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Locus of Reaction Time Change in Schizophrenic and Normal Subjects

by

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ABSTRACT

Simple reaction times obtained from trials presented in isotemporal series (preparatory intervals of the same duration) were partitioned into pre-motor and motor-time components for 20 schizophrenic and 20 normal subjects according to procedures developed by Weiss 1965). This procedure allowed for an examination of the relative contributions made by central versus peripheral factors to: 1) overall mean reaction time, and 2) the crossover pattern of responding as first observed by Huston, Shakow, and Riggs (1937) and recently re-examined by Bellissimo and Steffy (1972). In addition, a within subject comparison of the traditional press-release motor task and an alternative press-only motor task was made. Differential predictions were made as to the effect of the task manipulation from: 1) the loss of major set, and 2) the reactive inhibition interpretational position.

It was found that the schizophrenics' crossover pattern of responding was specific to the press-release task. Furthermore, it was apparent that factors at the peripheral level, as reflected by the motor-time component of overall reaction time contributed significantly to: 1) their overall longer mean reaction times, as well as 2) their increased magnitude of crossover. The results were seen as supporting the view that inhibitory processes triggered by the increased levels of arousal during the isotemporal series are responsible for the schizophrenics' crossover pattern of responding on the press-release task. It was noted that the loss of major set explanation need not be seen as incompatible with a reactive inhibition explanation of the crossover effect.

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INTRODUCTION

It has been recognized since the time Bleuler wrote Dementia Praecox or the Group of Schizophrenias in 1911 that schizophrenics, in addition to their outwardly bizarre behaviour, also manifest attentional dysfunction. As Neuchterlein (1977) points out, Bleuler's conceptualization of the schizophrenic disorder put attentional dysfunction subordinate to affectivity and it was therefore never thought of as a primary symptom. Recently, however, various investigators, most notably Shakow (e.g., Shakow, 1977), have come to view attentional dysfunction as a primary symptom which precipitates affectivity. Whether seen as a cause or effect of psychopathology, attentional dysfunction has long been seen as characteristic of schizophrenia.

The dependent measure most often used in empirical studies designed to examine attentional processes has been that of reaction time (RT), --the time taken for an organism to respond in a specified manner to a given stimulus. Slower RTs were thought to reflect poorer attention to the relevant stimuli. However, considering the many aspects of the bizarre schizophrenic physiognomy which have been studied for possible etiological or theoretical relevance, measures of reaction time must appear at first glance to be among the least germane. In order to understand the shift in focus from study of "major" symptoms to the undertaking of investigations of such apparently inconsequential measures as RT, a quotation from Cromwell (1978) offers an appropriate starting point.

> . . . I also would suggest that psychopathology is described and defined primarily in terms of how it deviates from the norms and expectancies of society in general. Certain manifestations of schizophrenia deviate enough to be viewed as bizarre, intolerable, or threatening. Other manifestations do not and they are overlooked. This distinction is apparently so important that we have different terms to refer to the tolerable and the intolerable manifestations. The tolerable manifestations are usually referred to as behavioral deficits. The intolerable ones are referred to as clinical symptoms. The intolerables, i.e., the clinical symptoms, have been the central focus by which to understand schizophrenia, not because they are more important in etiological, prognostic, or treatment considerations but because they are indeed intolerable to the patient and/or the community. (p. 219)

As Cromwell points out, the more dramatic and "crazy" behaviours have often been the focus of study in attempting to solve the schizophrenia puzzle. However, our understanding of schizophrenia has been advanced very little by these approaches. Study of these "clinical symptoms" has revealed that they: 1) have very little prognostic relevance (e.g., Strauss & Carpenter, 1972), 2) fluctuate dramatically, and lead to, 3) extremely poor reliability of traditional diagnostic subgroups (e.g. Cromwell, 1975). Furthermore, as pointed out by Buchsbaum and Haier (1978), since indistinguishable clinical symptoms may be caused by radically different etiologies the search for homogeneous subgroups of schizophrenics based on symptom clusters is very unlikely to prove fruitful. Instead, Buchsbaum and Haier advocate grouping individuals on the basis of the old dependent variables (e.g., responsivity to phenothiazines, elevated RT, magnitude of crossover, etc.) and ignoring the previous independent variables (e.g., process schizophrenia, paranoid schizophrenia, etc.) as a method of achieving within group homogeneity on the variables under

study. As Helzer, Robins, Taibleson, Woodruff, Reich and Wish (1977) point out we are clearly in need of a new improved set of operational diagnostic criteria for psychiatric disturbances in general--these need not include traditional symptom clusters.

The above situation has led various investigators to consider the possibility that the less dramatic, and more stable peculiarities typically thought of as deficits may be more fundamental and important to the understanding of schizophrenia than the more peculiar and intolerable behaviours. The reason, then, for studying RT in schizophrenics has been related to the search for a common denominator among the schizophrenias. It is well known that none of the typically schizophrenic behaviours are common to all schizophrenics. It has been found that simple mean RT varies positively with degree of psychopathology within the schizophrenias, however, slow RT is not specific to schizophrenia and is associated with disorders such as mental retardation. Consequently, focus has been shifted to the more intricate and subtle nuances of response patterns such as the cross-over effect observed in simple RT experiments. Measures of cross-over have been observed since the 1930s and have remained one of the best discriminators of both within and between group psychopathology. As well, it appears that the magnitude of crossover is greater in the first degree relatives of schizophrenics than in the general population, a finding which has led to the speculation that measures of crossover may be useful as genetic markers in identifying high-risk populations (Cromwell, De Amicis, Hayes, & Briggs, 1979).

Shakow was the first to note, in addition to the typically

slower and more variable RTs of the schizophrenics, the distinctive crossover effect (Huston, Shakow & Riggs, 1937). Subjects were presented with a series of simple auditory RT trials with varying preparatory intervals (PI)--the time between the warning signal and the signal to respond--of between 0.5 and 25.0 seconds. These trials were presented in both a regular and an irregular series. In the regular series, trials of equal PI duration were presented in blocks, whereas trials in the irregular series were presented in an apparently haphazard order. It was observed that for both the schizophrenics and the normals, in both presentation series, best performance was achieved around PI = 2.0 or 3.0 seconds. The RTs of the normals were shorter for the regular series but rose gradually as a function of PI duration to the point where they approached those of the irregular series. The schizophrenics' RTs during the regular series were shorter than those of the irregular condition up to about PI = 3.0 seconds at which point they rose quickly to a level slower than that observed on the irregular series. In attempting to explain how this crossover of the two curves may have come about, Huston et. al. proposed that at the longer PIs the schizophrenics' failure to take advantage of the "predictability" of the regular series was due to their inability to maintain a preparatory set to respond. At longer PIs the difficulty in maintaining a preparatory set becomes so great that the schizophrenics apparently revert to a lower level of functioning, and consequently have longer RTs. The major deficit was described as an inability to maintain task relevant vigilance--"major set"--due to the intrusion of task irrelevant distractions or "minor sets" when the demands

of the experimental situation became too severe. In this case major set was readiness to lift a finger. Alluding to the adaptive significance of such a process, Zahn, Shakow and Rosenthal (1961) proposed that ". . . minor sets could be considered as serving the defensive purpose of protecting the patient from being overloaded in situations that for him have difficult requirements." This argument appears circular in that the intrusion of minor sets was proposed to be both the cause and the cure of the schizophrenics' difficulties at longer PIs. In other words, the schizophrenic was first said to be in a difficult situation because of his inability to ward off the intrusion of minor sets, then minor sets were proposed to act as a retreat from the difficult situation.

Although the crossover effect was initially believed to be due solely to a deterioration in performance within the regular series some evidence for the involvement of the irregular series has been offered (Zahn, Rosenthal, & Shakow, 1963). It was observed that the PI duration of the preceding trial (PPI) exerted a strong influence on RTs of the subsequent trial. Specifically, a longer PPI resulted in slower RTs, whereas a shorter PPI resulted in faster RTs. The degree of influence imposed by the PPI was proportional to the difference between the PPI and the PI with short PPIs resulting in more anticipatory responses and long PPIs resulting in slower RTs while PPI = PI resulted in optimal performance. These results suggest that performance may improve within the irregular series as a function of PI duration due to the fact that trials with longer PIs are necessarily preceded by shorter PPIs whereas the trials with shorter PIs are

necessarily preceded by longer PPIs, thus producing a progressive PPI facilitation effect as a function of increasing PI duration. Although the PPI had a significant influence on the RTs of normals as well as schizophrenics, the effect was significantly less pronounced for the normals. Zahn et. al. (1963) interpret these results as indicating that schizophrenics, confronted once again with a difficult task, "simplify" their task by using only the information obtained from the previous trial in their preparation strategy. The extent to which this strategy may be seen as "simpler" than adopting, for example, a generalized response set is questionable. Perhaps, a general preparedness to respond would not require specific attention to temporal referents throughout the PI but rather a general set to respond within a certain time span after the warning signal. An alternative explanation for the PPI-PI effect is that the decreased opportunity to establish set on the short PIs, rather than the fact that the short PI trials are preceded by longer PPIs, is responsible for improvement within the irregular series.

In a re-examination of the PPI-PI effect Nideffer, Neale, Held-Kopfstein, and Cromwell (1971) have reported data which suggest that the influence of the PI on the RT of the subsequent trial may have been over-estimated due to a confounding of the PPI-PI relationship with PI duration. Nideffer et. al. observed that when PI durations were held constant the between group differences in PPI-PI effect failed to reach statistical significance. The extent to which the PPI-PI effect during the irregular series may be seen as contributing to the schizophrenics' increased crossover is questionable in that although the

influence of the PPI may be operating on both schizophrenics' and controls' RT it is no more pronounced for the schizophrenics. Also questionable, as argued by Schneider (1978), is the possibility of the co-existence of the PPI-PI effect--perseveration of expectancy, and the loss of major set process--"flightly" attention. Perseveration of expectancy probably has as a prerequisite perseveration or fixation of attentional focus. As has been suggested by Matthysse (1978), the loss of major set concept characterized by inability to focus attention, and perseveration of attention are diametrically opposed from a psychopharmacological stance. Suffice it to say that schizophrenics may suffer from one or the other of the above disorders but not both. It is interesting to note that Shakow's perseveration of expectancy interpretation of PPI=PI resulting in optimal performance would seemingly predict superior performance on the regular series than on the irregular series of trials. Since long PI trials on the irregular series may be best preceded by extremely short PIs, the effect of which is not as beneficial as PPI=PI, there appears to be no way to predict a greater deterioration in performance on the regular series unless we invoke Shakow's (e.g., Rodnick & Shakow, 1940) conceptualization of the schizophrenic reverting to a lower level of functioning as an escape from a situation which for him is too demanding. In short, it appears that the evidence for the involvement of the PPI-PI effect, particularly during the irregular series, in producing the schizophrenics' greater crossover effect is less than compelling.

Employing an "embedded set" trial format, Bellissimo and Steffy (1972) set about re-examining the crossover effect. Subjects

were presented with a series of irregular trials within which were embedded blocks of four isotemporal trials. The first trial in a block represented the irregular series of trials in that it was preceded by trials of varying PI duration, whereas the last trial in a block represented the regular series in that it was preceded by trials of equal PI duration. The crossover of the regular and irregular trial series as a function of PI duration endured Steffy's methodological change.

Bellissimo and Steffy (1972) observed that across an isotemporal series of trials at the longer, seven second, PI duration process schizophrenics showed an initial improvement in overall RT followed by a progressive deterioration in performance. The authors referred to this progressive deterioration in performance across an isotemporal block of trials at the longer PIs as a "redundancy associated deficit" in that this dramatic deterioration in performance was unique to the repetitive and more predictable regular series. This redundancy associated deficit was interpreted as reflecting the operation of two distinct processes viz., 1) an initial improvement in performance afforded by the more predictable nature of the isotemporal trials followed by 2) a subsequent deterioration in performance due to the build-up of an inhibitory process. The significant deterioration in performance characterizing this redundancy associated deficit was found to be specific to process schizophrenics and not observed in the data of reactive schizophrenics, non-schizophrenic psychiatric patients, or normals. The overload of information caused by the repetitive isotemporal trials apparently pushed the schizophrenics' arousal level beyond an optimal level which in turn triggered an

inhibitory process designed to attenuate this increased amount of stimulation so that arousal levels could return to a more normal level. Assuming that the schizophrenics did indeed process the regularity of PI duration within the isotemporal blocks of trials, it could be argued that in an attempt to reduce the amount of incoming stimulation the schizophrenics' poorly modulated inhibitory mechanisms over-compensated to an extent which left them with even less information than they had prior to the isotemporal set. The authors propose that a redundancy or overload of information afforded by the predictability of the regular trials, mitigated against the likelihood of a better performance because of the ". . . build-up of an inhibitory process, perhaps related to the narrow, highly redundant focusing" (p. 307).

Although the general pattern of a deterioration in performance across an isotemporal series of trials appears to have held up (e.g., Steffy & Galbraith, 1974; Bellissimo & Steffy, 1975) the original redundancy associated deficit pattern characterized by an initial improvement in performance from the first to the second trial appears to be less consistently observed (Steffy, Note 1). Bellissimo and Steffy (1972) interpret the findings of the above study as indicating the involvement of an inhibitory process rather than a loss of major set as a viable explanation for the crossover phenomenon. As the authors point out, a loss of major set process could perhaps predict no difference in performance on the regular relative to the irregular series but certainly not a deterioration in performance.

In an attempt to test more directly the viability of the loss of major set explanation versus an inhibitory process explanation for the

crossover effect, Steffy and Galbraith (1974) embarked upon a study which examined the effects of altering inter-trial-intervals (ITI) on the magnitude of crossover. If the crossover effect is indeed due to a loss of major set as proposed by Shakow, then the effect should vary exclusively as a function of the PI duration since it is only during this time that specific attentional demands are being made. This process should not be influenced by the size of the ITI duration. If, on the other hand, crossover is due to a build-up of inhibition across the isotemporal series of trials, one would expect that lengthening the ITI should decrease the magnitude of crossover by allowing for a dissipation of inhibition. Zahn, Shakow, and Rosenthal (1961) had previously tested these alternative possibilities by varying both PI (PI = 2.0, PI = 12.0 seconds) and ITI (ITI = 4.0, ITI = 14.0 seconds) durations and found that only the manipulation of PI duration had an effect on the schizophrenics' RT performance. Unfortunately, Zahn et. al. omitted the crucial comparison cell of long PIs combined with long ITIs which rendered the results of their study difficult to interpret. In an attempt to clarify the impact of ITI duration on the magnitude of crossover, Steffy and Galbraith (1974) performed a within subject comparison of a short (ITI = 2.0 seconds) and a long (ITI = 7.0 seconds) ITI duration. The results of this study indicated quite clearly that the magnitude of crossover was smaller at the longer ITI interval. Steffy and Galbraith propose that at the longer ITI durations there was a greater opportunity for a build-up of inhibition to dissipate and therefore the deterioration in performance across the block of four isotemporal trials was not as severe as during the two second ITI condition.

These findings, then, lend support to an inhibitory process explanation rather than a loss of set explanation. Bellissimo and Steffy (1975) have since reported a set of three studies which has demonstrated the independence of the magnitude of the redundancy associated deficit at the long, seven second, PIs and contextual influences such as the length of the PIs of filler trials. These findings reinforce the notion that the crossover effect is due to a deteriorative process within the regular series rather than to a facilitation of performance on the irregular series.

The combined data obtained by the Steffy and Shakow groups, then, points most strongly towards a deterioration in performance within the regular (isotemporal) series at the longer PI duration as the major cause of the crossover phenomenon. This point is well established in that it has been arrived at repeatedly from two different theoretical persuasions backed by their respective supporting empirical evidence. The major disagreement between the Steffy and Shakow positions is theoretical in nature. Whereas Shakow feels that a loss of major set is the major reason for the deterioration in performance as a function of PI duration, Steffy holds that a build-up of inhibition is the active force. Although both groups have supported their positions with considerable data, only the Steffy and Galbraith (1974) study, concerned with the manipulation of ITI durations, has provided a direct comparison of the two positions with a priori differential predictions.

Although not directly concerned with the crossover phenomenon per se, predictions about schizophrenics' performance on an isotemporal series of RT trials can be made from Zubin's (1975) neuronal

trace model. Very simply stated, Zubin has proposed a model, supported by neurophysiological evidence, which holds as its major assumption that facilitating and inhibitory neural traces persist for a longer duration in schizophrenics than in normals. The processing of the features of a particular RT trial leaves a facilitating trace for subsequent trials with similar features and an inhibitory trace for trials with dissimilar features. Although Zubin was concerned primarily with stimulus rather than temporal characteristics of the RT trial, his model is sufficiently general to allow speculation about performance within an isotemporal series of trials where stimulus features are held constant.

Zubin's model would appear to predict that within a series of isotemporal trials performance should improve due to the cumulative facilitation of similar trial traces; this effect should be even more pronounced for schizophrenics than for normals since dissimilar or irrelevant aspects of a trial should be inhibited more strongly than for normals. Schizophrenics, then, should be less rather than more distractible than normals. Thus, the Zubin model appears to be inconsistent with Shakow's notion of intruding minor sets, yet leads to the same prediction as Shakow's model concerning the influence of the PPI. Since trace strength deteriorates as a function of time the Zubin model is consistent with Steffy's (Steffy & Galbraith, 1974) finding of decreased influence of previous trials as a function of increased inter-trial-intervals (ITI). However, the neuronal trace model would never predict a deterioration in performance across a series of isotemporal trials, at best, no influence of PPI would be expected when trials are

separated by extremely long ITIs. It is interesting to note that Shakow's (Zahn et. al., 1963) finding of PPI = PI resulting in optimal performance is also quite discordant with observations of deterioration in performance across an isotemporal series of trials. Steffy's tentative finding of an initial improvement followed by a deterioration in performance across a series of isotemporal trials can accommodate both reactive inhibition and neuronal trace positions.

