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'No mAN IS AN ISLAND'. Testing THE SPECIFIC ROLE OF SOCIAL ISOLATION IN FORMAL THOUGHT DISORDER

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Title: 'No man is an island'. Testing the specific role of social isolation in formal thought disorder.

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Abstract: Recent work has focused on the role of the environment in psychosis with emerging evidence that specific psychotic experiences are associated with specific types of adversity. One risk factor that has been often associated with psychosis is social isolation, with studies identifying isolation as an important feature of prodromal psychosis and others reporting that social networks of psychotic patients are smaller and less dense than those of healthy individuals. In the present study, we

tested a prediction that social isolation would be specifically associated with formal thought disorder. 80 patients diagnosed with psychosis-spectrum disorder and 30 healthy participants were assessed for formal thought disorder with speech samples acquired during an interview that promoted personal disclosure and an interview targeting everyday topics. Social isolation was a highly significantly associated with formal thought disorder in the neutral interview and in the salient interview, even when controlling for comorbid hallucinations, delusions and suspiciousness. Hallucinations, delusions and suspiciousness were not associated with social isolation when formal thought disorder was controlled for. Formal thought disorder is robustly and specifically associated with social isolation. Social cognitive mechanisms and processes are discussed which may explain this relationship as well as implications for clinical practice and future research.

Keywords: formal thought disorder; social isolation; psychosis; schizophrenia; hallucinations; delusions. .

1. Introduction

Over the last decade, there has been a renewed interest in the role of social adversity in schizophrenia (van Os et al., 2010; Read et al., 2014). Factors such as familial miscommunication (de Sousa et al., 2013), migration (Cantor-Graae and Selten, 2005), exposure to urban environments (Vassos et al., 2012), childhood sexual abuse, bullying and other childhood (Varese et al., 2012b) and adulthood adverse events (Beards et al., 2013) are associated with an increase in the risk of psychosis. In

addition, there is emerging evidence that specific adversities are related to specific psychotic symptoms. Examples include associations between childhood sexual abuse and hallucinations and between disrupted early attachment relationships and paranoia (Bentall et al., 2012; Shevlin et al., in press). Psychological mechanisms that might explain these relationships have also been suggested (Varese et al., 2012; Bentall et al., 2014; Sitko et al., 2014).

1.1. The relevance of formal thought disorder (FTD)

FTD refers to a set of communicational, cognitive and language disturbances that render the speech of some individuals difficult to follow and apparently unintelligible (Andreasen, 1982). Examples of FTD can vary from instances of incoherence (e.g. "Yes, they add up and kind of like a solution. It's say, it's a equine or equinox, like fungi. Something in the brain tells you it's a high number. Bacteriology, a numerate number, it's a particle, therefore it contains solution is to answer the right question" Laws et al., 1999, p. 105) to illogicality (e.g. "Parents are the people that raise you. Anything that raises you can be a parent. Parents can be anything, material, vegetable, or mineral, that has taught you something" Andreasen, 1986, p. 478).

These disturbances have been relatively neglected in social psychiatry research but are important for several reasons. First, FTD is highly prevalent in psychotic patients, with some estimates reaching 91% (Roche et al., 2014). Second, it is associated with poorer occupational functioning (Racenstein et al., 1999), poorer social functioning (Bowie and Harvey, 2008; Bowie et al., 2011), and poorer quality of life (Tan et al., 2014). Third, FTD has been found to be highly predictive of future psychotic relapse (Wilcox, 1990) a picture that is further complicated by the relative lack of evidence-based therapeutic strategies to address it (Beck et al., 2009; Stolar and Grant, 2011) and its persistent course (Marengo and Harrow, 1987, 1997; Docherty et al., 2003; Bowie et al., 2005). Last but not least, FTD seems to be an early predictor of later conversion into psychosis in high-risk populations (Ott et al., 2002; Cannon et al., 2008; Bearden, et al., 2011) providing clinicians and services alike with a potential window of opportunity for early detection and preventative work.

1.2. Psychological mechanisms in FTD

Over the years several psychological mechanisms have been evoked to explain FTD including difficulties at the level of 'theory-of mind' (ToM; Frith, 1992; Hardy-Baylé et al., 2003; Sprong et al., 2007), poor internal source monitoring (Harvey, 1985; Nienow and Docherty, 2004), deficits at the level of executive function (McGrath, 1991; Kerns and Berenbaum, 2002) and semantic hyperpriming (Spitzer, 1997; Pomarol-Clotet et al., 2008). A widely replicated finding, reported in both schizophrenia patients and bipolar patients, is that FTD and communication disturbances are more evident when patients discuss affective-laden topics (Shimkunas, 1972; Docherty et al., 1994; Haddock et al., 1995; Docherty, 1996; Tai et al., 2004; Docherty, 2005).

Much less is known about social predictors of FTD. Although FTD has often been assumed to be an endophenotype of schizophrenia (Meehl, 1962; Levy et al., 2010) several studies have identified important psychosocial factors associated with its development such as dysfunctional family communication (Wahlberg et al., 1997, 2000; Roisko et al., 2014), childhood adversity (Toth et al., 2011; Shah et al., 2014) and institutionalization (Walker et al., 1981).

