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W.F. Angermeier
John B. Phelps
Florida Presbyterian College

Herbert H. Reynolds, Lt Colonel, USAF
Aeromedical Research Laboratory

Robert Davis
VA Research Center
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The animals used in this study were handled in accordance with the "Guide for Laboratory Animal Facilities and Care" as promulgated by the National Academy of Sciences - National Research Council.

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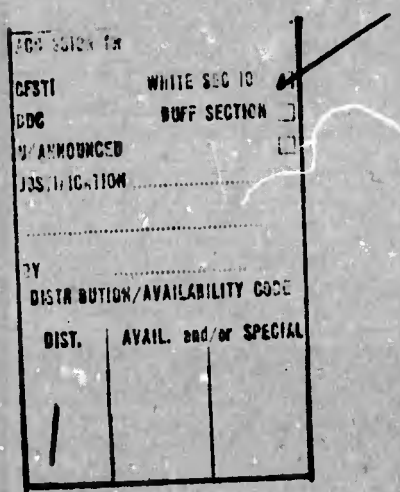

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FOREWORD

This experimentation, which began on 1 November 1966 and was completed on 31 July 1967, was performed by the Primate Neuro-Sciences Laboratory at Florida Presbyterian College, St. Petersburg, Florida. The research was conducted under contract AF29600-67-C-0011 with the 6571st Aeromedical Research Laboratory, Holloman AFB, New Mexico and Project 7906, Office of Aerospace Research. The research was conducted under the monitorship of Lt Colonel Herbert H. Reynolds.

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Appreciation is expressed to Smith, Kline and French Laboratories, Philadelphia, Pennsylvania for making Stelazine (trifluoperazine) available to this study without charge.

This technical report has been reviewed and approved for publication.

C.H. KRATOCHVIL, Colonel, USAF, MC
Commander

ABSTRACT

A study was made to determine the effects of social change versus chemotherapy upon performance and biochemical response in non-human primates (rhesus monkeys). Twenty-four male rhesus monkeys from 26-30 months of age were used for this research. The results indicated the following: (1) performance of complex discrimination improves for social subdominant animals changed to isolation; (2) performance of complex discrimination shows a decrement for isolated animals which become subdominant after the change to a state of social companionship; (3) social status along the dominant-subdominant scale seems to be more important for prediction of performance than the perceptual conditions of the living environment; (4) both changed environments and injections of Stelazine (trifluoperazine) improved the biochemical condition of subjects so treated; (5) there was little or no difference between the relative therapeutic effects of changed social environments and Stelazine injections; (6) Stelazine reduced sensitivity to shock in a shock-escape match-to-sample task according to degrees of previous environmental stimulation during early rearing. The least affected Ss were the animals reared in strict isolation. Both partial isolates and normal social Ss were moderately affected. The greatest reduction of reactivity was observed in the enriched social Ss. The noted effects were interpreted as indicating differential early sensory threshold development in the four rearing groups used in this experiment; (7) differential rearing conditions, as used in this study, had no effect upon any of the factors mentioned above.

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INTRODUCTION

A great many experiments have been published describing the effects of early experience upon adulthood, including biochemistry and brain size. From the wealth of data, only those studies in which perceptual enrichment, group rearing and social isolation were important variables are discussed here.

Animals reared in perceptually enriched environments performed significantly better than their isolated counterparts on a closed-field test (Hymovitch, Ref. 1), on reversal discrimination under food deprivation (Krech, Rosenzweig and Bennett, Ref. 2), and showed more advantageous brain chemistry and anatomy (Krech, Rosenzweig and Bennett, Ref. 3). Socially facilitated restriction of the fear response in animals raised in groups was observed by Morrison and Hill (Ref. 4) and Angermeier, Philhour and Higgins (Ref. 5).