In spite of the lack of agreement at the theoretical level the crossover effect is certainly robust phenomenologically. This distinctive pattern has been observed consistently since the 1930s by a diverse array of experimenters employing an equally diverse variety of methodologies. The crossover effect appears: 1) to be specific to schizophrenia (e.g., Bellissimo & Steffy, 1972; Tizard & Venables, 1956; Zahn & Rosenthal, 1965), 2) to vary as a function of pathology level as measured by a wide variety of instruments (e.g., Shakow, 1977), 3) to be independent of mean RT (e.g., Olbrich, 1972; Steffy & Galbraith, Note 2), 4) to be independent of medication (e.g., cf. Bellissimo & Steffy, 1972; Rodnick & Shakow, 1940), 5) to be independent of intelligence (e.g., Czudner & Marshall, 1967; Tizard & Venables, 1956), 6) to vary along process-reactive and chronic-acute dimensions (e.g., Bellissimo & Steffy, 1972; Shakow, 1977), and 7) to be found to a significantly greater degree in the first degree relatives of schizophrenics than in the general population (Cromwell, De Amicis, Hayes, & Briggs, 1979).

It is indeed difficult to determine exactly what is being reflected by changes in schizophrenics' RTs. As mentioned earlier, the

traditional interpretation given to changes in RT centre around dysfunction of attentional processes. However, a recent review of the literature on schizophrenics' RT performance by Nuechterlein (1977) uncovered a listing of hypothetical constructs employed to explain their peculiar response patterns which range from segmental set, narrowed attention, selective filter deficit, response competition, and protective inhibition to social withdrawal, sensitivity to social censure, defective biological motivation, and impression management. It is interesting to note that of all the explanations offered for the schizophrenics' slower and more variable RTs none have considered an explanation for this motor task which deals in a direct way with motor functioning at the peripheral level. While only two major theoretical camps have addressed themselves directly to the phenomenon of increased magnitude of crossover in schizophrenia, both have held that "central" rather than "peripheral" sources of variance were responsible for the effect. The Shakow camp holds that a primary attentional deficit, as reflected by various RT experiments, leads to schizophrenic thought disorder, whereas, the Steffy camp believes that a primary schizophrenic disorder of cortical over-arousal mediates the peculiar responses seen on RT tasks. Perhaps an examination of differences between schizophrenics and normals at the "peripheral" level during an RT task may complement the various explanations offered, which have to date been concerned with "central" processing differences. As Steffy (1977) urges ". . . Consequently, in addition to a need for further study of decision processes, more intensive study of the mechanisms basic to performance on the

traditional RT procedure also seems warranted," (p. 449). Pursuing this line of inquiry, the aim of the present investigation was to examine the time taken by central versus peripheral processes in overall RT in order to determine the relative contribution of processes taking place at these two levels to: 1) overall mean RT, and 2) magnitude of crossover. [Shakow (1963) has noted that schizophrenics and normals perform at the same level on simple motor tasks such as tapping and has therefore not considered differences at the peripheral level to be important. King (e.g., King, 1975) and Broadhurst and Eysenck (1973), however, are definitely not in agreement with Shakow's claim that schizophrenics' tapping patterns are the same as those of normals. These authors' data suggest that schizophrenics' tapping speeds are both slower and more variable than normals.] The distinction between central and peripheral components of RT provides a useful way of conceptualizing the RT interval; these two "levels" of activity are clearly not easily separable, however the dichotomy does make for a useful working model. In fact, some support is given for the usefulness of conceptualizing RT as composed of central and peripheral components (e.g., Botwinick & Thompson, 1966; Schmidt & Stull, 1976; Schneider, Note 3; Weiss, 1965).

The RT interval has been partitioned into central and peripheral components by monitoring electromyographic (EMG) activity in a simple finger lift RT paradigm; the time between the onset of the stimulus and the first noticeable change in EMG activity constituted the pre-motor time (PMT) and was held to reflect the central component of the overall RT. The total RT minus PMT represented motor

time (MT)--the peripheral component, (Botwinick & Thompson, 1966; Weiss, 1965). Other attempts to partition the RT interval into various components or processing stages have been made (e.g., Sternberg, 1969); however, the approach developed by Weiss (1965) appears to be the most straight forward method of differentiating peripheral and central components. Interestingly, methods of partitioning RT such as Sternberg's (1969) which systematically alter input or output characteristics such as: 1) the quality of the stimulus, 2) size of positive set, 3) response type, and 4) relative frequency of response type which are held to respectively affect a) stimulus encoding, b) serial comparison, c) binary decision, and d) translation and response organization in a linear fashion, still consider only processes within the PMT component of the Weiss model and ignore factors which could alter the MT interval.

It was decided that the present study should 1) examine more carefully the contribution of peripheral factors in overall RT performance by employing the Weiss (1965) method as described above, as well as 2) make a within subject comparison of the traditional "press-release" motor response with a "press-only" response. While reviewing the literature on RT and schizophrenia, and more specifically the crossover effect, it was noted that, to the best of the author's knowledge, without exception all of the studies reporting the crossover effect have employed a press-release task--that is, subjects were presented with a warning signal at which point they were to depress a key and maintain pressure throughout the PI, the demand stimulus was then presented and RT was measured as the time between the stimulus

presentation and release of the key. No explanation has been offered as to why this task rather than a press-only task had been used. At first glance, the choice of response task may appear to be a trivial point, however, aspects of the press-release task may in this application viz., a comparison of central and peripheral factors in RT, represent a potential confound. In the press-release task the amount of work required, the amount of resultant fatigue, and the amount of muscular inertia will vary as a function of PI duration. The longer isometric pressure is maintained in a single direction, the longer it will take to reverse the motion. In the regular series, RT is known to increase as a function of PI duration. Therefore, the possibility exists that the slower RTs were due to muscular function as just described, or alternatively to loss of major set, reactive inhibition, or some such other central factor as traditionally supposed. In order to check this possibility a second, press-only, task was also used. In the press-only task, the subject was required to rest his finger above the key when the warning signal was presented but not to press the key. When the demand signal was presented the subject's task was to depress the key as quickly as possible. In this second task the amount of neuro-muscular involvement was constant regardless of PI duration and therefore not as susceptible to the same possible confounding of muscular involvement with attentional demands inherent in the press-release task.

If, for example, the crossover effect is due to an attentional or reactive inhibition process, one would expect that a change in the motor response should not alter the magnitude of the effect since all

time intervals were held constant between the press-release and press-only tasks. However, from Shakow's position, given that the press-release response requires a greater amount of task relevant focusing and involvement throughout the PI, one would perhaps expect to see less crossover on the press-release task than the press-only task where the schizophrenic has relatively less task relevant stimuli to hold his attention. On the other hand, from Steffy's position, the greater task relevant involvement required by the press-release relative to the press-only task throughout the PI would conceivably supply the subject with more precise temporal referents which may be perceived by the schizophrenic as an overload of information and therefore result in a reactive inhibition response and consequently more crossover. Thus, the Shakow and Steffy theoretical positions lead to differential predictions with respect to the present task manipulation. Shakow's position would predict more whereas Steffy's position would predict less crossover during the press-only relative to the press-release task.

EXPERIMENT 1

Method

Subjects. Ten male, caucasian, process schizophrenics, with a mean age of 32.3 years (SD = 12.2 years) and Ullmann-Giovannoni scores of 10 or less (Ullmann and Giovannoni, 1964; Appendix A) constituted the experimental group. All subjects had held a hospital diagnosis of schizophrenia for five years or more and were deemed able to handle the required tasks by hospital staff. Ten male, caucasian undergraduates with a mean age of 24.4 years (SD = 4.2 years) served as the control subjects.

Procedure

Each of the 20 subjects visited the laboratory individually for one, approximately 75 minute, session. Upon arrival to the laboratory the experimenter introduced himself and provided instructions which briefly familiarized the subject with the apparatus and the tasks to be performed.

Recording procedure. As mentioned above RT was broken down into PMT and MT components. This was accomplished according to the electromyographic (EMG) procedures developed by Weiss (1965) and since employed by Botwinick and Thompson (1966) and Schmidt and Stull (1976).

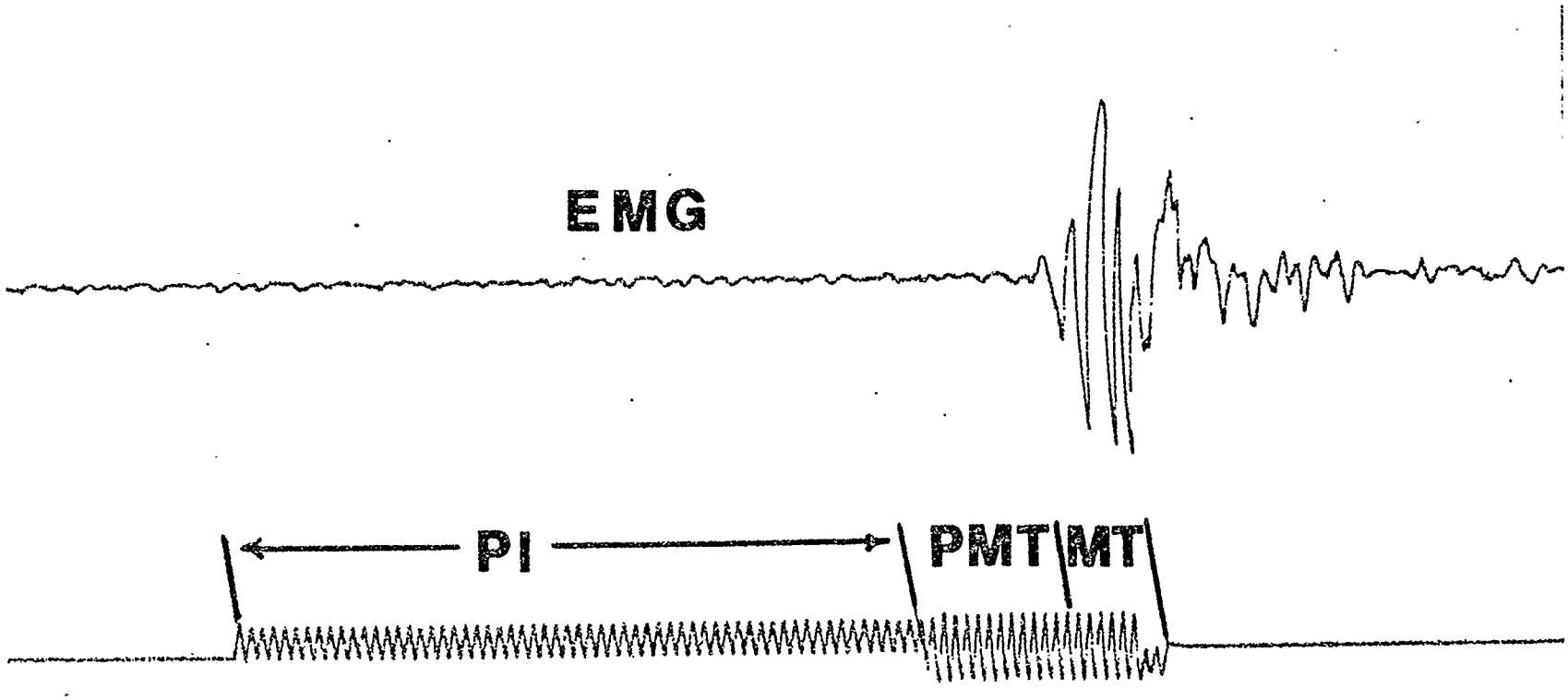
EMG was recorded continuously from the extensor digitorum communis of the perferred arm. Two Beckman silver-silver chloride

standard (16 mm) surface electrodes were placed 10 cm apart, each one 5 cm from the mid-point of the forearm. A ground electrode was placed on the shoulder of the preferred arm. All skin surfaces were first cleaned with Hewlett Packard Redux Creme and then washed with absolute ethyl alcohol before electrodes were attached. Each electrode cap was then filled with Beckman Electrode Paste and affixed with adhesive collars in the above manner. EMG was recorded using a Grass Model 7P5-B Wide Band A.C. preamplifier in conjunction with a Grass Model 79 polygraph. All time intervals were recorded in parallel with the EMG trace by way of the time-and-event marker channel. The time between the presentation of the demand stimulus and the onset of EMG activity was referred to as PMT, whereas the time between the end of PMT and the end of RT was referred to as MT (RT = PMT + MT; Figure 1).

Trial Arrangement. Each subject was tested on two RT procedures. Every other subject was presented with the "press-release" task first followed by the "press-only" procedure separated by a five minute rest. The other half received the tasks in reverse order. In the press-release procedure the subject depressed a key at the onset of the warning light and maintained the pressure throughout the PI; his response to the demand signal (tone)[1] was the release of the key. The press-only procedure required the subject to maintain vigilance throughout the PI as in the press-release procedure but to depress the key only to the demand signal.

For each of the two tasks subjects received 112 trials with PI durations varying from 1.0 seconds to 8.0 seconds within which 12

Figure 1. Sample trial depicting pre-motor time (PMT) and motor time (MT) components of overall reaction time as computed from electromyographic (EMG) recording.


EMG
PI
PMT
MT
CHART SPEED = 50 mm / sec

blocks of four isotemporal (PIs of equal duration) trials were embedded.

Whereas, Shakow (e.g., Rodnick & Shakow, 1940) typically presented subjects with a series of irregular trials (trials with apparently random PI durations) followed by a series of regular trials (multiple blocks of trials with equal PI durations), Steffy (e.g., Bellissimo & Steffy, 1972) has developed a unique "embedded set" arrangement which was used in the present study. In this procedure blocks of four isotemporal trials are embedded within an otherwise irregular or random array of filler trials. The first trial in an isotemporal block represents the traditional irregular series in that it is preceded by a series of trials of varying PI duration. The fourth or last trial in an isotemporal block represents the regular series in that it is preceded by trials of the same PI duration. Within each of these 112 trial series, one isotemporal block of trials was presented at PI = 1.0 seconds and one at 3.0 seconds. The 7.0 second PI duration which is held to be the most relevant to the crossover effect, was sampled 10 times (i.e., 10 isotemporal blocks at PI = 7.0 seconds). Steffy (Note 4) has developed a series of 10 different counter-balanced arrangements of 112 trials each (Appendix B) in order to ensure a random presentation of filler trials. Thus, multiples of 10 subjects should be used to completely fill this "balanced-square" design. Each of the 10 subjects in the two groups received two different trial arrangements according to the order in which they participated in the study (e.g., subject No. 1 received orders, 1, 2; subject No. 2 received 3, 4, etc.). The rationale for this "multiple 7s" design (developed by

Steffy cited in De Amicis & Cromwell, Note 5) was that if the cross-over effect is present it will usually be observable by the 7.0 second PI in the form of a slower RT on the regular (fourth) relative to the irregular (first) trial. Therefore, the multiple 7s design allows for more sampling at the most crucial PI duration.

Each subject was given a few practice trials at PI = 5.0 seconds before beginning each task series.

Results

General analyses. Mean PMT, MT, and RT are presented in Table 1 for schizophrenics and normals on both the press-release and press-only tasks. (Only trials within isotemporal blocks at PI = 7.0 seconds were scored). These measures were subjected to three, 2 (schizophrenic/normal) x 2 (press-release/press-only) repeated measures analyses of variance (ANOVA). The analysis of mean PMTs indicated no statistically significant differences between either groups [F (1, 18) = 2.34, $p \geq .10$] or tasks [F (1, 18) = 0.04, $p \geq .10$] (Table 2). Mean MTs, however, were significantly longer for schizophrenics than for normals [F (1, 18) = 21.53, $p \leq .001$], independent of task [F (1, 18) = 0.55, $p \geq .10$] (Table 3). The third ANOVA revealed significantly longer overall mean RTs for the schizophrenic group [F (1, 18) = 9.60, $p \leq .01$] which was again independent of task [F (1, 18) = 0.77, $p \geq .10$] (Table 4).

In summary, then, schizophrenics displayed significantly longer MTs and overall RTs than the normals; this effect was independent of task differences. Mean PMTs were not affected by either group

Table 1

Means and standard deviations of premotor, motor, and overall reaction times of schizophrenics and normals on press-release and press-only tasks.

			Premotor time (msec.)	Motor time (msec.)	Reaction time (msec.)
press-release	Schizophrenics	$\bar{X}$	269.32	199.21	468.53
	n = 10	SD	148.79	39.73	132.44
	Normals	$\bar{X}$	195.52	110.90	306.42
	n = 10	SD	18.52	13.05	23.55
press-only	Schizophrenics	$\bar{X}$	242.90	255.85	498.75
	n = 10	SD	77.76	182.52	228.88
	Normals	$\bar{X}$	212.40	101.40	313.80
	n = 10	SD	36.54	11.96	42.05

Table 2

Group by task repeated measures ANOVA of mean pre-motor time scores

Source	SS	DF	MS	F	Significance
A schizophrenic/ normal	26381.05	1	26381.06	2.33	NS
B press-release/ press-only	159.00	1	159.00	0.04	NS
A x B	4352.44	1	4352.44	1.19	NS
S(A)	203012.39	18	11278.46		
SB(A)	65768.84	18	3653.82		

Table 3

Group by task repeated measures ANOVA of mean motor time scores

Source	SS	DF	MS	F	Significance
A schizophrenic/ normal	145232.63	1	145232.63	21.53	$p \leq .001$
B press-release/ press-only	5971.91	1	5971.91	0.55	NS
A x B	11517.54	1	11517.54	1.00	NS
S(A)	121385.86	18	6743.66		
SB(A)	195466.14	18	10859.23		

Table 4

Group by task repeated measures ANOVA of mean reaction time scores

Source	SS	DF	MS	F	Significance
A schizophrenic/ normal	304022.81	1	304022.81	9.60	$p \leq .01$
B press-release/ press-only	3454.95	1	3454.95	0.77	NS
A x B	1120.95	1	1120.95	0.25	NS
S(A)	569788.89	18	31654.93		
SB(A)	80486.44	18	4471.47		

or task differences. Mean RTs for each of the four trials within an isotemporal block at PI = 7.0 seconds are presented graphically in Figure 2 (Individual subject means are presented in Appendix C).

