Dynamic Association Between Interpersonal Functioning and Positive Symptom Dimensions of Psychosis Over Time: A Longitudinal Study of Healthy Adolescents

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Background: Cross-sectional studies have indicated that alterations in social functioning, particularly interpersonal functioning, are associated with the occurrence of psychotic symptoms and experiences at different levels of the extended psychosis phenotype (ranging from population psychometric expression of liability to overt psychotic disorder). However, more research is needed on the development of this association over time. Methods: Cross-lagged path modeling was used to analyze bidirectional, longitudinal associations between 4 dimensions of subclinical psychotic experiences (persecutory ideation, bizarre experiences, perceptual abnormalities, and magical thinking) and interpersonal functioning in an adolescent general population sample (N = 881 at T1, N = 652 at T2, and N = 512 at T3) assessed 3 times in 3 years. Results: All symptom dimensions showed some association with interpersonal functioning over time, but only bizarre experiences and persecutory ideation were consistently and longitudinally associated with interpersonal functioning. Poorer interpersonal functioning predicted higher levels of bizarre experiences and persecutory ideation at later measurement points (both T1 to T2 and T2 to T3). Conclusions: Poorer interpersonal functioning in adolescence may reflect the earliest expression of neurodevelopmental alterations preceding expression of psychotic experiences in a symptom-specific fashion.

Key words: psychotic disorder/interpersonal relation/social support/longitudinal studies/risk factors/schizophrenic psychology

Introduction

Psychosis is thought to exist as an extended phenotype including levels below clinical expression.1 Subclinical psychotic experiences are commonly reported in the general population,2 particularly during adolescence, when expression of psychosis proneness peaks.3,4 Although mostly transient in nature,5,6 psychotic experiences may be predictive of later psychotic disorder in some individuals.5,7 According to the psychosis proneness—persistence—impairment model,8 the pathway from incidental psychotic experiences to clinical psychosis is mediated by the persistence of these experiences, which may eventually lead to need for care. Persistence of subclinical experiences and shifts along the extended psychosis phenotype are thought to result from an interactive process influenced by a number of biological, psychological, and social factors.9,10

One factor that impacts on risk for psychosis is social functioning. Deviations in social functioning are a common feature in patients with schizophrenia, those experiencing a first episode of psychotic illness, and in help-seeking individuals at ultra-high risk (UHR) for psychotic disorder.11 This is consistent with evidence of deficits in premorbid social development in childhood12,13 and adolescence14 in individuals destined to develop non-affective psychotic disorder. Individuals at UHR who transition to psychotic disorder also show poorer social functioning compared with those who do not make the transition.15–18 At the general population level, persistence of subclinical psychotic experiences is similarly associated with poorer social functioning.19 A recent prospective study of a general population sample from Israel showed that transition from subclinical psychotic experiences to hospital admission for psychotic disorder occurred almost...
exclusively in the group with psychotic experiences who also showed deviant premorbid social functioning. 19
Together, these findings suggest that poor social functioning, possibly reflecting alterations in neurodevelopment, are associated with development of psychotic illness in those at psychometric risk. However, several issues remain. Most studies have only addressed one dimension of social functioning, predicting psychosis rather than vice versa, or have used a cross-sectional design, which precludes observing how the variables are related over time. Another issue is that most studies employed a broad and variable definition of social functioning, capturing quality of social relations as well as occupational and educational achievements. Distinguishing between these concepts is important because they may be differentially related to outcome. For example, Cornblatt and colleagues 15 showed that poorer social functioning predicted the transition from UHR status to overt psychotic disorder, whereas role (academic/work) functioning did not. 15 Similarly, Velthorst et al 17 found that amid a range of disability domains, only “getting along with people” predicted the onset of psychosis in their UHR sample. 17

The concept of subclinical psychotic experiences is similarly broad and captures many dimensions, which may be quite different in their pattern of associations with other measures. Several dimensional solutions have been proposed in both adult 20 and adolescent 3,4 populations. Yung and colleagues 3 demonstrated a 4-dimensional structure of subclinical positive psychotic experiences (persecutory ideation, bizarre experiences, perceptual abnormalities, and magical thinking). These separate symptom dimensions were differentially associated with secondary distress and other measures of psychopathology such as depression.

