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Relationship Between Subjective Self-Report of Cognitive Dysfunction and Objective Information-Processing Performance in a Group of Hospitalized Schizophrenic Patients

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Summary. This study examines the relationships between subjective self-report of cognitive difficulties associated with schizophrenia and performance parameters of an objective choice reaction time task. The predicted relationships did not emerge and the results are discussed with regard to the methodological difficulties of measuring self-report and the features of the CRT task used. One positive finding was the significant relationship between chronicity of illness and the CRT measures.

Key words: Schizophrenia - Information theory - Reaction time

Introduction

The area of research into cognitive dysfunction in schizophrenia suffers from an inherent difficulty due to the absence of any obvious external criterion for disordered thought. Measures of cognitive disorder have traditionally been validated in terms of the extent to which they differentiate schizophrenic patients from other patients and from "normals". It is well recognized, however, that schizophrenia is a disjunctive concept including within it a highly heterogeneous mixture of symptoms and problems which carry with them diverse life-courses and prognoses. A substantial proportion of individuals diagnosed as schizophrenic are not judged as demonstrating clinical thought disorder (e.g. Cancro 1968; Stephens 1970) whereas many investigations have found non-schizophrenic psychiatric subjects, especially manic and brain-damaged patients, to show abnormal cognition on objective measures similar to those designed to reflect schizophrenic thought disorder (e.g. Oltmanns 1978; Harrow and Quinlan 1977; Goldstein 1978). Cognitive abnormalities have also been detected in non-symptomatic individuals such as other members of schizophrenics' families and patients in remission (Garmezy 1975; Wohlberg and Kornetsky 1973). Since schizophrenics can fail to show thought disorder and other patient groups and non-symptomatic individuals can demonstrate such disorder, the use of the diagnosis of schizophrenia as the principle criterion against which to validate measures of cognitive dysfunction seems to be inappropriate.

There is nonetheless a lengthy tradition whereby some form of cognitive disorganisation is viewed as fundamental and primary in schizophrenia. A number of formulations for the nature of this cognitive abnormality have been proposed, many expressed in terms of Information Theory developed over the past 30 years by human experimental psychologists (e.g. Broadbent 1958 and 1971). Whereas earlier theorists tended to implicate the perceptual input component of the information-processing channel, (McGhie 1969; Payne 1961) suggesting that schizophrenics have difficulty filtering out irrelevant from relevant stimulus information, later experimental work has indicated that a defect in the theoretical, perceptual "filter" is not specific to schizophrenia, being found in other subject groups (e.g. Schneider 1975; Hemsley 1976; Hemsley and Zawada 1976; Oltmanns 1978). More recent theorists have pointed to the confusion over different types of attention and, in particular, to a failure to distinguish between stimulus and response uncertainty. They have postulated that schizophrenic cognitive disorder is specifically associated with impairment at the response decision/selection stage of the information-processing system (Broen 1968; Marshall 1973; Hemsley 1976a). Using a choice reaction time task to vary stimulus and response complexity independently, Hemsley (1976a) found that acute schizophrenics were significantly more retarded by increasing response complexity than were matched, acutely depressed subjects, whereas neither group was significantly affected by increasing stimulus complexity.

If there is suggestive evidence that schizophrenics tend to show a specific difficulty in handling increasing complexity in response alternatives, the problem remains of how to verify such a formulation. We need to establish that there is some meaning to an information-processing taks measure involving increasing response complexity, relating to aspects of the subjects' functioning in "real life" e.g. to subjects' complaints, their problems as rated by others, the prognosis of their disorder in terms of their subsequent degree of independence, frequency of relapse etc. This study is part of an attempt to investigate the practical significance of an information-processing measure derived from a choice reaction time (CRT) task investigating the relationship between CRT functions and self-reported difficulties in everyday situations, in a sample of in-patient subjects having the unequivocal hospital diagnosis of schizophrenia.

