Reprinted from
INTERNATIONAL JOURNAL OF PARAPSYCHOLOGY
Autumn 1963 • Volume V, No. 4

PHYSIOLOGICAL CORRELATES OF PSI COGNITION

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If one may speak of "fashions" in parapsychological research, the study of physiological correlates of extrasensory perception is probably the most current. The present paper illustrates the potentials and limitations of work in this field.

■ ALL BEHAVIOR is apparently accompanied by physiological changes in the behaving organism, and one would not expect psi cognition to be an exception. (For the purposes of this paper, "psi cognition" refers to the process or processes operative when a significant correlation is found between behavioral and/or physiological events in a living organism and some other real world event, when, according to our present knowledge of physics, no relevant information about the event could have reached the organism.) Previous research in this area has fallen into two categories: (a) attempts to find some physiological variable whose value was altered by an event to which the subject was responding by psi cognition; and (b) attempts to find physiological states in which the operation of psi cognition was enhanced. This paper will review studies in both of these areas and report a new experiment of the first type.

Hettinger*(10)* measured the galvanic skin responses (GSRs) of an unreported number of "sensitive" subjects while an unreported number of agents, located at distances ranging from five to 200 miles

away, were occasionally subjected to such stimuli as whistles, loud noises, and physical exercise. According to Hettinger, the subjects showed a very high amount of GSR activity while the agents were being stimulated and very little when the agents were not stimulated. It is impossible to adequately evaluate this study, however, as a number of essential details, such as the method for selecting the times to stimulate the agents, were not reported.

Wallwork*(21)* recorded the electroencephalogram (EEG) of one male subject during a card guessing experiment. This subject had scored above chance in a previous ESP experiment. There were no gross changes in the subject's EEG pattern associated with correct guesses, nor did a detailed analysis of the alpha rhythm yield any significant results. In another series, the EEGs of both the agent and the subject were simultaneously recorded during card guessing, but again no significant relationships were found. As Wallwork points out, however, the subject did not score above chance on the card guessing, so psi cognition may not have been operative in this study.

Woodruff and Dale*(23)* conditioned a GSR to one of three symbols which were projected in random order on a screen in front of their subjects. A painful electric shock was the unconditioned stimulus. They then presented the slides to their 24 subjects simply by placing them beside the projector rather than in it, and measured the GSRs of their subjects on each such trial. They found that the subjects who showed the greatest amount of GSR activity throughout the study also had the highest number of correct guesses, although the differences fell short of statistical significance. In a second experiment*(23)* of somewhat different design, this finding was replicated, although still below a statistically significant level. If this latter result is not due to chance, it indicates that a condition of greater arousal or activation*(12)* is more favorable to psi cognition than one of low arousal.

Cadoret*(5)* found no correlation between card guessing scores and endosomatic GSR (direct current skin potential), but does not present the data upon which this conclusion is based.

Otani*(13)*, using himself as the subject, measured basal skin resistance (BSR) at the beginnings and ends of DT clairvoyance runs through 25-card Zener decks. With the subject in a relaxed mental state, there were more correct guesses associated with BSR

increases of 10,000 ohms or more from the beginning to the end of the run than with lesser increases or with decreases in BSR. In a later study, under somewhat different conditions*(14)*, Otani reports results in the same direction but which were not statistically significant. It is known that BSR rises as a subject becomes more relaxed*(3, 4, 7, 11, 18, 19, 22)*, so Otani's finding, if it is valid, contradicts that of Woodruff and Dale*(23)*, as it indicates that increased relaxation rather than increased arousal is more favorable to psi cognition. There were important procedural differences in the studies, however, which might account for the different findings.

Figar*(8)* carried out 119 experiments in which two subjects sat in opposite halves of a room which was divided by heavy curtains. None of the subjects knew there was anyone in the curtained-off part of the room, nor the purpose of the study. Hydraulic plethysmograph recordings from the left hand of each subject were simultaneously recorded. In a large number of the experiments striking parallelisms between the two records were found, under conditions of both subjects relaxing and of one subject doing mental arithmetic problems while the other relaxed. Pairs of subjects who were related, such as mother and son, showed the greatest degree of parallelism. As Figar points out, however, the possibility of subliminal auditory stimuli accounting for the parallelism rather than psi cognition cannot be ruled out.