Research has shown that environmental risk factors for psychotic experiences may be associated with specific dimensions of these experiences, such as hallucinations or paranoia. 21 It may be hypothesized that distinct symptom dimensions of psychotic experiences may also be differentially related to aspects of interpersonal functioning. For example, persecutory ideation may be related to interpersonal functioning because paranoia frequently involves misinterpretation of other people’s behavior. 22 Furthermore, experimental studies using virtual reality paradigms to investigate paranoia in different social contexts have demonstrated that individuals with paranoid thinking patterns interpret neutral social signals as threatening 23,24

The current study addressed the longitudinal association between dimensions of subclinical positive psychotic experiences (as identified in the current sample by Yung et al 3 and interpersonal functioning in an adolescent general population sample followed over 3 years. The study aimed to examine longitudinal bidirectional associations between interpersonal functioning and psychotic experiences. Interpersonal functioning was defined as functioning in context of family and peers, and 4 specific subdimensions of subclinical psychotic experiences were examined, including, persecutory ideation, bizarre experiences, perceptual abnormalities, and magical thinking. Because earlier work has previously found association of social function with depressive and negative symptoms, these symptoms were controlled for. 25

Methods
Sample
Participants were recruited through secondary schools in the western metropolitan region of Melbourne, Australia. Sixty secondary schools were approached to participate; 34 consented. Three data collection waves were completed: T1 (baseline), N = 881; T2 (12 months after baseline); N = 652 (74% of original cohort); and T3 (3 years after baseline assessment), N = 512 (58% of the original cohort). At baseline, 51% was female. The mean age was 15.6 years (SD 2.6).

At T1, students from each school were assessed by questionnaire. Trained research assistants were present in the classroom to answer queries. All participants provided written informed consent and assent from their parent/guardian. The second wave of data collection (T2) comprised a semistructured interview and questionnaires conducted in the participant’s home or at Orygen Youth Health, a youth mental health service. Written consent was again obtained from participants and their parent/guardian if they were still under 18 years of age. This process was repeated at T3. The study was approved by Research and Ethics Committees at the University of Melbourne, Victorian Department of Education and the Catholic Education Office.

Instruments
The Community Assessment of Psychic Experiences (CAPE) positive experiences subscale (20 self-reported items), based on the Peters et al Delusion Inventory, 26 was used to assess psychotic experiences at all study phases. 27 The CAPE negative symptom subscale was only assessed at T1. Each CAPE item rates 2 aspects of psychotic experiences: (a) frequency and (b) associated distress, both rated on a 4-point scale of never/not distressed (1), sometimes/a bit distressed (2), often/quite distressed (3), and nearly always/very distressed (4). The CAPE items showed good internal consistency at all time points (T1, Cronbach’s alpha = .85; T2 and T3, .82). The 20 frequency items of the positive experience subscale were used to index psychotic experiences. The 4 sum scores of the subscales of the CAPE defined by Yung et al (persecutory ideation, bizarre experiences, perceptual abnormalities, and magical thinking) were used to separately investigate the association of each
symptom dimension with interpersonal functioning. Persecutory ideation was defined using 7 items including “Have you ever felt that you are being persecuted in some way?” Bizarre experiences included 6 items including, eg, “Have you ever felt as if the thoughts in your head are being taken away from you?” Three items measured perceptual abnormalities, eg, “Have you ever heard voices when you were alone?” and 4 items defined magical thinking, such as “Have you ever thought that people can communicate telepathically?”

The sum score of the 12 frequency items of the negative subscale was used as a continuous indicator of baseline subclinical negative symptoms (Cronbach’s alpha = .83 at T1).

The Revised Multidimensional Assessment of Functioning Scale was used to assess interpersonal functioning at all 3 measurement points. The 23-item questionnaire designed at Orygen Youth Health assesses functioning in the domains of family, peer, and general daily life. Peer relationships were assessed with 6 items (eg, “I feel close to my friends,” “I spend quite a lot of time with my friends”) and family functioning with 7 items (eg, “I get on well with my parents,” “My parents disapprove of my friends, lifestyle or appearance”). Items are rated from “not at all or rarely applicable” (rated “0”) to “(almost) always applicable” (rated “5”), higher scores indicating better functioning. Peer functioning and family functioning (both as observed variables) were set to load on a latent factor labeled “interpersonal functioning.”

The Center for Epidemiologic Studies Depression Scale (CES-D) was used at T1 to assess level of self-reported depressive symptomatology over the past week. The CES-D consists of 20 items that rate frequency of depressive symptoms from 1 (rarely) to 4 (mostly). The sum score defined continuous depression outcome (T1, Cronbach’s alpha = .75).

Analysis

Analysis was conducted with Mplus 5.1 (Muthen and Muthen, 1998–2007) and PASW Statistics 18. Full information maximum likelihood was used for model estimation in Mplus, and, given that data were nonnormally distributed, robust maximum likelihood was used. This method estimates a mean-adjusted $\chi^2$ that is robust to nonnormality. Baseline differences between participants who completed all assessments and those who dropped out of the study at T2 or T3 were analyzed using independent $t$-tests.

Path analysis was used to investigate relationships between symptom dimensions of subclinical positive psychotic experiences and interpersonal functioning over time, using observed as well as latent variables. Stability paths of symptom dimensions and interpersonal functioning over time were also included in the model. All dimensions of subclinical psychotic experiences were entered as observed variables. A path analysis was used to examine a model of interpersonal functioning and psychotic experiences.