Group rearing increases the effectiveness of social reinforcement, as shown in a study by Angermeier (Ref. 6), but decreases the likelihood of dominance over animals reared in isolation as described by Uyeno and White (Ref. 7). Even the selection of social partners seems to depend upon the nature of prior contact during rearing. The test animals used in a study by Pratt and Sackett (Ref. 8) preferred other animals reared under the same conditions. Isolation takes its toll not only in terms of implicit pathological conditions, as was described in a study by Kaufman and Rosenblum (Ref. 9), but also in endocrinopathy (Hatch, Wiberg, Balazs and Grice, Ref. 10) and in manifestations of stress, as in weight loss, relative adrenal weights, and relative adrenal steroid output (Stern, Winokur, Eisenstein, Taylor and Sly, Ref. 11). An important question to ask now is this: "Are these changes and modifications brought about during early rearing irreversible or can procedures be designed which would counteract the seeming disadvantages stemming from early isolation and perceptual impoverishment?"

Although some of the effects of early restriction are undoubtedly irreversible or extremely difficult to modify (Harlow, Ref. 12), there is evidence that this is not uniformly the case. Rosenzweig (Ref. 13) pointed out "that the cortex of the adult rat brain is as capable of adaptive growth as is the cortex of the young animal." Baron, Kish and Antonitis (Ref. 14) showed that the

effects of early isolation or social contact in chickens may be modified by later social experiences. Perhaps the most unequivocal answer to the question posed above comes from a study by Reynolds (Ref. 15). This investigator placed rats, reared in isolation, into a social environment. As a result, their performance of an escape task improved significantly. When these same animals were returned to their original isolate state, performance showed a significant decrement. On the other hand, the performance of social control Ss -- which were changed to isolation and later returned to the former social state -- showed no significant increment or decrement. It appears from this study that the change to the social environment was "therapeutic" for the animals previously reared in isolation.

The hypothesis, implicit in Reynolds' (Ref. 15) findings, was tested in this study on a group of male rhesus monkeys to further discern phyletic relationships and differences. Specifically, the effects of changing environments versus injections of a well-known anti-anxiety drug, Stelazine (trifluoperazine), upon performance of a discrimination task and concomitant blood biochemistry variations were investigated.

GENERAL METHODOLOGY

Subjects

Twenty-four male rhesus monkeys from a colony of 28, 20-22 months old at the beginning of the main testing phase, were used as Ss. Six animals each had previously been reared under one of the four following conditions: (1) Strict Isolation (SI): one animal per cage, no visual or tactual contact with peers. (2) Partial Isolation (PI): one animal per cage, with visual but little tactual contact with peers. (3) Social Environment (S): two animals per cage, some interaction between cages. (4) Enriched Social Environment (ES): two animals per cage, with play objects, swings and colored lights added. Since the age of 14-16 months, i.e., 6 months before the main testing phase began, these animals had also been exposed to 8 hours of daily television watching on a black-and-white screen. The animals were maintained on fresh fruit and biscuits in addition to water.

Apparatus: Physical Properties

The apparatus consisted of a performance cage 18 inches wide, 24 inches long, 32 inches high. All sides of the apparatus except the top and the performance panel were made of 3/8 inch stainless steel rods, spaced 1 inch center to center. The top of the cage was constructed of 1/2 inch clear plastic. One of the sides, 18 inches wide and 32 inches high, constituted the performance panel, a frontal view of which is shown in Figure 1.

