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Self-monitoring dysfunction and the schizophrenic symptoms of alien control

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ABSTRACT

Background. Frith & Done (1988) have proposed that the experience of alien control symptoms in schizophrenia is related to a failure by such individuals to monitor effectively their own willed intentions, actions and thoughts.

Method. To examine this hypothesis, a heterogeneous group of 35 patients, all carrying a DSM-III-R diagnosis of schizophrenia (or schizophreniform psychosis) and 24 non-patient controls, completed a battery of neuropsychological and cognitive tests, which *inter alia*, included four putative measures of self-monitoring. Patients took part in a detailed clinical interview to assess current levels of symptomatology.

Results. Patients generally performed at a lower level on most components of the test battery, including the four self-monitoring tests. Moreover, patients currently experiencing symptoms of alien control tended to experience greater difficulty with each of the self-monitoring tests; an effect that was relatively independent of neuropsychological or general cognitive function.

Conclusions. The relationship between poor self-monitoring and the presence of alien control symptoms provides support for Frith & Done's account of the origins of these symptoms in schizophrenia.

INTRODUCTION

Over recent years, there has been renewed interest in the contributions of neuropsychological deficits to the clinical manifestations of schizophrenia. Frith (1987) and Frith & Done (1988) have developed a neuropsychological model of schizophrenia in which it is proposed that certain positive psychotic symptoms result from a failure to monitor properly internally generated intentions to act. These can be regarded as relating to the experience of alien control and they include such apparently disparate symptoms as thought insertion or withdrawal, delusions of control, auditory hallucinations and passivity phenomena. The theory also suggests that many negative features, such as social withdrawal, avolition, alogia and anhedonia, arise from a failure to initiate spontaneous actions.

Frith & Done's model proposes that actions may arise by two distinct routes. In the first, actions are responses to external or environmental stimuli, while in the second, actions are self-generated, arising as a result of willed intentions. The authors propose that ordinarily, and irrespective of the route, people constantly (and usually unconsciously) monitor their actions against their intentions. However, should the monitoring system become defective, or should information regarding self-generated actions fail to reach it, then the individual might misattribute self-generated actions as having non-self origins. It is this misattribution that is

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seen as underlying the development of symptoms of alien control.

Despite the inherent problems in attempting to conduct research into such hypothetical constructs as willed intentions and self-monitoring, Frith & Done's model has received support from experimental scrutiny. A number of findings, which pre-date the publication of Frith & Done's model, have been successfully re-interpreted within the self-monitoring dysfunction paradigm. For example, Braff *et al.* (1977) reported that, unlike healthy controls, schizophrenic patients failed to show the normal attenuation of cortical evoked potentials in response to tones that they themselves had initiated, which is consistent with a failure to monitor willed intentions. Malenka *et al.* (1982), using a visual choice reaction time test, found that schizophrenic subjects were much less likely to correct errors than were control subjects. Subsequently, Frith & Done (1989) used a more sophisticated version of Malenka's procedure, involving the control of a projectile depicted on a computer screen, to confirm this finding in drug-free schizophrenic patients. Although the sample size was small, the results implied that rapid error correction was especially poor in those patients exhibiting symptoms of alien control.

A number of groups have examined self-monitoring using tests of memory. Frith *et al.* (1991) demonstrated impaired performance in schizophrenic patients on the Memory for Action test (MFA). As this test requires subjects to differentiate words that they had said from words that had been said to them by the experimenter, this may provide further evidence of a self-monitoring impairment, although test performance was not associated specifically with symptoms of alien control. Brébion *et al.* (1996) also reported similar findings, although patients showed impairments in other aspects of source memory that would not necessarily involve self-monitoring. More recently, Stirling *et al.* (1997), using a modification of the MFA test which had been designed to test self-monitoring more specifically, also reported poorer performance among schizophrenic patients. However, there were no clear associations with symptoms of alien control, and it was not possible to discount the interpretation that self-monitoring deficiency is simply one component of a wider ranging cognitive failure involving many executive and mnemonic functions.

