Mindfulness Scale (TMS) [5] was used. The curiosity subscale asks participants to express how well what they experienced is described by items such as "I was curious about my reactions to things", while the decentering subscale asks participants items such as "I experienced myself as separate from my changing thoughts and feelings". Items on the subscales are rated on a 5-point Likert scale (0 = "not at all", 4 = "very much"). Scores on the subscales summed. Qualitatively, participants engaged in a semi-structured interview that prompted them to describe the details of their curiosity and decentering experiences with interview questions adapted from the TMS subscale questions.

Self-Reflection. Self-reflection for each challenge was measured primarily through a semi-structured interview that focused on the how self-reflection was experienced. In addition, the 12-item self-reflection subscale (SRIS-SR) of the Self-Reflection Insight Scale (SRIS) [19] was used. Self-reflection items include; "It was important to me to try to understand what my feelings mean". The items are on 7-point scales (1 = Strongly Disagree, 7 = Strongly Agree). Lastly, we added some customized survey questions that sought to elicit insights on the frequency of moments of self-reflection.

Utility. At the end of the study each user completed ratings of how useful the different design embodiments were to supporting self-reflection (See Table 3).

3.4   Participants

We recruited 11 participants from several New York City universities. Participants were required to have never previously meditated or engaged in cognitive behavioral therapy, as well as have a personal iPhone they can use for the study. The average age was (M = 25.09, SD = 3.86), and 7 out of the 11 participants were female (64 %).

3.5   Procedure

Participants were asked to complete an initial survey when signing up to ensure they had not engaged in any form of meditation or cognitive-behavior therapy prior to this experience. Each user was prompted to complete all of the five challenges over one week, and complete a survey each time a challenge was completed. The survey included questions that span the TMS and SRIS-SR measures, as well as customized questions that focused on the frequency of self-reflection. The order of the challenges completed by users was counterbalanced to minimize any learning effects. After completing all of the challenges, users completed a utility survey and engaged in an hour-long semi-structured interview. The interview protocol was structured to address each of the design and theoretical conjectures.

4 Results

This mixed method study was structured as sequential explanatory [20] in which the first phase was to analyze our quantitative data so as to inform subsequent semi-structured interviews conducted with all of the eleven participants (Table 2).

4.1 Phase I: Quantitative Analysis

Curiosity, decentering and SRIS-SR scores for each mental event type were all normally distributed, as assessed by Shapiro-Wilk's test (p > .05). In addition, when running a repeated measures ANOVA on curiosity, decentering, and SRIS-SR, we used Greenhouse-Geisser correction. For curiosity, post hoc tests using the Bonferroni correction revealed that conflict significantly differed from every other mental event type in curiosity (p < .005). For decentering, post hoc tests using the Bonferroni correction revealed that all of the challenges differed from each other by mental event type (p < .05), except between self-compassion and self-criticism. Lastly, for SRIS-SR post hoc tests using the Bonferroni correction revealed that all of the challenges differed from each other by mental event type on SRIS-R scores, except for Gratitude and Self-Compassion (p < .0005).

Table 2. Summary of Quantitative Analysis

Mental Event	Curiosity	Decentering	SRIS-SR
All	(F(3.056, 30.557) = 5.462, p < .005)	(F(2.913, 29.135) = 4.114, p < .05)	(F(2.804, 28.039) = 12.937, p < .001)
Self-Criticism	M = 17.64, SD = 4.86	M = 16.73, SD = 3.23	M = 49.27, SD = 3.38
Envy	M = 17.27, SD = 4.13	M = 15.73, SD = 2.70	M = 47.00, SD = 3.85
Self-Compassion	M = 17.27, SD = 3.29	M = 16.64, SD = 3.78	M = 51.91, SD = 4.34
Gratitude	M = 17.36, SD = 4.01	M = 18.27, SD = 3.29	M = 51.73, SD = 4.13
Conflict	M = 12.64, SD = 3.11	M = 13.09, SD = 3.81	M = 44.27, SD = 3.26

The self-reflection in-action (SR-InAct) question served the purpose to inform subsequent interview questioning only, rather than be used as part of an inferential analysis. As such only the means were calculated. Negative thinking (M = 3.91, SD = 1.221) and gratitude (M = 3.91, SD = .701) were slightly above neutral. Self-compassion had the highest mean (M = 4.45, SD = .688), and envy (M = 1.36, SD = .505) and conflict (M = 1.27, SD = .467) were on the lower end.

The mean ratings on the utility of the various design embodiments were 4 or above, indicating that no embodiment did not contribute to self-reflective practices. In looking at the response rate of end-of-day check-ins that required recalling the moment and engaging in breath awareness, about 96 % of end-of-day checkin reminders led to a completed challenge, while the remaining were incomplete and required an repeated enrollment in the challenge – two challenges in the entire study.

