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COINCIDENCE OF EEG ALPHA PATTERNS IN HUMANS

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Final Report

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Introduction

Previous experimentation [1] involving photic driving of the EEG had disclosed the fact that a significant number of normal subjects became uneasy or ill when stimulated with a rapidly flashing light. On the basis of this observation and on the common, but poorly documented, knowledge that identical twins experience some sort of empathy particularly in times of stress even when remotely situated with each other, it was decided to test the relationships of the EEG patterns in such individuals. At the outset it was recognized that the simpliest and most easily stimulated and reproducible patterns in the normal EEG were the alpha patterns which occur most frequently upon closure of the eyes. A preliminary and qualitative experiment [2] testing the hypothesis as to whether the appearance of alpha in one identical twin had any relationship with its appearance in the other, revealed sufficiently encouraging results for us to devise a quantitative analysis of this phenomenon. The purpose of this report is to describe such an approach to the coincidence of alpha patterns in humans and to present our findings and interpretation thereof. Our primary goal has been to attempt to delineate whether the EEG of one individual was in any way, other than random, concomitant with anothers.

Methodology

Experimental Subjects. Our previous experiment [2] dealt exclusively with identical twins. In order to avoid introducing another complicating and confusing factor into the present attempt of quantitative analysis it was decided to restrict this study to additional identical twins, though this seriously retarded the pool of available subjects and, in some ways, served as a handicap to the rapid acquisition of data. Identical twins of either sex between the ages of 16 and 40 years were the subjects of the experiment. Controls were non-related individuals between the ages of 18 and 25 years. No attempt was made to firmly establish identity in the twins. Almost all subjects resided in the Philadelphia area.

Data Acquisition. All tests were conducted in our laboratory, an area of which had been modified for this study. Subjects, controls and observers were seated in three separate but adjacent 5 x 8 x 8 foot rooms. Room assignment was randomly selected. Previously, subcutaneous EEG leads were inserted over the occipital protruberances of each. An indifferent electrode was placed on the flexor surface of one or the other wrist. All leads were fed into a preamplifier situated along side the subjects whence signals were conducted to an observation room. Each subject held in his hand a centrally activated silent compressor which squeezed his hand and was designed to inform him to close his eyes. Simultaneously a small light behind him informed the observer that a command had been sent. Subjects were carefully instructed to sit quietly and to read actively when their eyes were open. Upon command they were to close their eyes and to rotate them upward and were to keep them closed until the hand compressor was released at which time they were to avidly resume reading. During test runs, usually lasting 1 1/2 hours, each individual room was kept isolated with no overt communication from one to another.

In the central area the preamplified signals from each room were filtered through a 60 cycle rejection filter and fed into a polywriter (Beckman model) and into an analog computer (Heath model) Figure 1. On the polywriter a simultaneous record was obtained of the alpha pattern, the evaluation from the analog computer and the status of stimulation for each subject. The analog computer was programmed to identify alpha patterns by obtaining an envelope of the EEG signal and discriminating its amplitude. The discrimination level was determined by inspection of the polywriter tracing and by observation in an adjacent oscilliscope. Once set the discrimination level remained constant throughout the experiment. The output of the analog was fed into the polywriter and into a digital analyzer. The digital analyzer by "anding" in succession the information obtained from the analog computer, from the stimulator and from a master clock (10 ms) provided numerical outputs used for further analyses. These were: the total time of the run, the periods of alpha present in each individual, the periods of stimulated alpha present in each individual, the total coincidence of alpha between each of the possible pairings and the total presence of coincident alpha among the pairings when one was being stimulated. Details of the combined analog and digital device have been published elsewhere. (3) Stimulation, of course, was the command to close the eyes activated by a switch at the central control. At the same time the subject received the command, a signal was presented to both the polywriter and the analyzer. In later experiments some of the results were selectively displayed on a higher quality recorder (Brush model) and the data necessary for additional analyses of the information (EEG pattern from each subject, stimulation status, and master clock) were stored on an instrumentation tape recorder (Honeywell model).

Typical Run. (See Appendix I)

Subjects, controls and observers were randomly placed in three rooms described above. All doors including that to a common hall way were closed. During a four-minute run all (twins and control) were repeatedly simultaneously stimulated. Periods of command were determined by a stop watch. The run was completed; the counters read and reset to zero. In the second part individuals, selected on a random basis, were repeatedly stimulated with appropriate rest periods. Then each was intermittently stimulated again, on a random basis. Following this 17 1/2 minute period, the counters were again read and reset.

The computer logic was then set to negative and the lights in the test subjects' rooms were extinguished while they kept their eyes open. Counted then were the periods of non-alpha under similar protocols as outlined above. About 3/4 way through the total study we became convinced from analysis of on-going data that this portion of the data acquisition was not contributing to the answer of the basic question; namely, whether the presence or absence of concomitant alpha patterns could be demonstrated in humans in a quantitative manner. It was, therefore, discontinued.