Research findings from studies in the non-verbal domain have tended to provide better support for Frith & Done's model. For example, Garrud *et al.* (1989), using a reaction time paradigm, demonstrated that a group of schizophrenic patients with symptoms of alien control were slower to correct errors than both healthy non-patients and chronic schizophrenic patients.

Mlakar *et al.* (1994) tested self-monitoring using a paradigm involving the production and identification of drawings. Schizophrenic patients who were experiencing symptoms of alien control were compared with patients who were not, and with healthy controls. In two simple but elegant experiments, Mlakar *et al.* found that their 'alien control' group of patients made more errors as the task demands put a greater burden on self-monitoring. Although this study is perhaps one of the most convincing indications of a self-monitoring deficit in schizophrenia, the findings must still be regarded with some caution as other measures of cognitive function, such as current IQ and recognition memory, were not reported. This leaves open the possibility that the group differences attributed to defective self-monitoring may, in fact, reflect more general neuropsychological deficits.

Clearly, there now exists a sizeable body of evidence suggesting self-monitoring impairments in schizophrenia, yet a number of important questions remain unanswered. For a variety of reasons, the relationship between self-monitoring and symptoms of alien control has not always been apparent. Moreover, it is difficult to discount the possibility that self-monitoring impairments simply reflect a wider pattern of cognitive deficiencies. Thus, in the present study, we set out to assess self-monitoring ability in schizophrenia, using both timed error-correction tasks and a group of tests involving the monitoring of drawings. The drawing tests, in particular, are considerably less complex than those used in earlier studies, and were designed so as to allow specific impairments in self-monitoring to be distinguished from abnormalities in cognitive function more generally. In order to examine this issue further, the putative self-monitoring tests were augmented with a series of more conventional tests of IQ, executive function and memory.

METHOD

Participants

Thirty-five patients were recruited to take part in the study on the basis that: (*a*) they were considered by their psychiatrist to be suffering from schizophrenia; (*b*) they were aged between 16 and 55 at time of initial diagnosis; and (*c*) there was no evidence of current drug misuse or organic brain disease. Information obtained from review of the case notes, discussion with the patient's psychiatrist and clinical interview was collated. Comparisons with published guidelines confirmed that all patients met DSM-III-R criteria for schizophrenia or schizophreniform psychosis (2 patients) (APA, 1987).

Seventeen participants were in-patients in a local hospital department of psychiatry at the time of testing (14 from an acute ward, and 3 from a long-stay rehabilitation ward); 14 were recruited from the day hospital; and 4 from the hospital depot clinic. The mean age of this group was 41 years (range 22–61). There were 21 males and 14 females. The average duration of treated illness was 158 months. All but one subject were receiving neuroleptic medication at the time of testing (average dose in chlorpromazine equivalents per day = 821 mg).

Twenty-four control subjects were recruited from among hospital and university personnel. These subjects stated that they had not previously suffered from, or been treated for, psychological illness, and all responded negatively to a series of preliminary screening questions compiled to identify individuals currently suffering from psychological disorder. The mean age of this group was 39 years (range 24–62).

Clinical assessment

All patients completed a detailed clinical interview lasting approximately 1 h. From the interview it was possible to rate participants in respect of current symptomatology on the Schedules for the Assessment of Positive (SAPS) and Negative (SANS) Symptoms (Andreasen, 1981; Andreasen & Olsen, 1982).

Procedure

All subjects completed a battery of putative self-monitoring and neuropsychological tests, taking approximately 45 min to complete, usually on the same day as the clinical interview. Data were collected by the third author and clinical ratings were made without reference to neuropsychological test performance.

