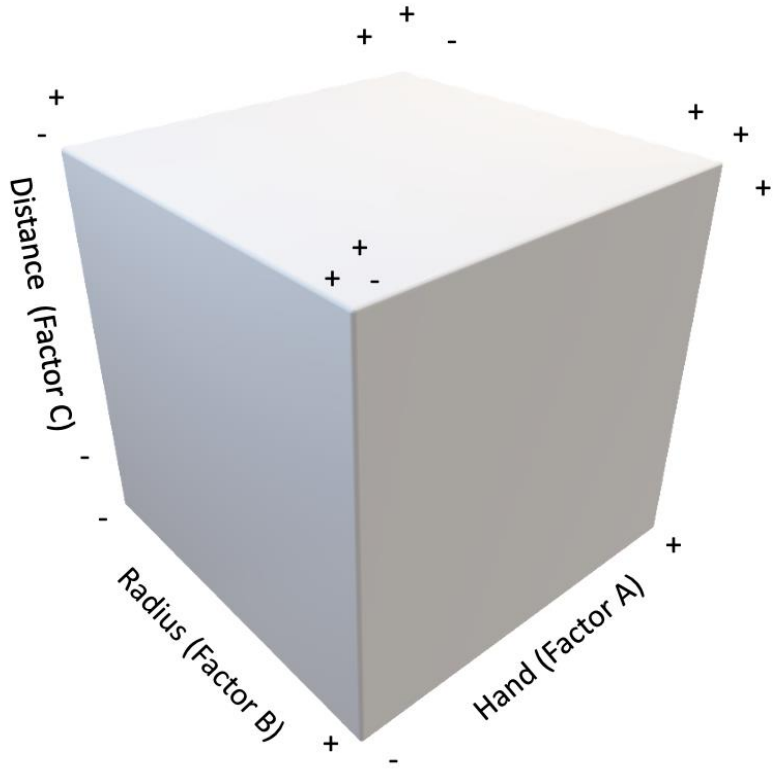
STAT- 424 FINAL PROJECT

Hand Eye Coordination

GROUP MEMBERS:

- SHUBHAM MEHTA (MEHTA45)
- UMESH KARAMCHANDANI (UMESHK2)

