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Timing of puberty and syndromes of schizotypy: a replication ☆

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Abstract

The view of schizophrenia as a neurodevelopmental disorder involving an abnormality in the programmed elimination of excitatory synapses during puberty has been supported by recent neuroimaging studies suggesting disordered functional connectivity in schizophrenia. We investigated a model predicting dysfunctionally high or low synaptic density in extreme early or late maturers at puberty, respectively (Saugstad, L.F., 1989. Clin. Genet. 36, 156–167; Saugstad, L.F., 1994. Int. J. Psychophysiol. 18, 189–203). In an earlier study (Gruzelier, J.H., Kaiser, J., 1996. Schizophr. Res. 21, 183–194), we found increased psychosis proneness scores in both extremes of the pubertal timing spectrum in the normal population. Here we present a replication study where $N = 100$ healthy adults completed a retrospective pubertal timing scale and the 'Personality Syndrome Questionnaire' measuring schizotypy syndromes. The following relationships were replicated: (1) elevated scores on scales of the total Unreality syndrome and the Ideas of Reference subscale in both maturation extremes; and (2) a trend for a positive correlation between the Withdrawal scale and the composite maturation score in males. Cognitive Unreality and Suspiciousness were higher in early than late maturing females. Social Anxiety was elevated in female extreme maturers compared with average maturers, but the opposite was found for males, where average maturers had higher scores than early or late maturers. Active syndrome findings were confined to the male subsample with late maturing males showing higher scores on the Cognitive Failures and Odd Speech subscales than early maturers. As in the previous study, there was

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no relationship between a global psychosis proneness scale and maturational rate. These findings support a neurodevelopmental model of psychosis-proneness and show the importance of adopting a syndromal view.

Keywords: Schizotypy; Syndromes; Pubertal timing; Sex differences; Replication

1. Introduction

Schizophrenia has its typical onset in late adolescence and early adulthood. This fact gave rise to various neurodevelopmental theories. Some have implicated interactions between early lesions and late brain maturational processes (Weinberger, 1987; Murray, 1991; Wolf and Weinberger, 1996). However, with recent neuroimaging findings suggesting disordered functional connectivity in schizophrenia (Weinberger et al., 1992; Grasby et al., 1994; Friston and Frith, 1995; Fletcher et al., 1996; McGuire and Frith, 1996), theoretical approaches focusing on abnormalities in late brain maturation have regained importance (e.g. Randall, 1980; Feinberg, 1982/83). These are based on the fact that the selective elimination of approximately 40% of cortical synapses constitutes the last major event of cerebral development which coincides with puberty (Huttenlocher, 1979). The idea that excessive synaptic pruning accounts for the onset of psychotic symptoms (Hoffman and McGlashan, 1994; Keshavan et al., 1994) has been supported by neuroanatomic evidence for reduced numbers of excitatory synapses in schizophrenia (Garey et al., 1994). Magnetic resonance spectroscopy and imaging findings of altered membrane phospholipid metabolism (Pettegrew et al., 1993) and grey matter volume reductions in schizophrenia (Zipursky et al., 1992) have also been interpreted as consistent with synaptic overpruning at adolescence.

On the basis of epidemiological and psychopharmacological observations, Saugstad (1989, 1994) has related differences in maturational rate at puberty to extremes in synaptic density. She hypothesised that in extreme early maturers, there would be a premature arrest to pruning resulting in high synaptic density and an increased risk for affective psychosis. In extreme late maturers, the extended pruning process would lead to low synaptic density and under-connectivity which was considered to be a risk factor for schizophrenia.

We attempted to test Saugstad's (1989, 1994) model by measuring psychosis proneness in extreme early and late maturers selected from a sample of healthy adults. The rationale for this approach is that trait-like risk factors underlying schizophrenia can be identified in the normal population (Claridge, 1985, 1987; Chapman et al., 1994). Our approach to psychosis-proneness relates to a three-syndrome model of schizophrenia evolved on the basis of neuro-psychophysiological and factor-analytic studies (Gruzelier, 1991, 1994, 1996, 1999). The Active syndrome was characterised by over-activity, accelerated cognition, non-Schneiderian and affective delusions, and positive or labile affect. In contrast, the Withdrawn syndrome involved poverty of speech, blunted affect, social and emotional withdrawal and motor retardation. Finally the Unreality syndrome comprises Schneiderian symptoms. We have found strong affinities between this three-syndrome model of schizophrenia and three-factor solutions of schizotypy scales in normals (Gruzelier et al., 1995; Gruzelier, 1996; Gruzelier and Doig, 1996).

