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The Assessment of Schizotypy and Its Clinical Relevance

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This article reviews several approaches to assessing schizotypal traits using a wide variety of self-report and interview measures. It makes a distinction between clinical approaches largely based on syndrome and symptom definitions, and psychometric approaches to measuring personality traits. The review presents a brief description of the content and psychometric properties of both sets of measures; these cover both the broad rubric of schizotypy often, but not exclusively based on DSM conceptions, as well as measures with a more specific focus. Measurement of schizotypy has taken place within clinical and nonclinical research utilizing a range of designs and methodologies. Several of these are elucidated with respect to the assessment choices open to researchers, and the implications of the measures chosen. These paradigms include the case–control study, "high risk"/"ultra-high risk" groups, a variety of nonclinical groups and other groups of interest, large scale epidemiology and "in vivo" designs. Evidence from a wide variety of designs continues to provide evidence of the validity of both clinical and personality approaches to schizotypal assessment.

Key words: schizotypy/assessment/nonclinical/psychometric/personality/paranoia

Introduction

Over the past 40 years, the theoretical ideas subsumed within the schizotypy rubric have been operationalized in a variety of interview and self-report measures. These vary in important ways both in terms of the concepts they seek to encapsulate (single "symptoms" or broader constellations), as well as the view taken of the constellation of features comprising schizotypy, or more broadly psychosis proneness. The broadest distinction theoretically is between measurement approaches seeking a clinical, dichotomous content more akin to psychiatric assessment, and those designed to assess broad personality traits in a continuous fashion. My objective here is to help the interested reader understand the range of issues pertaining to measurement so as to make their own informed choices, rather than to advocate a particular measure or measures. Different measures are appropriate to different needs—populations, research questions, statistical treatments, and so forth. The article discusses some widely used questionnaires from both the "clinical" and "personality" tradition; and then outline a number of research paradigms that together form a "how to do" guide. My own view is that both traditions have valuable contributions to offer, and that a "dualist" model embracing both categorical and continuum approaches is the most plausible, and supported by much evidence. Lastly, this is not intended to be an exhaustive guide: the full list of published measures is very lengthy and many have fallen out of common use or are so recent as to not have received widespread use to date. While there may be important omissions, I have concentrated on measures in current widespread use, though many of these have items taken from earlier measures.

Measurement Approaches

As many questionnaires contain items that broadly operate in a similar fashion, numerous multivariate analyses have combined these in factor/principal component or cluster analyses to arrive at underlying constructs in this arena. However, the theoretical distinctions do have some practical import; eg, in the breadth and "severity" of the items' content. There is a broad contrast between the "clinical" approach to measurement and the "personality" approach. The former takes either single symptom constructs (eg, perceptual aberration) or diagnostic criteria (eg, schizotypal personality disorder) as their starting point. These items tend to "dilute" the clinical flavor of the item content but remain "symptom-like." The latter approach conceives of a personality construct in much the same vein as global traits such as neuroticism with a number of subdimensions. Item content extends beyond

the manifestly psychopathological to tap phenomena thought to be theoretically relevant (eg, Déjà vu experiences). Of course the nature and number of these subscales vary according to what items are included, and to a degree, the population assessed. There is also little uniformity by way of the evidence quoted for validity, though of course many quote broadly acceptable reliability indices (table 1). Whichever approach one takes, empirical work has converged on a partial consensus about the factorial nature of schizotypy, and this is outlined following descriptions of contemporary scales used in both the clinical and personality traditions.

Clinical

The now historic work of Paul Meehl was rooted in the Minnesota Multiphasic Personality Inventory (MMPI) approach. Meehl arrived at the 7-item "Schizoidia" scale based on criterion referencing. However, this ambitious approach proved too unreliable as with so few items it cannot discriminate sufficiently. In the same vein but with scales that are substantially more sophisticated and lengthy, are the so-called "Chapman" scales developed by Jean and Loren Chapman and others (table 1). Each takes a single attenuated form of psychotic experience and translates this into questionnaires with substantial item content, with the aim of sufficient reliability and discrimination power to achieve clinical identification of the putative "schizotype." Most items are quite rarely endorsed in general population samples, and their use in "normal" experimental situations is thus somewhat limited. Nevertheless, they possess an impressive range of content and other validation evidence. The most widely used are the Physical and Social Anhedonia scales, with substantial evidence that anhedonia is a risk marker for psychosis. In terms of positive schizotypy, the Perceptual Aberration and Magical Ideation scales have been widely used—often together to form the "Per-Ab" scale. Addressing their considerable length and probable inclusion of poorly discriminating items, Winterstein et al[1] have developed short forms using item response theory.