EXPERIMENT



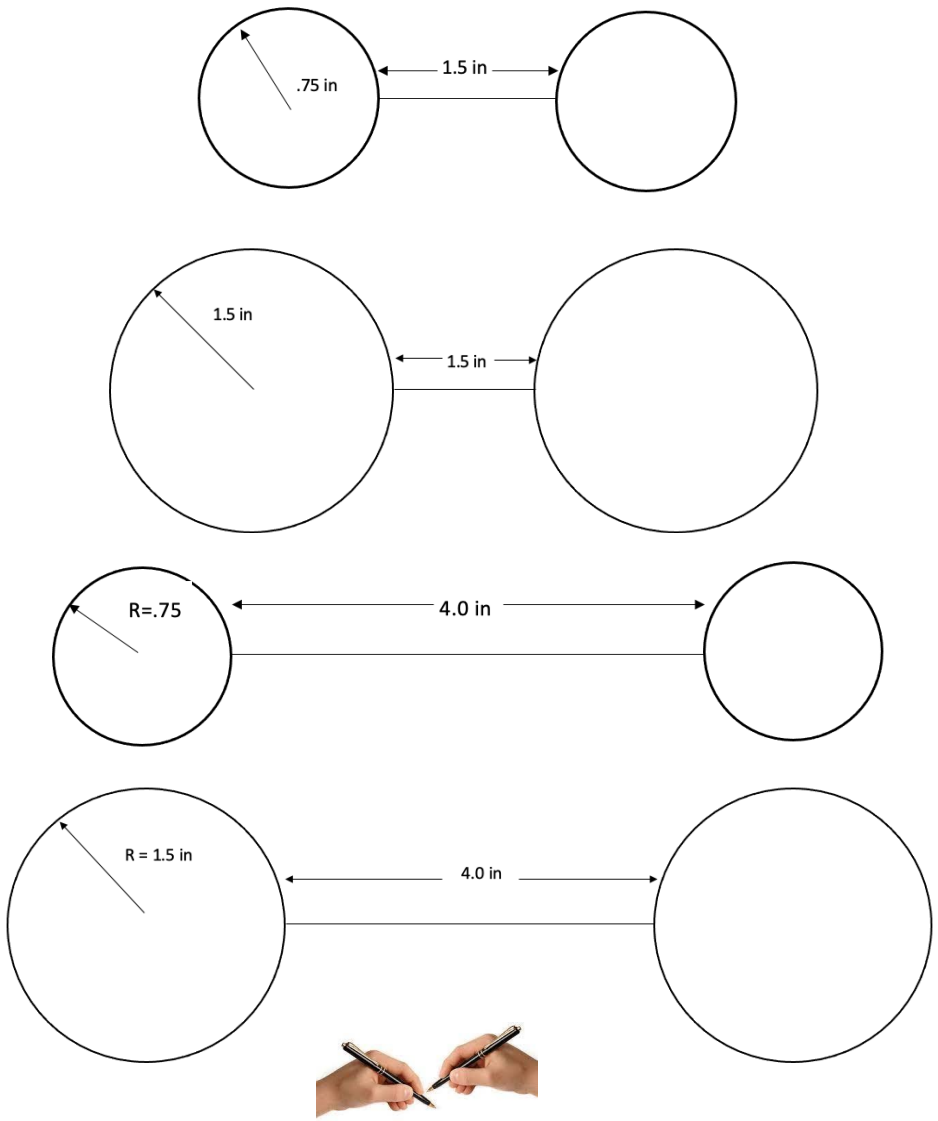
- **Experiment:** Given two drawn circles placed adjacent to each other, mark dots in them alternatively using only one hand in 10 seconds

- **Factor Levels:**
  - A) Which hand holds the pen
    - \+ Dominant Hand
    - \- Non-Dominant Hand
  - B) Distance Between Circles
    - \+ Large
    - \- Small
  - C) Radius of The Circle
    - \+ Large
    - \- Small

- **Response:** No. of cycles (set of dots) completed across both the circles in 10 Seconds

NULL HYPOTHESIS

TREATMENTS



- **Null Hypothesis:** The response i.e. number of cycles completed should be independent of hand, circle radius and distance between two circles
- **Significance Level** : 5 %
- **Design:** 2^3 Factorial Design
- The experiment is **replicated twice** so there are **16 runs.** The order in which the runs are made is also random, so this is a completely randomized experiment.

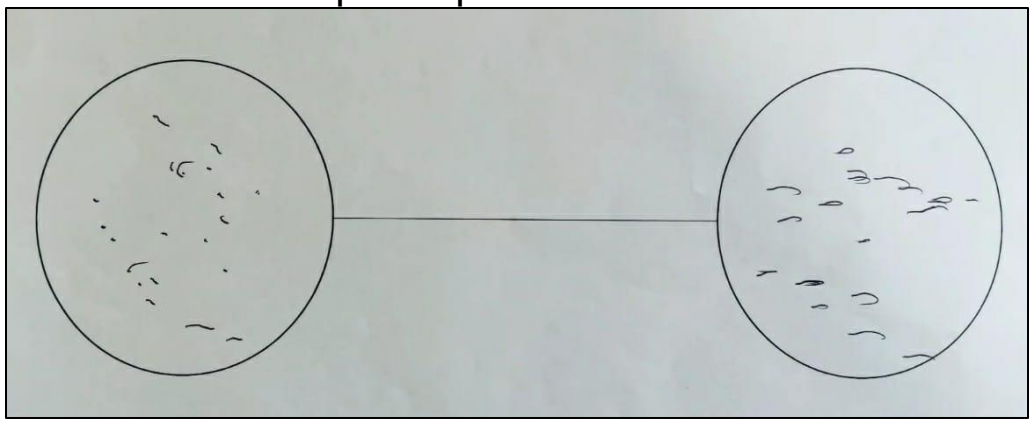
Model

$$Y_{ijk} = \mu + \alpha_i + \beta_j + \gamma_k + (\alpha\beta)_{ij} + (\beta\gamma)_{jk} + (\alpha\gamma)_{ik} + (\alpha\beta\gamma)_{ijk} + e_{ijkl}$$