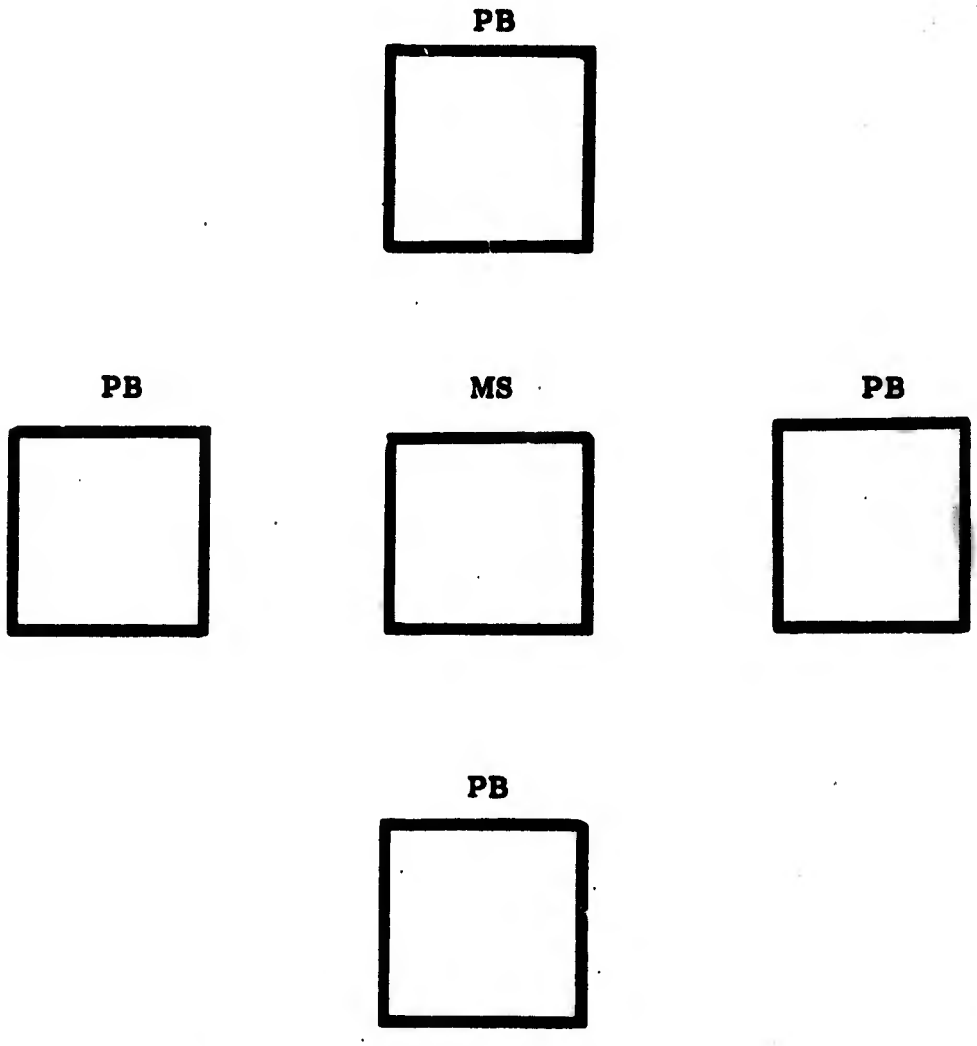


Figure 1. Frontal View of Performance Panel. (Distance between MS and PB = 3.75 inches center to center.)

The plastic pushbutton in the center served as a master sample (MS) and could not be depressed. The other four plastic pushbuttons (PBs) were resting on microswitches, which could be activated by a horizontal depression of 1/16 inch. Affixed to the back of all the pushbuttons (MS and PBs) were inline digital display units (IDDs) which permitted the presentation of outlines of various geometric symbols and colors. In this experiment, only four symbols and the color red was used. The four symbols were: O, □, Δ, and +. All experimental contingencies were programmed automatically with the aid of relay circuitry equipment.

Apparatus: Functional Properties

For this study, the experimental contingencies were programmed as follows: A 1000 CPS tone was given; 2 seconds later shock (1.0 - 3.0 ma) activated the rods of the performance cage; 1 second after the onset of shock, the MS and the PBs presented the symbols to the animal. The first three presentations in the series of 26, programmed into a stepper, are shown in Figure 2.

