PSYCHOPHYSIOLOGICAL MEASURES OF INFORMATION PROCESSING
IN SCHIZOPHRENIA

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INTRODUCTION

Vulnerability theory - Zubin 1966 et al.

SL: MODELS OF SCHIZOPHRENIA

Selection of the neurophysiological model for the information processing aspects;
emphasis on multiple psy.physio. measures.

SL: QUESTIONS

In order to explore these questions, and their relevance to psychopathological research, I have selected to review both our own research efforts as well as some ongoing work from other laboratories. It is worth suggesting that, regardless of what is demanded by administrators, no single research team is likely to provide the ultimate solution to the problem of schizophrenia, especially since the questions as to its nature and definition are even today still being generated.

For much of the research presented today, Joseph Zubin has been involved in all phases of the project. He was responsible for the first incarnation of the Biometrics Research Unit at NYS Psychiatric Institute, with our psychophysiology branch guided by Sam Sutton, Gad Hakerem and Mitch Kietzman, physically located in the depths of
Brooklyn State Hospital. The majority of our current work is conducted in the Biometrics Research Unit at the Highland Drive VA Medical Center overlooking the hills of Pittsburgh, which at least, in its physical presentation, is more picturesque than SL: HDVAMC

Brooklyn State. However, it was in those earlier laboratories that such achievements as the discovery of the P300 component of the ERP, signal averaging of the pupillary response, investigation of two-flash sensory integration phenomena, and development of the cross-modality technique in reaction time took place, which has given us a firm base on which to expand.

Sometimes it is difficult to imagine how such measures are actually obtained, and so I thought that those of you who suffer from labratophobia might appreciate a view of the testing situation.

SL: PUPILLOMETER

In this scene, a patient from the Clinical Assessment Unit is sitting in front of the infra-red camera of our pupillometer system. Weekly, schizophrenic patients are tested for their light reaction. During the tasks discussed today, the subject would also be dressed with a montage of EEG electrodes on the scalp, and additional electrodes to record heart rate.

SL: LABORATORY APPARATUS

We monitor all data in a separate room. The multiple polygraph outputs (for EEG, EOG and EKG), pupillometer signal, and behavioral data are stored on computer. Most psychophysiological laboratories today have several of these elements in common, although recording of multiple measures at once is rare.

We are now ready to consider the first situation posed:
SL: THERE IS A DIRECT CORRESPONDENCE AMONG TASK MANIPULATIONS, OVERT BEHAVIOR, AND PSYCHOPHYSIOLOGICAL RESPONSES

To demonstrate this situation, I will utilize some of the data from a paradigm that we have been employing with different patient groups. It is a slight variation of the "oddball" task [which has been described in other papers presented today].

SL: CONDITIONAL PROBABILITY -- STIMULI

On every trial, either a high or low pitched tone is presented, with one tone every 3 seconds for a total of 80 trials. The subjects are given certain information:

SL: SUBJECT INFO & TASKS: COUNTING AND CHOICE RT

1) There are fewer high tones, and 2) There will never be two high tones in a row. This holds true for two tasks that are imposed: a counting task, in which the subject silently counts the number of targets, that is, the high tones; and a choice reaction task, in which a different finger press is associated with each tone. Today we will be examining data collected mostly with the counting task, but for most types of comparisons among groups and experimental conditions, both procedures result in similar effects.

SL: OVERALL PROBABILITY -- SECOND ORDER SEQUENCES

One tone is designated to be more rare, and the probability is more of an important variable than whether it is the high or low pitched tone that is the rare one. So, I will describe all tasks with the high tone as the rare, or target, stimulus. This occurs on 25% of all trials, with the low or non-target tone on the rest of the trials. But because the subject has been told that there are never two targets in a row, this has an effect on how the sequence of trials may be predicted: the same number of times that a high tone occurs, a low tone occurs on the very next trial. The remaining low tones (50% of all trials) are defined by the fact that they are repetitions -- they have been preceded by a similar low tone.
SL: CONDITIONAL PROBABILITY

Thus, when a high tone has occurred, a low tone can be predicted with complete certainty on the next trial (that is, for subjects who remember that high tones don't repeat, $p=1.00$). Once a low tone has occurred, though, the next trial will consist of a high tone one-third of the time ($p=0.33$), and of a low tone on the complementary two-thirds occasions ($p=0.67$).