Taking a broader syndromal approach, several others have utilized various versions of the Diagnostic and Statistical Manual—most notably Adrian Raine's Schizotypal Personality Questionnaire (SPQ).[2] In both long and brief forms, this assesses the 9 features described in DSM-III-R/IV. Though the original structure is of 3 factors (cognitive–perceptual, disorganized, and interpersonal), larger factor structures have been reported to both the brief and full versions.[3,4] Nevertheless, its very extensive use in the long form makes it an important instrument for schizotypy research. The brief form[5] has received a more mixed reception: based on maximizing high internal consistency within factors, the number and breadth of content of items has been dramatically reduced. This seems to have led to a high level of intercorrelation between items from different subscales (eg, Compton et al's study),[6] and less robust factorial structure. Even so, its internal consistency has been found to be less than ideal (<0.70) in a range of studies—a common problem with shortened scales. Cohen et al[7] suggest a revised brief scale with alternative items and scoring to address these problems.

The most prominent interview measure is the Structured Interview for Schizotypy originally developed by Kendler, and later revised and shortened (SIS-R).[8] The symptoms largely reflect schizotypal personality disorder and are rated for frequency, duration, and level of conviction. Of course other structured assessments of personality disorders have elements within them of relevance to schizotypy but space precludes outlining these here. The SIS-R remains the most detailed interview measure entirely focused on schizotypy in use today.

In addition, several individual scales have aimed to measure a single feature such as proneness to hallucinations[9] or delusional thinking.[10] The Revised Hallucination Scale (RHS: Morrison et al, 2010) is a useful addendum to the broader trait measures elsewhere. The Peters Delusions Inventory (PDI)[10] takes a different approach firmly rooted in the Beckian cognitive tradition in that delusional ideas are additionally rated for conviction, preoccupation, and distress. This usefully enables measurement of the appraisal of experiences, in addition to the presence of delusional-type experiences themselves. Based in part on the PDI, with 2 additional hallucination items and 14 negative items, the Community Assessment of Psychic Experiences[11] has 2 subscales for reporting psychotic experiences (positive and negative, though no disorganization factor).

While adult scales may be appropriate for late adolescence, some scales have been adapted or particularly developed for late childhood and early adolescence (see Fonseca-Pedrero et al[12] for review). These scales are particularly relevant to early detection of individuals at high risk.

Personality

The Eysenckian approach of very broad personality dimensions initially dominated this sphere with both the early and later Psychoticism Scales (table 2). The early form had content manifestly relevant to psychosis but suffered from poor reliability and low endorsement rates—the very antithesis of the intention of ostensibly "normal" or at least normally distributed personality traits. The revision corrected these weaknesses but shifted coverage to antisocial, impulsive, and nonconformist traits. This led others to construct attempted improvements, broadening out the trait content. To review all the developments here would be largely historical, but led the work of Bentall, Claridge and others studying a wide range of scales (the Combined Schizotypal Traits Questionnaire) to clarify

Table 1. Schizotypy Scales Based on Clinical Concepts or Definitions

Test	Derivation/Content	Subscales and Items	Test-Retest Reliability	Alpha Coefficient	Summary of Validity
Magical Ideation Scale. Eckblad and Chapman (1983)	Thought transmission, psychokinesis, precognition, astrology, spirit influences, reincarnation, psychic energy transfer, secret messages	Single scale with 30 items	6 weeks, 0.81	0.83–0.85	Magical ideation group reported greater schizotypal experience than controls. Predicts spectrum disorders.
Perceptual Aberration Scale. Chapman et al. (1978)	Unclear body boundaries; unreality, estrangement, change in body parts or appearance	Single scale with 23 items	6 weeks, 0.76	0.88–0.94	Discriminated schizophrenia and controls. Predicts spectrum disorders.
Physical Anhedonia Scale. Chapman et al. (1976)	Lack of pleasure from physical sources such as eating, touch and sight or sound	Single scale with 40 items	6 weeks, 0.79	0.78–0.84	Discriminated schizophrenia and controls. Not correlated with other symptoms.
Revised Social Anhedonia Scale. Eckblad et al. (1982)	Schizoid indifference to other people	Single scale with 40 items	—	0.84–0.88	Associated with psychotic-like experiences, schizotypal and schizoid symptoms. Predicts spectrum disorders.
Cognitive Slippage Scale. Miers and Raulin (1985)	Cognitive slippage: speech deficits and confused thinking	Single scale with 35 items	1 month later, 0.75–0.80	0.88–0.90	Correlates with other schizotypy scales. Identifies people with increased communication impairments and poor executive control.
Schizotypal Ambivalence Scale. Raulin (1986)	Strong simultaneous/ rapidly interchangeable positive and negative feelings	Single scale with 45 items	3 months later 0.81	0.87 (n = 394), 0.86 (n = 1177), 0.87 (n = 1349)	Correlates with Perceptual Aberration Scale. High scores in acute schizophrenia patients.
STA Scale. Claridge and Broks (1984)	Based on DSM-III SPD description	Single scale with 37 items	4 years, 0.64	0.86	STA correlates: hemispheric, PEN psychoticism, PEN neuroticism. Factorial validity of 3 components.
Schizotypal Personality Questionnaire. Raine (1991)	Based on 9 DSM-III-R criteria for schizotypal personality disorder	Ideas of reference; excessive social anxiety; odd beliefs or magical thinking; unusual perceptual experiences; odd or eccentric behavior; no close friends; odd speech; constricted affect; suspiciousness	0.82	0.91	Correlated with Schizophrenism, STA, SPD diagnosis, and continuous SPD interview scores. 55% of subjects scoring in top 10% of SPQ scores had clinical diagnosis of SPD.
Schizotypal Personality Questionnaire-Brief Raine and Benishay (1995)	May be used as an initial screening for DSM-IV SPD	3 subscales: cognitive-perceptual, disorganized, and interpersonal (22 items in total)	—	0.83 Total scale.0.72–0.78	SPQ-B correlated with DSM-III-R SPD SCID dimensional scores.

