

Schizotypy, creativity and mating success in humans

Daniel Nettle^{1,*} and Helen Clegg²

¹Psychology, Brain and Behaviour, University of Newcastle, Henry Wellcome Building,
Framlington Place, Newcastle NE2 4HH, UK

²Department of Psychology, The Open University, Walton Hall, Milton Keynes MK7 6AA, UK

There is an evolutionary puzzle surrounding the persistence of schizophrenia, since it is substantially heritable and associated with sharply reduced fitness. However, some of the personality traits which are predictive of schizophrenia are also associated with artistic creativity. Geoffrey Miller has proposed that artistic creativity functions to attract mates. Here, we investigate the relationship between schizotypal personality traits, creative activity, and mating success in a large sample of British poets, visual artists, and other adults. We show that two components of schizotypy are positively correlated with mating success. For one component, this relationship is mediated by creative activity. Results are discussed in terms of the evolution of human creativity and the genesis of schizophrenia.

Keywords: schizotypy; schizophrenia; creativity; mate choice

1. INTRODUCTION

Schizophrenia is a chronic and highly impairing condition that affects around 1% of the human population (Jablensky 1995). Incidence appears to be broadly stable over time and across cultures (Gottesman 1991; Jablensky *et al.* 1992). It is substantially heritable (Gottesman 1991; Cardno *et al.* 1999), though what is inherited is best described as a diathesis or vulnerability that may or may not lead to actual illness, and whose progression is affected by environmental factors (Tsuang *et al.* 2001). Many studies have shown that schizophrenia is associated with impaired physical health (Brown *et al.* 2000), and drastically reduced probability of reproduction (Bassett *et al.* 1996; Avila *et al.* 2001). This naturally raises an evolutionary puzzle. Reduced fitness in sufferers would be expected to lead to the disappearance of the heritable traits predisposing individuals to the condition. The fact that this does not appear to happen has led many commentators to speculate that there must be other, beneficial effects of the traits, most probably manifest in healthy relatives (Huxley *et al.* 1964; Jarvik & Deckard 1977; Nettle 2001; Shaner *et al.* 2004).

Schizophrenia-proneness is manifest in a suite of personality traits, measured by questionnaire and collectively known as schizotypy (Mason *et al.* 1995; Claridge 1997). Schizotypy consists of four separable dimensions (Claridge *et al.* 1996). Schizophrenia patients score more highly than controls on all four dimensions, and patients with bipolar affective disorder, which has substantial phenotypic overlaps with schizophrenia (Kendell & Gourlay 1970; Kendell & Brockington 1980; Crow 1990), score more highly than controls on three of them (Nettle *in press*). Moreover, sufferers from more minor psychiatric illnesses score intermediately between schizophrenia patients and controls (Van Os *et al.* 1999; Verdoux *et al.* 1999). Schizotypy scores are also predictive of the

onset of schizophrenia in longitudinal studies (Chapman *et al.* 1994).

Many studies have also found that individuals active in the creative arts have elevated levels of some schizotypal traits (Schuldberg 1988; Schuldberg 2000; for reviews see Brod 1997; Nettle 2001). This explains the frequency of serious psychiatric illness in the families of successful artists (Karlson 1970), and the prevalence of a variety of more minor psychiatric disorders in creative groups (Andreasen 1987; Richards *et al.* 1988; Ludwig 1995). The association with artistic creativity is a candidate for the evolutionarily beneficial effect of schizotypy (O'Reilly *et al.* 2001).

But why would artistic creativity contribute to reproductive success? Geoffrey Miller (Miller 2000, 2001) has argued that human artistic production has its origins in costly displays of quality whose function, like that of the peacock's tail or bower bird's bower, is to attract mates. Though there are a number of patterns of behaviour consistent with this hypothesis (Miller 1999; Kanazawa 2000; Kanazawa 2003; Miller & Haselton *in press*), direct tests are rare. A direct prediction would seem to be that successful engagement in artistic production should be correlated with achieved number and/or quality of sexual partners.

Recent studies have found correlations, in contemporary human populations, between numbers of sexual partners attained and stature (Mueller & Mazur 2001; Nettle 2002), physical symmetry (Thornhill & Gangestad 1994; Gangestad *et al.* 2001), and facial attractiveness (Rhodes *et al.* 2005). Thus, mate choice effects are clearly still operative in humans, and it is worth examining mating success in relation to artistic creativity even in a modern population.

