How to Make the Best Movie Theater Popcorn

A Statistical Analysis by Seth Hyatt

Purpose:

Cinemark is dedicated to providing movie-goers across the world with the best movie-going experience possible. While this grand experience requires many factors, (digital performance, cleanliness of theater, guest satisfaction, etc.), one of the staples in any movie theater is the popcorn. And, as many would say, popcorn is nothing without butter and salt. Therefore, I seek to analyze which butter topping – salt content combination is most preferred by Cinemark's Guests. A third factor contributing to the taste preference of Cinemark's Guests would be their age. I assume a significant interaction to be found between salt and age, as one's age often predicts their sensitivity to taste. In the end, a main effect will only be declared significant if the corresponding p-value is less than 0.05.

Design:

The ultimate popcorn that is most preferred by Cinemark Guests will be estimated by offering guests samples of random combinations of differing salt levels and butter types. The Guests will provide a taste score and record their age. The combinations are as follows:

Overall Means	SALT			
BUTTER	Low	Normal	High	AGE
Odell's				<18
Odell's				18<= <50
Odell's				50<=
ButterFace				<18
ButterFace				18<= <50
ButterFace				50<=

Low Salt being defined as ½ tbsp.

Normal Salt as 1 tbsp.

High Salt as 1½ tbsp.

Odell's Supur-kist is currently the standard topping

Butterface is Cinemark's branded 100% real butter

Age groups are defined as in the table

With the BF[3] model: $y_{ijk} = \mu + \alpha_i + \beta_j + \lambda_k + \alpha\beta_{ij} + \beta\lambda_{jk} + \alpha\lambda_{ik} + \alpha\beta\lambda_{ijk} + \varepsilon_{ijk}$

In making the calculations to determine *n*, a difference in taste score of 1 was desired, with a variance of 1.6 within each of the 18 groups, and power of 80%. [1]This yielded a proposed 9 subjects in each group, or collectively, 162 subjects. Because I was unable to choose my subjects, as this experiment was voluntary, I was unsure 9 subjects of every age group was attainable. [2]So, a second *n* was determined with the same power and variance, with a taste score difference of 1, but with only 6 groups. This *n* was 17.

Data was collected through a voluntary sample at the Cinemark University Mall theater lobby performed on Monday February 25 and Wednesday February 27. The batches of popcorn were popped in a random order having been assigned prior. On day 1, the batch order was low, normal, high. On day 2, high, low, normal. All batches were made by me with the same kettle directly after each other as to best eliminate confounding variables in preparation. Butter was added in the middle and on top of each batch and then the popcorn was mixed around.

Samples of the six differing combinations were set on a table in a high traffic area of the lobby. The placement of the combinations was also determined randomly.

Day 1:

HO	LBF	LO
HBF	NBF	NO

Day 2:

NBF	HO	HBF
NO	LBF	LO

As potential subjects walked by, they were offered to sample the popcorn. They would record their age and a taste score 1-10 of the popcorn on a note which they would place in the corresponding cup. [3]Because many subjects were rushed to see their movie, some only sampled one or two combinations. This led to unbalanced observations across the six main groups. The movies playing and their showtimes were the same on the two days, so there should have been no confounding effects there. However, during the experiment, it was noted more families with younger children came on Monday than Wednesday.

Analysis:

[4]As the experiment consisted of independent subjects, produced a mostly normal histogram of the residuals, and resulted in a max/min variance ratio of 2, the conditions for an ANOVA test were met.

The null hypotheses are as follows:

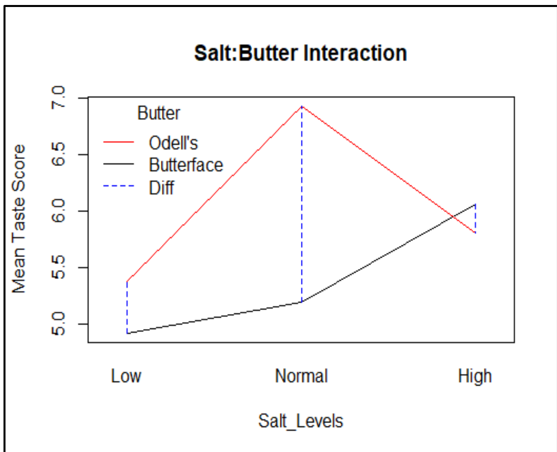
- H_o: Mean taste scores are the same regardless of salt content
- H_o: Mean taste scores are the same regardless of butter topping
- H_o: Mean taste scores are the same regardless of age

Main Effect	Df	Sum Sq	Mean Sq	Fvalue	Pr(>F)	Sig
Age_Group	2	17.7	8.849	1.9515	0.14548	
Butter_Type	1	14.95	14.9464	3.2961	0.07134	.
Salt_Levels	2	30.51	15.2532	3.3638	0.0371	*
Age_Group:Salt_Levels	4	12.91	3.2282	0.7119	0.58493	
Butter_Type:Salt_Levels	2	29.4	14.7011	3.242	0.0417	*
Age_Group:Butter_Type	2	22.9	11.4504	2.5252	0.08327	.
Age_Group:Butter_Type:Salt_Levels	4	15.67	3.918	0.864	0.487	
Residuals	158	716.46	4.5345			

[5]The above ANOVA table gives the results of a Sum of Squares I for Age and shows significance for the Salt effect and the interaction between Salt and Butter. [6]Other variations of the ANOVA test show significance for the Age-Butter interaction and approaching significance for the Butter effect. [7]Unfortunately, the results of the data showed too low of power (minimum of 30.7%) to conclude any important differences, even if they were statistically significant. Therefore,

three basic BF[2] models were configured using only two of the factors. [8]These models were 1) Salt-Butter, 2) Salt-Age, and 3) Butter-Age. [9]Again, the power was analyzed within these basic models. Only the Salt-Butter model yielded a strong enough power, 80.9%, to conclude the results of a t-test not only significant, but worthwhile. [10]This model also fit all conditions of an ANOVA test with a variance ratio 1.12 and showed the interaction between these two factors were significant with a p-value of 0.0393.

