

External Factors on Performance via Reaction Time Testing

Ian Chen

2025-05-01

1 Abstract

Purpose: In this study, we investigate the effect of lifestyle and mental state on students' mental acuity. We also characterize a set of confounders which play into one's environment. **Methods:** We conduct a survey for the students of an introductory statistics class at the University of Illinois, Urbana Champaign. Through ANOVA testing, we determine features of the environment that are significantly correlated with students' reaction time, a proxy for their performance. **Results:** High stress levels were associated with degraded performance on average. However, for athletes, this effect was reversed, with them improving with higher stress. We did not find any association due to fatigue levels, nor distraction-free environments. **Implications:** Stress is commonplace in academic settings, and so there is interest in developing systems to deal with stress. This study shows that we need different priorities when helping athletes and gamers. Moreover, there may need to be a re-evaluation towards the beneficial effects of sleep and distraction-free environments.

2 Introduction

It is common wisdom that a healthy lifestyle is crucial to maintain academic performance. In this study, we explore which indicators are significantly correlated with reaction time, a proxy for their performance.

2.1 Investigative Questions

Here, we have three primary research questions:

1. Does impaired mental state affect students' performance on aim trainers?
2. Are there environmental factors consistent with impaired mental state?
3. Does the above change when taking into account games or sport activity?

3 Materials and Methods

We collect our dataset from introductory statistics students at the University of Illinois, Urbana Champaign. An online survey was posted that all students needed to fill in, and was graded (i.e. it was not anonymized). Students had a week to submit the form, and could do so asynchronously.

All students submitted their scores for their first three attempts. In this study, we will take their median response.

First, we only consider datapoints that have Stable Wifi (so we remove 2 points). Next, to control for disparities in technology, we pre-filter our dataset to only include the input devices for *Mouse* and *Trackpad*. Moreover, to make sure we are not overfitting, we partition into 90% training and 10% testing. Fitting models on the training set, we verify *a posteriori* whether the results are consistent on the testing set. Finally, we conduct a differential study (fitting different models) on each category.

Table 1: Dataset Properties

	Mouse	Trackpad	Total
Training	48	69	117
Testing	6	6	12

After filtering, we have 118 datapoints in the training and 13 entries in the testing set, with marginally more datapoints for the trackpad condition (Table 1).

