Analyses of a survey on delinquency and deviance in people with bipolar disorder

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Chapitre 1

Introduction

Emotions as such are not pathological, everyone can experience them. It is normal to feel happy at rewarding events and to feel sad at negative ones. What is less normal is when a state of sadness or euphoria persists and is not sensitive to the elements of the environment.

1.1 What is then Bipolar Disorder ?

Bipolar disorder is defined as "a psychiatric condition characterised by alternating acute bouts of euphoric mania and melancholic depression in the same individual" [1], 2021. There exist three types of bipolar disorder or psychosis : type I, type II and type III. Each type is characterized by the length and intensity of the phase, which can be associated with comportment [2]. Although it's complicated to determine perfectly the phase in which the individual is, because there exist some mixed state (mixed depression and dysphoric mania) [3]. The proportion of men who are bipolar is the same as the women, even if women have more problems due to their hormonal cycle which can influence their moods.

[11]. However, this global statement is mostly for the type I bipolar disorder which doesn't consider the bipolar disorder according to at least one manic phase without taking account to any depressive phase [12]. It is suggested that women with type II bipolar disorder are more affected by certain phases like mixed episodes and hypomania [9]. The phases in which the bipolar person can pass are various and can be seen as a spectrum. The main two phases are mania and depression, but there exist in between (mixed episodes and hypomania) [3]. A basic view of the phases will give us from the state of sadness to euphoria : Severe depression < Light/ Moderate depression < Melancholy < Mixed episodes < Euthymia < High mood < Mania. We could also find psychotic episodes which are implied by the co-morbidity (e.g. addiction or personality disorder). The Euthymia is as it implies the "real mood", so a calm state of mind [10].

Mania

Mania is the most typical and oldest known disorder, which in Hippocrates' time was called "raving delirium"[7]. Its meaning evolved over time, Philippe Pinel had called it "insanity", then the term monomania appeared, until Kraepelin renamed it "manic-depressive psychosis" [7].

It has been possible to define that there are several forms of mania, such as pure mania (or euphoric form) and manic fury (or aggressive form) [7]. At present, we can defined derivatives of mania. Indeed, we can find depression in mania : dysphoric manias (also called mixed states), psychotic mania or hypomania [3].

The manic state sets in within a few days, it is quite rare for it to be progressive and over several weeks. There seems to be characteristic symptoms for each subject, which arise at the beginning of each relapse [4]. Without any treatment, the manic episode usually lasted between 3 and 4 months and disappeared by itself, often followed by a depressive relapse [4]. In half of the cases, a depressive phase precedes the manic episode. At present, and ideally, patients should be treated from the beginning of the episode [8]. Some intense stress or life event may trigger the manic phase. It has also been noted that it is sometimes the patient's own behaviour that induces the event that will lead to a crisis, because of loss of self-esteem due to bad behaviour around the close circle (friends and family) [4]. Apart from life events, other factors can also be triggers, such as taking or stopping certain medications (e.g. antidepressants), or taking legal (alcohol) or illegal drugs (cocaine, etc.) [4]. For some researcher the highest manic phase might be the least dangerous, but have to be carefully observed because it might hide a depression phase or a mixed state, which are supposed to be more dangerous [4].

Depression

Depression is the most typical case of consultation for a treatment, during this phase the bipolar is the most sensitive and at high risk of dangerous behaviour (high risk of suicide) [6]. Depression episodes appears more often than manic episodes [11].

Bipolar disorder, delinquency and deviance

Some research has shown moderate but significant associations between mental disorders and violent crime [5]. The take of mood stabiliser can diminish the probability of dangerous behaviour [11]. Research in the United States shows that 2% of people who do not meet the criteria for a psychiatric disorder have experienced violence in the past year, but this figure rises to 7% in the case of major depression, 9% in the case of dysthymia and 16% in the case of bipolar disorder [5]. In manic episodes, antisocial acts are described as relatively frequent, but less severe than in depression [5]. Mania is rarely associated with

serious criminality but often leads to various minor offences [5]. Contrary to mixed state or depression which lead to major offences, but this state may be accentuated by other co-morbidity like alcoholism, addiction and personality disorders [5]. However, one study found a significant number of violent behaviours among manic patients (48 cases), most often physical aggression (19 cases), but also one homicide and two rapes. Whereas delinquency and violence were rare in patients with major depressive disorder : only 10 depressives out of 702 had committed violent acts [5]. The bipolar phases may play a role in the delinquent behaviour. We'll consider this in our analysis.

1.2   Description of the database

Our database is the result of a survey conducted from February to April 2021. This database contains 113 individuals. These individuals are all diagnosed with bipolar disorder. This database contains 3 parts.

The first part (Part1-A) corresponds to a general piece of information : age ; gender ; the age of diagnosis ; other comorbidities ; if a treatment is taken, for how long and whether it is being taken regularly ; if there is a psychological follow-up. This part contains 14 variables.

The second part consists of questions about delinquency. The second part is about delinquency reported to justice (Part2-A, 24 variables), the delinquency non-reported to justice (Part2-B, 25 variables) and the delinquency experienced by the individuals (Part2-C, 27 variables). The question asked about which type of delinquency were committed (contravention, misdemeanours and/or crimes) ; the subject of the delinquency (Offences against the person, financial and economic, theft, road traffic, public order offences, use or purchase of drugs/substance abuse and/or sexual) ; the phase in which they were during these delinquencies ; if they were under treatment at this time and if they were under the influence of any type of drugs.

The last part corresponds to the behaviour of the individuals, the deviance that is shown in daily life. The deviance is self-reproached (Part3-A, 23 variables) and reproached by other people in their life (Part3-B, 23 variables). The question asked in this part are ; what is the subject of deviance (behavioural, verbal language, lies, sexual and/or financial) and the social sphere in which they exhibit those behaviours, and the phase they were in when they exhibited those behaviours. This study aims to determine whether any of the phases of bipolar disorder might increase the risk of deviant and/or delinquent behaviours. And finally, to determine whether there are factors that can increase these risks.

This survey was made by Bézille M. in the context of her Master thesis about maniac phases and criminality, all the data is under a confidentiality agreement.

1.3   Goal of the survey

This study aims to determine whether there are factors that can increase the risk of delinquency. To simplify our analysis we'll only take into account some of the variables which are representative of some behaviour or characteristics of the individuals.

1.4   Selection of variables

Major variables in the study were sectioned into delinquency transferred to justice or not, self reproached deviance and deviance reproached by others, and finally, delinquency experienced by the bipolar person. All the variables are qualitative ones, and the questions associated to them are in Appendix 1 and the description and definition in Appendix 2.

FIGURE 1.1 – Frequencies of general information corresponding to gender (A), ages (B), treatment (C) and if they have committed a delinquency transferred to the justice (D), for the 113 individuals questioned, all this individuals have bipolar disorder.
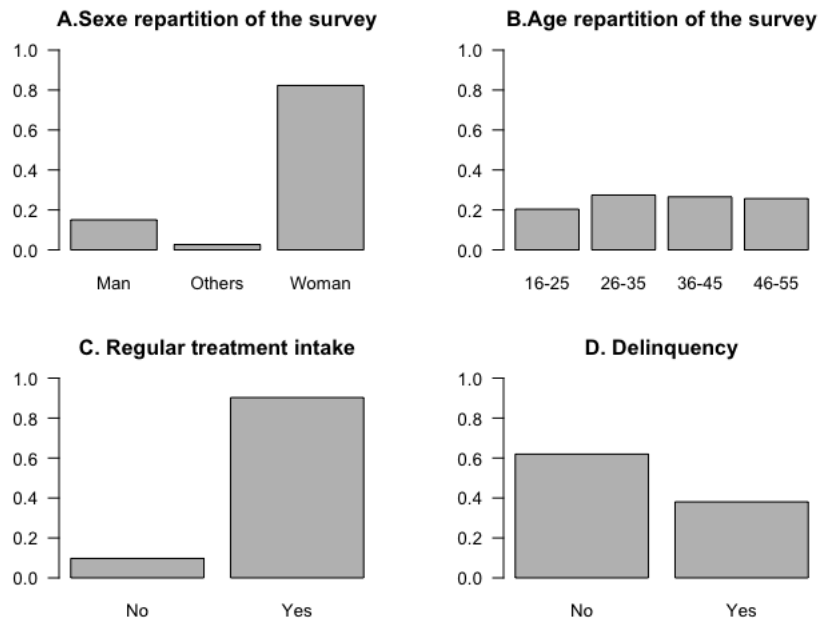
However, for these major variables, other sub factors led to them being classified as such. Thus, in a particular scenario, other factors/variables determined whether a person ended up being transferred to justice or not. In the introduction we presented some factors that may trigger the delinquency, and theses

factors are the presence of co-morbidity, the intake of drugs illegal or not and the phase in which the person is. We choose to analyse the delinquency reported to the justice.

