Available online at www.sciencedirect.com
ScienceDirect
Psychiatry Research xx (2007) xxx–xxx
PSYCHIATRY RESEARCH
www.elsevier.com/locate/psychres

Awareness of everyday executive difficulties precede overt executive dysfunction in schizotypal subjects

Keith R. Laws [a,*], Devina D. Patel [a], Philip J. Tyson [b]

[a] School of Psychology, University of Hertfordshire, College Lane Hatfield, AL10 9AB, UK
[b] School of Biological and Behavioural Sciences, University of Gloucestershire, UK

Received 7 November 2006; received in revised form 19 March 2007; accepted 3 June 2007

Abstract

Much evidence indicates that schizophrenic patients exhibit deficits on tests of executive functioning. It is therefore hypothesized that individuals with high schizotypal personality traits that may have a predisposition to schizophrenia, are also likely to exhibit impairments in neuropsychological tests of executive function. The sample consisted of ~~61~~ healthy controls that were divided into high and low scorers on the Schizotypal Personality Questionnaire (SPQ-B: Raine et al., 1995). Participants completed a battery of executive tasks (category and letter fluency, the Hayling test, Zoo map); however, a MANOVA revealed no significant differences between high and low SPQ scorers. Nevertheless, high SPQ scorers scored significantly higher on the ~~dysexecutive~~ (DEX) self-rating scale of everyday executive problems; and these self-ratings correlated significantly with the disorganisation and cognitive–perceptual features of the SPQ-B, but not with the interpersonal features. This suggests that perceived executive dysfunction is pre-morbidly present and may become evident in test performance only with the onset of schizophrenia itself.

Keywords: Schizotypy; Schizophrenia; Frontal lobes; Dysexecutive syndrome; Awareness

1. Introduction

Executive function is a broad term which encompasses the cognitive processes involved in the control and regulation of goal selection, higher order inferences and problem solving. Executive systems allow us to inhibit immediate responses, flexibly switch between problem-solving strategies, plan and execute strategies, monitor complex behavioural sequences and to re-direct and sustain attention flexibly. Much evidence shows that patients with schizophrenia are impaired on a wide range of tasks believed to tap such executive functions (for a review, see Laws, 1999). A meta-analytic review (Heinrichs and Zakzanis, 1998) comparing the performance of patients with schizophrenia and controls has revealed large effect sizes on the most widely-used tests of executive function: fluency (d=1.39), Stroop Colour Word Test (d=1.22), Trail Making Test B (TMT-B: d=1.07), and the Wisconsin Card Sort Test (WCST: d=.95)[1]. The nomenclature of Cohen (1988) suggests the following classification of effect sizes (small d=

* Corresponding author.
E-mail address: k.laws@herts.ac.uk (K.R. Laws).

[1] ~~The nomenclature of Cohen (1988) suggests the following classification of effect sizes (small d=0.20; medium d=0.50; and large d=0.80).~~

0165-1781/$ - see front matter © 2007 Published by Elsevier Ireland Ltd.
doi:10.1016/j.psychres.2007.06.004

0.20; medium $d=0.50$; and large $d=0.80$). It is argued that executive functioning is mediated primarily by the prefrontal lobes; and a meta-analysis of functional brain imaging studies in schizophrenic patients points to reduced blood flow and metabolism in their frontal cortex when performing executive tests (Hill et al., 2004 for a meta-analysis). Furthermore, meta-analysis of executive functioning in unaffected relatives of schizophrenics reveals moderate effect sizes (TMT-B $d=.51$; fluency $d=.35$; Stroop $d=.28$; WCST $d=.29$) and has been proposed as putative endophenotypic markers for schizophrenia (Sitskoorn et al., 2004; Szöke et al., 2005).

