

Schizotypy: The Way Ahead

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Abstract

Background: Empirical evidence suggests that schizotypy is a useful construct for analyzing and understanding psychotic disorders. However, several issues remain to be resolved. **Method:** This selective, critical review, addresses some questions and limitations, and discusses future directions of work. **Results:** First, we present a conceptual outline and discuss the evidence from translational and interdisciplinary studies on schizotypy. Next, we examine and discuss newer analytical and methodological approaches, including network and machine learning approaches. We also discuss newer psychometric identification approaches, such as those using biobehavioral and ambulatory assessment. Next, we review recent cross-cultural studies in schizotypy research. Finally, we identify new challenges and directions and draw conclusions. **Conclusions:** This selective, critical review suggests that new methods can contribute to the construction of a solid scientific model of schizotypy as a risk construct.

Keywords: Psychosis, schizotypal traits, schizotypy, review, update.

Resumen

Esquizotipia: el Camino a Seguir. Antecedentes: la evidencia empírica ha demostrado que la esquizotipia es un constructo útil para analizar y comprender los trastornos psicóticos. Sin embargo, todavía quedan por resolver varias cuestiones. **Método:** en esta revisión selectiva y crítica se abordan algunas limitaciones, se discuten interrogantes y se comentan direcciones futuras de trabajo. **Resultados:** en primer lugar, se presenta una delimitación conceptual y se comenta la evidencia acumulada en diferentes estudios y niveles de análisis en el campo de la esquizotipia. A continuación, se examinan nuevos modelos psicopatológicos, como el modelo de red, y se presentan las diferentes herramientas desarrolladas y validadas para su evaluación. Seguidamente, se abordan algunas inquietudes metodológicas de fondo y se presentan nuevas técnicas y procedimientos psicométricos, como la evaluación ambulatoria y bioconductual. También se analizan algunos de los problemas inherentes en la investigación entre países y culturas. Finalmente, se establecen las conclusiones y se abordan nuevos desafíos y direcciones futuras de investigación. **Conclusiones:** esta revisión selectiva y crítica plantea que es necesario continuar trabajando en la construcción de un modelo científico sólido y refutable e incorporar nuevas pruebas científicas en el campo de la esquizotipia.

Palabras clave: psicosis, rasgos esquizotípicos, esquizotipia, revisión, actualización.

Schizotypy was originally defined as a latent personality organization reflecting a putative liability for schizophrenia (Meehl, 1962; 1990). Schizotypy as a complex construct, mainly related to psychosis risk, has been examined across populations, settings, and cultures over recent decades. However, in spite of the large body of research, critical gaps and caveats remain unresolved. It is necessary to continue working on the construction of a solid scientific model of schizotypy and to incorporate new scientific evidence. The understanding and misunderstanding of this construct requires vigilance in order to ensure that the approach continues to yield the fruit that it has (Lenzenweger,

2010; 2015), namely psychosis prevention. Thus, the main goal of the present article is to conduct a critical and selective review of the schizotypy construct.

In this review, conceptual definitions of schizotypy are examined in lieu of ongoing differences of opinion about what the construct may reflect. Second, we critically discuss the evidence for the schizotypy construct with an eye towards international, multidisciplinary, and translational research. Third, we examine increasingly used statistical approaches like network analysis that can evaluate schizotypy as a complex system. Fourth, newer measurement tools are presented, and some critical issues raised, in particular, the need for more objective and digital phenotyping research. Fifth, some methodological concerns (e.g., sampling, infrequency scales, confounders, moderators, mediators, and follow-up studies) are addressed. Sixth, we review psychometric techniques, including ambulatory assessment, to better understand schizotypy and related phenomena (e.g., schizophrenia-spectrum psychopathology). Seventh, we discuss cross-cultural schizotypy

research. We then present future directions and recommendations for research on this arena.

Conceptual delimitation and its discontents

The role of schizotypy in the etiology of schizophrenia-related psychopathology are well described (Lenzenweger, 2010; 2015; 2018). At the phenotypic level, schizotypy is considered to manifest itself in a variety of subclinical and clinical outcomes, such as schizotypal traits, psychotic-like experiences, subclinical psychotic symptoms (e.g., at risk mental state), and psychosis-spectrum disorders. Hence, any substantive increase in subclinical psychotic phenomena may represent the manifestation of risk for psychosis (e.g., Barrantes-Vidal et al., 2015; Debbané et al., 2015; Linscott & van Os, 2013; van Os & Reininghaus, 2016). However, schizotypy is more than a simple risk factor for schizophrenia, it is a genuine manifestation of its latent liability (Lenzenweger, 2015). In addition, schizotypic psychopathology may occur in the general population and across all domains of psychopathology, including anxiety and depression (e.g., van Os & Reininghaus, 2016).