Table 3. Utility for Design Conjectures

Question	Rating
By accepting the challenge I felt I was setting an intention to self-reflect	M = 4.18, SD = .60
Setting an intention to self-reflect made it more likely I would self-reflect	M = 4.09, SD = .70
Without the reminders I would have not self-reflected throughout the day	M = 4.18, SD = .75
My self-reflection experience was different based on the mental event	M = 4.27, SD = .46
Recalling a moment was easier when I self-reflected throughout the day.	M = 4.45, SD = 52
Focusing on breathing was helpful in changing the focus of my attention	M = 4, SD = .77

4.2   Phase II: Qualitative Analysis

The eleven semi-structured interviews were transcribed and analyzed using analytic codes that were directly mapped to the five design conjectures and two theoretical conjectures illustrated in Fig. 1. Each coded interview was treated as a case with the unit analysis as each user's single experience with the mobile app. Cases were individually analyzed for themes and concurrently arranged in a word table for cross-comparisons and shared themes [21] across the seven different conjectures. From the word table a review of themes was conducted and a list of the major themes contributing to the initial research questions were outlined and are discussed below.

5   Discussion

The goal of this study is to better understand how specific design embodiments enacted self-reflection and in turn influenced curiosity and decentering experiences. While overall users scores on the TMS and SRIS-SR indicated high levels of curiosity and self-reflection, and varied levels of decentering, we focused on how such processes were experienced, and how specific embodiments shaped these experiences.

5.1   Perceived Control

The theme of perceived control is about the extent to which users felt they could handle the degree of self-reflection asked by the challenges. All of the users felt strongly that initially accepting the challenge felt like they were formally setting the intention to self-reflect. In addition, users felt "strongly" or "very strongly" that setting an intention for the day was essential to feeling they would self-reflect.

In our interviews, the length of the intention (i.e., day), and clarity on what was expected was highlighted as important to their perceived control over self-reflection. For instance one user shared that he, "would have lost steam if I was committing to something for more than a day, but I took it one day at a time." Another user shared she, "liked how simple it seemed at first" and another user said, "I could understand what I was supposed to do, like, if I see it, just acknowledge I observed it."

The use of reminders played into this perceived control in that forgetting was consistently mentioned, as a reason why they thought self-reflecting throughout the day would be challenging. Over 90 % of users felt strongly that without the reminders they would not have self-reflected throughout the day on specific mental events. This is line with research that suggests that when situated in everyday contexts there may be a lack of cognitive resources that can serve as an obstacle to challenging automatized cognitive habits, such as not being aware of specific mental events [22].

The implications for design suggest there is value in the use of reminders to prompt situated self-reflection in general. In addition, our findings suggest that short temporal commitments (e.g. daylong) and clear implementation intentions may help create a strong sense of control over being able to self-reflect throughout one's often busy and attention-demanding day. In addition, the use of reminders when motivation obstacles are not apparent may be effective in supporting one's perceived sense of control and in turn strengthen one's intention to observe internal mental events.

5.2   Likelihood of Opportunities to Observe

Across all of the challenges curiosity scores were high yet we did notice differences in self-reflection scores (SRIS-SR). The pattern was that challenges that targeted narrow mental events had lower self-reported engagement in self-reflection. In other words, there seemed to be difficulty with self-reflecting on mental events we categorized as "narrow." Mean scores of our self-reflection in-action question asking users to rate the degree to which they self-reflected throughout the day supports this findings. At the lower end of all the challenges was envy (M = 1.36, SD = .505) and conflict (M = 1.27, SD = .467).

In our interviews users consistently shared that self-reflecting was hard for envy because it did not seem to come up too often in their day-to-day interactions. One user did state that outside of the study he began to notice mental events he would characterize as "envious." One user shared that, "I feel like I used to feel envy a lot, but now I have this job and I'm not about that." Another user described the challenge as, "looking for something and [I] didn't know if I was making it happen because I was looking for it." In other words, for most users envy just did not occur too often and as a result they experienced difficulty in self-reflecting and rated the activity of recalling observed moments challenging.

However, in exploring why curiosity levels remained high despite low self-reflection scores we understood that for this narrow mental event, the reminders served less as reminders to observe, but more as an invitation to think deeper on what they might be missing or how they may be interpreting events. In other words, as one user put it, "I just didn't notice moments of envy. But then I was like, maybe I'm just not realizing their envy, you know? So I just started thinking back, like maybe I'm missing something. Maybe I'm just totally not labeling it right." Other users shared similar sentiments of addressing the difficulty with self-reflecting on envy by retrospectively looking back and trying to see if they were incorrectly characterizing certain thoughts and feelings they had. The low scores on the SRIS-SR subscale which removes motivation from picture [23] was, most likely, sensitive to challenges in observing, while the curiosity

subscale picked up on the investigative aspect of one's reaction to the challenge. We noticed the same thematic pattern with the mental event type, conflict, which we labeled as "relational", although to a lesser degree.