The current study examines the relationship between schizotypy and mating success in a large sample of British adults. The sample includes a general population group, augmented by targeted sampling of artists and poets.

* Author for correspondence (daniel.nettle@ncl.ac.uk).

Thus, the sample is not representative of the population, but rather specifically designed to produce a full range of schizotypy scores in a non-clinical context. The four schizotypy dimensions (Mason *et al.* 1995) are as follows. Unusual experiences contains items referring to perceptual and cognitive aberrations and magical thinking. Cognitive disorganization describes difficulties of attention and concentration. Impulsive non-conformity refers to violent and reckless behaviours. Finally, introvertive anhedonia measures lack of enjoyment and social withdrawal. Unusual experiences and impulsive non-conformity are elevated in poets and artists, while there is no effect for cognitive disorganization (Nettle *in press*). Introvertive anhedonia is positively associated with schizophrenia, but negatively associated with artistic creativity (Schuldberg 2000; Nettle *in press*), thus providing a clear differentiation between creative and clinical groups.

As well as schizotypy scores, information about mating success, life history, and production of poetry and visual art was also gathered. The predictions were as follows. Increasing those components of schizotypy that are associated with creativity (unusual experiences, impulsive non-conformity) should lead to an increase in number of sexual partners. Such an effect should operate at least partly via the production of artistic products such as poems and paintings. The components of schizotypy that schizophrenia patients but not artistic groups show (i.e. introvertive anhedonia) should be negatively correlated with mating success.

2. MATERIAL AND METHODS

Participants were 425 British adults (156 male, 269 female) with a mean age of 40.5 years (standard deviation 14.5 years). Participants received a small honorarium for participation in the form of a gift token for a major store. The majority were recruited from the general population in three ways. An advertisement was placed in the local online newsletter of a small town in southern England (107 responses), questionnaire packs were pushed through letter boxes in a residential neighbourhood of the same town (82 responses), and participants in a residential psychology course for mature students took a questionnaire pack (50 responses).

Specialist creative groups were recruited by placing an advertisement in a major visual art magazine (60 responses), on the website of a major poetry organization (16 responses), or by writing directly to published poets whose addresses appeared in *Who's Who in Poetry* (2003; 20 responses). Approximately 100 further participants heard about the study by word of mouth as a consequence of one or the other method of recruitment.

Participants filled in a questionnaire pack and returned it anonymously by mail. The questionnaire contained the O-LIFE schizotypy inventory (Mason *et al.* 1995) and a section on psychiatric history. It also contained a section on creative interests, in which the participant indicated their degree of creative activity in poetry or visual art. Participants rated themselves as not producing poetry or art (241 participants), being a hobby producer (57), a serious producer (60) or a professional producer (67) in either domain. Creative activity is treated as a categorical variable, except for the path analysis (see below), where it is treated as continuous.

The hypothesis predicts a correlation between mating success and quality of creative output. Obviously, information on quality of the participants' work was not directly available. However, it is assumed that increasingly serious engagement with the activity is generally correlated with increasing quality and visibility of work. Thus, there should be a correlation between degree of creative activity and mating success.

A final section of the questionnaire contained wide-ranging personal history questions. This provided information on education, income and social class for background comparison. Of these variables, social class, categorized using the reduced classification of the NS-SEC (1, managerial and professional; 2, intermediate occupations; 3, routine and manual occupations; 4, never worked and long-term unemployed; Pevalin 2003) was retained as the most useful single socio-economic variable for analysis. The questionnaire also provided information on mating success, in the form of the following questions: 'Since you were 18, how much of the time have you been in a steady relationship?' and 'Since you were 18, how many different partners have you had (please include all your relationships, however, short)?' Mating success could mean either number or quality of mates, and the latter cannot be directly measured here. Moreover, a large number of partners could reflect failure to retain any for very long. However, it is assumed that on average, increasing numbers of partners is a reasonable proxy for success in obtaining the partners desired, especially if not accompanied by a reduction in time spent in a steady relationship. Moreover, number of sexual partners is often used as a measure of mating success in studies of this kind (Gangestad *et al.* 2001; Faurie *et al.* 2004). Number of children was also recorded.

