THE CONTINGENT NEGATIVE VARIATION AND ITS SIGNIFICANCE FOR PSI RESEARCH

W. GREY WALTER, SC.D.

Burden Neurological Institute
Bristol, England

WALTER: Before I launch into my technical discourse, I would like to express my deep appreciation of Eileen Garrett's hospitality and to mention that my interest in these borderline studies derives both directly from her material support, and, even more important, from her affectionate encouragement over a period of several years.

Like Dr. Buchsbaum, I shall start with a brief survey of the technical background of my work, because unfortunately in this field everybody develops his own techniques and his own paradigms, so that generalization is impossible and misleading.

Our specific technological resources change with time. Fig. 1 is a schematic diagram of the experimental equipment. The subject, in a secluded part of the room, can be submitted to a battery of stimuli by means of television, flash and sound generators, touch capsules, etc. He is surveyed by a closed circuit television system, and has access to a little box by which he can control the operation of the machinery. Then there are conventional amplifiers and recorders (we use 16 channels) providing a primary paper record of the usual type. We also use various types of storage devices and a timing system, an elaborate clock which synchronizes various stimuli with the operation of the computers. In our present rig, all the analytical components have been replaced by a single LINC 8 computer.

Very important for the study of parapsychological phenomena is the stimulus generator which can produce a variety of signals, physiological such as flashes, tactile stimuli, electrical shocks, etc., or semantic, that is, pictorial or verbal stimuli. The whole system can be initiated by a spoken word on the part of the subject or of the experimenter.

Notice that when we use semantic stimuli there is little or no energy transfer. One of the basic hypotheses upon which experiments of this kind are based, and which makes them perhaps relevant to parapsychological research, is that the brain is a probability computer, interested in the probabilities of significance. In essence it is a system whose electrical and chemical responses are a function not of intensity or modality, but of significant association.

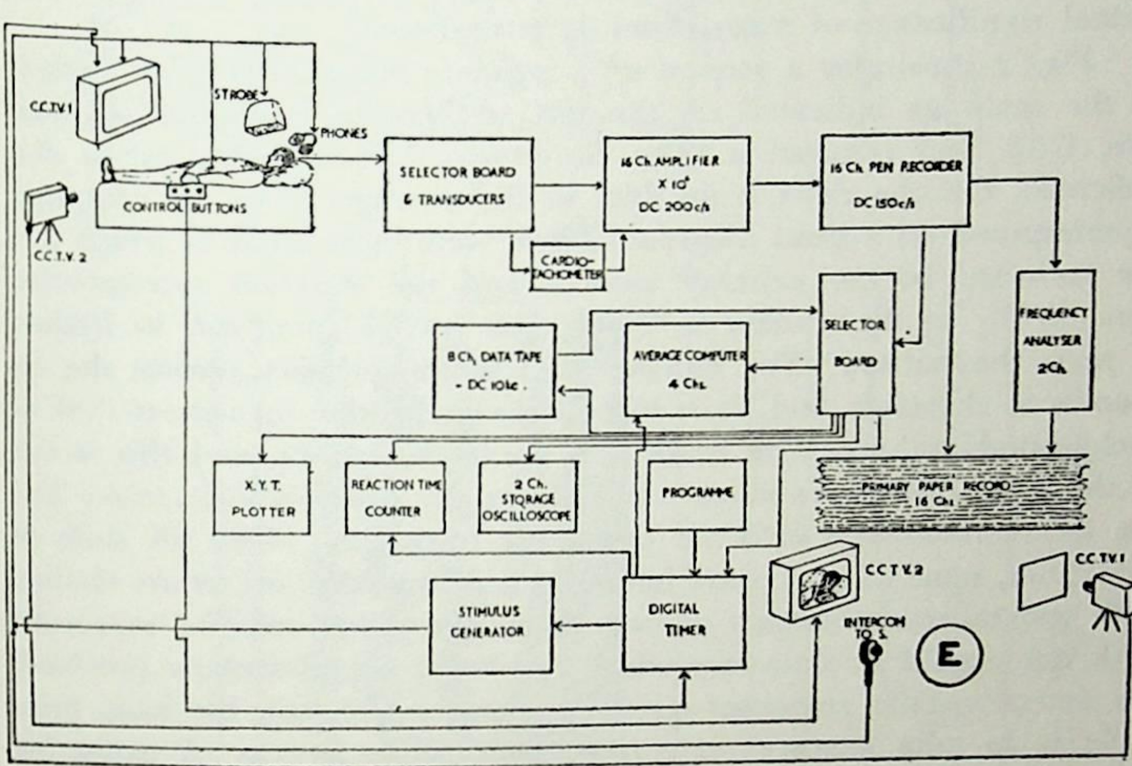

FIG. 1. Experimental setup.

The records I will show you are nearly all of associated stimuli in which the subject is in some way engaged. I will repeatedly use this word "engagement," not to beg the question as to attention or motivation, but to imply that the subject is somehow involved in the situation and is engaged in both the colloquial and the technical sense. Our next experimental refinement was to use a telemetry set, picked up by an aerial in the laboratory, so that the whole system could be used with a free-ranging subject, not hampered by leads. In a typical experimental situation, the experimenter is throwing a ball and the subject is catching it, while his brain responses are transmitted on eight channels to the laboratory.

Our system is entirely automated. After placing the electrodes (which is an extremely important operation, as the flesh-metal junction is the weakest point of the whole machinery), all the experimenter needs to do is to press a button to initiate a long and complex experiment. The computer will provide the stimuli, recording all events, and plotting the results.

Let me now describe what our experiments are about, what our paradigm is. In my classical education, the first time I heard the word paradigm was in relation to the conjugation of Greek verbs. To me this word has a dynamic quality implying the manipulation of contextual significance of some event or parameter.