The implications for design here are that personalization or on-demand interactions may better address differences in the likelihood of engaging in particular kinds of mental events. In addition, future research on how low likelihood mental events may positively impact motivation to self-reflect may be worth exploring.

5.3 Self-Regulation Impulse

In our phase I quantitative analysis we saw variations in decentering scores between challenges by mental event type. The post-hoc analyses did not yield any additional insight in that all of the types significantly differed from each other. In looking at means scores we noticed that gratitude (a positive valence event type) hovered above all the rest (M = 18.27, SD = 3.289). Our initial thought was that all positive valence types might have higher decentering scores, yet in the middle were self-criticism and envy and self-compassion with means all hovering around 16, and the lowest decentering score was the conflict challenge (M = 13.09, SD = 3.81).

From our interviews what emerged was a theme of self-regulation impulse that was connected to how negative the user felt the particular mental event was. For instance, one user shared, "I felt like the point of the gratitude one was to feel good, but I didn't see what the point of the other one – the criticism one. I was just wanting to, you know, change it." This is in contrast with another user who described their experience on self-reflecting as, "I was okay just sitting with that thought and moving on."

All of the users shared the sentiment that focusing on self-criticism made them want to be proactive in some way. This is inline with research that suggest there may be two different kinds of self-reflection – one that is problem focused (PF) and the other that is self-focused (SF) [23]. In describing how this impulse to self-regulate influenced their sense of thoughts as passing or as separate from themselves, users repeatedly described feeling attached to negative thoughts, while being able to let go of positive ones. For instance one user shared, "In the gratitude one I felt it in my breath and I moved on. But in the other one. The critical one. I was like, I should stop doing that." We sought to understand why self-compassion, which we labeled as positive, did not fall into our hypothesized pattern that positive valence mental events did not elicit strong impulses to self-regulate. Users shared that they felt self-compassion overlapped with self-criticism in that many were self-compassionate about mistakes or things they were saying to themselves. This indicates that the valence of mental events may be more complicated to clearly delineate as positive or negative.

In discussing the conflict challenge with users, which had the lowest decentering score was the conflict challenge (M = 13.09, SD = 3.81), there was by far dominant focus on problem-solving rather than acknowledging the presence of specific mental events. This suggests that prompting users to self-reflect on relational instances, such as conflict between people, may bring the focus to problem solving and exacerbate impulses to self-regulate.

The implications for design are that focusing on mental events that are likely to induce negative affect, may benefit from embedded emotion regulation activities that can leverage impulse to self-regulate. In addition the findings also suggest the need to explore differentiated interactions to support decentering. Given all five mental event types used the same recall and breathing exercises, perhaps extended or guided decentering activities are needed to counteract ones desire to self-regulate.

5.4 Shifting Attention Through Body Awareness

Overall breath awareness was described easy to engage in. In our utility ratings, most users reported that, "Focusing on breathing was helpful in changing the focus of [their] attention." Interviews indicated that body awareness provided a general sense of calm and detachment before dealing with negative mental events. One user stated, "I felt like I had to remember something annoying or shameful, and then just let it go by focusing somewhere else." Another described it as, "the breathing was like at school when you have to take a minute before you do something you'll regret. Except here I think you do it so you could just be okay with what went down." The design implication here is that body awareness may be a powerful design embodiment in shifting attention during an end-of-day reflection and leading to a sense of "letting go" and "being with it", which are in line with decentered experiences.

6   Conclusions and Future Work

A limitation of this study is the limited data points on users' engagement with the challenges and mental event types. An increased number would have provided a larger lens and reduction in confounding situational factors (e.g., a rough day at work) in the data. Furthermore, there was no experimental design that may have allowed for different causal claims to be made about specific design embodiments. In addition, the use of SRIS-SR and TMS have their limitations. SRIS-SR is not written as a state-based retrospective instrument, and TMS is intended for primarily meditation-based experiences. Lastly, there was limited control over situational factors during sample selection (e.g. heavy commuters, demanding work schedules).

Future studies may want to explore the potential for such situated approaches to harness self-regulatory impulses to connect to more traditional forms of cognitive behavioral strategies such as cognitive reappraisal. Recent research has made the case that mindfulness states may support cognitive reappraisal [24]. Furthermore, an experimental design comparing different forms of decentering, and reflection prompts may provide deeper insights into how variations in language, frequency, and body awareness interactions can influence curiosity and decentering through self-reflection.

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