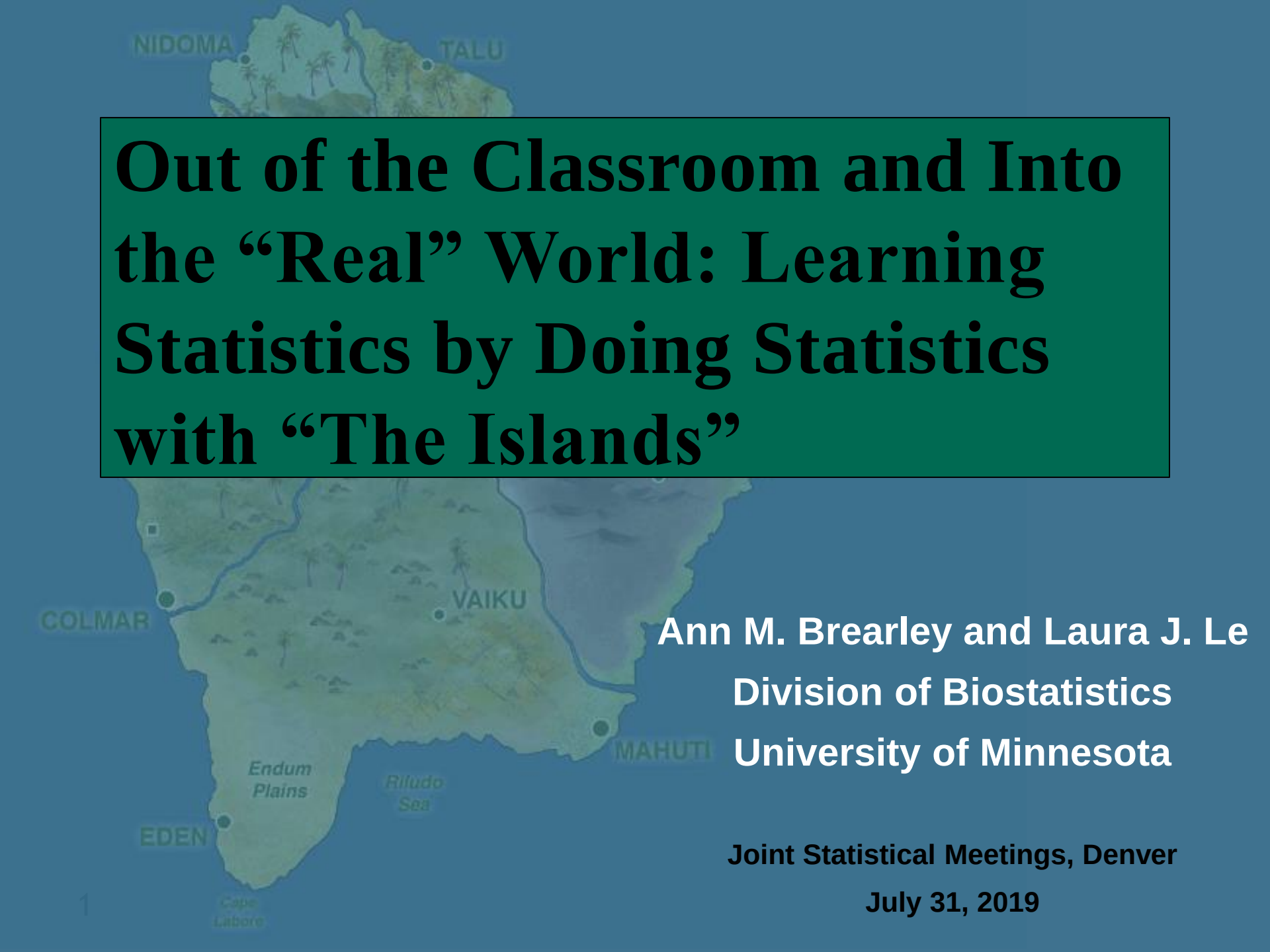

Out of the Classroom and Into the "Real" World: Learning Statistics by Doing Statistics with "The Islands"

