

Synchronization and Analysis of the Biomarkers Under Noise and Stress



UNIVERSITY OF
EASTERN FINLAND



KYS

Team Data Scientists
Industrial Project
Presentation

Introduction

Team Data Scientists

Group Members, Project Details, Purpose.





Group Information

Team Data Scientists

Fatima Rabia Yapicioglu	306627	Chairperson & Data Scientist
Mariia Sorokina	306548	Content Distributor & Data Scientist
Rhythm Bhatia	308847	Tool Searcher & Data Scientist



Project Details

Project Name: Synchronization and Analysis of the Biomarkers Under Noise and Stress

Supervisors: Hana Vrzakova - Antti Huotarinen

Teacher: Markku Hauta-Kasari

Data Collected: 21 Participant's .mp4 video file (annotated frame by frame). ,Experiment Outcomes Analysis Data, Physiological Data .ASC Files.

Tools that are used: BORIS, Eye-Tracker, Jupyter Notebook, Kaggle, Matplotlib, Seaborn, Plotly.



Purpose

Analyzing the data of biomarkers who work under stress and noise by making a summary boxplot graph in Python/R to show how long each task lasted for all participants. And for each participant, computing the mean and standard deviation for each physiology signal.

Methods

Team Data Scientists

Data Collections, Visualizations, Summary Statistics



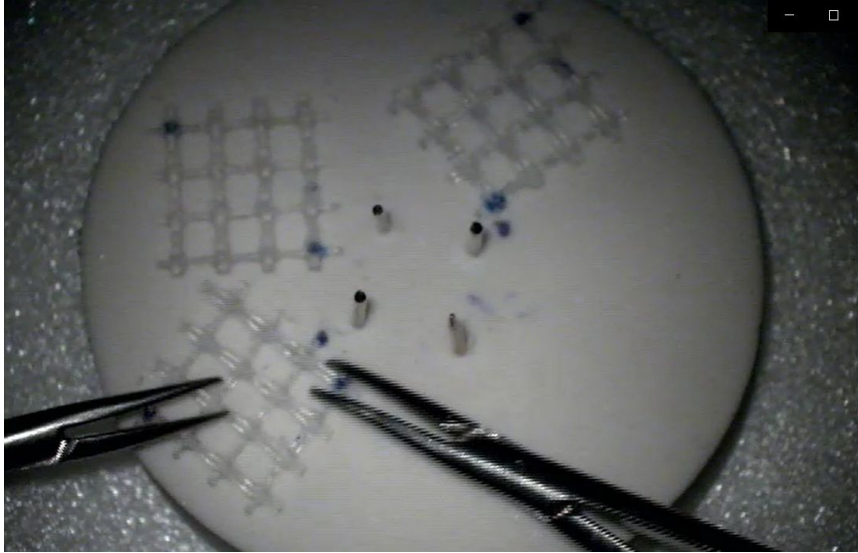


Methods - Data Collection Methods

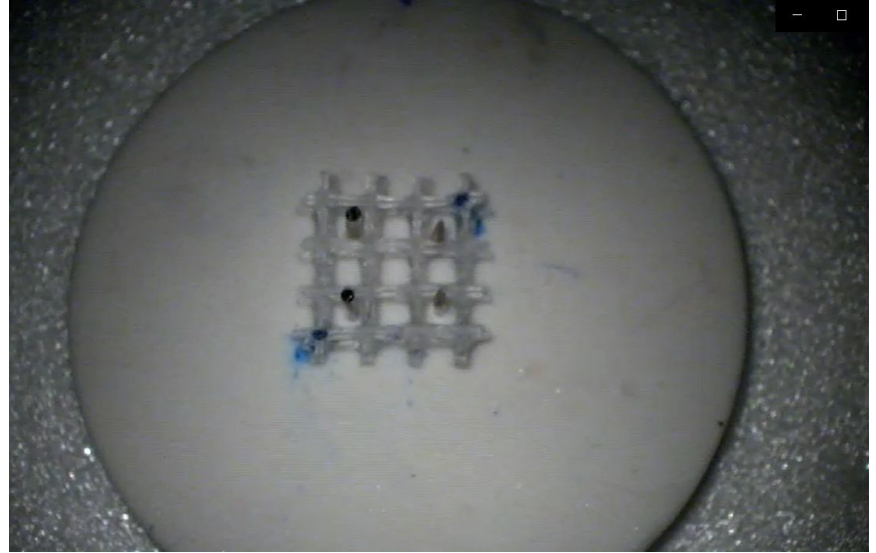
- We had 21 participants (biomarkers).
- Each participant was doing three tasks,
 - Mesh Alignment
 - Knotting
 - Go-Around.
- Each participant has three sessions,
 - Pre-Exposure
 - Exposure
 - Post-Exposure.



Mesh Alignment



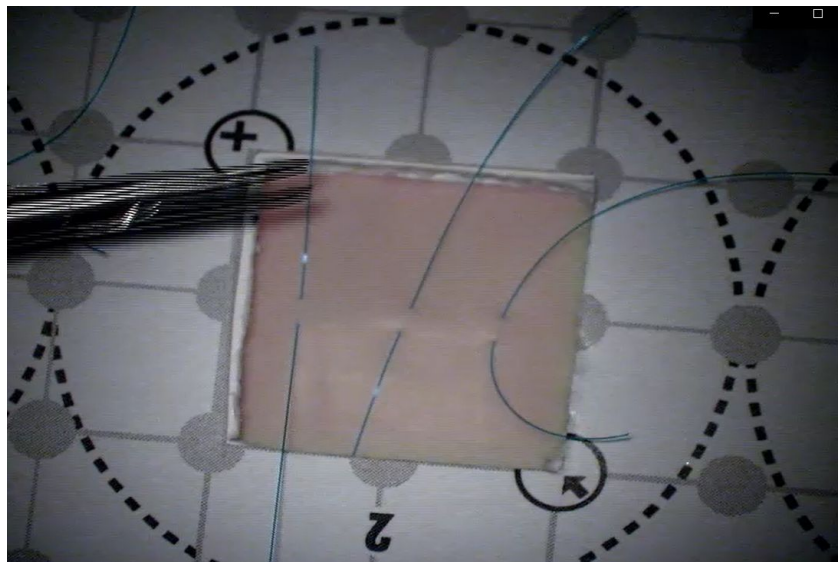
Mesh Alignment Start Frame



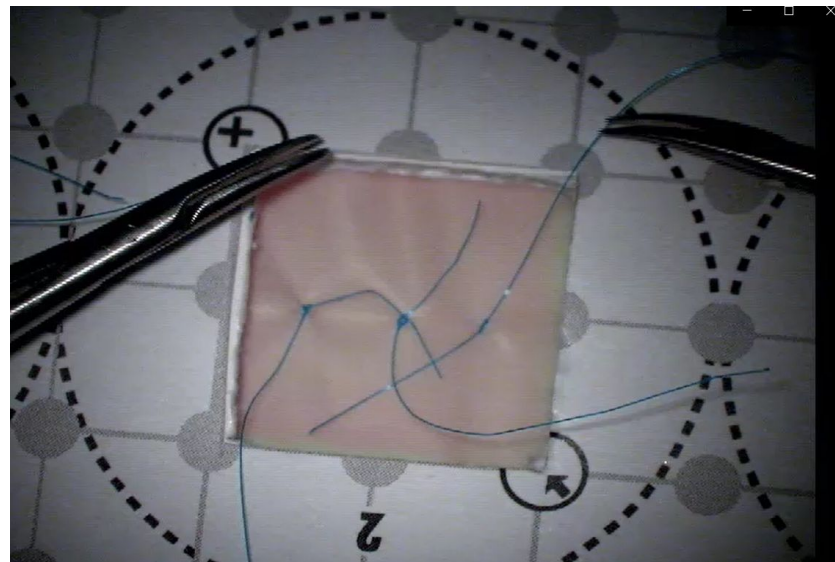
Mesh Alignment End Frame



Knotting



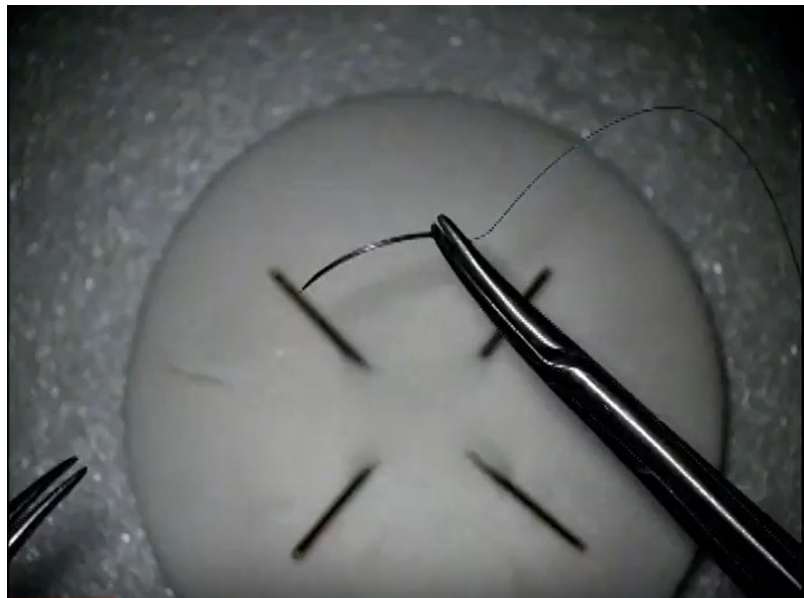
Knotting Start Frame



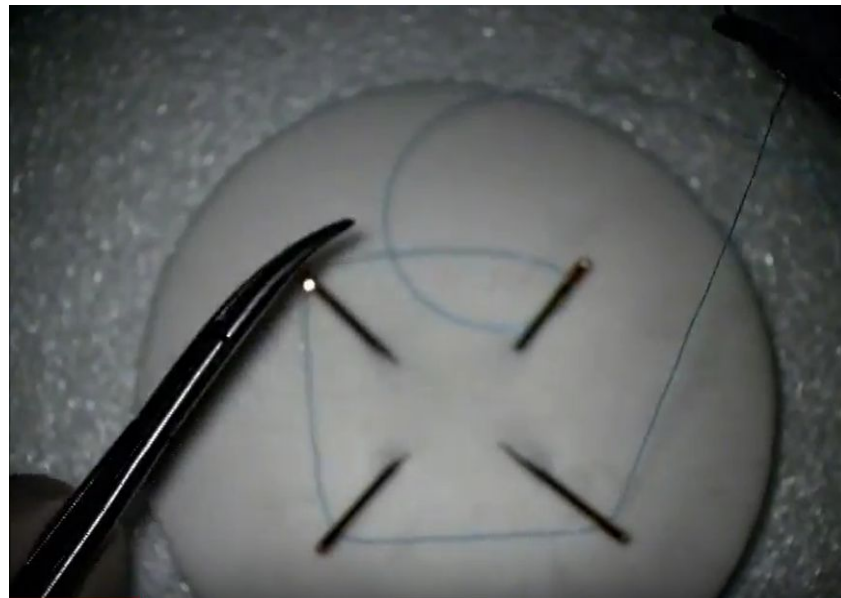
Knotting End Frame



Go-Around



Go-Around Start Frame



Go-Around End Frame



Frame Numbers Excel Table

ParticipantID	Phase	Task	Task name	Repetition	Start	End
P1	Pre-exposure	Task 1	Mesh Alignment	Trial 1	26265	26990
P1	Pre-exposure	Task 1	Mesh Alignment	Trial 2	29245	29600
P1	Pre-exposure	Task 1	Mesh Alignment	Trial 3	30795	31565
P1	Pre-exposure	Task 2	Knotting	Trial 1	20538	22322
P1	Pre-exposure	Task 2	Knotting	Trial 2	-	-
P1	Pre-exposure	Task 2	Knotting	Trial 3	-	-
P1	Pre-exposure	Task 3	Go-around	Trial 1	9427	10839
P1	Pre-exposure	Task 3	Go-around	Trial 2	13615	14596
P1	Pre-exposure	Task 3	Go-around	Trial 3	16616	17436