Self-monitoring tests

Four tests were devised, based loosely on the procedures described by Garrud *et al.* (1989) (test 1; versions A and B) and Mlakar *et al.* (tests 2, 3 and 4). The 'odd–even' and 'left–right' tests (1A and 1B) were intended to predispose respondents to make anticipatory errors that had to be corrected as quickly as possible. The drawing tests (2, 3 and 4) required participants to generate simple images that they later had to identify from other identical drawings presented in different orientations. There were different levels of feedback in each of the three drawing tests, but no requirement for rapid responding.

Test 1A: odd–even test (*error correction time*)

The subject viewed the screen of a note-book computer upon which was presented (at a rate of one every 4 s) an alternating sequence of randomly generated odd or even digits (1–9). The subject was required to press a button on a hand set (marked EVEN) each time an even digit was shown, and a different button (marked ODD) each time an odd digit was shown. The alternating sequence was occasionally (and unpredictably) broken by the presentation of two successive odd or even numbers, often prompting anticipatory errors. The visual display remained on screen until the subject had corrected the error, and the time taken to do this was recorded by the computer. There were 20 sequence disruptions quasi-randomly embedded in 200 stimulus presentations.

Test 1B: left–right test (*error correction time*)

The procedure and scoring in this test were identical to the odd–even test except that the critical stimuli (geometric shapes) were now presented either to the left (or right) of the centre of the computer screen, requiring a LEFT or RIGHT button press by the subject. Once again, there was a total of 200 presentations, with 20 breaks in the predictable alternating sequence.

Subjects were given the opportunity to practice each of these tests until they felt confident about the procedures.

Table 1. *Patient* v. *controls: age, pre-morbid and current IQ, IQ decline*

	Patients		Controls		
	Mean	S.D.	Mean	S.D.	Probability*
Age	41·29	12·94	37·71	10·05	NS
Pre-morbid IQ (NART)	107·29	7·41	110·21	6·84	NS
Current IQ (QT)	94·21	11·41	108·52	7·24	$P < 0{\cdot}001$
IQ decline (NART–QT)	13·08	8·99	1·69	2·55	$P < 0{\cdot}001$

* *t* test for independent samples. All probabilities two-tailed.

Test 2: own drawing, no feedback

Subjects were asked to make a series of 'creative/abstract' drawings of their own choice on separate squares of paper (12 cm by 12 cm) located out of sight of the subject behind a small curtain. Objects that could be named (e.g. a car, house, etc.) were not permitted. In fact, by using carbonized paper, the subject actually produced four copies of his/her drawing. Immediately after each trial, the four copies (randomly rotated 0°, 90°, 180° or 270°) were presented to the subject who had to select the correct orientation in which the drawing had originally been made.

Test 3: instructed drawing, no feedback

This test employed an identical procedure to the preceding one, except that subjects were now told explicitly what to draw (e.g. wavy lines, zig-zags, overlapping circles, etc.). Once again, an orientation recognition test was undertaken after each drawing.

Test 4: instructed drawing, with feedback

This test employed the same procedure as test 3, except that the subject was now able to watch him/herself draw each of the objects.

In addition to the practice trials, eight trials were recorded for each of the three drawing tests (making 24 recognition trials altogether). It was anticipated that the tests would put differing levels of demand on self-monitoring, with performance on test 2 requiring the greatest and test 4 the least vigilant monitoring.

Neuropsychological test battery

Continuous performance test (CPT)

This test, based on the procedure of Rosvold *et al.* (1956), was administered as described by Frith *et al.* (1991).

Visuospatial recognition memory test (VRMT)

This test was based upon Warrington's (1984) procedure except that stimuli comprised 15 cards, each bearing a different abstract pattern, shown at the rate of one every 3 s. Subjects were then tested on recognition memory, with each target pattern being presented alongside three hitherto unseen patterns.

Stroop test (word and colour)

In this test, first described by Stroop (1935), subjects were shown a card with the words BLUE, RED, GREEN, and TAN (printed in contrasting colours) arranged in four columns. In the word task, subjects were required to read the words as quickly as possible, ignoring their colours, while in the colour task the task was to identify the colour in which each word was printed.

