Season of birth, mixed-handedness, and psychometric schizotypy: Preliminary results from a prospective study

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ABSTRACT

Season of birth and hand preference were examined in a sample of 42 (7 males, 35 females) individuals who were identified as schizotypic based on their scores on selected scales of the Chapman Psychosis Proneness Scales (CPPS) and a matched comparison sample of 42 individuals with non-deviant CPPS scores. Presence or absence of schizotypy was analyzed using chi square tests of independence with the presence or absence of each risk factor serving as the independent variable. Further analyses incorporated independent means t tests to examine mean scores on the CPPS with the presence or absence of each risk factor again serving as the independent variable. Results supported the hypothesis that winter/early-spring birth would be associated with psychometric schizotypy, although the results for mixed-handedness fell just short of statistical significance. However, mixed hand preference was associated with higher scores on MagId and PerAb scales of the CPPS, but not the RSA scale, which suggests that mixed laterality is associated with the more cognitive-perceptual aspects of schizotypy.

Results are discussed in relation to previous literature and their relevance to the prediction of schizophrenia-related psychosis.

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1. Introduction

There has been a growing focus on identifying indicators of elevated risk for developing schizophrenia-related psychosis (SRP). Among the key attributes of a multifactorial/threshold model of SRP development is the assumption that the majority of individuals with increased liability to SRP will not decompensate into psychosis, although they may experience schizotypal symptoms or neurobehavioral deficits (Lenzenweger, 2006, 2010). Many of these markers are genetically influenced, but others result from prenatal factors (McGrath, 1995; Takei et al., 1995; Geddes et al., 1999). This model also suggests that as risk factors for the disorder accumulate so, too, does psychiatric deviance. Thus, although no marker of risk may serve as a “magic bullet” in explaining the onset of SRP, it is possible that these markers may have an additive effect in determining which individuals cross over the liability threshold for SRP and which do not.

1.1. Psychometric assessment of schizotypy

One marker that might provide clues to the precise nature of the development of psychiatric disorders is psychometrically assessed personality. Among measures found to be effective in identifying psychosis-proneness, or schizotypy, are the Chapman Psychosis Proneness Scales (CPPS), which include the Perceptual Aberration Scale (PerAb; Chapman et al., 1978), the Magical Ideation Scale (MagId; Eckblad and Chapman, 1983), and the Revised Social Anhedonia Scale (SocAnh; Eckblad et al., 1982), among others. Studies have found higher incidence of SRP among individuals identified as schizotypic on the basis of CPPS scores relative to comparison groups at 10-year follow-up (Chapman et al., 1994; Kwapił, 1998), as well as more frequent and severe psychotic-like experiences at 5-year follow-up (Gooding et al., 2005, 2007). Thus, there is an adequate evidence to support the utility of the CPPS in identifying schizotypic individuals well before the onset of clinically significant symptoms. This is especially important as, although the single best predictor of developing SRP remains having an identical twin with the disorder (Meehl, 1990), it has been noted that 45% of individuals determined to be at risk via psychometric means had no family history of psychosis (Chapman and Chapman, 1985), which suggests that reliance on genetic relatedness for determination of increased liability to SRP may lead researchers to overlook a significant subset of individuals having increased liability, but no family history of the disorder. An additional benefit of the CPPS is that they are intended to measure liability to SRP in a population of sub-threshold individuals who are unlikely to exhibit overt symptoms of psychosis, and in some cases may have no easily observable signs of schizotypy. By investigating liability factors in...
this population, investigators may be more likely to detect aspects of the disorder that may be obscured in the fully decompensated illness (Lenzenwegger, 2010).

Further, Lenzenwegger (2006, 2010) has suggested that an additional benefit of psychometric assessment of schizotypy, as opposed to clinical assessment, is that it makes use of quantitative rather than qualitative measures, which can lead to enhanced precision in the measurement of schizotypic phenomena.