In the model, both family and peer functioning were used as indicators of the latent factor of interpersonal functioning. This latent factor of interpersonal functioning (one for each measurement point) represents an estimation of a general interpersonal functioning phenotype, ie, the overlap between interpersonal functioning in both domains. A cross-lagged path model was made with interpersonal functioning and the 4 CAPE subdimensions. Paths were drawn allowing psychotic experiences to predict interpersonal functioning over time and vice versa. All symptom dimension scores (persecutory ideation, bizarre experiences, perceptual abnormalities, and magical thinking) and interpersonal functioning were allowed to correlate at all time points. To extract the unique contribution of situation-specific functioning, the model also contains 2 context-specific common factors, one each for family and peer interpersonal functioning; hence, the specific association between subclinical psychotic experiences and general interpersonal functioning was investigated. This approach, combining both aspects of interpersonal functioning into one latent factor, reduces error variance. The path model was corrected for gender, baseline depression as measured by CES-D, and baseline negative symptoms as measured by CAPE at baseline.

Results

Descriptives

There were no significant differences in age, socioeconomic status, baseline depression, overall CAPE scores, and interpersonal or general functioning between participants who completed all phases of the study and those who dropped out at T2 or T3. Participants who completed all phases had lower baseline scores on persecutory ideations ($t(868) = -2.02, P = .044$) and magical thinking ($t(860) = -2.06, P = .040$) than those who dropped out at T2 or T3. There were no baseline differences between the groups with respect to the other symptom dimensions. Furthermore, we tested cannabis use and socioeconomic status as possible confounders; however, although cannabis was associated with psychotic experiences, it was not with social functioning, which would be required for it to confound the association. Furthermore, socioeconomic status was associated with interpersonal functioning but not with psychotic experiences. Therefore, these factors were not included in the model.

Path Analysis

Model with Latent Interpersonal Functioning Factor. The model for interpersonal functioning with all paths included showed good model fit ($\chi^2(123) = 253.543$; comparative fit index = 0.962 and root mean square of error approximation = 0.035). In Figure 1, all significant paths...
(\(P < .05\)) are shown (beta coefficients indicate path strength). As expected, symptom dimensions were intercorrelated at all different time points (for parsimony, these correlations are not depicted). Cross-sectional correlations between symptom dimensions were positive (range \(r = .20-.47\)). At T1, there was no significant correlation between interpersonal functioning and bizarre experiences (\(r = .01, P = .86\)), perceptual abnormalities (\(r = -.09, P = .11\)), persecutory ideation (\(r = -.05, P = .41\)), or magical thinking (\(r = .03, P = .65\)). At T2, interpersonal functioning was negatively correlated with bizarre experiences (\(r = -.27, P = .004\)), perceptual abnormalities (\(r = -.18, P = .04\)), and persecutory ideation (\(r = -.41, P = .000\)), but not with magical thinking (\(r = .08, P = .35\)). At T3, interpersonal functioning was correlated with persecutory ideation (\(r = -.35, P = .000\)), but not bizarre experiences (\(r = -.16, P = .08\)), perceptual abnormalities (\(r = -.15, P = .10\)), or magical thinking (\(r = -.08, P = .39\)). The interpersonal functioning factor was indicated by both peer and family functioning. This model showed good model fit and all items loaded significantly (\(P < .05\)) on the factor. The factor loadings were quite stable over time: 0.72–0.80 for family functioning and 0.41–0.56 for peer functioning. Factor loadings were higher for family functioning than peer functioning, indicating that the common interpersonal functioning factor was determined more strongly by functioning in family than peer context.

Longitudinally, interpersonal functioning at T1 predicted bizarre experiences (\(\beta = -.15, P = .014\)) and persecutory ideation (\(\beta = -.17; P = .002\)), but not perceptual abnormalities or magical thinking at T2. Interpersonal functioning at T2 predicted bizarre experiences (\(\beta = -.17, P = .024\)), persecutory ideation (\(\beta = -.17, P = .017\)), perceptual abnormalities (\(\beta = -.16, P = .042\)), and magical thinking (\(\beta = -.18, P = .007\)) at T3. None of the subclinical psychotic experiences predicted interpersonal functioning over time.