Fig. 2 illustrates a section of a primary record from five regions of the scalp as indicated on the left together with records of pulse rate, GSR and respiration. The continuous frequency analysis is also indicated. On the right is the plot of the averages from the computer superimposed on a head diagram. There were eight trials of which five are included in the primary records and the situation corresponded semantically to the statement "*If* there is a click there *will be* flashes, so *press* the button." You can see that in the primary records the responses to the click and flash stimuli are embedded in a great deal of background activity. The brain is a great chatterbox, and this is one of the main difficulties in our research, as the gossip is ineluctable. The ten thousand million cells are constantly interacting about all kinds of trivialities, some of which are housekeeping functions, others are dealing with spontaneous thoughts or intentions, and a few may be concerned with the stimuli or situations which are being experimentally provided. To detect specific responses related to imposed stimuli, the basic principle is to take averages or to use some other system of extracting signals from noise.

The most important feature of our work is to impose a fairly regular true paradigm. We do conjugate our verbs, speaking to the subject through physiological or semantic stimuli. We start off with a purely indicative statement. We say to the subject: "there are flashes"; we then say: "there are clicks," and we look at the brain responses to these simple indicative statements.

One of the effects which one observes with this procedure is that you get habituation to a simple statement. If you go on saying the same thing to the brain, physiologically or semantically, it gets tired and no longer responds. This phenomenon has been extensively studied by the late Hernández-Peón.[1] It is one of the most peculiar and subtle properties of the brain, and I commend it to your attention in relation to parapsychology. If you change a stimulus parameter in any way, the response will return. This means, among other things, that the

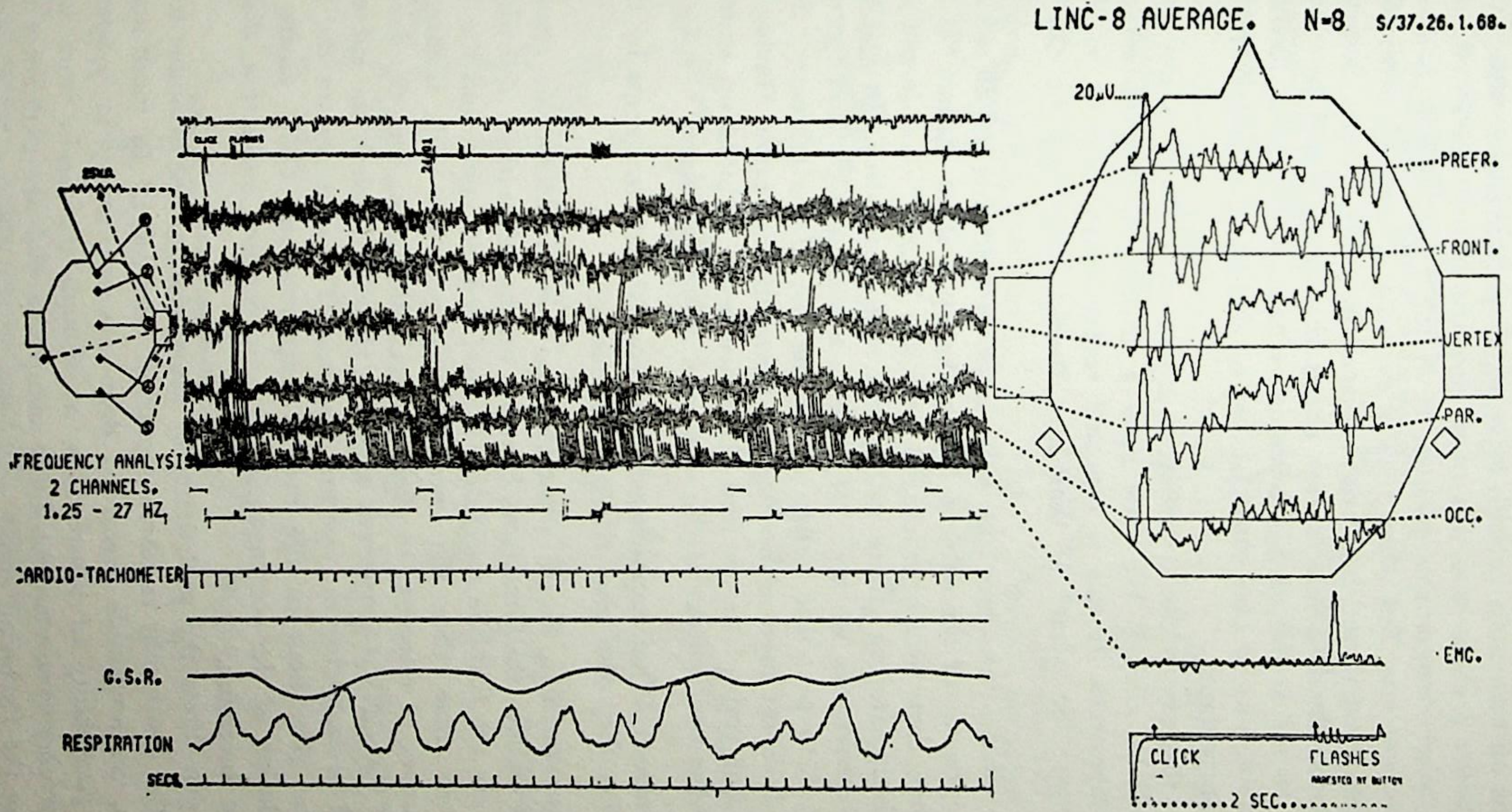

Fig. 2. Distribution of the CNV.

brain has an enormous rubbish store of all signals and events. For example, when I came into this room the first day I was faced with a, to me, rather disagreeable picture, to which I got rapidly habituated, and no longer saw. But when I came in today, I suddenly realized that it had disappeared and had been replaced by a blackboard. Somewhere in my brain detailed information about that picture had been stored. It looks to me as though the brain must have an enormous amount of trash stored, just in case some feature of this trash should change and become important.

