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Exploring User Perspectives on Brief Reflective Questioning Activities for Stress Management: Mixed-Methods Study

Abstract

Background: Current online interventions dedicated to assisting individuals in managing stress and negative emotions often necessitate substantial time commitments. This can be burdensome for users, leading to high dropout rates and reducing the effectiveness of these interventions. This highlights an urgent need for concise digital activities that individuals can swiftly access during instances of negative emotions or stress in their daily lives.

Objective: The primary aim of this study is to investigate the viability of utilizing a brief digital exercise, specifically a reflective questioning activity (RQA), to help people reflect on their thoughts and emotions about a troubling situation. The RQA is designed to be quick, applicable to the general public, and scalable without requiring a significant support structure.

Methods: We conducted three simultaneous studies. In the first study, we recruited 48 participants who completed the RQA and provided qualitative feedback on its design through surveys and semi-structured interviews. In the second study, we utilized a between-subjects design to compare the RQA to a single-question activity, involving 215 participants from Amazon Mechanical Turk. Our hypotheses posited that the RQA would yield greater immediate stress relief and higher perceived utility, while not significantly altering the perception of time commitment. To assess these, we measured survey completion times and gathered multiple self-reported scores. In the third study, we assessed the RQA's real-world impact as a periodic intervention, exploring engagement via platforms like email and text messaging, complemented by follow-up interviews with participants.

Results: In our first study, participants appreciated the RQA for facilitating structured reflection, enabling expression through writing, and promoting problem-solving. However, some experienced confusion and frustration, particularly when they were unable to find solutions or alternative perspectives on their thoughts. In the second study, the RQA condition resulted in significantly higher ratings (p = 0.003) for the utility of the activity and a statistically significant decrease (p < 0.001) in perceived stress rating compared to the single-question activity. Although the RQA required significantly more time to be completed (p<0.001), there was no statistically significant difference in people's subjective perceived time commitment (p = 0.37). Deploying the RQA over two weeks in the third study identified some potential challenges to consider for such activities, such as: the monotony of doing

the same activity several times, the limited affordances of mobile phones, and the importance of having the prompts align with the occurrence of new troubling situations.

Conclusions: The paper describes the design and evaluation of a brief online self-reflection activity based on cognitive behavioral therapy principles. Our findings can inform practitioners and researchers in the design and exploration of formats for brief interventions to help people with everyday struggles.

Keywords: Reflection; Mental Health; Stress; RQA; Brief Intervention; Computer-Mediated Communication; Email; Text Message

Introduction

Computer-mediated communication (CMC) platforms offer accessible resources to assist people in managing their stress and negative emotions [1,2]. Nevertheless, current online interventions can be time-consuming and inconvenient [3], necessitating users to commit to a series of hour-long sessions to achieve optimal results. Social media groups and text-messaging programs also require a substantial time commitment from users to deliver maximum benefit [3,4]. Although research demonstrates that these programs can be as effective as in-person therapy [5,6], the considerable time investment required may lead to high dropout rates. Consequently, the convenience of online resources is paramount in enhancing their efficacy and user engagement [7].

Therefore, **we investigate whether it might be possible to construct a brief digital activity (as simple as answering questions in a web form) that people can easily reference or practice when they experience negative thoughts and emotions in their daily lives.** Through a simple interface with a series of questions, we explore whether a brief reflective questioning activity (RQA) could merely prompt people to reflect on a stressful situation. This process of articulating thoughts and emotions has the potential to enhance an individual's understanding of their personal challenges and foster a sense of self-agency [8,9], eventually strengthening their belief in their own ability to manage stress and negative emotions [10]. Brief activities like RQAs, which require minimal effort and may provide tangible benefits, can also serve as a stepping stone to more extensive treatments [11,12]. This approach has tremendous potential in terms of convenience as well because such RQAs can be delivered to anyone anytime via email, apps, and text messages. We posit that activities like this can be made generalizable enough so that they can be adapted to fit the unique needs and preferences of individuals from diverse backgrounds and situations. For example, an individual experiencing stress at work may use reflective questioning to reflect on their thoughts and emotions related to a difficult conversation with a coworker, and another individual may adapt the same activity to reflect on their feelings after a breakup or a family conflict.

In our work, we draw on insights from clinical psychology and human-computer interaction literature on how to design brief RQAs that are helpful for people to manage psychological well-being and adopt healthy behaviors [13–15]. Murgraff et al. [15] demonstrated that a persuasive two-page pamphlet distributed at the beginning of an 8-week study period and informing female university students about recommended drinking limits could effectively reduce unhealthy drinking behaviors. Carney et al. [16] used a similar intervention to support substance-using adolescents and their caregivers. These studies suggest that extensive interventions are not always necessary to foster healthy behavior; providing a brief guideline with crucial information and actionable practices for self-directed application can be beneficial too.

Our work is focused on the goal of promoting self-reflection, a crucial component of cognitive-behavioral therapy (CBT) [17] and psychology in general. One can understand self-reflection as a person's conscious effort to understand and re-evaluate their own thoughts regarding any situations, thoughts, or feelings [18,19]. Self-reflection is often the driving force that converts one's intentions into action [20]. Furthermore, it allows an individual to view situations from a different perspective, enabling them to understand others' opinions [20,21]. Researchers in recent years have incorporated many reflective activities into mental health and behavior change interventions, particularly through mobile phone applications that show users summaries of their mood or physical activity [22–24]. Other digital tools have attempted to promote self-reflection through conversational agents [25,26]. As evident with the recent emergence of chatbots like ChatGPT [27,28], conversational agents continue to become more sophisticated in parallel with advances in natural language processing, but they are still limited in their ability to have nuanced and empathetic conversations [27]. Furthermore, the literature suggests that back-and-forth conversations are not always necessary to elicit self-reflection, as asking probing questions with the words "why" or "how" can be enough to increase one's own understanding of a problem [29,30].