There are some suggestions in the literature that cognitive measures do relate to other significant indices of individual functioning. Austin and Hemsley (1978) found with a normal subject sample that subjective ratings of ability to concentrate and of distractibility were significantly correlated with speed of processing measures on various cognitive tasks. In the field of schizophrenia, Cancro (1968), Cancro et al. (1971), and Zahn and Carpenter (1978) have found simple reaction time on admission to be significantly related to prognosis as measured

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by subsequent duration of hospitalization or short-term clinical improvement. Cognitive abnormalities have been found to be related to ratings of mental health (Rosenthal et al. 1960) and to be reduced with treatment (e.g. Shimkunas 1970; Goldberg 1972). Improvement in cognitive performance has been related to adjustment in the community on discharge (Penk 1978). In addition, some authors have posited a relationship between cognitive performance and social functioning (Wing 1975; Hemsley 1978; Garmezy 1978) whereby the attainment of social competence is hypothesized as being dependent upon intact information-processing functions in a social environment highly complex for both stimulus and response variability.

In this study, the main information-processing measure derived from a discrete CRT task is the slope function relating reaction time to the amount of stimulus and response uncertainty (i.e. to the number of stimulus and response alternatives, varied simultaneously from one to two to four).

Self-reported difficulties were assessed by means of a standard questionnaire, the Frankfurt Complaint Questionnaire (Sullwold 1977). The Frankfurt Questionnaire was developed from a collection of verbatim statements made by schizophrenic patients. It includes items relating to a wide range of difficulties and a factor analysis (Schunemann-Wurmthaler 1980) has yielded distinct dimensions for disorders of perception and motor responses, thought and speech, and secondary emotional reactions. Giessen (1981) has found a significant relationship between Frankfurt scores and clinical ratings of mental state. Zehner (1979) found Frankfurt scores to be related to clinical judgements about the degree of improvement patients had made in treatment.

In view of the consistent reports of the association between simple reaction time and short-term and long-term prognosis in schizophrenia (e.g. Cancro 1968; Zahn and Carpenter 1978) the same associations with self-report were investigated for simple reaction time scores (RT).

To summarize: the principle hypotheses under test were (1) there is a positive correlation between a response complexity deficit measure (CRT-slope—an absolute measure of information-processing impairment) and self-reported cognitive difficulties as assessed by the Frankfurt Questionnaire, specifically the "thought and speech" factor. (2) The correlations between CRT slope and self-report exceed the corresponding correlations calculated for RT.

Additional measures were employed to describe the patient sample, also as control variables for use in a subsequent study where different patient groups were to be compared and to test subsidiary hypotheses.

1. *WAIS Verbal Scale Vocabulary subtest* (Wechsler 1955) was used as a screening test for general ability since an adequate level of functioning (approximate IQ equivalent 80) was thought necessary for the experimental tasks. A general ability measure was also required as a control for the CRT tasks, especially since it has been suggested (e.g. Jensen and Munro 1979) that intelligence is correlated with speed on reaction time tasks. Other writers (e.g. Hunt 1980; Smith and Stanley 1980) have found the intercorrelations to be low and accounting for little common variance.

2. *Premorbid social competence* was assessed by the Abbreviated Scale of Premorbid Sexual and Personal Social Adjustment (Harris 1975) derived from the Phillips scale (Phillips 1953). This rating scale covers the development of heterosexual behaviours from casual dating to stable relationships and of social behaviour from minimal social contact to leadership of adult social groups. Some investigators have found differences in cognitive functioning between process and reactive schizophrenics defined by such a scale (e.g. Pavy 1968; Traupmann 1975).

3. *Chronicity of Illness.* Many investigators have found differences between acute and more chronic patients on experimental measures (e.g. Prior 1973; de Silva and Hemsley 1977; Williams et al. 1976). Several writers have postulated processes of adaptation to the original acute disorder with subsequent modifications of overt behaviour (e.g. Broen 1968; Hemsley 1977). A specific prediction about the relationship of chronicity of illness to CRT slope, however, is not clear, except that in so far as chronic subjects are by definition, poor prognosis individuals, more chronic schizophrenics could be expected to show increased RT and CRT slope.

4. *Severity of Illness.* Individual subject's psychiatrists were asked to provide a rating on a seven-point scale of the severity of illness shown at the time of testing.

