

ECE 1778 Final Project

Portable Emotion Regulation Learning Service (PERLS)

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Word Count: 2201

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1. Introduction

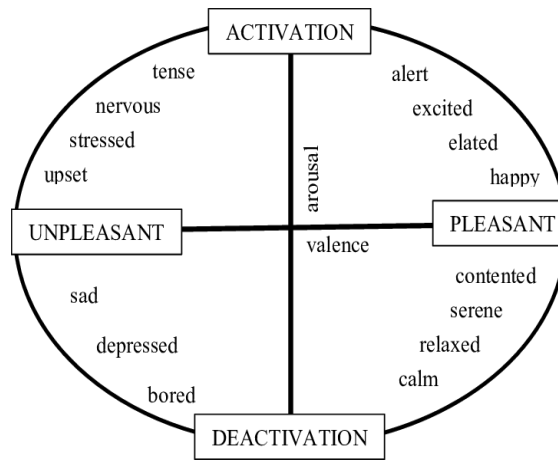
“PERLS” stands for Portable Emotion Regulation Learning Service. It was designed to help individuals learn and practice skills to diversify their emotion regulation skills in real-time. We did this because we all experience emotions that require regulation. Our emotions may be distressing and uncomfortable, counterproductive to our current behavior, and/or more intense than the current context allows (i.e., around other people). Therefore, we are motivated to use emotion regulation skills to change or modify our emotions. Being able to engage in emotion regulation is a universal skill that occurs when people desire to change their emotional experience in response to a stressor (e.g., failing an assignment; receiving a difficult email; dealing with an irritating coworker). Many skills to regulate our emotions exist, some that tend to be more effective (e.g., reframing your experience) while others less effective (e.g., drinking to cope) to help our overall well-being. Research has shown that the ability to regulate emotions flexibly using different skills is an important mechanism underlying mental well-being. Therefore, learning and practicing emotion regulation skills may therefore help individuals more adaptively respond to stress and improve their overall emotional functioning, reducing the impact of mental health difficulties.

2. Statement of Functionality & Screenshots

Describe the overall functionality of the work: PERLS incorporates three core strategies of skills training: (1) identifying the emotion you are experiencing which can help determine which emotion regulation strategies to use; (2) weighing the pros and cons of different strategies to evaluate the short-term and long-term benefits and consequences of using particular strategies; and (3) helping people practice more adaptive or functional strategies such as cognitive reappraisal, grounding, and mindfulness.

To accomplish our real-time emotion regulation skill training goal, PERLS incorporates mobile sensing by utilizing the accelerometer to determine elevated arousal based on a predefined model of affectivity called the circumplex model (Russell, 1980). The circumplex model can incorporate and explain all emotional experiences within two dimensions: (a) arousal from low (deactivation) to high (activation); and (b) valence from negative (unpleasant) to positive (pleasant). An example of the emotional experiences that map onto the circumplex model is depicted in Figure 1.

Figure 1. Circumplex model showing how most basic emotional experiences can be subsumed within 2 dimensions.