Difference scores. Magnitude of crossover was reflected by the extent to which performance on the regular trials was worse than that on the irregular trials. In order to better understand the group and task influences on this phenomenon, difference scores--obtained by subtracting irregular (first) trials from regular (fourth) trials--were next analyzed in a series of three, 2 (schizophrenic/normal) x 2 (press-release/press-only) repeated measures ANOVAs. These difference scores are presented in Table 5 and graphically portrayed in Figure 3. Statistical analyses revealed no significant group or task influences on either mean PMT or mean MT difference scores (Tables 6, 7). A significant task effect on mean RT crossover [F (1, 18) = 4.65, $p \leq .05$] (Table 8), however, prompted within group comparisons which revealed that both schizophrenics [t (9) = 1.87, $p \leq .05$] and normals [t (9) = 2.77, $p \leq .025$] showed significantly greater crossover on the press-release than on the press-only task.

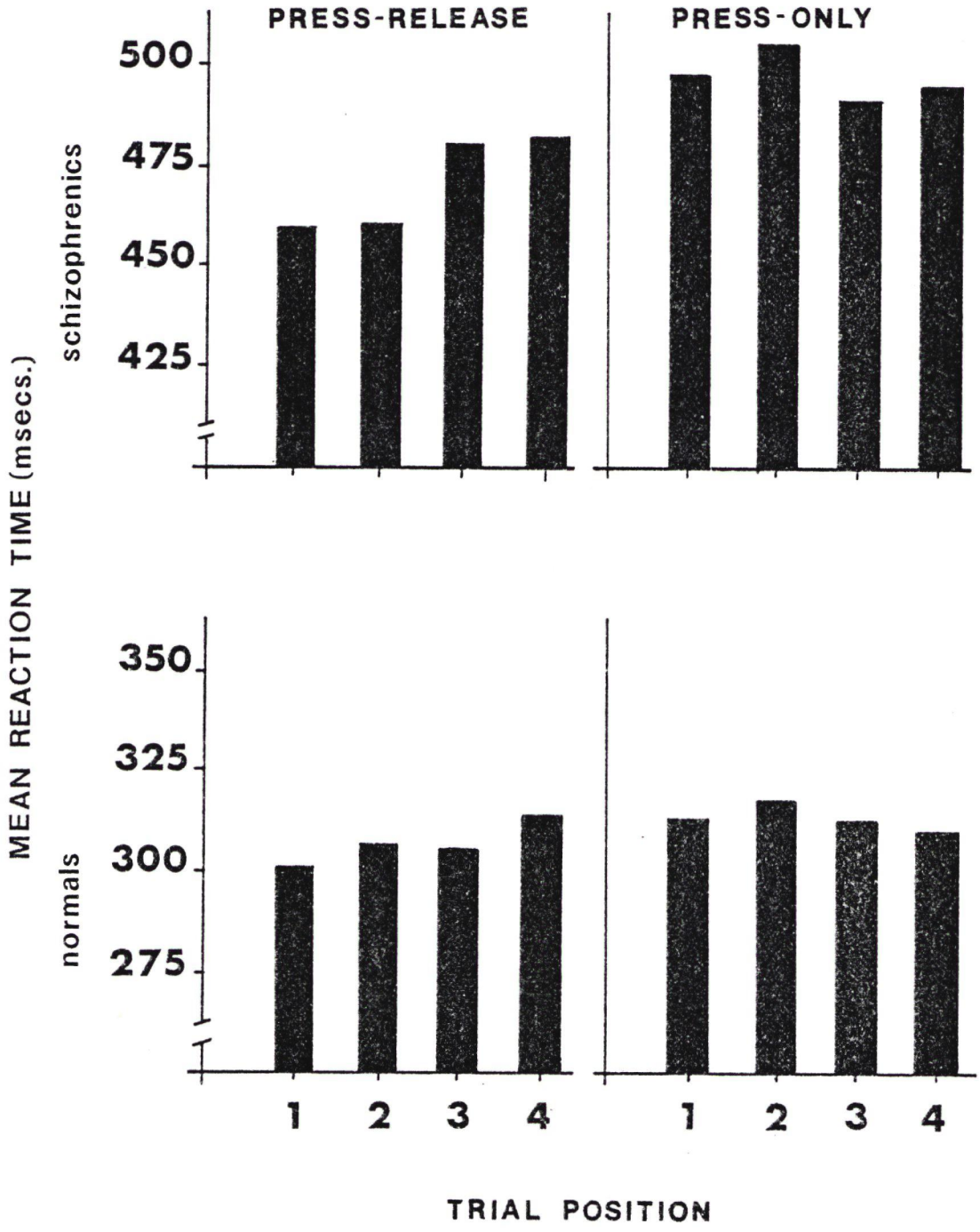


Figure 2: Bargraph reflecting mean RT at each of the four trials within the isotemporal series of trials at PI = 7.0 seconds for schizophrenics and normals on each task (press-release/press-only).

Table 5

Mean premotor, motor, and overall reaction time mean difference scores for schizophrenics and normals on press-release and press-only tasks.

			Premotor time (msec)	Motor time (msec)	Reaction time (msec)
press-release	Schizophrenics	$\bar{X}$	11.5	12.3	23.8
	n = 10	SD	33.43	21.73	35.97
	Normals	$\bar{X}$	10.3	0.7	11.0
	n = 10	SD	11.79	5.33	9.86
press-only	Schizophrenics	$\bar{X}$	-3.1	2.	-1.1
	n = 10	SD	30.97	28.06	24.45
	Normals	$\bar{X}$	-2.9	1.2	-1.7
	n = 10	SD	9.40	2.61	9.29

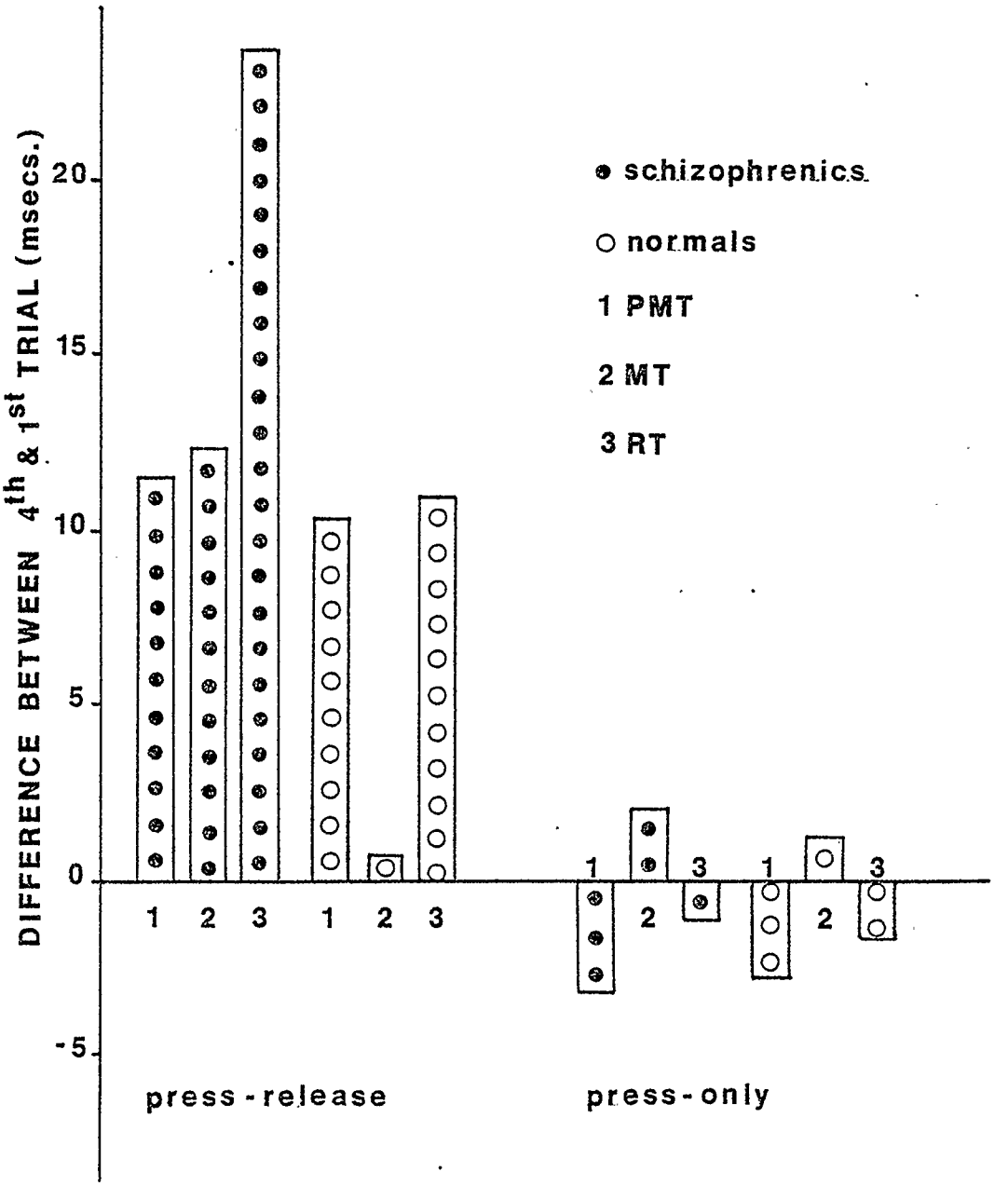


Figure 3: Bargraph depicting magnitudes of cross-over for each of the groups (schizophrenic/normal), on each task (press-release/press-only) on each of the reaction time components (1 = PMT, 2 = MT, 3 = RT).

Table 6

Group by task repeated measures ANOVA of mean pre-motor time difference scores

Source	SS	DF	MS	F	Significance
A schizophrenic/ normal	2.50	1	2.50	0.02	NS
B press-release/ press-only	1935.10	1	1932.10	1.92	NS
A x B	4.9	1	4.90	0.00	NS
S(A)	2614.4	18	145.24		
SB(A)	18130.00	18	1007.22		

Table 7

Group by task repeated measures ANOVA of mean motor time difference scores

Source	SS	DF	MS	F	Significance
A schizophrenic/ normal	384.40	1	384.40	2.49	NS
B press-release/ press-only	240.10	1	240.10	0.48	NS
A x B	291.60	1	291.60	0.59	NS
S(A)	2774.50	18	154.14		
SB(A)	8883.30	18	493.52		

Table 8

Group by task repeated measures ANOVA of mean reaction time difference scores

Source	SS	DF	MS	F	Significance
A schizophrenic/ normal	632.02	1	632.02	1.68	NS
B press-release/ press-only	3080.02	1	3080.02	4.65	$p \leq .05$
A x B	540.22	1	540.22	0.82	NS
S(A)	6768.85	18	376.04		
SB(A)	11918.25	18	662.12		

Discussion

As indicated above and as typically reported, the schizophrenics' mean RTs in the present study were found to be slower than those of the normals. This was the case regardless of the task. Of extreme interest and counter to the previously held implicit assumption of "neuro-muscular sameness," the mean MTs of the schizophrenic group across all conditions were significantly longer than those of the normals. This finding supports the notion that peripheral factors are contributing to the schizophrenics' characteristic slower mean RT. Indeed, to the extent that PMT reflects central processing time, schizophrenics and normals were shown not to be significantly different as far as attentional or cognitive processing times are concerned. These findings do not support the supposition that the typically

slower RTs of the schizophrenic are solely indicative of attentional deficit or some such other cognitive dysfunction. It could very well be that some sort of neuro-muscular dysfunction had a slowing effect on the MT component (e.g., Meltzer, Goode, & Arora, 1979). This first study, then, yields tentative support to the notion that estimates of attentional or cognitive impairment in schizophrenia based on simple RT experiments may have been exaggerated due to the failure of investigators to monitor between group differences in the time taken by the muscle to execute the movement once all input and decision processes had been made.

Magnitude of crossover was reflected by the difference scores obtained by subtracting times recorded on the irregular (first) trial from those on the regular (fourth) trial. Analyses of these difference scores indicated that both schizophrenics and normals showed significantly greater crossover of overall RT on the press-release task relative to the press-only task. Since all aspects of the two tasks were held constant except for the actual motor response, these results suggest that the crossover phenomenon is specific to the press-release task and that it is very likely a feature of the task that has a differential effect on the muscular component of the response which is producing the schizophrenics increased crossover. Although analyses of PMT and MT difference scores revealed no statistically significant differences, an examination of Figure 3 suggests that the schizophrenics' increased crossover of overall RT on the press-release task was due mainly to a larger crossover of the MT component. These results, then, may be seen as tentative evidence for the involvement

of neuro-muscular sources of variance in the schizophrenics' pathognomonic behavioural deficit--the crossover effect.

It was interesting to note (Figure 3) that within the press-only condition not only did neither group show a deterioration in performance from the first to fourth trial across the isotemporal series but rather a slight (non-significant) improvement. In addition, the pattern of the component mean difference scores was virtually identical for the two groups within the press-only condition. This finding of no difference between schizophrenic and control in crossover on the press-only condition again suggests that some aspect of the press-release motor task during the repetitious isotemporal series was found to be particularly taxing by the schizophrenics.

It was surprising to note (Table 1) that the MTs of the schizophrenics during the press-only task were longer and a good deal more variable than the MTs recorded during the press-release task. Since the press-release task was criticized above for its potential confounding of peripheral and central demands the present investigator had expected, if anything, to observe longer and more variable MTs on the press-release task. In light of these peculiar observations the possibility existed that failure to obtain crossover on the press-only task was merely a reflection of this task's insensitivity--due to the increased variability of the MT measures--to the sorts of dysfunction being tapped during the press-release task. It was therefore decided to defer a more detailed theoretical discussion of the present results until the findings had been replicated.

Careful observation of a few pilot subjects, however, revealed

the likely cause of the long and variable MTs encountered on the press-only task. It was observed that due to a lack of clarity in the instructions some subjects held their index finger as much as two inches above the response key during the PI of the press-only task while waiting for the demand stimulus. This increased distance, of course, would serve to increase the length of the MT component considerably as well as add a tremendous amount of variance to the MT scores.

Having demonstrated: 1) a significantly greater crossover effect on the press-release relative to the press-only task, and 2) tentative support that for the notion factors at the peripheral level were contributing greatly to the schizophrenics' deviant RTs, it was felt that a replication of the first study was essential given the considerable theoretical implications of these findings. Since eliminating the variability of initial finger position in the press-only task would allow for a better comparison of the two tasks, it was decided that a refinement of the procedure in the present study should be undertaken. Retaining the essential features of the first study, the second study provided an explicit set of instructions designed to eliminate the variable distances travelled during the press-only response. It was decided that the second study should also attempt to monitor various other aspects of the motor response at points throughout each trial in order to compare the schizophrenics' behaviour with that of the normals in a more complete fashion. In addition, various demographic variables were recorded for each subject so that they may be related to differences in psychomotor behaviour.

EXPERIMENT 2

Method

Subjects. Twenty caucasian schizophrenic patients from the Moditen Clinic at the Foothills Hospital served as the experimental group. All subjects held a diagnosis of schizophrenia for two years or more and were deemed able to handle the required tasks by hospital staff. All experimental subjects were experimentally naive, volunteered freely, and were paid $1.50 for their participation in the study. Measures of age, sex, state-trait anxiety (Spielberger; Gorsuch, and Lashene, 1970, Appendix D), process-reactive psychois (Ullmann and Giovannoni, 1964), length of hospitalization, and medication dosage are presented in Table 9. Twenty caucasian undergraduates from the University of Calgary served as the control group. All control subjects were experimentally naive, volunteered freely, and were paid $1.50 for their participation in the study. Measures of age, sex, and state-trait anxiety are also presented in Table 9 for the control group.

Procedure

Each of the 40 subjects visited the laboratory individually for one, approximately 50 minute, session. Upon arrival to the laboratory the experimenter introduced himself and briefly familiarized the subject with the apparatus. A brief questionnaire (Appendix E) was administered in order to collect demographic information. Subjects were then given one of two standard sets of memorized instructions depending on task order (Appendix F). Subjects were seated in a chair

Table 9

Summary of Group Means on Demographic Variables

Group		Age* (years)	Male/ Female	State P-R	State P-O	Trait*	Ullmann Giovannoni	Length of Hospitalization (years)	Medication Dosage (mg)
Schizophrenic	$\bar{X}$	39.2	13/7	39.1	39.3	42.6	11.75	11.2	.70
	SD	13.8	--	9.5	8.8	9.0	3.0	7.5	.86
	RANGE	47	--	31	31	38	14	23	3.0
Normal	$\bar{X}$	23.1	5/15	36.9	35.6	35	--	--	--
	SD	3.9	--	9.2	8.1	5.7	--	--	--
	RANGE	18	--	30	25	18	--	--	--

*$p \leq .01$.

behind a desk on which the response key was placed within easy reach. Electrodes were attached and recordings made as in Experiment 1.

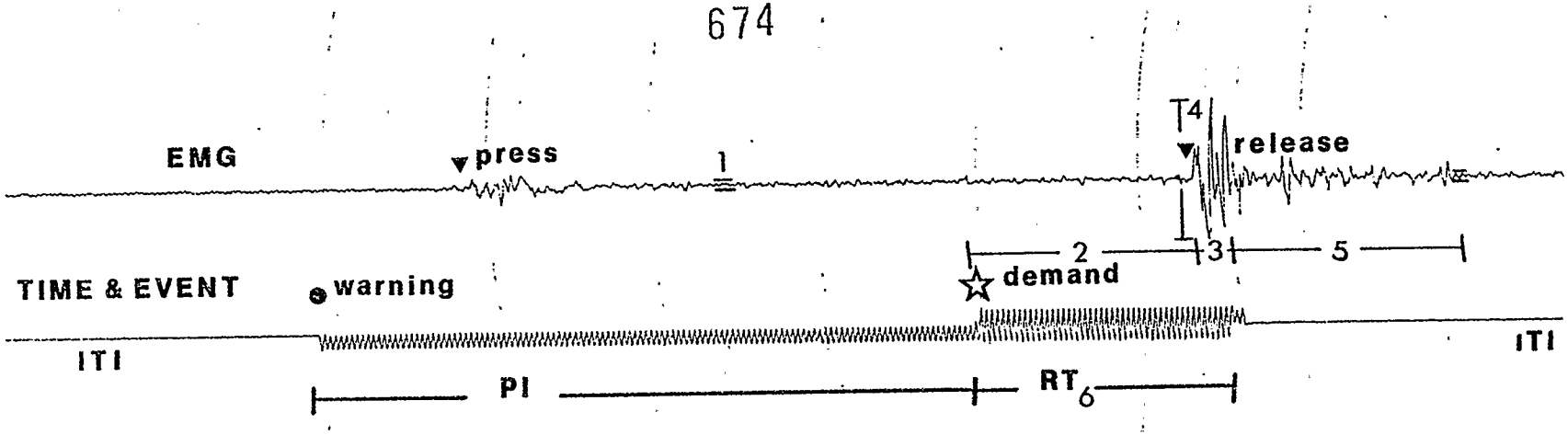
RT Breakdown. As in Experiment 1.

