

USING NETWORK COMMUNITY DETECTION TO INVESTIGATE PSYCHOLOGICAL AND SOCIAL FEATURES OF INDIVIDUALS CONDEMNED FOR MAFIA CRIMES

Chiara Capri, Salvatore Micciché, Lucia Sideli, Daniele La Barbera

Abstract

Objective: Only few studies have investigated social and personality characteristics of members of Italian organized criminal groups: Mafia, Camorra, 'Ndrangheta, and Sacra Corona Unita. This study aimed to explore the most relevant social and clinical features of Mafia criminals and their psychopathic traits.

Method: The Psychopathy Check List-Revised (PCL-R) and a socio-demographic questionnaire were administered to 30 condemned for Mafia crimes and imprisoned in the "Pagliarelli" district prison of Palermo (Italy). The results were investigated applying the methods of Network Theory.

Results: The study identified two communities, which were statistically different in terms of history of juvenile delinquency, levels of education, and antisocial and deviant behaviours score at PCL-R.

Conclusions: The onset of antisocial behaviour and educational achievement might be relevant variables in understanding mafia offences, as well as antisocial behaviours in general. Moreover, methodologies of Network Theory may be used to characterize real-world complex systems of sociological and clinical dates.

Key words: psychopathy, mafia, deviance, antisocial behaviour, network theory, organised crime, criminal organisation

Declaration of interest: ??

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Introduction

Psychological and social risk factors for criminal behaviour have been extensively studied (Patterson et al. 1989, Martens 2000). However, less is known about psychological, psychopathological, and social characteristics of the members of large organized criminal groups, such as, in Italy, Mafia, Camorra, 'Ndrangheta, and Sacra Corona Unita.

Mafia activities are characterized by an underlying organization providing inputs, expertise and support for committing crimes. In other words, Mafia crimes are not planned and performed by isolated individuals, but by people involved in a social, albeit criminal, context characterized by specific values, code of conduct, and a peculiar way of thinking, conceiving social relationships, and communicating skills (Di Maria and Di Novo 1984, Mannino and Giunta 2015). Many studies in the literature point out that Mafia members develop their personal identity within close family groups, are brought up under values of honour, manhood, silence, and a disregard for the State, its laws and authorities. This identity homogenization prevents members of the organization from getting in touch with any alternative way of thinking, feeling, and acting; psychic and cultural diversity are not tolerated and there is a large presence of family secrets (Lo Verso 1998). Moreover,

for some authors Mafia and specifically Cosa Nostra has a fine strategy: it exploits the weaknesses of the human soul, a "primary narcissism" to become the only State, "where everything is already written, where there is no space for the other, for the different, for new things, for freedom, for the human" (Mannino and Giunta 2015). Before being accepted in the organization, teens grown up in Mafia families are required to demonstrate resolution, self-control, and ruthlessness and eventually they must be able to control their emotions during and after the crime (Lo Verso 2013, Lo Verso et al. 2015). However, it must be emphasized that, the relevance of psychological factors, such as emotions, in the Mafia context is a debated point. In fact, Schimmenti et al. (2014) and Caretti et al. (2013) found that Mafia affiliates are less unemotional than other criminals. As we will see in the Results section, our results confirm that such psychological factors play a minor role in the determining the personality traits of Mafia affiliates.

On the other hand, similarly to individuals with high psychopathic traits, most of the people belonging to Mafia were described as remorseless, insensible, pitiless, and cruel (Lo Verso and Lo Coco 2004). However, a recent study found that Mafia members showed lower level of the interpersonal/affective component of psychopathy (assessed using the Psychopathy Checklist-Revised) than other inmates convicted for non-Mafia crimes

(Schimmenti et al. 2014). This might depend on the fact that Mafia offences are, by definition, “associative offences”, meaning that they are implemented by individuals who act as part of a “family”, which is a group of individuals who share common authorities, aims, rules, and rituals, and are tied to each other by mutual loyalty, which prevents personal initiatives and external relationships. To become a “Mafioso” there is a need to take an oath: «It shows that the mafia is not only an individual manifestation of an instinctive tendency to bully people, but it is instead a sect with a life of its own, which operates in the shadows» (Dickie 2011, p. 102-103). Moreover, Mafia members tend to show emotional connection and concerns, both toward their close relatives as well as toward the other members of the organization, suggesting that they might compartmentalize their criminal behaviour from their private lives (Schimmenti et al. 2014). Again, this separation between public and private behaviours is a debated issue that we will also address in our investigation. In particular, as we will see in the Discussion section, our results seem to confirm the existence of a separation between private and public behaviours.

It is worth mentioning that to date only a few studies investigated psychological and social characteristics of Mafia members. While qualitative research has extensively investigated psychological features of Mafia members, including personality traits, values, family relationship, and communication style (Lo Verso 1998, Bovenkerk 2000, Lo Verso and Lo Coco 2004, Lo Verso 2013, Lo Verso and Giordano 2015, Mannino and Giunta 2015, Calandra and Giorgi 2017), only little research has been carried out using quantitative methods (Schimmenti et al. 2014). Even fewer studies have evaluated the presence of Mafia on the Italian territory (Calderoni 2011). This is particularly unfortunate, because such studies might have been useful in understanding how the territorial features affect the substantiation of a “Mafioso” behaviour: the more we know about how mafia is distributed over the Italian territory, the better we can understand its social determinants. Furthermore, in several cases, the investigation of the development of mafia takes into account its cultural impact on the society and the way we perceive it (Dainotto 2015). In fact, we are fully aware of the fact that many things we know about Mafia people may appear to be based on popular perception, or on ‘journalistic’ accounts with limited factual support. This is partly due to the fact that Mafia has been perceived as a “problem” for the Italian society only starting from the eighties of the previous century. Moreover, people condemned for mafia crimes are difficult to be approached by researchers, due to the many limitations present in the penal institutes or jails. Finally, the availability of Mafia members in discussing their activities with somebody external to the organization has only been achieved in relatively recent times. In fact, such taboo has been broken in 1984 by the first *collaborator of justice*, who revealed to the Palermo magistrates the details of the Mafia organization. After a few years talking about Mafia has become a possibility also for all other Mafia affiliates.

