POSSIBLE PARANORMAL COMPONENTS OF ANTICIPATION: PSYCHOPHYSIOLOGICAL EXPLORATIONS

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In the search for a more reliable psi measure, some parapsychologists have attempted to utilize the growing knowledge of the physiological concomitants of psychological processes. These psychophysiological methods have been used primarily in two ways in parapsychological research. (For a review, see Beloff, 1974) One approach has used psychophysiological monitoring of test subjects in hopes of identifying physiological correlates of psi-conducive states; however, as yet, drawing generalizations from this work is difficult. The many problems in defining and identifying psychological states are compounded at present by the lack of understanding of the relationship between psychological constructs and physiological variables.

The other common psychophysiological method in parapsychology has used physiological measures themselves as ESP responses. Typically an agent receives a sensory stimulus (e.g. shock, emotional picture, etc.) while elsewhere one or more autonomic processes of a subject are monitored. The experimenter attempts to identify physiological responses in the subject when the agent receives a stimulus. Such technically complex experiments are carried out because researchers often assume the largest source of error in the ESP process arises when the ESP information is mediated from the unconscious into consciousness. It is hoped that by measuring autonomic functions directly we can utilize responses that are closer to their unconscious origin and thus circumvent some of the problems associated with conscious ESP responses.

Although not independently replicated, the most well known work using physiological measures as ESP responses is the plethysmograph research by Dean (1966, 1967). However, Dean has found that subjects under stress show reversals or psi missing in their vascular responses, i.e. larger fluctuations in the control rather than experimental conditions. This indicates that autonomic responses may still be susceptible to the myriad of psychological problems normally associated with conscious ESP responses—an important point when interpreting parapsychological experiments.

An alternative psychophysiological approach is to measure anticipation or preparation for a future response. That is, can physiological evidence be found that a person is spontaneously anticipating a random event when in fact that event is imminent? Presumably, the person's anticipation or preparation would be based on paranormal knowledge of the upcoming event. Such anticipation may not be conscious and thus physiological methods, not requiring an overt awareness or anticipation, seem appropriate.

Although physiological activities such as heart rate (Lacey & Lacey, 1970) and EMG (Goldstein, 1972) have been associated with anticipation or preparation for a motor response, the most sophisticated measure is probably the contingent negative variation (CNV). Discovered in 1964 (Walter, et al., 1964), the CNV is a slow negative EEG potential that arises when a person anticipates an event requiring a response. Typically, a constant foreperiod reaction time paradigm is used. A warning stimulus S1 is followed in a short period (one to four seconds) by another stimulus S2, to which the subject responds as quickly as possible. After S1 and before S2 the subject's EEG recorded at the vertex will show a slow negative shift or CNV. The CNV is buried in background EEG activity and is usually apparent only by averaging several trials. However, it has been estimated that the CNV can be readily seen in the raw EEG record of about 20% of normal adults while another 10% do not show any CNV waveform (Tecce, 1971).

The amplitude of the CNV has been related to psychological functions such as expectancy, intention to act, general motivation, attention, and arousal. The evidence for relationships with these constructs comes from various experimental findings (for a review, see Tecce, 1972,). The amplitude of the CNV has consistently been found to be small or non-existent during conditions when a motor response was not required for S2. Several studies have found the CNV amplitude is related to subsequent reaction time. The CNV amplitude decreases if extraneous stimuli distract the subject or if S2 is randomly omitted on about 50% of the trials without warning to the subject. The subject's psychological set can have a strong effect on the CNV amplitude.

However, it should be noted that other studies investigating these same effects have found remarkably inconsistent or contradictory results. The suggested explanations for the unreliability of the CNV findings include: “The CNV might index a global mobilization common to many tasks but not determining fine-grained behavioral parameters,” or perhaps the surface CNV may be the sum of several independent event-related slow potentials (Hillyard, 1973).

Investigations of the CNV have been further hampered by technical problems such as controlling eye movement artifacts and the use of different measures of CNV amplitude (Tecce, 1972; Donchin, 1973). And, not surprisingly, the use of psychological constructs like expectancy, arousal, motivation, etc. have been criticized as not having "specific operational ties to observable events"(Hillyard, 1973, p. 162).

For the purposes of parapsychological research, the CNV appears to be a measure of expectancy or preparation based on cortical processing.