1.3. Social isolation and psychosis

Since Faris and Dunham's (Faris, 1934; Faris and Dunham, 1939) classic ecological study in Chicago, there has been an accumulation of studies showing that social isolation is an important factor in psychosis (van Os et al., 2000; Boydell et al., 2004). The relevance of social isolation in schizophrenia has also been well acknowledged in the psychoanalytical literature (Sullivan, 1953). For example, Freud argued for the centrality of the patient's withdrawal from the surrounding world as a crucial process in psychosis (i.e. process of libidinal decathexis, Freud, 1914) and other authors have argued that this process of desocialisation is crucial to understand psychotic experiences given its detrimental impact on symbolic thought (Arieti, 1955).

Consistent with this, early empirical studies have reported for example higher levels of social isolation in communities with high incidence rates of schizophrenia (Jaco, 1954) and higher rates of social isolation in patients diagnosed with schizophrenia (Hirschberg, 1985). These findings have been supported by other studies that have reported that psychotic patients have smaller social networks (Erickson et al., 1989), fewer individuals in their social networks (Macdonald et al.,

2000), fewer confidants (Morgan et al., 2008) and are three times more likely to have low frequency of contact with others in their social network (Reininghaus et al., 2008) with some studies suggesting that this may be significantly more pronounced in urban environments (Schomerus et al., 2007).

Population studies with a non-clinical samples have also reported associations between lack of perceived social support and psychotic experiences (Alptekin et al., 2009) and a dose-response relationship between having smaller primary network at baseline and self-reported psychotic experiences at 18-month follow-up (Wiles et al., 2006). Other studies and reviews have reported that isolation is also a factor that challenges patient's recovery (Soundy et al., 2015), is associated with increased number of admission (Simone et al., 2013) and with poorer outcomes (Harvey et al., 2007).

It has been suggested that social isolation may be the result of a "social network crisis" following first admission to a mental health ward (Lipton et al., 1981). However, the population studies mentioned above have been carried out with samples of non-clinical participants that have never been admitted. Moreover, both retrospective and prospective birth cohort studies have found that social isolation in childhood is associated with a later diagnosis of schizophrenia (Jones et al., 1994; Cannon et al., 1997; Welham et al., 2009). In a cohort study of 50,054 Swedish conscripts, individuals who later developed psychotic experiences at a 15-year follow up were significantly more likely to have fewer than two friends and to prefer smaller groups (Malmberg et al., 1998) suggesting that social isolation may predate the onset of symptoms and the diagnosis. Consistent with this, a recent systematic review revealed that individuals diagnosed with first episode of psychosis have significantly smaller social networks than healthy individuals suggesting again that social isolation and smaller social networks predate onset of psychotic disorder (Gayer-Anderson and Morgan, 2013). Finally, studies of individuals with prodromal symptoms report as well that social withdrawal is a very common feature in individuals before the onset of psychosis (Tan and Ang, 2001; Mäki et al., 2014).

1.4. Social isolation and specific symptoms

How might social isolation contribute to the onset, development or maintenance of individual psychotic symptoms? Hoffman (2007, 2008) has suggested that social isolation and withdrawal during critical developmental periods may lead to deafferentation of brain regions that support social cognition and therefore predispose individuals to psychotic experiences (e.g. leading to the induction of anomalous experiences). Studies using animal models have reported findings consistent with this hypothesis (Silva-Gómez et al., 2003; Fone and Porkess, 2008; Fabricius et al., 2011).

In a more psychological account, Freeman and colleagues (Freeman et al., 2002; Freeman and Garety, 2006; Freeman, 2007) have suggested that social isolation may contribute to maintenance of persecutory beliefs by not allowing opportunities for these beliefs to be reviewed and disconfirmed by people in the social network of the individual. Drawing on data from large population study, Freeman et al. (2011) reported an association between self-reported paranoia and a range of demographic (e.g. being single) and psychological indicators of social isolation (e.g. less perceived social support). However, in a different study the association between number of social supports and paranoia was not significant when authors adjusted for confounders (Freeman et al., 2008).

The possible association between FTD and social isolation has not yet been explored empirically but there are some interesting clues to why isolation might be a particularly relevant factor in this cluster of symptoms. Some authors have reported that, when thought-disordered patients are asked to clarify some of their utterances, for example by providing more contextual information, these utterances become intelligible and comprehensible (Harrow et al., 1983). Hence, patients seem able to construct coherent utterances when cued to do so in an appropriate social context. The same group of researchers proposed that patients' apparent unintelligible utterances may be a consequence of the *intermingling* of decontextualized personal concerns and worries coupled with an inability to take the perspective of the listener and to speak to the listener's needs (Harrow et al., 1983; Lanin-Kettering and Harrow, 1985; Harrow et al., 2000) which is a prerequisite for the establishment of conversational alignment (Pickering and Garrod, 2006). Such an account is consistent with those social-cognitive models of FTD (Frith, 1992; Hardy-Baylé et al., 2003; Sprong et al., 2007) that propose that the thought disordered individual is unable to adjust speech to the

needs of an audience due to a failure to represent the state of knowledge of the listener.

One possible explanation for the FTD is that an inability to take the perspective of the listener may be due to a lack of social contact and consequentially missed opportunities for social feedback during conversation (Hammer et al., 1978); after all, conversation is a social skill. To the best of our knowledge, this hypothesis has never previously been tested but it is consistent with evidence from studies that have reported that communicability in FTD participants can be improved through video-taped feedback (Satel and Sledge, 1989).