Main Effect	Df	Sum Sq	Mean Sq	F value	Pr(>F)	Sig
Butter_Type	1	13.93	13.9349	3.0061	0.0848	.
Salt_Levels	2	27.93	13.9649	3.0126	0.0518	.
Butter_Type:Salt_Levels	2	30.59	15.2947	3.2994	0.0393	*
Residuals	170	788.04	4.6355			



[11]The interaction plot to the left shows the means of the two Butter types separated by the level of salt content. [12]The first t-test performed tested the means of taste scores with Low Salt content with the Butter as Odell's > Butterface. This test yielded a p-value of 0.2161. The second test at Normal Salt with Odell's > Butterface produced a p-value of 0.0015. And the final t-test at High Salt content with Butterface > Odell's gave a p-value of 0.3073. Therefore, the only difference between Butter types with the Normal Salt can be determined to be significant at an α=.05 level.

[13]To offer a contrast, t-tests showed Normal and High Salt content to yield a statistically significantly greater mean of taste scores than Low salt. However, there was not much difference between Normal and High Salt content. [14]Also, further testing showed that those younger than 50 years old would prefer the Odell's butter over Butterface. But due to the low powers accompanying these tests, the results may not in actuality be that important.

Conclusion:

To conclude, we would fail to reject all three of our initial null hypotheses and determine my initial assumptions to be incorrect. However, due to the p-value of the BF[2] Salt – Butter ANOVA test being 0.0393 (seen above in ANOVA table), we can be 95% confident of this interaction affecting taste for at least one combination. In addition, the t-test comparing the mean taste score of Normal Salt – Odell's Butter to be greater than that of Normal Salt – Butterface produced a p-value of 0.0015. Therefore, we can conclude with 95% confidence and 80.9% power that the former combination of salt and butter on the Guests' popcorn would yield greater taste than the latter combination.

While every step of this experiment was randomized as much as possible, there were some limitations and possible confounding variables limiting these results. Mostly, as this experiment was voluntary based, inference to a population is limited to the guests of Cinemark University Mall.

Appendix:

Green text beginning with # is commented code from R

Italicized text is used to distinguish a specific note specifically for understanding within the appendix.

1) Initial sample size calculations
   a) #Assuming within.var = 1.6 from Tolley Example#
      #18 groups - Difference in Age
      i) power.anova.test(groups = 18, between.var = var(c(0,0,0,0,0,0,1,1,1,0,0,0,0,0,0,1,1,1)), within.var = 1.6, sig.level = .05, power = .8)$n
      ii) 8.677065

   b) #18 groups - Difference in Butter
      i) power.anova.test(groups = 18, between.var = var(c(1,1,1,1,1,1,1,1,1,0,0,0,0,0,0,0,0,0)), within.var = 1.6, sig.level = .05, power = .8)$n
      ii) 7.804259

   c) #18 groups - Difference in Salt
      i) power.anova.test(groups = 18, between.var = var(c(1,0,0,1,0,0,1,0,0,1,0,0,1,0,0,1,0,0)), within.var = 1.6, sig.level = .05, power = .8)$n
      ii) 8.677065

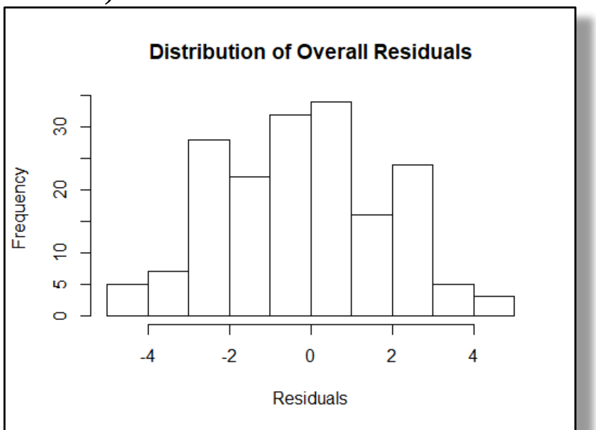
2) Basic sample size calculations
   a) #6 groups - Difference in Age or Salt
      i) power.anova.test(groups = 6, between.var = var(c(0,0,0,0,1,1)), within.var = 1.6, sig.level = .05, power = .8)$n
      ii) 16.3406

   b) #6 groups - Difference in Butter
      i) power.anova.test(groups = 6, between.var = var(c(0,0,0,1,1,1)), within.var = 1.6, sig.level = .05, power = .8)$n
      ii) 14.63324

3) Checking actual sample size
   a) tapply(Taste_Scores, Salt_Levels:Butter_Type:Age_Group, length)
   b) *represented as table with <9 obs/group highlighted as red:*
      i)

Overall #Obs	SALT			
BUTTER	Low	Normal	High	AGE
Odell's	6.00	5.00	7.00	<18
Odell's	18.00	20.00	22.00	18<= <50
Odell's	5.00	4.00	6.00	50<=
ButterFace	6.00	5.00	6.00	<18
ButterFace	14.00	18.00	19.00	18<= <50
ButterFace	4.00	3.00	8.00	50<=

