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Exposure to Traumatic Events and Development of Psychotic Symptoms in a Prison Population: A Network Analysis Approach

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A B S T R A C T

Previous studies consistently observed an association between exposure to traumatic events and psychotic symptoms. However, little is known about the differential impact of distinct traumatic events and the role of general symptoms in mediating this relationship. Thus, our study aimed to explore the differential association of several traumatic events to the psychotic symptoms in a sample of prisoners and whether this association is mediated by general symptoms. The total sample from the *Survey of Psychiatric Morbidity Among Prisoners in England and Wales* (N = 3039; 75.4% male) was used. Participants completed a list of traumatic events experienced before reclusion, the Psychosis Screening Questionnaire, Clinical Review Schedule-Revised. Network analysis was used to estimate the network of interactions between traumatic events and general and psychotic symptoms. Shortest paths analysis was performed to identify the different development trajectories. Results suggested that memory problems, compulsions, and irritability might be key mediating symptoms for most traumatic events. However, sexual abuse showed alternative mediators that might be specific of this traumatic event. Finally, the traumatic events, suffered from violence at work, separation/divorce and been homeless showed direct associations with specific psychotic symptoms.

1. Introduction

The development of the psychotic symptoms has been the topic of extensive debate (Sideli et al., 2012). Several perspectives have arisen that explain the emergence of psychotic symptoms with genetic variants (Zwicker et al., 2018), pre and perinatal neurodevelopment (e.g., maternal stress, maternal anemia, viral infection; Brown and Patterson, 2011; Fineberg et al., 2016; Nielsen et al., 2016) and substance use (e.g., cannabis, tobacco; Gurillo et al., 2015; Schlosser et al., 2012). Another perspective associates the psychotic symptoms with childhood adversities (Trotta et al., 2015) and repeated exposure to traumatic events (Schlosser et al., 2012). In fact, poly-victimization, that is, the experience of repeated traumatic experiences throughout the course of life, seems more common in individuals diagnosed with psychotic symptoms (Arseneault et al., 2011; Crush et al., 2018; Kelleher et al., 2013).

Incarcerated individuals seem to have been through more traumatic events than the general population (Baillargeon et al., 2009) and, in this population, the prevalence rates of psychotic disorders are 5 to 10 times higher than in the general population (Brugha et al., 2005). Indeed, psychotic symptoms have been continually associated with violent crime, particularly homicide (Fazel et al., 2014, 2009). This leads to a large number of prisoners with psychotic symptoms (Saavedra et al., 2017) in institutions that are historically unable to provide specialized treatment (Kinsler and Saxman, 2007).

Recent reviews suggest that traumatic events are indeed associated with the development of psychosis both in the general population (Varese et al., 2012) and in incarcerated individuals (Fazel et al., 2014). Unfortunately, the boundaries of what constitutes a traumatic event are unclear (Greenberg et al., 2015). So, for this study, we have broadened the definition of traumatic events, including some events that might be otherwise considered psychosocial stressors. Regardless, it has been suggested that the relationship between these events and psychotic symptoms might be mediated by the individuals' neurodevelopmental characteristics (Read et al., 2014) and cognitive affective processes (Hardy et al., 2016).

Nevertheless, as pointed out by Bentall and colleagues (2014), these results implicitly assume a single pathway to psychosis, but its complex nature, the lack of support for its current categorical taxonomy, and the complex covariation of symptoms are unlikely to be the product of one single causal process. However, it's still not clear what these specific complex interactions are between traumatic events and psychotic symptoms (Gibson et al., 2016). In light of this, the authors initiated a search for relationships between exposure to specific traumatic events and psychotic symptoms and found that specific traumas have associations with specific psychotic symptoms (e.g., childhood sexual abuse was related with a high risk of developing hallucinations [Bentall, Wickham, Shevlin et al., 2012] and childhood neglect was associated

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with paranoid symptoms [Sitko, Bentall, Shevlin et al., 2014]). Also, Shevlin and colleagues (2015) found similar conclusions in a sample of incarcerated individuals, observing that prisoners with a past history of violence at home, institutional care, and bullying were more likely to develop paranoid symptoms.