Analysis of Data

Obviously, analysis of the results are the key to this experiment. Rigid statistical analysis is necessary to determine whether the results differ significantly from those which can occur due to random selection. The following schema was employed.

The pattern analyzer presented 16 bits of data measuring in 10's of milliseconds as follows:

1. Total Time (t)	Total time of experimental run.
2. Alpha A (αA)	Total time alpha rhythm present in subject A. (irrespective of stimulation, coincidence, etc.)
3. Alpha B (αB)	Total time alpha rhythm present in subject B.
4. Alpha C (αC)	Total time alpha rhythm present in subject C.
5. Stimulated Alpha A ($\alpha \bar{A}$)	Total time alpha rhythm appeared in subject A while he (A) was stimulated. (Eye closure, darkened room, etc.)

6. Stimulated Alpha B $(\alpha \bar{B})$ — Total time alpha rhythm appeared in subject B while he was stimulated.

7. Stimulated Alpha C $(\alpha \bar{C})$ — Total time alpha rhythm appeared in subject C while he was stimulated.

8. Alpha Coincidence in A and B (αAB) — Total time alpha rhythm appeared coincidentally in subjects A and B. (Regardless of stimulation of either)

9. Alpha Coincidence in A and C (αAC) — Total time alpha rhythm appeared coincidentally in subjects A and C.

10. Alpha Coincidence in B and C (αBC) — Total time alpha rhythm appeared coincidentally in subjects B and C.

11. Alpha A during alpha stimulation B $(\alpha A\bar{B})$ — Total time alpha rhythm appeared in A while alpha rhythm occurred in B during stimulation of B.

12. Alpha A during alpha stimulation C $(\alpha A\bar{C})$ — Total time alpha rhythm appeared in A while alpha rhythm occurred in C during stimulation of C.

13. Alpha B during alpha stimulation A $(\alpha B\bar{A})$ — Total time alpha rhythm appeared in B while alpha rhythm occurred in A during stimulation of A.

14. Alpha B during alpha stimulation C $(\alpha B\bar{C})$ — Total time alpha rhythm appeared in B while alpha rhythm occurred in C during stimulation of C.

15. Alpha C during alpha stimulation A $(\alpha C\bar{A})$ — Total time alpha rhythm appeared in C while alpha rhythm occurred in A during stimulation of A.

16. Alpha C during alpha stimulation B $(\alpha C\bar{B})$ — Total time alpha rhythm appeared in C while alpha rhythm occurred in B during stimulation of B.

The goal of the analysis was to determine whether alpha rhythm as produced in one subject influenced its appearance in another. It was postulated that the production of alpha in one identical twin may influence its production in the other twin. In order to test this hypothesis, data from the two twins and a control subject were analyzed in the following manner.

Three subjects were noted as A, B, and C. Under conditions of this experiment at various times, each may be considered to have been a "transmitter" of alpha and at other times the "receiver" of same. Essentially, what was sought was an analysis of the influence among these subjects with regard to the presence or absence of alpha patterns in their EEG's. Schematically this is outlined in Figure 2.

"Transmitting"

"Receiving"	Subject A	Subject B	Subject C
Subject A	1.	2. Is alpha A Altered?	3. Is alpha A Altered?
Subject B	4. Is alpha B Altered?	5.	6. Is alpha B Altered?
Subject C	7. Is alpha C Altered?	8. Is alpha C Altered?	9.

Figure 2

Consider cell No. 2, Figure 2. The question was asked, does the presence of alpha in B alter alpha in A?

In order to answer this question, cell No. 2 must be expanded as follows:

Subject B
("Transmitting")

	Total Period of Experiment			Stimulated Periods of Experiment		
Subject A ("Receiving")	Coincidence of alpha	Non-coincidence of alpha	Significance	Coincidence of alpha	Non-coincidence of alpha	Significance
	Equation (3)	Equation (4)		Equation (5)	Equation (7)	

Figure 3

First data must be analyzed to determine if, during the experiment, the appearance of alpha in B significantly altered the coincident appearance of alpha in A or,

Is, $$\frac{\alpha AB}{B} \times 100 \quad (1)$$

Different from, $$\frac{\alpha A - \alpha AB}{t - \alpha B} \times 100 \quad (2)$$

This asked whether the ratio of coincidence alpha in A and B to its presence in B was different from ratio of "spontaneous" or non-coincident alpha A which appeared in the rest of the experimental period while alpha B was absent.