Table 1. *Continued*

Test	Derivation/Content	Subscales and Items	Test-Retest Reliability	Alpha Coefficient	Summary of Validity
Schizotypal Personality Questionnaire-Brief Revised. Cohen et al. (2010)	Items tapping SPD traits from all 9 SPQ subscales. Altered response format.	Ideas of reference/ suspiciousness, no close friends/ constricted affect, eccentric behavior, social anxiety, magical thinking, odd speech, unusual perceptions (32 items in total)	—	Subscale alphas: 0.84, 0.81, 0.86, 0.84, 0.82, 0.82, 0.70	Studied factorial validity.
Referential Thinking Scale. Lenzenweger et al (1997)	Referential experiences, and guilty referential interpretation of an interpersonal or intrapersonal nature	34 items in total	1 month, 0.86	0.83 to 0.85.0.80	REF correlated strongly with range of schizotypy scales.
Revised Hallucination Scale. Morrison et al. (2000)	Predisposition to auditory and visual hallucinations	2 subscales: auditory (7 items) and visual (6 items)	—	0.64 auditory, 0.75 visual	Correlates with a range of schizotypy and meta-cognitive belief scales.
Peters Delusional Inventory (40). Peters et al. (1999)	A variety of delusional ideas are rated for presence and appraisals of distress, preoccupation, and conviction	Ten different domains of delusional belief. 40 items in total	6 months, 0.82	0.88	Correlates with positive schizotypy. Psychotic inpatients had higher scores than controls PDI total and dimensions.
Peters Delusional Inventory (21). Peters et al. (2004)	A variety of delusional ideas are rated for presence and appraisals of distress, preoccupation, and conviction	11 different domains of delusional belief 21 items in total	6 months, 0.78 appraisals 0.78–0.81	0.82–0.93	Correlates with positive schizotypy. Deluded patients higher than mixed student/community sample. Factorial validity of 3 factors.
Poor Cognitive Control Scale Cicero and Kerns (2010)	Attentional difficulties, confusion, language impairments, difficulty with beginning and finishing tasks, following directions, impulse control, and memory	Single scale with 30 items	—	0.89	Correlated with other measures of disorganized schizotypy; less so with measures of positive schizotypy, dissociation, neuroticism, inattentiveness.
Wisconsin Schizotypy Scales Short Forms. Winterstein et al. (2011)	Short forms based on Wisconsin Schizotypy Scales	Magical thinking, perceptual aberration, social anhedonia, physical anhedonia (60 items in total)	—	0.74 MagId, 0.83 PerAb, 0.75 SocAnh, 0.62 PhysAnh	Positive schizotypy correlated with affective dysregulation, and approach-oriented traits. Negative schizotypy correlated negatively with curiosity, sensation seeking, hypomania, emotionality, and extraversion.