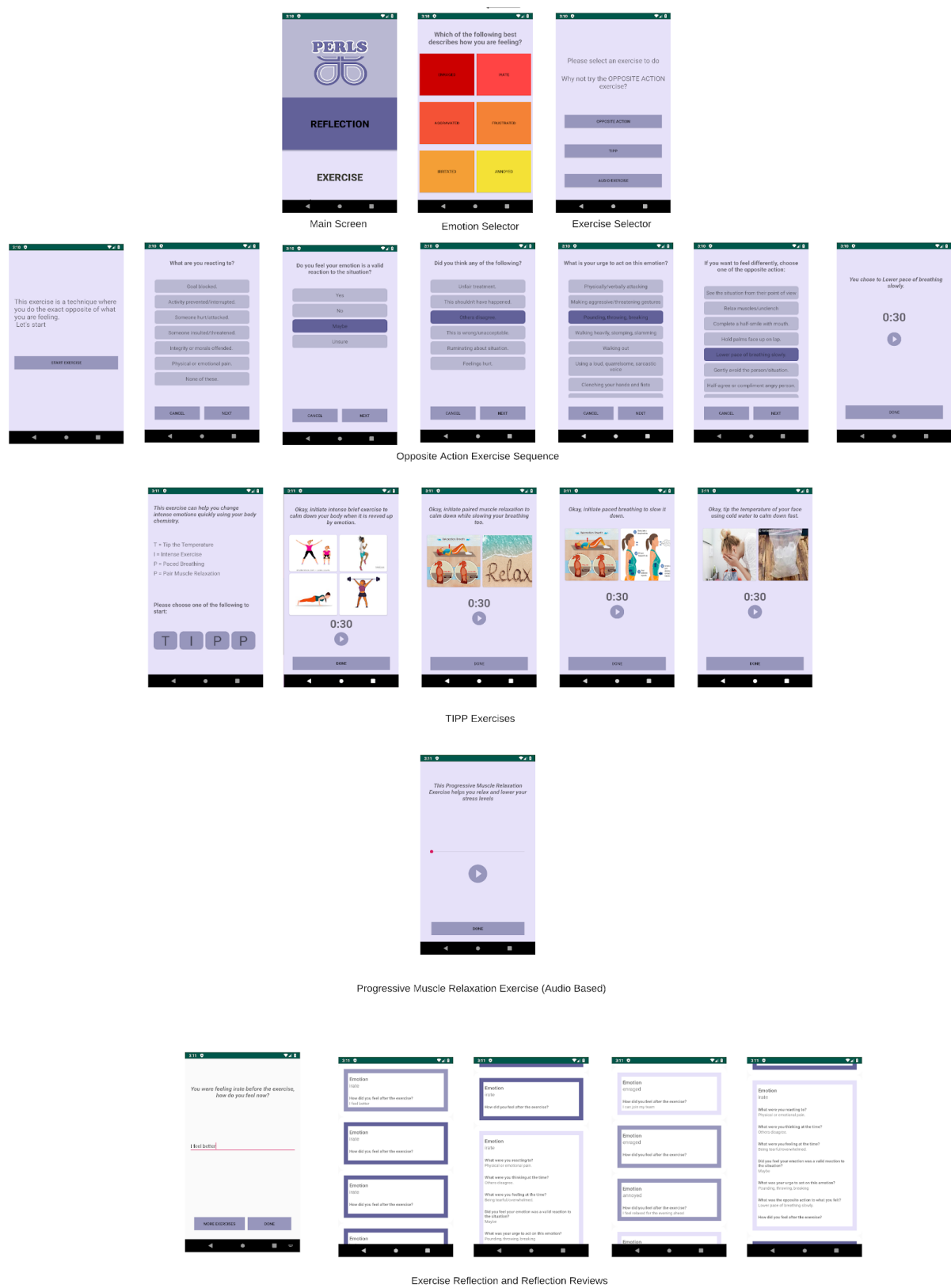
Based on previous research (see Olsen, 2016; Olsen & Torresen, 2016), we were able to use the built-in accelerometer to record pacing on the subject and map it to the top half of the circumplex model to detect high arousal. We then further increased the granularity of our accelerometer data processing, such that two thresholds of activity could be assessed, and recommending a user to complete exercises based on the intensity of physiological activity through a notification.

Within the app, the main screen directs users to either complete an exercise or review previous ones. The user can also be prompted via a notification based on arousal detection. The user is prompted to identify their emotion (in this case anger, specifically) as well as its intensity. Following this, the user is given the option to start one of three exercises (opposite action, TIPP, audio progressive muscle relaxation). The user is suggested to do an exercise based on how much they are pacing around, but it is ultimately up to the user to decide. Once they complete an exercise, they are given the option to review the change in emotion (and reflect on their exercise) or complete additional exercises if they feel they need more help. On the review screen, users can review the exercises they have done, the emotion selected, and displays text inputs in response to the exercises the user completed.

The UI images are shown below, a higher quality diagram can be accessed here:

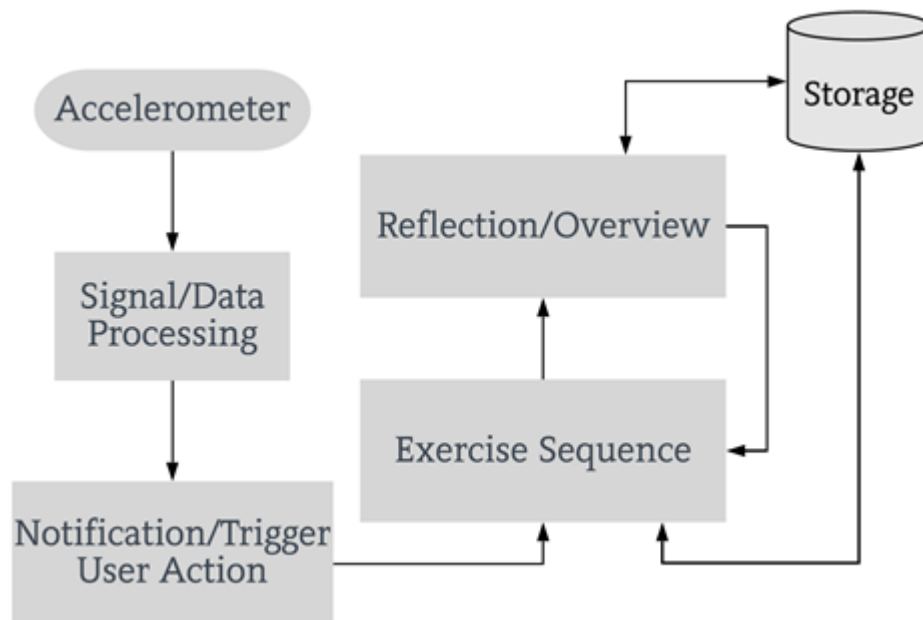
<https://www.lucidchart.com/invitations/accept/cef2b186-98a7-4b0c-88b6-9cd7dc7cc66b>

Figure 2. UI Diagram with Screenshots, as prepared using LucidChart software.



3. Overall Design & Block Diagram

Figure 3. Depiction of the final block diagram for PERLS.



Accelerometer sensing is filtered by our **signal/data processing** background service to create a **trigger**, which sends a **notification to the user** to prompt emotion regulating training and enter the **exercise sequence**. Now, this trigger can be dismissed by the user if there is a false alarm or the user cannot complete an exercise at that point in time.

Exercise sequence: Opposite action, progressive muscle relaxation, and TIPP exercises were implemented. The user can go through any number of these exercises in one session. Their response is then recorded for them to view later. Depending on the intensity of emotion that triggered the user notification, an exercise is recommended to the user. For example, if from the accelerometer readings, the user seems extremely agitated, an audio exercise will be suggested. Once completed, the user is prompted to do the **reflection/overview**.

Reflection/overview: After every exercise, the user can reflect on their experience and how they feel after doing an exercise. They can also choose to continue doing more exercises or end the session. These reflections are stored in our **storage** to be viewed later by the user. The app then goes back into the background state with the accelerometer being polled.

Storage: The user's response to the exercises and their reflections after each exercise are stored in Firebase Firestore database. On the Reflections page, this data is retrieved for the user to view.

4. Reflection: What did you learn and what would you do differently?

We felt that investing time into previous research saved us time in downstream tasks because it allowed us to determine which sensors to incorporate into PERLS. Previous research allowed us to determine that we did not need to measure heart rate thus saving us the cost of a wearable monitor and instead we were able to focus on using the built-in smartphone sensors such as the accelerometer and GPS. We underestimated the amount of time necessary to make skills training exercises mobile friendly. Coupled with this was the creativity needed to reduce text and ease the user's reading burden. Unfortunately, the dialectical behavior therapy (DBT) skills training manual (Linehan, 2014), where the exercises originated from, incorporates many different lessons and exercises, but the format is exclusively paper-based which creates a challenge to adapt the resource to delivery via a mobile device. We learned that we would need to use a variety of presentation modalities (text, static image, video, and audio) to help us navigate this problem. Finally, the engineering team felt that planning out the basic system architecture would have saved time because they were working to create the architecture based on what was needed for each spiral, without necessarily considering future iterations. This led to a lot of extra work to redesign and refactor previous iterations of the application because this was necessary in order to add new spiral target features.

5. Contribution by Each Group Member

Imtihan: Implemented the reflection review page where a user is able to review the exercises they have done and the reflection they have done after each set of exercises. I also implemented and maintained the Firebase Firestore database. The third feature I implemented is the background accelerometer activity and the notification system that mimics a part of the circumplex model to detect and respond to high arousal. I also helped write some of the exercise sequence code and fixed some of the bugs that arose over time.