1.2. Other markers of schizophrenia-related psychosis

Beyond the psychometric assessment of schizotypy, other measures have also been shown to be related to the development of SRP; many of these markers have shown small, but significant effects. Two such markers are season of birth and atypical handedness.

1.2.1. Season of birth

Numerous studies have investigated the relationship between an individual's season of birth and their likelihood of developing schizophrenia. As early as 1929, Tramer (1929) identified an excess number of winter births for patients with schizophrenia in Switzerland compared to the general population. Later research provided further support for this, with reports of 5–15% excess winter and early spring month births in the Northern Hemisphere (Modestin et al., 1995; Torrey et al., 1996).

Most recent studies have focused on further exploring this relationship between season of birth and SRP liability by investigating whether birth location and severity of climate impact the excess birth rates. In a meta-analysis of eight season of birth studies in the Northern Hemisphere, Davies et al. (2003) confirmed results of previous studies, showing an overall excess of births in the winter and early spring months, while also finding a small, but significant increase between the magnitude of the seasonal effect and increasing latitude. The latter finding has been replicated in lower latitudes and more temperate climates (e.g., Mexico; Muñoz-Delgado et al., 2003).

Results of similar studies in the Southern Hemisphere have been more equivocal. For example, Morgan et al. (2001) found support of a relationship between late winter/early spring births and schizophrenia only among females. Jordaen et al. (2006) investigated the relationship between season of birth and specific positive and negative symptoms of schizophrenia among South Africans, and found that avolition and apathy were significantly more common among autumn/winter-born patients 30 years-old and older.

Unfortunately, the precise mechanism behind the relationship between season of birth and SRP remains unknown, largely due to observed correlations between several factors such as family history and obstetric complications (Morgan et al., 2001). These factors, in conjunction with unique seasonal issues, may impact SRP risk in a number of ways, such as increasing exposure to prenatal viral or bacterial agents or altering recreational habits in parents of high-risk children, to name a few (Torrey et al., 1997).

1.2.2. Atypical handedness

A great deal of research has investigated a lack of hemisphere lateralization in patients with SRP. Several studies have indicated that individuals with SRP demonstrate a lack of lateralization in both language (van Veelen et al., 2011; Bleich-Cohen et al., 2012) and motor function (Mattay et al., 1997; White et al., 2009), indicating that, in these individuals, both brain hemispheres are more frequently utilized to complete functions that are usually localized to only one hemisphere. Moreover, several studies have also supported the notion that patients with SRP have greater atypical hand preference, which can be defined as either non-right-handedness or mixed-handedness, compared to their healthy relatives and healthy controls (Orr et al., 1999; Reilly et al., 2001; Sommer et al., 2001; Delisi et al., 2002; Draganic and Hammond, 2005; Draganic et al., 2005a; Dan et al., 2009). Some of these studies have focused on left-handedness, whereas others have focused on either left- or mixed-handedness. Draganic et al. (2005a), for example, found increased SRP among patients with either left- and mixed-handedness, although left-handed patients had, on average, more severe courses of illness than the mixed- or right-handed patients.

These findings of atypical hand preference (i.e., left-handed and mixed-handed) extend to schizotypy, as well as SRP. Draganic et al. (2005a, 2005b), for example, found that non-right-handed patients had higher scores on the Cognitive Perceptual Dysfunction factor of the Schizotypal Personality Questionnaire compared to healthy patients. We also see this association of atypical handedness and schizotypy in non-clinical populations. A meta-analysis of a non-clinical population with a schizotypal tendency demonstrated that mixed-handed subjects scored higher on schizotypy questionnaires compared to right-handed and strong left-handed subjects (Somers et al., 2009). Broadly, mixed-hand preference has been found to be associated with increased schizotypy scores in undergraduate populations (Annett and Moran, 2006), community samples (Claridge et al., 1998; Chapman et al., 2011), and in individuals from non-Western cultures (Asai and Tanno, 2009).

