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An investigation into the relationships between convergent and divergent thinking, schizotypy, and autistic traits

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ABSTRACT

This study explored the relationships between positive and negative schizotypy, convergent and divergent thinking, and autistic traits within the normal population. Seventy-seven students at Oxford University completed tasks to assess divergent and convergent thinking, and completed questionnaires to measure schizotypy and autistic tendencies. Evidence for relationships between negative schizotypy, autistic traits, and convergent thinking was found, but the expected association between positive schizotypy and divergent thinking was not replicated. These findings are discussed in the context of a cognitive inhibition theory of creativity.

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1. Introduction

The link between psychopathology and creativity is well-established, in many studies of the incidence of mental health problems in creative individuals (Andreasen, 1987; Jamison, 1993; Post, 1994; Wills, 2003; see also Nettle, 2001). The association between psychosis and creativity has also been demonstrated in psychiatric patients, using divergent thinking tasks to demonstrate a higher level of creativity test performance than in the normal population (e.g. Keefe & Magaro, 1980).

It is readily accepted, however, that in the real life situation psychopathology itself does not usually facilitate the creative act. Thus Brod (1997) argues that psychosis may 'block' productivity, a view supported by Jamison (1989) who found that writers and artists who had been treated for mood disorders were most productive prior to and following those periods during which their own mood ratings were highest. Brod (1997) therefore discusses the possibility that creativity is associated with milder psychopathology rather than full-blown psychosis. This idea is supported by evidence that creativity is higher amongst first-degree relatives of psychiatric patients than in the patients themselves (e.g. Heston, 1966; Richards, Kinney, Lunde, & Benet, 1988).

Such observations suggest conceptualising proneness to psychosis as a continuous, rather than a categorical, variable. Here the dominant theoretical construct has been 'schizotypy'. As described by Claridge (1997), this represents a fully dimensional personality variable, making it feasible to examine the relationship between creativity and psychosis-proneness within the general population. Taking this view, many studies have investigated the association (e.g. Burch, Pavelis, Hemsley, & Corr, 2006; O'Reilly, Dunbar, & Bentall, 2001; Woody & Claridge, 1977). The most commonly used methodology has been to examine the relationship between scores on schizotypy or other psychosis-proneness scales and performance on tasks (or variants of tasks) of divergent thinking, as originally developed by Wallach and Kogan (1965) and Torrance (1974).

In seeking a possible common link between the two domains, Eysenck (1993) proposed that the association may arise due to a lack of cognitive inhibition: fewer ideas are inhibited by the highly schizotypal individual, leaving a broader base of ideas with which to proceed. This idea is consistent with studies that have reported a more overinclusive thinking style (a conceptually similar construct to divergent thinking) in participants with higher schizotypy scores (e.g. Dykes & McGhie, 1976; Rawlings & Toogood, 1997). It is further supported by Beech and Claridge's (1987) demonstration of a significant relationship between schizotypy and reduced cognitive inhibition on a negative priming task, as well as a finding by Peters et al. (2000) of an association between reduced cognitive inhibition and the presence of positive symptoms amongst psychotic patients.

For perhaps understandable reasons almost all of the research in the field referred to has concentrated on the *upper* end of the schizotypy spectrum; *viz.* studying the creativity test performance of individuals with high scores on schizotypy scales. By comparison, little has been done on *low* schizotypy. Yet, given Eysenck's (1993) suggestion that the association between high schizotypy and creativity is the result of reduced cognitive inhibition, it might be expected that very low schizotypy would be characterised by the opposite: a greater level of cognitive inhibition, and accordingly, less 'creativity'. There is, of course, some indirect evidence for this in those studies that have demonstrated a negative

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correlation between schizotypy and cognitive inhibition. But while this is informative about the types of task that low schizotypes are less good at (those tasks requiring divergent thinking), it does not offer information about the types of tasks for which a higher level of cognitive inhibition might confer an advantage.

Davison-Jenkins (2003) suggested that, due to their presumed greater cognitive inhibition, low schizotypes should perform better than high schizotypes on tests that require narrow and focused thinking, *viz* convergent thinking tasks. This suggestion was based upon Guilford's (1967) distinction between convergent and divergent production, which is supported by neuropsychological evidence (e.g. Razoumnikova, 2000). Davison-Jenkins (2003) reported that low schizotypes did indeed complete the Missionaries and Cannibals task (a task requiring convergent thinking) in significantly fewer moves than high schizotypes. Although not significant for other convergent thinking tasks, her experiment provided some evidence that low schizotypy is associated with higher cognitive inhibition, and thus better performance on problem solving tasks requiring more linear, logical thinking.

