Abstract

Chronic stress can lead to illness. Current self-monitoring resources lack the personalization and usefulness to encourage proper stress management. A mobile application called *Daida* was designed to serve as a distress (extreme anxiety) awareness tool that supports/tracks the self-monitoring of daily distress levels, predicts future distress levels, and facilitates sociability between distressed friends. The application was evaluated using 4 tasks performed by 7 participants between 21-39 years old who experience stress multiple days a week. Summarizing the user's distress history and providing awareness about friends' distress levels were found to the most useful features of the application. Current stress management mobile applications could be improved by helping the user become more aware about their daily distress patterns and provide social features so friends can support each other in times of distress. Also, calculating the user's current distress level using self reports could be more personalized, and the method of predicting the user's future distress levels should be transparent so the user is more willing to trust the application.

Problem Space

Stress is a part of everyday life for most working adults. It is a state of arousal that occurs in the body when a situation or event is perceived as a threat [2, 8]. When the state of arousal is prolonged without any relief, it can lead into a negative reaction called distress [4, 10]. Distress can cause irritability, nervousness, raise blood pressure, contribute to poor diet, and weaken the immune system [4, 5, 6]. In the long term, distress can lead to more chronic illnesses such as heart disease, strokes, depression, and diabetes [6].

Since stress management is unique to an individual's situation, it is the responsibility of an individual to recognize their stressors, learn how it affects their emotions and behaviors, and find stress relief strategies that work for them [7]. However, current self-help resources lack the personalization and usefulness to encourage proper stress management. Individuals may have difficulty getting started on how to deal with their stress and finding effective coping strategies. There is a need for people to be able to monitor their daily stress so they can recognize what stresses them out, understand how it affects their body, and find healthy ways of coping with it in order to live healthier.

Research

Literature Review

Several scientific papers and web resources were consulted to research prior theories about stress management. Stress has typically been measured physiologically by detecting such factors as heart rate variability (HRV), blood pressure, and skin conductance [9]. Psychological measures (mental and emotional) usually involve self-assessment questionnaires such as the Short Stress State Questionnaire (SSSQ) [11] and Perceived Stress Scale (PSS). A detailed literature review by Staal revealed that the emotional response to a stressor is a preparatory step to formulate an action [9].

For many decades, researchers have used a technique called Ecological Momentary Assessment (EMA) to gain information about a person's in-the-moment behavior or experience in the their natural environment. The benefit of this is that it "minimizes recall bias and maximizes ecological validity" [13]. Furthermore, by using EMA-based measure and observing a person's history over time, predictive algorithms can be developed to anticipate risks and respond to them before it happens, such as detecting rising stress levels and intervening [13].

Mobile phones and applications provide a good platform for personal wellness management. *StressCheck* is a handy tool that asks the user to place their finger on the smartphone camera as the application looks for skin color changes caused by heart activity to calculate their heart rate variability [12]. Another application with a similar name, *Stress Check,* uses self-reported questionnaires as a way to estimate stress levels, tracks it over time, and provides mindful meditation techniques. Overall, the applications lack awareness about the cause of a person's stress [1], personalized stress relief tips, and social support, which can be a buffer for reducing stress [3]. This project aims to build upon and extend current ideas by improving stress awareness and incorporating social support.

Online Survey

An online survey was conducted to acquire background information about people's habits, attitudes, and opinions regarding psychological stress (mental and emotional). A total of 32 participants (19 males and 13 females) between 18-65 years old took part in the study. Most of them have either a High School/GED diploma or a Bachelor's Degree as their highest level of education. The top two most popular job industries that they work in are the Arts, Design, Entertainment, and Media industry and Healthcare/Medical industry.

The survey results revealed that almost half of the participants (14 of 32) experience stress 5-7 days a week. The most common stressors are job pressure and money, followed by relationships and school. Office/work facility and home were the most common stressful environments. 21 of 32 participants stated at least one unhealthy or potentially unhealthy technique that they use for relieving stress, including: drinking alcohol, smoking, avoiding social contact, eating, and not coping at all. Very few participants (2 of 32) stated that they tried to identify their stressor as a way to manage their stress. This is particularly interesting because the first step to stress management, according to experts, is to identify what is causing their stress [7].

Although most of the participants already have coping techniques that help them relieve stress, the most common techniques may not always be applicable during work hours for everyone (i.e. talk to someone, listen to music, exercise). The majority of participants who have used self-help resources like how the resources conveyed positive, motivating, and relaxing feelings that helped them stay calm during times of stress. More than half (18 of 32) of the participants are willing to use a mobile application that suggests different ways to properly coping with stress. They also prefer an informative tool that they can use at anytime and anywhere.