4) Conditions
   a) ##Checking Conditions##
      i) hist(model5$residuals, main = "Distribution of Overall Residuals", xlab = "Residuals")



         (1)
      ii) max(tapply(Taste_Scores, Salt_Levels:Butter_Type:Age_Group, sd))/ min(tapply(Taste_Scores, Salt_Levels:Butter_Type:Age_Group, sd))
         (1) 2.046311
         *(2) *Note: Because the ratio rounds to 2, I did not proceed with a log transformation*

5) "Model 5"
   a) ##Building and Testing Comparable ANOVA Models##
      i) model5 <- lm(Taste_Scores ~ Age_Group + Butter_Type + Salt_Levels + Salt_Levels:Age_Group + Salt_Levels:Butter_Type + Butter_Type:Age_Group + Salt_Levels:Butter_Type:Age_Group)
      ii) anova(model5) #yields sig. for Salt, Salt:Butter

6) Other Various ANOVA models
   a) ##Building and Testing Comparable ANOVA Models##
      i) model1 <- lm(Taste_Scores ~ Salt_Levels + Butter_Type + Age_Group + Salt_Levels:Butter_Type + Butter_Type:Age_Group + Salt_Levels:Age_Group + Salt_Levels:Butter_Type:Age_Group)
      ii) anova(model1)

      iii) model2 <- lm(Taste_Scores ~ Salt_Levels + Age_Group + Butter_Type + Salt_Levels:Butter_Type + Salt_Levels:Age_Group + Butter_Type:Age_Group + Salt_Levels:Butter_Type:Age_Group)
      iv) anova(model2)

      v) model3 <- lm(Taste_Scores ~ Butter_Type + Salt_Levels + Age_Group + Butter_Type:Age_Group + Salt_Levels:Butter_Type + Salt_Levels:Age_Group + Salt_Levels:Butter_Type:Age_Group)
      vi) anova(model3) #yields sig. for Butter:Age 0.04567

(1)

Main Effect	Df	Sum Sq	Mean Sq	F value	Pr(>F)	Sig
Butter_Type	1	13.93	13.9349	3.0731	0.08154	.
Salt_Levels	2	27.93	13.9649	3.0797	0.04874	*
Age_Group	2	21.29	10.643	2.3471	0.09897	.
Butter_Type:Age_Group	2	28.54	14.2719	3.1474	0.04567	*
Butter_Type:Salt_Levels	2	24.73	12.3645	2.7267	0.06851	.
Salt_Levels:Age_Group	4	11.94	2.9858	0.6585	0.62177	
Butter_Type:Salt_Levels:Age_Group	4	15.67	3.918	0.864	0.487	
Residuals	158	716.46	4.5345			

vii) model4 <- lm(Taste_Scores ~ Butter_Type + Age_Group + Salt_Levels + Butter_Type:Age_Group + Salt_Levels:Age_Group + Salt_Levels:Butter_Type + Salt_Levels:Butter_Type:Age_Group)

viii) anova(model4)

ix) model6 <- lm(Taste_Scores ~ Age_Group + Salt_Levels + Butter_Type + Salt_Levels:Age_Group + Butter_Type:Age_Group + Salt_Levels:Butter_Type + Salt_Levels:Butter_Type:Age_Group)

x) anova(model6)

7) Actual Powers

a) ##Testing Actual Power for the 18 groups##

i) Complex_Powers <- power.anova.test(groups = 18, between.var = var(tapply(Taste_Scores, Salt_Levels:Butter_Type:Age_Group, mean)), within.var = 4.5345, sig.level = .05,
n = tapply(Taste_Scores, Salt_Levels:Butter_Type:Age_Group, length))$power

ii) min(Complex_Powers) #refers to NBF:50< = ; only 3 observations

iii) *represented as table with <0.80 power highlighted as red:*

(1)

Overall Powers	SALT			
BUTTER	Low	Normal	High	AGE
Odell's	0.731	0.609	0.825	<18
Odell's	0.999	0.999	0.999	18<= <50
Odell's	0.609	0.463	0.731	50<=
ButterFace	0.731	0.609	0.731	<18
ButterFace	0.997	0.999	0.999	18<= <50
ButterFace	0.463	0.307	0.891	50<=

8) 6 Basic Models

a) ##Simplifying to Basic Models##

i) Basic_Model1 <- lm(Taste_Scores ~ Salt_Levels + Butter_Type + Salt_Levels:Butter_Type)

ii) anova(Basic_Model1)

iii) Basic_Model2 <- lm(Taste_Scores ~ Butter_Type + Salt_Levels + Salt_Levels:Butter_Type)

iv) anova(Basic_Model2)

v) Basic_Model3 <- lm(Taste_Scores ~ Salt_Levels + Age_Group + Salt_Levels:Age_Group)

vi) anova(Basic_Model3)

vii) Basic_Model4 <- lm(Taste_Scores ~ Age_Group + Salt_Levels + Salt_Levels:Age_Group)

viii) anova(Basic_Model4)

ix) Basic_Model5 <- lm(Taste_Scores ~ Age_Group + Butter_Type + Butter_Type:Age_Group)

x) anova(Basic_Model5)

xi) Basic_Model6 <- lm(Taste_Scores ~ Butter_Type + Age_Group + Butter_Type:Age_Group)

xii) anova(Basic_Model6)

xiii) *Models represented as the following tables (Two ANOVA models per table (SSI vs SSIII))*

(1)

Basic Model 1	SALT		
BUTTER	Low	Normal	High
Odell's			
Butterface			

(2)