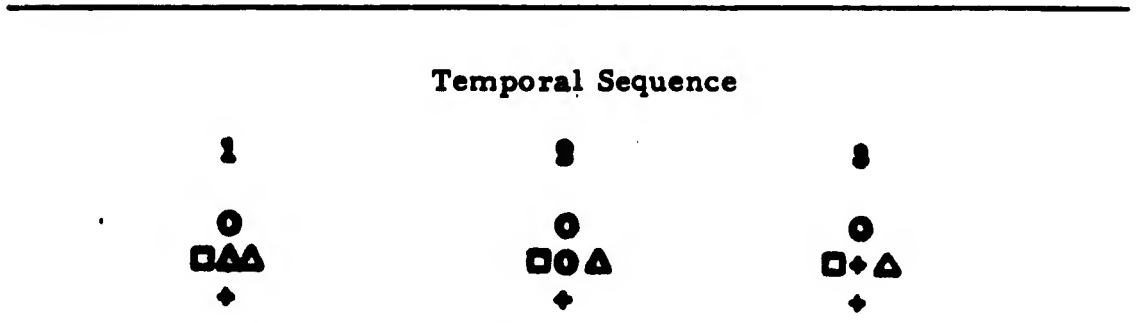


Figure 2. Part of Presentation Sequence

For the complete sequence, see Appendix I.

A depression of the PB which matched the MS turned off the shock and gave the animal a 15-second time-out (TO). After TO, the next presentation of the shock-escape paradigm appeared as described above. The animals were given 50 trials per session. Since the stepper contained 26 steps in sequence it was assured that the animal always started his 50-trial session at a point in the sequence which was different from S's previous 50-trial session.

When training was first begun, an additional circular red color cue was used which embedded the yellow lighted outline of the symbol on the MS and the corresponding correct PB. To eliminate this color cue eventually, four phases were programmed:

Phase I - Color cue at 100 percent brightness
Phase II - Color cue at 75 percent brightness
Phase III - Color cue at 50 percent brightness
Phase IV - Color cue absent

An animal was permitted to progress from one phase to the next when it had obtained a score of 90 percent (45 of 50) correct first responses in a 50-trial session.

Procedure

All of the 24 animals used in this study had previous experience with a similar 4-choice match-to-sample (M-T-S) task. Six months prior to the start of this study, these animals were exposed to a 15-week match-to-sample task, using both positive and negative reinforcement (Angermeier and Phelps, Ref. 16). From these 24 animals (six of each rearing group), the four best performers of the ES and S groups and the four worst performers of the SI and PI groups (a total of 16 Ss) were selected for the behavioral study described here.

The rationale for this procedure was, following Reynolds' (Ref. 15) experience with rats, to detect any performance increment in the SI and PI animals and to detect any performance decrement in the S and ES animals.

From the beginning of the experiment, all Ss were exposed to a 50-trial session on alternate days, week-ends and holidays included. When 80 percent of the animals reached an asymptotic level of performance (± 5 percent deviation over 250 trials), the main experimental phases were begun. The temporal sequence of these phases is shown in Table I.

TABLE I

Temporal Sequence of Experimental Phases

Temporal Order	Independent Variable	Blood Withdrawal	Performance
1 (17 months)	Rearing Environment		
2 (20 weeks)	Rearing Environment		M-T-S Asymptotic level reached
3 (10 days)	Rearing Environment	Day 7	M-T-S Post-asymptotic performance
4 (30 days)	Changed Environments[a]	Days 3, 13, 23	M-T-S
5 (10 days)	Rearing Environments	Day 3	M-T-S
6 (30 days)	Rearing Environments and Stelazine injections[b]	Days 3, 13, 23	M-T-S

[a]Two of four ES animals were changed to SI (total SI colony N=8).
Two of four S animals were changed to PI (total PI colony N=8).
Two of four PI animals were changed to S (total S colony N=6).
Two of four SI animals were changed to ES (total ES colony N=6).

[b]The animals previously changed were given a 0.01 mg/lb body weight Stelazine injection twice daily, at 7 A.M. and 7 P.M. All other animals (a total of 16 Ss) received equivalent (in volume) injections of Saline.

None of the animals were handled, except during blood withdrawal. All injections were given intraperitoneally and for these, as well as for transfer to the performance cage, the animals were handled by standard squeeze-cage techniques.

The rationale for this part of the procedure was to determine both the effects of changed environments and Stelazine injections on M-T-S performance and blood biochemistry.

Data Selection

The behavioral data selected consisted of:

(1) 10-day sums of latencies
(2) 10-day sums of number of first correct responses
(3) 10-day sums of number of trials completed on the M-T-S task.