In order to obtain these figures, periods of stimulated alpha ($\alpha\bar{A}$) must be obviously excluded. Therefore, equations 1 and 2 were modified as follows and the above stated question became:

Is, $$\frac{\alpha AB - \alpha\bar{A}B}{B - \bar{A}B} \times 100 \quad (3)$$

Different from, $$\frac{(\alpha A - \alpha\bar{A}) - (\alpha AB - \alpha\bar{A}B)}{(t - \alpha\bar{A}) - (\alpha B - \alpha\bar{A}B)} \times 100 \quad (4)$$

Numerical data to be substituted in equations 3 and 4 were supplied by the coincidence pattern analyzer and the ratios were calculated. Calculation of significance between the difference of the ratios was obtained by constructing a 2 x 2 contingency table and estimating the probability of such occurrence by the chi-square test. In instances where the probability level was sufficiently low, results were verified by calculating the exact probability of such an occurrence.

Similarly, the data had to be analyzed to determine whether <u>stimulation</u> of alpha in B influences its appearance in A. Simply represented, Is, $\frac{\alpha A\bar{B}}{\alpha\bar{B}} \times 100$ (5)

Different from, $\frac{\alpha A - \alpha A\bar{B}}{t - \alpha\bar{B}} \times 100$ (6)

Again periods of stimulated alpha ($\alpha\bar{A}$) had to be excluded from the calculation thus,

Is, $\frac{\alpha A\bar{B}}{\alpha\bar{B}} \times 100$ (5) (Repeated)

Different from, $\frac{(\alpha A - \alpha\bar{A}) - \alpha A\bar{B}}{(t - \alpha\bar{A}) - \alpha\bar{B}} \times 100$ (7)

Again the significance of ratio differences were calculated.

The usual approach of determining significance levels in a two by two contingency table is the chi-square method. This was used to evaluate the significance of differences in the ratios. The values of the chi square and of the chi square with the Yates correction are shown in the table below for each case. The results were considered significant only if extraordinary high values of the chi square preferably over 100 were found. This corresponded to a level of significance far in excess of 0.005, which is reached at the chi square between 7.8 and 7.9. Usual tables do not contain probability values for chi squares over 10 which are considered so high to be beyond question. The existence of high values of chi square, of course, indicates correlation between the findings. In other words, the data cannot be considered as obtained by random fluctuations.

Two basic critiques could be applied to the chi-square method. The first one involved the fact that the chi square was only an approximation technique which was valid in not too skewed distributions, and may not have been too valid in large degrees of skewness. To investigate this possibility a computer program was written to evaluate the probability of the distribution and of more extreme distributions using an exact probability function. This program was used to spot check low chi-square result and to confirm the high value cases. As was to be expected, a close correlation did exist in the low values and in the high values the probability was zero in a machine that did accept 12 decimal places.

The second critique was of a more fundamental nature. The basic theory of the chi-square distribution is based on a Bernoulli model. This is to say that each event is completely independent in its occurrence to the existence or non-existence of any other event in the series. In the specific case of the alpha pattern this was not a completely valid representation. If one instance in time was within an alpha train, the probability for an instant in time 10 milliseconds later to be within the same train was significantly higher than if the first instant was not within the alpha train. Such a situation has been extensively studied recently and is called the Markov Chain. We were unable to find a critical evaluation of the validity of the chi-square integral for the evaluation of the randomness or non-randomness of events of the Markovian nature. Therefore, it was decided to write a program to stimulate lengthly Markovian chains built at random based on a random number generator, and obtain the chi square of the resulting distribution. To our satisfaction it proved that the chi-square values remained low having the same general distribution as on a Bernoulli series which was also run as a control. Therefore, we feel safe to say that this objection was not valid to our analysis of the data.

Results

The preliminary data analysis on 15 technically completed runs shows positive results in 11 of the cases. Positive is considered a deviation from the expected distribution of the alpha patterns with a significance corresponding to a chi square of more than 100. The results are tabulated (Table 1) following the arrangement explained in the data analysis and illustrated in Figures 2 and 3. As inspection of Table 1 reveals, deviation occurs as an increase of the percentage of occurrence which could be called a stimulation. Also the effect occurred both during stimulated periods and during total periods.

Discussion

From the above it is our impression that in certain instances the presence of alpha patterns in one human may influence its appearance in another. Contrary to our original opinion this is not more likely to occur in identical twins than in non-related subjects; i.e., between one of the twins and a control subject. This became apparent early in the experiment, but the original format was rigorously persued in order to avoid entrance of extraneous variations in the protocol which might have vitiated the results.

From the above preliminary data, under the conditions set, the phenomenon is not uncommon. It occurred in 11 out of 15 cases (technically complete runs). As stated the conditions were rather rigorous.

Many ideas and modifications have come to our attention. Are the same results expected in fraternal twins and siblings or in husband and wives or close friends? Does the time of day, month or year influence the results? Are the findings repeatable? How far apart may the subjects be placed and still obtain positive results? Do drugs or diet influence the phenomenon? Does it appear in lower animals? Is one subject actually influencing another or are both reacting to some outside source or influence? What is the nature of the influence; where does it fit in the electro-magnetic spectrum and how is it transmitted and received? Is it possible to be screened and thus inhibited? Are there several forms of influence? These are just a few of the questions which have occurred to us or have been suggested. We bring no evidence to bear on any of these points.