However, there are several reasons to speculate that brief reflective questioning activities may not effectively help individuals manage their stress. Firstly, prompts for self-reflection may not provide people with something concrete or tangible (e.g., new information or social validation) and might require repeated exposure to yield benefits that people can see [31,32]. Moreover, it is unclear whether people would see value in answering reflective questions and whether an extended series of questions would add much value. Answering a static set of questions could not only be perceived as a waste of people's time but could also surface more negative emotions without a conversational partner to give input. Furthermore, people might prefer knowing that their thoughts and emotions are being shared with another person rather than relying on themselves to gain benefits.

Drawing upon these potential opportunities and challenges, we set the following guiding principles for our exploration:

- **Minimal time commitment:** The activity should be simple enough so that people can complete it in 15 minutes — the equivalent of a midday coffee break at work or a fraction of a person's morning routine.
- **Applicability to the general public:** The activity should not be targeted towards a particular domain, culture, or population. In other words, the activity should be generalizable to the point where people can adapt it to their own context and situation.
- **Scalability:** The activity should be implemented and deployed in a way that does not need a significant support structure. This means that the activity should not require a live conversational partner or intensive scaffolding (e.g., tutorial videos).

To investigate the feasibility, challenges, and opportunities in the design of digital RQAs, we created a design probe that asks people to answer a series of nine questions to reflect on a troubling situation. The questions in our RQA are intended to help people articulate their thoughts and emotions about the situation using principles from CBT [33]. We leveraged thought records [34] and behavioral chaining analysis [10] — techniques that encourage people to connect their thoughts, experiences, and emotions to identify triggers that generate negative patterns and come up with alternative ways of thinking.

We provide insights into the design of our RQA and how it was experienced by users, which we hope will inform the design of future interventions with similar goals. We gathered these observations through three studies. For our first study, we used a convenience sample of crowdworkers to administer the RQA and obtain qualitative feedback on the design of the activity. In our second study, we investigated whether the perceived benefits of going through RQA outweighed the additional time commitment required to answer a series of probing questions. In our third and final study, we investigated the potential impact of the RQA when delivered repeatedly over a two-week period in a real-world context; we also explored the implications of distributing the RQA over email versus text messaging. The design of our RQA was kept constant across all three studies so that we could maintain consistency across evaluations and determine which observations held true across the different scenarios.

We found that the structured analysis supported by our RQA helped people reduce their stress and identify solutions for improvement. Although our RQA consisted of nine questions, people did not complain about the time commitment required to complete it and generally wrote thoughtful responses to the prompts. However, deploying the RQA over the course of two weeks raised some potential challenges, including the monotony of doing the same activity several times, the limited affordances of mobile phones, and the importance of having the prompts align with the occurrence of new troubling situations. These highlight design considerations and opportunities for researchers and practitioners to consider as they develop their own digital RQAs, such as giving users control over the frequency of prompts and automated question personalization.

In summary, our main contribution is an investigation into whether people see value in a brief digital RQA without a conversational partner for interaction or advice. We deliver this contribution in multiple parts:

- The creation of an RQA probe that people can complete on their computer or phone to reflect upon a stressful situation,
- Insights into the value and pitfalls of RQAs gathered via surveys and interviews from 42 MTurk participants and 6 university students,
- Evidence that people see value in an RQA relative to a baseline activity via a comparison study run on MTurk with 215 participants, and
- Observations and design considerations from a two-week deployment of our RQA using different CMC platforms.

Methods

In this section, we first discuss the design of our RQA and then go on to describe the logistics of the three studies we conducted. The studies were done simultaneously with the same RQA design in order to explore different aspects of the intervention. Study 1 involved gathering feedback on the qualities of the RQA from a broad demographic using surveys and semi-structured interviews. In Study 2, the perceived benefits of the RQA were compared to a shorter baseline activity with the goal of determining if the additional time commitment required to complete the RQA was justified by the benefits of the intervention. Study 3 aimed to explore how people would perceive the RQA during their everyday lives and how to best prompt engagement using email and text messaging.

The Design of Our RQA

Our research team, which consists of graduate students and faculty members with experience in psychology and human-computer interaction, was guided by existing CBT resources to create an RQA that helps people reflect on a troubling situation in their lives. We first reviewed popular CBT apps and websites intended for personally guided use (e.g., Youper [35], Depression CBT Self-Help Guide [36], Kokobot [37], and Woebot [38]) to identify the techniques they employed to provide benefits to users. In particular, we found that these resources leverage several components of a CBT exercise called a thought record [10]. A thought record is a worksheet with a grid that includes five columns: Situation, Thoughts, Emotions, Behaviors, and Alternative Thoughts. The exercise aims to encourage behavioral chaining — a process through which people draw connections between their thoughts and emotions to identify triggers and irrational thoughts — revealing potential opportunities to reframe their way of thinking [10,39].

Researchers have identified several benefits to thought records and behavioral chaining. Thought records can help people recall memories of prior events that were initially assumed to be unimportant [40]. Identifying the full timeline of an event can help people recognize their own faulty behavior patterns, thus preparing them for similar events in the future [41]. Moreover, informal exposure to negative

experiences can increase one's ability to tolerate troubling situations [42] or recover from problematic behaviors (e.g., binge drinking, self-harming) [10]. Thought records are typically introduced as CBT homework assignments that patients can complete between visits with a trained professional, providing them with the scaffolding to complete the activity on their own.