In general there has been little research on personality characteristics of adults who were extreme early and late maturers at puberty. Jones and colleagues (Jones and Bayley, 1950; Mussen and Jones, 1957; Jones and Mussen, 1958; Jones, 1965) have reported data on 150 participants of the California growth study (Jones, 1938) obtained with observer ratings and the Thematic Apperception Test (TAT). At puberty, early maturing boys were found to be more accepted among peers and treated as more mature by adults and other children. In contrast, the late maturing boys exhibited various forms of imma-

ture behaviour, e.g. by showing greater activity and strive for attention and in some cases by withdrawal (Jones and Bayley, 1950). On the TAT, these boys had more negative self-conceptions, feelings of inadequacy, feelings of being rejected and dominated, dependency needs and a rebellious attitude toward parents (Mussen and Jones, 1957). Interestingly, similar patterns were observed in the same subjects 20 years later. The adult early maturer was found to be poised, responsible, achieving and conventional in cognitive patterns and attitudes. Late maturers, however, were active and exploring, insightful, independent and impulsive with a certain fearfulness and vulnerability to threat (Jones, 1965).

For girls, observational ratings by teachers and parents and reputational ratings by classmates suggested a temporary disadvantage for early maturers due to the developmental distance from later maturing girls and all boys (Faust, 1960). However, in a study using the TAT (Jones and Mussen, 1958) a trend similar to males was found, with late maturing girls being characterised by less adequate self-concepts, poorer parent–child relationships and stronger dependency needs. Unfortunately, to our knowledge there was no follow-up study into adulthood.

In general, these studies should be interpreted with caution because of the social changes over the last 50 years and the subjective nature of most measures employed. Furthermore, a systematic comparison with average maturers has not been presented. The authors had originally assumed that the discrepancies in physical development disadvantage particularly early females and late males because these groups are at the extremes of the overall maturational spectrum across the two sexes. Whereas late maturing boys showed psychological maladjustment that even continued into adulthood, this was not confirmed for females, where early maturers were only temporarily disadvantaged. The fact that late maturers of both sexes showed psychological deficits, and that these deficits pervade into adulthood, would be in keeping with a model which predicts abnormalities due to differences in brain development rather than psychological factors.

In a previous study we assessed the relationship between timing of puberty and schizotypy syndromes in healthy adults (Gruzelier and Kaiser, 1996). One hundred and sixty-one young adults completed a retrospective puberty questionnaire, Raine's Schizotypal Personality Questionnaire (SPQ; Raine, 1991) and Claridge's scales of schizotypy (STA; Claridge and Broks, 1984) and borderline personality (STB). On the basis of previous research, subscales of the SPQ questionnaires were assigned to the three syndromes Active, Withdrawn and Unreality. Whereas there were no group differences on total schizotypy scores, we found increased Unreality scores in both maturation extremes when compared with average maturers. This was in keeping with Saugstad's model, given the communality of hallucinations and delusions, in a general sense, to both major psychoses. Withdrawn scores were elevated in late maturing males but in early maturing females. The association with late maturing males corresponded to Saugstad's notion that slow maturation is linked to severe, negative-symptom forms of schizophrenia. In early maturing females, affective aspects of the Withdrawal syndrome could hint at an association with depressive withdrawal. Finally, we observed increased Active scores in late maturing females which would be consistent with Saugstad's model given that schizophrenia in females has a more florid, positive-symptomatic character.

The present study aimed at replicating and clarifying these findings. For the first time we used a new instrument to measure psychosis proneness, the Personality Syndrome Questionnaire (PSQ) of which a revised version is now available from the authors (Gruzelier et al., in press).

2. Methods

2.1. Subjects and procedure

Subjects were medical students ($N = 100$; 53 females and 47 males) aged 19–31 years (mean age 20.33 years, S.D. = 1.59). The questionnaires

were completed in one group session. Two females and three males had incomplete data sets, thus analyses were performed on a total of $N = 95$ subjects.