Trail making test (forms A and B)

Conventional trail-making tests were administered, as first described by Reitan (1958).

Tests of general cognitive function

Quick Test (QT)

Ammons & Ammons' (1962) instructions and procedure for Form 1 were followed, although

Table 2. *Patients* v. *controls: tests of self-monitoring*

Self-monitoring test	Patients Mean	Patients S.D.	Controls Mean	Controls S.D.	Probability*
Average error correction time (ms) tests 1A and 1B combined	2304	848·18	1873	270·26	0·016
Average number of anticipatory errors in tests 1A and 1B	3·14	3·56	1·11	1·14	0·003
Drawing test 2	4·14	2·51	5·91	1·28	< 0·001
Drawing test 3	5·05	2·18	7·34	1·37	< 0·001
Drawing test 4	6·63	1·72	7·78	0·85	0·004

* Analysis of variance. All probabilities two-tailed.

the test was introduced as a picture game rather than an IQ test. Scores were converted to give estimated current IQ equivalents using the published conversion table.

National Adult Reading Test (*NART*)

This test was devised by Nelson & O'Connell (1978) and in non-clinical samples is highly correlated with other measures of verbal IQ.

RESULTS

Comparison of patients and controls: age and IQ

There was no significant difference between groups in respect of age or pre-morbid IQ (as estimated by NART). There was a significant difference in terms of current IQ (measured by QT), and IQ decline. These data are shown in Table 1.

Comparison of patients and controls: tests of self-monitoring

These data are show in Table 2. Data from the two error correction tests (tests 1A and 1B) were amalgamated, and although our interest was primarily with correction speed, we also recorded the number of errors made on each test. Results suggest that patients were slower to correct errors ($P = 0{\cdot}016$) and made more errors overall ($P = 0{\cdot}003$). There was a significant difference in recognition score between patients and controls for each of the three drawing tests, with the performance of patients becoming progressively poorer as demands on self-monitoring increased (group by tests interaction: $F = 18{\cdot}47$, 2 = df, $P < 0{\cdot}001$).

Comparison of patients and controls: other neuropsychological tests

These data are shown in Table 3. The results indicate that schizophrenic subjects performed at a significantly worse level than controls on the CPT ($P = 0{\cdot}05$), recognition memory ($P = 0{\cdot}015$), both Stroop tests ($P = 0{\cdot}035$ and $P < 0{\cdot}001$) and both Trails tests ($P < 0{\cdot}001$).

Relationship of neuropsychological, IQ and self-monitoring tests within the patient group

Average error correction time (tests 1A and 1B) was correlated significantly with performance on drawing test 2 ($r = -0{\cdot}364$, $P = 0{\cdot}048$), but not with test 3 ($r = -0{\cdot}307$) or test 4 ($r = -0{\cdot}342$). No significant correlations were seen with any other neuropsychological assessment, or with number of errors made.

Our three self-monitoring drawing tests correlated highly significantly with one another (tests 2 and 3, $r = 0{\cdot}938$; tests 2 and 4, $r = 0{\cdot}854$; tests 3 and 4, $r = 0{\cdot}818$; all $P < 0{\cdot}001$). Combined performance on all three drawing tests was correlated with CPT ($r = 0{\cdot}360$, $P = 0{\cdot}035$), indicating a modest but significant association between poor self-monitoring of drawings and increased tendency towards errors on the CPT. Otherwise, the self-monitoring drawing tests did not correlate significantly with any of the other neuropsychological measures.