Our RQA attempts to distill this exercise into a brief guided activity that can be completed on a person's computer or phone without the need for external support. After writing a collection of brief questions to encapsulate these concepts, we iteratively added, removed, revised, and reordered the questions until we reached the RQA structure shown in Table 1. Our primary design goal was to give people a structured activity they could use independently to organize their thoughts. Inspired by thought records and behavioral chaining, our activity guides users through the following line of thinking: trigger → thought → feeling → behavior [9,10].

Table 1: The prompts and questions that compose our reflective question activity (RQA). The design of these questions is influenced by thought records and behavioral chaining.

Prompt: Think of a particular situation where you felt stressed or had a negative emotion, which you can try to reflect on as you go through this activity. It could be a current situation, one in the past, or one you anticipate in the future.		
Question	Example Response	Purpose
Q1. What's the situation? Feel free to explain it in as much detail as you'd like.	"My son has moved away and left no way for me to get in contact with him."	Provides context for the activity
Q2. What part of the situation is the most troubling?	"The fact that he does not care enough to reach out to me and let me know he is safe."	Sets an agenda for the rest of the activity
Q3. What are you thinking to yourself?	"I hope he is okay and safe. I wonder why he would do this. I thought we had a good relationship."	Identifies troubling thoughts
Q4. What thought is the most troubling?	"I don't know if he is safe."	Focuses attention on the most troubling thought
Q5. What do you feel	"Panicked and worried."	Reinforces the core CBT

when you think this?		principle that thoughts trigger feelings
Q6. When you have these feelings, what actions do you take? What actions do you avoid?	"I try to refocus my thoughts on something else. I try to avoid thinking about what bad things could be happening to him."	Identifies behaviors that are caused by the cascading effect of thoughts and feelings
7. Retype the summary of the situation in the following format: Trigger: Thought: Feeling: Behavior:	"I am triggered by thoughts of my son taking off and not staying in contact. I think about all the bad things that could happen and why he would do this. I feel panicked and worried. When feeling this way I try to think about other things and not focus on the negative of the situation."	Synthesizes past reflection by highlighting the connection between the trigger and its manifestations
Q8. Consider whether the trigger truly justifies this type of thinking. Explain below.	"The trigger does justify it. This is my child that I raised. I no longer know where he is, I cannot get in touch with him and I don't know if he is okay."	Challenges potentially negative thought patterns
Q9. If you were to explore an alternative line of thinking, how would you do it?	"I raised my child to be independent and he is trying to exercise that independence for the first time in his life. He needs me to take a step back for a while so that he can do this on his own."	Encourages alternative thoughts that can provoke different feelings and behaviors

We first start by asking the user to think about a stressful situation and to write about it in as much detail as they like. Prior work suggests that this sort of open-ended question allows users to open up about their problems and be comfortable with the activity [9]. The next five questions (Q2–Q6) become more specific, asking users to identify the most important stressor, the most troubling thoughts and

feelings, and the behaviors that come from those thoughts and feelings. The seventh question then asks users to retype the situation in a structured format. Beyond leading people through the process of behavioral chaining, these questions also allow users to iterate upon their initial thoughts regarding their stressful situation. The structured format in the seventh question is also designed to help users draw connections between several components of their situation. This leads to the eighth question, which challenges the user's mental process by asking them whether they believe that trigger justifies their thoughts. Doing so can help people identify flaws in their logic or possible cognitive distortions [10]. The final question asks the user to explore alternative ways of thinking that would enable them to see the problem from a different perspective and induce a different emotion [43].

We presented our RQA to four clinical psychologists with expertise in CBT to validate its construction and to help us consider the best ways of evaluating it. The psychologists verified that our RQA is aligned with activities that would be used in psychotherapy, but they also remarked that the questions focused on advanced techniques that were usually introduced only after several sessions of evaluation and psychoeducation. They also suspected that people might find the activity too lengthy or that people might not know how to respond to some of the questions. One psychologist even posited that more than two questions might be excessive for an online format without a conversational partner. The study that follows in this paper demonstrates that although these concerns were warranted, participants found value in the additional line of questioning.

Study 1: User Perspectives After One-Time Use of Our RQA

Our first study gathered qualitative feedback on the qualities that people saw in the proposed RQA irrespective of other factors (e.g., when it was being used, how it compared to other interventions). We used surveys to collect diverse feedback from a broad demographic, and then we used semi-structured interviews to gather deeper insights into some of the salient topics.

Participants

We initially recruited 50 participants from MTurk. Participants were required to have a minimum approval rating of 95%. We did not incorporate explicit attention check questions in our surveys but implemented a thorough manual review process to ensure data quality. Two independent members of our research team examined each response, discarding any that were incomplete or contained gibberish or irrelevant content. Due to the data quality issues, we discarded data from 8 participants, leaving us with a final sample of 42. This cohort included 35 males and 7 females with an average age of 34.6 years. We identified these participants as M1–M42, and they were compensated $4 CAD for their time. We also recruited six additional people via email and word-of-mouth from a university campus community to serve as interview participants. This cohort included 1 male and 5

females with an average age of 19.7 years. We identified these participants as L1–L6, and they were compensated $15 CAD for their time. There were no inclusion criteria since we were interested in observing how our RQA would be perceived by the general population.

Study Procedure

All participants were asked to complete the RQA online on the Qualtrics survey platform, with all the questions being presented on a single page. The data from this survey was saved and made accessible to the research team. After participants finished the RQA, they were requested to provide their feedback on the activity through a separate survey. The questions included but were not limited to: "How did this activity affect your stress levels?", "How did you feel about answering these questions in this online format?", and "Was any part of the activity not helpful or could be improved?". The university students also answered similar questions, although they participated in semi-structured interviews immediately after completing our RQA. The interviews took 45–60 minutes and were held either in person or through different video-conferencing platforms.

