
Knowing What You're Doing or Knowing What to Do: How Stress Management Apps Support Reflection and Behaviour Change

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Abstract

Feelings of stress can have negative impacts on mental and physical health. In response, a significant number of stress management applications (apps) have been developed but little is known about their functionality. We conducted a feature analysis of 26 stress management and monitoring apps to identify required improvements and support healthcare providers assess how stress management apps may be leveraged in clinical care. We found that the reviewed apps support users with reflecting on their data, but did not include adequate functions for supporting action taking (i.e. initiating and maintaining behaviour change). This paper contributes a discussion of how to improve the design of stress management apps with examples of good practice.

Author Keywords

Personal Informatics; Data Visualisation; Behaviour Change; Stress.

ACM Classification Keywords

H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous;

To pass the inclusion criteria the app should:

1. come from "Health & fitness" or "Medical" categories;
3. allow for self-tracking as this enables to review/evaluate data visualisations;
4. free to use as most apps (91.5%) found on Google play store in "Medical" and "Health and Fitness" categories are free.
5. not a duplicate
6. be in English;
7. be focused on healthy adults and not specific clinical conditions or children. These user groups will have disease and age specific needs that cannot be effectively evaluated in line with the needs of healthy adults;
8. not require a wearable device as such apps will have different collection and representation requirements.

List 1: App inclusion criteria.

Introduction

Chronic stress is a highly prevalent and costly public health problem, leading to both physical and mental symptoms. If not treated, it can lead to serious mental health disorders, such as anxiety and depression [1]. Stress management apps therefore have the potential to be a valuable early intervention by increasing access to evidence-based stress management techniques. Most existing stress management apps focus on delivering mindfulness meditations, guided breathing exercises, and/or including stress monitoring functions [4]. Whilst previous research has evaluated the functionality provided by mood tracking apps [2] the extent to which stress management apps support users in gaining insights from their data, specifically through visualisations of personal data, and using these to achieve behaviour change is currently unclear.

In this paper, we combine behaviour change and personal informatics theory to investigate how stress management apps support reflection and action. In this context, reflection refers to reviewing personal data and considering whether there is a need for any behavioural adjustments (action) [8]. Personal informatics research [8] defines how people interact with and gather insights from their data, however, it falls short on explaining how people use these insights to change their behaviours. In contrast, behaviour change research does not consider usability, but it provides a detailed account of how people's intentions (possibly formed after reflection) can lead to action [11]. Therefore, these two lines of research can complement one another by providing a detailed account on how people reflect and act on their data.

Previous reviews of stress management apps have considered their grounding in health and behavioural

theories as they play an important role in shaping their effectiveness [3,6]. However, most of these reviews overlooked the period of reflection and self-discovery which Li et al's stage based model of personal informatics states pre-empts action taking [8]. Therefore, the focus of our review includes the critical stages of reflection and action as they are the most proximal to behavior change in both behavior change and personal informatics models [8,11]. Understanding and improving on how mobile apps support these stages could have a direct impact on their efficacy.

Reflection

According to Fleck and Fitzpatrick [7] technology supported reflection allows users to revisit events that are difficult to perceive (e.g, step count) or are otherwise easily forgotten. This allows to review and re-evaluate specific actions and their outcomes, highlighting an opportunity for behaviour change [9]. Challenges encountered in the reflection stage, such as confusing visualisations, can create barriers when transitioning to the action stage, dampening the overall effectiveness of the app [8]. It is therefore important to understand how well such apps support users in exploring and reflecting on their own data.

Action

The stage based model explains that during the action stage individuals decide whether there is a need for any behavioural adjustments based on the insights gathered during the reflection stage [8]. Behaviour change research additionally specifies that action taking can be facilitated by using action control constructs: self-monitoring, goal setting, planning, use of prompts [11]. The inclusion of these constructs helps to ensure that the users are not only becoming aware of their

Reflecting on personal data (Li et al., 2011), does the app allow users to:

Status. Compare the current state with the goal state?

History. Identifying whether there are any trends and patterns in the data, specifically, how a stress management technique may be affecting the user's stress levels?

Goals. Make it clear what goals should be pursued?

Discrepancies. Identify whether there are any discrepancies between the current state and the goal state?

Context. Enable the user to recognise what other factors might be affecting their present state/behaviour?

Factors. Show whether there are any factors/trends influencing behaviour change outcomes over longer periods of time?

List 2: A snapshot of part 1 of the scales evaluating how people reflect on their personal data and how visualisations support this process.

stress levels through reflection, but are also engaging in active stress management (action) to reduce their stress levels [3,11].

