North Carolina State University

Institutional Review Board for the Use of Human Subjects in Research

#### Submission for New Studies

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# GENERAL INFORMATION

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| 1. **Date Submitted:** |
| 1. **Title of Project:** An Investigation of the Effects of Mental Fatigue on Programming Tasks’ Performance |
| 1. **Principal Investigator:**  Saurabh Sarkar |
| 1. **Principal Investigator Email:** [ssarkar4@ncsu.edu](mailto:ssarkar4@ncsu.edu) |
| 1. **Department:** Computer Science, Psychology |
| 1. **Campus Box Number:** |
| 1. **Phone Number:** 919-527-8542 |
| 1. **Faculty Sponsor Name if Student Submission:** Chris Parnin |
| 1. **Faculty Sponsor Email Address if Student Submission:** [cjparnin@ncsu.edu](mailto:cjparnin@ncsu.edu) |
| 1. **Source of Funding** (Sponsor, Federal, External, etc)**: Laboratory for Analytic Sciences**   *If Externally funded, include sponsor name and university account number:* **558349** |
| **RANK:**  Faculty: ; Student: Undergraduate  Masters  PhD; Other: |

As the principal investigator, my signature testifies that I have read and understood the University Policy and Procedures for the Use of Human Subjects in Research. I assure the Committee that all procedures performed under this project will be conducted exactly as outlined in the Proposal Narrative and that any modification to this protocol will be submitted to the Committee in the form of an amendment for its approval prior to implementation.

**\*Electronic submissions to the IRB are considered signed via an electronic signature\***

**Principal Investigator:**

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| --- | --- | --- |
| *Saurabh Sarkar* |  |  |
| (typed/printed name) | (signature) | (date) |

*As the faculty sponsor, my signature (or electronic submission) testifies that I have reviewed this application thoroughly and will oversee the research in its entirety. I hereby acknowledge my role as the* ***principal investigator of record****.*

**Faculty Sponsor:**

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| *Chris Parnin* |  |  |
| (typed/printed name) | (signature) | (date) |

*PLEASE COMPLETE AND E-MAIL TO:* [**irb-coordinator@ncsu.edu**](mailto:irb-coordinator@ncsu.edu)

**Please include consent forms and other study documents with your application and submit as one document. \*Electronic submissions to the IRB are considered signed via an electronic signature. For student submissions this means that the faculty sponsor has reviewed the proposal prior to it being submitted and is copied on the submission.**

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## For SPARCS office use only

### Reviewer Decision (Expedited or Exempt Review)

Exempt  Approved  Approved pending modifications  Table

Expedited Review Category:  1  2  3  4  5  6  7  8a  8b  8c  9

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Reviewer Name Signature Date

**North Carolina State University**

**Institutional Review Board for the Use of Human Subjects in Research**

**GUIDELINES FOR A PROPOSAL NARRATIVE**

**In your narrative, address each of the topics outlined below. Every application for IRB review must contain a proposal narrative, and failure to follow these directions will result in delays in reviewing/processing the protocol.**

**A. INTRODUCTION**

1. Briefly describe in lay language the purpose of the proposed research and why it is important.

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| The purpose of this research is to identify the tools, behaviors, and techniques which are utilized to help programmers avoid their fatigue state to control errors in programming, and eventually aid them to be more productive. This will help in further developing best practice behaviors for software development. Specifically, we will be able to identify when changes in the cognitive processes employed in the development process of programming tasks occur and how they may predict the best coping mechanism and ways to avoid it.  Mental fatigue is caused due to exhaustion and tiredness, triggered by long and demanding tasks (Lauren et. al., 1999). Studies have shown possible relations between mental fatigue and specific programming tasks such as a program construction, modeling and debugging (Schneiderman, & Mayer, 1979). Empirical studies have been conducted in the cognitive aspects of software engineering. Khan et. al. have worked on the effect of programmers’ moods on the performance of programming debugging, which also comes under the umbrella of psychological causes (Khan, & Brinkman, 2011). This approach takes mental fatigue as the psychological factor rather than mood and focuses on all the programming tasks than just on program debugging. Pimenta et. al. have worked on monitoring and analyzing the human performance with respect to the computers and the effects of fatigue on it (Pimenta, 2014). The proposed research is the extension of this approach by using different ways to analyze the effects of fatigue and providing an aid to the programmer. Industries need a tool which can help programmers detect the mental fatigue state and work on it. The research is to conduct, monitor, and analyze data in a non-invasive and non-intrusive way and present the results in a cordial manner. There is not a lot work done in this problem area, so my approach would be to create incremental models that can be refined over time with continuous evaluation of the research. This proposed project is first of the many steps taken in this direction, opening a wider scope for more research in the domain. |

