MoodPrism: Mental health support on your phone.

Final Report

12 December 2016

Contract Working Project title

Music as a Canary – a mobile application and research determining whether automatic monitoring of young people’s music use, physical activity and social networking (via the mobile application) can predict change in depression risk.

Investigators

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Main messages

• Nearly one in every two Australians will experience a mental health condition at some time in their life, and one in five will experience depressive symptoms. It’s estimated only half of those seek professional help

• Early detection of symptoms is one of the best ways to act on symptoms before they escalate into more serious disorders

• Mental health and well-being apps are being used increasingly by people of all ages and mental health needs. Evidence for the credibility, functionality and efficacy of these apps is however lacking.

• Mood tracking apps like MoodPrism are a contemporary means of addressing mental health needs by engaging users with their feelings, providing feedback on increased risk of depression and anxiety, and linking the user with mental health services

• MoodPrism was designed and developed by a cross-university collaborative team of researchers with beyondblue funding. It can be used on either iPhone or Android devices, enabling users to monitor their mental health in any context, whether they’re at work, home, or on public transport.

• MoodPrism functions like a modern day mood diary, which asks users how they are feeling on a day-to-day basis. After answering a few questions, the app converts and records responses into a colourful ‘Mood History’.

• Users can explore their Mood History at any time to gain insight into their emotional well-being and overall mental health. This can provide insight into patterns of mood and whether these fluctuate with certain people or places, or times of the week.

• The more the app is used, the more detailed this information becomes. Positive functioning scores are unlocked after one week’s use. Depression and anxiety scores are unlocked after two weeks of use.

• MoodPrism is one of the few apps with a focus on enhancing positive psychological functioning as well as alleviating negative symptoms of depression and anxiety, and is therefore designed to help everyone achieve their best possible mental health

• MoodPrism also provides health information that is tailored to daily mood scores, linking this to a range of appropriate online mental health resources like beyondblue and Headspace.

• Information collected by MoodPrism is currently being used for research purposes, shedding light on different patterns of resilience to stressful events, and how online social interactions may help predict depression and anxiety

• Users rated MoodPrism positively in comparison to other mental health apps, finding it easy to use, interesting and enjoyable. For ongoing sustainability, the app could easily be upgraded from its current research focus to a highly engaging and less content heavy user-centric app. The automated monitoring features could also be easily enhanced.

• We believe that using MoodPrism could be a powerful technological tool for
  o Individuals, helping them to become aware of their emotional health and well-being, with potential for improvements in well-being for those with more severe symptoms.
  o For organizations, clubs and schools to receive wealth of highly relevant data, enabling them to proactively support the health and well-being of their staff, members or students
  o For researchers to use more dynamic data to predict depression and anxiety as well as positive emotional functioning.

• The app is now available on both Android and Apple platforms and can be downloaded by anyone with a smartphone. The main purpose of MoodPrism currently is as a research app, but with small modifications, it could become a more user-friendly, depression monitoring app.
Executive Summary

MoodPrism is a new smartphone app that provides unprecedented access to the changing moods of its users. The app tracks moods over time to support mental health and well-being. This raises self-awareness of emotional state, and can signal when the risk of depression or anxiety has increased. MoodPrism also provides links to mental health services to assist an individual to seek the help they might need.

Background

Depression is common, but is preventable. Early detection of symptoms is one of the best ways to reduce the impact of depression, and prevent preclinical symptoms escalating to a serious disorder. Identification of depressive symptoms increases an individual’s self-awareness of their emotional state, which can then increase likelihood of seeking help from mental health services. Early detection requires regular monitoring and identification of increased risk of depression. Regular monitoring is also crucial for reducing risk of relapse in people already diagnosed with depression.

One in five young people experience depressive symptoms, but less than half of these seek professional help. Of those that seek assistance, ongoing monitoring is a significant challenge for mental health services. One challenge is that it is difficult to obtain regular (e.g., daily) input on how people are feeling without becoming intrusive or ‘artificial’. A second challenge – partly resulting from the difficulty in monitoring people on such a regular basis – is that there has been less research on dynamic, day-to-day predictors of depression risk.

The goal of this project was to develop an innovative methodology to achieve daily monitoring of individuals in a non-intrusive way. “MoodPrism” was developed to help users learn about their mood by transforming daily mood reports into a colourful summary of their emotional health and wellbeing. To enhance likelihood of help-seeking when required, monitoring should be linked to feedback to raise awareness, and improved access to mental health services.

MoodPrism provides ongoing daily feedback on emotional wellbeing, and can provide insight into patterns of mood and whether these fluctuate with certain people or places. The more the app is used, the more detailed this information becomes. Positive functioning scores are unlocked after one week’s use. Depression and anxiety scores are unlocked after two weeks of use. MoodPrism also provides health information that is tailored to daily mood scores, linking this to a range of mental health resources.

Approach: The app was designed to track a user’s moods over time. Unlike previous apps, MoodPrism uses a combination of methods to monitor a user’s emotional state, and predict increasing risk of depression or anxiety. MoodPrism collects data via:

- Daily experience samples of mood
- Daily experience samples of significant events
- Daily experience samples of context
- Online behavioural data
- Psychometric surveys
- Demographic data

Risk indices are calculated using established cut-off thresholds which indicate increased risk of depression or anxiety. The user can access feedback on their emotional health on demand. This feedback is tailored based on their risk index for that day. The feedback is also transformed into a colour coded chart, which can be viewed as an overview, or in more detail on a daily basis.