The nature and structure of schizotypy has been analysed. The distribution of schizotypy across the population is a point of some contention, as at least three major models of schizotypy have been proposed, named “taxometric”, “quasi-dimensional” and “fully-dimensional” can be mentioned (e.g., Grant et al., 2018; Lenzenweger, 2010; Linscott & van Os, 2010). These models refer to whether schizotypy is categorically distinct or continuous within the population. Both ends of the spectrum are possible, and many believe in a latent class and latent trait hybrid model. Regardless, our current understanding of genetic and phenotypic risk may make this point irrelevant: we can now empirically test continuous genetic and phenotypic models of risk and of schizotypy. In both clinical and non-clinical populations, factor analyses appear to support schizotypy as a multidimensional construct, which commonly regroups three factors (Cognitive-Perceptual, Interpersonal -Negative-, and Disorganization), phenotypically similar to that found in persons with psychosis (Fonseca-Pedrero, Debbané et al., 2018; Fonseca-Pedrero, Ortuño-Sierra et al., 2018). However, overfitting is a continual concern, since these factor structures are based on measures that were typically developed based on positive, negative, and disorganized schizophrenia symptom facets.

To date, although there is no commonly agreed definition of schizotypy, some common ground does indeed exist. Here, we highlight the common ground.

Collecting evidence

A large body of research suggests that schizotypy, as a construct, provides a useful framework for understanding schizophrenia spectrum phenomena, psychopathology, and healthy variation in the general population (e.g., Barrantes-Vidal et al., 2015; Fonseca-Pedrero & Debbané, 2017; Kwapil & Barrantes-Vidal, 2012; Raine, 2006; Schultze-Lutter et al., 2019).

First, previous research has suggested that schizotypy, as measured by interviews and self-reports, is a valid putative liability marker for psychosis (e.g., Barrantes-Vidal et al., 2015; Grant, 2015). Schizotypy, defined by measurement of psychometric risk for psychosis-spectrum disorders at a population level, may represent the expression of distributed multifactorial

risk for psychosis (Barrantes-Vidal et al., 2015; Debbané et al., 2015; Linscott & van Os, 2013; van Os & Reininghaus, 2016). Within this framework, schizotypy dimensions are associated with, and in some cases predict, the onset of psychosis-spectrum disorders in four different types of samples: general population, clinical risk samples according to Ultra-High Risk (UHR) and/or basic symptom criteria, genetic (familial) risk, and schizotypal personality disorder (Debbané et al., 2015; Flückiger et al., 2016; Fonseca-Pedrero, Debbané et al., 2016; Nordentoft et al., 2006; Salokangas et al., 2013; Shah et al., 2012). For instance, and stressing the powerful role of this construct in those youths at high genetic risk, schizotypy improves the individualized prediction of schizophrenia onset above and beyond the predictive capacity of neuroanatomical and neurocognitive variables (Zarogianni et al., 2017).

Second, schizotypy dimensions share many similar genetic, neurochemical, neuroanatomical, neurofunctional physiological, neuropsychological, cognitive, and phenomenological abnormalities and deficits, have been found in persons with psychosis spectrum disorders (e.g., Cohen et al., 2015; Ettinger et al., 2014; Ettinger et al., 2015; Kwapil & Barrantes-Vidal, 2012; Myles et al., 2017; Nelson et al., 2013; Raine, 2006; Siddi et al., 2017; Walter et al., 2016).

Third, schizotypy is tied to demographic, environmental, psychological, and genetic risk factors, which appear to impact risk (obstetric complications, affective comorbidities, childhood trauma, male gender, unemployment, single status, urbanicity, etc.) (Linscott & van Os, 2013; Morton et al., 2017; Nelson et al., 2013); however, causal directionality or bi-directionality remains unclear. For instance, childhood trauma, other stressful events (e.g., bullying), and cannabis use are all associated with schizotypy symptoms (Sánchez-García et al., 2020; Szoke et al., 2014; Velikonja et al., 2015).

Fourth, schizotypy and schizotypal traits increase the risk for non-psychotic psychopathology such as depression and suicide behaviours (e.g., Díez-Gómez et al., 2020; Fisher et al., 2013; Jahn et al., 2016; Kelleher et al., 2014; Kwapil et al., 2013; Schimanski et al., 2017). And likely vice versa. Thus, the liability for psychosis is expressed pleiotropically, and not limited, to the psychosis phenotypes (van Os et al., 2017).

Fifth, and related to previous point, schizotypy and schizotypal traits have been associated, amongst other factors, with impairments in neurocognition, mental health status (distress), quality of life, social adjustment, and daily functioning (Cella et al., 2013; Chun et al., 2017; Fonseca Pedrero & Debbané, 2017; Kwapil, Brown et al., 2012). For instance, schizotypy dimensions predicted psychotic-like, paranoid, and negative symptoms and were associated with negative experiences, diminished positive affect, and social disinterest in daily life (Barrantes-Vidal, Chun et al., 2013; Kwapil et al., 2020). That is, this psychosis liability, as well as the subclinical expression of psychosis phenotype, appear to predict myriad negative outcomes.

Sixth, schizotypy allows us to study the psychotic spectrum phenomena without the effects commonly associated in clinical samples (e.g., medication, iatrogenic effects of psychotic breakdown and hospitalization, social ruptures, etc.).

Collectively, these findings converge to suggest that schizotypy, as a risk construct, may provide a useful framework for targeting the etiology, development, course, treatment, and prevention of psychotic experiences.