1. If student research, indicate whether for a course, thesis, dissertation, or independent research.

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| Not Applicable |

**B. SUBJECT POPULATION**

1. How many subjects will be involved in the research?

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| We plan to recruit approximately 300 participants for the survey from the North Carolina State University student population and online forums.  We plan to recruit from two separate subject pools: One for a laboratory version of the study and another for a distant version of the study just using DevFatigue. We plan to recruit approximately X participants for the laboratory study from the North Carolina State University student population and approximately Y participants from the North Carolina State University student population and personal contacts for the distant version. There might be the same participants for both the studies, if they opt to. |

1. Describe how subjects will be recruited. Please provide the IRB with any recruitment materials that will be used.

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| The participants will be recruited through recruitment flyers posted across campus (see Appendix A), and emailing to classmates/colleagues/friends. |

1. List specific eligibility requirements for subjects (or describe screening procedures), including those criteria that would exclude otherwise acceptable subjects.

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| Participation in this laboratory study is limited to adult participants who do not (1) require eye-glasses or corrective lenses, since they interfere with the eye-tracking system’s ability to accurately track participants’ gaze behaviors. (2) wear face coverings, since they interfere with the facial recognition program’s ability to detect and classify facial expressions of emotions (e.g., confusion, frustration) if facial features are occluded. Participants should have some technical (coding) experience, mainly Java. It may be academic or industrial.  There will be no such limitations for the distant version of the study, except that participants must have some technical (coding) experience, mainly Java and the participant should have access to Eclipse. |

1. Explain any sampling procedure that might exclude specific populations.

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| This study does not include a sampling procedure that excludes specific populations. |

1. Disclose any relationship between researcher and subjects - such as, teacher/student; employer/employee.

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| There is no relationship between the researcher team and participants. |

1. Check any vulnerable populations included in study:

minors (under age 18) - if so, have you included a line on the consent form for the parent/guardian signature

fetuses

pregnant women

persons with mental, psychiatric or emotional disabilities

persons with physical disabilities

economically or educationally disadvantaged

prisoners

elderly

students from a class taught by principal investigator

other vulnerable population.

7. If any of the above are used, state the necessity for doing so. Please indicate the approximate age range of the minors to be involved.

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| Not applicable |

**C. PROCEDURES TO BE FOLLOWED**

1. In lay language, describe completely all procedures to be followed during the course of the experimentation. Provide sufficient detail so that the Committee is able to assess potential risks to human subjects. In order for the IRB to completely understand the experience of the subjects in your project, please provide a detailed outline of everything subjects will experience as a result of participating in your project. Please be specific and include information on all aspects of the research, through subject recruitment and ending when the subject's role in the project is complete. All descriptions should include the informed consent process, interactions between the subjects and the researcher, and any tasks, tests, etc. that involve subjects. If the project involves more than one group of subjects (e.g. teachers and students, employees and supervisors), please make sure to provide descriptions for each subject group.