Executive functioning has also been examined in healthy volunteers (typically undergraduates) who are psychometrically classified as *psychosis-prone* according to their scores on measures of schizotypy. Raine (2006) has reviewed over 250 studies of schizotypal subjects revealing difficulties across a variety of domains including executive function as well as sustained attention, working memory, verbal and spatial learning and memory, latent inhibition, negative priming, hemisphere asymmetry, and motor ability. Compared to healthy controls, studies report that schizotypal subjects show an increase in perseverative errors (Spaulding et al., 1989; Raine et al., 1992a; Lenzenweger and Korfine, 1994; Poreh et al., 1995; Suhr, 1997; Daneluzzo et al., 1998; Gooding et al., 1999; Tallent and Gooding, 1999), fewer completed categories and more failures in maintaining set (Lyons et al., 1991; Gooding et al., 1999). In those studies reporting deficits in schizotypal subjects, the effect size for percentage perseverative errors has ranged from moderate ($d=.55$ Suhr et al., 1995) to large ($d=.99$ Poreh et al., 1995; $d=.97$ Daneluzzo et al., 1998) and so, falls midway between the effect sizes generally reported for schizophrenic patients and for their relatives. Poreh et al. (1995) also found that high schizotypals performed significantly worse on the Trail Making Test (TMT) part B, but not for Design Fluency. Suhr (1997) also reported significantly worse performance by high schizotypals on the Stroop. Similarly, individuals clinically diagnosed with schizotypal personality disorder have also shown a greater degree of executive impairment on the WCST than healthy controls (Trestman et al., 1995; Vogelmaier et al., 1997; Diforio et al., 2000). Nevertheless, not all studies have found executive dysfunction in schizotypal subjects on the WCST (Condray and Steinhauer, 1992; Raine et al., 1992b; Lin et al., 2000; Jahshan and Sergi, 2007) or indeed, on other tests of executive function, including the Stroop (Spitznagel and Suhr, 2002), TMT (Suhr, 1997; Mitropoulou et al., 2002; Spitznagel and Suhr, 2002), verbal and semantic fluency (Trestman et al., 1995; Diforio et al., 2000; Kiang and Kutos, 2006) and the Tower of Hanoi/London task (Suhr, 1997; Diforio et al., 2000).

Despite the often-significant cognitive problems associated with having frontal lesions, it is notable that patients with frontal lobe lesions tend to *underestimate* their everyday executive difficulties (as measured by the dysexecutive (DEX) questionnaire: Wilson et al., 1996). In a similar vein, patients with schizophrenia often show a lack of insight and furthermore, that this shows a small but significant relationship with executive dysfunction (for a meta-analysis, see Aleman et al., 2006). A previous study using the DEX along with various executive measures in patients with schizophrenia, revealed no association between their impaired executive test performance and relatively good DEX self-ratings (Evans et al., 1997). Poor awareness of deficit on the DEX has also been found to correlate with poor executive functioning in patients with brain injury (Wilson et al., 1996). The DEX self-perception measure has not been used in schizotypal subjects; however, given the lack of insight in patients with schizophrenia, we might expect high schizotypal subjects to also show lowered awareness of any executive difficulties (as might be revealed on standardised tests).

As little doubt remains that executive functioning is one of the most impaired cognitive abilities in schizophrenia, it is important to determine if similar, but milder forms of executive dysfunction appear in schizotypal subjects (or unaffected relatives of schizophrenics). This psychometric high-risk approach is advantageous because it avoids the potential confounds of medication, lengthy hospitalization, and florid symptoms associated with studies of schizophrenic patients. The main aim of the current study is to test whether non-psychotic individuals who score high and on the Schizotypal Personality Questionnaire (SPQ-B: Raine and Benishay, 1995), show significantly worse performance on executive functioning tests when compared to individuals with a low SPQ-B scores; and to examine for differences in perceived everyday executive difficulties.

2. Method

2.1. Participants

A convenience sample of 65 undergraduate students (10 males and 55 females) aged between 18 and 48 years of age ($M=22.0$; S.D.$=6.4$ years) participated in the study. Participants were excluded if English was their second language, or they reported any history of head injury that may have resulted in unconsciousness or

Please cite this article as: Laws, K.R. et al. Awareness of everyday executive difficulties precede overt executive dysfunction in schizotypal subjects. Psychiatry Research (2007), doi:10.1016/j.psychres.2007.06.004

psychiatric illness history. The local ethical committee at the University of Hertfordshire approved the study.

2.2. Materials and procedure

All participants completed the following test battery: the Schizotypal Personality Questionnaire, Category and Letter fluency, the Zoo map test, the Hayling test and finally, the DEX questionnaire. These measures were chosen to cover a range of executive functions (e.g. Hayling — initiation speed and response suppression; Fluency — strategic retrieval processes and monitoring; Zoo map — planning) and to utilize time-based dependent variables to more sensitively tap the presence of executive problems.

2.2.1. Schizotypal Personality Questionnaire (SPQ-B: Raine and Benishay, 1995)

The SPQ-B (Raine and Benishay, 1995) is a 22 item dichotomous (yes–no) questionnaire derived from the larger SPQ questionnaire (Raine, 1991). The statements in the SPQ-B are based on the DSM-IIIR diagnostic criteria for schizotypal personality disorder. The questionnaire taps three main factors of the schizotypal personality: cognitive–perceptual (8 items) e.g. *When shopping do you get the feeling that other people are taking notice of you?*; interpersonal (8 items) e.g. *Do you feel that you are unable to get "close" to people?*; and disorganised (6 items) symptoms e.g. *I sometimes use words in unusual ways'*.