We have steadfastly avoided trying to answer all these questions and others because it seemed superfluous to study ramifications before it had been established whether coincidence of alpha patterns is a real phenomenon which can be demonstrated quantitatively. As stated above that objective alone has been the goal of the present investigation. To our satisfaction this question has now been answered affirmatively. If and when confirmed by others, various aspects and manifestations of the phenomenon deserve extensive and thorough study.

It is well known that alpha patterns spontaneously appear in certain individuals under circumstances where it is not commonly expected; namely, with eyes open in a lighted room. Any analysis of statistical influences from one subject to another would have to take these into account as described above. However, it is within the realm of possibility that the "spontaneity" may indeed be the response to some outside stimulation to that individual. Nevertheless, the analysis employed in this experiment measures coincidence of all alpha patterns stimulated or unstimulated and these are compared to the likelihood that they might have appeared by chance.

In the earlier experiment [2] some criticism was leveled that possibly the subjects were communicating. Moderate precautions (closed rooms, silent stimuli, impartial observers) were employed in this study to avoid such possibilities. It is unlikely that any of the subjects tested were aware of and capable of controlling their alpha waves. [4]

We recognize that our analysis of the results may be wanting though we have gone to some pains to check our methodology with knowledgeable experts in the fields of neurophysiology and in probability. We hope and prefer that our techniques will be repeated by others. Fortunately many of the data are on tape.

These are available to bona fide investigators for their own analysis (costs of reproduction and shipping to be borne by them).

If the findings of this experiment can be verified by others, it becomes apparent that many further studies may be undertaken to further elucidate this hitherto suspected but unrecognized and undocumented phenomenon.

Conclusion

The appearance of alpha patterns in one human may influence its appearance in another human. In selected instances, the coincidence of alpha patterns appear simultaneously in the EEG to a highly significant greater degree than would be expected by random chance. The nature of the influence accounting for the coincidence warrants further investigation.

