A Survey on Face Recognition

B.Stat 2nd Year

Indian Statistical Institute, Kolkata

Course name:

Psychology

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Contents

Acknowledgement:

I would like to express my profound gratitude and indebtedness to Mr. Debdulal Dutta Roy , Associate Professor of Head, Psychology Research Unit, Indian Statistical Institute and for his contributions to the completion of my project **"Face Recognition".**

I express my special thanks for his time and efforts he provided for the project. Your useful advice, constant inspiration and suggestions were really helpful to me during the project's completion. In this aspect, I am eternally grateful to you.

I would like to acknowledge that this project was completed entirely by me and not by someone else.

Last but not the least, regards and gratitude are being extended to my parents, friends and relatives for their good wishes which always inspire me to go ahead.

Samahriti Mukherjee

Date: June 11, 2022
Place: Kolkata

1 Executive Summary

From our analysis, we can conclude that people consider human face as an important tool for face recognition. So they pay more attention to the human face as a whole in general, but not in any particular area of face except eyes. People has a good short term face memory. They get least attracted by good looks or don't dislike people less with too much facial hair etc. So overall people are less concerned about external features, else they like people smiling whole-heartedly. People show slightly higher face recognition ability. Also they agree that good looking persons are more keen to get better opportunities.

2 Introduction

The human face is a very important visual stimulus in the human experiential world. It is a powerful social stimulus and is also responsible for drawing inferences about individuals we come across in our day to day lives. Information can be gained from both its static form and also its dynamic form the human face. Facial features play a crucial role behind overall face perception. Another important aspect in this regard is related to memory. Memory works more in the domain of identification and recognition of human faces. Mostly all faces consist of similar features (eyes, nose and mouth) in the same configuration. Hence distinguishing among faces and recognizing them correctly becomes a very visually demanding task. Despite this we are able to identity /recognize individuals across a variety of environmental settings. Our faces also play a key role in mate selection and interpersonal relationships. Often biases exist in terms of which face we find attractive. Based on the above evidences, the domains of memory, social understanding, attention, perception and facial features have been incorporated in the questionnaire for face recognition. There are four steps involved in face recognition:

- Learning
- Retention
- Retrieval
- Recognition

2.1 Study Variable

The Study Variables we are dealing with are

- Face Memory
- Face Attention and Perception
- Face Social Understanding
- Facial Features

2.1.1 Scope and Importance

The importances and scopes of each study variable are given below:

- By the variable 'Face Memory', we can predict how much individuals :
  - can easily remember unfamiliar faces.
  - can easily recall familiar faces.
  - find it easy to recognize their childhood friends.
  - find it easy to identify people based on their facial features.
  - possess a good face-recognition ability.
  - find it easier to recognize familiar faces but are often unable to trace their identity.

- By the variable 'Face Attention and Perception', we can predict how much individuals :
  - pay more attention to the human face as a whole in general.
  - tend to pay more attention to external features of the face.
  - think that the face is an important tool for information processing.
  - tend to focus more on the lower part of the face.
  - tend to attend faster to familiar faces than unfamiliar ones.
- By the variable 'Face Social Understanding', we can predict how much individuals :
  - consider the human face as an important tool for daily communication.
  - get attracted easily to beautiful and fair-skinned faces.
  - are more keen to get involved with a good-looking person.
  - feel that attractive people are able to get better opportunities.
  - consider themselves lucky for having attractive facial features.
  - get easily carried away by good-looks .
- By the variable 'Facial Features', we can predict how much individuals :
  - are more drawn towards the eyes of a person.
  - dislike people with too much facial hair.
  - like to keep their face clean and glowing.
  - are easily attracted towards toned cheek-bones.
  - prefer make up on their face or partner's face.
  - like people with sharp facial features, e.g.: sharp nose.
  - like to mix with people who smile whole-heartedly.

Asking same questions in different manners will also help us to check the consistency of an individual towards Face Recognition.

2.2 Objective of the Study

The objective of the study is **to explore the correlates of the face recognition through literature survey.**

3 Literature Review

Human faces are able to capture attention more easily than other objects (Ro, Russell Lavie, 2001). Additionally, it is believed that facial images also facilitate subsequent processing at the locations where they occur (Axelrod, Bar Rees, 2015). People also tend to make faster and greater accurate responses with regard to their own faces than in comparison to the faces of familiar others (Sui, Liu Hans, 2009; Tong Nakayama, 1999). Human beings tend to infer about individual's sex, race and age effortlessly and automatically from their faces (Macrae Bodenhausen, 2000). These implications are based upon multiple features including hair, shape of face, the eyes and brows and even mouth (Brown Perrett, 1993; Roberts Bruce, 1988). Attractive people are also considered as more extraverted with higher level of self-esteem and enhanced social skills (Langlois et al.,2000).

4 Method

Face Recognition largely uses the same quantitative and qualitative methods as other psychological disciplines. However, whereas other psychological disciplines often have one dominant research paradigm, face recognition is characterized by the use of a wide diversity of methods. Each research method has its strengths and weaknesses. Choosing a method typically involves a trade-off between internal and external validity. Internal validity reflects the extent to which cause–effect relationships can be established. External validity reflects the extent to which the results of a study can be generalized to other populations or settings. The main research methods used in face recognition research include questionnaire studies, laboratory experiments, simulation studies, field studies, and case studies.

4.1 Participants

We have collected data from undergraduate students of ages 19-21 years. Both males and females are included.

4.1.1 Inclusion and Exclusion

- The studies had followed standard statistical analysis (where applicable) of face recognition.
- The questionnaire is in English. So we could collect the data from only those people who can speak, read and write English.

4.2 Instruments

There are total 44 items. We have categorized the replies of each item as:

- Most Frequently as 5
- More Frequently as 4
- Undecided as 3
- Less Frequently as 2
- Least Frequently as 1

The questionnaire is madde by our PhD Scholar, **Dr. Sabornee Karmakar**.

4.3 Research Design

We have used 'Survey' method to collect data. The experimenter should create a rapport establishment first and then must take consent of the subject to collect data. Then the experimenter will ask the questions and rate those according to the answers of the subjects.

4.4 Statistics

We have used R to analyse the data. Here are the Statistical tools we have used:

- Barplots
- Linecharts
- Correlation
- Correlation Plots
- Item Total Correlation
- Factor Analysis

- Very Simple Structure
- mean
- median
- Standard Deviation
- Skewness
- Kurtosis
- Frequency and Percentage Distributions
- Item Cluster Analysis
- Violin Plot
- Density Estimation
- Item-Wise Best Line Fit

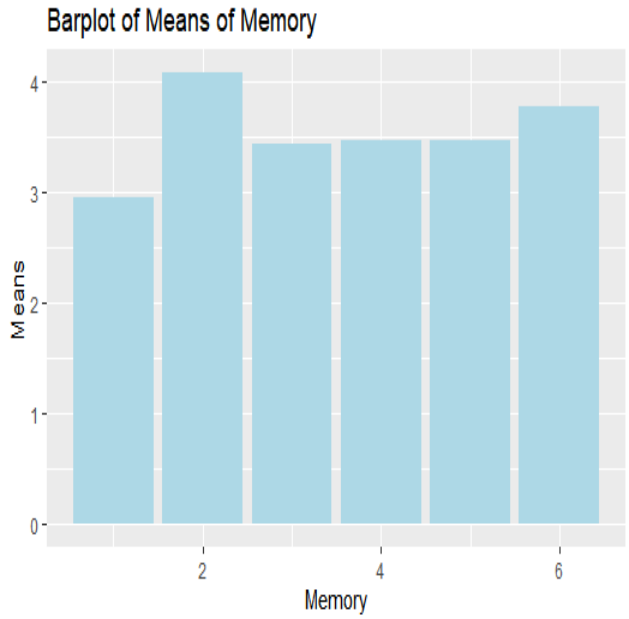
4.5 Control

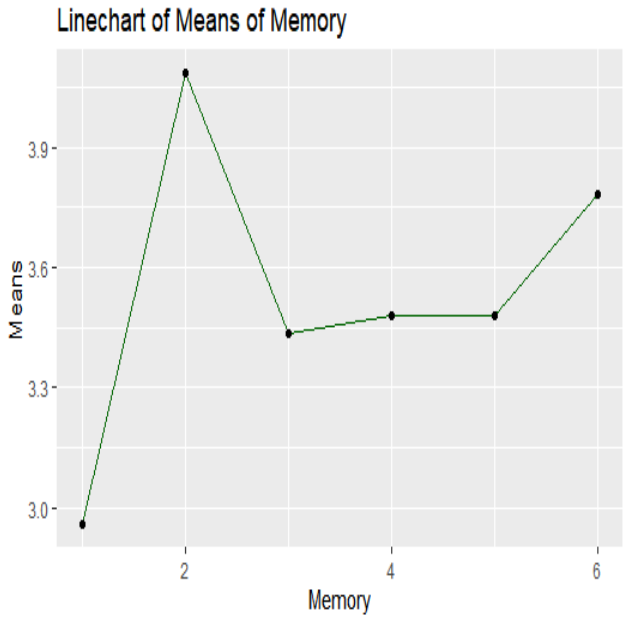
We have to control noise while collecting the data.

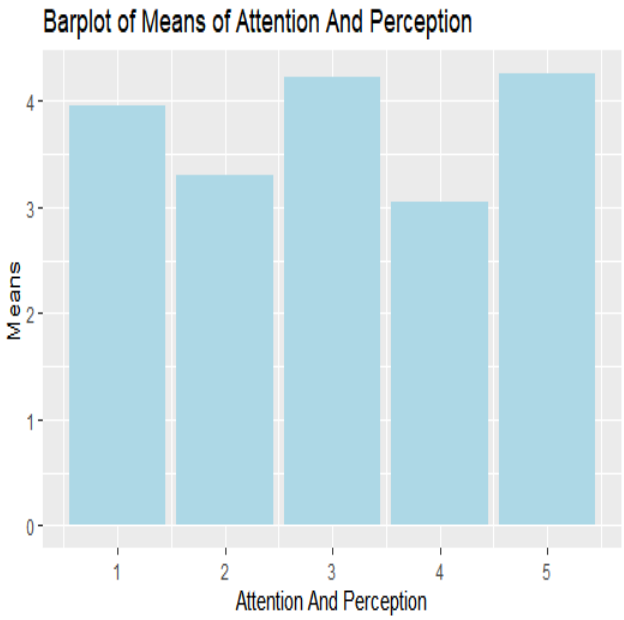
5 Results

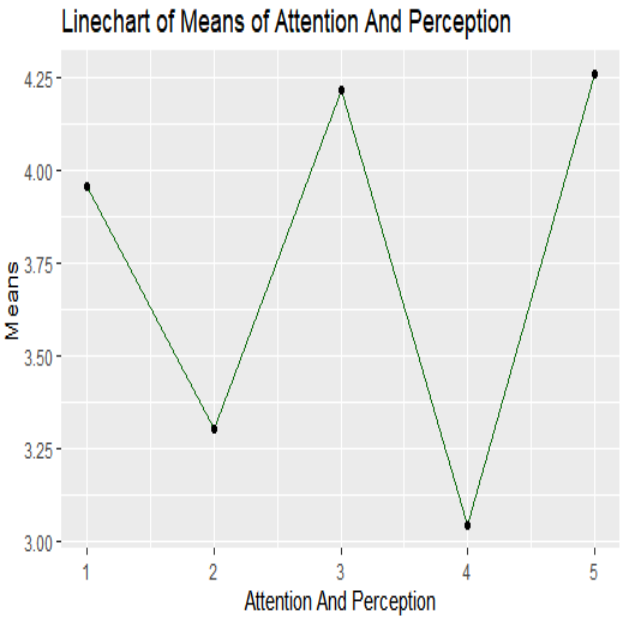
5.1 Descriptive Statistics

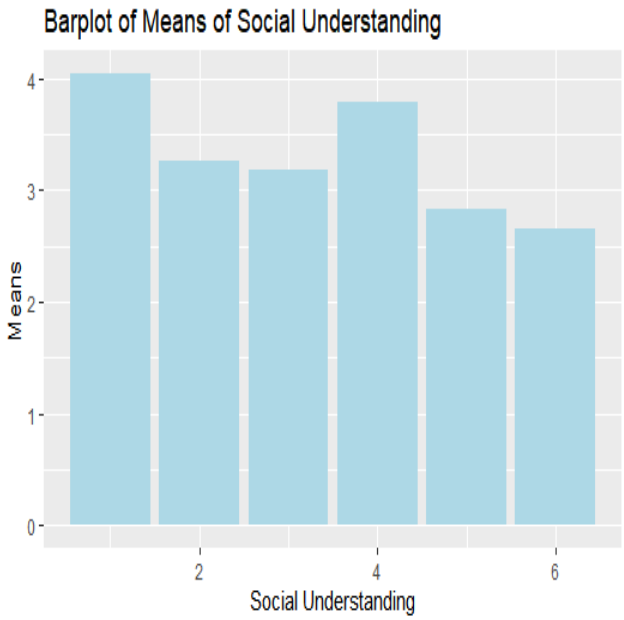
We have first plotted Linecharts and Barplots for each Study Variables considering means of each answer of questions:

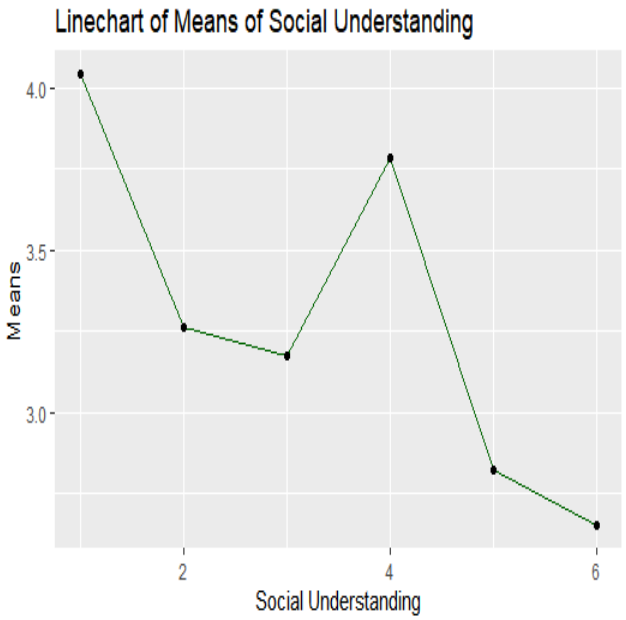


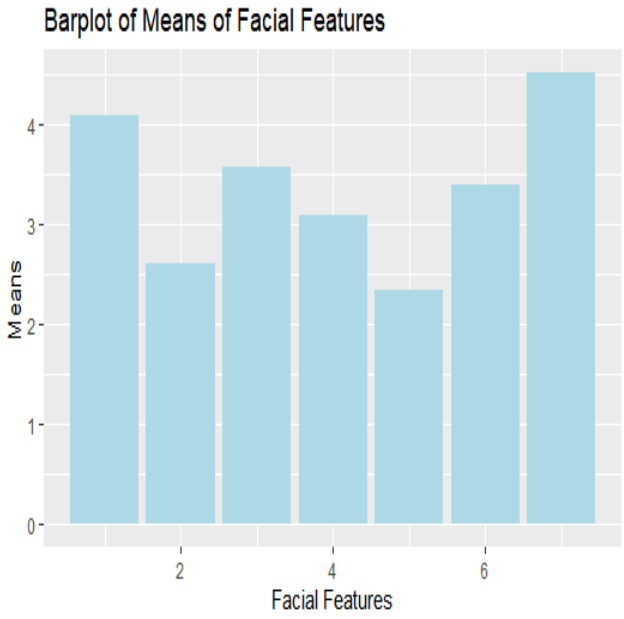


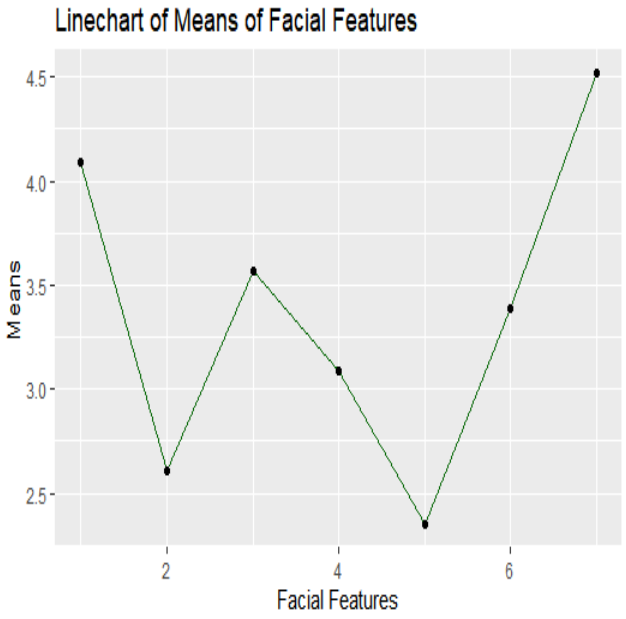




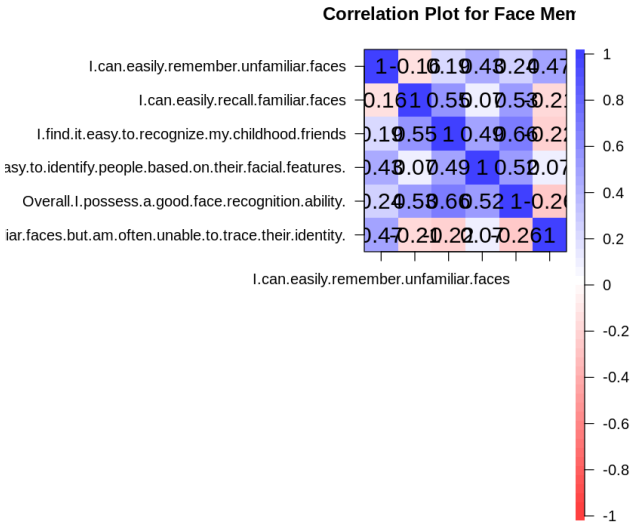

Barplot of Means of Social Understanding
Means
Social Understanding
0
1
2
3
4
2
4
6

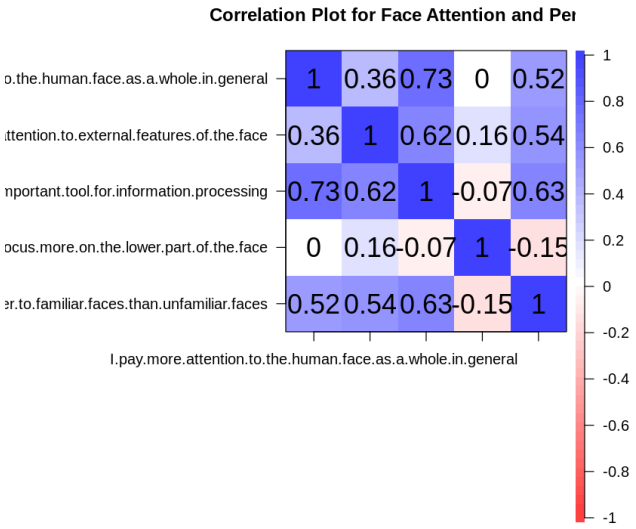

Linechart of Means of Social Understanding
Means
Social Understanding
3.0
3.5
4.0
2
4
6

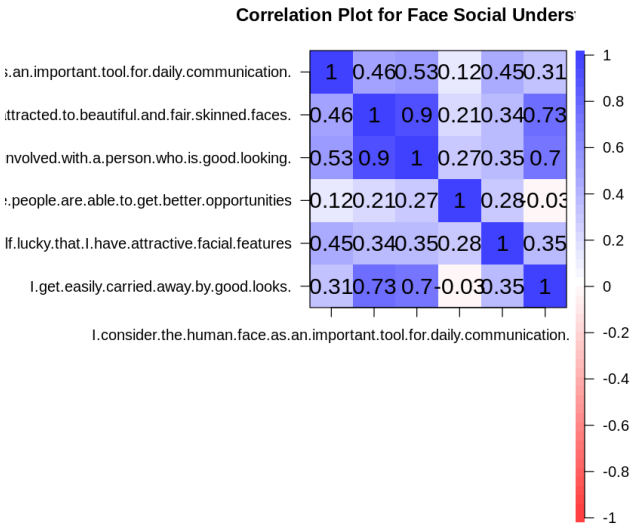

Barplot of Means of Facial Features
Means
Facial Features
0
1
2
3
4
2
4
6

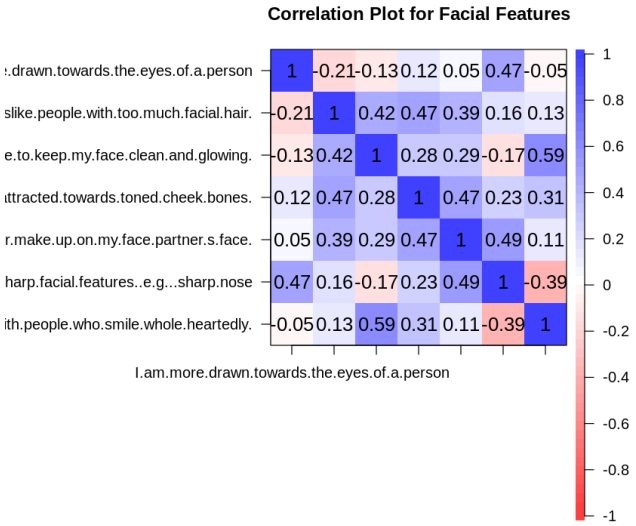

Linechart of Means of Facial Features
Means
Facial Features
2.5
3.0
3.5
4.0
4.5
2
4
6

Then we plot the correlation plot for each study variable:

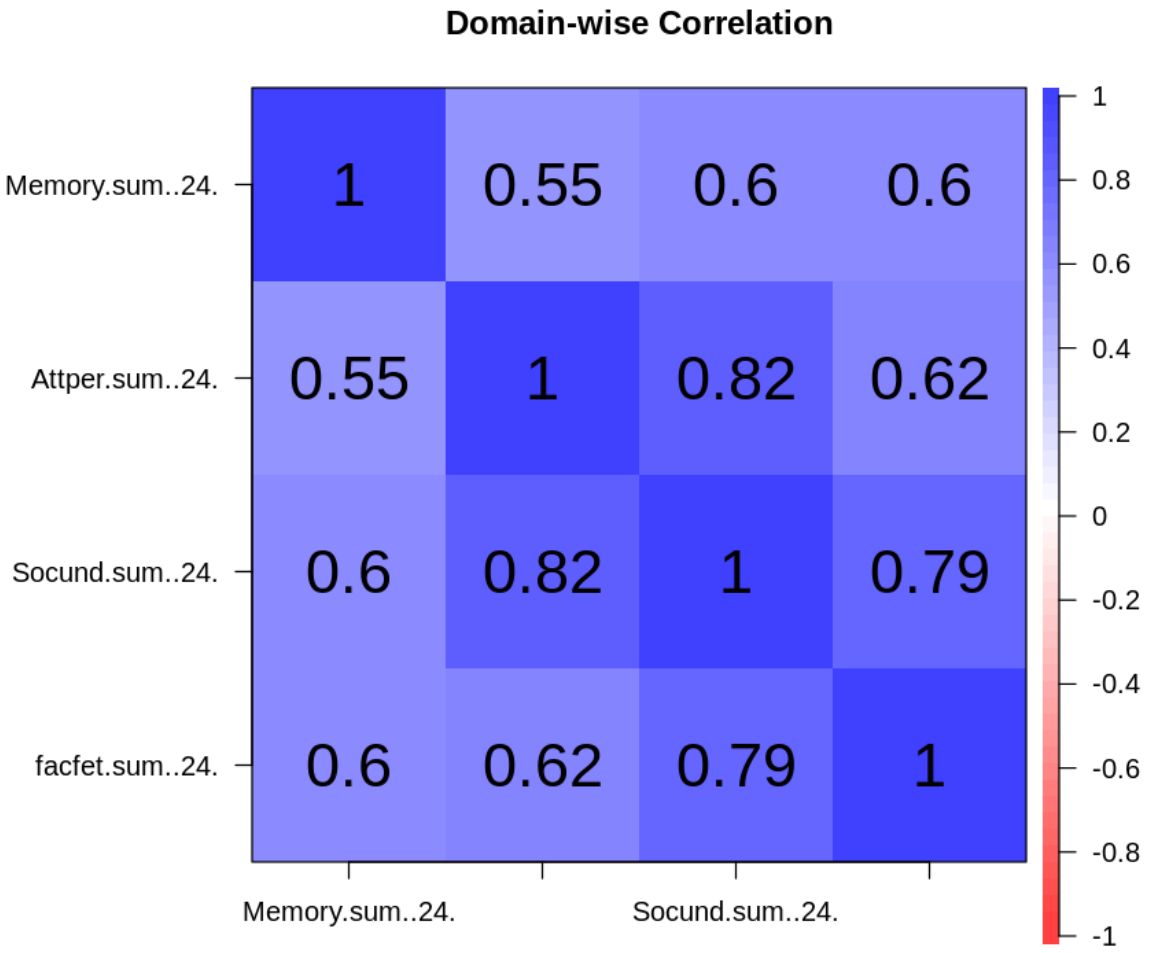




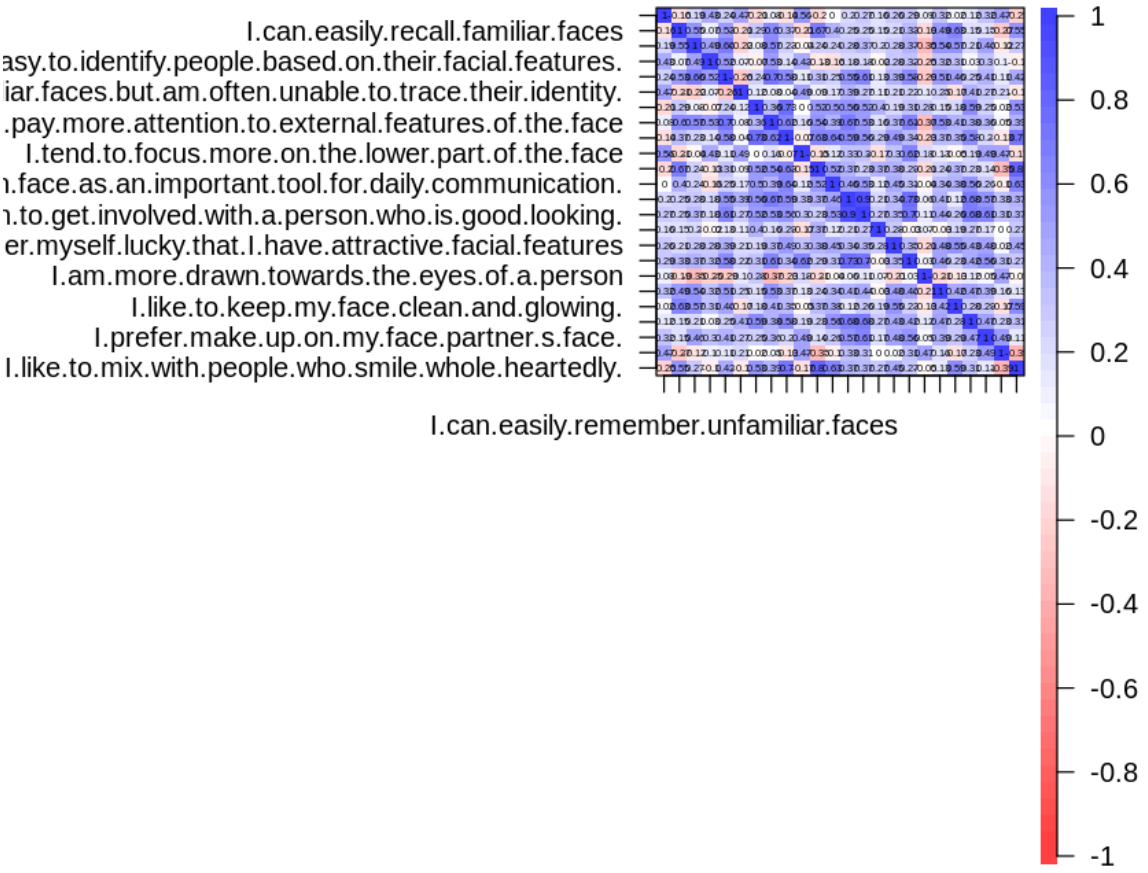

Correlation Plot for Face Social Unders
s.an.important.tool.for.daily.communication.
ttracted.to.beautiful.and.fair.skinned.faces.
nvolved.with.a.person.who.is.good.looking.
s.people.are.able.to.get.better.opportunities
lf.lucky.that.I.have.attractive.facial.features
I.get.easily.carried.away.by.good.looks.
1 0.46 0.53 0.12 0.45 0.31
0.46 1 0.9 0.21 0.34 0.73
0.53 0.9 1 0.27 0.35 0.7
0.12 0.21 0.27 1 0.28 0.03
0.45 0.34 0.35 0.28 1 0.35
0.31 0.73 0.7 -0.03 0.35 1
I.consider.the.human.face.as.an.important.tool.for.daily.communication.
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1


Correlation Plot for Facial Features
s.drawn.towards.the.eyes.of.a.person
slike.people.with.too.much.facial.hair.
e.to.keep.my.face.clean.and.glowing.
ttracted.towards.toned.cheek.bones.
r.make.up.on.my.face.partner.s.face.
harp.facial.features..e.g...sharp.nose
ith.people.who.smile.whole.heartedly.
1 -0.21 -0.13 0.12 0.05 0.47 -0.05
-0.21 1 0.42 0.47 0.39 0.16 0.13
-0.13 0.42 1 0.28 0.29 -0.17 0.59
0.12 0.47 0.28 1 0.47 0.23 0.31
0.05 0.39 0.29 0.47 1 0.49 0.11
0.47 0.16 -0.17 0.23 0.49 1 -0.39
-0.05 0.13 0.59 0.31 0.11 -0.39 1
I.am.more.drawn.towards.the.eyes.of.a.person
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1

Then we plot Domain-Wise correlation plot:



Then we plot the correlation plot of the whole dataset:



Now we present some tables which represent the **Item Total Correlations**:

- **Item Total Correlation of Face Memory:**

Categories	FM1	FM2	FM3	FM4	FM5	FM6
Correlation-Coefficient	0.60341	0.4751846	0.749412	0.7478213	0.752442	0.2334925

- **Item Total Correlation of Face Attention and Perception:**

Categories	AP1	AP2	AP3	AP4	AP5
Correlation-Coefficient	0.7594035	0.7900871	0.8383234	0.3175806	0.7124509

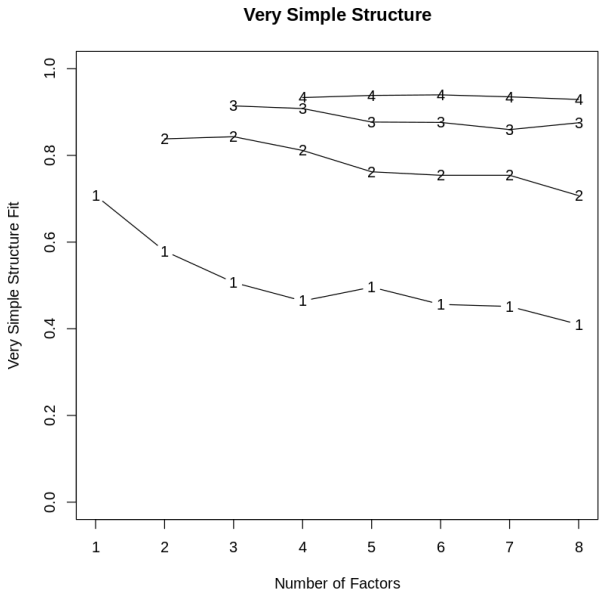
- **Item Total Correlation of Social Understanding:**

Categories	SU1	SU2	SU3	SU4	SU5	SU6
Correlation-Coefficient	0.6825658	0.8582353	0.8806028	0.4062313	0.6684274	0.7378215

- **Item Total Correlation of Facial Features:**

Categories	FF1	FF2	FF3	FF4	FF5	FF6	FF7
Correlation-Coefficient	0.2463233	0.667886	0.610785	0.746314	0.7392739	0.4311035	0.4192941

Now after Factor Analysis, we plot a Very Simple Structure Fit:



Now we present some basic descriptive statistics:

Description of the Whole Dataset:

A psych: 24 × 13

	vars	n	mean	sd	median	trimmed	mad	min	max	range	skew	kurtosis	s
	<int>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl
I.can.easily.remember.unfamiliar.faces	1	23	2.956522	1.0650762	3	2.842105	1.4826	2	5	3	0.94488004	-0.3888302	0.222083
I.can.easily.recall.familiar.faces	2	23	4.086957	1.0406748	4	4.263158	1.4826	1	5	4	-1.32051067	1.4047003	0.216995
I.find.it.easy.to.recognize.my.childhood.friends	3	23	3.434783	1.1994729	3	3.526316	1.4826	1	5	4	-0.38234249	-0.6964378	0.250107
I.find.it.easy.to.identify.people.based.on.their.facial.features.	4	23	3.478261	1.3439956	4	3.578947	1.4826	1	5	4	-0.54682616	-0.9256355	0.280242
Overall.I.possess.a.good.face.recognition.ability.	5	23	3.478261	1.1626602	4	3.578947	1.4826	1	5	4	-0.94569831	0.1022283	0.242431
it.easier.to.recognize.familiar.faces.but.am.often.unable.to.trace.their.identity.	6	23	3.782609	1.1660548	4	3.947368	0.0000	1	5	4	-1.24103422	0.5538734	0.243139
I.pay.more.attention.to.the.human.face.as.a.whole.in.general	7	23	3.956522	1.2239378	4	4.105263	1.4826	1	5	4	-0.77541527	-0.6180898	0.255208
I.tend.to.pay.more.attention.to.external.features.of.the.face	8	23	3.304348	1.2589600	3	3.368421	1.4826	1	5	4	-0.42457569	-0.8340982	0.262511
The.face.is.a.n.important.tool.for.information.processing	9	23	4.217391	1.1263990	5	4.421053	0.0000	1	5	4	-1.32156872	0.8570560	0.234870
I.tend.to.focus.more.on.the.lower.part.of.the.face	10	23	3.043478	1.2960871	3	3.052632	1.4826	1	5	4	0.28312299	-1.1801288	0.270252
I.tend.to.attend.faster.to.familiar.faces.than.unfamiliar.faces	11	23	4.260870	1.0098331	5	4.421053	0.0000	1	5	4	-1.51850144	2.1953463	0.210564
I.consider.the.human.face.as.an.important.tool.for.daily.communication.	12	23	4.043478	1.1862186	4	4.263158	1.4826	1	5	4	-1.32949296	1.0300375	0.247343
I.am.easily.attracted.to.beautiful.and.fair.skinned.faces.	13	23	3.260870	1.1368774	3	3.315789	1.4826	1	5	4	-0.49300201	-0.1977376	0.237055
I.am.more.keen.to.get.involved.with.a.person.who.is.good.looking.	14	23	3.173913	1.1541299	3	3.210526	1.4826	1	5	4	-0.49239321	-0.6285990	0.240652
I.feel.that.attractive.people.are.able.to.get.better.opportunities	15	23	3.782609	0.9980218	4	3.842105	1.4826	2	5	3	-0.37056834	-1.0118083	0.208101
I.consider.myself.lucky.that.I.have.attractive.facial.features	16	23	2.826087	1.3021721	3	2.789474	1.4826	1	5	4	-0.04757099	-1.2832631	0.271521
I.get.easily.carried.away.by.good.looks.	17	23	2.652174	1.2652235	3	2.578947	1.4826	1	5	4	0.38031812	-0.7476730	0.263817
I.am.more.drawn.towards.the.eyes.of.a.person	18	23	4.086957	0.9493080	4	4.210526	1.4826	2	5	3	-0.77183920	-0.4098523	0.197944
I.dislike.people.with.too.much.facial.hair.	19	23	2.608696	1.4058039	3	2.526316	1.4826	1	5	4	0.30387661	-1.2532815	0.293130
I.like.to.keep.my.face.clean.and.glowing.	20	23	3.565217	1.1609591	4	3.631579	1.4826	1	5	4	-0.31767094	-0.9019295	0.242076
I.am.easily.attracted.towards.toned.cheek.bones.	21	23	3.086957	1.0834727	3	3.105263	0.0000	1	5	4	0.04264877	-0.3373941	0.225919

Now we show the frequency and percentage distributions of each study variable:

Frequency Distribution of Face Memory:

A matrix: 5 × 6 of type int

	FM1	FM2	FM3	FM4	FM5	FM6
3	10	2	8	5	6	0
2	9	1	2	2	0	2
5	4	9	5	6	3	5
4	0	10	6	7	11	14
1	0	1	2	3	3	2

Percentage Distribution of Face Memory:

	FM1	FM2	FM3	FM4	FM5	FM6
3	43.47826	8.695652	34.782609	21.739130	26.08696	0.000000
2	39.13043	4.347826	8.695652	8.695652	0.00000	8.695652
5	17.39130	39.130435	21.739130	26.086957	13.04348	21.739130
4	0.00000	43.478261	26.086957	30.434783	47.82609	60.869565
1	0.00000	4.347826	8.695652	13.043478	13.04348	8.695652

