

Online Research @ Cardiff

This is an Open Access document downloaded from ORCA, Cardiff University's institutional repository: <http://orca.cf.ac.uk/113432/>

This is the author's version of a work that was submitted to / accepted for publication.

Citation for final published version:

Quattrone, Diego, Di Forti, Marta, Gayer-Anderson, Charlotte, Ferraro, Laura, Jongsma, Hannah E, Tripoli, Giada, Cascia, Caterina La, Barbera, Daniele La, Tarricone, Iaria, Berardi, Domenico, Szoke, Andrei, Arango, Celso, Lasalvia, Antonio, Tortelli, Andrea, Llorca, Pierre-Michel, Haan, Lieuwe de, Velthorst, Eva, Bobes, Julio, Bernardo, Miguel, Sanjuan, Julio, Santos, Jose Luis, Arrojo, Manuel, Del-Ben, Cristina Marta, Menezes, Paulo Rossi, Selten, Jean-Paul, Jones, Peter B., Kirkbride, James B., Richards, Alexander L., O'Donovan, Michael C., Sham, Pak C., Vassos, Evangelos, Rutten, Bart P.F., Os, Jim van, Morgan, Craig, Lewis, Cathryn M., Murray, Robin M. and Reininghaus, Ulrich 2019. Transdiagnostic dimensions of psychopathology at first episode psychosis: findings from the multinational EU GEI study. *Psychological Medicine* 49 (8) , pp. 1378-1391. 10.1017/S0033291718002131 file

Publishers page: <https://dx.doi.org/10.1017/S0033291718002131>
<<https://dx.doi.org/10.1017/S0033291718002131>>

Please note:

Changes made as a result of publishing processes such as copy-editing, formatting and page numbers may not be reflected in this version. For the definitive version of this publication, please refer to the published source. You are advised to consult the publisher's version if you wish to cite this paper.

This version is being made available in accordance with publisher policies. See <http://orca.cf.ac.uk/policies.html> for usage policies. Copyright and moral rights for publications made available in ORCA are retained by the copyright holders.



Original Article

*Joint first author

†For a full list of collaborators, see Appendix

Cite this article: Quattrone D *et al* (2018). Transdiagnostic dimensions of psychopathology at first episode psychosis: findings from the multinational EU-GEI study. *Psychological Medicine* 1–14. <https://doi.org/10.1017/S0033291718002131>

Received: 27 January 2018

Revised: 1 July 2018

Accepted: 24 July 2018

Keywords:

Bifactor model; diagnostic categories; first episode psychosis; psychopathology; symptom dimensions

Author for correspondence:

Diego Quattrone, E-mail: diego.quattrone@kcl.ac.uk

© Cambridge University Press 2018. This is an Open Access article, distributed under the terms of the Creative Commons Attribution licence (<http://creativecommons.org/licenses/by/4.0/>), which permits unrestricted re-use, distribution, and reproduction in any medium, provided the original work is properly cited.

Transdiagnostic dimensions of psychopathology at first episode psychosis: findings from the multinational EU-GEI study

Diego Quattrone^{1,2,*}, Marta Di Forti^{1,2,*}, Charlotte Gayer-Anderson³, Laura Ferraro⁴, Hannah E Jongsma⁵, Giada Tripoli⁶, Caterina La Cascia⁴, Daniele La Barbera⁴, Ilaria Tarricone⁷, Domenico Berardi⁷, Andrei Szöke⁸, Celso Arango⁹, Antonio Lasalvia¹⁰, Andrea Tortelli¹¹, Pierre-Michel Llorca¹², Lieuwe de Haan¹³, Eva Velthorst¹³, Julio Bobes¹⁴, Miguel Bernardo¹⁵, Julio Sanjuán¹⁶, Jose Luis Santos¹⁷, Manuel Arrojo¹⁸, Cristina Marta Del-Ben¹⁹, Paulo Rossi Menezes²⁰, Jean-Paul Selten^{21,22}, EU-GEI WP2 Group†, Peter B Jones^{5,23}, James B Kirkbride²⁴, Alexander L Richards²⁵, Michael C O'Donovan²⁵, Pak C Sham^{26,27}, Evangelos Vassos¹, Bart PF Rutten²², Jim van Os^{6,22,28}, Craig Morgan^{2,3}, Cathryn M Lewis¹, Robin M Murray^{2,6} and Ulrich Reininghaus^{3,22,29}

¹Social, Genetic and Developmental Psychiatry Centre, Institute of Psychiatry, Psychology and Neuroscience, King's College London, London SE5 8AF, UK; ²National Institute for Health Research (NIHR) Mental Health Biomedical Research Centre at South London and Maudsley NHS Foundation Trust and King's College London, UK; ³Department of Health Service and Population Research, Institute of Psychiatry, King's College London, De Crespigny Park, Denmark Hill, London SE5 8AF, UK; ⁴Department of Experimental Biomedicine and Clinical Neuroscience, University of Palermo, Via G. La Loggia 1, 90129 Palermo, Italy; ⁵Department of Psychiatry, University of Cambridge, Herchel Smith Building for Brain & Mind Sciences, Forvie Site, Robinson Way, Cambridge, CB2 0SZ, UK; ⁶Department of Psychosis Studies, Institute of Psychiatry, King's College London, De Crespigny Park, Denmark Hill, London SE5 8AF, UK; ⁷Department of Medical and Surgical Science, Psychiatry Unit, Alma Mater Studiorum Università di Bologna, Viale Pepoli 5, 40126 Bologna, Italy; ⁸INSERM, U955, Equipe 15, 51 Avenue de Maréchal de Lattre de Tassigny, 94010 Créteil, France; ⁹Department of Child and Adolescent Psychiatry, Hospital General Universitario Gregorio Marañón, School of Medicine, Universidad Complutense, IISGM (CIBERSAM), C/Doctor Esquerdo 46, 28007 Madrid, Spain; ¹⁰Section of Psychiatry, Azienda Ospedaliera Universitaria Integrata di Verona, Piazzale L.A. Scuro 10, 37134 Verona, Italy; ¹¹Etablissement Public de Santé Maison Blanche, Paris 75020, France; ¹²Université Clermont Auvergne, EA 7280, Clermont-Ferrand 63000, France; ¹³Department of Psychiatry, Early Psychosis Section, Academic Medical Centre, University of Amsterdam, Meibergdreef 5, 1105 AZ Amsterdam, The Netherlands; ¹⁴Department of Medicine, Psychiatry Area, School of Medicine, Universidad de Oviedo, Centro de Investigación Biomédica en Red de Salud Mental (CIBERSAM), C/Julián Clavería s/n, 33006 Oviedo, Spain; ¹⁵Barcelona Clinic Schizophrenia Unit, Neuroscience Institute, Hospital clinic, Department of Medicine, University of Barcelona, IDIBAPS, CIBERSAM, Barcelona, Spain; ¹⁶Department of Psychiatry, School of Medicine, Universidad de Valencia, Centro de Investigación Biomédica en Red de Salud Mental (CIBERSAM), C/Avda. Blasco Ibáñez 15, 46010 Valencia, Spain; ¹⁷Department of Psychiatry, Servicio de Psiquiatría Hospital "Virgen de la Luz", C/Hermanidad de Donantes de Sangre, 16002 Cuenca, Spain; ¹⁸Department of Psychiatry, Psychiatric Genetic Group, Instituto de Investigación Sanitaria de Santiago de Compostela, Complejo Hospitalario Universitario de Santiago de Compostela, Spain; ¹⁹Division of Psychiatry, Department of Neuroscience and Behaviour, Ribeirão Preto Medical School, University of São Paulo, São Paulo, Brazil; ²⁰Department of Preventative Medicine, Faculdade de Medicina FMUSP, University of São Paulo, São Paulo, Brazil; ²¹Rivierduinen Institute for Mental Health Care, Sandiforddreef 19, 2333 ZZ Leiden, The Netherlands; ²²Department of Psychiatry and Neuropsychology, School for Mental Health and Neuroscience, South Limburg Mental Health Research and Teaching Network, Maastricht University Medical Centre, P.O. Box 616, 6200 MD Maastricht, The Netherlands; ²³CAMEO Early Intervention Service, Cambridgeshire & Peterborough NHS Foundation Trust, Cambridge, CB21 5EF, UK; ²⁴Psylyfe Group, Division of Psychiatry, University College London, 6th Floor, Maple House, 149 Tottenham Court Road, London W1T 7NF, UK; ²⁵Division of Psychological Medicine and Clinical Neurosciences, MRC Centre for Neuropsychiatric Genetics and Genomics, Cardiff University, Cardiff CF24 4HQ, UK; ²⁶Department of Psychiatry, the University of Hong Kong, Hong Kong, China; ²⁷Centre for Genomic Sciences, Li KaShing Faculty of Medicine, The University of Hong Kong, Hong Kong, China; ²⁸Brain Centre Rudolf Magnus, Utrecht University Medical Centre, Utrecht, The Netherlands and ²⁹Central Institute of Mental Health, Medical Faculty Mannheim, University of Heidelberg, Mannheim, Germany

Abstract

Background. The value of the nosological distinction between non-affective and affective psychosis has frequently been challenged. We aimed to investigate the transdiagnostic dimensional structure and associated characteristics of psychopathology at First Episode Psychosis (FEP). Regardless of diagnostic categories, we expected that positive symptoms occurred more frequently in ethnic minority groups and in more densely populated environments,

and that negative symptoms were associated with indices of neurodevelopmental impairment. **Method.** This study included 2182 FEP individuals recruited across six countries, as part of the European network of national schizophrenia networks studying Gene–Environment Interactions (EU-GEI) study. Symptom ratings were analysed using multidimensional item response modelling in *Mplus* to estimate five theory-based models of psychosis. We used multiple regression models to examine demographic and context factors associated with symptom dimensions.

Results. A bifactor model, composed of one general factor and five specific dimensions of positive, negative, disorganization, manic and depressive symptoms, best-represented associations among ratings of psychotic symptoms. Positive symptoms were more common in ethnic minority groups. Urbanicity was associated with a higher score on the general factor. Men presented with more negative and less depressive symptoms than women. Early age-at-first-contact with psychiatric services was associated with higher scores on negative, disorganized, and manic symptom dimensions.

Conclusions. Our results suggest that the bifactor model of psychopathology holds across diagnostic categories of non-affective and affective psychosis at FEP, and demographic and context determinants map onto general and specific symptom dimensions. These findings have implications for tailoring symptom-specific treatments and inform research into the mood-psychosis spectrum.

Introduction

Current nosology classifies the observed manifestations of psychosis into two main categories of non-affective (e.g. schizophrenia, schizoaffective disorder) and affective psychosis (e.g. bipolar and major depressive disorders with psychotic features) (World Health Organization, 1992; American Psychiatric Association, 2013). However, the scientific accessibility of discrete ‘natural disease entities’ in psychiatry has been questioned since Kraepelin’s original distinction between dementia praecox and manic-depressive psychosis (Kraepelin, 1899; Murray *et al.*, 2004; Craddock and Owen, 2005; Hoff, 2017). On this basis, it has been proposed, and is now widely accepted, that the categorical classification system alone is too reductionist to explain the complexity of psychotic phenomena (Van Os *et al.*, 1999; Linscott and van Os, 2010). Various evidence-based perspectives might support a scheme incorporating symptom dimensions in psychotic disorders, as a possible approach to address the following limitations of categorical distinctions.