Are these probabilities affecting the responses of the central nervous system? It turns out that for most "normal" subjects, psychophysiological responses do react to these relative differences to some degree.

SL: NORMAL PUPIL & ERP COUNTING

Averaged waveforms for the event-related potential at two electrodes, and for the pupillary response, which like the EEG has been averaged to minimize the effects of irrelevant signal sources, are shown for a control subject. The pupil calibration equals an average change of only one-tenth of a mm. Yet we can see three different response curves: the largest dilation during the two second period shown is in response to the rare event, which according to information theory provides us with the most information. The least dilation is seen to the predictable non-target, but this is still different from the non-target which could not be predicted: the latter response falls between the 0.33 and 1.00 conditions, though is more similar to the 1.00 probability response. The ERP data reveals a large P300 (the downward going wave) which also is different for the three conditions.

In this case, there is relatively (though not perfectly) good correspondence between the psychophysiological data and the manner in which the sequential probabilities of events have been conceived -- remember that there was no experimental contingency to compel the subject to distinguish between the two types of non-targets.

In examining the data for psychopathological groups, it may be that we find patients
who respond just as normals. This seems to be the case for depressed subjects tested on this paradigm.

**SL: DEPRESSIVE - COUNTING PUPIL AND ERP**

These data for a depressed patient, while showing individualistic features in the overall morphological structure of the waveshapes, still show vigorous response amplitudes and a clear differentiation among the experimental conditions, in both the pupil and ERP. While we and others have reported that group data for depressives is intermediate between that for normals and schizophrenics, this appears to be due to a small portion of patients for the ERP response, though less so in the pupil. In general, most depressed patients are indistinguishable on these measures from controls.

If we suggest that this is associated with behavioral variation, then it is necessary to obtain variation. In the data presented just now, and in all data presented today with the following exception, our subjects' performance was required to be relatively accurate. We looked at several subjects whose counting varied in accuracy across blocks within the experiment.

**SL: DEPRESSIVE POOR COUNTING**

Here are the ERP data of one depressed patient for blocks in which counting was poor. The different columns, from left to right, represent increasing probability, which should show clearly decreasing P300 amplitudes; each row illustrates data for a separate electrode location. Little clear P300 activity is present, even in the left-most column representing the rare stimulus. But something entirely different is seen when we look at those blocks on which the subject counted well.

**SL: DEPRESSIVE -- GOOD COUNTING**

A distinct P300 is visible, similar to what is obtained in control subjects; it shows covariation with the conditional probability of events. Had we examined data for this subject without regard to performance accuracy, we might have been led to infer that the
deviant responses characterized the subject. However, what was actually found was that the psychophysiological responses were accurately reflecting behavioral attention or inattention.

In our attempt to understand the relationship between brain and behavior, the overt behavior itself and even the task demands are not sufficient to reveal underlying nervous system activity. The function of psychophysiological measures in this case has been to provide a bridge between brain processes and the accompanying behavior. Some might argue, correctly, that this is interesting (especially to those of us interested in delineating brain-behavior relationships), but that it reveals no more in terms of processing ability than the overt behavioral measures taken alone. This was once the "core" argument of behaviorism, although in truth many behaviorists did not hesitate to deal with relevant physiological investigations. Today, however, the mantle of the "black box" approach has been taken up, surprisingly, by a significant number of cognitive psychologists. While I believe that their approach is unfortunate, that is a separate issue beyond the scope of this presentation.