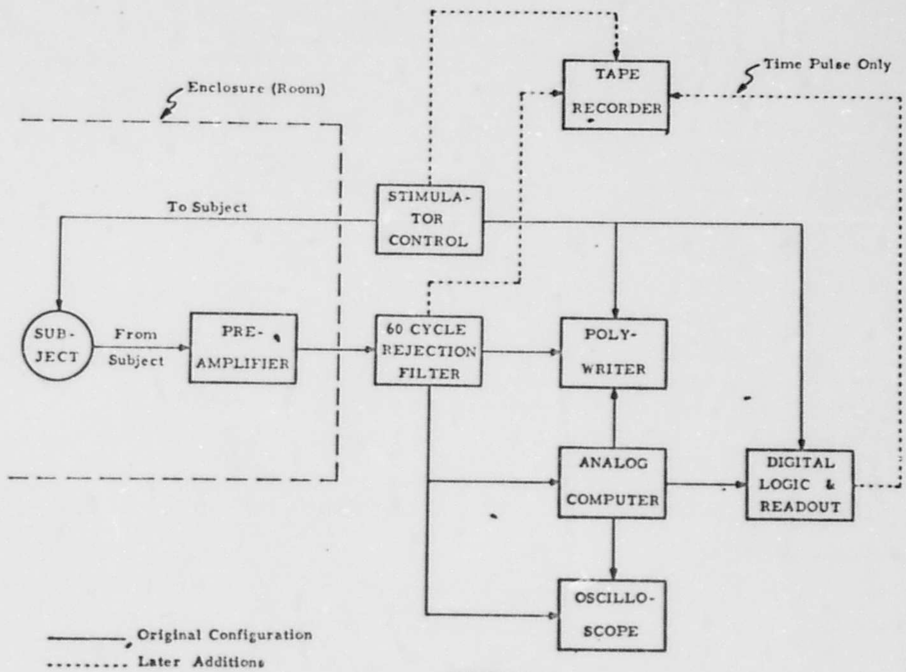

FIGURE 1

FLOW DIAGRAM OF EXPERIMENTAL DESIGN

TABLE I

	SUBJECT A						SUBJECT B						SUBJECT C					
roup I	(3)	(4)	Signif	(5)	(7)	Signif	(3)	(4)	Signif	(5)	(7)	Signif	(3)	(4)	Signif	(5)	(7)	Signif
bject A							2.69%	2.84%	1.66 1.60	.64%	2.97%	139.18 138.33	4.80%	2.56%	180.40 179.59	2.57%	2.81%	.61 .53
bject B	24.16%	20.44%	41.76 41.54	24.32%	20.55%	20.18 19.95							21.80%	20.50%	9.86 9.78	19.68%	20.67%	1.81 1.75
bject C	14.70%	7.73%	323.48 322.55	13.16%	7.96%	84.90 84.20	8.52%	7.93%	9.46 9.38	7.52%	8.13%	3.42 3.34						
roup II																		
bject A							21.19%	21.37%	.39 .38	21.45%	21.32%	.04 .03	21.76%	21.17%	3.85 3.82	20.82%	21.38%	1.66 1.63
bject B	24.29%	24.38%	.08 .08	25.37%	24.33%	1.70 1.65							21.24%	25.44%	178.85 178.62	26.95%	24.07%	40.23 40.09
bject C	17.83%	17.22%	4.37 4.32	15.26%	17.44%	9.55 9.40	13.61%	18.80%	345.99 345.62	18.62%	17.31%	4.89 4.80						
roup III																		
bject A							.14%	.42%	14.94 14.26	.09%	.41%	16.49 15.68	.56%	.37%	9.02 8.54	.01%	.43%	34.52 33.46
bject B	2.35%	2.32%	.02 .008	2.41%	2.32%	.15 .11							1.40%	2.44%	46.61 46.16	1.50%	2.40%	27.22 26.83
bject C	2.91%	2.84%	.07 .05	1.62%	2.89%	21.93 21.47	1.32%	2.99%	80.45 79.85	1.31%	2.95%	59.38 58.78						
roup IV																		
bject A							5.13%	5.88%	12.53 12.39	1.67%	6.11%	246.83 246.02	6.23%	5.66%	8.89 8.78	7.48%	5.66%	33.40 33.07
bject B	9.49%	7.19%	85.94 85.61	8.50%	7.42%	11.65 11.49							11.59%	6.49%	579.39 578.66	12.26%	7.20%	204.72 203.99
bject C	15.06%	14.45%	3.33 3.28	15.47%	14.45%	5.89 5.80	17.96%	13.96%	154.96 154.64	13.51%	14.61%	6.59 6.51						
roup V																		
bject A							.45%	.68%	21.47 21.08	.16%	.61%	22.19 21.42	1.03%	.54%	32.47 31.62	.61%	.58%	.13 .08
bject B	43.26%	38.62%	53.53 53.34	44.39%	38.57%	76.65 76.41							47.27%	38.12%	274.26 273.88	45.77%	38.42%	140.28 139.99
bject C	2.34%	1.95%	4.29 4.10	1.74%	2.00%	1.87 1.73	2.52%	1.59%	106.71 106.23	.93%	2.06%	41.39 40.81						

	SUBJECT A						SUBJECT B						SUBJECT C					
roup VI	(3)	(4)	Signif	(5)	(7)	Signif	(3)	(4)	Signif	(5)	(7)	Signif	(3)	(4)	Signif	(5)	(7)	Signif
bject A							2.01%	1.25%	59.84 59.29	.42%	1.47%	53.37 52.61	1.81%	1.32%	18.69 18.34	.77%	1.41%	10.15 9.68
bject B	8.93%	11.45%	38.45 38.20	5.02%	11.65%	216.83 216.17							5.50%	12.14%	458.76 458.09	17.38%	11.03%	135.39 134.73
bject C	7.07%	9.93%	56.66 56.34	4.96%	10.01%	143.52 142.95	5.16%	10.73%	492.31 491.68	11.39%	9.60%	24.27 24.07						
roup VII																		
bject A							5.24%	7.95%	99.33 98.95	4.72%	7.84%	74.05 73.61	7.89%	7.64%	.93 .89	7.34%	7.68%	.25 .20
bject B	4.49%	5.26%	11.46 11.31	6.15%	5.15%	5.97 5.76							4.44%	5.28%	14.52 14.35	4.38%	5.19%	2.15 1.99
bject C	9.27%	10.30%	11.09 10.98	5.52%	10.33%	74.08 73.55	10.36%	10.17%	.40 .38	11.90%	10.09%	19.36 19.16						
roup VIII																		
bject A							48.48%	42.71%	273.88 273.64	55.23%	43.70%	280.32 279.85	47.94%	43.64%	101.88 101.71	48.92%	44.14%	36.41 36.22
bject B	26.26%	22.67%	173.80 173.61	30.80%	24.01%	114.88 114.51							25.08%	24.18%	6.13 6.08	27.86%	24.18%	28.87 28.67
bject C	14.76%	11.86%	184.76 184.51	24.71%	12.64%	582.01 580.96	13.38%	13.16%	.88 .86	14.32%	13.16%	6.14 6.04						
roup IX																		
bject A							2.77%	1.99%	59.04 58.70	1.19%	2.38%	53.89 53.35	4.17%	2.19%	58.25 57.36	.25%	2.29%	21.48 20.57
bject B	33.06%	28.90%	48.95 48.75	29.27%	29.20%	.01 .007							28.27%	29.23%	1.43 1.38	0 %	29.57%	435.42 433.99
bject C	3.73%	2.34%	48.63 48.04	2.31%	2.44%	.30 .25	3.28%	1.95%	166.36 165.80	2.42%	2.43%	.008 .003						
roup X																		
bject A							23.74%	16.49%	570.72 570.22	34.74%	17.23%	660.86 659.66	24.28%	16.62%	556.16 555.63	6.32%	17.98%	208.81 208.02
bject B	19.58%	13.94%	484.35 483.92	23.13%	14.70%	337.59 336.93							6.56%	16.57%	1068.12 1067.34	5.10%	15.38%	184.33 183.53
bject C	14.68%	11.32%	214.84 214.52	.63%	12.76%	848.63 847.48	6.03%	13.39%	860.41 859.71	9.50%	12.15%	20.9 20.66						