Many of the CNV experimental findings are in line with the hypothesis that ESP could be entering into the process. Thus, the subtle and elusive variables related to the CNV are not necessarily discouraging to parapsychologists since they commonly encounter equal difficulties with very similar variables related to psi. Also, the studies indicating the average amplitude of the CNV is lower during conditions when S2 is randomly omitted than during conditions when S2 is always present are in accordance with a parapsychological hypothesis. Since lower CNV amplitudes are expected on trials without motor responses (i.e., no S2), a paranormal component of expectancy would lead to small amplitudes for the non-S2 trials, and thus a lower average overall.

However, in none of these studies have the experimenters compared the amplitude of the CNV on trials with S2 to trials without S2—an analysis that would test the ESP hypothesis. The use of the EEG to paranormally "forecast" random flashes of light was apparently suggested as early as 1946 by A.J. Good (Good, 1961); however, this was much before the discovery of the CNV. Grey Walter (1970) has discussed the use of the CNV in parapsychological work, but the anticipation method was not discussed per se.

Basic Method

This paper reports four series using the CNV to investigate possible paranormal components of expectancy. On each trial, an amber warning light flashed (S1) and a short time later either a red or green light flashed (S2). The decision whether S2 was red or green was made by a Schmidt binary random number generator immediately prior to stimulus delivery.[1]

The subject was asked to press a button as quickly as possible in response to the green light and not to react to the red light. It was hypothesized that from the CNV amplitude, one could predict whether or not a motor response was going to be required, i.e., whether S2 was going to be a red or a green light. The subjects would be unintentionally anticipating which S2 was forthcoming.

For all series, predictions were made by comparing the CNV amplitude of a given trial with the mean amplitude of all the usable trials in a particular condition for that subject. Trials with an amplitude larger than the mean were predicted to have a green S2; those with an amplitude smaller than the mean were predicted to have a red S2. The main analysis was carried out by comparing the proportion of green light trials in the predicted green and predicted red categories. In general, a chi-square statistic (X^2)was

[1] This paper uses the terminology of precognition for the sake of simplicity in presentation rather than conceptual certainty. PK is of course possible using the random number generator rather than a predetermined target sequence. For the presents any paranormal effect would be of interest.

used for comparison, unless otherwise noted. Scoring was based upon the color of S2 (red or green). Trials with an improper absence or presence of button response were included in the analysis.

Technical details for this work are presented in an appendix.[2] However, one technical problem is important in understanding the analysis. CNV recordings are very vulnerable to eye blink and movement artifacts. Some method is needed to eliminate these artifacts (Corby & Kopell, 1972). The most conservative technique, and one of the most common, is to throw out all trials contaminated by eye blinks or movements. However, using this method many of the subjects would have very few usable trials. Therefore, only trials severely contaminated by movements were discarded.

The movement artifact selection technique previously reported for Series I (Levin & Kennedy, 1975) very possibly introduced data selection problems. This has been corrected for the analysis reported here. Although the algorithm reported here will not lead to data selection, the question of how strict to make the selection criteria still remains. Some subjects have essentially all trials contaminated while others have very few contaminated trials. Exploration of the selection criteria will be presented with the results.

SERIES I

Procedure and Subjects

This was the first CNV work done at FRNM and preliminary analysis of this exploratory group has been reported previously (Levin & Kennedy, 1975). Five subjects were used, the present author (J.K.) plus four participants in the 1974 Summer Study Program at FRNM. The experimenters were Jerry Levin and the present author.

The interval between the onset of S1 and the onset of S2 was 1.5 seconds and the interval between trials was random with an average of 5.5 seconds. For the first three subjects the absence of the green light indicated no response rather than a red light. The length of the experimental runs varied from 15 to 40 minutes for exploratory purposes but were predetermined for each subject. Thus, the number of total trials for each subject differed.

The intended procedure called for each subject to do about 12 practice trials followed by two experimental runs. A different psychological set was explored with each run. For

[2] In the main text I have attempted to present the concepts and primary results of this work for the non-technical reader. The technical details needed for a critical evaluation or for further work are given in the appendix http://jeksite.org/psi/cnvapp.pdf. Also, various analyses that will be of interest only to the technically oriented reader are presented in the appendix.

the first run, the subject's orientation was toward making quick responses while in the second run, subjects were instructed to try to make the green light come on (PK) as well as to respond quickly. Although each subject's knowledge of the specific hypothesis under investigation varied, all subjects knew that physiological aspects of anticipation were being measured.

As this was the first attempt at CNV recording, reapplication of some electrodes and much equipment adjusting was usually necessary before everything was operating correctly. No practice trials were available since there was often a half-hour or more of equipment re-adjustment after the session started.

