

reaction time and attention in schizophrenia: a comment on K. H. Nuechterlein's critical evaluation of the data and theories*

Bonnie Spring and Joseph Zubin

In his exhaustive review, Nuechterlein (1977) has discussed both the earliest and the most recent contributions to the literature on reaction time (RT) in schizophrenia. Instead of synthesizing this summary or introducing additional research, we have decided to focus on a circumscribed aspect of the literature. In this paper we will be concerned only with the Shallow set paradigm and the Sutton and Zubin cross-modality technique, as well as with their respective theoretical interpretations. Specifically, our objectives are: (1) to compare and contrast both RT techniques in terms of the procedures employed and the variables manipulated; (2) to point out an aspect of the Shallow set paradigm that seems to have been generally overlooked; and (3) to discuss and respond to some comments on the Zubin neuronal trace model.

As a necessary preliminary, we will review the two RT procedures in terms of their task requirements and relevant variables. Superficial comparisons of the set and cross-modal RT paradigms often obscure essential differences in method. These discrepancies, in turn, relate to fundamental distinctions between the theoretical constructs and subsystems of attention that are under study in each procedure.

In the set procedure, each trial is usually initiated by a warning signal. Thus, in most experiments, the subject has no control over the timing of the onset of a trial. The warning signal initiates a preparatory interval (PI) or waiting period. The subject may have no information about the duration of the PI (uncertain condition), or he may be told whether it will be long or short (certain condition). The duration of the PI may range from a very

brief span of 0.5 second to a very long span of 25 seconds. The PI duration is either held constant for an entire block of trials (regular series) or varied within a block (irregular series). For an irregular series, pairs of trials may be examined to compare: (a) sequences in which the preceding preparatory interval (PPI) was longer than the PI for the current trial ($PPI > PI$); (b) sequences in which it was shorter ($PPI < PI$); and (c) sequences in which it was identical ($PPI = PI$). The PI is terminated by an imperative stimulus, the signal to respond. The modality of the imperative stimulus is not varied. It may be either sound or light, but the modality is held constant throughout any single experiment. Once the response (RT) has been made, there is an inter-trial interval (ITI) that is of predetermined length. The ITI is terminated by the warning signal that begins the next trial.

Set Paradigm (Shallow)

The set procedure is well suited to the manipulation of certain theoretically interesting variables. These variables and their general effects on schizophrenic patients are listed below.

1. *Duration of PI.*—Generally, in regular PI series, schizophrenic patients show increasingly greater slowing of RT as the PIs become longer. When RT is expressed as a function of PI duration, schizophrenic individuals display steeper slopes than do normal subjects.

2. *Duration of ITI.*—The length of the PI, rather than the duration of the ITI or the tempo of the trials, seems to be the critical factor determining the schizophrenics' steeper slope of RTs in a regular PI series.

3. *Regularity of the sequence of PIs in a block of trials.*—For normal subjects, one finds what might be

*Reprint requests should be addressed to the first author at the Department of Psychology and Social Relations, Harvard University, 1102 William James Hall, Cambridge, Mass. 02138.

described as a "main effect" for regularity: RTs are faster for regular series than they are for irregular series. For schizophrenic patients, however, one finds an interaction between regularity and PI duration.

4. *Interaction between PI duration and regularity of the sequence of PIs.*—This interaction is of course the basis for the well-known crossover index. For schizophrenic patients, at PI durations from 0.5 second up to between 2 and 6 seconds, RTs are faster in the regular than the irregular series. At longer PI durations, RTs are faster in the irregular rather than the regular series.

5. *Certainty about the duration of PIs.*—The unusual features of schizophrenic performance at long PIs in the irregular series do not seem to be simply explained by unpredictability of PI duration. For schizophrenic individuals, RTs at long PIs are approximately similar regardless of whether the subject has or has not been informed of what PI duration to expect.