Frequency Distribution of Face Attention and Perception:

A matrix: 5 × 5 of type int

	FA1	FA2	FA3	FA4	FA5
3	5	7	3	7	3
4	4	7	5	2	7
5	11	4	13	5	12
2	2	2	1	7	0
1	1	3	1	2	1

Percentage Distribution of Face Attention and Perception:

	FA1	FA2	FA3	FA4	FA5
3	21.739130	30.434783	13.043478	30.434783	13.043478
4	17.391304	30.434783	21.739130	8.695652	30.434783
5	47.826087	17.391304	56.521739	21.739130	52.173913
2	8.695652	8.695652	4.347826	30.434783	0.000000
1	4.347826	13.043478	4.347826	8.695652	4.347826

Frequency Distribution of Face Social Understanding:

	FS1	FS2	FS3	FS4	FS5	FS6
5	10	3	2	6	2	3
4	8	6	8	9	6	1
3	3	11	8	5	6	9
1	2	3	3	0	5	5
2	0	0	2	3	4	5

Percentage Distribution of Face Social Understanding:

	FS1	FS2	FS3	FS4	FS5	FS6
5	43.478261	13.04348	8.695652	26.08696	8.695652	13.043478
4	34.782609	26.08696	34.782609	39.13043	26.086957	4.347826
3	13.043478	47.82609	34.782609	21.73913	26.086957	39.130435
1	8.695652	13.04348	13.043478	0.00000	21.739130	21.739130
2	0.000000	0.00000	8.695652	13.04348	17.391304	21.739130

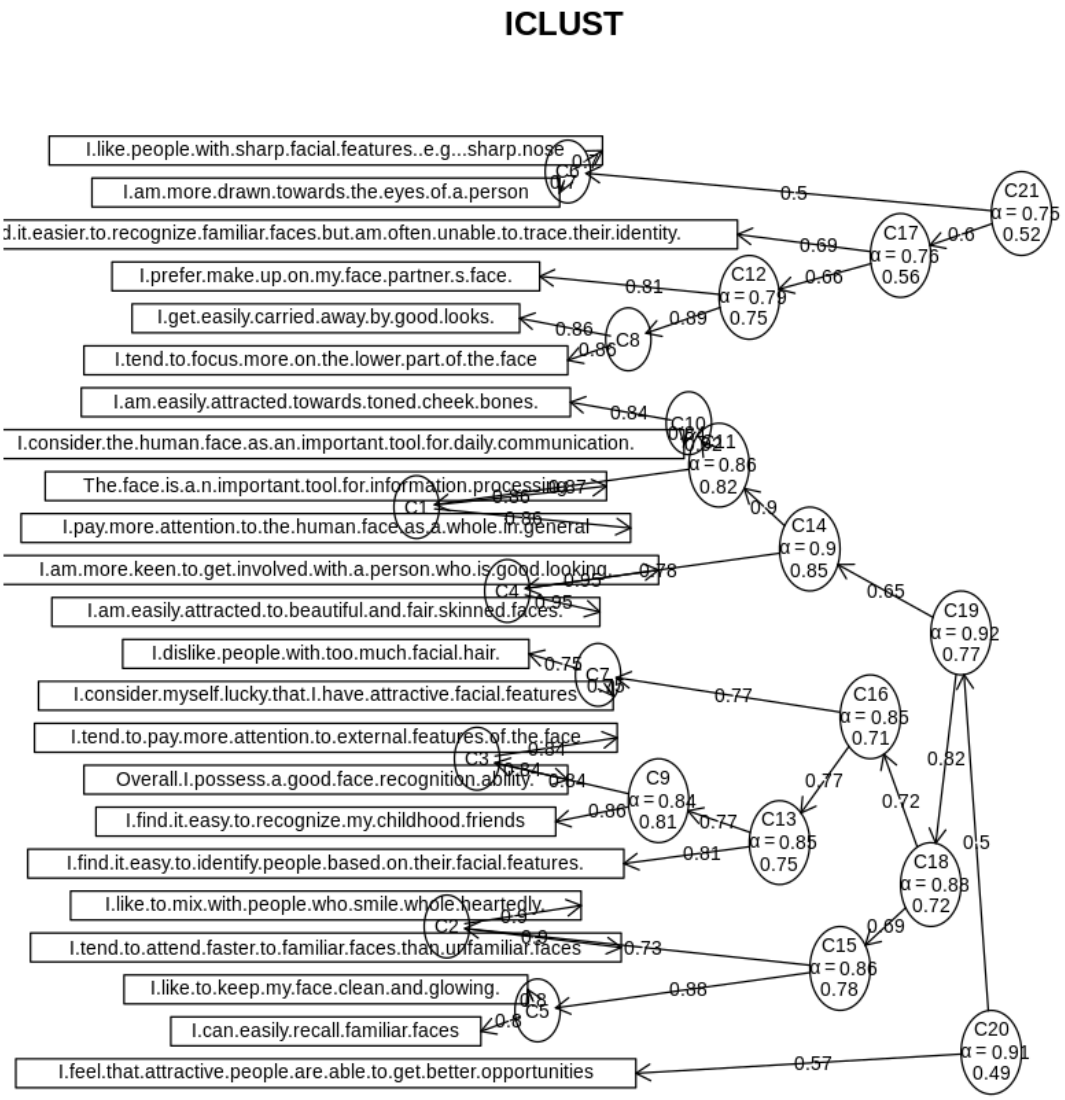
Frequency Distribution of Facial Features:

	FS1	FS2	FS3	FS4	FS5	FS6	FS7
5	9	3	6	3	2	3	16
4	9	3	6	3	2	7	5
2	2	4	3	3	7	4	0
3	3	6	7	12	5	9	1
1	0	7	1	2	7	0	1

Percentage Distribution of Facial Features:

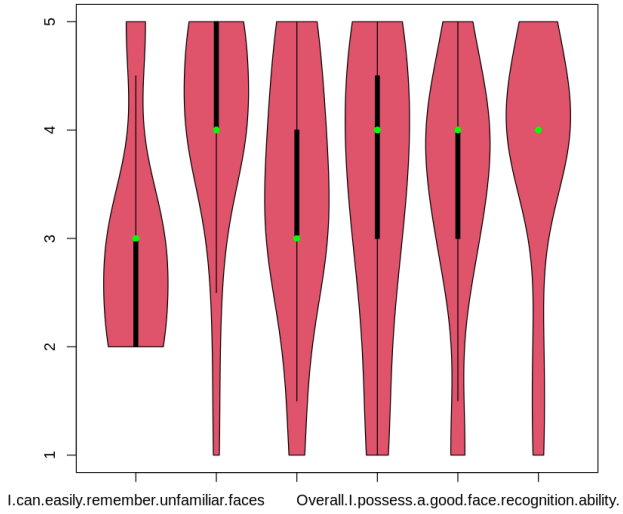
	FS1	FS2	FS3	FS4	FS5	FS6	FS7
5	39.130435	13.04348	26.086957	13.043478	8.695652	13.04348	69.565217
4	39.130435	13.04348	26.086957	13.043478	8.695652	30.43478	21.739130
2	8.695652	17.39130	13.043478	13.043478	30.434783	17.39130	0.000000
3	13.043478	26.08696	30.434783	52.173913	21.739130	39.13043	4.347826
1	0.000000	30.43478	4.347826	8.695652	30.434783	0.00000	4.347826

Now we use Item Cluster Analysis to identify homogeneous subgrouprings of 24 items:

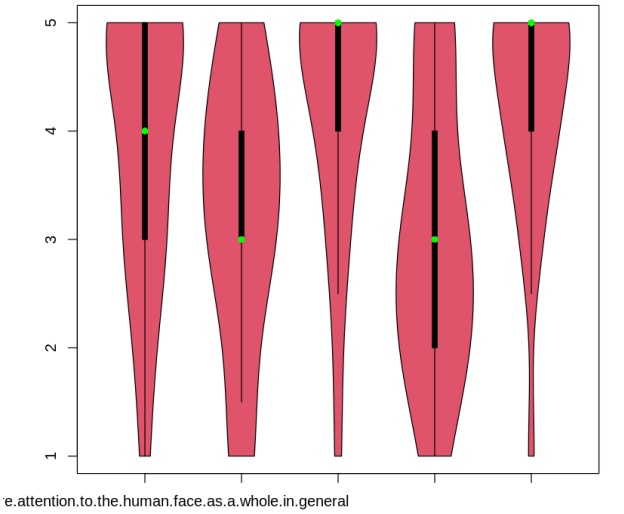


Now we present Violin Plots of all the 4 study variables:

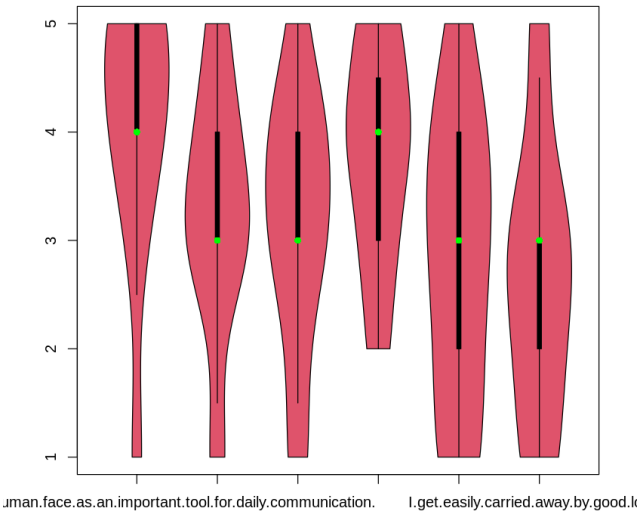
Violin Plot of Face Memory:



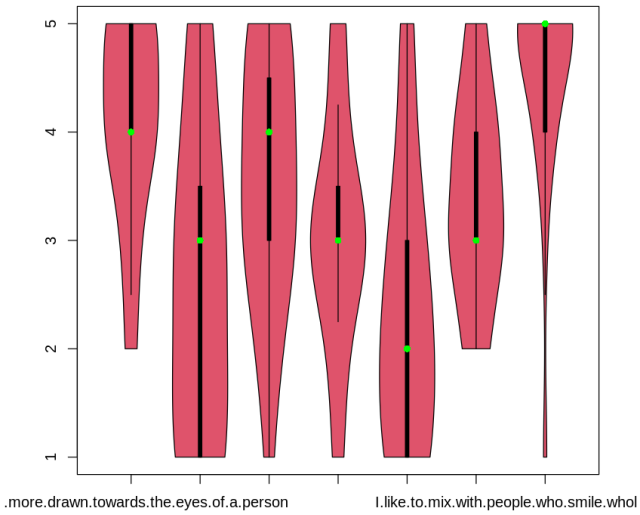
Violin Plot of Face Attention and Perception:



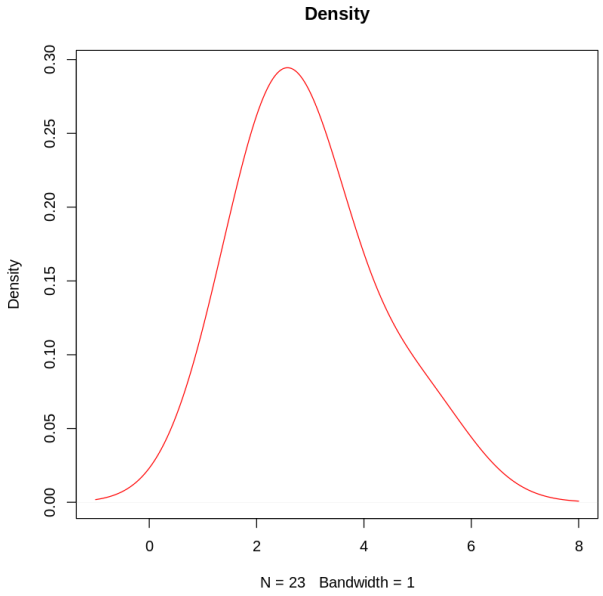
Violin Plot of Face Social Understanding:

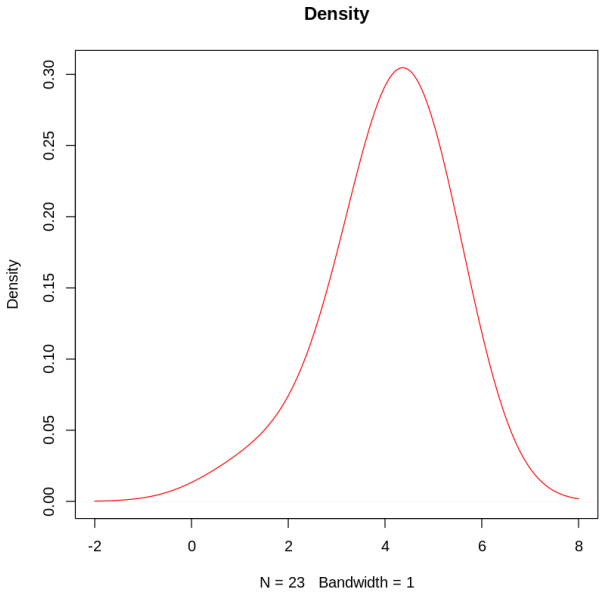


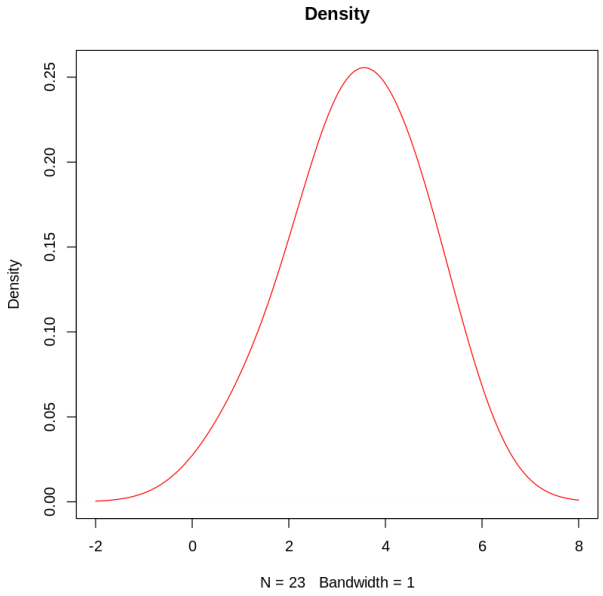
Violin Plot of Facial Features:

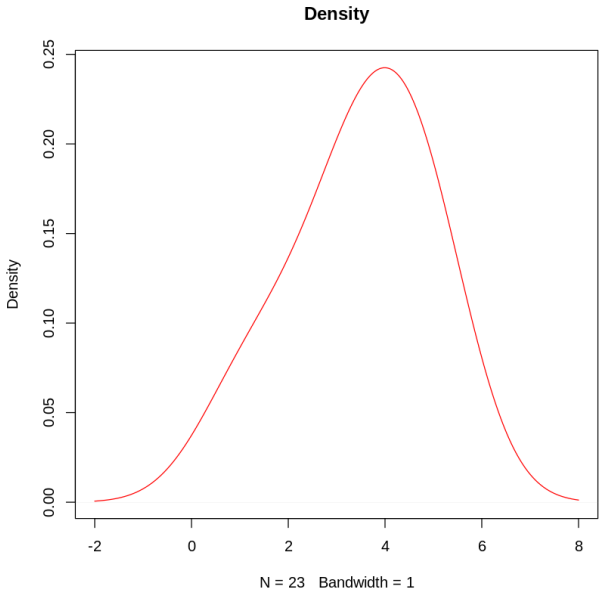


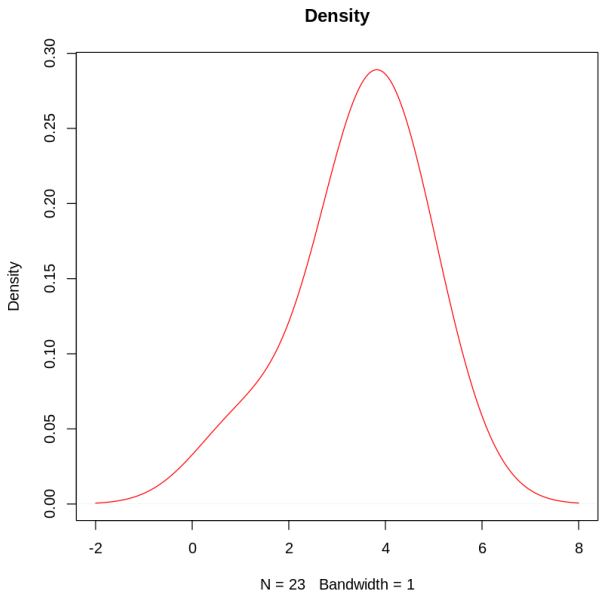
Now we show the **Density Estimations** of all the 24 variables:







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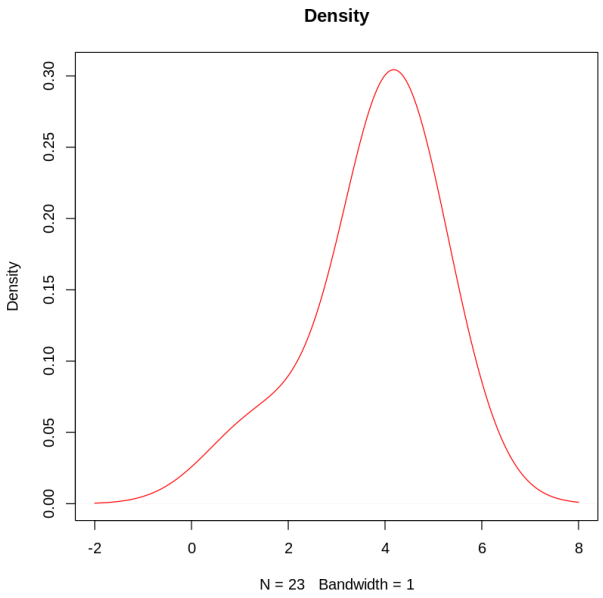
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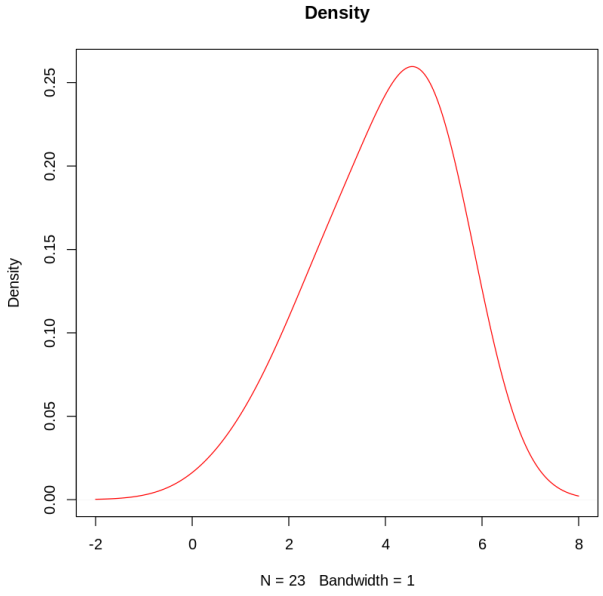
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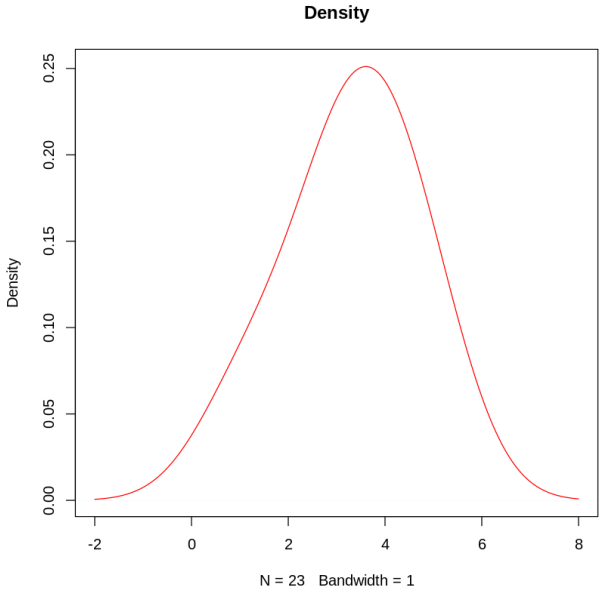
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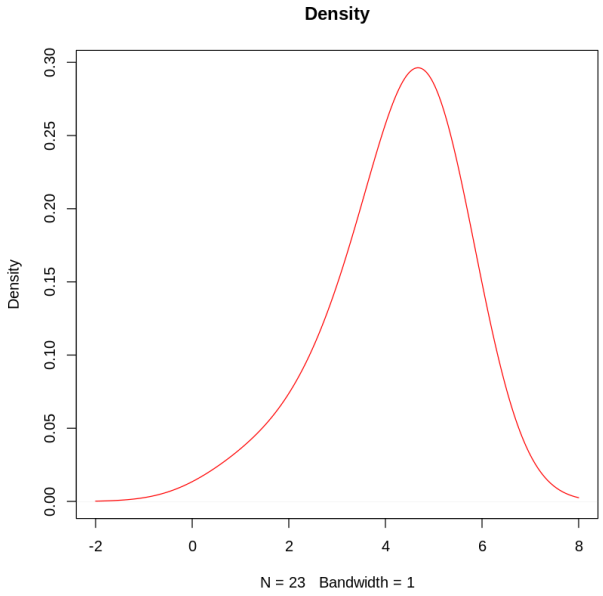
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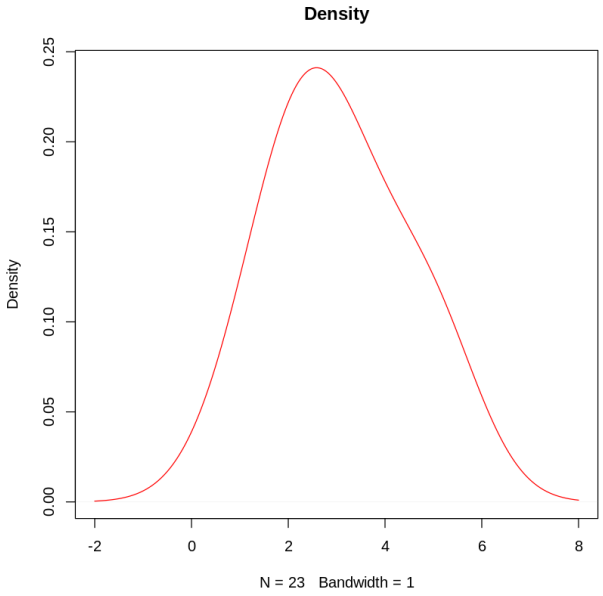
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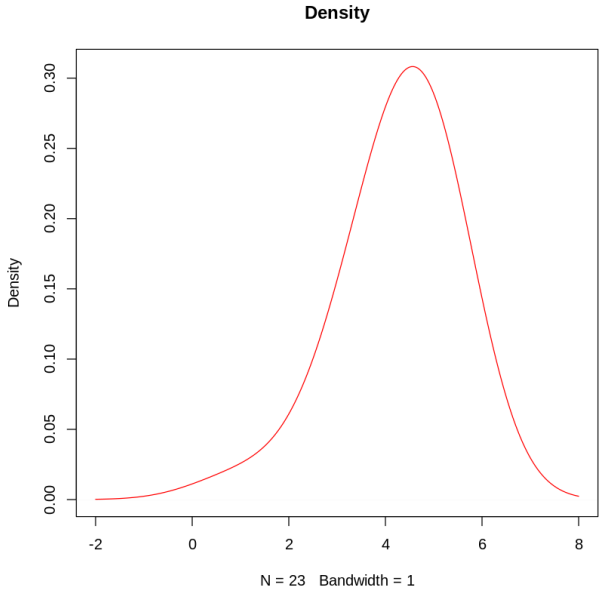
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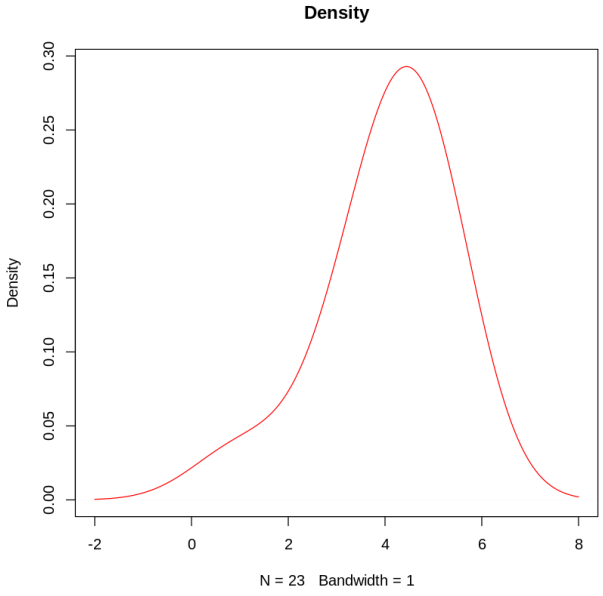
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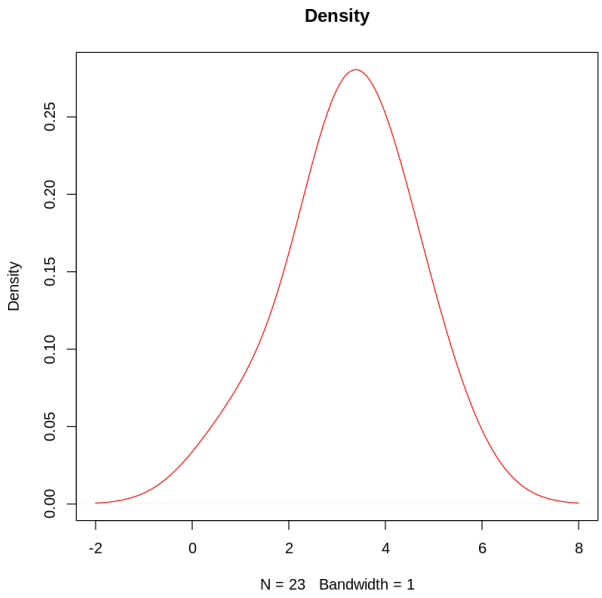
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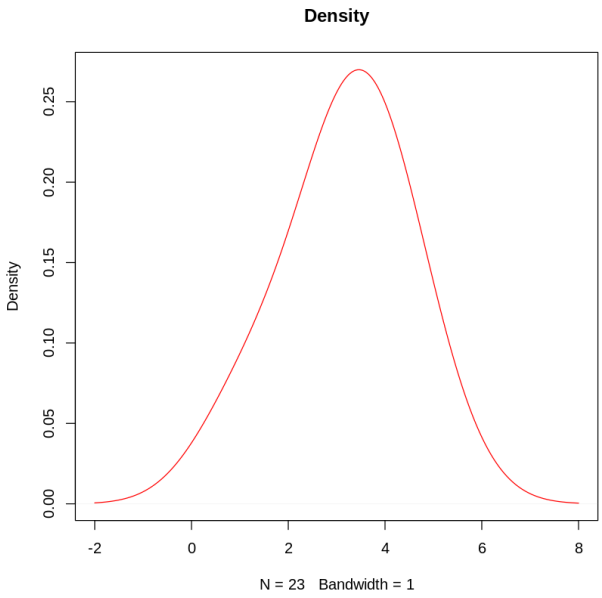
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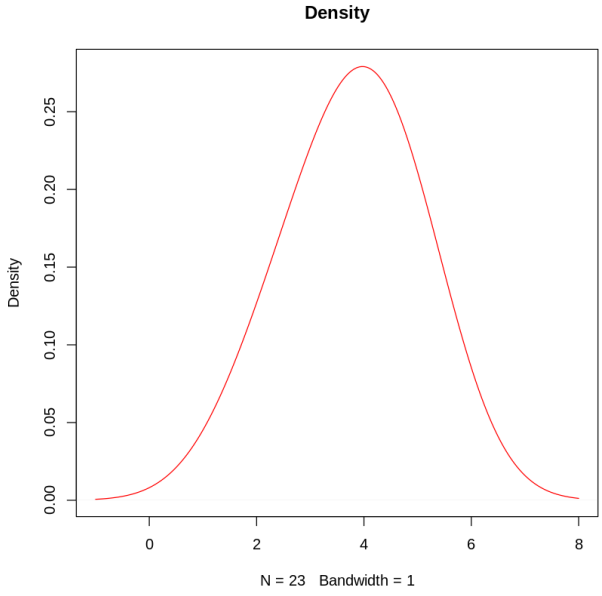
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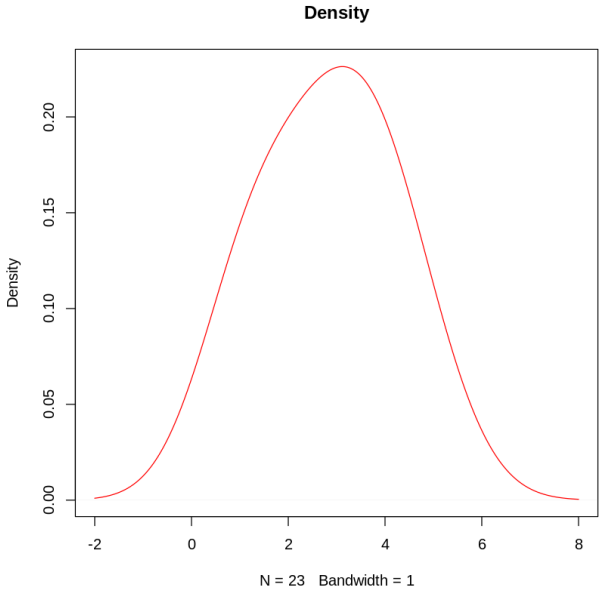
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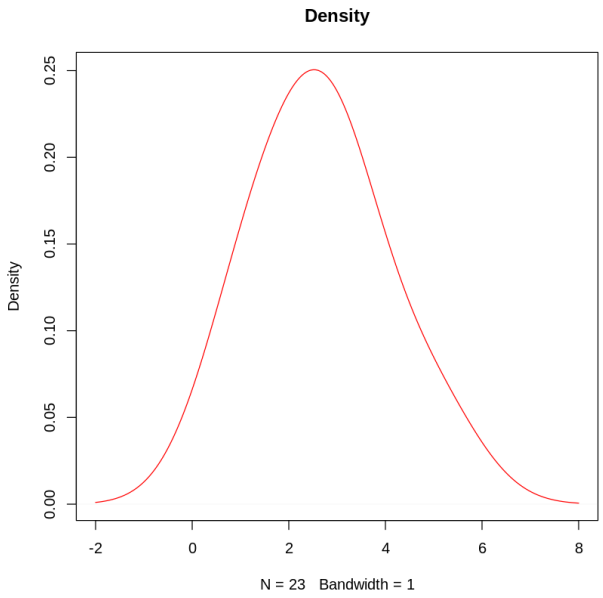
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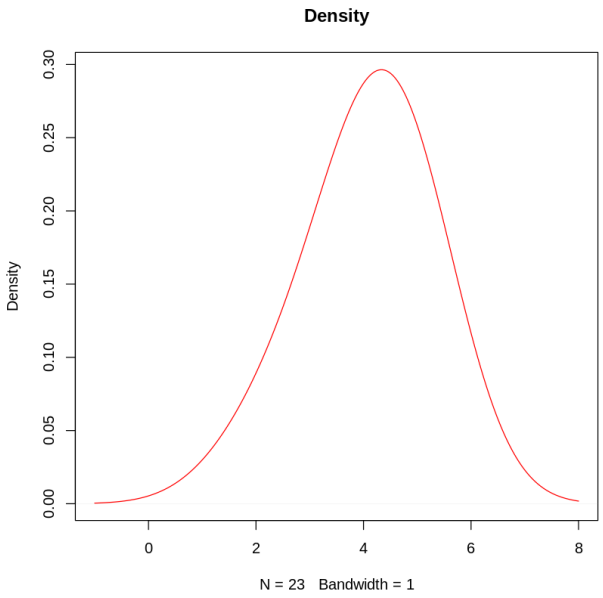
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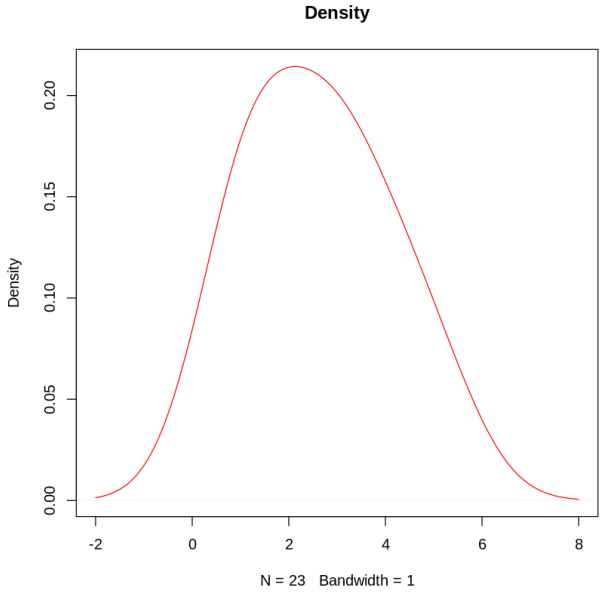
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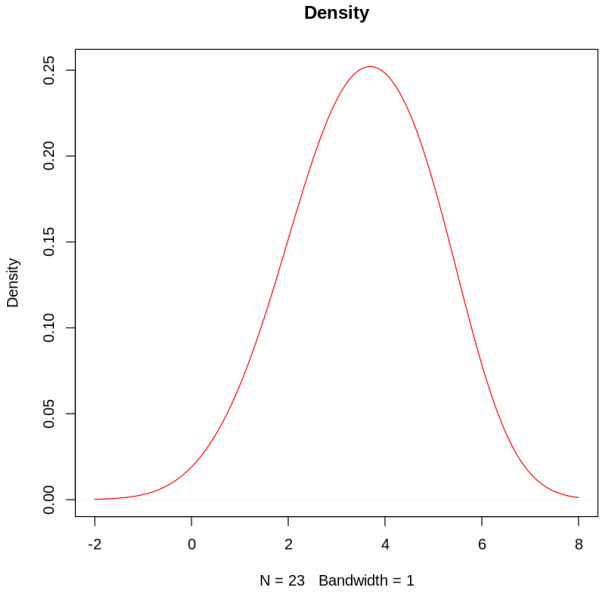
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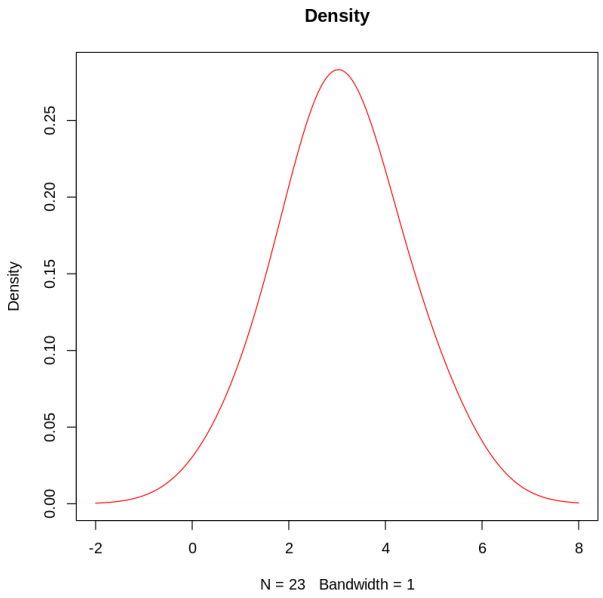
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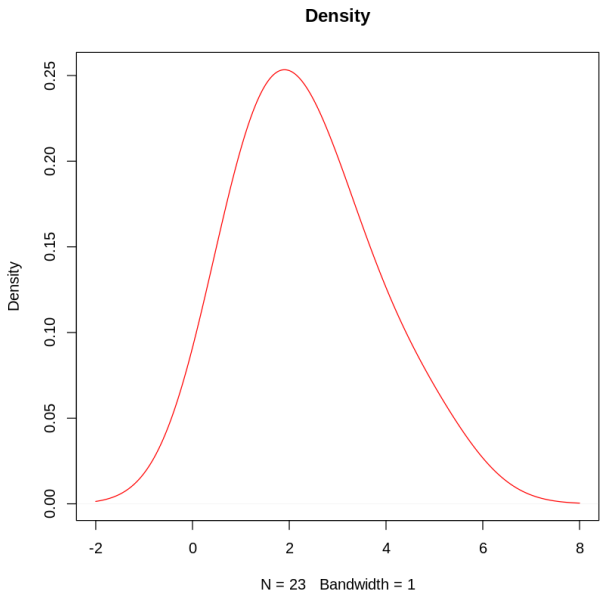
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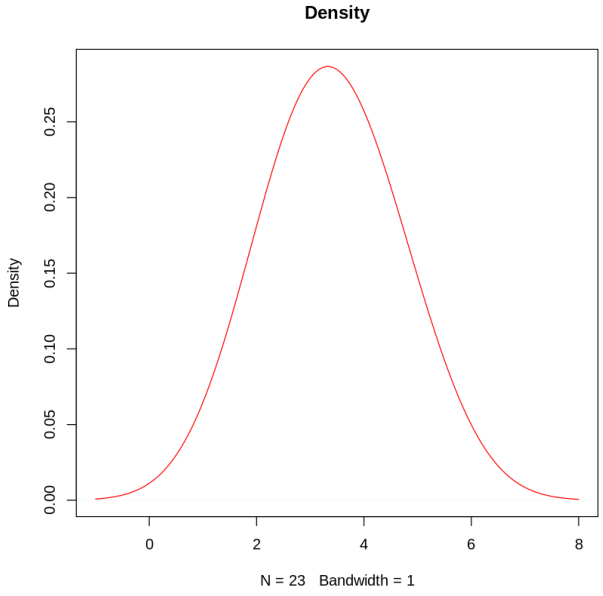
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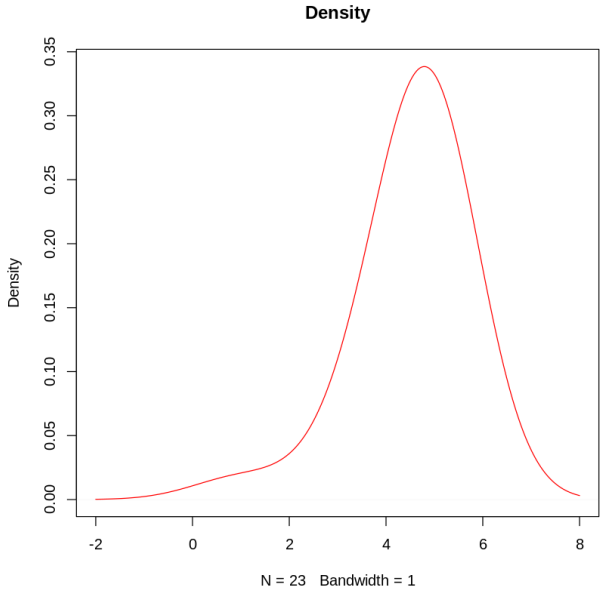
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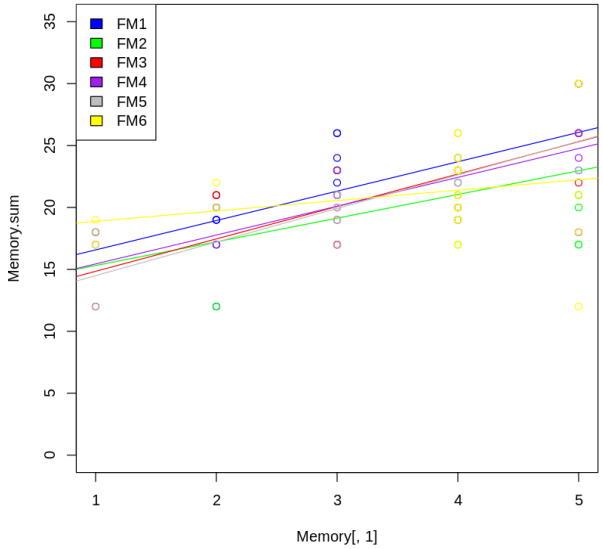
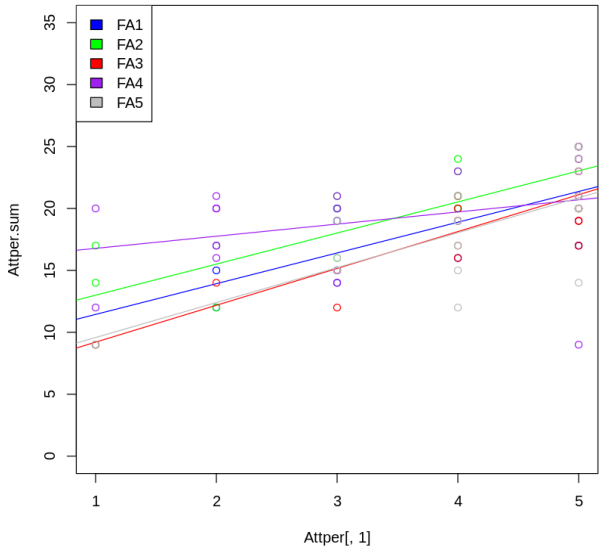
Now, we plot