**Discussion**

The present study investigated the bidirectional, longitudinal association between interpersonal functioning and different dimensions of subclinical positive psychotic experiences (persecutory ideation, bizarre experiences, perceptual abnormalities, and magical thinking) in an adolescent general population sample. All subdimensions showed some longitudinal association with interpersonal functioning, interpersonal functioning predicting later psychotic experiences, but only bizarre experiences and persecutory ideation were predicted consistently. In addition, while deviations in interpersonal functioning predicted persecutory ideation and bizarre experiences over time, this did not hold the other way round. The unidirectional nature of the association is consistent with earlier research suggesting that poor social functioning precedes the occurrence of symptoms and transition to psychosis in individuals with increased risk for psychotic disorder.\(^3^9\) The finding that magical thinking was less strongly predicted by interpersonal functioning shows a milder form of psychotic experiences.\(^3^4\) On the other hand, a less robust association between interpersonal functioning and perceptual abnormalities contrasts previous findings, which suggested that this dimension carries more pathological weight, eg, shows a strong association with depressive symptoms.\(^3^3\) It is possible, however, that the more pathological nature of perceptual abnormalities is mediated by associations with other dimensions of psychopathology (eg, behavioral or emotional problems) rather than directly by interpersonal functioning.\(^4\) Other research demonstrates that the link between functioning and subclinical perceptual abnormalities emerges mainly when perceptual abnormalities are accompanied by delusional experiences,\(^7\) suggesting that a deterioration in social functioning is neither required nor sufficient for subclinical perceptual abnormalities to occur.

The current results extend earlier work in several ways. First, most studies have examined overall psychotic symptomatology or psychotic illness as the outcome, but not separate (subclinical) symptom dimensions.\(^3^1\) Because different subtypes of psychotic symptoms may be differentially related to outcome,\(^3^0\) it is important to examine subtypes separately. Second, earlier studies comparing social functioning between groups at different levels of risk for psychosis often employed cross-sectional designs. This makes it impossible to draw conclusions about possible causality, in contrast to the present study. Third, most studies tested only one direction of the association, namely, whether interpersonal functioning predicts psychosis.\(^1^8\) This study examined the association bidirectionally. Importantly, the majority of studies were conducted in help-seeking UHR or patient populations, but not in the general population. In help-seeking and clinical populations, it may be difficult to draw conclusions because the very presence of clinical psychotic experiences may color the interpretation of (neutral) social stimuli. The current results emphasize the importance of the quality of interpersonal relations in the development of specific psychotic experiences at the level of the general population and suggest that at the subclinical stages of psychosis, interpersonal functioning may be particularly important for the formation of persecutory ideation and bizarre experiences.

Several mechanisms may be hypothesized to underlie this association. First, family interactions are particularly important early in life when the child develops basic schemas about interpersonal relationships and may determine trust in others from early life onwards.\(^3^2\) This is supported by the findings that factor loadings of peer functioning on the common interpersonal functioning factor were lower than the factor loadings of family functioning, suggesting
that family functioning still plays an important, central role in determining social functioning in adolescence. Early (deficient) interpersonal functioning may thus be a powerful (psychological) mechanism for onset of persecutory ideation. Second, neurodevelopmental mechanisms may drive these longitudinal associations.

The direction of the association between interpersonal functioning and psychotic experiences is in line with earlier work by Dominguez and colleagues, who found in a longitudinal study on adolescents that negative symptoms, which were associated with markers of developmental deviance, preceded positive symptoms, but not the other way around. Thus, social dysfunction and negative symptoms preceding positive symptoms may reflect the unfolding of an underlying neurodevelopmental process associated with psychosis liability.

Social functioning is closely related to social cognition, and individuals at risk for psychosis show alterations not only in social functioning but also in social cognition, including poor emotion recognition and altered theory of mind capacities. These deviations may increase the probability of psychotic symptom expression, as early subclinical pathological ideas are not corrected in social interaction, resulting in even worse interpersonal functioning. Breaking this cycle may be important and may offer opportunities for early intervention, eg, using cognitive behavioral therapy.

The results of the study should be interpreted in light of its strengths and limitations. First, clinical outcome data were not available; however, the main aim was to examine the development of symptoms at the level of subclinical expression during a phase of life characterized by both a peak in psychosis proneness and changing social roles and relationships. Second, there was significant sample attrition between T1 and T3. However, there were no differences in either CAPE scores or interpersonal functioning between those who did and did not remain in the study. Furthermore, the estimator used for model estimation used all available data and did not delete individuals listwise.

Keeping these limitations in mind, this study’s major strength was the availability of both symptom dimensions and interpersonal functioning at all measurement points, enabling the testing of bidirectional associations in one model and to address this relationship in more detail. Furthermore, a latent factor of interpersonal functioning was used, reducing error variance and representing a more exact estimator of interpersonal functioning because it represents the overlap between peer and family functioning. Further examination of this kind of longitudinal association between variables early in life may have implications for psychological models of psychosis, help test plausible causal mechanisms underlying shifts along the extended psychosis continuum and development of need for care.

and gain a better understanding of early mechanisms preceding the development of subclinical psychotic experiences. It should be remembered that associations between psychotic experiences and other concepts, such as interpersonal functioning, may differ at different positions along the extended psychosis continuum.

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