Method

The subjects were in-patients at the Maudsley-Bethlem, St. Francis, East Dulwich and Goodmayes Hospitals (London, GB) and were between the ages of 18 and 60 years. All subjects had received an unequivocal hospital diagnosis of schizophrenia and, under the International Classification of Diseases, could be placed within one of the categories of hebephrenic, paranoid or residual schizophrenia (Codes 295.1, 295.3, 295.6). As discussed above, some aspects of heterogeneity within the sample (i.e. those factors hypothesized to relate significantly to the dependent variables viz. general intellectual level, premorbid social competence, chronicity and severity of illness) were assessed and studied. Thus it is clear that variations attributable to the inclusion of the chronic, residual ICD category were to be investigated. Differences attributable to heterogeneity in symptoms between the hebephrenic and paranoid categories were not the subject of the present study. Although the use of the paranoid-non-paranoid distinction has a long history in psychiatry, some recent workers e.g. Cromwell (1975); Berkovitz (1981) have argued against the validity of the distinction. Berkovitz concludes that the criteria for inclusion have often been unclear and inconsistently used with the result that there are many inconsistent and contradictory findings. No clear predictions about information-processing could be made.

Patients with history of ECT within the preceding 3 weeks, with alcoholism or known cerebral organic involvement were excluded. Appropriate patients were located by discussion with ward staff and were assessed at some variable point during their in-patient stay, at a time when they were considered able to co-operate but not symptom-free. All patients were receiving therapeutic doses of phenothiazine medication at the time of testing.

Patients were given a standard description of the tasks involved in the study and invited to take part. Approximately one-third of those patients approached refused to co-operate.

Testing was usually carried out in a single session lasting 1-1½ h. The tests were administered in a standard order.

1. WAIS Verbal Scale Vocabulary subtest, administered according to the instructions in the manual (Wechsler 1955) to yield IQ equivalent scores (VIQ).

2. RT and CRT Tasks. The tasks were similar to those employed by Karras (1973) being discrete CRT tasks with different levels of complexity. The simplest condition ($RT(R_0)$) is equivalent to a simple reaction time task in which the subject is required to extinguish a single light by means of a single response button i.e. no response uncertainty is involved in performing the task. In the first CRT task ($CRT(R_1)$), the subject is required to respond to one of two alternative light stimuli by depressing the button contralateral to the illuminated light i.e. in this condition, one piece of stimulus/response uncertainty is resolved. In the more complex CRT task ($CRT(R_2)$), four alternative lights are involved and the subject is required to extinguish an illuminated light by depressing the response button closest to the *adjacent* light, in a clockwise direction around the board i.e. two pieces of uncertainty are resolved in responding correctly on each trial. In condition R_1 and R_2, contralateral responses were employed since it has been suggested that stimulus-response compatibility greatly affects information-processing functions (e.g. Ogden and Alluisi 1980). Hemsley (1976) has reviewed the literature on information-processing deficits in schizophrenia and concludes that tasks involving low stimulus-response compatibility have been more sensitive to deficits in schizophrenia, such deficits being hypothesized to result from difficulties in response decision/selection.

Apparatus

For each level of stimulus/response uncertainty, subjects were shown a board upon which was mounted one, two or four light stimuli and correspondingly one, two or four switch buttons. A start point equidistant from switches and lights was also marked on the board. Onset of a light stimulus was controlled by the experimenter and offset achieved by depressing the correct response button. The interval between onset and offset was timed automatically and recorded in s to 3 decimal places by means of a Gould Timer Counter TC 314. Errors were ignored, but occasional, very long reaction times when a subject virtually made an error but corrected himself before depressing the wrong button were counted, although omitted from calculations of means. Since we were principally concerned with the variance contributed by response complexity, it was decided to attempt to minimise the influence of the preparatory interval before stimulus onset (described by e.g. Rodnick and Shakow 1940) by using a brief and regular preparatory interval. The auditory verbal warning signal "Ready" was given by the experimenter approximately 2–2.5 s before stimulus onset. The preparatory interval was timed approximately by use of a stop watch. (Karras 1973 warns against anticipatory responses occurring with completely regular stimuli.) The interval between trials was kept constant at 6 s where possible, although some subjects broke off during the sequence of RTs.