Goals and Requirements

Goals

The purpose of the *Daida* (Daily Distress Awareness) mobile application is to serve as a distress (extreme anxiety) awareness tool. The primary goals of the application are to:

1. Support and track the self-monitoring of daily distress.
2. Estimate the user's future distress levels and provide potential interventions.
3. Facilitate social support between friends who may be distressed.

Target Audience

- 21-47 years old, college students and/or working individuals
- Individuals who are stressed multiple times a week
- Individuals who have difficulty coping with stress
- Smartphone and social media users

Functional Requirements

- The user should receive alerts during different times of the day to take the distress questionnaire.
- The user should be able to report on their distress-related emotions, stressors, physical symptoms, and locations, and get appropriate feedback based on their distress details.
- The user should be able to view a summary of their distress history and details.
- The user should be able to get a prediction of their future distress levels (i.e. the next day) based on their distress history.
- The user should be able to view and assess a friend's distress level.
- The user should be able to customize the application settings (i.e. privacy).

Usability Requirements

Effectiveness

- The application must allow the user to self-report on their distress state and monitor it over time.
- The application must inform the user about their predicted future distress levels.
- The application must allow the user assess a friend's distress state and provide support for a distressed friend.

Efficiency

- The application must allow the user to quickly assess their distress level.
- The application must provide immediate and appropriate feedback depending on the user's distress level and details.

Safety

- The application must allow the user to customize what type of information is viewable by other users.

Utility

- The application must provide alerts when it is time for the user to take the distress questionnaire, when their predicted future distress level is moderate to extreme, and when a friend is distressed.
- The application must provide tips for managing stress based on their distress details.

Learnability

- The application's navigation must be easy-to-learn.
- The application's user interface must be meaningful and intuitive (i.e. labels, icons, etc.).

Memorability

- The application must keep track of the user's distress trends (i.e. most common stressors).

Scenario 1: Predicting future distress

Paula is a 26-year-old working student who is currently having a tough time balancing her job and school. She has been using the *Daida* mobile application to record and monitor her daily stress and get some helpful tips on how to relax. Paula's stress levels this past week have been high as she has been studying for an important exam coming up in a couple of days. Paula receives an alert on her smartphone from *Daida* predicting that her most stressful day of the week is tomorrow, according to her past distress history. She clicks on the notification and gets a suggestion that she should get plenty of rest tonight. She decides to follow through with the suggestion and sleeps early.

The next morning, Paula wakes up and checks her phone. She instantly receives a tip from *Daida* to eat a healthy breakfast to start off her day and a motivational quote to encourage her to think positive. By the time Paula gets to work, she is feeling well-rested and energized. Although her work day has just begun, she is feeling confident and motivated to make it a productive day.

Scenario 2: Providing social support for a distressed friend

It is lunch hour and Paula is leaving her workplace to meet up with her friend, Denise, for lunch. She receives a call from Denise that she can't make it to their lunch date because she is caught up at work. From the tone of her voice, Paula can tell that Denise is frustrated so she didn't bother asking her too much about how things were going.

Paula checks her *Daida* app to look at Denise's latest distress level and sees that Denise is highly distressed. Paula decides to send Denise a funny joke about work and an inspirational picture quote from the app gallery to help brighten her day. Later that evening, Paula receives a call from Denise thanking her for the words of encouragement. Eventually, they make plans to go out to dinner and a movie this coming weekend with a couple of their friends and enjoy the end to this stressful week.

Conceptualization

Metaphor and Analogies

The metaphor for the *Daida* (Daily Distress Awareness) mobile application is a distress tracker and forecaster, similar to a weather tracker and forecaster system. It will enable users to record information about their daily stress (i.e. stressors), monitor it over time, and get a prediction of their future distress levels based on their distress history. Users can also monitor recent distress levels of close friends and provide them with social support.

Concepts, Objects, and Operations

The application has three main concepts: memorability, predictability, and sociability.

1. **Memorability** –They will also identify their main stressor, physical symptom, and location which will be tracked over time so users can get an overview about their distress patterns (i.e. common physical symptoms).
2. **Predictability** – The application will learn the user's distress levels over time and predict their level of distress for the next few days.
3. **Sociability** – The application will allow the user to submit their assessment and observations regarding a friend's distress state using a short questionnaire. This will let a group of close friends be aware of each others' distress levels so that they can provide social support.

Relationship Between the Concepts

The **distress questionnaire** is the most important feature in the product concept. The user will take a questionnaire throughout different time periods each day to calculate their distress level. The questionnaire involves rating 5 distress emotions (Dissatisfied, Impatient, Annoyed, Angry, and Irritated) on a Likert scale from 1 (not at all) to 5 (extremely), which is adapted from the Short Stress State Questionnaire (SSSQ) [11]. It calculated **distress level** contributes to the user's **average distress level** for the day, generates helpful **tips for stress relief**, and gathers other **distress details** about the stressful situation. The user's distress data can be tracked over time and used for summarizing their overall **distress history** and predicting **future distress levels**. The user can also view a friend's distress level and assess their current distress level, which contributes to that friend's current **average distress level** for the day. Furthermore, the user can message a distressed friend using the application to provide social support.