The biochemical analyses performed by standard techniques, included the following:

(1) Cholinesterase (Ref. 17, 18)
(2) Calcium (Ref. 19)
(3) Tyrosine (Ref. 20)
(4) Cholesterol (Ref. 21)
(5) Serum Total Proteins (Ref. 22)
(6) Serum Glutamic Oxalacetic Transaminase - SGOT - (Ref. 23)

The selection of these particular biochemical analyses was dictated by the findings of a previous study (Ref. 24) in which these measures were found to be the most sensitive in a series of 21 biochemical analyses performed on rhesus monkeys.

RESULTS AND DISCUSSION: BEHAVIORAL MEASURES

1. The Effects of Changed Environments

Percent first correct responses were analyzed by a Type III Analysis of Variance Design, suggested by Lindquist (Ref. 25). Only temporal sequence proved to be significant ($F = 3.49$ for 4 and 32 dfs, $p < .05$).

All raw data can be seen in Appendix II. A separation of the animals' performance along the dominance-subdominance dichotomy can be seen in Figure 3. In Figure 3, the change in performance of the dominant animals and the control animals shows no significant increment or decrement. The formerly subdominant animals now changed to isolation actually showed a significant increment in performance efficiency.

In order to determine the significance of these changes, the maximum decrements and increments in percent first correct responses for each group in Figure 3 between the pre-change period and the respective change period was computed by using t-tests for differences between correlated means. The results can be seen in Table II.

TABLE II

Effect of Changed Environment on Performance

Change	Increment	Decrement	p
Social subdominant Ss to Isolation (A)	X		.05
Social dominant Ss to Isolation (B)	-	-	-
Isolated Ss to Social State (dominant) (C)	-	-	-
Control Ss (D)	-	-	-
Isolated Ss to Social state (subdominant) (E)		X	.01
Difference between A and E (F)	-	-	.01