DATA ACQUISITION

Random Sampling

Sample Experiment Run



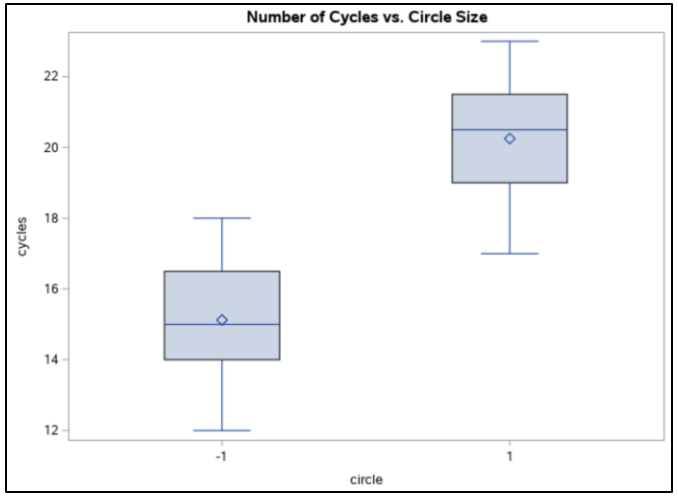
Observed Data

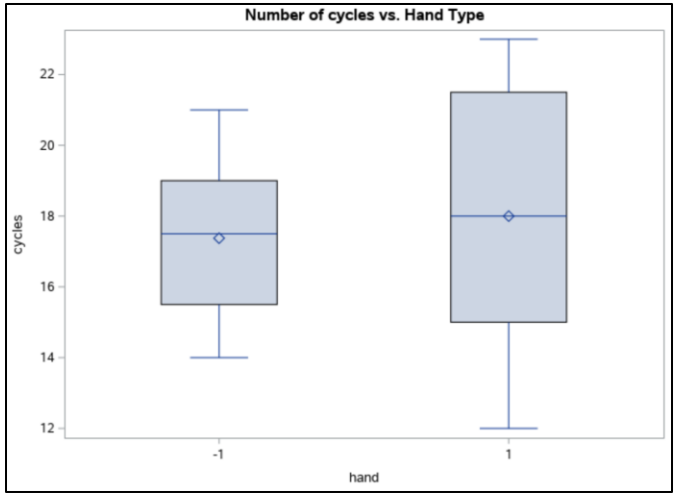
	Circle (Big-1)	Distance (Large - 1)	Hand (Dominant - 1)	# cycles (Run - 1)	# cycles (Run - 2)
1	1	1	1	20	21
2	1	1	-1	18	17
3	1	-1	1	22	23
4	1	-1	-1	20	21
5	-1	1	1	12	15
6	-1	1	-1	14	14
7	-1	-1	1	15	16
8	-1	-1	-1	17	18

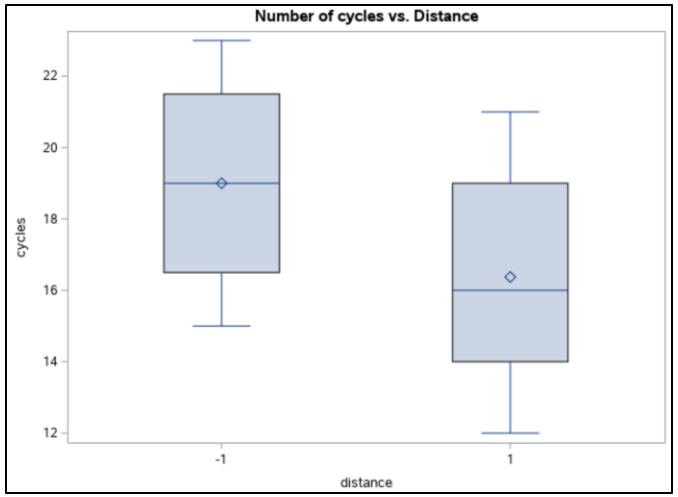
To ensure Experiment Validity, Following steps were ensured:

- Experiment was performed with single subject (Human)
- Experiment runs performed in same environment i.e. location, marker, observer, posture.
- Individual runs performed over a period of 3 days after every 3 hours to remove **"Warm-Up Effect" or "Muscle Memory"**
- Observations records were concealed from subject to reduce human bias

FACTORS vs. NUMBER OF CYCLES







- The number of completed cycles are more in bigger circles as compared to smaller circles
- More cycles were completed when distance between circles is less
- Similarly, more cycles are observed when dominant hand is used
- **Is the difference significant ?**

FINAL ANOVA MODEL

Final Model : cycles ~ circle + distance + hand + circle * hand

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	4	148.2500000	37.0625000	44.37	<.0001
Error	11	9.1875000	0.8352273		
Corrected Total	15	157.4375000			

Source	DF	Type III SS	Mean Square	F Value	Pr > F
circle	1	105.0625000	105.0625000	125.79	<.0001
distance	1	27.5625000	27.5625000	33.00	0.0001
hand	1	1.5625000	1.5625000	1.87	0.1987
circle*hand	1	14.0625000	14.0625000	16.84	0.0017

circle	hand	cycles LSMEAN	Standard Error	Pr > |t|	LSMEAN Number
-1	-1	15.7500000	0.4569538	<.0001	1
-1	1	14.5000000	0.4569538	<.0001	2
1	-1	19.0000000	0.4569538	<.0001	3
1	1	21.5000000	0.4569538	<.0001	4

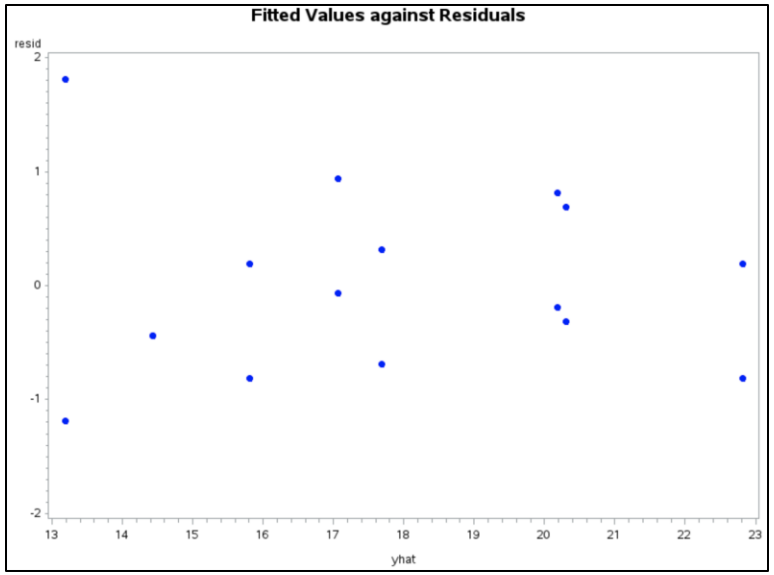
Least Squares Means for Effect circle*hand
t for H0: LSMean(i)=LSMean(j) / Pr > |t|