Mapping Between the Concepts and User Experience (Interaction Types)

The *Daida* app has 4 interaction types:

1. **Conversing** – The application will alert user at different times of the day to take the distress questionnaire and calculate their distress level at the moment. They will also provide additional distress details (i.e. main stressor) and receive tips on how to cope with it based on their inputs. The user will accumulate a distress history that can be analyzed by the application to inform the user about their predicted future distress levels and provide tips. The application will alert the user about a friend's distress levels so social support can be provided.

2. **Exploring** – The user can explore their distress history to view details such as their most common stressors, physical stress symptoms, stressful locations, and most stressful days of the week to learn about their overall distress patterns.
3. **Manipulating** – The user can open and take the distress questionnaire any time in order to calculate their momentary distress level or the distress level of a friend. The user can also open the message attachment options, such as the picture quote gallery, to send an inspirational or humorous message to a distressed friend.
4. **Instructing** – The user can instruct the application to navigate to certain pages, calculate their distress level, send a message to a distressed friend, and save settings by pressing buttons on a mobile touchscreen.

Design and Prototypes

Sketches

Early ideation involved creating multiple sketches for the application's interface and core features. See Appendix A

Low-Fidelity Prototypes and Cognitive Walkthroughs

Low-fidelity digital prototypes were created to use for the cognitive walkthroughs. See Appendix B

The participants for the cognitive walkthroughs were recruited face-to-face and through e-mail. Five colleagues (graduate students) between 21-47 years old who experience stress multiple days a week agreed to take part in the study. To uncover any usability issues on the application, they performed 4 tasks on the low-fidelity prototype and evaluated each step required to perform a task by answering the following questions from the Streamlined Cognitive Walkthrough technique [14]:

1. Is the correct action obvious to the user? Why or why not?
2. Will the user know whether he/she has made the right or wrong choice? Why or why not?

At the end of each task, the participants were interviewed to gain an understanding about the difficulties they encountered and suggestions for improvement. Each cognitive walkthrough session was approximately 1 hour per participant.

Analysis of the cognitive walkthrough results involved examining the participant comments. "Yes" answers for a question indicated success. Any questions that generated a "No" answer indicated problems with the user interface that should be fixed. Unfortunately, not all questions were explicitly answered with a "Yes" or "No". Only absolute "Yes" answers are considered as positive/successful answers. Otherwise, "Maybe", "Yes, but…", and "No" answers are considered as negative answers. The number of positive answers out of all possible answers for each task was calculated.

All tasks revealed usability issues regarding unclear labels/icons and inappropriate feedback. The most successful tasks (highest positive response rate) were Task 2 and Task 4.

The results are as follows:

- **Task 1** (Find your predicted distress level for tomorrow): 30% positive answers
- **Task 2** (Find out what has been your most common stressor this week): 70% positive answers
- **Task 3** (Send a message to a moderately distressed friend): 52% positive answers
- **Task 4** (Rate your distress level at this moment and read the tip for coping with it): 75% positive answers

The general issues found were:

- The large numbers used for representing distress level visually competed with the number used for the date, and it's not very intuitive what the current day is.
- The concept of sending a picture quote message to was not expected to be the only way to send a message.
- Using weather-like icons to represent the distress levels did not make that much sense. For example, a rainy icon may not always mean the user is highly distressed.
- The "Submit" button label used on each page of the questionnaire was misleading because users thought they were finished, but had to answer other questions.

High-Fidelity Prototypes

High-fidelity digital prototypes were created for the usability tests. The new main screens based on the results of the cognitive walkthroughs are **My Distress** (today's distress level average and future distress levels), **My Stats** (distress history), and **My Friends** (friends' current distress levels). See Appendix C.

The main design changes are:

- Today's average distress level and future distress levels are combined on one page and the distress level numbers are in a smaller font size to avoid confusing it with the date.
- Sending a message to a friend includes a typical textbox with more attachment options (i.e. Photo/Video).
- Regular emoticons are used to visually represent the distress levels.
- The distress questionnaire includes an option for the user to skip inputting their location, stressor, and symptom in case all they want to do is calculate their distress level at the moment.
- Typical bar graphs are used to display the distress statistics so it's easier to understand.

Final Evaluation

Participants for the usability test were recruited face-to-face and via e-mail. A total of 7 participants (3 females and 4 males) between 21-39 years old took part in the usability test for approximately 1 hour per participant. The majority of the participants were full-time college students, while 2 participants were working full-time. Only 1 participant had prior experience with using stress management mobile applications.