As absolute partner numbers will have a highly skewed distribution, a scale was used, as follows: (i) none, (ii) one, (iii) two, (iv) three, (v) four, (vi) five to ten, (vii) ten to twenty and (viii) more than twenty. This produced a non-skewed distribution suitable for parametric statistics. For time in relationship, the following scale was used: (i) have not had a steady relationship, (ii) less than half of the time, (iii) about half the time, (iv) most of the time and (v) all of the time. The scores on these scales are treated as continuous variables for the purposes of analysis.

3. RESULTS

Mean scores on the schizotypy measures in these samples were similar to previously published norms, albeit with slightly increased variance, and reliability measures were acceptably high (see Nettle *in press* for details).

A multiple regression analysis was performed with the four schizotypy scores plus age, sex and social class as independent variables, and the number of partners scale as the dependent. The β coefficients for the four schizotypy scores are shown in table 1. There are significant positive relationships between unusual experiences and number of partners, and impulsive non-conformity and number of partners, and a significant negative relationship between introvertive anhedonia and number of partners. It is possible that these relationships arise because the specialist artist and poet groups who were recruited, and who are high in unusual experiences and impulsive non-conformity, have different lifestyles than the general population. The analysis was, therefore, repeated with only those 239 individuals who were recruited by general population sampling. The relationships between number of partners

Table 1. Standardized regression coefficients (β) for number of sexual partners on the four schizotypy dimensions, with age, sex and social class as additional independent variables. (Analysis repeated for the whole sample, the generally recruited sample, and the specialist art and poetry groups; * $p < 0.05$.)

dimension	whole sample ($N=425$)	general population only ($N=239$)	specialist population only ($N=186$)
unusual experiences	0.12*	0.12	0.08
cognitive disorganization	0.07	0.01	0.01
impulsive non-conformity	0.21*	0.22*	0.17
introvertive anhedonia	-0.20*	-0.24*	-0.16

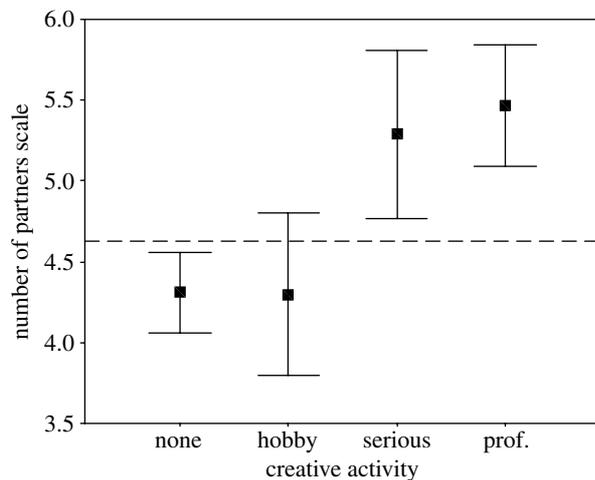


Figure 1. Mean scores (with 95% confidence interval for the mean) on the number of partners scale, by level of creative activity. The dashed horizontal line represents the overall mean.

and schizotypy dimensions are also found within the general population, with the coefficients little changed (table 1). Within the 186 participants recruited through specialist artistic groups, the coefficients are lower and non-significant. This is, however, to be expected, as these groups display a restriction of range in terms of schizotypy.

In a similar multiple regression including age, sex and social class, there were no significant associations between any of the schizotypy dimensions and time spent in steady relationships. For number of children, the only significant association with schizotypy was with cognitive disorganization ($\beta = -0.12$, $p < 0.05$).

The prediction was that if schizotypy increased mating success, it would do so at least partly through enhancing creative behaviour. Figure 1 shows the relationship between number of partners and level of engagement with poetry and visual art. Serious and professional producers have larger numbers of sexual partners than non-producers and hobby producers (controlling for age and sex, $F_{3,411} = 8.19$, $p < 0.001$). There is no significant interaction between sex and creative activity ($F_{3,411} = 2.01$, n.s.), suggesting that the pattern is the same for male and female producers. There was no effect of creative activity on the proportion of time spent in a steady relationship ($F_{3,413} = 0.19$, n.s.), or on number of children ($F_{3,415} = 0.66$, n.s.).

