PERCEPTUAL CORRELATES OF CONSCIOUSNESS: A CONCEPTUAL MODEL AND ITS TECHNICAL IMPLICATIONS FOR PSI RESEARCH

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LINDSLEY: Ladies and gentlemen, I would like to express the appreciation of all of us for the fine hospitality we are enjoying.

Dr. Hernández-Peón was a member of the group here last year and was expected to be with us this year, chairing, as a matter of fact, this session which I am now chairing. I consider it most appropriate that this meeting be dedicated to his memory.

An experimental neuropsychological approach, dealing with perception, is now going to be discussed by Dr. Silverman, who will introduce the theoretical bases of this type of research. Dr. Buchsbaum will then discuss in detail the techniques involved, and Dr. Silverman will conclude with an overview of their implications for psi research.

SILVERMAN: Our presentation is concerned with the development of a paradigm, that is of a conceptual framework and a methodology, equally applicable to the study of ordinary waking states of consciousness and of other states of consciousness. We use the term paradigm here to refer to a conceptual model which defines a strategy of research. The term paradigm seems to have been used in this conference to refer to an experimental design. We will be talking about something more than an experimental design, about a model, a theory of perception.

The model to be elaborated is, in effect, one of how organisms pay attention. It has its origins in the writings of William James[1] who some 70 years ago suggested that each of us literally chooses by his way of attending to things what sort of a universe he shall appear to himself to inhabit. As our attention model stands now, it incorporates several of the most recent findings in the fields of perception, computer technology and neurophysiology.

We distinguish three major dimensions of attention. They are derived from factor analytic studies which have been replicated in populations of normals and psychotics (schizophrenics).

We call the first factor *stimulus intensity control*. We find that tests which correlate with this factor have two kinds of characteristics. They measure the sensitivity of an organism to stimulation, and the way it modulates the effects of stimulation. People who are unusually sensitive to stimulation appear also to have some kind of built-in capacity to attenuate high-intensity stimulation. We differentiate between people who augment the experienced intensity of stimulation, and people who turn it down. Certain schizophrenics and LSD drug subjects show an unusual sensitivity[2] in classical psychophysical procedures, and also a capacity to attenuate high intensity stimulation.[3,4] This is one of the factors originally derived from perceptual tests which more recent research indicates to have a neurophysiological correlate. For each of the factors we will be discussing first the perceptual dimension and then its neurophysiological counterpart.

The second dimension is concerned with the *extensiveness of scanning of environmental stimuli*. Originally it was inferred from certain kinds of perceptual judgment tasks. More recently we have found parameters of eye movement which underlie scanning behavior. We differentiate between eye movements which are concernd with information search behavior and those which are concerned with ocular motor control. Individuals are categorized as minimal, balanced, or extensive scanners.

The third dimension has to do with *field articulation*, i.e., the degree to which environmental stimulus patterns are differentiated into salient and irrelevant cues. There are two aspects to this dimension. One has to do with how individuals articulate the field into figure and ground aspects, and the other with their degree of distractibility—i.e., how responsive they are to extraneous, irrelevant cues.

Each of these dimensions is obtained by giving large batteries of tests to individuals, intercorrelating the test scores and then factor analyzing the correlation matrix. Whether we work with psychotics or with normals, we find essentially the same dimensions. With psychotics, an additional major factor emerges, which appears to reflect either perceptual inefficiency or some kind of inability to perform well. One of the implications of this latter finding is that with people in altered states of consciousness, a criterion of performance-efficiency obscures the assessment of what underlies their performance.

Using this research strategy, not only do we examine aspects of the attentional process, but we are also able to differentiate between types of people simply by profiling their individual scores on these various dimensions.

I. Stimulus Intensity Control

Sensitivity

Hypo ———————x—— Hyper

Intensity Modulation

Augmentation ———————x—— Reduction

II. Scanning Control

Information-search

Extensive ———————x—— Minimal

III. Field Articulation Control

Differentiation

Segmentalizing-analytic ———————x—— Global Relational

Distractibility

Hypo ———————x—— Hyper

FIG. 1. Dimensions of Attention

(The xs indicate a pattern of scores which a prototypic non-paranoid schizophrenic subject would evidence.)

Looking at data obtained with people in the normal waking state and in various altered states of consciousness (like those produced by LSD intoxication, psychosis, or meditation), we find that certain significant comparisons can be made. The ordinary waking state is characterized by mid-range sensitivity, balanced scanning and an active analytic approach to organizing information. Persons in altered states of consciousness tend to be hypersensitive to stimulation, to tone down high-intensity input, and to scan the environment minimally. They do not distinguish salient from irrelevant cues and tend to be highly distractible.

These constructs are quite useful in attempting to make sense out of the rather confusing literature in the area of perceptual behavior.

In our studies of individual differences, we type people on the basis of their profiles on these various dimensions. We are guided by some interesting studies which correlate perceptual and personality characteristics. For example, if you divide a sample of so-called normal subjects into those with high and low visual sensitivity,[5] you find that the high sensitivity subject is more easily distracted by outside stimuli, and his mood is more readily influenced by people around him. Such a finding is also reported with LSD subjects, more often than for non-drugged subjects, and with normal women more often than with normal men.[6] It is most interesting to note that from the earliest days of life, females evidence a greater sensitivity and receptiveness to social cues than males.

When we examine schizophrenics' performances, we find that they define the extremes of the dimensions. Our strategy has been to profile individuals (normals and schizophrenics) in terms of their response characteristics on tests which are highly correlated with the dimensions. When we did this, we found prototypes of schizophrenia on both extremes of these dimensions. The people at either extreme make sense out of their environments in very different ways. Furthermore, the symptom patterns and other psychophysiological response characteristics of these attentional style types are quite different. This kind of evidence is consistent with other findings which indicate that schizophrenia can be a misleading diagnostic label.

A person in an altered state of consciousness, however induced, is "somewhere else." It is very naive on our part to think that he should be performing on psychological tests in a particular way just because we ask him to. Indeed, when you ask an LSD subject to do something for you, if he has ingested enough LSD, he will not oblige, and you will erroneously label his performance as "inferior."

In our recent electroneurophysiological studies, we have expanded the significance of the attentional-styles formulation. Dr. Buchsbaum will now discuss some of the specific parameters of this new area of research.

He will also discuss some aspects of this research relevant to the study of psi phenomena.

BUCHSBAUM: The experiments I would like to discuss today relate to Dr. Silverman's first dimension of attention, *stimulus intensity control.* As he has mentioned, the performance of a subject on a psychophysical task may reflect poorly the quality of his perceptual experience. We have attempted to use a neurophysiological measure, the average evoked response, to avoid certain aspects of performance measures. As some of the participants may not be familiar with this measure, let me briefly describe the technique.

Cortical average evoked responses (AER) are patterns of electrical response to sensory input which are recorded using a modification of standard electroencephalographic procedure. Evoked responses are usually of such small amplitude as to be completely lost in the apparently random fluctuations of the EEG. They are generally 5 to 20 times smaller than random EEG fluctuations. However, we can take advantage of the fact that whereas the background EEG activity varies and bears no fixed relationship to sensory stimuli, an evoked response is always time-locked to a sensory stimulus. By presenting the subject with a long series of stimuli, such as flashes of light, and summing the EEG singularities for a brief time interval after each stimulus (using a computer of average transients), an average evoked response pattern is produced. Evoked responses are quite similar from trial to trial, and similar enough from person to person so that specific peaks and latencies of the AER wave form can be named and compared. AER can be computed even in individuals in trance or hypnotic states or during sleep, since they do not require the subject's active collaboration.