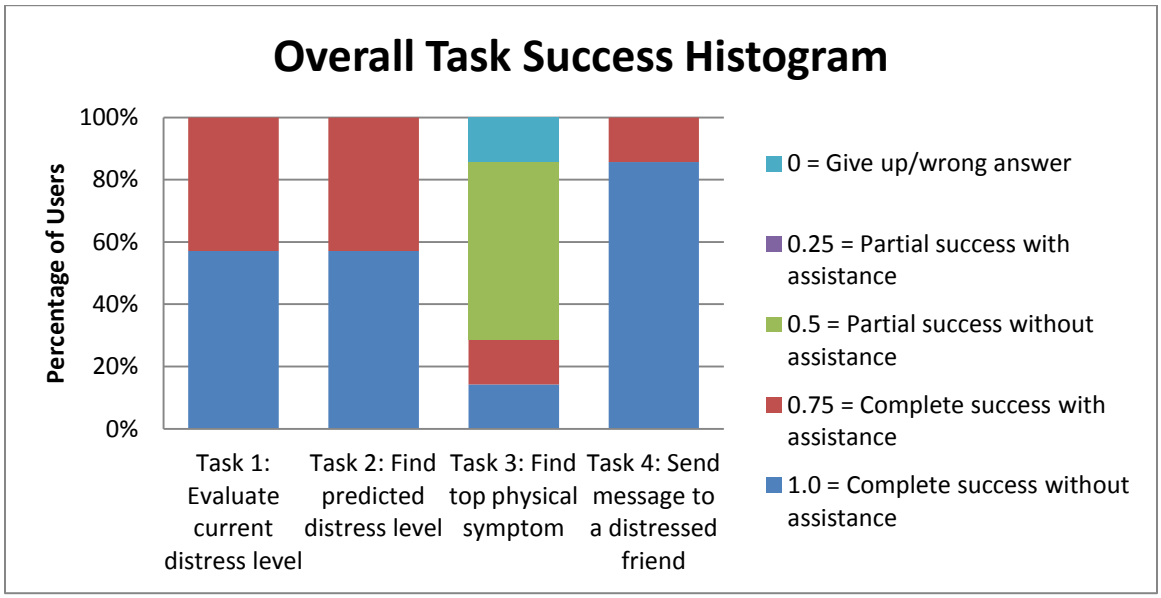
Each user performed 4 tasks involving the main application features on the high-fidelity prototype using an iPod Touch device. The investigator recorded the users' task completion level, time-on-task, errors, usefulness-of-feature ratings, and system satisfaction/usability ratings. A short interview after the completion of each task and at the end of each session was also conducted to gain an understanding of the user's difficulties and suggestions for improvement. Analysis of the usability test results involved examining the quantitative data that was collected and comparing the results with their acceptable thresholds. The qualitative data was examined for user difficulties and suggestions for improvement. The analysis is summarized in the following sections.

Task Completion Rate

The level of success in task completion is coded in the following way:

- 1 = Complete success without assistance
- 0.75 = Complete success with assistance
- 0.5 = Partial success without assistance
- 0.25 = Partial success with assistance
- 0 = Gave up/wrong answer

In this case, "complete success" refers to the user answering both task questions correctly. "Partial success" refers to the user answering only one task question correctly. Also, "assistance" refers to any time the investigator had to help the user navigate through the interface to stay on the ideal path. The overall task completion rate success threshold for all tasks is 0.5 and higher (at least partial success without assistance). The success threshold is the *minimum* acceptable level of success. If at least 5 of 7 users have a 0.5 or higher level of success for a task, then that task is considered successful overall and no interface revisions are necessary. Otherwise, interface revisions involving that task should be highly considered.



For all tasks, at least 5 of 7 users (71%) were able to get at least partial success without assistance (0.5 or higher). Both **Task 1** and **Task 2** required assistance from the investigator to complete the task almost half of the time (3 of 7 users or 43%). **Task 3** had the lowest rate for