To complete the analysis, the relationship of error rate and general test performance was investigated. Combined error rate on the two error correction tests correlated significantly with CPT performance ($r = -0{\cdot}559$, $P < 0{\cdot}001$), and with current IQ ($r = -0{\cdot}452$, $P = 0{\cdot}006$). It also correlated with Stroop (words) ($r = 0{\cdot}391$,

Table 3. *Patients* v. *controls: other tests of neuropsychological functioning*

Neuropsychological test	Patients Mean	Patients S.D.	Controls Mean	Controls S.D.	Probability*
CPT	17·65	4·29	19·42	0·83	0·050
Stroop: Colours (time: s)	67·03	32·92	51·82	11·67	0·035
Stroop: Words (time: s)	174·43	51·99	121·79	40·95	< 0·001
Trail test A (time: s)	59·53	24·27	29·36	10·35	< 0·001
Trail test B (time: s)	113·24	50·04	79·25	40·68	< 0·001
VRMT (number correct)	7·80	2·48	9·33	2·01	0·015

* Analysis of variance. All probabilities two-tailed.

Table 4. *Patients* v. *controls: self-monitoring tests with covariates*

Self-monitoring test	ANOVA probability	Probability with ANCOVAR Covariate: Current IQ	Covariate: CPT	Covariate: VRMT
Average error correction time (ms) tests 1A and 1B combined	0·016	NS	NS	—
Average number of anticipatory errors tests 1A and 1B combined	0·003	NS	NS	—
Drawing test 2	< 0·001	0·009	< 0·001	< 0·001
Drawing test 3	< 0·001	0·017	< 0·001	< 0·001
Drawing test 4	0·004	NS	0·020	0·023

$P = 0{\cdot}033$) and Trails tests A and B ($r = 0{\cdot}601$, $P < 0{\cdot}001$; and $r = 0{\cdot}460$, $P = 0{\cdot}021$ respectively).

Comparisons between patients and controls revisited: self-monitoring with covariates

Because of the associations described above, we repeated some of the comparisons reported in section two for error correction speed and error rate, and the three drawing tests, using analysis of covariance. For error correction time estimated current IQ and CPT performance were entered as covariates. In each case, the analysis rendered the main effect non-significant.

For the drawing tests, estimated current IQ, CPT and picture recognition memory were included as covariates. With current IQ, the difference in performance on test 4 no longer reached significance, while for tests 2 and 3 the main effects remained significant. With CPT and picture recognition memory scores as covariates, all the main effects remained significant. These data and analyses are shown in Table 4.

Self-monitoring, symptoms of alien control, other symptomatology and the influence of medication

We examined the relationships of patients' scores on each of the four self-monitoring tests with selected individual and summary symptom scores associated with alien control from the SAPS. The individual symptoms chosen were auditory hallucinations, thought insertion and delusions of control, while the summary scores used were global ratings of delusions, hallucinations and formal thought disorder. Mean error-correction speed correlated with delusions of control ($r = 0{\cdot}477$, $P = 0{\cdot}008$), thought insertion ($r = 0{\cdot}506$, $P = 0{\cdot}004$) and global formal thought disorder ($r = 0{\cdot}450$, $P = 0{\cdot}013$). Stepwise regression analysis indicated that the only clinical variable predictive of error correction speed was thought insertion ($t = 2{\cdot}831$, $P = 0{\cdot}010$), accounting for almost 23% of the variance.

The three drawing tests were correlated significantly with all the symptom scores identi-

Table 5. *Correlations* (*and probabilities*) *between self-monitoring test performance and current symptom profile: symptoms of alien control, negative symptom summary scores and general psychopathology* (*patients only*)