In many individuals, within ranges of moderate stimulus intensities, the amplitudes of evoked responses increase with increasing intensity of stimulation. However, subjects appear to fall into two groups: those whose evoked responses increase in amplitude with increasing stimulus intensity, "augmenters," and those whose evoked responses do not increase or even decrease, "reducers." An example of these two patterns is shown in Figure 2. We have been interested in the peak-to-trough amplitude from positive peak 3 at 80 to 90 milliseconds to negative peak 4 at 120-140 milliseconds. In two separate experiments[7,8] we have found that subjects who have reducer type evoked responses show scores indicative of a tendency to reduce the perceived intensity of strong stimulation on a psychophysical judgment task, the kinesthetic figural aftereffect (KFA). Figure 3 shows the AER amplitude as a function of

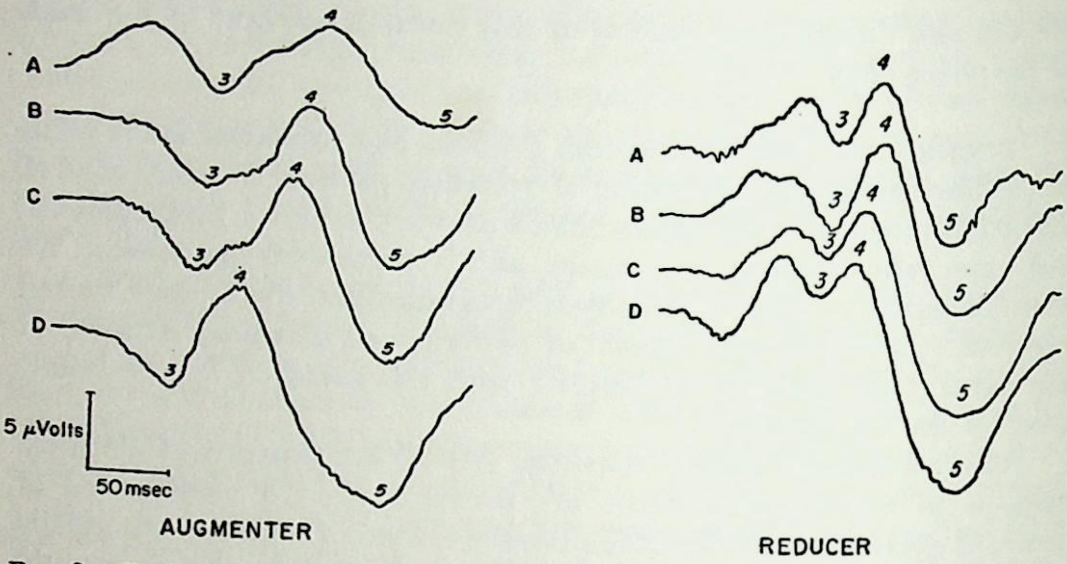

FIG. 2. Evoked response wave forms to four intensities of photic stimulation from dim (curve A) to bright (curve D) for typical augmenter and reducer subjects.

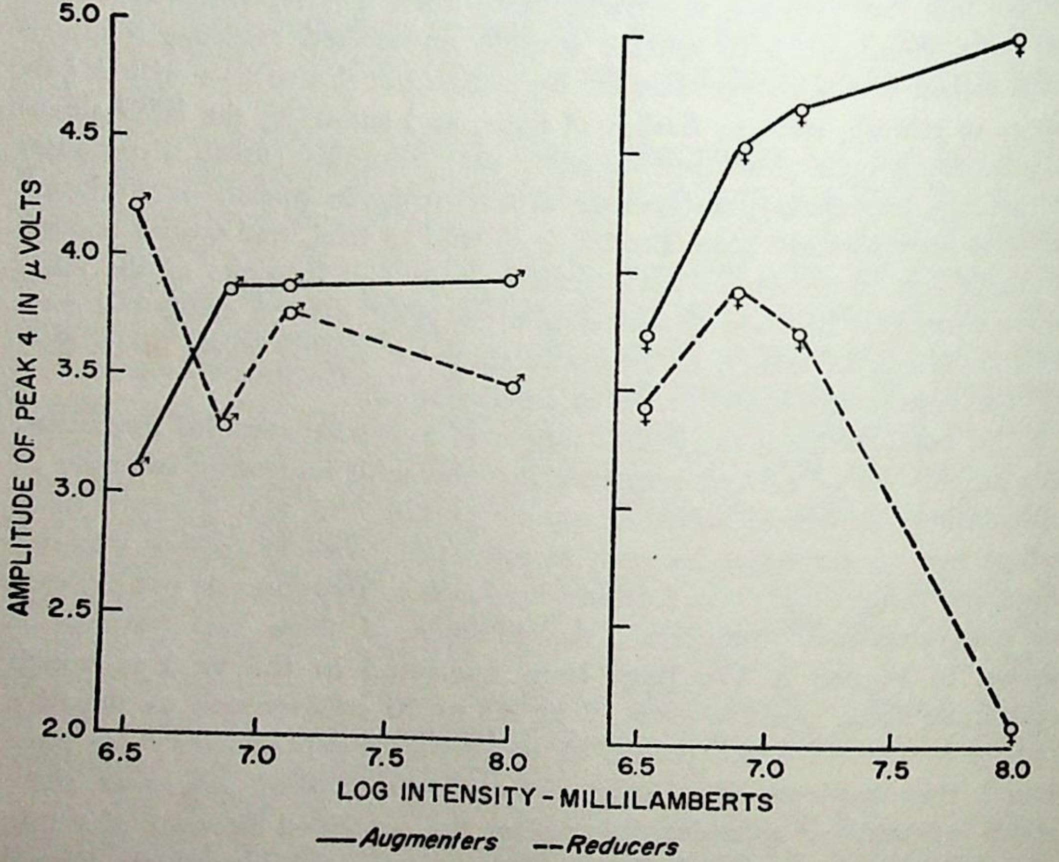

FIG. 3. Average evoked response amplitude intensity functions for subjects with augmenter or reducer scores on the KFA psychophysical procedure, separated by sex.

intensity for subjects divided into augmenters and reducers on the basis of being above and below the median KFA score. The difference between the end points is statistically significant. Analysis of variance shows the groups to be different. Correlation coefficients between the linear slopes of each person's evoked responses curve and their KFA score were 0.78.

This technique appears to reflect a relatively stable perceptual dimension. Test-retest values are comparable from day to day; Figure 4 shows a 48 hour retest on the same subject. Genetic factors may play