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Division of Biostatistics

University of Minnesota

Joint Statistical Meetings, Denver

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Outline

- Our courses, students, and teaching approaches
- The Islands – a brief tour
- Islands Projects
  - Structure and timing
  - Example projects
  - Benefits and challenges
- Where to get more info

Our Courses and Students

Courses

- Biostatistical Literacy (PubH 6414)
- Biostatistics I & II (PubH 6450 & 6451)
- Introduction to Clinical Trials (PubH 3415/7415)

Class Format:

In-person

&

Online

Class Size:

25 to 150 Students

Student Background

- PH graduate students
- Health-related graduate students
- Medical and PH professionals
- Undergraduates interested in PH or medicine

Our Teaching Approaches

- Goal: To make our courses (in-person and online) more active, relevant, and effective
  - Partially or fully flipped courses
  - Active learning in the classroom
  - Collaborative answer keys for activities
  - **Group projects using The Islands**

Islands Project Overview

- Students work in groups to **design**, **conduct**, **analyze, and report** results of a study using the virtual world of The Islands.
  - Groups of ~2 to 6 students.
  - TAs serve as statistical consultants
- Students present their findings in a **research paper** or **poster session** at the end of the course.

The Islands

- Created by Michael Bulmer (University of Queensland)[1]
  - Originally had one island (called “The Island”)
  - Now has three islands
- We (Univ. of Minnesota, Division of Biostatistics) began using it in 2012
  - Collaborated with Dr. Bulmer to add features to facilitate medical studies (e.g. clinics, hospitals)

1. Bulmer, M., & Haladyn, J.K. (2011). Life on an Island.: A simulated population to support student projects in statistics. *Technology Innovations in Statistics Education, 5*(1). http://escholarship.org/uc/item/2q0740hv

https://theislands.umn.edu/

https://theislands.umn.edu/login.php

Search

THE ISLANDS

Welcome to the home of the Islanders, a virtual human population that has been developed to support learning and teaching in experimental design, epidemiology and statistical reasoning.

The three Islands of Ironbard, Providence and Bonne Santé were settled by the survivors of simultaneous shipwrecks around 250 years ago. The initial settlements have grown and there are now twenty-seven villages with a combined population of over forty thousand Islanders for you to study. Login below to visit them.