Until now, studies exploring the association between exposure to traumatic events and psychotic symptoms assumed that these paths are direct; however, as aforementioned, there are potential mediators in this relationship. In fact, the role of general psychopathological symptoms has been recognized as a potential mediational mechanism between traumatic events and the development of psychotic symptoms (Isvoranu et al., 2017). Isvoranu and colleagues (2017) explored this by estimating a model of the complex network of interactions between traumatic events, general psychopathological symptoms, and psychotic symptoms. In network models, these interactions are modeled as part of a causal system that contributes to explaining the underlying mechanisms that lead to the development of mental disorders (Borsboom and Cramer, 2013). Recently, this approach has been providing a deeper understanding about the etiology of mental disorders (Borsboom and Cramer, 2013), their nosography (Galderisi et al., 2018; van Rooijen et al., 2017; Wigman et al., 2017) and comorbidity structures (Cramer et al., 2010). Also, it was suggested that network models can help disentangle the mechanisms behind the relationship amongst traumatic events and the psychosis spectrum (Isvoranu et al., 2016). Unfortunately, only a strict number of studies have explored this relationship through this framework (Guloksuz et al., 2016; Isvoranu et al., 2017, 2016; Moffa et al., 2017). Guloksuz and colleagues (2016) showed that the exposure to environmental risk factors (childhood trauma, urbanicity, cannabis use, and discrimination) increases the connectivity of the network. This might mean that an increase in the exposure to environmental risk factors increases the expression of psychosis. However, this study only supports previous findings that partially explain this phenomenon, failing to clarify how traumatic events interact and possibly lead to the expression of psychotic symptoms. To solve this, Isvoranu and colleagues (2016) studied the specificity of interactions between environmental risk factors, general psychopathology, and psychotic symptoms. Their results point to the impact of traumatic events (i.e., physical neglect, emotional neglect, sexual abuse, emotional abuse, physical abuse) in psychotic symptoms being mostly mediated by general psychopathology. Moffa and colleagues (2017) studied the impact of bullying in the development of psychosis through network analysis and found a direct relation with persecutory ideation and a mediated relationship by general symptoms with hallucinations, which opens the possibility that some environmental risk and traumatic events are directly associated with psychotic symptoms whereas others are indirectly associated with psychotic symptoms. This, however, awaits further clarification and replication. Furthermore, Isvoranu and colleagues (2016) and Moffa and colleagues (2017) focused on a limited selection of traumatic events and general psychopathological symptoms that might be oversimplifying the complex interaction between traumatic events and symptoms. In this context, we aim to contribute to the clarification of the interactions between traumatic events and psychotic symptoms by exploring the impact of diverse traumatic events associated with the development of psychosis and the mediational role of a large number of general psychopathological symptoms.

2. Method

2.1. Participants

We analyzed data from a previous epidemiological study, the *Survey of Psychiatric Morbidity Among Prisoners in England and Wales, 1997* (see Brugha et al., 2005, for a detailed description). This survey was carried out by the Social Survey Division of the Office for National Statistics and commissioned by the Department of Health of the UK (Singleton et al., 1997). This study assessed the prevalence of psychiatric morbidity among prisoners in order to inform general policy decisions (Singleton et al., 1997). A total of 131 penal establishments were included in the survey (Coid et al., 2002) and all the participants included in the study provided written informed consent. In this way, a group of psychiatric disorders were assessed, namely, personality disorders, psychosis, neurotic symptoms, suicide and alcohol misuse and dependence. Regarding psychosis, the disorders covered were schizophrenia and other non-organic psychotic disorders, and a set of affective psychosis, namely, manic episode, bipolar affective disorder, severe or recurrent depression with psychosis. The prevalence of any

Table 1
Sociodemographic characteristics of participants.

	n (%)
Sex	
Male	2291 (75.4)
Female	748 (24.6)
Age	
16 to 17	152 (5.0)
18 to 19	293 (9.6)
20	129 (4.2)
21 to 24	576 (19.0)
25 to 29	678 (22.3)
30 to 34	516 (17.0)
35 to 39	276 (9.1)
40 to 44	189 (6.2)
45 to 49	112 (3.7)
50 to 54	64 (2.1)
55 to 59	37 (1.2)
60 +	17 (.6)
Marital Status	
Married	345 (11.4)
Cohabiting	838 (27.6)
Single	1450 (47.7)
Widowed/ divorced/separated	388 (12.8)
Ethic Origin	
White	2442 (80.4)
Black - Caribbean	250 (8.2)
Black - African	115 (3.8)
Black – Other black group	45 (1.5)
Indian	38 (1.3)
Pakistani	32 (1.1)
Bangladeshi	8 (0.3)
Chinese	3 (0.1)
None of these	105 (3.5)
Education Levels	
Higher	391 (12.9)
GCES	725 (23.9)
Others qualifications	435 (14.3)
No qualifications	1482 (48.8)
Employment Status before Prison	
Working	1122 (36.9)
Seeking work	622 (20.5)
Living of crime	453 (14.9)
Economically inactive	798 (26.3)
Sentence Lenght	28 (0.9)
Less than 3 months	
3 - 5 months	86 (2.8)
6 – 11 months	151 (5.0)
1 -3 years	693 (22.8)
4 – 9 years	472 (15.5)
10 years or more	94 (3.1)
Life sentence	105 (3.5)
Crimes	
Violence	585 (19.2)
Sex offence	159 (5.2)
Robbery	1174 (38.6)
Frauds/ forgery	88 (2.9)
Drugs	558 (18.4)
Other	345 (11.4)
Unknown	125 (4.1)
Previous Criminal Convictions	
Yes	2289 (75.3)
No	750 (24.7)