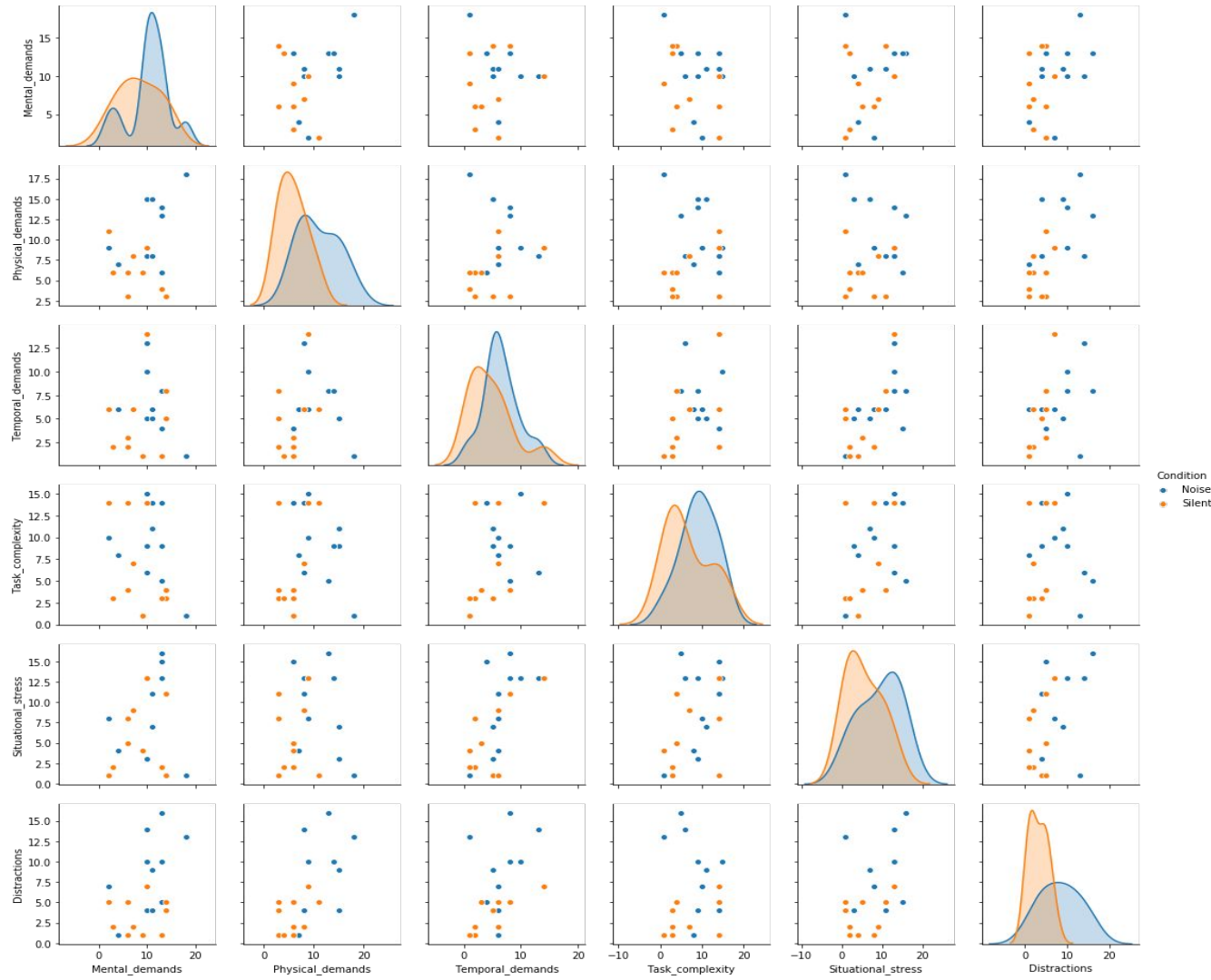
Experiment Outcomes Analysis

Team Data Scientists

Heatmaps, Box plots, Pie Plots, Density Graphs, ASC visualizations



Group By Condition All Features Scatter Plot





Experiment Outcomes Analysis

```
import pandas as pd
```

```
df=pd.read_csv('data_final.csv',sep=';')
```

```
df.head()
```

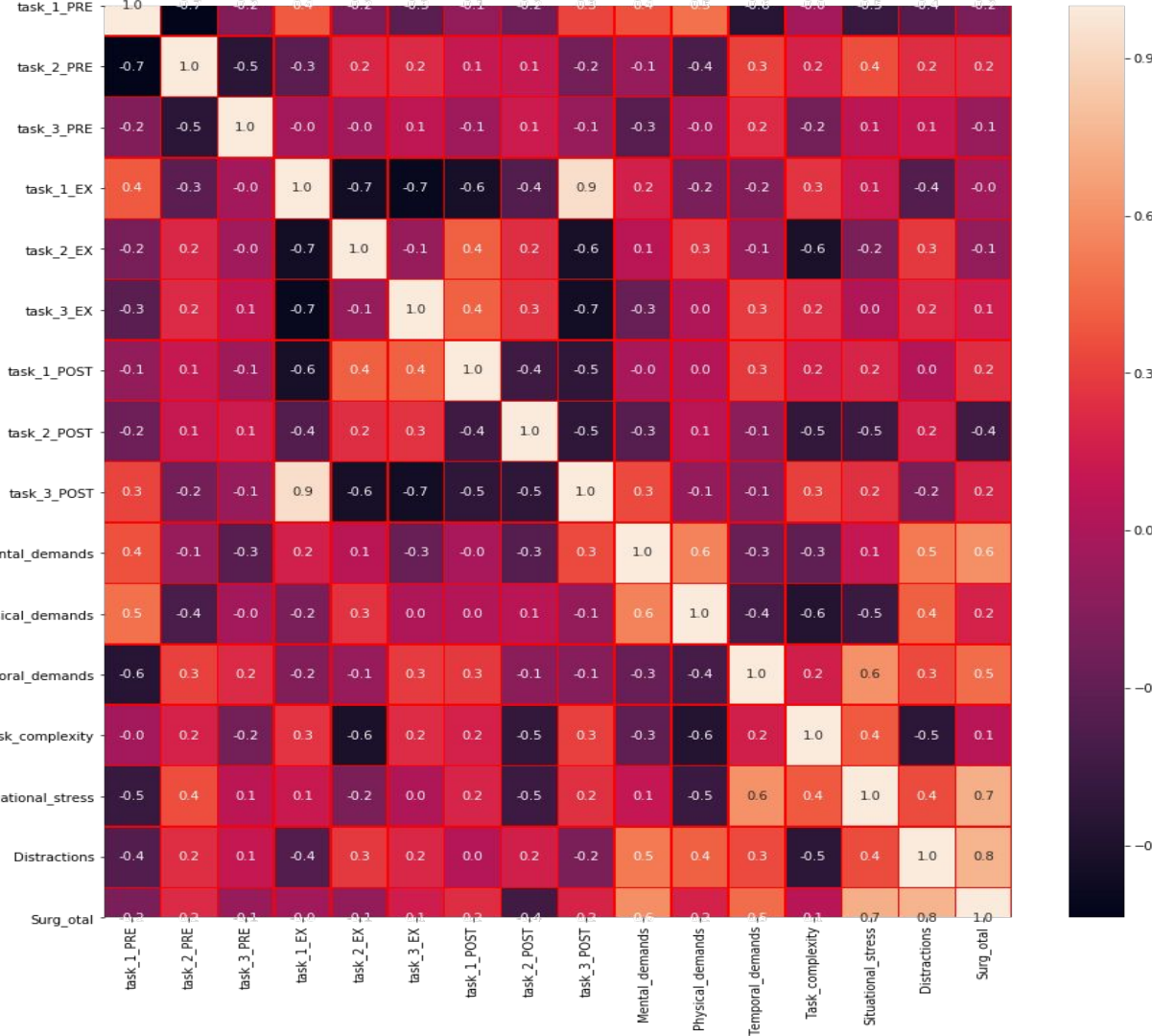
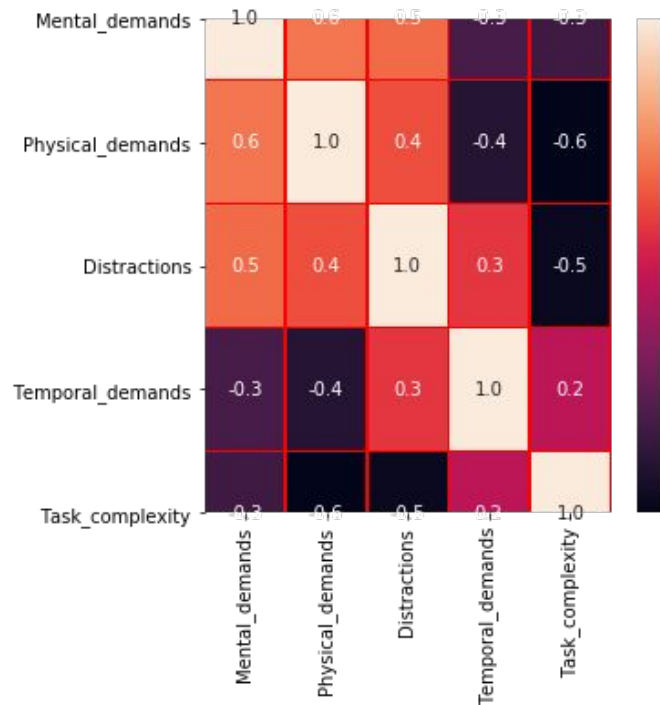
	Date	Gender	ID	Condition	task_1_PRE	task_2_PRE	task_3_PRE	task_1_EX	task_2_EX	task_3_EX	...	Physical_demands	Temporal_demands	Ta
0	23.11.2017	F	P1	Noise	2	1	3	3	2	1	...	13	8	
1	23.11.2017	M	P2	Silent	3	1	2	1	2	3	...	6	2	
2	23.11.2017	F	P3	Noise	1	3	2	1	3	2	...	9	6	
3	24.11.2017	F	P4	Silent	2	1	3	3	1	2	...	8	6	
4	24.11.2017	M	P5	Noise	3	2	1	2	3	1	...	18	1	

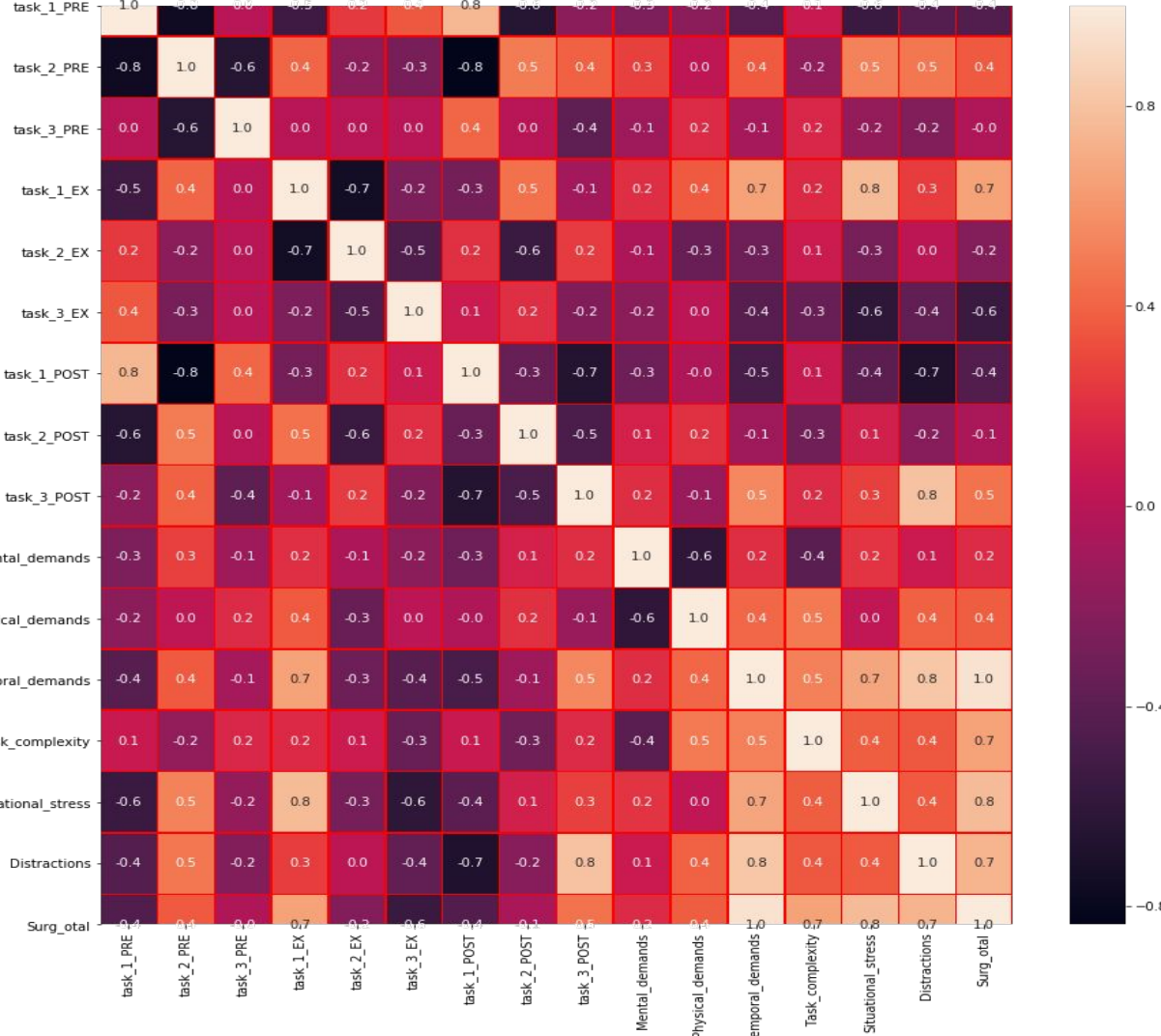
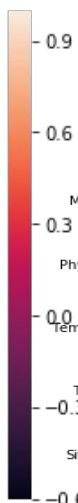
5 rows × 24 columns