The funding received by beyondblue support the design, development and trial of the research version of the app. Research on the outcome measures was beyond scope of this initial funding.
Summary of app design:

Explanatory Statement

Consent form

How old are you?
Over 18:

Baseline Surveys
(Can be done over several days – at convenience)

Once completed

MOODPRISM App

Mobile Behaviour Monitoring PLUS
1 months’ ESMs (short prompts every day) with colour coded mood feedback on demand

Mental health links (available on demand)
Mental health alerts (triggered by risk index)

Monitoring of ESM completion

Final Surveys

Once completed

Feedback Survey

Go into the draw for incentives

Findings:

Design and Development

The app was successfully designed and developed via the collaboration of the Research team and the Two Bulls app developers. The process has been described in detail in Rickard, Arjmand, Bakker & Seabrook (2016). An initial pilot of the beta version of the app was conducted, and generated extensive feedback. Revisions of the app were undertaken to deliver the release version of the app. This version was released on the Apple and Android stores, and are freely available.

Important insights were also gained into the challenges of translating research practices and mental health content into the digital space. These insights have also been documented in Seabrook et al (in preparation) to provide guidance for other researchers considering development of mental health apps. Finally, recommendations for enhancing the process of mental health app development, and the credibility and efficacy of these apps, have been generated in Bakker, Kazantzis, Rickwood and Rickard (2016) for the benefit of future researchers and app developers.
Assessment of usability

A sample of 164 users who used MoodPrism for at least 2 weeks was obtained to assess usability. Of these, 60% reported mild-moderate symptoms of depression, while 27% reported moderately severe depressive symptoms. User feedback was obtained from two different sources; a feedback survey built into the app, and the Mobile Application Rating Scale. Feedback indicated that users found MoodPrism to be enjoyable, engaging and interesting to use, and the content credible. All ratings were above the midpoint, reflecting a positive user experience, and MARS ratings were generally higher than the average of 50 apps rated previously. Areas of potential improvement related to how motivating the app was, the functionality of the app and the content load.

The app was also analysed to assess whether it generated data that would be useful for predicting mental health in future research. Preliminary analyses suggest that all forms of data obtained by MoodPrism – psychometric surveys, daily ESM mood reports and automated data collection – are likely to assist in prediction of depression and anxiety. A trend showing that use of positive and negative words on online social networking site Facebook may predict depressive state is also emerging in early data. This finding suggests that MoodPrism may be useful as an automated mood monitoring app, which can deliver information about the risk of depressive symptoms without for invasive questioning of the user.

Finally, a preliminary assessment of whether using the app itself had any positive effect was also performed. At this stage, there is some indication that using MoodPrism can significantly enhance wellbeing scores, particularly for those with more severe depressive symptoms. Users who engage more with the app also appear to show increased emotional self-awareness and coping self-efficacy. These results require corroboration however in future research which is beyond the scope of this report.

Conclusions and Recommendations

Development of mental health apps is a complex endeavour requiring effective collaboration between a research/practitioner and app developers. MoodPrism was successfully developed as a research tool, with the data demonstrating integrity and potential for enhancing prediction of depression and anxiety. Three research projects are currently in progress which draw their primary data from MoodPrism, and are already generating novel findings with regard to depression and anxiety, and online social networking, resilience and well-being. A randomized control trial (RCT) is also in progress which will compare wellbeing outcomes following 30 days use of MoodPrism, with two other mental health apps (MoodMission and MoodKit) or no use of a mental health app. Results from these exciting projects are due throughout 2017.

User feedback indicated that MoodPrism is easy to use and enjoyable. A number of issues were identified from user feedback which currently limits MoodPrism achieving its full potential. For the app to be sustained beyond its current research purpose, it is recommended that the following modifications be made to enhance the user experience in terms of issues identified around content, functionality and motivation:

1) Extend use beyond 30 day research period so that users can continue to use it indefinitely
2) Change random daily mood prompts to user-determined daily mood reports.
3) Add ‘achievements’ for gamification to motivate users
4) Reduce content heaviness by excluding surveys which data show are less informative
5) Streamline welcome screens for more streamlined interface
6) Add more extensive links in response to identified risk (e.g., HealthEngine)

We are able to achieve these outcomes in collaboration with a leading app developer (Spark Digital) for $20,000.

The current project demonstrates the enormous potential for dynamic and automated monitoring of moods and online behaviour for enhancing our understanding of mental health and wellbeing. We recommend a modified version of MoodPrism as an adjunct to the mental health professional’s toolkit, and believe it would be an excellent resource for individuals who might not otherwise seek help.
The Report

1 Project Context

Emotional wellbeing, which incorporates positive emotional functioning, emotional resilience and the absence of depression and anxiety, is fundamental for psychological health. Increases in emotional wellbeing are associated with resilience, broader attention, productivity and longevity. In contrast, decreases in emotional wellbeing are associated with development of affective disorders such as depression and anxiety, and reduced physical health and social capital.

One in five young people experience depressive symptoms, but less than half of these seek professional help. This is particularly true in young populations who are most likely to experience low levels of emotional health, but are most reluctant to seek professional help for mental health problems. Young people consistently indicate that they prefer non-professional means of managing their mental health\(^3\). Of those that seek assistance, ongoing monitoring for onset of relapse is a significant challenge for mental health services. An absence of research on dynamic, day-to-day predictors of increased risk, combined with the practical challenge of obtaining regular input on how individuals are faring between visits, means that current methods for detecting increased risk of relapse as it occurs are ineffective. A priority challenge facing the Australian health care system is achieving practicable and sustainable means of supporting self-management of health and wellbeing.

eMental Health services are beginning to erode some of the practical access barriers to mental health support for people by providing flexible and confidential information, support and interventions via the internet. Mobile mental health ‘apps’ have the potential to be at the forefront of this technological revolution due to the widespread use of mobile phone technology.