Schizotypy: A complex dynamic system

As occurs in psycho(patho)logy and psychiatry fields, new theoretical and measurement models have to be tested and refined. These new approaches must move from static to dynamic views; from latent trait model to complex system models (e.g., network perspective); from symptom-based to mechanism-based models or from DMS/ICD labels to contextual precision diagnosis across stages of psychopathology (Borsboom & Cramer, 2013; Nelson, et al., 2017; van Os et al., 2013). Newer perspectives may result from contributions of the network model (Borsboom, 2017), chaos theory (Nelson et al., 2017), and the Research Domain Criteria (RDoC) initiative (Insel et al., 2010). These are new ways of conceptualizing and classifying mental health problems that may be relevant to schizotypy.

Here, we focus on the network model in particular, as it represents a recent approach in psychopathology, though it is not new in the scientific field (Borsboom, 2017; Borsboom & Cramer, 2013). From this viewpoint, mental disorders are emergent properties that arise from causal relations among mental states (behaviours, symptoms, signs, traits, etc.). Mental disorders are not brain disorders (Borsboom et al., 2018). The network approach provides an alternative way to conceptualize psychopathology problems and disorders by considering them as complex dynamic systems. From network models, schizotypy can be seen as a system of interacting cognitive, emotional, behavioural, and affective traits (Fonseca-Pedrero, Ortuño-Sierra, Debbané et al., 2018; Fonseca-Pedrero et al., 2020). Just as schizophrenia is phenotypically heterogeneous, encompassing a broad range of emotional, cognitive, perceptual, social, and behavioural functions, schizotypy involves a diverse set of traits and experiences that dynamically relate one to another during development and in their expression.

This notion of schizotypy, as a network, is consistent with recent developments in the psychosis field (e.g., Isvoranu et al., 2016; Wüsten et al., 2018). These findings can be considered within the network model of onset psychotic disorder proposed by Linscott and van Os (2012). The debut for the clinical outcome can be understood in part as different symptoms (signs, traits, behaviours, etc.) and variables (e.g., trauma experiences, cannabis use, bullying, brain abnormalities) that causally impact on each other over time (developmental approach) both within and across levels. This is congruent with previous research that showed how negative/disorganized psychotic symptoms predicted positive psychotic symptoms (Debbané et al., 2013; Domínguez et al., 2010) or how hallucinations gave rise to delusions (Krabbedam et al., 2004). Within this proneness-persistence-impairment model, subclinical expression of psychosis (e.g., schizotypal traits) may causally impact each other over time. This can be done via network dynamic interactions, may become abnormally persistent, help-seeking, and eventually give rise to the transition into a psychotic spectrum disorder and impairment (Linscott & van Os, 2013; van Os & Linscott, 2012; van Os & Reininghaus, 2016). These observations are made whilst taking into account the complex interplay between Gen-Person-Environment (i.e., bio-psycho-social model). This model is also consistent with the concept of emergence. As Lenzenweger (2010) pointed out, mental disorders represent complex configurational outcomes of multiple interacting systems that cannot be reduced to a mere collection of constituent parts. These findings allow for a deeper understanding of the nature of interactions that take place between the schizotypal traits that contribute to psychosis liability. Figure 1 depicts an example of an estimated network for schizotypy. In addition, this network

model has been expanded to multiple level of analyses, beyond that of a phenotypic level. Figure 2 depicts this tentative network model where multiple levels of analyses are combined. This model should incorporate environmental or contextual levels.

It is noteworthy that psychosis network research is currently in its infancy, and is not free of limitations (e.g., Guloksuz et al., 2017). In addition, the use of network models must clearly be related with the goals of the researcher. It is also necessary to complement it with other psychometric and measurement models (e.g., Item Response Theory), and to understand temporal stability in networks in order to better understand schizotypy.

It is also worth mentioning the application of various machine learning approaches to understanding schizotypy. While the majority of studies applying machine learning within the schizotypy space have been applied to schizophrenia (Cannon et al., 2016), the use of “big data”, collected on large and demographically heterogeneous samples, can also help address norming and generalizability constraints that have plagued traditional assessments (Cohen, 2019). Moreover, machine learning approaches can help optimize algorithms using large and varied predictors, and hence, can be paired with a wide range of self-report, historical and other data. Clinical applications of machine learning, based largely on medical record mining, have been successful within the suicide behavior literature (e.g., Ruderfer et al., 2020).

Measuring schizotypy

Schizotypy can be measured by genetic, psychometric, laboratory, or/and clinical indicators (Lenzenweger, 2010,