Date , Gender , ID ,Condition, task_1_PRE, task_2_PRE, task_3_PRE, task_1_EX, task_2_EX, task_3_EX, task_1_POST, task_2_POST, task_3_POST, Mental_demands, Physical_demands, Temporal_demands, Task_complexity, Situational_stress, Distractions, Surg_otal, Surg_Average, A_quality_of_knot, B_efficiency, C_handling



Noise Environment





Building Data Summary by Using R

#Building a Data Summary Table

```
our_summary <-  
  list( "Mental Demands" =  
    list( "min"= ~ min( df2$Mental_demands),  
          "max"= ~ max( df2$Mental_demands),  
          "mean"= ~ qwraps2::mean_sd(df2$Mental_demands)),  
    "Physical Demands" =  
    list( "min"= ~ min( df2$Physical_demands),  
          "max"= ~ max( df2$Physical_demands),  
          "mean"= ~ qwraps2::mean_sd(df2$Physical_demands)),  
    "Temporal Demands" =  
    list( "min"= ~ min( df2$Temporal_demands),  
          "max"= ~ max( df2$Temporal_demands),  
          "mean"= ~ qwraps2::mean_sd(df2$Temporal_demands)),  
    "Task Complexity" =  
    list( "min"= ~ min( df2$Task_complexity),  
          "max"= ~ max( df2$Task_complexity),  
          "mean"= ~ qwraps2::mean_sd(df2$Task_complexity)),  
    "Situational Stress" =  
    list( "min"= ~ min( df2$Situational_stress),  
          "max"= ~ max( df2$Situational_stress),  
          "mean"= ~ qwraps2::mean_sd(df2$Situational_stress)),  
    "Distractions" =  
    list( "min"= ~ min( df2$Distractions),  
          "max"= ~ max( df2$Distractions),  
          "mean"= ~ qwraps2::mean_sd(df2$Distractions))  
  )  
  
whole <- summary_table(df2, our_summary)  
whole
```

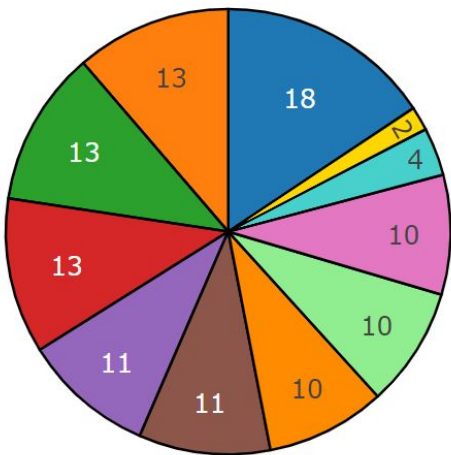
output

	df2 (N = 21)
Mental Demands	
min	2
max	18
mean	9.48 ± 4.38
Physical Demands	
min	3
max	18
mean	8.62 ± 4.31
Temporal Demands	
min	1
max	14
mean	5.71 ± 3.62
Task Complexity	
min	1
max	15
mean	8.05 ± 4.81
Situational Stress	
min	1
max	16
mean	7.62 ± 5.07

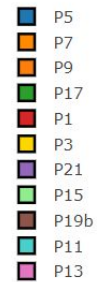
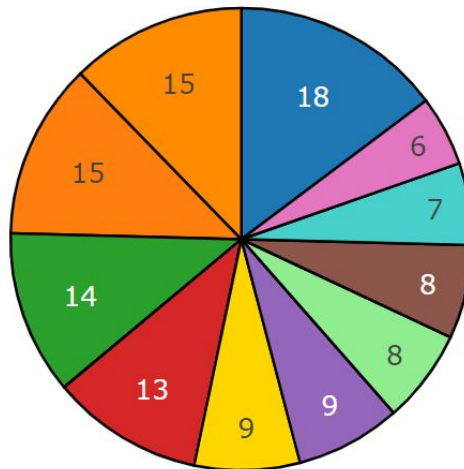


Noise Environment Participants

Mental demands



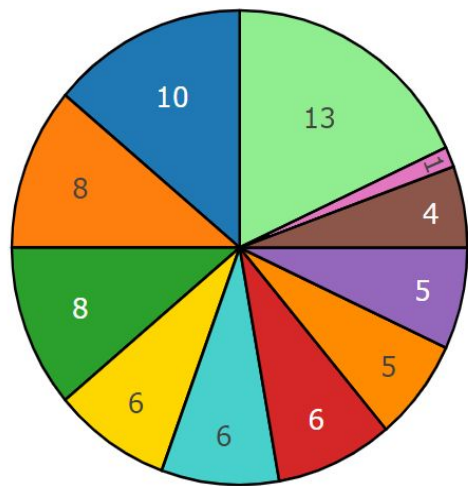
Physical Demands



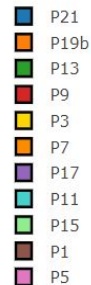
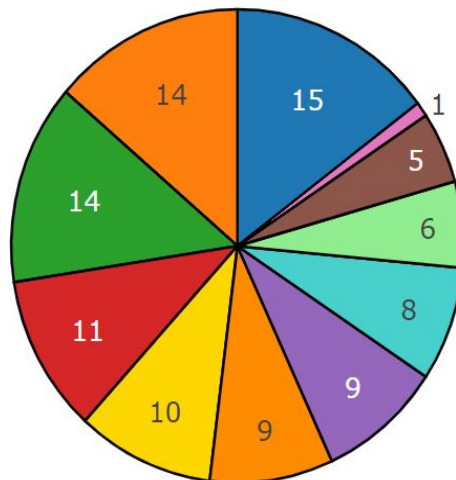


Noise Environment Participants

Temporal demands



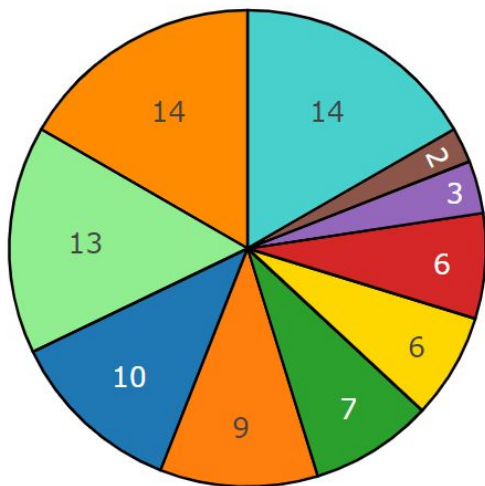
Task Complexity



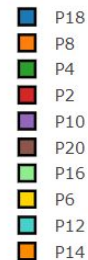
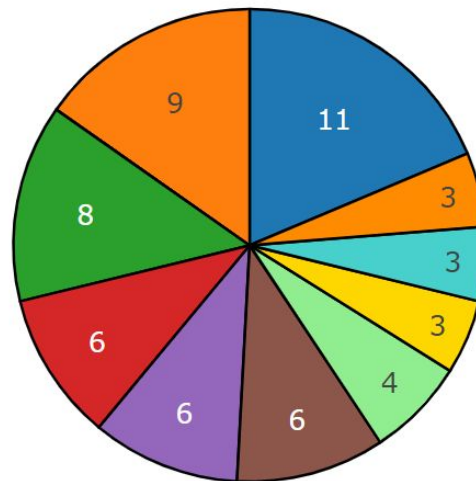


Silent Environment Participants

Mental demands



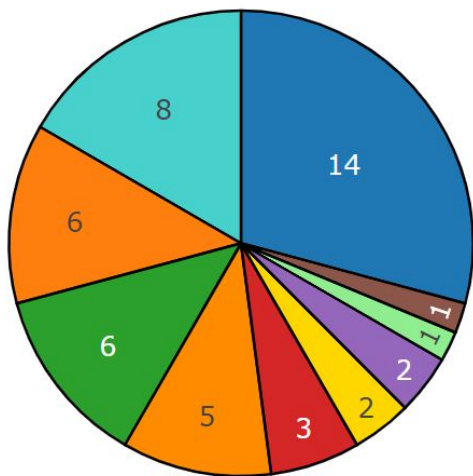
Physical Demands



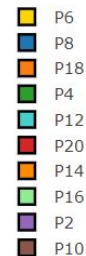
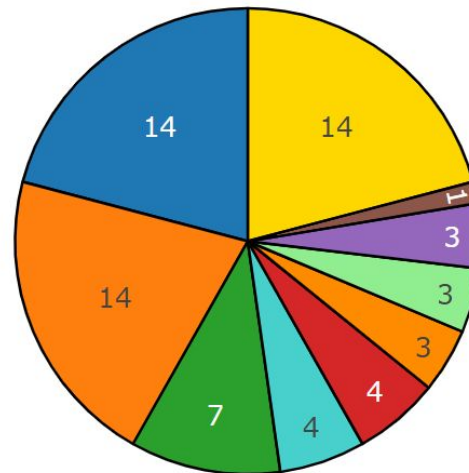
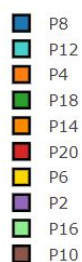