Table 2. Psychometric/Personality Measures of Schizotypy

Test	Derivation/Content	Subscales and Items	Test-Retest Reliability	Alpha Coefficient	Summary of Validity
Psychoticism Scale. Eysenck & Eysenck (1975) revised: Eysenck et al. (1985)	Aggressive, cold, egocentric, impulsive, antisocial, creative, unempathic, tough-minded, impulsive.	Original: 25. Revised: 32	Male: 0.83, Female: 0.71	Male: 0.74, Female: 0.68. Revised—Male: 0.78, FemaleL 0.76	Correlates with range of schizotypy scales. Higher scores of 153 psychotic patients on original scale
Rust Inventory of Schizotypal Cognitions. Rust (1988)	The positive cognitive content of schizotypy as a normative dimension: it covers suspicion, magical ideation, ritual, subjectivity, thought isolation, and self-delusion	26 items from a pool of 120	—	0.77	High scores in acute schizophrenia group
Community Assessment of Psychic Experiences. Stefanis et al. (2002)	Positive psychotic-like experiences; lack of emotions, motivation, and social interest; cognitive symptoms of depression.	Positive (18), negative (14), depression (8)	1 to 26 months, pos: 0.71, neg: 0.78, depression: 0.76	Pos: 0.63, neg: 0.64, depression: 0.62	Correlates with a range of schizotypy scales. However, scales correlate highly with one another.
Oxford-Liverpool Inventory of Feelings and Experiences. Mason, Claridge, and Jackson (1995)	UnEx: perceptual aberrations, magical thinking, hallucinations. CogDis: purposelessness, moodiness, social anxiety, poor attention and decision-making. IntAn: independence, solitude, social and physical anhedonia, avoidance of intimacy. ImpNon: impulsive, anti-social, eccentric behavior, lack of self-control	Unusual experiences (30), cognitive disorganization (24), introvertive anhedonia (27), impulsive nonconformity (23)	3–6 months. 0.86 UnEx, 0.93 CogDis, 0.84 IntAn, 0.77 ImpNon	0.89 UnEx, 0.87 CogDis, 0.82 IntAnh, 0.77 ImpNon	UnEx, CogDis, ImpNon correlates with STA. IntAnh weakly correlated with STA. Range of experimental and heredity studies.
O-LIFE Short. Mason, Linney, and Claridge (2005)	As for O-LIFE with reduced item set based on genotypic variance	Unusual experiences (12), cognitive disorganization (11), introvertive anhedonia (10), impulsive nonconformity (10)	1 month. 0.87 UnEx, 0.86 CogDis, 0.72 IntAn, 0.69 ImpNon	0.80 UnEx, 0.77 CogDis, 0.62 IntAnh, 0.63 ImpNon	Convergent validity with original scales. Factorial validity.
Aberrant Salience Inventory. Cicero, Kerns, and McCarthy (2010)	Measures the assignment of salience, significance, or importance to otherwise innocuous stimuli, ie, report of enhanced sensory, cognitive, or emotional perception of the world	Feelings of increased significance, senses sharpening, impending understanding, heightened emotionality, heightened cognition (29 items)	—	0.89	ASI correlates with positive schizotypy. High psychosis-proneness and diagnosed psychosis group had elevated ASI scores compared to controls.

this area of personality work. The main outcome of this in terms of scale development was the Oxford-Liverpool Inventory of Feelings and Experiences (O-LIFE),[13] which effectively shortened the much longer set of questionnaires to just over a hundred items. So named to avoid connotations of schizotypy/schizophrenia altogether, it assesses 4 dimensions: unusual experiences, cognitive disorganization, introvertive anhedonia, and impulsive nonconformity. Notably, the final dimension retains something of Eysenck's "psychoticism" concept without

its name: subsequent authors has disagreed widely as to its relevance to schizotypy per se. Norms[14] and shortened versions[15] have seen its popularity increase—discussion about the relevance of subscales notwithstanding. Rather than serving quasi-clinical aims, the majority of the use of the O-LIFE has been to explicate relationships with a range of preferences, behaviors, and task performances such as creativity, laterality, mentalizing, and neurocognition.

Factors/Dimensions

There remains something short of a full consensus as to the number of nature of factors or dimensions in this field. In part this originates from how one conceives its boundaries. Studies of "traditional" or narrow schizotypy measures almost always identify something akin to the division of positive and negative symptoms, and most commonly a "disorganized" factor often termed cognitive disorganization. "Positive schizotypy" is the most universally identified factor as indexed by perceptual aberration, magical ideation, RHS, and the relevant dimensions of several questionnaires. However, while the negative schizotypy factor usually includes items or scales pertaining to anhedonia, the SPQ includes social anxiety in this factor whereas several other analyses place social anxiety with the cognitive disorganization factor. If scales are included pertaining to impulsive nonconformity (both a scale of the Chapmans and the O-LIFE) or Psychoticism, then a fourth factor is often seen. While this may not be as relevant to schizophrenia, I would argue for its place within the broader rubric of psychosis proneness/the "psychosis continuum."[16]