Basic Model 2	SALT		
AGE	Low	Normal	High
<18			
18<= <50			
50<=			

(3)

Basic Model 3	AGE		
BUTTER	<18	18<= <50	50<=
Odell's			
Butterface			

9) Basic Powers

a) #Powers

i) Salt_Butter_Power <- power.anova.test(groups = 6, between.var = var(tapply(Taste_Scores, Salt_Levels:Butter_Type, mean)), within.var = 4.6355, sig.level = .05, n = tapply(Taste_Scores, Salt_Levels:Butter_Type, length))$power

ii) min(Salt_Butter_Power) #refers to LBF; 24 observations

iii) #Power is 80.87636% = > tests are worth the time

iv) Salt_Age_Power <- power.anova.test(groups = 6, between.var = var(tapply(Taste_Scores, Salt_Levels:Age_Group, mean)), within.var = 4.7912, sig.level = .05, n = tapply(Taste_Scores, Salt_Levels:Age_Group, length))$power

v) min(Salt_Age_Power) #refers to Normal:50< = 7 obs

vi) #Power is 22% = > Too low of powers for tests

vii) Butter_Age_Power <- power.anova.test(groups = 6, between.var = var(tapply(Taste_Scores, Age_Group:Butter_Type, mean)), within.var = 4.6995, sig.level = .05, n = tapply(Taste_Scores, Age_Group:Butter_Type, length))$power

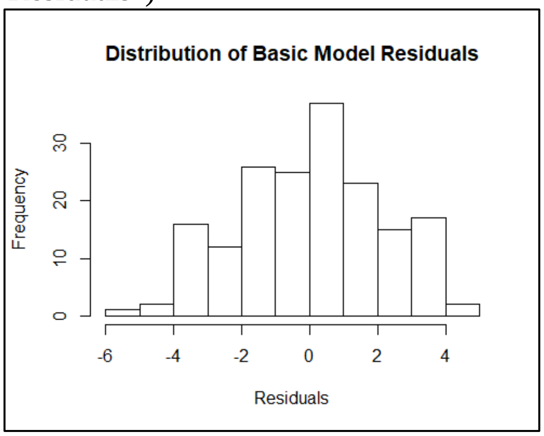
viii) min(Butter_Age_Power) #refers to Odell's:50< = ; 15 obs

ix) #Power is 47% = > Too low of powers for tests

10) Checking Basic Conditions

a) ##Checking Salt_Butter Model Conditions##

i) hist(Basic_Model1$residuals, main = "Distribution of Basic Model Residuals", xlab = "Residuals")

(1) 

ii) max(tapply(Taste_Scores, Salt_Levels:Butter_Type, sd))/ min(tapply(Taste_Scores, Salt_Levels:Butter_Type, sd)) #1.119254

11) Interaction Plots

a) ##Interaction Plots##

i) #Highly Significant

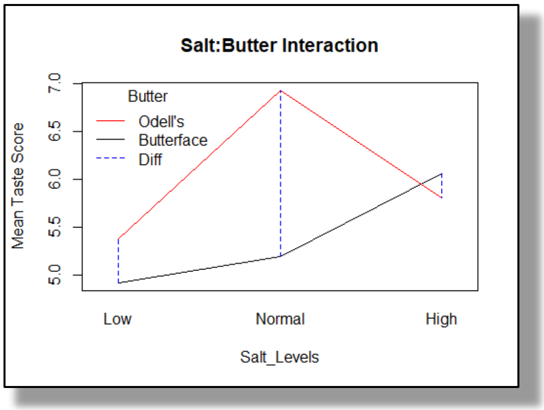
ii) interaction.plot(Salt_Levels, Butter_Type, Taste_Scores, ylab = "Mean Taste Score", col = 1:2,legend = FALSE, main = "Salt:Butter Interaction", lty = c(1,1,2))

iii) segments(1,4.91667,1,5.379310,col = "blue", lty = 2)

iv) segments(2,5.192308,2,6.931034,col = "blue", lty = 2)

v) segments(3,6.060606,3,5.8,col = "blue", lty = 2)

vi) legend("topleft", legend = c("Odell's", "Butterface", "Diff"), col = c(2,1,"blue"), lty = c(1,1,2), bty = "n", title = "Butter")

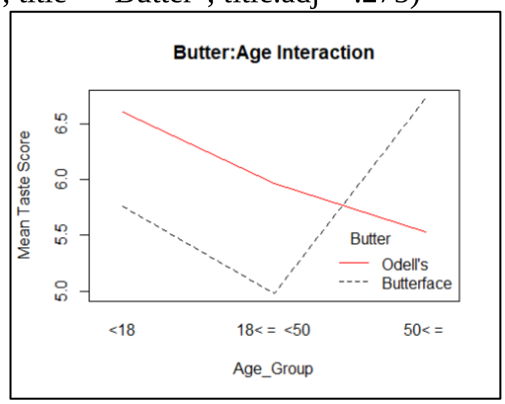


(1)

b) #Significant*

i) interaction.plot(Age_Group, Butter_Type, Taste_Scores, ylab = "Mean Taste Score", legend = FALSE, col = 1:2, main = "Butter:Age Interaction")