*Earlier research on mental health apps*: Mobile phone apps are increasingly used to promote mental health and wellbeing\(^4\). Mobile health has yet to be fully capitalized upon as a means of promoting emotional health and wellbeing, despite mobile phones being one of the few pieces of technology most people carry on their person every day. This pervasiveness means that mobile phones offer a highly natural and regular means by which information on emotional state could be obtained. It is acknowledged that obtaining temporally sensitive (e.g., daily) information on significant changes in emotional state would profoundly improve the capacity to promote emotional health\(^5\), but the resources required to obtain such information repeatedly over lengthy timeframes have to date made this real time monitoring prohibitive. Fortunately, mobile health is cost-effective and overcomes many socioeconomic and geographic boundaries. Smartphones now penetrate over 65% of the Australian population, and 76% of Australians are interested in using mobile phones to monitor and manage their own mental health\(^6\). Mobile health holds particular promise for management of emotional health, particularly for young people who often report fear of stigma associated with professional services for sensitive mental health issues\(^7\).

Several mobile phone apps have utilized experience sampling methodology (ESM) to track mood over time, and some favourable outcomes have been reported\(^8\). One of the barriers to sustainability of such programs, however, is that they require extensive voluntary input from the user. When evaluated, a common theme is initial compliance, followed by high dropout and poor self-reporting rates. Reasons for discontinued use include problems understanding how to use the program, invasiveness of the questions, the need for repetitive completion of questionnaires, insufficient personalization of the mental health advice and little motivation to engage with the program. Taken together with young people’s limited emotional insight and general reluctance to report on their own affective functioning, progress in this field is facing a major challenge.

This project aimed to develop a non-invasive, engaging and research-based e-health solution that monitors emotional health in a highly innovative way. Every day, we use a range of strategies to optimize emotion regulation and wellbeing, including online behaviours such as use of social networking sites and personal music listening\(^9\). Crucially, young people use mobile phones for music and social networking more than any other demographic\(^10\). Monitoring such behaviour may provide
valuable insight into underlying emotional state. We currently have little understanding, however, of the complex relationship between such behaviour and emotional wellbeing.

Rich data on users’ daily moods and online behaviours - each of which has been associated with changes in depressive risk - is collected confidentially via smartphones. Together, they have enormous potential to detect subtle changes in behaviour associated with depressive symptoms. Critically, this information is collected in real time, providing substantially more temporal sensitivity than current monitoring allows. Risk indices are calculated and used to deliver tailored mental health information (from beyondblue and Headspace) confidentially to the user’s own phone. This method unobtrusively assesses changes in affective state and behaviour and therefore represents a breakthrough advance in the monitoring of depression.

Theoretical understanding of real-time prediction of depressive risk is currently limited by difficulties in accessing day-to-day changes that may be associated with onset of relapse. Current predictive models are based on fixed (e.g. genetic) or distal (e.g. childhood adversity) factors, with limited detail on more proximal or state factors (e.g. physical activity, social interactions, mood changes). The mobile app enables collection of a wealth of momentary data on behaviour of depressed individuals during times of both high and low mood. The majority of data collected in this research is collected automatically at the time they occur, and therefore will not be adversely affected by retrospective self-reporting (e.g. biases in recall).

**Research Questions:** In this project, we explored whether the extraordinary role that mobile phones play in the lives of young people could be capitalized upon to significantly extend our approach to measuring emotional health and wellbeing. The aim was to develop a research-based smartphone app that monitors depressive risk in young people in a highly innovative way. The app – MoodPrism – was designed to confidentially collect a rich set of data on a user’s behaviour via their smartphone. Critically, this app was designed to collect this information in real time, providing substantially more temporal sensitivity than current monitoring allows.

The key outcomes of this research were to:

(i) Design and launch a fully-functioning mobile application (app) capable of collecting these type of dynamic and momentary data

(ii) Trial the app to evaluate its user functionality and engagement

(iii) Publicize the app widely

(iv) Collect preliminary data with a sample of individuals with depression to demonstrate the capacity of this methodology to achieve longer term aims of predicting depression from smartphone data.
2 Implications

There has been an urgent need for non-professional but evidence-based detection of early warning signs of depression in young people. MoodPrism provides an economical, but far reaching means of monitoring emotional health and providing access to basic mental health support. There are broad ranging implications of this project for policymakers, researchers and the broader community, including schools, organizations and practitioners.
Implications for policy makers:

- Strategic government research priority has been to build resilience and promotion of positive wellbeing rather than just absence of disease
- MoodPrism is for all individuals, not just those diagnosed already with a mental disorder, and provides feedback on positive psychological functioning, not just depression and anxiety symptoms
- Delivery of effective eMental health options like MoodPrism addresses the need for a practicable and sustainable health care system, empowering individuals to participate in some degree in self-management of their mental health
- Smartphone apps break through access barriers resulting from remoteness of health care services, stigma or socioeconomic limitations, maximizing health impact
- MoodPrism improves the health system’s capacity to remotely monitor individuals’ emotional health and wellbeing, and to provide a basic level of mental health support and resourcing to more individuals than only to those who seek out help from a mental health professional

Implications for researchers:

- Evidence based apps like MoodPrism harnesses opportunities offered by mobile technology
- Provides a dynamic and sensitive methodology for collecting real time data, both self-report and automated collection of online behaviours
- The wealth of data collected daily by MoodPrism offers significant opportunities for the research community to explore dynamic and proximal (that is, close in time to when events occur) predictors of emotional health and wellbeing in innovative and unprecedented ways

Implications for broader community:

- MoodPrism extends the potential of mental health apps for educational, clinical, community and corporate settings. Potential to provide organizations, clubs and schools to receive wealth of highly relevant data, enabling them to proactively support the health and well-being of their staff, members or students
- Delivered on both Android and iOS settings, users can monitor their mental health in any context, whether they’re at work, home, or on public transport.
- Helps students, club members, staff or other members of the community to become aware of their emotional health and well-being, with potential for improvements in well-being for those with more severe symptoms.
- Provides an engaging tool to assist parents, teachers and young people themselves to realize when help is needed
- For mental health professionals, MoodPrism enables a practitioner to recommend ongoing monitoring for their patients during visits, enhancing a patient’s awareness, and capacity to describe their own feelings.
- With a strong positive psychology foundation, MoodPrism can be used to enhance resilience building skills in a school or other community, to promote mental health literacy, and improve help seeking behaviours. These are crucial prerequisites for reducing the burden of mental illness in our communities.
Project Approach and Results

Phase 1: Development of the app

“MoodPrism” was developed by the Research team in collaboration with leading technology firm, TwoBulls. In Phase 1 of this project, a beta version of the app was developed.

The app consists of 4 main components:

1. **Onboarding surveys** consist of psychological questionnaires about personality, technology use, emotional awareness, social support and mental health/well-being. The data obtained from these surveys will be used to evaluate changes in key outcome measures after one month’s use of the app, and to explore potential individual differences in using the app (moderators).
2. **Daily reports** are invited about emotional state (including items about depression, anxiety, alertness and positive functioning), where/with whom the user is at the time of the daily report, and whether any significant positive or negative events have occurred in the past 24 hours. Users are prompted to complete these reports randomly within user-set hours, once a day for one month. The data obtained from these surveys provide finer detail about how mood changes over time, and how these changes might be influenced by other behaviours (e.g., social networking, music use).
3. **Behavioural data** is automatically collected via the smartphone, subject to user permission. The type of data currently collected by MoodPrism includes social networking meta-data from Facebook and/or Twitter (e.g. number of posts, frequency of emotional words), and music use patterns (collected from user’s own playlists). These data will be used to correlate with mood data, to determine if they may provide non-invasive prediction of mood states, without the need for subjective reporting.
4. **Feedback** is provided to the user in response to both on-boarding surveys, and in response to aggregated data from the daily reports. Personalized feedback is provided which may recommend the user consider contacting mental health professionals, or encourage them to seek information from mental health organization websites provided. Feedback is provided in various user-friendly formats, including daily, weekly or monthly views, with colourized and emoticon representations across time.
Testing the beta version of the app.

Feedback on the beta version of the app was first sought via consultation with key stakeholders, including the Young and Well CRC Youth Brains Trust, headspace, beyondblue, the University of Melbourne’s Positive Psychology Centre, and The National Centre of Excellence in Youth Mental Health, Orygen.

A sample of 22 participants participated in a one month trial, using the app daily, and keeping notes of their user experience. Information about the study was provided to participants and electronic consent was required before the app could be used. As part of the on-boarding procedure, options were offered to provide the app with access to social networking and music applications, as well as general (postcode) location. These data were then collected continuously and unobtrusively (without need for user input) over the month research period.

The app then proceeded to the initial surveys, which could be completed in multiple sittings, and in total required 30-60 minutes to complete. The participant was then requested to use the app for a month, during which they would be prompted daily to complete a set of short questions, and weekly to complete a short audio recording. If they were unable to respond to daily prompts, they were advised they could complete them at a time of their convenience up to midnight that day, or alternatively to ignore them. At the end of the month, users were invited to complete a final set of surveys, which in total required 15-30 minutes to complete.

Users were incentivized to continue use of the app through three strategies. First, mood and mental health feedback was provided to the user daily, with additional feedback unlocked after sustained use. Second, completion of daily prompts as well as the final surveys generated entries into a draw for one of four $AU100 gift vouchers. Third, users were informed that their data were contributing to research into the value of smartphone apps for monitoring mental health and well-being.

The sample was invited to provide more intensive qualitative feedback by either online questionnaire (n=6) or via attendance at a focus group session (n=5). They provided quantitative feedback by completing the Mobile Application Rating Scale (MARS). The app trial was approved by the Monash University Human Research Ethics Committee (Approval # CF14/968 – 2014000398).

Feedback about the functionality and usability of the app was obtained from 11 beta-testers, who completed a standard survey of app usability, the MARS.
MARS ratings for the MoodPrism app exceeded the average rating for 50 apps reviewed by Stoyanov et al for each MARS subscale. Highest satisfaction ratings were obtained for items relating to the app’s graphics quality (e.g., buttons, icons), gestural design (e.g., swipes, scrolls), ease of use (e.g., clear menus), credibility of the information sources, the layout aesthetics, and increased awareness of mood. Lowest ratings were obtained for entertainment value (e.g., fun to use), customization options, likelihood to change behaviour, motivations to address mood and interest, and likelihood to recommend to others.