The final issue relevant to measurement and scale structure, is how and where to place measurement of paranoia. Existing in a somewhat parallel research tradition as a single symptom approach, items relevant to suspiciousness and paranoia occur in many scales. Taken together with other schizotypy/psychosis items, these seem not to coalesce around a single factor. In a rather complex pattern of results it is apparent that unusual/"positive" experiences *may* lead to feelings of paranoia, as may heightened social anxiety or social withdrawal. Importantly, the latter may also be *consequences* of paranoid feelings. Probably because of the interactional and thus longitudinal nature of relationships, factor analyses based on cross sectional data remain quite unclear. This complexity may also reflect the association of paranoia with a wide range of axis I and II disorders. Probably, the simplest solution in research design is to complement schizotypy scales with a well-developed measure of paranoia (table 3). While Fenigstein and Vanable's Paranoia scale[17] is the most widely cited, others have argued that it lacks persecutory content of relevance to schizophrenia and much indication of severity. The more recent Paranoid Thought Scales[18] aim to address these lacunae and is acquiring more widespread use.

Schizotypy Research: A "How to Do?" Guide

The benefits of research paradigms including schizotypal individuals or schizotypy as a measurement approach are often rehearsed. These include the absence of effects of medication, hospitalization, and other treatments; reduced influence of illness variables such as chronicity, comorbidity, and lack of insight; the lack of diagnostic uncertainties stemming from differences in syndrome definition; and the de-stigmatizing effect of normalizing experiences as "personality" rather than symptoms. A less cited but important benefit is the plethora of experimental and nonexperimental designs that suit a wide range of research contexts. In addition to "mainstream" approaches to studying schizotypy, it is important to highlight where schizotypy can give added value at relatively low research cost to other designs in schizophrenia research. I have grouped these for clarity into 8 categories so as to highlight the flexibility and breadth of approaches to schizotypy research. Where references are given these are not intended to be definitional, or indeed superior to others; rather they are chosen as frequently cited or prototypic examples.

Extending the "Classic" Case–Control Study

This standard design usually compares a group of persons with schizophrenia with controls who are ideally matched in several ways. Inclusion of schizotypy measurement capitalizes on within group variance amongst control subjects and effectively offers further hypothesis testing concerning the dependent variable (DV), thus extending study of the DV for very little additional effort. The presence of relationships with schizotypy extends potential conclusions concerning the DV to be of premorbid significance, and helps negate its criticism as solely a consequence of illness or treatment. For example, many studies have shown poor set-shifting performance (eg, Wisconsin Card Sorting Test) in schizophrenia groups and while control subjects understandably perform far better, the WCST performance of controls is also well predicted by the SPQ (eg, Daneluzzo et al's study).[19] Though trait schizotypy measures might be thought less reliable and valid in patient groups, the SPQ was also able to predict WCST performance in the schizophrenia group in this study—though to a lesser extent. By combining measures across patient and control groups in this way, direct comparisons can also be made between the relationships in both.

A more substantive amendment of the classic case–control design is the inclusion of a psychometrically defined highly schizotypal control group in addition to a "normal" control group. An early study by Spaulding et al[20] illustrates how a schizotypal group may not simply exhibit neurocognitive deficits to a lesser degree than schizophrenia: rather they exhibited a limited set of quite selective deficits with some signs of compensatory abnormalities. A variant of this design is to contrast schizophrenia with matched controls, and additionally "low schizotypes" and