functional psychosis was 7% for male sentenced, 10% for male remand and 14% for female (see Singleton et al., 1997, for a detailed description).

In the present study, we excluded the prisoners that had not been exposed to any traumatic event before reclusion, and a distinction by type of sentence wasn't performed. In this way, data from 3,039 prisoners were analyzed (75.4% male). There was no missing data in any of the variables in our study. Sociodemographic characteristics are presented in Table 1.

2.2. Measures

Key Life Events and Post Traumatic Stress

The Key Life Events and Post Traumatic Stress questionnaire was used to assess the traumatic events. This questionnaire covers a list of traumas extracted from the "List of Threating Experiences" (Brugha et al., 1985) and was presented to the participants in the form of cards. This way, prisoners were asked to look at the cards and acknowledge which events they endured. The responses were coded as "Yes" or "No" and to ensure reliability of the answers the cards were presented by trained clinicians.

The traumatic events assessed were: suffered bullying; suffered violence at work; suffered violence at home; suffered sexual abuse; suffered serious illness/injury; suffered separation/divorced; suffered death of spouse/partner; suffered death of parent/sibling; suffered death of a close friend/relative; suffered stillbirth; expelled from school; been sacked /made redundant; run away from home; been homeless; and experienced serious money problems.

Psychosis Screening Questionnaire

In the *Survey of Psychiatric Morbidity Among Prisoners in England and Wales, 1997*, the Psychosis Screening Questionnaire (PSQ; Bebbington and Nayani, 1995) was used to assess positive psychotic symptoms. The PSQ is a 12-item questionnaire with five main items relative to hypomania, thought insertion, paranoia, strange experiences, and hallucinations. Participants answers to these items were used in the present study (alpha = .59). In the original study, the complete PSQ displayed a sensitivity of 97% and a specificity of 95% (Bebbington and Nayani, 1995).

Clinical Interview Schedule—Revised

The Clinical Interview Schedule—Revised (CIS-R; Lewis and Pelosi, 1990) was used to evaluate the presence of general psychopathology symptoms as well assess their nature and severity. The CIS-R covers 14 sections: somatic symptoms, fatigue, concentration and forgetfulness, sleep problems, irritability, worry about physical health, depression, depression ideas, worry, anxiety, phobias, panic, compulsions, and obsessions. Moreover, in a series of studies, the CIS-R showed a good interrater reliability ranging from .53 to .56 (Lewis et al., 1992). The symptoms analyzed in the present study are detailed in Table 2.

Table 2
Items of psychosis screening questionnaire and from the revised clinical interview schedule and list of the traumatic events.