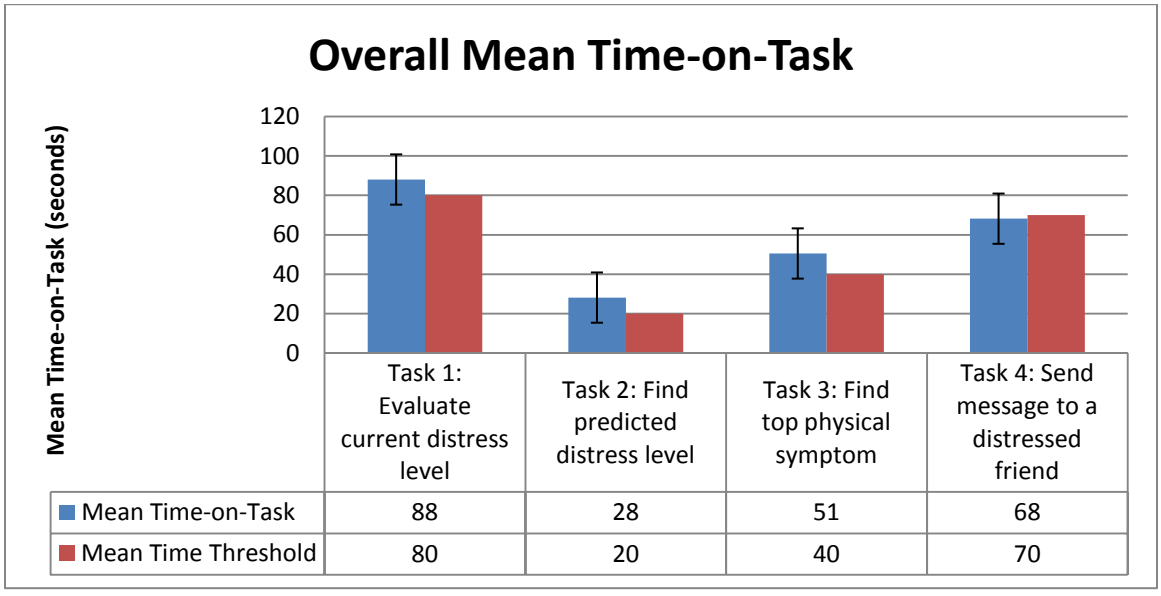
complete success without assistance (1 of 7 users or 14%). The reason is because the button that the users needed to click on lacked affordance. 4 of 7 users did not click on it at all and, therefore, missed other necessary steps to correctly answer the second task question. **Task 4** had the highest rate for complete success without assistance (6 of 7 users or 86%).

Time-on-Task

The user's total time on a task refers to the time between the user's initial touch on the screen until the user started to write down the answer to the second question for the task. Any amount of time it took for the investigator to clarify the task to the user was excluded from the user's total time-on-task. The mean time-on-task was calculated by taking the sum of all user times per task divided by the total number of users who completed the task. To get a clear measure of efficiency, only the times where a user was at least partially successful without assistance (0.5 or higher) was used in calculating the mean time-on-task.

The success threshold per task varies and is the *maximum* acceptable mean time-on-task for first-time users. If the mean time-on-task stays under its success threshold, then that task is considered successful overall and no interface revisions are necessary. Otherwise, interface revisions involving that task should be highly considered.

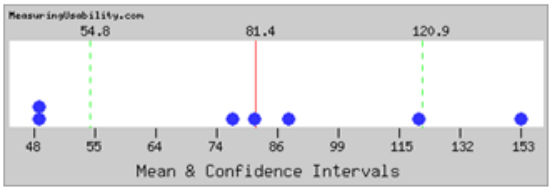
The overall mean time-on-task chart shows the average time it took for users to complete a task (in seconds) with standard error bars. **Task 1** and **Task 2** took 8 seconds longer than what is acceptable, while **Task 3** took 9 seconds longer. **Task 4** is the only task that stayed under its success threshold.



	Task 1: Evaluate current distress level	Task 2: Find predicted distress level	Task 3: Find top physical symptom	Task 4: Send message to a distressed friend
Mean Time-on-Task	88	28	51	68
Mean Time Threshold	80	20	40	70

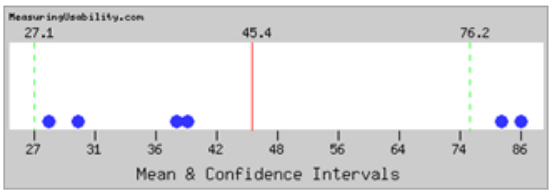
The charts below show the time-on-task distribution (spread) for each of the 4 tasks with a 95% confidence interval [15]. The chart also shows the geometric mean for each task (opposed to the arithmetic mean above).