Table 3. Psychometric Measures of Paranoia

Test	Derivation/Content	Subscales and Items	Test-Retest Reliability	Alpha Coefficient	Validity Studies
Paranoia Scale. Fenigstein and Vanable (1992)	Belief that people or external forces are trying to influence one's behavior/control one's thinking, that people are against one, belief that people talk about, refer to, or watch one, suspicion or mistrust of others' motives, feelings of resentment or bitterness	20 items	0.7 at 6 months	0.84	Paranoia negatively correlated with interpersonal trust, trust in close relationships, social desirability; positively with experience and expression of anger, belief in the control of powerful others, need for personal control, and self-consciousness
Paranoia/ Suspiciousness Questionnaire. Rawlings and Freeman (1996)	Suspiciousness and hostility in daily interpersonal interactions, tendency to be mistrustful and wary, perception that life is harsh and unfair, feelings of general unhappiness, loneliness, anger, lack of control	Interpersonal suspiciousness/ hostility, negative mood/withdrawal, anger/impulsiveness, mistrust/wariness, perceived hardship/ resentment. 47 items in total.	0.82 at 3 months	0.87 to 0.9. *Subscale alphas:* 0.77 IS, 0.66 NM, 0.71 AI, 0.65 MW, 0.74 PH	
Paranoia Checklist. Freeman et al. (2005)	Assesses a range of paranoid thoughts. Assesses frequency, conviction, and distress of paranoid and persecutory thoughts.	18 items, also 5-point scale for frequency, degree of conviction, distress	-	≥0.90. Rarer items associated with higher total score than the common items.	PS correlated with Paranoia Checklist frequency, conviction, and distress. Frequency correlated with conviction and distress; conviction correlated with distress.
Persecutory Ideation Questionnaire. McKay et al. (2006)	Assesses persecutory ideation with items from prior questionnaires.	10 items	—	0.9	Correlates with PSQ and SAPS paranoia in schizophrenia group
Green et al. Paranoid Thought Scales Green et al. (2008)	Range of persecutory and paranoid ideation with assessment of conviction, preoccupation and distress appraisals	Ideas of reference (16 items) and persecution (16 items).	2 week	0.90 Reference, 0.92 Persecution. 0.68–0.86 for other appraisals.	High correlations with Paranoia Scale, medium correlations with delusions, depression and anxiety. Greater scores in a clinical group.

"high schizotypes" within the same rubric. Though this multiplies both the study recruitment/testing and the statistical comparisons available, it enables the fullest dissection of the relationships of a DV to both risk traits and clinical states within the same experimental design. Henry et al[21] for example, recently contrasted these 4 groups on measures of prospective memory.

Relationships to Those at Genetically "High Risk"

The relatives of patients with schizophrenia have long been studied as a group of interest in determining their similarities and differences from both patients with the disorder and controls. The clear theoretical basis for including schizotypy as a set of at least partly genetically determined characteristics has meant that instruments pertaining to it are included almost as a matter of course. However, within a psychiatric rubric these are sometimes restricted to symptoms of schizotypal personality disorder (eg, Keefe et al's study).[22] More psychometrically informed measurement that goes beyond symptomatology is highly desirable as these help characterize which schizotypal traits co-aggregate and are predictive of

phenotypic abnormalities (eg, Grove et al's study).[23] They also enable comparison between relatives and controls. A particular relative of interest in schizophrenia research has been the "unaffected" twin of those with a schizophrenic spectrum diagnosis. Schizotypy has had a clear role in twin research for many years[24] that continues to clarify the nature and degree of its genetic contribution to schizophrenia.[25,26]

Whether self-report or interview based approaches are superior sees differing points of view with some evidence of a defensive attitude by relatives in self-reporting.[24] In this view, interview methods are superior in measuring schizotypal traits in patients and relatives.[27] However, in direct contradiction the Genetic Risk and Outcome in Psychosis investigators[28] chose a self-report measure for the patients and an interview measure for the controls. This has the advantage of minimizing defensive on the part of relatives. Unaffected siblings completed both in what was a combined unaffected sibling–control (sibling-control) and patient–unaffected sibling (cross-sibling) design. Interestingly both self-reported and interview-based strategies were similarly successful in predicting sensitivity to the psychotomimetic effects of cannabis. Relatedly, Kendler et al[24] have argued that the issue of defensive responding in relatives is over-stated.

Informing Longitudinal Study of a "High Risk" Cohort

There are numerous ways in addition to family members to identify a cohort at elevated risk of psychosis: perhaps most importantly in our context, those with the presence of "high-risk" markers such as developmental abnormalities, and those psychometrically defined as at "high risk." By moving beyond patient based studies, these sometimes make explicit the hope of identifying an endophenotypic marker predictive of later schizophrenia. However, the use of schizotypy is not restricted to this, and the longitudinal study of "high-risk" individuals helps inform potential neurodevelopmental pathways, and the trajectories of individuals into illnesses across the spectrum. Two different approaches to the psychometric high-risk paradigm are outlined by Mark Lenzenweger and Gordon Claridge in a now historic special issue of the *Bulletin* (Volume 20, Issue 1, 1994). Broadly, Lenzenweger outlined the Meehlian approach of using psychometric indices in combination with biobehavioral markers to identify those at risk (the "schizotype"); while Claridge suggested a continuity from health to illness potentially leading to different interpretations of research findings. Regardless of interpretative stance, important studies have shown the ability of psychometric schizotypy to predict those at subsequent risk of psychopathology.[29,30] Inclusion of schizotypy was an important element in the Mauritius Child Health Project set up by Professors Peter Venables, Sarnoff Mednick and Fini Schulsinger in 1972. As the overall sample size (1800) was rather small for detecting significant rates of transition to caseness, the dimensional measurement approach enabled sensitive detection of relationships to influenza exposure in utero and other psychophysiological markers.[31] Interestingly, a small group of those deemed at high risk received an environmental enrichment program (aged 3–5 years) that seemingly reduced schizotypal personality in adolescence.[32]