There is, however, an ambiguity in conceptualising the schizotypy spectrum merely as a single dimension defined at its extreme ends by 'high' and 'low'. It is well-established that schizotypy is not a unitary construct, but instead represents a collection of traits comprising elements of both the positive and negative features of psychosis. This is exemplified in the multiscale nature of many schizotypy questionnaires, such as the Oxford-Liverpool Inventory of Feelings and Experiences (*O-LIFE*) (Mason & Claridge, 2006; Mason, Claridge, & Jackson, 1995). Furthermore, according to those authors the negative component, known in the *O-LIFE* as introvertive anhedonia (IntAn), is not well correlated with the more positive aspects (unusual experiences [UnEx], impulsive nonconformity [ImpNon], and cognitive disorganisation [CogDis]).

In creativity research two further factors complicate the issue. One is the exclusive concentration on the positive aspects of schizotypy. The other is the equating of 'creativity' solely with the divergent mode of thinking, reduced cognitive inhibition, and originality in the artistic domain. However, recent findings have helped to clarify matters in this regard. Thus, Nettle (2006) found that people grouped according to their professions and hobbies differed in their profile of scores on the *O-LIFE*, with poets and artists obtaining high scores on the positive symptom dimension of UnEx but low scores on the negative symptom dimension, IntAn. Conversely, mathematicians scored low on the UnEx scale, but were high in IntAn. Nettle argues that although achievement in 'traditional' creative fields, such as writing or music, may be facilitated by lower cognitive inhibition (corresponding to positive schizotypy, divergent thinking and so on), for creative achievement in fields such as mathematics or science, a focused and convergent cognitive style might be more advantageous. In the context of creativity, it may therefore be more useful to refer to positive and negative schizotypy, as opposed to high and low schizotypy.

Nettle (2006) also argues that the convergent thinking style proposed to be associated with negative schizotypy is analogous to a cognitive style biased towards local rather than global information processing, as demonstrated by many people with autism (see Happé, 1999). Such a link between autism and convergent thinking is supported by the finding of more autistic-like profiles amongst scientists and mathematicians who are presumed to have more strengths in convergent thinking than in divergent thinking (Baron-Cohen, Richler, Bisarya, Gurunathan, & Wheelwright, 2003; Baron-Cohen, Wheelwright, Skinner, Martin, & Clubley, 2001). Thus, if negative schizotypy is associated with convergent thinking style, then it might also be expected to correlate with autistic traits. Indeed, Rawlings and Locarnini (2008) have recently published data supporting a link between those two.

This study repeated Davison-Jenkins (2003) investigation of schizotypy and divergent and convergent thinking within the normal population, but with the prediction that positive/negative schizotypy, as opposed to high/low schizotypy, would be related to performance on tasks of convergent and divergent thinking. The experiment also sought to determine whether convergent thinking and negative schizotypy would be related to a measure of autistic traits within the normal population, *viz*. the autism-spectrum quotient or (*AQ*) as devised by Baron-Cohen et al. (2001). It was expected that those who scored highly in positive schizotypy (the UnEx scale of the *O-LIFE*) would perform well on tasks of divergent thinking, and that those with high scores on negative schizotypy (the IntAn scale of the *O-LIFE*) would perform better on tasks of convergent thinking. It was also hypothesized that convergent thinking and negative schizotypy would be related to autistic traits.

As the study was conducted using student participants, it was also of interest to investigate whether degree subject was related to measures of cognitive style, schizotypy, and autistic traits. It was hypothesized that those participants completing science degrees would more closely fit the predicted profile of negative schizotypy, convergent thinking style, and greater autistic traits, whereas those completing arts degrees would fit the profile of positive schizotypy, divergent thinking style, and fewer autistic traits.

2. Method

2.1. Participants

Seventy-seven students at Oxford University took part in the study, of which 33 were male and 44 were female. The mean age of the participants was 20.7 years (range 17.9–26.6 years). Forty-four participants were studying for a science degree, 25 for a humanities degree, and eight for a social sciences subject, as assessed by Baron-Cohen et al. (2001) classification of degree subjects.[1] Participants were recruited via posters and email bulletins.