6. *Effects of PI of the immediately preceding trial (PPI).*—The RTs of schizophrenic patients are fastest when $PPI = PI$, longer when $PPI < PI$, and longest when $PPI > PI$.

Cross-Modal Paradigm (Sutton and Zubin)

In describing the cross-modal RT procedure, it is necessary to differentiate between older (Sutton et al. 1961 and Sutton and Zubin 1965) and more recent (Waldbaum, Sutton, and Kerr 1975) versions of this technique. In neither case is there a warning signal at the start of a trial. In the older procedure the subject was simply instructed to lift his finger from a key as rapidly as possible at the onset of any signal stimulus and then return it to the key. RT was measured by the time from stimulus onset to the finger lift response. The termination of each stimulus began the next trial. The time intervals between stimuli were varied randomly between 1 to 5 seconds for simple RT, and between 6 to 9 seconds for choice RT. Since no record was available of when the subject returned to the key and began to await the next stimulus, it was impossible to specify the proportion of the interstimulus interval that could have been considered an ITI as opposed to a PI. More recent experiments have used a slightly different technique. This newer procedure will constitute the basis for the subsequent discussion of the differences between the set and cross-modal methods.

In the current cross-modal procedure, the trial is

initiated when the subject selects and depresses a response key. The onset of each trial is therefore self-paced. Depressing the response key initiates the PI. All PIs are very short, ranging from 1.5 to 3.5 seconds. PIs are never systematically presented in a regular sequence. They are always randomly generated in order to decrease the anticipatory responses that occur with a fixed foreperiod. An imperative stimulus terminates the PI. Imperative stimuli for any given experiment may be a sound and a light, or there may be two lights (e.g., red and green) and two sounds (e.g., high and low tones). The subject may have no information about what the imperative stimulus will be (uncertain condition), or he may be informed of what stimulus to expect on each forthcoming trial (certain condition). In each block of trials the different imperative stimuli always appear in either quasi- or completely random order. There are no blocks of trials in which the sequence of stimuli is identical or regular. Regularity-irregularity is described for successive pairs of trials, according to whether stimuli on both trials are identical (ipsimodal identical), in the same modality but different in color for light or in pitch for sound (ipsimodal different), or in different modalities (cross-modal). When the subject has responded to the imperative stimulus there is an ITI. The ITI is terminated when the subject self-initiates the next trial, making the durations of the ITI variable according to the subject's pace.

The following are the principal variables and findings on the performance of schizophrenic patients tested with the cross-modal technique:

1. *Modality of the imperative stimulus.*—As expected, for both patient and control populations, RTs are longer to light than to sound.

2. *Consistency vs. shift of imperative stimulus modality.*—For schizophrenic individuals, RTs are fastest for ipsimodal identical sequences, slower for ipsimodal different sequences, and slowest for cross-modal sequences. Holding constant RT on ipsimodal identical sequences, schizophrenic patients show greater than normal retardation on cross-modal sequences.

3. *Interaction between stimulus modality and effects of modality shift.*—In the initial studies, schizophrenic subjects showed significantly greater than normal cross-modal retardation only for reactions to sound as the second stimulus. Although the trend for group differences in reactions to light stimuli was in the same direction, variability of performance was greater and the re-

sults were not significant. More recent research has found schizophrenic patients' RTs to be significantly more retarded than normals' by modality shift to either light or sound. It is believed that the early failures to find the effect for light were artifactual. This will be discussed below.

4. *Certainty about the modality of the upcoming stimulus.*—The schizophrenic individual's greater cross-modal retardation does not appear to be due to uncertainty about which stimulus to expect, since it is found even in the certain condition, when subjects are told what the forthcoming stimulus will be.