1.5. Aims of the present study

In the present study, we therefore test whether participants diagnosed with psychotic-spectrum disorders report significantly more social isolation than non-clinical participants and more importantly, if levels of social isolation specifically predict scores of FTD. Given previous arguments that hallucinations (Hoffman, 2007, 2008) and paranoia (Freeman et al. 2002; Freeman, 2007) are associated with social isolation, we also studied the associations between social isolation and these symptoms, in each case controlling for the presence of comorbid FTD.

2. Methods

2.1. Participants and procedures

80 clinical participants (see Table 1) were recruited from local mental health sites across the North West of England. Participants were identified and referred by local care coordinators such as mental health nurses, social workers and consultant psychiatrists. The recruitment targeted 18-65 year olds with a psychotic-spectrum disorder as primary diagnosis defined as schizophrenia (F20), schizoaffective (F25) or unspecified non-organic psychosis (F29) according to ICD-10 (World Health Organization, 2004). We excluded participants who lacked capacity for informed consent (as determined by care coordinator) whose first language was not English as well participants with severe learning difficulties; recent alcohol or drug abuse; history of neurological disorders or any other non-psychotic disorders that could affect brain function (only two potential participants were excluded – one because his first language was not English and the other because patient was deemed by own care team to be too unwell to take part in the study). Demographic and clinical information

was taken from participant during the first visit or from members of the care team (almost always the mental health practitioner responsible for the patient's care e.g. mental health nurse or social worker) with participant's prior consent. Antipsychotic medications were converted to chlorpromazine equivalents as per agreed conventions (Woods, 2003).

INSERT TABLE 1 HERE

For comparison purposes, 30 participants with no history of psychosis were recruited through local advertisements in the community (also shown in Table 1). All of these participants were screened for psychotic symptoms with the Psychosis Screening Questionnaire (PSQ; Bebbington and Nayani, 1995). An attempt was made to select participants who were approximately comparable with our participants in the clinical group on variables such as sex, age and ethnicity. None of the non-clinical participants was excluded.

The current study is a case-control study that is part of a larger research project on the social, cognitive and affective predictors of FTD. The research project has been approved by UK National Research Ethics Service (NRES), by the R&D departments of local NHS Mental Health Trusts (Merseycare NHS Trust and Cheshire and Wirral Partnership) and is sponsored by the University of Liverpool.

All participants were provided with information about the study and allowed a week to decide whether they wanted to take part. After consenting, all participants were seen twice on different days. The interval between the two sessions was in most cases a few days and never more than one week. Participants in the clinical group were interviewed with PANSS (Kay et al., 1987) whereas controls were screened with the PSQ (Bebbington and Nayani, 1995) all the interviews were carried out by first author and took on average 30-45 minutes. Following these assessments, participants then completed the QT and LSNS-18. All interviews and testing took place in the participants' homes with the exception of three participants who were interviewed at the University of Liverpool as per individual request. Each participant was interviewed using the salient and non-salient interviews (Haddock et al., 1995; Tai et al., 2004) in a randomly counterbalanced order across the two sessions. Each interview followed a strict protocol and each question started with the same statement

(e.g. "Can you tell me about…?"). Interviews lasted approximately 15 minutes on average, providing authors with 30-minutes of speech per participant. Each participant was paid £20 for participation.

The speech samples were recorded with a digital voice recorder (Olympus VN711 PC 2GB) and later transcribed by the first author and a professional transcriber, before being coded by PS and AS using the TLC.

The first and third authors independently coded 10% (22) of the speech samples for reliability purposes. The coding was preceded by the careful reading of the TLC and relevant papers (Andreasen, 1979a, 1979b, 1986; Andreasen and Grove, 1986) and by practice sessions. For some of the TLC items it was not possible to calculate a Kappa, as they were very infrequent (e.g. neologisms, clanging, etc.). For the remaining items all Kappa values were of substantial magnitude with tangentiality achieving the highest level of agreement (K= 0.82) and self-reference the lowest (K= 0.62).

2.2. Assessment tools

2.2.1. Psychotic symptoms

Psychotic symptoms were measured using the *Positive and Negative Syndromes Scale* (PANSS; Kay et al., 1987). The PANSS is a widely used clinical interview that measures 30 symptoms, comprising a positive symptom scale, a negative symptom scale, and a general psychopathology scale. Each item is scored from 1 to 7 with the higher score indicating increased severity. The scale has been found to have good psychometrical properties (Kay et al., 1987). The means and standard deviations for the clinical group are presented in Table 1.

2.2.2. IQ

Pre-morbid verbal intelligence was measured using the Ammon's Quick test (QT; Ammons and Ammons, 1962), a picture-vocabulary test, which is not timed and therefore ideal for the study. The participant is presented with four pictures of different situations (e.g. a policeman stopping the traffic with a whistle so that two schoolchildren can cross the road) and is asked to identify fifty progressively difficult words by simply pointing to the appropriate card where the word referent can be found (e.g. "whistle"). The final score is achieved by summing the number of words correctly identified by the participant. The QT has been extensively used in clinical

studies with mental health participants and correlates with WAIS scores (Lezak, 2004). All QT scores were converted into IQ equivalent scores using standardized guidelines. The means and standard deviations for both groups are presented in Table 1.