The Research Committee of the American Society for Psychical Research carried out a series of experiments*(1)* in which subjects' EEGs were recorded while agents were stimulated in various fashions, such as pinching them. No gross changes were noted in the subjects' EEGs, nor were any changes noted associated with correct guesses in a card guessing series.

These studies*(1, 5, 8, 10, 13, 14, 21, 23)* provide no definite evidence of the existence of physiological correlates of psi cognition. The two studies with highly positive results, Hettinger's and Figar's, are inadequately reported in the one case*(10)* and inadequately controlled for sensory leakage in the other*(8)*.

The present investigation attempted to find changes in skin resistance, finger pulse volume, and the EEG which could be considered responses to randomly occurring stimuli which could affect the subjects only if they employed some form of psi cognition. The usual experiment on psi cognition requires the subjects to discriminate

between several stimuli; in the present study the subjects were only required to respond to the presence or absence of stimuli, in the hope that this simpler task would be conducive to a high level of psi cognition.

■ THE SUBJECTS IN THE present study were college students, ten males and one female, each of whom participated once. None of the subjects were known to the present investigator, who served as agent for all the experimental sessions.

For each session the subject was seated in a sound-attenuating chamber, originally intended for sensory deprivation studies, and an assistant applied various electrodes. The EEG was measured bipolarly between two Grass silver disk electrodes, applied with Bentonite paste, one over the right occipital lobe and the other over the right parietal lobe. These electrodes were reapplied if their resistance was excessive or the EEG recording was unsatisfactory. A thin, freshly sanded lead plate, two centimeters by four centimeters, was taped to the plantar surface of each of the subject's feet, to measure skin resistance, no electrode paste being used.

Finger pulse volume was measured by means of a photoelectric plethysmograph, described elsewhere*(9, 16)*, placed on the middle finger of the subject's right hand. Skin resistance was measured by a specially designed and highly sensitive instrument, which has also been elsewhere described*(18, 19)*. The EEG was not recorded directly but analyzed by an electronic Period Analyzer*(2, 3, 4, 15, 20)*. This Analyzer measured the duration of each positive half wave of the EEG and classified it into one of three categories: (a) Delta or Theta waves, with a duration of less than .125 second (a frequency of less than eight cycles per second); (b) Alpha waves, with a duration of .125 to .08 second (eight to 12.5 cycles per second); and (c) Beta waves, with a duration of less than .08 second (12.5 cycles per second or higher). Each wave in one of these categories produced an output pulse on a separate output channel. Another output channel recorded the results of Complexity analysis of each wave in the EEG, producing an output pulse for each superimposed wave riding the basic EEG wave.

The output of the skin resistance machine, the plethysmograph, the taps from the subject's telegraph key, and the four outputs from the EEG Period Analyzer were recorded on a modified Grass model III-D EEG machine.

After the electrodes had been applied, the assistant instructed the subject that a "subliminal stimulus" would be presented at random intervals during the experiment, and that his task was to guess when such a stimulus had been presented. The subject was to indicate his guesses by pressing a telegraph key on the arm of his chair immediately after he believed a stimulus had occurred. No mention was made of psi cognition, although the subject was told to pay attention to his hunches. The assistant then left and allowed the subject to relax and adapt to the situation for a few minutes.

The agent was seated in a second sound-attenuating chamber, which was located in another laboratory and separated from the subject's chamber by several intervening concrete block walls. A connecting cable allowed the assistant to administer electric shocks to the agent through electrodes on the latter's ankle. These shocks, of two seconds duration, were raised in intensity until the agent indicated, via a connecting telephone, that they had reached the maximum level he could tolerate. The telephone was then disconnected for the remainder of the experimental session. The agent then began reading a book and tried to remain as relaxed as possible. When he was shocked at random intervals during the remainder of the session, he tried to influence the subject to press the telegraph key.

The assistant then informed the subject, via an intercom, that the experiment had begun. There was no further communication with the subject until the session was over.

The assistant then randomly picked a program for the session from a large number of such programs. These programs controlled the type of trial and the inter-trial interval. The trials were of two types, Shock and Nonshock. On the former, the agent was shocked for two seconds, while on the latter, the assistant manipulated a silently operating switch which diverted the two second shock to a resistor in the agent's chamber. Each program contained 25 trials of each type, randomly distributed. The interval between trials was 20, 40, or 60 seconds, also randomly distributed.

