Getting Lost in Your Own Mind – Coding as a Form of Therapy
Research Proposal
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Overview

Intended Audience: The American Institute of Stress (AIS) Board of Directors

Our mission is to help reduce stress levels amongst the American population by suggesting a non-traditional form of therapy; computer programming. We believe that computer programming exercises in a relaxed setting can be used as an effective stress reducer. As added benefits, we believe that this can potentially reduce instances of immediately jumping to medication, as well as helping others learn a beneficial skillset in today's world.

There is research from the National Library of Medicine that drove us to the idea of using programming to reduce stress:

- Research shows that learning words of a new language increases stimulation of a core part of the brain responsible for reward processing (fMRI activation in the ventral striatum). Due to this, we believe that there is opportunity for a computer programming ***language*** to provide the same effect. We believe that increases in the brains reward processing area can help others feel a sense of accomplishment and enhance mood, potentially reducing stress and other mental health issues.
- Research suggests engaging with jigsaw puzzles could prevent chronic states of stress by regulating distressing emotions. This is achieved through two leisure coping strategies, leisure palliative coping (psychological step away from stressors due to focused attention on puzzles) and mood enhancement (due to the fun, flow and mastery of puzzles). We believe that working and solving a jigsaw puzzle is similar to tackling computer programming exercises. Therefore, there may be opportunity for computer programming to provide the same benefits.

The goal of this analysis is to determine if computer programming can be used as an effective form of therapy to help reduce stress levels in people. Developing an optimal way to reduce stress is so important given how common mental health issues are in today's world, and these issues are on an increasing trend in a post-COVID pandemic world. According to a 2022 poll conducted by the American Psychological Association, we identified two alarming statistics (as I'm sure all of you are aware):

- 76% of American adults experienced at least one symptom of stress, such as fatigue, headaches, nervousness/anxiousness, or depression/sadness.
- 27% of Americans reported that they are so stressed most days that they cannot function.

It seems that a lot of this is caused by factors that are beyond our personal control. We have to take this seriously and think about the best ways to take care of people.

The rest of this document outlines our proposed design, including how we will determine if this innovative form of therapy does indeed reduce stress levels.

Research Question

Our primary research question: does regularly learning computer programming skills reduce an individual's stress levels?

- As described in the Study Design section in further detail, we are defining "regularly learning computer programming skills" as participants first completing an introductory computer programming course and then completing exercises on the Mimo coding app several times per week
- Our primary measure of "stress levels" will be a participant's cortisol levels. We will also be measuring other physiological data, including participants' blood pressure, body temperature and heart rate. Finally, we will be collecting the participants' self-reported stress levels through health surveys administered to the participants (see below 'Data' section for further detail).

Our secondary research question is understanding which types of programming exercises reduce stress levels?

- For example, we will explore whether the following types of programming exercises impact stress levels differently:
    - Rewards: Successfully completing a coding problem
    - Problem-solving: Working through a coding problem
    - Learning: Tutorials and instructional portions of the programming course

Study Design

In working to create the most unbiased and scientifically sound study, we need to focus on isolating the effect of learning programming to the resulting effect on cortisol level and other subquestion data points. We are using a mixed methods research design as noted above, collecting both quantitative and qualitative data. To best isolate the raw effect on stress, we will be testing a control group (no programming) vs. a test group which we will teach programming to. Our ultimate goal is to measure the effectiveness of coding within a vacuum so we will ensure that no one from the test group or the control group has any coding experience.

Once we have setup our sample groups, we will gather data over the course of our initial 12 week bootcamp. Given that none of the participants have any coding experience, we need to get them to a baseline of programming skill first, which will be the core of this 12 week initial bootcamp. During the 12 weeks we will have our participants run through a basic coding course via codeacademy. There will be an effort made to absent any form of grades and simply encourage learning via very basic questions which will be certainly answerable assuming one watched the videos.

Following the 12 week bootcamp, the main study will begin. We will ask them to continue programming questions via the Mimo app as we continue to monitor their progress over the course of a year. We want to again isolate more confounding variables like seasonality of stress and will monitor both the control and test groups over the course of the year - this should allow us to minimize any holiday or winter month stress/depression. We will ask the participants to join the testing facility three times a week during the course of the study. We will choose a fairly reasonable metro area to avoid traffic/driving stress. At the facility we will test the participants before and after coding, sessions should last around an hour. In addition, because we want this to be a legitimate coping strategy for stress, it needs to not have diminishing effects - this is why we want to track study participant stress over the course of a year. As we collect the data, we

will also require participants to let us know of any major life events(moving, health issues etc.) that could give us outlier data on their cortisol levels. We also need to make sure there isn't any spillover of the study design, and that the control group remains not programming for the entire year.