2.2. Materials

Participants each completed four laboratory tasks (two to assess divergent thinking, and two to assess convergent thinking), and two questionnaires (the *O-LIFE* and the *AQ*).

2.2.1. Divergent thinking tasks

The two divergent thinking tasks used were sub-tests selected from the Wallach–Kogan divergent thinking test battery (Wallach & Kogan, 1965, pp. 32–35), and were the same sub-tests used by Davison-Jenkins (2003). This battery of tests has high reliability and is poorly correlated with intelligence tests (Cropley & Mansley, 1969). It also demonstrates high internal consistency (Cropley, 1968). Due to time restrictions, only half of the items from each sub-test were used. The tasks were as follows:

Similarities task: Here the participant was given a pair of words, and had to list as many similarities between the words as they could, trying to be as creative as possible. There were five items, consisting of the following pairs: (a) a train and a tractor, (b) milk and meat, (c) a grocery store and a restaurant, (d) a radio and a telephone, and (e) a curtain and a rug. Each pair of words was presented on a piece of paper, and remained in front of participants as

[1] Science subjects included physics, chemistry, biological sciences, experimental psychology, physiology, mathematics, engineering, and medicine. Humanities included classics, languages, law, philosophy, English literature, history, and music. Social sciences included geography, economics and management, politics, archaeology and anthropology, and development studies.

they wrote down their answers. Participants were allowed two minutes for each item.

Pattern Meanings task: Here the participant was shown a pattern, and had to generate as many explanations as they could for what the pattern might be, trying to be as creative as possible. Participants told the experimenter their ideas, and the experimenter wrote them down. There were four items, consisting of items 2, 3, 6 and 8 from Wallach and Kogan's (1965) original battery. Each pattern was presented on a piece of 6" × 4" card. Participants were allowed two minutes for each pattern.

For both the similarities and the Pattern Meanings tasks, the total number of responses (across all items) was recorded. Responses were also scored for originality (one point for each response that was not given by any other participant) to give a total number of original responses for all items on that task.

2.2.2. Convergent thinking tasks

The two convergent thinking tasks were selected from Garnham and Oakhill (1994), on the basis that their starting states, operators, and goal states were well defined, so that a focused thinking style would be beneficial in solving them. The tasks were as follows:-

Missionaries and Cannibals: This task involves transporting three missionary figures and three cannibal figures to the other side of a river using a boat. The rules of the task are such that the boat can only carry two people at a time, and that there can never be more cannibals than missionaries on either bank. The task can be completed in a minimum of 11 moves.

Tower of Hanoi: In this task the participant moves discs between three vertical pegs. The rules are that only one disc can be moved at a time, and that a larger disc can never be placed on top of a smaller one. The configuration of discs at the beginning of the task is shown in Fig. 1a, the participant's task being to re-arrange them into the configuration shown in Fig. 1b. The task can be completed in a minimum of 15 moves.

There was no time limit for either the Missionaries and Cannibals task or the Tower of Hanoi task, but the time taken to complete the task, and the number of legal, illegal, and total (legal + illegal) moves made, were recorded by the experimenter. If participants made an illegal move, they were told why it was illegal, and asked to make the move again. They were not allowed to re-start either problem.

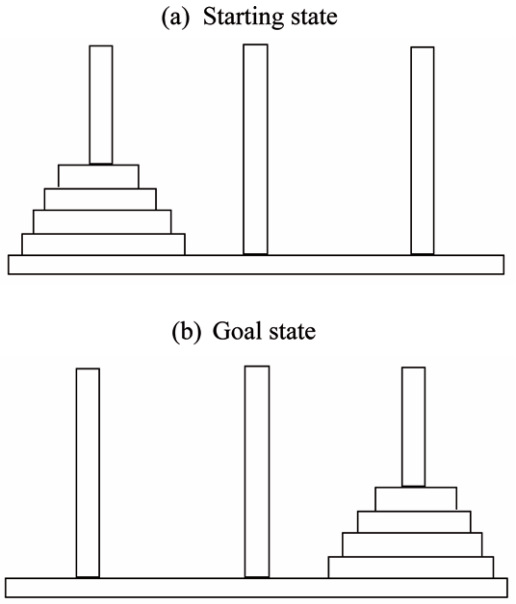

Fig. 1. Tower of Hanoi task.