Path analysis was carried out to further investigate the linkages among creative behaviour, mating success, and the different components of schizotypy (figure 2). Cognitive disorganization was not entered into the path analysis as it had no significant relationship with creative activity or mating success. The path analysis shows that

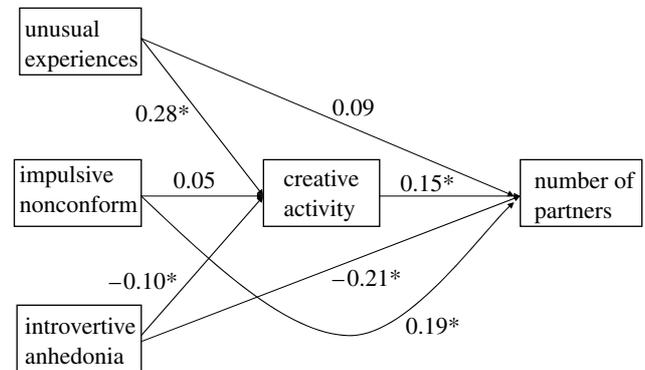


Figure 2. Path diagram of relationships between unusual experiences, impulsive non-conformity, introvertive anhedonia, creative activity in poetry and art, and number of sexual partners. Asterisked coefficients significant at $p < 0.05$.

unusual experiences has a significant positive effect on creative activity (poetry and art), which in turn has a significant positive effect on number of partners. Impulsive non-conformity, by contrast, has a direct positive effect on number of partners that is not mediated by creative activity. Introvertive anhedonia has both an inhibiting effect on creative activity, and also a direct inhibiting effect on number of sexual partners. (Essentially the same results are obtained by treating poetry production and visual art production as two separate variables rather than amalgamating them, data not shown.)

4. DISCUSSION

The results show significant positive relationships between unusual experiences and mating success, and impulsive non-conformity and mating success. In the case of unusual experiences, the relationship is mediated by creative activity; those high in unusual experiences produce poetry or art more seriously, and this in turn increases mating success. In the case of impulsive non-conformity, the relationship is not mediated by creative activity. Increasing this trait leads directly to an increased number of sexual partners. Introvertive anhedonia decreases creative activity, and also has a direct negative effect on mating success.

The significance of these results would appear to be threefold. First, because of the direct link between creative activity and number of partners, the evidence is consistent with Miller's hypothesis that artistic creativity functions as a mating display (Miller 2000, 2001). Second, schizophrenia patients, and those with bipolar affective disorder, are also high in unusual experiences and impulsive non-conformity (Nettle in press). Given the negative effects of psychotic disorders on fitness, it had previously been a mystery how these traits persist.

Thus, these results are consistent with the view that schizotypal traits are maintained in the human population at significant levels because the negative effects in terms of psychosis and other psychopathology are offset by enhanced mating success. For the impulsive non-conformity component, the increased recklessness can directly enhance mating success, whereas for the unusual experiences component, the effect is indirect, via enhanced artistic creativity. A simple model for the evolutionary equilibrium would be an inverted U-shaped one, whereby increasing schizotypy has beneficial effects on reproductive success up to a certain point, beyond which the disorganizing effects becoming predominant, and the effect on mating success negative (Nettle 2001). Schizophrenia patients would thus be more extreme in the distribution than poets or artists.

In fact, recent evidence suggests a different model. Poets and artists score as highly on unusual experiences and impulsive non-conformity as schizophrenia patients do (Nettle *in press*). They are differentiated from patients only by their low scores on introverted anhedonia. It may be that the consequences of traits like unusual experiences and impulsive non-conformity are condition-dependent. Individuals in good condition can channel them into creative output and adaptive behaviours, while those in poor overall condition succumb to their disorganizing effects, and develop psychiatric disorders. There are a number of observations consistent with this hypothesis. Many developmental factors generally detrimental to phenotypic condition are associated with an increased risk of schizophrenia. For example, vulnerability to schizophrenia is increased by winter birth, maternal viral infection, obstetric complications, and maternal caloric restriction (Torrey *et al.* 2000; Buka *et al.* 2001; Kunugi *et al.* 2001). Minor physical abnormalities and fluctuating asymmetry (which would be indicators of developmental perturbation) are also elevated in patients (Yeo *et al.* 1999). Moreover, first degree relatives of psychotic patients are often strikingly creative individuals, and the different outcome could be accounted for by better overall phenotypic condition (Heston 1966; Karlson 1970).