Data Analysis

The survey responses were analyzed using a thematic analysis approach [44]. After the interviews were transcribed, two researchers examined the data together to familiarize themselves with the general sentiments of the participants. The researchers then individually applied the open coding process [45] to a subset of the data to develop their own preliminary codebooks. After sharing their codebooks with one another, the researchers held multiple discussions to consolidate the codes into a shared codebook. Next, they applied this codebook to a different subset of the data and again refined the codebook. Finally, the researchers reached a consensus and applied the final codebook to separate halves of the data.

The interview transcripts were also analyzed using open coding. However, since the interviews aimed to gain deeper insights into what people had to say in the surveys, we used the same codebook generated from the survey responses.

Study 2: Comparing The RQA to a Baseline

The observed benefits of reflective questioning may be attributed to the act of discussing a troubling situation rather than the structured questions themselves. Furthermore, some clinical psychologists raised concerns that asking participants to answer more than a couple of questions may be overwhelming. To investigate these possibilities, we compared the effects of the RQA relative to simply asking participants to discuss their troubling situation without structured questions. In this baseline activity, participants were required to write about a stressful situation in as much detail as possible in response to a single question. If the structured questions in the RQA provide additional benefits over the baseline activity despite the added time commitment, we posited that the RQA would warrant further exploration as a tool for promoting self-reflection.

Participants

For Study 2, we again utilized MTurk and adhered to the same participant recruitment and data quality assurance procedures from Study 1. We initially recruited 255 participants for this study. After the data screening process, we discarded data from 40 participants (17 from the baseline group and 23 from the RQA group) due to issues related to data quality. This led to a final participant count of 215, with 111 individuals randomly assigned to the baseline group and 104 to the RQA group. Our study included participants of different genders, with 133 identifying as male, 77 as female, and 5 preferring not to disclose their gender. The mean age of the participants was 33.8 years. As with Study 1, all participants were compensated $4 CAD for their participation, and there were no inclusion criteria.

Study Procedure

The study had a between-subjects design in which participants were randomized into one of two conditions. The first condition, which we consider the RQA condition, entailed participants completing our nine-question reflective question activity. The second condition, which we call the Baseline condition, asked participants to reflect on a troubling situation they were experiencing in as much detail as they wished, answering only a single question.

We expected the RQA to take longer to complete than the Baseline condition given that it involved answering more questions. However, we were also interested in participants' perceptions of the activity's length and the value they placed on the additional time spent. By using a between-subjects design, the study aimed to assess whether completing the RQA would lead to differences in outcomes compared to the Baseline condition.

Data Analysis

We collected data before and after participants completed their respective activities to evaluate the following hypotheses:

Hypothesis 1: (Perceived Benefits) Participants in the RQA condition will experience more instantaneous stress relief from completing the activity than participants in the Baseline condition.

To evaluate this hypothesis, we asked participants to rate how useful they felt the activity was. We call this measure *Perceived Utility*, and it was measured along a 7-point scale (-3 for "strongly disagree" to 3 for "strongly agree"). We also asked participants to rate the degree to which they were feeling troubled about their selected situation before and after the activity. These ratings were given along an 11-point scale (-5 to +5) to increase the resolution with which people could express their stress. We call the difference between the ratings before and after the activity the *Perceived Stress Change*, with positive values indicating a decrease in stress. Both *Perceived Utility* and *Perceived Stress Change* were compared across conditions using independent samples Welch's t-tests. For each measure, the null hypothesis

(H_0) was that the mean for the RQA condition would be less than or equal to the mean for the Baseline condition. In contrast, the alternative hypothesis (H_a) was that the mean for the RQA condition would be greater than the mean for the Baseline condition.

Hypothesis 2: (Elapsed Time) Participants in the RQA condition will take more time to complete the activity than participants in the Baseline condition, yet the perceived time commitment will not be significantly different.

To evaluate this hypothesis, we recorded the time it took for participants to complete the activity, the number of words they typed across all questions, and a self-reported rating along a 7-point scale (-3 to +3) of whether they felt the activity was worth their time. We call these measures *Completion Time, Response Length,* and *Perceived Time Commitment*, respectively. All three measures were compared across conditions using independent samples Welch's t-tests. For each measure, the null and alternative hypotheses were set in a similar manner as detailed for Hypothesis 1.

Study 3: Observing Repeated Engagement with the RQA
In our third and final study, we aimed to assess the effectiveness of the RQA in a real-world setting as a periodic intervention and explore the most effective ways to prompt engagement through low-cost, asynchronous CMC platforms such as email and text messaging.

Participants
We recruited 11 participants (8 males, 3 females) with an average age of 20.6 years. Participants were recruited via email invitations and word-of-mouth from the same university campus community as Study 1 without any inclusion criteria. We refer to these participants as D1–D11. Participants were not compensated for completing our RQA to avoid undue influence on their level of engagement; however, they were compensated $10 CAD for completing surveys and $15 CAD for being interviewed.

Study Procedure
Participants were recruited to take part in our study for two weeks. During the enrollment phase, participants were asked to specify hours during each day when they would prefer to receive a notification to complete the RQA. They were asked to provide separate preferences for email and text messaging, and they were allowed to select multiple times during a given day. Participants were then randomized into one of two groups. One group received emails on the first week and text messages on the second week, while the other group experienced the reverse. The notifications prompted participants to complete the RQA and provided them with a link that took them to a webpage containing the RQA. We used the same link each time, and participants were aware of this fact.

Participants were prompted to complete the activity once per day for up to three days within a given week, similar to what has been done in previous work [46].

