



Evans, 1999), suggesting a deficient disengagement of attention from the irrelevant stimulus in schizophrenia.

Attentional deficits in schizophrenia have been attributed to an inadequate top-down (knowledge-driven) perceptual processing, as compared to the bottom-up (stimulus-driven) processing (Van den Bosch, 1995; Nestor & O'Donell, 1998; but see Jensterle, Mlakar, Vodusek & Frith, 2000). It has been shown, for example, that schizophrenics cannot utilize top-down (contextual cues) factors to segregate relevant from irrelevant acoustic material presented in the auditory stream, but they can use sufficiently bottom-up (acoustic properties) factors (Silverstein, Matteson & Knight, 1996). Similarly, top-down, experience-based influences are limited when schizophrenic patients process unstructured visual patterns (Silverstein, Bakshi, Chapman & Nowlis, 1998).

Top-down influences seem to modulate figure-ground segregation in visual processing under conditions of perceptual ambiguity (Humphreys & Mueller, 2000; Vecera & O'Reilly, 1998). Poor performance in figure-ground segregation has been demonstrated in schizophrenic patients (Eimon, Eimon & Cermak, 1983), and this has been associated with the presence of delusions and hallucinations (Liddle, 1988) suggesting poor top-down processing, a finding that is consistent with the literature above. Nevertheless, general perceptual organization in terms of utilizing the gestalt principles has been found to be intact in schizophrenia (Chey & Holzman, 1997; Knight, Manoach & Hershenson, 2000).

A traditional visuo-spatial test that involves figure-ground segregation is the Hidden Figures Test (Ekstrom, French, Harman & Dermen, 1976). This test requires the observers to identify which one of five simple figures (perceptually present) is hidden in a complex visual configuration. Although an impaired performance in the Hidden Figures Test has been reported in schizophrenic patients (Neville, 1995), there has been no effort to relate this deficit to the symptomatology of the disorder.

A frequent problem in schizophrenia research is the interpretational limitations that arise in terms of the reported neuro-cognitive deficits. It is not always clear whether the identified deficits are due to medication, poor motivation, disruptive effects of active psychotic symptoms, or the psychotic syndrome *per se*. Therefore, clinical research is often complemented through assessing healthy, psychometrically identified, high schizotypy scorers. Importantly, the approach of testing individuals that show some sub-clinical features of schizophrenia facilitates experimentation on schizophrenia-related hypotheses by making feasible the introduction of more complex and demanding experimental procedures that might not have been applicable to a clinical population.

The identification of psychotic-like features in the general population has often taken the form of a multi-dimensional approach, following various factor-analytic studies that have revealed three or four factors underlying the construct of schizotypy (Bentall, Claridge & Slade, 1989; Vollema & Van den Bosch, 1995). The Oxford–Liverpool Inventory of Feelings and Experiences (O–LIFE; Mason, Claridge & Jackson, 1995), for example, assesses four dimensions of schizotypy. The first three dimensions phenomenologically correspond to a three-factor model of schizophrenia (Liddle, 1987): a positive ('Unusual Experiences'), a negative ('Introvertive Anhedonia'), and a disorganized factor ('Cognitive Disorganization'). The fourth dimension ('Impulsivity Nonconformity') refers to the impulsive, aggressive and asocial aspects of psychosis, and is largely based on Eysenck's Psychoticism scale (Eysenck & Eysenck, 1975). Contributing to the experimental validity of this schizotypy inventory, various studies have confirmed that high schizotypy scorers, as

identified by the O-LIFE sub-scales, demonstrate the same neuro-cognitive deficits as the schizophrenic patients (e.g., Burch, Steel & Hemsley, 1998; Goodarzi, Wykes & Hemsley, 2000; Rawlings & Goldberg, 2001).

The purpose of this investigation was to assess figure-ground segregation by employing the Hidden Figures Test, and replicate in hypothetical high schizotypy scorers, as identified by the O-LIFE inventory, the finding that figure-ground segregation is impaired in schizophrenia (Eimon *et al.*, 1983, Liddle, 1988, Neville, 1995). Furthermore, it was sought to explore further the relationship between psychotic-like features and Hidden Figures Test within a multi-dimensional schizotypy approach. Given the putative link between this test and the frontal lobe functioning (Della Salla, Gray, Spinnler & Trivelli, 1998; Federico, 1984), which is itself putatively associated with the negative psychotic symptoms (e.g., Ananth, Burgoyne, Gadasalli, Aquino, 2001; Lahti, Holcomb, Medoff, Weiler, Tamminga, Carpenter, 2001; Schmajuk, 2001), it was expected that performance in the Hidden Figure Test would be particularly related to the negative psychotic-like features identified psychometrically.