We then introduce a different statement: "If there are flashes, there will be clicks." We now have a conditional and an indicative set of statements. If this is repeated several times, after a while the brain says: "So what? If there are flashes, there will be clicks, so what?"

We finally introduce the most important feature of all which is the engagement of the subject. We make up a third clause: "If there are flashes, there will be clicks, so press the button." We do not *say* it imperatively; it is a polite order, but still imperative. In our more recent experiments, we say: "If there is a television picture, there will be a word, so press the button to get the rest of the sentence." Something a little bit more elaborate, but essentially the same. Having conjugated our verb of flashes and clicks, we begin to build up sentences, and use the conjugation of the verb in a contextual sense.

PRIBRAM: What happens with the conditional statements by themselves? Do they also give rise to habituation?

WALTER: Yes. Fig. 3 illustrates the way in which the responses vary throughout the paradigm. Starting on the left with a trial without stimuli, we see first the responses to novel isolated clicks and the habituation of these, then the corresponding processes with flashes, the reappearance of responses to clicks paired with flashes, and the development of the CNV (contingent negative variation) when the subject is engaged in acquiring an operant response. The patterns on the right show the alterations in the evoked responses and CNV during the manipulation of the contingencies by equivocation, extinction, distraction and inversion.

If you dilute the probability of association of one stimulus to the other, the contingent negative variation diminishes.[2] In most normal subjects, its amplitude seems to drop almost exactly in proportion to the probability of associations, as though the brain were working as a very accurate probability computer. We ran extinction trials following the Pavlovian ritual: extinction of the response by distraction,

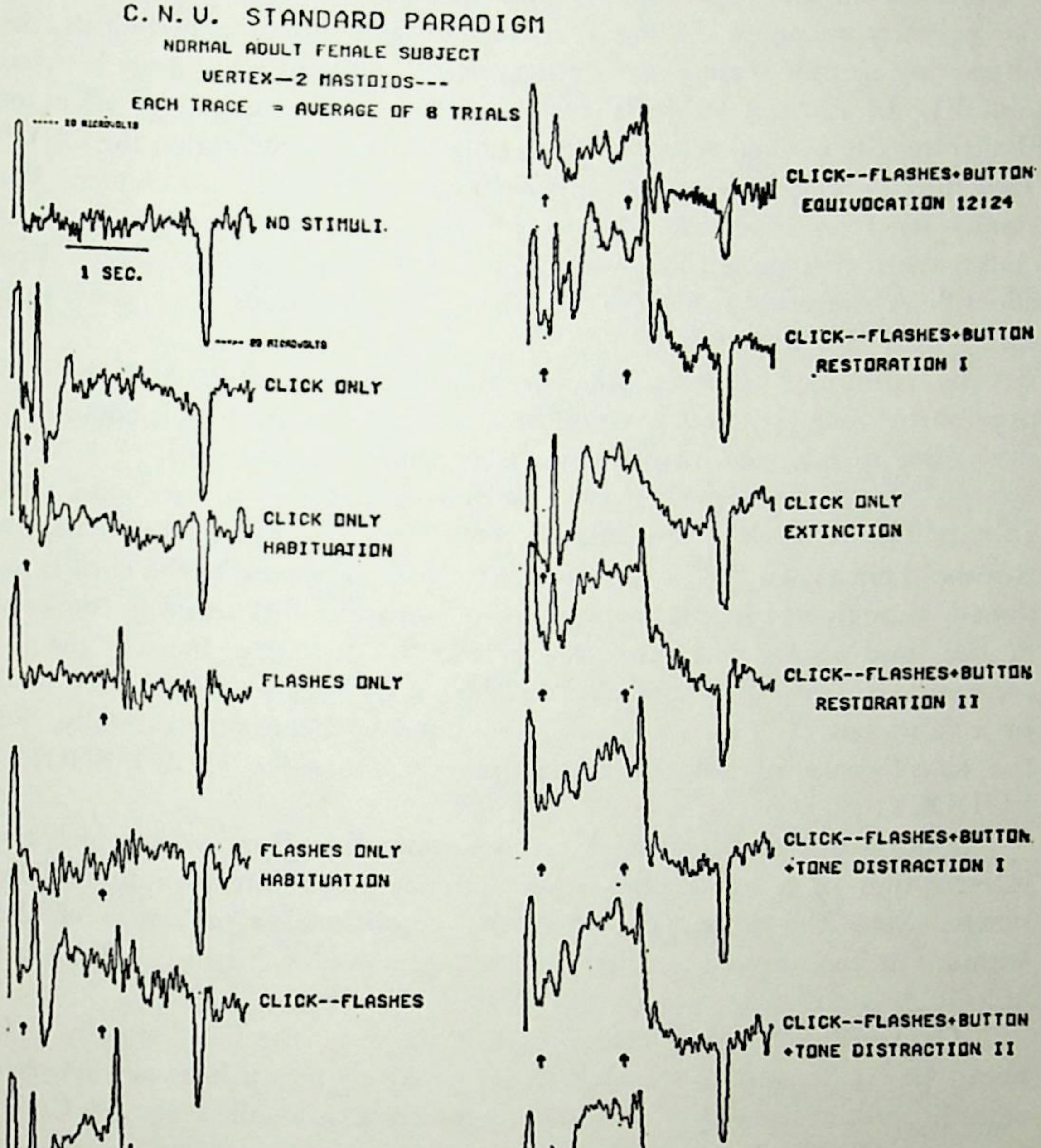

FIG. 3. CNV Standard Paradigm. The illustration shows a typical sequence of averages obtained during the standard CNV experiment.

withdrawal of the distracting stimulus, and consequent restoration of the primary response. When the conditioning stimuli were clicks, the distracting signals were buzzes, interspersed between trials (not between stimuli). In normal subjects they had the rather dramatic effect of abolishing the evoked response to the clicks, but of sustaining the CNV.[3] This may be very interesting in relation to paranormal phenomena. We finally tried an inversion of context. Instead of saying, "If there are clicks, there will be a flash," we said, "If there is a flash, there will be clicks." A normal subject can invert his attitudes and deal very easily with this situation.