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| Laboratory Study:  The Laboratory Study is conducted twice on each participant, once at the starting of the day and once at night. The exact time and day will depend on the participant’s weekly schedule and sleeping patterns.  Upon entering the lab, the participants will be greeted by the researcher and asked to complete the informed consent form (see InLab - Consent Form.doc). After the participant completes the informed consent form, the researcher will begin recording the participant through the use of multiple data channels: the eye-tracker, which collects the participant’s gaze, fixation, blink, and pupillometric data; a Shimmer Galvanic Skin Response + Optical Pulse Development Kit bracelet, which measures participants’ changes in skin conductivity and heart rate; video recording of facial expressions through the use of FACET software, which measures participants’ emotional states; screen recording and computer interaction log-files such as mouse clicks and key presses; and, video and audio recordings of the participant.  The participant will then fill out a questionnaire assessing their mental state and their ability to use Eclipse (see Appendix Pre).  The participant will then receive task instructions through the computer. The tasks are divided into 4 tasks sets. The first set includes a SAT test. The participant’s pool is selected from North Carolina State University, so they are assumed to have appeared for SAT or GRE tests before. Participants will be asked to appear for a written test which includes Math and Verbal questions. The second is a Code Walkthrough phase where the participant will be given a code to refer and will be asked some questions related to that code. There would be some scoring on the correctness of the answers, including negative marking, which will affect the compensation. The third set includes some code modification and debugging tasks. The process will repeat for each of the tasks (see Appendix T), which will increase in complexity. Once the participant completes these tasks, the final set includes a coding task. The coding will be based on Java which is an eligibility criterion as well. The participants will be given a problem statement and will have to code accordingly. The participants will be Eclipse as the IDE to code and a plug-in (DevFatigue\*) will be used to record their activities on the basis of mouse and key usage. Once the participant completes these subjective tasks, they will be instructed to complete a post-questionnaire (see Appendix P) regarding the tasks and their mental state.  At the completion of the final portion of the task, the participant will be debriefed and thanked for their time.  Distant Study:  The participants will be asked to install an Eclipse plug-in (DevFatigue\*) on their system and will be requested to use Eclipse as much as they can for their coding tasks. The study will be conducted for a period of one month. At the end of the study period, the participants will be asked to share the log-files generated by the plug-in.  Apart from that, the participants will be asked to maintain a dairy to record their sleeping schedule for the entire one month.  The participant will be asked to upload the log-files and the sleeping record. At the completion of this portion of the task, the participant will have the option of downloading a debriefing form see Appendix D) and thanked for their time.  \* http://www4.ncsu.edu/~ssarkar4/fatigue/eclipse/updatesite/ |

1. How much time will be required of each subject?

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| The experiment is divided into four task sets. The first three task set takes 20 minutes each. The final task set will take 30 minutes.  The distant version of the experiment will go on for a period of one month. |

**D. POTENTIAL RISKS**

* 1. State the potential risks (physical, psychological, financial, social, legal or other) connected with the proposed procedures and explain the steps taken to minimize these risks.

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| Minimal risks may include becoming fatigued from sitting or minor eye strain from focusing on a computer monitor for extended periods of time. If needed, participants will be allowed to take one 5 minute break between task sets. |

2. Will there be a request for information that subjects might consider to be personal or sensitive (e.g. private behavior, economic status, sexual issues, religious beliefs, or other matters that if made public might impair their self-esteem or reputation or could reasonably place the subjects at risk of criminal or civil liability)?

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| Participants may find it personal that their facial expressions and fixations are being recorded while in the research lab. |

* 1. If yes, please describe and explain the steps taken to minimize these risks.

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| For the lab study, minimal risks will be reduced by having a trained research assistant run the research protocol. |

* 1. Could any of the study procedures produce stress or anxiety, or be considered offensive, threatening, or degrading? If yes, please describe why they are important and what arrangements have been made for handling an emotional reaction from the subject.

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| The study procedures may induce some stress or anxiety while participants are performing the programming tasks. |

1. How will data be recorded and stored?

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| We will record the responses from the survey on password-protected computers. Only project research assistants who have the computer password will be able to access the data.  We will record the in-lab participants’ task log-files, the scores from the tasks, the associated files from each of the data channels (eye tracking, galvanic skin response, face recordings, screen recordings, and audiovisual recordings) from the laboratory study on password-protected computers. Only project research assistants who have the computer password will be able to access the data.  For the distant study, we will record the Eclipse log-files depending on the mouse and keys usage, and an sleeping record. No other personal information will be collected. |

* 1. How will identifiers be used in study notes and other materials?