Given that, we aim at bridging this gap by pursuing a completely different approach (Varese 2011), and following a rigorous scientific methodology. We will try to investigate what are the social and psychological characteristics of Mafia members in a fully quantitative

way and with a test, the PCL-R, specifically dedicated to the investigation of psychopathy. We want first to understand whether or not PCL-R permits to assess if subjects condemned for mafia crimes show personality traits associated to psychopathy and then what are the social determinants of such behaviours.

The general aim of this study is to investigate the social, psychiatric, and psychopathological features of a sample of individuals convicted for Mafia crimes. While Psychiatry deals with identifying a mental functioning and mental disease, Psychopathology deals with the study of mental disorders and diseases associated with them from a general point of view, by using diagnostic and classification criteria. While the Psychiatrist characterizes and analyzes the individual man, Psychopathologists consider general principles trying to categorize the experiences of paradigmatic subjects. Psychopathy is typically considered as a psychiatric feature. It has often been associated with structural and functional abnormalities in ventromedial prefrontal cortex and anterior cingulate cortex. These areas are theorized to mediate a number of social and affective decision-making functions that appear to be disrupted in psychopathy; and in subjects like those considered in our study can manifest itself in terms of impulsive and violent behaviour. A typical psychopathological feature can be an alteration of a psychic function such as alterations in attention, memory, perceptual or affective.

Indeed, one novelty of this work is the use, in the context of a quantitative analysis of Mafia affiliates’ personality traits, of innovative statistical analysis based on Network Theory and complex systems techniques, which are now quite standard in the statistical investigation of social complex systems (Granovetter 1983). In the literature on personality studies there are examples where the characterization of a certain group of individuals is done by investigating their mutual relationships (Burt et al. 1998). That implies considering the whole system as a network whose structure might be informative of the single individuals’ personality. Analogously, according to the Social Identity theory, probably mafia members perceive their group as better than others (Hogg and McGarty 1990, Turner 1999, Kalish and Robbins 2006). So they consider their code of honour and rules more important than law. For mafia members the group is the basic unit of survival (Hui 1988). For Triandis (1994), we can describe them like allocentrics, in fact for allocentric people the self is defined by affiliation with in group. They are Mafiosi and this group identity composed their self. Indeed, there is a growing body of literature on networks and their use in the context of personality studies (Cramer et al. 2010, Borsboom and Cramer 2013, van Borkulo et al. 2015).

However, we can go further in this approach. In fact, by using basic community detection algorithms, we can be able to detect sub-groups of subjects characterized by a common profile of answers to the PCL-R test and to investigate what are the features that determine the existence of such sub-groups.

The manuscript is organized as follows: in the next section Methods we will present our sample, the PCL-R test and the network theory tools we will use to investigate the sample. We will present the outcome of our investigations in the Results section. Such results will be analyzed in the Discussion section. Finally we will draw our Conclusions in the fifth and last section.

Method

Samples

This study involved 30 male subjects who were definitely convicted for Mafia crimes and were therefore imprisoned in the “Pagliarelli” district prison of Palermo (Italy). This jail does not host females convicted for Mafia crimes. As shown in **table 1**, these individuals belonged to different Mafia organizations and are quite heterogeneous in terms of age, education and committed crimes.

The 30 individuals investigated in the present study were part of a slightly larger cohort of 38 individuals including a few subjects imprisoned as sex offenders. In the present study we selected those individuals only involved in mafia crimes.

Variables and measurement instruments

Robert Hare’s Psychopathy Checklist Revised, PCL-R (Hare 2003), validated by Caretti and his working group in Italy in 2011 (Caretti et al. 2011),

Table 1. Demographic characteristics of the sample

Anonymized ID	Age	Education	Type of Mafia affiliation	Committed crimes
D7	55	Secondary school	Camorra	Assault, murder, kidnapping, attempted murder, illegal possession and carrying of weapons
D8	43	High school	Ndrangheta	Extorsion, bid rigging, waste trafficking
D9	35	High school	Camorra	Extorsion
D10	31	Secondary school	Cosa nostra	Extorsion, threats to the Court, injury, drug trafficking
D11	35	High school	Cosa nostra	Mafia supporter
D12	40	Secondary school	Cosa nostra	International drug trafficking
D13	23	Secondary school	Camorra	Mafia supporter
D14	44	Secondary school	Cosa nostra	Extorsion
D15	45	Primary school	Cosa nostra	Murder
D16	48	Primary school	Cosa nostra	Sexual assault, extorsion
D17	68	Secondary school	Cosa nostra	International drug trafficking
D18	39	High school	Cosa nostra	Extorsion, bid rigging
D19	36	Secondary school	Ndrangheta	Extorsion
D20	48	Primary school	Cosa nostra	Murder, aggravated theft, usury, extorsion, drug dealing
D21	42	Primary school	Sacra corona unita	Receiving stolen goods, weapons trafficking, theft, robbery, injury, extorsion, drug trafficking, illegal drug detention, underage consensual abduction
D24	40	Secondary school	Ndrangheta	Murder, robbery, receiving stolen goods, drug trafficking
D25	48	Secondary school	Cosa nostra	Extorsion, damage
D26	51	High school	Ndrangheta	Drug trafficking
D27	54	Primary school	Camorra	Murder, aggravated theft, illegal weapons detention
D29	57	Primary school	Camorra	International drug trafficking, theft, attempted murder
D30	53	Primary school	Cosa nostra	International drug trafficking, robbery, extorsion
D31	42	Secondary school	Cosa nostra	International drug trafficking, extorsion, robbery
D32	44	Primary school	Sacra corona unita	Robbery, resisting to police officers, illegal weapons detention, extorsion, escape, smuggling, driving without a license
D33	42	Primary school	Sacra corona unita	Robbery, drug dealing, illegal detention of weapons, false declarations about the identity, injury
D34	41	Primary school	Camorra	Extorsion, drug dealing, murder
D35	54	Primary school	Camorra	Gambling, robbery
D36	53	Primary school	Cosa nostra	Robbery, extorsion
D37	51	Primary school	Camorra	Resisting to police officers, illegal detention of weapons, extorsion, injury, robbery, threats, usury, counterfeit money trafficking
D38	40	Secondary school	Cosa nostra	Robbery
D39	35	Primary school	Cosa nostra	Drug dealing, robbery, injury

was used to investigate psychopathy because it allows investigating several different features within the psychopathy pathology.