By computer analysis, we have confirmed what we had observed previously,[4] namely, that the contingent negative variation is completely insensitive to intensity, provided significance is kept constant.

In Fig. 4 the top diagram shows a response to a *very* loud click (about 110 decibels); the bottom one, that to a very faint click (a threshold click). In the latter case the primary response to the click is reduced, though not in proportion to the objective difference in intensity of the loud clicks, but the CNV is exactly the same, because the information conveyed by the click is the same whether it is a very loud or a faint one. If I speak very softly, you have to listen very carefully, but the significance of what I say is exactly the same as if **I SHOUT LOUDLY.**

Taking this to the absurd, we investigated a situation in which the interruption of a continuous tone was the conditioned stimulus. The results were the same. Provided the conditional significance of the stimulus is maintained, neither its modality nor its intensity affects the amplitude or distribution of the CNV.

Concerning the time course of this response, the CNV usually took about half a second to develop to its peak; therefore intervals between stimuli shorter than that would only produce a small, distorted CNV. One can, however, extend it to a great length, up to ten seconds at least, by specific training of the subjects. In a typical learning experiment of this type, the subject would get an interesting picture on a television screen only if she pressed the button after an interval of 12 seconds had elapsed since she had received the warning click. The subject had to find out by trial and error the time pairing which would produce the picture. We observed a gradual rise in her CNV, then a fall about half way through, followed by a rapid rise to the crucial moment when she expected to be able to obtain the picture she wanted to see. She found the task extremely difficult and very tiring, and we therefore decided to help her by giving her time clicks, at one-second intervals. She immediately no longer bothered to produce any potential

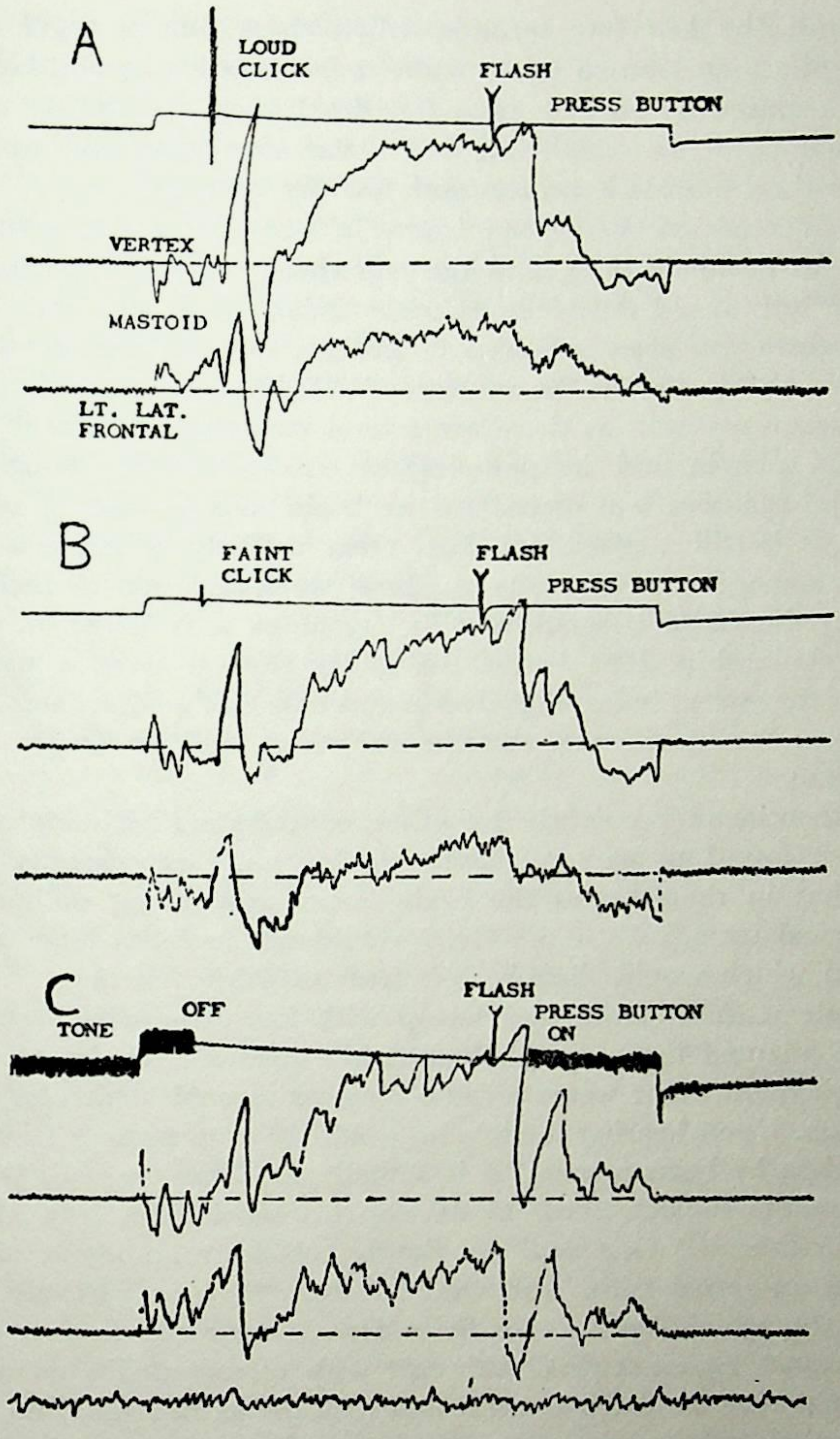

Fig. 4. Variations in response to stimuli of different intensities.