The subject was thus set to respond to minimal cues of an unknown nature and time of occurrence while he remained in a silent and dimly lit environment for about an hour. The agent was quietly

reading, except when shocked, at which times he concentrated on affecting the subject's behavior.

■ IN ORDER TO TEST the null hypothesis that fluctuations in the levels of the various physiological measures, referred to as responses, were independent of the occurrence of Shock and Nonshock trials, the responses during each two second trial were compared with the responses in a two second period which began ten seconds after the beginning of each trial. If psi cognition was not operative, the responses in these control periods should, on the average, have been equivalent in all respects to the responses during the trials. A similar technique was used by Davis*(6)* for evaluating responses to subliminal auditory stimuli.

The score for each trial and control period for the EEG was the number of pulses in each of the four output channels (Complexity, Beta, Alpha, and Delta-Theta) of the EEG Period Analyzer. A GSR was considered a response to a trial or control period if it began at least one second and not more than four seconds after the beginning of the trial or control period, a period covering the usual latencies of the GSR to stimulation reported in the literature*(7, 11, 22)*. The amplitude of the GSR was measured in ohms. Finger pulse volume changes had to meet the same criteria as the GSR in terms of latency, thus covering the latency of response of the optical plethysmograph reported by Shmavonian*(16)*. Key taps were arbitrarily considered responses to trials or control periods if they occurred within ten seconds of the beginnings of the trials or control periods.

The distributions of responses for the various measures were markedly skewed and non-Normal, so almost all the statistical analyses were done using the Wilcoxon matched-pairs, signed-ranks test*(17)*.

Table 1 presents the results for the group of 11 subjects. The entries in the body of the table are the sums of ranks used in the Wilcoxon test, the number of paired comparisons used for each test (non-zero differences are not used in the Wilcoxon test), and the significance level. As can be seen, the EEG showed a significantly greater amount of superimposed activity (Complexity) on both the Shock and Nonshock trials compared to their respective controls. The other EEG components do not reach statistical significance, but

show a pattern similar to what would be expected if the subjects had been receiving mild sensory stimuli on the trials, viz.: (a) an increase in Beta activity; (b) a decrease in Alpha activity; and (c) a decrease in Delta and Theta activity. The GSR amplitudes showed no significant differences.

TABLE 1

Sums of Ranks for Wilcoxon Matched-Pair Signed-Ranks Tests, Entire Group

Variable	*Type of Trial*	*Trial*	*Control*	*N*
Complexity	Shock	21,508.5	14,806.5	269**
	Nonshock	19,756.5	14,434.5	261*
Beta	Shock	19,355.0	15,361.0	263
	Nonshock	17,666.0	15,487.0	257
Alpha	Shock	13,419.0	14,547.0	236
	Nonshock	12,846.5	14,648.5	234
Delta-Theta	Shock	5,962.5	6,598.5	158
	Nonshock	4,586.5	5,424.5	141
GSR	Shock	1,864.0	2,231.0	90
	Nonshock	2,966.5	2,083.5	100

N: number of paired comparisons
*: probability less than .05, two-tailed
**: probability less than .01, two-tailed

The optical plethysmograph used provided only a relative measure of finger pulse volume, so the amplitudes of the responses could not be analyzed for the group as a whole. By noting only whether or not a response occurred during a trial or control period, however, it was possible to test the group results using the Friedman Two-way Analysis of Variance*(17)*. This technique was also used for analyzing the GSR and Key Tap responses. The distributions of responses are presented in Table 2, together with the probabilities that the obtained distributions arose through chance variation. There were significantly more finger pulse volume responses on both Shock and Nonshock trials compared to their respective controls, and the same pattern occurred in the GSR responses, although falling short of statistical significance. The distribution of Key Taps does not differ from chance.

The results for the subjects taken individually generally follow the group results, with no important exceptions.