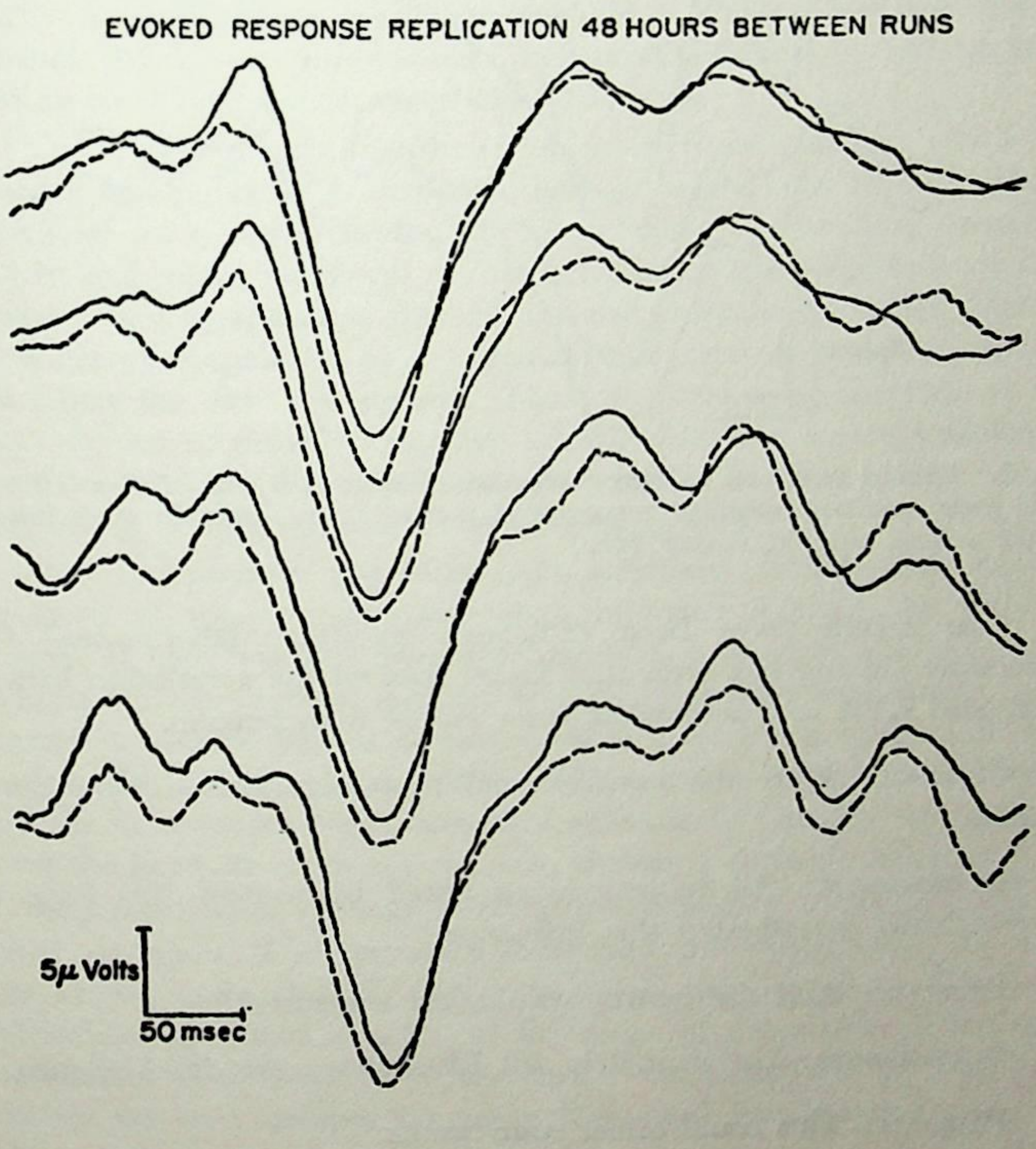

Fig. 4. Typical test-retest stability observed for four intensity average evoked response procedure.

a role; Figure 5 shows that a pair of identical twins have almost identical AER.

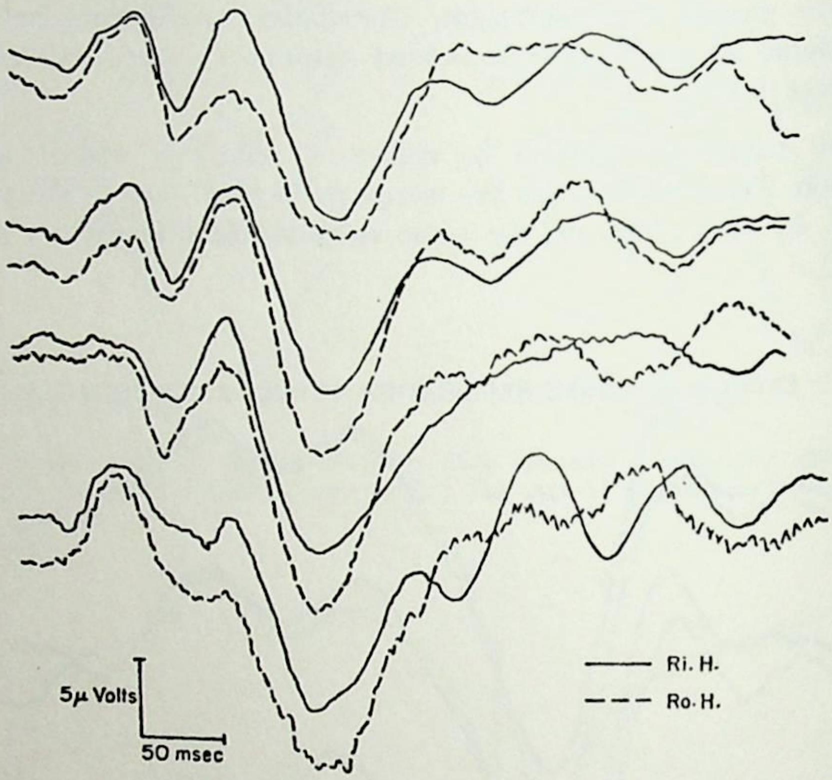

Fig. 5. Evoked responses to four intensities of light in a pair of identical twins show great similarity. Evoked responses of one twin are shown in solid line and of the second twin in dotted line.

Our results have been replicated in other laboratories.[9] One interesting finding has been that males showed the correlation between AER and KFA to a somewhat lesser extent than females.

Pribram: Were the psychological tests administered by males or females?

Buchsbaum: All subjects were tested by women. We have not systematically investigated this influence.

Pribram: And the neurophysiological measures?

Buchsbaum: Unfortunately, all EEG tests were done by men.

Pribram: This could affect your results.

Buchsbaum: There is no doubt about it.

Having found individuals who appear to have some kind of built-in capacity to attenuate high intensity stimulation, we were interested in exploring the other hypothesized characteristic of reducers and the one perhaps most relevant to this conference: unusual sensitivity to stimulation.

It has been suggested that reduction responsiveness is found, in a pronounced form, among individuals who respond to stimulation of minimal intensity more readily and more strongly than others.[8] Such individuals, conceivably hypersensitive to stimulation, require some form of compensatory adjustment (reduction responsiveness) to protect them from stimulation of high intensity. In the experiment to be presented here, which is based on this suggestion, the following hypothesis was tested: A relationship exists between slope on the average evoked response (AER)—amplitude—stimulus-intensity function, and performance on traditional sensory-threshold procedures.

The next step was to administer a threshold task, in which the presence or absence of a very dim light or sound was to be detected. Individual scores were divided above or below the median, according to light and sound thresholds. When we plotted the amplitude of their evoked response data, we found that the insensitive people followed the augmenters' pattern, as the paradigm suggested, and the sensitive individuals the reducers' pattern. Thus we have a psychophysical task which seemed to provide the same information as a neurophysiological procedure, and can be administered to people not only in the waking state, but in altered states of consciousness as well.[10]

Our next problem was to measure sensitivity directly with AER at low levels of stimulation, rather than inferring it from the subject's behavior at high levels of intense stimulation. I want to briefly describe the apparatus: the subject is seated in a chair, inside a soundproof room. Through a window he can observe outside the room a strobe unit in a soundproof box with a small window. The subject is completely isolated from the light source electrically and acoustically; in this way nothing except the light, as far as we can tell, is getting through to the subject.

As I mentioned, we were interested in detecting a very low level of evoked responses. The responses illustrated previously (Fig. 3) were quite bright, and relatively large potentials were involved. The ones studied here are much smaller, of the order of magnitude of less than 5 millionths of a volt. They are much more difficult to recognize; therefore we let a computer analyze them and decide whether or not they were at all present.

The computer presented light flashes according to a random number table and controlled the delay between flashes according to a separate table. The random numbers were known only to the computer. Five hundred twelve trials were presented to the subject: on half of the trials the light was actually flashed, and on the other half the light was not flashed. The subject observed the sequence of light flashes. The computer, using a third random number table, divided the 256 flash trials and 256 no-flash trials into 16 groups of 32 flashes each. An example of the data for a fairly bright light flash is shown in Figure 6.