SL: THERE IS A LACK OF PSYCHOPHYSIOLOGICAL RESPONSIVITY IN PATIENT GROUPS, EVEN WHEN ADEQUATE BEHAVIORAL PERFORMANCE IS OBSERVED

Just as schizophrenics are reported to show extremely poor behavioral responses in some situations, psychophysiological measures have also been reported showing little responsivity. For example, a significant proportion of schizophrenic patients show no clear skin conductance orienting response to novel, attention demanding stimuli. The orienting response, of course, is typically elicited in situations in which there is no behavioral response required on the part of the subject, but the lack of orienting activity
in some patients has been of major interest to psychopathologists.

In the very first studies of P300 in schizophrenic patients, by Roth and Cannon (1972) and Levit, Sutton and Zubin (1973), the major phenomenon observed was the extensive decrease in P300 amplitude relative to controls. Indeed, this is one of the most consistent observations in all of the literature on schizophrenia (Zubin, Kietzman & Steinhauer, 1985).

SL: LEVIT ET AL (1973) DATA

ERPs from Bob Levit's study are shown for normals in the column on the left, for depressed patients in the middle, and for schizophrenics to the right. The solid line was recorded under conditions of uncertainty, which elicits little P300 activity. The broken line was recorded while subjects were guessing, and for controls and most depressed patients, shows an enhanced late positive component. A close inspection of individual patient data usually indicates the presence of some component which is probably a P300, although there are instances in these and our own data in which no specific component can be discriminated either by eye or by computer. If we focus on studies reporting highly decreased amplitudes, an especially interesting finding emerges: schizophrenic patients who were performing a task adequately (that is, with appropriate behavior) still showed decreased amplitudes. For example, in the Levit et al. study, the patients were appropriately making guesses according to the experimentally contrived proportions associated with the stimuli.

SL: COUNTING TASK -- SCHIZOPHRENIC PUPIL AND ERP

During the counting task described earlier, a proportion of schizophrenics show little pupillary dilation and, in this case, little late component activity, even though the subject had been counting accurately. These findings suggest that generation of a distinct P300 was not required for some processing of the information to have occurred, at least in the
sense that Donchin (1979) refers to P300 as representing the "context-updating" of information. The patient data indicates that processing to at least some degree can occur even when P300 is relatively small in amplitude, which leads to the following, as yet unanswered question: For what types of processing activity is a robust P300 absolutely necessary? For this question, I can offer no solution, or even guesses, at this time.

Another problem raised is whether those patients who show little late component activity do not have the physiological capacity to emit a P300 response: is it essentially a problem at the functional neurophysiological level? One way to begin dealing with this question has been explored by Tom Roth and Lois Putnam, who found that even in the absence of task relevance, very loud (that is, 110 dB) stimuli will produce a P300 response associated with startle. Thus, in patients for whom little P300 is observed during a task, we can use the startle response to determine whether or not the P300 generating mechanism is still operative. This would permit us to differentiate the absence of P300 due to insufficient information processing activities from a truly deviant physiological basis.

One problem, which at first glance appears insurmountable, is that the ability to perform a task as required by the experimenter may be approached through different strategies. Control subjects may perform a task quite easily, but patients who have trouble focusing their attention may find the same task to be much more difficult. For example, what may be a relatively moderate sensory discrimination for controls may be difficult for those with attentional deficits, and loss of information due to difficulty in discrimination ("equivocation" in the ERP, as described by Ruchkin & Sutton, 1978), decreases P300 amplitude. Thus, we may often be led to assume that the subjects are not even trying to perform tasks well. Yet in some instances, our patients report subjectively that they are working very hard to perform adequately. This suggests that we need
procedures for evaluating both sensitivity to signal presentation, as well as attentional effort. The former might be amenable to sensitivity estimates from signal detection procedures; the latter might involve the assessment of tonic levels of those measures which appear sensitive to overall effort, such as prestimulus pupillary diameter and heart rate (but note that the phasic responses of these systems are more closely related to processing activities, as are the late components of the ERP).