PCL-R includes 20 items, reported in **table 2**, which can be rated on a 3-point Likert scale (from 0 to 2, where score 2 means “yes”, score 0 means “no” and score 1 means “maybe/up to a certain extent”). These twenty items are aggregated into four components: the “interpersonal components”(Q1, Q2, Q4, and Q5), the C2 “emotional components” (Q6, Q7, Q8, and Q16), the C3 “lifestyle components” (Q3, Q9, Q13, Q14,

criterion validity, strongly correlating with a social danger index (ranging from 1 to 10, 1=least dangerous, 10=maximum dangerous) rated by two independent judges (Pearson’s correlation with PCL-R total score 0.91, $p<0.001$). A ROC curve analysis then showed that a PCL-R total score of 27 had a sensitivity of 91.3% and a specificity of 87.9% in predicting average scores between 9 and 10 in social dangerousness (Caretti et al. 2011).

Usually, research about psychopathy involves samples much larger than our. For example, Hare et

Table 2. Description of the items of the Psychopathy Checklist Revised scale

ID	Item	Component	Factor
Q1	Glibness/ Superficial charm	C1	FC1
Q2	Grandiose sense of self worth	C1	FC1
Q3	Need of stimuli/ Propensity for boredom	C3	FC2
Q4	Pathological lying	C1	FC1
Q5	Conning / manipulative	C1	FC1
Q6	Lack of remorse or guilt	C2	FC1
Q7	Shallow affect	C2	FC1
Q8	Callous / lack of empathy	C2	FC1
Q9	Parasitic lifestyle	C3	FC2
Q10	Poor behavioral controls	C4	FC2
Q11	Promiscuous sexual behavior	==	==
Q12	Early behavioral problems	C4	FC2
Q13	Lack of realistic/long term goals	C3	FC2
Q14	Impulsivity	C3	FC2
Q15	Irresponsibility	C3	FC2
Q16	Failure to accept responsibility for own actions	C2	FC1
Q17	Many short-term marital relationships	==	==
Q18	Juvenile Delinquency	C4	FC2
Q19	Revocation of conditional release	C4	FC2
Q20	Criminal versatility	C4	FC2

and Q15) and the C4 “antisocial components” (Q10, Q12, Q18, Q19, and Q20). The two components C1 and C2 are further aggregated into Factor FC1, called “Interpersonal/Emotional”, while the two components C3 and C4 are combined in Factor FC2, called “Deviant behaviour”. Items Q11 and Q17 are not included in any component. Finally, the Total score results from the sum of the scores of the questions (with Q11 and Q17 too). According to the Total score obtained, the subjects are classified into three different psychopathy classes. There is a general consensus to consider “psychopathic” any subject with a total score higher than or equal to 30, “borderline” those scoring lower than 30 and higher than or equal to 20, and “normal” those who scored lower than 20 (Caretti et al. 2011).

Based on a semi-structured interview, the PCL-R allows discriminating amongst different psychopathic behaviours (the total score) and different criminal’s characteristics (the PCL-R components and factors).

Both the original and Italian versions of the PCL-R showed excellent psychometric properties. Specifically, the Italian version demonstrated good internal consistence (Cronbach’s alpha: Total= 0.81, FC1=0.79, FC2=0.84) and convergent validity with the Minnesota Multiphasic Personality Inventory, MMPI, Psychopathic Deviation and Hypomania scales (Pearson’s correlation with PCL-R total score ranging from 0.23 to 0.37). Moreover, it showed excellent

al (Hare et al. 1990) analysed, 925 imprisoned and 356 forensic psychiatric subjects to investigate the correlation between the original PCL and the revised version. They concluded that the PCL-R measures the same construct as the original one and therefore it is a reliable and valid instrument for psychopathy’s assessment. Another study conducted in Sweden (Grann et al. 1999) explored the predictive power of PCL-R in a population of 352 personality-disordered violent offenders subjected to forensic psychiatric evaluation. In our case, the reduced size of the considered sample is mainly due to two reasons: firstly, in Italy it is very difficult to obtain the permission from Department of Prisoner Administration to administer clinical tests to subjects condemned for Mafia crimes. Secondly, for the security issues, each prison usually hosts only a small number of subjects condemned for Mafia crimes and therefore, for bureaucratic reasons, it is difficult to gather large samples of subjects.

The PCL-R scale was complemented by an *ad-hoc* socio-demographic semi-structured interview in order to collect information related to the participants’ personal and criminal history, including their previous criminal behaviour, their conduct in prison, their criminal versatility, and their *modus operandi*. Additional social and psychiatric features are reported in **table 3**. Such features have been selected because in literature they are considered relevant risk factors for the development of

delinquent behaviour, see previously cited bibliography and also (Lansford et al. 2007). Some of these items (particularly F5, F6, and F7) were far less objective than those investigated by the PCL-R test, since they mainly relied on the participant's judgment. For instance, a city district was assessed as violent if the participant reported crimes or drug dealings in his city district. Analogously, the existence of family violence was assumed if the participant reported parental discordance or if there was a history of drugs or alcohol abuse in the family. Finally, the participant was rated as living in a context of poverty if he reported economic difficulties or if he was forced to drop out school to work to earn money.

Robert Hare (Hare 1991) psychopathic individuals typically are grandiose, arrogant, callous, dominant, superficial, deceptive, and manipulative. This last trait can be investigated by using component C1, which is related to the interpersonal level. From the point of view of affectivity, as measured by component C2, psychopathic individuals are unable to form strong emotional bonds with others, and lacking in empathy, guilt, remorse, or deep-seated emotions. Their particular characteristics are associated with a socially deviant lifestyle (component C3) with irresponsible and impulsive behaviour and a tendency to ignore or violate social conventions and morals (component C4).