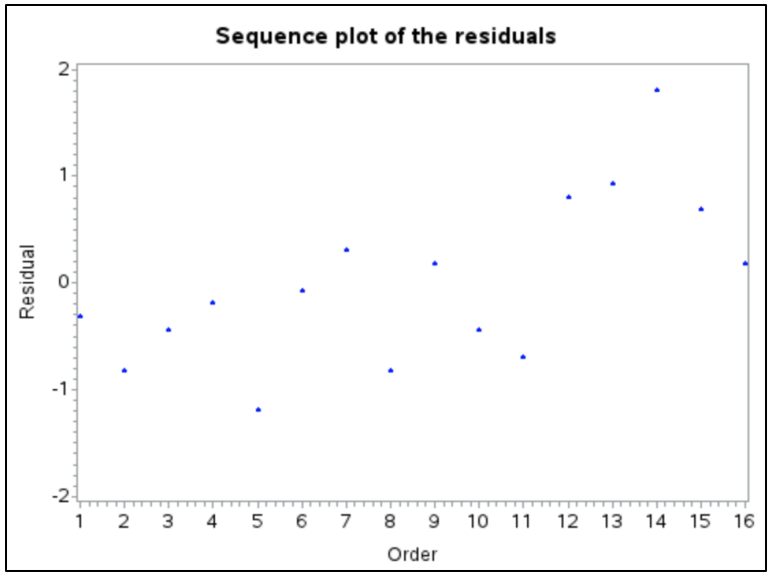
Dependent Variable: cycles

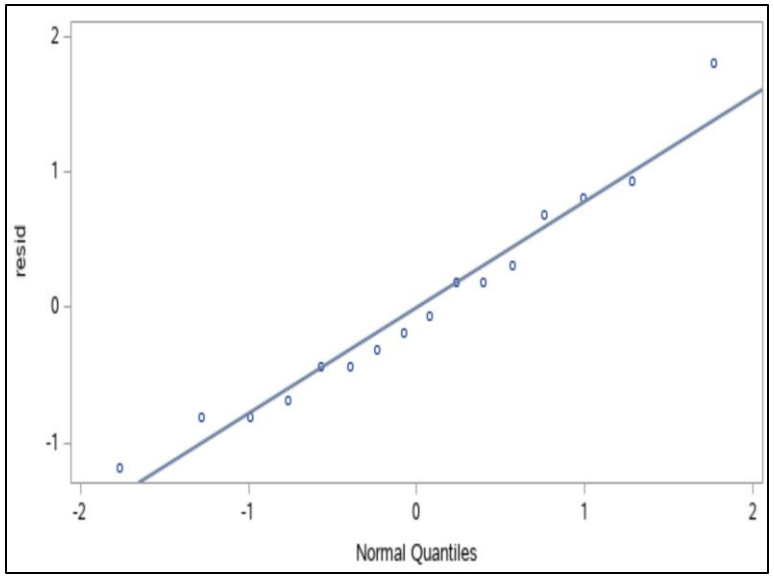
i/j	1	2	3	4
1		1.934295 0.2694	-5.02917 0.0019	-8.89776 <.0001
2	-1.93429 0.2694		-6.96346 0.0001	-10.8321 <.0001
3	5.029167 0.0019	6.963461 0.0001		-3.86859 0.0119
4	8.897756 <.0001	10.83205 <.0001	3.86859 0.0119	

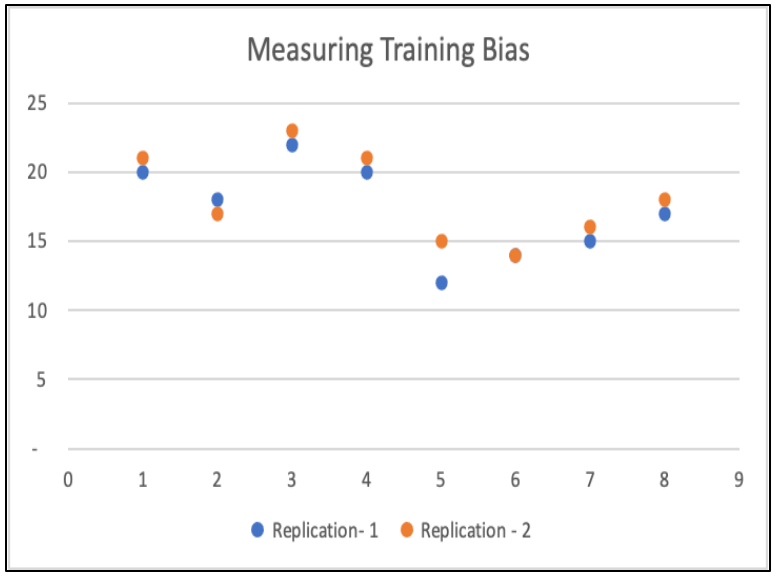
- The overall p-value is less than 0.05, which indicates that at least one of the factors is significant
- Circle, distance and interaction of circle & hand was significant
- Size of the circle is the most important factor
- Since interaction of circle and hand is significant, hand type is kept in the final model
- Contrast of every circle and hand combination is significant except the smaller circle & dominant hand vs. smaller circle & non-dominant hand