The three factors and total score from the SPQ-B have internal reliabilities ranging from .72 to .80, correlations with the full 74-item SPQ range from .89 to .94, and test–retest reliabilities across a two month interval between .86 and .95 (Axelrod et al., 2001; Raine and Benishay, 1995). Correlation between the SPQ-B and clinical interview measures of schizotypal personality disorder is good (ranging from .63 to .73). The original mean SPQ-B reported by Raine and Benishay (1995) was 9.6[S.D. = 5.3]; however, more recent studies suggest a smaller mean, e.g. Compton et al. (2007) reported $M = 5.2$ [S.D. = 4.1] and Mata et al. (2005) reported $M = 7.3$[S.D. = 4.2]. Mata et al. documented their top 10% as scoring 12+ and the lowest 10% scoring <3.

2.2.2. Category and letter fluency test (Goodglass and Kaplan, 1972; Benton and Hamsher, 1976)

These fluency tests measured the number of words generated in one minute. Four fluency tests were administered: two category tests 'animals' and 'fruits' and two letter tests 'F' and 'S'.

2.2.3. Zoo map subtest (Behavioural Assessment of the Dysexecutive Syndrome: Wilson, Alderman, Burgess, Emslie, and Evans, 1996)

The Zoo map was used to assess the ability to independently formulate and implement plans. In this test, participants are given a map of a zoo, a set of instructions describing places they need to visit in the zoo (e.g., elephant house, lion's cage) and rules they must not contravene (e.g. starting at the entrance and finishing at the picnic area, without using unshaded paths more than once and by only taking one camel ride). The experimenter recorded the amount of time spent planning and drawing (i.e. executing) a route.

2.2.4. Hayling sentence completion task (Burgess and Shallice, 1997)

The Hayling sentence completion test was administered to participants to measure response inhibition. The test involves hearing a sentence which the participant must complete with one word. In one condition (Automatic sentence), the sentence is completed by a meaningful word e.g. "The old house will be torn ……." — a correct response would be "down". In the second condition, the participant provides a word that is completely unconnected to the sentence (Inhibition sentence), e.g. "None of the books made any ……." a possible response might be 'button'. The word produced and the response time was recorded by the researcher on a response sheet for both sections. The total response time for all 15 items in each condition (automatic and inhibition) was the performance measure.

2.2.5. Dysexecutive questionnaire (Behavioural Assessment of the Dysexecutive Syndrome: Wilson, Alderman, Burgess, Emslie, Evans, 1996)

The DEX questionnaire obtained from the BADS battery of tests consisted of 20 statements that describe behaviour associated with the dysexecutive syndrome. An example of a question from the questionnaire is 'I have problems understanding what other people mean unless they keep things simple and straight forward'. The questionnaire uses a likert self-rating scale ranging from 'never' to 'often' (0–4). Two recent studies (Chan et al., 2001 and Wilson et al., 1996) revealed mean DEX scores of 22.12 (S.D. = 8.86) and 20.99 (S.D. = 9.63) in samples of 93 and 216 healthy subjects respectively.

The 20 items assess problems associated with the following four factors derived from 293 healthy subjects (Mooney et al., 2006): inhibition, intention, social regulation and abstract problem solving. Items in the first factor included those questions relating to the inability to inhibit behavioural and emotional responses.

Please cite this article as: Laws, K.R. et al. Awareness of everyday executive difficulties precede overt executive dysfunction in schizotypal subjects. Psychiatry Research (2007), doi:10.1016/j.psychres.2007.06.004

t1.1 Table 1
t1.2 Mean standard deviation performance on executive tasks for high and low schizotypal groups