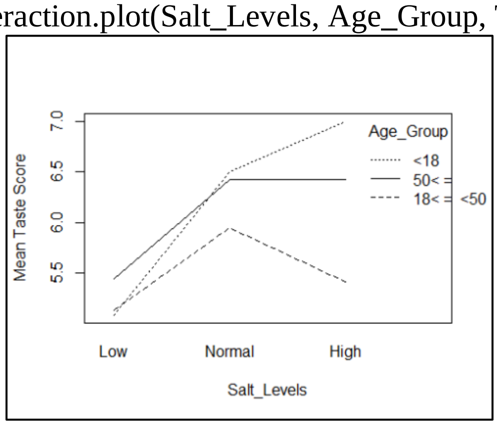
ii) legend("bottomright", legend = c("Odell's", "Butterface"), col = 2:1, lty = 1:2, bty = "n", title = "Butter", title.adj = .275)



(1)

(2) **Note: Even though statistically, this interaction was determined significant, there was not enough power (over 80%) to deem practically important*

iii) interaction.plot(Salt_Levels, Age_Group, Taste_Scores, ylab = "Mean Taste Score")



(1)

Note: t-tests using names created in R were unusable, so 'tapply' functions were used to determine appropriate means, sd's, and n's. These numbers were then used in the manually *calculated tests themselves, with 'MSq' defined as 4.5345 and 'DegF' as 158. These numbers came from the ANOVA model and therefore account for the other factors as well.*

12) T-tests for Salt:Butter interaction
    a) #Salt:Butter#
        i) tapply(Taste_Scores, Salt_Levels:Butter_Type, mean)
        ii) tapply(Taste_Scores, Salt_Levels:Butter_Type, sd)
        iii) tapply(Taste_Scores, Salt_Levels:Butter_Type, length)

    b) #LBF less than LO
        i) pt((4.916667-5.379310)/sqrt(((1/24)+(1/29))*MSq), DegF)
        ii) #p = 0.2161388 = > insuf.

        iii) #NBF less than NO
        iv) pt((5.192308 - 6.931034)/sqrt(((1/26)+(1/29))*MSq), DegF)
        v) #p = 0.001459537 = > stat. sig. at 0.005 / 99.5%
        vi) (5.192308 - 6.931034) + c(1,-1) * 1.984 * sqrt(((1/26)+(1/29))*MSq)
        vii) #95% conf int = > (-0.5976829 -2.8797691)

    c) #HBF greater than HO
        i) pt((6.060606 - 5.8)/sqrt(((1/33)+(1/35))*MSq), DegF, lower.tail = FALSE)
        ii) #p = 0.3073492 = > insuf.

13) T-test for Salt Factor
    a) #Salt#
        i) tapply(Taste_Scores, Salt_Levels, mean)
        ii) tapply(Taste_Scores, Salt_Levels, sd)
        iii) tapply(Taste_Scores, Salt_Levels, length)

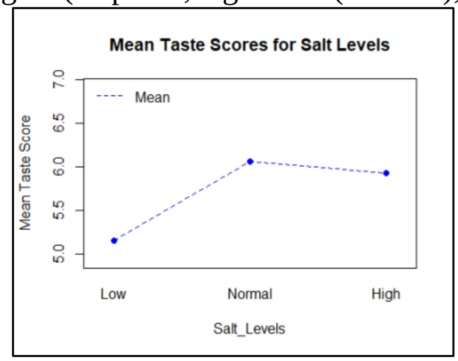
    b) #Low less than Normal
        i) pt((5.169811-6.109091)/sqrt(((1/53)+(1/55))*MSq), DegF)
        ii) #p = 0.0116249 = > stat. sig. at 0.05 / 95%
        iii) (5.169811-6.109091) + c(1,-1) * 1.984 * sqrt(((1/53)+(1/55))*MSq)
        iv) #95% conf int = > (-0.126077 -1.752483)

    c) #Normal greater than High
        i) pt((6.109091-5.926471)/sqrt(((1/55)+(1/68))*MSq), DegF, lower.tail = FALSE)
        ii) #p = 0.3184695 = > insuf

    d) #Low less than High
        i) pt((5.169811-5.926471)/sqrt(((1/53)+(1/68))*MSq), DegF)
        ii) #p = 0.02712571 = > stat. sig. at 0.05 / 95%
        iii) (5.169811-5.926471) + c(1,-1) * 1.984 * sqrt(((1/53)+(1/68))*MSq)
        iv) #95% conf int = > (0.01745711 -1.53077711)

    e) interaction.plot(Salt_Levels, Butter_Type, Taste_Scores, ylab = "Mean Taste Score", col = c("white", "white"),legend = FALSE, main = "Mean Taste Scores for Salt Levels",lty = c(1,1,2))

i) abline(points(1,y = 5.147989, pch = 16, col = "blue"), points(2,y = 6.061671, pch = 16, col = "blue"), points(3,y = 5.930303, pch = 16, col = "blue"))
ii) segments(1,5.147989,2,6.061671,col = "blue", lty = 2)
iii) segments(2,6.061671,3,5.930303,col = "blue", lty = 2)
iv) legend("topleft", legend = c("Mean"), col = "blue", lty = 2, bty = "n")

(1) 