SL: TASKS LEAD TO SIMILAR OVERT BEHAVIORS BUT DIFFERENT PSYCHOPHYSIOLOGICAL RESPONSES AMONG SUBJECT GROUPS

This is the situation in which the responses of the patient groups are not merely deviant from controls in some overall way (for example, either in highly reduced amplitudes, or no difference in amplitude across all conditions), but that they vary across experimental conditions in a manner that is qualitatively different from controls.

In data collected by Connie Duncan (1985), the variation in P300 amplitude attributable to preceding sequences of multiple stimuli was similar in both schizophrenic and control groups, even though amplitudes were smaller for patients overall. In that case, there was no qualitative difference in the manner in which the information was apparently processed. A difference was reported, however, by Levit et al. (1973) in that while controls and depressed patients exhibited larger P300s to cross-modal than ipsi-modal stimuli, the opposite pattern was found to characterize schizophrenics.

There is some plausible evidence in the ERP literature that an essential deficit observed among schizophrenics may reflect more than merely attentional focusing when such deficits occur after the initial identification of a stimulus from an attended sensory channel. Jacynthe Baribeaum and colleagues (Baribeaum-Braun, Picton & Gosselin, 1983)
presented patients with an auditory selective attention task -- subjects were to identify the target when presented to a specific ear, but not to the "ignored" ear. At a slow rate of presentation (500 to 1500 msec between stimuli), neither the N100 nor P300 responses discriminated target stimuli. At a faster rate, however (an ISI of 250 to 750 msec), the N100 component was enhanced in the patients for target stimuli presented in the attended ear, yet P300 was still diminished. Baribeau et al. noted that even when there was physiological evidence of earlier selective attention (the larger N100 response to attended targets in the "fast" condition), the subsequent stage of evaluation represented by P300 still appeared deviant in the patients.

In our version of the Counting task, described earlier, it is not only reduced amplitudes of psychophysiological responses which characterize most of the patients, at least during periods of illness, but the pattern of responses across conditions that deviates from that of normals. The data which are used to illustrate these patterns, collected on small samples originally, have been replicated with an additional group of over 30 normals and 20 patients.

SL: NORMAL VS SCHIZOPHRENIC PUPILLARY GRAPH

The amplitude of pupillary dilation is shown in relation to the conditional probability of events. As noted earlier, normals show decreasing pupillary dilation as the probability associated with the event increases. Schizophrenics, while showing decreased amplitudes, still show statistically significant differences across the three conditions -- but not in the same pattern observed for the normals. Surprisingly, they are characterized by having larger responses to the extreme probability conditions -- the rare tone and the predictable frequent tone -- than to the repeated frequent tones of intermediate probability.

SL: SCHIZOPHRENIC PATIENT PUPILLARY RESPONSE

As an example, pupillary responses for one schizophrenic are shown which have the
largest dilation in response to the rare target, as might be expected, but the next largest
response to the predictable frequent tone.

A similar pattern can be found in looking at the amplitude of the P300 response.

**SL: GROUP P300 AMPLITUDES GRAPHED BY CONDITION**

The normal subjects show a monotonic, though non-linear, relationship to event
probability, with depressives somewhat lower in amplitude, but most intriguing is the
response pattern of the schizophrenics which is like the one just observed for the pupil.
Again, slight variations of this pattern can be seen in individual data.

**SL: SCHIZOPHRENIC P300 ERP DATA LARGER IN 1.00 CONDITION**

For this subject, the largest P300 occurs in the most predictable condition -- the 1.00
probability frequent tone in the right-hand column. Thus, P300 is present for this
subject, but does not seem to "follow the same rules" for data of others.

The robustness of these patterns is not even limited to just the ERP and the pupillary
response. Cardiac data were also recorded simultaneously during the Counting task.