First, the dichotomous model of non-affective and affective psychosis does not fit the cases presenting with both prominent mood and psychotic symptoms. This is testified by the notion of a third category of schizoaffective disorder (Kasanin, 1933), which nevertheless implies further nosological challenges (Abrams *et al.*, 2008).

In addition, if criteria-based classification systems could identify genuine disorders within the psychosis spectrum, the diagnostic overlap would be relevant to only a few patients. On the contrary, there is a large comorbidity index between schizophrenia, schizoaffective, bipolar, and major depressive disorders (Laursen *et al.*, 2009; Uptegrove *et al.*, 2017). Similarly, the 10-year outcomes of the Aetiology and Ethnicity in Schizophrenia and Other Psychoses (ÆSOP-10) study showed that diagnoses within psychosis other than schizophrenia at baseline tend to be unstable over time (Heslin *et al.*, 2015).

Also, the dichotomous model is neither consistent with family studies showing familial co-aggregation of non-affective and affective psychosis (Cardno *et al.*, 2002; Lichtenstein *et al.*, 2009; Chou *et al.*, 2017) nor with the accumulated evidence from genome-wide association studies that genetic risk is in

part shared among schizophrenia, bipolar disorder, and major depressive disorder (International Schizophrenia Consortium *et al.*, 2009; Demjaha *et al.*, 2011; Cardno and Owen, 2014; O’Donovan and Owen, 2016; Power *et al.*, 2017).

Last, several studies show the efficacy of agents which impact on dopamine signalling in the treatment of both non-affective and affective symptoms. For example, antipsychotics antagonise D2-receptor functioning and are used in bipolar disorder and schizophrenia (Post, 1999; Taylor *et al.*, 2015), and clozapine is prescribed for both treatment-resistant bipolar disorder and schizophrenia (Li *et al.*, 2015; Goodwin *et al.*, 2016; Howes *et al.*, 2016). These findings suggest that dopamine dysregulation may contribute to both positive and manic symptoms, as supported by recent positron emission tomographic findings (Jauhar *et al.*, 2017).

Taken together, the above evidence challenges the binary categorization of non-affective and affective psychosis, enhancing research into non-categorical approaches. Pioneering studies using factor analysis examined associations among non-affective symptoms in schizophrenia and showed that these symptoms segregated in three groups (Liddle, 1987); however, these groups could not accommodate the whole symptom diversity in schizophrenia (Kay and Sevy, 1990). Thus, psychopathology models including also depressive and manic factors were proposed and replicated in schizophrenia (Lindenmayer *et al.*, 1994; Salokangas, 1997; Wickham *et al.*, 2001; Wallwork *et al.*, 2012). This type of structure was likewise confirmed in psychotic disorders (Salokangas, 2003; Dikeos *et al.*, 2006; Demjaha *et al.*, 2009), and in a sample of bipolar patients (Lindenmayer *et al.*, 2008). Hence, its validity across the spectrum of non-affective and affective psychosis has been consistently supported.

Recent findings suggest a more fundamental general, transdiagnostic dimension encompassing non-affective and affective symptoms, in addition to five specific symptom dimensions (Reininghaus *et al.*, 2013; Reininghaus *et al.*, 2016; Shevlin *et al.*, 2017). This conceptualization statistically reflects a bifactor model, with one general factor representing shared variance among all symptoms, and a set of specific factors where the remainder of the variance is shared among subsets of symptoms (Reise *et al.*, 2007). This is the first study set to investigate, in an incidence sample of First Episode Psychosis (FEP) patients: (1) whether the general psychosis dimension holds across

diagnostic categories of non-affective psychosis (i.e. schizophrenia, schizoaffective disorder) and affective psychosis (i.e. bipolar and major depressive disorder with psychotic features); (2) whether formation of specific symptom dimensions is justified in addition to a general psychosis dimension; and (3) the association of demographic characteristics (i.e. age, gender, ethnicity), social context (i.e. urbanicity), and clinical factors (i.e. diagnosis) with general and specific psychosis dimensions.

The hypotheses underlying the third aim, based on the existing literature, were:

- (a) Positive symptoms would be more common in ethnic minority groups and in people living in more densely populated environments (van Os *et al.*, 2001, Janssen *et al.*, 2003).
- (b) Negative symptoms would be associated with indices suggestive of neurodevelopment impairment in psychosis (Limosin, 2014; Patel *et al.*, 2015), such as being a man or having an early age at onset.

Methods

Sample design and procedures

Individuals suffering from their FEP were recruited between 2010 and 2015 as part of the large EUropean network of national schizophrenia networks studying Gene–Environment Interactions (EU-GEI) study (<http://www.eu-gei.eu>). Specifically, FEP individuals were recruited as part of the ‘Functional Enviromics’ work package, which consisted of an incidence and a case-sibling-control study conducted across six countries with the aim to investigate clinical, genetic, and environmental interaction in the development of psychotic disorders.

The study had 17 catchment areas, including urban and less urban populations: Southeast London, Cambridgeshire and Peterborough (England); central Amsterdam, Gouda and Voorhout (the Netherlands); part of the Veneto region, Bologna municipality, city of Palermo (Italy); 20th arrondissement of Paris, Val-de-Marne, Puy-de-Dôme (France); Madrid (Vallecas), Barcelona, Valencia, Oviedo, Santiago, Cuenca (Spain); and Ribeirão Preto (Brazil).

Participants

We screened all subjects who were referred to mental healthcare services with a suspicion of psychosis. The ascertainment period of cases ranged from 12 months in London to 48 months in Val-de-Marne and Bologna, with a median of 25 months. In each site, a psychiatrist experienced in epidemiology research oversaw the local team, which was centrally trained to minimize non-differential recruitment bias in the different healthcare systems. Written consent was obtained from the subjects who agreed to take part of the case-sibling-control study. For incidence-only cases, local research ethics committees approved the extraction of demographics and clinical information from patient records. More detailed information is available on the EU-GEI core paper on the incidence rates of schizophrenia and other psychotic disorders (Jongsma *et al.*, 2018).

Patients were included in the current study if they met the following criteria during the recruitment period: (a) aged between 18 and 64 years; (b) presentation with a clinical diagnosis for an untreated FEP, even if longstanding [International Statistical Classification of Diseases and Related Health Problems, Tenth

Revision (ICD-10) codes F20-F33]; (c) resident within the catchment area at FEP. Exclusion criteria were: (a) previous contact with psychiatric services for psychosis; (b) psychotic symptoms with any evidence of organic causation; and (c) transient psychotic symptoms resulting from acute intoxication (ICD-10: F1x.5).

Measures

Data on age, gender, and ethnicity was collected using a modified version of the Medical Research Council Sociodemographic Schedule (Mallett, 1997). Ethnicity was defined as self-reported. Country of heritage or birth was used as a proxy for ethnicity in people of a North African background. The OPERational CRITeria (OPCRIT) system (McGuffin *et al.*, 1991; Williams *et al.*, 1996) was used by centrally trained investigators, whose reliability was assessed throughout the study ($\kappa=0.7$). The OPCRIT system allows to: (1) assess the pre-morbid history and current mental state; and (2) establish the diagnosis of psychotic disorders based on algorithms for several diagnostic classification systems. It consists of a checklist which can be filled using different sources, e.g. case records or clinical interviews. Fifty-nine items relate to the mental state examination. We used diagnoses based on Research Diagnostic Criteria (RDC) (Spitzer *et al.*, 1978), since this classification system provides a better representation of schizoaffective disorder, which is a common presentation in clinical practice. OPCRIT RDC-based diagnoses have a good-to-excellent agreement with best-estimate consensus diagnostic procedures (Craddock *et al.*, 1996). In each catchment area, population density was computed as a number of inhabitants per square kilometre, based on official population estimates.

Statistical analysis

Psychopathology items were dichotomized as 0 ‘absent’ or 1 ‘present’. In order to ensure sufficient covariance coverage for item response modelling, we used the items with a valid frequency of ‘present’ $\geq 10\%$ in our sample, which included individuals with ≤ 20 missing values in the psychopathology rating. OPCRIT data used in the analysis contained missing values, which we assumed to be missing at random, allowing for the maximum likelihood estimator to provide unbiased estimates. We performed multidimensional item response modelling in *Mplus*, version 7.4 (Muthén and Muthén, 2012) to estimate unidimensional, multidimensional, bifactor, and second-order models of psychosis.

Extending previous analyses of OPCRIT data in individuals with enduring psychosis (Reininghaus *et al.*, 2016), we estimated five alternative item-response models (online Supplementary Fig. S1): (a) a unidimensional model with one unique general factor (model A), which is consistent with the pre-Kraepelinian unitary concept of psychosis (Berrios and Beer, 1994); (b) a multidimensional model with five uncorrelated specific factors of positive, negative, disorganization, manic, and depressive symptoms (model B); (c) a multidimensional model with five correlated specific factors (model C), which, together with model B, is consistent with the pentagonal psychosis model (van Os and Kapur, 2009); (d) a bifactor model with one general latent factor along with five uncorrelated specific factors (model D) (Reininghaus *et al.*, 2016); and (e) a hierarchical model with five first-order specific factors and one general second-order factor (model E), which, as model D, is consistent with the notion of a transdiagnostic spectrum of non-affective and affective psychosis (Craddock and Owen, 2005; Reininghaus *et al.*, 2016). Some previous

OPCRIT exploratory analysis showed a combined negative/disorganization dimension (Serretti *et al.*, 2001; Fanous *et al.*, 2005). We did not have a strong theoretical rationale for testing such a structure in a confirmatory analysis. By contrast, we considered specific negative symptoms as a clinically observable marker of neurodevelopmental impairment in psychosis (Limosin, 2014).

The five models were compared using Log-Likelihood (LL), Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC), and Sample-size Adjusted BIC (SABIC) as model fit statistics. For the model showing the best fit, we calculated reliability and strength indices, such as McDonald's omega (ω), omega hierarchical (ω_H), and index H . Coefficient ω is an estimate of the proportion of common variance accounted by general and specific symptom dimensions. Coefficient ω_H is an estimate of the proportion of reliable variance accounted by the general dimension, treating variability in scores due to specific dimensions as measurement error (Rodriguez *et al.*, 2016b). Ω_h formula can be extended to each specific factor, i.e. treating variability in scores due to the general factor as a measurement error, to compute omega hierarchical for subscales. Based on omega and omega hierarchical coefficients, which can vary from 0 to 1, we computed the ratios of ω/ω_H , namely the relative omega, as the amount of reliable variance explained in the observed scores attributable to (1) the general factor independently from the specific symptom dimensions, and (2) each specific symptom dimension independently from the general factor. To estimate the extent to which symptom dimensions were represented by their own set of OPCRIT items and their replicability across studies, we computed the construct reliability index H (Hancock and Mueller, 2001). The index H ranges from 0 to 1, with values closer to 1 indicating better reliability and replicability (Rodriguez *et al.*, 2016a). Quantitative scores for all symptom dimensions were calculated using the 'FSCORES' function in *Mplus*.