change until the last few seconds, when there was a rapid rise in potential. She then learned to do without the time clicks, and her brain showed an extremely regular response, developing very slowly towards the optimal point at which she knew the electronic gate would be open. She then pressed a button and saw her picture.

In this situation, with long intervals, the intervals between trials also have to be made long, and the experiment becomes tedious. This is why we introduced the pictorial presentation, because to wait for ten seconds before you press a button to avoid a flash of light is extremely boring. We also looked at the relation of this effect to rhythmic changes in brain wave patterns, as there are several recurring rhythms in almost all normal people and in pathological conditions. We thought that perhaps information was stored in the brain as a process of coherent rhythms. It is still a possibility, but rather unlikely in this context. In computer experiments on alpha rhythms, we found that in high alpha conditions the CNV is small, and in low alpha it is large; there is an inverse relationship. The larger the alpha rhythm is at a particular moment (the system being triggered in this case by the alpha amplitude), the smaller the contingent negative variation, and the longer the reaction time.

As mentioned previously by other contributors high alpha states have been found to be most favorable for some experiments. If this means that in those states the brain is not responding to immediate physiological stimuli, then the CNV would not mobilize large areas of the brain which would then be left free for other functions.

A telemetric experimental set-up with free-ranging subjects might easily be adapted to parapsychological investigations. Under one condition, the experimenter wears a radio receiver through which he receives instruction. Upon hearing a click, he would have to make a feint movement; when he hears a tone, he is actually to throw the ball. With this procedure the subject learns to develop his expectation only when the ball is in the air.[5] One could obviously substitute an intent of movement for an actual feint. This would technically be a perfectly feasible experiment, which has not yet been done. One could in fact perform long distance experiments of this sort with direct satellite communication, comparing the radio transmission with the extra-sensory modalities. We have already carried out experiments between our laboratory in Bristol and colleagues in Minneapolis, linked by satellite.

Considering another facet of the problem, clinical conditions might be somehow related to parapsychological phenomena. One of the most striking features of the CNV is its extraordinarily high correlation with certain types of clinical disturbances, in particular chronic anxiety neurosis and early untreated schizophrenia. In our distraction experiments, we found with no exceptions for the chronic anxiety subjects that the introduction of the distracting buzzes completely suppressed the CNV.[3] In the schizophrenic patient, the picture is more complicated. When we used as signals a series of flashes without semantic content, we observed a drop of the CNV. But in the schizophrenics, who already have a rather small CNV, we noted a large negative rise after the imperative stimulus. In the distraction experiments, the CNV is suppressed, in the schizophrenics as in the anxiety subjects; but this secondary rise is not.

When we questioned our subjects, the answer of those schizophrenics who could reply coherently was quite simple: "I was so interested in the beautiful experience of the flashing lights." Illusory experiences produced by flashing lights may be in fact quite interesting. (Nowadays they are used as a standard method of stimulation in some subcultures. I should be paid a royalty because I was the first to describe these effects.)[6] In this situation, the schizophrenic produces this secondary rise in response to a signal which to other people is simply a trivial one. To him, it is a highly significant generator of sensory experience more important than the trivial task of pressing a button.

Let us now consider a more interesting situation, which could be useful in the study of paranormal phenomena. We tell a normal subject to press a button when an image comes on his television screen. As a stimulus we use a drawing of an impossible object, such as the 3-pronged fork which cannot exist. You can draw things which you cannot actually make, and these have considerable intrinsic interest. In this situation, for half of the 1-second interval, before stimulus number 2 comes, the brain is preoccupied with the semantic oddity of this impossible object. A sequence of several impossible objects is used every time, which causes an inherent incongruence in the conditional stimuli. We are not simply saying: "If there is a flash . . ." but "If you see something impossible, try to do something." The subject's brain says: "This is difficult. What do you mean by something 'impossible'?"

We devised another experimental situation which involves a dynamic sequence of pictures. We again saw irregularities in the response pattern as a result of the conditional stimulus being self-significant, interesting or intriguing. In the next step we used moving pictures. The subject is watching a horse race on television, and every now and then, to his annoyance, there is a click, and a second later the television picture goes off. If he presses a button, he will get the picture back again. The distraction effect becomes increasingly apparent as he is watching the finish of the race. He must still press the button to see it, but his brain is concentrated on the race and not on the simple task of pressing the button. In fact, there is almost no response to the click. After the race, when he has lost his bet and is bored, his responses return to their earlier regular pattern. In this way, we can measure the attention of a subject, titrate, as it were, the concentration of a subject on the control situation against the power of other social or semantic factors.

With more complex experiments we showed that when people perform intricate tasks, different parts of their brains are being used. The same regions of the brain are operating each time for a particular task, and one can observe exactly the same distribution of activity throughout the cortex, month after month, as though the brain were programmed like a computer. Here again one could introduce, for example, a paranormal stimulus as a part of an intricate task and see whether it would function as a distracting or an amplifying factor.