Silent Environment Participants

Temporal demands



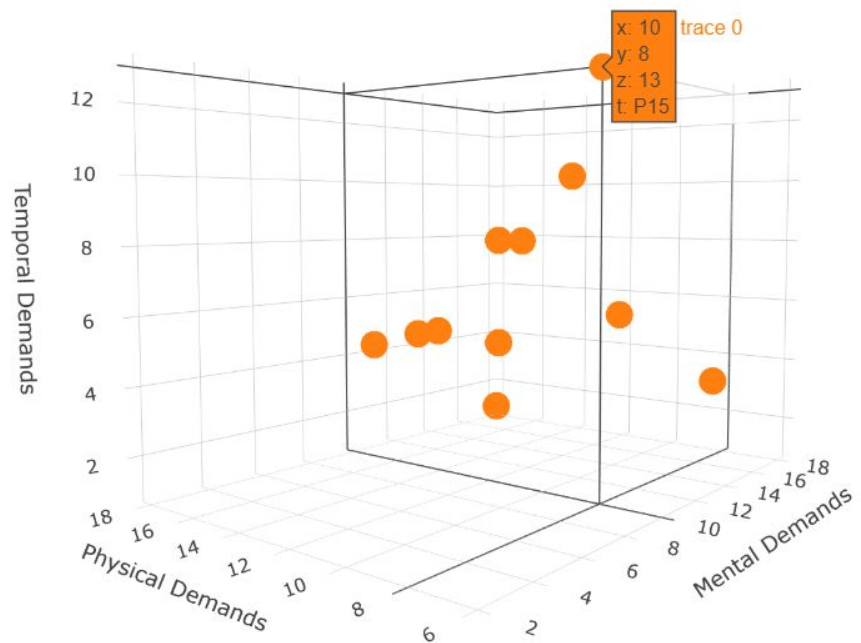
Task Complexity



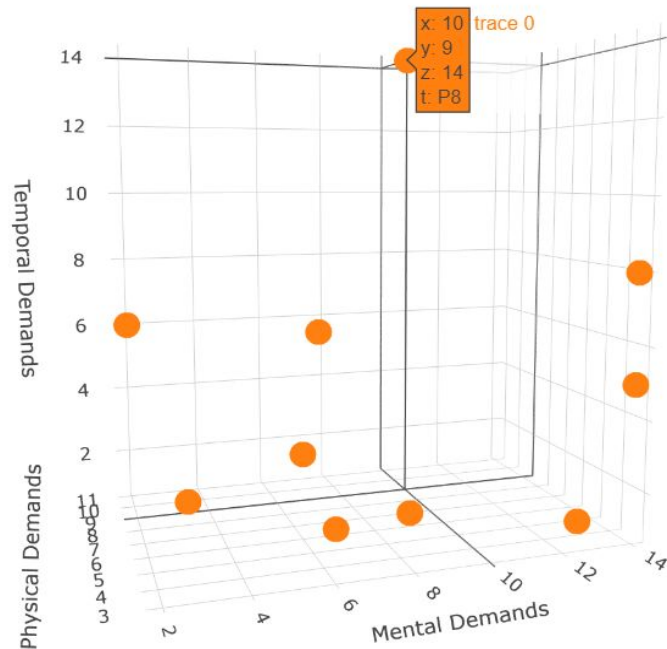
3D Visualizations



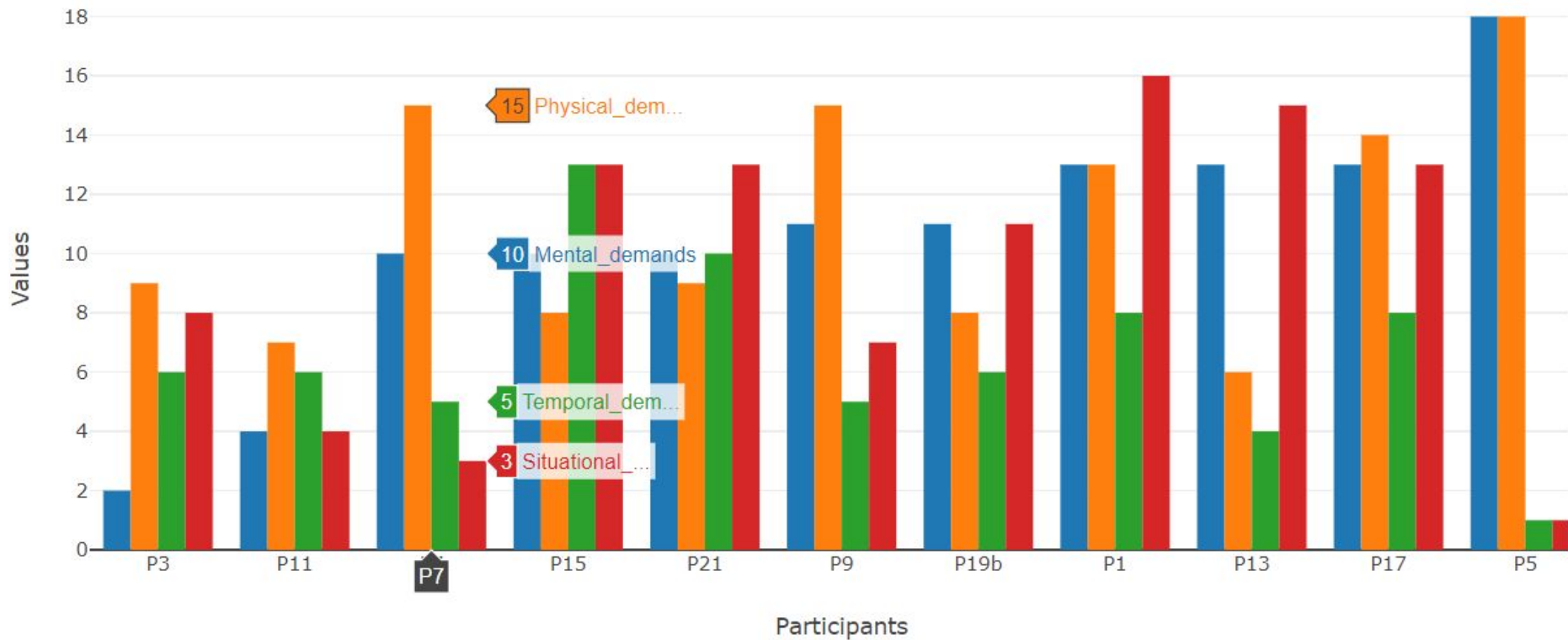
Noise Environment



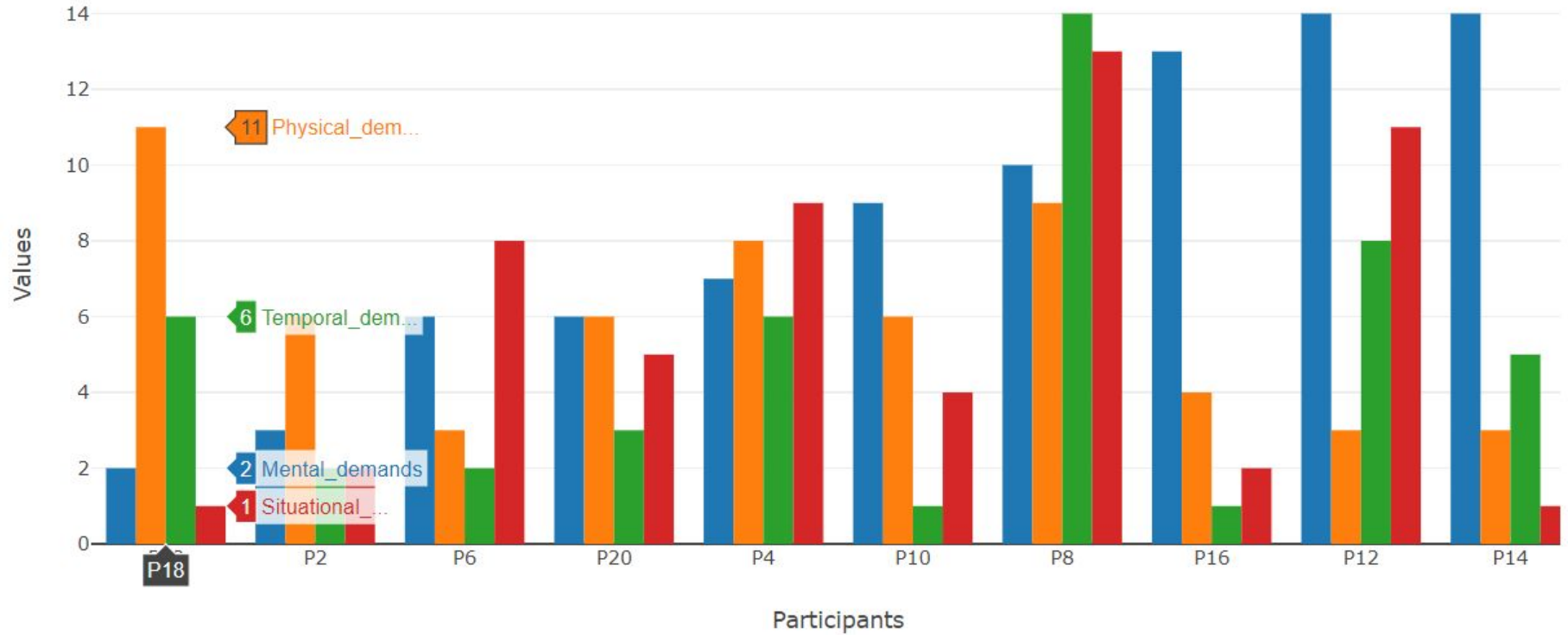
Silent Environment

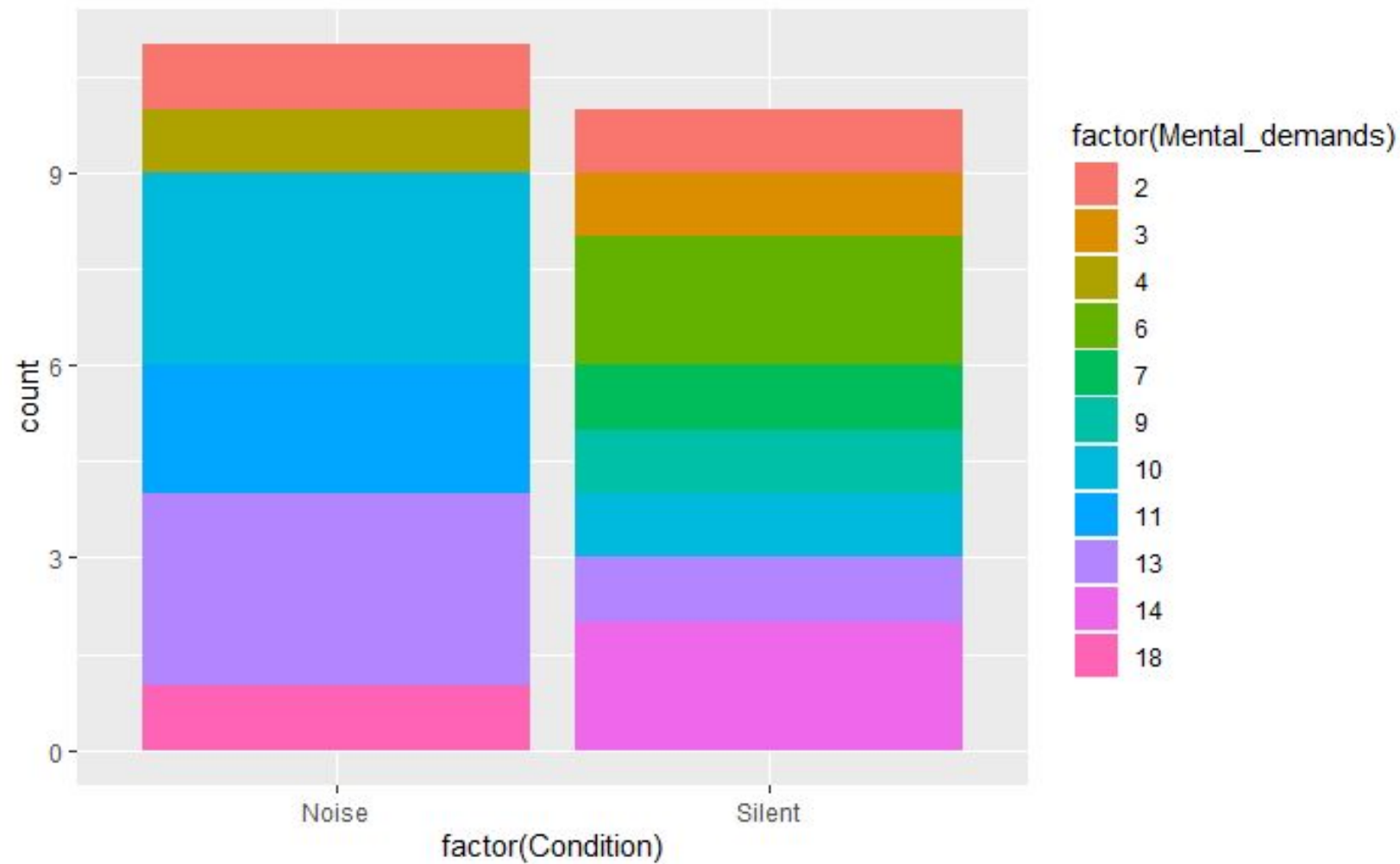


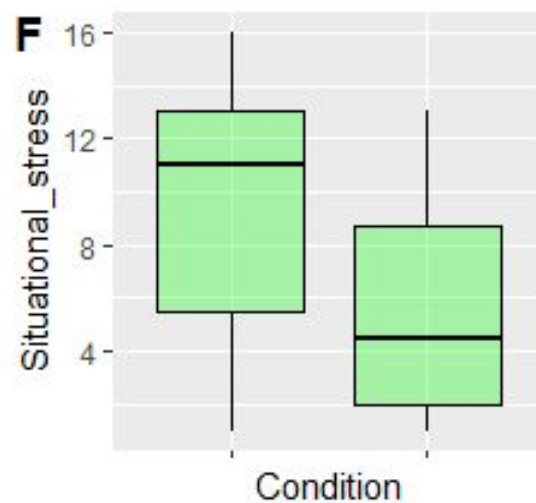
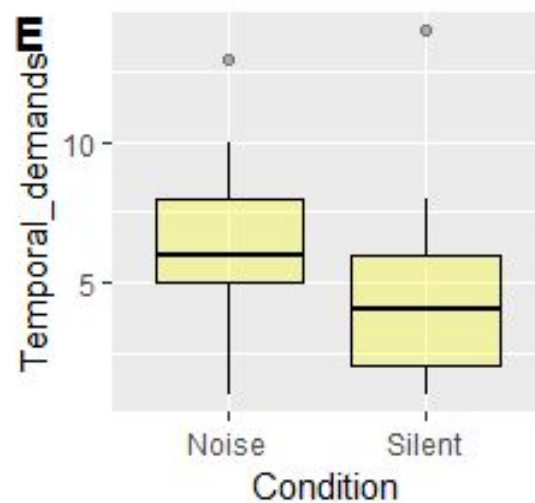
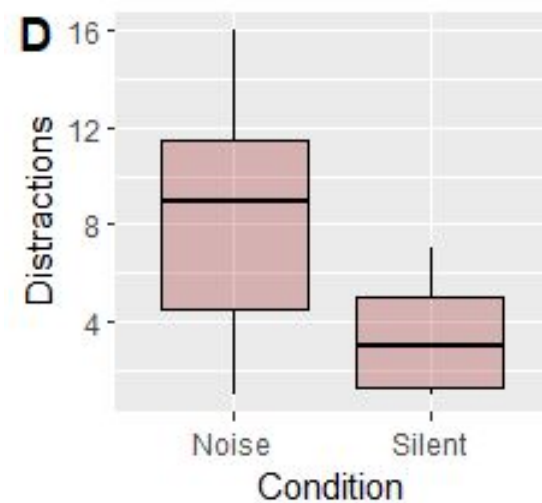
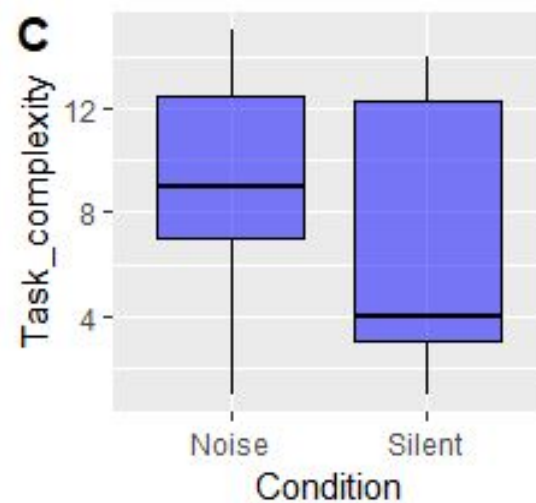
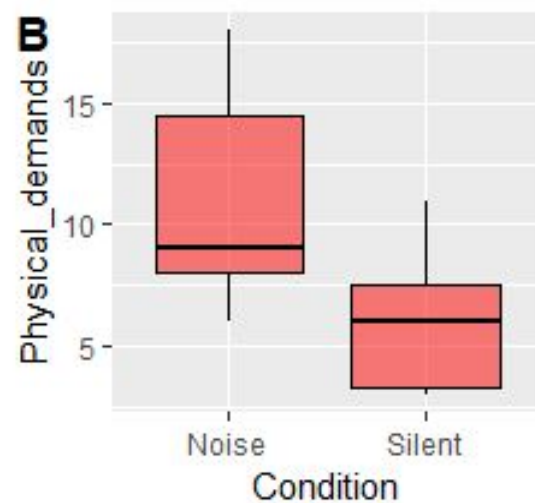
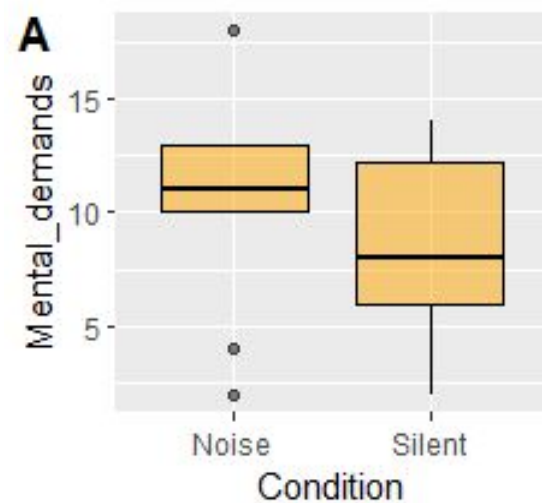
Noise Participants Data