	SUBJECT A						SUBJECT B						SUBJECT C					
Group XI	(3)	(4)	Signif	(5)	(7)	Signif	(3)	(4)	Signif	(5)	(7)	Signif	(3)	(4)	Signif	(5)	(7)	Signif
Subject A							17.61%	6.56%	539.93 538.21	4.44%	6.89%	13.19 12.81	8.08%	6.75%	22.27 22.06	5.65%	6.93%	13.58 13.38
Subject B	5.05%	1.04%	1028.10 1025.22	1.87%	1.39%	3.84 3.51							2.12%	1.34%	35.63 35.06	.90%	1.43%	10.91 10.53
Subject C	4.91%	2.88%	120.87 120.19	3.21%	3.06%	.18 .13	6.92%	2.95%	149.76 148.43	4.58%	3.04%	11.14 10.62						
Group XII																		
Subject A							3.02%	3.25%	1.63 1.55	3.03%	3.24%	.63 .57	3.71%	3.13%	15.01 14.83	2.96%	3.26%	2.60 2.53
Subject B	6.33%	6.31%	.0045 .0020	6.42%	6.31%	.14 .12							6.09%	6.36%	1.82 1.77	6.15%	6.33%	.54 .51
Subject C	7.29%	7.39%	.11 .09	6.29%	7.46%	12.63 12.46	8.03%	7.30%	7.45 7.35	9.39%	7.27%	30.62 30.31						
Group XIII																		
Subject A							2.10%	6.93%	1013.32 1012.38	6.79%	5.34%	14.83 14.55	5.43%	5.39%	4.10 3.31	5.73%	5.38%	1.19 1.12
Subject B	35.70%	30.33%	104.49 104.23	81.87%	29.14%	3978.00 3975.52							34.03%	30.30%	74.24 74.06	44.08%	30.08%	442.00 441.34
Subject C	8.37%	8.27%	.108 .094	9.19%	8.25%	3.52 3.39	7.79%	8.52%	15.54 15.44	9.52%	8.23%	7.87 7.70						
Group XIV																		
Subject A							.37%	1.08%	32.77 32.07	0%	1.08%	46.07 45.02	.30%	1.07%	23.69 22.95	.28%	1.06%	22.32 21.56
Subject B	1.74%	3.15%	40.91 40.43	1.58%	3.15%	43.54 43.01							3.30%	3.04%	.90 .81	2.39%	3.08%	5.97 5.74
Subject C	.03%	.47%	27.55 26.56	0%	.47%	26.81 25.75	.79%	.41%	20.80 19.96	.16%	.46%	7.82 7.17						
Group XV																		
Subject A							2.66%	2.92%	1.11 1.02	1.97%	2.94%	10.32 9.98	4.85%	2.83%	61.68 60.97	5.08%	2.85%	49.84 49.06
Subject B	1.97%	1.49%	8.23 7.92	1.82%	1.51%	1.80 1.60							3.54%	1.43%	127.14 125.73	1.74%	1.51%	.92 .78
Subject C	1.50%	1.54%	0.08 0.05	.58%	1.57%	18.08 17.44	2.82%	1.49%	52.20 51.33	.78%	1.58%	12.86 12.35						

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APPENDIX I (See Table I, Group XII) (See Figure 4)

The following represents an actual example of a run. The randomized work sheet and the results as read from the counters in the analyzer are reproduced. Also included is a segment of the polywriter record showing the alpha pattern of the three subjects, the status of stimulation and the analysis of alpha by the pattern analyzer.

TYPICAL TWIN PROTOCOL

Date 14 March 1968

Time 2:30 p.m.

A. Name Mary Smith Age 18 Sex F Relationship Control

Address ____________ Phone ____________

Observer ____________

B. Name John Doe Age 21 Sex M Relationship Twin

Address ____________ Phone ____________

Observer ____________

C. Name George Doe Age 21 Sex M Relationship Twin

Address ____________ Phone ____________

Observer ____________

Instrument Setup

1. Connect electrodes to subjects A, B, C. (two occipital, one wrist ground)
2. Connect commands to subjects A, B, C.
3. Test recorder.
4. Test commands - hand held and room lights.
5. Test pattern analyzer.