The choices of the other variables were considered in function of information we wanted to highlight. The variables "Gender" (Man, woman and other) and "age" (16-24, 26-35, 36-45, 46-55, the individuals who are older than 55 years are in the level 46-55) would allow us to interpret whether the sample in this survey is globally representative of the population. This survey was proposed to support groups for people with bipolar disorder. In most of these groups, the majority are often female. This may be one of the reason why there are more women in the survey. The percentage of individuals who committed a delinquency will be our main interest, because we want to see if the variables we suspect are indeed linked with it. This type of individual represents about 38% of our sample.

Each of the variables in Figure 1.2 corresponds to a "yes or no" question. The interest behind these values is to determined if the act of delinquency transferred to justice is influenced by one of them.

FIGURE 1.2 – Frequencies of individual's delinquency not transferred to the justice (A) and experienced (B) and deviance reproached by other (C) and self-reproached, for the 113 individuals
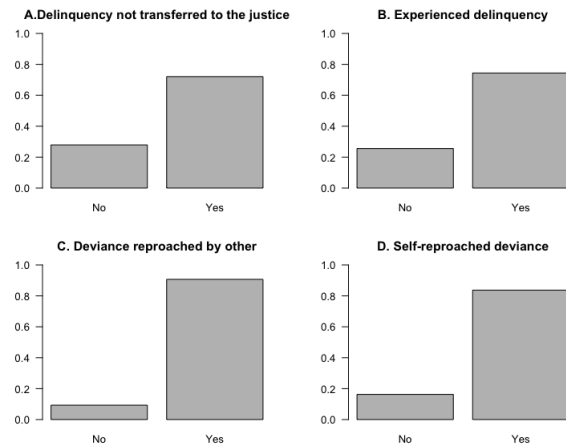
The co-morbidities are important (Fig. 1.3), because in the documentation the authors supposed that some types of co-morbidity may interact with the bipolar disorder and may increase the act of delinquency or deviance. The co-morbidities to highlight are Addictions, Personality disorders and Psychotic disorder. In both of the frequencies observed : in the total of the group and the group for the Delinquency, the frequencies seems similar. We can add that the Attention deficit disorder is not represented in the group Delinquency.

The only data that we have on drugs, is the one during the delinquency. So we do not have a general idea if the persons consumes drugs in a way where it

FIGURE 1.3 – Frequencies of co-morbidity in our sample (113 individuals)(A) and in the sample of the individuals which committed a delinquency transferred to the justice (43 individuals) (B). Some individuals had more than 1 co-morbidity.
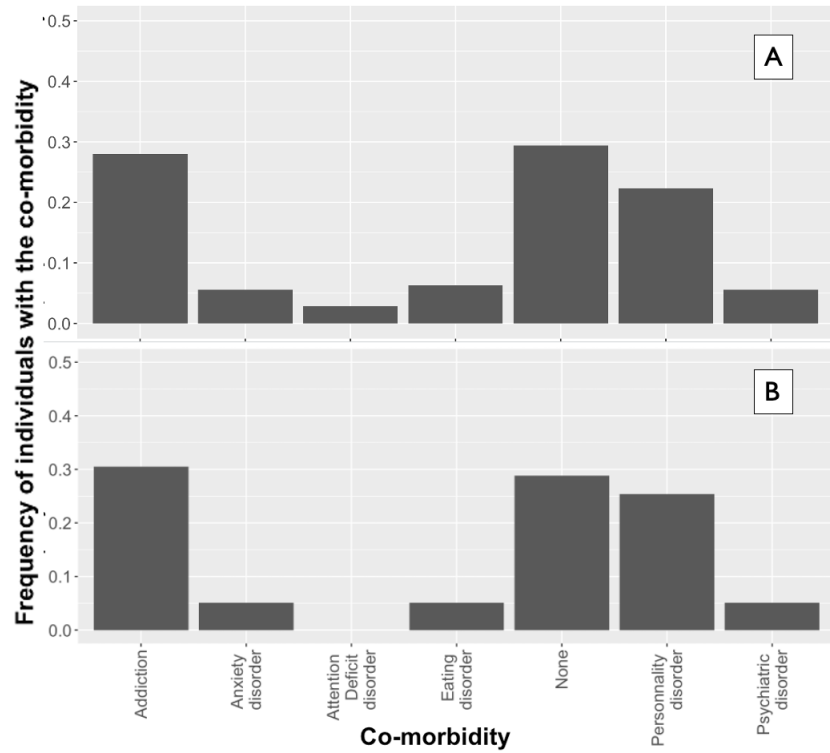
could be dangerous for them. But we have the type of drug they were under the influence of during the delinquency (Fig. 1.4).

As the variable "drugs", the variable "phases" are only for those who committed a delinquency (Fig. 1.5).There are different phases, and we decided to see the result clearer to group the severe depression and the light/moderate depression into a "depressed" modality.

The phase, drugs and co-morbidity were analysed separately of this document. Khi square test were not possible because of the lack of information in some modalities and we resulted in analyzing other factor that may increase or not the delinquency transferred to the justice. But we leave the description of these variable as idea for the interpretation of our results.

FIGURE 1.4 – Frequencies of drugs the individuals (43 ind.) were under during the delinquency. Some individuals had taken more than 1 drug.
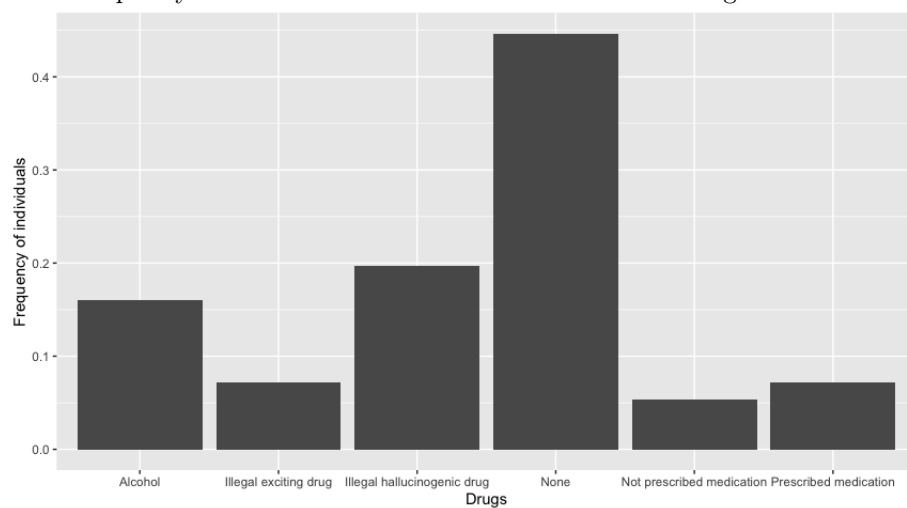
FIGURE 1.5 – Frequencies of phases the individuals (43 ind.) were under during the delinquency. Dprs : Depressed ; Dntk : Do not know ; Elvm : Elevated mood ; Ethm : Euthymia ; Hypm : Hypomania ; Mani : Mania ; Mixd : Mixed ; Psyc : Psychotic phase.
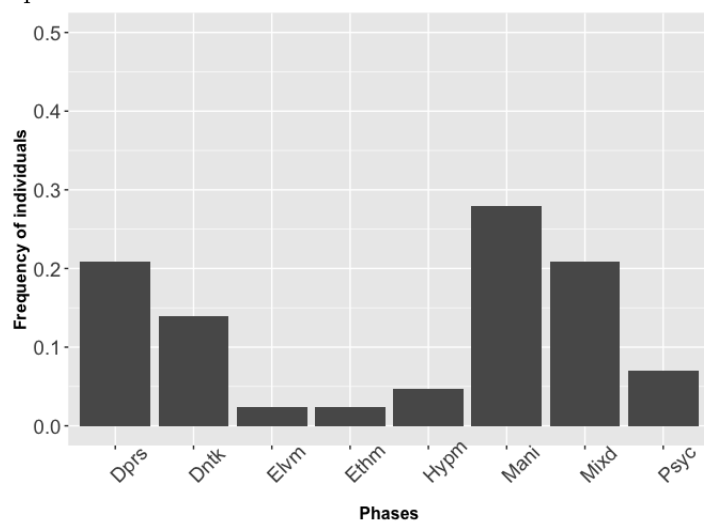
Chapitre 2

Analysis of independence of the variables : Khi squared and Binary Correspondence Analysis

Here, independence and dependence of each binary variable with the principal variable delinquency was checked. Initially some preliminary calculations were performed as presented below. In this section, we present the procedure followed for only the first binary variable with delinquency because, subsequent variables employed the same methodology and analysis. While taking into account the variable, treatment, the following analysis was carried out ;

2.1   Khi squared of independence

2.1.1   Description of the methodology

In order to assess the independence between delinquency reported to justice and the various variables such as age, treatment and the various other types of delinquency, we will analyze :
    - The contingency table
    - The table of relative frequencies
    - Line profiles
    - Column profiles
    - The attraction / repulsion matrix
    - The test statistics khi-squared and phi-squared