Marie: Implemented the exercise sequence and exercise review features. Given that some exercises like opposite action are text-based and are typically done on paper, I worked with the specialist to figure out how to make the exercises mobile-friendly without compromising their quality. I implemented the progressive muscle relaxation and TIPP exercises that are audio and visual-based to provide users with a range of exercises they can engage in depending on the intensity of their emotions. In addition to the exercises, implemented the exercise review page which gets saved for the user to view later.

Alex: Research and reading on mobile sensors to detect stress/physiological arousal related to emotional experiences and incorporation of the circumplex model. Used existing DBT resources to produce exercises and modified them to be more mobile-friendly. Designed a logo and color

scheme for the app. Located audio resources for a progressive muscle relaxation exercise. Located images and other visual icons to help reduce the amount of text on the app. Contributed to the app home screen and flow designs between screens. Tagged issues on Github for the group to attend to. Contributed to each group assignment and presentation.

6. Specialist Context (Clinical Psychology)

There are few mobile apps that incorporate dialectical behavior therapy skills training (DBT-ST) or help users regulate their emotions in real-time using mobile sensing. Based on a close review of apps, some apps provide interventions to help with urges to harm oneself or use substances, but they do not incorporate mobile sensing. Other apps present skills learned in DBT, but there is no real-time component (and sometimes a lack of interaction with the user beyond text-based review). Future versions of PERLS could allow users to input multiple emotions and engage in multiple DBT-ST exercises in the same session, and could serve as a potential therapeutic intervention for those with mental health difficulties. Many individuals with mental health conditions (e.g., depression, anxiety, alcohol and/or substance use disorders) experience high emotion dysregulation, which is described as difficulties regulating one's emotions. PERLS could be used in tandem with a healthcare professional to teach and develop skill training ability to engage in healthier emotion regulation skills and to reduce their negative emotions more effectively. Therefore, PERLS supports the skills training necessary to reduce the emotion regulation difficulties that contribute to mental health difficulties, such as using strategies that are not effective or conducive to changing emotional experiences. Moreover, it could work as a standalone app, provided there were improvements to its functionality and instructions. DBT is a transdiagnostic intervention, that is, it works by alleviating symptoms of mental disorder regardless of a clinical diagnosis and teaches people skills to regulate their emotions more effectively (Linehan, 2014). Traditional face-to-face formats of DBT are lengthy (≥ 6 months), resource-intensive (requiring multiple specialized staff members), and usually limited to acutely suicidal individuals. Access to DBT is therefore very difficult to obtain for the average person wanting to improve their emotion regulation skills (i.e., people with depression and/or anxiety without suicidal behaviors would not be referred to hospital-run DBT programs). Traditional formats are not required for most individuals and the effectiveness of briefer, skill-training formats (DBT-ST) has been validated in patients with depression, anxiety, and high levels of emotion dysregulation. With further refinement, PERLS can function as a coach, helping to detect periods of emotion dysregulation (e.g., negative emotional arousal) in real-time and presenting the user with skills to help them manage their emotions. I am not aware of any app on the market that attempts to do this. I am hopeful that future iterations of PERLS could be used in a research study to examine the acceptability, feasibility, and effectiveness in reducing symptoms of mental disorder in a clinical sample.

7. Future Work

To improve on our project, we will need to integrate multiple smartphone sensors (as per Zhang et al., 2018) to improve the accuracy in predicting levels of stress and arousal according to the Circumplex model. Suggestions include GPS and ambient noise monitoring as ways to improve the signal prediction. Future work could implement continuous monitoring of physiological arousal so that the app could inform the participant whether their arousal has been reduced (as feedback to the user). We also need to expand the app to focus on other emotional experiences, as we only demonstrated our proof-of-concept with anger (and various intensities such as irritability to being irate). Finally, we would like to incorporate text-based lexicon analysis to predict emotional experiences using a user's text inputs in response to various questions. As most of the exercises prompt the user to comment on how they feel after each exercise, the lexicon analysis may help us monitor changes in emotional experiences. Previous work on this topic has been completed by [IBM](#). There also exists a Linguistic Inquiry and Word Count program ([LIWC](#); Pennebaker et al., 2015). This program provides 73 validated dictionaries covering a wide range of "dimensions" including several for emotional and/or affective experiences.

8. Public Postings

Post on course website:

1. Video of final presentation: Yes
2. Report: Yes
3. Source code: Yes

All members agree on sharing.

References:

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