According to (Lykken 1995), Factor FC1

Table 3. *Social and psychiatric features*

ID	Name	ID	Name
F1	Crimes committed as a teenager with or without a police report	F13	Level of education
F2	Child labour	F14	Age
F3	Sexual or physical abuse	F15	Type of crime
F4	Relatives arrested	F16	Phratry position
F5	Grown up in violent city district	F17	Mother age at participant's birth
F6	Grown up in violent family	F18	Father age at participant's birth
F7	Grown up in conditions of "poverty"	F19	Age at first conviction
F8	History of substance use disorder		
F9	History of alcohol use disorder		
F10	Psychiatric disorder of the participant or in any family members		
F11	Attempted suicide		
F12	Marital status		

After consultation of the trial dossier, all potential participants were introduced to the aim of the study and signed an informed consent. It was specified that data were recorded according to confidentiality principles, by replacing the participant's name with an anonymous numerical code, and that they would be able to withdraw from the study at any time. All approached participants accepted to be involved in the study.

Next, the first author (CC), who was trained in the administration and scoring of the PCL-R instrument, administered the socio-demographic questionnaire and the PCL-R semi-structured interviews. Consistently with the PCL-R manual (Hare 2003, Caretti et al. 2011), participants were asked to talk as much as possible in order to understand their point of view regarding the crimes they were involved in. During the interview, tone of voice, body language, reactions to the questions, the way the questions were answered, the words used to describe the victims of the committed crime were recorded in order to assess psychopathy traits of the participant, to try to understand whether he was telling the truth, and to compare his stories with those found in the trial dossiers. To overcome the peculiar tendency of people with psychopathic traits to lie, (a feature that in the past has been a constraint in the validity of self-report tests on psychopathy, see Hare 2003), the PCL-R includes a specific item regarding pathological lying and the PCL-R assessment procedure asks to compare the interviewee's responses with the prison dossier and the police reports (Hare 2003).

For our purposes, component C2 is particularly relevant as it can signal psychopathic lifestyles. For

corresponds to primary psychopathology traits, that is, it describes the primary cause of the undesirable and aggressive behaviour. When Factor FC1 is high, individuals tend to perceive other people as instruments, they don't care about having genuine relationships with them. When a relationship is settled, often it is motivated by the possibility of accumulating money or status. (Cornell et al. 1996). Factor FC1 is positively associated with a narcissistic and histrionic personality disorder. In another study (Florez-Mendoza et al. 2008) PCL- R was administered to 124 Brazilian male inmates and the Factor FC1 correlated positively with the number of violent crimes, fraud and total number of crimes. In the same study, Factor FC2 was only related to property crimes and to the total number of crimes committed. Generally speaking, Factor FC2 corresponds to secondary psychopathology traits, as a consequence of other disorders. When Factor FC2 is high, aggression is the result of an inability to regulate emotions or control behaviour appropriately (Cornell et al. 1996). Factor FC2 is positively associated with behavioural activation: impulsive, risky, and aggressive acts, seek rewards (Wallace et al. 2009).

Method of analysis

In order to analyze the psychological and social features of individuals involved in Mafia crimes, a three-step strategy was adopted. It was based on the use of statistical tools some of which are quite standard in the statistical investigation of social complex systems

(Granovetter 1983). The first step was to introduce a measure of similarity among these subjects (Albert and Barabási 2002). The similarity measure has been constructed starting from the answers given to the PCL-R questionnaire and to the additional social features mentioned above. In fact, for each of the 30 participants involved in the study, a vector V_i , $i=1, \dots, 30$, of length $L=32$ has been constructed. The first 20 entries of this vector were given by the numerical scores (0, 1 or 2) of the answers given to each of the 20 questions in the PCL-R questionnaire. A conventional value of 9 was assigned when the participant had not answered to the question. The other 12 entries were given by a numerical binary (0, 1) code that codified the answers given to some of the investigated sociological items. Specifically, the items from F1 to F12 were considered. The 1 code was assigned when the investigated feature was present. The 0 code was applied in the absence of that feature. We selected the 12 items that had a clear answer in terms of yes/not. By doing so, we could construct a totally unsupervised measure of similarity between participants.

One possible similarity measure between subject i and subject j is given by the Jaccard Index (Tanimoto 1958), i.e. the ratio between the intersection and the union of the vectors V_i and V_j relative to the i -th and j -th subjects.

Once the similarity measure amongst subjects was constructed, as a second step, groups (clusters) of elements that presented a common profile in terms of the answers given during the interview were identified. A possible way to search for communities within a set of elements is to use a community detection algorithm such as the Radatool (Dutch and Arenas 2005). In fact, starting from the similarity measure it can be derived a network where the nodes are the 30 subjects and any pair (i, j) of nodes is connected by a link to which one can associate a weight given by \cdot . Such a network can be partitioned in communities. Specifically, the considered algorithm is based on the maximization of a function called “modularity” (Fortunato and Barthelemy 2007). For a given partition, the modularity Q is the normalized sum of the weight of the links within each community minus the expected weight P_{ij} of the links between the i -th and j -th participants for a given null model. The most popular choice for P_{ij} is the one proposed by

Newman and Girvan (2003). Actually, the null model network was obtained by performing a randomization of the links that preserves the strength of each node.

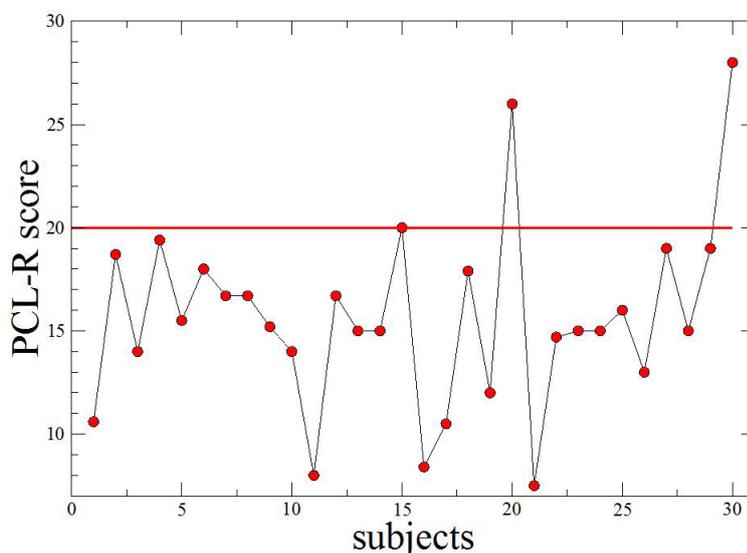
As a third step, the clusters obtained above were then characterized in terms of some psychiatric or social features. In fact, by using the methodology illustrated in Tumminello et al. (2011), given the subjects in the clusters and the attributes of each subject, it is possible to assess the attributes which are more common in the cluster, with respect to a random null hypothesis. The idea is that these attributes are those characterizing the cluster. Suppose to have a community of K nodes. Suppose that X out of K nodes are characterized by having a certain attribute A . Suppose that in a network of N elements the attribute A can be associated to M out of N nodes. Then the probability that X is observed by chance is given by the hypergeometric distribution. For each attribute present in a community and for each community in the network one can, therefore, obtain a p -value. Thus, by considering an appropriate multiple hypotheses testing correction it is possible to investigate what are the attributes that result to be over-expressed in a community with respect to the null hypothesis. In the present study the considered attributes were (i) the answers given to some of the items considered during the interviews, as well as (ii) the scores of the Factors and Components of the PCL-R test. An univariate 5% p -value threshold and the Bonferroni correction for multiple comparisons were used.

