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Analyzing Reaction Time

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STAT 425

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Contribution:

Faith Han: Data Analysis, Exploratory Data Analysis

Rohit Iyer: Model Diagnostics and Exploratory Data Analysis

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Abstract

(Briefly outline the problem, methods, and key findings.)

In this project, we will analyze the Survey.csv dataset, which aims to gather data on reaction time and the other potentially relevant variables suggested by the students at the start of the semester in STAT 425. We examine how factors such as age, health, and environmental conditions affect human reaction times, using multiple linear regression, Diagnostics, stepwise regression, and other statistical methods to analyze the reaction time. We found that distraction, age, and temperature affect the reaction.

Exploratory Data Analysis:

(Focus on meaningful graphical displays and key numerical summaries of the data.)

Variable Description:

- Reaction.time -Participant's response time to a visual stimulus (Numeric)
- Class- The academic level of the participant (Categorical)
- Age- The participant’s age (Numeric)
- Avg.sleep.time- The average amount of sleep the participant received per day over the last week. (Numeric)
- Last.night.sleep.time- No. of hours the participant slept the night before the survey. (Numeric)
- Awake.hours- Total hours the participant was awake before participating in the gameplay. (Numeric)
- Fatigue.level- The participant's self-reported fatigue level during gameplay (Categorical)
- Stress.Level- The participant's self-reported stress level during gameplay(Categorical)

- Distraction- the participant experienced any distractions during the gameplay. (Categorical)
- Noise.level- The noise level in the participant's environment during gameplay. (Numeric)
- Temp.level- The temperature of the participant's surroundings during gameplay. (Categorical)
- Game.freq- How often does the participant play video games that require quick reactions(Categorical)
- Sport.freq- How often the participant engages in sports that practice quick reactions. (Categorical)
- Avg. hours.exercise- The total hours per week the participant engages in physical exercise (Numeric)
- Caffeine intake- Whether the participant consumed any caffeinated beverages within 3 hours before the gameplay(Categorical)
- Alcohol.intake- Whether the participant consumed any alcoholic beverages within 5 hours before the gameplay, (Categorical)
- Visual.acuity- The participant's level of visual clarity after any necessary corrections(Categorical)
- Primary.hand- hand primarily used by the participant for writing and other manual tasks
- Use.primary.hand- Indicates whether the participant used their dominant hand during the gameplay(Categorical)
- Cautious. level- How cautious the participant describes themselves(Categorical)
- Input.device- The type of input device used during the gameplay(Categorical)
- Devise.OS- The type of device or operating system used during gameplay(Categorical)

- Wifi.stable- Stability of the Wi-Fi connection(Categorical)

We can begin analyzing by knowing the meaning and type of variables.

Graphical Displays:

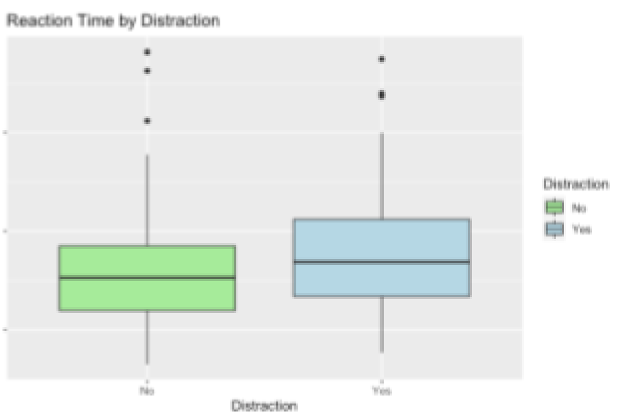

Figure 2.1: Reaction Time by Distraction

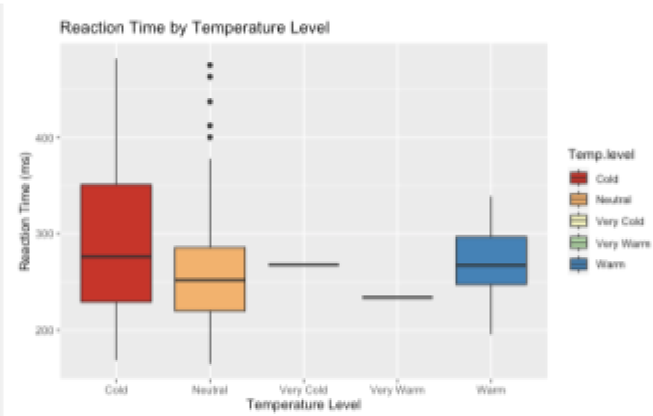

Figure 2.2: Reaction Time by Temperature Level

Based on figure 2.1, boxplot, Reaction Time by Distraction shows that individuals without distractions have notably faster reaction times and less variability compared to those who are distracted. The median response is shorter in the “No” distraction group compared to the “Yes” distraction group, implying quicker reactions when not distracted. The interquartile range of the “yes” distraction group seems marginally wider. When it comes to outliers, both distraction groups appear to have outliers, while “Yes” appears to have more. Therefore, this visual interpretation strongly supports the notion that distractions adversely affect reaction time. This aligns with the psychological theory, indicating that distractions could slow response time due to increased cognitive load.

In Figure 2.2, Reaction times are shown in a box plot for the following five temperature ranges: cold, neutral, very cold, very warm, and warm. With a median response time of about 300 ms, the Cold category has the biggest response time variability, with many outliers indicating slower reactions. On the other hand, the median reaction durations for the Neutral and Very Cold categories are lower and more stable at 250 ms, suggesting faster and more consistent responses. Similar to Neutral or Very Cold, the Very Warm and Warm categories likewise display median reaction times that are nearly 250 ms, but with a little bit greater fluctuation. Overall, the evidence indicates that more moderate temperatures allow for quicker and more consistent reactions, while colder temperatures result in slower reaction times. Therefore, based on this, we can conclude that both cold and warm extremes negatively affect the reaction performance.

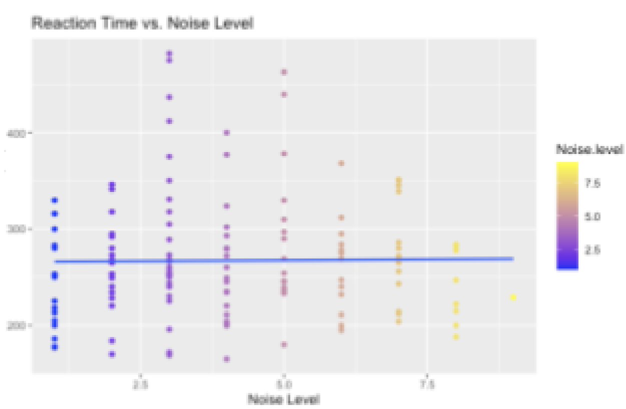

Figure 2.3: Reaction Time vs. Noise Level

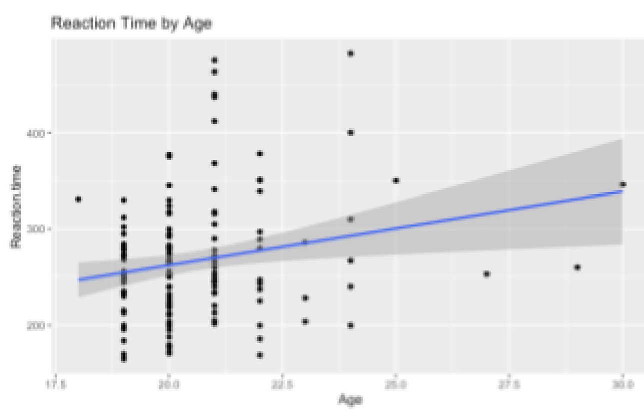

Figure 2.4: Reaction Time by Age

Figure 2.3 shows that the linear regression line in blue indicates a slight decreasing trend in reaction time as the noise level increases. The spread of the reaction time at different noise levels is broad, while there are outliers at noise levels 2.5 and 5.0, where some individuals have higher reaction time than others. Overall, this plot hints at the relationship between noise level and reaction time, which is impacted by individual differences in noise sensitivity.

