Is the excess risk of psychosis-like experiences in urban areas attributable to altered cognitive development?

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Abstract Background Rates of psychotic disorder and related attenuated psychotic experiences are higher in urban areas. We examined to what degree differences between urban and rural areas could be attributed to differences in cognitive development. Method Scores on the nine subscales of the schizotypal personality questionnaire (SPQ) as well as IQ and specific neuropsychological functions of memory and attention were assessed in a representative sample of 943 young army conscripts from the 49 counties of Greece. Results You men from urban areas had higher scores on the SPQ subscale Odd beliefs/magical thinking (OR = 1.99, 95 % CI: 1.42, 2.78), but lower scores on Excessive social anxiety (OR = 0.63, 95 % CI: 0.49, 0.81) and No close friends (OR = 0.42, 95 % CI: 0.29, 0.62). Adjustment for demographic factors, IQ and specific neuropsychological functions did not change the results. When the lower scores on Excessive social anxiety and No close friends were taken into account, the differences on the Odd beliefs/magical thinking subscale became even more pronounced (OR = 2.33, 95 % CI: 1.56, 3.49). Conclusions Young men from urban areas are socially more competent, but display higher levels of positive psychotic experiences, which are not mediated by lower IQ or higher levels of neuropsychological impairment.

Key words schizotypy – psychosis – risk – urban environment – cognition

Introduction

Previous work has shown dose-response relationships between the level of clinical and non-clinical psychotic experiences on the one hand, and growing up in an urban environment on the other, suggesting that environmental factors in urban areas impact on development in such a way that the expression of mental states that increase the risk for psychotic disorder is facilitated (Pedersen and Mortensen 2001; Van Os et al. 2001). Environmental factors that are more prevalent in urban environments such as poverty and malnutrition, pre- or post-natal infectious diseases, exposure to lead and exposure to psychological stress (Dalgard and Tambs 1997; Freeman 1994; Mueser et al. 2001; Thornicroft et al. 1993; Torrey and Bowler 1990) may all impact on the developing organism and facilitate expression of psychosis. Previous work has suggested that differences between urban and rural areas in psychosis rates are not related to differences in childhood SES and obstetric complications (Harrison et al. 2003).

Instead of the search for particular factors possibly mediating the association between urbanicity and psychosis, an alternative strategy is to examine possible mediation by an underlying indicator of neurodevelopmental impairment. As the expression of psychosis is preceded by developmental changes in cognition (Jones et al. 1994; Marcus et al. 1993), and adult schizophrenia is characterised by neuropsychological impairment, in particular in the areas of memory and attention (Krabbe dam et al. 2001), it is attractive to speculate that the impact of the urban environment on the expression of psychosis is mediated by changes in cognitive development.

The aim of the current study was twofold: i) to replicate our previous finding of an association between exposure to an urban environment and expression of psy-
chosis-like experiences, and ii) to examine whether the difference in distribution of psychotic experiences between urbanised and non-urbanised areas could be attributed to differences in the underlying distribution of the neuropsychological factors that have been associated most with schizophrenia.

**Subjects and methods**

### Sample and measures

In eight separate waves, between January 1999 and March 2000, 2243 randomly selected young male conscripts aged 18–24 years were recruited from the Greek Air Force, during their first 2 weeks of admission in the National basic Airforce training centre. A full description of sample and methods was given in earlier work (Stefanis et al. 2002). Conscripts are selected into a particular section of the army on the basis of a weighted (depending on how many recruits are needed) random selection procedure. Conscripts underwent an extensive interview of computerised neurocognitive abilities and a self-rated schizotypy scale, the SPQ (Raine 1991). The SPQ is a 74 “dichotomous” item (yes/no) questionnaire that assesses all nine aspects of DSM-III-R SPD (Schizotypal Personality Disorder), thus yielding nine subscale scores (ideas of reference, excessive social anxiety, odd beliefs/magical thinking, unusual perceptual experiences, odd or eccentric behaviour, no close friends, odd speech, constricted affect, suspiciousness). In order to verify the degree of collaboration with the self-report scales, we used the four validity items of the Temperament and Character Inventory (Cloninger et al. 1993). Only individuals found to respond reliably to these items were included in the analysis (n = 1411). Conscripts were excluded if they had failed to respond to at least two items of any specific SPQ subscale or to more than seven items in the total SPQ questionnaire, or because they had missing data on county of residence. Thus, the SPQ subscale scores of 1337 conscripts were eventually available for analyses. Subscale scores were expressed as proportions of the sum of positive responses divided by the number of items of each subscale minus missing values.