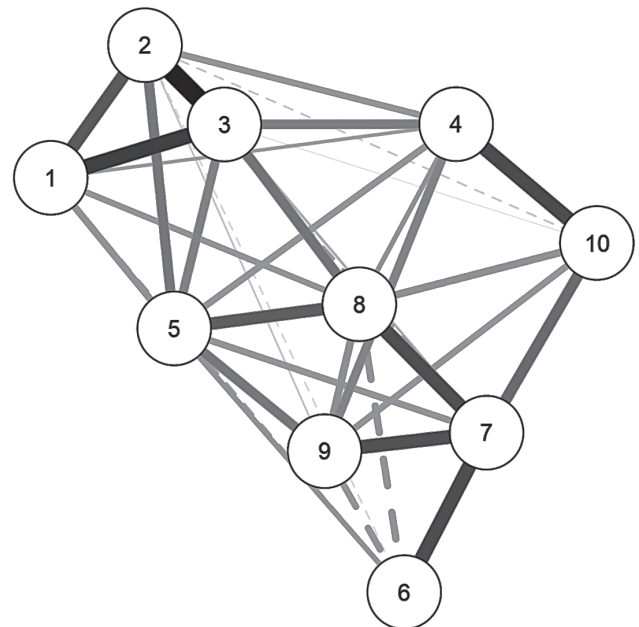


Figure 1. Estimated network for schizotypal traits in a sample of adolescents

Note: By layout style, the figure is presented in black and white. The nodes (circles) correspond to the schizotypy dimensions (ESQUIZO-Q). The edges are the degree of association between nodes. The thickness of the edge indicates the strength of the association. Solid line indicates positive relationship between nodes, dotted line negative relationship. 1 = ideas of Reference; 2 = magical thinking; 3 = unusual perceptual experiences; 4 = odd thinking; 5 = paranoid ideation; 6 = physical anhedonia; 7 = social anhedonia; 8 = odd behavior; 9 = no close friends; 10 = social anxiety

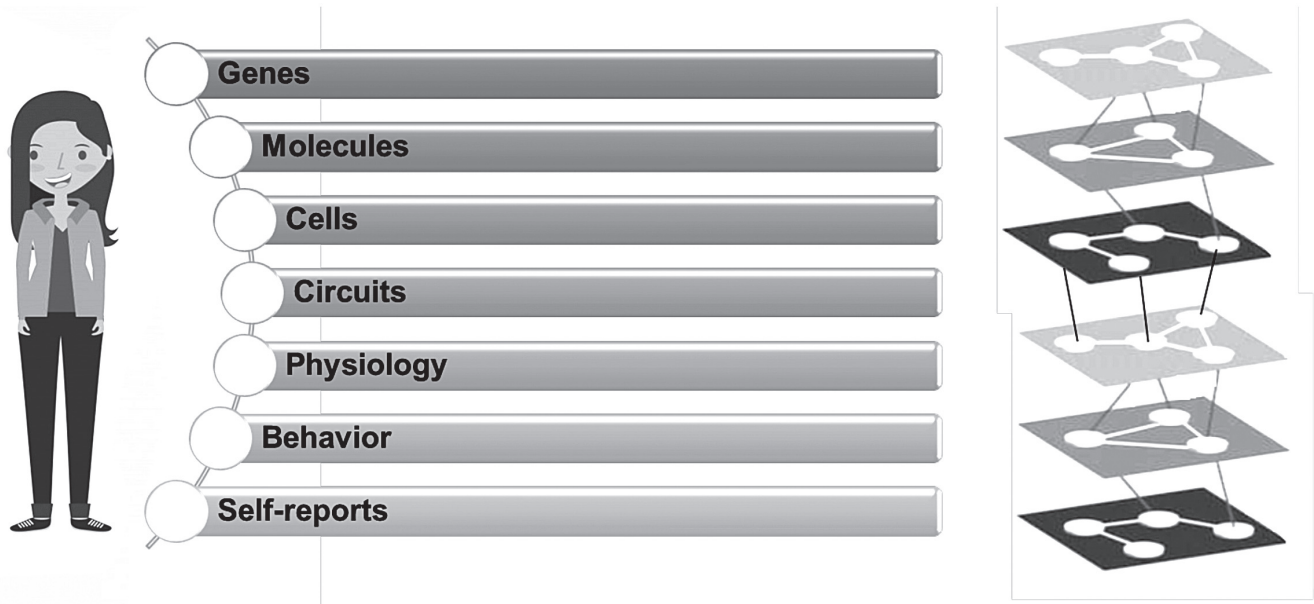


Figure 2. Network model of schizotypy across levels of analyses

2015). In particular, a wide range of psychometric instruments is currently available for the schizotypy assessment and related phenomena. The construction and validation of schizotypy tools has been overwhelming. These schizotypy tools are crucial in order to capture and measure this construct properly (e.g., sources of validity evidence, reliability, norms). These measures are strongly linked with the theoretical models and measurement approaches mentioned above. Figure 3 depicts a genealogy of

the main instruments used in this field. A more exhaustive review of schizotypy tools can be found elsewhere (Fonseca-Pedrero, Gooding et al., 2016; Mason, 2015).

The psychometric assessment of schizotypy in community samples (e.g., psychometric high-risk approach) offers distinctive benefits, such as being relatively inexpensive, non-invasive, and useful for screening large samples in order to identify and intervene on those participants potentially at increased risk for psychosis.