2.2.3. Questionnaires

2.2.3.1. O-LIFE. The *O-LIFE* questionnaire (Mason et al., 1995) was chosen on the basis that it has good internal consistency when administered to normal samples (Mason & Claridge, 2006). It was scored for each of its four scales: UnEx, CogDis, IntAn, and ImpNon.

2.2.3.2. AQ. This was chosen on the basis that it had good test–retest reliability and internal consistency in a sample of university students (Baron-Cohen et al., 2001). It was scored dichotomously, as described by Baron-Cohen et al. (2003), 10 being the maximum score on each of the following subscales: Social Skill, Attention to Detail, Imagination, Communication, and Attention Switching.[2]

2.3. Procedure

Participants attended an individual session during which they completed the experimental tasks and questionnaires in the following order: Similarities, Missionaries and Cannibals, Pattern Meanings, Tower of Hanoi, *O-LIFE, AQ.*

3. Results

Variables that were normally distributed were analysed using parametric statistics. Variables that were positively skewed were analysed using non-parametric statistics. Two-tailed tests were used in all cases.

3.1. Gender differences

All the variables collected were analysed for gender differences. Females scored significantly higher than males on the CogDis scale of the *O-LIFE* ($t(75) = 3.22$, $p < 0.01$) and also made significantly more illegal moves than males on the Missionaries and Cannibals task ($U = 355.50$, $z = 3.110$, $p < 0.01$). Males scored significantly higher than females on the IntAn scale of the *O-LIFE* ($t(75) = 2.53$, $p < 0.05$).

3.2. Experimental tasks

3.2.1. Divergent thinking tasks

Total number of responses on the Similarities task was significantly correlated with total number of responses on the Pattern Meanings task ($r = +0.64$, $p < 0.001$). The scores for original responses across the two tasks were also correlated ($r = +0.48$, $p < 0.001$).

For further analysis a composite score for the two divergent thinking tasks was calculated, using the originality scores. These were chosen because it was considered that originality would be more indicative of divergent thinking (and creativity) than pure productivity. This followed Wallach and Kogan's (1965) suggestion that it is the originality of answers that is important in assessing creativity. The composite score for both divergent thinking tasks was created by calculating a *z*-score for the number of original responses on each task and adding these to give a total originality score. There was no significant difference between males and females on this composite score.

[2] For each subscale of the *AQ*, higher scores correspond to more autistic-like tendencies. Thus, in the case of Social Skill, Imagination, Communication, and Attention Switching, higher scores indicate difficulties in these areas rather than strengths. On the Attention to Detail sub-scale, higher scores represent a strength in this area, mirroring the fact that people with autism perform better than other groups on tasks requiring attention to detail.

3.2.2. Convergent thinking tasks

Illegal moves on the Missionaries and Cannibals task were significantly correlated with illegal moves on the Tower of Hanoi task ($r = +0.31$, $p < 0.01$). The times taken on the two tasks were also correlated ($r = +0.39$, $p < 0.001$). Correlations for other scores across the two tasks were not significant.

For further analysis, it was decided to form a composite score for the two convergent thinking tasks using the time variable. Two *z*-scores were calculated – one for each of the time scores – and then added to produce a total score. There was no significant difference between males and females on this composite score.

There was a near-zero correlation between the composite score for convergent thinking tasks and the composite score for divergent thinking tasks.

3.3. Questionnaires

Table 1 shows the correlations between the scales of the *O-LIFE*. It can be seen that UnEx, CogDis, and ImpNon were all significantly inter-correlated, but the important point to note is the lack of association between IntAn and the main positive symptom component, UnEx. IntAn was, however, significantly correlated with the total AQ score and with several of its subscales (see Table 2). Bearing in mind the direction of scoring of the AQ, these correlations can be interpreted to mean that high IntAn scorers showed more autistic traits in the areas of Social Skill, Attention Switching, and Communication. Significant correlations were not found for Attention to Detail or Imagination, although, the latter fell near significance ($r = +0.22$, $p < 0.07$).