2.2.3. Interviews

Speech samples were gathered from all participants using two interview protocols that had been previously developed to elicit FTD (Haddock et al., 1995; Tai et al., 2004). The protocols elicited speech samples relating to emotionally-laden (salient interview) and neutral topics (non-salient interview), given the evidence that participants diagnosed with psychosis show more FTD when asked to talk about emotional topics (Shimkunas, 1972; Docherty et al., 1994; Docherty, 2005). The salient interview involved fifteen questions (and eight reserve questions) that promoted self-disclosure by asking for negative autobiographical memories (e.g. "Can you tell me about the most awful thing that someone has done to you?"), whereas the neutral interview included fifteen questions (and six reserve questions) that did not promote self-disclosure (e.g. "Can you tell me about travelling on public transports?"). Mean duration of the interviews as well as means and standard deviations of the different word counts are presented in Table 2.

INSERT TABLE 2 HERE

2.2.4. FTD

The speech samples were rated using the Scale for the Assessment of Thought, Language and Communication (TLC; Andreasen, 1986), a widely used scale that provides definitions and scores for 18 different types of FTD. Some items are considered more pathological and others less pathological. The different categories of FTD are rated on a scale of severity ranging from 0 to 4 or 0 to 3 (depending on the item). The global rating is achieved by summing the scores of the different subscales (with the score of the more pathological items being multiplied by 2). The scale can be applied to any speech samples and has been shown to have good psychometric properties (Andreasen, 1979b, 1986).

2.2.5. Social Isolation

Social isolation was measured with the *Lubben Social Network Scale* (LSNS-18; Lubben, 1988), a self-report questionnaire that measures the size, closeness and frequency of contacts within social network using 18 items (e.g. "How many relatives do you see or hear from at least once a month?"). The scores for each question range from 0 to 5 with the higher score representing more social isolation (we reversed the original scoring for purposes of simplicity). The questionnaire is divided across three social network domains (family, neighbours and friends) and the instrument has been found to have good internal consistency (Lubben and Gironda, 2004). The highest possible total score is 90 and the lowest score is obviously 0. Table 1 shows the mean and standard deviation of the scores for both groups.

2.3. Statistical analysis

Statistical analyses were carried out on IBM SPSS Statistics. T-tests and Chi-squares were used to characterize and compare the groups on demographic variables and social isolation. Interrater reliability for TLC scores (FTD) was calculated using Cohen's kappa coefficients for the different TLC items. We tested the differences in the frequency of the different TLC items between groups for both interviews using a MANOVA with Bonferroni correction for multiple comparisons as suggested in the literature (Sainani, 2009). A 2x2 mixed ANOVA was used to compare FTD variables between groups and across conditions. We used partial correlations to explore relationships between variables controlling for age, sex, education and verbal IQ (Bowie et al., 2005; Roche et al., 2014) with and without Bonferroni correction. Finally, to test whether FTD was significantly and specifically predicted by social isolation we conducted two independent two-stepped linear regressions with the FTD scores of both interviews (neutral and salient interview) as the outcome variable. In both regression models we entered the PANSS scores for hallucinations, delusions and suspiciousness in the first step and added the social isolation score in the second step. Finally, to complement the statistical analyses, we conducted three further two-stepped linear regressions using PANSS scores for delusions, hallucinations and suspiciousness as dependent variables. In these, FTD scores and remaining symptoms were entered in the first step as control variables and social isolation was added in the second step.

3. Results

3.1. Demographics and clinical variables

Table 1 shows descriptive statistics for some of the demographic and clinical measures. The two groups did not differ for sex (χ^2 = 0.07; p= 0.795), age (t= 0.33; p= 0.746) or ethnicity (χ^2 = 0.01; p= 0.936). However, our comparison group had significantly more years of education (t= -3.35; p< 0.001) and significantly higher scores on the Quick test (t= -5.18; p< 0.01). The means and standard deviations of the PANSS factors approximate to the values reported in other studies (Kay et al., 1987). More participants in our clinical group were single and unemployed than in the comparison group (χ^2 = 11.38; p< 0.001 and χ^2 = 44.76; p< 0.001, respectively).

3.2. FTD

Table 2 displays the distribution of FTD scores across the two groups and interviews with between group comparisons for the individual TLC items. One-way MANOVAs based on all of the individual TLC items showed significant differences between groups in both salient (F[18,91]= 2.67, p< 0.001, ηp^2 = 0.35) and non-salient interviews (F[17,92]= 2.84, p< 0.001, ηp^2 = 0.34). After Bonferroni correction, patients displayed significantly more FTD only on poverty of speech (marked reduction in speech), tangentiality (these two items in both interviews) and derailment in the neutral interview. However, it should be noted that the Bonferroni method is a highly conservative test (*see* Sainani, 2009). The frequency of the different items in both participants and comparisons comes very close to the distributions of scores originally reported by Andreasen and Grove (1986) with the exception that we found more instances of circumstantiality. This may well be due to the nature of our protocol, which invited participants to speak about emotionally challenging topics. TLC categories such as circumstantiality (a pattern of speech that is delayed getting to the point and that is marked by excessive and irrelevant details), illogicality (a pattern of speech marked by inferences that are illogical) or tangentiality (speaker replies to a question in a way that is only vaguely related to the topic) could just reflect that the participant found it hard to answer the emotionally-salient question or even avoided it by "going off on a tangent". Moreover, it is interesting to note that we found evidence of attenuated FTD amongst healthy volunteers, especially in the salient condition,

replicating Andreasen's original findings (Andreasen, 1979a; Andreasen and Grove, 1986).