The Contingency Table

This was used to summarize the relationship between categorical variables by simultaneously showing the binary variables. Thus for variables Treatment vs Delinquency, the marginal values n_j for j =1,..., J =2 (respectively $n_{.k}$ for k = 1, ..., K = 2) at the level of rows (and respectively columns) are obtained by summing the observed values n_{jk} at row level (and respectively columns). This is given by :

$$n_{j.} = \sum_{k=1}^{K} n_{jk} \tag{2.1}$$

$$n_{.k} = \sum_{j=1}^{J} n_{jk} \tag{2.2}$$

This was performed in R software with the following command :

agg=table(data[, c(column1 ;column2])

Frequency Table

This table considered for example : the Treatment and Delinquency variables was calculated to show the relative frequency or count of occurrences of their respective levels of joint frequencies.

freq=agg/sum(agg)

It is given theoretically as ;

$$f_{jk} = \frac{n_{jk}}{n}, j, k = 1, \ldots, 2 \tag{2.3}$$

With marginal frequencies computed theoretically given by,

$$f_{j.} = \frac{n_j}{n}, \quad j, k = 1, \ldots, 2 \tag{2.4}$$

$$f_{.k} \frac{n_{.k}}{n}, \quad j, k = 1, \ldots, 2 \tag{2.5}$$

Rows and columns profiles

The rows profiles are given by :

$$f_{k|j} = \frac{f_{jk}}{f_{j.}}, \quad j, k = 1, \ldots, 2 \tag{2.6}$$

The columns profiles are given by :

$$f_{j|k} = \frac{f_{jk}}{f_{.k}}, \quad j, k = 1, \ldots, 2 \tag{2.7}$$

The respective commands in R were :

Profl = prop.table(agg, 1)
Profc = prop.table(agg, 2)

These tables enable us to examine the links between the variables by analyzing the dependence between the two in what is known as a binary correspondence analysis. It begins by first recognizing that if the two variables are independent, then the rationale for doing a correspondence analysis is not necessary as the two variables have no links

Khi squared of independence

It is important to recall that, the probability estimates of the variables in the group can be gotten from their relative frequencies which must also meet the condition of probability as presented below.

$$f_{jk} \approx f_j \cdot f_{.k} \tag{2.8}$$

$$f_{j|k} = \frac{f_{jk}}{f_k} \approx f_j \tag{2.9}$$

$$f_{k|j} = \frac{f_{jk}}{f_{j.}} \approx f_{.k} \tag{2.10}$$

From here, the theoretical and relative theoretical frequencies are defined under the independence assumption as follows :

$$n_{jk}^* = \frac{n_j \cdot n_{.k}}{n} \tag{2.11}$$

$$f_{jk}^* = f_{j.}f_{.k} = \frac{n_{jk}^*}{n} \tag{2.12}$$

At this point the independence test can be used to find solutions about the below null and alternative hypothesis.
H0 : X and Y are independent
H1 : X and Y are not Independent
The Khi squared is realized on R with the following code, on the contingency table : **chisq.test(table(our2var))**

The statistics test is given as :

$$\chi^2 = \sum_{j=1}^{J} \sum_{k=1}^{K} \frac{\left(n_{jk} - n_{jk}^*\right)^2}{n_{jk}^*} = n \sum_{j=1}^{J} \sum_{k=1}^{K} \frac{\left(f_{jk} - f_{jk}^*\right)^2}{f_{jk}^*}. \qquad (2.13)$$

The important thing being verified here is the comparison of theoretical frequency value with the observed value under the null hypothesis. That is, if there is a large difference between n_{jk}^* and n_{jk}, then the statistic χ^2 will be large, thus, resulting in the rejection of the null hypothesis (H0). Likewise, if the gap is small under the independence assumption, then χ^2 will be small meaning H0 cannot be rejected. Thus, it suffices to follow the distribution law of χ^2 under H0 in order to decide on rejecting or accepting H0. Under H0 :

$$\chi^2 \approx \chi^2_{(J-1)(K-1)}$$

We thus, reject the null hypothesis at the level α if,

$$\chi^2 > \chi^2_{(J-1)(K-1),1-\alpha}$$

or if p-value $< \alpha$, where α is considered at generally 5% significance level. The following commands was inserted into R to obtain the χ^2 for the Treatment vs Delinquency table.

test =chisq.test (agg)

Yielding : $\chi^2 = 0.9200147$, p-value $= 0.3374711$. Thus, at the 0.05 level, we could not reject independence between Treatment and delinquency.

We also calculated the total inertial in this the case the ϕ^2 given by,

$$\phi^2 = \frac{\chi^2}{n} = 0.008141723$$

and applied this in R with

phi2=(test\$statistic)/sum(agg)

2.1.2   Results

Delinquency/Treatment

Contengency and frequency table

Our study of the 113 individuals with bipolar disorder shows us that only 43 of them claim to have committed a delinquent act that has been brought to justice against 70 individuals : this is what the table 2.1 shows us

TABLE 2.1 – Contingency table of the Delinquency in function of the regular take of a treatment

	Delinquency		
Treatment	No	Yes	Total
No	8	3	11
Yes	62	40	102
Total	70	43	113

In addition, the study shows that this delinquent act is accentuated in individuals undergoing drug treatment against the disorder, constituting 93 percent (see table) of individuals having committed this act, or 35 percent of all individuals (see table)

TABLE 2.2 – Frequency table of the Delinquency in function of the regular take of a treatment

	Delinquency		
Treatment	No	Yes	Total
No	0,071	0,027	0,097
Yes	0,549	0,354	0,903
Total	0,619	0,381	1

Row and column profiles

To establish the relationship of independence between the treatment and delinquency variable, the table of row profiles and column profiles tells us about the existence of independence between these variables.

TABLE 2.3 – Row profiles of the Delinquency in function of the regular take of a treatment

	Delinquency		
Treatment	No	Yes	Total
No	0,727	0,273	1
Yes	0,608	0,392	1

TABLE 2.4 – Column profiles of the Delinquency in function of the regular take of a treatment

	Delinquency	
Treatment	No	Yes
No	0,114	0,070
Yes	0,886	0,930
Total	1	1

Indeed, under the assumption of independence, one will assist the checking of equation 2.9 and 2.10 on the matrices of the row profiles and that of the column profiles respectively. The visualization of these matrices denotes an absence of independence between the treatment variable and the delinquency variable. Let's take our analysis further by performing a chi-square test on these data.

khi squared of independence

The conditions of application of the Chi-square test not being respected, we carried out the test and obtained the following results :

Pearson's Chi-squared test with Yates' continuity correction

data : aggregation X-squared = 0.20097, df = 1, p-value = 0.6539

Based on such a test result, the p-value being greater than the 10 percent threshold set, we would conclude on the independence between the treatment variable and the delinquency variable reported to justice.

Attraction Repulsion matrix The repulsion attraction matrix below shows

us that the modalities taking treatment (treatment yes) attract with the modalities delinquency (delinquency yes) while the modalities not taking treatment (treatment no) attract with the modalities. absence of delinquency (non delinquency).

TABLE 2.5 – Attraction Repulsion matrix of the Delinquency in function of the regular take of a treatment, with Khi squared of 0.001

	Delinquency	
Treatment	No	Yes
No	1,174	0,717
Yes	0,981	1,031

This matrix shows the influence of treatment on the delinquency of individuals with bipolar disorder. We can think that the end of the delinquent act in these individuals will come with a treatment which is not lasting.

Delinquency/Age

Contengency and frequency table

Bipolar disorder is a disease that affects virtually all age groups of the population. In our target population, individuals aged 16 to over 46 were questioned.

It emerges from the study that out of the 43 individuals who have committed delinquency reported to the courts, the majority are under 36 years old. These represent the 71 percent of individuals having committed a delinquent act brought before the courts (ie 27 percent of all individuals).

TABLE 2.6 – Contingency table of the Delinquency in function of the age

	Delinquency		
Age	No	Yes	Total
16-25	21	2	23
26-35	21	10	31
36-45	13	17	30
46-	15	14	29
Total	70	43	113

TABLE 2.7 – Frequency table of the Delinquency in function of the age

	Delinquency		
Age	No	Yes	Total
16-25	0,186	0,018	0,204
26-35	0,186	0,088	0,274
36-45	0,115	0,150	0,265
46-	0,133	0,124	0,257
Total	0,619	0,381	1,000

However, would age really have an influence on delinquency committed by individuals ? Let us examine the tables of row and column profiles of this contingency table.

Row and column profiles

TABLE 2.8 – Row profiles of the Delinquency in function of the age

	Delinquency		
Age	No	Yes	Total
16-25	0,913	0,087	1,000
26-35	0,677	0,323	1,000
36-45	0,433	0,567	1,000
46-	0,517	0,483	1,000

TABLE 2.9 – Columns profiles of the Delinquency in function of the age

Age	No	Yes
16-25	0,300	0,047
26-35	0,300	0,233
36-45	0,186	0,395
46-	0,214	0,326
Total	1,000	1,000

With regard to the table of row profiles and column profiles of we cannot conclude that the delinquency and age variables are not independent.

Let us rely on the chi-square test to be able to establish whether there is not an independence between these two variables.

khi squared of independence

Carrying out the chi-square independence test between the age and delinquency variable leads us to conclude on an absence of independence between these two variables at a very rigorous threshold of 1 percent (P-value = 0.002249). X-squared = 14.546, df = 3, p-value = 0.002249

Therefore, the age of the individual is a factor that can considerably influence the passage to the deviant act in an individual suffering from bipolar disorder.