Results

The total PCL-R score obtained by the 30 subjects condemned for Mafia is shown in **figure 1**. It shows that no one can be classified in the psychopathic category. As illustrated in **figure 1**, most of them fall in the Normal category. Two out of 30 belong to the Borderline category: D29 and D39. Both of them spent their childhood in a reformatory and committed robberies before the age of 18.

In our result Mafia members have a low PCL-R factor FC1 (interpersonal/affective) scores. Probably this means that they were less narcissistic and unemotional than the other criminals (Lo Verso and Lo Coco 2004, Caretti and Schimmenti 2013, Schimmenti et al. 2014).

Figure 1. Total Psychopathy Checklist-Revised score



They often expressed remorse for the time they are lost with their families and because they weren't a good fathers. As anticipated in the Introduction, such low values of FC1 seem to indicate that emotions play a minor role in determining the Mafiosi personality traits, differently from what has been observed in (Lo Verso 2013, Lo Verso and Giordano 2015).

The sample showed an overall low level of education. The majority of the sample completed the primary school (n=14, 46.7%), 11 (36.7%) got a secondary school diploma, and only 5 (16.7%) attended high school, while no one reached a university degree.

Another interesting feature was the incidence of child labour. In fact, 21 out of 30 prisoners for Mafia crimes began working before 18 years of age (mean age= 13.1, standard deviation=1.9). Moreover, 17 out of 30 participants committed some kind of crimes before the age of eighteen, even without actual convictions of the Juvenile Court. However, the correlation between these two features (i.e. working before the age of 18 and committing crimes before the age of 18), was low (0.015). On the other hand, there was evidence of a relation between level of education and having worked before the age of 18 (-0.43) and between level of education and committing crimes before the age of 18 (-0.55).

Only a minority of participants referred of being exposed to childhood abuse (perpetrated either by family members or non-relatives) or family violence (n=4, 13.3%).

As mentioned above, the Jaccard coefficient was used in order to assess the similarity between any two pairs

of participants. In **figure 2** it is shown the probability density function of these coefficients. The mean correlation value was 0.52 with a standard deviation equal to 0.11. The maximum correlation value was 0.81 and the minimum was 0.19. In the right panel of **figure 2** it is shown the contour-plot of the correlation matrix. This gives a pictorial representation of the correlation matrix and it is obtained by substituting the actual numerical values of the correlation between pair of elements with a colour according to a predefined color-code. In this case, lighter shadows of red indicate smaller values of correlation while darker colours indicate higher values of correlation, as indicated in the color-code bar on the right of the panel. The black diagonal strip indicates the correlation with any element with itself, which is equal to unity by definition.

Starting from these Jaccard coefficients, the complete weighted network of subjects has been considered. In such a network the nodes were the 30 subjects and the links between any two pair of nodes were weighted with the Jaccard coefficient. The network was complete because all possible links between nodes were present, given that all weights were different from zero. Such network can be partitioned by using the Radatool algorithm. In the left panel of **figure 3**, it is shown how the network was partitioned in two large communities each of size 15. The first community R1 included the following participants: D7, D8, D10, D11, D12, D14, D17, D18, D24, D25, D26, D30, D31, D36, D37. The second community R2 included the participants: D9, D13, D15, D16, D19, D20, D21, D27, D29, D32, D33, D34, D35, D38, D39. In the right panel of **figure 3** it is

Figure 2. Jaccard coefficient probability density function (left) and contour plot (right)

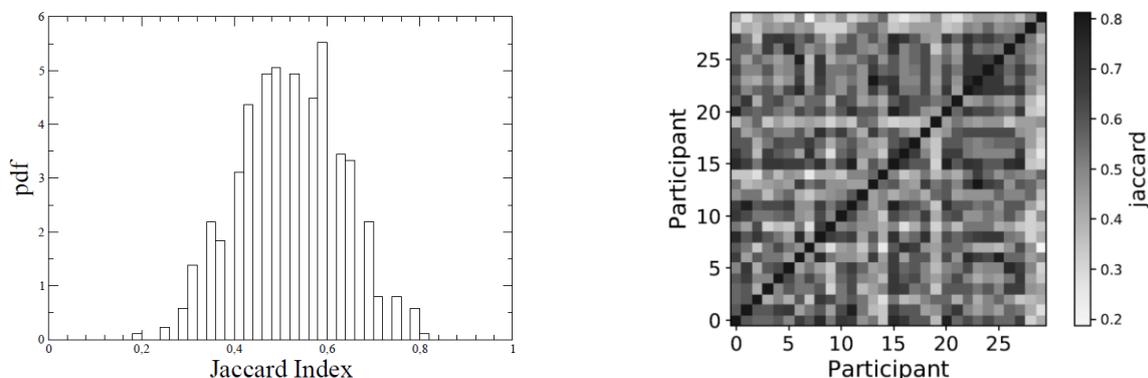
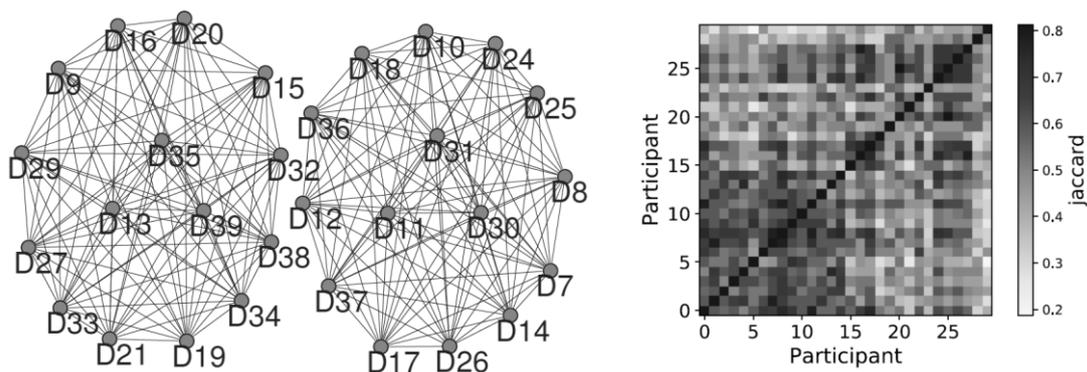