In order to compare FTD between groups and across conditions (salient and non-salient interview), we conducted a 2x2 mixed ANOVA using TLC total scores. There was a non-significant interaction between group and condition, $F[1,108]= 3.88$, $p= 0.052$, $\eta p^2 = .04$. There was substantial main effect for condition, $F[1, 108]= 38.33$, $p< 0.001$, $\eta p^2 = 0.26$ with both groups showing an increase in FTD in the salient condition (see Figure 1). The main effect comparing the two groups was also significant, $F[1, 108]= 28.93$, $p< 0.001$, $\eta p^2 = 0.21$.

INSERT FIGURE 1 HERE

3.3. Social Isolation

The means and standard deviations for the social isolation scores are presented in Table 1. As expected, the clinical group was significantly more isolated than our comparison group ($t= 5.80$; $p< 0.001$).

3.4. Social Isolation and symptoms

FTD in the comparison group was not significantly correlated with social isolation in either the salient ($r= 0.21$, $p= 0.269$) or the non-salient condition ($r= 0.04$; $p= 0.818$). Table 3 shows the partial correlations between social isolation, FTD in both salient and non-salient interviews, hallucinations (P3), delusions (P1), suspiciousness (P6) and conceptual disorganization (P2) for our 80 clinical participants controlling for sex, age, years of education and verbal IQ. It is worth noting the lack of significant associations between social isolation and delusions, hallucinations, suspiciousness as opposed to the strong association with FTD in both interviews. Also, relevant is the robust and significant associations between FTD on both interviews and conceptual disorganization item of the PANSS (P2). These p-values survived Bonferroni correction.

INSERT TABLE 3 HERE

In order to explore the relationships between symptoms and social isolation in more detail we conducted five regression analyses using data from our clinical sample only. Control symptoms were entered in the first step and then isolation scores we entered in a second step (see Table 4). In the analysis with FTD from the salient interview as the dependent variable, the initial model with the other symptom predictors (hallucinations, delusions and suspiciousness) was significant. Adding social isolation improved the model, leading to a final significant model, in which, social isolation was a significant predictor of FTD (b= 0.52, p< 0.001).

In the second analysis, we used FTD from the neutral interview as the dependent variable. The initial model with the other symptom predictors (hallucinations, delusions and suspiciousness) was significant. Adding social isolation improved the model, leading to a final significant model, in which, social isolation was a significant predictor of FTD (b= 0.46, p< 0.001).

In three further analyses, we used PANSS P1 (delusions), P3 (hallucinations) and P6 (suspiciousness) as dependent variables using both FTD scores (salient and non-salient) as well as the remaining symptoms as control variables in the first step. In each case, the addition of social isolation in the second step failed to improve the model, F_{change} [1, 74]= 0.3, p> 0.5 for all analyses, and social isolation failed to predict the symptom in the final model.

INSERT TABLE 4 HERE

4. Discussion

First and foremost, the results of the present study show that our clinical participants reported significantly more social isolation than our non-clinical controls which is consistent with previous studies (Hirschberg, 1985; Erickson et al., 1989; Macdonald et al., 2000; Reininghaus et al., 2008). Secondly, and more importantly social isolation was found to be strongly and specifically associated with FTD even when comorbid psychotic experiences such as hallucinations, delusions and suspiciousness and potential important confounders such sex, age, years of education and verbal IQ were accounted for (Gayer-Anderson and Morgan, 2013). That social isolation did not predict either hallucinations or delusions was unexpected given that isolation has been theorized to be implicated in their development and maintenance (Freeman, 2007; Hoffman, 2007, 2008) but again, and as discussed in the introduction, the association

between paranoia and social isolation has been proven to be weak at least in non-clinical samples (Freeman et al., 2008). In this study, we also replicated previous findings showing that FTD worsens when patients discuss emotionally-laden topics i.e. emotional reactivity of speech (Docherty et al., 1994).

It is also interesting to note the significant association between FTD and delusions but not between FTD and hallucinations (although this association did not survive Bonferroni correction). One possible explanation for this pattern of co-occurrence is that the personal worries and concerns that are at the core of delusional beliefs may be the same decontextualized worries and concerns that intermingle and intrude in the thought disordered patient's speech as suggested by Harrow and colleagues (Harrow et al., 1983; Harrow and Quinlan, 1985; Lanin-Kettering and Harrow, 1985).

The present findings can be contextualized in a larger endeavor to link specific adversities to psychotic symptoms (Bentall et al., 2012; Varese et al., 2012) and are especially important given our currently poor understanding of the role of social context and the environment in FTD. Obviously, this cross-sectional study cannot answer the direction of causality, and it remains possible that FTD leads to social isolation. In this context, it is interesting to note that social isolation has been found to predate the onset of psychosis in birth cohort (Jones et al., 1994; Welham et al., 2009) and in prodromal studies (Malmberg et al., 1998; Tan and Ang, 2001). In addition, it could be argued that, if social isolation was a consequence of psychosis we should expect to observe stronger associations with hallucinations and delusions. Furthermore, some researchers have reported a significant association between deactivating attachment strategies and FTD in patients diagnosed with schizophrenia and bipolar disorder (Dozier and Lee, 1995). Deactivating strategies are employed when proximity seeking is perceived as dangerous and they help to maintain psychological distance, suppress attachment-related needs, avoid intimacy, emotional involvement and self-disclosure (Shaver and Mikulincer, 2007) which could potential explain why our participants showed more FTD in the interview that promoted personal disclosure.