2.2. Questionnaires

Timing of puberty was assessed with the Adolescence Scale (AS-ICSM, Kaiser and Gruzelier, 1999a) which was developed on the basis of Sanders and Soares's work (Sanders and Soares, 1986) and supplemented by an item on height velocity (Tanner, 1986) and one on voice break in males. This latter item had not been included in the adolescence scale used in our previous study. Retrospective puberty scales have been shown to be reliable and valid by Gilger et al. (1991). The questions were as follows:

1. Compared with others of the same sex, did you reach sexual maturity — 'much earlier', 'earlier', 'same time', 'later', 'much later'? (a five-point scale ranging from −2 to +2).
2. How old were you when you increased most in height?
3. For females:
   - How old were you when you began to menstruate?
4. For males:
   - How old were you when your voice started to break?
   - How old were you when you began to shave regularly?
   - How old were you when you had your first nocturnal emission?

Psychosis proneness was measured with the first version of the Personality Syndrome Questionnaire (PSQ) of which a revised version has now been completed (Gruzelier et al., in press). This questionnaire comprises 84 items with a 'true–false' response mode. The 12 subscales were assigned to the three syndromes Unreality, Withdrawn and Active on the basis of a factor analysis. There were four Unreality subscales: Cognitive Unreality (8 items), Perceptual Unreality (9 items), Suspiciousness (8 items) and Ideas of Reference (8 items). The Withdrawn syndrome was formed by three subscales: Social Anxiety (7 items), Contained Affect (6 items) and Withdrawal (9 items). The Active syndrome comprised five subscales: Active speech (7 items), Odd Speech (8 items), Cognitive Failures (4 items), Odd Behaviour (4 items) and Activity (6 items). The sum of each syndrome provided what is referred to as the syndrome composite score, and the sum across all subscales provided the schizotypy total score.

2.3. Statistical analysis

A maturation composite score was obtained for

Table 1
Maturation self-rating and puberty milestones (means and standard deviations) in early, average and late maturers

	Early maturers		Average maturers		Late maturers	
	Mean	S.D.	Mean	S.D.	Mean	S.D.
Females						
Self-rating	−1.17	0.58	−0.32	0.55	0.92	0.51
Growth spurt	10.63	1.11	11.50	1.45	13.50	1.46
Menarche	10.91	0.94	12.54	0.73	13.80	0.92
Males						
Self-rating	−1.08	0.67	−0.22	0.42	0.83	0.39
Growth spurt	12.6	1.69	14.5	1.24	15.3	1.12
Noct. emission	12.58	0.72	13.95	1.34	15.50	1.18
Voice break	12.47	1.42	13.89	0.82	15.73	1.21
Shaving	13.97	2.02	15.81	1.39	17.54	1.27

each sex by averaging across each z-transformed item of the AQ-CXWMS. The statistical analysis comprised two steps. In a first step, normality of distribution of all variables was assessed and then Pearson correlation coefficients were calculated between the maturation composite score and each PSQ subscale and syndrome composite score. This was done for the full sample as well as for females and males separately. In a second step this composite score was then used to identify the 12 extreme early and extreme late maturing females and males, corresponding approximately to the top and bottom quarter of the distribution. The remaining subjects (29 females and 23 males) were assigned to the 'average' group. Means and standard deviations of the maturation variables in the three groups are shown in Table 1. Two-way analyses of variance (ANOVA) were then employed to test the effects of maturation group (early vs. average vs. late) and sex (female vs. male) on the PSQ subscales and syndrome composite scores. This was done to be able to assess non-linear relationships which had been found in the previous study for the Unreality syndrome (Gruzelier and Kaiser, 1996). Sex was included as an independent variable because it had been found to have a moderating effect on the relationship between pubertal timing and psychosis proneness.

3. Results

3.1. Global schizotypy

Correlation coefficients between schizotypy total score and composite maturation score can be found in Table 2 and means (M) and standard deviations (S.D.) are shown in Table 3. There were no main effects or interaction of maturation group and sex. This mirrored our earlier findings, where there was no relationship between maturational rate at puberty and the SPQ global scale.

3.2. Unreality syndrome

Correlation coefficients between Unreality syndrome scores and subscales and the composite maturation score can be found in Table 2 and means and standard deviations for early, average and late maturing males and females are shown in Table 3.

