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

Nora Ptakauskaite
UCL Interaction Centre
University College London
London, UK
nora.ptakauskaite.16@ucl.ac.uk

Anna L Cox
UCL Interaction Centre
University College London
London, UK
anna.cox@ucl.ac.uk

Nadia Berthouze
UCL Interaction Centre
University College London
London, UK
n.berthouze@ucl.ac.uk

CHI'18 Extended Abstracts, April 21–26, 2018, Montreal, QC, Canada

ACM ISBN 978-1-4503-5621-3/18/04.
https://doi.org/10.1145/3170427.3188648

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. We found that the reviewed apps supported users with reflection, but did not include adequate functions to support 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 and how healthcare providers can use this information to leverage such apps in clinical care.

Author Keywords
Personal Informatics; Data Visualisation; Behaviour Change; Stress.

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

Introduction
Chronic stress is a highly prevalent and costly public health problem, leading to both physical and mental

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.

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 [10]. 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 behaviour change in both behaviour change and personal informatics models [8,10]. 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 the users 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 further facilitated by using action control constructs: self-monitoring, goal setting, planning, use of reminders [10]. The inclusion of these constructs helps ensure that the users are not only aware of their stress levels and what might be influencing these (reflection), but are also engaging in active stress management (action) [3,11]. This is because stress can

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 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 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.

create barriers to engage in health behaviours as it depletes people of their self-regulatory resources. The lack of such resources can be overcome by including functions supporting action control constructs on which the users can fall back on when stressed [9,10,11].

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 as past research [2] indicated that this is the main modality used to support reflection in similar type of apps (mood tracking). The aim of this study is therefore to *systematically review and evaluate how well stress management apps and visualisations generated by such 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 [10], 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 patters, 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 [10]. 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's visualisation of mood trends allows users to ask questions such as "Does my mood go up over time?".

Figure 4: Weltorry visualisation of sleep vs. stress provides actionable insights by suggesting that by getting more sleep the users can reduce their stress levels over time.

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. 20 apps provided visualisations of stress and/or mood trends. 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, indicating which activities/behaviours have an impact on stress over time. Exploration of patterns in time series data was possible in 15 apps. 6 apps displayed before and after effects to show the link between a relaxation activity and reduced stress. 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 (see Figure 4) or used numerical or visual representation of a general wellness score or other indicators such as a heart shape filling up. 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. Only 1 app visualised context factors affecting the current state and 15 apps allowed to track several pre-set variables affecting stress over time.

Part 2. Action control and action taking

Most apps (19 out of 26) supported the tracking of one or more additional variables alongside mood or stress. Planning was supported by 15 apps, however, only 4 of them did so in a structured way, e.g., helped to plan future activities, provided a visual action plan/roadmap. 5 apps enabled the users to track predefined goals and 6 apps allowed them to iteratively set short and long-term goals. 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 12 apps allowed the user to set reminders to perform stress management activities.

Discussion

Stress management apps reviewed in this study were shown to adequately support reflection, but not action taking. This suggests that most apps enable their users to identify what their stress levels are, but provide little support in addressing this issue. One of the main shortcomings identified in the reviewed apps was that even though most of them provided guidance on how to perform a stress management activity, they failed to provide adequate features supporting action planning and more than half failed to send reminders to do a stress management activity.

Implications for Design

We describe the functions of several apps as examples of best practice for facilitating reflection and action taking in the context of a stress management app.

Figure 5: Dailyo calendar visualisation of mood patterns displays days of the week when the user experiences reoccuring stress, indicating when to best perform relaxation activities.

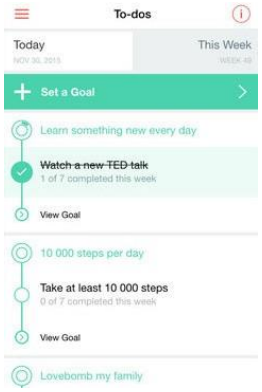

Figure 6: Remente app displays an action plan, allowing to compare discrepancies between the current and goal states.

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 the data collected throughout the day in the evenings, this way helping to identify what activities might have influenced their stress/mood.

Guidance on reflection: It can also be beneficial to present information on what relationships or patterns to look for as well as to provide more varied data visualisations [7]. This broadens the types of questions the users can ask during the reflection stage, which can help increase the actionable insights gathered from their data (see Figures 3-5) [9].