It has been argued that one of many criteria for inferring causality in non-experimental studies is the identification of plausible mechanisms (Hill, 1965). This issue is especially relevant given the robustness and specificity of the association we report. Why would social isolation be so toxic for the communication, cognitive and

linguistic skills of the psychotic individual? Given our current knowledge of the psychological processes and mechanisms involved in TD, one plausible explanation is that social isolation affects aspects of social cognition such as ToM (Frith, 1992; Corcoran et al., 1995; Hardy-Baylé et al., 2003; Sprong et al., 2007; Docherty et al., 2013) and internal source monitoring (Harvey, 1985; Nienow and Docherty, 2004) which have both being implicated in this cluster of symptoms. Perhaps a lack of social interaction and conversational opportunities has a detrimental impact on the individual's capacity to successfully align and share topics. This impact is felt through an effect on social cognitive mechanisms (e.g. ToM, emotion perception, social perception and social knowledge) known to be impaired in psychotic participants (Savla et al., 2013) and which are important for effective communication. Interestingly, the same social-cognitive difficulties have also been reported in the relatives of participants diagnosed with schizophrenia (Lavoie et al., 2013) and are consistent with patterns of family miscommunication found in parents of psychotic participants (de Sousa et al., 2013).

4.1. Limitations

There are several limitations to the present study. The most obvious, already noted, is that we used a cross-sectional design making it very difficult to disentangle cause and effect. Furthermore, social isolation develops and changes across time and this dynamic aspect is very difficult to capture with a cross-sectional design.

Another important limitation of the present study is the use of a self-report questionnaire to measure the participants' social networks. These measures are obviously open to distortions and recall biases that are extremely difficult to control. Also, we opted to recruit only participants diagnosed with psychotic-spectrum disorders but there is evidence that FTD is a transdiagnostic cluster of experiences that is highly prevalent in patients diagnosed with bipolar affective disorder (Andreasen and Grove, 1986; Tai et al., 2004) amongst other diagnoses (McKenna and Oh, 2005).

In a future study, it would be interesting to investigate the relationship between social isolation and FTD across time using a longitudinal design and employing more robust measures of social isolation (e.g. a standardized interview where non-specific prompting can be used and collateral information can be gathered

from significant others). It may also be useful to use a transdiagnostic framework by including participants with other diagnoses (e.g. bipolar affective disorder).

Finally, in our study we only controlled for hallucinations, delusions and suspiciousness in future studies it would be relevant to include specific measures for other symptoms (e.g. anxiety or negative symptoms) and measures targeting specific psychological factors associated with psychotic experiences (e.g. degree of conviction of delusional belief).

4.2. Clinical implications: from the lab to therapy

Further exploration of the psychological mechanisms mediating between life circumstances and psychosis and especially FTD may have important implications for clinical care. At present, there are no evidence-based strategies to address FTD but the identification of the responsible mechanisms could lead to the development of targeted interventions that can be tested in clinical trials (e.g. specific training in conversational alignment with sensitive feedback when speech is difficult to follow). As reported elsewhere in this paper some authors have provided some tentative evidence that simple audiotape replay can be beneficial (Satel and Sledge, 1989).

Another avenue may be to provide patients with conversational opportunities (e.g. in the context of a therapeutic community). Along with the results of the present study, there are several clues to suggest that this approach might be helpful. For example, St-Hilaire and Docherty (2005) have reported a significant association between affective reactivity of speech in psychotic patients and difficulties relating to others and fear of social relationships. In line with these findings, Grant and Beck (2009) reported that evaluation sensitivity (i.e. dysfunctional beliefs about social acceptance) seems to play an important mediating role in FTD, possibly worsened by the individual's awareness of their communication difficulties (McGrath and Allman, 2000). Hence, in future clinical studies it may be useful to assess the possible role of general supportive environments such as therapeutic communities in helping the thought disordered patient. There is some evidence that this community-based therapeutic milieu offers an important alternative to standard psychiatric care (Calton et al., 2008). Alternatively, and perhaps less costly, may be to utilise social network interventions. These interventions have been proven to be effective in reducing isolation in socially withdrawn individuals (Terzian et al., 2013).

Another potential avenue may be to strenghten existing social skills training programmes by emphasising components on conversational skills (e.g. starting, maintaining and terminating a conversation, modeling and role-playing different conversational situations, etc.) and specific strategies to address social isolation in thought disordered patients (e.g. providing opportunities for pleasant experiences of conversation, scheduling positive social activites to counteract isolation, etc.). Social skills training programmes have a long history in the field of schizophrenia and consist of behavioural therapy principles and techniques aimed at helping patients improved their interpersonal and independent living skills (Kopelowicz et al., 2006). There is now evidence that these programmes are effective improving community functioning and social and daily living skills in patients diagnosed with schizophrenia (Kurtz and Mueser, 2008). In future studies, it would be relevant to study the impact that these interventions may have on FTD.

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Fig. 1 Means and standard errors for formal thought disorder (axis Y) scores in patients and comparisons across both neutral and salient interviews.

Table 1 Clinical and demographic variables.