14) T-test for Butter:Age interaction

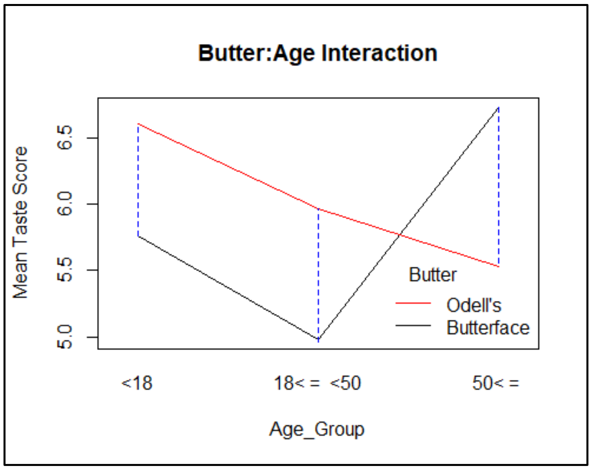
a) #Butter:Age#
   i) tapply(Taste_Scores, Butter_Type:Age_Group, mean)
   ii) tapply(Taste_Scores, Butter_Type:Age_Group, sd)
   iii) tapply(Taste_Scores, Butter_Type:Age_Group, length)

b) #BF:<18 lesser than O:<18
   i) pt((4.764706 - 6.611111)/sqrt(((1/17)+(1/18))*MSq), DegF)
   ii) #p = 0.005642478 = > stat. sig. at 0.01 / 99%
   iii) (4.764706 - 6.611111) + c(1,-1) * 1.984 * sqrt(((1/17)+(1/18))*MSq)
   iv) #95% conf int = > (-0.4175779 -3.2752321)

c) #BF:18< = <50 lesser than O:18< = <50
   i) pt((4.980392 - 5.9666667)/sqrt(((1/51)+(1/60))*MSq), DegF)
   ii) #p = 0.008070258 = > stat. sig. at 0.01 / 99%
   iii) (4.980392 - 5.9666667) + c(1,-1) * 1.984 * sqrt(((1/51)+(1/60))*MSq)
   iv) #95% conf int = > (-0.1816245 -1.7909249)

d) #BF:50< = greater than O:50< =
   i) pt((6.733333 - 5.533333)/sqrt(((1/15)+(1/15))*MSq), DegF, lower.tail = FALSE)
   ii) #p = 0.06238063 = > insuf. ALMOST!

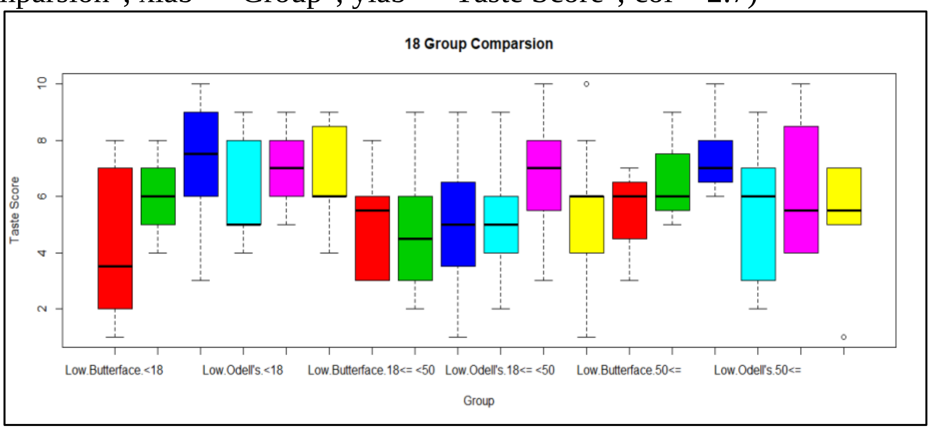
e) interaction.plot(Age_Group, Butter_Type, Taste_Scores, ylab = "Mean Taste Score", legend = FALSE, col = 1:2, main = "Butter:Age Interaction", lty = c(1,1,2))
   i) segments(1, 5.764706, 1, 6.611111, col = "blue", lty = 2)
   ii) segments(2, 4.960392, 2, 5.966667, col = "blue", lty = 2)
   iii) segments(3, 6.733333, 3, 5.533333, col = "blue", lty = 2)
   iv) legend("bottomright", legend = c("Odell's", "Butterface"), col = 2:1, lty = c(1,1,2), bty = "n", title = "Butter", title.adj = .275)

(1) 

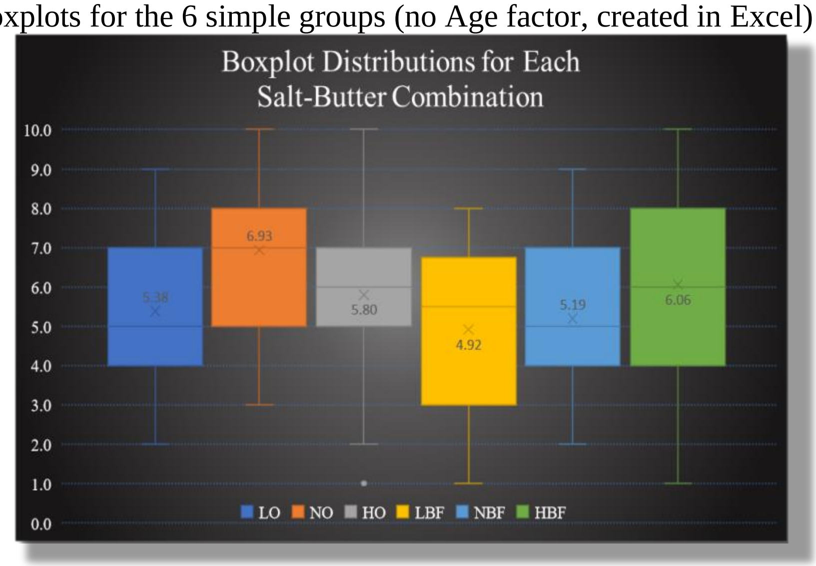
15) Additional graphics used in presenting

a) Initial 18 Group Boxplots

i) boxplot(Taste_Scores ~ Salt_Levels:Butter_Type:Age_Group, main = "18 Group Comparsion", xlab = "Group", ylab = "Taste Score", col = 2:7)

