Oxygen and Cognitive Abilities:

The Effect of Oxygen Percentage on Reading Comprehension

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Literature Review

The Brain:

- As brain activity increases during mentally challenging tasks, there is evidence of an associated increase in the metabolic demands of neural tissues (Williams et al.)
- The energy required by the brain is dependent on the oxidative breakdown of glucose (Ho-Jun Seo et al.)

Hypoxia:

- It has been well established that hypoxia impairs mental function (Williams et. al)
- There is evidence that brief hypoxia has a larger negative affect on cognitive performance than longer-term hypoxia (Ho-Jun Seo et al.)

Hyperoxia:

- Both young adults and elderly adults have enhanced mental performance when oxygen concentration increased (Kim, Hyun-Jun et al.)
- Intellectually disabled individuals have enhanced mental performance when oxygen concentration increased (Kim, Hyung-Sik et al.)
- Even inhaling less than 10% more oxygen has improved participant accuracy (Chung et al.)

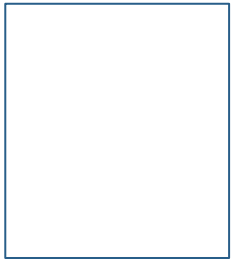
Research Questions

- What effect will oxygen level and exposure time have on the Islanders' reading comprehension levels?
- Are these effects statistically significant?
- Is there an interaction between oxygen level and exposure time?

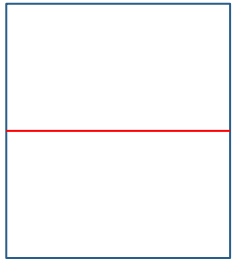
Design

- Two-Way Randomized Block Design

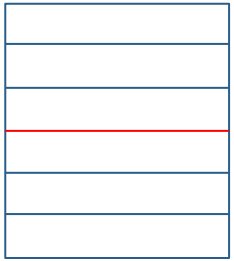
Response	Reading Comprehension Score		
Treatment 1 (Oxygen Level)	15%	Normal	40%
Treatment 2 (Exposure Time)	10 minutes	20 minutes	30 minutes
Block (Gender)	Male		Female



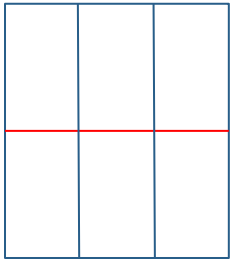
Benchmark
D.F = 1



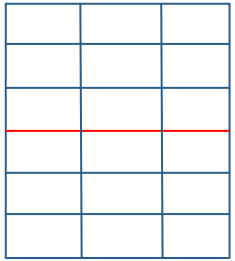
Block (Gender)
D.F = 1



Oxygen Level
D.F = 2



Exposure Time
D.F = 2

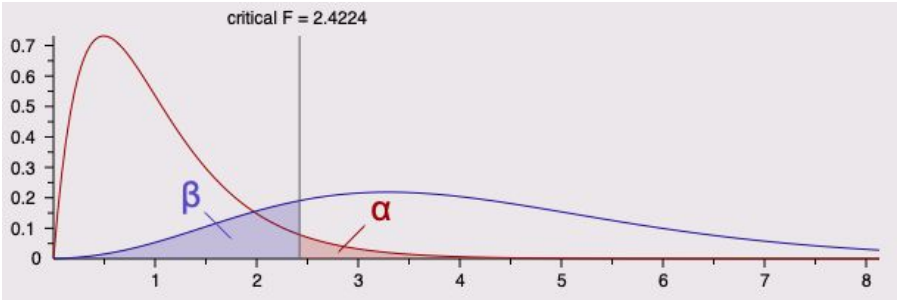


Interaction between
Oxygen Level and
Exposure Time
D.F = 4

Sampling Methods

Sample Size Determination

- Power = 80%
- Alpha = 0.05
- Effect Size = 0.25
- Sample Size = 197
- Rounded up to 198 to have 18 groups of 11 for a balanced design