We reasoned that if time-locked evoked activity were present, the eight evoked responses to the light should be more similar in wave-form than the eight no-flash control averages. Using product-moment correlation coefficients as a measure of similarity, and calculating this similarity measure over time bands of 128 milliseconds[11] we can compare the

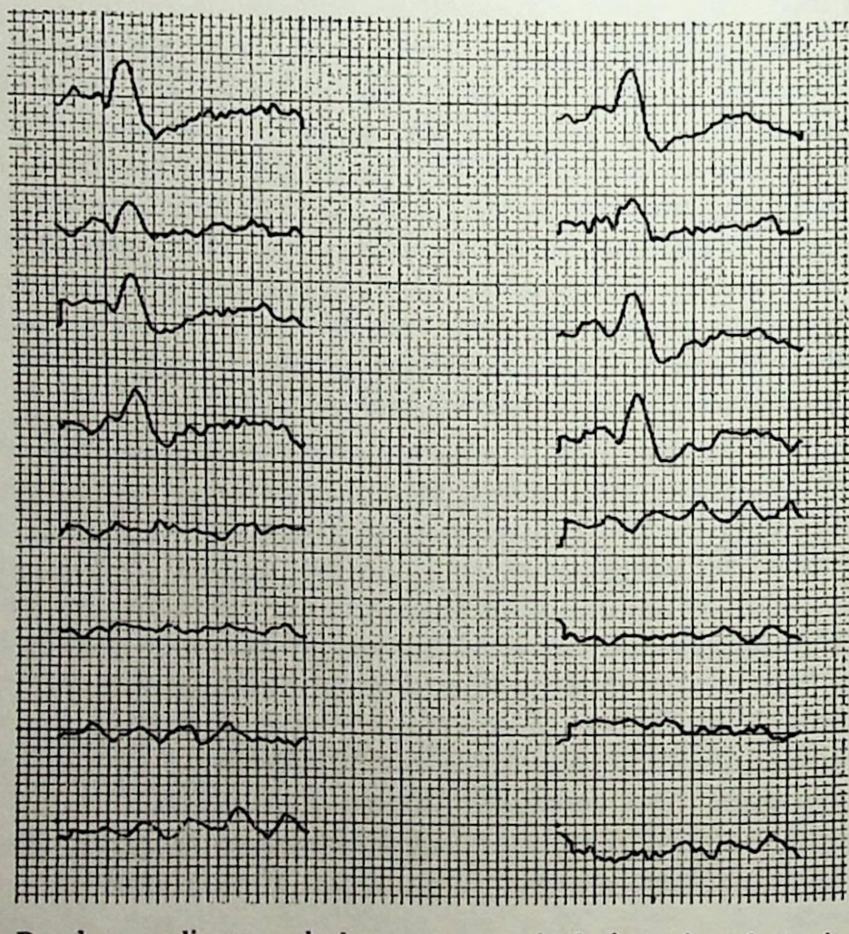

FIG. 6. Random replicate evoked responses to single intensity of photic stimulation, averaged for 500 milliseconds. The top eight curves each represent the average of 32 light flashes. The bottom eight each represent the average of 32 trials without photic stimulation. Time-locked evoked activity can be clearly seen only in the top eight trials.

similarity at various points on the AER. Figure 7 shows the results of this technique using light flashes attenuated with neutral density filters

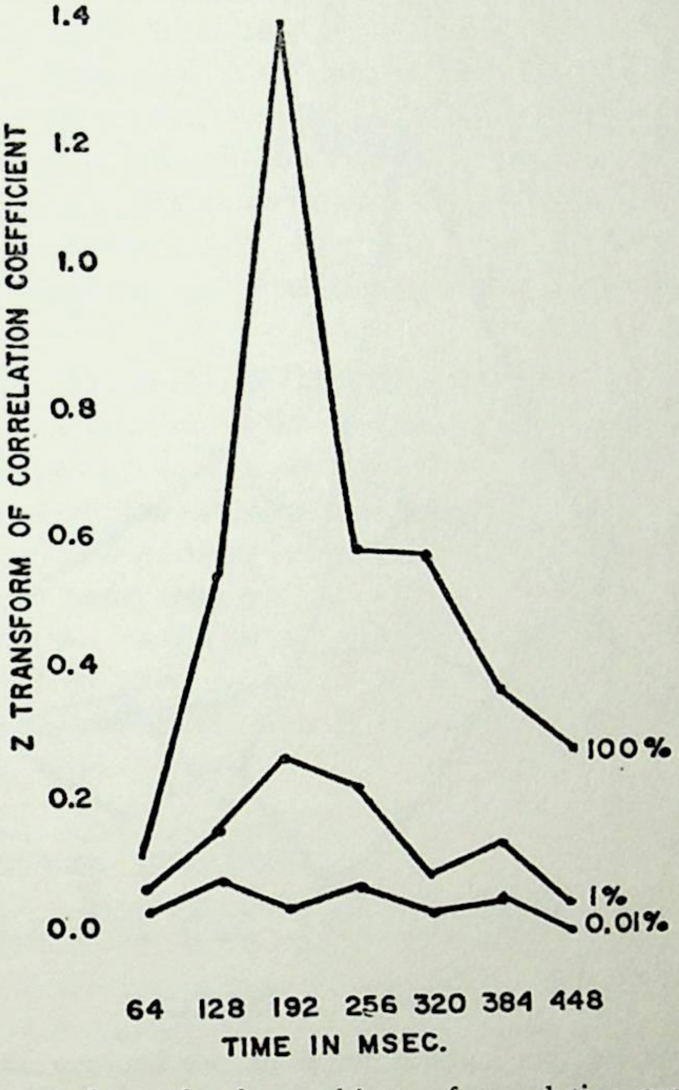

Fig. 7. Mean z transforms for four subjects of correlation coefficients between segments of the eight evoked response wave forms averaged after photic stimulation. Percentage of transmission of neutral density filters placed between subject and light are shown to the right of each curve.

of varying percentages of transmission. A central band of time-locked activity from 70 to 150 milliseconds appears to stand out most clearly. High correlations can be observed with bright flashes. As the intensity goes down, the correlations fall, but they still follow the same temporal course. As the light becomes very dim, there is almost no correlation, no temporal course. The mean difference between z transforms of the 24 intercorrelations of the flash AER and the mean of the 24 intercorrelations of the no-flash AER can be tested with a t test to yield a measure of the presence or absence of an AER.

This technique is currently being further developed and statistical problems studied. Figure 8 shows the t test values for the same neutral density values; the data shown are the mean values for four female