4 Exploratory Data Analysis

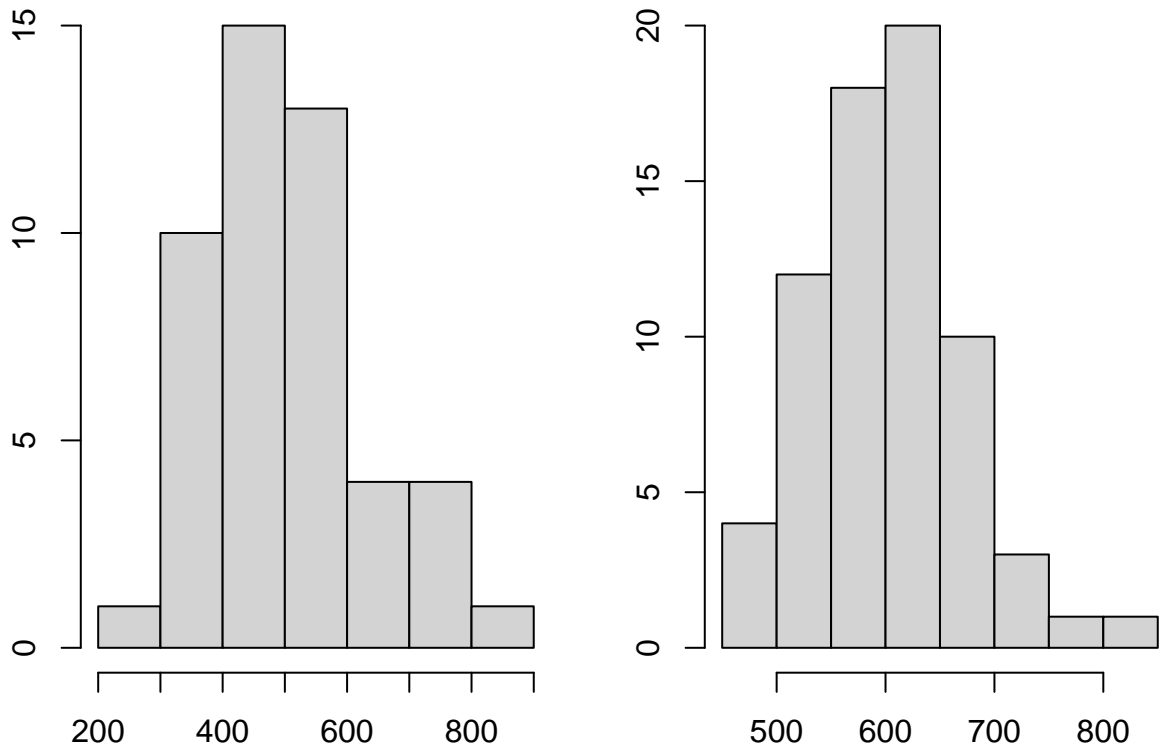


Figure 1: Distribution of Response Variable on the Training Dataset. The x-axis describes the average response time in milliseconds. The y-axis describes the number of results. Left: Using the mouse input device. Right: Using the trackpad input device.

We see that the response variable is roughly normally distributed across all conditions (Figure 1, Figure 2). This is similar for the video game activity, except for the *Mouse* users that seem to play *Video* games more often than other categories (Figure 3).

Since there is only one datapoint for high stress and fatigue, we remove them from our study.

5 Model Building

5.1 Research Question One

We investigate the effect of one’s mental state on their performance, for the *Mouse* condition.