Item Label	Domain color	Item description	*n* (%)
te1	Blue	Suffered bullying	882 (29.0)
te2	Blue	Suffered violence at work	169 (5.6)
te3	Blue	Suffered domestic violence	1006 (33.1)
te4	Blue	Suffered sexual abuse	446 (4.7)
te5	Blue	Suffered serious ilness/injury	486 (16.0)
te6	Blue	Sufferd separation/divorced	1378 (45.3)
te7	Blue	Suffered death of spouse/partner	268 (8.8)
te8	Blue	Suffered death of parent/sibling	855 (28.1)
te9	Blue	Suffered death of close friend	1440 (47.4)
te10	Blue	Suffered stillbirth	256 (8.4)
te11	Blue	Expelled from school	1494 (49.2)
te12	Blue	Been sacked/ made redundant	1323 (43.5)
te13	Blue	Run away from home	1561 (51.4)
te14	Blue	Been homeless	1306 (43.0)
te15	Blue	Had serious money problems	1608 (52.9)
ps16	Orange	Hipomania	1863 (61.3)
ps17	Orange	Thought Insertion	829 (27.3)
ps18	Orange	Paranoia	1821 (59.9)
ps19	Orange	Strange Experiences	1228 (40.4)
ps20	Orange	Hallucinations	638 (21.0)
gs21	Green	Loss of appetite	1127 (37.1)
gs22	Green	Weight loss	1065 (35.0)
gs23	Green	Increase in appetite	800 (26.3)
gs24	Green	Weight increase	967 (31.8)
gs25	Green	Somatic complains	1836 (60.4)
gs26	Green	Fatigue	1472 (48.4)
gs27	Green	Concentration problems	1395 (45.9)
gs28	Green	Memory problems	1355 (44.6)
gs29	Green	Insomnia	2031 (66.8)
gs30	Green	Irritability	1945 (64.0)
gs31	Green	Health concerns	1305 (42.9)
gs32	Green	Depressive mood	2359 (77.6)
gs33	Green	Anhedonia	1378 (45.3)
gs34	Green	Lack of sexual interest	710 (23.4)
gs35	Green	Restlesness	1165 (38.3)
gs36	Green	Do things more slowly	1025 (33.7)
gs37	Green	Quiet	1409 (46.4)
gs38	Green	Guilt	927 (30.5)
gs39	Green	Inferiority	807 (26.6)
gs40	Green	Hopelessness	1243 (40.9)
gs41	Green	Worry	2026 (66.7)
gs42	Green	Anxiety	1818 (59.8)
gs43	Green	Phobias	222 (7.3)
gs44	Green	Panic	646 (21.3)
gs45	Green	Compulsions	842 (27.7)
gs46	Green	Obsessions	1417 (46.6)
gs47	Green	Not worth living	1424 (46.9)
gs48	Green	Wished was death	1352 (44.5)
gs49	Green	Suicidal ideation	1376 (45.3)
gs50	Green	Suicidal attempt	855 (28.1)
gs51	Green	Flashbacks	682 (22.4)
gs52	Green	Nightmares	500 (16.5)
gs53	Green	Intrusive memories	601 (19.8)
gs54	Green	Avoidance	644 (21.2)

2.3. Network Estimation and Analysis

The Ising model, implemented in the IsingFit package (version 0.3.1.; Van Borkulo et al., 2014) for R (version 3.6.1; R Development Core Team, 2018) was used to estimate the network connections between traumatic events, general psychopathology symptoms, and positive psychotic symptoms. The graphical representation of the network was computed using the Fruchterman-Reingold layout algorithm (Fruchterman and Reingold, 1991) in the package qgraph (version 1.6.3; Epskamp et al., 2019) for R (version 3.6.1.; R Development Core Team, 2018). This package was also used to estimate the shortest paths between traumatic events and psychotic symptoms and the shortest paths analysis by gender. Dijkstra's algorithm was used to compute the shortest paths (Dijkstra, 1959).

The accuracy and stability of the network was analyzed with R package bootnet (version 1.3; Epskamp & Fried, 2020), which estimates 95% bootstrapped confidence intervals (CIs) for each one of the connections. The correlation stability coefficient (CS-Coefficient; Epskamp et al., 2018) was also computed using R package bootnet. The CS-Coefficient estimates the maximum number of cases that can be dropped from the original data while maintaining a correlation of at least 0.7 (95%) between the original network and the one with the missing data (Epskamp et al., 2018).

3. Results

3.1. Network Descriptives

Fig. 1 represents the network of interactions between traumatic events, general psychopathological symptoms, and positive psychotic