TABLE 2

Distribution of Finger Pulse Volume, GSR, and Key Tap Responses

Type of Trial	Finger Pulse Volume		GSR		Key Taps	
	Trial	*Control*	*Trial*	*Control*	*Trial*	*Control*
Shock	35	25	60	57	12	10
Nonshock	47	12	77	49	15	20
	$Pr < .01$ two-tailed		$Pr < .10$ two-tailed		not significant	

■ THE RESULTS of the present study generally support the hypothesis that the subjects were physiologically responding to both the Shock and Nonshock trials by some form of psi cognition. For both types of trials, compared to their controls, the EEG shows more superimposed activity and Beta waves, and fewer Alpha, Delta, and Theta waves; there are more GSRs and more finger pulse volume responses. All of these data are indicative of greater activation*(12)* during the trials, as would be expected if the subjects had been receiving mild sensory stimuli*(2, 3, 4, 16, 18, 19, 20)*. The only data which contradict this activation pattern are the GSR amplitudes for the Shock trials, but these were not statistically significant.

Since the agent's being shocked seemed, *a priori,* to be a more "significant" event than current flowing through a resistor, it was expected that the subjects would, if psi cognition were operative, respond primarily to the Shock trials rather than the Nonshock trials. The instructions to the subjects did not orient them to look for any particular kind of stimulus, however, and inspection of the data seems to indicate that the subjects responded about as well to both kinds of trials.

This lack of differences between the Shock and Nonshock trials raises the question of whether the shocking apparatus generated some auditory cue on both sorts of trials that the subjects responded to, rather than psi cognition having been operative. Considering that the chamber in which the subject sat attenuated sound between 40 and 70 decibels throughout the audible range, so that a person outside who was shouting could barely be heard inside, this possibility may be definitely ruled out.

Inspection of the distributions of finger pulse volume responses and GSRs, presented in Table 2, shows that the differences are much greater for the Nonshock trials versus their controls than for the Shock trials versus their controls. The EEG patterns are mixed in this respect. One might hypothesize, *post hoc*, that if the subjects were responding to the agent's reactions to being shocked they would still show some activation even ten seconds after the trial, for the agent would still be highly activated. The lowest number of finger pulse volume and GSR responses do occur in the Nonshock control periods.

Although no measurements of the agent's finger pulse volume were taken, there were certainly large changes during the shocks, so the results of the present study are consistent with those of Figar*(8)*.

The significant EEG changes found in the present study were probably due to the use of the highly sensitive Period Analyzer, whereas the previous studies*(1, 21)* depended on visual judgment of the EEG recording. The Complexity analysis channel, in particular, was highly sensitive to minimal changes in activation level*(2, 3, 4, 20)*.

The subjects' conscious guesses, indicated by Key Taps, as to when they had been stimulated, did not differ from chance. Since some of their physiological responses were significantly different from chance, the subjects were "using" psi cognition on an "unconscious" level. But while some of the physiological responses were *statistically* significant, the overall effect was still quite small, and the present study definitely requires replication before the results can be regarded as firm evidence for physiological correlates of psi cognition. There were not enough correct conscious guesses to allow a comparison of the physiological concomitants of correct and incorrect guesses.

In one respect, the conditions of the present study were unfavorable to the operation of psi cognition. The agent did not know the subjects and vice versa. The fact that the subjects did not respond more significantly to the Shock than the Nonshock trials may be due to this factor. Perhaps husband-wife or mother-child teams might show a higher level of psi cognition in this type of experiment, as Figar's study*(8)* indicated.

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SUMMARY

In individual sessions, eleven college students sat in a soundproof chamber and tried to guess when "subliminal stimuli" were presented. At random intervals either: (a) an agent in another soundproof room was electrically shocked; or (b) the shock was delivered to a resistor. The subjects' skin resistances, finger pulse volumes, and EEGs were continuously recorded, and the EEGs were electronically analyzed.

The physiological responses of the subjects were significantly related to the occurrence of both types of events, showing a pattern for the group generally indicative of a higher level of activation during the trials, viz.: (a) a faster and more complex EEG pattern; (b) more frequent galvanic skin responses; and (c) more frequent changes in finger pulse volume. As the subjects' conscious guesses of when trials had occurred did not differ from chance, they may be said to have responded on an "unconscious" level.

RESUME

En séances individuelles, onze étudiants du secondaire étaient placés dans une chambre insonorisée et s'efforçaient de deviner le moment où des "stimuli subliminaux" étaient présentés. A intervalles déterminés au hasard, ou bien (a) un agent se tenant dans une autre chambre insonorisée recevait un choc électrique, ou bien (b) le choc était administré à une résistance. Les résistances épidermiques, les volumes des pouls digitaux et les électroencéphalogrammes des sujets étaient constamment enregistrés et les électroencéphalogrammes analysés électroniquement.