Comments

A Twin Protocol

Instrument Setup

1. Set logic to positive.
2. Set counters to zero.
3. Start recorder.
4. Start run.

Stimuli - Simultaneous
(lighted room: on - eyes closed; off - eyes open)

1. 30-second non-stimulated run.
2. 10 on 20 off 10 on 20 off 10 on 20 off
   10 on 20 off 10 on 20 off 10 on 20 off
3. 30-second non-stimulated run.

Instrument

1. Stop run.
2. Stop recorder.
3. READ COUNTERS.

   a. total time 240.89

   b. alpha A 43.23 alpha B 39.78 alpha C 58.54

   c. stim. alpha A 38.48 stim. alpha B 34.42 stim. alpha C 39.59

   d. alpha A alpha B 24.52

      alpha A alpha C 28.36

      alpha B alpha C 24.64

   e. alpha A stim. alpha B 23.60 alpha B stim. alpha C 26.64

      alpha A stim. alpha C 23.75 alpha C stim. alpha A 24.41

      alpha B stim. alpha A 26.10 alpha C stim. alpha B 23.83

B Twin Protocol

Instrument

1. Set logic to positive.
2. Set counters to zero.
3. Start recorder.
4. Start run.

Stimuli - Individual
(lighted room: on - eyes closed; off - eyes open)

1. 30-second non-stimulated run.

2. B — 10 on 20 off, 10 on 20 off, 10 on 20 off / 10 on 20 off, 10 on 20 off, 10 on 20 off

2.	__B__	10 on 20 off	10 on 20 off	10 on 20 off
		10 on 20 off	10 on 20 off	10 on 20 off

3. 30-second non-stimulated run.

4.	__A__	10 on 20 off	10 on 20 off	10 on 20 off
		10 on 20 off	10 on 20 off	10 on 20 off

5. 30-second non-stimulated run.

6.	__C__	10 on 20 off	10 on 20 off	10 on 20 off
		10 on 20 off	10 on 20 off	10 on 20 off

7. 30-second non-stimulated run.

8.	A	10 on	20 off	C	10 on	20 off	C	10 on	20 off	C	10 on	20 off
	C	10 on	20 off	B	10 on	20 off	C	10 on	20 off	A	10 on	20 off
	C	10 on	20 off	B	10 on	20 off	A	10 on	20 off	A	10 on	20 off

9. 30-second non-stimulated run.

Instrument

1. Stop run.
2. Stop recorder.

B Twin Protocol (continued)

3. READ COUNTERS.

a. total time 1052.46

b. alpha A 99.53 alpha B 112.47 alpha C 173.85

c. stim. alpha A 67.72 stim. alpha B 49.10 stim. alpha C 103.90

d. alpha A alpha B 7.66

alpha A alpha C 10.35

alpha B alpha C 14.91

e. alpha A stim. alpha B 1.42

alpha A stim. alpha C 3.38

alpha B stim. alpha A 4.36

alpha B stim. alpha C 6.39

alpha C stim. alpha A 4.26

alpha C stim. alpha B 4.61

C Twin Protocol

Instrument

1. Set logic to negative.
2. Set counters to zero.
3. Start recorder.
4. Start run.

Stimuli - Simultaneous
(eyes open: on - room light on; off - room light off)

1. 30-second non-stimulated run.
2. 10 on 20 off 10 on 20 off 10 on 20 off
   10 on 20 off 10 on 20 off 10 on 20 off
3. 30-second non-stimulated run.

Instrument

1. Stop run.
2. Stop recorder.
3. READ COUNTERS.
   a. total time 240.88
   b. alpha A 193.35 alpha B 179.54 alpha C 149.21
   c. stim. alpha A 44.00 stim. alpha B 61.51 stim. alpha C 42.27
   d. alpha A alpha B 148.74
      alpha A alpha C 125.67
      alpha B alpha C 121.93
   e. alpha A stim. alpha B 61.05 alpha B stim. alpha C 48.13
      alpha A stim. alpha C 46.54 alpha C stim. alpha A 46.46
      alpha B stim. alpha A 55.00 alpha C stim. alpha B 58.34

D Twin Protocol

Instrument

1. Set Logic to negative.
2. Set counters to zero.
3. Start recorder.
4. Start run.

Stimuli - Individual

(eyes open: on - room light on; off - room light off)

1. 30-second non-stimulated run.

2.

C	10 on 20 off	10 on 20 off	10 on 20 off
	10 on 20 off	10 on 20 off	10 on 20 off

3. 30-second non-stimulated run.

4.

B	10 on 20 off	10 on 20 off	10 on 20 off
	10 on 20 off	10 on 20 off	10 on 20 off

5. 30-second non-stimulated run.

6.

A	10 on 20 off	10 on 20 off	10 on 20 off
	10 on 20 off	10 on 20 off	10 on 20 off

7. 30-second non-stimulated run.

8.