Trial arrangement. Each subject was tested on the two RT procedures in a counterbalanced fashion as in Experiment 1 except for the following differences. Trials were separated by a 2.0 second rather than a 3.0 second ITI. Secondly, the isotemporal blocks of four trials at PI = 1.0 seconds and 3.0 seconds were eliminated and replaced with two additional blocks of four isotemporal trials at PI = 7.0 seconds providing 12 rather than 10 isotemporal blocks of four trials at PI = 7.0 seconds. Thirdly, each task occupied only one half of each set of trials--or six sets of four isotemporal trials at PI = 7.0 seconds per task. This approach allowed for the continuance of a within subject task comparison without the lengthy testing time required by the presentation of one complete series of trials per task.

Results

General analyses. Features of the motor response including measures[2] of 1) EMG amplitude during the PI, 2) time between the onset of the demand stimulus and the onset of increased EMG activity (PMT), 3) time between the end of PMT and the end of the lift/press response (MT), 4) amplitude of response burst, 5) length of time required for EMG amplitude to return to the level observed during the PI, and 6) RT, were all recorded as shown in Figure 4 and presented in Table 10. All EMG amplitudes were measured in millimeters of pen deflection from the polygraph record. Attempts to quantify the

Figure 4. Sample trial depicting the series of events in a reaction time (RT) trial including relevant measures: 1) EMG amplitude during the PI, 2) pre-motor time, 3) motor-time, 4) response amplitude, 5) EMG post-response recovery time, and 6) RT.



SAMPLE TRIAL

Table 10

Means and standard deviations of times and amplitudes of components of RT trials for schizophrenics and normals on press-release and press-only tasks.

			PI EMG Amplitude	Response Amplitude	Recovery Time (msec)	PMT (msec)	MT (msec)	RT (msec)
Press-Release	Schizophrenics	$\bar{X}$	2.80	11.07	409.26	224.82	179.50	404.32
	n = 20	SD	1.39	5.68	327.78	76.74	35.60	94.52
	Normals	$\bar{X}$	1.61	9.52	224.78	174.32	152.49	326.81
	n = 20	SD	0.65	4.46	177.59	33.63	17.63	35.03
Press-Only	Schizophrenics	$\bar{X}$	2.09	10.96	357.52	250.35	134.83	385.19
	n = 20	SD	2.20	5.60	157.58	66.12	32.98	82.69
	Normals	$\bar{X}$	1.31	10.66	199.75	204.66	108.97	313.45
	n = 20	SD	0.77	4.43	119.93	34.89	28.32	42.87

EMG tracings with any greater degree of precision or in alternative units of measure were not made in light of Basmajian's (1974) discussion of the evaluation of electromyographic recordings. Only trials within the isotemporal blocks at PI = 7.0 seconds were scored.

These data were subjected to six, 2 (schizophrenic/normal) x 2 (press-release/press-only) repeated measures analyses of variance. It is evident from the first analysis of mean EMG amplitudes during the PI that although the schizophrenics' amplitudes were significantly higher than those of the normal [F (1, 38) = 9.22, $p \leq .01$] there were no differences attributable to the task factor [F (1, 38) = 2.88, $p \geq .10$] (Table 11). Neither factor affected mean response amplitude (Table 12). The schizophrenics, however, displayed significantly longer mean recovery times [F (1, 38) = 10.19, $p \leq .01$] which were again not influenced by the task factor [F (1, 38) = 0.67, $p \geq .10$] (Table 13).

The fourth ANOVA (Table 14) indicated that both group and task factors influenced mean PMT levels. The schizophrenics' PMTs were significantly longer than those of the normals [F (1, 38) = 8.37, $p \leq .01$] while the PMTs obtained for both groups were longer for the press-only relative to the press-release [F (1, 38) = 20.58, $p \leq .001$].

Both group and task factors also affected mean MT durations (Table 15): schizophrenics' being significantly longer than normals [F (1, 38) = 10.40, $p \leq .01$], whereas press-release MTs were longer than those obtained on the press-only task [F (1, 38) = 99.45, $p \leq .001$]. Once again there was no group by task interaction [F (1, 38) = 0.01, $p \geq .10$]. Since mean RT is equal to the sum of mean PMT and mean

Table 11

Group by task repeated measures ANOVA of mean EMG amplitudes during the preparatory interval

Source	SS	DF	MS	F	Significance
A schizophrenic/ normal	19.35	1	19.35	9.22	$p \leq .01$
B press-release/ press-only	5.22	1	5.22	2.88	NS
A x B	0.82	1	0.82	0.45	NS
S(A)	79.71	38	2.09		
SB(A)	68.92	38	1.81		

Table 12

Group by task repeated measures ANOVA of mean EMG response amplitudes

Source	SS	DF	MS	F	Significance
A schizophrenic/ normal	17.16	1	17.16	0.40	NS
B press-release/ press-only	5.25	1	5.25	0.58	NS
A x B	7.86	1	7.86	0.87	NS
S(A)	1620.99	38	42.66		
SB(A)	342.00	38	9.00		

Table 13

Group by task repeated measures ANOVA of mean EMG recovery times

Source	SS	DF	MS	F	Significance
A schizophrenic/ normal	648885.30	1	648885.30	10.20	$p < .01$
B press-release/ press-only	17272.50	1	17272.50	0.67	NS
A x B	379.54	1	379.54	0.01	NS
S(A)	2418974.05	38	63657.21		
SB(A)	699743.00	38	25440.61		

Table 14

Group by task repeated measures ANOVA of mean pre-motor time scores

Source	SS	DF	MS	F	Significance
A schizophrenic/ normal	46260.17	1	46260.17	8.37	$p < .01$
B press-release/ press-only	15610.80	1	15610.80	20.60	$p < .001$
A x B	115.80	1	115.80	0.15	NS
S(A)	209990.99	38	5526.07		
SB(A)	28816.44	38	758.00		

Table 15

Group by task repeated measures ANOVA of mean motor time scores

Source	SS	DF	MS	F	Significance
A schizophrenic/ normal	13973.32	1	13973.32	10.40	$p \leq .01$
B press-release/ press-only	38875.99	1	38875.99	99.45	$p \leq .001$
A x B	6.68	1	6.68	0.01	NS
S(A)	51047.18	38	1343.35		
SB(A)	14853.89	38	390.90		

MT it was not surprising to note that schizophrenics' mean RTs were significantly longer than those of the normals [F (1, 38) = 13.23, $p \leq .001$], while mean RTs obtained on the press-release task were longer than those obtained on the press-only task [F (1, 38) = 5.27, $p \leq .025$] with no group by task interaction [F (1, 38) = 0.16, $p \geq .10$] (Table 16). The overall mean RTs for each group on each task for each of the four trials within the isotemporal blocks at PI = 7.0 seconds are presented graphically in Figure 5. (Individual subject means are presented in Appendix G.) In order to get a better impression of the activity within the isotemporal block depicted in Figure 5 analyses of difference scores (regular minus irregular trials) were performed.

Difference scores. As mentioned earlier, magnitude of cross-over was reflected by the difference between the regular (fourth) and

Table 16

Group by task repeated measures ANOVA of mean reaction time scores

Source	SS	DF	MS	F	Significance
A schizophrenic/ normal	111362.27	1	111362.27	13.23	$p \leq .001$
B press-release/ press-only	5277.86	1	5277.86	5.27	$p \leq .025$
A x B	167.11	1	167.11	0.16	NS
S(A)	319855.22	38	8417.24		
SB(A)	38069.27	38	1001.82		

irregular (first) trials in an isotemporal series of four trials at PI = 7.0 seconds. Postive difference scores, therefore reflected cross-over in that performance was necessarily worse on the regular (fourth) relative to the irregular (first) trial. Negative difference scores, on the other hand, reflected an improvement in performance within an isotemporal block in that performance was better on the regular relative to the irregular trials. Mean difference scores (regular/fourth minus irregular/first) are summarized in Table 17 for each of the six measures described above, and graphically in Figure 6 for the RT components only.

The obtained mean difference scores were subjected to six, 2 (schizophrenic/normal) by 2 (press-release/press-only) analyses of variance. Neither group nor task factors significantly affected

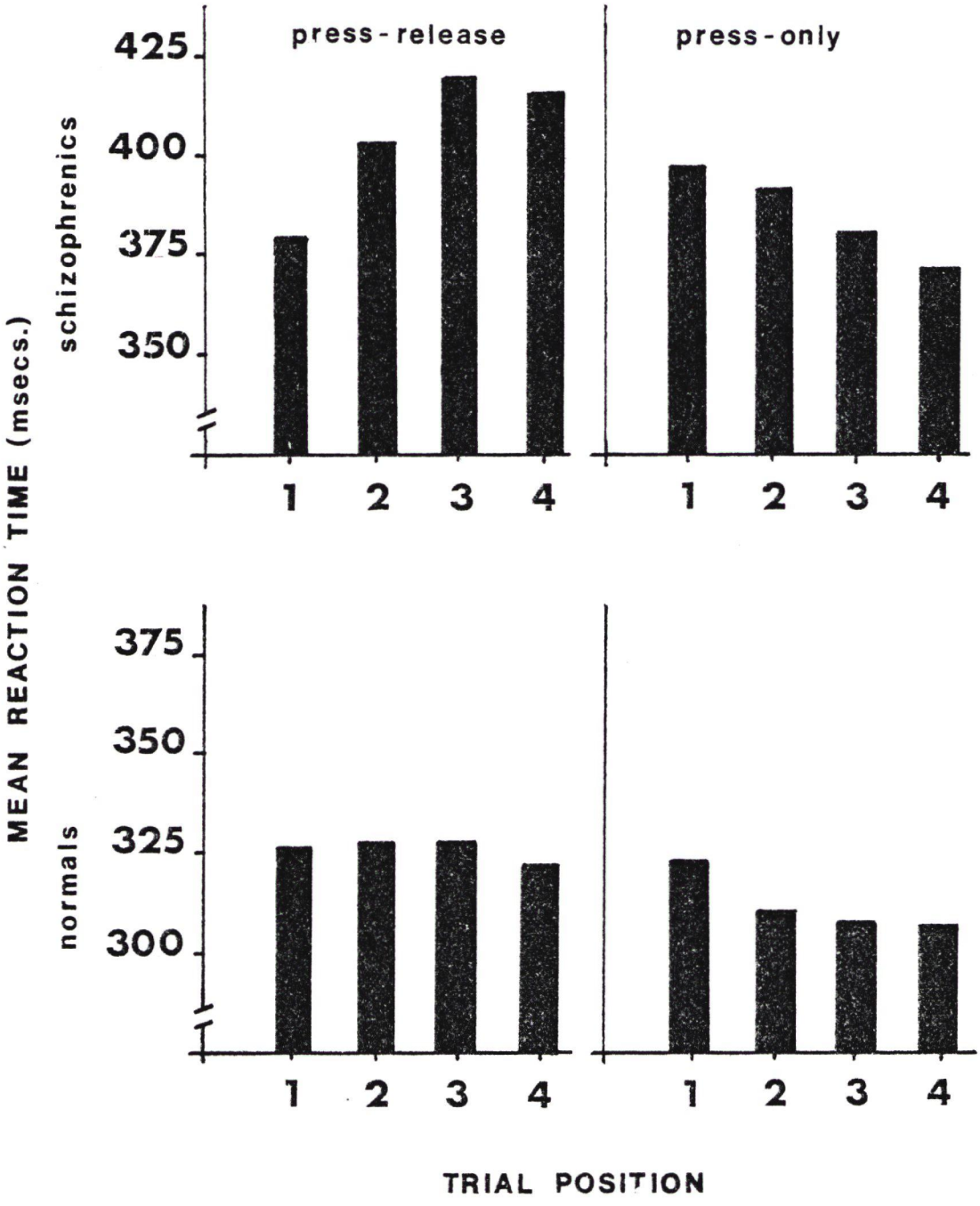


Figure 5: Bargraph reflecting mean RT at each of the four trials within the isotemporal series of trials at PI = 7.0 seconds for schizophrenics and normals on each task (press-release/press-only).

Table 17

Means and standard deviations of differences between measures obtained on the regular versus the irregular trials within the isotemporal blocks for both groups and tasks on each of the times and amplitudes recorded.

			PI EMG Amplitude	Response Amplitude	Recovery Time (msec)	Pre-motor Time (msec)	Motor Time (msec)	Reaction Time (msec)
Press-Release	Schizophrenics	$\bar{X}$	0.03	0.35	28.25	14.58	22.17	36.75
	n = 20	SD	0.31	2.58	100.73	36.64	31.47	50.53
	Normals	$\bar{X}$	-0.008	-1.38	1.41	-2.79	0.125	-2.66
	n = 20	SD	0.22	6.83	70.23	15.46	11.82	14.29
Press-Only	Schizophrenics	$\bar{X}$	0.06	-0.77	-19.39	-12.58	-13.42	-26.0
	n = 20	SD	0.28	1.97	112.45	59.39	19.47	53.04
	Normals	$\bar{X}$	-0.008	-0.48	-9.16	-13.42	-2.24	-15.66
	n = 20	SD	0.07	3.96	78.01	26.06	16.59	32.65

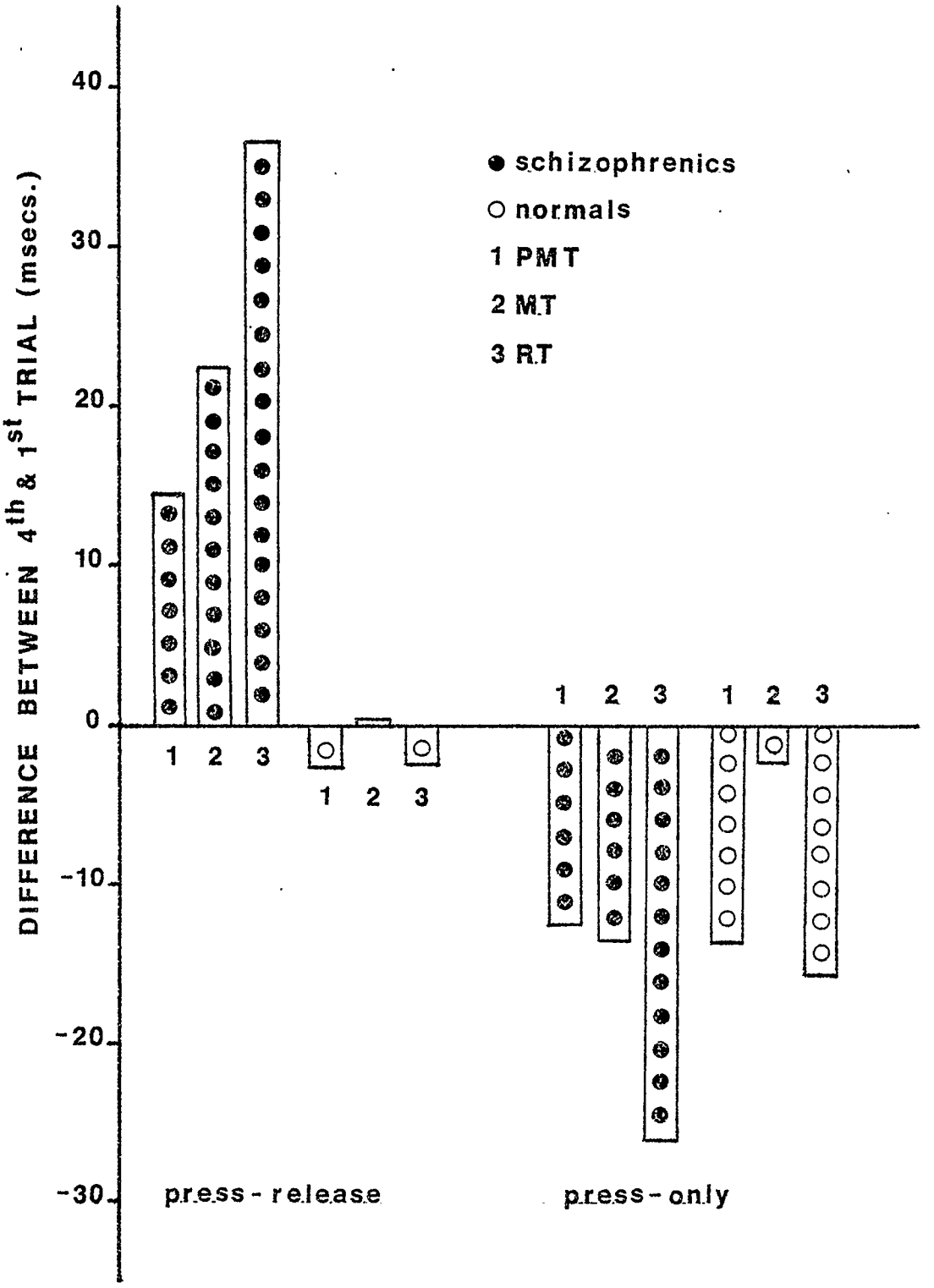


Figure 6: Bargraph depicting magnitudes of cross-over for each of the groups (schizophrenic/normal), on each task (press-release/press-only) on each of the reaction time components (1 = PMT, 2 = MT, 3 = RT).

difference scores for, 1) EMG amplitude during PI, 2) EMG response amplitude, or 3) EMG recovery time (Tables 18, 19, 20). Analysis of variance indicated that only the task factor significantly affected mean PMT difference scores, [F (1, 38) = 6.78, $p \leq .025$], with those of the press-release condition being longer (Table 21). Although the interaction between group and task was not statistically significant [F (1, 38) = 1.29, $p \geq .10$], a post-hoc between group t-test indicated a significantly longer mean PMT difference score for schizophrenics than for the normals within the press-release condition only [t (38) = -2.79, $p \leq .005$]. Mean MT difference scores also showed a significant difference due to the task factor [F (1, 38) = 14.31, $p \leq .001$], and a non-significant group effect [F (1, 38) = 1.18, $p \geq .10$], however the significant group by task interaction [F (1, 38) = 10.06, $p \leq .01$] prompted a within task examination which revealed a significantly larger mean difference score for the schizophrenics than for the normals within the press-release condition [t (38) = 2,50, $p \leq .01$] and a significantly larger improvement for the schizophrenics than for the normals within the press-only condition [t (38) = -1.83, $p \leq .05$] (Table 22).