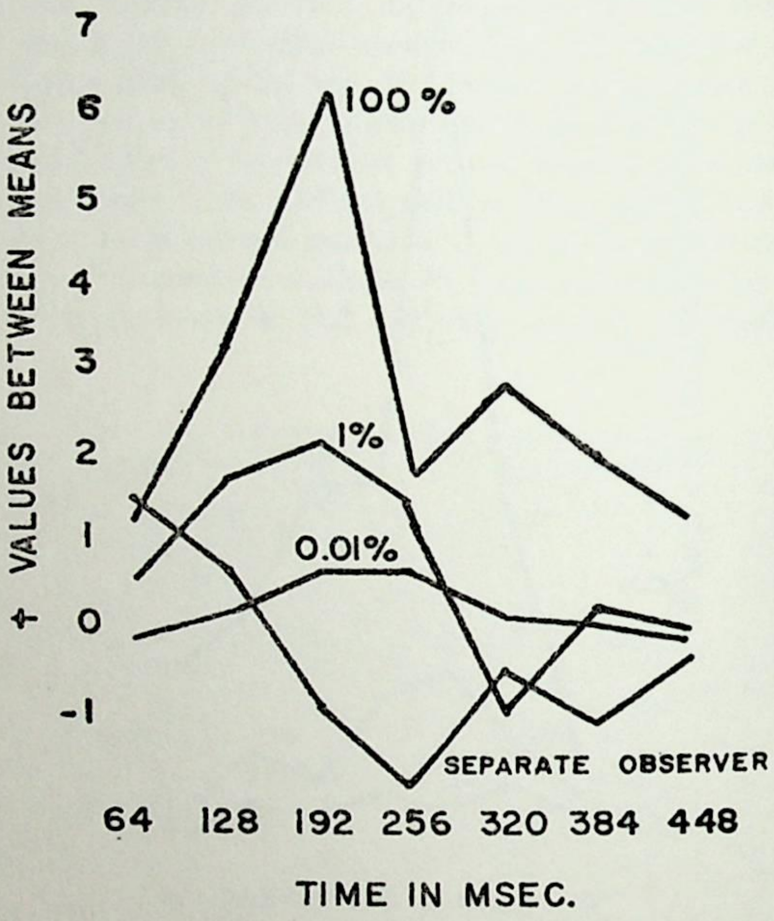

FIG. 8. Mean t-test for four subjects for difference between mean z transforms of correlation coefficients between the 8 light flash evoked wave forms and the 8 no-flash average wave forms. High values are indicative of the presence of evoked response activity. Percentage of transmission of neutral density filters indicated above curves. See text for explanation of curve labeled "separate observer."

undergraduate volunteer subjects. It is interesting to note, however, in these pilot studies that the t-value falls below 2, close to what appears to be the subjective threshold of the subject.

Following Dr. Cavanna's visit last year, I thought it might be interesting to turn the box around and let a separate observer watch it. This observer, seated in another soundproof room, would view the strobe. The experimental receiver subject would have his EEG processed by the computer and the AER computed separately for the flash and no-flash conditions. The analysis described would be computed in the same manner. This experiment would have several advantages. Since there is no experimenter involved, any kind of bias or influence would be avoided. The experimenter has no way of knowing when the light is going to flash; there is no way in which he can systematically influence the subject. This type of analysis should be good for any kind of wave-form. If a psi evoked response is totally different from a normal evoked response, it would still be detected with this kind of statistical approach. A large number of trials can be presented in rapid succession in a relatively short time with little effort on the part of the subject. And finally it might tell us whether psi operation follows any natural laws.

Based on Dr. Hernández-Peón's comments in last year's proceedings, I will discuss what kind of evoked response one would expect to see if telepathic communication were to occur between a subject watching the box outside the soundproof room, and the EEG-wired subject inside. My treatment will cover only telepathy, as clairvoyance and precognition do not fit so easily into our model.

First of all, we would expect some sort of delay. The telepathic communication could not occur instantaneously after the light flash; possibly it would have to be delayed approximately one central nervous system reaction time.

MARGENAU: Why is that?

BUCHSBAUM: Because even if it were an unconscious act, it would have to be received and processed by the brain. It seems unlikely that an organ such as the retina would be involved in a telepathic communication. As Dr. Hernández-Peón suggested, some specialized area of the cortex would be the most likely source rather than one of the primary projection areas. We know from other experiments that central reaction time is of the order of magnitude of 100 milliseconds; therefore, we would not expect to see any activity in the receiver for the first 100 milliseconds.

According to Dr. Tart's model, whatever energy is involved in telepathy would have to be decoded into neural information. This decoding would presumably not follow the usual pattern we see in the primary projection areas. We might then see that part of the evoked response which we interpret as a conscious perception of a light flash. Thus we would expect the evoked response in this experiment to consist of first, a period of no activity for 100 milliseconds following the light flash, followed by a 50 to 70 millisecond period of waves not typical of the usual visual AER, followed by the usual visual AER late components. The time course of the t-value should resemble the other curves but the peak should be shifted 100 milliseconds later in time. This is only a flight of imagination but we have to begin somewhere.

These experiments assume that the processes involved occur in a relatively reproducible way with each transmission and that the variability in latency of response is minimal.

We have demonstrated already that both bright and quite dim flash AER can be detected using this technique. Two further control conditions were explored. A 10 K resistor in place of the subject yielded no detectable evoked responses. An opaque screen between subject and strobe also prevented detectable evoked responses.

Figure 8 shows the t-test values obtained for the separate observer experiment; the t values remain low and the predicted delayed peak does not appear. We cannot therefore claim to have demonstrated any psi phenomena using this technique. Whether this failure represents the lack of an adequately "sensitive" subject as a receiver, the inconstancy and variability of the temporal course of psi phenomena, or the complete absence of a bona fide phenomenon to study is impossible to say at this time. The technique may however still be a useful tool in exploring this area.

Silverman: At this point I would like to summarize our presentation and suggest its possible implications for psi research. The model we are using is based upon three dimensions of attention or perception. Attentional style patterns emerged from this factor-analytically derived model. Each factor represents both a response dimension and an hypothetical neurophysiological mechanism underlying behavior. Performances on our tests are explained in terms of factors with which the tests are correlated and in terms of the underlying hypothetical mechanisms. Thus, for example, people who are hypersensitive to stimulation evidence typical evoked response characteristics and also the capacity to attenuate high intensity input.

In extreme individuals such as non-paranoid schizophrenics, unusual hypersensitivity and paradoxically high pain tolerance occur. Wiener[12] has summarized the literature which indicates that the abnormal sensitivity of these individuals extends into many areas of their day-to-day activities. It is certainly noteworthy that psi phenomena are commonly reported by individuals in this altered state. Their extraordinary hypersensitivity to low intensity stimulation could be a precursor of psi sensitivity. Up to now the reluctance of clinicians to collect data in this area has obscured the significance of psi occurrences reported by hypersensitive individuals. In this respect it is interesting to note that in studies aimed at enhancing sensitivity to low-intensity stimulation, a relaxed, yielding perceptual attitude is conducive to more receptive states. That is, sensitive people can become even more sensitive when instructed to relax their critical perceptual orientation.

Studies in subliminal perception[13] have indicated that perceptually receptive, non-analytical individuals register subliminal cues, whereas those who are perceptually analytic do so to a significantly lesser extent. Receptivity to subliminal stimulation and perceptually undifferentiated responsiveness are typically found in the non-paranoid schizophrenic. Contrary to common belief, the paranoid schizophrenic, who is analytic and organizing in his perceptual behavior, is not hypersensitive to low intensity stimulation. He is too busy making *non*sense out of his environment.

The finding that there is a tendency for individuals with extreme scores on one dimension to show extreme scores on other dimensions, such as we have found with our schizophrenics, suggests a way of studying individual differences in psi sensitivity. One could outline the profile for psi-sensitive individuals. It would be expected that their scores would be extreme on these perceptual dimensions. Psi-sensitive individuals should be a) receptive to low intensity stimulation, b) yielding in the way they process information (i.e., non-analytic, non-restructuring), and c) probably minimally concerned with scanning environmental stimuli.

In conclusion, it appears that our approach has three areas of application for psi research: 1) The identification and examination of attentional style patterns of alleged psi sensitive individuals. 2) The evaluation of the occurrence of these patterns in psychopathological individuals, whose verbal reports are not usually regarded as credible.* 3) The neurophysiological-perceptual examination of individuals in psi-receptive states.

LINDSLEY: We have three discussants: Dr. Kamiya, Dr. Pribram, and Dr. Walter. Joe, would you like to lead off?

