

# Stats 101B Final Project

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## Introduction

As an athlete, I know that when I have been running around, my decision-making is impeded. In ultimate frisbee, which is my sport, making good decisions as to where to throw the disc is incredibly important. During a long point where I feel physically fatigued, I lose the ability to think straight, and feel mentally fatigued as well. As such, I wanted to put this phenomenon to the test in an experiment.

**Research Question:** Will students score lower on an IQ test after running a 1K?

For this experiment, students will take an IQ test, then run a 1K, then take another IQ test. My expectation is that students will, on average, score lower on the second IQ test than the first. This would align with my own real-world experiences with mental fatigue in sports. If there were a statistically significant mean difference between the two IQ test scores, there would be statistical evidence to suggest that students will score lower on an IQ test after running a 1K.

## Design of Experiment

For this experiment, I am choosing to use a randomized block design. Specifically, I am using a paired comparison design, since each student does the IQ test twice. Thus, the results are paired. I chose this design because there is only one factor of interest in my experiment: whether the test was taken before or after the 1K. Everything else in the experiment is controlled for, so we can tell exactly what is causing a difference in the data. Of course, there are things that we can't control for, which could cause confounding variables, but that will be discussed later in the limitations section.

I randomly sampled 30 students from Hofn University for this experiment. The way I did this was by numbering the students from Hofn University 1 to 356 and running a random number generator in R to choose the students. For each of the students who declined to participate, I just ran the random number generator again to choose someone else. I chose to only do students from Hofn University because I wanted to make a conclusion specifically about students and I was concerned there may be discrepancy in the intelligence or fitness level of students from different universities.

## Justification of Sample Size

```
> pwr.anova.test(k = 2, n = 30, f = 0.657, sig.level = 0.05)

Balanced one-way analysis of variance power calculation

      k = 2
      n = 30
      f = 0.657
sig.level = 0.05
power = 0.99883

NOTE: n is number in each group
```

Using power analysis with parameters  $k = 2$ ,  $n = 30$ ,  $f = 0.657$ , and  $\alpha = 0.05$ , we get a power level of 0.9988, which is sufficiently large and justifies our sample size of 30.

## Results and Interpretation

### Data

After running the experiment, this is what the collected data looked like:

Name	IQ before	IQ after
Cariel Blomgren	104	94
Madison Brown	121	116
Klemens Brunner	127	115
Tracey Cameron	136	125
Felix Carlsen	86	79
Pierrick Carlsen	110	101
Jarroed Edwards	117	106
Magnar Eklund	111	100
Nils Hahn	90	77
Mimi Hall	119	113
Nico Ibsen	94	85
Theresa Ibsen	103	94
Beatrix Kunz	116	107
Kirsten Lenz	111	107
Valerie Mori	99	97
Silvia Pfeiffer	139	129
Franck Prevost	85	79
Gunnar Reainhardt	100	94
Grace Sato	87	82
Brenda Solberg	128	119
Brigit Solberg	106	98
Dahl Solberg	100	93
Jorn Solberg	110	105
Thurston Solberg	94	85
Tobias Solberg	94	92
Hanne Sorensen	99	92
Sonja Sorensen	117	113
Souta Suzuki	82	78
Maya Wilson	116	105
Tatsuya Wilson	132	124

After putting the data in R, we can see the group means:

```
> iq <- c(104, 121, 127, 136, 86, 110, 117, 111, 90, 119,
+         94, 103, 116, 111, 99, 139, 85, 100, 87, 128,
+         106, 100, 110, 94, 94, 99, 117, 82, 116, 132,
+         94, 116, 115, 125, 79, 101, 106, 100, 77, 113,
+         85, 94, 107, 107, 97, 129, 79, 94, 82, 119,
+         98, 93, 105, 85, 92, 92, 113, 78, 105, 124)
> when <- c(rep("before", 30), rep("after", 30))
> data <- data.frame(iq = iq, when = when)
>
> require(Hmisc)
> summary(iq ~ when, data = data)
iq      N= 60

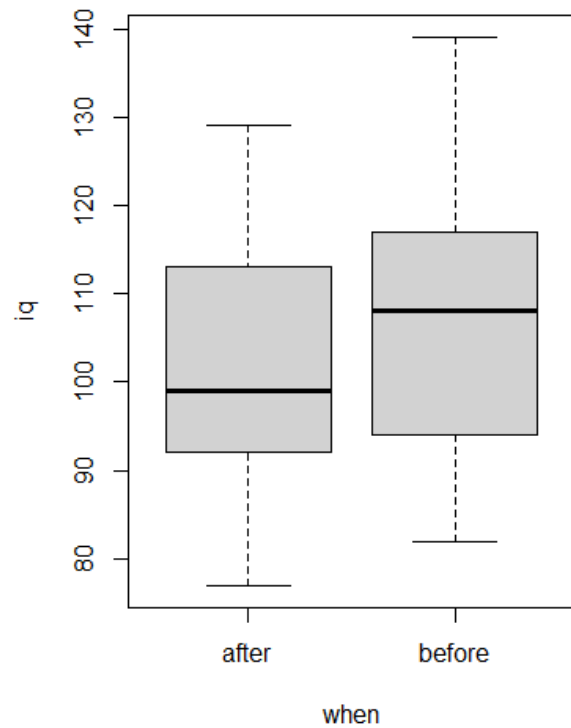
+-----+-----+--+-----+
|      |      | N |      | iq |
+-----+-----+--+-----+
|  when| after|30|100.1333|
|      |before|30|107.7667|
+-----+-----+--+-----+
|overall|      |60|103.9500|
+-----+-----+--+-----+
```