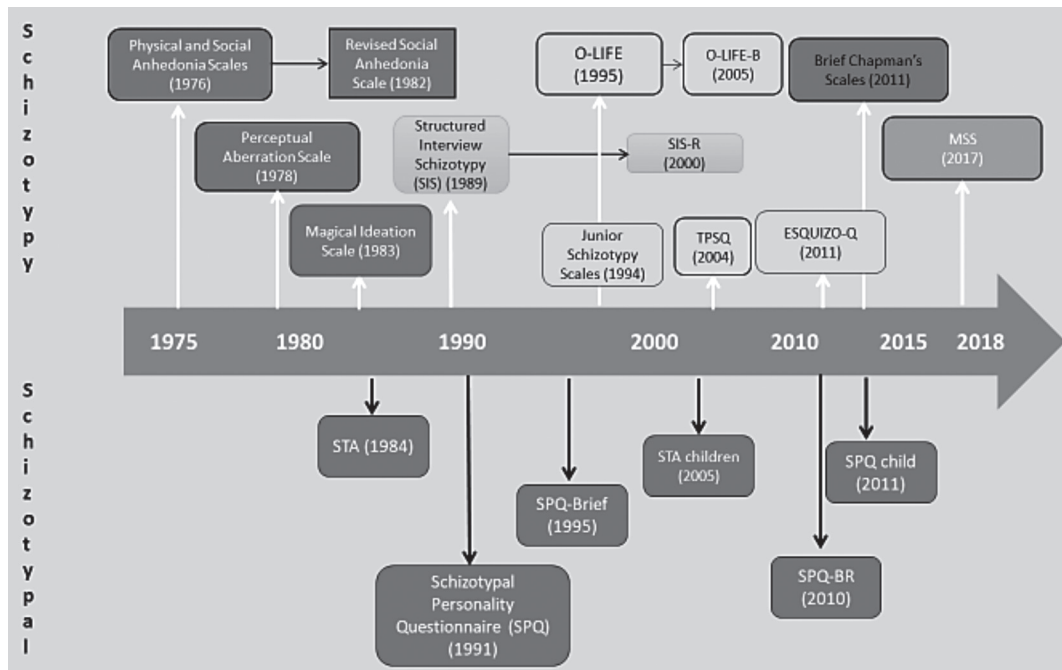


Figure 3. Genealogy of the main schizotypy and schizotypal personality measuring instruments

Note: O-LIFE: Oxford-Liverpool Inventory of Feelings and Experiences; STA: Schizotypy Traits Questionnaire; TPSQ: Thinking and Perceptual Style Questionnaire; MSS: Multidimensional Schizotypy Scale; ESQUIZO-Q: Oviedo Schizotypy Assessment Questionnaire; SPQ-BR: Schizotypal Personality Questionnaire-Brief Revised

The validity and clinical relevance of psychometric high-risk methodology has been documented. For instance, research has found that this approach showed concordant results with research on individuals with psychotic symptomatology (Cochrane et al., 2010) as well as with conventional UHR interview-based for psychosis (Barrantes-Vidal, Gross et al., 2013; Cicero et al., 2014; Flückiger et al., 2016). In addition, schizotypy is a relevant construct in genetic, UHR, and clinical samples. Of course, these measures have some limitations, such as their association with stigmatization and negative labelling.

In particular, the Multidimensional Schizotypy Scale (Gross et al., 2018; Kwapil et al., 2018) and the Oviedo Schizotypy Assessment Questionnaire (Fonseca-Pedrero et al., 2010) deserve to be highlighted. They are based on large samples and new psychometric models as Item Response Theory (IRT). In addition, as gold standard measures, it is relevant to mention the recent development and validation of the Wisconsin Schizotypy Scales-Short Forms (Gross et al., 2012) or the Schizotypal Personality Questionnaire-Brief Revised (Callaway et al., 2014).

In this section, two points have to be mentioned. First, although the psychometric properties of the tools are supported empirically, it is true that a new critical reexamination of the psychometric properties of schizotypy/schizotypal measures is required. Validation studies need to be conducted in representative and large samples of the general population, using random sampling, standardized testing practices, and international guidelines for test construction (Muñiz & Fonseca-Pedrero, 2019). In addition, new research studies have to provide specific test norms (e.g., percentile, *z*-scores), in order to compare cut-off scores and standardized testing practices in this field (e.g., develop a manual for all measures). The study of the reliability of the scores and evidences of validity has clear implications on the results, both at theoretical and practical levels (e.g., identification and detection those potentially at high risk for psychosis).

Second, there are inherent limitations with self-report, and it is possible to leverage ambulatory and digital phenotyping technologies to enhance schizotypy measurement (Cohen, 2019; Cohen, Schwartz et al., 2020). We believe that schizotypy research requires more studies including empirical data that goes beyond self-report information. It is necessary to combine several levels analysis (e.g., genetic, brain, cognitive), procedures (e.g., interviews, experimental tasks), and informants (e.g., family members, teachers). Should we exclusively recollect data from a self-report level, we would be missing a large part of the schizotypy puzzle. For instance, several experimental tasks, such as the mirror-gazing test (Fonseca-Pedrero et al., 2015), white noise speech illusion (Catalan et al., 2018), auditory mismatch negativity (Broyd et al., 2016), or computer-based measures of speech (Cohen et al., 2014), have been used to assess psychosis liability. Laboratory research offers a number of benefits, amongst others that of objective performance-based and behavioral measures (Matusiewicz et al., 2018). In addition, interviews to assess schizotypy are also very scarce. To date, the Structured Interview for Schizotypy-Revised (Vollema & Ormel, 2000) is the only one of this kind, but is also now outdated and, therefore, rarely used in the field. Perhaps, future studies will develop a new interview for schizotypy assessment based on the recent theoretical models, as well as psychometric advances.