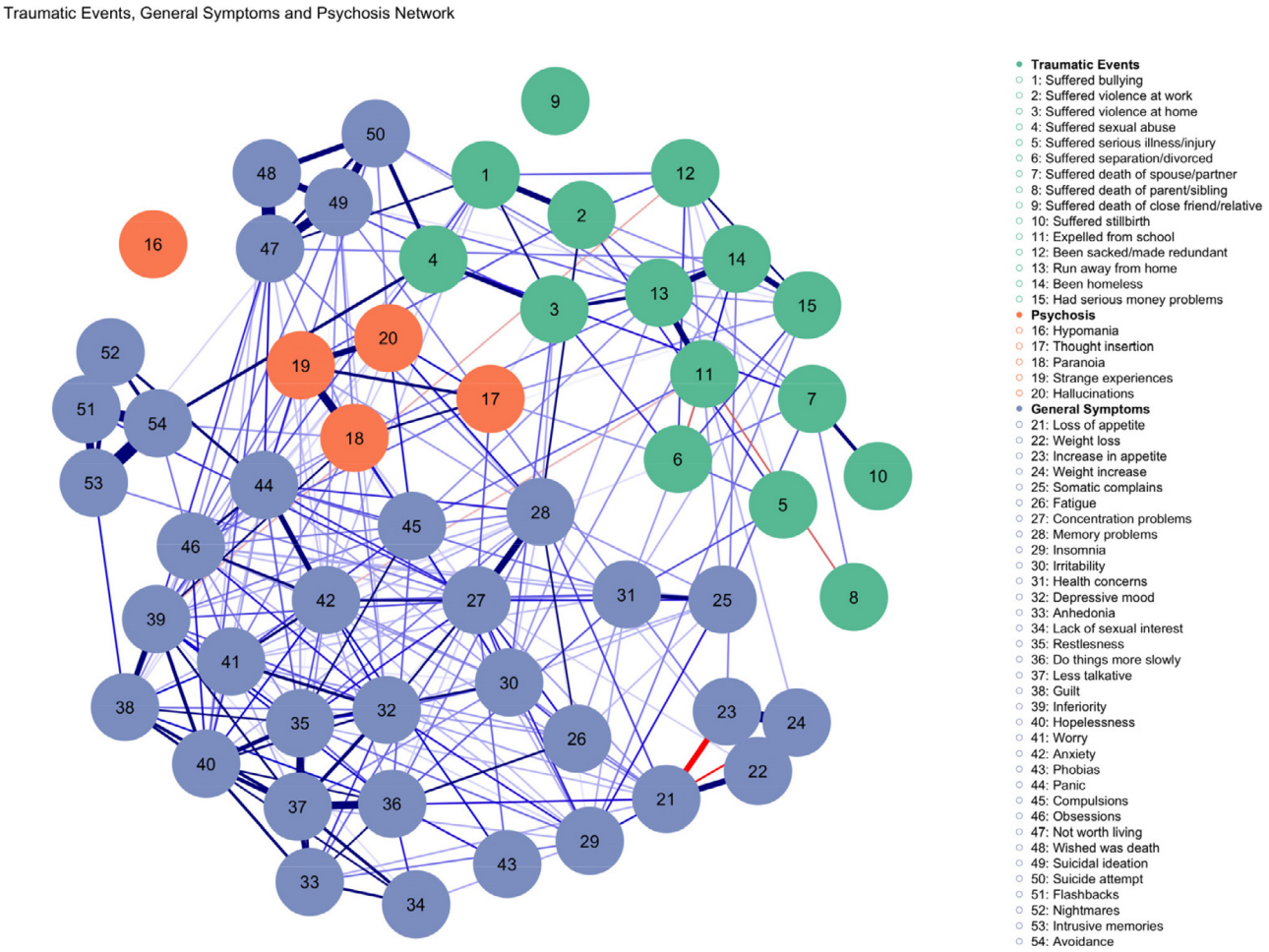

Figure 1. Network depicts the interactions between traumatic events, general symptoms and positive psychotic symptoms. Symptom groups are differentiated by colors. Green nodes represent traumatic events; orange nodes represent positive psychotic symptoms and blue nodes represent general symptoms. The thicker the lines are the stronger the connections between symptoms are. Positive correlations are represented in blue and negative correlations in red. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

symptoms. The network is constituted by 280 connections (density = .195), 272 positive connections, and eight negative connections. Positive connection weights varied between .012 and 2.814 (M = .347; SD = .416) and negative connections between .088 and 3.153 (M = .937; SD = 1.149). One psychotic symptom, "hypomania" (ps16), and one traumatic event, "suffered death of a close friend/relative" (te9), were isolated.

Regarding the stability of the network, the bootstrapped CIs and the CS-coefficient for the centrality strength was .75 and the CS-coefficient for betweenness centrality was .28. Closeness centrality did not show any variance. Analyses of network accuracy and stability are available in Figure 3, 4, 5 and 6 of supplementary materials.