Further, we examined the diagnostic classification accuracy based on general and specific symptom dimension scores using multinomial receiver operating characteristic (ROC) analysis in STATA 14 (StataCorp, 2015). In addition, we performed a sensitivity analysis, examining subjects with item ratings based on face-to-face interview and based on clinical records separately.

We used multiple linear regression to examine the association between factor scores of general and/or specific psychosis dimensions as the outcome variable and demographic variables, including gender, age-at-first-contact with psychiatric services, ethnicity, and diagnosis as covariates. Country and assessment method were treated as a priori confounders.

To examine the individual-level effect of urbanicity on symptom dimension scores, standardized population density values were used as a continuous independent variable, while controlling the analysis for gender, age-at-first-contact, ethnicity, diagnosis, and assessment method. Sensitivity analysis included post-hoc multiple regressions within each country, where population density was dichotomized at its median as a dummy variable for urbanicity.

Results

Sample characteristics

We identified 2774 treated incidence cases of psychosis (Jongsma *et al.*, 2018), of whom 2182 had (complete or missing at random) OPCRIT data available for analysis under the provision of local research ethics committees (Table 1). OPCRIT item ratings

were completed based on face-to-face assessment for 51% ($n = 1112$) and based on clinical records for 49% ($n = 1070$) of the sample. The sample prevalence of psychotic symptoms is presented in Supplementary Table S1.

Fifty-seven per cent of FEP were men. Subjects were mostly people of a White ethnicity. Other main ethnic groups included Black African and Black Caribbean, North African, Mixed, and Asian. Mean age-at-first-contact with psychiatric services was 32.1 years; this was lower in men ($M = 30.1$) compared with women ($M = 34.7$; $t = -9.6$, $p < 0.001$). Age-at-first-contact differed across ethnic groups, with individuals of Black ethnicity ($M = 29$) being younger than individuals of White ethnicity ($M = 32.7$; $F = 7.72$, $p < 0.001$). The most common RDC-based diagnosis was broad or narrow schizophrenia (38.6%), followed by schizoaffective disorders (35%), unspecified non-organic psychotic disorder (16.3%), bipolar disorder (5.9%), and psychotic depression (4.2%).

Symptom dimensions in the EU-GEI sample

The bifactor model was the best fit for the OPCRIT symptom data compared with all other models, as consistently indicated by each of the model fit statistics (Table 2), and explained 54% of the total variance.

Figure 1 shows that, within the bifactor model, general and specific dimensions accounted for 93% of the common variance. Overall, statistical indices derived from the bifactor model suggest that its explained variance was due to individual differences in both general and specific symptom dimensions, which therefore might complement each other in reflecting the psychopathological structure at FEP. This is illustrated by the relative omega coefficients, which, for example, showed that 47% of the reliable variance was due to the general factor when partitioning out the variability in scores due to the specific factors (Fig. 1). High H values were consistently observed for all latent factors, indicating that they were well defined, and that the bifactor model had high reliability and replicability (Fig. 1). Sensitivity analysis showed that the bifactor model was the best fit for the OPCRIT data in both the assessment methods (online Supplementary Tables S2.1 and S2.2).

Symptom dimensions and item factor loadings

Table 3 shows standardized factor loadings for the bifactor model. On the general dimension, a positive factor loading was observed for all OPCRIT items with statistically significant loadings. In addition, the magnitude of factor loadings of items on the general dimension was small, except for some manic/delusional items for which loadings of moderate magnitude were observed. On the specific dimensions, most of the items showed moderate to strong positive loadings. Finally, latent factor scores were strongly and positively associated with simplified weighted OPCRIT sum scores for use in clinical practice (online Supplementary Table S3).

Symptom dimensions and categorical diagnoses

Findings from regression analyses are shown in Table 4 and predicted symptom dimension scores for each RDC-based diagnostic category are reported in Fig. 2. Compared with bipolar disorder, factor scores for the positive dimension were moderately higher in schizophrenia and schizoaffective disorder; factor scores for the negative dimension were moderately higher in schizophrenia,

Table 1. Demographic and clinical characteristics of the sample included in the factor analysis

Characteristics	N (%) 2182	Differences by assessed method ^a Test statistics	Differences by country ^b Test statistics
Age			
Mean (s.d.)	32.1 (11.2)	$t(2180) = -5.57; p < 0.001$	$F(5,2176) = 7.42; p < 0.001$
Median (IQR)	30 (23–40)	Kruskal–Wallis $\chi^2(1) = 29.19; p < 0.001$	Kruskal–Wallis $\chi^2(5) = 37.4; p < 0.001$
Gender^c			
Male	1247 (57.2)	$\chi^2(1) = 14.73; p < 0.001$	$\chi^2(5) = 16.59; p < 0.01$
Ethnicity^d			
White	1245 (57.1)	$\chi^2(4) = 69.06; p < 0.001$	$\chi^2(20) = 535.15; p < 0.001$
Black	231 (10.6)		
Mixed	168 (7.7)		
Asian	79 (3.6)		
North African	61 (2.8)		
Other and missing self-reported	398 (18.2)		
Research Domain Criteria Diagnosis^e			
Bipolar disorder	129 (5.9)	$\chi^2(4) = 19.25; p = 0.001$	$\chi^2(20) = 137.47; p < 0.001$
Major depression with psychotic features	92 (4.2)		
Schizophrenia spectrum	842 (38.6)		
Schizoaffective disorder	764 (35)		
Unspecified psychosis	355 (16.3)		

^aPsychopathology assessment methods included face-to-face interview or review of clinical notes.

^bStudy countries were England, the Netherlands, France, Spain, Italy, and Brazil.

^c29 missing values excluded from tabulation and age analysis.

^dOther and missing self-reported groups excluded from ethnicity analysis.

^eSchizophrenia spectrum encompassed Broad Schizophrenia ($N = 194$) and Narrow Schizophrenia ($N = 648$); Schizoaffective disorder encompassed Schizoaffective/manic ($N = 112$); Schizoaffective/depressive ($N = 566$); Schizoaffective/bipolar ($N = 86$).

schizoaffective and psychotic depression; and factor scores for the depressive dimension were markedly higher in psychotic depression and schizoaffective disorder. Bipolar disorder showed the highest factor scores for the manic and the general dimensions. Dimension scores based on ICD diagnostic categories are presented in Supplementary Fig. S2 and Supplementary Table S4.

Finally, ROC analysis showed that classification accuracy into RDC categories based on general and specific symptom dimension scores was markedly higher for patients with psychopathology rating based either on face-to-face interview (95% CI 0.54–0.63) or case note review (95% CI 0.56–0.65), compared with a classification by chance (95% 0.32–0.41). Moreover, symptom dimensions showed similar diagnostic classification accuracy across countries (online Supplementary Figs S3.1 and S3.2).

Symptom dimensions by gender, age-at-first-contact, and ethnicity

Findings on factor scores by gender, age-at-first-contact, and ethnicity, are shown in Fig. 2 and Table 4. Early age-at-first-contact was associated with higher scores for the general, negative, disorganized, and manic symptom dimensions, and with lower scores for the depressive symptom dimension. Men showed fewer depressive symptoms and more negative symptoms than women, even after adjusting the analysis for several confounders. Table 4 further shows that participants of Black and North African ethnicity presented with higher scores on the positive

symptom dimension compared with an individual of White ethnicity. Finally, higher scores for the disorganization dimension and lower scores for the depressive dimension were observed in Black compared with White ethnicity. Noteworthy, the magnitude of the effect was small for all the results.

Symptom dimensions by urbanicity

A moderate positive association was observed for more densely populated environments and the general dimension score. Table 4 further shows a weaker positive association between population density and specific negative, disorganization, and manic symptom dimensions. Post-hoc analysis of symptom dimensions within countries showed that positive symptoms were more common in urban study sites in the UK (i.e. London v. Cambridge), whereas a negative association was observed in Spain (online Supplementary Table S5).

Discussion

Principal findings

This is the first study on general and specific symptom dimensions in an incidence sample of psychosis. First, we found in our FEP sample that manic and delusional symptoms primarily underlie the identified general psychosis factor across diagnostic categories of non-affective and affective psychosis. Second, findings showed that specific dimensions of positive, negative,

Table 2. Model fit statistics of unidimensional, multidimensional, bi-factor, and second-order models

Sample size: 2182	Full information fit statistics ^a			
	LL	AIC	BIC	SABIC
A – Unidimensional Model	-54809	109813	110370	110059
B – Multidimensional Model (five uncorrelated factors)	-50645	101487	102044	101733
C – Multidimensional Model (five correlated factors)	-50439	101095	101709	101365
D – Bifactor Model (one general factor and five specific uncorrelated factors)	-49710	99713	100549	100082
E – Hierarchical Model (five first-order specific correlated factors and one second-order general factor)	-50608	101420	102000	101676

LL, log-likelihood; AIC, Akaike Information Criterion; BIC, Bayesian Information Criterion; SABIC Sample-size Adjusted Bayesian Information Criterion.

^aA difference of 10 in AIC, BIC and SABIC is considered important. Lower values indicate a statistically better model fit.

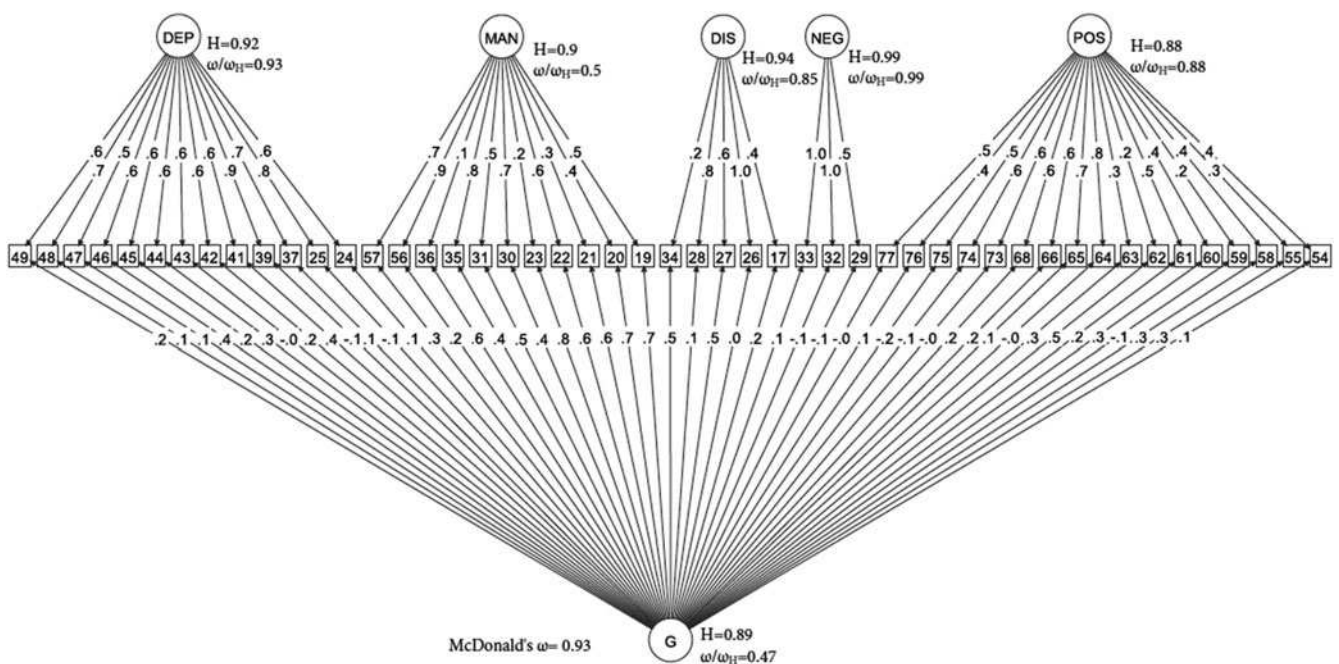


Fig. 1. Bifactor model. (□) Observed variables (No. of OPCRIT items); (○) Unobserved variables (latent factors); (→) standardized item loading estimation onto latent factors; G, general psychosis factor; specific symptom factors: DEP, depression; MAN, mania; DIS, disorganization; NEG, negative; POS, positive. Reliability and strength estimates: H = construct reliability index; ω = McDonald omega; ω_1 = hierarchical omega; ω/ω_1 = Relative omega. Explanatory note: McDonald's ω is an estimate of the proportion of the common variance accounted by general and specific symptom dimensions. Relative omega (ω/ω_1) is the amount of reliable variance explained in the observed scores attributable to (1) the general factor independently from the specific symptom dimensions, and (2) each specific symptom dimension independently from the general factor. H is an index of the quality of the measurement model based on the set of OPCRIT items for each symptom dimension. Index H can range from 0 to 1, with values closer to 1 indicating a better construct reliability and replicability across studies.