Eight of the participants were available for more than three days, so the days on which they received prompts were randomly selected. The three participants who were available for fewer than three days (D2, D8, and D9) received a message on every day of their availability.

At the end of the study, participants were asked to complete an exit survey containing questions about their overall experience and their CMC preferences in the context of the RQA. They were then invited to a semi-structured interview session to elaborate on their experience. The interviews lasted 15–30 minutes, with frequent topics including the barriers people faced while completing the RQA, the applicability of the RQA to their lives, and the tradeoffs of being prompted to complete the RQA repeatedly. Seven people took part in the interviews. The interviews were conducted over the Zoom teleconferencing platform.

Data Analysis

We recorded a variety of data to assess how people engaged with our RQA. We measured how often participants responded to our prompts without a limit on how long they had to respond. In other words, if a participant received a prompt in the morning but waited until the next day to complete our RQA, we still counted that as a response. We calculated the response rate in this way since it is well-documented that people respond to emails and text messages at their convenience rather than at the moment of reception [47]. As in Study 2, we asked participants to rate their stress along an 11-point scale before and after the activity, and we reported the change in that rating. We also report the time it took for participants to complete the RQA and the word count of their responses as proxies for engagement. We analyzed the interview responses using the same procedure that was applied to Study 1; however, we did so with a new, blank codebook.

Ethical Considerations

We recognize that conducting research on mental health can raise several ethical issues. For example, our particular set of questions can induce stress or symptoms of depression and anxiety, particularly when participants are asked to recall a troubling situation. To mitigate these negative outcomes, we clearly explained the potential risks in the consent materials and reminded participants that the RQA was part of a research study. We also provided survey participants with the contact information of several mental health helplines. The interviewers were trained to clearly explain the goal of the project and maintain an appropriate level of empathy and support. Interviewers were also trained to run the Columbia-Suicide Risk Assessment protocol [48] if interviewees showed any indication of self-harm or suicidal ideation. Interviewees also had the option to skip any question they did not want to answer or to leave the interview session at any point. All of our research activities were approved by the University of Toronto's Research Ethics Board (Protocol #36582).

Results

Study 1: User Perspectives After One-Time Use of Our RQA

During our first study, we elicited four major themes related to the benefits and pitfalls of our RQA for first-time users. We provide evidence for each theme below.

Appreciation for Structured Reflection

Participants were appreciative of the fact that our RQA helped them break down the components of their stressful situation. By deconstructing the situation, participants felt that they were able to become more aware of the causes of their negative emotions, putting their thoughts *"in the right order"* (L2). Some participants also noted that the activity helped them recognize faulty thought patterns. For example, M17 said, *"The activity helped me pinpoint my maladaptive coping strategy ... [it] led me to think more with my brain and less with my immediate emotional reaction."*

Venting Negative Thoughts Through Writing

Participants enjoyed expressing their thoughts and feelings through writing as it allowed them to *"get out all thoughts and feelings and take that weight off of my shoulders"* (L5). Moreover, some participants appreciated seeing their thoughts typed out in front of them, commenting that the act of writing helped solidify previously nebulous or disjointed thoughts. For example, L4 thought that the RQA forced them to dissect their feelings that would have otherwise been unorganized. M11 went on to suggest that writing about their thoughts allowed them to examine their situation *"from an outside perspective"*, almost as if they were analyzing someone else's situation instead of their own. This affordance made it easier for them to ignore personal tendencies and instead think more objectively about their thought process.

Helping Identify Solutions

Participants also stated that the activity prompted them to adopt a problem-solving approach to improve their situation. They could better identify the root cause of their stress because they were prompted to describe their troubling situation in a structured order, which made it easier for them to find a solution to their problem. Since the end of our RQA prompted users to consider alternative ways of thinking, participants like L3 felt empowered since they were often able to emerge from the activity with at least one prototype solution.

Incidental Negative Side-Effects

Our RQA did not unilaterally help people become less worried about their troubling situation. L5 noted that as they were considering an alternative line of thinking, they found it confusing to keep track of both their original thought process and the reframed one. L6 felt that this confusion led directly to frustration, while others were frustrated because they could not identify a solution by the end of the activity. As M19 said, *"The questions just made me think about how much pain I was in and really didn't offer any solution whatsoever to the stress"*. Some participants also felt at a loss when asked to think of alternative perspectives on their thoughts.

Study 2: Comparing the RQA to a Baseline

Out of 215 participants, 111 were randomly assigned to the baseline condition and 104 were randomly assigned to the RQA condition. The summary statistics for the measures that were collected during Study 2 are shown in Table 3.

Measure	RQA Condition	Baseline Condition	df	t-statistic	p-value	Cohen's d
Perceived Utility**	1.2 ± 0.2	0.5 ± 0.2	213	2.82	0.003	0.38
Perceived Stress Change***	0.7 ± 0.2	-0.4 ± 0.1	213	4.46	<0.001	0.61
Completion Time***	8.9 ± 0.8 minutes	1.6 ± 0.3 minutes	213	9.09	<0.001	1.27
Response Length***	87 ± 11.6 words	29 ± 5.5 words	213	4.52	<0.001	0.63
Perceived Time Commitment	-0.2 ± 0.2	-0.3 ± 0.2	213	0.33	0.37	0.05

Table 3. Summary measures and statistics from Study 2. Statistical significance between measures in the RQA and Baseline conditions is indicated in the first column according to independent samples Welch's t-tests. Averages are given with the standard error within each condition. For each measure, we set our hypotheses as follows: The null hypothesis (H_0) was that the mean for the RQA condition would be less than or equal to the mean for the Baseline condition. In contrast, the alternative hypothesis (H_a) was that the mean for the RQA condition would be greater than the mean for the Baseline condition.