Results

The overall results for the first run reported previously were suggestive ($p \sim .05$, 2-tailed). However, several mistakes were made in that analysis and upon re-analysis of available data, the totals did not approach significance. For the re-analysis the data for one subject were discarded when found to be severely contaminated by skin potential artifacts.

Most of the significance in the original report was due to two people, J.E. (the first subject tested) and J.K. (the last subject). J.K.'s data were lost so a full re-analysis could not be made; however, J.E. showed an increase in significance from $p < .05$ to $p < .005$ 2-tailed upon re-analysis of his first run (see Table 1). A further breakdown showed that much of the significance was contributed by the first half (72 trials) and the effect showed up nicely even in the first 30 trials (see Table 1).

Re-analysis of the total first run scores for the three subjects (2 males, 1 female) with usable data are shown in the first section of Table 5. To investigate the possibility of a novelty effect, the first 60 trials of each subject were examined alone but no suggestive trends were found. The PK run showed no noteworthy effects either in green light biases or evidence of correct anticipation. Although not based on any precedent in the literature, vertex alpha activity was also explored as a predictor of S2. Comparing trials with vertex alpha activity above, versus below, the subject's mean did not distinguish green from red lights.

Thus, keeping in mind the exploratory nature of the work, the results suggest that one of three subjects showed evidence of correctly anticipating the outcome of a random event.

Table 1
ORIGINAL AND CORRECTED PREDICTION RESULTS FOR SUBJECT J.E

CONDITION	No. of Green Light (Response) Trials / No, of Trials: NOT GREEN	GREEN PREDICTED	TOTAL	X^2	*P*(2-tailed)
Original analysis	38/79 48.10%	42/63 66.67%	80/142 56.34%	4.18	$p < .05$
Re-analysis	31/71 43.66%	51/73 69.86%	82/144 56.94%	9.04	$p < .005$
1st 72 trials**	14/36 38.89%	24/36 66.67%	38/72 52.78%	4.51	$p < .05$
2nd 72 trials	19/35 54.29%	25/37 67.57%	44/72 61.11%	.84	n.s.
1st 30 trials	5/16 31.25%	10/14 71.43%	15/30 50.00%		$p < .07$*

* Using Fisher's Exact method.
** The subdivisions use the mean of the actual trials used (i.e., 72, 72, and 30) rather than the mean of the total, as the predicting cutoff.

After an extended vacation and much thought on parapsychological topics, the author developed a particular interest in the use of practice trials and in the first few "experimental" trials in psi research. Consideration of the often-called-upon idea of beginner's luck and the abundance of declines in laboratory psi experiments had led to the concept that psi may manifest more frequently when a person is in unfamiliar circumstances. Psi may tend to come into use more when the person has no past experiences or associations to draw upon. As a person gains more experience in a situation, the use of psi may decrease and, from an evolutionary point of view, psi may be less needed. In an experiment the first trials, when the subject is becoming familiar with the task, may be the best place to look for psi. Also, during the practice trials, subjects may feel less self-conscious than during the "real experiment."

Series II was carried out in the author's absence, without consideration .of these ideas by the experimenters.

SERIES II

Procedure and Subjects

The procedure for Series II was very similar to Series I except most of the technical fumbling had been eliminated by this time. Only one of the sessions had significant difficulties in set-up and no practice trials were recorded for this session. Nine high

school students (8 females, 1 male) plus a (male) friend of the experimenters each participated in one session. For all 10 subjects a red light was used for S2 when no response was required and the green light stayed on until a response was made. The intertrial interval was random with an average of 6.5 seconds and the S1-S2 interval was again 1.5 seconds. After about 20 practice trials, the experimenter knocked on the door of the experimental room to indicate the beginning of the 30 minute experimental run. Each volunteer participated in only one run of approximately 240 trials. The subjects were informed that the experiment was "investigating the relationship of physiological preparation for reaction and ESP" and the reaction time procedure was explained. Jerry Levin and Evelyn Crumpacker were the experimenters.

Frontal is EMG activity was also recorded.

Results

As can be expected occasionally, one subject did not show a CNV waveform. For the sake of completeness, her data are included although they do not contribute significantly to the results.

For the practice trials, the CNV was able to predict S2 to a suggestive degree (X^2=3.06, $p < .1$, 2-tailed), but the total results for the experimental runs did not approach significance (See Table 5). Examination of the first 20 and first 40 trials in the experimental runs showed no encouraging trends. Also, a post hoc division of the run into four blocks of 60 trials did not reveal any significant effects.