Task 1: Evaluate current distress level

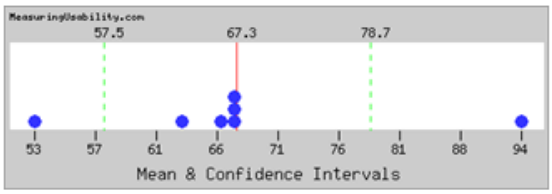


Task 2: Find predicted distress level

Task 3: Find top physical symptom



Task 4: Send message to a distressed friend

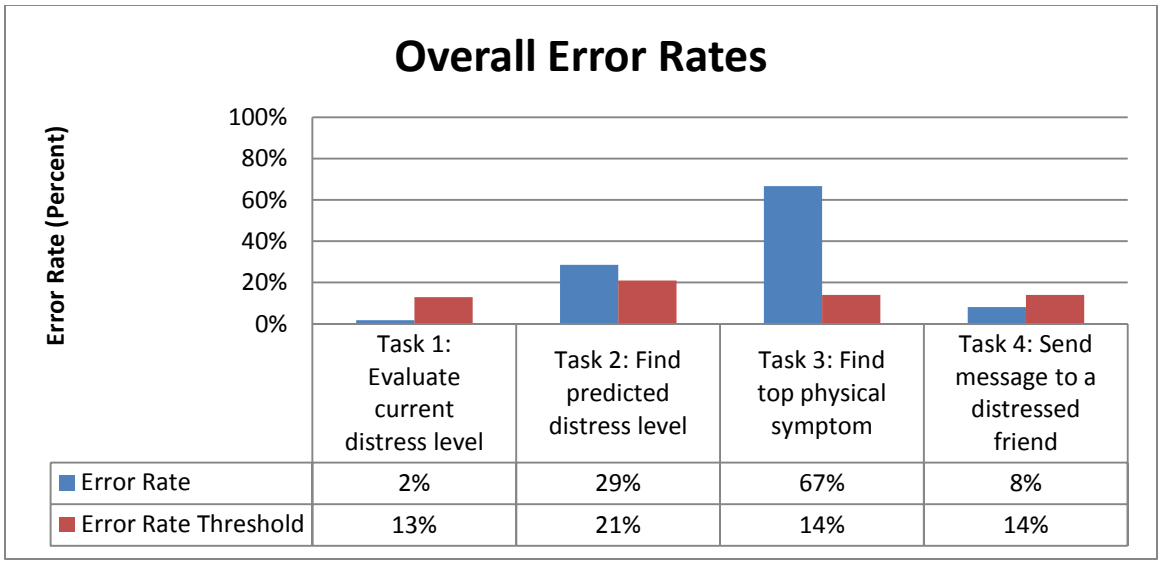


Task 1 standard deviation is 37.73 (range: 54.8, 120.9). For Task 1, the reason why 2 of 7 users were faster at completing the task was because their calculated distress level was "No Distress" and the tip was displayed on the same page, so they did not need extra time to visit additional pages. **Task 2** standard deviation is 11.87 (range: 16.7, 39.8). For Task 2, 2 users stated that they were unsure which page to go to find the information. **Task 3** standard deviation is 26.33 (range: 27.1, 76.2). For Task 3, 4 of 7 users were faster at finishing the task because they missed some additional steps since the buttons lacked affordance. 2 of 7 took longer because they misunderstood the task instructions and also spent time deciding where to find the answer since the buttons lacked affordance. Only 6 user times are displayed because 1 user failed to complete the task (wrong answer). **Task 4** standard deviation is 12.47 (range: 57.5, 78.7). For Task 4, 1 user took longer at completing the task because the user tried to read the small text on the thumbnails (unaware that the thumbnails could be enlarged) and took time deciding which picture quote to attach with the message.

Task Error Rate

In this case, an "error" refers to any missed steps in the ideal path. To calculate the error rate per task, the number of missed steps was divided by the total number of error opportunities in the task. The error rate success threshold per task is the *maximum* acceptable error rate. If the error rate stays under its success threshold, then that task is considered successful overall and no interface revisions are necessary. Otherwise, interface revisions involving that task and error should be highly considered.

The overall error rates chart below shows the percentage of errors per task with multiple error opportunities. **Task 1** and **Task 4** error rates stayed under its success threshold. **Task 2** exceeds its acceptable threshold because 3 of 7 users clicked on the wrong buttons when trying to find the information. **Task 3** had the highest error rate because 5 of 7 users failed to click on the correct button, which caused them to miss additional steps to acquire the correct answer for the second task question.



Task 1 only had 1 error total (out of 56 error opportunities total), which was recovered with assistance from the investigator. **Task 2** had 4 errors total (out of 14 error opportunities total), which half were recovered with and without assistance. **Task 3** had the most problems with 14 errors total (out of 21 error opportunities total). 10 errors were not recovered, while 3 were recovered with assistance, and only 1 was recovered without assistance. **Task 4** had 4 errors total (out of 49 error opportunities total), which 3 errors recovered with assistance and only 1 was recovered without assistance.