If this model is correct, then components of schizotypy like unusual experiences are functioning as fitness-indicator traits, such that variation in their display correlates well with overall condition (Rowe & Houle 1996). Such a role for schizotypy has recently been proposed (Shaner *et al.* 2004), and appears to be supported by the results of the current study. Introverted anhedonia appears to be the critical condition-related dimension that differentiates between the positive and negative sequelae of schizotypal traits.

We observed no sex differences in the relationships between creative output and reproductive success. Males benefit more than females from additional matings, and as such, Miller predicts sexual dimorphism in creative display (Miller 1999). However, what our results show is that when either sex invests in creative output, it has similar effects on mating success. We have not directly addressed the question of whether males and females in the population at large make such investment to the same degree. Moreover, there are potential benefits to females of attracting additional mates, including higher mate quality and greater mate investment. The question of sex differences requires further investigation.

We hope that future research will include further characteristics that could be related to creativity and mating success, such as intelligence, and general personality factors such as the 'big five', which covary with schizotypy measures to some extent (Rawlings & Freeman 1997). It would also be of interest to understand in greater depth exactly how schizotypy relates to mating behaviour; for example, through an increase in extra-pair copulations, a higher turnover of relationships, or less time between relationships. A further issue of interest would be to examine other components of fitness in artistic groups. Previous investigations have found them to have poor health and decreased life expectancy (Cassandro 1998; Kaufman 2003), perhaps through some combination of psychopathology and the impulsivity observed in the current sample.

In conclusion, then, we believe that these data form the most direct evidence to date that, as hypothesized by Miller (2000) and Nettle (2001), mate choice is linked to creativity, and creativity in turn to schizotypy and thence to schizophrenia.

This research was supported by a grant from the British Academy. We are grateful to Paul Preece, Adi Lerer, Jo Halliday and Yvonne Royals for their help with data collection and management, and to two anonymous referees for helpful comments.

REFERENCES

- Andreasen, N. C. 1987 Creativity and mental illness: prevalence rates in writers and their first degree relatives. *Am. J. Psychiatry* **151**, 1650–1656.
- Avila, M., Thaker, G. & Adami, H. 2001 Genetic epidemiology and schizophrenia: a study of reproductive fitness. *Schizophr. Res.* **47**, 233–241. (doi:10.1016/S0920-9964(00)00062-1)
- Bassett, A. S., Bury, A., Hogkinson, K. A. & Honer, W. G. 1996 Reproductive fitness in familial schizophrenia. *Schizophr. Res.* **21**, 151–160. (doi:10.1016/0920-9964(96)00018-7)
- Brod, J. H. 1997 Creativity and schizotypy. In *Schizotypy: implications for illness and health* (ed. G. Claridge), pp. 274–299. Oxford, UK: Oxford University Press.
- Brown, S., Inskip, H. & Barracough, B. 2000 Causes of the excess mortality in schizophrenia. *Br. J. Psychiatry* **177**, 212–217. (doi:10.1192/bjp.177.3.212)
- Buka, S. L., Tsuang, M. T., Torrey, E. F., Klebanoff, M. A., Bernstein, D. & Yolken, R. H. 2001 Maternal infections and subsequent psychosis amongst offspring. *Arch. Gen. Psychiatry* **58**, 1032–1037. (doi:10.1001/archpsyc.58.11.1032)
- Cardno, A. G. *et al.* 1999 Heritability estimates for psychotic disorders: the Maudsley twin psychosis series. *Arch. Gen. Psychiatry* **56**, 162–168. (doi:10.1001/archpsyc.56.2.162)
- Cassandro, V. J. 1998 Explaining premature mortality across fields of creative endeavor. *J. Personal.* **66**, 805–833. (doi:10.1111/1467-6494.00033)
- Chapman, L. J., Chapman, J. P., Kwapil, T. R., Eckblad, M. & Zinser, M. C. 1994 Putatively psychosis-prone subjects 10 years later. *J. Abnorm. Psychol.* **103**, 171–183. (doi:10.1037/0021-843X.103.2.171)
- Claridge, G. (ed.) 1997 *Schizotypy: implications for illness and health*. Oxford, UK: Oxford University Press.
- Claridge, G., McCreery, C., Mason, O., Bentall, R., Boyle, G. & Slade, P. 1996 The factor structure of 'schizotypal' traits: a large replication study. *Br. J. Clin. Psychol.* **35**, 103–115.