Identification of contributing factors: The option of adding another variable to the visualisation helps with understanding whether there are any additional factors affecting stress levels and what specific actions should be performed or avoided (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), which helps to identify when to perform a stress management activity [5].

Supporting action: The least incorporated features were those based on the action control constructs from the M-PAC model, specifically, goal setting, planning, and using reminders [10]. Some apps, such as Remente [13], supported action by instructing its users to create an action plan by specifying when to send a reminder to do a specific stress management or recreational activity (which can be effectively identified by employing reflection strategies described earlier). Remente also allowed users to set daily achievable goals that can be easily monitored and ticked off when completed, then displaying a history of how such micro practices contributed towards achieving the long-term goal (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. Healthcare professionals could support patients in selecting stress management apps, particularly by recommending apps with integrated stress monitoring (reflection) and management (action) functions (see Appendix A) or advise on combining several complementary apps in relation to individual user 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.

References

1. APA. 2015. Paying with Our Health. *http://www.apa.org*. Retrieved March 19, 2017 from http://www.apa.org/news/press/releases/stress/2014/financial-stress.aspx.

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

Good (3.5 – 5)

Average (2.5 – 3.4)

Poor (≤2.4)

Appendix A. List of the 26 reviewed apps together with the information on how well they support functions related to

2. Clara Caldeira, Yu Chen, Lesley Chan, Vivian Pham, Yunan Chen, and Kai Zheng. 2017. Mobile apps for mood tracking: an analysis of features and user reviews. Retrieved November 13, 2017 from https://amia2017.zerista.com/event/member/389348.

3. Corinna Anna Christmann, Alexandra Hoffmann, and Gabriele Bleser. 2017. Stress Management Apps With Regard to Emotion-Focused Coping and Behavior Change Techniques: A Content Analysis. *JMIR mHealth and uHealth* 5, 2.

4. Sandra M. Coulon, Courtney M. Monroe, and Delia S. West. 2016. A Systematic, Multi-domain Review of Mobile Smartphone Apps for Evidence-Based Stress Management. *American Journal of Preventive Medicine* 51, 1: 95–105.

5. Andrea Cuttone, Michael Kai Petersen, and Jakob Eg Larsen. 2014. Four Data Visualization Heuristics to Facilitate Reflection in Personal Informatics. *Universal Access in Human-Computer Interaction. Design for All and Accessibility Practice*, Springer, Cham, 541–552.

6. Joseph Firth, John Torous, Jennifer Nicholas, Rebekah Carney, Simon Rosenbaum, and Jerome Sarris. 2017. Can smartphone mental health interventions reduce symptoms of anxiety? A meta-analysis of randomized controlled trials. *Journal of Affective Disorders* 218, Supplement C: 15–22.

7. Rowanne Fleck and Geraldine Fitzpatrick. 2010. Reflecting on Reflection: Framing a Design Landscape. *Proceedings of the 22Nd Conference of the Computer-Human Interaction Special Interest Group of Australia on Computer-Human Interaction*, ACM, 216–223.

8. Ian Li, Anind Dey, and Jodi Forlizzi. 2010. A Stage-based Model of Personal Informatics Systems. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, ACM, 557–566.

9. Ian Li, Anind K. Dey, and Jodi Forlizzi. 2011. Understanding My Data, Myself: Supporting Self-reflection with Ubicomp Technologies. *Proceedings of the 13th International Conference on Ubiquitous Computing*, ACM, 405–414.

10. Pacifica Labs Inc. 2017. Pacifica. Retrieved from http://www.thinkpacifica.com/.

11. Ryan E. Rhodes and Gert-Jan de Bruijn. 2013. What predicts intention-behavior discordance? A review of the action control framework. *Exercise and Sport Sciences Reviews* 41, 4: 201–207.

12. Falko F. Sniehotta, Ralf Schwarzer, Urte Scholz, and Benjamin Schüz. 2005. Action planning and coping planning for long-term lifestyle change: theory and assessment. *European Journal of Social Psychology* 35, 4: 565–576.

13. Remente - Personal Development. Retrieved January 7, 2018 from https://remente.com.

14. Daylio - The Big Idea of Micro Diary. Retrieved January 7, 2018 from https://daylio.webflow.io/.