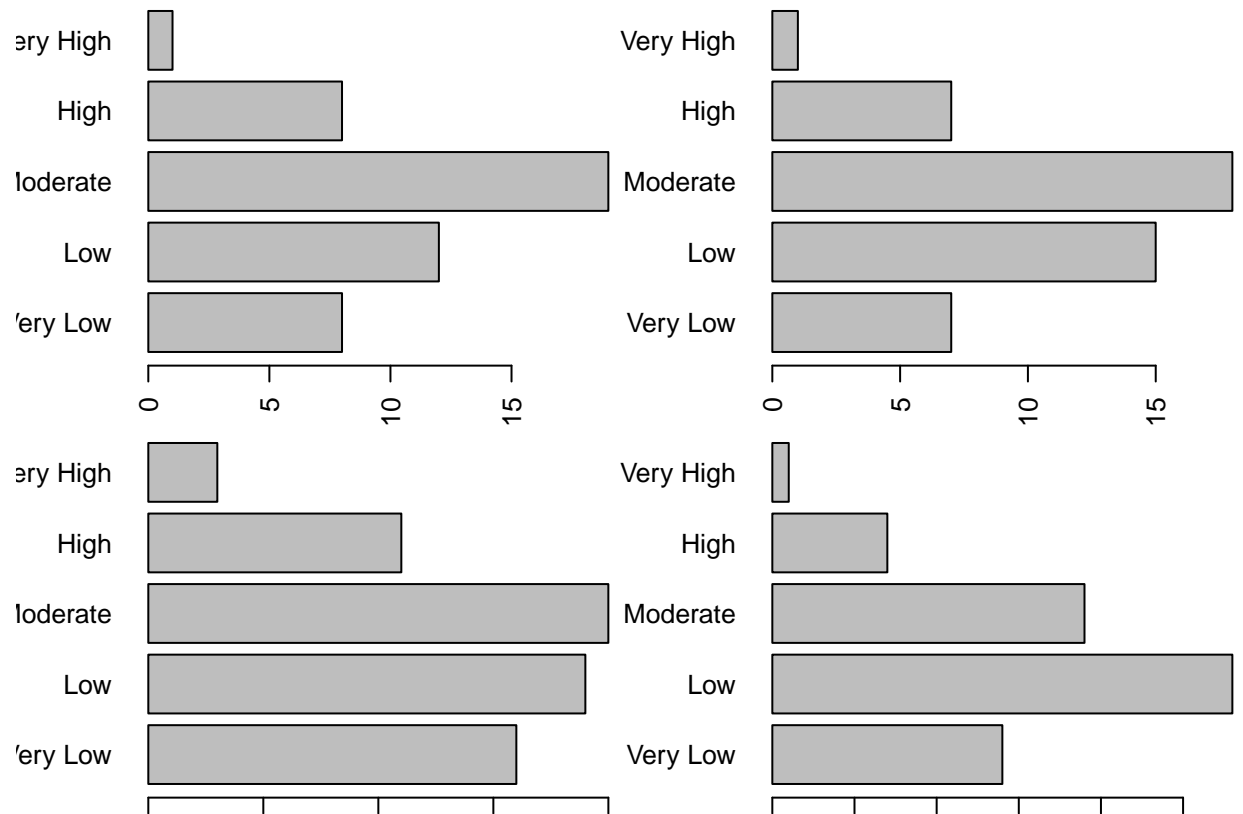


Figure 2: Frequency of Stress and Fatigue on the Training Dataset. The x-axis describes the amount of stress or fatigue, in ascending levels. The y-axis describes the number of results. Top: Using the mouse input device. Bot: Using the trackpad input device. Left: Stress. Right: Fatigue.