It is now appropriate to consider three points of confusion about the effects of modality shift on schizophrenic patients. The first issue, raised by Nuechterlein, is the question of whether the greater schizophrenic cross-modal retardation is inconsistent across stimulus modalities. The Waldbaum, Sutton, and Kerr (1975) study found the effect for both light and sound as the second stimulus. Separate analyses of covariance were carried out for both modalities, and these results are presented in the Kriegel (Kriegel-Waldbaum) dissertation (1967). Since the same trends appeared in the findings for both light and sound, unfortunately only the results for the combined data were presented in the short published article (Waldbaum, Sutton, and Kerr 1975). Unlike the previous researchers, Waldbaum, Sutton, and Kerr used signal detection methods to equate the sound and light stimuli in terms of sensation level. It is believed that this methodological improvement is responsible for finding the effect in both modalities. A replication by Spring is now in progress to verify this finding.

Another possible point of confusion involves the role of uncertainty and false expectations about the modality of the impending stimulus in generating the schizophrenic patients' greater cross-modal retardation. As stated above, the effect persists at a significant level even in the certain condition when subjects are told in advance what stimulus to expect. The mean lengthening of schizophrenic RT to cross-modal as compared to ipsimodal sequences is less in the certain condition than it is in the uncertain condition. Since the variability of patient RT performance is also greatly reduced in the certain condition, however, the schizophrenic patients' cross-modal retardation actually emerges as a somewhat stronger effect in this condition. Nuechterlein has concluded that:

... the role of false expectancies in generating the schizophrenic's undue influence by prior stimuli was again found to account for at best only part of their RT slowing. [p. 387]

For three reasons we take the stronger position that the role of false expectancies plays *no* part in generating the schizophrenic's greater cross-modal retardation. First, when Waldbaum, Sutton, and Kerr asked subjects to indicate their expectancies by guessing the next stimulus in the uncertain condition, there was no difference between the patients and controls in overall correctness of expectations. Normals were correct on 51 percent of the trials and patients were correct on 50 percent of the trials. Second, a bias in expectancies might contribute to schizophrenic cross-modal retardation if patients, regardless of correctness, more often had ipsimodal expectations. However, the trend for guessing behavior is in the opposite direction. Normals are slightly more likely to guess that the next stimulus will be ipsimodal. Finally, if schizophrenic cross-modal retardation were due to false expectations, one might expect to find significant modality-shift differences between patients and normals only for trials associated with wrong guesses. The opposite is true. Patient-normal differences are significant only for trials associated with correct guesses. Waldbaum, Sutton, and Kerr have suggested that the effects of being wrong and of cross-modal shift are independent sources of disturbance in performance. When the subject is wrong, the resulting increase in variability seems to obscure the effect of shift in modality.

A final point requiring clarification concerns the effect of varying the ITI on cross-modal retardation. The effect of variations in ITI is of particular importance for Zubin's neuronal trace theory because the disruptive effect of an inhibitory trace left by a preceding stimulus in a different modality would be expected to dissipate as the ITI is lengthened. Nuechterlein and others (Waldbaum, Sutton, and Kerr 1975 and Sutton, Spring, and Tuetting, in press) have stated that the effect of modality shift is not decreased by lengthening the ITI. However, a more careful examination of the cross-modal procedure leads instead to the conclusion that variations in the duration of the ITI have not been systematically examined with the cross-modal technique. In the early cross-modal experiments with *simple* RT, the interstimulus intervals (ISIs) were randomly varied between 1 and 5 seconds. Only some proportion of this time represents the ITI; the rest constitutes the PI. Longer ISIs were

not used in the simple RT context. Moreover, since the ISIs were randomly varied and RTs were grouped over all trials, no attempt was made to compare cross-modal retardation at longer and shorter ISIs. In the current procedure, which permits the subject to self-initiate trials at his own pace, ITI is neither controlled nor systematically recorded. Future procedural modifications are needed to carefully examine this important variable.

To recapitulate, table 1 reviews the differences between the procedures and principal variables that are examined in the set and cross-modal techniques.