3.2. Shortest Paths Between Traumatic Events and Psychotic Symptoms

Fig. 2 summarizes the shortest paths between traumatic events and positive psychotic symptoms (shortest path for each traumatic event are available in Fig. 2 of the supplementary materials). The shortest paths between each one of the traumatic events and the psychotic symptoms are detailed in the supplementary materials. Some traumatic events, namely, "suffered violence at work" (te2), "suffered separation/divorced" (te6), and "been homeless" (te14), showed direct associations with "strange experiences" (ps219), "thought insertion" (ps17), and "paranoia" (ps18), respectively. The remaining traumatic events are indirectly associated with psychotic symptoms either through one of these traumatic events or through general symptoms. For example, the shortest path between the exposure to "had serious money problems" (te15) and "paranoia" (ps18) includes "been homeless" (te14). In fact, frequent connections between traumatic events were observed. Three general symptoms mediated the association between traumatic events and psychotic symptoms: "memory problems" (gs28), "irritability" (gs30), and "compulsions" (gs45). "Memory problems" (gs28) were implicated in the shortest paths involving exposure to "suffered violence at work" (te2) and "hallucinations" (ps20); "irritability" (gs30) was implicated in the shortest paths involving "suffered violence at home" (te3) and "paranoia" (ps18); and "compulsions" (gs45) were implicated in the shortest paths involving "expelled from school" (te11) and "hallucinations" (ps20).

The impact of "suffered sexual abuse" (te4) followed a different pattern. The shortest path between "suffered sexual abuse" (te4) and "hallucinations" (ps20) was mediated only by "suicide attempt" (gs50). Moreover, the shortest path from "suffered sexual abuse" (te4) to "paranoia" (ps18) was mediated by "suicide attempt" (gs50), "suicidal ideation" (gs49). In turn, the shortest path from "suffered sexual abuse" to "strange experiences (ps19) and "thought insertion" (ps17) was mediated by "avoidance" (gs54), "flashbacks" (gs51), "nightmares" (gs52), and symptoms associated with "panic" (gs44).

4. Discussion

In this study, we aimed to detail the specificity of the relationship between different traumatic events and symptoms of psychosis. Our