The box plot depicts reaction times across five temperature levels: Cold, Neutral, Very Cold, Very Warm, and Warm. The Cold category shows the highest median reaction time, approximately 300 ms, with significant variability and numerous outliers suggesting slower responses. In contrast, the Neutral and Very Cold categories demonstrate lower and more consistent median reaction times around 250 ms, indicating quicker and more uniform responses. The Very Warm and Warm categories also show median reaction times close to 250 ms but with slightly more variability than Neutral or Very Cold. The data suggests that reaction times are slower in colder temperatures, with more moderate temperatures facilitating quicker and more consistent responses.

- Numeric Summary

Distraction <chr>	Mean_Reaction_Time <dbl>	SD_Reaction_Time <dbl>
No	260.3587	58.94523
Yes	279.5102	68.15978

Figure 2.5: Mean and SD of Reaction.time by Distraction

Based on the numeric summary, this suggests that being distracted leads to a longer reaction time on average (around 19 ms more) than not being distracted. The standard deviation is also higher when distracted, indicating more variability in reaction times under distraction.

Temp.level <chr>	Mean_Reaction_Time <dbl>	SD_Reaction_Time <dbl>
Cold	290.8571	96.16961
Neutral	263.3564	61.84636
Very Cold	268.0000	NA
Very Warm	234.0000	NA
Warm	269.8333	40.42456

Figure 2.6:Mean and the SD of Recation.time by Temp.level

Relate to the data shown in the table the data indicates that reaction times are generally shortest under "Very Warm" conditions and longest under "Cold" conditions. The variability (standard deviation) also appears to be greatest when the temperature is "Cold". The "Neutral" temperature level has reaction times that are lower than in "Cold" and "Warm" settings but higher than in "Very Warm".

The standard deviations for "Very Cold" and "Very Warm" cannot be interpreted due to missing data, possibly indicating that these conditions had fewer observations, thus limiting the reliability of these specific results.

Model Building

- Model Fitting

Model1:Main effects only (This model includes Age, Distraction, Noise Level, and Temperature Level as predictors)

Model2: Including Interaction Terms (This model includes interaction terms between Age and Distraction and between Noise Level and Temperature Level)

Model3:Extensive Interaction Terms (This model adds more interaction terms involving Age, Distraction, and Temperature Level)

Significant findings:

Model 1 revealed a significant effect of the Distraction variable, indicating that not being distracted correlates with a decrease in reaction time, which makes intuitive sense. Model 2 and Model 3 highlighted significant effects for Age and an interaction between Age and Cold temperature level, respectively. These findings suggest that age impacts reaction time, particularly in cold environments. This is plausible as both age and environmental conditions can affect physiological and cognitive responses.

- Diagnostics/ Remedials

The diagnostic plots for Model 3 suggest that while there might be some issues with outliers and possibly slight deviations from normality, the model does not exhibit clear signs of non-linearity or heteroscedasticity. The potential problems with outliers and normality should be further investigated using robust regression techniques or transformations to achieve better adherence to model assumptions.

	df <dbl>	AIC <dbl>
model1	9	1570.1083
model2	12	1574.4436
model3	18	1576.6381
model3_transformed	18	-743.0139

	df <dbl>	BIC <dbl>
model1	9	1596.6471
model2	12	1609.8287
model3	18	1629.7158
model3_transformed	18	-689.9362

Figure 2.7: AIC and BIC comparison

Based on the AIC and BIC comparison values, transformed model 3 could be considered the best model since it indicates that the data transformation employed was effective in enhancing the model explanatory fitting. In contrast, transformed model 3 is statistically preferable; however, it is vital to ensure that this also makes sense from a practical point of view.

Discussion of Results and Conclusions:

The data suggests that reaction times are slower in colder temperatures, with more moderate temperatures facilitating quicker and more consistent responses. Distractions adversely affect reaction time, which aligns with the psychological theory that distraction could slow down response time due to increased cognitive load. Being distracted leads to a longer reaction time on average compared to not being distracted. Also, our results indicate that distractions have a negative effect on reaction time, which is consistent with the psychological theory suggesting that distractions increase cognitive load and subsequently slow down response times. Additionally, our analysis revealed significant effects on age in Model 2 and an interaction between age and cold temperature level in Model 3. These findings suggest that age influences reaction time, particularly in cold environments. This is plausible given that both age and environmental conditions can impact physiological and cognitive responses.