Of course the differences between the set and cross-modal procedures are not fortuitous, and it is important to consider the logic behind the design of each technique. Zubin (1975) and others have proposed a distinction among different types or subsystems of attention: (a) selective, (b) sustained, and (c) shift. Shakow's theory appears to postulate that the schizophrenic patient's principal dysfunction is in sustained attention:

the maintenance of attention over an extended time period. This is why temporal variables such as the duration of the PI are critical in the set paradigm. A primary objective was to determine whether schizophrenic RT performance deteriorated as attention had to be maintained for longer and longer waiting periods. The steep slope of the schizophrenic's RT in relation to PI duration seems to support this theory. However, Shakow also theorized about *why* maintenance of attention broke down at long PIs. The Shakow model attributes this deficit to the loss of an optimal set and the intrusion of minor sets to stimuli that have happened immediately before. Comparisons of regular and irregular long PI series, and analyses of PPI effects are most directly relevant to the aspects of the Shakow theory concerned with loss of a major set.

In contrast, the Zubin model would predict that the schizophrenic patient's primary attentional problem involves difficulty in shifting his attention from one stim-

Table 1. Comparison of procedures and principal variables in the set and cross-modal RT techniques

Set	Cross-modal
Procedures	
1. Warning signal 2. Long or short PI 3. PI arranged to be regular or irregular by blocks of trials 4. Modality of imperative stimulus constant 5. ITI of fixed length	1. No warning signal (self-initiated) 2. Short PI only 3. All blocks of trials entail irregular PI 4. Modality of imperative stimulus varied within each block 5. ITI of variable length and uncontrolled
Principal variables	
1. Duration of PI systematically varied and investigated 2. Duration of ITI investigated 3. Blocks of regular vs. irregular PIs compared 4. Pairs of trials in irregular series studied: comparison of sequences with $PPI > PI$ or $PPi < PI$ against $PPI = PI$. 5. Certainty/uncertainty investigated with regard to duration of PI 6. Modality of stimulus held constant within an experiment and not investigated	1. Duration of PI varied randomly and not investigated 2. Duration of ITI not investigated 3. No block-by-block comparisons with regard to PI duration or imperative stimuli 4. Pairs of trials in irregular series studied: comparison of cross-modal or ipsimodal different sequences against ipsimodal identical sequences 5. Certainty/uncertainty investigated with regard to modality of imperative stimulus 6. Modality of stimulus systematically varied and investigated

ulus to another. To examine this theory, the cross-modal procedure is used to investigate sequential pairs of trials in which attention is or is not required to shift. In addition to being an appropriate test of the theory, the decision to look at pairs rather than blocks of ipsimodal and cross-modal stimuli helped to eliminate a methodological problem. Whenever blocks of trials are compared, there is always a possibility that response set, criterion changes, or fatigue factors may enter differentially into the blocks being compared. The influence of temporal factors was deliberately kept to a minimum by using only short PIs that were randomly varied. In this way it was possible to examine shift of attention relatively uncontaminated by sustained attention. But long time intervals were avoided not only to cope with the confounding of subsystems of attention, but also to avoid introducing the variable of time judgment.

The role of time estimation in the set paradigm has received very scant attention despite the fact that it may be an important factor in the schizophrenic subject's performance on this task. Whenever PI duration is varied in an RT task, the subject's speed of response depends on: (1) his ability accurately to anticipate and estimate the duration of the PI, and (2) his speed of response once the stimulus has been presented. This is particularly true in a regular PI series in which the PI duration is held constant and subjects can develop an expectancy for its length. It is no doubt also true in an irregular PI series. In fact, although much is inferred and assumed, little is known about the factors upon which subjects base their expectations of PI duration in an irregular PI series. However, regardless of whether estimates of PI duration are based upon: (a) the duration of the PPI; (b) consideration of all possible PIs (which Shakow considers the optimum set); or (c) an averaging of all possible PIs (as would be expected from Helson's [1964] adaptation-level theory), the ability to estimate time contributes to RT performance.