The sequence of stimuli used in conditions R_1 and R_2 was standard and derived from a table of random numbers, with the exception of the practice trials for R_2 where the frequency of the four alternatives was roughly equated to provide equal practice for the four response alternatives.

The subjects were introduced to each task condition with standard instructions asking them to switch the light off by moving their index finger from the start point to the button as quickly as possible. Subjects were given five practice trials in R_0 and ten practice trials in R_1 and R_2 or more if accuracy was less than chance. Although a variable number of practice trials was allowed under the administration procedure according to the number of errors in the first practice trials, more than ten practice trials were only rarely required. The literature suggests that several hundreds of trials are required before the function relating RT and information load is changed (e.g. Fitts and Deininger 1954; Briggs and Blaha 1969). The original number of experimental trials was set at 40 trials per condition but analysis of the data for the first 14 subjects showed that there were no significant differences between the means for the first 20 and total 40 trials for all three conditions. This finding is consistent with the results of Venables and O'Connor (1959). The number of trials was subsequently reduced to 20 and all analyses were performed on data from the first 20 trials only. Means were calculated for each individual for $RT(R_0)$, $CRT(R_1)$ and $CRT(R_2)$ conditions and the CRT slope function (CRTS) calculated by subtracting $RT(R_0)$ from $CRT(R_2)$ scores.

3. Frankfurt Complaint Questionnaire (PQ) (Sullwold 1977). This was administered aurally as a structured interview. Subjects scoring below IQ equivalent 80 were excluded from the study as this level of functioning was thought necessary for adequate comprehension of the questionnaire. Although items were only read aloud, repeated but not explained in any other way, it was often possible to detect by subjects' comments that items had been interpreted in an idiosyncratic way. Repetition of the items helped to reduce this misinterpretation thereby, perhaps, increasing the meaningfulness of the measure. The questionnaire yields scores on three factors: (1) perceptual and motor disorders (PM), (2) thought and speech disorders (TS), (3) secondary emotional reactions (SER) and a total score (FQT) which includes some additional items not loading on any of the factors.

In addition, further information about subjects was gathered indirectly.

4. Premorbid Social Competence (Social Competence). Information relevant to the Abbreviated Scale (Harris 1975) was gathered from each patient's case notes. Where information was missing, (more often for the personal-social than sexual scale) scores were prorated from those obtained. Scores vary from 0–12, low scores indicating highly developed social competence.

Chronicity of Illness. The duration of time (to the nearest whole year) since the first psychiatric admission was recorded from information in the patient's case notes.

Results

The characteristics of the patient sample are summarised in Table 1

It will be noted that the sample is biased towards the more chronically ill: only five patients had been receiving psychiatric

Table 1. Characteristics of patient sample

	Sex: 9 F; 15 M		
	Mean	SD	Range
Age	41.21 years	13.14 years	19– 59 years
VIQ	104.17	11.39	78–118
Chronicity	11.5 years	9.70 years	<1– 34 years
Social compt.	5.79	3.39	0– 12
Severity	3.71	1.23	2– 6

treatment for less than 3 years before testing. An increased bias in selection may have been introduced by asking psychiatrists to refer only unequivocal cases: first-admission patients especially may be "given the benefit of the doubt" where the diagnosis of schizophrenia is concerned. It will also be seen that all the descriptive measures show considerable variability. On average the sample can be described as of moderate premorbid social competence, average general ability and moderately ill at the time of testing. As outlined in the introduction, one aim of the study was to examine the relationships of these descriptive characteristics with the experimental variables.

The means, standard deviations and ranges for each experimental measure are shown in Table 2.

The data was analysed by means of Pearson Product-Moment Correlations calculated between each pair of variables. The significant correlation coefficients are reported in Table 3.