In addition to setting up the control and the test group, we want to minimize placebo as noted above. We will avoid letting the subjects know that the subject matter we care about is stress. We will collect lots of different data sources and firmly communicate that we are indeed collecting biomedical data for ethical purposes, but we won't harper on the fact that stress is really the key variable we are testing for.

Data

Prior to the start of the study, participants will be asked to fill out a questionnaire in order to determine if any illnesses or lifestyle habits will affect the data collected.

Illnesses can include heart disease, kidney disease, diabetes, Cushing syndrome and Addison's disease as these can directly affect a patient's blood pressure and cortisol levels and can falsely establish stress due to the physiological effects measured.
Lifestyle habits can include smoking and excess alcohol consumption as they have been linked to cortisol secretion (smoking more inconsistently).

For data collection, we will be collecting physiological data, participant activity descriptions paired with a screen recording of their coding as well as health surveys to establish stress levels. No information on the stressors will be collected from the participants to maintain participant privacy.

Physiological data:

- Cortisol levels will be measured through a saliva test at the start and end of each visit of the trial. A blood test was also an alternative means of collection but was not chosen due to its invasive nature.

  Cortisol is often referred to as the stress hormone and is released in the bloodstream because of stress. Cortisol levels can stay alleviated for several hours after the onset of stress and can drop after relaxation. A saliva test provides immediate information on stress levels. This will allow us to comprehend changes in stress levels during each visit because of our research design. The cortisol test may also allow us to identify chronic stress due to the longitudinal nature of our study.

  Since cortisol levels peak in the morning and decrease as the day progresses, each participant will be scheduled for a trial during the same time frame. Heart rate monitoring throughout the activity and participant temperature at the start and end of each visit. Both measurements can increase as a response to a fight or flight response elicited by stress.

- Participant vitals (Blood pressure, temperature, and Heart rate) during the activity. During a stressful situation, blood pressure, temperature, and heart rate can rise. This will allow us to monitor stress levels in real time through participant vitals and identify any variation as a result of the coding activity.

Only monitoring devices like smart watches/cuffless devices will be used so that the devices can be seamlessly used without creating an added source of stress.

- Electroencephalography (EEG) monitoring during each visit of the trial. EEG can capture brain signals in relation to any activity a participant may carry out.

  EEG can allow us to study brain functions, in a non-invasive way by collecting electrical brain signals through electrodes that are in direct contact with a participant's scalp. The brain signals, greatly affected by stress are alpha and theta waves and will be the main focus of our data collection using EEG caps. Alpha waves are associated with relaxation and awareness and will be suppressed in stressful situations. Theta waves are associated with stress and mental tasks and as such will be incited during stressful events.

Pairing participant vitals with EEG data will provide us with a more reliable and precise avenue to gather real-time data on participants' stress, which the individual data forms may not be able to provide individually, as a direct result of the coding activity during each visit..

Health surveys:

We will deploy two questionnaires, one that establishes each participant's stress in the prior week, which would only be deployed during the last visit of the week due to the structure of the questions. This would provide the baseline level of stress for the rest of the week, The second questionnaire will be given at the end of each visit and can establish the self-reported stress levels during the coding activity for each participant as well as gauge their feelings towards the activity.

Example of questions used in the first questionnaire can be seen below:

- In the last week, how often have you felt nervous and stressed?
- In the last week, how often have you felt that things were not going your way?
- In the last week, how often have you failed to control irritations in your life?
- In the last week, did you feel ill, if so, how often?
- In the past week, how often did you feel little interest in your tasks?
- In the past week, how often did you consume alcohol?
- In the past week, have you taken any medication, if so, how often?
- In the past week, how often did you engage in strenuous exercise?
- In the past week, how often did you feel tired or low in energy?
- In the past week, did you come in contact with anyone that you considered ill?
- How would you rate your overall health today, 1 being Not in good health and 5 being feeling extremely well.

Example questions in the second questionnaire include the following:

- During today's activity, how often did you feel stressed or nervous?
- During today's activity, how often did you feel that things were not going your way?
- During today's activity, how often did you feel frustrated?
- During today's activity, how often did you have difficulty focusing on the task?

- Please rate the difficulty of your coding exercise, with 1 being not difficult at all and 5 being extremely challenging.

Sample

For this study, participants with no prior coding experience will be recruited through online advertisements on craigslist, physical flyers on university campuses, libraries, and community centers as well as referrals from psychiatrists. This will allow us to capture data from a wider demographics of participants and to better allow us to deduce how our research design can reduce stress at a greater level.