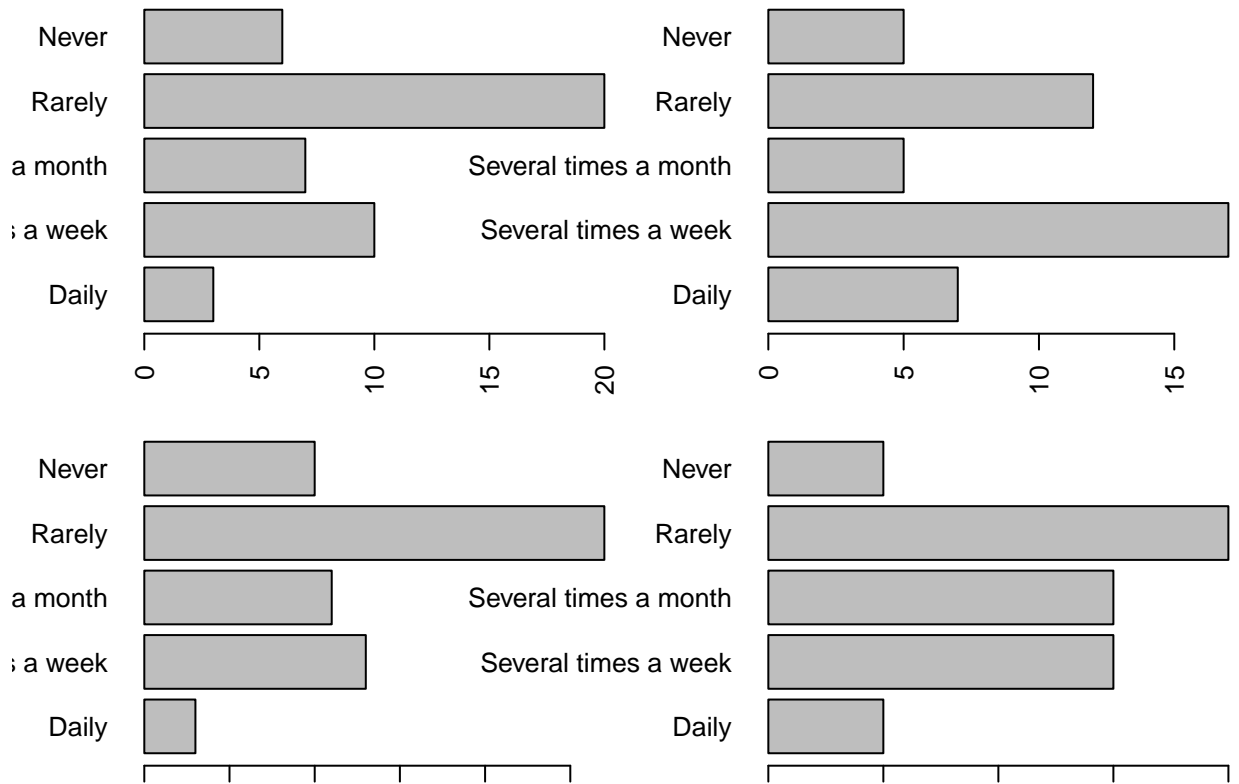


Figure 3: Frequency of Sports and VideoGame Activity on the Training Dataset. The x-axis describes the frequency of performing the activity, in ascending frequency. The y-axis describes the number of results. Top: Using the mouse input device. Bot: Using the trackpad input device. Left: Playing any sort of sports. Right: Playing any kind of video games.