		Patients	Comparisons	
Number		80	30	
Single (%)		67 (83.7%)	15 (50%)	**χ^2 (1)= 13.10, p< 0.001**
Unemployed (%)		77 (96.3%)	11 (36.7%)	**χ^2 (1)= 48.41, p< 0.001**
Social isolation (LSNS-18)		60.2 (16.3)	40.8 (13.7)	**t (108)= 5.80, p< 0.001**
Sex (%)	Male	58 (72.5%)	21 (70%)	χ^2 (1)= 0.07, p= 0.795
	Female	22 (27.5%)	9 (30%)	
Ethnicity (%)	White British	74 (92.5%)	28 (93.3%)	χ^2 (1)= 0.02, p= 0.881

		Patients	Comparisons	
	White Irish	2 (2.5%)	1 (3.3%)	
	Black British	3 (3.8%)	0 (0%)	
	Other	1 (1.3%)	1 (3.3%)	
Age (years)		39.3 (11.6)	38.4 (13.3)	*t* (108)= 0.33, *p*= 0.746
Years of education		11.2 (1.9)	12.7 (2.3)	**_t_ (108)= -3.35, _p_= 0.001**
IQ		98.4 (10.6)	109.5 (8.3)	**_t_ (108)= -5.18, _p_< 0.001**
Diagnoses (%)	Schizophrenia (F20)	48 (60%)	N/a	
	Schizoaffective (F25)	18 (22.5%)	N/a	
	Other Psychoses (F29)	14 (17.5%)	N/a	
Duration of illness		15.2	N/a	

		Patients	Comparisons
(years)		(10.9)	
History of admission (yes)		73 (91.3%)	N/a
History of Mental Health act (yes)		62 (77.5%)	N/a
First-generation antipsychotics (%)		26 (23.6%)	0 (0%)
Second-generation antipsychotics (%)		58 (72.5%)	0 (0%)
'Mood stabilizers' (%)		14 (17.5%)	0 (0%)
Anti-depressants (%)		31 (38.7%)	0 (0%)
Equivalent CPZ dose (mg)		469.7 (389.1)	N/a
PANSS	Positive	17.1 (5.2)	N/a
	Negative	14 (4.7)	N/a

	Patients	Comparisons
General	38.6 (9.2)	N/a
Total	69.8 (16.1)	N/a

Table 2 Frequencies and percentages of the TLC items across groups and interviews with group comparisons (with and without Bonferroni corrections).

	Neutral			Salient		
	Patients	Comparisons	$F(2, 109)$	Patients	Comparisons	$F(2, 109)$
Poverty of speech	30 (37.5%)	0 (0%)	**13.25**$^{**}_{*}$	40 (50%)	1 (3.3%)	**18.90**$^{**}_{*}$
Poverty of content of speech	1 (1.3%)	0 (0%)	0.37	9 (11.3%)	0 (0%)	3.29
Pressure of speech	7 (8.8%)	0 (0%)	2.49	8 (10%)	0 (0%)	2.87
Distractible speech	13 (16.3%)	2 (6.6%)	1.79	15 (18.8%)	1 (3.3%)	4.26*
Tangentiality	50 (62.5%)	4 (13.3%)	**26.52**$^{**}_{*}$	59 (73.8%)	10 (33.3%)	**23.32**$^{**}_{*}$
Derailment	34 (42.5%)	2 (6.6%)	**12.89**$^{**}_{*}$	36 (45%)	6 (20%)	9.00**
Incoherence	7 (8.8%)	1 (3.3%)	1.18	18 (22.5%)	3 (10%)	3.17

	Neutral			Salient		
	Patients	Comparisons	$F(2, 109)$	Patients	Comparisons	$F(2, 109)$
Illogicality	25 (31.3%)	4 (13.3%)	5.05*	36 (45%)	9 (30%)	4.70*
Clanging	3 (3.8%)	0 (0%)	1.15	5 (6.3%)	0 (0%)	1.96
Neologisms	2 (2.5%)	0 (0%)	0.76	3 (3.8%)	0 (0%)	1.15
Word approximations	27 (33.8%)	6 (20%)	2.77	26 (32.5%)	8 (26.6%)	1.73
Circumstantiality	15 (18.8%)	10 (33.3%)	0.49	27 (33.8%)	15 (50%)	0.01
Loss of goal	17 (21.3%)	1 (3.3%)	5.04*	22 (27.5%)	6 (20%)	1.12
Perseveration	9 (11.3%)	0 (0%)	3.30	29 (36.3%)	6 (20%)	4.72*
Echolalia	0 (0%)	0 (0%)	-	2 (2.5%)	0 (0%)	0.76
Blocking	5 (6.3%)	0 (0%)	1.76	10 (12.5%)	2 (6.6%)	0.89
Stilted speech	4 (5%)	0 (0%)	0.33	5 (6.3%)	0 (0%)	1.46
Self-reference	16 (20%)	1 (3.3%)	4.76*	12 (15%)	0 (0%)	4.53*
Words spoken	1388	2046.4	37.37**	1424.5	2042.9	24.8***

	Neutral			Salient		
	Patients	Comparisons	$F(2, 109)$	Patients	Comparisons	$F(2, 109)$
	(556.3)	(315.1)	*	(622.6)	(359.1)	
Duration of interview	00:15:04	00:15:03	0.0	00:15:15	00:15:02	0.28
Formal thought disorder	8.16 (6.143)	1.77 (2.019)	31.09** *	12.35 (9.312)	3.93 (2.791)	22.12** *

Note:
Values highlighted in **bold** represent significance after Bonferroni correction $p < .0028$ (alpha = 1–0.95)
* $p < 0.05$
** $p < 0.01$
*** $p < 0.001$;

Table 3 Partial correlations (Pearson's r) between psychotic symptoms, PANSS factors, formal thought disorder and social isolation after controlling for gender, age, years of education and verbal IQ (with and without Bonferroni correction).