Mean RT difference scores followed essentially the same pattern as mean MT difference scores (Table 23). The task factor indicated a significantly greater crossover for the press-release task relative to the press-only [F (1, 38) = 17.66, $p \leq .001$]. Again, a non-significant group effect was observed [F (1, 38) = 2.49, $p \geq .10$], however, in light of the significant group by task interaction [F (1, 38) = 7.62, $p \leq .01$], a post-hoc within the task group comparison was made

Table 18

Group by task repeated measures ANOVA of mean PI EMG amplitude difference scores

Source	SS	DF	MS	F	Significance
A schizophrenic/ normal	0.072	1	0.072	0.89	NS
B press-release/ press-only	0.005	1	0.005	0.14	NS
A x B	0.005	1	0.005	0.14	NS
S(A)	3.06	38	3.06		
SB(A)	1.27	38	1.27		

Table 19

Group by task repeated measures ANOVA of mean EMG response amplitude difference scores

Source	SS	DF	MS	F	Significance
A schizophrenic/ normal	8.99	1	8.99	0.44	NS
B press-release/ press-only	0.06	1	0.06	0.004	NS
A x B	18.68	1	18.68	1.14	NS
S(A)	768.62	38	20.22		
SB(A)	619.39	38	16.29		

Table 20

Group by task repeated measures ANOVA of mean EMG recovery-time difference scores

Source	SS	DF	MS	F	Significance
A schizophrenic/ normal	1379.19	1	1379.18	0.18	NS
B press-release/ press-only	16950.75	1	16950.75	1.78	NS
A x B	6866.60	1	6866.60	0.72	NS
S(A)	282417.02	38	282417.02		
SB(A)	360023.88	38	360023.88		

Table 21

Group by task repeated measures ANOVA of mean pre-motor time difference scores

Source	SS	DF	MS	F	Significance
A schizophrenic/ normal	1657.71	1	1657.71	0.90	NS
B press-release/ press-only	7141.05	1	7141.05	6.78	$p \leq .025$
A x B	1368.13	1	1368.13	1.30	NS
S(A)	69956.86	38	1480.97		
SB(A)	40025.88	38	1053.31		

Table 22

Group by task repeated measures ANOVA of mean motor time difference scores

Source	SS	DF	MS	F	Significance
A schizophrenic/ normal	675.70	1	675.70	1.18	NS
B press-release/ press-only	7491.67	1	7491.67	14.30	$p \leq .001$
A x B	5267.71	1	5267.71	10.05	$p \leq .01$
S(A)	21747.90	38	572.31		
SB(A)	19900.67	38	523.70		

Table 23

Group by task repeated measures ANOVA of mean reaction time difference scores

Source	SS	DF	MS	F	Significance
A schizophrenic/ normal	4229.20	1	4229.20	2.49	NS
B press-release/ press-only	28690.31	1	28690.31	19.66	$p \leq .001$
A x B	12375.31	1	12375.31	7.62	$p \leq .01$
S(A)	64415.21	38	1695.14		
SB(A)	61710.76	38	1623.97		

which revealed a significantly greater crossover for the schizophrenics than for the normals within the press-release task [t (38) = 3.36, $p \leq .005$] and a non-significant improvement for schizophrenics within the press-only task [t (38) = -0.74, $p \geq .10$].

Demographic variables. Two correlational analyses were made between demographic variables and mean difference scores for RT components--one within group analysis for each group (Tables 24, 25). For the schizophrenics', age correlated significantly with length of hospitalization [r (19) = .78, $p \leq .01$], sex (male = 1, female = 0) correlated significantly with MT crossover within the press-release condition [r (19) = -.62, $p \leq .01$], while state anxiety after the press-release task correlated significantly with state anxiety after the press-only task [r (19) = .67, $p \leq .01$]. Mean RT crossover within the press-release task correlated significantly with both mean PMT crossover [r (19) = .67, $p \leq .01$] and mean MT crossover [r (19) = .69, $p \leq .01$] within the press-release condition. However, mean RT crossover within the press-only condition correlated significantly with mean PMT crossover only [r (19) = .95, $p \leq .01$].

Within the normal group, state anxiety after the press-only task was significantly correlated with state anxiety after the press-release task [r (19) = .90, $p \leq .01$] as well as trait anxiety [r (19) = .59, $p \leq .01$], Mean RT crossover within the press-release condition was significantly correlated with mean PMT crossover within the press-release condition [r (19) = .69, $p \leq .01$]. Within the press-only condition mean RT crossover correlated significantly with both mean PMT crossover [r (19) = .87, $p \leq .01$] and mean MT crossover

Table 24

Correlations between schizophrenics' demographic variables and difference scores for each task

		1	2	3	4	5	6	7	8	9	10	11	12	13	14
1.	Age	1	-.49	.16	.08	-.33	.01	.78*	-.40	-.23	.49	.20	-.17	.04	-.17
2.	Sex		1	-.13	-.27	-.04	.11	-.20	.1	.02	-.62*	-.44	-.25	.25	.37
3.	State P-R			1	.67*	.41	-.03	-.15	-.25	-.14	.30	.13	.11	-.44	-.03
4.	Anxiety P-O				1	.40	-.20	-.11	.13	-.04	.19	.12	.18	-.30	.08
5.	Trait Anxiety					1	.13	-.35	.04	-.03	-.14	-.13	-.05	-.00	-.06
6.	Ullmann-Giovannoni						1	.30	-.18	.04	.11	-.12	-.11	.17	-.06
7.	Hospitalization (years)							1	-.28	-.25	-.08	-.12	.00	.23	.09
8.	Medication								1	-.15	-.25	-.30	.03	-.02	.02
9.	Press-Release PMT									1	-.07	.67*	.33	-.12	.33
10.	Press-Release MT										1	.69*	-.32	-.03	-.37
11.	Press-Release RT											1	.00	-.11	-.04
12.	Press-Only PMT												1	-.47	.95*
13.	Press-Only MT													1	-.16
14.	Press-Only RT														1

* $p \leq .01$, d.f. = 19

Table 25

Correlations between Normals' demographic variables and difference scores for each task

		1	2	3	4	5	6	7	8	9	10	11
1.	Age	1	.25	-.22	-.22	.02	-.03	-.11	-.12	-.14	.12	-.07
2.	Sex		1	-.14	.07	.25	-.19	-.04	-.23	-.27	-.00	-.18
3. State	P-R			1	.90*	.49	.19	-.24	-.00	.04	-.19	-.16
4. Anxiety	P-O				1	.59*	.24	-.25	.05	-.11	-.11	-.16
5. Trait Anxiety						1	.30	-.08	.26	-.00	.08	.02
6. Press-	PMT						1	-.48	.69*	.16	.11	.12
7. Release	MT							1	.31	.12	.38	.29
8.	RT								1	.27	.32	.37
9. Press-	PMT									1	.12	.87*
10. Only	MT										1	.58*
11.	RT											1

* $p \leq .01$

[r (19) = 58, $p \leq .01$].

Discussion

A discussion of mean component times will be followed by a discussion of crossover as reflected by analyses of difference scores.

Mean component times. It is apparent that the concerns raised with respect to the sensitivity of the press-only task can be set to rest with a reasonable degree of confidence in that both the means and standard deviations of the MT components obtained on the press-only task returned to their expected levels with the introduction of a more precise set of subject instructions. Both schizophrenics and normals were observed to have lower MTs on the press-only relative to the press-release task as predicted earlier. This finding allowed for a more confident between task comparison.

The schizophrenics' mean overall RTs, as expected, were significantly longer than those of the normals on both the press-release and the press-only task. Also, the mean overall RTs of both the schizophrenics and the normals were significantly longer on the press-release relative to the press-only task. In order to determine more precisely the locus (central/peripheral) of the group and task influences on overall RT, analyses of mean PMT and MT components were made. The mean PMTs of the schizophrenics' were found to be significantly longer than those of the normals on both the press-release and the press-only tasks, while the mean PMTs for both groups were significantly longer on the press-only than on the press-release task. Interestingly, while the schizophrenics' mean MTs

were again significantly longer than those of the normals on both tasks, the MTs of both the groups were significantly longer on the press-release than on the press-only task. In other words, the differing response requirements of the two tasks elicited a differential effect on the central and peripheral components of overall RT such that for both groups mean PMT was significantly shorter whereas mean MT was significantly longer on the press-release relative to the press-only task. In this regard, it is interesting to note that Schmidt and Stull (1970) have observed a differential effect of pre-response tension levels on PMT and MT components of overall RT in the same directions as those observed in the present study. Higher pre-response tension levels were associated with shorter PMTs and longer MTs. It seems likely, then, that for some reason the press-release task was perceived by both groups as more arousing than the press-only task. As predicted earlier, perhaps the greater task relevant involvement required by the press-release task afforded the production of more articulate proprioceptive temporal referents throughout the PI, which may have been perceived as information overload as proposed by Steffy (Bellissimo & Steffy, 1972) and thus resulted in increased arousal. This effect would have, as observed, an increased effect on schizophrenics relative to normals.

With respect to differences in motor responding as reflected by 1) EMG amplitude during the PI, 2) amplitude of EMG-response burst, and 3) length of time taken for post-response EMG amplitudes to return to the level recorded during the PI, only group effects were observed. While EMG response amplitude was not affected by group or task

differences, schizophrenics displayed significantly greater EMG amplitudes during the PI as well as significantly longer post-response recovery times. Weinberg and Hunt (1976) have observed a similar pattern of responding (with the additional finding of greater EMG response amplitudes) in the responding of high anxious relative to low anxious normals. We may, therefore, interpret the observed elevated EMG activity during the PI and longer EMG recovery times of the schizophrenics as possibly reflecting a generally heightened level of arousal independent of task differences. This interpretation seems reasonably well founded in that it is congruent with the data obtained from the state-trait anxiety measures. Schizophrenics were observed to have significantly higher scores on trait anxiety than normals. Although the schizophrenics' state anxiety scores were higher than those of the normals, this difference did not reach statistical significance, there were also no differences in state anxiety recorded after the press-release versus after the press-only task. It was suggested above that perhaps the press-release task was more arousing than the press-only task. One would then expect to see higher state anxiety scores after the press-release task than after the press-only task. Failure to obtain this result could reflect: 1) an error in interpretation of the EMG data, 2) the insensitivity of the test instrument to the differential subtle differences in arousal elicited by the two tasks, or 3) fundamental differences between arousal at the peripheral level and subjective feelings of anxiety as measured by the state anxiety questionnaire employed in the present study. It was felt that the third explanation viz., differences between peripheral arousal and subjective

feelings of anxiety as measured, was perhaps the best interpretation given the above data in light of the compatibility of 1) the differential effect of task differences on PMT and MT components perhaps reflecting greater muscular tension throughout the trial (c.f. Schmidt & Stull, 1970) and 2) the increased EMG activity during the PI combined with longer recovery times which may be seen as reflecting greater anxiety (c.f. Weinberg & Hunt, 1976). Given the greater task relevant involvement required by the press-release task, one would also predict, in light of Steffy's (Bellissimo & Steffy, 1972) proposition of increased information beyond a certain level contributing to increased arousal, increased levels of arousal on the press-release relative to the press-only task, due to its requirements of greater involvement throughout the PI.

Crossover analyses. As mentioned above differences in RT between the regular and irregular series at the longer seven second PIs, referred to as crossover, were reflected by difference scores. Difference scores were obtained by subtracting the RTs of the irregular (first) trials from the RTs of the regular (fourth) trials. The fourth trial in an isotemporal block of four trials represented the regular series in that it was preceded by a series of trials of the same PI duration. The first trial of an isotemporal block represented the irregular series in that it was preceded by a series of trials of varying PI duration. Therefore, positive difference scores reflected crossover in that the RTs of the regular series were longer than those of the irregular series at the long, seven second PI. Negative difference scores, on the other hand, reflect an improvement rather than a

deterioration in performance across the series of isotemporal trials in that the RTs on the regular (fourth) trials were shorter than those on the irregular (first) trials.

On the basis of the analyses of difference scores it was found that the overall RT of both groups displayed significantly more crossover on the press-release than on the press-only task and that within the press-release task the magnitude of the schizophrenics' RT crossover was significantly greater than that of the normals. On the press-only task negative rather than positive mean difference scores were obtained for both groups indicating, rather than crossover, an actual improvement in overall RT across the isotemporal block of trials.

Again, in order to determine the locus (central/peripheral) of the group and task influences on the magnitude of mean difference scores of overall RT analyses of mean PMT and MT difference scores were also made. It was observed that mean PMT difference scores were significantly larger on the press-release than on the press-only task for both groups and that within the press-release task the mean PMT crossover of the schizophrenics was significantly greater than that obtained by the normals. On the press-only task neither group displayed a crossover of the PMT component but again an actual improvement within the isotemporal block which was not significantly different between groups.

Analysis of mean MT difference scores revealed significantly more crossover on the press-release relative to the press-only task. Again, mean MT actually improved across the isotemporal block regardless of group membership, yielding negative mean MT

difference scores on the press-only task. More specifically, schizophrenics displayed significantly greater crossover of MTs on the press-release task and significantly greater improvement in MTs across a block of isotemporal trials within the press-only task than did the normals. It was evident that the MT components of the normals overall RTs across a block of isotemporal trials were not affected by differences between the press-release and press-only tasks and that changes in the schizophrenics' MT difference scores produced the overall between task differences. Analyses of mean difference scores for measures of 1) EMG activity during the PI, 2) EMG response amplitude, and 3) post-response recovery time revealed that neither of these measures were significantly influenced by task or group differences.

As anticipated from Steffy's theoretical position, the press-release condition yielded a greater crossover of overall RT than did the press-only condition. In fact, the crossover effect was specific to the press-release condition--an actual improvement in overall RT was observed across the isotemporal block of trials on the press-only task for both groups. It is conceivable that, as Steffy (Bellissimo & Steffy, 1972) has suggested, a redundancy of information within the isotemporal blocks at the longer seven second PI triggered an inhibitory process in order to attenuate the amount of incoming information, thus producing a deterioration in performance across the isotemporal block of trials. If, as suggested earlier, the schizophrenics can be viewed as having a heightened initial level of arousal, we would expect this effect to have an earlier onset and be more enhanced for the

schizophrenic group. Furthermore, if we are correct in assuming that the press-release task, due to its requirement of greater task relevant involvement, may be supplying the subject with more precise proprioceptive temporal referents throughout the trial which constitute increased information, we would expect to see a greater redundancy associated deficit on the press-release relative to the press-only task. Therefore, the findings of greater crossover on the press-release relative to the press-only task, and significantly more of it for schizophrenics, are perfectly reasonable and as previously predicted from Steffy's theoretical position. The deterioration in performance of both PMT and MT components across the isotemporal block of trials for the schizophrenics on the press-release task could be viewed as reflecting a generalized "shut-down" of the system. As Cromwell (1978) points out: ". . . At such high levels [of arousal] the organism might shift his resources away from the assigned performance goals simply to restore a more normal state of arousal" (p. 222).

During the press-only condition neither schizophrenics nor normals displayed crossover but rather an improvement in overall RT across the isotemporal series of trials. This sort of performance is consistent with the prediction made from Zubin's (1975) neuronal trace model, which, as mentioned earlier, proposes that the processing of the various features of a particular RT trial leave a facilitating trace for subsequent trials with similar features and an inhibitory trace for trials with dissimilar features. An assumed difference between schizophrenics and normals is that the facilitating and inhibitory neural traces persist longer for the schizophrenic than for the

normal. Thus, one would expect that the schizophrenic would be able to profit even more from the regularity of an isotemporal series of trials than the normal. This effect was, in fact, observed within the press-only condition for the MT component while the PMT component and overall RT failed to reach statistical significance.

The obvious question at this point is: if a series of isotemporal trials constitutes an improved situation for the schizophrenics due to the greater persistance of facilitating neural traces how do we reconcile their deterioration in performance on the press-release series? The Zubin model and Steffy's notion of reactive inhibition need not be seen as mutually exclusive but rather may be seen as complementary explanations of schizophrenics' RT performance in a variety of situations--both processes can be operating at the same time to greater or lesser degrees depending on the organism's state of arousal. If we may assume that neural trace strength varies as a positive function of the amount of processing directed towards a particular RT trial then trace strength may vary as a positive function of: 1) the length of time involved in processing aspects of a particular RT trial, or 2) the amount or richness of the task relevant information available per unit of time during a particular RT trial for processing, or both. Next, considering the reactive inhibition factor, the more information provided above and beyond some optimal level, the greater the induced arousal, and therefore, the greater the organism's task irrelevant attempts to return to a normal level of arousal. Considering only performance on the press-release task for the moment, it is typically found (e.g., Bellissimo & Steffy, 1972; Sutton & Zubin, 1965) that

across an isotemporal series of trials at shorter PI durations (PI = 1.0-3.0 seconds) RT performance progressively improves. This is compatible with both a reactive inhibition position and a neural trace position because at the shorter PI durations the organism profits from the facilitating neural traces of the isotemporal series, yet because of the short exposure duration it is not stimulated to a degree that would elicit a reactive inhibition response. At the longer PIs however, a more articulate facilitating neural trace is being etched due to the increase in processing required, but these advantages are offset by the organism's reactive inhibition response caused by the overstimulating effect of the increase in information.