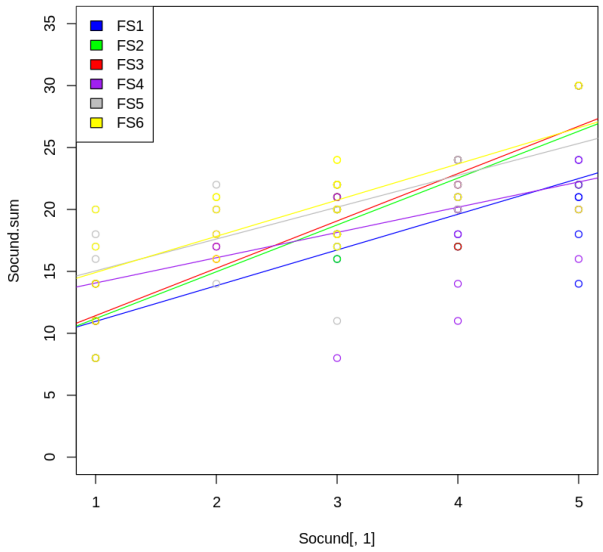
Item-wise best-fit line on Face Memory:



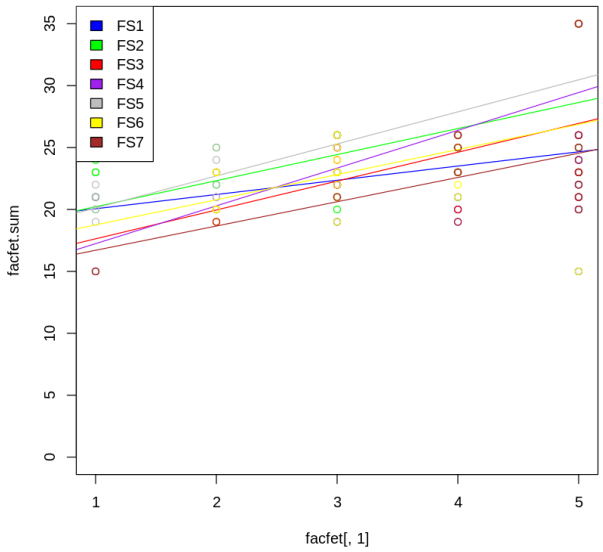
Item-wise best-fit line on Face Attention and Perception:



Item-wise best-fit line on Face Social Understanding:



Item-wise best-fit line on Facial Features:



5.2 Interpretation

Interpretation from the Barplot and Linechart of Face Memory:

By seeing the barplot of Face Memory, we can say that except the 2nd and 4th category, all the categories are almost undecided. People recall familiar faces more frequently. But they are often unable to trace their identity.

Interpretation from the Barplot and Linechart of Face Attention and Perception:

By seeing the barplot and linechart of Face Attention and Perception, we can say that people more frequently pay more attention to the human face as a whole in general and tend to attend faster to familiar faces than unfamiliar faces. They also consider face as an important tool for information processing.

Interpretation from the Barplot and Linechart of Social Understanding:

From the barplot and linechart of Social Understanding, we can say that except the 1st and 4th category, almost all are undecided. People more frequently consider human face as an important tool for daily communication and also feel that attractive people are able to get better opportunities.

Interpretation from the Barplot and Linechart of Facial Features:

From the barplot and linechart of Facial Features we can see that people most frequently like to mix with people who smile whole heartedly and more frequently are drawn towards the eyes of a person.

Interpretation from the Correlation Plots of Face Memory:

We can see that in the Face Memory, finding easy to recognise childhood friends and possessing a good face-recognition ability are somewhat highly positively correlated. Recalling familiar faces and unfamiliar faces are negatively correlated. Also being unable to trace familiar people's identity is negatively correlated with recaling familiar faces, ability of recognising childhood friends and possessing a good face-recognition ability.

Interpretation from the Correlation Plots of Face Attention and Perception:

We can see that in the Face Attention and Perception, all the categories are somewhat highly correlated with the belief that face is an important tool for information processing expect tending to focus more on the lower part of the face, which is negatively correlated.

Interpretation from the Correlation Plots of Face Social Understanding:

We can see that getting carried away by good looks is highly correlated with getting easily attracted to beautiful and fair-skinned faces, which is expected.

Interpretation from the Correlation Plots of Facial Features:

We can see that tending to mix with people smiling whole-heartedly is somewhat highly correlated with keeping face clean and glowing but negatively correlated with liking people with sharp facial features. Being more drawn towards the eyes of a person is negatively correlated with disliking people with too much facial hair, keeping face clean and glowing. Keeping face clean and glowing is negatively correlated with liking people with sharp facial features

In all the item-wise correlation, no highly negative correlation is seen.

Interpretation from the Domain-Wise Correlation :

All the domains of Face Recognition are somewhat highly correlated. Face Attention and Perception is very highly correlated with Face Social Understanding. Face Social Understanding is highly correlated with Facial Features.

Interpretation from the Item Total Correlation of Face Memory:

We can see that finding easy to recognise childhood friends, identify people based on their facial features and possessing a good face-recognition ability are very highly related with Face Memory within the mindset of the participants.

Interpretation from the Item Total Correlation of Face Attention and Perception:

We can see that except tending to focus more o the lower part of the face all categories are highly related with Face Attention and Perception frame within the mindset of the participants.

Interpretation from the Item Total Correlation of Face Social Understanding:

We can see that getting easily attracted to beautiful and fair skinned faces, getting involved with good looking person and getting easily carried away by good-looks are highly related with the Face Social Understanding frame within the mindset of the participants.

Interpretation from the Item Total Correlation of Facial Features:

We can see that getting easily attracted towards tone cheek-bones and preferring make up are very highly related with the Facial Features frame within the mindset of the participants .

Interpretation from the Percentage and Frequency Distributions of Face Memory:

We can see that people are undecided about easily remembering unfamiliar faces and recognize childhood friends, and possess other abilities more frequently .

Interpretation from the Percentage and Frequency Distributions of Face Attention and Perception:

Here we see that people most frequently possess all things except undecided or more frequently pay more attention to external features of the face and undecided or less frequently pay attention to the lower part of the face.

Interpretation from the Percentage and Frequency Distributions of Face Social Understanding:

Here people most frequently consider human face as an important tool for daily communication. They are mostly undecided about all the other categories except more frequently feel that attractive people are able to get better oportunities.

Interpretation from the Percentage and Frequency Distributions of Facial Features:

Here people most or more frequently drawn towards the eyes of a person and most frequently like to mix with people smiling whole heartedly. They least or less frequently prefer make up on their face or partner's face and least frequently dislike people with too much facial hair. Also they less frequently like people with sharp facial features, like to keep their faces clean and glowing and easily attracted towards toned cheek-bones.

Interpretation from the Very simple Structure:

Looking at the Very Simple Structure, we can conclude that VSS complexity 1 achieves a maximimum of 0.68 with 1 factors VSS complexity 2 achieves a maximimum of 0.84 with 2 factors

Interpretation from the Violin Plot of Face Memory:

We can see that center of Face Memory located mostly in more frequently, except recalling unfamiliar faces and recognising childhood friends which is undecided.

Interpretation from the Violin Plot of Face Attention and Perception:

We can see that center of attending faster to familiar faces than unfamiliar and face being an important tool for information processing is 5, paying more attention to the human face as a whole in general has center 4 and center of paying more attention to the external feature or loewr part of the face has center undecided.

Interpretation from the Violin Plot of Face Social Understanding:

We can see that center of Face Social Understanding is almost 3, except considering the human face as an important tool for daily communication and feeling that attractive people are able to get better opportunities which have center 4.

Interpretation from the Violin Plot of Facial Features:

We can see that center of liking to mix with people smiling whole heartedly is 5, disliking people with too much facial hair, getting easily attracted towards toned cheek-bones and liking people with sharp facial features has center 3, being more drawn towards the eyes of a person and liking to keep face clean and glowing has median 4, and center of preferring make up on their faces or partner's face has median 2.

Interpretation from the Density Estimation Plot:

From the Density Plot we can conclude that almost all the variables are undecided or positively skewed.