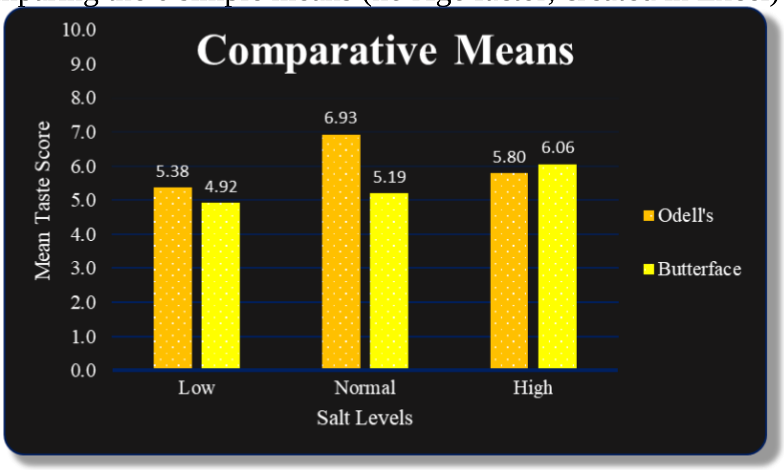
(1) 

b) Boxplots for the 6 simple groups (no Age factor, created in Excel)



i)

c) Comparing the 6 simple means (no Age factor, created in Excel)



i)

Raw Data:

Raw Data					
L O	N O	H O	L BF	N BF	H BF
43-05	43-05	60-05	16-01	17-07	67-07
31-05	16-07	67-07	43-04	9999-07	17-08
31-02	17-08	22-06	08-07	35-03	25-03
18-06	52-10	29-08	67-07	10-04	16-06
29-03	9999-06	17-09	35-08	43-05	21-04
16-05	29-04	27-08	17-03	31-02	31-04
17-05	19-08	17-06	18-06	18-06	20-04
10-04	10-05	18-06	9999-04	17-05	9999-06
17-08	9999-08	10-08	31-03	16-06	9999-03
16-05	35-05	43-06	50-06	25-04	43-08
50-07	08-09	9999-05	9999-09	21-04	08-09
60-03	31-08	9999-09	10-02	67-09	31-06
9999-04	31-07	21-10	60-06	08-08	29-08
9999-06	67-07	20-08	9999-04	9999-05	19-06
21-05	17-06	25-06	14-04	31-04	23-06
23-09	18-07	22-06	22-03	19-09	22-08
19-04	21-05	31-05	31-03	20-06	31-03
25-03	25-08	16-06	17-08	31-04	51-07
67-06	60-04	16-04	19-03	57-05	10-03
08-09	31-07	51-06	9999-04	26-07	35-05
35-06	23-10	31-03	27-06	71-06	22-05
31-02	32-10	35-04	20-07	39-02	60-07
39-07	26-08	31-06	21-03	18-07	33-03
57-02	28-10	18-06	39-06	30-02	80-06
19-08	33-07	08-06	36-08	36-06	06-10
30-04	36-07	71-07	30-06	33-05	20-03
36-06	33-06	57-01	33-05	33-02	59-09
33-08	30-03	18-10	57-03	28-07	71-06
21-06	57-04	20-05			39-01
71-09	39-10	33-02			57-07
33-04	18-06	20-04			52-10
		30-01			34-05
		17-09			30-09
		36-06			36-07
		33-06			17-07
		78-05			
		39-02			

Interpretation:

Day 1 Observations – black text

Day 2 Observations – purple text

Unusable Data – red highlight (no age given, 9999 used to distinguish)

Data Format – “AGE-SCORE”

Code:

Salt	Butter	Code
Low	Odell's Supur-kist	LO
Low	Butterface Real Butter	LBF
Normal	Odell's Supur-kist	NO
Normal	Butterface Real Butter	NBF
High	Odell's Supur-kist	HO
High	Butterface Real Butter	HBF