The only noteworthy individual result was a significant reversal by one subject for her experimental run; trials with red S2 predicted had 72/122 (59.02%) green lights and trials with green S2 predicted had 50/122 (41.32%) green lights. The difference was significant X^2 =6.92, $p < .01$, 2-tailed. The CNV waveform for this subject was unusual. The early part of the averaged CNV waveform shifted negatively very abruptly after S1 but returned to the baseline just before the green lights. When S2 was red, the averaged CNV remained negative throughout the interval.

Movement and eye blink artifacts were a more severe problem in this group -- perhaps because the subjects were younger and less familiar with the lab than the first group. Only two of the ten volunteers had what from visual inspection could be considered good data.

Thus, explorations of the movement artifact criteria seemed in order and the data were analyzed using five different levels. Criterion A had no trials rejected while B, C, D and E applied increasingly strict acceptance levels. Condition B was used in Series I and in the analysis reported above for Series II. Empirical observations had indicated this was the minimum that would discard badly distorted EEG records.

As shown in Table 2, the discriminating ability of the CNV for practice trials became stronger as the selection criteria were made more stringent. In condition D, six out of

nine subjects were in the expected direction and the $p < .02$ level was reached. Further selection procedures later applied to the eye channel record gave greater significance ($X^2 = 8.06$, $p < .01$, 2-tailed; See Table 9 and discussion in the appendix.)

Table 2
DISCRIMINATION RESULTS FOR PRACTICE TRIALS IN SERIES II*

SELECTION CONDITION	No. of Green Light (Response) Trials / No. of Trials: NOT GREEN PREDICTED	GREEN PREDICTED	TOTAL	X^2 (1 df)	P(2-tailed)	No. Subjs. in Expected Dir.
A	38/86 44.19%	45/81 55.56%	83/167 49.70%	1.73	*P* <.25	5/9
B	33/78 42.31%	46/80 57.50%	79/158 50.00%	3.06	*P* <. 10	5/9
C	28/71 39.44%	43/76 56.58%	71/147 48.30%	3.66	*P* <.10	5/9
D	22/62 35.48%	37/62 59.68%	59/124 47.58%	6.34	*P* <.02	6/9
E	16/49 32.65%	28/46 60.87%	44/95 46.36%	6.51	*P* <.02	8/9

*Nine subjects--Condition A has all contaminated trials included, whereas B, C, D, and E have increasingly fewer such trials.

The two subjects with good data (i.e., few movement and eyeblink artifacts in the record) showed the strongest effects with $p < .0005$, 2-tailed for condition D (see Table 3.) The results for the experimental runs using the more stringent selection criteria did not approach significance. Analysis of the Series I data under conditions C, D, and E also showed no significant trends.

All subjects showed some type of significant change in absolute EMG activity across the experimental run (5 showed inclines, 4 showed inverted U curves, and one showed a U curve), so frontalis EMG amplitude was measured relative to a pre-S1 baseline. For the pooled totals, no evidence was found that ESP was reflected in EMG activity in the practice trials, in the total experimental trials, in any subdivision of the experimental run, nor in interactions between CNV and EMG amplitude. Also, the amount of alpha activity on each trial showed no evidence of discriminating which S2 was forthcoming.

Table 3
DISCRIMINATION RESULTS FOR PRACTICE TRIALS FOR TWO SUBJECTS IN SERIES II WITH FEW MOVEMENT ARTIFACTS

SELECTION CONDITION	NOT GREEN PREDICTED	GREEN PREDICTED	TOTAL	FISHER'S EXACT *P* (2-tailed
B	2/15 13.33%	14/22 63.64%	16/37 43.24%	*P* <.006
D	2/16 12.50%	13/17 76.47%	15/33 45.45%	*P* <.0005
E	1/13 7.69%	9/13 69.23%	10/26 38.46%	*P* <.004

SERIES III

After the first two series were conducted, new evidence appeared indicating the CNV was, in fact, comprised of at least two independent waveforms (Loveless & Sanford, 1975; Rohrbaugh, Syndulko, & Lindsley, 1976). This became apparent when the S1-S2 interval was longer than the one to two seconds commonly used in CNV studies. With intervals of four or five seconds, S1 evoked an early wave (first second or so after S1) while a later wave preceding S2 was identified with preparation for a response. The late wave was found to be significantly related to reaction time while the early wave was not (Rohrbaugh, Syndulko & Sanford, 1976), suggesting that much of the confusion in earlier studies occurred because short inter-stimulus intervals confounded the two processes. For Series III, the procedure was modified to accommodate these findings.