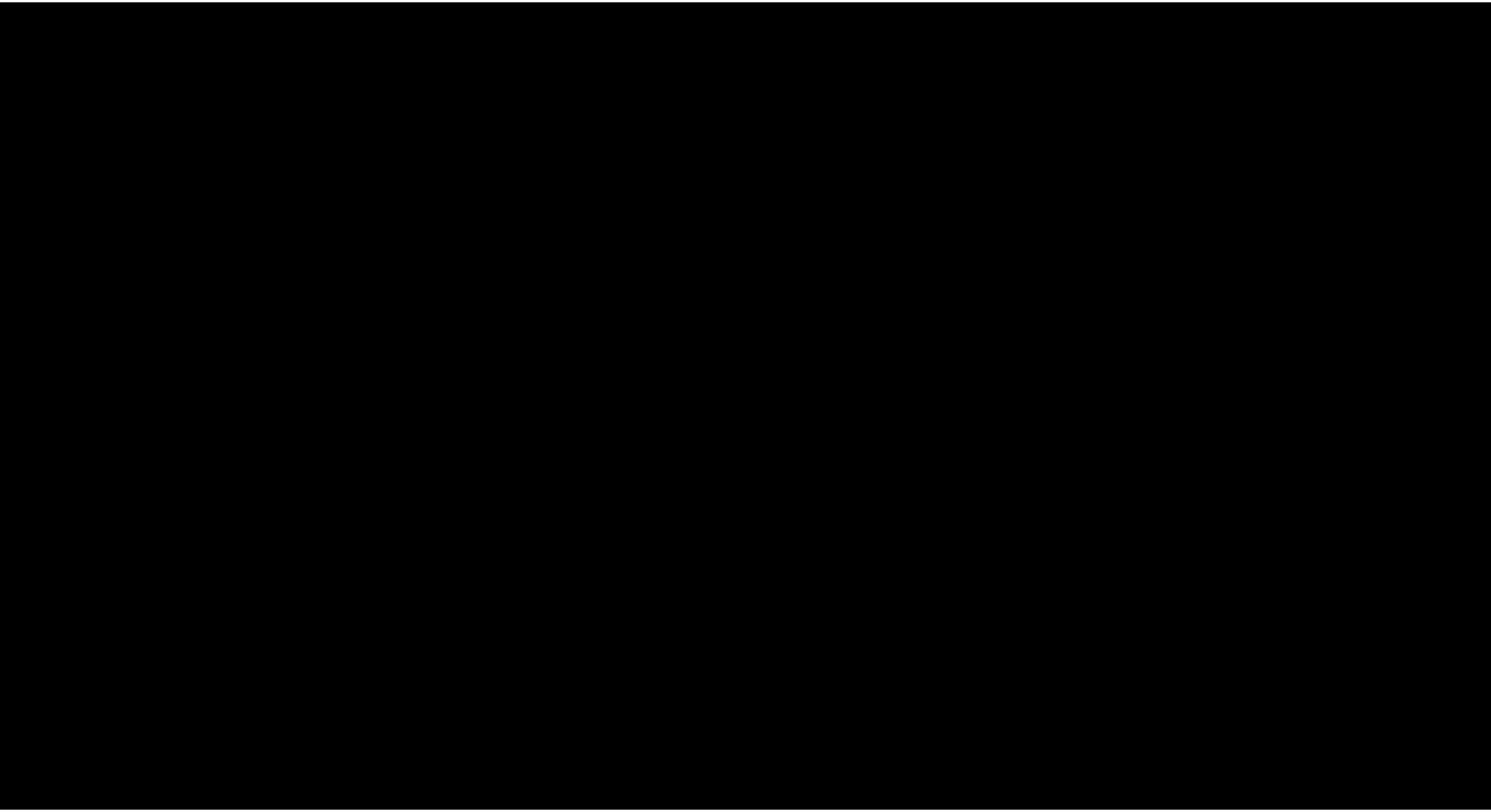
Email Address

Password

Sign In

Need to set or reset your password?

Brief Video Tour of The Islands (5:13)



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Islands Project Structure and Timing

Week	Activity
1	Islands exploration activity
2	Journal of Island Studies activity
3	Formulate research question
4	Carry out pilot study
5	Finalize study introduction and methods
6-7	Data collection
8-9	Data analysis (by TA/consultant, for the literacy class)
10-11	Finalize study results and discussion
12-14	Prepare presentation
15	Presentations to the class

Islands Project Examples

- Effects of Methamphetamine on Cognitive Function in Young Adults
- **RE-WINE**: The Effect of Red Wine on Serotonin Release
- **YIKES!** Youth Islander Knowledge Enhancement Study [Effect of Dextroamphetamine on Arithmetic Performance]
- Effects of Smoking on Pulmonary Functioning and Exercise Tolerance
- The **DREAM** Study: The Effect of Different Exercise Assignments on Melatonin

Short-Term Effect of Exercise on Serotonin in Islanders (STEESI)

John Stansfield, Nicole Cairns, Tom Madsen, Annie Deng and Justin Williams
University of Minnesota, USA

Abstract

The purpose of the STEESI study is to examine the effect of aerobic exercise on blood serotonin levels in a randomized intention-to-treat clinical trial. Participants were divided into three treatment groups, including a 100 meter run treatment, a 1 kilometer run treatment, and a non-exercising control group. Blood serotonin levels were measured before and after treatment. Analysis showed a significant increase in serotonin levels between both experimental groups compared to the control group. However, there was no significant difference between the two experimental groups.

Introduction

According to the National Institute of Mental Health (NIMH), "major depressive disorder affects approximately 14.8 million American adults, or about 6.7 percent of the U.S. population age 18 and older in a given year." Multiple studies have previously shown exercise's effect on depression, providing promising results implying exercise may be a future treatment option for individuals with moderate to severe depression (Dey). One of the hypothesized mechanisms for exercises effectiveness is monoamines, such as serotonin (Brosse). Many antidepressants (Zoloft and Prozac) target serotonin receptors to block the reuptake of serotonin at 5HT receptors (Lacasse). Serotonin has been shown to have a close linkage to happiness by neuroscientists (Inglehart).