Table 2
Correlation coefficients between maturation composite score and PSQ scales

	Both sexes	Females	Males
Schizotypy total	0.042	−0.054	0.178
Unreality syndrome	−0.081	−0.182	−0.040
Cognitive unreality	−0.225*	−0.172	−0.192
Perceptual unreality	−0.054	−0.081	−0.043
Suspiciousness	−0.055	−0.285*	0.171
Ideas of reference	0.080	−0.011	0.146
Withdrawn syndrome	0.134	0.042	0.212
Withdrawal	0.186†	0.012	0.277†
Social anxiety	0.042	0.074	0.024
Contained affect	0.075	0.009	0.172
Active syndrome	0.081	0.047	0.201
Active speech	−0.053	−0.015	0.029
Odd speech	0.120	0.024	0.316*
Cognitive failures	0.096	−0.019	0.355*
Odd behaviour	0.132	0.216	−0.006
Activity	0.040	0.004	0.094

†$P < 0.10$.
*$P < 0.05$.

There was no significant correlation between the Unreality syndrome score and the composite maturation score. In line with previous findings, on the total Unreality syndrome scale there was a main effect of maturation group ($F_{2,89} = 3.67$, $P = 0.029$) whereas there was no effect of sex and no interaction group × sex. Post-hoc tests showed that early maturers had significantly higher scores than average maturers ($t_{70} = 2.63$, $P = 0.011$) but did not differ from late maturers. The difference between average and late maturers did not reach significance. Both extremes combined had significantly higher scores than the average group [M = 12.3 (S.D. = 6.4) vs. M = 9.1 (S.D. = 6.1), $t_{93} = 2.45$, $P = 0.016$].

A similar main effect for maturation group was found on the Ideas of Reference scale ($F_{2,89} = 3.65$, $P = 0.030$) whereas there was no effect of sex or an interaction of the two variables. Again this was expected on the basis of our previous

Table 3
Means and standard deviations (in parentheses) for the PSQ global score and the Unreality, Withdrawn and Active syndrome composite scores and subscales in early, average and late maturing males and females

	Early maturers		Average maturers		Late maturers	
	Males	Females	Males	Females	Males	Females
PSQ global score	28.55 (14.99)	35.18 (12.63)	28.73 (13.10)	27.50 (12.60)	34.45 (13.40)	33.08 (10.26)
Unreality syndrome						
Composite score	11.91 (7.27)	15.00 (6.87)	9.36 (6.59)	8.96 (5.84)	12.09 (6.14)	10.33 (5.19)
Cognitive unreality	3.36 (2.58)	4.45 (1.86)	2.00 (1.77)	2.86 (2.07)	2.09 (1.58)	2.83 (2.04)
Perceptual unreality	3.27 (2.15)	2.91 (2.74)	2.27 (2.21)	2.46 (2.30)	2.82 (2.04)	2.25 (1.71)
Suspiciousness	2.27 (2.00)	4.27 (2.00)	2.82 (2.06)	1.57 (1.50)	3.09 (2.51)	2.25 (2.01)
Ideas of reference	3.00 (2.79)	3.36 (2.01)	2.27 (2.00)	2.07 (1.78)	4.09 (2.81)	3.00 (2.34)
Withdrawn syndrome						
Composite score	4.55 (2.16)	6.36 (3.29)	7.64 (4.68)	5.61 (4.50)	7.55 (4.68)	7.17 (2.92)
Withdrawal	1.45 (1.57)	1.55 (1.29)	2.41 (2.48)	1.57 (1.93)	3.36 (2.66)	1.75 (1.42)
Social anxiety	2.27 (1.49)	3.73 (1.35)	3.82 (1.94)	2.75 (1.97)	2.73 (1.42)	4.08 (1.38)
Contained affect	0.82 (0.75)	1.09 (1.22)	1.41 (1.37)	1.29 (1.41)	1.45 (1.29)	1.33 (0.89)
Active syndrome						
Composite score	12.09 (7.74)	13.82 (6.29)	11.73 (5.60)	12.93 (6.79)	14.82 (5.67)	15.58 (6.42)
Active speech	3.00 (2.32)	4.00 (1.67)	2.59 (1.74)	3.36 (2.36)	3.36 (2.29)	4.50 (2.15)
Odd speech	2.00 (2.37)	3.55 (2.21)	3.68 (2.01)	3.36 (2.13)	3.55 (1.86)	4.00 (2.30)
Cognitive failures	1.55 (1.21)	2.18 (1.54)	1.50 (0.91)	1.75 (1.24)	2.45 (0.82)	2.00 (1.21)
Odd behaviour	2.18 (1.78)	1.00 (1.41)	1.09 (1.41)	1.39 (1.50)	2.00 (1.34)	1.75 (1.36)
Activity	3.36 (1.69)	3.09 (1.58)	2.86 (1.58)	3.07 (1.65)	3.45 (1.57)	3.33 (1.44)