**SL: CONTROL HEART RATE -- IBI DATA**

Data for controls are shown for each condition in terms of the time in msec between
successive heartbeats -- the Interbeat Interval. Upward change, representing longer
interbeat intervals, indicates cardiac deceleration. Stimulus onset occurs during the
interval indicated by a vertical line. For the two events which cannot be predicted, the
heart slows down in anticipation of taking in information. After stimulus delivery, there
is an acceleration which, in normals, is related to the information provided. The extent
of this change is seen more easily in the next figure.

**SL: DECELERATION AND ACCELERATION, NORMALS AND CONTROLS**

On the left, we see that normals (solid line) show the deceleration observed before
unpredictable events, while patients (the broken line) show little anticipatory activity.
Data on the right side, illustrating post-stimulus processing, are remarkably similar to the data for the pupil and ERP responses. Normals show substantial cardiac deceleration to the rare event, which decreases as the event becomes more predictable. The patients, however, show not only decreased acceleration overall, but the same pattern noted earlier - a greater response for the two extreme conditions, noting an association with the probabilities of these conditions.

We have inferred from these data that, in addition to performance of the task, patients tend to react to the difference from immediately preceding stimuli more than to overall sequential probability (as do controls). Our rationale is that both the rare tone and the predictable frequent tone each occur after a physically different stimulus, which for the patients results in a larger response than when the frequent tone is repeated. This is somewhat akin to the fact that longer reaction times are reported for all subjects in crossmodality experiments, with greater than usual prolongation for schizophrenics, although all stimuli in our tasks are in the auditory modality.

In this situation, the psychophysiological response permits us to infer (correctly or not) something about the manner in which information is being utilized which may not be available in the behavioral response.

SL: NO DIFFERENCE IN P300 FOR .67 AND 1.00 CONDITIONS

In the data for this subject, for example, while a large P300 response is observed for the rare tone, there is little difference between the two non-target conditions, from which we might infer that the subject has not, at least physiologically, discriminated the two types of frequent tones. The essential point of this section is that it is possible, depending on the characteristics of the paradigm employed, to make inferences regarding the style or complexity of information processing involved even when there is no overt "differential" behavior associated with different experimental conditions. The next step
is to look at combinations of complex behavioral and situational events.

SL: THERE IS A DISSOCIATION BETWEEN BEHAVIORAL AND PSYCHOPHYSIOLOGICAL DATA

While the fact that physiological and behavioral data may diverge, would appear at first to weaken the relevance of psychophysiological findings, it may actually provide one of the most interesting challenges for distinguishing among types and stages of information processing and response selection activities. Most of the relevant research, however, has been limited to non-patient groups.

ERP data may serve as a measure of processing activity, related to stimulus evaluation, which can be independent of overt response selection and performance which follows that evaluation. (Marta) Kutas, McCarthy and Donchin (1977) examined P300 and reaction time on individual trials across tasks that varied in the complexity of classifying names, which could be grouped by being identical, same sexed, or synonyms, and where the subject was asked to either keep count, to make a quick response, or to respond quickly but try especially hard to minimize errors. Greater task complexity resulted in longer latencies of the P300 component during counting and accuracy conditions. The correlation of P300 latency with reaction time was low when subjects were told to respond quickly, but higher when they were told to be accurate. Especially interesting was the observation that on error trials, the reaction time occurred before the peak latency of P300, suggesting that information processing was continuing and had not been completed at the time of response execution. Furthermore, the data indicated that stimulus evaluation, indexed by P300 latency, could be distinguished as independent from stages of response selection and execution.
A distinction between response selection and stimulus evaluation has been demonstrated by Connie Duncan (1981) for subjects performing the Stroop test, in which words consisting of names of colors or neutral words are printed in different colors. Subjects were asked to name the word or the color of the word. Both P300 latency and reaction time were increased during color naming compared to word naming, but the type of word had no differential effect of P300 latency within each task -- that is, the time for identification of the stimulus did not depend on the stimulus type, and there were no RT differences during word naming. However, during color naming, RT was prolonged most when naming incongruent words (where the word represented a color different from the printed color). Since this did not occur for P300 latency, it indicated that the difficulty in selecting the appropriate response was the basis for the Stroop effect, and not the evaluative aspects of the stimulus which were reflected by P300 latency.