3.4. Relationships between questionnaires and experimental tasks

3.4.1. Convergent thinking and questionnaires

Correlations were carried out between the composite convergent thinking score and the subscales of the *O-LIFE* and *AQ*, as well as the total *AQ* score. The convergent thinking score was significantly negatively correlated with the Imagination subscale of the *AQ* ($r = -0.27$, $p < 0.05$) but not with any other questionnaire scales, or total *AQ* score. As higher scores on the subscales of the *AQ* correspond to more autistic-like traits (i.e. poor Imagination), and as lower scores on the convergent thinking measure indicate less time taken (and thus better performance), the association was therefore between good performance on the convergent thinking tasks and poor (or more autistic) Imagination. This negative correlation was stronger, however, when only the results for males were considered ($r = -0.51$, $p < 0.01$). The corresponding correlation in females was not significant.

3.4.2. Divergent thinking and questionnaires

The composite score for divergent thinking tasks was not significantly correlated with any of the four scales of the *O-LIFE*, or with any of the five subscales of the *AQ*, or the total *AQ* score. However, when scores for males and females were analysed separately, there was a significant positive correlation ($r = +0.31$, $p < 0.05$) between divergent thinking score and ImpNon in females, but not in males.

3.5. Effect of degree subject

As the size of the group of participants studying a social sciences subject was so small ($N = 8$), the humanities and social sciences groups were combined to form a 'non-scientist' group ($N = 33$). All experimental variables, and the composite scores for the divergent and convergent tasks, were then analysed for differences related to the degree subject of the participants. Scientists scored significantly higher than non-scientists on the Imagination subscale of the *AQ* ($t(70) = 2.47$, $p < 0.05$), but significantly lower than non-scientists on the Attention to Detail subscale ($t(70) = -2.18$, $p < 0.05$). Scientists also made significantly fewer legal moves ($U = 532.00$, $z = 2.02$, $p < 0.05$), and significantly fewer total moves ($U = 535.00$, $z = 1.99$, $p < 0.05$) than non-scientists on the Tower of Hanoi task. All other comparisons were non-significant.

When the composite score for convergent thinking tasks was correlated with questionnaire measures for scientists and non-scientists separately, the correlation between the convergent thinking score and Imagination was significant amongst scientists ($r = -0.33$, $p < 0.05$), but not amongst non-scientists. Correspondingly, when the composite score for divergent thinking tasks was correlated with questionnaire measures for scientists and non-scientists separately, the correlation between divergent thinking score and ImpNon was significant amongst scientists ($r = +0.30$, $p < 0.05$) but not amongst non-scientists.

4. Discussion

Three ideas lay behind the study reported here. The first was that, in the context of creativity research, schizotypy could be usefully construed as a dimension from negative to positive schizotypy – measured by, respectively, the IntAn and UnEx scales of the *O-LIFE* questionnaire. The second was that these two 'poles' of schizotypy are characterised, respectively, by a style of thinking that is predominantly convergent or predominantly divergent: problem solving tasks and open-ended tasks were considered good ways of examining these differences. Thirdly, an overlap was conceived between negative schizotypy and the autistic spectrum. The hypotheses derived from this formulation were confirmed or disconfirmed in varying degree.

The strongest observation was in the supporting of the proposal that the negative features of schizophrenia as seen in the normal

Table 1
Correlations between subscales of the *O-LIFE*.

	Unusual experiences	Introvertive anhedonia	Cognitive disorganisation	Impulsive nonconformity
Unusual experiences		$r = +0.14$	$r = +0.42^{***}$	$r = +0.48^{***}$
Introvertive anhedonia			$r = +0.25^{*}$	$r = +0.04$
Cognitive disorganisation				$r = +0.50^{***}$

* $p<0.05$.
*** $p<0.001$.

Table 2
Correlations between IntAn and subscales of the *AQ*.

	Social Skill	Attention Switching	Attention to Detail	Communication	Imagination	Total *AQ* score
IntAn	$r = +0.59^{***}$	$r = +.031^{**}$	n.s.	$r = +0.51^{***}$	$r = +0.22$	$r = +0.50^{***}$

** $p<0.01$.
*** $p<0.001$.

population are indeed correlated with autistic traits, evidenced by the positive correlation between anhedonia, assessed by the *O-LIFE*, and the total score (as well as four of the subscale scores) from Baron-Cohen's *AQ* measure of the autism-spectrum. This result agrees with an identical finding recently reported by Rawlings and Locarnini (2008) and is perhaps not surprising, given that the introversion, schizoidness, and social withdrawal found in psychosis overlap conceptually with the social characteristics of people with severe autism.