The results of other studies, however, are less clear. For example, Deep-Soboslay et al. (2010) did not find a significant left- or mixed-handed preference in patients with SRP compared to their healthy relatives and healthy controls. Claridge et al. (1998) found that non-patient participants having the greatest degree of mixed-handedness had the lowest schizotypy scores, whereas those with mild mixed-handedness had the highest schizotypy scores, a finding that is the opposite of what one might expect. Further, Bryson et al. (2009) found an association of positive schizotypy and mixed-handedness when handedness was measured with a questionnaire, but not when a behavioral measure was used, suggesting that behavioral measures assess hand skill, whereas questionnaires assess hand preferences.

Thus, current research remains equivocal with the majority in favor of atypical handedness associated to SRP and schizotypy. Further research is necessary to increase our understanding of the precise nature of the extant relationship. Many of the above-noted studies have incorporated a methodology of comparing only mean scores on a measure of schizotypy (e.g., the SPQ; Raine, 1991 or the CPPS) by handedness, without also examining the distributions of those above and below the threshold for schizotypy. Although the former analyses indicate whether one group scores higher, on average, than the other group, the results of such tests say nothing about whether atypical handedness is actually associated with a classification of schizotypy. For example, it is quite possible for one group’s mean score to be significantly higher than another group’s mean score on a measure of pathology — and this may well indicate increased risk for that particular pathology — yet both group’s scores could remain below the threshold for actually having that pathology. The former question is one of degree, whereas the latter is one of type.

1.3. Present study

The current study examined the relationship between psychometrically-identified schizotypy, season of birth, and atypical handedness in a sample of college students who have never met diagnostic criteria for SRP. Specifically, we hypothesized the following:
1. Individuals who were identified as schizotypic by psychometric means would be more likely to be born during the high-risk months than would a comparison sample of non-schizotypic.

2. Individuals who were identified as schizotypic by psychometric means would be more likely to display mixed hand preference than would a comparison sample of non-schizotypic.

Further, we compared mean scores on the CPPS by birth-risk group and handedness group so that our results can be compared to those of previous studies.

2. Methods

2.1. Participants

2.1.1. Initial participant pool

Participants were drawn from a sample of 290 (73 males, 217 females) college students between the ages of 18 and 24 years who received course credits for their participation. The current study is part of a larger, ongoing study of psychosis proneness that is currently in the second of three years of baseline data collection. For inclusion in the larger study, participants’ responses had to meet validity criteria for additional measures beyond those included in the current study for inclusion in the final sample. In addition to the CPPS, validity measures of the MMPI-2 and the PDQ-IV were utilized.

2.1.2. Final sample

The final sample consisted of 42 individuals (7 males, 35 females) identified as schizotypic (SZT group) on the basis of their CPPS scores and 42 individuals (7 males, 35 females) in a matched comparison (MC) group. The criterion for inclusion in the SZT group was a score of more than 1.96 standard deviations above the gender-based mean on any of the CPPS scales of interest in the current study. For males, the cutoff scores were $\text{SocAnh} \geq 20$, $\text{MagId} \geq 22$, or $\text{PerAb} \geq 19$; for females, the scores were $\text{SocAnh} \geq 16$, $\text{MagId} \geq 21$, or $\text{PerAb} \geq 19$. Age among the males in the SZT group ranged from 18 through 21 years ($\text{M} = 19.1, \text{SD} = 1.77$); ethnic group membership consisted of five Caucasians, one African–American, and one Hispanic individual. Among the females in the SZT group age ranged from 18 through 20 years ($\text{M} = 18.7, \text{SD} = 0.68$); ethnic group membership consisted of 23 Caucasians, 10 African–Americans, and two Hispanic individuals.