An extensive review of various studies (see McKenna, 1984) suggests a close relationship between the ability to identify a simple figure embedded in a complex configuration and general intelligence, as assessed by the Raven's Progressive Matrices. Given the often-reported intellectual decline associated with schizophrenia (Bilder, Lipschutz-Broch, Reiter & Geisler, 1992; Gold, Arndt, Nopoulos, O'Leary & Andreasen, 1999), the Raven's Progressive Matrices were administered in the present investigation in order to control for the IQ level of the participants.

## Method

### *Participants*

One hundred undergraduate psychology students (22 males and 78 females) took part in this study as a part of a course requirement. Their age ranged from 18 to 53 ( $M = 19.6$ ,  $SD = 4.5$ ). The participants were naïve to the purpose of the investigation.

### *Cognitive Tasks*

*Hidden Figures Test.* The Hidden Figures Test (Ekstrom *et al.*, 1976) has been often used as a measure of field-dependence/independence (e.g. Noppe, 1985; Schmidt & Stephans, 1991), and as a task assessing frontal lobe function in neuropsychological patients (e.g., Della Salla *et al.*, 1998). In this test, each participant is presented with five simple figures (available throughout the task) and thirty-two complex figures/problems. Participants identify which one of the five simple figures is hidden in each of the complex figures. The test is divided in two sections, each of which consists of sixteen problems, and the level of difficulty remains the same within and across the sections.

The time available to complete the task was twenty minutes. The number of correctly answered problems was the dependent measure of this task. Incorrect responses were recorded as well to control for the false alarm rate.

*Raven's Progressive Matrices.* The Raven's Standard Progressive Matrices (Raven, Court, & Raven, 1977) have been argued to provide a non-verbal, culturally free measure of the general ability to solve novel problems and adapt to new situations (fluid intelligence). This IQ test has been shown to have acceptable validity and reliability (Carroll, 1993; Lezak, 1995). The test consists of sixty items, grouped

into five sets of twelve (A to E), and the level of difficulty gradually increases across sets. The time available to complete the task was forty-five minutes. The dependent measure was the total number of correctly answered items.

### **Schizotypy**

The Oxford–Liverpool Inventory for Feelings and Experiences (O–LIFE) consists of 159 items selected on the basis of factor-analytic studies of scales that have been employed in the past to assess psychotic-like features in the general population (Bentall *et al.*, 1989; Mason *et al.*, 1995). More specifically, it assesses the following dimensions:

‘*Unusual Experiences*’ reflects the positive symptoms of psychosis, and consists of items assessing magical thinking, unusual perceptual aberrations, and hallucinatory experiences (e.g., “When in the dark do you often see shapes and forms even though there is nothing there?”; “Are your thoughts sometimes so strong that you can almost hear them?”).

‘*Cognitive Disorganization*’ reflects the disorganized aspect of psychosis, and consists of items assessing difficulties with concentration and decision making, as well as social anxiety (e.g., “No matter how hard you try to concentrate do unrelated thoughts always creep into your mind?”; “Are you sometimes so nervous that you are blocked?”).

‘*Introvertive Anhedonia*’ reflects the negative aspects of psychosis, and consists of items assessing the lack of enjoyment from social contact, physical activities, coupled with aversion to emotional and physical intimacy (e.g., “Are you much too independent to get involved with other people?”; “Are people usually better off if they stay aloof from emotional involvements with people?”).

‘*Impulsive Non-conformity*’ consists of items assessing aggressive, anti-social and impulsive behaviour (e.g., “Were you ever greedy by helping yourself to more than your share of anything?”; “Do you ever feel the urge to break or smash things?”).

### **Procedure**

The psychometric measures were administered in three group sessions. The instructions and the tests were administered by the authors with the help of four lab demonstrators. The participants were fully debriefed about the purpose of the study at the end of both sessions.

### **Results**

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Table 1 about here

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Table 1 shows the means, standard deviations, and inter-correlations between the O–LIFE scales. The means and the standard deviations were quite similar to those reported in the original study on the development of the scales (Mason *et al.*, 1995), as well as those reported in later studies (Rawlings & Goldberg, 2001). In terms of the inter-correlations, the overall pattern was consistent with that obtained in the previous studies. The only exception was the absence of a significant negative correlation between ‘*Impulsivity Nonconformity*’ and ‘*Introvertive Anhedonia*’. In

the Mason *et al.* study, this was  $r = -0.10$ ,  $p < 0.05$ . Given, however, that the correlation between these two scales was low and negative in both studies, this deviation could be due to the difference in the sample size between the original study ( $N = 508$ ) and the present investigation ( $N = 100$ ).