Digital phenotyping efforts, involving the quantification of *in situ* phenotypes using personal digital devices, holds the potential

to dramatically reshape how schizotypy assessment is conducted (Cohen, 2019; Cohen, Cowan et al., 2020). Digital phenotyping can employ data from social media, smart phone, audio and video recordings, and other sources, to quantify natural behavior collected from an individual as they navigate their daily routine. From a pragmatic perspective, digital phenotyping allows for automation and dissemination in ways traditional measures cannot, and helps allow for repeated assessment. Moreover, digital phenotyping can improve precision for understanding and predicting relatively specific aspects of schizotypy, as traditional self-report measures are prone to biases, temporal drift, regression to the mean, and other issues affecting their ability to predict and understand future outcomes.

Some methodological issues

A new era of researchers and clinicians have improved the quality of schizotypy research in recent years. That being said, several limitations and caveats have to be mentioned. Here we will focus on the relevance of methodological rigor in the schizotypy field, particularly on the samples' requirements (sampling procedures), the use of infrequency scales, and the role of confounders moderators and mediators, as well as follow-up studies.

Firstly, most of the studies in the schizotypy field are composed frequently of college students. As mentioned above, few studies have been conducted in random and large samples of the general adult population. In samples of adolescents several studies have been carried out in representative samples (Ericson et al., 2011; Fonseca-Pedrero et al., 2009). Few birth cohorts (Venables & Raine, 2015) or samples with 22q11Ds -characterized by high rates of psychotic symptoms making this condition a promising human model for studying risk factors for psychosis- have been carried out in this field (Fonseca-Pedrero, Debbané et al., 2016)

Second, it is relevant to use infrequency scales in order to avoid the (pseudo)random or invalid responses of some individuals (Chapman & Chapman, 1983; Fonseca-Pedrero et al., 2009). Although recognized as a time consuming task of required effort, this is crucial in order to improve the quality of our collected data and to assure the validity of our conclusions and decisions. Our research team has conducted several schizotypy studies on more than 10,000 participants (young adults and adolescents) and have consistently found that at least 7-10% of the individuals who respond to schizotypy measures have to be dropped from the sample based on their scores on infrequency response scales.

Third, confounders, mediators, and moderators need to be addressed. To date, the role of confounders, mediators, and moderators in schizotypy research has been required in order to further our understanding of schizotypy. In recent years, new methodologies have also allowed us to test new and more complex models. Depending on the set goals, it is also relevant to add confounders, such as gender, age, IQ, or socio-economic status. To assess socio-economic status, the researcher could use proxies via tools like the Family Affluence Scale-II (Boyce et al., 2006). In new studies, we should be looking for possible mediators and moderators, such as mentalization, attachment, cannabis use, etc. of schizotypy-outcome relationships (e.g., Debbané et al., 2016).

Fourth, schizotypy, itself, is framed in a developmental model (Debbané & Barrantes-Vidal, 2015). Thus, it is relevant to conduct strong follow up studies and adopt a life span perspective (Venables & Raine, 2015). These kind of studies are expensive

and time consuming, but relevant to recollect information about the developmental trajectories pathways, relationship between schizotypy dimensions, and etiological (environmental and genetic) mechanisms underlying psychosis (and other mental disorders) outcomes (Debbané et al., 2013; Venables & Raine, 2015; Wang et al., 2018). Previous findings suggest that there may be distinct developmental trajectories for schizotypy (Wang et al., 2018) or that disorganization schizotypal features mediate the relationships between the negative and positive dimensions of schizotypy (Debbané et al., 2013). These kind of longitudinal studies allow us to consider the schizotypy potential in the study of gene-person-environment interactions (Barrantes-Vidal et al., 2015). Furthermore, longitudinal studies have started charting the association between brain development and early manifestations of schizotypy (Derome, Tonini et al., 2020; Derome, Zöllner et al., 2020). Further inquiry into the neuroscience of schizotypy may provide key insights into its developmental mechanisms.

The four issues mentioned are related to the measuring instruments section commented above and new psychometric developments.

Psychometric and assessment developments

Psychometric and assessment advances are also crucial in the progression of our understanding of schizotypy and related phenomena. It would be relevant to include new psychometric techniques, procedures, and software in further research. However, in order to use these procedures, we require strong psychometric skills, as well as theoretical coherence and background. Mixture modelling (latent class analysis-dichotomous outcome- or the latent profile analysis -continuous outcome-), exploratory structural equation modelling, IRT, bifactor model, differential item functioning (DIF), computerized adaptive testing (CAT), taxometric methods, or advances in reliability estimation (e.g., ordinal alpha, omega), are some good examples. These procedures are being used progressively in schizotypy field such as CAT (Fonseca-Pedrero et al., 2013; Moore et al., 2018), DIF (Cicero, Martin et al., 2019), IRT (Fonseca-Pedrero et al., 2013; Kwapil et al., 2017) and bifactor model (Moussa-Tooks et al., 2020).

These psychometric procedures depend on the main goal of the research, as well as the underlying theoretical models. For instance, if the idea of the researcher is identifying classes of individuals (e.g., Meehl's model), mixture modelling would be one of the appropriate techniques to choose. There must be a clear link between the theoretical schizotypy model, main goals, psychometric methodology and data analysis, results, and conclusions.

As we said, the incorporation of new technologies is another relevant issue. Information technologies, like digital phenotyping, have a clear impact in the field of psychotic spectrum phenomena and mental health (Insel, 2017). Artificial intelligence (e.g., learning machine) (Brodey et al., 2018), virtual reality (Veling et al., 2016), latent semantic analyses (Marggraf et al., 2018), ambulatory assessment (Trull & Ebner-Priemer, 2009), or ecological momentary interventions (Reininghaus et al., 2016), are just some good examples.