Figure 3. Partitioned network (left panel) and countour-plot (right panel) of the correlation matrix where the elements are ordered according to the Radatool findings



shown the contour-plot of the correlation matrix where the elements are ordered according to the previous partition. The two equally-large communities are visible as blocks of homogeneous elements along the diagonal.

The two communities R1 and R2 were characterized in terms of some psychiatric or social features. Hereafter, a 5% p-value threshold and the Bonferroni correction for multiple comparisons have been considered. Our results are summarized in **table 4**. In a first investigation the two Factors and the four Components of the PCL-R were considered as attributes. Specifically, for each of these six attributes a positive mark was assigned to each subject whenever its individual score was above the average score for that attribute and a negative mark was assigned whenever its individual score was below the average score for that attribute. This investigation showed that the two communities were characterized by the following attributes: Factor FC2 (Deviant behaviour) and Component C4 (Antisocial behaviour). Specifically, the first community R1 was characterized by values above average for Component C4 with p-value $p=1.25 \cdot 10^{-3}$ and Factor FC2 with p-value $p=5.79 \cdot 10^{-5}$. In these two cases the Bonferroni threshold was $p^*=0.015$. By contrast, the second community R2 was characterized by values below average for Component C4 and Factor FC2. In this way scores of Factors and Components can be used to assess what are the specific

words, our results indicate that the subjects in the first community R1, characterized by values above average for Component C4, are statistically expected to have a greater social deviance that can be possibly traced back to a young criminal behaviour, a deficit of control behaviour, and a greater capacity to commit different typologies of crimes. This group finally has a greater social deviance.

In a second analysis, it was investigated whether the two communities were characterized by any of the psychiatric and social features. It turned out that the only relevant features was F1 (Crimes committed as a teenager with or without a police report) and F13 (Education). Specifically, the first community R1 was characterized by an over-expression of the presence of the F1 feature, while the second community R2 was characterized by an over-expression of the absence of the F1 feature. The p-values in both cases were $p=8.77 \cdot 10^{-7}$ with a Bonferroni threshold $p^*=0.017$. Furthermore, the first community R1 was characterized by the fact that their members attended only primary school, with p-value $p=4.61 \cdot 10^{-3}$ and a Bonferroni threshold $p^*=8.33 \cdot 10^{-3}$. The subjects in R1 are therefore statistically expected to have lower levels of education (possibly primary school) and to have committed crimes in adolescence.

Table 4. Summary of cluster characterization

Cluster ID	Cluster Size	Number of attributes in the cluster	Attribute	Attribute value	Number of elements with that attribute in the system	Number of elements with that attribute in the cluster	p-value	p-value threshold
2	15	2	Component C4	Below average	13	11	$1.25 \cdot 10^{-3}$	$1.25 \cdot 10^{-2}$
1	15	2	Component C4	Above average	17	13	$1.25 \cdot 10^{-3}$	$1.25 \cdot 10^{-2}$
1	15	3	F13 level of education	Above average	14	11	$4.61 \cdot 10^{-3}$	$8.33 \cdot 10^{-3}$
2	15	2	F1 Crimes committed as a teenager with or without a police report	Below average	13	13	$8.77 \cdot 10^{-7}$	$1.67 \cdot 10^{-2}$
1	15	1	F1 Crimes committed as a teenager with or without a police report	Above average	17	15	$8.77 \cdot 10^{-7}$	$1.67 \cdot 10^{-2}$
2	15	2	Factor FC2	Below average	13	12	$5.79 \cdot 10^{-5}$	$1.25 \cdot 10^{-2}$
1	15	2	Factor FC2	Above average	17	14	$5.79 \cdot 10^{-5}$	$1.25 \cdot 10^{-2}$

behavioural aspects of the subject that contribute to its total score, and then what are eventually the most problematic aspects in relation to psychopathy and his personality. In fact, the score of the Factor FC2 (Social Deviance) results by the sum of the score Component C3 "Lifestyle" and Component C4 "Anti-social behaviour"; Component C4 is obtained by evaluating 4 items: "Poor behavioural controls", "Early Behavioural Problems", "Juvenile Delinquency", "Revocation of Conditional Liberty", "Criminal versatility". In other

Discussion

Psychopathy traits in Mafia offenders

As reported in a previous study on the same sample, the vast majority of participants had Normal levels of psychopathy, according to the PCL-R, while only two out of thirty subjects were classified as Borderline, having a Total score between 20 and 30. This is not entirely surprising since criminal conducts do not

always imply, *per se*, an underlying mental disorder and, within psychiatric diagnoses, there may be large discrepancies between categorical and dimensional diagnosis. Indeed, the Diagnostic and Statistical Manual of Mental Disorder (DSM) diagnosis of antisocial personality disorder (American Psychiatric Association 2000, American Psychiatric Association 2013) has been often criticized for over-identifying people with criminal histories, showing that between a half and two third of the prison population would meet the criteria for the disease, against only about 15% of offenders, who would be classified as psychopathic, according to the PCL-R (Ogloff 2006). This suggests that dimensional diagnosis of psychopathy personality traits might be more accurate than categorical diagnosis of antisocial personality disorder in assessing behavioural, cognitive, and emotional problems in the prison population and in characterizing different types of offenders.