Attraction repulsion matrix

Let's explore the repulsion attraction matrix to see the age groups most attracted to committing delinquent acts.Let's explore the repulsion attraction matrix to see the age groups most attracted to committing delinquent acts.

TABLE 2.10 – Attraction repulsion matrix of the variable Delinquency and Age, with a Khi-squared of 0.128

	Delinquency	
Age	No	Yes
16-25	1,474	0,229
26-35	1,094	0,848
36-45	0,700	1,489
46-	0,835	1,269

The repulsion attraction matrix between delinquency and age shows us that ages over 36 are attracted by the delinquency yes modality while ages under 35 are attracted by the delinquency no modality.

Delinquency/Delinquency not transferred to justice

next to delinquency brought back to justice we also have delinquency which is committed but not resorting to justice. In our studies against delinquency reported to justice, we note here that 71 individuals out of the 113 (i.e. 62 percent of all individuals) claim to have committed acts of delinquency that have not been transferred to justice.

TABLE 2.11 – Contingency table of the Delinquency in function of the delinquency not transferred to the justice

	Delinquency		
delinquency not transfered to justice	No	Yes	Total
No	30	12	42
Yes	40	31	71
Total	70	43	113

TABLE 2.12 – Frequency table of the Delinquency in function of the delinquency not transferred to the justice

	Delinquency		
delinquency not transfered to justice	No	Yes	Total
No	0,265	0,106	0,372
Yes	0,354	0,274	0,628
Total	0,619	0,381	1,000

Independence test : row profiles, column profiles and chi-square statistic

The analysis of row profiles and column profiles leads one to think of an independence between these two variables.

Indeed, this is observed through the chi-square statistic which leads us to accept the null hypothesis of independence between these two variables (p-value greater than 10 percent).

TABLE 2.13 – Row profiles of the Delinquency in function of the delinquency not transferred to the justice

	Delinquency		
delinquency not transfered to justice	No	Yes	Total
No	0,714	0,286	1,000
Yes	0,563	0,437	1,000

TABLE 2.14 – Column profiles of the Delinquency in function of the delinquency not transferred to the justice

	Delinquency	
delinquency not transfered to justice	No	Yes
No	0,429	0,279
Yes	0,571	0,721
Total	1,000	1,000

Pearson's Chi-squared test with Yates' continuity correction data : aggregation X-squared = 1.9494, df = 1, p-value = 0.1627

attraction Repulsion matrix

The repulsion attraction matrix between these two variables shows that the yes modalities of the two variables attract as well as the no modalities.

TABLE 2.15 – Attraction Repulsion matrix of the Delinquency in function of the delinquency not transferred to the justice, with a Khi squared of 0.017

	Delinquency	
delinquency not transfered to justice	No	Yes
No	1.1530612	0.7508306
Yes	0.9094567	1.1473960

Delinquency/Delinquency experienced

On another level the delinquency perceived in our study does not summarize that transferred or not to justice ; it also integrates the aspects of the delinquency suffered by ourselves.

Contingency table

In our sample, only 68 individuals out of the 113 claim to have suffered delinquency against 45 who claim not to have suffered delinquency.

TABLE 2.16 – Contingency table of the Delinquency in function of the delinquency experienced

	Delinquency		
Delinquency experience	No	Yes	Total
No	34	11	45
Yes	36	32	68
Total	70	43	113

TABLE 2.17 – Frequency table of the Delinquency in function of the delinquency experienced

	Delinquency		
Delinquency experience	No	Yes	Total
No	0,265	0,106	0,372
Yes	0,354	0,274	0,628
Total	0,619	0,381	1,000

Independence test : row profiles, column profiles and chi-square statistic

The analysis of row profiles and column profiles leads one to think of an independence between these two variables. Since marginal profiles are very different from row profiles and column profiles, we cannot assume that these variables are independent.

TABLE 2.18 – Row profiles of the Delinquency in function of the delinquency experienced

	Delinquency		
Delinquency experience	No	Yes	Total
No	0,7555556	0,2444444	1
Yes	0,5294118	0,4705882	1

TABLE 2.19 – Column profiles of the Delinquency in function of the delinquency experienced

Delinquency experience	Delinquency	
	No	Yes
No	0,4857143	0,255814
Yes	0,5142857	0,744186
Total	1	1

Indeed, the chi-square statistic which leads us to reject the null hypothesis of independence between these two variables (p-value below the threshold of 5 and 10 percent).

Pearson's Chi-squared test with Yates' continuity correction

data : aggregation X-squared = 4.9547, df = 1, p-value = 0.02602

Attraction Repulsion matrix

The repulsion attraction matrix between these two variables shows that the yes modalities of the two variables attract as well as the no modalities.

TABLE 2.20 – Attraction Repulsion matrix of the Delinquency in function of the delinquency experienced, with a Khi squared of 0.043

Delinquency experience	Delinquency	
	No	Yes
No	1,220	0,642
Yes	0,855	1,237

Delinquency/Deviance self-reproached

Contingency table and Frequency table

In a similar way to the previous one, the analysis of the relationship between delinquency reported to justice and deviance reproached by oneself shows us that : 97 individuals out of all 113 individuals blame themselves for deviant behavior that 'they may have committed.

TABLE 2.21 – Contingency table of the Delinquency in function of the deviance self-reproached

	Delinquency		
Deviance_self	No	Yes	Total
No	12	4	16
Yes	58	39	97
Total	70	43	113

TABLE 2.22 – Frequency table of the Delinquency in function of the deviance self-reproached

	Delinquency		
Deviance_self	No	Yes	Total
No	0,106	0,035	0,142
Yes	0,513	0,345	0,858
Total	0,619	0,381	1,000

Independence test : row profiles, column profiles and chi-square statistic

On the other hand, out of these 85 percent of individuals blaming themselves for a deviant act, only 40 percent claim to have committed a delinquent act which has been taken to court.

TABLE 2.23 – Row profiles of the Delinquency in function of the deviance self-reproached

	Delinquency		
Deviance_self	No	Yes	Total
No	0,750	0,250	1
Yes	0,598	0,402	1

TABLE 2.24 – Column profiles of the Delinquency in function of the deviance self-reproached

	Delinquency	
Deviance_self	No	Yes
No	0,17142857	0,09302326
Yes	0,82857143	0,90697674
Total	1	1

However, the analysis of the independence between these self-reproached deviations and the delinquency brought back to court leads us to accept the hypothesis of independence between these two variables with regard to row profiles, column profiles and chi-square statistics.

Pearson's Chi-squared test with Yates' continuity correction

data : aggregation X-squared = 0.77938, df = 1, p-value = 0.3773

Attraction Repulsion matrix

The repulsion attraction matrix between these two variables shows that the yes modalities of the two variables attract as well as the no modalities.

TABLE 2.25 – Attraction Repulsion matrix of the Delinquency in function of the deviance self-reproached, with Khi squared of 0.006

	Delinquency	
Deviance_self	No	Yes
No	1,2107143	0,6569767
Yes	0,965243	1,0565812

Delinquency/Deviance reproached by other

Contingency table

next to the self-reproaching deviance we also have the deviance reproached by others which could be put in relation with the delinquency brought back to justice.

TABLE 2.26 – Contingency table of the Delinquency in function of the deviance reproached by other

	Delinquency		
Deviance reproached by other	No	Yes	Total
No	24	7	31
Yes	46	36	82
Total	70	43	113

Just like self-blamed deviance, more than 70 percent of individuals claim to have committed a deviant act for which they have been blamed by others.

TABLE 2.27 – Frequency table of the Delinquency in function of the deviance reproached by other

	Delinquency		
Deviance reproached by other	No	Yes	Total
No	0,212	0,062	0,274
Yes	0,407	0,319	0,726
Total	0,619	0,381	1

Independence test : row profiles, column profiles and chi-square statistic

Viewing row and column profiles leads to an absence of independence between these two variables.

Thus we will push the analysis by a chi-square test on the contingency table.

TABLE 2.28 – Row profiles of the Delinquency in function of the deviance reproached by other

	Delinquency		
Deviance reproached by other	No	Yes	Total
No	0,774	0,226	1
Yes	0,561	0,439	1

TABLE 2.29 – Column profiles of the Delinquency in function of the deviance reproached by other

	Delinquency	
Deviance reproached by other	No	Yes
No	0,3428571	0,1627907
Yes	0,6571429	0,8372093
Total	1	1

The analysis of independence using chi-square statistics leads us to reject the null hypothesis of independence between the deviance variable criticized by others and the delinquency variable. At 90 percent confidence level we can accept the alternative hypothesis of lack of independence between these two variables.

Pearson's Chi-squared test with Yates' continuity correction

data : aggregation X-squared = 3.4811, df = 1, p-value = 0.06207

Attraction Repulsion matrix

The repulsion attraction matrix between these two variables shows that the yes modalities of the two variables attract as well as the no modalities.