Considering the major predictions: –

Table 2. Means, standard deviations and ranges of experimental measures

	Mean	SD	Range
$RT(R_0)$	0.51	0.23	0.29- 1.07
$CRT(R_1)$	0.77	0.20	0.46- 1.38
$CRT(R_2)$	1.08	0.34	0.58- 1.88
CRTS	0.59	0.37	0.12- 1.48
FQPM	7.92	4.31	0 -19
FQTS	10.71	4.24	0 -19
FQSER	6.83	2.70	2 -12
FQT	35.04	13.92	4 -61

Abbreviations: VIQ = Vocabulary scale IQ equivalent; $RT(R_0)$ = Simple reaction time; $CRT(R_1)$ = Choice reaction time (2 choices); $CRT(R_2)$ = Choice reaction time (4 choices); CRTS = Choice reaction time slope function; FQPM = Frankfurt Questionnaire perception and motor factor; FQTS = Frankfurt Questionnaire thought and speech factor; FQSER = Frankfurt Questionnaire secondary emotional reactions factor; FQT = Frankfurt Questionnaire total score

1. The Relationship Between CRT Slope and Self-Reported Cognitive Difficulties

The correlations between CRTS and all self-report measures failed to reach significance, disconfirming the first hypothesis. A significant negative correlation was obtained between CRT (R_2) and FQ SER indicating that the more retarded subjects, on the most complex CRT condition only, reported less secondary emotional symptoms.

2. The Relationships Between Simple RT and Self-Reported Cognitive Difficulties

The correlations between $RT(R_0)$ and all self-report measures failed to reach significance.

Subsidiary hypotheses and other findings:

1. Vocabulary IQ. Correlational analysis revealed significant inverse relationships between VIQ and $RT(R_0)$, $CRT(R_1)$ and $CRT(R_2)$. These findings are consistent with theories whereby intelligence is explained in terms of speed of mental operations. VIQ was not, however, related to CRTS, indicating that, within this group, the response complexity deficit measure cannot be explained in terms of general intellectual loss i.e. it is tapping a function distinct from VIQ and simple RT.

VIQ was also found to be highly inversely related to FQPM, FQTS and FQT i.e. more intelligent subjects were less likely to affirm dysfunctional statements especially those related to perception and motor responses, thought and speech.

2. Chronicity of Illness. Chronicity was found to be highly correlated with $CRT(R_1)$ and $CRT(R_2)$ and to a lesser extent with CRTS i.e. more chronically ill individuals showed relatively greater impairment in the more complex CRT conditions as compared with simple RT performance. $RT(R_0)$ did not correlated with chronicity.

3. Frankfurt Questionnaire. Results from this small sample of schizophrenic subjects show strong intercorrelations between the three scales and between each scale and the total score such that it is doubtful whether the three scales are measuring meaningfully separate functions. The strong negative correlations with VIQ have already been noted. It seems possible that the source of these latter relationships lies in the fact that

Table 3. Intercorrelations reaching 5%* and 1%* levels of significance

		1	2	3	4	5	6	8	9	10
1	Age									
2	VIQ									
3	Chronicity	0.63**								
4	$RT(R_0)$		−0.62**							
5	$CRT(R_1)$	0.51**	−0.59**	0.49**	0.72**					
6	$CRT(R_2)$	0.50**	−0.39*	0.56**		0.66**				
7	CRTS			0.35*			0.84**			
8	FQPM		−0.47**							
9	FQTS		−0.53**					0.60**		
10	FQSER	−0.40*						0.38*	0.68**	
11	FQT	−0.39*	−0.47*				−0.36*	0.81**	0.91**	0.73**

Abbreviations: VIQ = Vocabulary scale IQ equivalent; $RT(R_0)$ = Simple reaction time; $CRT(R_1)$ = Choice reaction time (2 choices); $CRT(R_2)$ = Choice reaction time (4 choices); CRTS = Choice reaction time slope function; FQPM = Frankfurt Questionnaire perception and motor factor; FQTS = Frankfurt Questionnaire thought and speech factor; FQSER = Frankfurt Questionnaire secondary emotional reactions factor; FQT = Frankfurt Questionnaire total score

some questionnaire items are complex statements with many qualifications, making them quite specific (e.g. "Sometimes it is too much for me when there are people around me being busy or talking; then I withdraw in order to find some peace and rest."). Probably more intelligent subjects are more able to comprehend each statement as a whole and, therefore, they are more likely to disconfirm when qualifications do not apply. Less intelligent subjects may be more likely to respond to a word or phrase in isolation and, such part-items being more general, have an increased tendency to affirm.

