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Choice Reaction Time Performance in Hospitalized Schizophrenic Patients and Depressed Patients

Ruth M. Williams and David R. Hemsley

Department of Psychology, Institute of Psychiatry, De Crespigny Park, Denmark Hill, London SE5 8AF, Great Britain

Summary. The choice reaction time performances of matched groups of hospitalized patients diagnosed schizophrenic or depressed were compared with normal controls to test a hypothesis concerning thought disorder specific to schizophrenia. Both patient groups were abnormal compared to controls providing evidence inconsistent with the diagnostic specificity issue. The results are discussed in terms of cognitive dysfunction in depression, the effects of institutionalization and the problems of diagnostic heterogeneity.

Key words: Schizophrenia – Depression – Reaction time

Introduction

It has been proposed that cognitive dysfunctions in schizophrenia can be explained in terms of a deficit at the response decision/selection stage of the human information-processing system (Hemsley 1976). According to this model, human performance is accounted for by a limited capacity, information-transmitting, communication system. Hick (1952) demonstrated a linear relationship between reaction time (RT) and the logarithm of the number of equiprobable stimulus alternatives employed, the slope of this function being regarded, therefore, as an inverse measure of the capacity of the transmission channel. Subsequent research has shown that the log/linear relationship holds between RT and task complexity, irrespective of whether the complexity consists of terms of stimuli, responses or memory load, (Briggs and Johnson 1973; Briggs and Swanson 1970) although it is suggested that the effects of increased response complexity are greater than those of increasing stimulus complexity (Garner 1962). Hemsley (1976a) drew attention to the importance of the distinction between stimulus and response complexity, ignored by earlier theorists (Yates 1966) who attempted to apply an information theory model to schizophrenic cognition. He also indicated the importance of the stimulus-response (S-R) compatibility aspect of experimental tasks in interpreting their results. Broadbent (1971) defined S-R compatibility as the degree to which unpracticed subjects can guess the response that is correct for a particular stimulus. With high S-R compatibility or prolonged practice, the slope function relating RT to stimulus and response complexity decreases markedly i.e. under these conditions, it is difficult to maintain that the slope function is a measure of channel capacity. Wickens (1974) suggested that under these circumstances, the response decision/selection stage may be by-passed by a direct S-R link.

Using the discriminations between stimulus and response complexity and between varying degrees of S-R compatibility, Hemsley (1976) reviewed the studies of choice reaction time (CRT) in schizophrenia, and concluded that in general the schizophrenic CRT slope increases abnormally mainly as a function of increasing response uncertainty but only when tasks employ low S-R compatibility (e.g. Venables 1958; Slade 1971). He points out, however, that Karras (1973) failed to find differences between schizophrenics and depressives on an incompatible, discrete CRT task. This negative finding could be explained in terms of the limited range of response uncertainty used but it is also possible that the use of a discrete rather than continuous CRT task was responsible: the majority of tasks that have revealed a specific schizophrenic deficit have been continuous. Hemsley (1976) suggested that a study similar to that of Karras (1973) should be carried out using a discrete, incompatible CRT task but increasing the range of response uncertainty. One aim of this study was to test these interpretations.

The use of psychiatric subjects with a diagnosis other than schizophrenia as a control group is clearly indicated for validation of a theory specific to schizophrenic cognitive dysfunction. Nevertheless there are arguments against the exclusive reliance upon diagnostic specificity even when the diagnosis is arrived at by a reliable procedure. 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 thinking (Oltmanns 1978; Harrow and Quinlan 1977; Goldstein 1978). The presence and explanation of cognitive dysfunctions in depressed patients remains a contested issue. Indeed the results of studies by Friedman (1964) and Granick (1963) have been taken to indicate that depression is not associated with cognitive, motor and perceptual deficits, that depressives merely underestimate their performance. Miller (1975), however, in a review of the literature, indicated the wealth of studies demonstrating deficits on a wide variety of cognitive tasks e.g. intellectual speed, word learning, discrimination learning and psychomotor speed. More recently, Byrne (1976) measured two components of response latency in a CRT task with groups of neurotic and psychotic depressive in-patients and normal controls. He found both "decision time" and "movement time" components to be significantly longer in the patient groups. Only "decision time" was significantly increased in the psychotic group compared with the neurotic group, but the psychotic group was also significantly older. Decision time was also found to vary with depressive severity (Hamilton Rating Scale) within the neurotic group. As Cornell et al. (1984) pointed out, however, Byrne's experimental differentiation between cognitive and motor aspects of behaviour is of questionable validity. The present experimental procedure holds movement constant and allows investigation of the effect on total RT of increasing cognitive complexity. If motor performance is impaired we would expect an increased intercept on the CRT uncertainty function. If central decision making functions are impaired we predict an increased CRT slope.