On another front, if paranormal components of anticipation do exist, they should occur in many situations. Since a slow negative cortical potential shift known as the readiness or motor potential occurs just before (.5-1.0 seconds) a person makes a voluntary spontaneous movement (see Tecce, 1972), it seemed reasonable to use this EEG measure in exploring the anticipation hypothesis beyond the warned reaction time procedure. Therefore, as described below, a condition consisting of trials without the warning or red lights was added to the procedure.

Procedure and Subjects

With the recent CNV findings in mind, the S1-S2 interval for Series III was extended to three seconds -- the limit given existing analysis software.

In this series, the EMG channel was connected to the subjects' responding arm in an attempt to measure muscle activity related to anticipation to respond. Several other

technical improvements and changes were made and are discussed in the appendix. The amber, green and red lights were used as before.

Participants in the 1976 Summer Study Program at the FRNM and friends of the experimenters were chosen as subjects (7 females, 3 males) for Series III in the hope that this group would have fewer movement artifacts contaminating the polygraph record. The experimental plan called for each of the 10 subjects to participate in one session and two were tested a second time to follow up interesting results from their first sessions.

Each session consisted of 20 practice trials, a run of 60 experimental trials, and a run of 60 green light only trials. The practice and experimental run trials were similar to previous series with the subject responding to green lights and not responding to red. The green only run consisted of the green light coming on at random intervals with no warning or red lights displayed to the subject. As in the other conditions, the subject pushed the response button as quickly as possible when the green light came on. A signal equivalent to the red light was marked on the polygraph record to provide control data.

After completing the three standard conditions, various other conditions and tasks were explored as the participants' interests dictated. Six subjects (two during their second session) tried a telepathy condition in which an agent in another part of the building knew during the S1-S2 interval which light was going to come on. Other tasks not relevant to the present investigation will not be mentioned.

The experimenters, JoMarie Haight and the author, talked with the subjects before and after each run aid the atmosphere was generally jovial. The subjects knew there was a psi aspect to the task, but most did not know the specific hypothesis under investigation. They were told to concentrate on the reaction time task and any ESP would occur without conscious effort on their part.

Analyses of the practice trials under selection criteria B and D were planned in advance. Since the longer S1-S2 interval would have an unknown effect on the selection algorithm, these analyses were somewhat exploratory.

Results

Technical problems prevented recording of polygraph data during the practice trials of one subject. The results for the practice trials for the other nine are shown in Table 4. For criterion B, 6 of 9 subjects were in the expected direction but the total was not significant. With Criterion D, the results were non-significantly in the opposite direction.

As discussed in the appendix, the selection algorithm discarded a much larger percentage of trials in Series III than in Series I and II. This may be due to more movement artifacts in the data or to the effects of the selection algorithm with the new experimental procedure. Selection level B was chosen for the following post hoc analyses.

Table 4
DISCRIMINATION RESULTS FOR PRACTICE TRIALS IN SERIES III

SELECTION CONDITION	PREDICTED NOT GREEN	PREDICTED GREEN	TOTAL	NO. SUBJECTS IN POSITIVE DIRECTION
B	30/63 47.63%	41/80 51.25%	71/143 49.65%	6/9
D	21/37 56.76%	20/44 45.45%	41/81 50.62%	3/8*

*0ne subject was discarded because she had only one usable trial

The CNV predictions of the experimental runs were non-significantly reversed from expectation (see Table 5) and neither half of the run alone suggested any effects. The GESP condition also produced no suggestive predictions based on the CNV amplitude. No hint of a CNV or readiness potential prior to the light were apparent in the green only runs, nor did the amplitude of the EEG indicate any possible ESP effects.