Hypothesis 1 (Perceived Benefits)

Participants in the RQA condition saw significantly more utility in completing the activity than those in the Baseline condition (t(213) = 2.82, p = 0.003, Cohen's d = 0.38). The average rating for our RQA was 1.2 ± 0.2, while the average for the Baseline activity was 0.5 ± 0.2. Although both of these averages were near the neutral score of 0, there were many more positive ratings for our RQA. 79% of the participants who used our RQA gave a non-neutral positive score, while only 57% did the same for the single-question activity. Participants also reported a statistically significant change in stress rating in the RQA condition relative to the Baseline (t(213) = 4.46, p < 0.001, Cohen's d = 0.61). Whereas people who used our RQA experienced a 0.7 ± 0.2 point decrease in their perceived stress rating, people who used the single-question activity actually experienced a 0.4-point increase. A paired t-test performed on the pre- and post-scores of the RQA condition revealed a

statistically significant decrease in stress scores after completing the RQA in comparison to before starting (t(103) = 3.59, p < 0.001, Cohen's d = 0.36).

These results suggest that the additional questions from our RQA may not only help in potentially mitigating stress but also possibly counteract an initial increase in stress from revisiting the troubling situation.

Hypothesis 2 (Elapsed Time)

Participants in the RQA condition took 8.9 ± 0.8 minutes on average to complete the activity, while those in the Baseline condition only took 1.6 ± 0.3 minutes on average; the difference between the two conditions according to this measure was statistically significant (t(213) = 9.09, p < 0.001, Cohen's d = 1.27). We also found that participants wrote significantly longer responses while going through our RQA. Participants in the RQA condition wrote 87 ± 11.6 words on average, while those in the Baseline condition wrote 29 ± 5.5 words on average; that difference was also statistically significant (t(213) = 4.52, p < 0.001, Cohen's d = 0.63). Although the RQA required significantly more effort, there was no statistically significant difference in people's subjective perceived time commitment (t(213) = 0.33, p = 0.37, Cohen's d = 0.05). We conclude from these results that people found value in the additional time they spent completing the series of questions.

Study 3: Observing Repeated Engagement with Our RQA

Fig. 1 illustrates participants' response rate to our RQA sent over email and text messaging over the course of the study period. The figure not only shows the aggregated data across all interactions with our RQA but also splits the results according to the CMC platform through which the prompts were sent. We do not rely on quantitative data to claim that one way of delivering an RQA is better than the other; instead, we look into qualitative data to understand the role that technology plays in supporting long-term engagement with one.
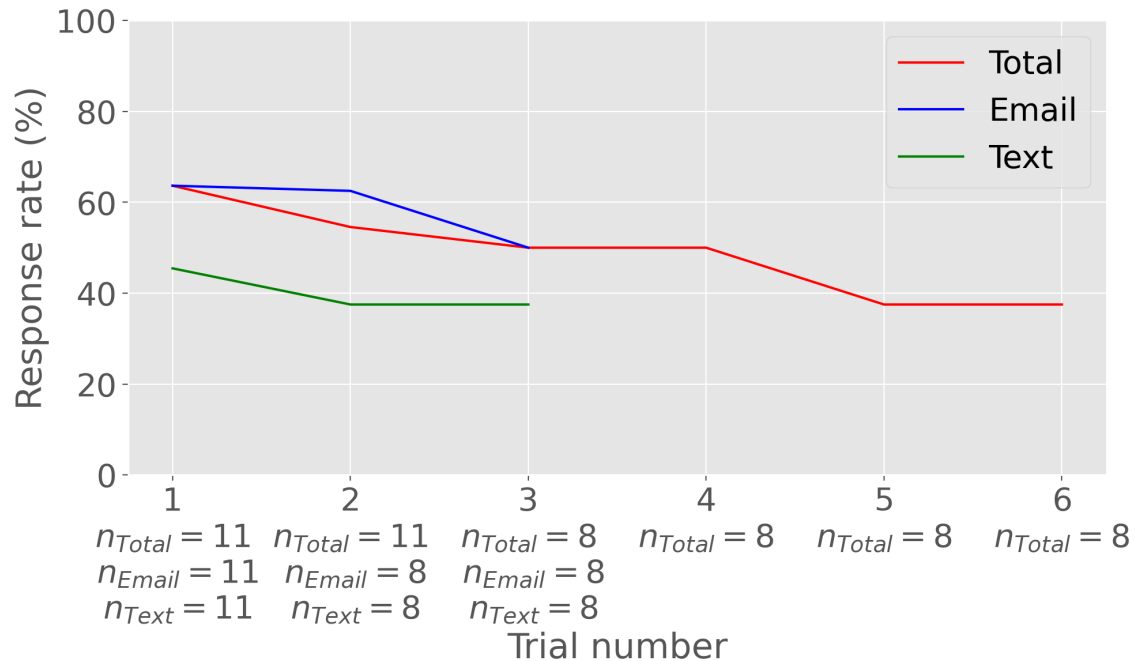
Fig. 1: Participants' response rate to our RQA over the study period. The tick marks below the graph indicate the sample size for each data point.

Overall Engagement

We observed moderate engagement throughout the two-week period of our study. We sent participants a total of 54 prompts via email and text messaging (equally distributed between the two), and participants completed the RQA in 27 of those cases (50%). On three occasions, participants completed the RQA twice in response to the same prompt, so our RQA was actually completed 30 times during the study. On average, people spent 18.5 ± 1.2 minutes, wrote a total of 212 ± 24.2 words, and experienced an average stress level reduction of 1.2 ± 0.3 points after completing the RQA.