TABLE 2.30 – Attraction repulsion matrix of the Delinquency in function of the deviance reproached by other, with Khi-squared of 0.03

	Delinquency	
	No	Yes
Deviance reproached by other		
No	1,250	0,593
Total	0,906	1,154

2.2 Conclusion

What we have found out from the independence analysis of the various variables are different links between the Delinquency reported to the justice and medical and social environment of the individuals. Particularly, we observed through our various attraction-repulsion matrices that there the following of a treatment may reduces the frequency of the delinquency observed for an individual. However, the absence of a treatment doesn't reinforce significantly the frequency of delinquency (i.e. the values in the matrix are quite close to 1).

If we look at the deviancy reproached by others as well as self-reproached, we clearly see that there is a clear link between the image an individual has of himself and the frequency of delinquency observed. Indeed, an individual that presents with no self-reproaching deviancies is less likely to commit a delinquency of any kind. Similarly, the image others have of an individual also plays a role in the delinquency recorded by the justice. An individual that doesn't experience judgment seems to be less likely to be caught by the justice for a delinquency.

Finally, we can also not that age plays a role in the frequency of delinquencies recorded. Contrary to common belief, it seems that for a bipolar individual, the age category of 36-45 years seems to be the one where delinquencies are most observed.

Furthermore, the age group of 16-25 years presents with a negative correlation, which means that in that age category, you are less likely to be recorded committing a delinquency.

What we have found out from the independence analysis of the various variables are different links between the Delinquency reported to the justice and medical and social environment of the individuals. Particularly, we observed through our various attraction-repulsion matrices that there the following of a treatment may reduce the frequency of the delinquency observed for an individual. However, the absence of a treatment doesn't seem to reinforce significantly the frequency of delinquency (i.e. the values in the matrix are quite close to 1).

The link between Delinquency and Delinquency experienced is quite interesting, since it shows that the past experiences sees to influence the current behaviours of individuals. Indeed in our Matrix there is a link between the Yes-Yes modalities and the No-No modalities. This could mean that being the victim of a delinquency or crime could induce a bipolar individual to act in the same

way. In the same way, it would seem that an individual that hasn't been a victim of a delinquent act is less likely to act in a delinquent way.

If we look at the deviancy reproached by others as well as self-reproached, we clearly see that there is a link between the image an individual has of himself and the frequency of delinquency observed. Indeed, an individual that presents with no self-reproaching deviancies seems to be less likely to commit a delinquency of any kind. Similarly, the image others have of an individual also plays a role in the delinquency recorded by the justice of that same individual. A person that doesn't experience judgment is less likely to be caught by the justice for a delinquency.

Finally, it seems that age plays a role in the frequency of delinquencies recorded. Contrary to common belief, it seems that for a bipolar individual, the age category of 36-45 years seems to be the one where delinquencies are most observed. Furthermore, the age group of 16-25 years presents with a negative correlation, which could mean that in that age category, you are probably less likely to be recorded committing a delinquency.

In the end, these analyzes of independence between these variables and our target variable, which is delinquency, will lead us to mainly retain five for our MCA. These variables are those which are asymptotically linked to delinquency (treatment, age, delinquency suffered and deviance reproached by others).

Chapitre 3

Multiple Correspondence Analysis (MCA), Delinquency reported to the justice

In our sample of the population we already have done independence analysis, so we'll use the variables for which are coherent to analyse the delinquency reported to justice. We want to know how the variables Age, Treatment, Delinquency experienced and Deviance reproached by other, may be related to the Delinquency.

To answer the following questions : How the variables react with each other ? How the delinquency is determined by this factors ? The realisation of a Multiple Correspondence Analysis may satisfy our demands.

The presentation of our variables can be see in the Table 3.1.

TABLE 3.1 – Description of the variables used for the MCA.

Variables	Modalities
Age	16-25
	26-35
	36-45
	>46
Treatment	Yes
	No
Delinquency experienced	Yes
	No
Delinquency	Yes
	No
Deviance reproached by other	Yes
	No

3.1 Preliminary analysis

The first thing to do is to create a contingency table on the variables we have. We did so with the utilisation of the following package and commands on R.

library(dummies)
dummy.data.frame()

The table 3.2 gives a preview of the contingency table, the five first row. This table is composed of 12 columns and 113 rows.

Now that we have the contingency table we could make an attraction repulsion table, and in our case we have too many individuals (113), and therefore it would be to difficult to interpret the results. We will also not do the row profiles for the same reason as the other analysis, also because our goal is to analyse the variables.

TABLE 3.2 – First five rows of the contingency table created with R

Variables	Age				Treatment		Delinquency experienced		Delinquency		Deviance reproached by other	
Modalities	16-25	26-35	36-45	>46	Yes	No	Yes	No	Yes	No	Yes	No
1st row	0	0	1	0	0	1	0	1	0	1	0	1
2nd row	0	0	1	0	0	1	0	1	0	1	0	1
3rd row	0	0	0	1	0	1	0	1	0	1	0	1
4th row	0	0	1	0	0	1	0	1	0	1	0	1
5th row	0	1	0	0	0	1	0	1	0	1	0	1

3.1.1 Studying the categorical variables : Table of column profiles

The column profiles c_{pl} of the l modality of the variable Y_p is defined as :

$$(c_{pl})_i = \frac{f_{ipl}}{f_{.pl}} = \frac{x_{ipl}}{n_{pl}} \tag{3.1}$$

where n_{pl} is the total effective of a variable, so for example if we look at the variable Delinquency for the modality "yes" we will have $n_{pl} = 43$ (because 43 individuals said "yes" to this question), and :

$$x_{ipl} = \begin{cases} 1 & \text{if the individual have the modality } p \\ 0 & \text{otherwise } 1 - p \end{cases} \tag{3.2}$$

The column profiles were obtain with the following code R, the **t()** function permit to have the transpose of the matrix and **colSums()** make of the columns.

columnprofiles=t(data)/colSums(data)

The table 3.3 represent the five first column of the Column profil.

TABLE 3.3 – Column profiles obtain with the contingency table

Age				Treatment		Delinquency		Delinquency_experience		Deviance_by_other	
16-25	26-35	36-45	46-55	No	Yes	No	Yes	No	Yes	No	Yes
0,00E+00	0,00E+00	3,33E-02	0,00E+00	0,00E+00	9,80E-03	0,00E+00	2,33E-02	0,00E+00	1,47E-02	0,00E+00	1,22E-02
0,00E+00	0,00E+00	3,33E-02	0,00E+00	0,00E+00	9,80E-03	0,00E+00	2,33E-02	0,00E+00	1,47E-02	0,00E+00	1,22E-02
0,00E+00	0,00E+00	0,00E+00	3,45E-02	0,00E+00	9,80E-03	0,00E+00	2,33E-02	0,00E+00	1,47E-02	0,00E+00	1,22E-02
0,00E+00	0,00E+00	3,33E-02	0,00E+00	0,00E+00	9,80E-03	0,00E+00	2,33E-02	0,00E+00	1,47E-02	0,00E+00	1,22E-02
0,00E+00	3,23E-02	0,00E+00	0,00E+00	0,00E+00	9,80E-03	0,00E+00	2,33E-02	0,00E+00	1,47E-02	0,00E+00	1,22E-02

3.1.2 Khi squared distance from the centre of gravity

The center of gravity can be calculated for the rows or column profiles. In our case, we want the center of gravity of the column profiles. So we calculate the centre of gravity of the column profile $G_c \in R^n$, with n the number of individual we have in our sample :

$$G_c = \left[\frac{1}{n} \ldots \frac{1}{n}\right]' \in R^n \tag{3.3}$$

In our case the center of gravity is equal to $\frac{1}{113}$. And we saw in the course that the distance between the center of gravity (G_c) and a modality (C_{pl})are given by the equation (3.4) and the results are in the Table 3.4.

$$d_{\chi^2}^2 (C_{pl}, G_c) = \sum_{i=1}^{n} n \left((c_{pl})_i - \frac{1}{n} \right)^2$$
$$= \frac{n}{n_{pl}} - 1 \tag{3.4}$$

TABLE 3.4 – Khi squared distance between the center of gravity and the modalities for the MCA

Variables	Age				Treatment		Delinquency experienced		Delinquency		Deviance reproached by other	
Modalities	16-25	26-35	36-45	>45	No	Yes	No	Yes	No	Yes	No	Yes
$d_{\chi^2}^2 (c_{pl}, c_{qm})$	3,913	2,645	2,767	2,897	9,273	0,108	1,511	0,662	0,614	1,628	2,645	0,378

We can see that the modalities the less represented are the interval of 16-25, the Treatment not taken regularly, the not experienced delinquency and the deviance reproached by other which didn't occurs. The Delinquency are more or less at the same distance (1,6 and 1,5) (Table 3.4).