t1.3 Test	High SPQ-B	Low SPQ-B	*F* value	Effect size
t1.4	*n*=(29)	*n*=(32)		*d* (95% CI)
t1.5 Letter fluency	12.60 (4.2)	12.02 (3.5)	*F*=1.84, ns	−0.15 (−.29 to −.02)
t1.6 Category fluency	17.50 (4.3)	16.98 (3.4)	*F*=0.38, ns	−0.13 (−.31 to −.04)
t1.7 Zoo planning (s)	98.48 (78.2)	79.19 (51.3)	*F*=0.93, ns	−0.28 (−.42 to −.16)
t1.8 Zoo drawing (s)	122.31(53.2)	119.56 (58.9)	*F*=0.11, ns	−0.04 (−.18 to .08)
t1.9 Hayling auto (s)	4.31 (5.9)	6.66 (7.7)	*F*=1.64, ns	0.34 (.20 to .47)
t1.10 Hayling inhib (s)	20.9 (20.6)	26.09 (22.4)	*F*=0.13, ns	0.25 (.36 to −.14)
t1.11 Total DEX score	31.76 (10.8)	21.28 (8.2)	*F*=13.81, *P*<.001	−1.07 (−1.24 to −.94)
t1.12 DEX inhibition	10.38 (4.2)	6.72 (3.1)	*F*=15.23, *P*<.001	−1.01 (−1.69 to −0.46)
t1.13 DEX intention	7.21 (3.3)	5.37 (2.3)	*F*=6.35, *P*=.015	−0.66 (−1.22 to −0.13)
t1.14 DEX social regulation	8.34 (3.7)	5.66 (3.0)	*F*=9.80, *P*=.002	−0.82 (−1.39 to −0.28)
t1.15 DEX abstract problem solving	5.97 (2.4)	3.56 (1.8)	*F*=19.57, *P*=.001	−1.15 (−1.78 to −0.58)

The intentionality factor includes items concerning planning and decision-making problems. The social regulation factor consists of items relating to emotional and social behaviour, lack of insight. The abstract problem-solving factor consists of items such as abstract thinking problems, perseveration, confabulation, and variable motivation.

3. Results

The participants were divided into two non-overlapping groups based on the mean SPQ-B scores (M=26.31; S.D.=10.78) and the data for four participants at the midpoint were removed. This resulted in 32 participants in the low SPQ-B group (M=3.8; S.D.=1.7; range 1–7) and 29 in the high SPQ-B group (M=11.3; S.D.=2.7; range 8–17). The high and low schizotypal groups did not differ in years of education (14.89 vs. 15.1: $F<1$) or sex ratio (high: 24 female and 5 male; low: 27 female and 5 male). The low SPQ group was significantly older than the high SPQ group (19.97 vs. 23.31: $F_{(1,\ 59)}=6.26$, $P=.015$) and so was included as a covariate in the analyses (although it made no difference to the outcomes). We recorded errors on the Zoo map and Hayling tasks, but the error rates were too low to analyse.

A one-way between groups MANOVA (involving all six cognitive measures and age as covariate) revealed no significant main effect for group on the omnibus test: $F_{(6,\ 53)}<1$. By contrast, a univariate ANCOVA for the self-report DEX measure revealed a main group effect with the high SPQ group reporting more executive problems ($F_{(1,\ 59)}=13.8$, $P<0.001$). Effect sizes were small, except for the DEX, which produced a large effect size (see Table 1). Further analysis and comparison of the high and low SPQ groups on the four subscales of the DEX revealed significant group differences for each factor.

3.1.1. Schizotypy factors and executive performance

To further investigate the relationship between SPQ and executive functioning, we correlated the subscale scores within the SPQ (disorganised, interpersonal, and cognitive–perceptual) with the subject scores on each executive task using Pearson's r.

The most notable finding was the large significant correlation of DEX scores with both the cognitive–perceptual syndrome and the disorganised syndrome (the correlation with the interpersonal syndrome failed to reach significance). The DEX also failed to correlate

t2.1 Table 2
t2.2 Correlations Pearson (*r*) between executive test performance, SPQ-B subscales and total DEX score

t2.3	SPQ cognitive–perceptual	SPQ interpersonal	SPQ disorganisation	Total DEX score
t2.4 Letter fluency	−.01	−.18	.28*	.16
t2.5 Category fluency	.17	−.23	.03	.14
t2.6 Zoo (planning time)	.02	.20	−.01	−.22
t2.7 Zoo (drawing time)	.14	−.11	−.05	−.07
t2.8 Hayling (automatic time)	−.10	−.11	−.13	−.05
t2.9 Hayling (inhibition time)	−.13	.13	.09	−.10
t2.10 DEX score	.40**	.24	.59**	–

t2.11 *$P<0.05$, **$P<0.01$.

Please cite this article as: Laws, K.R. et al. Awareness of everyday executive difficulties precede overt executive dysfunction in schizotypal subjects. Psychiatry Research (2007), doi:10.1016/j.psychres.2007.06.004

significantly with any of the executive measures (see Table 2).