A much more recently popularised approach to high risk has been those with early prodromal signs of psychosis. Schizotypy has been firmly implicated in many studies or what are termed "at risk mental states" or "ultra-high risk"[33,34] with evidence that it contributes to predicting those who will transition to psychosis alongside neurocognitive and other markers. In this context, discriminating what is an enduring trait effect, from that of symptomatic changes requires a sensitive measurement approach. Measures of psychometric schizotypy have been included in treatment trials for preventing transition.[35]

Studying Nonpsychotic Groups of Psychopathological Interest

Schizophrenic spectrum disorders have not solely been of interest, and many studies have long reported on other psychiatric groups with both a primary relevance to psychosis (eg, bipolar)[36] and without (eg, obsessive-compulsive disorder [OCD]).[37] In the case of OCD this has even led to a proposed schizotypy subtype.[38] Another potentially illuminating disorder of interest is that of PTSD, as schizotypy appears to be a vulnerability factor for traumatic intrusions induced by experimental means.[39] This relationship extends to individuals with post-traumatic stress disorder [PTSD] for whom positive schizotypy predicts more frequent trauma-related intrusions, greater hyper-vigilance, avoidance, and low mood.[40]

The potential relevance of schizotypy extends to neurodevelopmental disorders such as autism[41], fraxile X,[42] epilepsy,[43] and 22q11 deletion syndrome.[44] The phenotypic relationship between schizophrenia and autism has been difficult to clarify with suggestions of both overlap (social/communication) and exclusion, and diametric opposition (hyper-developed theory of mind in schizophrenia vs lack of theory of mind in autism). Dinsdale et al[45] recently adduced evidence from nonclinical psychometric data in support of both accounts: while negative schizotypy relates positively to autistic spectrum features, neurocognitive measures supported an "autism-positive schizotypy axis."

Overall, this eclectic strand of schizotypy research has led both to the illumination of schizophrenia/schizotypy by findings from beyond the spectrum, and of how subclinical psychotic traits inform a wide range of psychiatric and neurodevelopmental conditions. In some cases this may point to common underlying pathophysiology (eg, epilepsy) or psychological processes (eg, PTSD).

Describing Groups With a Characteristic of Interest

Aside from those meeting clinical group membership or possessing a feature of theoretical relevance to schizophrenia, many other groups have been studied that possess characteristics of phenomenological interest. Without listing exhaustively, these have included those with particular religious/spiritual outlooks,[46] visual artists,[47] comedians,[48] and poets.[49] The links to creativity are discussed later in this issue.

Stemming from phenomenological and psychopharmacological points of comparison, several groups of drug users have also been of interest to students of schizotypy. The relationships between personality predisposition and drug use correlates including neurocognitive function are ever more complex and extend to users of cannabis,[50] ketamine,[51] mephedrone,[52,53] methamphetamine[54] and others. Schizotypy measures have even been shown to be sensitive to differences in the type of cannabis used with higher levels of positive schizotypy seen in those with no evidence of the neuroprotective cannabis constituent cannabidiol in their hair (an indicator over time of the cannabis habitually used).[55]

Large-Scale/Epidemiological Research

A number of large birth cohorts and other population-wide samples have included indicators for schizotypal traits. These range from cohorts studied for a wide range of health outcomes to those specific to psychotic disorders; some are cross sectional while others originate from birth or from conscription to the military or other large-scale screening. The Dunedin cohort is a well-known example following over 1000 children from birth, and evidenced how "psychotic symptoms" aged 11 predicted subsequent outcomes.[56] Utilizing the Environmental Risk Longitudinal Twin Study (A UK birth cohort of over 2000), Polanczyk et al[57] used the same assessment format for "self-reported psychotic symptoms" which comprise 7 positive schizotypy items: they found evidence for both genetic and social risk factors. Even larger than these is the Northern Finland 1966 Birth Cohort Study comprising nearly 5000 individuals who completed schizotypy measures at age 31: A wide range of perinatal and postnatal predictors were found.[58] Large cohorts have also been used to investigate environmental factors such as psychological trauma. Evidence from the Early Developmental Stages of Psychopathology (EDSP) study[59] suggests that pre-existing schizotypy interacts with subsequent trauma to increase psychotic symptoms in a dose–response fashion.