	Social Isolation	**Hallucinations (P3)**	**Suspiciousness (P6)**	**Delusions (P1)**	**Conceptual disorganization(P2)**
Social isolation	-	0.02	0.22	0.15	**0.52*** **
Formal thought disorder (Non-salient)	**0.43*** **	0.13	0.26*	0.31**	**0.65*** **
Formal thought disorder (salient)	**0.54*** **	0.06	0.34**	0.24*	**0.79*** **

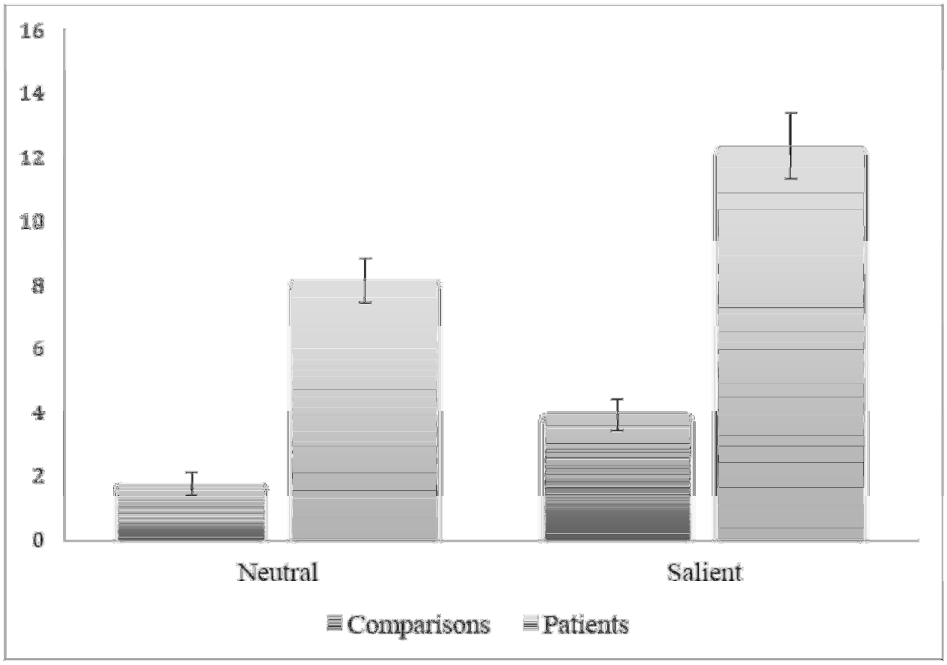
Note:
* $p < 0.05$
** $p < 0.01$
*** $p < 0.001$

Table 4 Two-stepped regressions with formal thought disorder (n= 80) from both interviews as the outcome and hallucinations (P3), delusions (P1), suspiciousness (P6) and social isolation as predictors.

	Predictors	B (S.E.)	95% CI		*b*	Model Summary
Salient interview	Hallucinations (P3)	–0.18 (0.68)	–1.54	1.18	–0.03	F (3,76)= 4.25** R^2 $_{adjusted}$= 0.11
	Delusions (P1)	1.39 (0.78)	–0.15	2.93	0.23	
	Suspiciousness (P6)	1.47 (0.79)	–0.10	3.05	0.22	
	Hallucinations (P3)	–0.25 (0.58)	–1.41	0.90	–0.04	F (4,75)= 12.13*** R^2 $_{adjusted}$= 0.36
	Delusions (P1)	0.74 (0.67)	–0.59	2.07	0.12	
	Suspiciousness (P6)	0.99 (0.68)	–0.36	2.34	0.15	
	Social isolation	**0.29 (0.05)**	**0.19**	**0.41**	**0.52*****	
	Predictors	B (S.E.)	95% CI		*b*	Model Summary
Neutral Interview	Hallucinations (P3)	0.22 (0.44)	–0.67	1.10	0.06	F (3,76)= 4.25** R^2 $_{adjusted}$= 0.11
	Delusions (P1)	1.36 (0.50)	0.36	2.36	0.34**	
	Suspiciousness (P6)	0.40 (0.52)	–0.62	1.43	0.09	
	Hallucinations (P3)	0.18 (0.39)	–0.60	0.96	0.05	F (4,75)= 10.72*** R^2 $_{adjusted}$= 0.33
	Delusions (P1)	0.98	0.09	1.88	0.25*	

Predictors	B (S.E.)	95% CI		*b*	Model Summary
	(0.45)				
Suspiciousness (P6)	0.12 (0.46)	–0.79	1.03	0.03	
Social isolation	**0.17 (0.04)**	**0.10**	**0.25**	**0.46*****	

Note:
$^{*}p< 0.05$
$^{**}p< 0.01$
$^{***}p< 0.001$



Highlights

- Thought disorder is significantly more prevalent when participants are asked to discuss emotionally salient topics.
- There was no association between hallucinations and social isolation.
- Social isolation is significantly and specifically associated with thought disorder in participants diagnosed with schizophrenia-spectrum disorders.