disorganized, manic and depressive symptoms are complementary to the general dimension. Third, general and specific symptom dimensions discriminated well between diagnoses of psychotic disorders. Fourth, positive symptoms were more common among individuals of Black and North African ethnicity. Fifth, there was some evidence that early age-at-first-contact was associated with higher scores for several dimensions, such as of negative, disorganised and manic symptoms. Sixth, men presented with more negative and less depressive symptoms than women. Finally, higher scores for the general dimension were observed for individuals living in urban neighbourhoods.

Limitations

Before interpreting our findings, we must consider potential limitations. Symptoms were rated with a semi-structured face-to-face

interview or from case note review. Still, study investigators underwent a specific and centrally organized training for OPCRIT and demonstrated good inter-rater reliability for individual item ratings; moreover, OPCRIT is a tool specifically designed to allow use with different sources (McGuffin et al., 1991; Cardno et al., 1996; Rucker et al., 2011). However, we found consistently lower symptom ratings using case note review compared with face-to-face interviews. It is possible that clinicians failed to record all symptoms; alternatively, patients presenting with less severe psychopathology had a shorter contact with services, and therefore less chances to be interviewed by researchers. Whether or not differences in ratings are genuine or a surrogate of different sources of item ratings, we treated this potential bias as artificial confounding of our findings and adjusted all analyses for the type of assessment method. On the other hand, the use of an incident sample allowed the best possible approximation of the true

Table 3. Standardized factor loadings in the bifactor model

OPCRIT item	Item no.	Factor	Specific factor loading	General factor loading	Communalities
Persecutory delusions	54	POS	0.36***		0.14
Well organized delusions	55	POS	0.27***	0.34***	0.19
Delusions of influence	58	POS	0.43***	0.33***	0.29
Bizarre delusions	59	POS	0.21***		0.05
Widespread delusions	60	POS	0.42***	0.29***	0.26
Delusions of passivity	61	POS	0.49***		0.27
Primary delusional perception	62	POS	0.23***	0.51***	0.32
Other primary delusions	63	POS	0.30***	0.31***	0.19
Delusions & hallucinations last for 1 week	64	POS	0.81***		0.65
Persecutory/jealous delusions & hallucinations	65	POS	0.66***		0.45
Thought insertion	66	POS	0.60***		0.38
Thought broadcast	68	POS	0.60***	0.24***	0.41
Third person auditory hallucinations	73	POS	0.61***		0.37
Running commentary voices	74	POS	0.62***		0.39
Abusive/accusatory/persecutory voices	75	POS	0.54***		0.33
Other (non-affective) auditory hallucinations	76	POS	0.42***		0.19
Non-affective hallucinations in any modality	77	POS	0.51***		0.26
Negative formal thought disorder	29	NEG	0.54***		0.30
Restricted affect	32	NEG	1.00***		1.00
Blunted affect	33	NEG	0.98***		0.97
Bizarre behaviour	17	DIS	0.42***	0.21***	0.23
Speech difficult to understand	26	DIS	0.96***		0.93
Incoherent	27	DIS	0.62***	0.47***	0.60
Positive formal thought disorder	28	DIS	0.84***		0.72
Inappropriate affect	34	DIS	0.23***	0.46***	0.27
Excessive activity	19	MAN	0.53***	0.73***	0.82
Reckless activity	20	MAN	0.36***	0.67***	0.58
Distractibility	21	MAN	0.29***	0.60***	0.45
Reduced need for sleep	22	MAN	0.55***	0.56***	0.61
Agitated activity	23	MAN	0.16***	0.76***	0.59
Pressured speech	30	MAN	0.74***	0.43***	0.73
Thoughts racing	31	MAN	0.54***	0.49***	0.53
Elevated mood	35	MAN	0.85***	0.41***	0.89
Irritable mood	36	MAN	0.12**	0.55***	0.32
Increased self esteem	56	MAN	0.87***	0.24***	0.81
Grandiose delusions	57	MAN	0.67***	0.30***	0.54
Slowed activity	24	DEP	0.55***		0.31
Loss of energy/tiredness	25	DEP	0.80***		0.64
Dysphoria	37	DEP	0.74***		0.55
Loss of pleasure	39	DEP	0.87***		0.76
Poor concentration	41	DEP	0.62***	0.42***	0.56
Excessive self-reproach	42	DEP	0.60***		0.38
Suicidal ideation	43	DEP	0.55***		0.31

(Continued)

Table 3. (Continued.)

OPCRIT item	Item no.	Factor	Specific factor loading	General factor loading	Communalities
Initial insomnia	44	DEP	0.65***	0.32***	0.53
Middle insomnia (broken sleep)	45	DEP	0.65***	0.25***	0.48
Early morning waking	46	DEP	0.56***	0.39***	0.46
Excessive sleep	47	DEP	0.46***		0.23
Poor appetite	48	DEP	0.69***		0.48
Weight Loss	49	DEP	0.56***	0.20***	0.35

General, general psychosis factor; specific symptom dimensions: DEP, depression; MAN, mania; DIS, disorganisation; NEG, negative; POS, positive. Only loadings ≥ 0.2 for the general factor are shown for simplicity. Significance: *** = $p < 0.001$; ** = $p < 0.01$.

distribution of psychosis symptoms at FEP, which may have reduced potentially inflated presence of positive and negative symptoms in previous studies conducted in hospital settings (Allardyce *et al.*, 2007). Also, OPCRIT does not cover some relevant aspects of negative symptoms related to passive social withdrawal, lack of motivation, and difficulties in abstract/symbolic thinking. Consequently, we constructed a narrow negative symptom dimension with three items. Finally, some authors have argued that, in a bifactor model, the general factor may be difficult to interpret and in general may overfit the data (Bonifay *et al.*, 2016). However, the bifactor model allows solutions to dimensionality issues that arise when the conceptual breadth of a construct cannot be fully determined (Reise *et al.*, 2007), as is likely to be the case for the construct of psychosis, which, in the past, has been considered as unidimensional and multidimensional at the same time. For example, the bifactor model discerns each specific symptom dimension from the common item effect, which is captured by the general dimension, thus allowing an accurate evaluation of the unique contribution of each subset of symptoms. Last, this solution provides crucial information which cannot be determined from the other models, i.e. how much of the phenotypic variance that we aim to measure is due to a unidimensional construct *v.* a multidimensional construct of psychosis. Hence, it was a suitable model for addressing dimensionality issues for psychosis and generating reliable phenotypes.

Comparison with previous research

In our study, the bifactor model of psychopathology best explained the observed symptoms at FEP compared with unidimensional and multidimensional models. Our findings are consistent with, and extend, previous research on psychotic symptoms in people with enduring psychotic disorders (Reininghaus *et al.*, 2013; Reininghaus *et al.*, 2016) and the general population (Shevlin *et al.*, 2017) to a multinational incidence sample of FEP. They provide further evidence that non-affective and affective psychotic disorders lie on a common mood-psychosis spectrum (Murray *et al.*, 2004). In addition, we provided the first evidence in psychosis that a bifactor solution shows better model fit statistics compared with a second-order hierarchical solution. However, compared with findings in enduring psychosis (Reininghaus *et al.*, 2016), we found a less specific general psychopathology factor with more general disturbances and affective features. As illnesses develop, the non-affective psychotic phenomena may become more and affective features less prominent.

We found some evidence of gender differences in symptom dimension scores. Men showed less depressive symptoms and more negative symptoms compared with women. This finding is consistent with other studies in stable schizophrenia (Shtasel *et al.*, 1992; Roy *et al.*, 2001; Galderisi *et al.*, 2012), first episode psychotic disorder (Morgan *et al.*, 2008), and the general population (Maric *et al.*, 2003). In our sample, we also showed that early age-at-first-contact was associated with a higher level of general and specific psychopathology. Notably, it has been proposed that gender-related and symptom profiles differences in psychosis may be suggestive of different neurodevelopmental trajectories (Castle and Murray, 1991; Seeman, 1997; Riecher-Rössler and Häfner, 2000).

We further found that symptom dimensions vary in terms of ethnicity. Consistent with a previous report (Kirkbride *et al.*, 2016), we provided evidence that people of Black ethnicity presented at FEP with more positive and disorganized symptoms and fewer depressive symptoms compared with people of White ethnicity. Moreover, in line with another study (Veling *et al.*, 2007), we found in our sample that the North African group presented at FEP with more positive symptoms compared with people of White ethnicity. It has been debated whether similar findings reflect true differences in symptom presentation or instead result from raters being more likely to overrate symptoms in the context of ethno-cultural diversity (Mukherjee *et al.*, 1983; Hutchinson *et al.*, 1999; Barrio *et al.*, 2003; Arnold *et al.*, 2004; Vega and Lewis-Fernandez, 2008). Recent studies using standardized procedures for assessing symptomatology blind to ethnicity have suggested that misdiagnosis or rating bias cannot account for differences across ethnic groups (Morgan *et al.*, 2010). However, we must remain cautious in interpreting these results.