Materials and Methods

Method

Psychiatric subjects were in-patients at the Maudsley-Bethlem, St. Francis and Goodmayes Hospitals, London, UK. Normal subjects were staff volunteers. All patients had received an unequivocal diagnosis of schizophrenia or depression as a primary disorder and, under the International Classification of Diseases, could be classified within one of the categories of hebephrenic, paranoid or residual schizophrenia (Codes 293.1, 293.3, 295.6) or manic-depressive psychosis depressed type, manic-depressive psychosis circular type currently depressed or neurotic depression (Codes 296.1, 296.3, 300.4).

Individuals with purely paranoid symptoms were excluded as were those with a history of ECT within the preceding 3 weeks, alcoholism or known cerebral organic involvement. Most patients were receiving medication in the form of major tranquillizers of anti-depressants. Patients were tested at a variable point during their hospital admission, at a time when they were considered able to co-operate but not symptom-free. Approximately two-thirds of patients approached agreed to take part in the study.

In addition to the experimental tasks, other measures were taken to describe the subject samples and to act as control variables. (1) The WAIS Verbal Scale Vocabulary Sub-test was administered according to the instructions in the manual (Wechsler 1955) to yield Verbal IQ equivalent scores (VIQ). (2) A global severity of illness rating on a 7-point scale was completed on each patient by his/her psychiatric registrar, within 2 days of testing. (3) Premorbid social competence was assessed from case notes by means of the Abbreviated Scale of Premorbid Sexual and Personal-Social Adjustment (Harris 1975) derived from the Phillips' scale (Phillips 1953). (4) The chronicity of each patient's illness was measured from the date of the first psychiatric admission to the time of testing, to the nearest whole year.

CRT Tasks

The tasks were similar to those employed by Karras (1973) being discrete CRT tasks with different levels of complexity. The simplest condition ($RT(R_0)$) was equivalent to a simple RT task in which the subject was required to extinguish a single light by means of a single response button i.e. no response uncertainty was involved in performing the task. In the first CRT task ($CRT(R_1)$), the subject was 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 S-R uncertainty was resolved. In the more complex CRT task ($CRT(R_2)$), four alternative lights were involved and the subject was 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. 2 pieces of uncertainty were resolved in responding correctly on each trial. In conditions R_1 and R_2, contralateral responses were employed since it has been suggested that S-R compatibility greatly affects information-processing function (Ogden and Alluisi 1980). Hemsley (1976) reviewed the literature on information-processing deficits in schizophrenia and concluded that tasks involving low S-R 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 S-R 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 TC314. 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 calculation of means. Since we were principally concerned with the variance contributed by response complexity, it was decided to attempt to minimize the influence of the preparatory interval before stimulus onset (described by Rodnick and Shakow 1940) by using a brief and irregular preparatory interval. An 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 sequences 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 4 alternatives was roughly equated to provide equal practice for the 4 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 5 practice trials in R_0 and 10 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 10 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 (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 3 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 for schizophrenic, depressed and normal groups.

Results

The characteristics of the subject groups are summarized in Table 1.

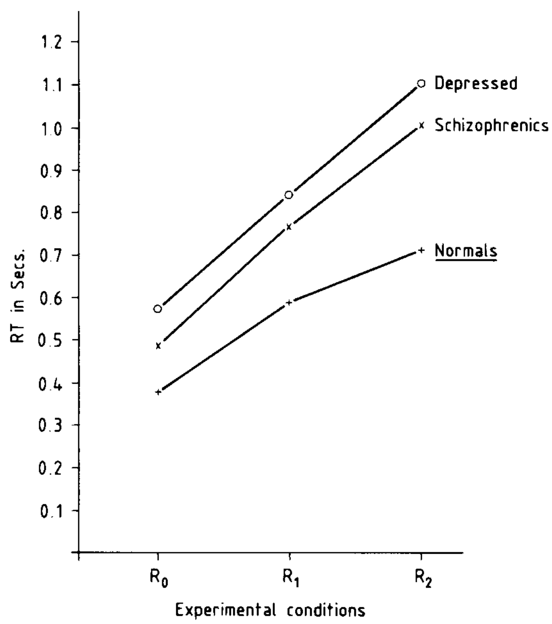

Fig. 1. Mean RT for 3 complexity conditions and 3 subject groups

"*t*"-Tests were calculated between the means for each pair of groups, for each control variable. The only significant difference found was between schizophrenics and depressed on premorbid social competence ($t = 3.0979$; $P < 0.01$). It will be observed that the patient groups were biased towards the more chronically ill: only 4 schizophrenics and 5 depressed had been receiving psychiatric attention for 2 years or less. The patient groups also differed in sex ratio. In order to test for the effect of sex differences on the experimental measures, the scores on $RT(R_0)$, $CRT(R_1)$ and $CRT(R_2)$ were compared for the 12 males and 8 females within the schizophrenic group. "*t*"-Tests between the means for male and female groups yielded no significant differences for any of the 3 conditions.