	Average error correction time (tests 1A and 1B combined)	No. of anticipatory tests (tests 1A and 1B combined)	Drawing test 2	Drawing test 3	Drawing test 4
SAPS: Auditory hallucinations	0·306	0·066	−0·652	−0·617	−0·671
	NS	NS	< 0·001	< 0·001	< 0·001
SAPS: Delusions of control	0·478	0·184	−0·582	−0·512	−0·615
	0·008	NS	< 0·001	< 0·002	< 0·001
SAPS: Thought insertion	0·506	−0·082	−0·515	−0·573	−0·571
	0·004	NS	0·002	< 0·001	< 0·001
SAPS: Global hallucinations	0·231	−0·122	−0·540	−0·504	−0·564
	NS	NS	0·001	0·003	0·001
SAPS: Global delusions	0·238	0·044	−0·463	−0·504	−0·389
	NS	NS	0·005	0·003	0·021
SAPS: Global formal thought disorders	0·450	0·220	−0·591	−0·623	−0·705
	0·013	NS	< 0·001	< 0·001	< 0·001
SANS: Global affect	−0·176	−0·054	0·005	−0·049	−0·072
	NS	NS	NS	NS	NS
SANS: Global alogia	−0·007	−0·048	0·149	−0·231	−0·277
	NS	NS	NS	NS	NS
SANS: Global anhedonia	−0·022	0·086	−0·290	−0·247	−0·323
	NS	NS	NS	NS	NS
SANS: Global attention	−0·067	0·142	−0·078	−0·068	−0·107
	NS	NS	NS	NS	NS
SANS: Global avolition	−0·001	0·035	−0·147	−0·168	−0·191
	NS	NS	NS	NS	NS
PANSS: General psychopathology	0·585	0·260	−0·535	−0·584	−0·615
	0·030	NS	0·001	< 0·001	< 0·001

fied above, with coefficients ranging from −0·389 to −0·705. These correlations are tabulated in Table 5, and indicate a strong relationship between presence of these symptoms of alien control and poor performance on our self-monitoring tests. Stepwise regression demonstrated that overall performance on the drawing tests was best predicted by auditory hallucinations ($t = 5{\cdot}025$, $P < 0{\cdot}001$), which alone accounted for almost 44% of total variance, with global formal thought disorder ($t = 2{\cdot}801$, $P < 0{\cdot}010$) accounting for a further 12% of variance.

In contrast to the associations reported above, correlational and regression analyses failed to show any consistent relationships between symptoms of alien control and performance on general neuropsychological tests. Similarly, correlations between patients' scores on the self-monitoring tests and the five summary scales of the SANS uniformly failed to reach statistical significance.

Neuroleptic medication at time of testing was recorded for each patient, and converted, using standard published tables, into daily chlorpromazine equivalent dosage. This measure was unrelated to performance on both self-monitoring and neuropsychological tests.

Finally, we compared test scores of the 10 patients who were receiving anti-cholinergic medication with those of the 25 patients who were not. The only significant difference was a superior performance on the CPT among patients receiving anti-cholinergics ($P = 0{\cdot}025$).

DISCUSSION

We have compared the performance of a heterogenous group of schizophrenic patients with that of a group of healthy controls on a neuropsychological test battery which included several putative measures of self-monitoring. Our findings indicate that patients with schizophrenia evince a broad neuropsychological test deficit profile. However, our principal findings provide strong support for the hypothesis that patients who are currently experiencing symptoms of alien control perform particularly poorly on tests of self-monitoring. Furthermore, impairment in self-monitoring appears unrelated

to both general cognitive or neuropsychological performance. In addition, severity of alien control symptoms in our sample was independent of general cognitive performance.

It was our intention that the drawing tests should make differing demands on self-monitoring: test 2 required the subject to invent his/her own sketch out-of-sight; test 3 required the subject to produce a sketch to instruction (e.g. 'draw a spiral') but again without visual feedback, and test 4 engaged the subject in a directed drawing task, but with full visual feedback. Thus, test 2 made the most and test 4 the least demand on self-monitoring mechanisms. Table 2 indicates that our patients generally found test 2 the most difficult, subsequently recognizing the correctly orientated drawing on just over 50% of trials. Recognition rate among the patients for tests 3 and 4 was 72·5% and 83·5% respectively. (Chance performance would be 25%.) Within the patient group, the tests correlated very highly with one another, and performance on all three tests correlated inversely with presence of symptoms of alien control.