We showed that high population density is positively associated with the general and specific disorganized, negative and manic dimensions. In our multinational sample, we were not able to replicate previous findings on the relationship between urbanicity and the positive dimension (Kirkbride *et al.*, 2007). Nevertheless, stratified analysis by country was consistent with the previously reported association between urbanicity and positive symptoms in the UK. The relationship between urbanicity and a higher incidence of psychotic disorders is well-established (Vassos *et al.*, 2012). However, it has been found to show non-linearity (Kirkbride *et al.*, 2017), which implies that the effect of urbanicity may depend on exposure to additional socio-environmental factors associated with urban contexts, for example cannabis use (Kuepper *et al.*, 2011) and childhood adversities (Frissen *et al.*, 2015). Similarly, our findings support the

Table 4. Symptom dimension scores by sociodemographic, categorical diagnosis, and social context variables

	General B (95% CI)	Positive B (95% CI)	Negative B (95% CI)	Disorganization B (95% CI)	Manic B (95% CI)	Depressive B (95% CI)
Women v. Men ^a	0.01 (-0.07 to 0.09)	0.01 (-0.08 to 0.1)	-0.12** (-0.21 to 0.23)	0 (-0.08 to 0.1)	0 (-0.09 to 0.08)	0.11** (0.02 to 0.17)
Age at first contact ^a	-0.01* (-0.09 to -0.01)	-0.02 (-0.06 to 0.03)	-0.05** (-0.1 to -0.01)	-0.09*** (-0.14 to -0.05)	-0.1*** (-0.14 to -0.06)	0.04* (0.01 to 0.08)
Ethnicity ^a						
Black v. White	0.07 (-0.06 to 0.19)	0.19** (0.04 to 0.33)	0.01 (-0.14 to 0.15)	0.14* (0.01 to 0.28)	0.03 (-0.1 to 0.16)	-0.22*** (-0.34 to -0.1)
Mixed v. White	0.02 (-0.12 to 0.17)	0 (-0.16 to 0.17)	0.1 (-0.07 to 0.27)	0.18* (0.02 to 0.34)	0.06 (-0.09 to 0.21)	-0.1 (-0.25 to 0.03)
Asian v. White	-0.06 (-0.25 to 0.13)	0.11 (-0.1 to 0.33)	-0.05 (-0.28 to 0.18)	0.07 (-0.13 to 0.28)	0.01 (-0.19 to 0.21)	-0.08 (-0.27 to 0.1)
North African v. White	-0.02 (-0.24 to 0.2)	0.32** (0.07 to 0.57)	-0.22 (-0.48 to 0.04)	-0.05 (-0.29 to 0.2)	-0.17 (-0.4 to 0.06)	0.05 (-0.16 to 0.27)
Diagnosis ^a						
Schizophrenia v. Bipolar	-0.78*** (-0.96 to -0.6)	0.9*** (0.69 to 1.1)	0.53*** (0.32 to 0.75)	0.24* (0.06 to 0.45)	-1.7*** (-1.88 to -1.51)	0.78 (-0.1 to 0.25)
Schizoaffective disorder v. Bipolar	-0.47*** (-0.65 to -0.29)	0.94*** (0.73 to 1.14)	0.59*** (0.37 to 0.8)	0.3** (0.1 to 0.5)	-1.33*** (-1.52 to -1.15)	0.97*** (0.8 to 1.14)
Major Depression v. Bipolar	-1.16*** (-1.42 to -0.91)	-0.24 (-0.52 to 0.05)	0.72*** (0.42 to 1.02)	-0.23 (-0.5 to 0.05)	-1.95*** (-2.21 to -1.69)	1.54*** (1.3 to 1.79)
Unspecified Functional Psychosis v. Bipolar	-0.99*** (-1.19 to -0.8)	0.36** (0.14 to 0.58)	0.5*** (0.27 to 0.73)	-0.06 (-0.27 to 0.15)	-1.67*** (-1.87 to -1.47)	0.3** (0.11 to 0.49)
Urban v. less urban ^b	0.3*** (0.24 to 0.36)	-0.03 (-0.1 to 0.03)	0.12** (0.05 to 0.19)	0.08** (-0.02 to 0.14)	0.01 (-0.06 to 0.06)	0.02 (-0.04 to 0.07)

B, unstandardised regression coefficient; CI, confidence interval.

^aCovariates in multiple models were gender, age, ethnicity, diagnosis, study country, and type of assessment method (interview v. case records).

^bPopulation density analysis was adjusted for gender, age, ethnicity, diagnosis, and type of assessment method (interview v. case records).

hypothesis that urban environment does not have a dimension-specific effect and may act to confer risk for different psychopathological outcomes in psychosis (van Os *et al.*, 2002). Noteworthy, similar findings have been reported in the general population (van Os *et al.*, 2001), which may require future studies to consider the additive interaction between putative risk factors for psychosis and urbanicity.

Implications

In the context of a general effort to move away from DSM and ICD categories (Demjaha *et al.*, 2009; Reininghaus *et al.*, 2016; Kotov *et al.*, 2017; Van Dam *et al.*, 2017; Whalen, 2017; Zachar and Kendler, 2017), we found evidence that supports, and may inform, the use of dimensional measures in the field of psychosis. In our sample, the bifactor model was a valid platform for research into FEP. Nevertheless, the plausibility of our statistically-guided approach depends on the extent to which: (1) symptom dimensions represent coherent environmental and biological factors; and (2) meaningful clinical information or decisions may derive from the latent constructs.

From a research perspective, our findings suggest that the general dimension may reflect a phenotype for the study of general risk factors. For example, urbanicity may impact on the risk and profile of psychosis through the combination of other, more specific socio- or bio-environmental factors. In addition, we showed a substantial variation of sociodemographic determinants at the specific dimension level, which may support an integrated socio-developmental model of psychosis (Morgan *et al.*, 2010).

We may further suggest using the general dimension as a quantitative measure of psychopathology for research into the genetic component shared across psychotic disorders. The evidence is required to establish the extent to which pathophysiology of schizophrenia, bipolar disorder, and psychotic depression is shared at the level of pathways and neuronal cell mechanisms (Forstner *et al.*, 2017). Based on the data presented on specific symptom dimensions, it is intriguing to speculate whether the distribution of psychotic symptoms reflects a gradient of neurodevelopmental impairment or socio-environmental risk (Morgan *et al.*, 2010; Howes and Murray, 2014) resulting in different patterns of functional abnormalities (Murray and Lewis, 1987; Murray *et al.*, 1992; Demjaha *et al.*, 2011; Owen and O'Donovan, 2017).

From a clinical perspective, although each patient presents with a specific pattern of psychopathology and response to treatment at FEP, attention has been traditionally focused on the positive dimension management. Mental health professionals may integrate observations of the whole range of symptoms and signs with a consideration of neurodevelopmental and socio-environmental risk factors. Such an approach should aim to plan and optimize pharmacological and non-pharmacological treatments (Murray *et al.*, 2016), thus focusing further on treatment of negative, disorganized and affective dimensions (Wykes *et al.*, 2011; Giacco *et al.*, 2012; Carbon and Correll, 2014; Pelayo-Teran *et al.*, 2014; Rosenbaum *et al.*, 2014).

We may further suggest promoting mental health professionals to adopt treatment plans guided by dimensions, and increasing their confidence in dimensional classifications. Reconciling contradictory concerns of clinicians and researchers (Kendell and Jablensky, 2003) may represent the first milestone towards a gradual nosology refinement.

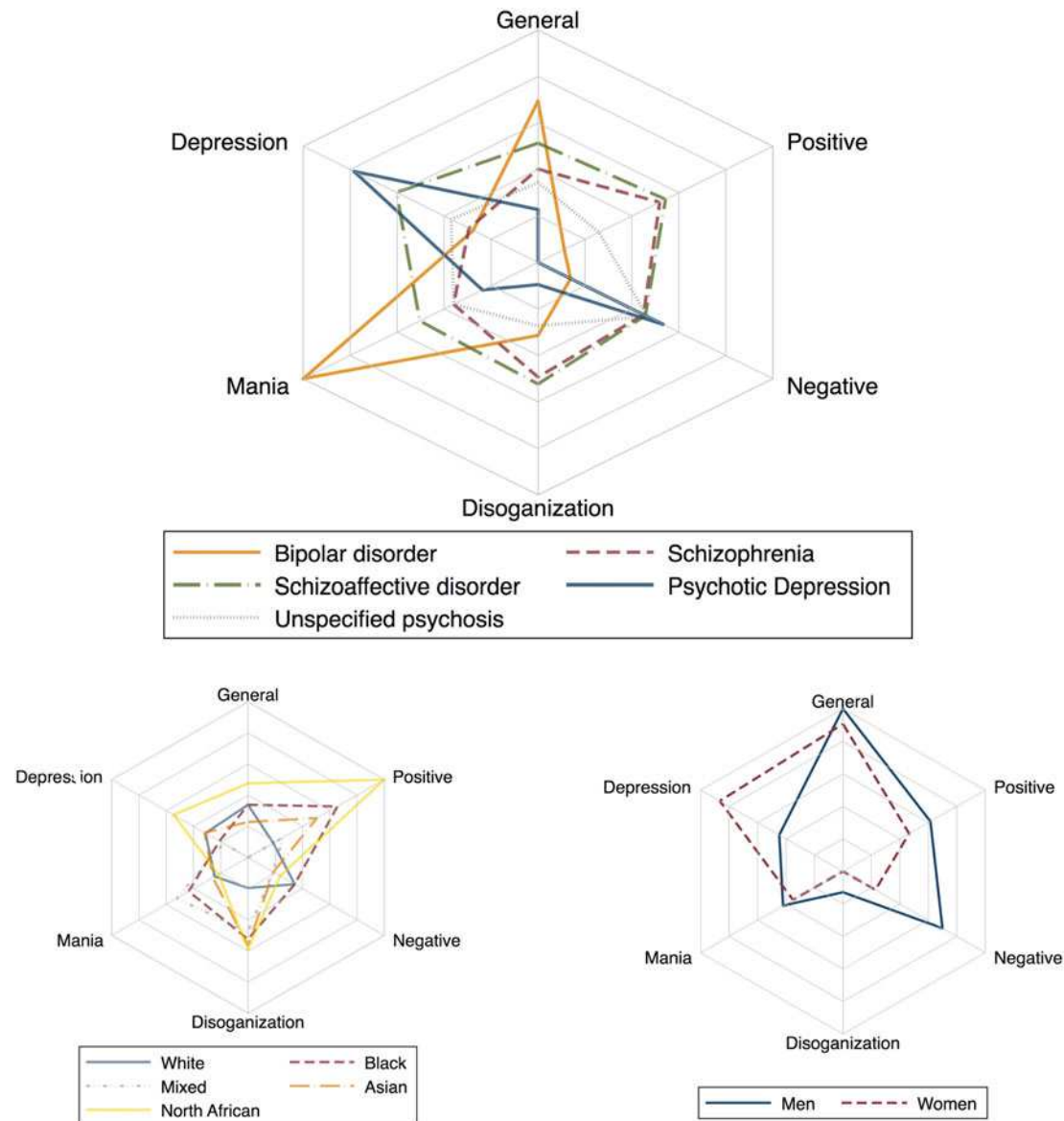


Fig. 2. Predicted symptom profiles by RDC-based diagnostic category, gender, and ethnicity. Explanatory note: After the estimation of the bifactor model, the continuous scores for general and specific symptom dimensions were computed using the function 'FSCORES' in *Mplus* (setting mean=0 and standard deviation=1), and used as the outcome variable in the regression analyses.