The results of the three subject groups for the 3 experimental conditions are summarized graphically in Fig. 1. In order to test for the significance of group differences within the 3 conditions, univariate and multivariate analyses of variance were performed. The detailed results are given in Table 2. It will be seen that the main difference obtained was between the patient groups combined and the normal group. The difference between schizophrenic and depressed groups was not significant, indeed the scores of the two groups were very closely matched. Analysis of linear and quadratic vectors derived from the distributions of scores indicated that the significant difference between normal and combined patient groups performance was attributable to differences in the linear component.

A question arose whether the comparison between mean scores across patient groups obscured qualitative differences in performance between the two diagnostic categories. More specifically it was hypothesized that schizophrenic RT could be more variable within subjects, such a difference being concealed by the use of mean scores over 20 trials for each subject. To test this hypothesis, the variance within trials for the most complex $CRT(R_2)$ condition was calculated for each subject and the difference in mean variance between the schizophrenic and depressed groups compared using a *t*-test for the significance of difference between means of independent samples. The difference in mean variance was not significant.

The relationships between the experimental and control measures within the schizophrenic group have been discussed elsewhere (Williams et al. 1984).

Table 1. Characteristics of subjects groups

	Age $\bar{x}$	Sex n		VIQ $\bar{x}$	Severity $\bar{x}$	Premorbid social competence $\bar{x}$	Chronicity $\bar{x}$
		M	F				
Schizophrenics (n = 20)	41.35	12	8	106.75	3.65	6.1	11.1
Depressed (n = 20)	41.53	3	17	113.2	4.35	3.2	8.8
Normals (n = 10)	33.6	5	5	115.7	—	—	—

Table 2. Results of univariate and multivariate analyses

		F ratio	*P*
Univariate analyses:	Normals vs schizophrenics + depressives	7.0112	<0.0110
	Depressives vs schizophrenics	0.6413	N.S.
Multivariate analyses:	Normals vs schizophrenics + depressives × conditions	3.6263	<0.0345
	Depressives vs schizophrenics × conditions	0.2049	N.S.

Conclusions

The main findings of this study support the general hypothesis of deficit in information-processing capacity in individuals diagnosed as schizophrenic relative to non-psychiatric individuals but raise questions as to whether such a deficit is specific to schizophrenia, since hospitalized depressed subjects were found to be similarly impaired. Our findings are consistent with those of Karras (1973) although our experimental task involved a greater range of response uncertainty. The possibility remains that a specific schizophrenic deficit is only tapped by a continuous performance task where recovery between trials is impossible.

As has already been noted, however, exclusive reliance on diagnostic discrimination may be misleading. The schizophrenic subjects investigated in this study were not selected on the basis of being thought-disordered and many gave no overt indication of being so. It could be argued that experimental investigations of 'thought disorder' should be directed at subjects judged to be thought-disordered whether schizophrenic or not.

Byrne (1976) concluded that the CRT performance of depressed patients is indicative of a central information-processing impairment as well as motor retardation. The present results are supportive of such an interpretation. The CRT slope function of the mixed depressed group closely matched that of the schizophrenic group showing increased intercept and increased slope relative to the normal control group.

The group of patients studied here was biased towards the more chronically ill (mean years since first admission = 10.6 years). It could be that chronic or relapsing illness per se or institutionalization may be responsible for the deficits found. Such interpretations could be tested by comparisons with chronically non-psychiatrically ill individuals and institutionalized persons such as prisoners.

A question about information-processing deficits more fundamental than their diagnostic discriminatory potential may be in relation to their validity. Diagnosis is not impressively predictive. Could information-processing task performance have important correlates other than diagnosis? Cancro (1968), Cancro et al. (1971) and Zahn and Carpenter (1978) found simple RT on admission to be significantly related to prognosis as measured by subsequent duration of hospitalization and 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 (Shimkunas 1970; Goldberg 1972). Improvement in cognitive performance has been related to adjustment in the community on discharge (Penk 1978). Recently Kolakowska et al. (1985) found that the presence of cognitive impairment on neuro-psychological tests differentiated remitted good outcome patients from the chronically symptomatic. In addition some authors have posited a relationship between cognitive performance and social functioning (Wing 1975; Hemsley 1978; Garmezy 1978) whereby 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. Such questions invite further research.

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