Furthermore, a previous study on the same sample (Schimmenti et al. 2014) showed that Mafia members obtained PCL-R total scores, interpersonal and affective (PCL-R Factor FC1) scores and lifestyle scores (PCL-R Factor FC2) lower than other criminals convicted for violent crimes (Schimmenti et al. 2014). Factor FC1 clearly reflects a set of interpersonal and affective characteristics, such as egocentricity, lack of remorse, callousness; these factors are considered fundamental to clinical conceptions of psychopathy and were observed in early studies on psychopathy (e.g., Henderson 1939, Redl and Wineman 1951, McCord and McCord 1964, Greenwald 1974, Cleckley 1982). Previous studies (Hart and Hare 1989, Harpur et al. 1989, Hare 1998) indicate that Factor FC1 is positively correlated with clinical ratings of psychopathy, with prototypical ratings of narcissistic and histrionic personality disorder, and with self-report measures of machiavellianism and narcissism. It is also negatively correlated with measures of empathy and anxiety. Many authors have suggested that the inability of psychopaths to establish and to keep strong relational bonds derives from childhood experience of neglect, deprivation, abuse and inconsistent discipline (Akhtar 1992, Bird 2001, McWilliams 2011). Other authors emphasized instead that genetic and temperamental influences – for instance, the callous-unemotional traits (Frick 2002) – are at the core of psychopathy (Caretta and Schimmenti 2013). On the other hand, Factor FC2 reflects aspects of psychopathy such as impulsive, antisocial, and unstable lifestyle. It is positively correlated with diagnoses of antisocial personality disorder, criminal behaviours, low socioeconomic status and antisocial behaviour (Harpur et al. 1989, Hare et al. 1991).

Social and psychiatric risk factors

Several studies have investigated the biological and environmental risk factors associated to psychopathy and antisocial behaviours (Shaw and McKay 1942, Shaw 1952, Farrington 1989, Gottfredson and Hirschi 1990, Eaves et al. 2000, Patterson et al. 2000, Plomin and Asbury 2005). Fornari claimed that the influence of the components of biological, genetic and neurological nature is always directly or indirectly mediated or moderated by psychological, emotional, relational, family, and contextual factors (Fornari 2012).

In this study, it was found that individuals convicted for Mafia crimes achieved low educational degree and were often exposed to child labor. Furthermore, associations were found between level of education and having worked before the age of 18 and between level of education and juvenile delinquency. This is consistent

with other studies that found a correlation between poor education achievement and juvenile crime (Barnert et al. 2015). Broadly speaking, several studies found that children from low socio-economic status show higher prevalence rates or mean symptom counts of behavioural problems (Costello et al. 2003, Amone-P'Olak et al. 2011). Recently, Piotrowska's global meta-analysis (2014) demonstrated a significant relationship between socioeconomic status and child and adolescent antisocial behaviour, particularly with callous-unemotional personality traits. Intriguingly, the association between antisocial behaviour and socioeconomic status was relatively independent by potential confounders at community-level, such as social inequality and levels of individualism in society.

Only 4 out of 30 subjects reported a history of childhood abuse or family violence. This result is different from the findings by Dutton and Hart (1992) who found that exposure to childhood physical abuse predicted family violence and higher number of violent crime in adulthood and that childhood sexual abuse led to sexual crimes both against family members and subjects external to the family. It may be speculated that the Mafia family structure is governed by a "code of honor" that prevents deviant sexual conduct. Alternatively, it is possible that childhood abuse was underestimated because participants did not feel confident in disclosing childhood trauma during a single face-to-face interview. Indeed, according to (Hare 2009), childhood adversities are not necessarily associated to psychopathy, but contribute to the behavioural expression of psychopathy traits. However, a study on family relationships and criminal behaviour found that offenders with high psychopathic traits tend to be involved in a greater number of violent crimes if they grew up in problematic families (De Vita et al. 1990).

The fact that Mafia offenders have on average a lower score of Factor FC1 with respect to other offenders might support the observation that Mafia members work in and with the "Family". As anticipated in the Introduction, this seems to confirm the results of (Schimmenti et al. 2014) on the existence of a separation between private and public behaviours. Also, Mafia offenders usually need to develop an information system on the reliability of business criminal partners and to base his confidence in underlings on primary bonds of the organization based on kinship, family, nationality or confidant. Mafia offenders have a non-negligible average value of item Q2 equal to 0.9. This might relate to the fact that Mafia bosses have to show their immunity for the law and they believe to be superior and special. These characteristics remember the Theodore Millon's "narcissistic-antisocial (aggressive) mixed personality (Millon 1981): the attitude of omnipotence and self-assurance, a feeling that the rules of society do not apply to them, immature fantasies of success, beauty, or love, minimally constrained by objective reality, often lie to redeem self-illusions. This seems the kind of psychopathology that may help to become successful among the leadership of organized crime. The psychopaths usually have even higher values of item Q2, although for completely different reasons. In fact the typical psychopath try to be manipulative and to exert his control on other people.

The lower observed score of Factor FC2 with respect to other offenders might be associated to the fact that item Q3, item Q14 and item Q15 usually are not very high. In our set we observe an average value of 0.90, 0.97 and 0.50, respectively. Again this is different from what observed in psychopaths where these items show values well above unity. Again these observations are compatible with the fact that mafia offenders are usually

part of a social context, while other types of offenders tend to be autonomous entities.

By looking at the single PCL-R items one can notice that, when averaging over all participants, very low scores (≤ 0.50) are attained for the following items: Q4, Q7, Q8, Q9, Q15, Q17. Items Q4 and Q17 are not incompatible with the typical description of the Mafioso, who is usually thought to be loyal and dedicated to his own family. It is also worth noticing that most participants declare to be married. On the other side, the low average values observed in items Q7 and Q8 might support the fact that Mafiosi can act even against their own relatives when the organization requires that. Finally, the low average values observed in item Q9 contrasts with the common view of a Mafioso as a parasite. Rather he is somebody who works for his own interest without caring of social constraints. This last aspect might be also confirmed by the fact that, when averaging over all participants, high scores (> 1.00) are attained for item Q6. Other items with average value higher than 1 are Q12, Q16, Q20. While high values of item Q20 and Q16 are expected, the result about item Q12 is surprising and reveals a personality trait worth of further investigation requiring a clearer stratification of the considered sample. In fact, while it is true that the environment where the Mafioso grew up plays a relevant role in this context, Mafiosi can also be professionals or politicians, i.e. someone who is expected to have grown up in a positive context.