Studies of "Nonclinical" Groups

Though often termed "nonclinical" or more broadly "nonpathological" this should be interpreted cautiously: firstly although axis I disorders and other conditions thought to be confounding such as brain injury are often excluded, this is usually by self-report and may well not be reliable. Secondly, the general population by definition contains a wide range of many, if not all, psychiatric and neurological conditions (even if unknown to the sufferer), and while some may be confounding of relationships, it is not possible to exclude all potential for this. Moreover, potential confounding does not solely come from "pathology." It may be essential, eg, in a study of lateralized cerebral functioning, to exclude nonright handers. Careful thought should be given to inclusion and exclusion criteria as there are 2 negative consequences of poorly chosen criteria. The first and more obvious consequence is that over-inclusiveness can lead to the introduction of error variance and obscure the relationship under study. The second consequence is that potential "true" variance may be lost by excluding part of the variance of the dimension under study. Both may result in a misleading pattern of results, and do not solely come from pathology in any case.

Those "research health warnings" notwithstanding, 2 broad designs aim to capture individual differences in "nonclinical" schizotypy in relation to aspects of psychological, physiological, or cognitive functioning. In general it is to be preferred that researchers make the theory to be tested explicit, and align their methods and designs accordingly. The first design studies a wide cross-section of a putatively "nonclinical" sample with the aim of correlating schizotypal characteristics with other features. This may involve "slicing" the sample artificially into, eg, "high," "medium," and "low" groups for the purposes of statistical analysis. Another design with similar intent aims to preselect 2 or more groups on the basis of schizotypy scores. This second approach has the practical advantage of testing fewer participants on what may be a demanding battery of tests. Sometimes these designs may be evaluated as almost synonymous though the first amounts to the statistical treatment preference for what is a correlational design. The second design is sometimes seen as inherently aligned with the clinical approach, though this is not necessarily the case.

Preference for one or other design is often based on pragmatic considerations: most fMRI studies are based on groups from the extremes of a distribution.[60] Though even here, entirely correlational studies are not unknown albeit they are demanding of sample size.[61] In some researchers' minds the "extreme scoring" group approach *necessarily* aligns with identification of a "schizotypal taxon" sometimes proposed as the top decile or 15% of the general population. However, this type of measurement approach is not synonymous with taking a categorical viewpoint: Indeed often the cut-points do not match this translation of theory into measurement. The statistical evidence for and against a taxon has been heavily rehearsed and does not seem to be close to any consensus. Usually it is a matter of suitability of theory, design, and statistical approach that influences whether

2 or more groups, a single sample, or indeed a combination of the 2 is chosen. This is not to say that methodological choices are atheoretical—some are antithetical to a theory.

"Microlongitudinal" Designs

Momentary assessment techniques, such as experience sampling methodology (ESM), utilize increasingly sophisticated technologies to achieve repeated assessment over time. ESM allows the identification of contextual determinants and patterns of reactivity to environmental stress, and will probably prove a useful tool in the field of gene–environment interaction. Unlike retrospective measures of distal exposures, ESM prospectively collects repeated measures of proximal environmental factors; this allows the detection of subtle and varied common environmental pathogens, their possible cumulative effects, and chains of effects rather than the impact of a single factor in one exposure.[62] Initially used at the intersection of cannabis use and schizotypy,[63] it is increasingly used in the context of everyday life.[64,65] Thus, Barrantes-Vidal et al[65] found that a range of stressor at the preceding ESM measurement point predicted psychotic-like symptoms, and that this association was moderated by positive schizotypy, treated as a dimensional measure.

Conclusions

Overall, the plethora of methodological approaches I have outlined suggest that schizotypy has secured a key role in both schizophrenia and personality research. There remains a place for a wide range of theoretical and empirical approaches. However, the field should not be seen to have reached a satisfactory outcome in terms of measurement: I have not described many older scales precisely because many of their items are outdated. Even more recent scales are often guilty of limited conceptualization and evidence of construct validity. Issues of ethnic difference[66] and lack of longitudinally predictive findings are very relevant to the majority, even of the most widely used scales. While studies understandably concentrate of psychopathological outcomes, care should be taken to contrast these with a range of adaptive outcomes. These are not necessarily contradictory to the construct, and it is important to discriminate what predicts a range of outcomes.

Finally, the process of construct validation should include repeated assessment over time by a variety of methods so as to vouchsafe what they are able to add to understanding risk: questionnaires must also be supplemented with in vivo assessments offering ecological validity. Only with well-identified and replicated endophenotypic indicators, can measurement of this complex set of constructs be deemed successful.

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