KAMIYA: I found the experiments quite fascinating. The general strategy of trying to parcel out various seemingly irrelevant perceptual components of behavior (which might be involved in psi-sensitivity) is very reasonable. It is time that we began to collect more specific informa-

* Furthermore, were it found that psi-sensitive and non-paranoid schizophrenics evidenced similar response patterns, this would contribute to the therapists' greater appreciation of their patients' perceptual experiences.

tion about individual differences, in addition to the general personality questionnaires. Some manner of perception seems to be involved in psi; therefore it is reasonable to look at the perceptual profiles of individuals who proved to be sensitive by past history of formal testing.

The presentation goes far toward relating vast amounts of perceptual data collected in psychological laboratories to the physiological data now obtained through stimulation of both animals and humans.

Looking for correlated indicators at the behavioral and the physiological level is not desirable just because it is interdisciplinary, but rather because by using two independent levels of observation one can arrive at independent formulations of the hypothetical constructs for the perceptual process. I am not an expert in the field of psi research, but judging from the substantial number of references being made to a physiological substrate, I think this is a reasonable approach. Dr. Margenau remarked that hypothetical theories ought to be checked by observations. I think this kind of approach is commendable.

I have a few specific remarks. First, with regard to the curves of the evoked potential differentiating augmenters versus reducers, if my understanding of your experiment is correct, you did not sample the full range of light intensities. This might bias your judgment about whether a person is of high- or low-sensitivity.

SILVERMAN: What we did was first to differentiate subjects on the basis of a perceptual procedure similar to one which Petrie has been using.[14] From subjects' scores on this procedure, inferences were made regarding augmenting and reducing perceptual behavior. We then examined the evoked responses of our subjects to four intensities of light. We obtained different functions for augmenters and reducers. Concerned about the problem of range of intensities of stimulation, we undertook a further experiment using a neutral density filter to explore a lower range of intensities in which our subjects were administered sensory threshold tasks. Performance scores on these tasks were correlated with evoked response patterns on the four intensities of light. We obtained essentially the same curves for high- and low-sensitivity individuals that we had obtained for augmenters and reducers. The curve which was found for reducers using the augmenting-reducing procedure was essentially the curve found for highly sensitive individuals.

KAMIYA: O.K., that made it clearer. Technically speaking, I am a little concerned about the specific psychophysical method used. Perhaps a signal detection approach would yield a slightly more sensitive indication, and may even sharpen the relationships you observed.

In reference to the question of how psi inhabits time and space, one might expect psi evoked potentials to have latencies that would be quite different from those seen in conventional evoked potentials. They could occur, for example, as much as several seconds or even minutes after the stimulus was presented to the sender. A more sensitive procedure might be to discriminate the average evoked potential for periods with bursts of light, spaced one second apart, versus periods with no bursts of light, the experiment being protracted for several minutes.

That is all I have to say besides commending the presentation for its promise in general strategy.

LINDSLEY: Thank you, Joe. Dr. Karl Pribram, would you like to comment?

PRIBRAM: I would like to ask some specific questions. First, have you ever used recovery cycles rather than simple evoked responses?

SILVERMAN: No, we have not.

PRIBRAM: Recovery cycles have the advantage of controlling for the state of the organism since the measure is relative. In this technique, two spaced flashes are used, and the interflash interval is changed. If one flash follows the next too rapidly, the system is still busy processing the first response, and the second response is therefore very small. As you extend the interflash interval, the second response becomes larger.

My second question concerns your factor analytic treatment. In our work we cannot distinguish field articulation control from scanning. Information search and differentiation turn out to be practically the same thing in my model. Therefore, I would need some additional evidence to distinguish, as you have done, between these two variables.

SILVERMAN: Using the sensory, perceptual, and cognitive measures in our battery, it was found that the scanning and field articulation factors are independent and reproducible.[15,16] Clearly the kinds of measurement procedures used determine the factor structures which emerge from a factor analysis. How you spin the wheel, so to speak, will determine what kind of relationships between tests and factors you will observe and what kind of "story" you will make up about your results.

PRIBRAM: But it may be the wrong story. When you rotate your axes in your factor analytic design, you spin the wheel, as you say, and hope it will fall in the right place. This is a game. If you spun your axes according to some physiological or anatomic reference, then you would get an anchor point which would help you in deciding whether this particular way to orient your axes is better than another. What I am saying is that you should re-examine your old data in the light of your new data, and just keep going back and forth until something much more solid comes out.

SILVERMAN: I agree. Our basic concern all along has been to generate good experiments. So far we have succeeded, using this kind of approach. Using your kind of formulation we might also obtain some very interesting, innovative results.

LINDSLEY: Dr. Grey Walter, please.

WALTER: This game of trying to analyze perceptual factors is one that many people have played. It's a very good game. . . . It seems to me that in your classification you have identified an intensity factor which in your case is the brilliance of the light, a time-space dependence for scanning by which the spatial components can be transposed onto a time scale, and an organizational factor. I just use different names. Unfortunately, what seems to be missing here is *significance*, that is, the actual meaning, the semantic content of the perceptual stimulus. What the subject actually thinks about the signal seems of paramount importance for the evoked response. In psi experiments this may be the most important factor of all; the actual meaning, the implications of the stimulus as opposed to the merely physiological, physical factors.

My second point is related to this technically; there are many categories of evoked responses. In other words, the brain does not only respond in its primary receiving area, but also in primary association areas and also in the non-specific areas of the cortex. I gathered from your diagrams that you are dealing mainly with the primary visual response.

The occipital currents include, besides the rather small contributions from the primary receiving and association areas, also the responses of non-specific regions which might be particularly sensitive to those psychological factors which you manipulate. It seems to me worthwhile to try to distinguish between these different responses, because it seems rather unlikely that the primary receiving or association areas would be involved in a paranormal response.

There is another technical problem. In using averaging techniques, you are assuming a high redundancy. If you do not have a high redundancy, the results obtained with the techniques described might be misleading. I think it would be better to use a filter technique, which is more difficult to program (it can be done with modern computers), but will pick out the various patterns that might occur at any time.

Thus, you would not be restricted to events time-locked to the stimulus, and you would therefore be able to cope with possible precognitive situations as well as with variable delays. Furthermore, you would not be tied to any wave form or pattern. This has been used already by Derbyshire[17] for identifying individual responses as well as average responses.

KRIPPNER: Drs. Buchsbaum and Silverman are to be congratulated not only for their fine presentation, but also for their willingness to investigate the evoked responses of sensitives. This would be the right thing to do, but there is a possibility that they would wind up with the same sort of data that they found for the schizophrenics. As there really is no such thing as a schizophrenic, maybe there is no such thing as a sensitive. Therefore, I think that some sort of psi testing should be administered at the same time. Many alleged sensitives might actually not have psi.

SILVERMAN: We can type schizophrenics in a very neat way by our independent assessment procedure. We can predict which persons are going to be sensitive in our stimulus intensity experiments, and also, within limits, what kind of a recipient pattern they have. What we learned in this way will help us to determine which "sensitives" are sensitive and which are not.

RECHTSCHAFFEN: Did you look at pupil size as a possible mediator of sensitivity? Pupil size was found to correlate with interest value. It might reflect the size of evoked potentials.

SILVERMAN: No, we have not done this type of study.

By the way, within our research framework each factor has its own significance. If we presume at this stage of the work that one of them has a lower priority than the others, we may be unpleasantly surprised later on. Each of the factors we have been concerned with refers to an aspect of attention or perception which relates to important attributes of information processing. Thus, each of these factors is assumed to underlie higher organizational responses. Differently stated, ways in which sensory inputs are organized determine the ways one "makes sense" out of one's environment. At this stage of our research all of our factors are given equal priority. Our primary aim is to generate hypotheses. We are not prepared to give a comprehensive formulation of the interrelationship of the factors.