(A) t = 2.62/10 dfs
(E) t = 4.58/10 dfs
(F) t = 4.43/10 dfs

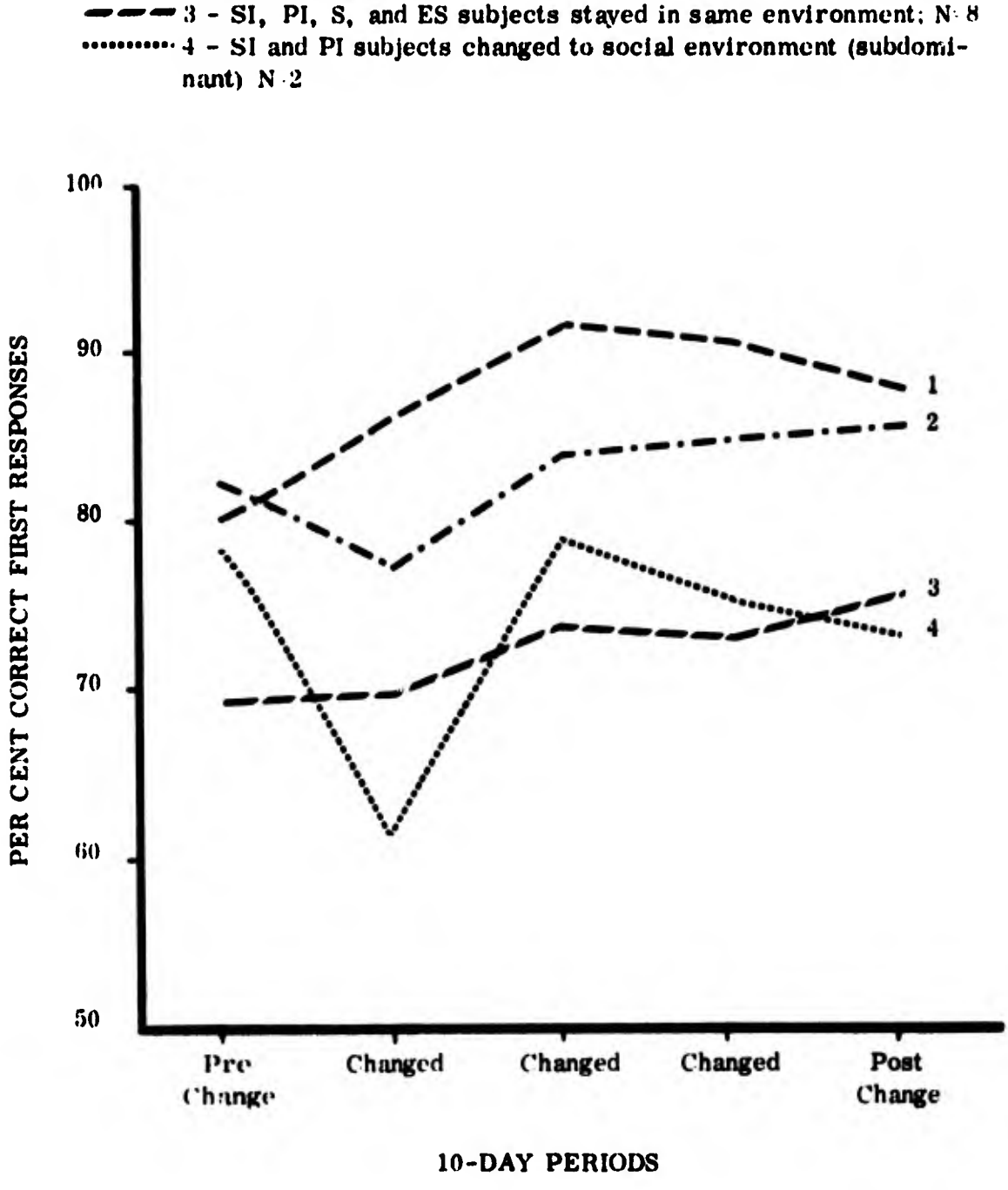


Figure 3. The effects of changed environments upon percent first correct responses of a match-to-sample task.

Latencies were analyzed next. Again a Type III Analysis of Variance Design was used.

TABLE III

Summary Analysis of Variance: Latencies
(The Effects of Changed Environments)

Source	dfs	MS	F
Environments (B)	3	230,721.14	
Changes (C)	1	93,913.51	
B X C	3	203,271.38	
Error b	8	224,612.31	
Temporal Sequence (A)	4	244,827.09	7.37***
A X B	12	27,636.59	
A X C	4	4,661.23	
A X B X C	12	34,260.18	
Error w	32	33,207.46	

*** Significant at the .001 level.

An analysis of the simple effects showed that A1 was significantly larger than A2, A3, A4, and A5. This relationship is more clearly evident in Figure 4. In this figure the latency data of all experimental animals (C1) are combined and compared with those of the control animals (C2).

The data presented in this section (Tables II and III, and Figures 3 and 4) indicate that only animals which were or have become subdominant are significantly influenced by the change of the social environment. Control Ss and animals who were or have become dominant show no significant change in performance. For the subdominant social Ss which go into isolation, the change appears to be "therapeutic", as measured by significant increments in correct