As calculated via the http://www.raosoft.com/samplesize.html calculator, using a 99.5% confidence interval with a population size of 300MM and a standard error of 5%, we will look to gather 1000 individuals for both the control and the test group, for a total of 2000 in our entire sample size. These individuals will be randomly selected from all applications, randomly chosen to enter either the control or test group, and once randomly selected will be screened through demographic characteristics to ensure our demographic balance table is balanced to reflect the American population, as well as balanced between control and test group.

In choosing both our control and test groups we want to have a randomly stratified sample of participants. This will best allow us to extrapolate our resulting findings on the general population post study result. To achieve this, we will have a demographic table setup with multiple factors (education, gender, race, age etc.) Although we have participants signing up, we will only allow into our sample group those that help group demographic balance. In addition to requiring little coding experience, before allowing participants into our study group we would like to test their connotation towards programming. Oftentimes mindset going into a study can influence your overall cognitive response or placebo towards it. We want to ensure that no participant has an overwhelmingly negative or positive response to learning programming. In addition, we will also require that participants have the requisite time available in their schedule. Schedules being jammed up are a frequent source of stress, and learning programming even just a few hours a week could offer a time stress to participants - this time stress is something we want to limit as it could be a confounding variable that influences the result of our study. In addition, because stress is a legitimate health concern, we want to be ethically sound in not intentionally creating more stress in our participants' lives. Because we have a control and test group, we will randomly split up all participants into control and test, while maintaining similar demographic balances between both groups.

Beyond having to adhere to our demographic balance table, our inclusion criteria is that no participant already has any former programming experience. As learning programming could provide stress in and of itself, we want to make sure our study is honest in not including individuals who already may program as a hobby, or are excellent at it. We should note, given the monetary reward there may be individuals included into our study who may already have programming experience and lie to get access to our study for some extra money - this is a noted limitation. In addition, even through sampling via online flyers - we may already skew our sample towards a more tech savvy population who do not have any trepidation about programming. Another limitation to note is that we will be conducting this study in a large metropolitan area, this geographic and cultural difference is another limitation which will leave us with error in extrapolating to the entire population.

Finally, our study application will ask the below questions after personal information has been collected:

- Do you have any programming experience? Y/N
- If answered no to the above question: Please choose one of the below options that best reflects the first idea that comes to mind when you consider the idea of you programming:
    - I think programming would not be for me
    - I am indifferent to programming
    - I would love to program'

Our exclusion criteria post random stratified selection would be first any participant that answers Y to having programming experience, and any individual who selects that programming would not be for them or that they would love to program. In effect, we would only select individuals who, after passing random stratified selection, choose I am indifferent to programming.

Variables and/or Intervention

With our experiment we hope to determine whether coding can be a good alternative therapy for stress reduction. Our secondary goal is to determine what type of coding challenge/learning opportunity, if any, would lower our participants' stress levels the most.

Using our sampling method, we will randomly assign the participants to an experimental group or to a control group. Within our experimental group, we will have subgroups of participants that will be coding using different learning methods after their 12 week long coding bootcamp. The following are the learning methods deployed:

1) Coding challenge video tutorial - the participants will be shown a video tutorial on how to complete the challenge prior to their coding assignment. The participants will be allowed to rewatch the tutorial as many times as needed in order to prevent any added stress of trying to remember the solution.
2) Gamification - participant will be provided a score on correctness after completing the challenge which will go on a leaderboard that will only be visible to the participants within the subgroup
3) Traditional problem-solving - participant will solve the coding challenge upon receiving the challenge instructions with no interventions

Participants in our control group will not partake in any coding activities or in the 12 week coding bootcamp but will be asked to come in for each visit to provide their physiological and the appropriate health survey data.

Statistical Methods

We will use conventional statistical methods to compare health measurements (cortisol levels, etc.) of participants who were given computer programming as part of therapy (treatment condition) and participants who were not given programming as part of therapy (control condition).

An example of methods we will use is hypothesis testing, where our hypothesis would be:

- Null Hypothesis: No difference in mean health measurements between the two groups.
- Alternative Hypothesis: Mean health measurements are better (lower cortisol levels, etc.) in those that receive computer programming therapy than those that do not.

We will use a 2-sample t-test to see if the sample results are statistically significant. If statistically significant, there would be evidence to suggest that mean health measurements are better for those that receive computer programming therapy than those that do not.

To best assess the treatment effect, we will control for various external factors that may influence health measurement outcomes.