3.1.3 Distance between modalities

The distances between modalities are given by $d_{\chi^2}^2$:

$$d_{\chi^2}^2 (c_{pl}, c_{qm}) = n \sum_{i=1}^{n} \left(\frac{x_{ipl}}{n_{pl}} - \frac{x_{iqm}}{n_{qm}} \right)^2 \tag{3.5}$$

where l is the modality of the variable p and m is the modality of the variable q. Which give us the Table 3.4

The R text bellow was made to do the calculation of the distance between the modalities.

```
dist.chisquare <- function(M)
M <- as.matrix(M)
m <- ncol(M)
out <- matrix(NA, ncol=m, nrow =m)
for(j in 1 :(m))
for(i in 1 :(m))
out[i,j] <-
n*sum(((M[j,]/colSums(M))-(M[i,]/colSums(M)))^2)
Out <- matrix(NA, nrow=m, ncol=m)
Out[lower.tri(Out)] <- out[lower.tri(out, diag=TRUE)]
colnames(Out) <- colnames(M)
as.dist(Out)
```

TABLE 3.5 – Distance of the Khi squared between the modalities

		Age				Treatment		Delinquency		Delinquency experienced		Deviance reproached by other
		16-25	26-35	36-45	46-55	No	Yes	No	Yes	No	Yes	No
Age	26-35	0.00	/									
	36-45	0.00	1.20	/								
	46-55	0.25	0.00	0.24	/							
Treatment	No	0.00	0.25	1.20	0.24	/						
	Yes	0.24	0.00	0.00	1.20	0.08	/					
Delinquency	No	0.94	0.24	0.25	0.00	0.25	0.13	/				
	Yes	1.28	0.94	0.25	0.25	0.944	0.34	0.24	/			
Delinquency experienced	No	0.00	1.28	1.20	0.24	1.20	0.33	0.944	0.259	/		
	Yes	0.13	0.00	1.29	0.94	0.00	1.08	0.00	1.37	/		
Deviance reproached by other	No	0.34	0.13	0.25	1.28	1.18	1.19	1.28	1.2839	1.27	0.00	/
	Yes	0.24	0.34	0.39	0.00	1.27	0.00	1.18	1.41	0.347	0.13	0.34

This distance calculated with the equation (3.5) depend not only on the distance of the modalities but also on their frequencies.

But seeing this table we may have an idea of the relation between the variables. A lot of the modalities are really close, so close it's seems that there are no distance between them, but that might be due to the fact that some of the modalities frequencies are low.

Relation between age and Treatment

The distance between the modalities Treatment-No and Age-16-25 is of 0. But the distance between the modalities Treatment-Yes and Age-26-35 and 36-45 are also 0. It's seem that the take of a Treatment regularly depends on the age of the person. But after 45 the distance with the modality treatment-yes, increases again.

So, the take of a treatment regularly may happen during the 26 to 45 phase of a life of a person with bipolar disorder. It might by less probable that the

person under 25 and over 45 years have a regular treatment. The treatment for bipolar disorder is supposed to balance the mood, and it is really difficult to evaluate the treatment because each patient react differently to the doses and different molecules. So it might be because in the early phase of the diagnostic the person change the treatment and after 45 the person is more calm and have learned to balance her/his/them moods.

Relation between Delinquency experienced and Delinquency

The distance between the modalities Delinquency experienced-yes and delinquency-yes is really close to 0, it may be interpreted as all the persons in our sample had experienced delinquency had also committed one which was transferred to the justice. We already know from the previous Khi squared of independence analysis that the variable were dependant.

It might also be due by the fact that in our sample there were more individuals which experienced delinquency then individuals which did a delinquency. The modalities No and No for this two variables have a higher distance between them (0.944).

This results may imply that, the experienced delinquency may trigger a delinquency, but if there is no delinquency experienced the person might anyway commit one, maybe depending on other variables.

Relation between Deviance reproached by other and Treatment

The relation between this two variables seem to implies that the "yes" modalities are dependent, we have a distance of 0 for this two variables too. In a way anyone which have been reproached of deviant behaviour take a regular treatment. The "no" modalities are distant from each other (1,27) as well as the "yes-no" modalities (1,18 and 1,19).

This would mean that a regular take of a treatment and the deviance reproached by other, are dependent in the way that most a the person which were reproached a deviant behaviour

This would mean that a regular take of a treatment and the deviance reproached by other, are dependent in the way that most a the person which were reproached a deviant behaviour is taking a regular treatment. But the fact that the frequencies for the modality treatment-no is low might play a role in theses results.

3.1.4 Calculating the Total Inertia

The Total Inertia of our point cloud can be calculated easily with the equation (3.6)

$$I_{\chi^2}\left(N_c, G_c\right) = \sum_{p=1}^{P} \sum_{l=1}^{K_p} f_{.pl} d_{\chi^2}^2\left(C_{pl}, G_c\right) = \frac{K}{P} - 1 \qquad (3.6)$$

With K the number of modality and P the number of variables, so we have $\frac{K}{P} - 1 = \frac{12}{5} - 1 = 1,4$. This values measure the dispersion with respect to the center of gravity of our point cloud. We would expect a rather small cloud of point.

With R, the command CA() takes the 5 first dimension automatically for the graphical component.

3.1.5   The Burt table

The fact that we are more interested in linking the variables that the individuals, and that we have 113 individuals. We will consider the Burt table for the following analysis.

The Burt Table (Table 3.6) was made with the following R code :

library(GDAtools)
data_mca = burt(data)

The data file here is the one we used to make the contingency table.

TABLE 3.6 – Burt table obtain the variables chosen for the MCA

		Age				Treatment		Deliquency		Delinquency experienced		Deviance reproached by other	
		16-25	26-35	36-45	>45	No	Yes	No	Yes	No	Yes	No	Yes
Age	16-25	23	0	0	0	6	17	21	2	7	16	7	16
	26-35	0	31	0	0	1	30	21	10	13	18	10	21
	36-45	0	0	30	0	1	29	13	17	11	19	9	21
	>45	0	0	0	29	3	26	15	14	14	15	5	24
Treatment	No	6	1	1	3	11	0	8	3	1	10	1	10
	Yes	17	30	29	26	0	102	62	40	44	58	30	72
Delinquency	No	21	21	13	15	8	62	70	0	34	36	24	46
	Yes	2	10	17	14	3	40	0	43	11	32	7	36
Delinquency experienced	No	7	13	11	14	1	44	34	11	45	0	15	30
	Yes	16	18	19	15	10	58	36	32	0	68	16	52
Deviance reproached by other	No	7	10	9	5	1	30	24	7	15	16	31	0
	Yes	16	21	21	24	10	72	46	36	30	52	0	82

### 3.1.6   Factorial analysis on the Burt Table

We applied an MCA on the Burt table. We used the following R code :

library(FactoMineR)
mca=CA(data_mca)

3.1.7 Eigenvalue and Percentage of Inertia

First we have analysis the Eigenvalues that we plot (Fig. 3.1), to determined the number of dimension to keep, we should base our-self on the fact that we should retain a principal component only if the eigenvalue associated is higher then 1/number of variable, which is equal in our case to 0.2. But under 0.05 the eigenvalue is considered as noise and in our case the highest eigenvalue are at 0.08. So we considered a threshold at 0.05 and any value below the principal component will not be taken.

FIGURE 3.1 – Eigenvalues obtain with the MCA
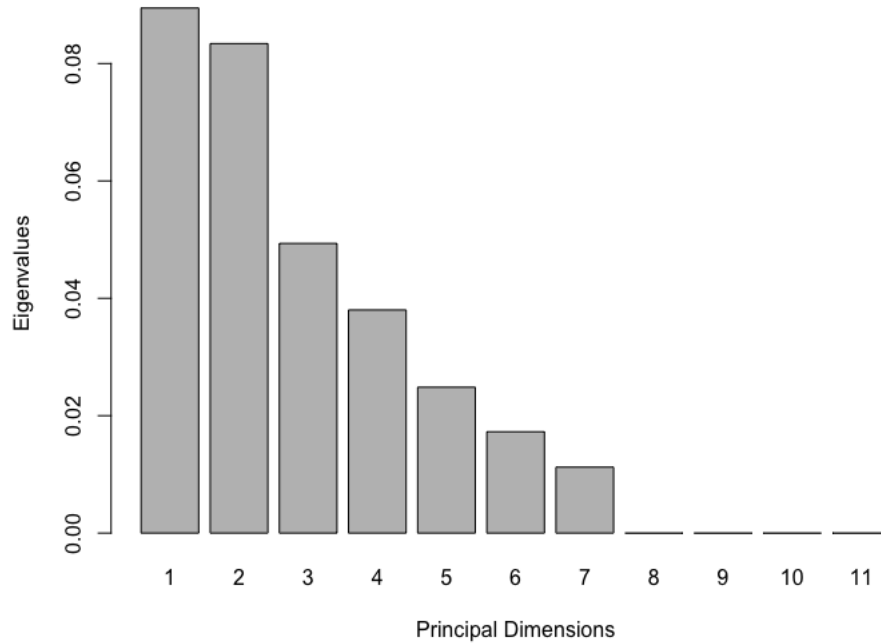
So we keep our first two dimensions and we can see that, the 55% of the Inertia is explained by the first two axes. This result might be because we only had 1.4 of Total Inertia. And the fact that have 113 individuals does not allow us to be spared of rare modalities. That's the reason why we decided diminish the data base, to 12 variables. And the choices of this variables were determined by the literature on the subject.