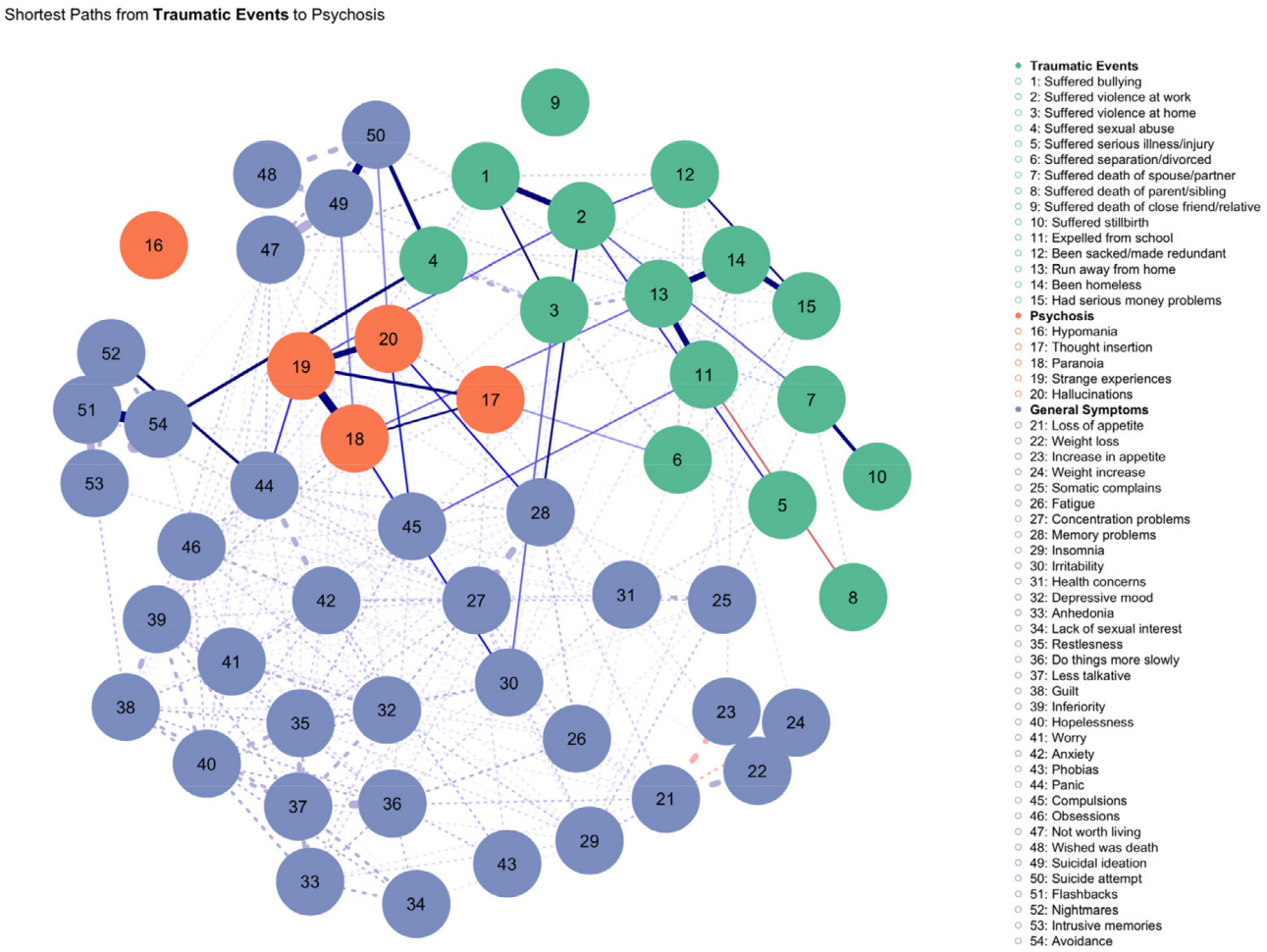

Figure 2. Network depicts the shortest paths between traumatic events, general symptoms and positive psychotic symptoms. Symptom groups are differentiated by colors. Green nodes represent traumatic events; orange nodes represent positive psychotic symptoms and blue nodes represent general symptoms. The thicker the lines are the stronger the connections between symptoms are. Positive correlations are represented in blue and negative correlations in red. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

results showed that the majority of the shortest paths between traumatic events and psychotic symptoms were mediated by symptoms of common mental health disorders. These results are in line with previous research in network analysis (Isvoranu et al., 2017, 2016; Moffa et al., 2017) and expand the earlier results by focusing on more general levels of trauma, not limiting to a particular traumatic event (i.e. childhood trauma).

Our results pointed to a restricted number of general symptoms involved in the paths between the traumatic events and psychotic symptoms, specifically, memory problems, compulsions, and irritability. Memory problems are common after exposure to a traumatic event (Brewin et al., 2007) and have been consistently associated with the development of psychosis (Bora and Murray, 2014; Geddes et al., 2016; Reichenberg et al., 2010). In particular, in this study memory problems were consistently implicated on the shortest path involving distinct traumatic events and hallucinations, which is consistent with the observation that the way trauma is cognitively processed can in part determine the occurrence of hallucinations (Geddes et al., 2016). Overall, these results suggest that difficulties in processing diverse traumatic experiences derived from cognitive problems may contribute to the emergence of psychotic symptoms, specifically hallucinations.

Compulsions were also implicated in most paths between traumatic events and psychotic symptoms, particularly hallucinations. Childhood adversities are one of the factors that contribute to the etiology of obsessive-compulsive disorders (Bey et al., 2017; Dhuri and Parkar, 2014.) and compulsions might be present in the prodromal period of psychosis (Bottas et al., 2005; Poyurovsky et al., 2012). Therefore, compulsions may have an important role in the development of psychosis after a traumatic event. This is important since it might help explain the high comorbidity rates between obsessive-compulsive disorder and psychotic symptoms (Cunill et al., 2013) and the severity of the latest symptoms (Schreuder et al., 2017).

Irritability was also involved in the interaction between traumatic events and psychotic symptoms, which is congruent with previous studies that revealed that a history of childhood trauma leads to fear and anger (Russo et al., 2015) that can turn into irritability due to the inability of psychotic patients to recognize their emotions (Bilgi et al., 2017). This inability to recognize emotions in psychotic patients and the anger originated by childhood trauma might explain why irritability appears as a mediator. Also, it helps explain the high rates of violence, hostility, impulsivity, and poor impulse control in patients with psychotic symptoms (Fazel et al., 2009; Witt et al., 2013).

A different set of general symptoms were implicated in the shortest paths between sexual abuse and psychotic symptoms related with suicide behaviors, traumatic symptoms, and panic. Suicidal behaviors are frequently reported by victims of sexual abuse (Bedi et al., 2012; Miller et al., 2017) and both are highly prevalent in individuals presenting psychotic disorders (Conus et al., 2010; Phillips et al., 2009). In the study of Kilcommons and Morrison, (2005), posttraumatic symptoms showed several associations with psychotic symptoms, and sexual assault was related specifically to hallucinations. In this study, this was also the case with the shortest path involving hallucinations and also

paranoia. Another network study that explored the impact of sexual abuse in psychosis found that anxiety is involved the path between sexual abuse and psychosis (Isvoranu et al., 2017). This study found similar results, with panic intervening in the pathway between sexual abuse and psychosis along with posttraumatic stress symptoms.