These results strongly supporting the findings from Mlakar *et al.*'s second experiment. However, our inclusion of measures of both general and specific neuropsychological functioning, as covariates, allowed us to re-examine patient–control differences using analysis of covariance. Results shown in Table 4 indicate that when CPT or picture recognition memory performance were selected as covariates, neither eliminated the main effect. Even the use of current IQ failed to eliminate the significance of the main effect in two of the three drawing tests, though it reduced to trend significance ($P < 0{\cdot}100$) the main effect for test 4.

We thus feel confident in concluding that the generally poor performance of our schizophrenic patients on the drawing tests was independent of (or at least additional to) general neuropsychological deficits as measured by CPT or QT, or to impairments in recognition memory. The simplicity of the tests, together with the absence of any time constraints on performance, compel us to the view that they do indeed provide a measure of the effectiveness of self-monitoring. The pronounced correlations between drawing test performance and symptoms of alien control lends further support to Frith & Done's model of the origin of such symptoms and suggests that these develop when self-monitoring mechanisms are impaired or ineffective.

Our other putative self-monitoring test, which was modelled on the procedures of Garrud *et al.* produced more equivocal results. Although patients, as predicted, had slower error correction times, statistical significance was lost once current IQ and CPT performance were included as covariates. Only modest correlations were found between error correction time and performance on the drawing tests, but, as predicted, error correction time was associated significantly with the symptoms of delusions of alien control, thought insertion and the global measure of formal thought disorder, and regression analysis identified thought insertion as the best predictor of slow correction speed.

The rapidity of error correction in normal subjects has been amply demonstrated by Megaw (1972) and Rabbitt & Vyas (1981), and has been assumed by Frith & Done (1989) to depend on an intact self-monitoring system. The rationale for this view is that rapid error correction, in the absence of feedback, necessitates the subject making a comparison of what s/he did, with what s/he had intended doing. Therefore, only if a mis-match is identified will a correction be generated. Frith & Done, using an adaptation of an error correction procedure initially described by Malenka *et al.* (1982), demonstrated that schizophrenic patients who were experiencing symptoms of alien control had slower error correction times than patients who were not. Our results are consistent with these findings, but the difference between patients and controls is reduced when current IQ and CPT performance are included as covariates.

Clearly, in order to correct errors, subjects had firstly to make them. In fact, all but four of the patients made and corrected at least one error, while 10 of the controls remained error free. Error production reflects a failure in the monitoring of external stimuli rather than internally generated willed intentions, and thus cannot be considered a measure of self-monitoring. Nevertheless, our patient group did generate significantly more errors on average than control subjects and error rate was associated with poor performance on other neuropsychological tests. These findings, coupled with

the modest correlations between error correction speed and the drawing tests within the patient group, lead us to conclude that the poor performance of patients in error correction may be more a reflection of attentional deficits or general cognitive dysfunction than of self-monitoring deficiencies *per se*.

This is not to say that shortcomings in self-monitoring have no impact on error correction speed: rather, that in our experimental procedure at least, the tests make heavy demands on attentional and motor systems, and require high levels of general cognitive functioning, in addition to accurate self-monitoring.

In summary, we have demonstrated that schizophrenic patients evince abnormalities on a range of tests of self-monitoring. These deficits occur in the context of a broader impairment in neuropsychological function, but appear to be relatively independent of this. Furthermore, impairments in self-monitoring are associated with the experience of symptoms of alien control, which is consistent with the proposal that these abnormalities underlie the development of a number of the positive symptoms of schizophrenia. In view of the nature of our patient sample, it is clear that these impairments are not restricted to new, acute, or unmedicated patients, neither do they appear to be influenced by concurrent anti-cholinergic or antipsychotic medication. What remains to be seen is whether self-monitoring deficiencies wax and wane in relation to alien control symptoms, or whether they are, for some individuals at least, an enduring underlying feature of schizophrenia.

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