There was a relatively low correlation ( $r = 0.22$ ,  $p < 0.05$ ) between the number of correct responses on Raven's Progressive Matrices ( $M = 47.94$ ,  $SD = 5.31$ ) and Hidden Figures Test ( $M = 11.24$ ,  $SD = 6.38$ ), suggesting that the two measures, although related, maintained a substantial amount ( $> 95\%$ ) of non-shared variance.

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Table 2 about here

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To examine whether schizotypy scores can predict performance on the Hidden Figures Test, and control for the contribution of the IQ level, a multiple regression analysis was performed in two successive steps. At the first step, the number of correct responses on the Raven's Progressive Matrices was entered in the regression equation as a predictor variable. The number of correct responses on the Hidden Figures Test was the dependent variable. The overall equation was significant,  $F_{(1, 98)} = 5.01$ ,  $p < 0.05$ , and this accounted for 4% of the total variance (adjusted  $R^2$ ). At the second step of this analysis, the four O-LIFE scales were entered in the regression equation as predictor variables together with the number of correct responses on the Raven's Progressive Matrices. The number of correct responses on the Hidden Figures Test remained the dependent variable. The overall equation was significant,  $F_{(5, 94)} = 6.08$ ,  $p < 0.001$ , accounting for 20 % of the total variance (adjusted  $R^2$ ). Table 2 presents the regression coefficients for the predictor variables. The regression slopes for 'Unusual Experiences', 'Cognitive Disorganization' and 'Introvertive Anhedonia' were negative, indicating that an average increase in each of them was associated with a decrease in the dependent variable. Contrary to this pattern, the slopes for 'Impulsivity Nonconformity' and number of correct responses on the Raven's Progressive Matrices were positive. However, only 'Introvertive Anhedonia', 'Impulsivity Nonconformity' and Raven's Progressive Matrices made significant independent contributions to the dependent variable.

The number of correct responses on the Hidden Figures Test correlated negatively with the number of incorrect responses on the same task (Person's  $r = -0.25$ ,  $p < 0.01$ ). However, there was no other significant correlation between the number of incorrect responses and any other measures, all  $ps > 0.20$ , eliminating the possibility that the observed contribution of the schizotypy measures was the result of a high false alarm rate.

## Discussion

The present investigation was undertaken in order to determine whether different schizotypy dimensions could predict a top-down (knowledge/goal-driven) perceptual processing, such as segregating a simple figure embedded in a complex background, as assessed by the Hidden Figures Test. Negative schizotypy was found to be a

significant predictor of performance on this task, in accord with past evidence that figure-ground segregation in general, and in Hidden Figures Test in particular, is impaired in schizophrenic patients (Eimon *et al.*, 1983; Liddle, 1988; Neville, 1995). If performance on the Hidden Figures Test does reflect a frontal lobe function, as it has been argued (Della Salla *et al.*, 1998; Federico, 1984), and negative symptoms in schizophrenia are related to a frontal lobe hypo-function (Ananth *et al.*, 2001; Lahti *et al.*, 2001), then the negative relationship between negative schizotypy and performance on the Hidden Figures Test could be an indication, albeit indirect, of a putative link between negative schizotypy and frontal lobe function.

There was no indication of impaired performance for people scoring high in the positive or the disorganised schizotypy, as assessed by the 'Unusual Experiences' and 'Cognitive Disorganisation' scale, respectively. Healthy participants scoring highly on each of these two scales typically demonstrate the same pattern of neuro-cognitive deficits as the schizophrenic patients, with pronounced positive or disorganized symptomatology (e.g., Burch *et al.*, 1998; Goodarzi *et al.*, 2000; Rawlings & Goldberg, 2001). Therefore, the absence of an impaired performance on the Hidden Figures Test for participants who scored high on 'Unusual Experiences' and 'Cognitive Disorganisation', can reinforce further the idea that the observed impairment on the Hidden Figures Test is specific to the negative aspect of schizotypy, and possibly to negative symptomatology of schizophrenia.

The positive relationship between 'Impulsivity Nonconformity' and performance on the Hidden Figures Test was an unpredicted finding. The fact that there was no significant relationship between 'Impulsive Nonconformity' and number of incorrect responses (false-alarm rate) on the Hidden Figures Test, debilitates any explanation based on a possible tendency of high scorers on this scale to maximize their performance through employing a more "impulsive", and prone to false alarms (as a pay-off of random guessing) response pattern.

Given that the construction of the 'Impulsive Nonconformity' scale reflects anti-social and impulsive behavioural tendencies, an alternative account could be that high scorers were more likely to cheat during the group testing, than low scorers. This account, however, is limited by the absence of a relationship between 'Impulsive Nonconformity' and performance in the Raven's Progressive Matrices. The testing conditions (group administration) were the same for both Hidden Figures Test and Raven's Progressive Matrices, and there is no obvious reason to assume that high scorers on the 'Impulsive Nonconformity' scale were likely to cheat on the one test, but not on the other one.