study. Post-hoc tests confirmed that late maturers had significantly higher Ideas of Reference scores than average maturers ($t_{71} = 2.56$, $P = 0.013$) and early maturers showed a trend for higher scores than average maturers ($t_{70} = 1.96$, $P = 0.054$), whereas early and late maturers did not differ. When both maturation extremes were combined, they had significantly higher scores than average maturers [M = 3.36 (S.D. = 2.5) vs. M = 2.2 (S.D. = 1.9), $t_{93} = 2.68$, $P = 0.009$].

For Cognitive Unreality a negative correlation was found with the maturation composite score ($r = -0.225$, $P = 0.028$), indicating higher Cognitive Unreality scores with earlier maturation. A linear relationship was not expected on the basis of the previous study where a U-shaped relation was found. ANOVAs gave significant main effects for maturation group ($F_{2,89} = 4.59$, $P = 0.007$) and sex ($F_{1,89} = 4.17$, $P = 0.044$) but no interaction. Post-hoc tests showed that early maturers were significantly higher on Cognitive Unreality than average maturers ($t_{70} = 2.71$, $P = 0.009$) and late maturers ($t_{43} = 2.33$, $P = 0.024$). Average and late maturers did not differ on Cognitive Unreality. When males and females were compared in a post-hoc test, there was a trend for females to have higher scores on Cognitive Unreality (mean = 3.20, S.D. = 2.1) than males (mean = 2.38, S.D. = 2.0; $t_{94} = 0.053$).

For Suspiciousness there was a trend for a maturation group main effect ($F_{2,89} = 2.38$, $P = 0.099$) and a highly significant interaction group × sex ($F_{2,89} = 5.49$, $P = 0.006$) but no main effect for sex. Post-hoc tests showed that this was accounted for by female early maturers having significantly higher scores than average maturers ($t_{37} = 4.59$, $P < 0.001$) and late maturers ($t_{21} = 2.42$, $P = 0.025$), whereas average and late maturers did not differ. In females there was also a negative correlation between the maturation composite score and Suspiciousness ($r = -0.285$, $P = 0.043$). There was no relationship between Suspiciousness and pubertal timing in the male subgroup. In contrast to our earlier study, no

main effects or interactions of maturation group and sex were found for the Perceptual Unreality subscale.

3.3. Withdrawn syndrome

Correlation coefficients between Withdrawn syndrome score and subscales and the composite maturation score can be found in Table 2 and means and standard deviations are shown in Table 3. We found trends for positive correlations between the Withdrawal subscale and the maturation composite score in the full sample ($r = 0.186$, $P = 0.071$) and in males ($r = 0.277$, $P = 0.069$). For males, this meant a replication of our previous findings of increased Withdrawn scores in late maturing males. There was no correlation for females. The ANOVA, however, only gave a trend for a sex main effect ($F_{1,89} = 3.11$, $P = 0.087$). No main effect for maturation group or group × sex interaction was found.

For the Social Anxiety subscale there was a highly significant maturation group × sex interaction ($F_{2,89} = 6.02$, $P = 0.004$), but no main effects for either maturation group or sex. Post-hoc tests showed that in females both maturation extremes combined (M = 3.9, S.D. = 1.3) had higher scores than average maturers (M = 2.8, S.D. = 2.0; $t_{49} = 2.40$, $P = 0.020$). Comparing early, average and late maturing groups, this was largely found to be accounted for by late maturing females who had significantly higher scores than average maturers ($t_{38} = 2.12$, $P = 0.041$) but not early maturers. The difference between female early and average maturers failed to reach significance. The opposite picture was true for males. In contrast to our expectations, we found male average maturers to have higher Social Anxiety scores (M = 3.82, S.D. = 1.94) than both extremes combined (M = 2.50, S.D. = 1.44; $t_{42} = 2.56$, $P = 0.014$). Male average maturers had higher scores than early maturers ($t_{31} = 2.31$, $P = 0.028$) but not late maturers ($t_{31} = 1.65$, $P = 0.109$). There was no difference between male early and late maturers on Social Anxiety. No main effects or interactions of maturation group and sex were found for the total Withdrawn syndrome score, and neither was there a relationship between the Contained Affect subscale and maturational rate at puberty.