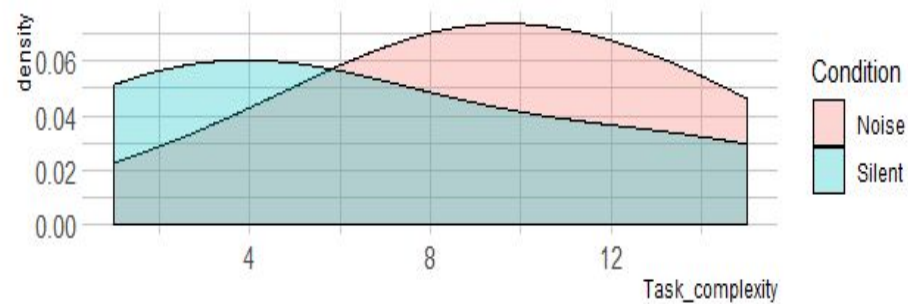
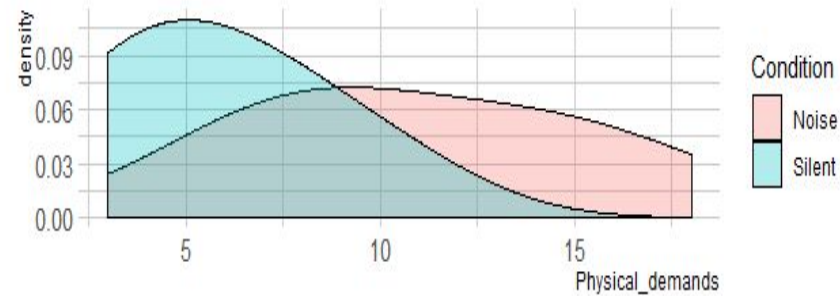
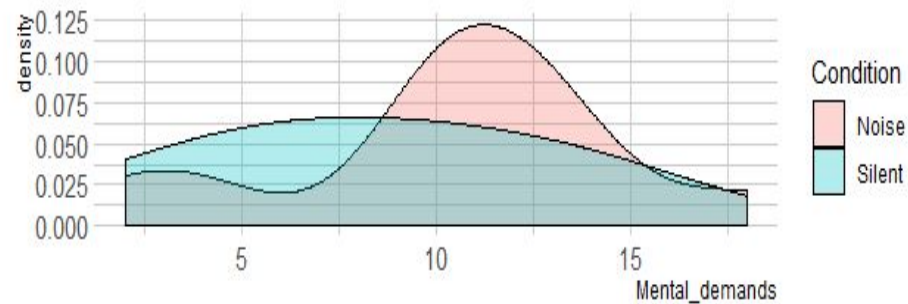
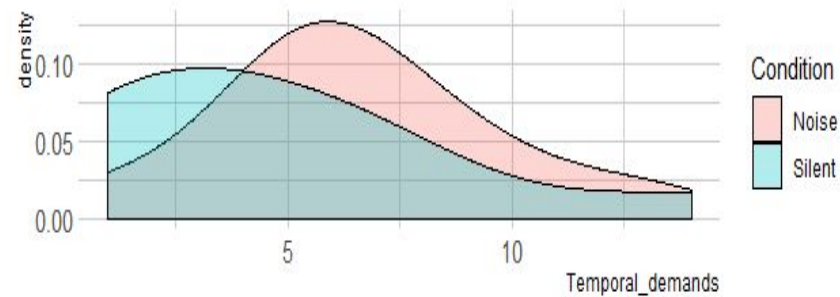


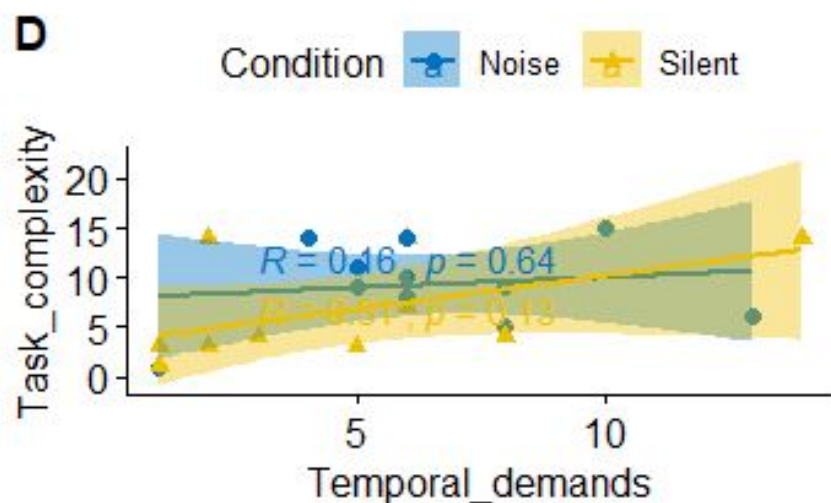
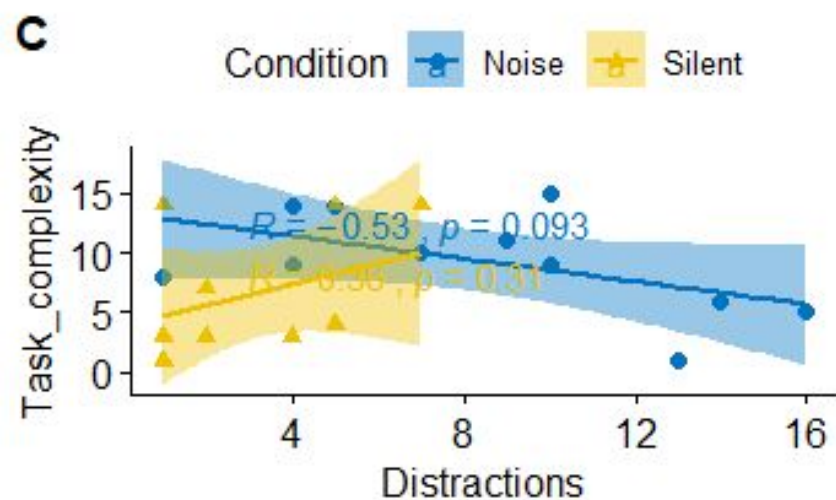
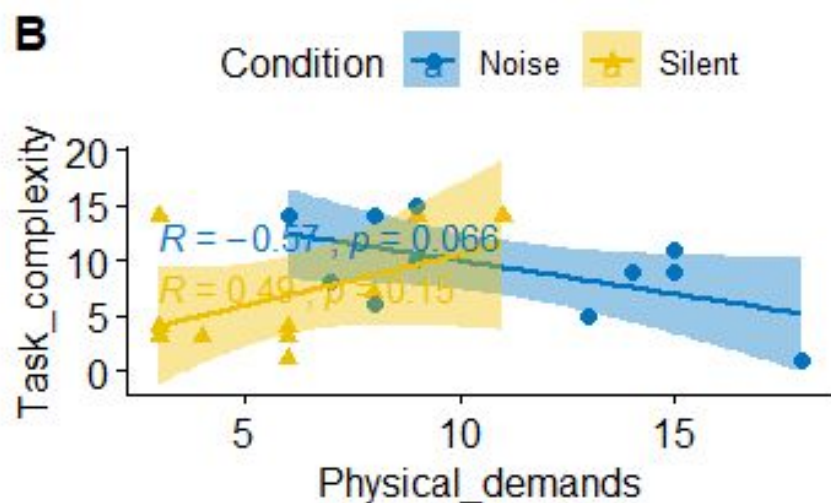
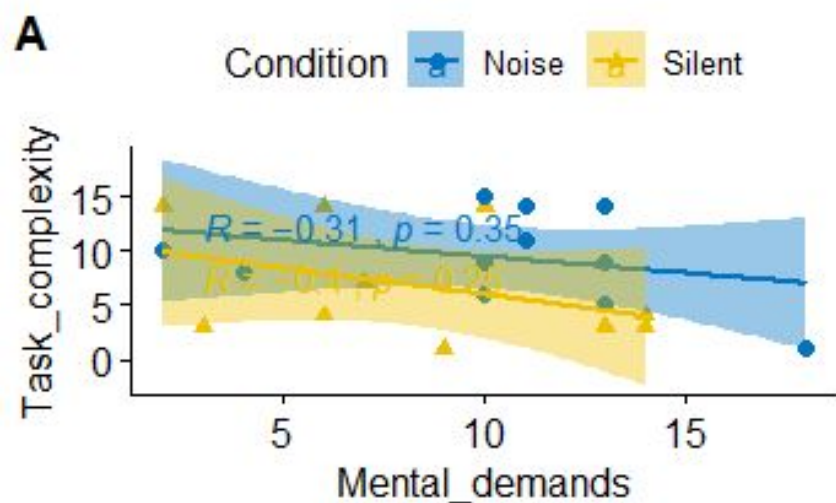
Silent Participants Data







A**A****B****B**



Results

Team Data Scientists

Heatmaps, Box plots, Pie Plots, Density Graphs, ASC visualizations



Summary, Participants in Noise Environment

```
1 s1=noise_participants.describe().T.tail(7)
2 s1
```

	count	mean	std	min	25%	50%	75%	max
Mental_demands	11.0	10.454545	4.367233	2.0	10.0	11.0	13.0	18.0
Physical_demands	11.0	11.090909	4.011348	6.0	8.0	9.0	14.5	18.0
Temporal_demands	11.0	6.545455	3.173756	1.0	5.0	6.0	8.0	13.0
Task_complexity	11.0	9.272727	4.244783	1.0	7.0	9.0	12.5	15.0
Situational_stress	11.0	9.454545	5.145165	1.0	5.5	11.0	13.0	16.0
Distractions	11.0	8.454545	4.719399	1.0	4.5	9.0	11.5	16.0
Surg_otal	11.0	55.272727	12.337673	30.0	49.0	57.0	65.5	71.0

Summary, Participants in Silent Environment

```
1 s2=silent_participants.describe().T.tail(7)
2 s2
```

	count	mean	std	min	25%	50%	75%	max
Mental_demands	10.0	8.4	4.351245	2.0	6.00	8.0	12.25	14.0
Physical_demands	10.0	5.9	2.766867	3.0	3.25	6.0	7.50	11.0
Temporal_demands	10.0	4.8	4.022161	1.0	2.00	4.0	6.00	14.0
Task_complexity	10.0	6.7	5.250397	1.0	3.00	4.0	12.25	14.0
Situational_stress	10.0	5.6	4.376706	1.0	2.00	4.5	8.75	13.0
Distractions	10.0	3.3	2.162817	1.0	1.25	3.0	5.00	7.0
Surg_otal	10.0	34.7	14.126807	18.0	25.25	32.0	39.00	67.0



