STAT 424 Group Project

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Problem Statement

- Putting raisins in a carbonated beverage will make them “dance”.
    - Bubbles escaping wrinkles of raisin make it move sporadically in the beverage.
- In this experiment, we investigate various factors that can influence release of CO_2
- time a raisin is suspended in the beverage measures this quantitatively.

Choice of Factors + Response

Factors:

- Temperature (2 levels)
  - Room temperature - 71.4°F or 21.89°C
  - Fridge temperature - 40.7°F or 4.83°C
- Type of Carbonated Beverage (3 levels)
  - Club soda, tonic water, and ginger ale
    - All very common carbonated beverages and all have the same carbonation method

Response Variable

- The amount of time between the raisin being dropped into carbonated beverage and it settling to the bottom after “dancing”

Choice of Design

Cross Factor Design

- Two by three level design
- Requires fewer observations
    - 6 treatment combinations
    - 3 replications
- Convenient design given the distance between group members and limitation of resources
- Decreases the likelihood of a Type II error if a treatment effect is actually significant

Conducting Randomization

- Listed each experimental combination and assigned a random number, 1-18, to each combination.
- Sorted our list by the randomly assigned number to obtain an order of application for our trials (shown in table).
- Labels were torn off of the bottles so that the beverage would be unknown
- Randomly assigned each of our raisins to a corresponding treatment combination.

Randomly Assigned Number	Temperature Group	Beverage Group	Time
1	High	Club	164
2	Low	Ginger	190
3	High	Tonic	166
4	High	Ginger	38
5	Low	Club	46
6	Low	Ginger	213
7	Low	Tonic	21
8	High	Tonic	146
9	High	Ginger	43
10	Low	Ginger	232
11	Low	Club	43
12	High	Tonic	196
13	High	Club	220
14	High	Club	250
15	Low	Club	51
16	High	Ginger	26
17	Low	Tonic	25
18	Low	Tonic	30

Execution of Experiment

- Used 10 fl. oz. translucent beverages from Canada Dry and Sun Maid raisins
- Picked out raisins of similar size, shape and mass (0.5 grams)
- Order of application and raisins were randomly assigned
- For each type of carbonated beverage (ginger ale, tonic water, club soda):
    - One bottle was placed in the refrigerator overnight (40.7°F)
    - One bottle was left to acclimate to room temperature (71.4°F)
- Bottle left to rest for 5 minutes
- Temperature accuracy checked using a thermometer
- After confirmation of temperature, raisins were immediately placed in beverages
- Using a stopwatch, we measured the time it took for the raisin to stop dancing and settle to the bottom of the bottle

Pictures of the Experiment

Statistical Analysis

- Beverage Type: P-value > 0.05, fail to reject Null Hypothesis
- Temperature: P-value < 0.05, reject Null Hypothesis

Effect Tests

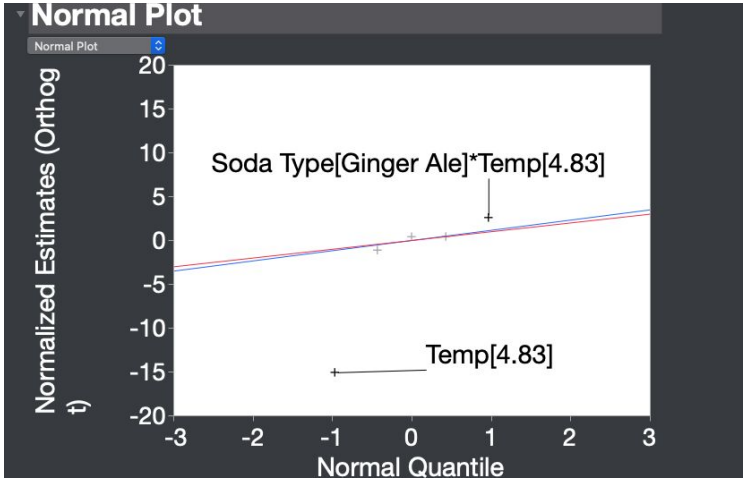
Source	Nparm	DF	Sum of Squares	F Ratio	Prob > F
Soda Type	2	2	751.00	0.7282	0.5029
Temp	1	1	117450.89	227.7651	<.0001*
Soda Type*Temp	2	2	3488.11	3.3821	0.0684