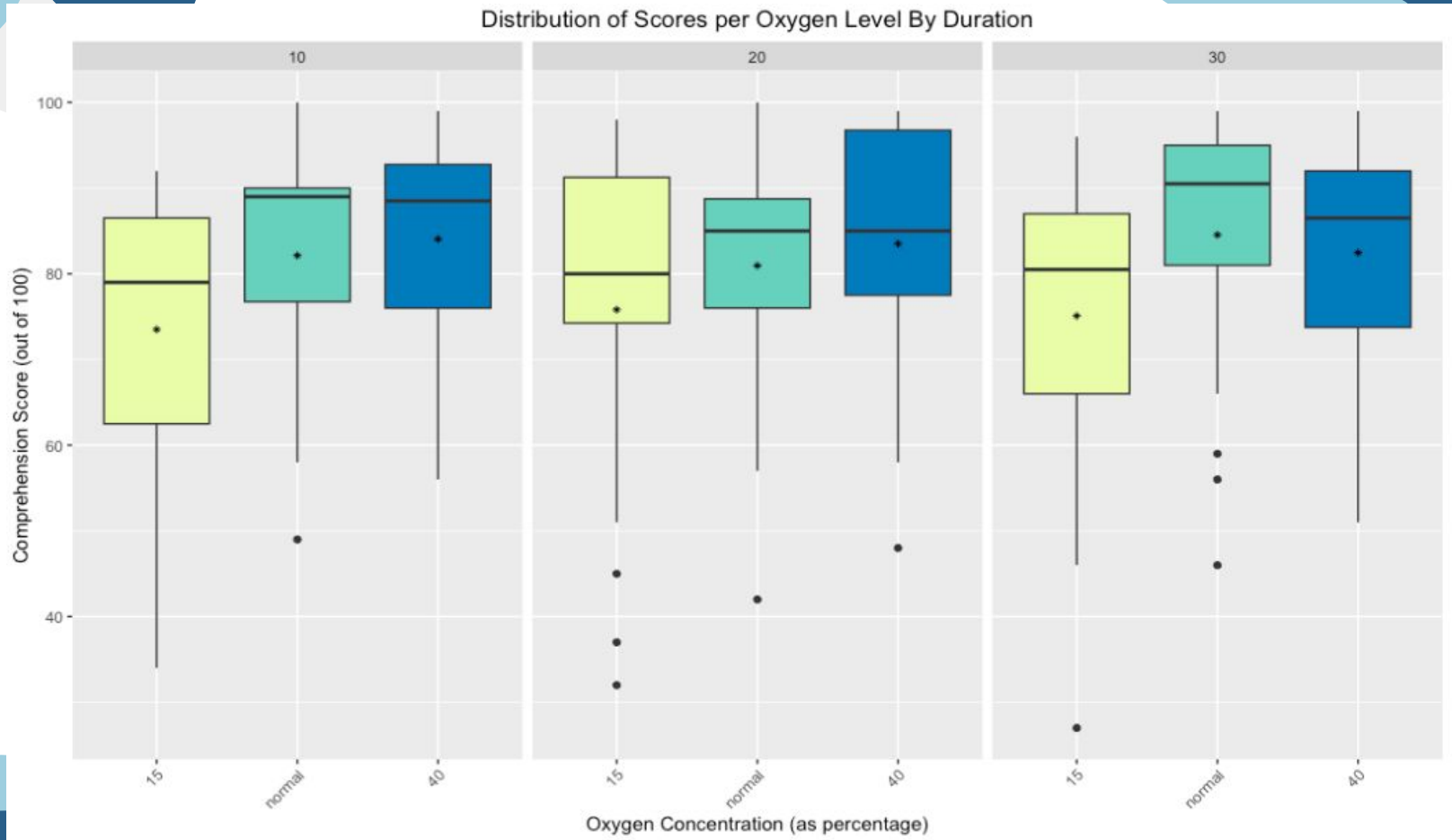


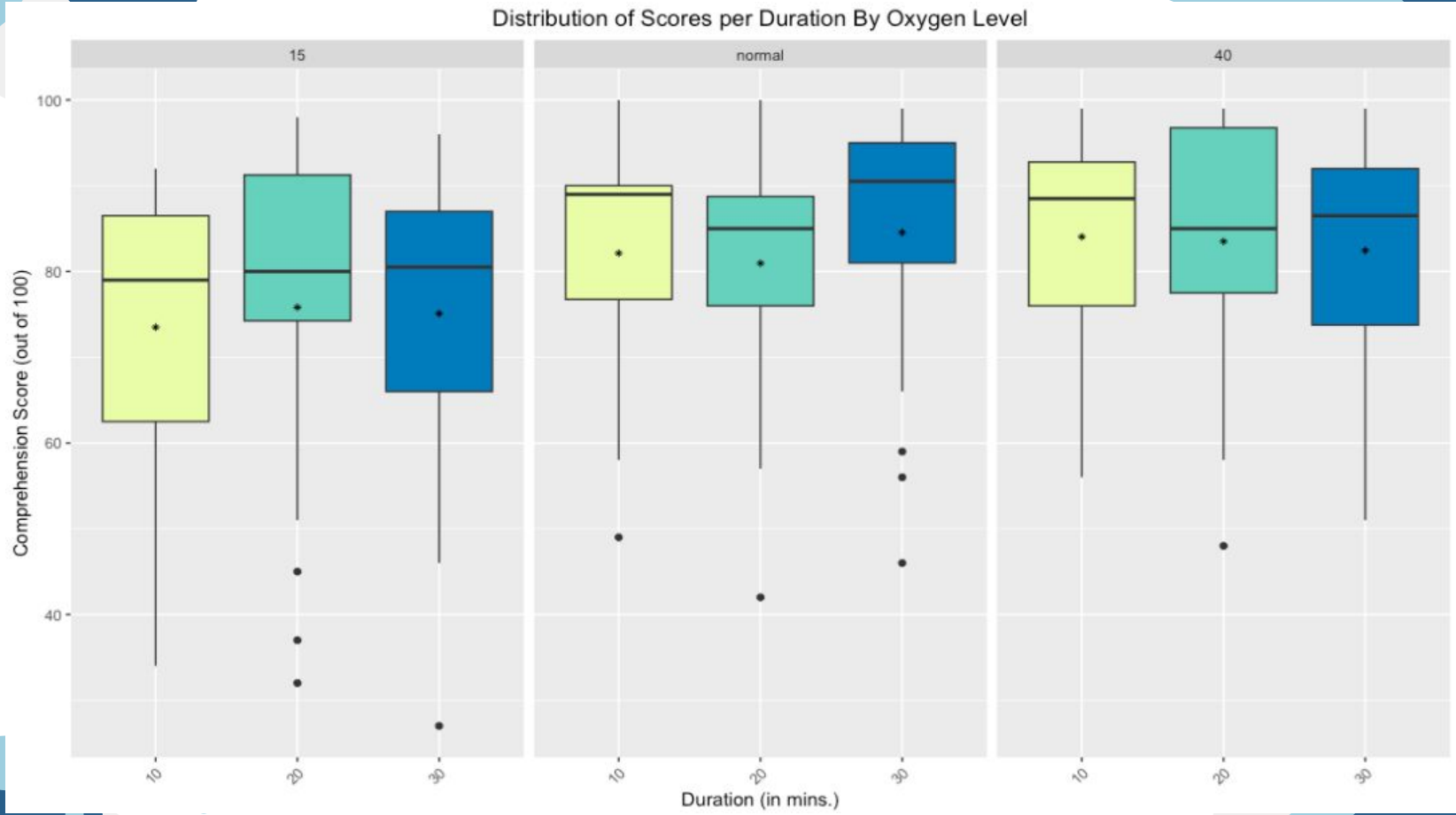
Sampling Method

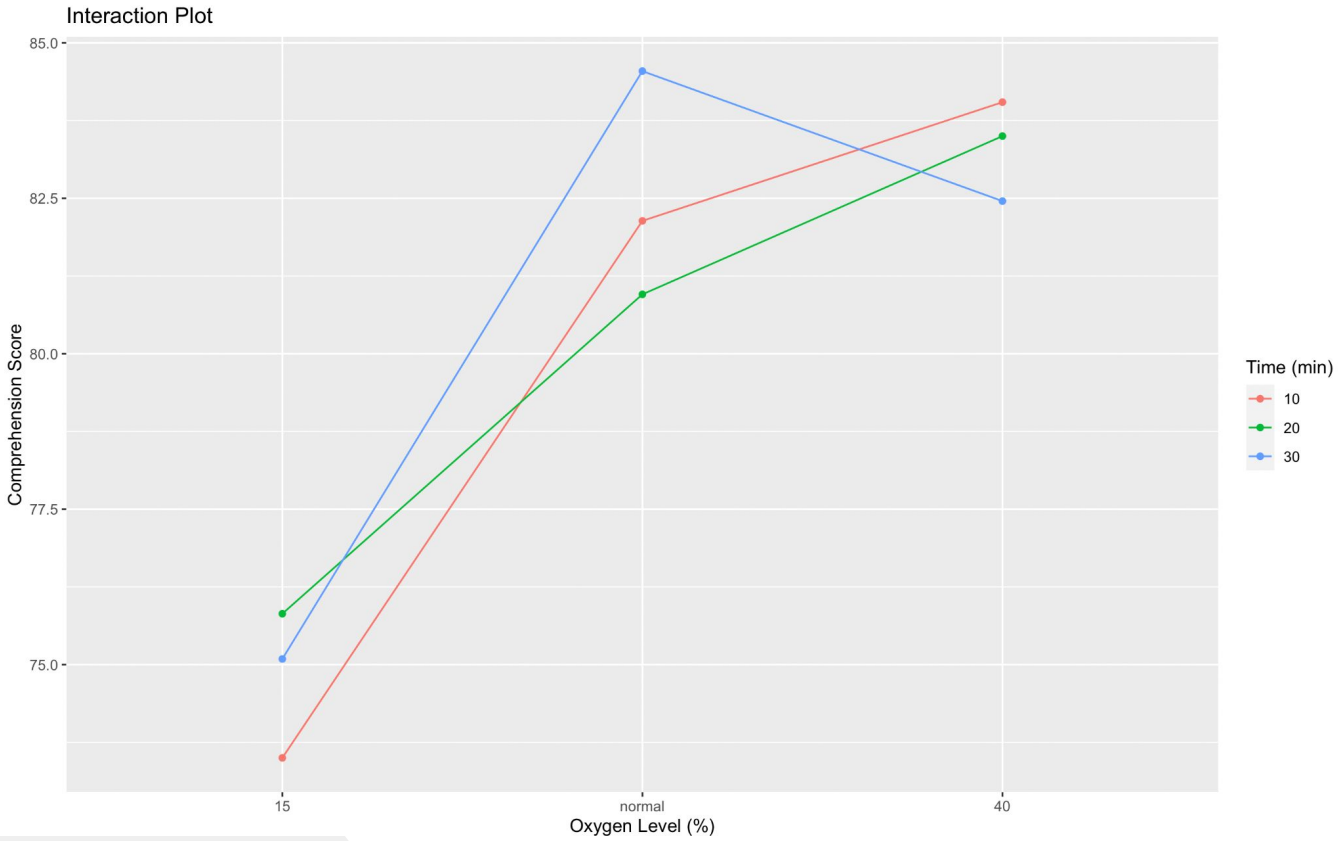
- Randomly selected 1 of 3 islands using random number generator
- Randomly selected four cities within the island of Ironbard
- Randomly selected a house within the city
- Randomly selected of-age individuals within a house
- Repeated bullets 3 and 4 until we had 99 males and 99 females

Methods

- Used R to randomly assign 11 individuals to each treatment group (ex. 11 islanders at 15% at 20 mins, 11 islanders at 40% at 30 mins, etc.)
- Perform the treatment for each individual in their particular treatment group
- Measured comprehension level right after performing the treatment
- Utilized R to perform data analysis


Distribution of Scores per Oxygen Level By Duration
10
20
30
100
80
60
40
Comprehension Score (out of 100)
15
normal
40
Oxygen Concentration (as percentage)