B	10 on	20 off	B	10 on	20 off	C	10 on	20 off	C	10 on	20 off
A	10 on	20 off	C	10 on	20 off	B	10 on	20 off	C	10 on	20 off
C	10 on	20 off	B	10 on	20 off	A	10 on	20 off	C	10 on	20 off

9. 30-second non-stimulated run.

D Twin Protocol (continued)

Instrument

1. Stop run.

2. Stop recorder.

3. READ COUNTERS.

a. total time 1021.53

b. alpha A 787.01 alpha B 777.76 alpha C 558.38

c. stim. alpha A 64.50 stim. alpha B 100.56 stim. alpha C 81.50

d. alpha A alpha B 607.06

alpha A alpha C 431.22

alpha B alpha C 426.35

e. alpha A stim. alpha B 71.85

alpha A stim. alpha C 68.69

alpha B stim. alpha A 99.23

alpha B stim. alpha C 60.09

alpha C stim. alpha A 24.19

alpha C stim. alpha B 58.97

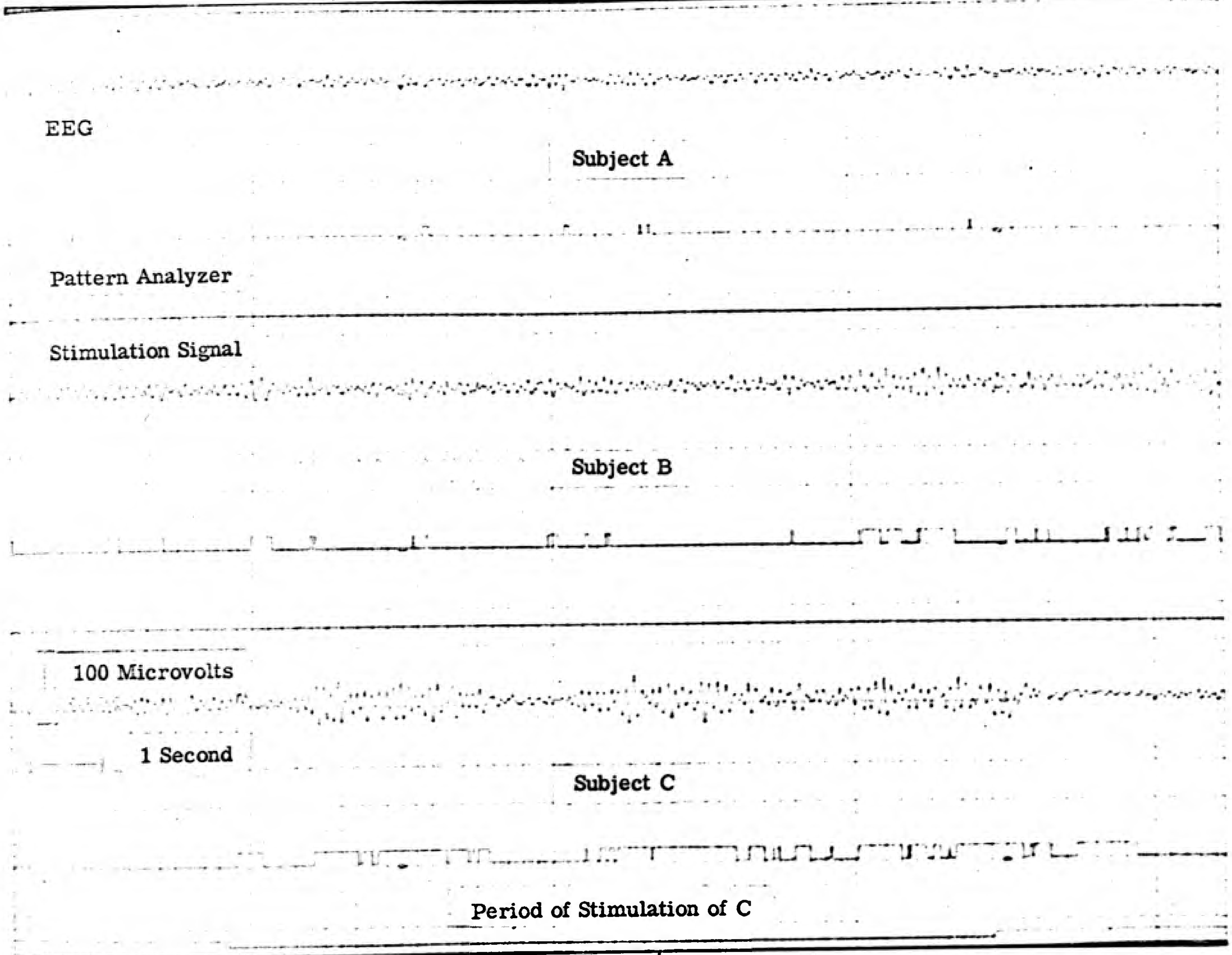
EEG
Subject A
Pattern Analyzer
Stimulation Signal
Subject B
100 Microvolts
1 Second
Subject C
Period of Stimulation of C

Figure 4

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