Comparison of Noise and Silent Environments

```
1 s1=noise_participants.describe().T.tail(7)
2 s1
```

	count	mean	std	min	25%	50%	75%	max
Mental_demands	11.0	10.454545	4.367233	2.0	10.0	11.0	13.0	18.0
Physical_demands	11.0	11.090909	4.011348	6.0	8.0	9.0	14.5	18.0
Temporal_demands	11.0	6.545455	3.173756	1.0	5.0	6.0	8.0	13.0
Task_complexity	11.0	9.272727	4.244783	1.0	7.0	9.0	12.5	15.0
Situational_stress	11.0	9.454545	5.145165	1.0	5.5	11.0	13.0	16.0
Distractions	11.0	8.454545	4.719399	1.0	4.5	9.0	11.5	16.0
Surg_otal	11.0	55.272727	12.337673	30.0	49.0	57.0	65.5	71.0

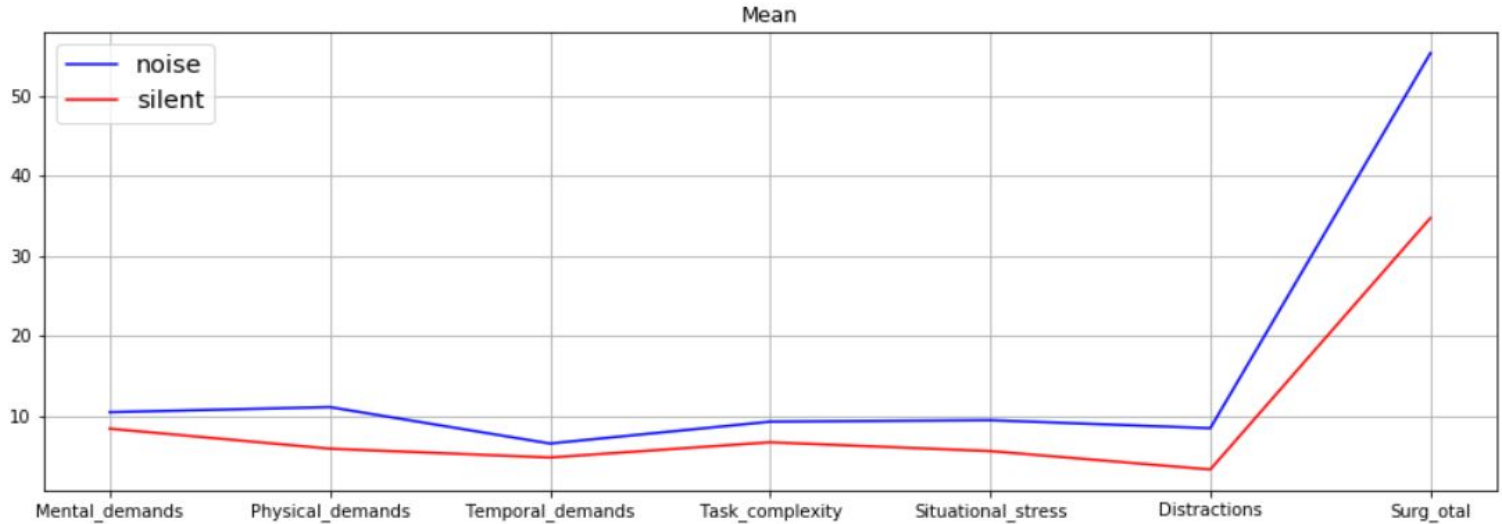
```
1 s2=silent_participants.describe().T.tail(7)
2 s2
```

	count	mean	std	min	25%	50%	75%	max
Mental_demands	10.0	8.4	4.351245	2.0	6.00	8.0	12.25	14.0
Physical_demands	10.0	5.9	2.766867	3.0	3.25	6.0	7.50	11.0
Temporal_demands	10.0	4.8	4.022161	1.0	2.00	4.0	6.00	14.0
Task_complexity	10.0	6.7	5.250397	1.0	3.00	4.0	12.25	14.0
Situational_stress	10.0	5.6	4.376706	1.0	2.00	4.5	8.75	13.0
Distractions	10.0	3.3	2.162817	1.0	1.25	3.0	5.00	7.0
Surg_otal	10.0	34.7	14.126807	18.0	25.25	32.0	39.00	67.0

Means Plot Graph

```
1 plt.figure(figsize=(15,5))
2 plt.grid()
3 plt.plot(s1['mean'],color='blue',label='noise')
4 plt.plot(s2['mean'],color='red',label='silent')
5 plt.legend(fontsize='x-large')
6 plt.title('Mean')
```

Text(0.5, 1.0, 'Mean')



Group by Condition; count, mean, std.

```
1 df.groupby("Condition")['Mental_demands'].describe()
```

	count	mean	std	min	25%	50%	75%	max
Condition								
Noise	11.0	10.454545	4.367233	2.0	10.0	11.0	13.00	18.0
Silent	10.0	8.400000	4.351245	2.0	6.0	8.0	12.25	14.0

```
1 df.groupby("Condition")['Physical_demands'].describe()
```

	count	mean	std	min	25%	50%	75%	max
Condition								
Noise	11.0	11.090909	4.011348	6.0	8.00	9.0	14.5	18.0
Silent	10.0	5.900000	2.766867	3.0	3.25	6.0	7.5	11.0

Group by Condition; count, mean, std.

```
1 df.groupby("Condition")['Temporal_demands'].describe()
```

	count	mean	std	min	25%	50%	75%	max
Condition								
Noise	11.0	6.545455	3.173756	1.0	5.0	6.0	8.0	13.0
Silent	10.0	4.800000	4.022161	1.0	2.0	4.0	6.0	14.0

```
1 df.groupby("Condition")['Task_complexity'].describe()
```

	count	mean	std	min	25%	50%	75%	max
Condition								
Noise	11.0	9.272727	4.244783	1.0	7.0	9.0	12.50	15.0
Silent	10.0	6.700000	5.250397	1.0	3.0	4.0	12.25	14.0



T-test code

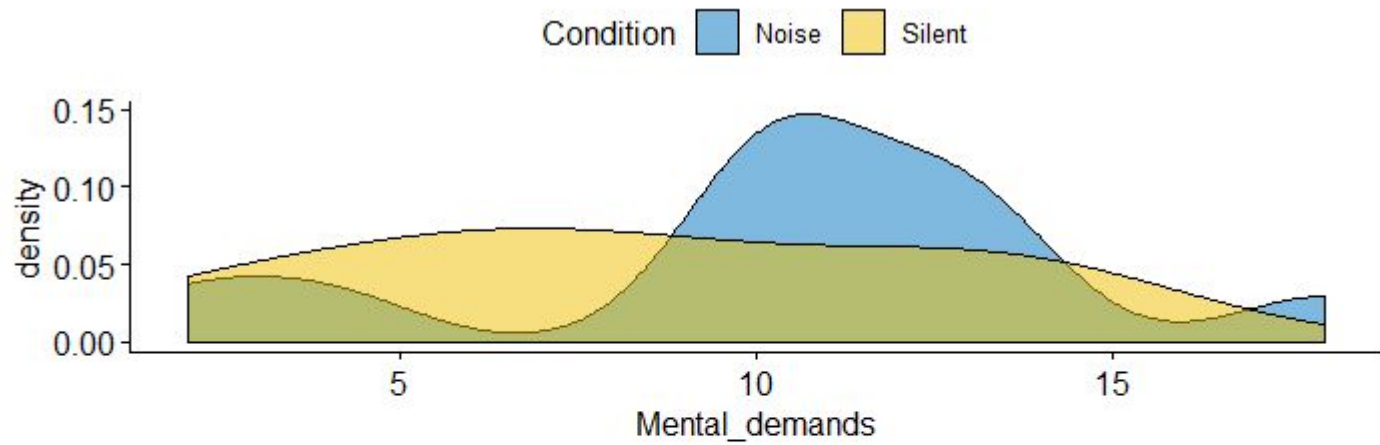
```
twosample_results = scipy.stats.ttest_ind(noise_participants['Mental_demands'], silent_participants['Mental_demands'])

matrix_twosample = [
    ['', 'Test Statistic', 'p-value'],
    ['Sample Data', twosample_results[0], twosample_results[1]]
]

twosample_table = FF.create_table(matrix_twosample, index=True)
py.ipplot(twosample_table, filename='twosample-table')
```

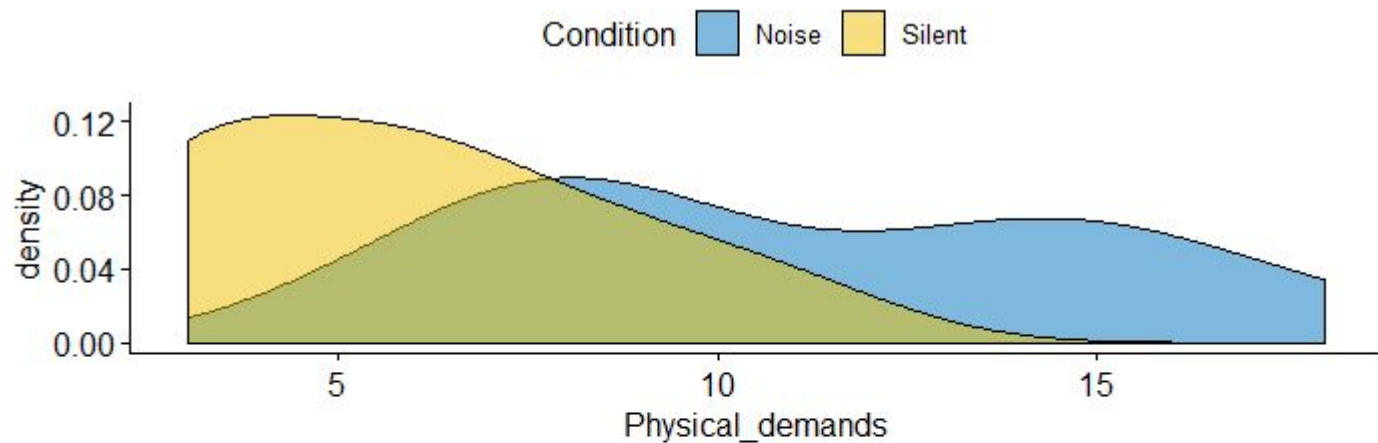
Two Samples,T-test Results

Mental Demands	Test Statistic	p-value	
Sample Data	1.0785719104519582	0.2942817213459388	EDIT CHART
Physical Demands	Test Statistic	p-value	
Sample Data	3.4160429024727317	0.0028973685939021046	EDIT CHART
Temporal Demands	Test Statistic	p-value	
Sample Data	1.1094705787911137	0.2810728450631287	EDIT CHART
Distractions	Test Statistic	p-value	
Sample Data	3.1598940082139584	0.0051571612986448506	EDIT CHART



Condition	mean	sd
Noise	10.45455	4.367233
Silent	8.40000	4.351245

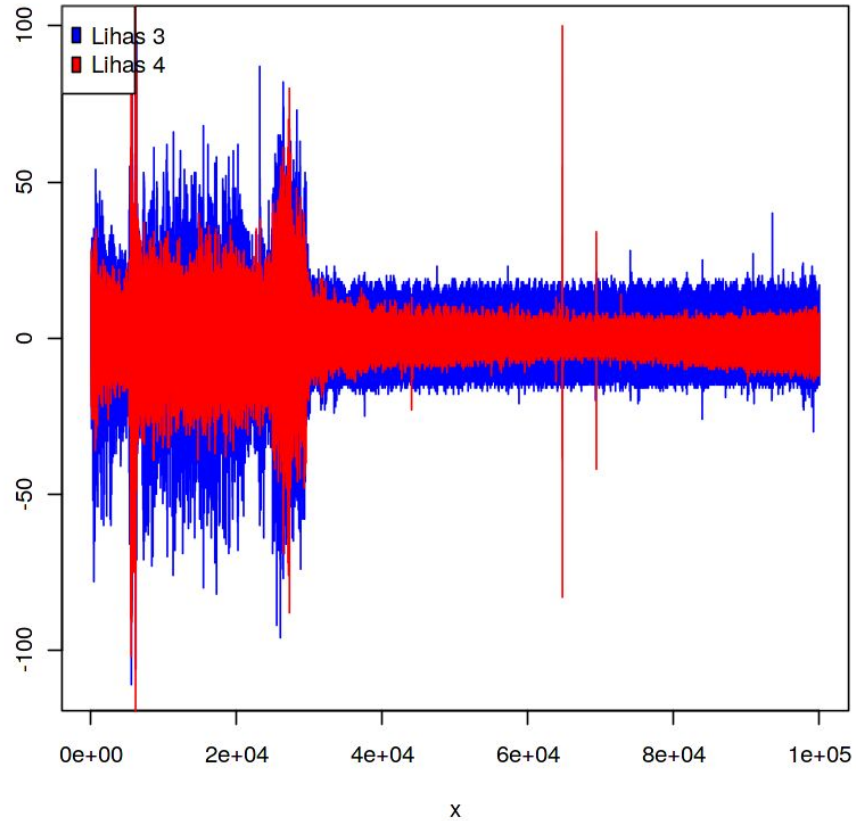
Figure 1: Density plot of Mental_demands for Noise and Silent conditions. The plot shows that the Noise condition has a higher mean and standard deviation compared to the Silent condition.