As read into R

```
Taste_Scores <- c(5,5,2,6,3,5,5,4,8,5,7,3,5,9,4,3,6,9,6,2,7,2,8,4,6,8,6,9,4,
5,7,8,10,4,8,5,5,9,8,7,7,6,7,5,8,4,7,10,10,8,10,7,7,6,3,4,10,6,
5,7,6,8,9,8,6,6,8,6,10,8,6,6,5,6,4,6,3,4,6,6,6,7,1,10,5,2,4,1,9,6,6,5,2,
1,4,7,7,8,3,6,3,6,2,6,4,3,3,8,3,6,7,3,6,8,6,5,3,7,3,4,5,2,6,5,6,4,4,9,8,4,9,6,4,5,7,6,2,7,2,6,5,2,7,
7,8,3,6,4,4,4,8,9,6,8,6,6,8,3,7,3,5,5,7,3,6,10,3,9,6,1,7,10,5,9,7,7)
```

```
Salt_Levels <-
c("Low","Low","Low","Low","Low","Low","Low","Low","Low","Low","Low","Low","Low","
Low","Low","Low","Low","Low","Low","Low","Low","Low","Low","Low","Low","Low","Lo
w","Low","Low","Normal","Normal","Normal","Normal","Normal","Normal","Normal","Norm
al","Normal","Normal","Normal","Normal","Normal","Normal","Normal","Normal","Normal","
Normal","Normal","Normal","Normal","Normal","Normal","Normal","Normal","Normal","Nor
mal","Normal","Normal","High","High","High","High","High","High","High","High","High","
High","High","High","High","High","High","High","High","High","High","High","High","High
","High","High","High","High","High","High","High","High","High","High","High","High","Hi
gh","Low","Low","Low","Low","Low","Low","Low","Low","Low","Low","Low","Low","Low
","Low","Low","Low","Low","Low","Low","Low","Low","Low","Low","Low","Normal","Nor
mal","Normal","Normal","Normal","Normal","Normal","Normal","Normal","Normal","Normal"
,"Normal","Normal","Normal","Normal","Normal","Normal","Normal","Normal","Normal","No
rmal","Normal","Normal","Normal","Normal","Normal","High","High","High","High","High","
High","High","High","High","High","High","High","High","High","High","High","High","High
","High","High","High","High","High","High","High","High","High","High","High","High","Hi
gh","High","High")
```

```
Butter_Type <-
c("Odell's","Odell's","Odell's","Odell's","Odell's","Odell's","Odell's","Odell's","Odell's","Odell's
","Odell's","Odell's","Odell's","Odell's","Odell's","Odell's","Odell's","Odell's","Odell's","Odell's"
,"Odell's","Odell's","Odell's","Odell's","Odell's","Odell's","Odell's","Odell's","Odell's","Odell's",
"Odell's","Odell's","Odell's","Odell's","Odell's","Odell's","Odell's","Odell's","Odell's","Odell's","
Odell's","Odell's","Odell's","Odell's","Odell's","Odell's","Odell's","Odell's","Odell's","Odell's","
Odell's","Odell's","Odell's","Odell's","Odell's","Odell's","Odell's","Odell's","Odell's","Odell's","
Odell's","Odell's","Odell's","Odell's","Odell's","Odell's","Odell's","Odell's","Odell's","Odell's","
Odell's","Odell's","Odell's","Odell's","Odell's","Odell's","Odell's","Odell's","Odell's","Odell's","
Odell's","Odell's","Odell's","Odell's","Odell's","Odell's","Odell's","Odell's","Odell's","Odell's","
Odell's","Odell's","Odell's","Butterface","Butterface","Butterface","Butterface","Butterface","Bu
tterface","Butterface","Butterface","Butterface","Butterface","Butterface","Butterface","Butterfa
ce","Butterface","Butterface","Butterface","Butterface","Butterface","Butterface","Butterface","
Butterface","Butterface","Butterface","Butterface","Butterface","Butterface","Butterface","Butte
rface","Butterface","Butterface","Butterface","Butterface","Butterface","Butterface","Butterface
","Butterface","Butterface","Butterface","Butterface","Butterface","Butterface","Butterface","Bu
tterface","Butterface","Butterface","Butterface","Butterface","Butterface","Butterface","Butterfa
ce","Butterface","Butterface","Butterface","Butterface","Butterface","Butterface","Butterface","
Butterface","Butterface","Butterface","Butterface","Butterface","Butterface","Butterface","Butte
rface","Butterface","Butterface","Butterface","Butterface","Butterface","Butterface","Butterface
","Butterface","Butterface","Butterface","Butterface","Butterface","Butterface","Butterface","Bu
tterface","Butterface","Butterface","Butterface")
```

```
Age_Group <- c("18< =  <50","18< =  <50","18< =  <50","18< =  <50","18< =
<50","<18","<18","<18","<18","<18","50< = ","50< = ","18< =  <50","18< =  <50","18< =
<50","18< =  <50","50< = ","<18","18< =  <50","18< =  <50","18< =  <50","50< = ","18< =
<50","18< =  <50","18< =  <50","18< =  <50","18< =  <50","50< = ","18< =  <50","18< =
<50","<18","<18","50< = ","18< =  <50","18< =  <50","<18","18< =  <50","<18","18< =
<50","18< =  <50","50< = ","<18","18< =  <50","18< =  <50","18< =  <50","50< = ","18< =
<50","18< =  <50","18< =  <50","18< =  <50","18< =  <50","18< =  <50","18< =  <50","18< =
<50","18< =  <50","50< = ","18< =  <50","18< =  <50","50< = ","50< = ","18< =  <50","18< =
<50","<18","18< =  <50","<18","18< =  <50","<18","18< =  <50","18< =  <50","18< =
<50","18< =  <50","18< =  <50","18< =  <50","<18","<18","50< = ","18< =  <50","18< =
<50","18< =  <50","18< =  <50","<18","50< = ","50< = ","18< =  <50","18< =  <50","18< =
<50","18< =  <50","18< =  <50","<18","18< =  <50","18< =  <50","50< = ","18< =
<50","<18","18< =  <50","<18","50< = ","18< =  <50","<18","18< =  <50","18< =  <50","50< =
","<18","50< = ","<18","18< =  <50","18< =  <50","<18","18< =  <50","18< =  <50","18< =
<50","18< =  <50","18< =  <50","18< =  <50","18< =  <50","18< =  <50","50< = ","<18","18< =
<50","<18","18< =  <50","18< =  <50","18< =  <50","<18","<18","18< =  <50","18< =
<50","50< = ","<18","18< =  <50","18< =  <50","18< =  <50","18< =  <50","50< = ","18< =
<50","50< = ","18< =  <50","18< =  <50","18< =  <50","18< =  <50","18< =  <50","18< =
<50","18< =  <50","50< = ","<18","18< =  <50","<18","18< =  <50","18< =  <50","18< =
<50","18< =  <50","<18","18< =  <50","18< =  <50","18< =  <50","18< =  <50","18< =
<50","18< =  <50","50< = ","<18","18< =  <50","18< =  <50","50< = ","18< =  <50","50< =
","<18","18< =  <50","50< = ","50< = ","18< =  <50","50< = ","50< = ","18< =  <50","18< =
<50","18< =  <50","<18")
```