Participants were much more engaged with our RQAs in this study compared to the MTurkers in Study 2 (i.e., spent more time and typed longer responses), even as they completed it multiple times. One explanation for this discrepancy could be the amount of time participants were willing to commit to the study. Participants in Study 2 likely completed our RQA in the midst of other crowdsourcing tasks or during their busy workdays. On the other hand, participants from Study 3 were able to pick a suitable time at their convenience, which in turn gave room for a longer time investment. D3 validated this hypothesis from their experiences:

"Although I initially said that I would be available in the morning, I found the best time to do it in the time between 9–11 pm. I used to see the emails and text messages shortly after they came, but I used to only do them at my convenient times in the night."

Our quantitative and qualitative data show that people could spend as little or as much time as they wanted with the activity without the need for significant scaffolding. In the interviews, participants expressed similar opinions about the benefits of our RQA as they did in our previous studies. Most notably, participants saw benefits to having a structured way of organizing thoughts as it helped them identify triggers and devise an alternate way of thinking.

Repeated Engagement with the RQA

A major goal of this study was to observe how participants engaged with the RQA over time. Unsurprisingly, we observed that the response rate decreased over time. Fig. 1 shows that the response rate was 63.6% when participants received their first prompt and then 54.5% for the second prompt. By the time they had seen six prompts, the response rate went all the way down to 37.5%. When we asked participants to explain this trend during our interviews, the main complaint was that doing the same activity in such a short interval was boring and tedious. D3 mentioned that the length of the activity was acceptable for a one-time event, but when they had to do the activity thrice in the same week, it *"came across as a chore".* Similarly, D10 said,

"When it started coming every other day, I felt like I had to do a school homework. So I felt a little bit of pressure to do the activity."

Participants expressed that they would prefer to have larger intervals (e.g., once a week) between the times they are requested to go through the RQA. This was not only due to the monotony of the task but also because participants struggled to think of new troubling situations to reflect upon. D6 remarked,

"By the time I got the last prompt, I could not find a stressful situation in my life. Maybe the frequency should vary depending on the amount of stress a person is going through."

Participants acknowledged that regularly prompting them to do our activity had value. A few of them noted that they would have forgotten to revisit the RQA had they not been given periodic reminders. D1 also believed that they *"got more comfortable with the activity [over time] and started setting aside a time to do the activity."*

Repeated engagement with our RQA also helped people form habits that yielded benefits outside of the activity itself. For example, D10 informed us that they did the activity multiple times in their mind either to think about how their previous responses could be improved or how they could apply these questions in a new situation. D4 found that doing the activity multiple times was a good mental exercise to prepare themselves for less stressful situations that they may encounter during the day.

CMC Platforms

Another goal of this study was to gain insights into the role of technology in deploying RQAs. Fig. 1 shows that there was a noticeable difference between the response rates over email and text messaging. Even in our exit survey, eight participants said that they would prefer email over text messaging for doing this activity, and the rest of the participants had no preference. One of the main reasons for the preference was the affordances of desktop and laptop computers when it came to completing the RQA. Most notably, participants commented on how computers are better suited for reading and writing longer passages of text. D1 said,

"Typing is very difficult in mobile phones. The screen size is small and editing stuff is a nightmare. On the other hand, if you want to write a long answer, you would probably do that on the computer because the process is just much easier."

Participants also felt that doing the RQA on a computer minimizes the chance for distractions. For example, D7 commented that sitting in front of their computer gave them the *"right mindset to do the activity".* With a computer, they felt that they had control over their workspace since they could easily close other tabs and applications. When they tried to do the activity on their phone, on the other hand, there were cases when a call or push notification disrupted their train of thought.

Although email was generally preferred for completing the RQA, many people agreed that mobile phones are a great mechanism for sending notifications and reminders. Participants like D4 and D6 had the concern that people may not check their emails as frequently as they check text messages, with D4 saying,

"Most of the time, I have my phone in my hand, whereas I check my emails at most once or twice a day. So if you need me to do something immediately, you would probably need me to reach via text messages. I can respond to an email even two days later."

Participants also informed us of instances when they switched between the two CMC platforms. When D6 was prompted to do the RQA over text messaging, they sent the link to themselves over social media and then accessed it on their desktop to complete the RQA. Some participants posited that the two CMC platforms could be integrated into the same system. D6 had the following suggestion:

"What you can do is you can ask me to answer the questions in the text message, but at the same time you will also send me an email that has the links to the actual page."

Alternatively, others suggested that the RQA could be advertised over social media platforms like Facebook or Instagram since people normally access their accounts across multiple devices. In doing so, people could have the option to choose whichever platform they see fit.

Discussion

Principal Results

In this work, we aimed to understand the benefits of a brief digital intervention that people could complete on their phone or computer to lessen their concerns about a troubling situation. Our second study showed that doing the RQA could be more effective in reducing instantaneous stress relative to simply reflecting on a troubling situation without structured questions, while our first and third studies elicited qualitative findings that we hope will inform the design of future interventions in this space. Most notably, we found that participants appreciated the RQA for its ability to help them undergo a structured analysis of their troubling situation, identify solutions to improve their situation, and vent out their negative feelings. Although participants felt that the series of questions was worth the additional time commitment, we also saw some obstacles toward long-term engagement with the RQA: the monotony of doing the same activity several times, the limited affordances of mobile phones, and the importance of having the prompts align with the occurrence of new troubling situations.