Les réactions physiologiques des sujets ont été en rapport significatif avec la réalisation de l'un et l'autre types de cas, montrant pour le groupe un modèle indiquant en général un niveau d'activation plus élevé pendant les expériences, à savoir: (a) un modèle d'électroencéphalogramme plus rapide et plus complexe; (b) des réactions épidermiques galvaniques plus fréquentes; et (c) des changements plus fréquents dans le volume du pouls digital. Comme les divinations conscientes des sujets sur le moment où les expériences s'étaient produites n'ont pas différé du hasard, on peut penser qu'ils ont réagi à un niveau "inconscient".

ZUSSAMMENFASSUNG

In Einzelsitzungen sassen elf Hochschulstudenten in geräuschdichten Kabinen und versuchten dargebotene "unterschwellige Reize" zu erraten. Mit beliebigen Zwischenräumen wurde entweder: (a) ein Sender in einer weiteren gegen Geräusche abgedichteten Kabine elektrisch geschockt; oder (b) der Schock wurde einem Widerstand übermittelt. Es wurde ständig der Hautwiderstand, das Fingerpulsvolumen und EEG der Versuchspersonen registriert und das EEG wurde elektronisch ausgewertet.

Die physiologischen Reaktionen der Versuchspersonen waren in signifikanter Weise auf beide Arten von Geschehnissen abgestimmt, wobei sich ein Schema für die Gruppe ergab, die allgemein einen höheren Grad von Aktivierung während der Versuche aufwies, z.B. (a) ein schnelleres und komplexeres EEG-Schema; (b) häufigere galvanische Hautreaktionen; und (c) häufigere Veränderungen im Volumen des Fingerpulses. Nachdem die Angaben der Versuchspersonen hinsichtlich des Auftretens der Stichproben nicht von den Zufallstreffern abwichen, kann man sagen, sie hätten auf einer "unbewussten" Ebene reagiert.

SOMMARIO

Nel corso di sedute individuali, 11 studenti universitarî sono stati posti in una stanza a prova di suono, e hanno cercato di captare i momenti in cui venivano sottoposti a "stimoli subliminali". A intervalli stabiliti a caso, (a) un agente in un'altra stanza a prova di suono riceveva una scossa elettrica, oppure (b) la scossa veniva somministrata a una resistenza. Furono continuamente registrati nel contempo la resistenza epidermica, il volume delle pulsazioni digitali e l'EEG dei soggetti. Questi EEG venivano analizzati elettronicamente.

Le risposte fisiologiche dei soggetti furono significative rispetto a entrambi i tipi di eventi, e tutto lo schema comportamentale del gruppo indicò un più alto livello di attivazione durante gli esperimenti, e cioè: (a) un tracciato EEG più rapido e più complesso; (b) più frequenti risposte galvaniche epidermiche; (c) mutamenti più frequenti nel volume delle pulsazioni digitali. Dato che i tentativi coscienti dei soggetti di individuare i momenti degli stimoli non differirono dalla probabilità casuale, si può dire che essi abbiano reagito ad un livello "inconscio".

RESUMEN

En sesiones individuales, once estudiantes secundarios sentados en una cámara a prueba de sonidos, trataron de adivinar cuando le eran presentados "estímulos subliminales". A intervalos aleatorizados: (a) un agente, en otra habitación a prueba de ruidos, era shockeado eléctricamente; o bien (b) el shock era descargado en una resistencia. La resistencia de la piel, el volumen del pulso de los dedos, y los EEGs de los sujetos fueron registrados en forma continua; los EEGs fueron analizados electrónicamente.

Las respuestas fisiológicas de los sujetos estuvieron correlacionadas significativamente con la ocurrencia de ambos tipos de sucesos, mostrando para el grupo secuencias generalmente indicativas de un alto nivel de activación durante los ensayos; a saber: (a) una secuencia del EEG más rápida y compleja; (b) respuestas galvanicas de la piel más frecuentes; y (c) cambios más frecuentes en el volumen del pulso de los dedos. Puesto que los ensayos conscientes efectuados cuando se presentaban los objetivos, no difirieron del azar, puede decirse que los sujetos respondieron en un nivel "inconciente".