4. Discussion

This study investigated whether undergraduate subjects scoring high on schizotypal traits show significantly worse performance on tests of executive functioning than low schizotypal scorers. High and low SPQ scorers failed to show differences on a variety of executive measures (letter and category fluency, the time taken to plan and draw a route, complete the Zoo map, the response time on the Hayling test for the connected and unconnected sentences). By contrast the high SPQ scorers did score significantly higher on the DEX i.e. a questionnaire tapping self-reported everyday executive problems; and this extended to all four factors of the questionnaire. Finally, the DEX scores were significantly correlated with scores on the disorganisation and cognitive–perceptual subscales of the SPQ. By contrast, the correlation between the DEX and the interpersonal subscale of the SPQ failed to reach significance.

It is unlikely that we failed to find any differences on the executive tasks because the 'high' schizotypal group was not extreme enough or because the study lacked power. Neither of these explanations would readily account for the very large effect size found in the same subjects for the DEX (post hoc power = .99). Of course, it remains possible that examination of a more extreme SPQ group might reveal some cognitive problems that emerge following the self-reported behavioural symptoms; however, our high and low group scores are comparable with those in previous work e.g. Mata et al., 2005; Compton et al., 2007. Additionally, of course, a different executive battery might be more sensitive to executive problems; however, we did choose timed tests to make measures as sensitive as possible. A recent study by Dinn et al. (2002) divided their healthy subjects into those scoring high, medium and low on the negative i.e. interpersonal subscale; or on the positive i.e. cognitive–perceptual features of the SPQ-B and examined for executive test performance differences. As in the current study, Dinn et al. (2002) found no differences for either subscale on measures of verbal fluency, TMT-A and B or the Stroop. Nonetheless, in the context of our finding enhanced awareness of executive problems, Dinn and colleagues did find self-rated differences on the Frontal Lobe Personality Scale (Grace and Malloy, 1992), which is a questionnaire tapping self-reported frontal lobe behaviours.

The failure to find impairments in executive functioning in the high SPQ group is inconsistent with some previous studies (Spaulding et al., 1989; Daneluzzo et al., 1998; Lenzenweger et al., 1991; Lyons et al., 1991; Raine et al., 1992a; Poreh et al., 1995; Suhr, 1997; Vogelmaier et al., 1997; Tallent and Gooding, 1999). Nevertheless, as noted in the Introduction, others have found evidence of no executive dysfunction in schizotypal subjects (Condray and Steinhauer, 1992; Trestman et al., 1995; Lin et al., 2000; Raine et al., 1992b; Diforio et al., 2000; Spitznagel and Suhr, 2002; Avons et al., 2003). One possible reason for the mixed findings may reflect the large reliance by many of the studies on the WCST and especially the perseverative measure. In the current study, we used a wide range of alternative executive tests (verbal fluency, semantic fluency, Zoo map test, and Hayling test), none of which found a significant difference. It is certainly not the case that the executive dysfunction in schizophrenic patients is restricted only to the perseverative measures from the WCST (for a review, Laws, 1999). It is also notable that a variety of measures of schizotypy have been used in such studies (however, only the SPQ-B taps the dimensions linked to all DSM diagnostic criteria).

The finding that high schizotypal participants scored higher on the DEX is perhaps surprising, since patients with acquired brain damage and degenerative disorders affecting the frontal lobes and moreover, schizophrenics show anosognosia i.e. *underestimate* their own executive problems (e.g. Wilson et al., 1996; Evans et al., 1997). Nonetheless, since constructs such as 'self-monitoring' and 'insight' are central to the broad concept of executive functioning, it is perhaps not surprising that underestimation occurs in patients with schizophrenia because of their lack of insight. Our finding of increased self-reporting of executive problems in the high SPQ group, however, accords with the notion that such individuals experience everyday problems and maintain a high degree of insight about those difficulties. This finding does, however, parallel a recent report of increased DEX scores in subjects reporting high levels of dissociative experiences. Hence both high schizotypals and high dissociative subjects may be hypervigilant to their executive failures (Bruce et al., in press). It is also possible that typical measures of executive functioning fail to capture the very real executive problems that high schizotypal and high dissociative subjects report. In this context, it is notable that patients with frontal lesions may perform within the normal range on tests of executive functioning, despite reporting experiencing difficulties in their daily lives (e.g. Shallice and Burgess, 1991). These findings suggest that executive functions may not solely be manifested at a cognitive level, measured by objective neuropsychological tests, but on a

Please cite this article as: Laws, K.R. et al. Awareness of everyday executive difficulties precede overt executive dysfunction in schizotypal subjects. Psychiatry Research (2007), doi:10.1016/j.psychres.2007.06.004

cognitive–behavioural level in daily-life tasks (Chan, 2001).