TABLE 5
SUMMARY OF CNV PREDICTION RESULTS
USING STANDARD BASELINE*

	SERIES I				SERIES II			
	PREDICTED NOT GREEN	PREDICTED GREEN	TOTAL	NUMBER POSITIVE	PREDICTED NOT GREEN	PREDICTED GREEN	TOTAL	NUMBER POSITIVE
Practice					33/78 42.31%	46/80 57.50%	79/158 50.00%	5/9
Experiment	159/309 51.46%	160/300 53.33%	319/609 52.38%	2/3	596/1161 51.34%	636/1240 51.29%	1232/ 2401 51.31%	7/10

	SERIES III				SERIES IV			
Practice	30/63 47.62%	41/80 51.25%	71/143 49.65%	6/9	18/34 52.94%	17/38 44.74%	35/72 48.615	0/4
Experiment	119/243 48.97	125/259 47.49%	242/502 48.21%	3/10	53/117 45.30%	47/111 42.34%	1OO/225 43.865	2/4
Green Only	125/247 50.61%	126/261 48.28%	251/508 49.41%	4/10	45/75 60.00%	42/71 59.15%	87/146 59.595	2/4
Alternate	3/9 33.00%	6/8 75.00%	9/17 52.94%	1/1 n.s.	34/73 46.58%	41/68 60.29%	75/141 53.195	4/4 n.s.
GESP	46/91 50.55%	48/100 48.00%	94/191 49.21%	3/5				

*Analysis carried out on trials selected with Criterion B on EEG Channel

The first person tested in this series showed an encouraging effect for the experimental run, but upon retesting, her results were equally strong in the opposite direction. The second subject produced a possible PK effect on the random generator; the three conditions gave random generator biases of 5/20, 15/60, and 22/60 (MCE = 50%, CR = 4.65, $p < 4 \times 10^{-6}$, 2-tailed), i.e., the green light came on fewer times than expected. No similar effect occurred when he was retested. Both subjects were retested before being informed of their original results.

For the group totals, EMG activity in the responding arm showed the same trend as the CNV (see Table 7). Although the practice trials were in the expected direction but not significant, the experimental trials were significantly reversed from expectation, i.e., the subjects showed more muscular activity in their arms when no responses were going to be required. Predictions for the green only trials were at chance while the GESP results were in the expected direction but not significant.

Vertex alpha activity as a predictor did not approach significance in any condition. For the GESP trials 5 of the 6 subjects had more response than no-response trials when the amount of alpha activity was above the individual's mean.

The scoring rate on the five trials with the largest physiological amplitude (CNV, EMG, amount alpha) for each subject was compared to the five trials with the smallest amplitude. The same analysis was also carried out using the extreme 10 trials, but when totaled, neither analysis added new information.

In order to check the validity of the CNV measure, a sensory condition was carried out with one subject in which she consciously knew which S2 was going to be presented. To give the subject full knowledge of the forthcoming S2, sequential trials alternated red and green 1ights -- a response trial was followed by a no-response trial and vice-versa. The CNV results were in the expected direction (see Table 5), but the EMG activity of the responding arm produced a more striking effect.

While exploring the sensory condition data, a different measure of CNV amplitude was found to give stronger results for the alternating trials. The standard procedure used here and elsewhere measures the CNV amplitude relative to a pre-S1 baseline. However, the absolute amplitude (relative to ground) was a more effective for these data (see Table 6).

This raised questions about the validity and efficiency of the accepted CNV measurement procedure and led to the next series.

SERIES IV

This series was conducted primarily to explore the validity and reliability of the CNV measure by comparing sensory results using the standard CNV baseline with those using the absolute measure. Most CNV research with long S1-S2 intervals has used the standard pre-S1 baseline; however, some workers have apparently used absolute measures (inferred since no mention of baseline was made in the report; Kohrbaugh, Syndulko, & Lindsley, 1976), and others have suggested alternative baseline measures (Loveless & Sanford, 1973).

Procedure and Subjects

An alternating (sensory) condition was added to the procedure. Each subject carried out 20 practice trials, 40 alternating trials, 60 experimental trials (as in Series III), and 40 green light only trials. The EMG of the responding arm and CNV were recorded as in Series III. Four subjects were tested, the two experimenters in Series III, another staff member, and a friend of the experimenters. The subjects, of course, fully knew the hypotheses under investigation. The analysis was carried out using selection criterion B.

Results

On the alternating trials, the absolute CNV amplitude was confirmed to be a better predictor than the standard measure. Using the standard baseline, the CNV amplitude discriminated S2 favorably for all four subjects, but the combined result was not significant (see Table 5). The absolute amplitude successfully discriminated S2 at the $p < .01$, 2-tailed, level (see Table 6). Also, the EMG in the alternating conditions again proved to be a more significant discriminator than the CNV (see Table 7).

For the ESP results, none of the four subjects were in the expected direction on the practice trials using the standard baseline; two of the four were in the expected direction using the absolute amplitude. No noteworthy individual effects were found.