TABLE 3.7 – Eigenvalues, Percentage of Inertia and Cumulative Inertia for each dimension, for the MCA realised on our data.

Dimension	Eigenvalues	% of variance explained by the axes	Cumulative variance
dim 1	0.083	28,5	28,5
dim 2	0.083	26,6	55,1
dim 3	0.049	15,7	70,9
dim 4	0.038	12,1	83,0
dim 5	0.024	7,9	90,9
dim 6	0.017	5,5	96,4
dim 7	0.011	3,6	100,0

3.1.8   Contribution to the Inertia

To understand the relation between the modalities and their representation on the dimension we have to calculate the contribution to the inertia (CTR_{Γ_h})of the column profiles. The contribution is given by :

$$CTR_{\Gamma_h}\left(X_{pl}\right) = \frac{n_{pl}}{nP\lambda_h}\psi_{h,pl}^2 \tag{3.7}$$

where $psi_{h,pl}^2$ represent the principal component for the axe h and the modality l of the variable p, and P is the number of variables. The following command have been used to calculate the contribution (Table 3.8).

library(FactoMineR)
contrib=(mca\$col\$contrib)

The modalities that contribute the most to the inertia of the first dimension are the 16-25 for the Age (20%), and the yes (28%) and no (17%) modalities of the variable Delinquence, which we want to understand.

For the second dimension the 3 modalities to contribute the most are the 16-25 (13%), the yes for delinquency (15%) and the no for treatment (35%).

These modalities will be the modalities that are the most well represented depending on the dimension. For example, the modality no for treatment will be well represented on the second dimension.

TABLE 3.8 – Contribution to Inertia of the first two dimensions

	Dimension	dim 1	dim 2
	16-25	20,94498	13,20568
Age	26-35	0,745462	6,218842
	36-45	9,696096	1,036551
	>45	3,244737	0,142553
Treatment	No	3,586648	35,3738
	Yes	0,386795	3,814822
Delinquency	No	17,65808	0,353214
	Yes	28,74572	0,575
Delinquency experienced	No	2,74926	15,0534
	Yes	1,819363	9,961807
Deviance reproached by other	No	7,563488	10,35111
	Yes	2,859367	3,913226

3.1.9   Quality of representation

Concerning the quality of representation of the modalities are globally well represented. However, there are some modalities that are not well represented on the two dimensions : -For the first dimension, the modalities : for the Age 26-35 and >45, and the two modalities for the variable Treatment and the Delinquency experienced. Which represent 6 of 12 modalities.

-For the second dimension, the modalities : for the Age 36-45 and >46, and the two modalities for the variable Delinquency.

The only variable which is not well represented on the two dimensions is the age >46, it might be because this modalities represent 2 groups of persons, the one between 46 and 54, and the one over 54 years.

TABLE 3.9 – Quality representation of the modalities in our MCA

	Dimension	dim 1	dim 2
Age	16-25	0,497653	0,292532
	26-35	0,022332	0,173691
	36-45	0,275213	0,02743
	>45	0,093523	0,003831
Treatment	No	0,077022	0,708229
	Yes	0,077022	0,708229
Delinquency	No	0,847544	0,015806
	Yes	0,847544	0,015806
Delinquency experienced	No	0,090995	0,464518
	Yes	0,090995	0,464518
Deviance reproached by other	No	0,214517	0,273712
	Yes	0,214517	0,273712

3.1.10   Graphical representation

The graphical representation of our modalities as we can see is mostly distributed on the second dimension because of the modality No for treatment. The >46 modality will not be interpret because it's not well represented on both the axes. The Total Inertia was low when we calculated it, and we can see that there is not so much Inertia in the graphic (Fig. 3.2).

FIGURE 3.2 – Multiple Correspondance Analysis (MCA) graphic
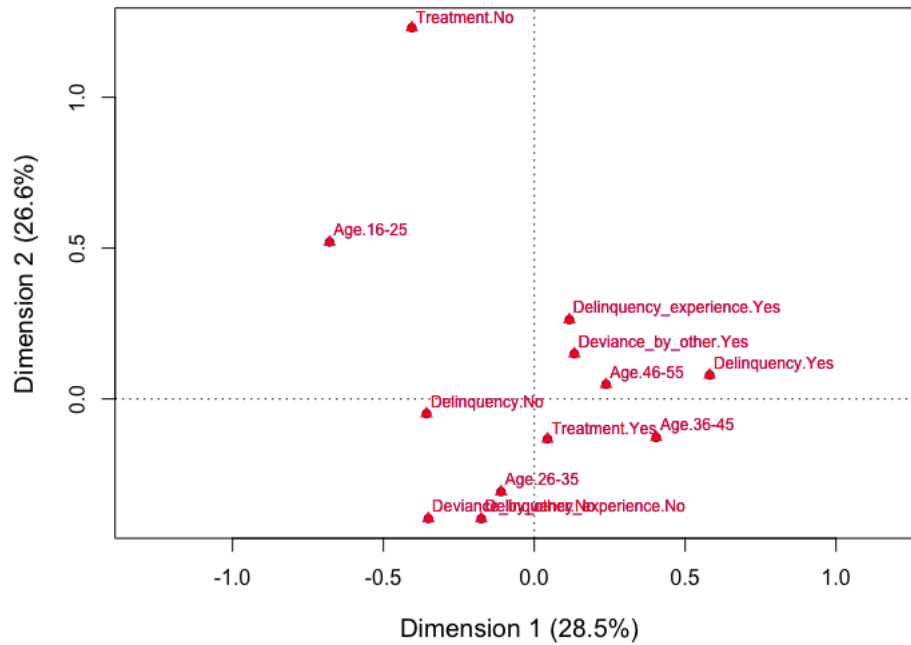
3.1.11   Axe interpretation

As underlined in the previous chapter, the yes modalities of the different variables retained tend to attract each other. In addition, we note that our first axis is strongly associated with the practice of delinquent and / or deviant acts. The delinquency variable strongly contributes to this axis. In fact, the characteristic features of bipolar individuals who have committed a delinquent act brought back to justice are age (individuals aged 36 and over), whether or not they took their treatment and their antecedent in terms of delinquency and deviance not having been taken. not subject to legal action.

Globally it does seem that the yes or no question are represented by the first dimension, even if the quality of representation was low for the delinquency experienced with the first dimension. In fact the major modalities that contribute to the Inertia of the first dimension are the modalities of the variable Delinquency. And we saw earlier in the analysis that all the variable we choose for the MCA are dependent of the Delinquency.

The second dimension seems to be determined by the modality no of the variable Treatment, and because of a few proportion of no for this modality, it may be the reason why we have this disparity with the second dimension.

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The age modalities are for most of them not well represented and doesn't contribute to the Inertia except for the interval 16-25, which contribute to 20% of the Inertia of the first dimension.

3.2 Conclusion

Our ACM analysis yields us some interesting results concerning the quality of our hypothesis concerning the variables we decided to use. Firstly, we must discuss the number of dimensions yielded by our ACM. The number of dimensions is limited by the minimum of modalities minus 1, thus our model gives us a total of 11 dimensions. We have decide to keep the first two dimensions with eigenvalues 0.083 and 0.083 with explains a total of 55.1 percent of the Total Inertia of the cluster of points. We have 28.5 explained by the first dimension and 26.6 by the second. It is noteworthy that the next dimension only explains an additional percentage of 15.7.

Furthermore, we can justify the choice of two dimensions by the contribution to the Inertia of each modality shown in Table 3.8. With only one dimension, we can see that we would lose a lot of contribution in the modality "No" of Treatment. The same can be said about both modalities in Delinquency experienced, as well as the modality "No" in Deviance reproached by others, which adds 10 points to the existing 7.5 almost doubling the contribution to Inertia for that variable.
However, variables like Delinquency have almost the entirety of their contribution to Inertia represented in the first dimension. The second dimension for Delinquency adds virtually no additional contribution to Inertia.

As for the quality of representation of the modalities, the choice to keep two dimensions seems very logical. Although the modalities for the variable Delinquency find a 0.84 quality in dimension 1 and almost nothing in dimension 2, other variables like Treatment are the complete opposite. Indeed, the modalities of Treatment find the majority of their quality of representation in the second dimension (i.e. 0.08 in dim 1 against 0.71 in dimension 2). For other variables, the quality is more evenly distributed between the two dimensions. In fact, the modalities of Deviance reproached by others are split almost evenly between the two dimensions (0.21 in dimension 1 against 0.27 in dimension 2). The modalities in the variable Age, are more heterogeneous as per their quality representation. Whereas the modality 16-25 years has a total quality of almost 0.80 over the two dimensions, the modality >45 years only yields a quality of 0.09 for the two dimensions. The two middle modalities are unevenly distributed amongst the two dimensions.

The graph in Figure 3.2 gives us a scatterplot of the points following the two first dimensions. The points are distributed in four different quadrants (quadrant 1 is the top left one, quadrant 2 is the top right one, quadrant 3 is the lower right one and quadrant 4 is the lower left one. Points in the same quadrant have a positive correlation whereas points in diagonally opposite quadrants have negative correlations.