The expectation that negative schizotypy/autism would be associated with greater convergent thinking – as judged by superior performance on the problem solving tasks used – was only partially supported. The composite convergent thinking score did not correlate with IntAn or much of the *AQ*. An exception was the latter's Imagination subscale where there was a significant tendency towards poorer imagination (in the *AQ* sense) amongst highly convergent thinkers. Taken together with the near significant correlation between IntAn and the Imagination scale, and the strong associations between IntAn and other *AQ* subscales, there might be some evidence here of at least an indirect relationship between negative schizotypy and convergent thinking, mediated by autistic traits. Or perhaps an effect in a subgroup of anhedonic individuals.

Data that might further clarify the above findings come from some gender differences. Here, Imagination and convergent thinking were only significantly correlated in males, while men – as is usually found on the *O-LIFE* – had higher IntAn scores than women. Then, in a larger data set ($N = 400+$) collated after this study was completed – and in which it was possible to do a reliable regression analysis – we have found that there is some interaction between gender and anhedonia, such that the correlation between AQ and IntAn is greater in males than in females. This pervasive influence of maleness throughout our data is in keeping with the well-established greater incidence of males at the upper end of the Asperger-autism-spectrum, and suggests that in future research particular attention should be paid to gender differences.

Compared with the findings for the convergent thinking tasks, there were disappointing results for divergent thinking. The latter was not, as predicted, correlated with the UnEx scale of the *O-LIFE*, a lack of association that is surprising, given the evidence supporting a link between positive schizotypy and creativity (e.g. Schuldberg, 2001). However, we did find a correlation with ImpNon, which at least concurs with other reports that scores on that *O-LIFE* scale are higher in creative individuals (e.g. Burch et al. (2006) who showed it in visual artists) The effect is arguably due to a lack of inhibition (of sometimes inappropriate responses) associated with impulsivity, and therefore consistent with Eysenck's (1993) reduced cognitive inhibition theory of creativity. A supplementary explanation is that offered by Claridge and Blakey (2009). They found the same relationship as here with divergent thinking and speculated that it might reflect the influence of hypomanic traits tapped by the ImpNon scale. However, our findings were quite weak: evident only in females – and amongst scientists. The reasons for this are possibly that the scales used to measure divergent thinking were not sensitive enough for use with a sample as small and homogenous as the one in this study.

A further aim of our study was to investigate whether degree subject would be related to the other variables, particularly science being more strongly associated with convergent thinking, negative schizotypy, and autistic traits. This was supported by two findings: a significant correlation between convergent thinking and Imagination amongst scientists, but not amongst non-scientists, and evidence that scientists performed better on one task, at least, of convergent thinking (the Tower of Hanoi task). However, there were no significant differences between scientists and non-scientists on the *O-LIFE*, and the comparisons of *AQ* scores yielded inconsistent results, with scientists scoring higher than non-scientists on one subscale (Imagination), but lower than non-scientists on another (Attention to Detail).

In summary, our own and other data support the existence of a complex of personality traits, defined partly by features of negative schizotypy and partly by characteristics described in a quite separate literature as belonging to the autistic spectrum. A predicted association with a predominantly convergent cognitive style, conducive to problem solving on tasks requiring linear thinking, was also confirmed, at least on one of the tests used. This cognitive/personality relationship seemed to be mediated mostly by the autistic component and significantly by male gender. At the outset we had presumed that the mirror image of this profile would be positive schizotypy and a tendency to a predominantly divergent cognitive style. Although, well-founded theoretically and validated by previous research, our results failed to confirm that hypothesis, the association with personality being confined to impulsive nonconformity. Even that connection was quite weak, but it has been noted by other workers and could fit a revised model of 'schizotypy' that is enlarged to cover all psychotic traits and re-labeled 'psychoticism' in a broader sense than Eysenck's usage (see Claridge, 2009).

Although, there were several shortcoming of this study – e.g. small sample and possibly poor choice of divergent thinking tasks – the experiment did explore a relatively neglected topic in the area and will hopefully act as a stimulus to further research.

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