Let us examine the effects of drugs which might be used in parapsychology. Caffeine, the commonest drug of addiction, seems to increase the regularity, consistency and amplitude of the CNV.

In a record of Mrs. Garrett as a subject, using a flash-click situation, before LSD administration, she was rather distracted and her CNV was small. She showed an incoherent alpha rhythm of about 11 cycles per second, which is quite characteristic in this situation. Two and a half hours after the administration of 100 micrograms of LSD, Mrs. Garrett described her particular vision of the universe and saw me as Zeus controlling things. The main neurophysiological change was an enormous increase in the distribution of the CNV. In Mrs. Garrett, as in most people, the usual distribution shows a definite vertex predominance, very little activity in the frontal areas and even less in the back. With LSD, the activity spreads over a very wide brain area, including the frontal and parietal lobes. The action of this drug, however it may actually work, seems empirically to extend the spread of the potential over the brain in response to a single visual stimulus. At the same time, the intrinsic alpha rhythms are suppressed. It is known that LSD first accelerates and then suppresses most alpha activity in normal subjects. We observed incoherent alpha rhythm while the occipital response seemed unchanged. This suggests that the effects of LSD are not on a primary visual pathway, but diffuse on the projections of visual information to the non-specific areas of the cortex in an almost explosive form.

Alcohol, studied in abstainers, somewhat reduced the CNV, but not markedly so, because our subjects took a lot of trouble to press the button very carefully.

Now we come to the last point I want to make, concerning a sort of electronic ESP, which might be incorporated in parapsychology experiments. Before one does any voluntary action, for instance, if I decide to scratch my ear, for about a second the brain potential is rising. By looking at a record, it is possible to determine when a person is going to do something. The experimenter can know before the subject actually takes action that he is going to do so. This wave was called, by Kornhuber and Deecke,[7] the Bereitschaftspotential. One can program a computer to recognize a rise of this shape and size and accordingly switch on a television picture. The potential rises to turn the clicks off, so the subject himself is actually doing nothing. He is lying absolutely passive, now and then wishing or willing that a particular event would occur (that the television picture would appear).

In this state of mind, one feels a very peculiar sense of meditation, concentration, a sort of narrowing tunnel vision of the particular object or event which one is trying to influence. We found that if the subject "tries to try," that is, concentrates on concentration, the whole thing is lost. After perhaps half an hour of practice, the subjects lie there and think to themselves: "I want the television picture to go on." And it appears. One interesting side effect, which several subjects noticed, is a very marked polyuria during this state of mind. It seems that not only was the cortex affected to produce this potential change, but also the hypothalamus was influenced in some way.

Lindsley: Thank you, Dr. Walter, for a very interesting presentation.

I will call on the official discussants: Dr. Pribram and Dr. Kamiya.

Pribram: I have two confirmatory comments to make of things that you have observed, Grey. The first concerns the distribution of your CNV over different cortical areas. We found something similar in monkeys. Looking for evoked responses in the visual cortex, we observed that the response configurations varied according to the different patterns flashed into the monkey's eyes. However, of about 50 electrodes implanted in the primary visual cortex, some showed the differences, others did not. In addition, some electrodes reacted to whether the monkeys received a reward or not. We also got records of "intention waves"; that is, we found that before the animal responds, there is a change in potential in some of the electrodes, but not in all. Our findings in the primary areas seem to confirm that a patchy address system of some sort, probably content addressable, is operating in evoked responses.[8]

Beloff: Is this phenomenon stable over long periods of time?

Pribram: Yes. It goes on month after month. Once you obtain it in one electrode, it stays there from then on.

Another series of experiments we did was called to my mind by your description of this tremendous spread in your CNV with LSD. Working with evoked potentials under hypnosis, when we told our subjects that they were blind or deaf, we were able to make the evoked response diminish in amplitude. These are unpublished data. Opposite effects were as striking. If we told the subjects: "Whenever a light flashes, bombs are bursting in the air," not only did we observe a fourfold increase in the evoked response, but also the electroretinogram was increased two or three times. Since we had shown that there are efferent connections between the brain and the retina,[9] we assumed that a central message had been sent. It is unlikely that a mere dilation of the pupils would give a fourfold increase in the evoked response.

Walter: In collaboration with Dr. Stephen Black, we have done some fairly well controlled experiments with subjects in deep hypnotic trance. We suggested to them that they were deaf and gave them clicks, and that they were blind and gave them flashes. We could not see any significant changes in the evoked responses. On the other hand, we have found that the CNV is strongly affected by suggestion. If we suggested to the subjects that the clicks they were going to hear were irrelevant, or that they would hear a lot of irrelevant clicks, as well as the real ones, the CNV would disappear completely. By simply mentioning the probability that some clicks might not be significant, all the clicks became no longer significant. If you then suggested that a particular click was of importance, the CNV would return, against the evidence of the senses. Only the CNV showed these effects. The evoked responses showed a statistically barely significant change, certainly not a very striking one. The only weakness of this experiment is that you can show the same thing without hypnosis. If you tell your subjects that it is very important to press a button, the CNV will be larger than if you just suggest to them that they might do so. In very young children, this shows what an enormous influence social pressure can have. At a very young age, social factors are more important than physiological ones in determining individual differences in perception of reality.

PRIBRAM: Let me emphasize also that simple, repeated movements, deprived of intention, do not produce the CNV.

WALTER: No. There has to be a deliberate intention. We have confirmed the observations of Kornhuber and Deecke[7] and of Vaughan[10] that a potential occurs only when there is a deliberate, conscious intention to do something, not just an automatic rhythmic movement.

KAMIYA: I found Dr. Walter's presentation extremely stimulating. I have just one or two questions and perhaps Grey can answer them right now.