## Results

```
Paired t-test

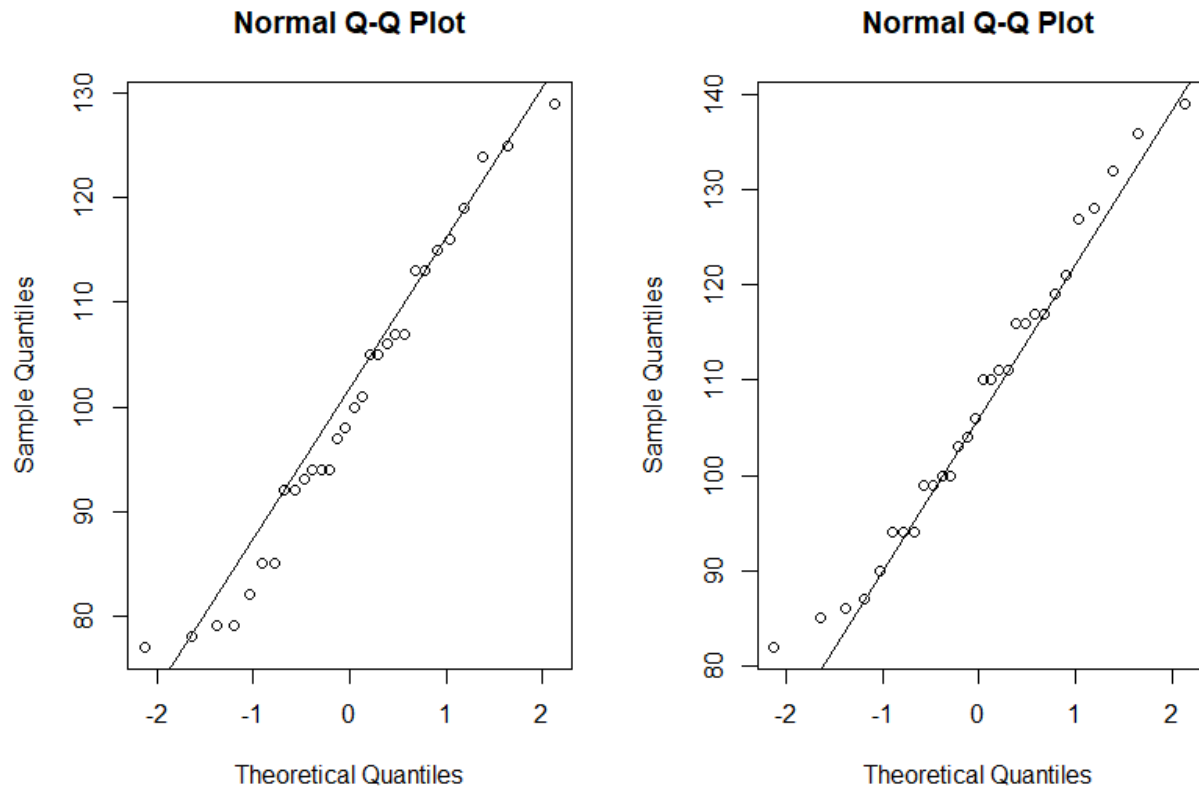
data:  iq by when
t = -14.269, df = 29, p-value = 1.209e-14
alternative hypothesis: true mean difference is not equal to 0
95 percent confidence interval:
 -8.727423 -6.539243
sample estimates:
mean difference
 -7.633333
```

In the results of the above t-test, we can see that the estimated mean difference is -7.63 between the two groups. The 95% confidence interval does not include 0, suggesting that the true mean difference is not equal to 0. Furthermore, the p-value of  $1.209 \times 10^{-14}$  is well below the significance level of 0.05. Therefore, we have statistical evidence to suggest that the true mean is not equal to 0. We conclude that students will score lower on an IQ test after running a 1K compared to before.



The boxplot supports the above conclusion that students will score lower on an IQ test, as each quartile in the after graph is lower than in the before graph.

## Normality Assumption



Based on the normal QQ plots, we can see that the data is approximately normally distributed, and we confirm the normality assumption.

## Discussion

Using a paired comparison design, we ran an experiment to see if students would score lower on an IQ test after running a 1K. From the collected data, we ran a t-test to compare the means of each group, and found that there is statistical evidence to suggest that students will score lower on an IQ test after running a 1K.

This makes sense based on my real-world experience. The experiment suggests that the mental fatigue I experience while playing ultimate frisbee is a result of the physical fatigue from running around.

There were some limitations of the experiment. First, the islanders did have the option of declining participation in the experiment, meaning that the sample we used is a biased sample. The islanders essentially volunteered in the experiment. Also, there are potential confounding variables that we did not control for, such as diet, sleep, and other potential sources of mental fatigue.