It has long been known that the time judgment of schizophrenic individuals is notoriously variable. In fact Goldstone (1975) considered variability in time judgment to be a hallmark of schizophrenia. Intuitively one would expect variability of time estimates in almost any chronically hospitalized population, since accurate judgment of time is neither useful, nor encouraged, nor encouraging in such a context. However, it has only recently been appreciated that there are lawful deviations in schizophrenic time estimation over and above its

variability. In an early study in this area King (1962) asked subjects to listen and fall in with a succession of regularly presented auditory stimuli by tapping along with the beat. The auditory stimuli were separated by regular interpulse intervals of 1.0, 1.5, 2.0, 2.5, or 3.0 seconds. The task required subjects to estimate the interpulse intervals as accurately as possible so as to tap simultaneously with the stimuli. Normals were somewhat more successful than schizophrenic patients at estimating the intervals. But far more important were the opposite directions of the two groups' errors in time estimation. Normals consistently underestimated the intervals and tapped in anticipation of the sounds. Schizophrenic individuals underestimated only at the 1-second interpulse interval; at all longer durations they overestimated. More recently Mo, Kersey, and Lowe (1977) have found that varying the duration of the PI affects estimates of the duration of a stimulus similarly for schizophrenic and normal individuals, provided that subjects are uncertain about PI duration. However, when cues to PI duration are given (as they are in a regular series), varying the PI duration affects time estimation differently for schizophrenic subjects and for controls.

The most conclusive evidence implicating time estimation anomalies in the schizophrenic's set performance is provided by Kaplan (1974). Kaplan studied process schizophrenic patients who demonstrated the crossover effect. He trained one group to judge and discriminate lengths of time and lengths of PI. A control group was trained in shape recognition. On repeat testing the crossover effect disappeared for the patient group trained in temporal discrimination.

It is difficult to ascertain the precise nature of the deficiency in schizophrenic time estimation without additional experimentation. Based on the findings just cited, one might expect that schizophrenics either have difficulty estimating or tend to overestimate time, particularly on long intervals. Overestimation of time intervals alone might explain the schizophrenic patient's increasingly greater increases in RT as the PIs become longer. Thus, the steeper slope of schizophrenics' RTs in the regular series might not reflect an inability to maintain attention, but rather an inability to estimate how long attention *should* be maintained before preparing to respond. Deficits in time estimation might also explain why telling subjects to expect a long or short PI does not eliminate the schizophrenic subject's RT retardation

at long PIs in the irregular series. The problem for the patient is not only one of lacking information about PI duration, but also one of being able to generate an accurate temporal expectancy once the information is given. Information about duration is not useful unless one has the time-estimation ability to use it effectively. To account for the crossover finding, or the long RTs due to $PPI > PI$, one needs to consider a hypothesis that is related to Shakow's but that has a slightly different emphasis: the schizophrenic's *estimates of time* may be inordinately influenced by what has happened on the immediately preceding trial. It is known, for example, that schizophrenics are more than normally influenced in their judgments of heaviness of weights by an anchor weight immediately preceding the weight to be judged (Salzinger 1957). Time estimation may be affected in a similar way by the anchoring effect of the PPI. Anchoring effects of the PPI would be expected to disrupt time estimation and, as a result, to lengthen RT whenever the PPI is different from the PI. Why then is RT slower for trials on which $PPI > PI$ than for trials on which $PPI < PI$? Probably because in the latter case, although the subject's estimate is wrong, he has at least prepared to respond, albeit too early. In the former case the subject would neither estimate the stimulus to be imminent nor prepare to respond until after it had passed.