Network theory approach

A finer investigation performed by using the network theory allows identifying four items useful to characterize in a statistically robust way two groups of Mafia offenders: the PCL-R factor “Deviant behaviour”, the PCL-R component “Antisocial behaviour”, and the social features “Crimes committed as a teenager with or without a police report” and “Education”. In fact, members of the R1 community are characterized by juvenile delinquency, low levels of education and early attitude toward antisocial and deviant behaviours. By contrast, members of the R2 community are characterized by reduced antisocial and deviant behaviours and absence of criminal offences in their adolescences. The statistical investigations presented in this study allowed us to demonstrate the existence of a statistically significant association between the above mentioned personality traits and some social features. Although we cannot conclude that there exists a causal relationship between them, we can hypothesize that low levels of education and an early criminal career are possible risk factors for antisocial and deviant behaviour.

In light of the findings of her well-known studies on the onset and course of deviant and antisocial behaviours, Moffitt (2001) identified two distinct groups of individuals: a small group who engaged in antisocial behaviour in their childhood, which showed life-long criminal behaviours, drug related and violent crime, higher level of psychopathy and higher rates of mental health problems in adulthood (“early onset/ life-course persistent”); a larger group characterized by later onset of antisocial behaviours that tend to decrease with age and were associated with less severe legal and health problems in adult age (“late onset/ adolescence limited”). Early onset antisocial behaviours were also related to neurocognitive impairment and impulsive/hyperactive temperament in childhood and a further study claimed the existence of a mutual influence between antisocial behaviour and poor reading achievement (Robins et al.

2001). Accounting for the limitation of a cross-sectional investigation and of the specificity of criminal career within mafia organization, it might be speculated that the two communities detected in our sample reflect the broader model proposed by Moffitt.

The approach pursued in this paper is slightly different from what has been done in the past. In fact we wanted to assess whether or not subjects imprisoned for mafia crimes are psychopathic by investigating what are the main features that are shared by patients as they emerge from the answers to the PCL-R test. For this reason we believe that an approach where tools and methodologies of Network Theory are used is most appropriate. More specifically, we introduced a network representation of the system where links amongst patients are weighted only according to the answer they give to the PCL-R test. The novel idea here is that we want to treat this system as a network, rather than simply considering the correlation matrix amongst the 30 individuals. In fact, having a network allows us to consider community detection algorithms in order to partition the system in smaller subsystems (communities). In principle, this is also possible starting from the correlation matrix and computing the hierarchical tree. However, the identification of the resulting clusters is not always clear and involves some degree of arbitrariness. On the contrary, once the community detection algorithm has been selected, the subsequent steps are totally unsupervised. Whether or not the obtained communities add something to our knowledge of the system is related to the further step we perform when characterizing such communities. In fact, by using the methodology of Tumminello et al. (2011) we can say what are the features that are present in each community in a statistically robust way. Again, this is a totally unsupervised methodology that, in the specific case, selects the statistically relevant features amongst the 19 items of **table 3**. In our case we believe that the fact that our procedure detected (i) education and (ii) having committed crimes as a teenager as characterizing features is important because these two features might therefore be considered as two relevant risk factors for criminal career also within large criminal organizations.

Strengths and limitations

A clear limitation of this study definitely consists in the small sample size, limiting generalizability of the findings. Further research is needed in order to evaluate whether the above-mentioned results are confirmed in larger and more heterogeneous samples. Moreover, given that this was a cross-sectional study we are not able to claim any causal relationships between the features that characterize the two communities, or to establish their predictive values in relation to the criminal and clinical course of participants.

On the other side, this study has two strengths. First, from a clinical point of view, this study provides a quantitative assessment of the psychopathy levels of subjects condemned for Mafia crimes, showing that overall such criminals are not psychopathic, although community detection algorithms detect a subgroup of subjects statistically characterized by greater deviant and antisocial behaviour.

Second, the above results might be also relevant from a sociological point of view, since the characterization of subjects in the two communities highlights that relevant characterizing factors are (i) education and (ii) having committed crimes as a teenager. These might therefore be considered as two relevant risk factors for criminal

career also within large criminal organizations.

This study might also be of support to magistrates, lawyers, and those involved in the administration of justice, as it improves the knowledge of the phenomenon, and might also help in better calibrating their investigation activities as well as in the implementation of more efficient measures of detention and rehabilitation.

Finally, from a methodological point of view, this research shows how tools and methodologies of Statistical Physics and Network Theory can be fruitfully used to characterize a real-world complex systems of sociological, clinical and biomedical nature, even in the context of psychiatry.

Conclusions

We have analyzed a set of 30 condemned for Mafia crimes and imprisoned in the “Pagliarelli”, district prison of Palermo (Italy). The aim of the study was that of understanding whether or not PCL-R permits to assess if subjects condemned for mafia crimes show personality traits different from subjects condemned for other crimes. Specifically, we were interested in psychopathy and therefore we considered the PCL-R test, which is specifically dedicated to the investigation of psychopathy. By using Network Theory, we also wanted to investigate the existence of sub-groups of subjects characterized by a common profile of answers to the PCL-R test and to investigate what are the features that determine the existence of such sub-groups.

Indeed, the study identified two communities, which were different in terms of history of juvenile delinquency, levels of education, and antisocial and deviant behaviours score at PCL-R.

Our results show that Mafiosi are not psychopaths. Rather, they work in and with the “Family”. And they usually operate inside a social context, and not as autonomous entities. Low levels of Education and having committed crimes in adolescence are possible risk factors. Finally, despite the fact that we have considered a relatively small sample, from a methodological point of view, this research shows how tools and methodologies of Network Theory can be fruitfully used to characterize a real-world complex systems of sociological, clinical and biomedical nature, even in the context of psychiatry.

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