Table 6

SUMMARY OF CNV PREDICTION RESULTS USING ABSOLUTE BASELINE*

	SERIES I				SERIES II			
	PREDICTED NOT GREEN	PREDICTED GREEN	TOTAL	NO. POSITIVE	PREDICTED NOT GREEN	PREDICTED GREEN	TOTAL	NO. POSITIVE
Practice					40/84 47.62%	39/74 52.70	79/158 50.00%	7/9
Experiment	156/309 50.49%	63/300 54.33%	319/609 52.38%	3/3	616/1216 50.16%	616/1185 51.98%	1232/ 2401 51.31%	5/10
	SERIES III				SERIES IV			
Practice	29/62 46.77%	42/81 51.85%	71/143 49.65%	8/9	19/37 51.35%	16/35 45.71%	35/72 18.71%	2/4
Experiment	112/236 47.46%	130/266 48.87%	242/502 48.21%	5/10	49/108 45.37%	51/120 42.50%	100/ 228 43.86	1/4
Green Only	113/249 45.38%	138/259 53.28%	251/508 49.41%	6/10	42/76 55.26%	45/70 64.29%	37/146 59.59%	3/4
Alternate	1/8 12.50%	8/9[a] 88.89%	9/17 52.94%	1/1	29/71 40.85%	46/70[a] 65.71%	75/141 53.19%	4/4
GESP	42/84 50.00%	52/107 48.60%	94/191 49.21%	3/5				

*Analysis carried out on trials selected with Criterion B on EEG Channel

[a] $p < .01$

Table 7
SUMMARY OF PREDICTION RESULTS FROM EMG OF RESPONDING ARM*

	PREDICTED NOT GREEN	PREDICTED GREEN	TOTAL	NO. POSITIVE	PREDICTED NOT GREEN	PREDICTED GREEN	TOTAL	NO. POSITIVE
Practice	36/81 44.44%	29/54 53.70%	65/135 48.15%	6/9	18/35 51.43%	11/21 52.38%	29/56 51.79%	2/3
Experiment	146/269 54.28%	89/218[a] 40.83%	235/487 48.25%	3/10	46/103 44.66%	34/68 50.00%	80/171 46.78%	2/3
Green Only	112/224 50.00%	107/210 50.95%	219/434 50.46%	5/10	35/62 56.45%	28/48 58.33%	63/110 57.27%	2/3
Alternate	2/10 20.00%	7/7[b] 100.00%	9/17 52.94%	1/1	20/65 30.77%	35/42[c] 83.33%	55/107 51.40	3/3
GESP	57/121 47.11%	63/112 56.25%	120/233 51.50%	4/6				

*Analysis carried out on trials selected with Criterion B on EEG Channel.
[a] $p < .01$
[b] $p < .005$
[c] $p < 10^{-6}$

RE-ANALYSIS OF PREVIOUS DATA

Given the increased sensitivity with the absolute CNV amplitude for the sensory condition in Series III and IV, re-analysis of all data of Series I, II, and III seemed required. However, several points; need to be considered. It is not clear a priori that the results of the conscious sensory task can be confidently extended to the unconscious psi process. This concern is further enhanced by the possibility that movements artifacts may have contributed to the CNV amplitude on the alternating trials. See the appendix for a more detailed discussion of why the absolute CNV amplitude gave better results.

Also, Series I and II may not be comparable to Series III and IV because of the longer S1-S2 interval in the latter. The establishment of a baseline is more difficult with the longer intervals (Loveless & Sanford, 1973), and unfortunately, no sensory data for comparison were collected in Series I and II. Furthermore, the fact that the selection algorithm discarded a much larger percentage of trials in Series III than in the other three series indicates uncontrolled variables had important effects.

The results of the re-analysis are presented in Table 6. For the practice trials, the results of Series III are still not significant but eight of the nine subjects are in the expected direction ($p < .04$, 2-tailed). The results for Series II show the same trend with seven of nine subjects in the expected direction, but the more stringent artifact selection criteria did not produce better results as occurred using the standard baseline.

The predictions for the experimental runs in each series are still very close to chance. In the long runs of Series I and II, each subject showed a significant chronological trend in absolute CNV amplitude (see appendix for discussion) so looking at trials above and below the mean may be essentially comparing the first versus second half of the runs. Such trends generally did not occur for the shorter runs of Series III and IV. However, even when the first 20 and 60 trials for each subject's experimental run in Series I and II were evaluated, no ESP effects were found,

In summary, the sensory data indicates the absolute CNV amplitude is best for Series III and IV. However, for Series I and II, a shifting baseline is needed to compensate for the chronological trends during the long experimental runs and the standard pre-S1 baseline is probably more appropriate. Chronological trends should not be a problem on the short practice runs, and the differing two results with the/amplitude measures must be attributed to other factors. In the absence of sensory data, it does not seem possible to establish which measure is more valid for the practice trials of Series II.