Supplementary material. The supplementary material for this article can be found at <https://doi.org/10.1017/S0033291718002131>

Acknowledgements. The EU-GEI Project was funded by the European Community's Seventh Framework Programme under grant agreement No. HEALTH-F2-2010-241909 (Project EU-GEI). The work was further funded by: Clinician Scientist Medical Research Council fellowship (project reference MR/M008436/1) to MDF; Veni grant from the Netherlands Organisation for Scientific Research (grant no. 451-13-022) to UR; Sir Henry Dale Fellowship, jointly funded by the Wellcome Trust and the Royal Society (grant no. 101272/Z/13/Z) to JBK; National Institute for Health Research (NIHR) Biomedical Research Centre for Mental Health at South London and Maudsley NHS Foundation Trust and King's College London. The Brazilian study was funded by the São Paulo Research Foundation under grant number 2012/0417-0. Funders were not involved in design and conduct of the study; collection, management, analysis and interpretation of the data; preparation, review or approval of the manuscript, and decision to submit the manuscript for publication.

Conflict of interest. The authors have no conflicts of interest to declare in relation to the work presented in this paper.

References

- Abrams DJ, Rojas DC and Arciniegas DB (2008) Is schizoaffective disorder a distinct categorical diagnosis? A critical review of the literature. *Neuropsychiatric Disease and Treatment* **4**, 1089–1109.
- Allardyce J, Suppes T and Van Os J (2007) Dimensions and the psychosis phenotype. *International Journal of Methods in Psychiatric Research* **16** (Suppl. 1), S34–S40.
- American Psychiatric Association (2013) *Diagnostic and Statistical Manual of Mental Disorders (DSM-5[®])*. Arlington, VA: American Psychiatric Publishing.
- Arnold LM, Keck Jr. PE, Collins J, Wilson R, Fleck DE, Corey KB, Amicone J, Adebimpe VR and Strakowski SM (2004) Ethnicity and first-rank symptoms in patients with psychosis. *Schizophrenia Research* **67**, 207–212.

- Barrio C, Yamada AM, Atuel H, Hough RL, Yee S, Berthot B and Russo PA** (2003) A tri-ethnic examination of symptom expression on the positive and negative syndrome scale in schizophrenia spectrum disorders. *Schizophrenia Research* **60**, 259–269.
- Berrios GE and Beer D** (1994) The notion of a unitary psychosis: a conceptual history. *History of Psychiatry* **5**, 13–36.
- Bonifay W, Lane SP and Reise SP** (2016) Three concerns with applying a bifactor model as a structure of psychopathology. *Clinical Psychological Science* **5**, 184–186.
- Carbon M and Correll CU** (2014) Thinking and acting beyond the positive: the role of the cognitive and negative symptoms in schizophrenia. *CNS Spectrums* **19**(Suppl. 1), 35–53.
- Cardno AG and Owen MJ** (2014) Genetic relationships between schizophrenia, bipolar disorder, and schizoaffective disorder. *Schizophrenia Bulletin* **40**, 504–515.
- Cardno AG, Jones LA, Murphy KC, Asherson P, Scott LC, Williams J, Owen MJ and McGuffin P** (1996) Factor analysis of schizophrenic symptoms using the OPCRIT checklist. *Schizophrenia Research* **22**, 233–239.
- Cardno AG, Rijdsdijk FV, Sham PC, Murray RM and McGuffin P** (2002) A twin study of genetic relationships between psychotic symptoms. *The American Journal of Psychiatry* **159**, 539–545.
- Castle DJ and Murray RM** (1991) The neurodevelopmental basis of sex differences in schizophrenia. *Psychological Medicine* **21**, 565–575.
- Chou JJ, Kuo CF, Huang YS, Grainge MJ, Valdes AM, See LC, Yu KH, Luo SF, Huang LS, Tseng WY, Zhang W and Doherty M** (2017) Familial aggregation and heritability of schizophrenia and co-aggregation of psychiatric illnesses in affected families. *Schizophrenia Bulletin* **43**, 1070–1078.
- Craddock N and Owen MJ** (2005) The beginning of the end for the Kraepelinian dichotomy. *The British Journal of Psychiatry: The Journal of Mental Science* **186**, 364–366.
- Craddock M, Asherson P, Owen MJ, Williams J, McGuffin P and Farmer AE** (1996) Concurrent validity of the OPCRIT diagnostic system. Comparison of OPCRIT diagnoses with consensus best-estimate lifetime diagnoses. *The British Journal of Psychiatry: The Journal of Mental Science* **169**, 58–63.
- Demjaha A, Morgan K, Morgan C, Landau S, Dean K, Reichenberg A, Sham P, Fearon P, Hutchinson G, Jones PB, Murray RM and Dazzan P** (2009) Combining dimensional and categorical representation of psychosis: the way forward for DSM-V and ICD-11? *Psychological Medicine* **39**, 1943–1955.
- Demjaha A, MacCabe JH and Murray RM** (2011) How genes and environmental factors determine the different neurodevelopmental trajectories of schizophrenia and bipolar disorder. *Schizophrenia Bulletin* **38**, 209–214.
- Dikeos DG, Wickham H, McDonald C, Walshe M, Sigmundsson T, Bramon E, Grech A, Touloupoulou T, Murray R and Sham PC** (2006) Distribution of symptom dimensions across Kraepelinian divisions. *The British Journal of Psychiatry: The Journal of Mental Science* **189**, 346–353.
- Fanous AH, van den Oord EJ, Riley BP, Aggen SH, Neale MC, O'Neill FA, Walsh D and Kendler KS** (2005) Relationship between a high-risk haplotype in the DTNBP1 (dysbindin) gene and clinical features of schizophrenia. *The American Journal of Psychiatry* **162**, 1824–1832.
- Forstner AJ, Hecker J, Hofmann A, Maaser A, Reinbold CS, Muhleisen TW, Leber M, Strohmaier J, Degenhardt F, Treutlein J, Mattheisen M, Schumacher J, Streit F, Meier S, Herms S, Hoffmann P, Lacour A, Witt SH, Reif A, Muller-Myhsok B, Lucae S, Maier W, Schwarz M, Vedder H, Kammerer-Ciernioch J, Pfennig A, Bauer M, Hautzinger M, Moebus S, Schenk LM, Fischer SB, Sivalingam S, Czernik PM, Hauser J, Lissowska J, Szeszenia-Dabrowska N, Brennan P, McKay JD, Wright A, Mitchell PB, Fullerton JM, Schofield PR, Montgomery GW, Medland SE, Gordon SD, Martin NG, Krasnov V, Chuchalin A, Babadjanova G, Pantelejeva G, Abramova LI, Tiganov AS, Polonikov A, Khusnutdinova E, Alda M, Cruceanu C, Rouleau GA, Turecki G, Laprise C, Rivas F, Mayoral F, Kogevinas M, Grigoriu-Serbanescu M, Becker T, Schulze TG, Rietschel M, Cichon S, Fier H and Nothen MM** (2017) Identification of shared risk loci and pathways for bipolar disorder and schizophrenia. *PLoS ONE* **12**, e0171595.
- Frissen A, Lievever R, Drukker M, van Winkel R, Delespaul P and Investigators G** (2015) Childhood trauma and childhood urbanicity in relation to psychotic disorder. *Social Psychiatry and Psychiatric Epidemiology* **50**, 1481–1488.
- Galderisi S, Bucci P, Ukok A and Peuskens J** (2012) No gender differences in social outcome in patients suffering from schizophrenia. *European Psychiatry: The Journal of the Association of European Psychiatrists* **27**, 406–408.
- Giacco D, McCabe R, Kallert T, Hansson L, Fiorillo A and Priebe S** (2012) Friends and symptom dimensions in patients with psychosis: a pooled analysis. *PLoS ONE* **7**, e50119.
- Goodwin GM, Haddad PM, Ferrier IN, Aronson JK, Barnes T, Cipriani A, Coghill DR, Fazel S, Geddes JR, Grunze H, Holmes EA, Howes O, Hudson S, Hunt N, Jones I, Macmillan IC, McAllister-Williams H, Miklowitz DR, Morriss R, Munafo M, Paton C, Saharkian BJ, Saunders K, Sinclair J, Taylor D, Vieta E and Young AH** (2016) Evidence-based guidelines for treating bipolar disorder: revised third edition recommendations from the British Association for psychopharmacology. *Journal of Psychopharmacology (Oxford, England)* **30**, 495–553.
- Hancock GR and Mueller RO** (2001) Rethinking construct reliability within latent variable systems. In Cudek R, Du Toit S and Sorbom D (eds), *Structural Equation Modeling: Present and Future: A Festschrift in Honor of Karl Jöreskog*. Lincolnwood, IL: Scientific Software International, Inc., pp. 195–216.
- Heslin M, Lomas B, Lappin JM, Donoghue K, Reininghaus U, Onyejiaka A, Croudace T, Jones PB, Murray RM, Fearon P, Dazzan P, Morgan C and Doody GA** (2015) Diagnostic change 10 years after a first episode of psychosis. *Psychological Medicine* **45**, 2757–2769.
- Hoff P** (2017) On reification of mental illness: historical and conceptual issues from Emil Kraepelin and Eugen Bleuler to DSM-5. In Kendler KS and Parnas J (eds), *Philosophical Issues in Psychiatry IV: Psychiatric Nosology*. New York, NY: Oxford University Press, pp. 107–117.
- Howes OD and Murray RM** (2014) Schizophrenia: an integrated sociodevelopmental-cognitive model. *The Lancet* **383**, 1677–1687.
- Howes OD, McCutcheon R, Agid O, de Bartolomeis A, van Beveren NJ, Birnbaumer ML, Bloomfield MA, Bressan RA, Buchanan RW and Carpenter WT** (2016) Treatment-resistant schizophrenia: treatment response and resistance in psychosis (TRIP) working group consensus guidelines on diagnosis and terminology. *American Journal of Psychiatry* **174**, 216–229.
- Hutchinson G, Takei N, Sham P, Harvey I and Murray RM** (1999) Factor analysis of symptoms in schizophrenia: differences between White and Caribbean patients in Camberwell. *Psychological Medicine* **29**, 607–612.
- International Schizophrenia Consortium, Purcell SM, Wray NR, Stone JL, Visscher PM, O'Donovan MC, Sullivan PF and Sklar P** (2009) Common polygenic variation contributes to risk of schizophrenia and bipolar disorder. *Nature* **460**, 748–752.
- Janssen I, Hanssen M, Bak M, Bijl RV, de Graaf R, Vollebergh W, McKenzie K and van Os J** (2003) Discrimination and delusional ideation. *The British Journal of Psychiatry: The Journal of Mental Science* **182**, 71–76.
- Jauhar S, Nour MM, Veronese M, Rogdaki M, Bonoldi I, Azis M, Turkheimer F, McGuire P, Young AH and Howes OD** (2017) A test of the transdiagnostic dopamine hypothesis of psychosis using positron emission tomographic imaging in bipolar affective disorder and schizophrenia. *JAMA Psychiatry* **74**, 1206–1213.
- Jongsma HE, Gayer-Anderson C, Lasalvia A, Quattrone D, Mule A, Szoke A, Selten JP, Turner C, Arango C, Tarricone I, Berardi D, Tortelli A, Llorca PM, de Haan L, Bobes J, Bernardo M, Sanjuan J, Santos JL, Arrojo M, Del-Ben CM, Menezes PR, Velthorst E, Murray RM, Rutten BP, Jones PB, van Os J, Morgan C and Kirkbride JB & European Network of National Schizophrenia Networks Studying Gene-Environment Interactions Work Package, G** (2018) Treated incidence of psychotic disorders in the multinational EU-GEI study. *JAMA Psychiatry* **75**, 36–46.
- Kasanin J** (1933) The acute schizoaffective psychoses. *American Journal of Psychiatry* **13**, 97–126.
- Kay SR and Sevy S** (1990) Pyramidal model of schizophrenia. *Schizophrenia Bulletin* **16**, 537–545.