In addition to these indirect paths between traumatic events and psychotic symptoms, direct paths were also observed. These traumatic events covered exposure to violence at work, separation/divorce and homelessness. Previous research has been acknowledging the relationship between work and mental health problems, such us, depression or anxiety (Bowling and Beehr, 2006; Nolfe et al., 2007). Yet, in a smaller extent, some research found the presence of psychotic symptoms among individuals that experienced violence, often recognized as bullying at work (Verkuil et al., 2015). In this way, work contexts depicted as authoritarian or in which a strong hierarchy is present (Ulaş et al., 2018), as well as, in environments where the realization of tasks is performed alone and with distress (Villotti et al., 2019) might favor the disposition to the development of psychotic symptoms.

Regarding separation/divorce, it has been argued that this condition is frequently experienced as a stressful event and is related with the development of mental health problems (Knöpfli et al., 2016). However, previous research has predominantly associated this situation with depression, anxiety and substance abuse disorders (e.g. Chatav and Whisman, 2007; Lin et al., 2019). Interestingly, in our study, we found a direct association with a psychotic symptom (i.e. thought insertion). We believe, that this finding might constitute a new insight about other possible mental health outcomes related with this stressful event. This way, we encourage future research to focus on this particular event and their possible mental health outcomes.

Likewise, been homelessness is perceived as a distressing and painful situation whereby, are considered high-risk group for the development of psychotic symptoms (Ayano et al., 2019; Fazel et al., 2008). This might occur through the repeated exposure to stressful and traumatic situations over the course of life (Nilsson et al., 2019), which might predispose them to a more vulnerable state for the development of psychotic symptoms. Nevertheless, research is limited about the interaction between these specific traumatic events and the development of psychotic symptoms. Importantly, these direct paths might also point to a lack of information in our network and the absence of other possible mediator symptoms for these specific events. Thus, our results open new venues for future research concerning the development of psychotic symptoms.

Lastly, we found various connections between different traumatic events. This result has also been found in similar studies using network analysis (Isvoranu et al., 2017), and it is consistent with the experience of repeated traumatic events (i.e., poly-victimization, which is more common in incarcerated and psychotic individuals; Arseneault et al., 2011; Crush et al., 2018; Kelleher et al., 2013).

All these results point to the benefits of network analysis on the examination of patterns of interaction, allowing for a more complex view of the interactions between symptoms and events, contributing to a better understanding of the specific relationships between traumatic events and psychotic symptoms.

Nevertheless, our results should be cautiously interpreted in light of some limitations of the present study. Firstly, our results pertain to a specific population, namely, a sample of prisoners, whereby the generalization of our findings to diagnosed patients' needs to be considered prudently. Secondly, we use cross-sectional data, whereby the positive psychotic symptoms would probably be at a subclinical level. Moreover, the use of cross-sectional data on a specific sample whose traumatic events were experienced at different ages may obscure developmental processes that modulate the psychological response to trauma (Sedgwick, 2014). In order to surpass these limitations, we suggest that future studies should perform clinical interviews to obtain a more comprehensive view of the different stages of the psychotic symptomatology and adopt an Ecological Momentary Assessment (EMA; Shiffman et al., 2008) design, in which it would be possible to assess general and psychotic symptoms at different times after the traumatic event. The use of this experimental procedure would enable a more detailed view of the symptoms developmental processes. Also, it should be noted that while we have estimated the shortest paths between traumatic events and psychosis, the development of psychosis might occur through different and possibly longer paths. Likewise, the exclusive assessment of positive psychotic symptoms constitutes a limitation; future research should also include negative symptoms to unveil and clarify other possible relationships between traumatic events and psychotic symptoms. Furthermore, the shortest paths do not allow the inference of direction and causality effects in the network. One way to advance in this direction is to use Bayesian techniques, such as Directed Acyclic Graphs (Jones et al., 2018) to explore the causality of the interactions between traumatic events, general symptoms, and psychotic symptoms. Alternatively, experimental studies could constitute a possibility to overcome the difficulties in establishing causal effects in the network.

In conclusion, our findings open new insights by detailing a vast number of associations between traumatic events and general and psychotic symptoms, which for treatment purposes might help design specific interventions and prevent the development of the worst prognosis among prisoners.

Contributors

FF, DC and TF conceived the study. ASA and ARF wrote the initial draft. FF, DC and TF wrote the final manuscript, performed the analysis and prepared the supplementary materials. TF supervised the project.

Declaration of Competing Interest

The authors declare that they have no conflict of interest.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.psychres.2020.112894.

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