During the press-only condition an improvement in performance across a series of isotemporal series of trials was observed and this effect was more pronounced for schizophrenics. It is likely, therefore, that the press-only task required a level of task relevant involvement or processing which could be assimilated adequately at PI durations of seven seconds. Because the product of intensity and duration of processing required by the press-only task did not result in a level of stimulation sufficient to elicit an inhibitory response, the individual was free to prosper from the facilitating neural traces across an isotemporal block of trials. Although, unfortunately, the relevant data are not available from the present study, one would perhaps expect that during the press-only task at shorter PI durations the schizophrenics and normals would show less improvement across an isotemporal series of trials given the decreased processing time afforded.

The results of the present study clearly did not seem to support a traditional loss of major set explanation for the crossover effect, as originally proposed by Shakow. As discussed above, due to the lesser degree of task relevant involvement required by the press-only task, one would expect the schizophrenic to be more susceptible to the intrusion of minor sets and therefore show more rather than less crossover. As noted above, the schizophrenics showed more crossover on the press-release task and actually improved on the press-only task--a situation which would clearly not have been predicted by Shakow. These findings should not be interpreted as indicating that schizophrenics do not have an attentional dysfunction of some sort. The results of the present study merely suggest that if an attentional deficit exists in schizophrenia it is not likely a direct contributor in producing the crossover effect.

If, however, we alter the traditional Shakow notion of loss of major set and view it, as Bleuler originally did, as a result rather than a cause of psychopathology, the reactive inhibition model and loss of major set concepts are quite compatible. As Cromwell (1978) points out the organism when over-aroused at longer PI durations may redirect his energies from task requirements to a reduction in arousal effort--thus, losing major set. The extent to which major set deteriorates will be a function of arousal level which in the RT situation will vary as a positive function of PI duration. The schizophrenic, then, may indeed be seen as suffering from a loss of major set during the isotemporal blocks of longer PIs; however, this deficit may be mediated by arousal level which also happens to vary as a positive

function of PI duration and increases across a set of isotemporal trials. Therefore, we must see the reactive inhibition response to over-arousal precipitating a loss of major set as a more efficient ordering of events.

Correlational analyses revealed that within the schizophrenic group length of hospitalization was related to age, as expected. The older the individual the more likely he is to have spent a longer time in hospital. It was also noted that the mean age of the schizophrenic sample was significantly greater than that of the normal sample. As noted by Woodworth and Schlosberg (1954) age does not significantly affect RT between the ages of 20 and 60 years. In addition, age was not found to correlate significantly with any of the difference scores of RT components, therefore, we may assume that differences in age between the two groups were not likely contributing to their differences in performance. The finding that females tended to have more cross-over of the MT component during the press-release task than males may reflect a greater degree of fatigue across an isotemporal series of trials perhaps due to their less developed musculature. Since sex correlated with none of the other demographic or crossover measures it is very likely non-reflective of a difference in psychopathology. State anxiety measures recorded after each task were correlated with each other indicating that no differential task effect on subjective feelings of anxiety existed. The schizophrenics' RT difference scores were correlated with both PMT and MT difference scores during the press-release task but only PMT difference scores during the press-only task. These results reflect once again the greater involvement

of peripheral sources of variance in the schizophrenics' magnitude of crossover within the press-release task, as compared to the press-only task.

Within the normal group all measures of anxiety were correlated suggesting an independence of task features and anxiety levels. Mean RT crossover was correlated with PMT crossover during the press-release series but correlated with both PMT and MT difference scores during the press-only condition. This indicates that whereas the normals' difference scores within the press-release task were due mainly to central influences, during the press-only task improvements in RT were due to an improvement in muscular functioning as well.

In summary, then, the two central findings of the present study were that: 1) an attentional deficit explanation as a primary cause of the crossover effect did not receive support whereas a combination of Zubin's neuronal trace model and Steffy's reactive inhibition model seemed to handle the data adequately, and 2) factors at the peripheral level contributed greatly to both the increased overall RT as well as the magnitude of RT crossover for the schizophrenic group. If we had examined only the PMT component of overall RT which encompassed only those central processing times which were typically thought to solely account for the variance in overall RT we would have drawn the same theoretical conclusions, however, the effects would not have been nearly as prominent. Activity at the peripheral level served to amplify the trends observed with respect to PMT change. Thus, we may conclude that estimates of schizophrenics' deviancies at the central level based on RT or other motor tasks have no doubt

been over-estimated or perhaps even misinterpreted altogether due to the failure of investigators to monitor sources of variance at the peripheral level.

The notion that schizophrenics and normals are very likely not functioning identically at the peripheral level receives additional support from two related areas of research. The first comes from theories of aminergic overactivity in schizophrenia (e.g., Sachar, Gruen, Altman, Langer, & Halpern, 1978). In brief, there is a considerable amount of evidence which suggests that schizophrenics and their first degree relatives have overactive dopamine pathways. Dopamine is a presumed neurotransmitter located primarily in the brain although some investigators have reported dopamine activity at various peripheral sites. Dopamine is typically found in the extrapyramidal system, the main function of which is the regulation of motor activity. Therefore, it is reasonable to speculate that dopamine over-activity may result in extrapyramidal dysfunction which could influence motor responding on such tasks as simple RT.

Another area of research which has obtained results directly relevant to schizophrenics' motor responding is that devoted to the study of neuromuscular dysfunction in schizophrenia. Meltzer et. al. (1979) have recently reviewed a number of studies which have found extensive neuromuscular dysfunction as reflected by anatomical, biochemical, and behavioural indices in schizophrenics and their offspring all of which may have been indirectly the result of over-active dopamine systems.

Considerable evidence underlining the importance of output

dysfunction in schizophrenics' psychomotor responding has been recently reported (e.g., Holzman, Proctor, & Hughes, 1973; Holzman, Proctor, & Levy, 1974; Meltzer, 1969, 1972; Meltzer & Crayton, 1974). To the extent that PMT and MT as measured in the present study may be seen as reflecting central and peripheral sources of variance, respectively, we may make the following interpretations. First of all, schizophrenics appear to require a greater amount of time to input, process, and make a decision to respond once the demand stimulus has been presented. Of course, it was not possible to determine which and to what extent each of the processes which take place during the PMT interval were being slowed. The PMTs of both groups were found to be longer for the press-only task relative to the press-release task. In addition, across tasks the schizophrenics musculature required a significantly greater amount of time to execute the motor behaviour once the information had reached the muscle fibre end-plates than did the normals'.

Of interest in this regard are the findings of a recent study by Wishner, Stein, and Peastrel (1978) who have employed Sternberg's (1969) method of identifying deficits at the various stages of information processing in order to discover the locus(ci) of the schizophrenic information processing dysfunction. Sternberg (1969) has postulated four stages of information processing which are, in order: 1) stimulus encoding, 2) serial comparison, 3) binary decision, and 4) translation and response organization, all of which occur within the bounds of what has been referred to in the present study as PMT. Wishner et. al. (1978) cite an unpublished and undated (Checkosky; cited in Wishner

et. al., 1978) account of an earlier attempt to apply Sternberg's method toward the same end. Checkosky apparently discovered no evidence of qualitatively different functioning in any of the first three stages between schizophrenics and normals. Unfortunately the fourth--translation and response organization--stage was not tested. Wishner et. al. hypothesized, in view of a number of recent studies implicating output dysfunction in schizophrenia, that perhaps Checkosky may have missed the most likely source of dysfunction by excluding the fourth stage. In a replication study Wishner et. al., however, failed to demonstrate any significant dysfunction in the fourth stage and although favouring a fourth stage deficit position suggest that perhaps ". . . we are dealing with an overall disorganization factor in schizophrenia that is not specific to any stage of information processing . . ." (p. 240). This apparent "disorganization" may in fact be due to a more pervasive generalized slowing of all input and output phases of psychomotor responding in an attempt to attenuate the overall arousal level of the organism.

SUMMARY

The two studies described in the present investigation agreed in their finding that the schizophrenics' distinctive crossover pattern of responding was specific to the traditional press-release RT motor task as compared to a press-only motor task. Failure to observe the crossover effect on the alternative press-only task, during which all time intervals and stimulus characteristics were held constant, was interpreted as not supporting an attentional deficit as a primary cause of the crossover effect. It was felt that because of the greater amount of task relevant involvement required by the press-release relative to the press-only task, perhaps differences in arousal levels were responsible for the between task differences. It was presumed that as arousal level increases so does the organism shift his energies away from the requested task and towards endeavours designed to reduce arousal to more normal levels, referred to as reactive inhibition. Thus, during the more arousing press-release task the organism's focus was relatively more occupied by homeostatic concerns than by our prescribed motor tasks. The outward manifestation of this process may be seen as simply a loss of major set. It was observed that the roles of loss of major set and reactive inhibition as causative agents in the crossover effect need not be seen as inconsistent but rather different stages of the same process, which operates at an intensity proportional to the arousal level elicited by the task. As focus is shifted towards reducing arousal it is necessarily shifted away from

task relevant concerns. Thus, loss of major set was seen as resulting from inhibitory processes rather than as an alternative etiological explanation for the crossover phenomenon.

The second important agreement found between the two studies was the finding of differences between schizophrenics and normals with respect to the time taken by the peripheral components of overall RT. When RT was partitioned into pre-motor and motor times it was found that the schizophrenics were slower during each of these components. Not only were the mean motor times longer for the schizophrenics than for the normals, which is inconsistent with the previously held implicit assumption of "neuromuscular sameness," but their motor times were also observed to contribute greatly to the magnitude of crossover of overall RT. This finding is of particular importance given the ubiquitous interpretation of deviant motor responding as indicative of attentional, cognitive, or intrapsychic disturbance. It is possible that estimates of these and other "central" dysfunctions based on studies that have failed to take possible differences in neuromuscular functioning into consideration may be greatly exaggerated or misinterpreted. It should also be noted that the present finding that neuromuscular sources of variance were accounting for a good deal of the schizophrenic's crossover of overall RT does not necessarily detract from the potential utility of crossover measures as predictors of high risk populations or as reflective of degree psychopathology. Increased magnitudes of crossover may still be seen as reflecting a dysfunction that is distinctively "schizophrenic," however, the nature of this anomalous functioning has been very likely distorted, due to

the failure of investigators to take into consideration factors previously thought not to vary as a function of the schizophrenic psychopathology.

FOOTNOTES

[1]The tone which was emitted from the plate which housed the response key was focused in a direction perpendicular to the response plate (i. e., towards the ceiling). The amplitude of this stimulus was 117 db from the source, 91 db from the forehead, and 85 db as measured from the subject's ear. A Brüel & Kjaer Artificial Ear Type 4152 was used in conjunction with a Brüel & Kjaer Microphone Amplifier Type 2603 set on the "A" Band in order to measure the stimulus amplitude. The stimulus was then matched with Wavetek Function Generator Multipurpose VCG Model 116 and fed into a Hickok Digital Systems Model DP 150 1 MC counter to determine its frequency at 2800 cps.

[2]Inter-rater reliabilities of the six EMG measures were as follows:

EMG amplitude during PI:	$r(39) = .90$, $p \leq .001$
EMG response amplitude:	$r(39) = .85$, $p \leq .001$
EMG recovery time:	$r(39) = .99$, $p \leq .001$
Pre-motor time:	$r(39) = .98$, $p \leq .001$
Motor Time	$r(39) = .95$, $p \leq .001$
Reaction Time:	$r(39) = .97$, $p \leq .001$.

REFERENCE NOTES

1. Steffy, R. A. Personal communication, January, 1979.
2. Steffy, R. A. & Galbraith, K. J. Latency and redundancy-associated deficit in process schizophrenics. In R. A. Steffy (moderator) Studies of redundancy-associated deficit in process schizophrenic patients. Symposium presented at the fortieth annual meeting of the Canadian Psychological Association, Quebec, P. Q., Canada, June 1979.
3. Schneider, R. D. The crossover effect: A phenomenon apparently specific to the RT motor task. Manuscript submitted for publication, 1979.
4. Steffy, R. A. Personal communication, June 1977.
5. De Amicis, L., & Cromwell, R. L. Reaction time crossover in process schizophrenics, their relatives, and control subjects. Unpublished manuscript, 1976.

REFERENCES

Basmajian, J. V. Muscles Alive: Their Functions Revealed by Electromygography. Baltimore: The Williams & Wilkins Co., 1974.

Bellissimo, A., and Steffy, R. A. Redundancy - associated deficit in schizophrenic reaction time performance. Journal of Abnormal Psychology, 1972, 80(3), 299-307.

Bellissimo, A., and Steffy, R. A. Contextual influence on crossover in the reaction time performance of schizophrenics. Journal of Abnormal Psychology, 1975, 84(3), 210-220.

Botwinick, J., and Thompson, L. W. Premotor and motor components of reaction time. Journal of Experimental Psychology, 1966, 71(1), 9-15.

Broadhurst, A., and Eysenck, H. J. Involuntary rest pauses (IRPs) in schizophrenics and normals. Journal of Motor Behavior, 1973, 5(3), 186-192.

Buchsbaum, M. S. and Haier, R. J. Biological homogeneity, symptom homogeneity, and the diagnosis of schizophrenia. Schizophrenia Bulletin, 1978, 4(4), 473-475.

Cromwell, R. L. Assessment of Schizophrenia. In: Rosenzweig, M. R., and Porter, L. W. (eds.). Annual Review of Psychology, 1975, Vol. 26. Palo Alto, California: Annual Reviews, Inc., pp. 593-619.

Cromwell, R. L. Attention and information processing: A foundation for understanding schizophrenia? In: L. C. Wynne, R. L. Cromwell, and S. Matthysse (eds.). The Nature of Schizophrenia: New Approaches to Research and Treatment. New York: John Wiley & Sons, 1978, pp. 219-224.

Cromwell, R. L., De Amicis, L., Hayes, T., and Briggs, D. Reaction time crossover, a vulnerability index: Mean reaction time, a symptom severity index. Psychopharmacology Bulletin, 1979, 15(1), 24-25.

Czudner, G., and Marshall, M. Simple reaction time in schizophrenic, retarded, and normal children under regular and irregular preparatory conditions. Canadian Journal of Psychology, 1967, 21, 369-380.

Helzer, J. E., Robins, L. N., Taibleson, H., Woodruff, Jr. R. A., Reich, T., and Wish, E. D. Reliability of psychiatric diagnosis. Archives of General Psychiatry, 1977, 34, 129-133.

Holzman, P. S., Proctor, L. R., and Hughes, D. W. Eye-tracking patterns in schizophrenia. Science, 1973, 131, 179-181.

Holzman, P. S., Proctor, L. R., Levy, D. L., Yasillo, N. J., Meltzer, H. Y., and Hurt, S. W. Eye-tracking, dysfunctions on schizophrenic patients and their relatives. Archives of General Psychiatry, 1974, 31, 143-151.

Huston, P. E., Shakow, D., and Riggs, L. A. Studies of motor function in schizophrenia, II Reaction time. Journal of General Psychology, 1937, 16, 39-82.

King, H. E. Psychomotor correlates of behavior disorder. In: M. L. Kietzman, S. Sutton, and J. Zubin (eds.). Experimental Approaches to Psychopathology. New York: Academic Press, Inc., 1975, pp. 421-450.

Matthysse, S. Missing Links. In: Wynne, L. C., Cromwell, R. L., and Matthysse, S. The Nature of Schizophrenia: New Approaches to Research and Treatment. New York: John Wiley & Sons, 1978, 148-150.

Meltzer, H. Y. Muscle enzyme release in the acute psychoses. Archives of General Psychiatry, 1969, 21, 102-112.

Meltzer, H. Y. Central core fibres in an acutely patient. Evidence for a neurogenic basis for the muscle abnormalities in the acute psychoses. Archives of General Psychiatry, 1972, 27, 125-132.

Meltzer, H. Y. Neuromuscular dysfunction in schizophrenia. Schizophrenia Bulletin, 1976, 2(1), 106-135.

Meltzer, H. Y., and Crayton, J. W. Muscle abnormalities in psychotic patients. II. Serum CPK activity, fiber abnormalities, and branching and sprouting of subterminal nerves. Biological Psychology, 1974, 8(2), 191-198.

Meltzer, H. Y., Goode, D. J., and Arora, R. C. Neuromuscular dysfunction and vulnerability to psychosis. Psychopharmacology Bulletin, 1979, 15(1), pp. 43-44.

Nideffer, R. M., Neale, J. M., Held-Kopfstein, J. H., and Cromwell, R. L. The effect of previous preparatory intervals upon anticipatory responses in the reaction time of schizophrenic and non-schizophrenic patients. Journal of Nervous and Mental Disease, 1971, 153, 360-365.

Nuechterlein, K. H. Reaction time and attention in schizophrenia: a critical evaluation of the data and theories. Schizophrenia Bulletin, 1977, 3(3), 373-428.

Olbrich, R. Reaction time in brain-damaged and normal subjects to variable preparatory intervals. Journal of Nervous and Mental Disease, 1972, 155, 356-362.

Rodnick, E. H., and Shakow, D. Set in the schizophrenic as measured by a composite reaction time index. American Journal of Psychiatry, 1940, 97, 214-225.

Sachar, E. J., Gruen, P. H., Altman, N., Langer, G., and Halpern, F. S. Neuroendocrine Studies of Brain Dopamine Blockage in Humans. In: L. C. Wynne, R. L. Cromwell, and S. Matthysse, (eds.). The Nature of Schizophrenia: New Approaches to Research and Treatment. New York: John Wiley & Sons, 1978, pp. 95-104.

Schmidt, R. A., and Stull, G. A. Premotor and motor time as a function of preliminary muscular tension. Journal of Motor Behavior, 1970, 11(2), 96-110.

Schneider, R. D. On the cogency of the PPI-PI effect. Schizophrenia Bulletin, 1978(a), 4(2), 154-155.

Shakow, D. Psychological deficit in schizophrenia. Behavioral Science, 1963, 8(4), 275-305.

Shakow, D. Schizophrenia: Selected papers. Psychological Issues, 1977, 10(2), Monograph 38.