For example, the incorporation of ambulatory assessment (methods of experience sampling, ecological momentary assessment) allows us to avoid some of the limitations of self-reports, analyzing the individual in their real life in a personalized way, with micro-longitudinal studies, and in interaction with the

environment, allowing us to understand underlying mechanisms and improving the ecological validity, amongst others (Oorschot et al., 2009; van Os et al., 2013; van Os, Reininghaus, & Meyer-Lindenberg, 2017). These technologies may provide vital information in gaining insight into schizotypy and its links with relevant variables like genetic liability, psychopathology, childhood trauma, etc. (Hasmi et al., 2017).

Crossing the borders: cultural issues

Rates of clinical and subclinical psychosis vary across cultures, countries, and ethnic groups (Jongsma et al., 2018; McGrath et al., 2015). Similar differences across countries are evident on schizotypy dimensions and schizotypal traits (e.g., Fonseca-Pedrero, Chan et al., 2018; Kwapil et al., 2012; Ortuño-Sierra et al., 2013).

Until 2017, little research has examined the epidemiologic landscape of schizotypal traits at a cross-national level. There have been many investigations of the associations of gender, age, nationality, and ethnicity with schizotypal traits. In most studies, comparisons have been restricted to Western countries or a small number of countries. In fact, we must not forget that most of the subsamples used in schizotypy research are WEIRD (Western, Educated, Industrialized, Rich, and Democratic) individuals and are most likely unrepresentative of the world's population (Henrich et al., 2010). That is, to date, cultural factors on schizotypy arena have been studied unsystematically. Given these limitations, the International Consortium for Schizotypy Research (ICSR) (<https://srconsortium.org/>), a collaborative multinational effort for schizotypy research (Debbané & Mohr, 2015), aimed to compare a broad array of schizotypal traits assessed with the SPQ from participants recruited from 12 Western and non-Western countries ($N = 27,001$ participants) (Fonseca-Pedrero, Chan et al., 2018). We sought to better understand international variation in the self-report of schizotypal traits. Furthermore, and despite the globalization of psychosis research, no previous study had analyzed the psychometric quality of SPQ in multinational samples.

This cross-national study was a clear milestone in the schizotypy field and extended psychosis phenotype. In this research, we did not have a priori hypotheses on how schizotypy would differ across participating countries. Briefly, schizotypal traits varied according to gender, age, and country. Females scored higher than males in the positive dimension, whereas males scored higher in the disorganization dimension. By age, a significant decrease in the positive schizotypal traits was observed. Epidemiological expression of schizotypal traits varied by country. Moreover, several interactions by gender, age, and country were found. The findings reveal that this kind of studies are rather complex. Table 1 shows a clear example of the impact of language on schizotypy assessment across countries. We assume that differences across countries would reflect a range of factors:

- a) Methodological variability. The use of different strategies for ascertaining and recruiting participants, sampling strategies, testing practices, tests adaptations and validations, etc.
- b) Measuring instrument. The SPQ was used to measure self-reported schizotypal traits. It must be added that the exclusive use of the SPQ, while advantageous in that, providing consistency across the compiled datasets with regard to the domains surveyed, may also have functioned

in distinctive ways in different countries. The SPQ in particular was developed in North America and has been most widely used in that context. The instrument may, thus, reflect idiosyncrasies (language, etc.) of that society, that do not translate easily to other cultural contexts (from Western to non-Western countries).

According to Fonseca-Pedrero, Chan et al. (2018) this multinational project does not provide answers to several questions, but we urge future researchers to consider it seriously. Cultures may also vary in the degree of acceptance of particular symptoms/traits (e.g., hallucinations and magical thinking) as normative experiences. For instance, some experiences, that members of individualistic cultures identify as anomalous or unusual, may be more readily tolerated by members of communal cultures. Upcoming studies would benefit from taking an “anthropological” or proper cross-cultural approach that would allow researchers to explore these possibilities in depth and to both generate and test specific hypotheses.

By assessing schizotypal traits in individuals who represent different cultures, we have the potential to gain important knowledge about cultural differences in social and affective functioning (Cohen et al., 2015) and to clarify how these cognitive, emotional, and motivational traits relate to important variations in human behavior (Henrich et al., 2010).

Future Challenges

A number of challenges transform the understanding of schizotypy and related phenomena. Open questions and challenges that are common to psychosis must, therefore, be highlighted:

a) *Improve prediction levels.* The combination of different risk markers from different levels of analysis (e.g., genetic, cerebral, psychophysiological, cognitive, behavioral) and the

role of the environment seems to be one of the best options when predicting the transition to psychosis (Padmanabhan et al., 2017; Schmidt et al., 2017). The combination of multiple indicators of different levels of analysis in sequential phases and stratification of the participants is necessary in order to understand this phenomena (Schmidt et al., 2017). In addition, current works seek to design a finer assessment of high-risk groups, generating more homogeneous subgroups, stratified by some variable (e.g., neurocognitive performance) (Carrión et al., 2017). Thus, combining psychosis liability subgroups and multiple psychopathology variables and risk indicators may improve our predictive power and prognosis (Zarogianni et al., 2017).