- Crow, T. J. 1990 The continuum of psychosis and its genetic origins. *Br. J. Psychiatry* **156**, 788–797.
- Faurie, C., Pontier, D. & Raymond, M. 2004 Student athletes claim to have more sexual partners than other students. *Evol. Hum. Behav.* **25**, 1–8. (doi:10.1016/S1090-5138(03)00064-3)
- Gangestad, S. W., Bennett, K. L. & Thornhill, R. 2001 A latent variable model of developmental instability in relation to men's sexual behaviour. *Proc. R. Soc. B* **268**, 1677–1684. (doi:10.1098/rspb.2001.1675)
- Gottesman, I. 1991 *Schizophrenia genesis: the origins of madness*. New York: Freeman.
- Heston, J. J. 1966 Psychiatric disorders in foster home reared children of schizophrenic mothers. *Br. J. Psychiatry* **112**, 819–825.
- Huxley, J., Mayr, E., Osmond, H. & Hoffer, A. 1964 Schizophrenia as a genetic morphism. *Nature* **250**, 274–285.
- Jablensky, A. 1995 Schizophrenia: recent epidemiological issues. *Epidemiol. Rev.* **17**, 10–20.
- Jablensky, A., Sartorius, N., Ernberg, G., Anker, N., Korten, A., Cooper, J. E., Day, R. & Bertelsen, A. 1992 Schizophrenia: manifestations, incidence and course in different cultures. A World Health Organization ten country study. *Psychol. Med. Suppl.* **20**, 1–97.
- Jarvik, D. L. & Deckard, B. S. 1977 The Odyssean personality: a survival advantage for carriers of genes predisposing to schizophrenia? *Neuropsychobiology* **3**, 179–191.
- Kanazawa, S. 2000 Scientific discoveries as cultural displays: a further test of Miller's courtship model. *Evol. Hum. Behav.* **21**, 317–321. (doi:10.1016/S1090-5138(00)00051-9)
- Kanazawa, S. 2003 Why productivity fades with age: the crime-genius connection. *J. Res. Personal.* **37**, 257–272. (doi:10.1016/S0092-6566(02)00538-X)
- Karolson, J. L. 1970 Genetic association of giftedness and creativity with schizophrenia. *Hereditas* **66**, 177–181.
- Kaufman, J. C. 2003 The cost of the muse: poets die young. *Death Stud.* **27**, 813–831.
- Kendell, K. & Brockington, I. F. 1980 The identification of disease entities and the relationship between schizophrenia and affective psychoses. *Br. J. Psychiatry* **137**, 324–331.
- Kendell, K. & Gourlay, J. 1970 The clinical distinction between the affective psychoses and schizophrenia. *Br. J. Psychiatry* **117**, 261–266.
- Kunugi, H., Nanko, S. & Murray, R. M. 2001 Obstetric complications and schizophrenia: prenatal underdevelopment and subsequent neurodevelopmental impairment. *Br. J. Psychiatry* **40**, S24–S29.
- Ludwig, A. M. 1995 *The price of greatness: resolving the creativity and madness controversy*. New York: Guilford Press.
- Mason, O., Claridge, G. & Jackson, M. 1995 New scales for the assessment of schizotypy. *Personal. Individ. Differ.* **1**, 7–13. (doi:10.1016/0191-8869(94)00132-C)
- Miller, G. F. 1999 Sexual selection for cultural displays. In *The evolution of culture* (ed. R. Dunbar, C. Knight & C. Power), pp. 71–91. Edinburgh: Edinburgh University Press.
- Miller, G. F. 2000 *The mating mind: how mate choice shaped the evolution of human nature*. New York: Doubleday.
- Miller, G. F. 2001 Aesthetic fitness: how sexual selection shaped artistic virtuosity as a fitness indicator and aesthetic preference as mate choice criteria. *Bull. Psychol. Arts* **2**, 20–25.
- Miller, G. F. & Haselton, M. G. In press Women's fertility across the cycle increases the short-term attractiveness of creative intelligence compared to wealth. *Hum. Nat.*