Such studies are distinguished by a careful analysis between increasing stimulus and task complexity, in which multiple processing operations must occur (for example, stimulus reception, stimulus classification, response selection, and response execution). The two-process theory of Schneider and Schiffrin (1977), comparing automatic and controlled processing, has been investigated by Hoffman, Simons and Houck (1983), and Kramer, Schneider, Fisk and Donchin (1986), for changes between types of performance which appear to be reflected in the ERP. Callaway and Nagdhi (1982) emphasized differences in serial and parallel processing activities, especially in relation to a variety of behavioral and psychophysiological findings which suggest that schizophrenics perform best in tasks that involve relatively automatic processing of information, but show deficits in serial processing and channel capacity.

One of the future tasks, it seems clear, is the application of more complex designs in testing of patients. The complexity may lie as much in how the data is to be
analyzed as it is in the procedure (and by this I mean not statistical complication, but complexity in how different conditions are related with respect to information processing activities). Even in the tasks described in this section, the instructions to normal subjects have been rather simple -- identify one stimulus characteristic or another. It is the cleverness of our paradigms that will allow us to capitalize on this approach.

Some work in this vein has already begun, especially by Callaway, Halliday and Naylor, who are employing the ERP to study different stages of processing activities and their relationship to specific types of central events, even to the point of distinguishing noradrenergic and cholinergically mediated functions.

SL: STUDYING MEMBERS OF THE SAME FAMILIES

Perhaps the hottest model of etiology for the '80s lies in the explanation of mental disorders on the basis of genetic factors, now that we can ascertain similarity among family members on blood markers. While strongly advocating the importance of this model, I bring a caveat that emerges from the following illustration:

OVERLAY OF FAMILY

Burger King and Dairy Queen are expected to have such ideal children as Dairy Princess and Burger Prince, but Pizza Hut is an embarrassment -- obviously, this can be explained as a regressive emergence. But such a notion ignores both the importance of genetic factors which interact with development, as well as the importance purely environmental, learning factors. Thus, I am usually more comfortable thinking in terms of familial factors which may or may not be primarily genetic in nature.

We had noted several years ago (Zubin & Steinhauer, 1981) that determining whether a potential marker was really a vulnerability marker or a state marker required, at least,
comparison of the same measure in relatives of the patients, including those unaffected, with a special emphasis on sibling data. Rick Josiassen has already reviewed today some of the data collected in Philadelphia. We have long been intrigued by some of the similarities seen when pupillary and ERP data are compared within families, although surprisingly little data of this type has been published. Bock (1976) examined both measures in twins and siblings, while P300 has been studied in twins by Surwillo (1980) and Polich (in press).

SL: FAMILY PUPILLARY DATA

This figure represents pupillary dilation responses recorded from a family of three daughters and their parents. All family members showed increasing amplitudes related to event probabilities. Especially interesting is the fact that for two of the daughters, the dilation in the .33 condition proceeded beyond the typical latency of 1200 msec. Very few subjects ever show such a pattern of late dilation. This makes us wonder whether there is something more common to these two sisters (the lower right pair) compared to their other sister, either physiologically or in how they approach the task cognitively.

In a study of alcoholic families conducted in collaboration with Dr. Shirley Hill in our laboratory at Western Psychiatric Institute and Clinic, University of Pittsburgh, we have been recording across generations.

SL: ALCOHOLIC FAMILY

Here are ERP data representing three generations: the proband, an affected brother, and an unaffected brother; both parents, and the child of the proband. A total of 30 control and 30 affected families are under study. One of the questions involved is how to compare across generations, taking into account affected status. My point in this figure is merely to depict that such data can be accomplished.
To provide a better illustration of why such data are valuable, we have superimposed the data for pairs of subjects who vary in their degree of familial similarity.