Additional feedback was obtained from the focus groups, and key themes were identified:
<table>
<thead>
<tr>
<th>Theme</th>
<th>Sample responses from beta app testers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Positive feedback</strong></td>
<td></td>
</tr>
<tr>
<td>Aesthetically pleasant</td>
<td>It looks nice!</td>
</tr>
<tr>
<td>Easy to use</td>
<td>Seamless and smooth to use</td>
</tr>
<tr>
<td>Daily reports quick to complete</td>
<td>Simple set of responses takes only a few minutes daily – easy to use daily</td>
</tr>
<tr>
<td>Feedback useful and specific.</td>
<td>Targeted questions gives specific feedback about links between mood and daily activities</td>
</tr>
<tr>
<td></td>
<td>Coloured display of mood was useful representation</td>
</tr>
<tr>
<td></td>
<td>Liked unlocking of content - motivated to keep using</td>
</tr>
<tr>
<td></td>
<td>Feedback was not upsetting</td>
</tr>
<tr>
<td>Good to be able to get feedback about how feelings change daily.</td>
<td>The ease of the app and being able to check in how exactly I’m feeling at a certain time</td>
</tr>
<tr>
<td><strong>Negative feedback</strong></td>
<td></td>
</tr>
<tr>
<td>Wording of some questions confusing</td>
<td>Many questions in the introductory questionnaires are confusing double-negative repeats of previous questions, combined with putting negative responses near the top (where you expect positive ones) is confusing. I've never been irked when people expressed ideas very different from my own: Yes or No&quot;. Is it possible to put Agree or Disagree instead?</td>
</tr>
<tr>
<td>Some content can make you feel negative</td>
<td>Quite morbid things in the list of &quot;most negative thing to happen to you today&quot; -- makes me imagine some pretty terrible rare events like &quot;death of a loved one&quot;, etc. -- not a great thing to remind someone with depression to think about on a daily basis. / Many questions are quite negative like this -- you think about how stressed, worried, out of control, etc. you are -- creates a major disincentive to participating -- they're not things you want to dwell on when you're depressed.</td>
</tr>
<tr>
<td>Feedback clarity</td>
<td>The summary information for tracking wellbeing across times seems simplistic. For example, if I was in a good but deactivated mood, it said I was &quot;on my way to thriving&quot; - but of course it's not healthy to be highly activated ALL the time. The other thing I thought could be made clearer is what the numbers on the main screen mean - they're all different colours for the different days of the month but not sure what those numbers/colours mean</td>
</tr>
<tr>
<td>ESM functionality</td>
<td>There are a couple of categories I felt were missing when logging the things that happened today. On the &quot;who are you with&quot; screen, the option of &quot;partner&quot; would be useful. The &quot;won something&quot; category in the positive events screen was less useful.</td>
</tr>
<tr>
<td>Privacy/Information issues</td>
<td>Need trust in the app to give permission for social media sharing. So should give permission later on, perhaps after surveys, after built trust in app after some use</td>
</tr>
<tr>
<td></td>
<td>Location information should be clarified to be postcode, not specific GPS point</td>
</tr>
<tr>
<td>Installation issues</td>
<td>Hard to download</td>
</tr>
</tbody>
</table>
Beta app to official app.
The majority of issues identified by the beta-testers were addressed for the officially released version of the app. For instance, the order of positively or negatively worded options was made consistent across all questionnaires, additional information on how location and social networking data will be used was provided, with reassurance that information collected was deidentified was added, and an explanatory key was provided for interpreting colours and emoticons. The only issues that were not able to be addressed related to the integrity of psychometrically validated questionnaires (and therefore wording could not be altered), inclusion of negative content (which was important to the primary purpose of the app), or installation difficulties (as they related to the trial version only, and would not be present in the Apple and Android Web-based stores).

Utility of the Behavioural data.
The automated behavioural recording was found to be complex for the app development company. Recording of activity, music use and social media interactions are all included in MoodPrism, but several features have been turned off due to limitations encountered.

Music Use: Since the initiation of this project, personal music use patterns have undergone massive change. Previously, smartphone users would access personal playlists stored on their own device, and MoodPrism is capable of accessing a range of features for this usage. However in the past few years, personalized music listening on smartphones has shifted dramatically to use of streaming services like Spotify. While accessing these data was possible via the Android platform, it is difficult via the iOS platform. Due to the limited data generated by music use from stored playlists, this feature was unfortunately not that informative on this version of MoodPrism, and has been turned off.

Physical activity: Feedback from beta testers indicated significant privacy issues associated with storing detailed information about location, which was required to monitor activity patterns. MoodPrism was therefore modified to collect broader location data only (postcode), and daily physical activity was therefore not available.

Social Networking Interactions: predictive data about mental health from social network sites such as Facebook has become a much more active research field since the inception of this project. This component of MoodPrism was consequently refined to ensure that use of the app would generate informative data from this source. Use of social media platforms also shifted from predominantly Facebook to Facebook and Twitter, so additional programming was achieved to collect data from Twitter via MoodPrism. This automated data collection is working effectively and is turned on.

The MoodPrism app was launched officially in April 2016, generating national media interest (e.g., radio interviews, health and medical magazines).
Detail on the Development of MoodPrism is reported in the peer reviewed publication:


Two other review papers have also been published relating to the development of mental health apps, including MoodPrism:


This research team’s work on mental health apps has also been publicized via other fora, including several conference presentations and popular media such as, *The Conversation*, which has had over 10,000 readers:

- Bakker, D., & Rickard, N.S. "How to find a good app for mental health" for publication. The Conversation, submitted 29/10/16. https://theconversation.com/how-to-find-a-good-app-for-mental-health-67787
Phase 2: Data collection in a depressed sample

In Phase 2, the Research Team recruited a sample of people with mild to severe depression to use the app for two periods of two weeks. Non-depressed individuals were also recruited as a comparison group. Recruitment was targeted to ensure a good representation of younger people, through secondary schools and the Monash University student residential association. Mean age of the sample was 30 years (SD: 12 years, median age 25 years), although the age ranged from 13-73 years.