Our study

This paper reports a review study of commercial mobile stress management apps that allow for self-tracking of and reflection on stress data in which we combined a feature analysis with an in-depth focus on data visualisation. The aim of this study is therefore to *systematically review and evaluate how well stress management apps support reflection and action*. A better understanding of how these processes are implemented in existing stress management apps enables us to identify the areas that need improvement, allows us to outline the design guidelines for increasing the impact of such apps and may support clinicians in recommending apps to patients.

Method

Inclusion Criteria

A systematic search on a UK based Google Play Store was conducted as Android is the most frequently used OS worldwide [3]. Apps that did not allow for self-tracking were excluded. The apps were evaluated on a Galaxy S7 Edge smartphone running Android 7.0. Apps meeting the inclusion criteria (see List 1) were downloaded, installed and tested in November 2017.

App Evaluation Scale

We developed a scale focusing on the two parts of the personal informatics model that are of interest: reflection and action. The items were drawn from action control constructs [11], personal informatics theory [8], and visualisation readability heuristics [5].

PART 1. REFLECTION

We explored the extent to which each app supports reflection through visualisation of personal data by using Cuttone's et al's [5] four visualisation heuristics: interpretability, exploration, discovery of trends and patterns, affordance for action taking. Personal data can be challenging to explore if it is presented in a numerical format only. Visualisations of such data can support self-insight by allowing the users to discover trends and patterns in their behaviours [5,9].

In addition, drawing on the stage based model of personal informatics [8] and the types of questions asked by self-trackers during the reflection stage [9] we evaluated the extent to which stress management apps and visualisations produced by such apps allow for exploration and reflection on personal data associated with stress (see List 2).

PART 2: ACTION CONTROL AND ACTION TAKING

The multi-process action control (M-PAC) model defines action control constructs as vital for behaviour adoption and maintenance. This part of the scale therefore investigated whether and how mobile apps for stress management include functions supporting action control constructs, which are goal setting, planning, and use of prompts/reminders, as these have been shown to be the most effective techniques for initiating and maintaining a behaviour [11]. It additionally considered the action stage described in Li et al's [8] stage model, outlining how individuals use insights from exploring their personal data to decide whether there is a need for any behavioural adjustments.



Figure 3: Pacifica visualisation of mood over time.



Figure 4: Weltoorry visualisations of productivity vs. stress, providing actionable insights, in this case, suggesting that by reducing stress levels, the user will become more productive.

Results

App selection

The search returned a total of 1250 apps. After assessing the apps against the inclusion criteria (see List 1), 26 apps were downloaded and evaluated (see Appendix A). A total of 11 apps were included under the search terms stress + management OR relief OR reduction. The search terms stress + tracking OR monitoring OR log resulted in 15 apps. Each item was evaluated on a 5-point Likert scale. A second rater reviewed 30% of the apps, with a good interrater reliability ($Kappa = .86$).

Part 1. Reflection

Reflection was mainly supported through data visualisation. However, only 6 displayed before and after effects to show the link between a relaxation activity and reduced stress. 14 apps used visualisations that enabled the identification of trends. 2 apps used visualisations that were low in quality and difficult to interpret. The other 10 did not support this.

19 apps provided visualisations that can be interpreted at a glance. Exploration of patterns in time series data was possible in 15 apps. Discovery of trends in multiple data streams was supported by 15. 8 visualised multiple variables in separate graphs, whereas 7 apps displayed several variables on the same graph. Affordance for action through data visualisation was provided by 12 apps. 8 of these apps visualised relationships between variables that could be translated into action or used numerical or visual representation of a general wellness score or other indicators such as a heart shape filling up to represent wellness. 23 apps provided a visualisation of the current state, but only 5 apps enabled the users to compare their current state

with their goal state. 20 apps provide visualisations of stress and/or mood trends over time, and an additional 7 apps visualise which activities have an impact on stress over time. Only 1 app visualized context factors affecting the current state and 15 apps allowed to track several pre-set variables affecting stress over time.

Part 2.1 Action control

Most apps (19 out of 26) supported the tracking of one or more additional variables alongside mood or stress. Planning was supported by 18 apps, however, only 4 of them did so in a structured way, e.g., helped to plan future activities, provide a visual roadmap. 5 apps allow the user to track predefined goals and 6 apps allow the user to iteratively set short and long-term goals. 8 apps included prompts or reminders to perform an activity, 5 reminded to input mood, 4 could do both.