SL: PAIRS OF ERP DATA

Only one condition of the ERP is shown, which generates a substantial P300 response. The left-most column shows data from two subjects who are unrelated (one in a heavy line, the other in a lighter line). Column two are data from a pair of non-twin siblings, who are likely to be no different than the pair of dizygotic twins in the third column. Data from a pair of monozygotic twins are drawn on the right. Not only are the data for the twin pairs similar, but even for the non-twin siblings there appears to be considerable resemblance.

We recently compared 14 pairs of adult male siblings by calculating sib-pair correlations for the amplitude and latency of the first five major ERP components.

SL: SIB-PAIR CORRELATIONS LATENCY

Data were collected at the three probability conditions on both the Counting and Choice Reaction task. In the Counting task only, high correlations for the latency of the first large negative component, N100, were observed, for which we have no explanation, as well as a single significant correlation for P300 latency. More consistent were correlations for amplitude.

SL: SIB-PAIR AMPLITUDE CORRELATIONS

The large P300 response in the Counting task for the rare event shows a significant correlation. For the Choice Reaction task, which demands more attention from subjects, the entire late positive complex appears significantly correlated for all conditions. The data suggest that as both information and task complexity are increased, the similarity of the ERP measures is increased for sib pairs.
Currently, we are involved in a study of schizophrenics and their siblings on a variety of psychophysiological, behavioral, and diagnostic measures. Our selection of appropriate tasks involves not only the ERP, pupillary and cardiac measures which have been heavily studied in our own laboratories, but also smooth pursuit eye movements as emanating from Phil Holzman and his colleagues, including Deborah Levy, the degraded-stimulus version of the CPT after Keith Nuechterlein, an adaptation of Bob Asarnow's Span of Apprehension task, and Bonnie Spring's Dichotic Listening Task. By this list, I mean to acknowledge that these other researchers not only established the importance of these measures, but have also been unselfish in collaborating with other researchers in implementing the procedures so that we are no longer restricted to searching for a single, unique, pathognomonic indicator of schizophrenia. But what will happen when we look at this multiplicity of measures?

SL: TWO OR MORE PSYCHOPHYSIOLOGICAL RESPONSES, WHICH TEND TO CHANGE IN SIMILAR DIRECTIONS ACROSS EXPERIMENTAL CONDITIONS FOR MOST SUBJECTS, MAY CHANGE IN DIFFERENT DIRECTIONS WITHIN THE SAME TASK FOR SOME INDIVIDUALS

Because, for example, the pupillary, ERP, and cardiac responses often follow the same variables, we expect them always to vary together. If this always happened, at least two of them would be redundant! But nature doesn't always work this way, and so we may see one pattern in one variable, but a different pattern on another measure recorded at the same time within the same subject. What this means seems to be: only record one measure, so that you're sure to be correct. Alternatively, we face some interesting problems in dealing with multiple psychophysiological variables. However, there are signs that such complications may lead to more propitious predictions regarding individual differences in psychopathology.
As a recent example, I refer to the work by Alvin Bernstein and colleagues. They have been trying to make some sense of the fact that skin conductance and finger pulse volume responses show a variety of combinations in subject groups. They have recently noted that schizophrenics show minimal responses on both measures during orientation, but both measures normalize when a signal indicates that a physical response is required. In comparison, depressives show deviant skin conductance in both situations, but normal finger pulse volume responses. In addition, a subgroup of non-patient subjects who score high on the Chapman scale for physical anhedonia have responses like those of schizophrenics. The implications drawn from these findings are that patterns of psychophysiological response, including variations among different measures, may have significance both for diagnostic purposes, as well as for increasing our understanding of mechanisms which underly differences among individuals. These ultimate aims, I believe, summarize the possibilities as well as the challenges which lie ahead for research in psychopathology.