A total of 1502 individuals downloaded the app, with about a third not completing any of the surveys. Of the remaining 906 users who provided data, the sample was somewhat representative of the general population, although it was biased towards a female student population.

![Graph showing age distribution](image)

![Graph showing gender distribution](image)

![Graph showing education distribution](image)

![Graph showing student distribution](image)
Approximately 80% of this sample (732 users) reported at least mild symptoms of depression.

Phase 3: Assessment of app utility

The Research team explored the data to determine whether the app

- was user-friendly
- generated data which might predict depression and anxiety outcomes
- produced positive outcomes from using it

Complete data – including a full set of surveys before and after use of MoodPrism, and daily reports for at least 2 weeks – were obtained from 164 participants only. Of this sample, 60% reported mild-moderate symptoms of depression, while 27% reported moderately severe-severe depressive symptoms.
Usability of MoodPrism
User feedback on using the app was obtained from two different sources. A feedback survey was built into the final set of surveys within the app. Users were asked 16 different questions designed to assess enjoyment and engagement when using the app, content and information, credibility and trustworthiness of the app and functional characteristics of the app such as navigation and battery use.

MoodPrism’s inbuilt feedback survey
The following 16 items were included in the final set of surveys completed after 30 days’ of use:

<table>
<thead>
<tr>
<th>Item</th>
<th>Mean rating (1-5)</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) I enjoyed using the app</td>
<td>4.06</td>
<td>0.70</td>
</tr>
<tr>
<td>2) The app was interesting</td>
<td>4.09</td>
<td>0.70</td>
</tr>
<tr>
<td>3) The app suited people of my age</td>
<td>4.09</td>
<td>0.64</td>
</tr>
<tr>
<td>4) The app was interactive</td>
<td>3.87</td>
<td>0.88</td>
</tr>
<tr>
<td>5) It was easy to use and understand</td>
<td>4.09</td>
<td>0.83</td>
</tr>
<tr>
<td>6) It drained my battery (R)</td>
<td>3.88</td>
<td>0.76</td>
</tr>
<tr>
<td>7) It was hard to navigate (R)</td>
<td>3.94</td>
<td>0.88</td>
</tr>
<tr>
<td>8) It had a nice design and feel</td>
<td>3.95</td>
<td>0.67</td>
</tr>
<tr>
<td>9) It did what it said it would</td>
<td>3.92</td>
<td>0.75</td>
</tr>
<tr>
<td>10) It had about the right amount of information</td>
<td>3.57</td>
<td>0.94</td>
</tr>
<tr>
<td>11) I felt I could trust the app</td>
<td>3.83</td>
<td>0.83</td>
</tr>
<tr>
<td>12) Using it got in the way of my everyday activities (R)</td>
<td>3.87</td>
<td>0.82</td>
</tr>
<tr>
<td>13) The alerts every day were a hassle (R)</td>
<td>3.98</td>
<td>0.86</td>
</tr>
<tr>
<td>14) Using it motivated me</td>
<td>3.40</td>
<td>0.92</td>
</tr>
<tr>
<td>15) I would recommend it to people I know</td>
<td>3.85</td>
<td>0.82</td>
</tr>
<tr>
<td>16) Overall I was satisfied with this app</td>
<td>3.81</td>
<td>0.85</td>
</tr>
</tbody>
</table>

(R) Reverse scored

The average score (out of a possible range of 1 (strongly disagree) to 5 (strongly agree)) was 3.89 (SD: 0.45), which is a broadly positive score. Strongest agreement ratings suggested that the app was easy, enjoyable and interesting to use. More ambivalent ratings were recorded for content items, particularly the amount of information in the app being appropriate, and whether the app motivated the user.
**MARS ratings**

A Randomized Control Trial is currently underway to compare MoodPrism with other mental health apps. Participants in this trial completed the full MARS after one month of using their app, enabling further evaluation of MoodPrism via these data. The MARS was presented online, and reliability for all scales was strong.

<table>
<thead>
<tr>
<th>MARS subscale</th>
<th>Reliability</th>
<th>Mean rating</th>
<th>SD</th>
<th>Norm* Mean</th>
<th>Norm* SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engagement</td>
<td>.866</td>
<td>2.94</td>
<td>0.69</td>
<td>2.68</td>
<td>1.15</td>
</tr>
<tr>
<td>Functionality</td>
<td>.915</td>
<td>3.79</td>
<td>0.79</td>
<td>4.01</td>
<td>0.88</td>
</tr>
<tr>
<td>Aesthetics</td>
<td>.820</td>
<td>3.49</td>
<td>0.84</td>
<td>3.49</td>
<td>0.90</td>
</tr>
<tr>
<td>Information (items 15-18 only)</td>
<td>.862</td>
<td>3.82</td>
<td>0.92</td>
<td>2.55</td>
<td>1.46</td>
</tr>
<tr>
<td>Subjective items</td>
<td>NA</td>
<td>3.05</td>
<td>0.92</td>
<td>2.31</td>
<td>1.17</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.24</td>
<td>1.38</td>
<td>2.46</td>
<td>1.12</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.29</td>
<td>0.46</td>
<td>1.31</td>
<td>0.60</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.24</td>
<td>0.77</td>
<td>2.69</td>
<td>1.06</td>
</tr>
<tr>
<td>Additional items specific to mood/mental health</td>
<td>NA</td>
<td>3.55</td>
<td>0.76</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Awareness</td>
<td></td>
<td>3.25</td>
<td>0.85</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Knowledge</td>
<td></td>
<td>3.10</td>
<td>0.79</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Attitudes</td>
<td></td>
<td>3.30</td>
<td>0.92</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Intention to change</td>
<td></td>
<td>3.15</td>
<td>0.81</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Help seeking</td>
<td></td>
<td>3.35</td>
<td>0.81</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Behaviour change</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Norm based on 50 other apps rated in Stoyanov et al (2015)*