3.4. Active syndrome

Correlation coefficients between Active syndrome score and subscales and the composite maturation score can be found in Table 2 and means and standard deviations are shown in Table 3. In contrast to the previous study where we found relationships between pubertal timing and Active syndrome scales only in late maturing females, here these relationships were confined largely to the male subgroup.

In the male subgroup only, we found a positive correlation between maturation composite score and Cognitive Failures subscale ($r = 0.36$, $P = 0.018$), indicating increased scores in late maturers. However, the ANOVA failed to give a main effect for maturation group or sex or an interaction between the two variables. Similarly, in males Odd Speech correlated positively with the composite maturation score ($r = 0.316$, $P = 0.037$) but no ANOVA effects were found. For Active Speech there was a significant sex main effect ($F_{1,89} = 4.30$, $P = 0.041$) but no effect for maturation group and no group × sex interaction. A post-hoc test showed that females had higher scores on Active Speech (M = 3.76, S.D. = 2.2) than males (M = 2.89, S.D. = 2.0; $t_{94} = 2.04$, $P = 0.045$). No relationships between maturational rate at puberty and the total Active syndrome score, Odd Behaviour or Activity were found.

4. Discussion

The present study differed from the previous one in some methodological aspects. The adolescence scale included one additional question for males, age at voice break. As puberty in males is not so clearly linked to one specific event as in females, the inclusion of one further item should increase the power of the scale. In fact the voice break item gave a higher item-total correlation than start of regular shaving or growth spurt. As for psychosis proneness, a new scale was applied,

the PSQ, which at the time had not been tested for reliability and validity. In fact a new revised version tested for reliability has now been developed on the basis of an evaluation of the original questionnaire (Gruzelier et al., in press). However, as most items closely resemble the ones in established scales like Raine's (1991) SPQ and Claridge and Broks's (1984) STA and STB, we felt confident about the use of this instrument. Still one must bear in mind that the comparability of the particular subscales between the present and our previous study were reduced. This discussion will therefore focus on syndrome scales rather than individual subscales.

Other differences between the two studies were as follows. The present sample was smaller and the margins for the extreme groups were wider (24 out of 95 instead of 20 out of 161) thus making the analyses more conservative and robust. However, as a consequence early and late maturers were only approximately 3 years apart, as opposed to four in the previous study. Particularly late maturing females in the second study had younger ages at growth spurt and menarche than in the first study.

Similar to the earlier study, there was no relationship between the global schizotypy scale and pubertal timing. This was an expected result, as our previous research has shown the relationship between maturational rate at puberty and schizotypy to be syndrome-specific with each extreme showing differential syndrome relations.

Our previous finding for the Unreality syndrome, i.e. increased scores in both maturation extremes taken together compared with average maturers, was replicated for the total Unreality syndrome score and for the ideas of reference subscale. Sex did not modulate this effect. However, whereas our earlier findings involved predominantly the perceptual unreality scale, the maturation groups in the present study did not differ on that scale. We found early maturers to have higher scores on the cognitive unreality and suspiciousness subscales of the Unreality syndrome than average or late maturers. The finding for cognitive unreality was present as a trend in females and a similar tendency could be seen in males. The finding for suspiciousness was highly significant in the female subsample only, whereas there were no differences for males. Stronger relationships between Unreality and pubertal timing in females had also been found in the earlier study (see also Gruzelier and Doig, 1996). Increased suspiciousness and cognitive unreality scores in early, but not late maturing females could be due to the fact that in this sample, female late maturers were on average less extreme in maturation than in the previous study.

Unreality in schizophrenia comprises Schneiderian symptoms which underlie psychosis in general, and the Unreality syndrome in normals has been related to magnocellular dysfunction (Gruzelier and Richardson, 1994). Psychological theories provide no basis on which elevated Unreality scores in maturation extremes could be expected. Saugstad's (1989, 1994) model, however, links both extremes to the major psychoses. The replicated finding of increased Unreality in both maturation extremes can therefore be interpreted as support to her theory.