When you showed the CNV in relation to the ball throwing, can we be sure that there was no involvement of the ocular potential?

WALTER: Yes. We were able to exclude it as a contaminant. The telemetry recordings were on 16 channels: muscles, eyes, pulse rate, respiration, etc.

KAMIYA: As I intimated yesterday, I have long been interested in the relation of psychological factors to brain waves, specifically in the trained self control of the alpha rhythm, which is a background activity, but I have not worked with the evoked potential, nor the CNV. From the evidence that Dr. Walter presented on the connections between CNV and "will-operated" TV, it seems justified to assume that the CNV could be subject to control by specifically trained individuals, if there is such a thing as a spontaneous CNV. If you made some reward, such as the appearance of a picture on a TV screen (if that is what the subject wants), contingent upon the appearance of the CNV, then I think you ought to be able to induce in a subject a kind of expectancy for specific events. It would be interesting for the comprehension of the phenomenology involved in the CNV to train an individual to produce it, and then ask him how he went about producing it. I think that something like expectancy could be easily abstracted out of the verbal testimony of subjects trained in this way.

I am also intrigued by the relationship of hypnosis or just straight suggestion to the CNV, and the alpha rhythm. I am impressed by several things you said, in relation to our own observations. I gather from your presentation that when there is a sustained burst of alpha activity, the CNV is likely to be attenuated. This suggests a certain kind of inattention which might be somehow conducive to psi reception. It would be quite interesting to look at the EEG of a person who is in a state of psi receptivity. We attempted to do this, but met with one major difficulty. None of our subjects at any moment in our telepathic experiments was actually being accurately receptive.

As individuals with arbitrarily high alpha tend to be more hypnotizable, I am intrigued by the relation of CNV to hypnosis. Apparently the CNV varies according to the specific content of the hypnotic suggestion.

LINDSLEY: Dr. Walter, will you kindly answer these questions, before we open the general discussion?

WALTER: Yes. With regard to the question of special training, there certainly are spontaneous CNVs. In other words, the brain does produce slow potential changes in response to spontaneous thoughts and ideas, and I think a good deal of the slow activity, which in conventional EEG is deliberately filtered out by short time constants, is just that. When you begin a conversation with your subjects, you see immediately the potential on various parts of their brain starting to rise. When they give an answer, it drops, then there is a rise again, and so on. These very slow waves fluctuate according to the subjects' attention in conversational situations. We learned how to take advantage of them, when we trained ourselves to operate machinery through our CNV. It seemed that we had to clear our mind of all those little thoughts, of those spontaneous slow waves, in order to succeed in turning the TV screen on. When we did not "want" it, the image suddenly appeared, so we learned "not to want" it. When one learns to do this, the record clears itself of these spontaneous slow waves. There is just a slow rising potential, as you intend to do something. This part of the self-training procedure reflects a very interesting state of mind. It is very peculiar and quite tiring. It is not entirely pleasant, but through it one learns how to concentrate. For example, my collaborators and I are now able to correct proofs much more quickly than we did before. We learned how to concentrate, by narrowing down the field and focusing our mental vision on a particular aspect, however uninteresting in itself.

The question on hypnotizability raises some very interesting points. Most hypnotists agree that only about 5 per cent of the population can be hypnotized into a deep trance. What is this difference due to? The only correlate, which Dr. Black found entirely by accident, is that all his deep trance subjects had blue sclerotics, which of course is a genetic trait (sometimes associated with fragility of the bones). In the deep hypnotic trance, in which a person could be made analgesic and amnesiac, if no suggestion at all was made, the response and CNV were identical to those in the waking state. The CNV changed only when something in relation to the stimuli was suggested directly.

My hypothesis is that the whole frontal cortex is part of a probability computer. It works as a statistical analyzer of external stimuli and determines which signals are significantly interrelated, and are worth responding to. What you do in hypnosis is to bias the system in favor of one particular set of probabilities, which is really what you do also in conditioning.

PRIBRAM: I have one more comment, which fits with what you said, and that is that cathodal polarization imposed on the cortex will delay learning, whereas anodal will speed it up. This fits in with the general idea that while you are concentrating, you do not allow anything new to come in. Only when that state is over can something new be imprinted into the brain.

WALTER: Karl, this raises a point worth mentioning here. Superficial polarization of the brain with a very simple electrode on the forehead and another on the leg, passing only 300 or 400 microamperes, has a spectacular effect on the evoked potential and on the CNV. A few good papers have appeared on this subject,[11] but there is still an extreme skepticism about these effects. The fact remains that if you pass a small direct current from an anode on the forehead to a cathode on the leg, in a normal person, he feels excited and stimulated. A depressed patient feels relieved, brighter, and more accessible. If the current is reversed, all subjects feel terrible, so much so that the procedure can be quite dangerous. It is such a simple system that I am certain they would restrict the sale of batteries the way they restrict the sale of LSD, if people started using it.

LINDSLEY: I think we should give the rest of our audience an opportunity to ask questions. Dr. Tart.

TART: A couple of simple questions: Is your contingent negative variation what you called the expectancy wave in other publications?

WALTER: Yes, but I do not like the term. It implies that I understand what it is about, which I do not. I do not use the term myself any more.

TART: Second question: Is this effect confined to the brain? Did you correlate these contingent negative variations with skin potential responses?

WALTER: The CNV is more reliable and reproducible than the autonomic system measures, like the GSR, and of course precedes it in time. In our paradigm the GSR usually fades out after the first few trials while the CNV grows steadily.

LINDSLEY: Any other comments or questions?

BELOFF: My question is of a very general nature. I want to understand more clearly whether Dr. Grey Walter has in mind any sort of specific parapsychological experiment in which the CNV could be exploited, or whether it would simply be used in trying to understand the brain processes of sensitives.