### Cognitive assessments

IQ was assessed with Raven’s Colored Progressive Matrices Test (Raven 1982) (hereafter: IQ). Verbal and spatial memory were assessed with the verbal and spatial N-BACK test respectively (Gevins et al. 1996), and attention was assessed with the Continuous Performance Test (CPT) (Cornblatt et al. 1989; Cornblatt et al. 1998). Other variables assessed were number of years of full-time primary and secondary education and age in years.

### Urbanicity

The conscripts were drawn from 49 different counties in Greece. We used a measure of population density, i.e. the number of inhabitants per square kilometre of current county of residence according to the 2001 census, as the urbanicity exposure. As the distribution of population density in the sample was binary, with 46% from the two counties with the highest population density of 4880 and 5069 persons per square kilometre, and the remainder from counties with population densities in the range of 733 to 2366, we used a dichotomous measure of urbanicity contrasting the two counties with the highest densities with the others (hereafter: urban vs. rural).

### Analyses

Mean scores on the nine SPQ subscales were compared between urban and rural areas. As the expression of psychosis is associated with younger age (Verdoux et al. 1998), and the mean age of the rural group of our sample was slightly younger than the rural group (mean rural group 20.7 years, mean urban group 21.1 years, $P < 0.001$), adjusted comparisons were conducted by assessing the association, expressed as the odds ratio, between urbanicity and the nine SPQ subscales, using logistic regression in STATA (StataCorp 2001) with the dichotomous urbanicity measure as the dependent variable. Similarly, we adjusted for number of years in full-time education. In order to assess independence of possible associations between urbanicity and multiple SPQ subscales, analyses were also conducted with multiple subscales entered together in the equation, effectively controlling the effect of one subscale for all others. In order to assess whether any differences in schizotypy between the rural and urban groups were mediated by IQ, memory or attention, these variables were added to the equation with assessment of the subsequent degree of change in the association between schizotypy and urbanicity.

As conscripts from the same county are more similar to each other than conscripts from different counties, compromising statistical independence of the data, the CLUSTER and ROBUST options were used in the STATA logistic regression analyses. The CLUSTER option combined with the ROBUST option allows for the use of observations which are not independent within clusters (in this case, within counties) and obtains the Huber/White/Sandwich estimator of variance instead of the traditional variance estimator. These procedures result in standard errors that are adjusted for clustering within counties.

As we conducted nine tests with correlated outcomes, we applied the Simes method for multiple hypothesis testing with positively dependent test statistics, which represents the correct alternative for the Bonferroni procedure in the case of related outcomes (Simes 1986).

### Results

The mean age of the conscripts was 20.9 years (SD = 1.9). As noted above, rural subjects were slightly younger than their urban counterparts. The mean number of years of education was 13.1 (SD = 2.2), slightly lower in rural subjects (12.9, SD = 2.2) than in urban subjects (13.3, SD = 2.1; $F = 15.1, df = 1328, P < 0.001$). A similar difference was apparent for Raven’s IQ (rural: 45.1, SD = 9.0; urban: 47.5, SD = 7.3; $F = 28.4, df = 1333, P < 0.001$), and the CPT (urban: 1.95, SD = 0.91; rural: 1.73, SD = 0.87; $F = 20.54, df = 1297, P < 0.001$). No large or significant differences were apparent for spatial and verbal memory. There were significant differences between the groups in three of the nine SPQ subscales, all with $P$-values smaller than the $P$ after correction with the Simes procedure, indicating statistically significant differences (Table 1). The differences indicated that urban subjects had higher scores on the *Odd beliefs/magical thinking* subscale, and lower scores on the *Excessive social anxiety* and the *No close friends* subscale. The odds ratios of these differences from the logistic regression procedure were 1.99 (95% CI: 1.42, 2.78) for the positive association with *Odd beliefs/magical thinking*, and 0.63 (95% CI: 0.49, 0.81) and 0.42 (95% CI: 0.29, 0.62) for the negative associations with the *Excessive social anxiety* and *No close friends* subscales, respectively.

Adjustment for age and years in full-time education did not essentially change the results. Similarly, neither adjustment of the effect of one subscale for that of the others, nor adjustment for IQ, memory and attention changed the associations. The association between urbanicity and *Odd beliefs/magical thinking* increased rather than decreased when the effect of the other two factors was taken into account (Table 2).