PRIBRAM: Is there anything you can do to reduce your work load? Do you have to go through the whole factor analytic procedure each time, or do you have some sort of indicators?

SILVERMAN: For each of our dimensions, an electroneurophysiological response procedure has been developed. We do not need to give perceptual tests (although we are still doing this in our research); we do give personality tests to study some of the personality correlates of these response patterns.

LINDSLEY: I congratulate Dr. Buchsbaum and Dr. Silverman on a very interesting and stimulating systematic approach to this problem. However, I have a comment I would like to make. You rate sensitivity in terms of a negative wave-component 4 which decreases as intensity is reduced, while the positive component 5 increases. Thus as the positive component grows it seems that the negative one decreases. In my experience the later positive component 5, if it is the one I think it is, is often associated with attentional factors as I will indicate presently. I think you ought to make sure that it was really the intensity of the light which reduced component 4. For example, positive component 5, being a later component in the evoked potential complex, often reflects increase of attention by increased amplitude as we have shown.[18] Being of opposite polarity to the negative wave-components on either side of it, its increase in amplitude may tend to reduce their amplitude. As a result, component 4 might be reduced whenever component 5 was increased as a result of increased attention to the stimuli giving rise to the entire evoked potential complex.

Another possibility may be suggested. You have compared the evoked potentials for four different intensity levels of your probe stimulus. Within the range of peak latencies from 80 to 160 msec we have found[19] that at lower levels of luminance an 80 msec negative wave is sensitive to changes in luminance. At first, it increases in amplitude as luminance is increased by steps, then it bifurcates or divides into two peaks both with decreased amplitude. Thus instead of a continued increase in amplitude as luminance increases there is an actual decrease at higher luminance levels. The point I wish to make is that one must exercise care in evaluating amplitude of the various components of the average evoked potential, since amplitude of certain wave-components may vary as a function of attention and of others as a function of stimulus intensity.

This is not brought up here with the intention of contradicting what you and Dr. Buchsbaum have said with regard to using flash stimuli and their average evoked potentials as probes to detect differences between subjects who might be described according to Petrie's classification of "augmenters" and "reducers." Nor are my remarks meant to disparage your efforts in this respect; on the contrary, I, like others who have commented, feel that you should be applauded for your efforts to find physiological as well as psychological bases for classifying subjects. Once you have classified them according to certain objective criteria you may proceed to further differentiation. In this way perhaps, once the criteria are available for establishing differences reliably, the same techniques might be applied to the problem of differentiating so-called "sensitives" from "non-sensitives," and persons with special mediumistic abilities from those without such qualification.

As I recall, Asenath Petrie[14] first used these concepts, "augmenters" and "reducers," primarily in relation to pain and tolerance to pain. However, I presume there is no reason why they could not apply as well to intensity differences in any sense modality. This brings to mind that some years ago Dr. George Klein, then working at the Menninger Clinic in Topeka, Kansas, came up with somewhat similar concepts relative to the acuteness of perception or the focusing of attention during perceiving. The terms he used were "*sharpeners*" and "*levelers*." As I recall, he was referring to certain personality or typological differences which manifested themselves in perceiving, with special reference to the *attensity* dimension of experience. Petrie's concepts of *augmenters* and *reducers* classify people according to an *intensity* dimension of experience. I could conceive that dimensions of *attensity* and *intensity* could be highly correlated, if not actually one and the same thing under some conditions, but quite different under others.

Just as one might learn to tolerate pain through extensive and repeated experiences with it and thus convert himself from an augmenter to a reducer, it is also possible to conceive of learning to attend, or to develop specific ways of perceiving which go beyond the ordinary capacities exhibited and expected in a normal population. I would presume that at least some of the especially gifted persons who are mediums, sensitives, or others with psi talents may be at one or the other end of a continuum for *intensity* of experience (augmenters-reducers), or for *attensity* of experience (sharpeners-levelers). And this brings up an interesting question—are sensitives sensitive because they have an intrinsically low threshold, or are they sensitive because of special augmentation mechanisms which facilitate or enhance input and cause it to rise above a stable threshold (or even an elevated one) which may shut out unwanted stimuli? Or are they reducers who typically attenuate all incoming stimuli to a near-threshold level (or even slightly sub-threshold), permitting only selected inputs of threshold margin to enter consciousness? In either case, whether by genetic endowment or by trained acquisition, the sensitive presumably has an advantage over the average individual, just as does the dog who can hear a highpitched tone at 40–50,000 Hz whereas his master is limited to a paltry 20,000 Hz or less.

PRIBRAM: These are exciting ideas Don and reflect some of my own thoughts expressed elsewhere.[20] Nonetheless, I wonder if some of these factors would not collapse if you used physiological indices.

MARGENAU: I want to express my delight at the return of our interest to fundamentals. On Monday I spoke of methodology in the epistemological sense, which includes both conceptual framework and experimental approaches. I believe that the time has come to focus our attention upon both aspects of a proper scientific methodology, namely the conceptual framework and the design of experiments. I used the word methodology of science to cover both extremes of the scientific process of investigation and explanation.

This very interesting investigation might give suggestions on how to differentiate empirically between two opposite conceptual approaches to psi. One is the physicalistic theory which relies upon a physical mechanism in the conveyance of whatever influence passes between persons during psi occurrences.

The other model might be called a theory of universal ambience, a psi field in which we are all immersed. Some Oriental philosophies make it more explicit. If the physicalistic approach were correct, we would expect the kind of time lag conjectured by Dr. Buchsbaum. In the other case, such a lag ought to be absent. This might be one of the discriminating features. I urge you to look for others.

LINDSLEY: May I say, Dr. Margenau, that in average evoked potentials or any electrical recordings, if we get simultaneity of response in two different systems, we generally know that we have an artifact somewhere.

Dr. Tart might like to comment.

TART: If we look at Drs. Silverman and Buchsbaum's experiment in terms of a model of the telepathic process I proposed two years ago,[21] some basic changes could be incorporated in the experimental procedure. A way of objectively distinguishing between telepathy and clairvoyance might result from this approach.

Figure 9 sketches a model for the telepathic process in an experimental situation. Briefly, the sender is stimulated and the stimulation produces a signal in a sense organ, which in turn produces a signal in his brain. We can be certain, however, that the electrochemical brain processes are not what is transmitted across space to the receiver. There must be some sort of mechanism which encodes the stimulus signal into whatever energy form (not necessarily a known one) is actually transmitted to the receiver.