WALTER: Both. You see, the thing that strikes me about this particular effect is its extreme sensitivity to social factors. Most of the brain responses are rather insensitive to suggestion. They occur more or less mechanically. They are subject to the laws of probability, and the more information they contain, the larger they are. The CNV, on the contrary, is very sensitive to subtle changes in human environment. For instance, when a subject is tranquil and feels friendly, he has a normal CNV; when he becomes impatient with the experimenters, his CNV becomes smaller. The CNV seems to be the most sensitive feature of the brain. This does not surprise me, as my contention is that it is the highest level function of the brain, the associative function. I do not mean that it is placed at the top at the cortical level, but at the highest operational level, in the sense of association, of contingency computing of probability. If by hypnotic suggestion one can increase the apparent importance of a stimulus, the corresponding CNV should be influenced, and it should not be too difficult to record it. This would be a more sensitive procedure. Unfortunately, one can generally see the CNV only by averaging. In some people, though, the individual records look like the average. Although unusual, it is possible to pick out subjects who do not need the attractive, but rather meretricious, averaging system in order to extract this information from their brains.

MOSS: I think that the "trying not to try" state which you described is the nearest to that of sensitives.

RECHTSCHAFFEN: Does performance actually improve with the size of the CNV? In other words, does the CNV reflect only a *feeling* of expectancy, or does it also reflect the *actual* readiness? For example, if you had a reaction time test, would the reaction time be smallest when the CNV is largest?

WALTER: We made several trials to check this. If we plot reaction time in milliseconds against the CNV in microvolts, we see an inverse relationship, and this is a pretty constant finding in all normal subjects. In a particular experiment, when the probability of association was progressively increased from .25 to .5 to .75 to 1 over a long number of trials, the CNV concurrently rose to its maximum. We then diluted the probability, going back along the same curve, but the CNV followed an hysteresis curve. In other words, as you raise the probability in a naive subject, it takes quite a long time before the CNV reaches its peak, while as you decrease the probability, there is a sudden drop, in concomitance with the first dilution, then a slight rise, to eventually end at the same point. The reaction times follow the same course.

RECHTSCHAFFEN: Then it would be possible to affect reaction time by polarizing in a certain way?

WALTER: Yes.

TART: I wonder if you could summarize your studies of Mrs. Garrett's trance behavior, particularly during "out-of-the-body" experiences, if she had such experiences while she was in your laboratory.

WALTER: We did hypnotic trials with Mrs. Garrett, but they were not very successful. In one mediumistic trance experiment, I did not want to interfere with her too much, so I perhaps made a mistake in speaking to her "control" through another person.

GARRETT: I was negative about the other person.

WALTER: The intrinsic rhythms of her EEG were not changed at all during the mediumistic trance. I thought that some effects which have been reported for other mediums might be due to overbreathing. In fact, Mrs. Garrett does breathe rather deeply, at least during the early part of a mediumistic trance, but not enough to produce any change in the EEG. The features of her alpha rhythm, for instance, were exactly as normal. When we asked her "control" to influence her responses to the stimuli, he gave the perfectly sensible reply that this was not his business.

REFERENCES

1. HERNANDEZ-PEON, R.: "Reticular Mechanisms of Sensory Control," in *M.I.T. Symposium on Sensory Communication* (The M.I.T. Press and John Wiley & Sons, New York, 1961), pp. 497 ff.

2. Black, S. and Walter, W. G.: "Effects on Anterior Brain Responses of Variation in the Probability of Association Between Stimuli," *J. Psychosom. Res., 9* (1965), 33.
3. McCallum, W. C. and Walter, W. G.: "The Effects of Attention and Distraction on the Contingent Negative Variation in Normal and Neurotic Subjects," *Electroenceph. Clin. Neurophysiol., 25* (1968), 319.
4. Walter, W. G.: "Brain Responses to Semantic Stimuli," *J. Psychosom. Res., 9* (1965), 51.
5. Walter, W. G., Cooper, R., Crow, H. J., McCallum, W. C., Warren, W. J. and Aldridge, V. J., and Storm Van Leeuwen, W. and Kamp, A.: "Contingent Negative Variation and Evoked Responses Recorded by Radio-Telemetry in Free-Ranging Subjects," *Electroenceph. Clin. Neurophysiol., 23* (1967), 197.
6. Walter, W. G., Dovey, V. J. and Shipton, H.: "Analysis of the Electrical Response of the Human Cortex to Photic Stimulation," *Nature, 158* (1946), 540.
7. Kornhuber, H. H. and Deecke, L.: "Hirnpotentialänderungen bei Willkürbewegungen und passiven Bewegungen des Menschen: Bereitschaftspotential und reafferiente Potentiale," *Pflügers Arch. ges. Physiol., 284* (1965), 1.
8. Pribram, K. H., Spinelli, D. N. and Kamback, M. C.: "Electrocortical Correlates of Stimulus Response and Reinforcement," *Science, 157* (1967), 3784.
9. Spinelli, D. N., Pribram, K. H., and Weingarten, M.: "Centrifugal Optic Nerve Response Evoked by Auditory and Somatic Stimulation," *Exptl. Neurol., 12* (1965), 303.
10. Gilden, L., Vaughan, H. G. Jr. and Costa, L. D.: "Summated Human EEG Potentials With Voluntary Movement," *Electroenceph. Clin. Neurophysiol., 20* (1966), 433.
11. Lippold, O. C. J., and Redfearn, J. W. T.: "Mental Changes Resulting from the Passages of Small Direct Currents through the Human Brain," *Brit. J. Psychiat., 110* (1964), 768-772.