- Mueller, U. & Mazur, A. 2001 Evidence of unconstrained directional selection for male tallness. *Behav. Ecol. Sociobiol.* **50**, 302–311. (doi:10.1007/s002650100370)
- Nettle, D. 2001 *Strong imagination: madness, creativity and human nature*. Oxford, UK: Oxford University Press.
- Nettle, D. 2002 Women's height, reproductive success and the evolution of sexual dimorphism in modern humans. *Proc. R. Soc. B* **269**, 1919–1923. (doi:10.1098/rspb.2002.2111)
- Nettle, D. In press Schizotypy and mental health amongst poets, artists and mathematicians. *J. Res. Personal.*
- O'Reilly, T., Dunbar, R. & Bentall, R. 2001 Schizotypy and creativity: an evolutionary connection? *Personal. Individ. Differ.* **31**, 1067–1078. (doi:10.1016/S0191-8869(00)00204-X)
- Pevalin, D. J. 2003 *A researcher's guide to the national statistics socio-economic classification*. London: Sage.
- Rawlings, D. & Freeman, J. L. 1997 Measuring paranoia/suspiciousness. In *Schizotypy: implications for illness and health* (ed. G. Claridge), pp. 38–60. Oxford: Oxford University Press.
- Rhodes, G., Simmons, L. W. & Peters, M. 2005 Attractiveness and sexual behaviour: does attractiveness enhance mating success? *Evol. Hum. Behav.* **26**, 186–201. (doi:10.1016/j.evolhumbehav.2004.08.014)
- Richards, R., Kinney, D. K. & Lunde, I. 1988 Creativity in manic-depressives, cyclothymes, their normal relatives, and controls. *J. Abnorm. Psychol.* **97**, 281–288. (doi:10.1037/0021-843X.97.3.281)
- Rowe, L. & Houle, D. 1996 The lek paradox and the capture of genetic variance by condition dependent traits. *Proc. R. Soc. B* **263**, 1415–1421.
- Schuldberg, D. 1988 Creativity and schizotypal traits: creativity test scores and perceptual aberration, magical ideation, and impulsive nonconformity. *J. Nerv. Ment. Dis.* **176**, 648–657.
- Schuldberg, D. 2000 Six subclinical spectrum traits in normal creativity. *Creativity Res. J.* **13**, 5–16. (doi:10.1207/S15326934CRJ1301_2)
- Shaner, A., Miller, G. F. & Mintz, J. 2004 Schizophrenia as one extreme of a sexually selected fitness indicator. *Schizophr. Res.* **70**, 101–109. (doi:10.1016/j.schres.2003.09.014)
- Thornhill, R. & Gangestad, S. W. 1994 Fluctuating asymmetry and human sexual behavior. *Psychol. Sci.* **5**, 297–302.
- Torrey, E. F., Rawlings, R. & Yolkein, R. H. 2000 The antecedents of psychosis: a case-control study of selected risk factors. *Schizophr. Res.* **46**, 17–23. (doi:10.1016/S0920-9964(99)00237-6)
- Tsuang, M. T., Stone, W. S. & Faraone, S. V. 2001 Genes, environment and schizophrenia. *Br. J. Psychiatry* **178**, s18–s24. (doi:10.1192/bjp.178.40.s18)
- Van Os, J., Verdoux, H., Maurice-Tison, S., Gay, B., Liraud, F., Salamon, R. & Bourgeois, M. 1999 Self-reported psychosis-like symptoms and the continuum of psychosis. *Soc. Psychiatry Psychiatr. Epidemiol.* **34**, 459–463. (doi:10.1007/s001270050220)
- Verdoux, H., Van Os, J., Maurice-Tison, S., Gay, B., Salamon, R. & Bourgeois, M. 1999 Increased occurrence of depression in psychosis-prone subjects: a follow-up study in primary care settings. *Compr. Psychiatry* **40**, 462–468. (doi:10.1016/S0010-440X(99)90091-3)
- Yeo, R. A., Gangestad, S. W., Edgar, C. & Thoma, R. 1999 The evolutionary genetic underpinnings of schizophrenia: the developmental instability model. *Schizophr. Res.* **39**, 197–206. (doi:10.1016/S0920-9964(99)00074-2)