DISCUSSION

Clearly, the first conclusion to be drawn from the present study is that more fundamental research on the measurement of the CNV is needed. The role of eye movement artifacts and various baseline measures need much further clarification. In retrospect, it is obvious that a sensory condition should have been included for all subjects to verify the validity of the measurements. The final evaluation of this work must await more complete understanding of CNV methodology. Of the existing data, Series III and IV provided results that were the most reliable in terms of sensory verification of the methodology.

The findings of Series III gave encouraging support to the hypothesis that an ESP component of anticipation would occur during the practice trials when the subjects were in an unfamiliar situation. Although the pooled practice results were not significant, the CNV amplitude was able to discriminate the red and green lights in the expected direction for eight of nine subjects ($p < .04$, 2-tailed, post hoc) and EMG activity of the responding arm was also in the expected direction for six of the nine subjects.

The results for practice trials in Series IV were not in line with the ESP hypothesis, but three of the four subjects had gone through the procedure before and thus were not in a completely unfamiliar situation. However, they were also fully aware of the importance of the practice trials and the other person was not as naive as the participants in Series III. Since the practice trials were presented to the subjects in Series III as being informal while the experimental condition was the serious part of the experiment, the unfamiliar situation hypothesis has been confounded by the distinction between informal and serious

trials. Other variables such as the addition of a sensory condition after the practice trials may also be important.

Although it does not seem possible at present to confidently select a proper CNV amplitude measure for Series II, with either the standard or absolute baseline the CNV amplitude discriminated the practice trials in the expected direction. Using the standard CNV baseline, the results were particularly encouraging. The discriminating ability of the CNV became stronger as more stringent movement artifact selection criteria were applied and the effect reached significance ($p < .01$). To the author's knowledge, no other data has been presented questioning the standard baseline for the short S1-S2 intervals used in Series I and II.

The CNV totals for the experimental runs were not significant for any of the four series. Apparently, the particular subjects and/or conditions needed for a stable effect were not present in these experiments. Although other, possibly more sensitive analysis methods could be applied to these data, the numerous exploratory analyses already carried out should have identified any genuine effects. One subject in Series I produced a significant effect while a subject in Series II had a significant reversal. These two results, selected from all the data, are not particularly remarkable, but it is perhaps noteworthy that the first subject tested gave the best results of any subject.

EMG activity of the responding arm for the ESP experimental runs of Series III showed a significant reversal from what was expected. The subjects' arms tended to show more activity on no response trials than on response trials. The possible importance of this result is enhanced by the fact that EMG of the responding arm proved to more effectively discriminate than the CNV on the sensory trials. Although it is tempting to speculate that the reversal occurred because subjects were frustrated by the ESP task, there is no independent support for this ad hoc explanation.

While the overall results of these experiments cannot be taken as striking support for the hypothesis of a paranormal component of anticipation, they are not particularly discouraging either. The primary value of this work probably lies in providing suggestions for further work. If one adheres to the popular view that people scan their environment paranormally and respond without awareness to extrasensory information (e.g., Stanford, 1974), then psychophysiological measures of anticipation would seem to be an immensely plausible tactic.

An important feature of this approach is that the subject is required to anticipate a future stimulus to the subject rather than respond to an artificial relationship with an agent or object. Also, experiments can be carried out with or without the subject's awareness that an ESP aspect is involved. However, realistic future studies should be aimed toward a more comprehensive investigation than the present work represents.

The validity and reliability of the physiological measures should be verified as part of the experimental design. Also, measuring several psychophysiological variables may be

desirable. For example, heart rate has been strongly linked with anticipation and the hypothesis that heart rate is related to internal versus external focusing of attention (Lacey & Lacey, 1970; Obrist, Webb, Sutterer, & Howard, 1970) would seem to be of particular interest for parapsychology. The most profitable strategy may be an individualized approach of measuring several physiological parameters (e.g., CNV, EMG, heart rate), and basing the ESP predictions for each subject upon their particular results in a predictor condition.

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The Technical Appendix is available at http://jeksite.org/psi/cnvapp.pdf.

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