Potential Risks

One potential risk in our study is **sample bias** and ensuring our sample groups are as representative of the general population as possible. Our intended plan, as described in the Data and Sample sections above, is to recruit a randomly stratified sample of participants for both the control and test cohorts that is representative of the general population. However, some of the entry criteria and recruitment methods will inherently attract a biased sample group. First, participants with specific education backgrounds and competency with basic mathematical principles will likely be more inclined to participate in this study. Second, despite our best efforts, our sample may be skewed to the demographic composition of the large metropolitan area where we run the study. We will need to ensure our conclusions from this study are appropriately caveated to apply to the profile of the sample population we work with and not to the general population.

Second, we face the risk of not measuring and controlling for all variables outside the specific intervention (learning programming) that may impact stress levels negatively or positively in our participants. Our surveys, described in the Data section above, will aim to collect as much information as possible from participants to measure these outside variables, but it will be impossible to capture all stress-related activities in participants' lives. While we will control for and characterize the various external factors we are tracking, our results will be limited by the impact of the factors we are not tracking.

Third, for several of our secondary outcome measures, we are reliant on participant's self-reported answers to our health survey questions. This self-reported data presents inherent limitations and **response bias** and will need to be reviewed in light of these limitations. For instance, despite the privacy protection of the participants, they may not feel comfortable being honest. In addition, participants' answers to survey questions may be impacted by the framing of questions and the conditioning of previous survey questions. As a result, we will only be reviewing the self-reported data in conjunction with the more objective measurements of stress (e.g., cortisol levels).

Finally, as in all studies on human research subjects, we will need to work with participants who opt in to the study and sign informed consent forms. While we will be de-identifying and anonymizing the participants' individual data, we will need to ensure throughout the study that our processes for protecting participant privacy are effective and adhered to by study administrators.

Deliverables:

- We will provide an interim PowerPoint presentation update to the AIS Board of Directors at two points prior to the final report:
    - 4 months into the study
    - 8 months into the study
- One month after the completion of the study, we will submit our report for peer review.
    - Simultaneously, we will present a presentation of our findings to the AIS Board of Directors
- Following peer review and depending on findings, we will look to publish our report in a scientific journal
- Finally, we will assess one month after peer review any subsequent experiments we want to conduct for the AIS Board of Directors

Statement of Contribution

Jordan:

- I worked on the Study design portion of the Research Design as well as the Sample portion - focusing on eliminating any external biases/extraneous variables and attempting to help capture the raw effect of programming on our tested variable of stress by focusing on minimizing confounding variables.
- I believe we did a great job working together, and everyone was truly invested in each other's parts trying to make the best experiment possible. We did a great job critiquing each other's work from our individual perspectives, and I think that helped create a good end product. To do a better job next time, I think formulating maybe specifics, i.e. diving deeper into which coding puzzles would most alleviate stress could be an interesting undertaking! We covered it more generally with different types but potentially a project that other researchers may have used could be good to use.

Sean Cotter's contribution statement

- I focused on the Research Question, Potential Risks and Deliverables sections of the Research Design report and presentation material. I also reviewed the broader design project and presentation, and we collectively reviewed the entire report and presentation as a group.
- Everyone in the group was committed to the project, delivered on agreed-upon responsibilities and collaborated well together. The group listened to each other well when we had constructive feedback for each other's sections. Working as a group improved each of our individual sections.
- The one area I think we could improve upon in the study design is adding A/B testing to our study design to more thoroughly investigate the secondary question of "how does each type of programming impact stress levels?" We could change the type of programming in a secondary group to see how that impacts their stress levels in an A/B testing design.

Sayyed:

- My contribution was to the data and the variables section of our Research Design. This included determining the relevant data to collect, provide a background reasoning for each data type as well as structure the experiment in order to answer the questions posed by both our primary and secondary research questions.
- Overall, we worked quite well as a group. Everyone brought their unique insights to each section which allowed us to further refine our overall research design

- To improve this research design we can aim to compare our research question against conditions that could occur due to stress (eg. depression, anxiety and heart condition) and aim to understand how our methodologies can alleviate these conditions. This would bring an insightful methodology to prove the efficacy of our proposal as well as further elevate the study question for the general public.

Steven Cherry:

- My contribution was to the Overview section of the Research Design, including our Intended Audience. I included details such as other research pieces that helped us come up with our idea, our mission & goal, and why achieving the goal is important. I also developed the Statistical Methods section.
- I had a great experience with the group. We collaborated well together, everyone was reliable and did their part, and we shared thoughts/feedback to each other throughout.
- If we had to do it again, one way we could improve the design to better answer the research question is to spend a ton of time thinking through how to best select our sample. We thought this through a ton but there is always the possibility of introducing bias that can affect things. Further thinking through ideas could always improve things.

References:

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