In order to control for the possible effect of demographic variables on the variables of interest, the MC group was selected whose demographics aligned as closely as possible with the SZT group. Thus, for each SZT participant, an MC participant was matched on (in order) gender, ethnicity, age, and college major from the remaining participants with valid protocols. When a match was not possible on one of these criteria, the match was made with the participant closest to the SZT participant on that particular criterion. Age among the males ranged from 18 through 23 years ($\text{M} = 19.1, \text{SD} = 1.77$). Age among the females in the MC group ranged from 18 through 21 years ($\text{M} = 18.7, \text{SD} = 0.82$). There were no significant differences in age by gender, group, or their interaction.

2.2. Procedures

As noted above, participants completed the CPPS so that schizotypy could be assessed. Participants’ birth dates were determined from responses to a brief questionnaire: December through mid-March birth dates were considered to be high-risk birth months in accordance with previous research. Laterality and hand preference were determined by the Edinburgh Handedness Inventory (Oldfield, 1971), a commonly-used measure for assessing hand dominance. For the purpose of the current study, mixed-hand preference was considered atypical, whereas strong laterality (i.e., a dominant hand) was considered typical, regardless of the hand dominance. Data were analyzed by $\chi^2$ tests for independence when appropriate. In situations where expected $N$ in at least one cell was less than five, Barnard’s exact test was chosen in lieu of Fisher’s exact test, as there have been suggestions that the latter is overly conservative with small samples (Martín Andrés et al., 2004). In addition, odds ratios were calculated for each comparison.

3. Results

3.1. Season of birth

Of the 42 SZT participants, 18 reported being born in the high-risk period, whereas 24 were not. Conversely, only seven of 42 MC participants reported being born during the high-risk period. This difference in the likelihood of being born in the high risk period was significant, $\chi^2 (1) = 6.891, p = 0.009$. Cramer’s $\varphi = 0.29$. The odds ratio indicates that individuals in the SZT group were 3.75 times more likely to be born in the high-risk months than were the individuals in the MC group (95% CI = 1.36–10.36). There were no significant mean score differences on any of the CPPS scales of interest by high-risk birth month status, either for the complete sample, combined, or within the SZT or MC groups, individually.

3.2. Atypical handedness

Among the 42 SZT participants, 36 displayed right-hand preference and six displayed mixed-hand preference; none of the SZT participants reported a left-hand preference. Within the MC participants, 41 displayed strong laterality (39 right-handed and two left-handed) and one displayed mixed laterality. Given the small expected $N$ (expected =3) in two cells of the contingency table, Barnard’s exact test was incorporated for this analysis; a two-tailed test fell just below the significance criterion ($p = 0.068$). The odds ratio indicates that individuals in the SZT group were 6.83 times more likely to display mixed-hand preference than were the individuals in the MC group, although, given the lack of statistical significance, the confidence interval includes 1 (95% CI = 0.79–59.48).

We also examined mean differences within the SZT group on the three CPPS scales of interest with mixed-handness/strong laterality as the grouping variable. The difference was non-significant for RSA; however, the atypical-handed group scored significantly higher than the typically-handed group on both MagId and PerAb (see Table 1). The pattern of these results was mirrored for the combined group, although the $t$ score and $df$ had to be adjusted when comparing PerAb scores due to inequality of variances among the two groups (results not reported here).

4. Discussion

Consistent with the results of previous research that compared the rates winter/early spring births between individuals with SRP and without the disorder, the present study provides evidence that winter/early spring birth is associated with psychometric indicators of schizotypy, as well. This finding is important as it demonstrates that the season of birth phenomenon is present in individuals with sub-threshold markers of schizotypy and relatively high functioning. Additionally, no significant differences in mean scores on any of the CPPS scales were present.