Since the two self-report measures correlated with each other, but not with cognitive test performance, this could be viewed as a possible response bias. Although some common variance overlap exists between the SPQ-B and the DEX, this accounted for less than 25% of the variance, suggesting a moderate overlap. It was notable that the DEX correlated significantly only the cognitive–perceptual and disorganisation subscales, but not with the interpersonal subscale. This suggests that the overlap with self-rated executive problems occurs more for the positive than the negative symptoms of schizotypy.

It is possible that because both scales are self-report based, that they may not be accurate reflections of an individual's psychological status and with no impairment on task performance, we might question the reliability of their responses or their insight. However, this is not unusual. For example, in several studies from the Edinburgh High Risk Study, examining young people who are at enhanced genetic risk of schizophrenia (Johnstone et al., 2000), no performance decrements have been found for the Hayling, Stroop and semantic fluency (Byrne et al., 1999; Whalley et al., 2004, 2005). Nonetheless, using fMRI, Whalley et al. (2004, 2005), they have found that compared to normal controls, those at high risk showed abnormal frontal lobe interactions when performing the Hayling test (even though no difference in test performance was noted). The latter suggests that abnormal brain activity may precede the appearance measurable cognitive disturbance. This might be viewed as consistent with the current finding of a dissociation between intact executive test performance and high self-rating of executive behaviours in everyday life. In other words, a heightened self-awareness of executive behavioural problems and even functional brain changes in high schizotypal subjects may precede the onset of clear deficits on executive tests themselves.

In summary, we have found no evidence of poor performance on executive tests in participants scoring highly on the SPQ-B. By contrast, the high SPQ group and in particular high scorers on the cognitive–perceptual and disorganisation features of schizotypy scored significantly higher on the DEX questionnaire. Heightened awareness of everyday executive dysfunction in schizotypal subjects was therefore more associated with the positive than the negative features of schizotypy. The finding of good levels of insight (into executive problems) in high schizotypal subjects suggests that the poor insight typically associated with schizophrenia may emerge only after illness onset (see Simon et al., 2006).

5. Uncited references

Bennett et al., 2005
Bogod et al., 2003
Chen et al., 2000
Krabbendam et al., 1999
Raine, 2005

References

Aleman, A., Agrawal, N., Morgan, K.D., David, A.S., 2006. Insight in psychosis and neuropsychological function: meta-analysis. British Journal of Psychiatry 189, 204–212.

Avons, S.E., Nunn, J.A., Chan, L., Armstrong, H., 2003. Executive functioning assessed by memory updating and random generation in schizotypal individuals. Psychiatry Research 120, 145–154.

Axelrod, S.R., Grilo, C.M., Sanislow, C., McGlashan, T.H., 2001. Schizotypal personality questionnaire-brief: factor structure and convergent validity in inpatient adolescents. Journal of Personality Disorders 15, 168–179.

~~Bennett, P.C., Ong, B., Ponsford, J., 2005. Measuring executive dysfunction in an acute rehabilitation setting: using the dysexecutive questionnaire DEX. Journal of the International Neuropsychological Society 11, 376–385.~~

Benton, A.L., Hamsher, K. deS., 1976. Multilingual Aphasia Examination. University of Iowa, Iowa City.

~~Bogod, N.M., Mateer, C.A., Macdonald, S.W.S., 2003. Self-awareness after traumatic brain injury: a comparison of measures and their relationship to executive function. Journal of International Neuropsychological Society 9, 450–458.~~

Bruce, A.S., Ray, W.J., Bruce, J.M., Arnett, P.A., Carlson, R.A., in press. The relationship between executive functioning and dissociation. Journal of Clinical and Experimental Neuropsychology.

Burgess, P.W., Shallice, T., 1997. The Hayling and Brixton Tests. Thames Valley Test Company, Bury St. Edmunds.

Byrne, M., Hodges, A., Grant, E., Owens, D.C., Johnstone, E.C., 1999. Neuropsychological assessment of young people at high genetic risk for developing schizophrenia compared with controls: preliminary findings of the Edinburgh High Risk Study EHRS. Psychological Medicine 29, 1161–1173.

Chan, R.C., 2001. Dysexecutive symptoms among a non-clinical sample: a study with the use of Dysexecutive Questionnaire. British Journal of Psychology 92, 551–565.

~~Chen, Y.L.R., Eric, Y.H., Felice, M., Lieh, 2000. Semantic verbal fluency deficit as a familial trait marker in schizophrenia. Psychiatry Research 95, 133–148.~~

Cohen, J., 1988. Statistical Power for the Behavioural Sciences. 2nd edn. Lawrence Erlbaum Associates, Hillsdale, NJ.