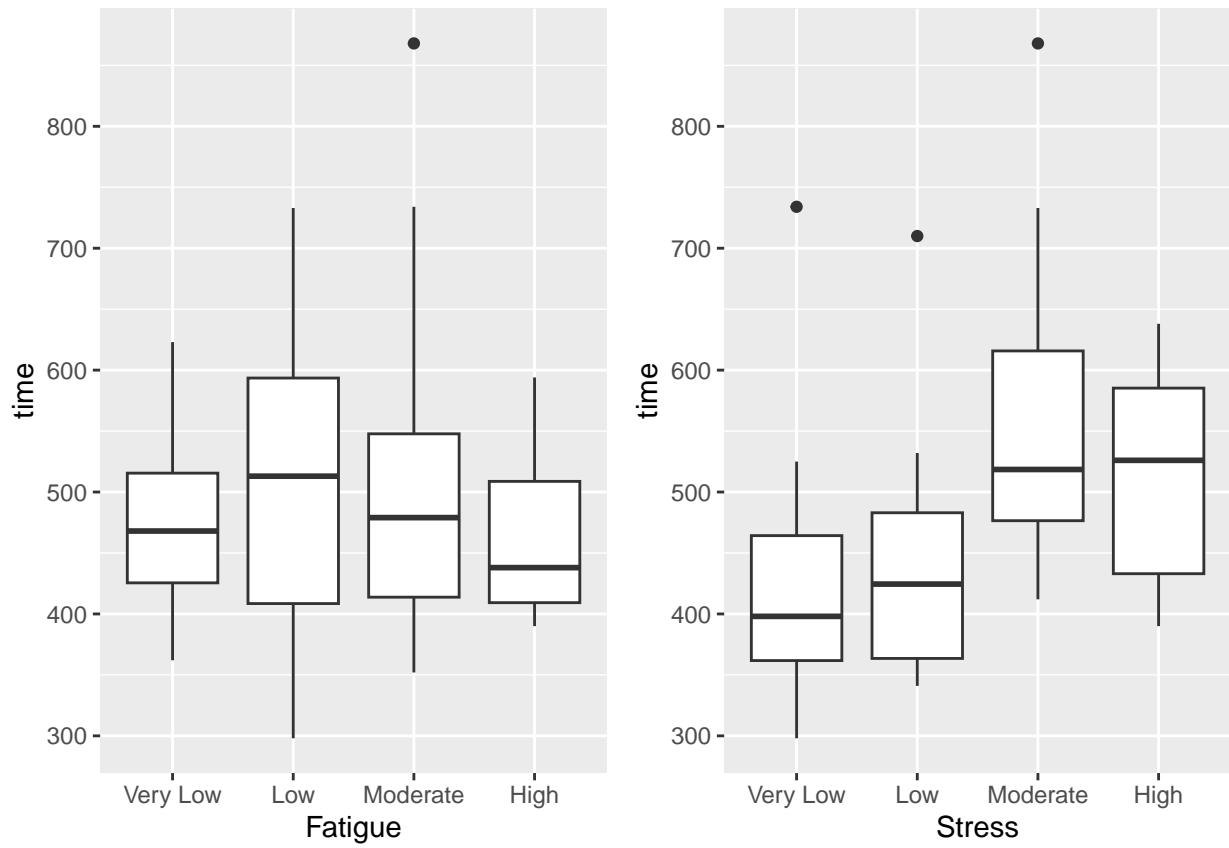


Figure 4: Median response time based on Fatigue and Stress levels. The y-axis shows the median response time across three trials. Left: Increasing Fatigue. Right: Increasing Stress.

Empirically, we see that for mouse users, the larger the reported stress, the slower the response time, but there seems to be a weaker trend with reported fatigue (Figure 4). Indeed, *Stress* is a significant predictor ($p=0.0419$), explaining about 9.1% of the variation. Assigning *Stress* with 1-4 based on the stress level, we fit a model of

$$ResponseTime \sim 397.71 + 37.13 * Stress$$

It appears that the larger one's stress, the slower they react (i.e. worse performance) (for Mouse, $p=0.00851$). However, this same trend does not seem to be the case for Fatigue ($p=0.362$). There are no outliers, determined by studentized statistics ($\alpha = 0.05$, with Bonferroi correction).

5.2 Research Question Two

Now, let us fit a larger model that includes the environmental factors, in addition to the students self-reported mental state. We use *AvgHoursExercise*, *AvgSleepTime*, *LastNightSleep*, *Distraction*, *NoiseLevel*, *Stress*, and *Fatigue* as predictors. With this model, none of the predictors are significant ($p > 0.05$).

Table 2: Variation Inflation Factors for Full Model: Mental State

AvgHoursExercise	AvgSleepTime	LastNightSleep	Distraction	NoiseLevel	Stress	Fatigue
1.083	1.156188	1.152484	1.480969	1.411661	1.196713	1.213703

There are low levels of collinearity for Stress and Fatigue (Table ??). Hence, we conclude that the environmental factors are not predictive one's mental state.

5.3 Research Question Three

Now, let us now consider the effect of sports and gaming activity. First, we shall create a combined indicator variable for the presence of sports and activity, and fit a model with additional interaction terms.

Being active in either video games are significant predictors for response time activity, and they both changes the effect of stress. Indeed, the sequential ANCOVA test confirms this ($p < 0.05$).

The fitted model is

$$ResponseTime \sim \begin{cases} 520.75 + 6.608 * Stress & \text{if not active in sports or games} \\ 732.78 - 88.29 * Stress & \text{if active in sports but not games} \\ 217.37 + 104.05 * Stress & \text{if active in games but not sports} \\ 429.28 + 9.153 * Stress & \text{if active in both} \end{cases}$$

5.4 a posteriori Validation

6 Discussion and Conclusion

In this study, we evaluated the effect of student's reported mental state as well as environmental conditions on their performance on an aim-trainer game, a proxy that we use for their mental acuity. We found that their Stress levels had a strong influence, where higher stress on average led to worse mental acuity on average, but their Fatigue level was not significant (RQ1).

We did not find any association between their Stress or Fatigue levels based on their lifestyle and environmental factors (RQ2). This is surprising, because one might expect a distraction prone and noise-heavy environment to inhibit student performances. In the future, we may have to re-evaluate what it means to have a healthy and supportive environment.

Most surprising was the differential effect on student gamers and athletes (RQ3). For those who are active in sports, they tend to improve (faster response time) when reporting high stress. For those who are active in

games, they tend to get worse (slower reaction time) when reporting high stress. Further research is needed to determine if this trend is a coincidence or can be generalized.