Condition	mean	sd
Noise	11.09091	4.011348
Silent	5.90000	2.766867

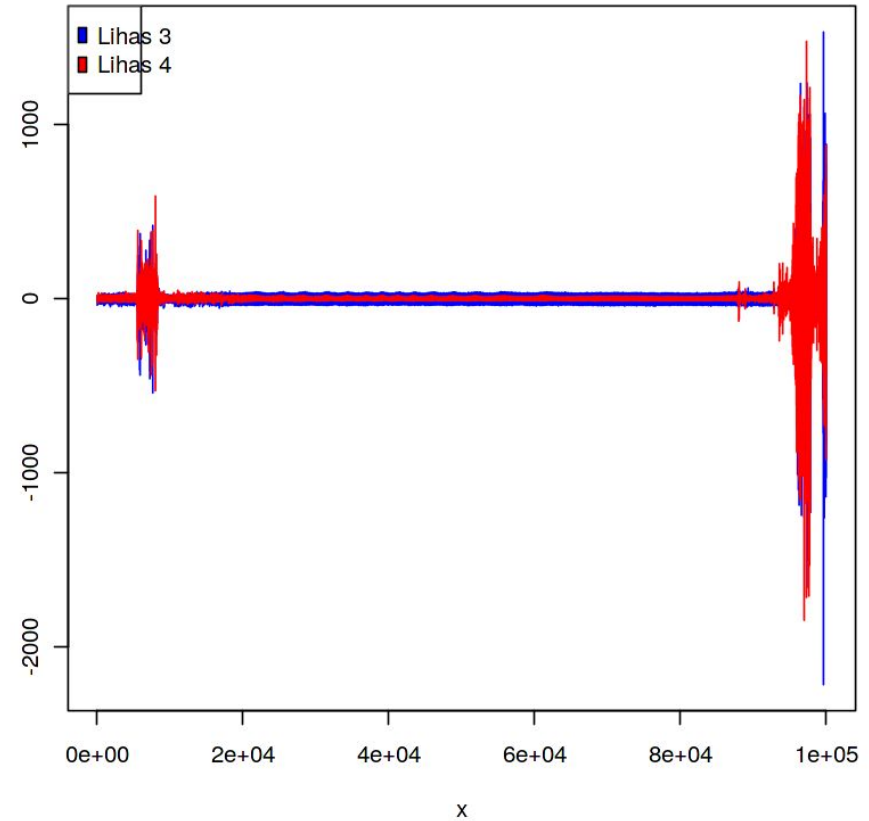
Noise Environment

Participant 1 - Lihas 3 & Lihas 4 (Right Hand Muscles)

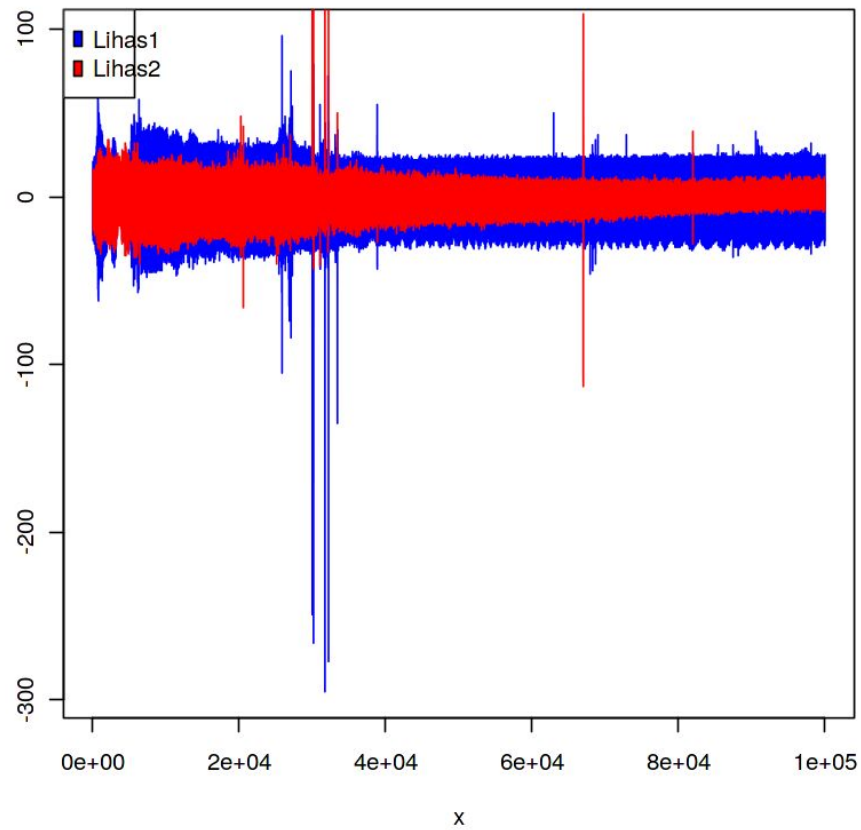


Silent Environment

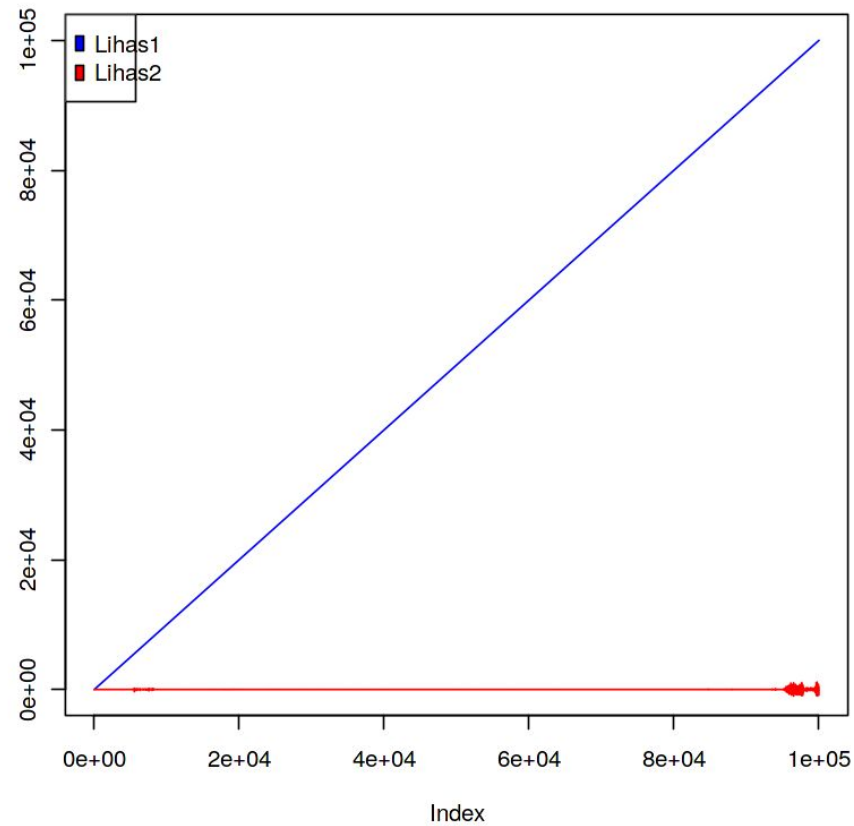
Participant 6 - Lihas 3 & Lihas 4 (Right Hand Muscles)



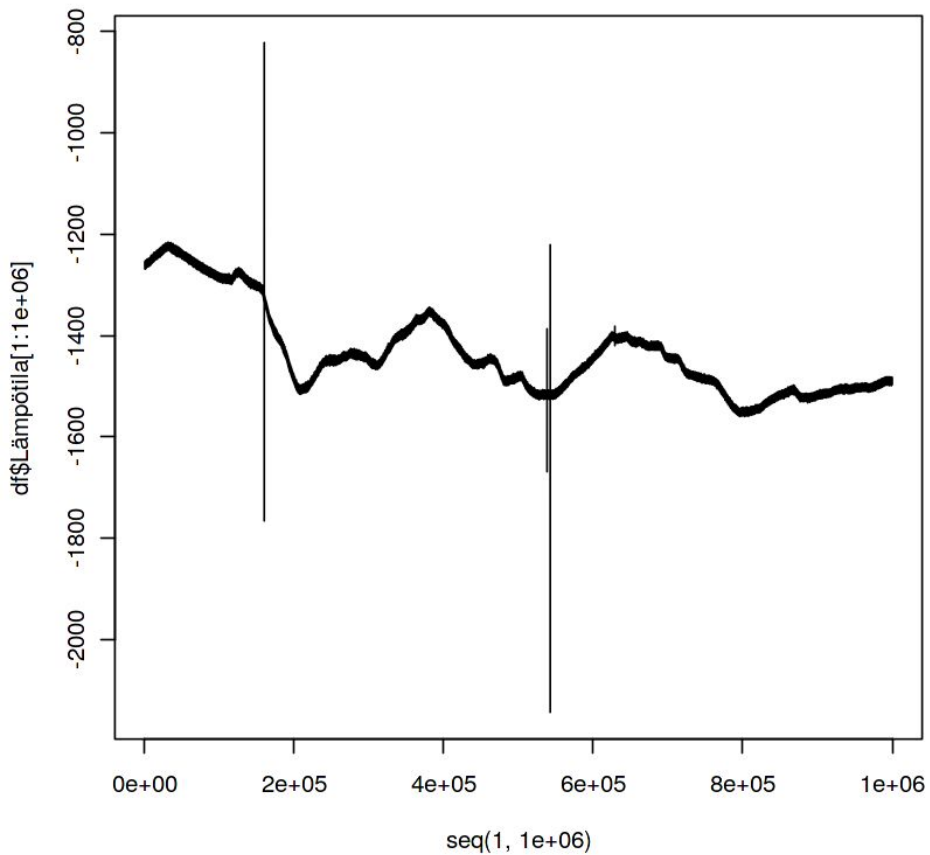
Participant 1 - Lihas 1 & Lihas 2 (Left Hand Muscles)



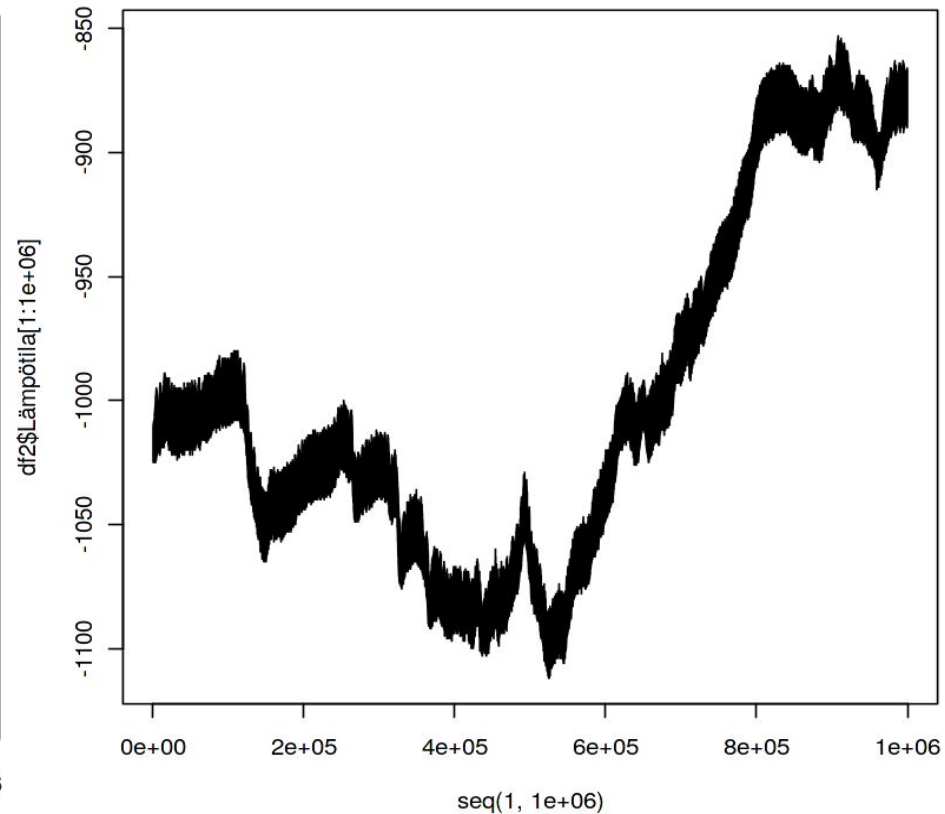
Participant 6 - Lihas 1 & Lihas 2 (Left Hand Muscles)