Spielberger, C. D., Gorsuch, R. L., and Lashene, R. E. Manual for the state - trait anxiety inventory. Palo Alto: Consulting Psychologists Press, 1970.

Steffy, R. A. Issues in the study of schizophrenic reaction time: A review of the K. H. Nuechterlein paper. Schizophrenia Bulletin, 1977, 3(3), 445-451.

Steffy, R. A., and Galbraith, K. A comparison of segmental set and inhibitory deficit explanations of the crossover pattern in process schizophrenic reaction time. Journal of Abnormal Psychology, 1974, 83(3), 227-233.

Sternberg, S. The discovery of processing stages: Extension of Donders' method. In: W. G. Koster (ed.), Attention and Performance. II. Acta Psychologia, 1969, 30, 276-315.

Strauss, J. S., and Carpenter, W. J. Jr. Prediction of outcome in schizophrenia. Archives of General Psychiatry, 1972, 27, 739-746.

Sutton, S., and Zubin, J. Effect of sequence on reaction time in schizophrenia. In: Welford, A. T., and Birren, J. E. (eds.). Behavior, Aging and the nervous system. Springfield, Ill.: Charles C. Thomas, Publisher, 1965, pp. 562-597.

Tizard, J., and Venables, P. H. Reaction time responses by schizophrenics, mental defectives, and normal adults. American Journal of Psychiatry, 1956, 112, 803-807.

Ullmann, L. P., and Giovannoni, J. M. The development of a self-report measure of the process-reactive continuum. Journal of Nervous and Mental Disease, 1964, 138, 38-42.

Weinberg, R. S., and Hunt, V. V. The interrelationship between anxiety, motor performance and electromyography. Journal of Motor Behavior, 1976, 8(3), 219-224.

Weiss, A. D. The locus of reaction time change with set, motivation, and age. Journal of Gerontology, 1965, 20, 60-64.

Wishner, J., Stein, M. K., and Peastrel, A. L. Stages of information processing in schizophrenia: Sternberg's paradigm. In: L. C. Wynne, R. L. Cromwell, and S. Matthysse (eds.). The Nature of Schizophrenia: New Approaches to Research and Treatment. New York: John Wiley & Sons, 1978, pp. 233-243.

Woodworth, R. S., and Schlosberg, H. Experimental Psychology. New York: Holt, Rinehart and Winston, 1954.

Zahn, T. P. and Rosenthal, D. Preparatory set in acute schizophrenia. Journal of Nervous and Mental Disease, 1965, 141, 352-358.

Zahn, T. P., Rosenthal, D., and Shakow, D. Reaction time in schizophrenic and normal subjects in relation to the sequence series of regular preparatory intervals. Journal of Abnormal and Social Psychology, 1961, 63, 161-168.

Zahn, T. P., Rosenthal, D., and Shakow, D. Effects of irregular preparatory intervals on reaction time in schizophrenia. Journal of Abnormal and Social Psychology, 1963, 67, 44-52.

Zahn, T. P., Shakow, D., and Rosenthal, D. Reaction time in schizophrenic and normal subjects as a function of preparatory and intertrial intervals. Journal of Nervous and Mental Disease, 1961, 133, 283-287.

Zubin, J. Problem of attention in schizophrenia. In: M. L. Kietzman, S. Sutton, and J. Zubin, (eds.). Experimental Approaches to Psychopathology. New York: Academic Press, Inc., 1975, pp. 139-166.

APPENDICES

APPENDIX A

ULLMANN – GIOVANONNI

T/F 1. When I leave the hospital, I will live with my wife.

T/F 2. I am married now.

T/F 3. I have fathered children.

T/F 4. I have been married.

T/F 5. Before I was seventeen I had left the home I was raised in and never went back except for visits.

T/F 6. When I leave the hospital, I will live with one or both of my parents.

T/F 7. As a civilian I have worked steadily at one job or for one employer for over two years.

T/F 8. I finished at least one year of education after high school--trade apprenticeship, business school, college, etc.

T/F 9. Adding up all the money I earned for the last three years, it comes to less than $700, before deductions.

T/F 10. In my teens I was a member of a group of friends who did things together.

T/F 11. I hardly ever went over to another kid's house after school or on weekends.

T/F 12. When I was in school I didn't like Physical Education classes.

T/F 13. Alcohol has nothing to do with my difficulties.

T/F 14. I have paid regularly to buy a house.

T/F 15. More than once in the last year I have stayed on after some group meeting and talked with some other members about something that went on.

T/F 16. Shortly before I came into the hospital there was some

Appendix A (Continued)

major change in my life - such as marriage, birth of a baby, death, injury, loss of job, etc.

T/F 17. I have been deeply in love with someone and have told them about it.

T/F 18. In the kinds of work I do, it is expected that people will stay for at least a year.

T/F 19. My top wage in the last five years was less than $1.25 an hour.

T/F 20. I have earned my living for longer than a year at a full time civilian work.

T/F 21. I have had to stay in a mental hospital for more than one year at a time.

T/F 22. Within the last five years I have spent more than half of the time in a mental hospital.

T/F 23. In my teens I was a regular member of a club or organization that had a grown-up who came to meetings. (Scouts, school club, 4-H, church youth club, etc.)

T/F 24. In my teens there was more than one girl with whom I had more than two dates.

APPENDIX B

"SERIES OF 7's".

REACTION TIME SCORE SHEET - "Series of 7's"

No. 1 Name _____

Date _____

PI	T	PI	T	PI	T	PI	T	PI	T	PI	T	PI	T
6		7		4		5		7		5		7	
2		1		7		1		7		1		5	
4		7		6		8		1		7		4	
3		7		8		5		8		7		7	
8		7		7		4		2		7		7	
7		7		7		2		6		7		7	
2		3		7		1		4		5		7	
8		1		7		1		6		2		6	
2		3		1		1		8		1		7	
7		5		4		1		7		2		8	
7		3		7		3		7		8		3	
7		3		1		2		7		7		5	
7		3		7		6		7		7		7	
5		3		7		4		3		7		7	
7		6		7		7		7		7		7	
4		3		7		7		6		3		7	

Appendix B (Continued)

REACTION TIME SCORE SHEET - "Series of 7's"

No. 2 Name _____

Date _____

PI	T	PI	T	PI	T	PI	T	PI	T	PI	T	PI	T
7		3		6		5		7		5		7	
5		2		4		4		7		4		6	
3		7		6		6		6		7		5	
4		7		1		8		1		7		7	
1		7		7		4		2		7		7	
3		7		7		8		7		7		7	
5		1		7		1		1		3		7	
2		8		7		1		6		7		3	
8		7		3		1		8		8		5	
7		5		2		1		7		7		4	
7		3		6		2		7		1		2	
7		3		3		1		7		7		8	
7		3		7		2		7		7		7	
4		3		7		1		6		7		7	
7		4		7		7		3		7		7	
2		7		7		7		8		5		7	

Appendix B (Continued)

REACTION TIME SCORE SHEET - "Series of 7's"

No. 3 Name _____

Date _____

PI	T	PI	T	PI	T	PI	T	PI	T	PI	T	PI	T
6		2		2		5		7		3		3	
2		1		3		7		7		6		5	
4		7		7		5		3		7		3	
6		7		1		7		8		7		7	
7		7		7		1		2		7		7	
4		7		7		3		1		7		7	
5		4		7		1		2		2		7	
4		3		7		1		8		1		6	
8		7		5		1		2		4		1	
7		5		6		1		7		7		7	
7		3		8		8		7		8		6	
7		3		4		6		7		7		1	
7		3		7		5		7		7		7	
2		3		7		8		4		7		7	
7		8		7		7		5		7		7	
3		4		7		7		6		1		7	

Appendix B (Continued)

REACTION TIME SCORE SHEET - "Series of 7's"

No. 4 Name _____

Date _____

PI	T	PI	T	PI	T	PI	T	PI	T	PI	T	PI	T
3		6		1		6		7		7		4	
6		1		3		7		7		2		7	
4		7		4		5		6		7		4	
3		7		1		2		7		7		7	
4		7		7		6		5		7		7	
5		7		7		2		4		7		7	
2		8		7		1		5		3		7	
1		6		7		1		2		7		1	
8		5		5		1		3		1		4	
7		8		8		1		7		7		7	
7		3		3		4		7		8		5	
7		3		1		2		7		7		8	
7		3		7		7		7		7		7	
6		3		7		5		1		7		7	
2		6		7		7		3		7		7	
8		8		7		7		2		3		7	

Appendix B (Continued)

REACTION TIME SCORE SHEET - "Series of 7's"

No. 5 Name _____

Date _____

PI	T	PI	T	PI	T	PI	T	PI	T	PI	T	PI	T
1		7		6		4		7		3		5	
6		8		1		8		7		1		7	
2		7		7		7		5		7		2	
8		7		1		5		3		7		7	
3		7		7		8		8		7		7	
5		7		7		5		4		7		7	
4		4		7		1		5		2		7	
6		6		7		1		4		7		5	
4		1		3		1		5		6		2	
7		2		1		1		7		2		4	
7		3		7		2		7		8		3	
7		3		8		1		7		7		1	
7		3		7		7		7		7		7	
2		3		7		3		6		7		7	
7		6		7		7		3		7		7	
8		3		7		7		6		4		7	

Appendix B (Continued)

REACTION TIME SCORE SHEET - "Series of 7's"

No. 6 Name _____

Date _____

PI	T	PI	T	PI	T	PI	T	PI	T	PI	T	PI	T
5		4		1		3		7		8		8	
7		8		7		1		7		1		2	
2		7		4		6		5		7		3	
7		7		5		8		7		7		7	
3		7		7		6		4		7		7	
2		7		7		7		6		7		7	
7		5		7		1		4		2		7	
1		1		7		1		5		8		4	
8		5		6		1		8		7		3	
7		4		2		1		7		6		1	
7		3		8		6		7		1		6	
7		3		1		5		7		7		4	
7		3		7		7		7		7		7	
4		3		7		2		3		7		7	
3		5		7		7		2		7		7	
6		3		7		7		3		2		7	

Appendix B (Continued)

REACTION TIME SCORE SHEET - "Series of 7's"

No. 7 Name _____

Date _____

PI	T	PI	T	PI	T	PI	T	PI	T	PI	T	PI	T
4		5		7		3		7		3		6	
2		4		4		1		7		8		3	
5		7		8		7		5		7		6	
7		7		1		6		7		7		7	
5		7		7		7		4		7		7	
3		7		7		2		2		7		7	
4		5		7		1		6		5		7	
6		2		7		1		3		1		8	
1		1		2		1		1		8		6	
7		7		7		1		7		4		3	
7		3		4		4		7		3		5	
7		3		2		6		7		7		8	
7		3		7		2		7		7		7	
8		3		7		8		6		7		7	
1		2		7		7		1		7		7	
3		8		7		7		7		5		7	

Appendix B (Continued)

REACTION TIME SCORE SHEET - "Series of 7's"

No. 8 Name _____

Date _____

PI	T	PI	T	PI	T	PI	T	PI	T	PI	T	PI	T
7		2		7		4		7		6		7	
2		6		8		3		7		1		3	
5		7		2		2		4		7		1	
3		7		4		6		8		7		7	
5		7		7		3		5		7		7	
2		7		7		6		2		7		7	
1		3		7		1		7		4		7	
6		6		7		1		4		7		4	
1		7		6		1		8		5		7	
7		5		8		1		7		1		5	
7		3		1		8		7		8		7	
7		3		8		1		7		7		2	
7		3		7		8		7		7		7	
3		3		7		3		3		7		7	
5		6		7		7		5		7		7	
1		2		7		7		4		4		7	

Appendix B (Continued)

REACTION TIME SCORE SHEET - "Series of 7's"

No. 9 Name _____

Date _____

PI	T	PI	T	PI	T	PI	T	PI	T	PI	T	PI	T
2		6		3		5		7		2		5	
3		3		4		7		7		1		8	
1		7		6		8		6		7		2	
5		7		8		7		4		7		7	
8		7		7		2		7		7		7	
6		7		7		4		5		7		7	
2		4		7		1		7		3		7	
3		7		7		1		1		1		5	
8		6		4		1		6		7		1	
7		5		6		1		7		3		5	
7		3		8		2		7		4		4	
7		3		1		4		7		7		8	
7		3		7		2		7		7		7	
5		3		7		1		3		7		7	
2		8		7		7		6		7		7	
1		7		7		7		7		3		7	

Appendix B (Continued)

REACTION TIME SCORE SHEET - "Series of 7's"

No. 10 Name _____

Date _____

PI	T	PI	T	PI	T	PI	T	PI	T	PI	T	PI	T
3		4		3		4		7		3		5	
8		8		7		5		7		1		3	
2		7		2		3		2		7		1	
6		7		4		7		1		7		7	
1		7		7		8		6		7		7	
7		7		7		3		5		7		7	
2		2		7		1		8		6		7	
6		4		7		1		4		4		5	
2		5		6		1		3		7		7	
7		4		1		1		7		1		1	
7		3		6		5		7		5		6	
7		3		8		7		7		7		8	
7		3		7		5		7		7		7	
4		3		7		1		2		7		7	
8		6		7		7		8		7		7	
2		7		7		7		7		3		7	

APPENDIX C

Experiment 1: Individual subject means for PMT, MT, and RT on each of the four trials within an isotemporal block at PI = 7.0 seconds for schizophrenics (S) and normals (N) on both the press-release (PR) and press-only (P-O) tasks.

		PMT				MT				RT			
PR	S	111	106	119	122	251	278	266	266	362	384	385	388
		598	607	706	703	135	127	140	133	733	734	846	836
		173	175	170	175	148	171	166	159	321	346	336	334
		233	210	245	237	198	206	191	193	431	416	436	430
		269	261	256	261	202	296	208	216	471	467	464	477
		286	269	294	284	233	224	213	235	519	493	507	519
		166	182	195	167	194	215	196	194	360	397	391	361
		211	187	214	218	147	147	156	154	358	334	370	372
		319	303	329	323	192	184	195	263	511	487	488	586
		319	330	367	310	187	199	224	197	506	529	591	507
	N	154	157	162	154	104	101	107	106	258	258	269	258
		207	227	198	226	113	107	109	109	320	334	307	334
		209	209	209	220	88	98	86	87	297	307	295	309
		180	184	178	183	114	113	116	114	294	297	294	298
		192	198	207	206	135	144	136	130	327	342	343	324
		191	202	197	209	107	102	101	114	298	304	298	322
		204	220	213	236	131	118	131	126	335	338	344	357
		186	183	193	201	103	99	99	107	289	282	292	299
		203	197	199	196	106	104	108	104	309	301	307	304
		184	183	182	182	106	116	120	117	290	299	302	297
PO	S	158	157	140	160	219	223	206	221	377	380	346	381
		346	399	405	271	770	744	733	832	1116	1143	1138	1103
		155	150	152	170	226	245	258	240	381	395	410	410
		228	235	206	204	213	246	255	246	441	481	461	450
		212	188	266	248	179	186	179	172	391	374	445	420
		307	326	297	304	185	177	188	169	492	503	485	473
		223	187	188	211	185	188	213	166	408	375	401	377
		213	207	245	242	160	177	162	158	373	384	407	400
		376	429	326	374	218	226	169	184	594	655	495	558
		210	200	188	213	188	180	173	175	398	380	361	388
	N	212	204	187	203	114	114	116	114	326	318	303	317
		312	315	318	311	116	114	102	113	428	429	420	424
		199	202	245	203	101	101	106	107	300	303	351	310
		190	197	185	179	100	107	99	102	290	304	284	281
		204	233	214	192	98	101	108	101	302	334	322	293
		212	193	214	205	121	116	104	124	333	309	318	329
		209	210	191	202	74	75	87	75	283	285	278	277
		191	211	203	199	100	102	114	102	291	313	317	301
		201	190	180	191	93	93	93	93	294	283	273	284
		194	207	178	210	89	89	91	87	283	296	269	297
		1	2	3	4	1	2	3	4	1	2	3	4

APPENDIX D

STATE - TRAIT

ANXIETY SCALE

STATE ANXIETY

		Not At All	Somewhat	Moderately So	Very Much So
1.	I feel calm	1	2	3	4
2.	I feel secure	1	2	3	4
3.	I am tense	1	2	3	4
4.	I am regretful	1	2	3	4
5.	I feel at ease	1	2	3	4
6.	I feel upset	1	2	3	4
7.	I am presently worrying over possible misfortunes.	1	2	3	4
8.	I feel rested	1	2	3	4
9.	I feel anxious	1	2	3	4
10.	I feel comfortable	1	2	3	4
11.	I feel self-confident	1	2	3	4
12.	I feel nervous	1	2	3	4
13.	I am jittery	1	2	3	4
14.	I feel "high strung"	1	2	3	4
15.	I am relaxed	1	2	3	4
16.	I feel content	1	2	3	4
17.	I am worried	1	2	3	4
18.	I feel over-excited and "rattled"	1	2	3	4
19.	I feel joyful	1	2	3	4
20.	I feel pleasant	1	2	3	4

TRAIT ANXIETY

		Almost Never	Sometimes	Often	Almost Always
21.	I feel pleasant	1	2	3	4
22.	I tire quickly	1	2	3	4
23.	I feel like crying	1	2	3	4
24.	I wish I could be as happy as others seem to be	1	2	3	4
25.	I am losing out on things because I can't make up my mind soon enough	1	2	3	4
26.	I feel rested	1	2	3	4
27.	I am "calm, cool, and collected"	1	2	3	4
28.	I feel that difficulties are piling up so that I cannot overcome them	1	2	3	4
29.	I worry too much over something that really doesn't matter	1	2	3	4
30.	I am happy	1	2	3	4
31.	I am inclinded to take things hard	1	2	3	4
32.	I lack self-confidence	1	2	3	4
33.	I feel secure	1	2	3	4
34.	I try to avoid facing a crisis or difficulty	1	2	3	4
35.	I feel blue	1	2	3	4
36.	I am content	1	2	3	4
37.	Some unimportant thought runs through my mind and bothers me	1	2	3	4
38.	I take disappointments so keenly that I can't put put them out of my mind	1	2	3	4
39.	I am a steady person	1	2	3	4
40.	I get in a state of tension or turmoil as I think over my recent concerns and interests	1	2	3	4

APPENDIX E

SUBJECT DATA

Name _____ Date _____ Time _____

Age _____ Sex _____ Diagnosis _____

Length of Hospitalization _____

Medication: Type _____
Dosage _____

Length of time on medication _____

Handedness _____

APPENDIX F

REACTION TIME STUDY

Subjects' Instructions - A

First of all we're going to place these adhesive caps on your arm in order to measure your arm movement. You will feel absolutely nothing, they are merely for recording purposes. Do you have any questions?. . . Are you left or right handed?. . . Ok, I'd like you to place your left/right arm on the table directly in front of you and roll-up your left/right shirt sleeve. Now, I'd like you to raise your index finger . . . Ok, lower it , . . . raise it again . . . Now we'll just clean the skin surface and apply these caps like this . . . now we hook-up these cords to our machine here. Ok then, here's what we'd like you to do. First of all, place your finger on this key just so it's resting on the key, and get ready. That's it. When you see the green light that means be prepared, a tone is about to sound. Always keep your finger rested on the key while the green light is on. Ok, as soon as you hear the tone we'd like you to press down on the key as quickly as you can. The test here is to see how quickly you can press down the key after you hear the tone. Any questions? . . . Ok, you practice a few times while I adjust our machine . . . I'll tell you when we're ready . . . Ok we'll begin now, . . . remember, each time you see the green light--get set, keep your finger rested on the key, and as soon as you hear the tone press down as quickly as you can. The series of trials will last about 10 minutes. . . Any questions? . . . Ok, we'll begin now.