In summary, our intention has not been to demonstrate any superiority of the cross-modal over the set RT procedure, or vice versa. Rather, we concur with Nuechterlein that different subtypes of attention must be investigated in order to determine the precise aspects of attention in which schizophrenic deviances are found. There is a need for diverse measurement strategies to operationalize not only sustained and shift of attention, but also selective attention and general alertness. However, it is also imperative that each measure be "purified" to the greatest extent possible, in order to rule out the influences of confounding variables that may override or interact with the attentional process under study. We hope that future investigations will help to elucidate additional potentially confounding variables. Only by doing so will it be possible to determine whether the schizophrenic patient's deviant cross-modal RT performance reflects anomalies of attentional shifting or some other deficiency. Similarly, it will be important to investigate whether the patient's characteristic set performance is due to deviances in time estimation

rather than, or in addition to, difficulties in maintenance of attention.

Finally, we would like to comment briefly on two of the shortcomings which Nuechterlein attributes to Zubin's neural trace hypothesis. Nuechterlein concludes that the neural trace theory is contradicted by findings that schizophrenic RT is disproportionately slowed by concurrent distracting stimuli. He states:

Zubin's proposals would appear to predict that the repeated identical imperative stimuli would create stronger cumulative facilitatory traces for schizophrenic than for normal individuals. Dissimilar stimuli, including irrelevant stimuli, should be inhibited more strongly by schizophrenics than by normals. The combination of these two factors would appear to lead to the prediction that schizophrenics would actually be less, rather than more, impaired by distracting stimuli in this situation. [p. 388]

We find this a puzzling interpretation of the Zubin model. The neural trace model was developed to account for performance in a particular experimental context: one in which two competing imperative stimuli are alternated in some way. It predicts that a sequence of presentations of one of these stimuli will tend to facilitate processing of the same stimulus and to inhibit processing of the competing stimulus. It also predicts that these effects will be more marked for schizophrenic subjects than for controls.

To return to Nuechterlein's comment, irrelevant distracting stimuli are not in the same category as competing imperative stimuli. Moreover, it is necessary to distinguish between two different types of distracting stimuli. In one form of distraction, the irrelevant stimulation is continuous and regular, and also operates concurrently with the RT stimulus, not alternately as is the case with a competing imperative stimulus. Continuous distraction by white noise or background speech exemplifies this type of distraction. Although the theory never specifically addressed this situation, it is reasonable to expect that such repetitive stimulation would indeed create a strong cumulative facilitatory trace for the entire distracting channel, especially for the schizophrenics. However, to discuss this problem would take us away from the phenomenon of shift of attention and into the area of maintenance of selective attention. The other type of distraction is an unfamiliar, intermittent stimulus (such as Steffy's probe stimulus). These types of intruding stimuli may have orienting qualities that cause attention to shift, and may therefore interfere

with facilitating or inhibiting traces laid down by prior stimulation.

Two other strictures raised against the neural trace model concern its failure to predict aspects of schizophrenic performance in the set paradigm. Nuechterlein observes that the neural trace model does not explain the excess of schizophrenic anticipatory responses, particularly when $PPI < PI$ (p. 388). As discussed above, we do not really find it necessary for a model of attention dysfunction to explain this finding, since it can be laid at the door of faulty time judgment in schizophrenia. Similarly, it is pointed out (p. 396) that the Zubin model would predict RT facilitation from shortening the ITI on regular PI series, as Steffy has done. Perhaps it is noteworthy that facilitation was in fact found when PI was 1 second, but not at longer PIs, when one might expect the schizophrenic patient's faulty time judgment to have a more prominent influence on RT performance.