It is possible, therefore, that elevated levels of impulsivity, as tapped by the 'Impulsive Nonconformity' scale, facilitated the detection of a simple figure hidden in a complex configuration. There is evidence that the tendency in certain individuals to act with relatively little forethought can actually be advantageous in various cognitive tasks (see, Dickman, 1993; 1996). For example, low and high impulsives differ in the degree to which attention remains fixed on a current source of input. It has been suggested (Dickman, 1993) that individuals who tend to act impulsively can shift their attention more easily from its current location than less impulsive individuals. Such differences in terms of allocating attention have been further confirmed in a visual search paradigm that involved individuals scoring high or low on impulsivity measures (Dickman, 2000), contributing further to the notion that impulsivity has both functional and dysfunctional facets. From this perspective, high scorers on the 'Impulsive Nonconformity' scale might have been facilitated from such a pattern of

rapid attentional shifts from fixation points while searching for a hidden shape in a complex visual configuration.

General intellectual ability, as assessed by the Raven's Progressive Matrices, was found related to performance on the Hidden Figures Test. This seems to be in congruence with past findings that have shown that the ability to segregate a simple figure embedded in a complex configuration is related to fluid intelligence (McKenna, 1984). Despite the often-reported intellectual decline in people suffering from schizophrenia (Bilder *et al.*, 1992; Gold *et al.*, 1999) there was no relationship between intelligence and any of the schizotypy dimensions. This latter finding is compatible with the view that the intellectual decline in schizophrenia is a possible result of the disruptive effect of the psychotic symptoms, rather than being a trait-marker for schizophrenia.

Although in the present investigation performance on the Hidden Figures Test was operationalised in terms of a top-down (goal-driven) perceptual processing (segregating a simple figure embedded in a complex background), alternative interpretations regarding the cognitive processes underlying this test also need to be considered. For example, it has been recently proposed (Miyake, Witzki, & Emerson, 2001) that performance in the Hidden Figures Test can be better understood from a working-memory perspective (i.e. maintaining temporarily a simple figure, while simultaneously scanning the complex configuration and keeping track of the possible solutions). Given that working memory has been linked to general fluid intelligence, as assessed by the Raven's Progressive Matrices, (Engle, Tuholski, Laughlin & Conway, 1999; Kyllonen, 1996) this is also compatible with an obtained significant positive relationship between performance on the Hidden Figures Test and the Raven's Progressive Matrices in this study. Consequently, there is also the possibility that the demonstrated impairment of the Hidden Figures Test in the negative schizotypy might actually reflect an impairment of working memory in negative symptomatology of schizophrenia, rather than a putative impairment that is specific to the figure-ground segregation process. The absence, however, of a relationship between negative schizotypy and performance on the Raven's Progressive Matrices makes this account less likely.

In summary, this investigation determined that impaired performance on the Hidden Figures Test was exclusively associated with the negative dimension of schizotypy. The implications, therefore, of these results for putative visuo-spatial deficits underlying negative schizotypy and negative psychotic symptoms can serve to motivate further research on more specific cognitive and perceptual mechanisms that are impaired in, and might be responsible for, the negative symptomatology in schizophrenia.

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**Table 1**  
Means and standard deviations of the scales on Oxford–Liverpool Inventory of Feeling  
and Experiences, and their inter-correlations

Schizotypy Scale	<i>M</i>	<i>SD</i>	1	2	3	4
‘Unusual Experiences’	10.42	5.1	-			
‘Cognitive Disorganization’	12.82	5.57	0.44*	-		
‘Introvertive Anhedonia’	5.16	3.98	0.07	0.29*	-	
‘Impulsive Nonconformity’	9.75	3.56	0.42*	0.41*	-0.01	-

\*  $p < 0.01$  (two-tailed)

**Table 2**  
 O–LIFE scales and scores on Raven’s Progressive Matrices as predictor variables for  
 the number of correct responses on the Hidden Figures Test

Predictor Variable	<i>B</i>	SEB	Beta	<i>t</i>
Raven’s Progressive Matrices	0.24	0.10	0.19	2.14*
‘Unusual Experiences’	-0.14	0.13	-0.11	-1.07
‘Cognitive Disorganization’	-0.01	0.13	-0.06	-0.49
‘Introvertive Anhedonia’	-0.37	0.15	-0.23	-2.42**
‘Impulsive Nonconformity’	0.73	0.19	0.40	3.91***

\* $p < 0.05$  , \*\* $p < 0.01$ ,  $p < 0.001$ \*\*\* (two-tailed)