End of first task

Ok, you can stop now, we'll take a break here. How was that? . . . Ok, now I'd like to know how you're feeling this very moment, not how you usually feel necessarily, but how you feel right now. In order to get a feel for this I'd like you to fill out this questionnaire. As you can see, for each of the statements you circle the response which is most correct . . . not at all, somewhat, moderately so, or very much so. You circle the best response for each of these statements. Do you have any problems reading? Ok, any questions? . . . remember, we want to know only how you're feeling this very moment. Ok, let me know when you're done.

Ok, now we have another series of trials we'd like you to try but this time the task is slightly different. This time you again keep your finger rested on the key but we'd like you to depress the key when you see the green light and hold it down until you hear the tone. As soon as you hear the tone you lift your finger as quickly as you can.

Appendix F (Continued)

This time, the test is to see how quickly you can lift your finger after you hear the tone. Any questions? . . . Ok, practice a few trials while I adjust our machine. I'll let you know when the series begins . . . Ok, we're ready. This series will last about as long as the last one. . . All set? Ok, begin.

Ok, you can stop now, this series is over. How did you find that? . . . Now this may seem funny but what I'd like to know now is how you're feeling this very moment. Not how you usually feel, or necessarily how you felt last time. You may answer a lot of questions the same, that's ok, we just want to know how you're feeling right now. Any questions? Ok, this is the same questionnaire you filled out last time. . . so just begin when you're ready and let me know when you're done.

Ok, now what I'd like to know is how you typically feel, not necessarily how you feel now, but how you usually feel. Any questions? . . . Ok, we have a new set of questions and answers. . . so for each of these statements circle the most correct response. . . either, almost never, sometimes, often, or almost always. Any questions? . . . Let me know when you're done.

Experimental Group Only

Ok, we now have one more thing to do and we're all done. For each of these statements I'd like you to circle "T" if it's true and "F" if it's false. Any questions? . . . Ok, let me know when you're done.

Ok, great, that's it, we're all finished. Let's just get these caps off your arm. . . Do you have any questions? . . . Thank you very much for your help in this project. . . here's the $1.50 for your participation. If you have any questions please feel free to drop by and talk.

Appendix F (Continued)

Subjects' Instructions - B

First of all we're going to place these adhesive caps on your arm in order to measure your arm movement. You will feel absolutely nothing, they are merely for recording purposes. Do you have any questions? . . .Are you left or right handed? . . .Ok, I'd like you to place your left/right arm on the table directly in front of you and roll-up your left/right shirt sleeve. Now, I'd like you to raise your index finger. . . Ok, lower it. . . raise it again. . . Now we'll just clean the skin surface. . . and apply these caps, like this. . . now we hook-up these cords to our machine here. Ok then, here's what we'd like you to do. First of all, place your finger over this key just so it's resting on the key and get ready. That's it. When you see the green light we'd like you to depress the key and hold it down until you hear a tone. As soon as you hear the tone you lift your finger as quickly as you can. The test here is to see how quickly you can lift your finger off the key after you hear the tone. Any questions? . . .Ok, you practice a few times while I adjust our machine. . .I'll tell you when we're ready. Ok, we'll begin now. . . remember each time you see the green light depress the key, hold it down, and as soon as you hear the tone lift-up as quickly as you can. The series of trials will last about 10 minutes. . .Any questions. . .Ok, we'll begin now.

End of first task

Ok, you can stop now, we'll take a break here. How was that? . . . Ok, now I'd like to know how you're feeling this very moment, not how you usually feel necessarily, but how you feel right now. In order to get a feel for this I'd like you to fill out this questionnaire. As you can see, for each of the statements here you circle the response which is most correct . . . not at all, somewhat, moderately so, or very much so. You circle the best response for each of these statements. Do you have any problems reading? Ok, any questions? . . . remember, we want to know only how you're feeling this very moment. Ok, let me know when you're done.

Ok, now we have another series of trials we'd like you to try but this time the task is slightly different. This time you again keep your finger rested on the key but do not depress the key when the green light comes on. When you see the green light that means be prepared, a tone is about to sound. Always keep your finger rested on the key while the green light is on. Ok, as soon as you hear the tone we'd like you to press down on the key as quickly as you can. This time, the test is to see how quickly you can press down the key after you hear the tone. Any questions? Ok, you practice a few times while I adjust our machine . . . I'll tell you when we're ready. . .Ok, we'll begin now . . .

Appendix F (Continued)

remember, each time you see the green light--get set, keep your finger rested on the key and as soon as you hear the tone press down as quickly as possible. Ok, we're ready. This series will last about as long as the last one. . . All set? Ok, begin. . .

Ok, you can stop now, this series is over. How did you find that? . . . Now this may seem funny but what I'd like to know now is how you're feeling this very moment. Not how you usually feel, or necessarily how you felt the last time. You may answer a lot of the questions the same, that's ok, we just want to know how you're feeling right now. Any questions? Ok, this is the same questionnaire you filled out last time. . . so just begin when you're ready and let me know when you're done.

Ok, now what I'd like to know is how you typically feel, not necessarily how you feel now but how you usually feel. Any questions? . . . Ok, we have a new set of questions and answers . . . so for each of these statements circle the most correct response . . . either, almost never, sometimes, often, or almost always. Any questions? . . . Let me know when you're done.

Experimental Group Only

Ok, now we have one more thing to do and we're all done. For each of these statements I'd like you to circle "T" if it's true and "F" if it's false. Any questions? Ok, let me know when you're done.

Ok, great, that's it, we're all finished. Let's just get these caps off your arm. . . Do you have any questions? . . . Thank you very much for your help in this project. . . here's the $1.50 for your participation. If you have any questions please feel free to drop by and talk.

APPENDIX G

SUBJECT MEANS FOR EMG AND TIME MEASURES

APPENDIX G

Experiment 2 (Press-Release): Individual subject means for each of the four trials within an isotemporal block at PI = 7.0 seconds for PMT, MT, and RT for each group.

	PMT				MT				RT			
S	223	185	223	210	133	153	152	145	357	338	375	355
	160	165	177	148	137	123	128	117	297	288	305	265
	197	188	188	202	120	108	115	125	317	297	303	327
	202	202	156	187	158	173	170	155	360	375	326	342
	203	203	198	240	212	193	212	175	415	397	410	415
	183	163	183	195	170	182	185	188	353	345	368	383
	210	185	238	282	202	227	205	208	412	412	443	490
	162	215	173	202	152	125	148	150	313	340	322	352
	428	452	482	382	155	207	192	208	583	658	673	590
	325	298	303	300	192	207	182	327	517	505	485	627
	270	325	407	275	133	142	203	192	403	467	610	467
	165	182	197	192	172	173	157	157	337	355	353	348
	168	218	182	182	140	182	187	167	308	400	368	348
	232	253	338	310	138	162	147	180	370	415	485	490
	230	218	247	240	152	163	137	185	382	382	383	425
	175	180	170	182	195	203	190	223	370	383	360	405
	250	388	427	348	207	272	312	268	457	660	738	617
	157	145	195	150	187	202	188	203	343	347	383	353
	153	142	140	132	230	210	213	222	383	352	353	353
	118	182	157	147	178	187	178	210	297	368	335	357
N	163	185	140	162	110	112	108	115	273	297	248	277
	188	193	197	195	157	137	138	130	345	330	335	325
	180	192	190	200	142	150	140	143	322	342	330	343
	118	132	132	120	162	167	168	157	280	298	300	277
	150	162	132	138	153	147	160	157	303	308	292	295
	208	172	185	205	175	172	168	168	383	343	353	373
	142	157	150	173	165	158	162	148	307	315	312	322
	155	155	152	145	132	142	137	133	287	297	288	278
	167	163	167	165	152	147	163	150	318	310	330	315
	178	195	230	178	152	163	165	165	330	358	395	343
	150	152	220	137	195	185	178	182	345	337	398	318
	162	152	148	142	142	147	140	153	303	298	288	295
	195	187	172	168	180	178	168	175	375	365	340	343
	290	282	305	268	112	127	130	129	402	408	435	397
	162	187	153	182	170	157	157	152	332	343	310	333
	142	153	153	125	153	147	150	165	295	300	303	290
	160	165	145	148	135	133	130	138	295	298	275	287
	203	197	175	193	148	148	158	160	352	345	333	353
	163	172	158	160	153	142	170	162	317	313	328	322
	195	198	207	212	167	170	172	173	362	368	378	385
	1	2	3	4	1	2	3	4	1	2	3	4

Appendix G (Continued)

Experiment 2 (Press-Only): Individual subject means on each of the four trials within an isotemporal block at PI = 7.0 seconds for EMG amplitude during PI, response amplitude, and recovery time for each group.

	PI				AMP				REC			
S	1	1	1	1	8	9	8	9	643	555	517	518
	11	10	10	12	20	20	19	20	278	430	600	487
	1	1	1	1	8	8	8	7	535	392	565	492
	2	2	2	2	13	13	11	14	297	348	322	335
	4	4	4	3	9	11	9	8	180	232	170	222
	1	1	2	2	25	18	25	23	573	732	643	668
	2	2	2	2	9	8	7	7	305	210	213	287
	1	1	1	1	7	7	7	8	313	332	370	293
	1	1	1	1	11	10	10	10	413	380	467	573
	3	4	4	4	7	6	6	7	263	292	227	165
	1	1	1	1	10	13	9	9	212	197	292	220
	1	2	2	1	15	15	17	15	260	276	287	252
	1	1	1	1	4	5	5	4	92	122	98	215
	1	1	1	1	18	18	16	20	690	650	725	502
	2	2	2	2	13	5	6	6	425	417	448	407
	1	1	1	1	5	6	5	5	325	282	285	317
	2	1	1	1	6	6	6	5	723	601	511	643
	1	1	1	1	6	9	9	7	343	287	155	152
	1	1	1	1	11	8	13	10	418	242	198	217
	4	4	4	4	23	21	22	21	380	613	408	320
N	1	1	1	1	8	6	6	3	63	60	63	53
	1	1	1	1	4	4	5	5	78	117	93	118
	4	5	4	4	8	7	9	10	307	312	318	215
	1	1	1	1	8	10	10	9	185	173	187	158
	1	1	1	1	7	8	10	9	160	150	222	245
	1	1	1	1	8	9	7	9	113	90	122	120
	1	3	1	1	30	12	17	15	230	248	223	172
	1	1	1	1	8	12	8	12	313	310	365	315
	1	1	1	1	6	6	4	5	182	132	75	75
	1	1	1	1	17	18	16	15	387	378	423	367
	1	1	1	1	7	8	8	7	100	110	105	80
	2	3	2	2	11	13	12	12	617	520	577	430
	1	1	1	1	9	9	7	9	148	215	147	157
	1	1	1	1	11	9	13	11	140	168	177	147
	1	1	1	1	12	12	11	14	58	58	70	67
	1	1	1	1	6	8	8	6	177	167	250	245
	1	1	1	1	20	15	18	21	143	148	128	115
	1	1	1	1	13	12	10	17	167	145	163	170
	1	1	1	1	20	21	20	16	187	175	150	125
	2	2	2	2	10	10	13	8	187	458	287	385
	1	2	3	4	1	2	3	4	1	2	3	4

Appendix G (Continued)

Experiment 2 (Press-Release): Individual subject means on each of the four trials within an isotemporal block at PI = 7.0 seconds for EMG amplitude during PI, response amplitude, and recovery time for each group.

	PI				AMP				REC			
S	2	2	2	2	20	13	12	16	990	483	635	898
	1	2	1	2	21	21	25	23	338	255	362	502
	4	3	4	3	14	8	8	13	227	275	215	318
	1	1	1	0	12	9	9	11	315	225	154	142
	4	4	4	4	10	11	11	11	183	175	248	185
	1	1	1	1	20	23	21	22	108	98	125	68
	2	2	2	2	7	8	8	7	140	133	160	157
	2	2	2	2	12	16	18	20	83	122	70	188
	4	4	4	4	12	11	11	13	467	605	578	453
	6	5	6	6	7	8	8	8	220	218	163	187
	3	4	3	3	7	8	6	5	155	188	172	165
	5	5	3	4	12	9	10	7	195	207	105	115
	4	4	4	5	1	1	1	1	115	140	138	173
	1	1	1	1	8	8	10	9	465	603	558	535
	2	2	2	2	7	6	7	7	922	673	783	853
	1	1	1	1	4	5	3	4	472	462	398	512
	3	3	3	3	6	6	5	5	903	1010	1195	1000
	3	3	3	3	16	15	15	16	300	763	498	397
	4	4	4	4	12	13	13	13	275	262	213	307
	4	3	4	5	18	17	15	20	1010	1203	1535	1293
N	1	1	1	1	4	4	4	5	138	318	103	158
	1	1	1	1	5	5	4	4	150	260	217	122
	3	4	3	4	7	7	7	7	115	153	158	117
	2	2	2	2	7	11	10	11	83	95	92	50
	1	1	1	1	9	4	4	8	145	207	123	160
	2	2	2	1	4	5	3	18	60	70	70	72
	1	1	1	1	10	19	8	7	678	543	657	648
	1	1	1	1	6	9	6	7	207	340	218	243
	2	1	2	2	10	11	9	4	275	282	157	200
	1	1	1	1	7	8	7	7	610	480	438	427
	2	2	2	2	8	10	8	7	147	147	283	177
	1	1	1	1	11	9	9	11	520	648	663	705
	2	2	2	2	8	8	8	8	128	185	227	195
	3	3	2	3	5	5	4	5	157	200	128	180
	3	2	2	3	18	18	17	17	32	9	5	0
	1	1	2	2	31	9	10	6	212	237	215	277
	1	1	1	1	13	13	15	14	352	323	358	387
	2	2	2	2	9	8	11	10	70	55	128	38
	1	1	1	1	25	22	21	21	10	30	30	7
	2	2	2	2	12	9	8	7	247	197	233	202
	1	2	3	4	1	2	3	4	1	2	3	4

Appendix G (Continued)

Experiment 2 (Press-Only): Individual subject means on each of the four trials within an isotemporal block at PI = 7.0 seconds for PMT, MT, and RT for each group.

	PMT				MT				RT			
S	200	190	170	160	115	108	110	108	315	298	280	268
	300	320	255	253	87	73	78	77	387	393	333	330
	253	235	240	248	88	98	88	98	342	333	328	347
	220	235	217	200	117	117	108	100	337	352	325	300
	310	327	282	257	98	102	103	105	408	428	385	362
	232	233	253	252	112	105	108	102	343	338	362	353
	180	162	163	207	107	115	95	108	287	277	258	315
	208	208	178	185	127	128	123	112	335	337	302	297
	400	377	420	383	173	142	158	155	573	518	578	538
	507	372	350	297	180	160	202	192	687	532	552	488
	247	315	272	273	162	163	168	163	408	478	440	437
	213	208	190	190	140	140	153	143	353	348	343	333
	248	262	290	312	123	123	98	103	372	385	388	415
	202	317	243	222	158	143	148	137	360	460	392	358
	247	257	312	345	188	185	147	127	435	442	458	472
	197	180	188	177	183	182	173	155	380	362	362	332
	353	345	305	358	202	183	192	162	555	528	497	520
	203	190	215	200	198	158	163	207	402	348	378	407
	183	183	215	152	165	142	142	122	348	325	357	273
	193	220	193	175	123	113	120	103	317	333	313	278
N	263	225	257	218	87	92	67	83	350	317	323	302
	257	217	203	232	103	112	102	92	360	328	305	323
	275	277	255	282	125	115	97	107	400	392	352	388
	150	167	147	135	143	172	155	148	293	338	302	283
	168	183	180	170	102	90	98	87	255	273	278	257
	197	173	188	205	142	130	122	123	338	303	310	328
	228	158	147	170	107	98	233	100	335	257	380	270
	163	158	148	163	85	90	83	92	248	248	232	255
	200	243	182	183	137	138	153	155	337	382	335	338
	162	197	175	198	92	95	97	90	253	292	272	288
	232	208	197	200	113	100	105	103	345	308	302	303
	227	187	193	173	75	80	82	82	302	267	275	255
	232	210	197	197	182	140	120	140	413	350	317	337
	313	290	280	270	120	100	87	98	433	390	367	368
	183	212	187	205	125	90	143	108	308	302	330	313
	182	170	188	160	60	70	67	83	242	240	255	243
	223	212	183	218	58	53	70	67	282	265	253	285
	223	210	217	242	132	138	137	152	355	348	353	393
	208	192	207	212	80	73	83	87	288	265	290	298
	208	208	225	193	147	147	128	157	355	355	353	350
	1	2	3	4	1	2	3	4	1	2	3	4