MoodPrism was rated favorably on most MARS subscales when compared against the normative values obtained from an evaluation of 50 mental health apps reported by Stoyanov et al (2015). The only notable domain on which MoodPrism performed more poorly than other similar apps was on functionality. This is consistent with anecdotal feedback received from many users regarding key functions of the app such as:

- Use beyond 30 day period
- Random instead of user-driven daily prompts
- Excessive welcome screens
- Excessive onboarding surveys
Prediction of depression scores

Full scale analysis of MoodPrism data prediction of Depression and Anxiety are beyond the scope of this project. Within scope is a demonstration that data collected by MoodPrism is capable of predicting outcome measures in a meaningful way.

Analyses demonstrated that after demographics of age and gender were controlled, both the initial surveys and the daily mood (ESM) reports significantly predicted depression and anxiety scores. Specifically, an additional 45% of the variability in depression scores and an additional 29% of the variability in anxiety scores was predicted by wellbeing, emotional self-awareness, coping self-efficacy and mental health literacy scores. Importantly, an additional 25% of the variability in depression scores and 22% of the variability in anxiety scores was predicted by daily mood scores. Further analysis suggests that the variability in mood scores across days may also help predict overall depression scores for some individuals. This shows that it may be possible to use daily mood tracking via an app to assist prediction of mental health outcomes even in the absence of psychometric questionnaires.

Future analyses will explore whether the behavioural tracking potential of this app – using automated data collection, such as online social networking interactions – can be further capitalized on to provide insights into mental health with no further data input required from the user at all. Preliminary analyses on the number of positive and negative words in posts extracted and automatically collated by MoodPrism have however been performed on a small sample of 9 participants. The relative proportion of positive and negative words from the total words written in posts was calculated. While these analyses are underpowered due to sample size, they have revealed trends that greater variability in the emotion valence expressed in posts is positively associated with greater depression symptoms \( r(9) = .56, \ p = .12 \), as is greater instability in emotion valence \( r(9) = .58, \ p = .099 \). This suggests that automated recording of this basic index in social network posts may assist prediction of depression, although full data analysis was beyond the scope of the currently funded project.

Change as a result of using MoodPrism

Age was found to be a significant confound in the data, with younger participants more likely to be depressed. When age was taken into account, there was a small but significant improvement over time in mental wellbeing scores, \( F(1,162)=4.77, \ p=.030, \eta^2=.03 \). The trends suggest that the greatest improvements were for those users with more severe depression symptoms.

No significant changes in emotional self-awareness, mental health literacy or coping self-efficacy were however observed over this short timeframe.
4 Additional Resources

Websites:

- MoodPrism App website: http://www.moodprismapp.com/
- MoodMission App website: http://moodmission.com

Peer-reviewed publications:


Media release: https://pursuit.unimelb.edu.au/articles/is-social-media-good-for-you
Release on Public Stores

iTunes (iOS) release:

MoodPrism is a newly developed app that helps you learn about your mood by transforming daily mood reports into a colourful summary of your emotional health.

You will receive feedback on your mood each day, and the more you use the app, the more detailed this information will become – with flourishing scores after 1 week’s use, and depression/anxiety scores after 2 weeks of use.

Google Play (Android) release:

MoodPrism is a newly developed app that helps you learn about your mood by transforming daily mood reports into a colourful summary of your emotional health.

You will receive feedback on your mood each day, and the more you use the app, the more detailed this information will become – with flourishing scores after 1 week’s use, and depression/anxiety scores after 2 weeks of use.
5 Further Research

While beyond the scope of the Beyond Blue funded contract, data collection using MoodPrism is in progress for a suite of research projects. A sample of these projects is provided below with a conference abstract on the early findings.

An exploration of resilience to minor stressors: A mobile experience sampling study profiling and identifying predictors of resilience.

The response to stress can be highly heterogeneous, and may be influenced by methodological factors. The integrity of data will be optimized by measuring both positive and negative affective responses to an event, by measuring responses in real time as close to the stressful event as possible, and by utilizing data collection methods that do not interfere with naturalistic behaviours. The aim of the current study was to explore short term prototypical responses to major stressor events on outcome measures encompassing both positive and negative indicators of psychological functioning. A novel mobile experience sampling methodology (m-ESM) was utilized to monitor both affective responses to stressors in real time. A smartphone mental health app ('Moodprism') which prompts users daily to report both their positive and negative mood, as well as whether any significant event had occurred in the past 24 hours, was developed for this purpose. A sample of 142 participants was recruited as part of the promotion of this app. Participants’ daily reported experiences of stressor events, levels of depressive symptoms and positive affect were collected across a 30 day period as they used the app. For each participant, major stressor events were identified on the subjective severity of the event rated by the user. Depression and positive affect ratings were extracted for the 3 days following the event. Responses to the event were scaled relative to their general reactivity across the remainder of the 30 day period. Participants were first clustered into groups based on initial reactivity and subsequent recovery following a stressor event. This revealed distinct patterns of responding along depressive symptomatology and positive affect. Participants were then grouped based on allocations to clusters in each outcome variable. A highly individualized nature in which participants respond to stressor events, in symptoms of depression and levels of positive affect, was observed. A complete description of the novel profiles identified will be presented at the conference. These findings suggest that real time measurement of both positive and negative functioning to stressors yields a more complex set of responses than previously observed with retrospective reporting. The use of smartphone technology to measure individualized responding also proved to shed significant insight.