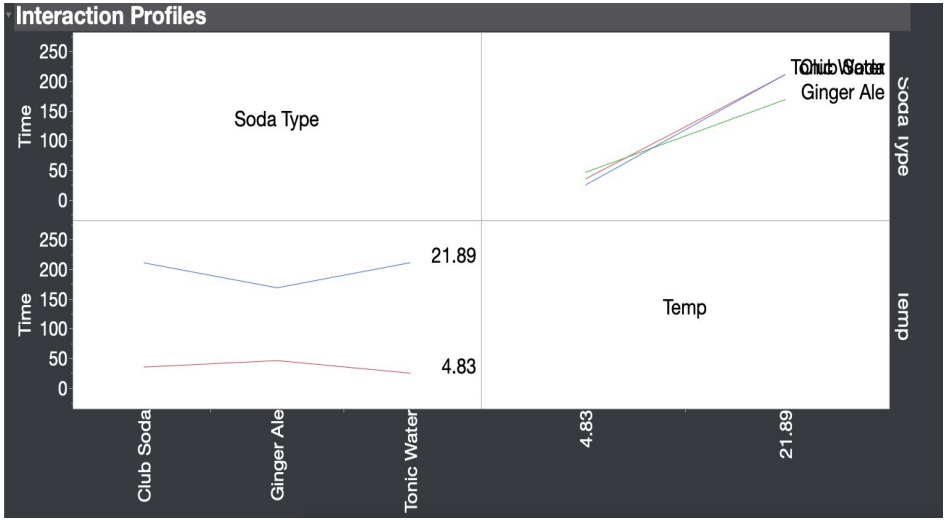
Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	5	121690.00	24338.0	47.1972
Error	12	6188.00	515.7	Prob > F
C. Total	17	127878.00		<.0001*

Statistical Analysis

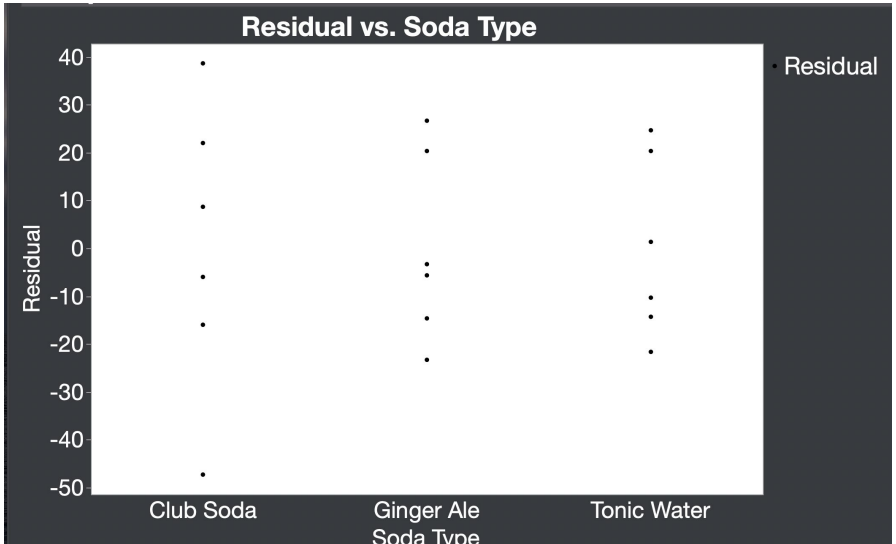
- Normal Plot shows our data is normally distributed
  - Little deviation from normality
- Interaction plot shows a mild interaction our 2 factors