Considering the Withdrawn syndrome, our previous finding of increased Withdrawn syndrome scores in late maturing males was replicated as a trend for a positive correlation between composite maturation score and the withdrawal subscale. Withdrawal involves social withdrawal and social anhedonia. Psychological approaches do not allow clear predictions, as late maturers have been found to try to compensate for their physical retardation mainly by attention-seeking, active behaviours, but sometimes also with withdrawal (Jones and Bayley, 1950). Males have a greater risk for negative-symptom forms of schizophrenia and poorer pre-morbid adjustment, e.g. with regard to social competence and antisocial behaviour (Lewine, 1981; Zeitlin, 1986; Murray, 1991). As Saugstad (1989, 1994) has associated late maturation with chronic, poor outcome and treatment-resistant forms of schizophrenia, the replicated finding of increased withdrawal with late maturation in males is fully consistent with her model.

The previous finding of increased Withdrawn syndrome schizotypy in early maturing females was not replicated. Instead we found female late maturers to have higher social anxiety scores than

average maturers. This would again support a relationship between late maturation and Withdrawn syndrome schizotypy. On the same subscale we unexpectedly found male average maturers to show significantly higher social anxiety scores than both maturation extremes. This can neither be explained by psychological nor neurophysiological approaches.

Whereas in the previous study the Active syndrome was related to late maturation in females only, here relationships between pubertal timing and Active syndrome scales were found only in males. The positive correlations between composite maturation score and the Cognitive Failures and Odd Speech subscales could be seen as consistent with the early social psychological studies relating unstable, active and attention-seeking behaviours to late maturation in males (Jones and Bayley, 1950; Jones, 1965). On the other hand, both the previous and the present studies have suggested a link between Active Syndrome schizotypy and late maturation, even though this was specific to either females or males depending on the study. The failure to find increased Active syndrome scores in late maturing females in the present study might again have been due to the fact that they were less 'late' than their counterparts in the first study. In short, despite the fact that there was no clear original hypothesis for the Active syndrome, its relationship to late maturation is in keeping with the hypothesised link between late maturation and an increased risk for schizophrenia.

In summary, the most consistent findings across our two studies were increased Unreality syndrome schizotypy scores in both maturation extremes and increased scores on subscales of the Withdrawn syndrome in late maturing males. The Unreality result cannot be explained by psychological approaches which did not measure perceptual or cognitive abnormalities but focused on socio-behavioural aspects of personality. Moreover, such theories would not predict maladjustment in male early maturers. In contrast, our Unreality syndrome data support Saugstad's (1989, 1994) model which predicts a link between both maturation extremes and an increased risk for psychosis in general. The second replicated finding, increased scores on one of the Withdrawn syndrome subscales in males is also consistent with Saugstad's hypothesis which links late maturation, particularly in males, with the more severe, chronic forms of schizophrenia. Such forms of the disorder typically have a symptomatology resembling the Withdrawn syndrome.

It is noteworthy that there was a differential involvement of both sexes in these relationships. Early maturing females had elevated scores on some of the Unreality syndrome subscales and late maturing males were involved in both withdrawn and active subscales. Bearing in mind that on average males mature approximately 1.5 years later than females, one would find those two groups, i.e. early maturing females and late maturing males, at opposite ends of the pubertal timing spectrum. Thus they should also be at opposite ends of the synaptic density distribution, with the highest synapse numbers in early females and the lowest in late maturing males. Increased schizotypy scores particularly in those two groups are in line with Saugstad's (1989, 1994) reasoning, as she explains the higher incidence of manic-depressive disorder in females with their earlier maturation and higher synaptic density and the higher risk for severe forms of schizophrenia in males with their later maturation and lower synaptic density.

In conclusion, we succeeded in replicating relationships between the Unreality syndrome and both extremes of maturation at puberty and the Withdrawn syndrome and late maturation in males. This study showed the importance of taking a syndromal approach to schizotypy, as a global view would have prevented the present relationships from being disclosed. Our findings, taken together with EEG coherence differences between extreme early and late maturers (Kaiser and Gruzelier, 1996, 1999b), support a theory that describes extremes in the normal variation of age at puberty as a factor contributing to the pathogenesis of the major psychoses.

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