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| All names and data will remain confidential. Data will be identified by participant number and maintained in secure file cabinets and password-protected computers. Data from the distant experiment will be identified by anonymous ids provided by the checkbox.io/ website and stored on password-protected computers. |

* 1. How will reports will be written, in aggregate terms, or will individual responses be described?

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| Reports will be written in aggregate terms. If specific individual responses are described, no personal identifiers will be included and participation will remain anonymous. |

1. If audio or videotaping is done how will the tapes be stored and how/when will the tapes be destroyed at the conclusion of the study.

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| The data will be stored in password-protected computers, and only project research assistants who have the computer password will be able to access the data. All audio and video data will be destroyed after five years. |

1. Is there any deception of the human subjects involved in this study? If yes, please describe why it is necessary and describe the debriefing procedures that have been arranged.

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| No deception will be used in this study. |

##### E. POTENTIAL BENEFITS

*This does not include any form of compensation for participation.*

1. What, if any, direct benefit is to be gained by the subject? If no direct benefit is expected, but indirect benefit may be expected (knowledge may be gained that could help others), please explain.

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| Participants may learn about new debugging errors they have not faced earlier. Participant may learn from the programming competition level coding question which will be assigned to them. |

1. **COMPENSATION**

*Please keep in mind that the logistics of providing compensation to your subjects (e.g., if your business office requires names of subjects who received compensation) may compromise anonymity or complicate confidentiality protections. If, while arranging for subject compensation, you must make changes to the anonymity or confidentiality provisions for your research, you must contact the IRB office prior to implementing those changes.*

1. Explain compensation provisions if the subject withdraws prior to completion of the study.

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| No compensation will be given. |

1. If class credit will be given, list the amount and alternative ways to earn the same amount of credit.

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| Not Applicable |

# G COLLABORATORS

1. If you anticipate that additional investigators (other than those named on **Cover Page**) may be involved in this research, list them here indicating their institution, department and phone number.

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| Not Applicable |

1. Will anyone besides the PI or the research team have access to the data (including completed surveys) from the moment they are collected until they are destroyed.

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| Not Applicable |

**H. CONFLICT OF INTEREST**

1. Do you have a significant financial interest or other conflict of interest in the sponsor of this project? *No*

2. Does your current conflicts of interest management plan include this relationship and is it being properly followed? *No*

**I. ADDITIONAL INFORMATION**

1. If a questionnaire, survey or interview instrument is to be used, attach a copy to this proposal. See Appendices.
2. Attach a copy of the informed consent form to this proposal. See Attachment.
3. Please provide any additional materials that may aid the IRB in making its decision. See Appendices and Attachments.

**J. HUMAN SUBJECT ETHICS TRAINING**

**\***Please consider taking the [Collaborative Institutional Training Initiative](http://www.citiprogram.org/) (CITI), a free, comprehensive ethics training program for researchers conducting research with human subjects. Just click on the underlined link.

Appendix A

Recruitment Flyer

Appendix Pre

Pre Experiment Questionnaire

1. When did you sleep last and for how long?

2. Do you feel tired or not? If yes, how much would you score it in a scale of 1 to 10, 1 being the least?

3. How would you rate your familiarity with using Java?

Not at all familiar

Slightly familiar

Somewhat familiar

Very familiar

Extremely familiar

4. How would you rate your familiarity with using Eclipse?

Not at all familiar

Slightly familiar

Somewhat familiar

Very familiar

Extremely familiar

Appendix P

Post Experiment Questionnaire (Given after final task set)

Appendix T

Code modifying and debugging tasks

Appendix D

Experiment Debriefing Form

Thank you for your participation in the study. If there is any questions about the study, please contact ssarkar4@ncsu.edu