b) *From the patient to the person.* Different movements (e.g., Hearing voices) and research show that the predominant model is one that talks about patients in the “third person”. A new vision should try to put the emphasis on the “first person”, that is, listen to people -from a phenomenological perspective- (Nelson, Parnas, & Sass, 2014; Pérez-Álvarez, 2012; 2018; Pérez-Álvarez & García-Montes, 2018). In addition, future studies should focus on the “p” of the person and not on the “p” of statistical significance. The functional impact of the person is much more relevant, because of its impact on day to day life, than the statistical significance. Research studies must have an echo in the real world of people.

c) *Focus on positive aspects and strengths.* As seen in the field of psychosis, we require to make a gradual transition towards a positive and optimistic view and steer away from a stigmatizing, negative construct. The idea that psychosis and related phenomena as “a chronic mental disorder of cerebral origin” are progressively changing. There must be a transition from the focus on the limitations of individuals to their strengths; from risk factors to protective factors (or at least more research in protective factors). For instance, it

Table 1
Item 1 of the Schizotypal Personality Questionnaire across different translated and adapted versions

Country	Item 1
UK	Do you sometimes feel that things you see on the TV or read in the newspaper have a special meaning for you?
Spain	¿Algunas veces notas que cosas que ves en la tele o lees en el periódico tienen un significado especial para ti?
Greek	Αισθάνεστε μερικές φορές ότι πράγματα που βλέπετε στην τηλεόραση
China	您是否有时在看电视或报纸时发现其中的内容对您有特殊的意义？
Turkey	قد أحسن أحيانا بأن ما أراه في التلفزة أو ما أقرأه في الجرائد موجه إلي شخصياً
Italy	Talvolta ha la sensazione che quello che vede in TV o legge sul giornale abbia un significato speciale per lei?
Malaysia	Adakah anda kadang-kadang rasa bahawa perkara yang anda tonton di TV atau baca di surat khabar mempunyai makna khas untuk anda?
Germany	Haben Sie manchmal das Gefühl, dass Dinge, die Sie im Fernsehen sehen oder in der Zeitung lesen, für Sie eine ganz besondere Bedeutung haben?
France	Il m'arrive d'avoir l'impression que ce que je vois à la télévision ou ce que lis dans les journaux m'est personnellement destiné?

is relevant to analyze the link of schizotypy with protective factors (e.g., Fumero et al., 2018).

- d) *Beyond the schizo-prism and the concepts of “transition” and “risk” for psychosis* (van Os & Guloksuz, 2018). We are moving towards a prevention model that goes beyond the schizo-prism, the concepts of “transition” or “risk of psychosis” to an approach based on stages (levels of severity), personalized, dynamic, and contextual. As observed in the field of psychosis, schizotypy is also in need of a global mental health prevention model that is not limited to the conglomerate of psychotic spectrum phenomena. We can move toward this by generating, for instance, initiatives such as Headspace (<https://headspace.org.au/>). In addition, schizotypy research has to move outside of clinical and mental health settings, e.g., school, work, etc.,
- e) *The role of negative schizotypy*. Schizotypy negative dimension (e.g., anhedonia) is on the most predictive factor on psychosis outcome (Radua et al., 2018; Ruhrmann et al., 2016). For instance, previous studies have shown that physical anhedonia was associated with CHR state, and high scores for physical anhedonia were predictive of conversion in conjunction with the CHR state (Ruhrmann et al., 2016). In addition, anhedonia (on component of negative dimension) is an important symptom of schizophrenia and schizotypal dimension, and increasingly recognized as an important feature in a range of other psychological disorders (Barkus & Badcock, 2019). We need to better understand the developmental bases of negative schizotypy across samples, in particular, during adolescence and prior to clinical outcome.
- f) *Integrating schizotypy into personality and psychopathology taxonomy*. To date, remains unclear whether and how schizotypal traits align with the personality taxonomy both big five model and personality disorders classification (e.g., Cicero, Jonas et al., 2019). For instance, it would be relevant to analyze the links with unusual beliefs and experiences, eccentricity, cognitive and Perceptual Dysregulation. Also, another interesting issue to move forward is to integrate schizotypy into the dimensional model of psychopathology.

For instance, to test the validity and utility of the current Hierarchical Taxonomy of Psychopathology [HiTOP] in the psychosis spectrum (Kotov et al., 2017; Kotov et al., 2020).

Discussion

This selective and critical review assesses several caveats and addresses open questions and future directions in the schizotypy arena. We must resolve these tentative limitations and obstacles in order to progress further in our understanding of schizotypy and its links to psychosis.

A large body of research has supported that schizotypy, and its phenotypic expressions, provides a useful construct in the understanding of psychotic disorders and related phenomena (etiology, development, course, treatment and prevention). Schizotypy is a complex construct defined as a latent personality organization reflecting a putative liability for schizophrenia. Schizotypy, and its phenotypic expression, are associated with impairment across a range of domains, and are observed to have a negative impact on people’s day to day lives.

We are confident that future research in the schizotypy arena will proceed with an eye toward theoretical coherence, methodological and psychometric rigor, validity, and clinical utility. It is necessary to continue working on the construction of a solid and refutable scientific model and to incorporate new scientific evidence. The study of schizotypy is a fruitful field where several extremely interesting questions remain unresolved.

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