Serotonin levels have been studied in conjunction with exercise directly in animal models

Methods

Participants

Participants were recruited from The Island cities of Moorfield, Black Beach, Macondo, Point Dubois, and Edwardton. Fifteen to sixteen people from each town were asked to participate in the study with an attempt to recruit men and women equally. A randomization schedule was produced before the recruitment and assignments were given based on the order that they gave consent. The participants were required to be between the ages of 18 and 80. This age range was chosen to sample people who are considered healthy and not at increased health risks associated with running 100m or 1k. One person per house was asked. Sample size per group was calculated using an alpha of .0167 and a beta of 0.134. This provided the ability to detect a difference of 5 ng/mL between treatment groups in our study with 86.6% power. To detect this difference a sample size of 78 was needed. Therefore, 78 participants were randomized into three groups of 26 people each. To insure that there were equal numbers of men and women, 39 men and 39 women were given separate randomization schedules into the three groups. The testing took place between 1 and 4 pm. The following measurements were recorded: age, sex, serotonin before and after the treatment, and run time.

Statistical Methods

After initial and final blood serotonin levels were measured, the difference between the two measurements was computed. This difference, calculated as the final serotonin level minus the initial serotonin level, was treated as the response variable. One-way fixed effects ANOVA was performed to compare the mean change in serotonin between the three treatment groups, followed by t-tests to compare the control group mean to the mean of the exercise groups and to compare the exercise groups to each other. The same analysis was performed for each gender subgroup. Additionally, an ANOVA was performed to examine the distribution of age and baseline serotonin amongst groups and sexes. Linear regression was performed to observe the effect of age on change on serotonin levels. An additional linear regression was performed to observe the effect of run time (a surrogate for baseline fitness) on change in serotonin levels. This regression was performed separately within both exercise groups. Data was initially collected in Excel and subsequently analyzed in R.

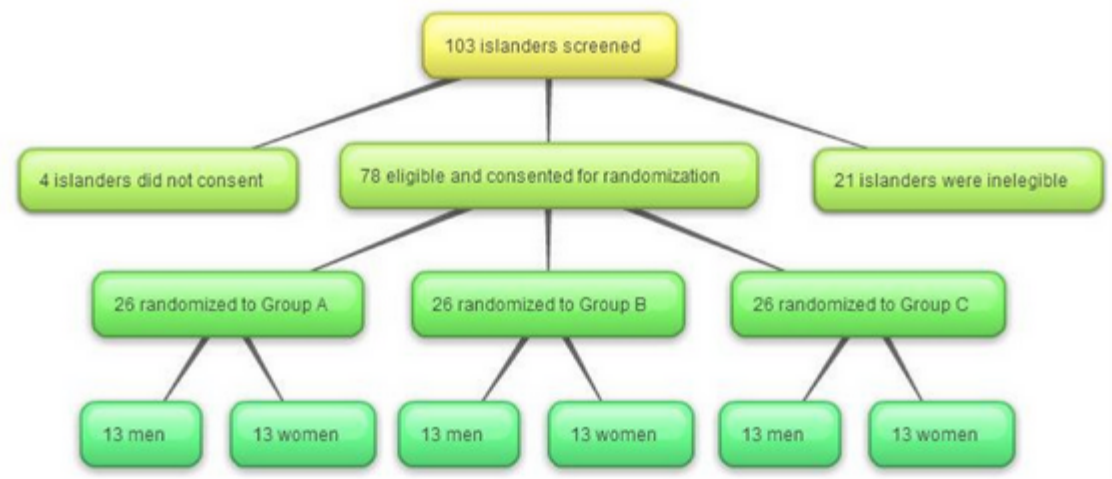
Randomization

The block permutation method was used in SAS to randomize participants. The block sizes alternated between three and six. Two strata (men and women), of nine blocks each, was used. Within each block there was an equal number of the three groups. Within each

Results

Participant Flow

103 island residents were initially screened. Four residents declined to consent for the study and twenty-one were ineligible. The remaining 78 participants were enrolled and randomized to one of the three treatment groups. There was no missing data or loss to follow up. Thirteen men and thirteen women were randomized to groups A, B, and C respectively. There were no losses and exclusions after randomizations. All randomized participants were analyzed. There were no significant differences in baseline characteristics between groups according to ANOVA analysis (Table 1). An overall significance level of 0.05 was employed for all statistical tests.