MODEL DIAGNOSTICS



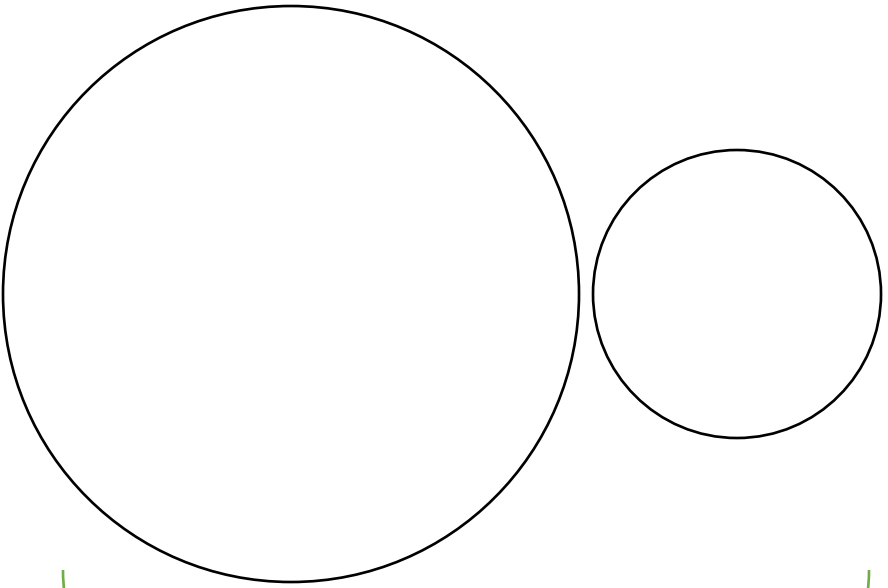




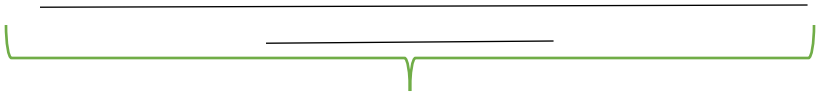


- The residual vs fitted plot is randomly scattered. Thus, assumption of constancy of variance is satisfied
- From the Q-Q plot, the points are very close to the line. Thus, it can be concluded that the residuals are normally distributed
- From the sequence plot, it can be observed that there is no auto-correlation
- The training effect was extremely limited as can be observed in the graph

CONCLUSION



Significant



Significant

Not Significant

Parameter	Estimate	Standard Error	t Value	Pr > |t|	95% Confidence Limits	
circle	5.12500000	0.45695385	11.22	<.0001	4.11925136	6.13074864
distance	-2.62500000	0.45695385	-5.74	0.0001	-3.63074864	-1.61925136
hand	0.62500000	0.45695385	1.37	0.1987	-0.38074864	1.63074864

- Size of the circle, distance between circles are significant at 5% level
- Choice of hand does not affect the number of cycles at 5% significance level
- Interaction of circle size and hand type is significant
- The difference in number of cycles between larger and smaller circle is +5.12 cycles
- The difference in number of cycles between larger and smaller distance is – 2.62 cycles

THANK YOU !!