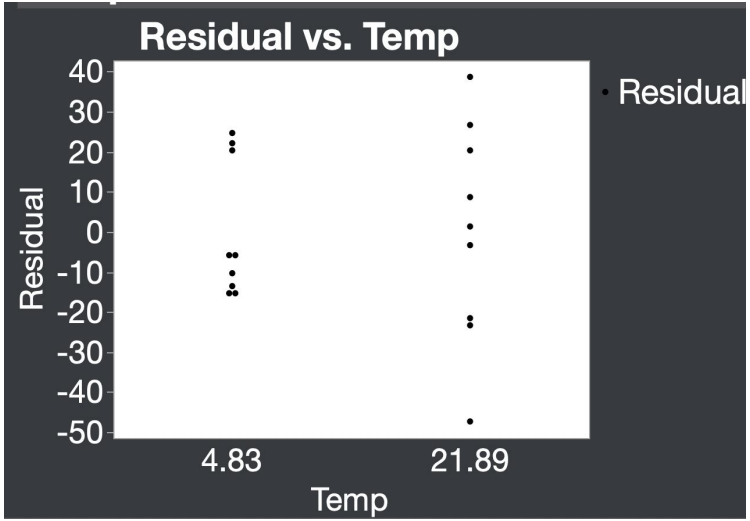




Statistical Analysis

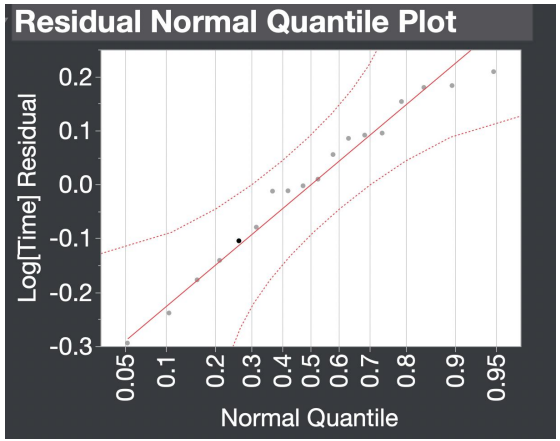
- “Residual VS. Temperature” do not share the constant variance, so the assumption of analysis is NOT satisfied.
- “Residual VS. Type” shares the constant variance, the assumption of analysis is satisfied.
- Hence, there exists the effect of variability due to the Temperature.

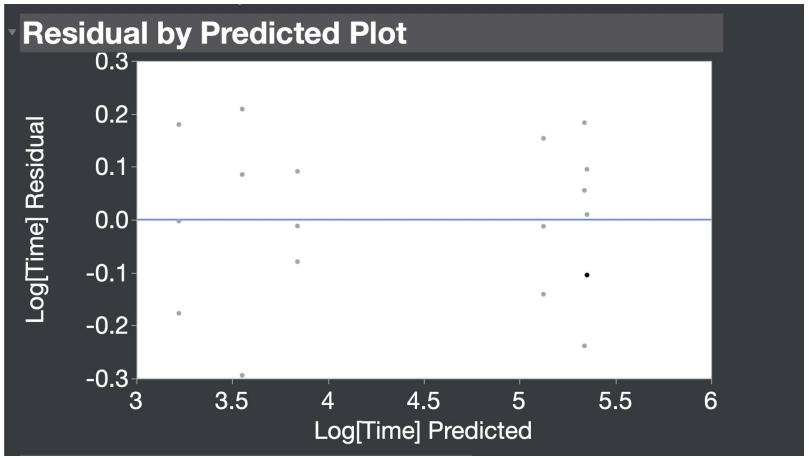




Statistical Analysis

- The time residuals follow a normal distribution
- The QQ plot shows deviation from normality, it is not significant and could be due to the small sample sizes
- Slight fanning in the Residual by Predicted Plot, but not enough for concern





Statistical Analysis

- Given a specific temperature and soda type, our prediction for the number of seconds the raisin ‘dances’ is shown below

Prediction Expression

$$0.6495375798 + -5.25 \bullet \text{Soda Type} + 9.4698449915 \bullet \text{Temp} + (\text{Soda Type} - 2) \bullet ((\text{Temp} - 13.36) \bullet -1.865963267)$$

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	116.66667	5.352396	21.80	<.0001*
Soda Type[Club Soda]	6.8333333	7.569432	0.90	0.3844
Soda Type[Ginger Ale]	-8.666667	7.569432	-1.14	0.2746
Temp[4.83]	-80.77778	5.352396	-15.09	<.0001*
Soda Type[Club Soda]*Temp[4.83]	-7.055556	7.569432	-0.93	0.3697
Soda Type[Ginger Ale]*Temp[4.83]	19.444444	7.569432	2.57	0.0246*

Conclusion

- Type of carbonated beverage has no significant effect on the dancing time of the raisins.
- Temperature of beverage has a significant effect on the dancing time of raisins
  - A colder beverage results in lowered dancing time
- Weaknesses
  - Accuracy of raisin mass
  - Could not account for shape and wrinkles of raisins
  - Refrigerated beverages warming to room temperature while conducting experiment
- Strengths
  - Found significant results in our data
  - Controlled confounding variables to the best of our capabilities