- Kendell R and Jablensky A** (2003) Distinguishing between the validity and utility of psychiatric diagnoses. *The American Journal of Psychiatry* **160**, 4–12.
- Kirkbride J, Boydell J, Ploubidis G, Morgan C, Fearon P, Dazzan P, Morgan K, Murray R and Jones P** (2007) The relationship between schizophrenia and neighbourhood-level social capital in an urban area: findings from the AESOP study. *Schizophrenia Bulletin* **33**, 237–238.
- Kirkbride JB, Hindocha C, Hameed Y, Perez J and Jones PB** (2016) Talk 3. Do symptom dimensions vary between ethnic groups at first presentation to early intervention in psychosis services? Evidence from the SEPEA study. *Early Intervention in Psychiatry* **10**(Suppl. 1), 16–16.
- Kirkbride JB, Hameed Y, Ankireddyalli G, Ioannidis K, Crane CM, Nasir M, Kabacs N, Metastasio A, Jenkins O, Espandian A, Spyridi S, Ralevic D, Siddabattuni S, Walden B, Adeoye A, Perez J and Jones PB** (2017) The epidemiology of first-episode psychosis in early intervention in psychosis services: findings from the social epidemiology of psychoses in east Anglia [SEPEA] study. *American Journal of Psychiatry* **174**, 143–153.
- Kotov R, Krueger RF, Watson D, Achenbach TM, Althoff RR, Bagby RM, Brown TA, Carpenter WT, Caspi A and Clark LA** (2017) The hierarchical taxonomy of psychopathology (HiTOP): a dimensional alternative to traditional nosologies. *Journal of Abnormal Psychology* **126**, 454.
- Kraepelin E** (1899) *Psychiatrie: Ein Lehrbuch für Studierende und Aerzte*. Leipzig: JA Barth.
- Kuepper R, van Os J, Lieb R, Wittchen HU and Henquet C** (2011) Do cannabis and urbanicity co-participate in causing psychosis? Evidence from a 10-year follow-up cohort study. *Psychological Medicine* **41**, 2121–2129.
- Laursen TM, Agerbo E and Pedersen CB** (2009) Bipolar disorder, schizoaffective disorder, and schizophrenia overlap: a new comorbidity index. *The Journal of Clinical Psychiatry* **70**, 1432–1438.
- Li XB, Tang YL, Wang CY and de Leon J** (2015) Clozapine for treatment-resistant bipolar disorder: a systematic review. *Bipolar Disorders* **17**, 235–247.
- Lichtenstein P, Yip BH, Björk C, Pawitan Y, Cannon TD, Sullivan PF and Hultman CM** (2009) Common genetic determinants of schizophrenia and bipolar disorder in Swedish families: a population-based study. *The Lancet* **373**, 234–239.
- Liddle PF** (1987) The symptoms of chronic schizophrenia. A re-examination of the positive-negative dichotomy. *The British Journal of Psychiatry: The Journal of Mental Science* **151**, 145–151.
- Limosin F** (2014) Neurodevelopmental and environmental hypotheses of negative symptoms of schizophrenia. *BMC Psychiatry* **14**, 88.
- Lindenmayer J-P, Bernstein-Hyman R and Grochowski S** (1994) Five-Factor model of schizophrenia initial validation. *The Journal of Nervous and Mental Disease* **182**, 631–638.
- Lindenmayer JP, Bossie CA, Kujawa M, Zhu Y and Canuso CM** (2008) Dimensions of psychosis in patients with bipolar mania as measured by the positive and negative syndrome scale. *Psychopathology* **41**, 264–270.
- Linscott RJ and van Os J** (2010) Systematic reviews of categorical versus continuum models in psychosis: evidence for discontinuous subpopulations underlying a psychometric continuum. Implications for DSM-V, DSM-VI, and DSM-VII. *Annual Review of Clinical Psychology* **6**, 391–419.
- Mallett R** (1997) *Sociodemographic Schedule*. London: Section of Social Psychiatry, Institute of Psychiatry.
- Maric N, Krabbendam L, Vollebergh W, de Graaf R and van Os J** (2003) Sex differences in symptoms of psychosis in a non-selected, general population sample. *Schizophrenia Research* **63**, 89–95.
- McGuffin P, Farmer A and Harvey I** (1991) A polydiagnostic application of operational criteria in studies of psychotic illness. Development and reliability of the OPCRIT system. *Archives of General Psychiatry* **48**, 764–770.
- Morgan VA, Castle DJ and Jablensky AV** (2008) Do women express and experience psychosis differently from men? Epidemiological evidence from the Australian National Study of Low Prevalence (Psychotic) Disorders. *Australian & New Zealand Journal of Psychiatry* **42**, 74–82.
- Morgan C, Charalambides M, Hutchinson G and Murray RM** (2010) Migration, ethnicity, and psychosis: toward a sociodevelopmental model. *Schizophrenia Bulletin* **36**, 655–664.
- Mukherjee S, Shukla S, Woodle J, Rosen AM and Olarte S** (1983) Misdiagnosis of schizophrenia in bipolar patients: a multiethnic comparison. *American Journal of Psychiatry* **140**, 1571–1574.
- Murray RM and Lewis SW** (1987) Is schizophrenia a neurodevelopmental disorder? *British Medical Journal (Clinical Research ed.)* **295**, 681–682.
- Murray RM, O'Callaghan E, Castle DJ and Lewis SW** (1992) A neurodevelopmental approach to the classification of schizophrenia. *Schizophrenia Bulletin* **18**, 319–332.
- Murray RM, Sham P, Van Os J, Zanelli J, Cannon M and McDonald C** (2004) A developmental model for similarities and dissimilarities between schizophrenia and bipolar disorder. *Schizophrenia Research* **71**, 405–416.
- Murray RM, Quattrone D, Natesan S, van Os J, Nordentoft M, Howes O, Di Forti M and Taylor D** (2016) Should psychiatrists be more cautious about the long-term prophylactic use of antipsychotics? *The British Journal of Psychiatry: The Journal of Mental Science* **209**, 361–365.
- Muthén L and Muthén B** (2012) *Mplus User's Guide*, 7th Edn. Los Angeles, CA: Muthén & Muthén.
- O'Donovan MC and Owen MJ** (2016) The implications of the shared genetics of psychiatric disorders. *Nature Medicine* **22**, 1214–1219.
- Owen MJ and O'Donovan MC** (2017) Schizophrenia and the neurodevelopmental continuum: evidence from genomics. *World Psychiatry* **16**, 227–235.
- Patel R, Jayatilake N, Broadbent M, Chang CK, Foskett N, Gorrell G, Hayes RD, Jackson R, Johnston C, Shetty H, Roberts A, McGuire P and Stewart R** (2015) Negative symptoms in schizophrenia: a study in a large clinical sample of patients using a novel automated method. *BMJ Open* **5**, e007619.
- Pelayo-Teran JM, Diaz FJ, Perez-Iglesias R, Suarez-Pinilla P, Tabares-Seisdedos R, de Leon J and Crespo-Facorro B** (2014) Trajectories of symptom dimensions in short-term response to antipsychotic treatment in patients with a first episode of non-affective psychosis. *Psychological Medicine* **44**, 37–50.
- Post RM** (1999) Comparative pharmacology of bipolar disorder and schizophrenia. *Schizophrenia Research* **39**, 153–158.
- Power RA, Tansey KE, Buttenschon HN, Cohen-Woods S, Bigdeli T, Hall LS, Kutalik Z, Lee SH, Ripke S, Steinberg S, Teumer A, Viktorin A, Wray NR, Arolt V, Baune BT, Boomsma DI, Borglum AD, Byrne EM, Castelao E, Craddock N, Craig IW, Dannlowski U, Deary IJ, Degenhardt F, Forstner AJ, Gordon SD, Grabe HJ, Grove J, Hamilton SP, Hayward C, Heath AC, Hocking LJ, Homuth G, Hottenga JJ, Kloiber S, Krogh J, Landen M, Lang M, Levinson DF, Lichtenstein P, Lucae S, MacIntyre DJ, Madden P, Magnusson PK, Martin NG, McIntosh AM, Middeldorp CM, Milaneschi Y, Montgomery GW, Mors O, Muller-Myhsok B, Nyholt DR, Oskarsson H, Owen MJ, Padmanabhan S, Penninx BW, Pergadia ML, Porteous DJ, Potash JB, Preisig M, Rivera M, Shi J, Shyn SI, Sigurdsson E, Smit JH, Smith BH, Stefansson H, Stefansson K, Strohmaier J, Sullivan PF, Thomson P, Thorgeirsson TE, Van der Auwera S, Weissman MM, Converge Consortium, CCGC, Breen G and Lewis CM** (2017) Genome-wide association for major depression through age at onset stratification: major depressive disorder working group of the psychiatric genomics consortium. *Biological Psychiatry* **81**, 325–335.
- Reininghaus U, Priebe S and Bental RP** (2013) Testing the psychopathology of psychosis: evidence for a general psychosis dimension. *Schizophrenia Bulletin* **39**, 884–895.
- Reininghaus U, Bohnke JR, Hosang G, Farmer A, Burns T, McGuffin P and Bental RP** (2016) Evaluation of the validity and utility of a transdiagnostic psychosis dimension encompassing schizophrenia and bipolar disorder. *The British Journal of Psychiatry: The Journal of Mental Science* **209**, 107–113.
- Reise SP, Morizot J and Hays RD** (2007) The role of the bifactor model in resolving dimensionality issues in health outcomes measures. *Quality of Life Research* **16**, 19–31.
- Riecher-Rössler A and Häfner H** (2000) Gender aspects in schizophrenia: bridging the border between social and biological psychiatry. *Acta Psychiatrica Scandinavica* **102**, 58–62.
- Rodriguez A, Reise SP and Haviland MG** (2016a) Applying bifactor statistical indices in the evaluation of psychological measures. *Journal of Personality Assessment* **98**, 223–237.
- Rodriguez A, Reise SP and Haviland MG** (2016b) Evaluating bifactor models: calculating and interpreting statistical indices. *Psychological Methods* **21**, 137–150.
- Rosenbaum S, Tiedemann A, Sherrington C, Curtis J and Ward PB** (2014) Physical activity interventions for people with mental illness: a systematic review and meta-analysis. *The Journal of Clinical Psychiatry* **75**, 964–974.