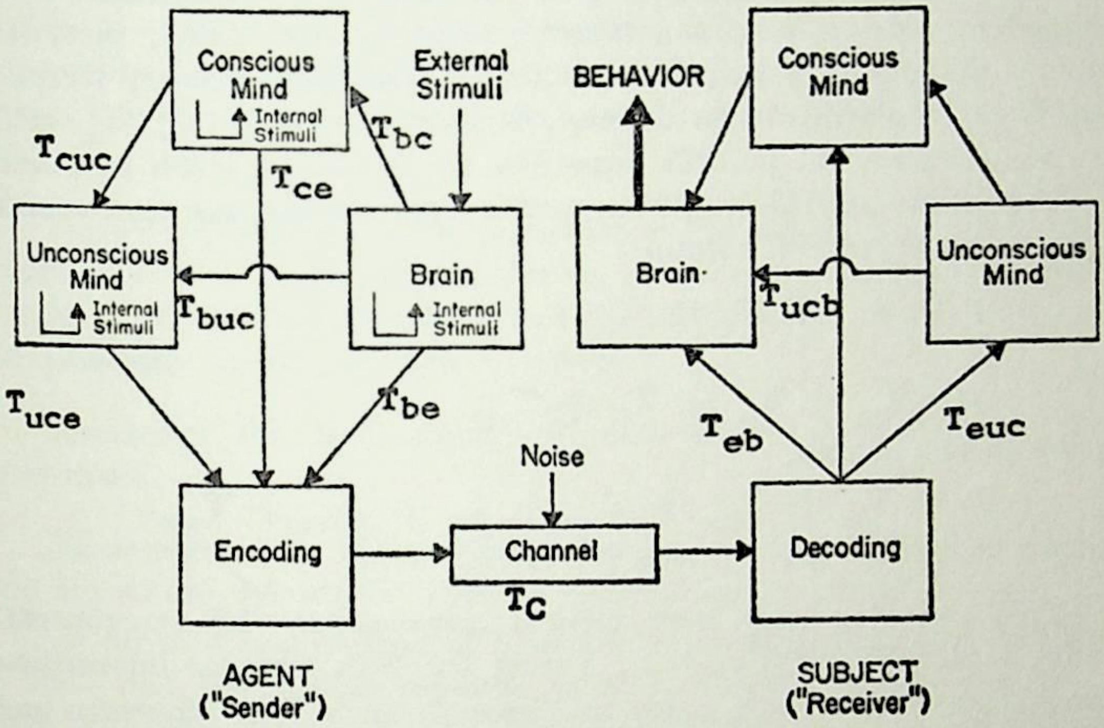

Fig. 9. Model for telepathy.

There may or may not be a direct flow of information about the signal from the brain to the encoder. If there is, it may go by way of the agent's conscious and/or unconscious mind. Similarly at the receiving end there must be a decoding mechanism that converts our postulated energy into electrochemical signals in the receiver's brain, which we then record and average. There may also be information flow in the receiver by way of conscious and/or unconscious routes, rather than a direct decoding-to-brain path. The consciousness of the receiver may be ignored in those experimental situations in which the receivers do not report awareness of the telepathic signals. When we use an EEG averaging technique, we need not assume that the stimulus signal is telepathically transmitted on every presentation: averaging enough trials can handle infrequent transmissions, assuming no change in the process of information flow *within* either subject. We must assume, however, that there is one and only one information flow route operating within each subject in our experiment, for if several different routes alternate this would impede our averaging process.

There is probably a time lag involved in each step within each subject. Let us assume for simplicity that they are all constant lags. If the averaging technique is to work, i.e., detect a telepathically transmitted signal, we must begin averaging after an appropriate time has elapsed since the stimulus presentation. Drs. Silverman and Buchsbaum have assumed that the appropriate interval could be that usually measured within a person for a stimulus-to-brain response in a primary receptor area. Using the symbols for the time lags on the figure (T_{bc}, T_{ce}, etc.) we can write several possible equations for τ (tau), which represents the "real" time needed for the telepathic signal to produce a detectable response in the receiver's brain:

$$\tau = T_{be} + T_C + T_{eb},$$

or

$$\tau = T_{bc} + T_{ce} + T_C + T_{eb},$$

or, the most complex,

$$\tau = T_{bc} + T_{cuc} + T_{uce} + T_C + T_{euc} + T_{ucb}.$$

Other possibilities are obvious.

This time lag may have critical consequences for experimental results. Unless T_{be}, T_C, and T_{eb} (using the least complex information flow route) are less than a few milliseconds each, Drs. Silverman and Buchsbaum may not have detected telepathy in their study, because they averaged the EEG of the receiver before the signal appeared in it.

In an experiment of this kind we must run a large number of trials and empirically try averaging after a wide variety of delays. This might produce spurious results, but replication would control for this. Furthermore, two valuable consequences might result from this conceptualization. First, if positive results were obtained, the time delay (τ) found might suggest the type and number of neurophysiological process involved and the order of magnitude of the transmission time between subjects. Secondly, a distinction could be made between telepathy and clairvoyance. If τ were of the order of magnitude found in direct sensory stimulation, and not so long as required even for the simplest telepathic model, we would know that we were dealing with clairvoyant perception by the receiver of the stimulus given to the transmitter. (A mixed case is possible, when two evoked responses appear, the earlier reflecting clairvoyant perception, the later telepathic perception.)

Several years ago, I conducted a similar study.[22] I measured the EEG and some autonomic responses of a receiver, while a sender in a distant room was administered severe electrical shocks of two seconds duration at random intervals. I compared the receiver's physiological responses during the time the sender was being shocked, with the same responses during control periods. I found significant activation patterns in both the EEG and the autonomic measures, indicating that psi was operating. As I did not have averaging equipment available, I was unable to analyze for differences between telepathic and clairvoyant transmission. The approach is very promising, and I am glad to see Drs. Silverman and Buchsbaum using such sophisticated equipment in this area.

Beloff: Could I raise a point about Dr. Tart's very fascinating suggestions? Due to the erratic nature of the time function of psi, I wonder if we can really expect this distinction. We cannot disregard the possibility of precognitive telepathy.

Lindsley: Dr. Buchsbaum will now answer the questions that were raised.

Buchsbaum: Dr. Kamiya suggested that we use some signal detection procedures. We are involved in investigating this area.

As far as giving clusters of light flashes as opposed to non-clusters, I think that the evoked response in psi transmission would need to have sufficient reproducibility and precise timing in order to be detected with signal averaging. If there is a latency variability in each signal greater than 20 milliseconds, we would detect little.

Dr. Walter suggested that we were dealing mainly with primary responses. Our EEG recordings were from vertex. Dr. Callaway repeated our experiments using occipital to ear and vertex to ear recordings.[23] He found that the augmenting-reducing KFA correlation appeared only with the vertex to ear leads and not with the occipital to ear leads. So it seems we are looking at a secondary perceptual process rather than at primary activity in the occipital cortex.

As far as adaptive filtering is concerned, Drs. Harris and Woody[24] at the National Institutes of Health have done some interesting experiments using a correlation coefficient technique for detecting variable latency signals. This technique is good when the signal-to-noise ratio is relatively high, and less effective when it is below .2. In our case, the signal-to-noise ratio was even more unfavorable. At such low signal-noise ratios, there is the danger that one might generate artifactually evoked responses. This is why I did not use this technique. Perhaps further mathematical advances will allow us to utilize adaptive filters at very low signal-to-noise ratios.

I appreciate Dr. Lindsley's comments. We have also been interested in the "sharpener-leveler" dimension. Gardner *et al*[15] noted that levelers are individuals who may rely heavily on anchors in perceptual tasks. We have found that individuals who show large starting position effects on psychophysical judgments tend to show reducing effects on the AER.

Dr. Lindsley suggested that the decrement in amplitude from component 3 to 4 might be due to an increase in component 4 to 5. The tendencies to augment or reduce, as measured by the amplitude between 3 and 4 or between 4 and 5, are correlated with one another in the same direction. In all three replications in our laboratory the correlations have been positive. In a group of 30 schizophrenics from St. Elizabeth's Hospital, the correlation between the psychophysical KFA and the AER slope was actually higher for peak 4 to 5 than for peak 3 to 4. So we do not think that increases in the 4 to 5 amplitude decreases the 3 to 4, although the 3 to 4 seems to be more highly correlated with the KFA, at least in groups of normal college-age subjects.

To conclude, I hope that by using our paradigm some progress will be made in the four major methodological problems confronting psi investigators. First, the detection of very weak signals in what seems to be a very unfavorable signal-to-noise ratio. Second, bridging the gap between subjective and objective experience: what the subject reports and what he is really experiencing. Third, reaching people in altered states, who might not be able to respond completely or cooperatively; and fourth, grasping in some way the mechanics of these very elusive phenomena.

LINDSLEY: Thank you very much, Dr. Buchsbaum.

Dr. Walter will now discuss the application of some of his neurophysiological techniques to psi research.

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