Chapitre 4

Conclusion

4.1 Relation between variable

As shown in our analysis of the independence between variables, the khi-squared tests we performed on the various variables give insight into the dependency of the variables. Our goal in this paper was to find out if there exists a link between deviancy and delinquency, as well as the effect of certain factors on the frequency of delinquency in the population of bipolar individuals.

All in all, we can confidently say that there is a link between delinquency and deviancy. However, the link exists for a deviancy that is either self-reproached or reproached by others, which implies a social factor and not simply the existence of a deviancy. Furthermore, the khi-squared tests show that age also has a link with delinquencies for individuals affected by bipolarity. The positive correlation exists for ages greater than 45. The 16-25 years age category actually shows a negative correlation with delinquency.

The effect of a treatment was quite interesting, since the presence of a treatment almost nullified the acts of delinquency, however the lack of a treatment yielded no significant result. We also saw that the treatment is related to the age of the individuals.

4.2 The delinquency reported to the justice explained trough the analyses

We decided to perform our ACM four factors (Treatment, Delinquency reported to Justice, Delinquency experienced, Deviance reproached by others) with two modalities ("Yes" or "No") and one factor (Age) with four modalities (16-25, 26-35, 36-45, >45). We made the choice to keep two dimensions in which the variables were described and interestingly the variable Delinquency reported to justice was virtually entirely explained in dimension 1 whereas all the other factors were split (sometimes evenly, sometimes not) between the two

dimensions with regards to Quality of Representation and Contribution to Total Inertia. There is still variation to find and it would be great to have more information.

4.3   critique on data analysis

There are a lot of imperfections in our analysis, first of all we didn't realize that some of the factors were nested, like the consummation of drugs which was the drugs consumed during the delinquency or deviant behaviour or the phases, which would lead to the diminution of our database. We runs a lot of Khi squared test before choosing the variables we used here. The Survey was problematic in a way that first of all, we do not have a sample that is representative of the population, indeed the proportion of women and men was not representative of the bipolar disorder population. This disorder affect both women and men. Although it's representative in the age variable, because we had more or less 20% of the population in the 4 first of the categories. But we combined the last two ones because if we didn't we would have some problems with the Khi squared test. The selection of variables was difficult because of these nested factors and so we decide to only show a description of what might influence the behaviour of a bipolar person.

Instead of asking if the person was under the influence of drugs during the delinquency, maybe a more global question about the consummation a person, could be favorable for this kind of analysis.

We could have taken the frequencies of the Delinquencies, which would have increase the number of modalities and so the degree of freedom of our tests, the problem was that by taking the frequencies we would have 43 individuals lefts and the rest would be "NA" (No answer) which are difficult to dealt with during this kind of analysis.

Bibliographie

[1] *Maladie Bipolaire, (Leonhardt, K.).* Académie de Médecine, consulté le 02/12/2021. Dictionaire de Médecine en ligne, édition 2018.

[2] American Psychiatric Association. *Diagnostic and statistical manual of mental disorders : DSM-IV.* Autor, Washington, DC, 4th ed. edition, 1994.

[3] Jean-Michel Aubry, Sébastien Weibel, and Gilles Bertschy. 6. États mixtes : de la dépression mixte à la manie dysphorique. In *Les troubles bipolaires*, Psychiatrie, pages 43–51. Lavoisier, 2014.

[4] Marc-Louis Bourgeois. 5. manie aiguë. In *Les troubles bipolaires*, Psychiatrie, pages 31–42. Lavoisier, 2014.

[5] Michel Bénézech and Patrick Le Bihan. 31. troubles graves de l'humeur et criminalité violente. In *Les troubles bipolaires*, Psychiatrie, pages 231–239. Lavoisier, 2014.

[6] Philippe Courtet, Sébastien Guillaume, and Émilie Olié. 29. troubles bipolaires et risque suicidaire. In *Les troubles bipolaires*, Psychiatrie, pages 214–219. Lavoisier, 2014.

[7] Marc-Antoine Crocq. 1. troubles maniaco-dépressifs et bipolaires : historique du concept. In *Les troubles bipolaires*, Psychiatrie, pages 1–9. Lavoisier, 2014.

[8] Julien De Carvalho and Rachel Lipson-Glick. 56. prise en charge des troubles bipolaires aux urgences. In *Les troubles bipolaires*, Psychiatrie, pages 420–431. Lavoisier, 2014.

[9] Arianna Diflorio and Ian Jones. Is sex important ? Gender differences in bipolar disorder. *International review of psychiatry (Abingdon, England)*, 22(5) :437–452, 2010. Place : England.

[10] Thomas Mauras, Marc Masson, and Christian Gay. 55. Traitement de maintenance des troubles bipolaires. In *Les troubles bipolaires*, pages 407–419. Lavoisier, 2014.

[11] Bruno Müller-Oerlinghausen, Anne Berghöfer, and Michael Bauer. Bipolar disorder. *The Lancet*, 359(9302) :241–247, 2002.

[12] Sarah Sportiche, Marine Delavest, and Jean-Pierre Lépine. 33. Principales données épidémiologiques dans le trouble bipolaire. In *Les troubles bipolaires*, Psychiatrie, pages 251–256. Lavoisier, Cachan, 2014.

Chapitre 5

Appendix

.1
Questions of the survey corresponding to the variables.

We will not do the question for age and gender which are trivial.

Delinquency : Have you ever been in trouble with the law ?

Co-morbidity : Associated comorbidities ? Comorbidities (if you ticked yes in the previous question) (multiple choice)

Phases : According to you or the doctor, at the time of the event, what stage of the disease were you in ?

Drugs (Alcohol, illegal, ect..) : Were you under the influence of a substance at the time of the incident ? If so, what type ?

Delinquency not transferred to the justice : Have you ever been involved in any behaviour that could be punished by law but for which you have not been prosecuted ?

Delinquency experienced : Have you ever been subjected to any form of delinquency by others ?

Deviance self-reproached : Have you ever behaved in a way that you consider, with hindsight, to be deviant towards yourself or others ?

Deviance reproached by other : Have you ever behaved in a way that other people have criticised you for because they considered it deviant ?

.2
Description and Definition of our variable

In total, 21 variables were retained for the analysis. These variables provided information on the state of the person with regards to what bipolar stage they were in. A presentation of these variables is given below ;

- Gender

This variable gave information to which sex the individual belonged to. Here, the sexes considered were male and female.

- Age

Age was classified with a difference of 5 years into 5 groups and starting from the age of 16.

- Treatment

From this variable, it was possible to tell the treatment status of any particular individual

- Delinquency

Here, minor offences were examined and from which it was possible to tell whether an individual had delinquent behaviors.

- Phase

Here, it was possible to examine at what phase any particular individual was at. The phases here included; light/moderate/severe depression, mania, euthimia, hypomania, mania, melancholy, mixed. Some individuals did not know at what phase they were in as such, classified as "Do not Know" otherwise NA.

- Delinquency transferred to justice

Acts stemming from delinquent behaviors and requiring the intervention of the justice department were recorded. From this, it was possible to tell if an individual had ended up at the hands of the justice department.

- Delinquency not transferred to justice

Acts stemming from delinquent behaviors and requiring the intervention of the justice department were recorded. From this, it was possible to tell if an individual did not end up at the hands of the justice department.

- Self-reproached deviance This variable looked at individuals who criticized and disaproved themselves for haven committed deviant acts.

- Deviance by others Here, the individual is noted as haven suffered or encountered deviant acts from other people due to their bipolar nature.

- Personality disorder

This is typically considered as a mental disorder with an individual having a rigid and unhealthy pattern of thinking, functioning and behaving. Such an individual has trouble perceiving and relating to situations and people.

- Eating disorder

This is commonly referred to as mental disorder with an individual practicing abnormal eating habits that affects a person's mental and physical health.

- Other psychiatric disorder

This variable as pertaining to the survey questions noted whether or not the person suffered extra disorders that had not been posed.

- Anxiety disorder

This refers to mental health disorder often characterized by feelings of worry, fear that are strong enough to interfere with one's daily activities.

- Attention disorder

This could also be referred to as attention deficit disorder referring to a condition with attention difficulties. It contributes to low self-esteem, troubled relationships and difficulty at school or work.

- Addictions

Addiction is also a disorder where an individual engages in activities/acts which are rewarding to their emotional state despite the adverse consequences of such acts.

- Alcohol

This explained whether the individual was alcoholic or not. Given that someone under the influence of alcohol is more liable to portray deviant behavior

- Prescribed medication A bipolar individual who is under prescribed medication has the potential to have his/situation under control and with this, it is possible to see to what extent medication helps at avoiding delinquencies or deviant acts.

- Illegal hallucinogenic drugs These are drugs that alter a person's thinking process and the overall perception of reality and for which a law is made annulling their consumption.

- Illegal excitant drugs These are drugs that can be used to quickly enhance physiological and psychological activity.

- No prescribed drugs This variable was intend ended to verify individuals who were consuming non medically prescribed drugs.