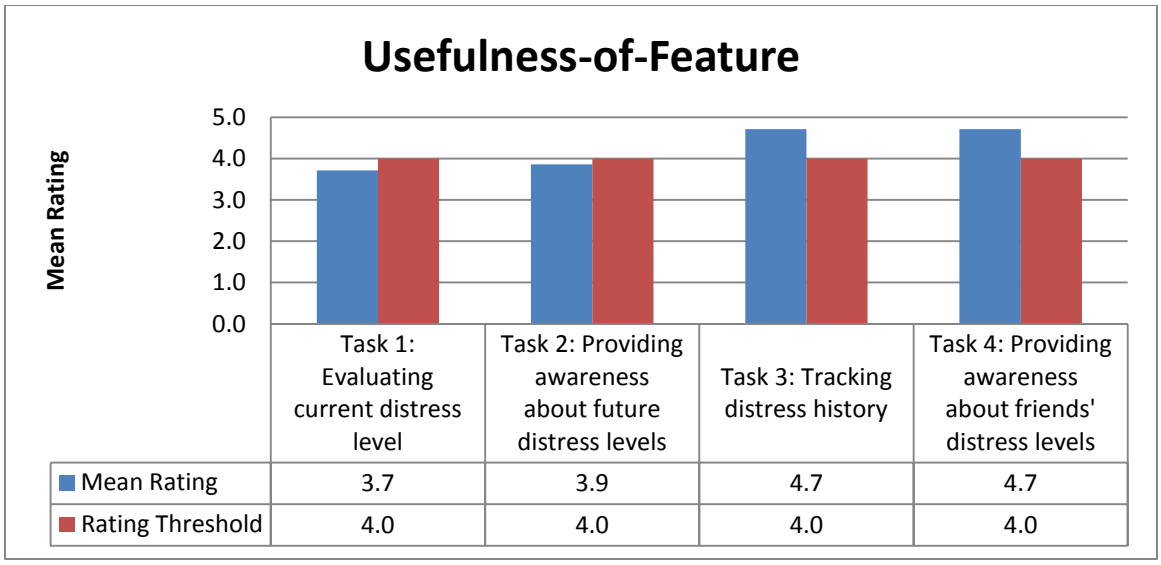
Usefulness-of-Feature

At the end of each task, the user was asked to rate the usefulness of the feature that he/she interacted with. The rating scale is as follows:

- 1 = Not useful at all
- 2 = Not really useful
- 3 = Neutral
- 4 = Useful
- 5 = Very useful

The mean rating for each feature is calculated by taking the sum of all user scores per task divided by the total number of users per task. The success threshold per task is 4.0 (useful), which is the *minimum* acceptable rating. If the mean rating per task feature is above its success threshold, then that feature is considered useful overall and no interface revisions are necessary. Otherwise, interface revisions involving that feature should be highly considered.

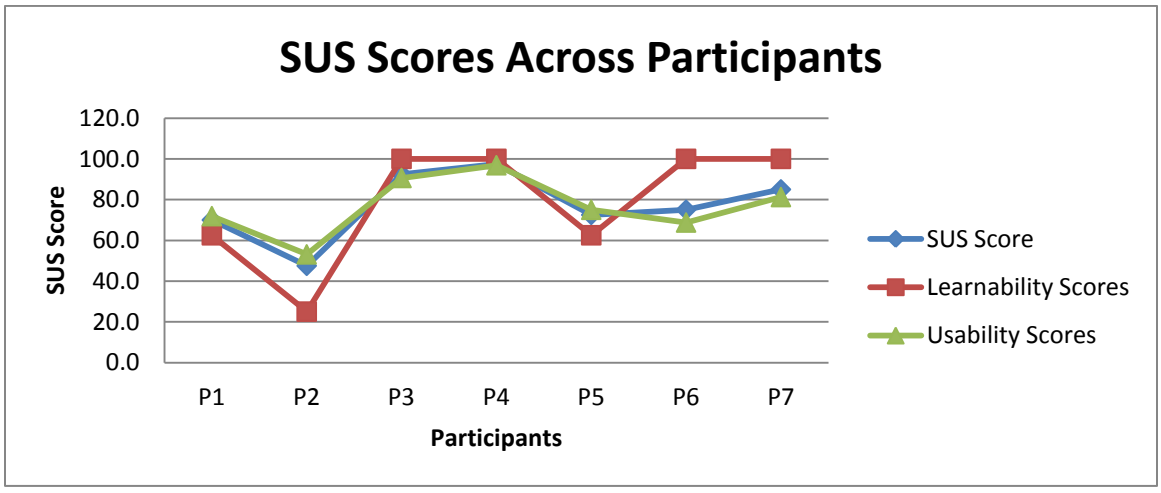
The feature of **evaluating the current distress level** (Task 1) and **predicting future distress levels** (Task 2) fell below the 4.0 success threshold. The feature of **tracking distress history** (Task 3) and **providing awareness about friends' distress levels** (Task 4) had the highest mean ratings and stayed above the success threshold.