With regard to atypical handedness, our results displayed a trend of individuals demonstrating psychometric schizotypy were more likely to exhibit mixed-hand preference than individuals in the MC group, indicating a lack of lateralization in motor performance consistent with previous investigations (Mattay et al., 1997; White et al., 2009), although a two-tailed test fell short of significance. It is likely that a larger sample size would

<table>
<thead>
<tr>
<th>Scale</th>
<th>$M$ (S.D.)</th>
<th>$t$</th>
<th>$p$</th>
<th>$d$</th>
</tr>
</thead>
<tbody>
<tr>
<td>RSA</td>
<td>16.17 (6.94)</td>
<td>20.03 (5.23)</td>
<td>1.600</td>
<td>0.117</td>
</tr>
<tr>
<td>MagId</td>
<td>16.17 (6.88)</td>
<td>9.94 (6.12)</td>
<td>-2.268</td>
<td>0.029</td>
</tr>
<tr>
<td>PerAb</td>
<td>12.50 (6.95)</td>
<td>5.72 (3.93)</td>
<td>-3.475</td>
<td>0.001</td>
</tr>
</tbody>
</table>

Note: $d$ = Cohen’s $d$. |
have resulted in statistical significance; the relative strong effect size that we found (odds ratio of 6.83) makes this an area of research worth continued investigation.

Although mixed-handedness was not associated with a higher frequency of deviance on the CPSS, individuals with mixed-hand preference did exhibit higher mean scores on Magid and Per
d than individuals with lateralized hand preference, although no difference was indicated for RSA. These results may indicate a qualitative difference between the potential symptomology of individuals with mixed-hand versus lateralized preference, with a lack of laterality being associated with the more cognitive-perceptual aspects of schizotypy, rather than social withdrawal, although as in the study by Bryson et al. (2009), hand preference was measured by questionnaire; we have recently begun collect- ing behavioral measures of handedness. The differences in brain structure and function between individuals with positive and negative symptom presentations have been discussed at length (c.f., Crow, 1980), and it would be interesting to see if the current results would replicate and if similar differences in laterization among those with positive and negative symptoms would be found for other functions, such as language.

Although both season of birth and atypical handedness demonstrated meaningful relationships with psychometric schizotypy there was no statistically significant relationship between them. This suggests that these indicators identify independent risk factors for schizotypy and SRP. Although the relationship between the indicators was not significant, there was some overlap observed across the two indicators. With a larger sample, the small observed relationship might reach the level of significance. It is worth noting, as well, that the one individual in the MC group who reported atypical handedness was also born during the high-risk period. An MFT model of risk would suggest that as risk factors accumulate, so, too, would psychiatric deviance. As we continue to gather the full sample for our prospective study, we will be able to examine whether individuals with both risk factors evidence greater dysfunction than do those with only one risk factor, or none, at all.

A major strength of this study is our use of psychometrically identified schizotypy as a dependent variable; further, we incor- porated a matched comparison sample for our criterion group, rather than using convenience samples or relying on sometimes unreliable family history information to determine risk status. Our design allows for a more direct analysis of the relationships between laterality and season of birth with schizotypy, rather than being limited to comparisons of mean scores on scales of schizotypy. Although the latter can provide important clues to how these risk factors may influence behavior, they do not provide direct information concerning the actual presence of schizotypy.

A weakness of the present study is the relatively small sample size resulting in small numbers of individuals exhibiting variables of interests. This is particularly notable when considering low base rate characteristics like atypical handedness. At the present time, we are one and a half years into collecting initial data; we plan to collect initial data for an additional two and a half years. As our sample size increases, we will be able to not only see if the current findings replicate, but also address questions such as whether deviancy increases as the number of risk factors increases. We are also gathering baseline data on processes such as eye-tracking, working memory, executive functioning, and personality. Further, since the project from which the current study comes is a prospective study we will be able to follow these individuals through their highest risk period (approximately 18–30 years old) for developing further symptoms of SRP or schizotypy.

Taken together, results of the present study contribute to our understanding of the nature of SRP and related liability markers. Additionally, it serves to provide information about the utility of psychometrics to identify schizotypy, and how such assessment may be related to other indicators. Finally, the present study further supports a multi-factorial/threshold model of SRP, where an additive effect of risk factors is presumed, and deviance increases as risk factors increase.