Development and evaluation of smartphone apps to promote and manage emotional well-being; Investigating how smartphone apps can increase emotional self-awareness, mental health literacy, coping self-efficacy, and mental health and well-being

Smartphone apps hold immense potential as mental health and wellbeing tools. Support can be made easily accessible and can be used in real-time while users are experiencing distress. Furthermore, data can be collected to enable machine learning and automated tailoring of support to users. While many apps have been developed for mental health purposes, few have adhered to evidence-based recommendations and even fewer have pursued experimental validation. This paper details the development and experimental evaluation of an app, MoodMission, that aims to provide support for low moods and anxiety, help prevent clinical depression and anxiety disorders, and serve as an adjunct to professional clinical supports. MoodMission was designed to deliver cognitive behavioural therapy for specifically reported problems in real-time, momentary interactions. Users report their low moods or anxious feelings to the app along with a subjective units of distress scale (SUDS) rating. MoodMission then provides a choice of 5-10 short, evidence-based mental health strategies called Missions. Users choose a Mission, complete it, and report their distress again. Automated tailoring, gamification, and in-built data collection for analysis of effectiveness was also included in the app’s design. The development process involved construction of an evidence-based behavioural plan, designing of the app, building and testing procedures, feedback-informed changes, and a public launch. A randomized controlled trial (RCT) was conducted comparing MoodMission to two other apps and a waitlist control condition. Participants completed measures of anxiety, depression, mental well-being, emotional self-awareness, coping self-efficacy and mental health literacy at the
start of their app use and 30 days later. At the time of submission (November 2016) over 300 participants have participated in the RCT. Data analysis will begin in January 2017. At the time of this submission, MoodMission has over 5000 users. A repeated-measures ANOVA of 1390 completed Missions reveals that SUDS (0-10) ratings were significantly reduced between pre-Mission ratings (M=6.20, SD=2.39) and post-Mission ratings (M=4.93, SD=2.25), F(1,1389)=585.86, p<.001, ηp²=.30. This effect was consistent across both low moods and anxiety. Preliminary analyses of the data from the outcome measures surveys reveals improvements across mental health and wellbeing measures as a result of using the app. Complete results from the RCT in which MoodMission was evaluated will be presented. Results will also be presented from the continuous outcome data being recorded by MoodMission. MoodMission was successfully developed and launched, and preliminary analysis suggest that it is an effective mental health and wellbeing tool. Feedback and data informed improvements will continue to be made to the app. In addition to the clinical applications of MoodMission, the app holds promise as a research tool to conduct component analysis of psychological therapies and overcome restraints of laboratory based studies. The support provided by the app is discrete, tailored, evidence-based, and transcends barriers of stigma, geographic isolation, financial limitations, and low health literacy.

An examination of emotional expression on Social Networking Sites: Exploring different user profiles

Examining time-dependent measures of emotion such as variability, instability, and inertia, provide critical and complementary insights into mental health status. Observing changes in the pattern of emotional expression over time could act as a tool to identify meaningful shifts between psychological well- and ill-being. From a practical standpoint, however, examining emotion dynamics day-to-day is likely to be burdensome and invasive. Utilizing social media data as a facet of lived experience can provide real-world, temporally specific access to emotional expression. Emotional language on social media may provide accurate and sensitive insights into individual and community mental health and well-being, particularly with focus placed on the within-person dynamics of online emotion expression. The objective of the current study was to examine the dynamics of emotional expression on the social network platform Facebook for active users and their relationship with psychological well- and ill-being. It was expected that greater positive and negative emotion variability, instability, and inertia would be associated with poorer psychological well-being and greater depression symptoms. Data were collected using a smartphone app, MoodPrism, which delivered demographic questionnaires, psychological inventories assessing depression symptoms and psychological well-being, and collected the Status Updates of consenting participants. MoodPrism also delivered an experience sampling methodology where participants completed items assessing positive affect, negative affect, and arousal, daily for a 30-day period. The number of positive and negative words in posts were extracted and automatically collated by MoodPrism. The relative proportion of positive and negative words from the total words written in posts was then calculated. Preliminary analyses have been conducted with the data of 9 participants. While these analyses are underpowered due to sample size, they have revealed trends that greater variability in the emotion valence expressed in posts is positively associated with greater depression symptoms (r(9) = .56, p = .12), as is greater instability in emotion valence (r(9) = .58, p = .099). Full data analysis utilizing time-series techniques to explore the Facebook data set will be presented at the conference. Identifying the features of emotion dynamics (variability, instability, inertia) that are relevant to mental health in social media emotional expression is a fundamental step in creating automated screening tools for mental health that are temporally sensitive, unobtrusive, and accurate. The current findings show how monitoring basic social network characteristics over time can provide greater depth in predicting risk and changes in depression and positive well-being.
6 References and bibliography

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Moody Prism: Mental health support on your phone


Simon GE, Ludman EJ. It’s time for disruptive innovation in psychotherapy. The Lancet 2009;374:594–595. PMID:19699995


References cited within endnotes


5 McDermott, B., et al., Clinical Practice Guidelines: Depression in Adolescents and Young Adults. 2010: Melbourne.