The reason why the feature of **evaluating the current distress level** (Task 1) had the lowest rating may be because some users felt that other factors should be included in calculating the distress level, such as rating positive emotions and include personal schedule. The reason why the feature of **predicting future distress levels** (Task 2) fell short of being useful may be because users did not fully understand how the application was able to make such a prediction. An explanation about how the application uses the user's distress history to predict their future distress levels may help in building trust between the user and application.

System Usability Scale (SUS)

At the end of the usability test, the participants rated the learnability and usability of the system using the 10-item System Usability Scale (SUS). It is considered a valid and reliable measure of system satisfaction and usability. The scoring is explained on: http://www.measuringusability.com/sus.php. The SUS score success threshold is 80.3, which is the point where users are more likely to recommend the application to a friend and is the *minimum* acceptable score. If the overall mean SUS score is above the success threshold, then the application is considered satisfactory and usable overall. Otherwise, some interface revisions should be considered to improve it.



The SUS scores across participants chart shows the relationship between the learnability score (scale items 4 and 10) and usability score (scale items 1, 2, 3, 5, 6, 7, 8, and 9). Overall, the learnability scores are higher than the usability scores. The mean SUS score is 77.1. Although the score is above average (at least 68.0), it falls short of the 80.3 success threshold.

Overall Thoughts About The Product Concept

(Quotes are paraphrased)

- "It's very useful. I don't know there are other apps like it. It's interesting. Perfect to use with smartphones. Good concept, but there has to be an easier way for people unfamiliar with smartphones to use it. Simplify it more."
- "I like it. Having gone through stress management classes, it's very useful. I like the social aspect."
- "It's very cool. I've never used anything like it before. I like that it keeps track of my data and predicts my stress. I like that it's simple, straight-forward. My mom who is not tech-savvy could probably use it."

Suggestions for Improvement

The following suggestions for improvement have been applied to the final prototype:

My Distress

- Put "Rate My Distress" button in the middle of the page so it's more noticeable.
- On the future distress details page: Include a note that says "Based on your distress history from the past few weeks, your predicted distress level is…" to inform the user how the prediction is being made.

My Stats

- Give the buttons under "Overall Summary" more affordance by changing the button style.
- Add a small note on the graph page indicating to "Click on bar item for more information".

My Friends

- Add note in gallery that says "Click thumbnail to enlarge".

View final high-fidelity prototype at: http://4ynfpb.axshare.com/

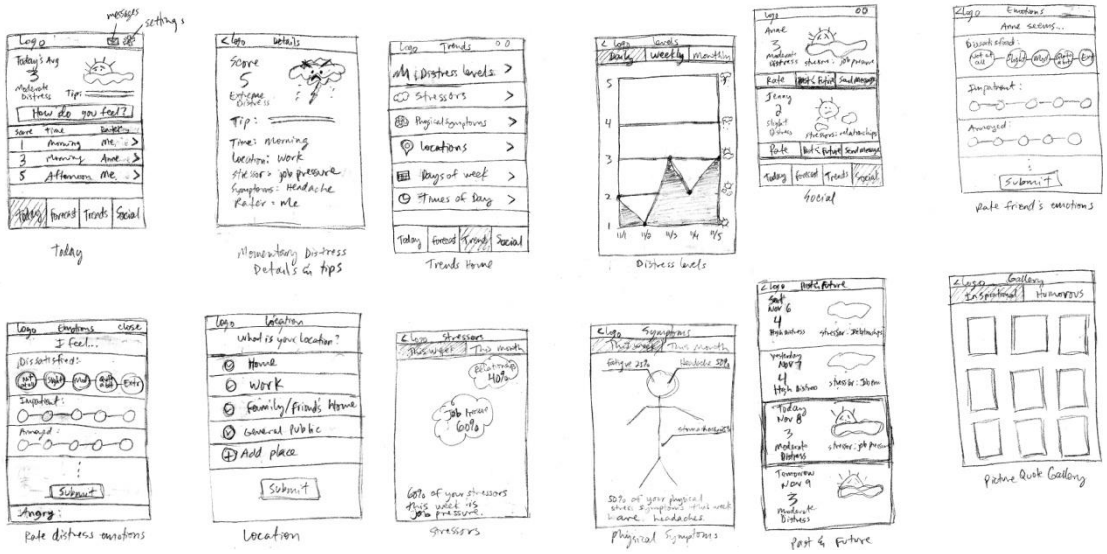
Future Developments

The following suggestions may also help improve the application in its future developments:

- Include other factors for calculating the user's distress level such as rating positive emotions, personal schedule, etc.
- Allow other attachment options (i.e. voice message) when sending a message to a friend.

Appendix

A. Sketches



B. Low-Fidelity Prototypes

Today **Future** **Trends** **Social**

C. High-Fidelity Prototypes

My Distress **My Stats** **My Friends**

Watch video demo at: http://youtu.be/xo4yFbEnhjM

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