Baseline

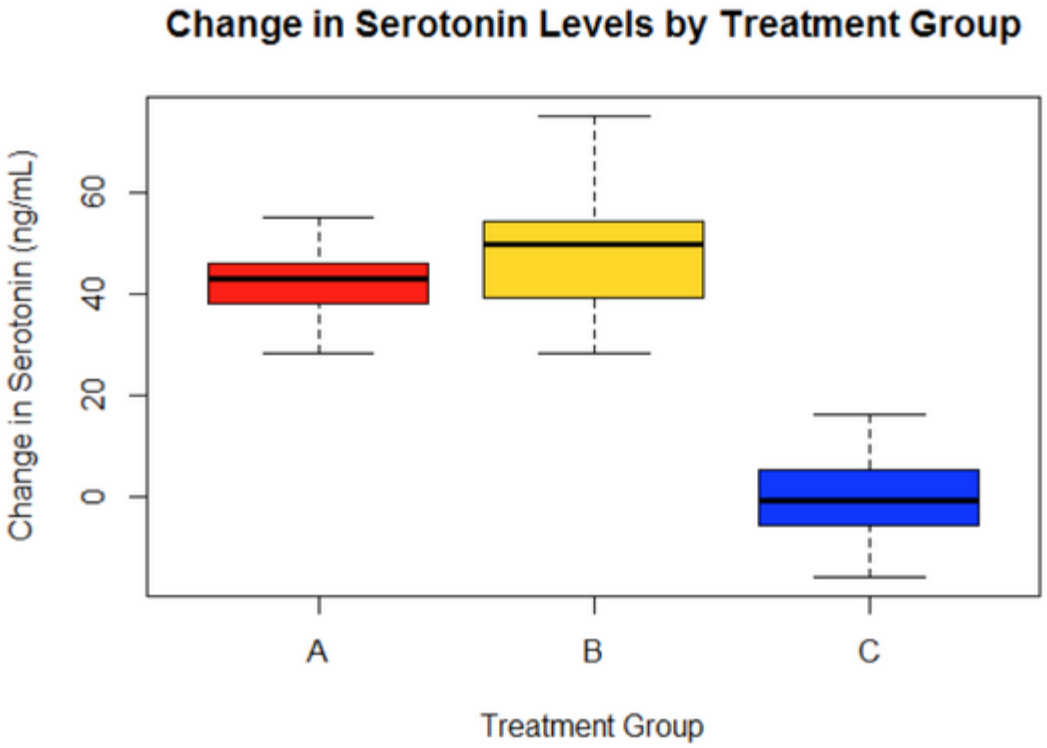
The ANOVA performed on the baseline characteristics suggests that there were no significant differences between treatment groups at baseline (Table 1). Therefore the observed response differences were assumed to be due to the treatment.

Characteristics	100m	1km	Control	ANOVA
Age (years old) Mean (SD)	34.7 (12.4)	37.7 (14.6)	38.2 (15.1)	*p*=0.63
Baseline Serotonin (mg/mL) Mean (SD)	219.4(33.5)	218.2(37.3)	215.7(30)	*p*=0.92

Table 1. Baseline characteristics comparison of the three treatment groups, stratified by gender

	100m	1km	Control
Serotonin Change Mean (SE)	42.15 (1.38)	47.5 (2.22)	-0.807 (1.57)

Table 2. Mean (standard error) serotonin change in each of the treatment groups.



Discussion

These results provide evidence that short-term aerobic exercise increases serotonin, as hypothesized. This result held regardless of the distance run. This knowledge could be used to treat patients who can't run long distances - it appears that any exercise is better than none. In addition, or instead, of prescribing anti-depression drugs, doctors may be able to use exercise as a treatment for depression. Due to the fact that our participants are both males and females that have a mean age of 34 (± 12) our conclusion of exercise increasing serotonin levels can be generalized across the overall healthy adult population (Table 1). Although we did not obtain a random sample of Islanders, we believe that our results can be safely generalized to the adult Island population.