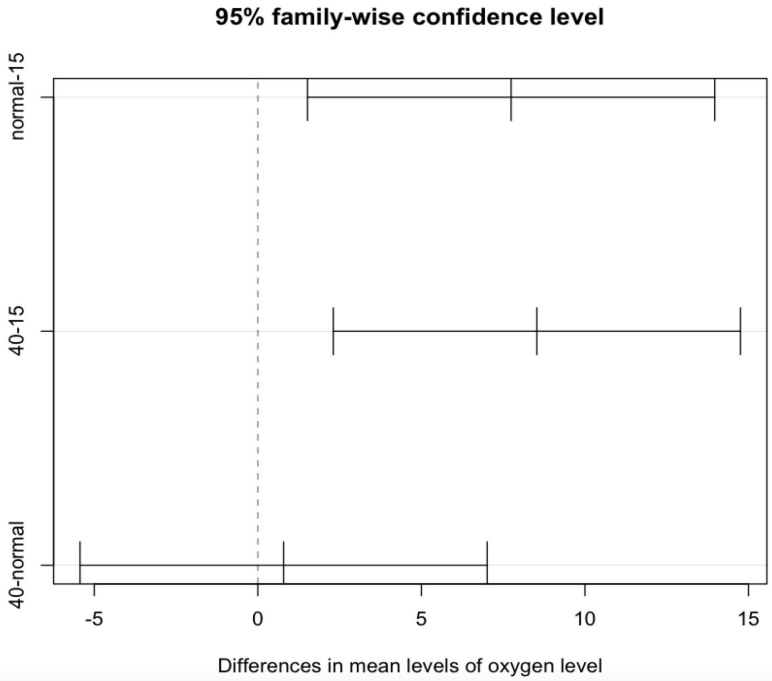

Distribution of Scores per Duration By Oxygen Level
15
normal
40
Comprehension Score (out of 100)
100
80
60
40
10
20
30
Duration (in mins.)

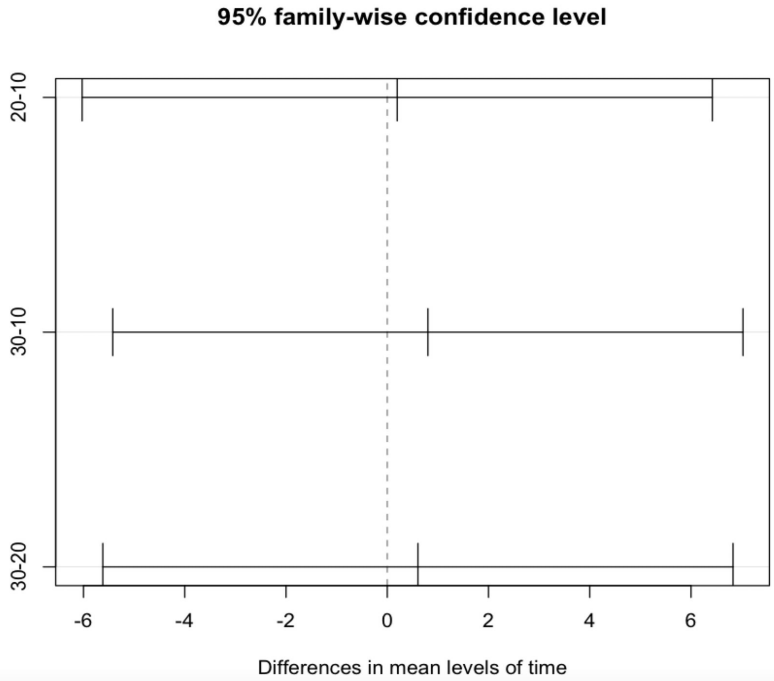

Interaction Plot
85.0
82.5
80.0
77.5
75.0
Comprehension Score
15
normal
40
Oxygen Level (%)
Time (min)
10
20
30

ANOVA Results

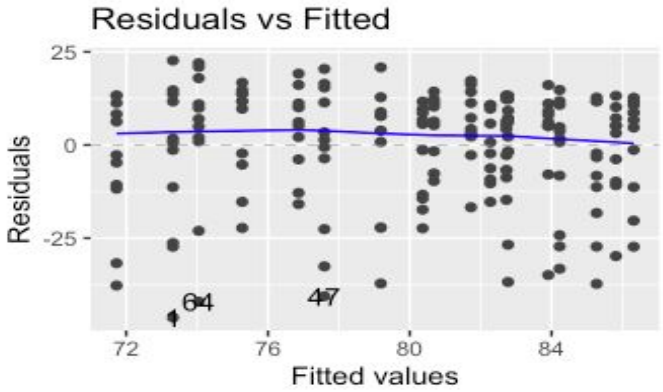
	DF	Sum Square	Mean Square	F Value	P Value
Oxygen Level	2	2,933.303	1,466.652	6.402	0.002
Time	2	23.121	11.561	0.050	0.951
Gender	1	622.227	622.227	2.716	0.101
Oxygen Level:Time	4	214.848	53.712	0.234	0.919
Residuals	188	43,067.273	229.081		