Part 2.2 Action taking

Action taking was supported by providing information and guidance on how to perform a stress management activity (7 apps), by providing information on the health-behaviour link (18 apps), and by visualising the before and after effects of a stress management activity to promote its use (6 apps). An additional 6 apps allowed the user to set reminders to perform stress management activities.

Discussion

Stress management apps reviewed in this study were shown to support reflection well, but not action taking. Reflection was mainly supported through data visualisation, however the majority of visualisations used did not provide affordance for action (22/26). 19 apps provided guidance on how to perform a stress



Figure 5: Dailyo calendar visualisations of mood patterns.

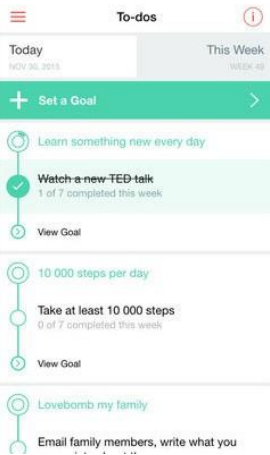


Figure 6: Remente app displays a roadmap, allowing to compare discrepancies between the current state and the goal state.

management activity, but only 6 of these sent prompts to do so. This suggests that most apps support their users in identifying what their stress levels are, but provide little support in addressing these issues. Importantly, apps that focus on stress management (rather than just stress tracking), such as Pacifica [10] and Welltory [12], include more features supporting reflection and action taking.

Implications for Design

We describe the functions of several apps as examples of best practice for facilitating reflection and action.

Prompts to reflect: Fleck and Fitzpatrick [7] suggest that reflection can be supported by providing guidance on when and why the users should reflect on their data. For example, the app Remente [12] explicitly instructs its users to reflect on data collected throughout the day in the evenings.

Guidance on reflection: It can also be beneficial to present information on what relationships or patterns to look for as well as provide more varied types of data visualisations [7]. This broadens the types of questions the users can ask when reflecting on their data [9]. For example, the Pacifica app [10] represents trends in mood by visualizing these on a line plot (see Figure 3). This allows the users to ask questions such as “Does my mood go up over time”.

Identification of contributing factors: The option to add another variable to the visualisation helps to make insights into whether there are any additional factors affecting stress (see Figure 4). Calendar views, such as the one used by the Dailyo app [13], can indicate periodic patterns in people’s moods (see Figure 5). Visualising data in such a way allows users to identify

whether there are specific days of the week when relaxation exercises should be performed [5].

Supporting action control: The least incorporated features were those based on the action control constructs from the M-PAC model, specifically, goal setting, planning, and using reminders [11]. For example, the app Remente instructs its users to create a plan specifying when they would like to be reminded to do a specific stress management or recreational activity. It also allows users to set daily achievable goals that can be conveniently monitored and ticked off when completed, later on displaying a history of how such micro practices contribute towards the long-term goals (see Figure 6). This allows the user to compare their current and goal states, identify discrepancies, and change their behaviours accordingly [8].

Implications for clinical practice.

The outcomes of this study indicate that even though stress management apps can support awareness of high and low periods of stress, they still require improvements for facilitating action taking. Health care professionals could support patients in choosing adequate stress management apps or even advise on combining two complementary stress-monitoring and management apps to match individual patient’s needs.

Conclusion

Stress management and tracking apps reviewed in this study were shown to adequately support reflection, but not action taking. Developing apps that support these requirements is important: by coupling flexible data visualisation and exploration methods with action control constructs, stress management apps can increase the likelihood that a behaviour, in this case, stress management, will be initiated and maintained.

App Name	Reflection	Action
Breathe2Relax	2.7	1.2
flowt	2.6	2.4
Remente	3.7	3.6
Welltory	3.9	3.2
MetaFi	2.3	1.4
Zenfie	1.4	2.6
InnerHour	1.8	3.8
Pacifica	4.3	4
Daylio	3.2	1.4
MindRazr	2.5	1
DeStressify	3.5	3.4
Moodlytics	4.1	3
Health Log	1.7	0.2
Moodtrack Diary	1	0
Moodpath App	2.2	2.2
Stop Breathe & Think	3.2	1.8
Moodfit	4.2	3.4
WellMind	1.8	2
HealthyMinds	2.4	4.6
Thrive: Feel Stress Free	3.1	3.2
MoodMission	2.4	2.4
Aura	2.5	3.2
Thought Waves Pro	2.8	2.6
TruReach	2.2	1.6
Mood Log	2.2	0.2
Stress Monitor	1.9	0.6

■ Good (3.5 – 5)

■ Medium (2.5 – 3.4)

■ Poor (≤ 2.4)

Appendix A. List of the 26 reviewed apps together with the information on how well they support reflection and action.

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