4. Age. As would be expected, a significantly positive correlation was found between subjects' age and chronicity of illness. Age was found to be related to scores on CRT (R_1) and CRT (R_2) but not to RT (R_0) or CRTS. Significant inverse intercorrelations of age with FQSER and FQT were also found indicating that older subjects were less likely to affirm dysfunctional statements, especially those relating to secondary emotional reactions.

Conclusions

The results of this study provide little support for the general hypothesis that there is an association between self-reported cognitive disturbances and information-processing functions as measured by a CRT task. Our findings call into question the validity either of self-report in assessing cognitive disorder, (an assumption which has formed the basis of contemporary studies of cognition in schizophrenia (e.g. McGhie and Chapman (1961), Freedman (1974)) or of the CRT measure as a crucial index of cognitive dysfunction, although it is possible though unlikely, that subjective and objective measure are related to completely distinct aspects of pathology and are therefore uncorrelated. It would appear that the present findings with the Frankfurt Questionnaire are at variance with those of Sullwold who reports low correlations with intelligence although the details of the factorial structure of the questionnaire are not made clear. It could be that differences in administration (oral and written) as well as in language may account for the discrepancies. Also relevant may be differences in subject characteristics: in one study Sullwold described 58% as "paranoide".

A frequently used questionnaire measure of self-reported cognitive disturbances failed to relate either to CRT functions or to simple RT. The methodological problems of self-report assessment have been recently discussed by Shapiro (e.g. Shapiro 1975) who severely criticized the validity of multiple-item questionnaires. When dealing with highly disturbed individuals, such problems are likely to be multiplied by, for instance, subjects' idiosyncratic ideas about the purpose of the assessment and the consequences of admitting to or denying problems in any area, especially when the experimenter is unknown to the subject and not involved in clinical matters. It has to be unrealistic to expect a patient who may make little social contact, either because of chronic incapacity or acutely florid symptomatology, to consider rationally a number of complex questions and to respond fully and truthfully. It is difficult to conceive of how to overcome the methodological problems in measuring subjective complaints when a prominent component of the disorder may be in the general area of interpersonal communication. Shapiro's Personal Questionnaire (Shapiro et al. 1973) has the advantage of using the individual's own terminology and having a built-in check on reliability but it does not deal directly with the more fundamental problems of disturbed interpersonal behaviour, attitudes and motivation. Possibly in addition, more severely disturbed individuals may genuinely show unreliable self-appraisal. The method also makes it difficult to compare across individuals. It seems likely, however, that multiple-item questionnaire measurement could be improved by, for example, simplifying items to maximise on the possibility of uniform comprehension thereby decreasing the high loading on intelligence. In addition, the use of computerized recording could be employed in an attempt to eliminate error due to idiosyncratic subject-experimenter interaction. Alternatively, only individuals well-known to subjects could be employed as experimenters.

On the question of the validity of the CRT measure as an index of cognitive dysfunction, the present task differs from the card-sorting task used by Hemsley (1976a) in that it is discrete rather than continuous. The present task employs discrete response trials separated by brief pauses whereas the card-sorting task requires continuous responding without a break. The provision of brief rest periods in the current procedure might allow for some kind of recovery between trials thus obscuring a crucial aspect of dysfunction only revealed by a continuous task. Consistent with such an interpretation, Karras (1973) found schizophrenic and depressed groups not to be differentiated on first testing with a discrete, incompatible RT task, but this task employed only limited variation in response-uncertainty.

The only relationship favourable to Hemsley's theory of cognitive dysfunction in schizophrenia was that obtained between CRT functions and chronicity of illness. More chronic individuals showed a greater response-complexity deficit and the lack of any relationship between the CRT functions and age suggests that this association is not explainable in terms of normal ageing. As has been pointed out, however, (Strauss 1973) we cannot conclude from cross-sectional data such as this that differences with chronicity result from adaptational changes occurring during the course of the illness. Explanation in terms of a selection bias whereby more chronic subjects are also more severely ill, is to be preferred in the absence of direct, longitudinal evidence. Both explanations, however, are consistent with Hemsley's theory.

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