- Roy M-A, Maziade M, Labbé A and Mérette C (2001) Male gender is associated with deficit schizophrenia: a meta-analysis. *Schizophrenia Research* **47**, 141–147.
- Rucker J, Newman S, Gray J, Gunasinghe C, Broadbent M, Brittain P, Baggaley M, Denis M, Turp J, Stewart R, Lovestone S, Schumann G, Farmer A and McGuffin P (2011) OPCRIT+: an electronic system for psychiatric diagnosis and data collection in clinical and research settings. *The British Journal of Psychiatry: The Journal of Mental Science* **199**, 151–155.
- Salokangas RKR (1997) Structure of schizophrenic symptomatology and its changes over time: prospective factor-analytical study. *Acta Psychiatrica Scandinavica* **95**, 32–39.
- Salokangas RK (2003) Symptom dimensions and outcome in schizophrenia. *World Psychiatry* **2**, 172–178.
- Seeman MV (1997) Psychopathology in women and men: focus on female hormones. *American Journal of Psychiatry* **154**, 1641–1647.
- Serretti A, Rietschel M, Lattuada E, Krauss H, Schulze TG, Muller DJ, Maier W and Smeraldi E (2001) Major psychoses symptomatology: factor analysis of 2241 psychotic subjects. *European Archives of Psychiatry and Clinical Neuroscience* **251**, 193–198.
- Shevlin M, McElroy E, Bentall RP, Reininghaus U and Murphy J (2017) The psychosis Continuum: testing a bifactor model of psychosis in a general population sample. *Schizophrenia Bulletin* **43**, 133–141.
- Shtasel DL, Gur RE, Gallacher F, Heimberg C and Gur RC (1992) Gender differences in the clinical expression of schizophrenia. *Schizophrenia Research* **7**, 225–231.
- Spitzer RL, Endicott J and Robins E (1978) Research diagnostic criteria: rationale and reliability. *Archives of General Psychiatry* **35**, 773–782.
- StataCorp L (2015) Stata Statistical Software: Release 14. [computer program]. StataCorp LP.
- Taylor D, Paton C and Kapur S (2015) *The Maudsley Prescribing Guidelines in Psychiatry*, 12th Edn. Chichester, UK: John Wiley & Sons.
- Uptegrove R, Marwaha S and Birchwood M (2017) Depression and schizophrenia: cause, consequence, or trans-diagnostic issue? *Schizophrenia Bulletin* **43**, 240–244.
- Van Dam NT, O'Connor D, Marcelle ET, Ho EJ, Cameron Craddock R, Tobe RH, Gabbay V, Hudziak JJ, Xavier Castellanos F, Leventhal BL and Milham MP (2017) Data-driven phenotypic categorization for neurobiological analyses: beyond DSM-5 labels. *Biological Psychiatry* **81**, 484–494.
- van Os J and Kapur S (2009) Schizophrenia. *The Lancet* **374**, 635–645.
- Van Os J, Gilvarry C, Bale R, Van Horn E, Tattan T, White I and Murray R (1999) A comparison of the utility of dimensional and categorical representations of psychosis. UK700 group. *Psychological Medicine* **29**, 595–606.
- van Os J, Hanssen M, Bijl RV and Vollebergh W (2001) Prevalence of psychotic disorder and community level of psychotic symptoms: an urban-rural comparison. *Archives of General Psychiatry* **58**, 663–668.
- van Os J, Hanssen M, de Graaf R and Vollebergh W (2002) Does the urban environment independently increase the risk for both negative and positive features of psychosis? *Social Psychiatry and Psychiatric Epidemiology* **37**, 460–464.
- Vassos E, Pedersen CB, Murray RM, Collier DA and Lewis CM (2012) Meta-analysis of the association of urbanicity with schizophrenia. *Schizophrenia Bulletin* **38**, 1118–1123.
- Vega WA and Lewis-Fernandez R (2008) Ethnicity and variability of psychotic symptoms. *Current Psychiatry Reports* **10**, 223–228.
- Veling W, Seltén J-P, Mackenbach JP and Hoek HW (2007) Symptoms at first contact for psychotic disorder: comparison between native Dutch and ethnic minorities. *Schizophrenia Research* **95**, 30–38.
- Wallwork RS, Fortgang R, Hashimoto R, Weinberger DR and Dickinson D (2012) Searching for a consensus five-factor model of the positive and negative syndrome scale for schizophrenia. *Schizophrenia Research* **137**, 246–250.
- Whalen DJ (2017) Using hybrid modeling to determine the latent structure of psychopathology. *Biological Psychiatry* **81**, e41–e42.
- Wickham H, Walsh C, Asherson P, Taylor C, Sigmundson T, Gill M, Owen MJ, McGuffin P, Murray R and Sham P (2001) Familiality of symptom dimensions in schizophrenia. *Schizophrenia Research* **47**, 223–232.
- Williams J, Farmer AE, Ackenheil M, Kaufmann CA and McGuffin P (1996) A multicentre inter-rater reliability study using the OPCRIT computerized diagnostic system. *Psychological Medicine* **26**, 775–783.
- World Health Organization (1992) *The ICD-10 Classification of Mental and Behavioural Disorders: Clinical Descriptions and Diagnostic Guidelines*. Geneva: World Health Organization.
- Wykes T, Huddy V, Cellard C, McGurk SR and Czobor P (2011) A meta-analysis of cognitive remediation for schizophrenia: methodology and effect sizes. *The American Journal of Psychiatry* **168**, 472–485.
- Zachar P and Kendler KS (2017) The philosophy of nosology. *Annual Review of Clinical Psychology* **13**, 49–71.

Appendix

Non-author EU-GEI collaborators

Kathryn Hubbard¹, Stephanie Beards¹, Simona A. Stilo², Mara Parellada³, Pedro Cuadrado⁴, José Juan Rodríguez Solano⁵, Angel Carracedo⁶, Enrique García Bernardo⁷, Laura Roldán³, Gonzalo López³, Bibiana Cabrera⁸, Esther Lorente-Rovira⁹, Paz García-Portilla¹⁰, Javier Costas⁶, Estela Jiménez-López¹¹, Mario Matteis³, Marta Rapado³, Emiliano González³, Covadonga Martínez³, Emilio Sánchez⁷, M^a Soledad Olmeda⁷, Nathalie Franke¹², Fabian Termorshuizen^{13,14}, Daniella van Dam¹², Elsje van der Ven^{13,14}, Elles Messchaert¹⁴, Marion Leboyer^{15–18}, Franck Schürhoff^{15–18}, Stéphane Jamain^{16–18}, Grégoire Baudin^{15,16}, Aziz Ferchou^{15,16}, Baptiste Pignon^{15,16,18}, Jean-Romain Richard^{16,18}, Thomas Charpeaud^{18,19,21}, Anne-Marie Tronche^{18,19,21}, Flora Frijda²², Giovanna Marrasso²³, Lucia Sideli²², Crocettarachele Sartorio^{22,23}, Fabio Seminerio²², Camila Marcelino Loureiro^{24,25}, Rosana Shuhama^{24,25}, Mirella Ruggeri²⁶, Sarah Tosato²⁶, Chiara Bonetto²⁶ and Doriana Cristofalo²⁶.

Affiliations

¹Department of Health Service and Population Research, Institute of Psychiatry, King's College London, De Crespigny Park, Denmark Hill, London SE5 8AF, UK

²Department of Psychosis Studies, Institute of Psychiatry, King's College London, De Crespigny Park, Denmark Hill, London SE5 8AF, UK

³Department of Child and Adolescent Psychiatry, Hospital General Universitario Gregorio Marañón, School of Medicine, Universidad Complutense, IISGM (CIBERSAM), C/Doctor Esquerdo 46, 28007 Madrid, Spain

⁴Villa de Vallecas Mental Health Department, Villa de Vallecas Mental Health Centre, Hospital Universitario Infanta Leonor / Hospital Virgen de la Torre, C/San Claudio 154, 28038 Madrid, Spain

⁵Puente de Vallecas Mental Health Department, Hospital Universitario Infanta Leonor/Hospital Virgen de la Torre, Centro de Salud Mental Puente de Vallecas, C/Peña Gorbea 4, 28018 Madrid, Spain

⁶Fundación Pública Galega de Medicina Xenómica, Hospital Clínico Universitario, Choupana s/n, 15782 Santiago de Compostela, Spain

⁷Department of Psychiatry, Hospital General Universitario Gregorio Marañón, School of Medicine, Universidad Complutense, IISGM (CIBERSAM), C/Doctor Esquerdo 46, 28007 Madrid, Spain

⁸Department of Psychiatry, Hospital Clinic, IDIBAPS, Centro de Investigación Biomédica en Red de Salud Mental (CIBERSAM), Universidad de Barcelona, C/Villarreal 170, escalera 9, planta 6, 08036 Barcelona, Spain

⁹Department of Psychiatry, School of Medicine, Universidad de Valencia, Centro de Investigación Biomédica en Red de Salud Mental (CIBERSAM), C/Avda. Blasco Ibáñez 15, 46010 Valencia, Spain

¹⁰Department of Medicine, Psychiatry Area, School of Medicine, Universidad de Oviedo, Centro de Investigación Biomédica en Red de Salud Mental (CIBERSAM), C/Julián Clavería s/n, 33006 Oviedo, Spain

¹¹Department of Psychiatry, Servicio de Psiquiatría Hospital "Virgen de la Luz", C/Hermanidad de Donantes de Sangre, 16002 Cuenca, Spain

¹²Department of Psychiatry, Early Psychosis Section, Academic Medical Centre, University of Amsterdam, Meibergdreef 5, 1105 AZ Amsterdam, The Netherlands

¹³Rivierduinen Centre for Mental Health, Leiden, Sandifortdreef 19, 2333 ZZ Leiden, The Netherlands

¹⁴Department of Psychiatry and Neuropsychology, School for Mental Health and Neuroscience, South Limburg Mental Health Research and Teaching

Network, Maastricht University Medical Centre, P.O. Box 616, 6200 MD Maastricht, The Netherlands

¹⁵AP-HP, Groupe Hospitalier “Mondor”, Pôle de Psychiatrie, 51 Avenue de Maréchal de Lattre de Tassigny, 94010 Créteil, France

¹⁶INSERM, U955, Equipe 15, 51 Avenue de Maréchal de Lattre de Tassigny, 94010 Créteil, France

¹⁷Faculté de Médecine, Université Paris-Est, 51 Avenue de Maréchal de Lattre de Tassigny, 94010 Créteil, France

¹⁸Fondation Fondamental, 40 Rue de Mesly, 94000 Créteil, France

¹⁹CMP B CHU, BP 69, 63003 Clermont Ferrand, Cedex 1, France

²⁰EPS Maison Blanche, Paris 75020, France

²¹Université Clermont Auvergne, EA 7280, Clermont-Ferrand 63000, France

²²Department of Experimental Biomedicine and Clinical Neuroscience, Section of Psychiatry, University of Palermo, Via G. La Loggia n.1, 90129 Palermo, Italy

²³Unit of Psychiatry, “P. Giaccone” General Hospital, Via G. La Loggia n.1, 90129 Palermo, Italy

²⁴Departamento de Neurociências e Ciências do Comportamento, Faculdade de Medicina de Ribeirão Preto, Universidade de São Paulo, Av. Bandeirantes, 3900-Monte Alegre- CEP 14049-900, Ribeirão Preto, SP, Brasil

²⁵Núcleo de Pesquisa em Saúde Mental Populacional, Universidade de São Paulo, Avenida Doutor Arnaldo 455, CEP 01246-903, SP, Brasil

²⁶Section of Psychiatry, Department of Neuroscience, Biomedicine and Movement, University of Verona, Piazzale L.A. Scuro 10, 37134 Verona, Italy