Condray, R., Steinhauer, S.R., 1992. Schizotypal personality disorder in individuals with and without schizophrenic relatives: similarities and contrasts. Schizophrenia Research 7, 33–41.

Compton, M.T., Chien, V.H., Bollini, A.M., 2007. Psychometric properties of the Brief Version of the Schizotypal Personality Questionnaire in relatives of patients with schizophrenia-spectrum disorders and non-psychiatric controls. Schizophrenia Research 91, 122–131.

Daneluzzo, E., Bustini, M., Stratta, P., Casacchi, M., Rossi, A., 1998. Schizotypal personality questionnaire and Wisconsin Card Sorting Test in a population of DSM-III-R schizophrenic patients and controls. Comprehensive Psychiatry 39, 143–148.

Please cite this article as: Laws, K.R. et al. Awareness of everyday executive difficulties precede overt executive dysfunction in schizotypal subjects. Psychiatry Research (2007), doi:10.1016/j.psychres.2007.06.004

Dinn, W.M., Harris, C.L., Aycicegi, A., Green, P., Andover, M.S., 2002. Positive and negative schizotypy in a student sample: neurocognitive and clinical correlates. Schizophrenia Research 56, 171–185.

Evans, J.J., Chua, E., McKenna, P.J., Wilson, B.A., 1997. Assessment of the dysexecutive syndrome in schizophrenia. Psychological Medicine 27, 635–646.

Goodglass, H., Kaplan, E., 1972. Assessment of Aphasia and Related Disorders. Lea and Febiger, Philadelphia.

Gooding, D.C., Kwapil, T.R., Tallent, K.A., 1999. Wisconsin Card Sorting Test in schizotypic individuals. Schizophrenia Research 40, 201–209.

Heinrichs, R.W., Zakzanis, K.K., 1998. Neurocognitive deficit in schizophrenia: a quantitative review of the evidence. Neuropsychology 12, 426–445.

Hill, K., Mann, L., Laws, K.R., Stephenson, C.M., Nimmo-Smith, I., McKenna, P.J., 2004. Hypofrontality in schizophrenia: a meta-analysis of functional imaging studies. Acta Psychiatrica Scandinavica 110, 243–256.

Jahshan, C.S., Sergi, M.J., 2007. Theory of mind, neurocognition and functional status in schizotypy. Schizophrenia Research 89, 278–286.

Johnstone, E.C., Abukmeil, S.S., Byrne, M., Clafferty, R., Grant, E., Hodges, A., Lawrie, S.M., Owens, D.G.C., 2000. Edinburgh high risk study — findings after four years: demographic, attainment and psychopathological issues. Schizophrenia Research 46, 1–15.

Kiang, M., Kutos, M., 2006. Abnormal typicality of responses on a category fluency task in schizotypy. Psychiatry Research 145, 119–126.

~~Krabbendam, L., de Vugt, M.E., Derix, M.M.A., Jolles, J., 1999. The Behavioural Assessment of the Dysexecutive Syndrome as a tool to assess executive functions in schizophrenia. Clinical Neuropsychologist 13, 370–375.~~

Laws, K.R., 1999. A meta-analytic review of Wisconsin Card Sort Studies in schizophrenia: general intellectual deficit in disguise? Cognitive Neuropsychiatry 4, 1–35.

Lenzenweger, M., Korfine, L., 1994. Perceptual aberrations, schizotypy, and the Wisconsin Card Sorting Test. Schizophrenia Bulletin 20, 345–357.

Lenzenweger, M.F., Cornblatt, B.A., Putnick, M., 1991. Schizotypy and sustained attention. Journal of Abnormal Psychology 100, 84–89.

Lin, C.C.H., Chen, W.J., Yang, H-J., Hsiao, C.K., Tien, A.Y., 2000. Performance on the Wisconsin Card Sorting Test among adolescents in Taiwan: norms, factorial structure and relation to schizotypy. Journal of Clinical and Experimental Neuropsychology 22, 69–79.

Lyons, M.J., Meria, M.E., Young, L., Kremen, W.S., 1991. Impaired cognitive functioning in symptomatic volunteers with schizotypy: preliminary findings. Biological Psychiatry 30, 424–426.

Mata, I., Mataix-Cols, D., Peralta, 2005. Schizotypal Personality Questionnaire-Brief: factor structure and influence of sex and age in a nonclinical population. Personality and Individual Differences 38, 1183–1192.

Mitropoulou, V., Harvey, P.D., Maldari, L.A., Moriarty, P.J., New, A.S., Silverman, J.M., Siever, L.J., 2002. Neuropsychological performance in schizotypal personality disorder: evidence regarding diagnostic specificity. Biological Psychiatry 52, 1175–1182.