6 Discussion

6.1 Summary

From our analysis, we can conclude that people consider human face as an important tool for face recognition. So they pay more attention to the human face as a whole in general, but not in any particular area of face except eyes. People has a good short term face memory. They get least attracted by good looks or don't dislike people less with too much facial hair etc. So overall people are less concerned about external features, else they like people smiling whole-heartedly. People show slightly higher face recognition ability. Also they agree that good looking persons are more keen to get better opportunities.

6.2 Links to Earlier Situation

Face recognition is an efficient technique and one of the most preferred biometric modalities for the identification and verification of individuals as compared to voice, fingerprint, iris, retina eye scan, gait, ear and hand geometry. This has over the years necessitated researchers in both the academia and industry to come up with several face recognition techniques making it one of the most studied research area in computer vision. A major reason why it remains a fast-growing research lies in its application in unconstrained environments, where most existing techniques do not perform optimally. Such conditions include pose, illumination, ageing, occlusion, expression, plastic surgery and low resolution.

6.3 Suggestion

We can use face recognition in many situations. The professions where face recognition is very important are:

- Law and Order
- Criminal Justice System
- Teaching

Development of recognising these things would help a good person to get a good job. Face Perception is also important in combat. Also we can use this in unlocking phones, airport and border control or finding missing persons.

7 Responses

The data set which we have collected by our survey is given in data.txt. In all the categories, Most Frequently, More Frequently, Undecided, Less Frequently and Least Frequently are replaced by 5,4,3,2,1 respectively.

8 Appendix

8.1 R Codes

```
install.packages("psych")
install.packages("GPArotation")
install.packages("ggplot2")
install.packages("reshape2")
library("ggplot2")
library("psych")
library("GPArotation")
library("reshape2")
data=read.csv("/content/project3_data.csv")
Proenv=data[1:24,3:26]
Proenv
Proenv1=lapply(Proenv,as.numeric)
r <- lowerCor(Proenv)
r
corPlot(r)
Proenv2=data.frame(apply(Proenv,2,function(x) as.numeric(as.character(x))))
describe(Proenv2)
Memory=data.frame(Proenv1[1:6])
Memory.sum=apply(Memory,1,sum)
recor=cor(Memory.sum,Memory)
recor
order(recor)
Memory1=data.frame(Proenv[,1:6])
r1=lowerCor(Memory1)
mean(Memory[,1])
rf1=cor(Memory)
gf=data.frame(colMeans(Memory[,1:6]))
for(i in 1:6)
gf$row.names[i]=i
gf
```

```
long.gf=melt(gf,id=c("row.names"))
plotted=ggplot(long.gf,aes(x=row.names,y=value))+geom_bar(stat='
identity',fill="lightblue")
plotted+ggtitle("Barplot of Means of
Memory")+xlab("Memory")+ylab("Means")
plotteda=ggplot(long.gf,aes(x=row.names,y=value,group=1))+geom_l
ine(color="darkgreen")+geom_point()
plotteda+ggtitle("Linechart of Means of
Memory")+xlab("Memory")+ylab("Means")
Attper=data.frame(Proenv1[7:11])
Attper.sum=apply(Attper,1,sum)
recor=cor(Attper.sum,Attper)
recor
order(recor)
Attper1=data.frame(Proenv[,7:11])
r1=lowerCor(Attper1)
mean(Attper[,1])
gf=data.frame(colMeans(Attper[,1:5]))
for(i in 1:5)
    gf$row.names[i]=i
gf
long.gf=melt(gf,id=c("row.names"))
plotted=ggplot(long.gf,aes(x=row.names,y=value))+geom_bar(stat='
identity',fill="lightblue")
plotted+ggtitle("Barplot of Means of Attention And
Perception")+xlab("Attention And Perception")+ylab("Means")
plotteda=ggplot(long.gf,aes(x=row.names,y=value,group=1))+geom_l
ine(color="darkgreen")+geom_point()
plotteda+ggtitle("Linechart of Means of Attention And
Perception")+xlab("Attention And Perception")+ylab("Means")
Socund=data.frame(Proenv1[12:17])
Socund.sum=apply(Socund,1,sum)
recor=cor(Socund.sum,Socund)
recor
order(recor)
Socund1=data.frame(Proenv[,12:17])
r1=lowerCor(Socund1)
mean(Socund[,1])
gf=data.frame(colMeans(Socund[,1:6]))
for(i in 1:6)
    gf$row.names[i]=i
gf
long.gf=melt(gf,id=c("row.names"))
plotted=ggplot(long.gf,aes(x=row.names,y=value))+geom_bar(stat='
identity',fill="lightblue")
plotted+ggtitle("Barplot of Means of Social
Understanding")+xlab("Social Understanding")+ylab("Means")
plotteda=ggplot(long.gf,aes(x=row.names,y=value,group=1))+geom_l
ine(color="darkgreen")+geom_point()
plotteda+ggtitle("Linechart of Means of Social
Understanding")+xlab("Social Understanding")+ylab("Means")
facfet=data.frame(Proenv1[18:24])
facfet.sum=apply(facfet,1,sum)
recor=cor(facfet.sum,facfet)
```

```
recor
order(recor)
facfet1=data.frame(Proenv[,18:24])
r1=lowerCor(facfet1)
mean(facfet[,1])
gf=data.frame(colMeans(facfet[,1:7]))
for(i in 1:7)
    gf$row.names[i]=i
gf
long.gf=melt(gf,id=c("row.names"))
plotted=ggplot(long.gf,aes(x=row.names,y=value))+geom_bar(stat='
identity',fill="lightblue")
plotted+ggtitle("Barplot of Means of Facial
Features")+xlab("Facial Features")+ylab("Means")
plotteda=ggplot(long.gf,aes(x=row.names,y=value,group=1))+geom_l
ine(color="darkgreen")+geom_point()
plotteda+ggtitle("Linechart of Means of Facial
Features")+xlab("Facial Features")+ylab("Means")
install.packages("vioplot")
library("vioplot")
vioplot(Attper,col=2,rectcol="red",linecol="white",colMed="green
",border="black",
pchMed=16,plotCentre="points")
Memory=data.frame(Proenv1[1:6])
vioplot(Memory,col=2,rectcol="red",linecol="white",colMed="green
",border="black",
pchMed=16,plotCentre="points")
Socund=data.frame(Proenv1[12:17])
vioplot(Socund,col=2,rectcol="red",linecol="white",colMed="green
",border="black",
pchMed=16,plotCentre="points")
facfet=data.frame(Proenv1[18:24])
vioplot(facfet,col=2,rectcol="red",linecol="white",colMed="green
",border="black",
pchMed=16,plotCentre="points")
for(i in 1:24)
plot(density(df[,i],bw=1),col="red",main="Density")
Memory.sum=apply(Memory,1,sum)
plot(Memory.sum~Memory[,1],col="blue",xlim=c(1,5),ylim=c(0,35))
abline(lm(Memory.sum~Memory[,1]),col="blue")
points(Memory.sum~Memory[,2],col="green")
abline(lm(Memory.sum~Memory[,2]),col="green")
points(Memory.sum~Memory[,3],col="red")
abline(lm(Memory.sum~Memory[,3]),col="red")
points(Memory.sum~Memory[,4],col="purple")
abline(lm(Memory.sum~Memory[,4]),col="purple")
points(Memory.sum~Memory[,5],col="grey")
abline(lm(Memory.sum~Memory[,5]),col="grey")
points(Memory.sum~Memory[,6],col="yellow")
abline(lm(Memory.sum~Memory[,6]),col="yellow")
legend(x="topleft",legend=c("FM1","FM2","FM3","FM4","FM5","FM6",
fill=c("blue","green","red","purple","grey","yellow"))
facfet.sum=apply(facfet,1,sum)
plot(facfet.sum~facfet[,1],col="blue",xlim=c(1,5),ylim=c(0,35))
```

```
abline(lm(facfet.sum~facfet[,1]),col="blue")
points(facfet.sum~facfet[,2],col="green")
abline(lm(facfet.sum~facfet[,2]),col="green")
points(facfet.sum~facfet[,3],col="red")
abline(lm(facfet.sum~facfet[,3]),col="red")
points(facfet.sum~facfet[,4],col="purple")
abline(lm(facfet.sum~facfet[,4]),col="purple")
points(facfet.sum~facfet[,5],col="grey")
abline(lm(facfet.sum~facfet[,5]),col="grey")
points(facfet.sum~facfet[,6],col="yellow")
abline(lm(facfet.sum~facfet[,6]),col="yellow")
points(facfet.sum~facfet[,7],col="brown")
abline(lm(facfet.sum~facfet[,7]),col="brown")
legend(x="topleft",legend=c("FS1","FS2","FS3","FS4","FS5","FS6","FS7"),
fill=c("blue","green","red","purple","grey","yellow","brown"))
Socund.sum=apply(Socund,1,sum)
plot(Socund.sum~Socund[,1],col="blue",xlim=c(1,5),ylim=c(0,35))
abline(lm(Socund.sum~Socund[,1]),col="blue")
points(Socund.sum~Socund[,2],col="green")
abline(lm(Socund.sum~Socund[,2]),col="green")
points(Socund.sum~Socund[,3],col="red")
abline(lm(Socund.sum~Socund[,3]),col="red")
points(Socund.sum~Socund[,4],col="purple")
abline(lm(Socund.sum~Socund[,4]),col="purple")
points(Socund.sum~Socund[,5],col="grey")
abline(lm(Socund.sum~Socund[,5]),col="grey")
points(Socund.sum~Socund[,6],col="yellow")
abline(lm(Socund.sum~Socund[,6]),col="yellow")
legend(x="topleft",legend=c("FS1","FS2","FS3","FS4","FS5","FS6"),
fill=c("blue","green","red","purple","grey","yellow"))
Attper.sum=apply(Attper,1,sum)
plot(Attper.sum~Attper[,1],col="blue",xlim=c(1,5),ylim=c(0,35))
abline(lm(Attper.sum~Attper[,1]),col="blue")
points(Attper.sum~Attper[,2],col="green")
abline(lm(Attper.sum~Attper[,2]),col="green")
points(Attper.sum~Attper[,3],col="red")
abline(lm(Attper.sum~Attper[,3]),col="red")
points(Attper.sum~Attper[,4],col="purple")
abline(lm(Attper.sum~Attper[,4]),col="purple")
points(Attper.sum~Attper[,5],col="grey")
abline(lm(Attper.sum~Attper[,5]),col="grey")
legend(x="topleft",legend=c("FA1","FA2","FA3","FA4","FA5"),
fill=c("blue","green","red","purple","grey"))
Memory1=data.frame(Proenv[,1:6])
magicfun<-function(x) x*100/23
lvls=unique(unlist(Memory1))
freq=sapply(Memory1,function(x)table(factor(x,levels=lvls,ordere
d=TRUE)))
colnames(freq)<-c("FM1","FM2","FM3","FM4","FM5","FM6")
freq
freq=apply(freq,2,magicfun)
freq
Attper1=data.frame(Proenv[,7:11])
magicfun<-function(x) x*100/23
```

```
lvls=unique(unlist(Attper1))
freq=sapply(Attper1,function(x)table(factor(x,levels=lvls,ordere
d=TRUE)))
colnames(freq)<-c("FA1","FA2","FA3","FA4","FA5")
freq
freq=apply(freq,2,magicfun)
freq
Socund1=data.frame(Proenv[,12:17])
magicfun<-function(x) x*100/23
lvls=unique(unlist(Socund1))
freq=sapply(Socund1,function(x)table(factor(x,levels=lvls,ordere
d=TRUE)))
colnames(freq)<-c("FS1","FS2","FS3","FS4","FS5","FS6")
freq
freq=apply(freq,2,magicfun)
freq
facfet1=data.frame(Proenv[,18:24])
magicfun<-function(x) x*100/23
lvls=unique(unlist(facfet1))
freq=sapply(facfet1,function(x)table(factor(x,levels=lvls,ordere
d=TRUE)))
colnames(freq)<-c("FS1","FS2","FS3","FS4","FS5","FS6","FS7")
freq
freq=apply(freq,2,magicfun)
freq
r2=lowerCor(Memory1)
corPlot(r2,main="Correlation Plot for Face Memory")
r2=lowerCor(Attper1)
corPlot(r2,main="Correlation Plot for Face Attention and Perception")
r2=lowerCor(facfet1)
corPlot(r2,main="Correlation Plot for Facial Features")
r2=lowerCor(Socund1)
corPlot(r2,main="Correlation Plot for Face Social Understanding")
dat=data.frame(Memory.sum[-24],Attper.sum[-24],Socund.sum[-24],facfet.sum[-24])
rr=lowerCor(dat)
corPlot(rr,main="Domain-wise Correlation")
```