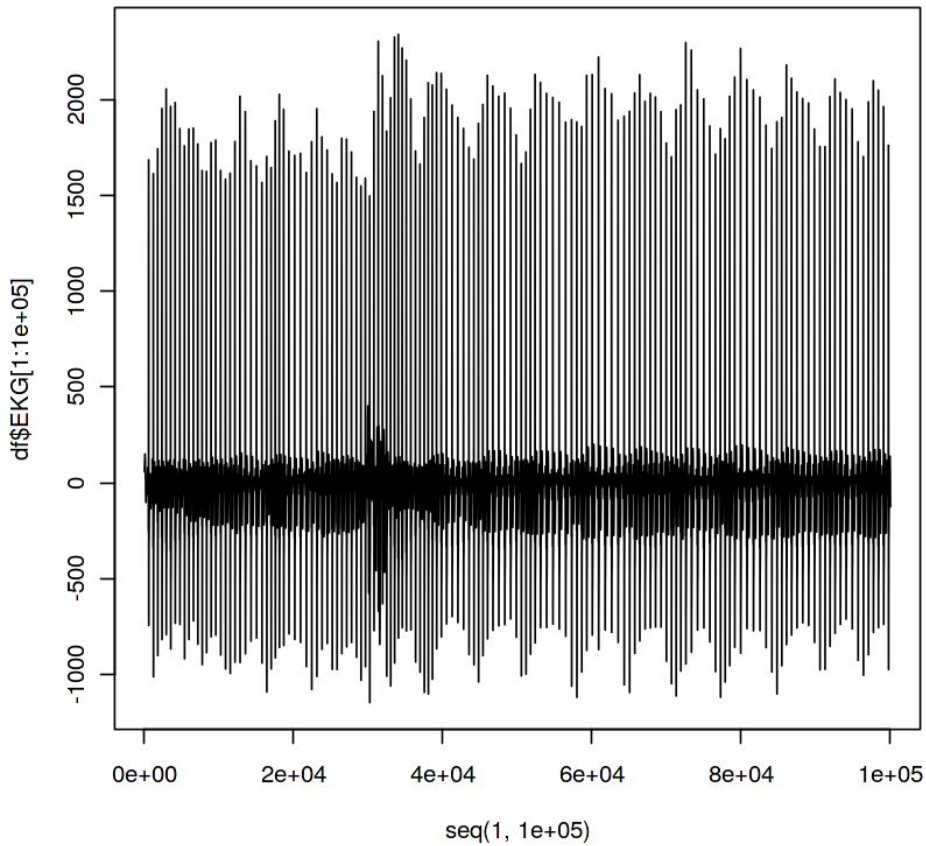
Body Temperature of Participant 1



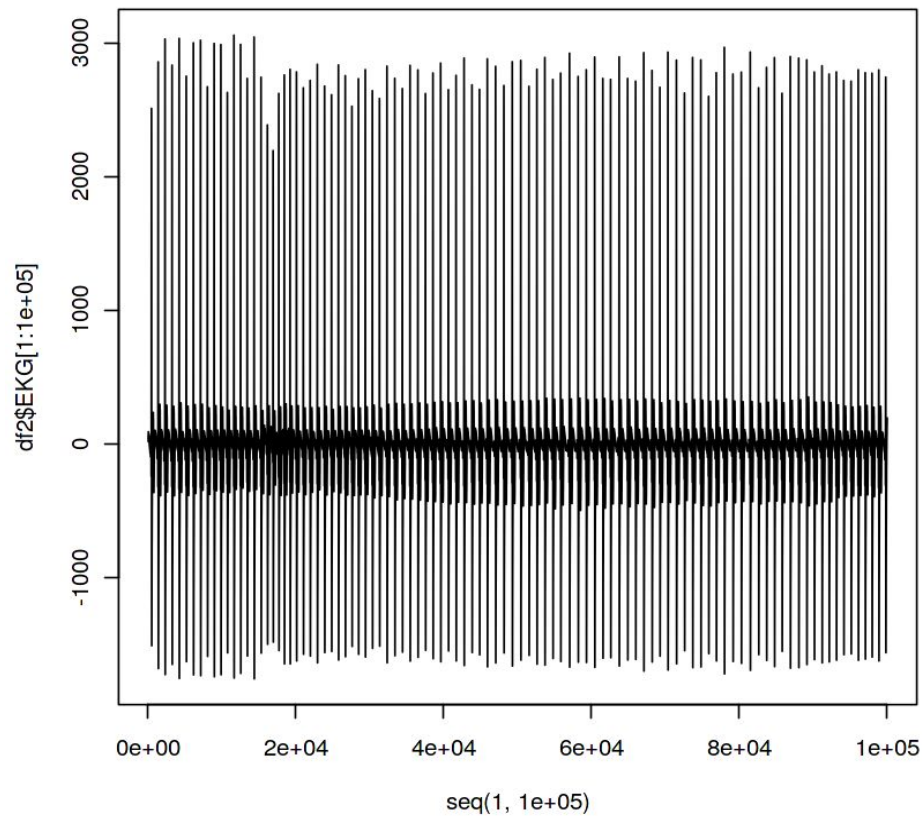
Body Temperature of Participant 6



EKG of Participant 1 During Experiment



EKG of Participant 6 During Experiment





Data Summary of Physiological Signals.

Participant 1 - Noise Environment

Lihäs1		Lihäs2		Lihäs3		Lihäs4			
Min.	: -3075.000	Min.	: -3413.000	Min.	: -3371.00	Min.	: -6169.000		
1st Qu.:	-45.000	1st Qu.:	-21.000	1st Qu.:	-25.00	1st Qu.:	-24.000		
Median :	0.000	Median :	0.000	Median :	1.00	Median :	1.000		
Mean :	0.217	Mean :	-0.577	Mean :	-0.61	Mean :	-0.825		
3rd Qu.:	41.000	3rd Qu.:	19.000	3rd Qu.:	26.00	3rd Qu.:	26.000		
Max.	: 3901.000	Max.	: 3557.000	Max.	: 5242.00	Max.	: 3509.000		
EKG		EOG		Lämpötila		Kiihtyvyys x		Kiihtyvyys y	
Min.	: -5952	Min.	: -6561	Min.	: -2144	Min.	: 8029	Min.	: 8031
1st Qu.:	-112	1st Qu.:	-6263	1st Qu.:	-1474	1st Qu.:	: 8035	1st Qu.:	: 8037
Median :	-17	Median :	-5342	Median :	-1440	Median :	: 8036	Median :	: 8038
Mean :	-19	Mean :	-1021	Mean :	-1423	Mean :	: 8036	Mean :	: 8038
3rd Qu.:	36	3rd Qu.:	5704	3rd Qu.:	-1381	3rd Qu.:	: 8037	3rd Qu.:	: 8039
Max.	: 2953	Max.	: 6158	Max.	: -822	Max.	: 8046	Max.	: 8047
Kiihtyvyys z		GSR							
Min.	: 8032	Min.	: -6906						
1st Qu.:	: 8037	1st Qu.:	-446						
Median :	: 8039	Median :	1496						
Mean :	: 8039	Mean :	1687						
3rd Qu.:	: 8040	3rd Qu.:	4571						
Max.	: 8048	Max.	: 5746						

Participant 6 - Silent Environment

V1		V2		V3		V4	
Mode:logical	Min.	:-4229.000	Min.	:-2688.0000	Min.	:-4071.000	
NA's:3679514	1st Qu.:	-16.000	1st Qu.:	-18.0000	1st Qu.:	-19.000	
	Median :	2.000	Median :	0.0000	Median :	1.000	
	Mean :	1.409	Mean :	0.6283	Mean :	0.298	
	3rd Qu.:	22.000	3rd Qu.:	22.0000	3rd Qu.:	21.000	
	Max.	: 3373.000	Max.	: 2470.0000	Max.	: 2732.000	
V5		V6		V7		V8	
Min.	:-3671.000	Min.	:-2033.00	Min.	:-6460.0	Min.	:-1223.0
1st Qu.:	-27.000	1st Qu.:	-70.00	1st Qu.:	-6240.0	1st Qu.:	-1079.0
Median :	0.000	Median :	-3.00	Median :	-4328.0	Median :	-995.0
Mean :	0.202	Mean :	-18.27	Mean :	-674.1	Mean :	-996.6
3rd Qu.:	26.000	3rd Qu.:	49.00	3rd Qu.:	5616.0	3rd Qu.:	-916.0
Max.	: 2255.000	Max.	: 3449.00	Max.	: 6118.0	Max.	: -750.0
V9		V10		V11		V12	
Min.	: -1	Min.	: -1	Min.	:8028	Min.	:-4321
1st Qu.:	:8035	1st Qu.:	:8037	1st Qu.:	:8038	1st Qu.:	-2188
Median :	:8037	Median :	:8039	Median :	:8039	Median :	-1909
Mean :	:8037	Mean :	:8039	Mean :	:8040	Mean :	-1721
3rd Qu.:	:8039	3rd Qu.:	:8040	3rd Qu.:	:8041	3rd Qu.:	-1256
Max.	:8052	Max.	:8053	Max.	:8054	Max.	: 605



Building an AI model

```
1 eval_model=classifier.evaluate(X_train, y_train)
2 eval_model
3 #loss and accuracy of our model by using these properties
```

14/14 [=====] - 0s 8ms/step

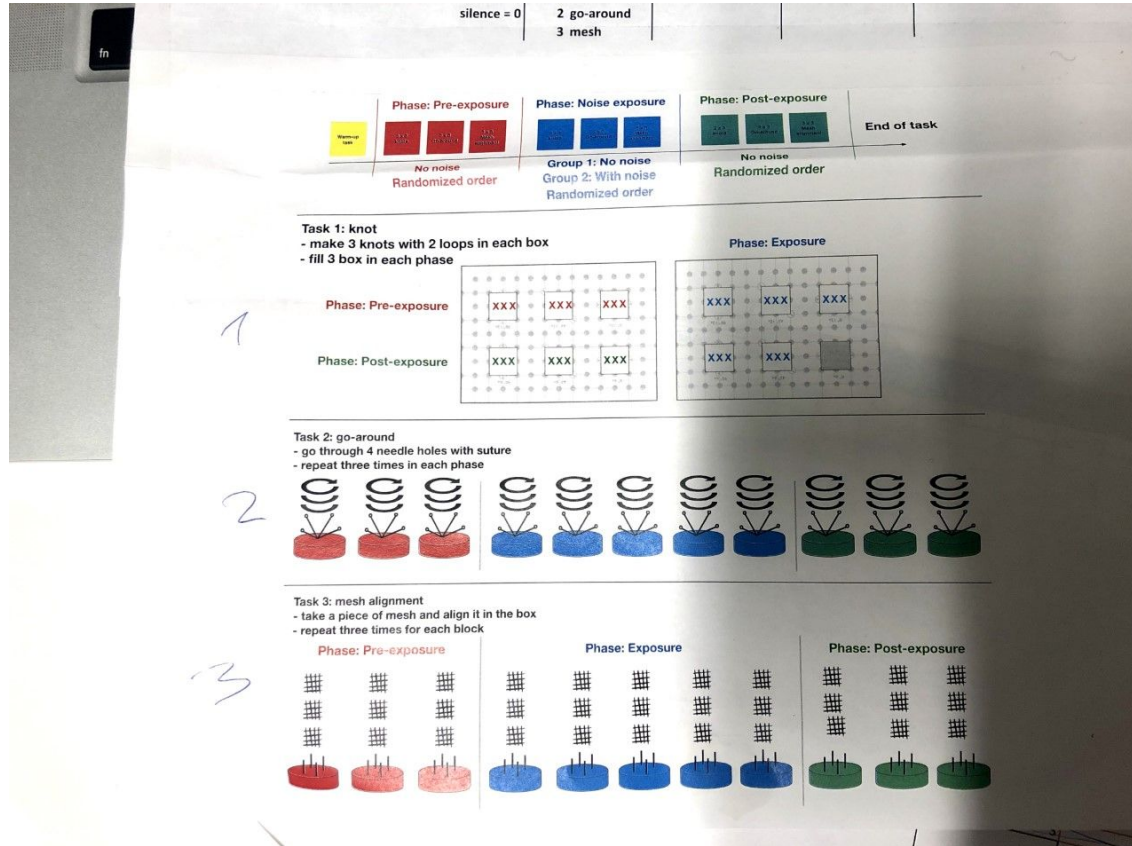
[0.32872629165649414, 0.9285714030265808]


```
1 y_pred=classifier.predict(X_test)
2 y_pred =(y_pred>0.5)
```

```
1 from sklearn.metrics import confusion_matrix
2 cm = confusion_matrix(y_test, y_pred)
3 print(cm)
```

```
[[2 0]
 [1 4]]
```

Discussions





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