Mooney, B., Walmsley, C., McFarland, K., 2006. Factor analysis of the self-report dysexecutive (DEX-S) questionnaire. Applied Neuropsychology 13, 12–18.

Poreh, A.M., Ross, T.P., Whitman, R.D., 1995. Reexamination of executive functions in psychosis-prone college students. Personality and Individual Differences 18, 535–539.

Raine, A., 1991. The SPQ: a scale for the assessment of schizotypal personality based on DSM-III-R criteria. Schizophrenia Bulletin 17, 556–564.

Raine, A., ~~2005~~, Schizotypal personality: neurodevelopmental and psychosocial trajectories. Annual Review in Clinical Psychology 2, 291–326.

Raine, A., 2006. Schizotypal personality: neurodevelopmental and psychosocial trajectories. Annual Review of Clinical Psychology 2, 291–326.

Raine, A., Benishay, D., 1995. The SPQ-B: a brief screening instrument for schizotypal personality disorder. Journal of Personality Disorders 9, 346–355.

Raine, A., Triphon, N., Kim, D., Hesler, A., Bird, L., Lencz, T., Redmon, M., Scerbo, A., 1992a. Schizotypal personality: factor structure, sex differences, psychiatric differences, genetics, psychophysiology and neuropsychology. Paper presented at the 1992 Western Psychological Association Meeting, Portland, Ore.

Raine, A., Sheard, C., Reynolds, G.P., Lencz, T., 1992b. Pre-frontal structural and functional deficits associated with individual differences in schizotypal personality. Schizophrenia Research 27, 45–53.

Shallice, T., Burgess, P.W., 1991. Deficits in strategy applications following frontal lobe damage in man. Brain 114, 727–741.

Simon, A.E., Begrer, G.E., Giacomini, V., Ferrero, F., Mohr, S., 2006. Insight, symptoms and executive function in schizophrenia. Cognitive Neuropsychiatry 11, 437–451.

Sitskoorn, M.M., Aleman, A., Ebisch, S.J.H., Apples, M.C.M., Kahn, R.S., 2004. Cognitive deficits in relatives of patients with schizophrenia: a meta-analysis. Schizophrenia Research 71, 285–295.

Szöke, A., Schürhoff, F., Mathieu, F., Meary, A., Ionescu, S., Leboyer, M., 2005. Tests of executive function in first-degree relatives of schizophrenic patients: a meta-analysis. Psychological Medicine 35, 771–782.

Spaulding, W., Garbin, C.P., Dras, S.R., 1989. Cognitive abnormalities in schizophrenic patients and schizotypal college students. Journal of Nervous Mental Disease 177, 717–728.

Spitznagel, M.B., Suhr, J.A., 2002. Executive function deficits associated with symptoms of schizotypy and obsessive–compulsive disorder. Psychiatry Research 110, 151–163.

Suhr, J.A., 1997. Executive functioning deficits in hypothetically psychosis-prone college students. Schizophrenia Research 27, 29–35.

Tallent, K.A., Gooding, D.C., 1999. Working memory and Wisconsin Card Sorting Test performance in schizotypic individuals: a replication and extension. Psychiatry Research 89, 161–170.

Vogelmaier, M.M., Siedman, L., Salisbury, D., McCarly, R.W., 1997. Neuropsychological dysfunction in schizotypal personality disorder: a profile analysis. Biological Psychiatry 41, 530–540.

Whalley, H.C., Simonotto, E., Flett, S., Marshall, I., Ebmeier, K.P., Owens, D.G.C., Goddard, N.H., Johnstone, E.C., Lawrie, S.M., 2004. fMRI correlates of state and trait effects in subjects at genetically enhanced risk of schizophrenia. Brain 127, 478–490.

Whalley, H.C., Simonotto, E., Flett, S., Marshall, I., Owens, D.G.C., Goddard, N.H., Johnstone, E.C., Lawrie, S.M., 2005. Functional disconnectivity in subjects at high genetic risk of schizophrenia. Brain 128, 2097–2108.

Wilson, B.A, Alderman, N., Burgess, P.W, Emslie, H., Evans, J.J., 1996. Behavioural Assessment of the Dysexecutive Syndrome. Thames Valley Test Company, Bury St Edmunds, England.

Please cite this article as: Laws, K.R. et al. Awareness of everyday executive difficulties precede overt executive dysfunction in schizotypal subjects. Psychiatry Research (2007), doi:10.1016/j.psychres.2007.06.004