However, due to the study design, the experiment can only comment on the instantaneous effect of aerobic exercise on serotonin levels. It is not possible to extrapolate the long lasting serotonin effects on individual participants. Also, due to island limitations all participants could not be given identical run times. Therefore, run times could not be standardized. It is also not possible to give the islanders a nontrivial task for 4 minutes during the control time period, and it is possible that some islanders chose to exercise of their own free will during that time. Some possible sources of bias include researcher bias due to the inability to blind the team collecting the data from the islanders.

In addition, sources of imprecision existed due to variability in run time since final blood serotonin level were taken immediately after completing the distance run. For the 100m run this averaged around 21.7 seconds and for the 1k run this averaged around 3.8 min. A possibly more objective analysis of running is to have all participants run the same amount of time regardless of distance completed. Other sources of imprecision arose from small sample size. With a larger sample size there may be detectable difference between short distance and long distance aerobic exercise.

Potential future studies include studying the effects of other exercise durations than those studied in STEESI. The "dose-response" effect of aerobic exercise on serotonin levels over time could be further examined by taking multiple measurements at specified time intervals. Yet another study could be done to see if recurrent exercise has a lasting effect on serotonin levels. However, before using exercise as additional treatment for depression, a relationship between blood serotonin and brain serotonin, which is the serotonin level that affects depression, has to be shown.

Citations

Benefits for Instructors

- **Addresses GAISE recommendations**
  - Students collect and analyze their own real data to answer their own research question.
- **Improves teaching**
  - Brings out issues students are having difficulty with (e.g. random sampling vs. random assignment).
  - Provides a built-in example to use in explanations.
- **Makes instructor-student relationship more collegial**
  - Instructors/TAs become statistical collaborators. (Instructor doesn't know 'the answer'!)
  - Vastly increases the amount of non-homework-, non-exam-related interaction with students.

Benefits for Students

- **Apply the concepts and methods** they learn in class to a “real” study.
  - Study design, sampling methods
  - Collecting and organizing (and cleaning!) data
  - Analysis and interpretation

- **Learn the necessity of teamwork** to carry out a research study.

Benefits for Students

- **Choose** their **unique** research question.
- Experience the entire **research process**.
  - See where statistics fits in a research study.
- Gain experience **presenting**.
- Forget that the Islanders are not **real**.

> *"The results from the pilot study indicated that the islanders did not behave like normal individuals. [Their behavior] disagreed with the literature."*

Learning Moments: Examples

- **Challenges in data collection:**
  - Losing study participants when they were discharged from the hospital and can't be found
  - Missing data when one student in the group forgets to take the measurements one day
- **Challenges with Islanders:**
  - Sleep at night
  - Can refuse to consent to your study
  - Can tell lies (in the interview and survey features)
- **Challenges in data management and analysis:**
  - There is no study database on the Islands for collecting all History information for study participants.
  - Nor is there any built-in analysis software.

Challenges

- Island projects can be time intensive for the students (and for the TA/consultants and the instructors).
- Students sometimes find group work challenging.
- Students' lack of knowledge of advanced methods (e.g. for correlated data) can constrain the types of studies they can do.

More information:

- Minnesota's mirror site:
  - https://theislands.umn.edu/
- Instructor access (to Minnesota mirror site):
  - Email your name, email, institution and department to theislands@umn.edu to be added to the instructor list
- Additional materials can be found in this Google Drive folder:
  - https://tinyurl.com/JSM2019-IslandsProject
  - Contents:
    - These slides
    - The *Islands Exploration Activity* worksheet
    - An *Islands Project Overview*

Acknowledgements

- UMN Biostatistics & Statistics instructors
  - Lynn Eberly, Rob Leduc, Greg Grandits, Susan Telke, Marta Shore, Barbara Kuzmak, Georgia Huang, Julian Wolfson
- Collaboration with U. Queensland
  - Led by Susan Telke and Sara Hurley
- Technical support
  - Sara Hurley (SPH Director of E-learning Services)
  - Chris Campbell, “Island(s) RA”

Questions?