Our findings indicate that people from the general population saw value in engaging with a simple, lightweight reflection activity without an active conversational partner. Although there has been significant research effort toward making mental health platforms more sophisticated and human-like [37,49], our work shows that simpler interfaces can also yield benefits. Across all of our studies, participants expressed that the structured nature of the RQA played a pivotal role in making them more aware of their troubling emotions. By deconstructing past events, participants were able to view their feelings in an organized manner and from a third-person perspective, enabling them to reevaluate whether their feelings were justified or not. The writing activity acted as a medium through which they could externalize repressed emotions, a helpful practice that has been noted by past psychology research [50]. People often falsely assume that their problems are a reflection of their own identity or their relationship with others. Failing to "separate problems from persons" can cause people to identify themselves as different from what society considers "normal", eventually leading them to fixate on their negative traits [51]. Our RQA provided people with the opportunity to explore the relationship between their problem and their own self but from a different perspective.

The RQA also offered a general structure that people could adapt to their own life situations. We saw that a few participants applied the same line of questioning outside of the activity itself, hinting at longer-lasting benefits.
We foresee that RQAs could serve as a gateway for people struggling with stress and depression to engage with more complex activities and therapeutic tools. Validating this potential would require a longer study, but our research already demonstrates the hurdles that RQA interventions must overcome to support long-term engagement.

Improving the Design of RQAs

The success of the RQA in our work does not mean that future RQAs could not be even better. Although we observed an average decrease in participants' stress levels after completing the RQA, some participants from Study 1 remarked that the activity left them confused and without a concrete solution. We hypothesize that such concerns could be remedied by providing users with sample responses to each question as a source of inspiration. These examples could be curated by researchers, or they could be collected from previous users who voluntarily contributed their responses to a database [52]. Topic modeling could be used to tag the examples with keywords related to their subject matter, and an information retrieval system could rank the relevance of these examples [53]. Collaborative filtering could even be used to gradually collect ratings for each example and then cater examples to individuals' preferences [54].

Another way that RQAs could be made better is by personalizing the questions themselves. The activity could ask users to rate the perceived benefit of each question, or we could utilize the average response length as a proxy for estimating the utility of each question. Using this information, we could extend or emphasize questions that individuals find most beneficial. We could also use this information to remove questions that induce stress; however, thought records and behavioral chaining are intentionally designed processes with many critical steps, so removing questions may detract from the activity's benefits.

Our nine-question RQA took inspiration from CBT, but future work could investigate RQA designs based on other psychological principles. For example, encouraging expressions of gratitude or social connections with others can play a key role in stress and depression management [55,56], so RQAs built around those practices can similarly help people manage their well-being. Future work could also explore different activity structures. Some participants in Study 3 complained about the inconvenience of typing on their smartphones, so an alternative activity could ask people to record and listen to their own voices for reflection. Another activity could encourage peer support by starting conversations between online peers. Lastly, researchers could create brief activities centered around other psychological frameworks beyond CBT, with past examples being centered around mindfulness [57], motivational interviews [58], and acceptance and commitment therapy (ACT) [59].

Considerations for Long-Term Engagement

Our two-week deployment in Study 3 enabled us to gain insights into how people would engage with RQAs over a period of time. Although participants were pleased with the fact that they could specify their hours of availability, receiving prompts for the RQA three times within the same week was overwhelming for most people. The biggest criticism was that people received multiple prompts without experiencing a new troubling event, so they either had to go through our RQA while analyzing the same event as before or recalling a troubling event from the distant past. Ideally, the frequency of prompts would adapt dynamically according to a person's needs. One

participant suggested that users should have control over how often they receive reminders to complete our RQA, explaining that individuals who experience more stress than others might benefit more from doing these activities in short intervals. Going a step further, future work could integrate physical activity trackers, smartphone sensors, and IoT devices to automatically detect periods of heightened stress [60,61], turning our RQA into a just-in-time adaptive intervention.

Another issue with completing our RQA too often was that answering the same set of questions became boring and tedious, yet adjusting the prompt frequency alone may not be enough to resolve these concerns. One way to add variety would be to mix an RQA with other microinterventions, as was done by Paredes et al. in their PopTherapy work [13]. Brief interventions like our RQA could also serve as a gateway to more time-consuming exercises or professional therapy. By giving people a preview of the potential improvement in the mood they can receive from articulating their thoughts and emotions, habits can be formed and users may become more motivated to build on that momentum [62].

Limitations

Rather than developing a mental health intervention for people suffering from clinical depression or other psychological disorders, our intention was to design our RQA for as broad of a population as possible. It would be imperative for researchers to conduct further studies specifically with more vulnerable populations to understand the benefits and potential risks of digitally delivered RQAs. We suspect that self-reflection could serve as a convenient mechanism for people to practice what they learn in psychotherapy, but it could also perpetuate negative thought patterns. We also recognize that our participant cohorts — MTurk crowdworkers and university students — do not represent all aspects of the general public. Most of our qualitative findings were not tied to participants' specific contexts, and we did not find any obvious evidence of substantial differences between the cohorts. Nevertheless, future work could deploy RQAs to more diverse populations.

Conclusion

In this work, we used principles from CBT to design a brief RQA that helps people articulate, reflect on, and change their thoughts and emotions about a troubling situation. The three studies we presented in our paper provide evidence that people are willing to engage with and find value in brief self-reflection activities delivered through CMC platforms, even without scaffolding like training or real-time feedback. We found that providing people with a brief online activity not only helped them reduce their perceived stress levels related to a self-selected situation but also helped them challenge their potentially negative thought patterns and identify alternative ways of thinking. We also found that people were willing to use the RQA more than once, although future work is needed to strike a balance between utility and monotony. We hope that our work inspires other researchers to explore new formats for brief interventions that help people with their everyday struggles.

Data Availability

Anonymized datasets will be made available from the corresponding author upon reasonable request.

Conflicts of Interest

None declared.

Abbreviations

CBT: Cognitive-behavioural therapy
CMC: Computer-mediated communication
JMIR: Journal of Medical Internet Research
RQA: Reflective Questioning Activity

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