Throughout this review we have stressed only the differences between the set and cross-modal paradigms. It is now appropriate to discuss some of the similarities. As has been noted previously (Zubin 1975), the change from PPI to PI in the irregular series of the set procedure can be regarded as analogous to the change between imperative stimulus modalities in the cross-modal technique. A difference between the two types of change can, however, be found in their continuity. The changes between PPI and PI in the set procedure are relatively continuous, varying from no change (ipsitemporal sequences), to decrements and increments of 1, 2, 3, . . . 24 seconds. The changes of imperative stimuli in the cross-modal technique are discontinuous, involving abrupt shifts from light to sound, or changes from red to green lights, and high- to low-pitch tones. Perhaps a parallel to the continuous variation of the PIs could be achieved in the cross-modal technique by continuously varying pitch for the imperative sound stimuli and color for the imperative light stimuli. Indeed, experimentation in this area might reveal that stimulus sequences involving sufficiently *different* stimuli within a single modality might generate RT retardation as marked as that found for cross-modal sequences. In the meantime, the correspondence is only partial between change of PI duration and change of stimulus modality over successive trials. The greatest equivalence between the two paradigms is found in the comparison of ipsimodal identical with ipsitemporal sequences. Just as RTs are faster to ipsi-

modal sequences, so is response speed faster to ipsitemporal ($PPI = PI$) than to all cross-temporal ($PPI \neq PI$) sequences. The set paradigm offers a comparison of a continuous array of cross-temporal departures from $PPI = PI$. In contrast, the cross-modal technique affords only two points of comparison with the ipsimodal identical sequence: the cross-modal, and the ipsimodal different (which can be construed as a "midpoint" between the ipsi- and cross-modal sequences).

Having pointed to the common ground between the two techniques, inasmuch as both compare the effects of similarity versus change over successive trials, an important question arises. Does the set paradigm, which we believe to involve primarily maintenance of attention and time estimation, also involve the effects of attentional shift? The issue is essentially one of whether attention must shift to process a change in PI duration in the same way, and to the same extent, that it shifts to process a change in the imperative stimulus. For several reasons, the answer to this question is not readily apparent. In order to state that one is measuring shifts of attention from one stimulus to another, it is presumably necessary to establish that attention has been paid first to one stimulus and then to a different one. In the cross-modal paradigm, it is relatively simple to establish that the subject has processed or attended to the imperative stimulus because he lifts his finger in response to it, and because, if asked, he can correctly tell us which stimulus has occurred. In the set procedure it is more difficult to determine: (a) whether the subject has attended to PI duration at all, and (b) if he has attended, whether he has derived an accurate impression of its length. Of course it is possible that the subject has acquired some type of "trace" for PI duration, even if he is not necessarily aware of having attended to this information. Indeed, the very existence of PPI effects on RT makes it likely that some type of impression of PPI duration has been left. Nonetheless, before concluding that the phenomenon of shift of attention is measured similarly by the two techniques, consideration must be given to such questions as: (a) whether the "trace" generated by attending to time/duration is comparable to that for stimulus modality, and (b) whether there may be important differences between these two types of impressions with regard to their accessibility to awareness or their "accuracy." Perhaps experiments comparing the same individuals on both techniques, as well as on other measures of shift and maintenance attention,

would help to clarify the similarities and differences between the components of attention measured by each task.

One of the most baffling problems presenting itself in schizophrenia research in general, and in RT and attention studies in particular, is the need to separate out the effects of the schizophrenic episode from the underlying characteristics of the patient in his pre- and postmorbid status (Spring and Zubin, in press). Characteristics reflecting the episode are best seen when the patient's symptomatology is in full bloom. More permanent traits, that might identify the schizophrenic individual in and out of an episode, may be more difficult to detect when psychopathology is most florid. In order to determine whether attentional difficulties are a persistent characteristic of the schizophrenic individual, it is necessary to rely on research involving the high risk and followup strategies. RT techniques have a good track record as devices that reveal the subtler aspects of schizophrenic attention. It is to be hoped that these techniques can be purified to test the full panoply of subsystems of attention over the lifespans of schizophrenic individuals.

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The Authors

Bonnie Spring is Instructor, Department of Psychology and Social Relations, Harvard University, Cambridge, Mass., and Research Scientist, Department of Psychophysiology, New York State Psychiatric Institute, New York, N.Y.; Joseph Zubin, Ph.D., is associated with the New York State Psychiatric Institute, New York, N.Y., and with the Highland Drive VA Hospital, Pittsburgh, Pa.