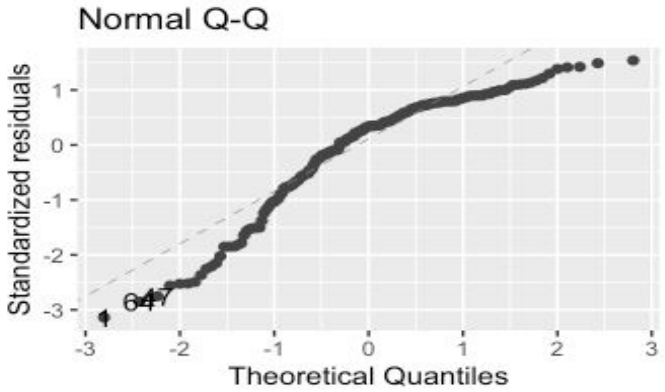
Tukey HSD

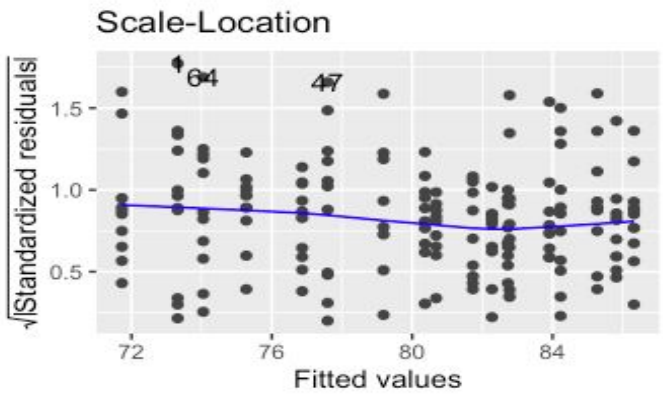

95% family-wise confidence level
normal-15
40-15
40-normal
-5
0
5
10
15
Differences in mean levels of oxygen level

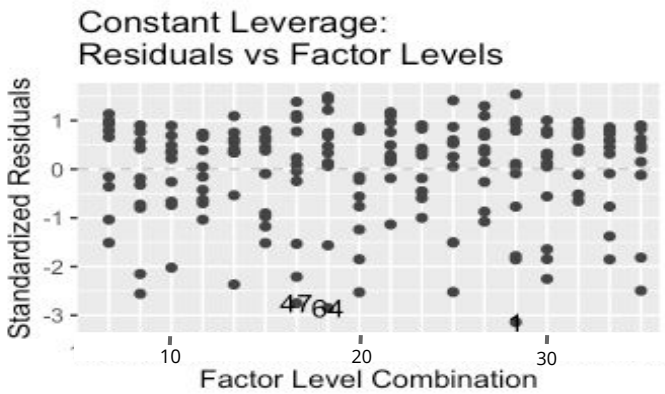

95% family-wise confidence level
20-10
30-10
30-20
-6
-4
-2
0
2
4
6
Differences in mean levels of time

Residual Plots









Conclusions

- Using a significance level α of 0.05, only oxygen level is a significant factor in affecting comprehension score.
- Based on the Tukey HSD, 15% oxygen level had a significant difference in means with both normal oxygen level and 40% oxygen level.
- In a practical setting, schools and offices may look into designing spaces with adequate ventilation in order to maintain optimal cognitive performance of students and employees.

Future Research Questions

- What are the effects of other oxygen levels on comprehension?
- What are the long term effects of changes in oxygen level on comprehension?
- Are similar results seen in comprehension for different languages?
- What are the underlying physiological mechanisms which cause the shift in comprehension score seen?

References

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