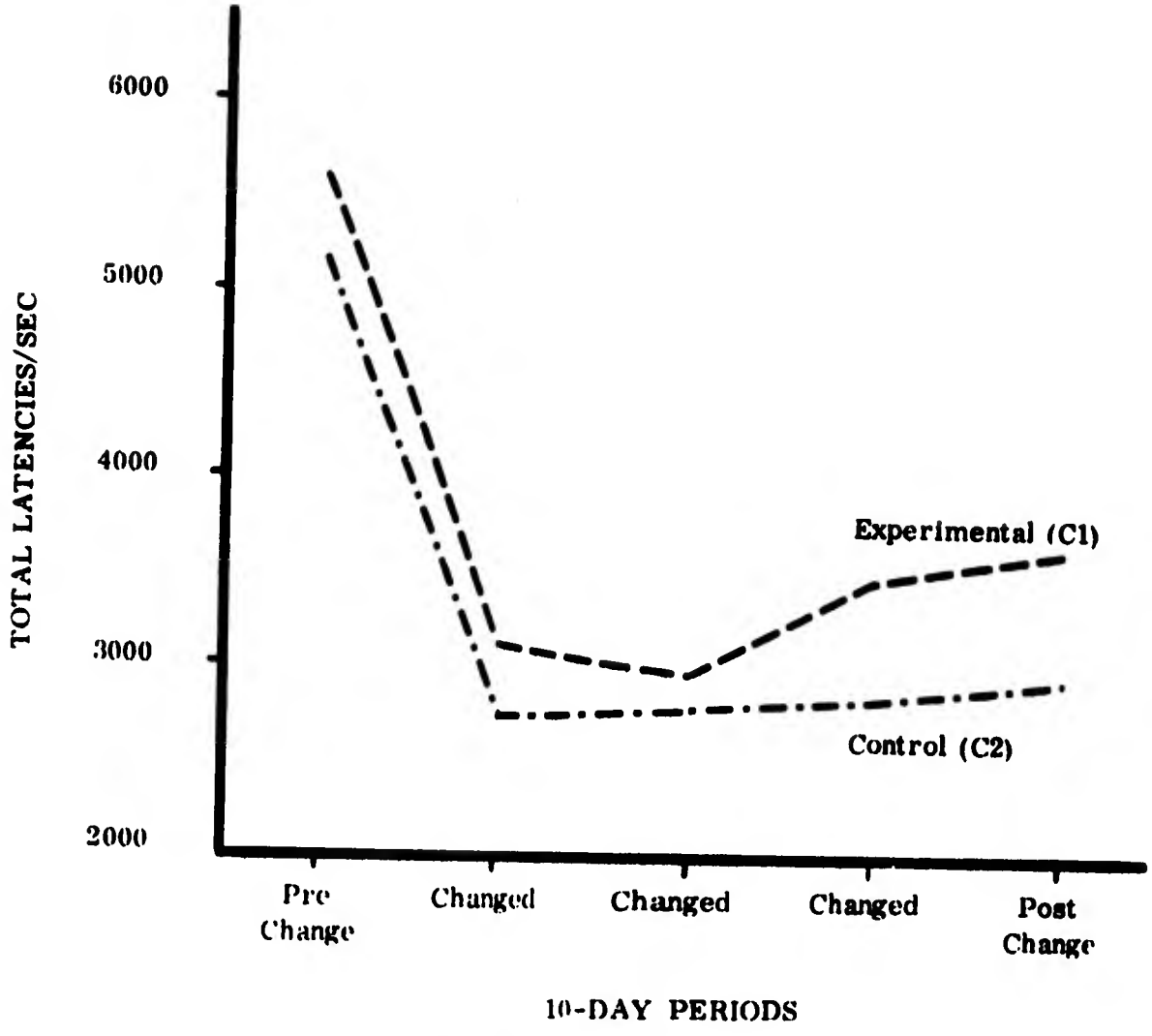


Figure 4. The effects of changed environments upon performance latencies.

M-T-S performance. The opposite is true for the formerly isolated Ss which are changed to a state of social companionship and become subdominant.

All these changes appear to be transient, as shown in Figure 3. The significant reduction in latencies is probably due to the general state of excitement when the social changes occurred in the animal colony.

II. The Effects of Stelazine

Since most of the C1 animals did not complete all or any of their 50-trial sessions during the 30-day Stelazine/Placebo injection phase, the only useful raw data to be analyzed were number of trials completed during this period. As in the previous analysis of percent first correct responses and latencies, so here, too, the sums of 10-day periods were used as the basic unit of analysis. Sessions were terminated when S failed to respond to one presentation within 200 seconds. The raw data are shown in Table IV and in Figure 5.

TABLE IV

Effects of Stelazine Upon Activity: Number of Trials Completed

Rearing Environments	First 10 days		Second 10 days		Third 10 days	
	S[a]	P[b]	S	P	S	P
Strict Isolation	304	500	396	500	500	500
Partial Isolation	153	500	270	500	106	500
Social	208	500	112	500	99	500
Enriched Social	88	500	11	500	51	500

[a]Stelazine injected
[b]Placebo (saline) injected

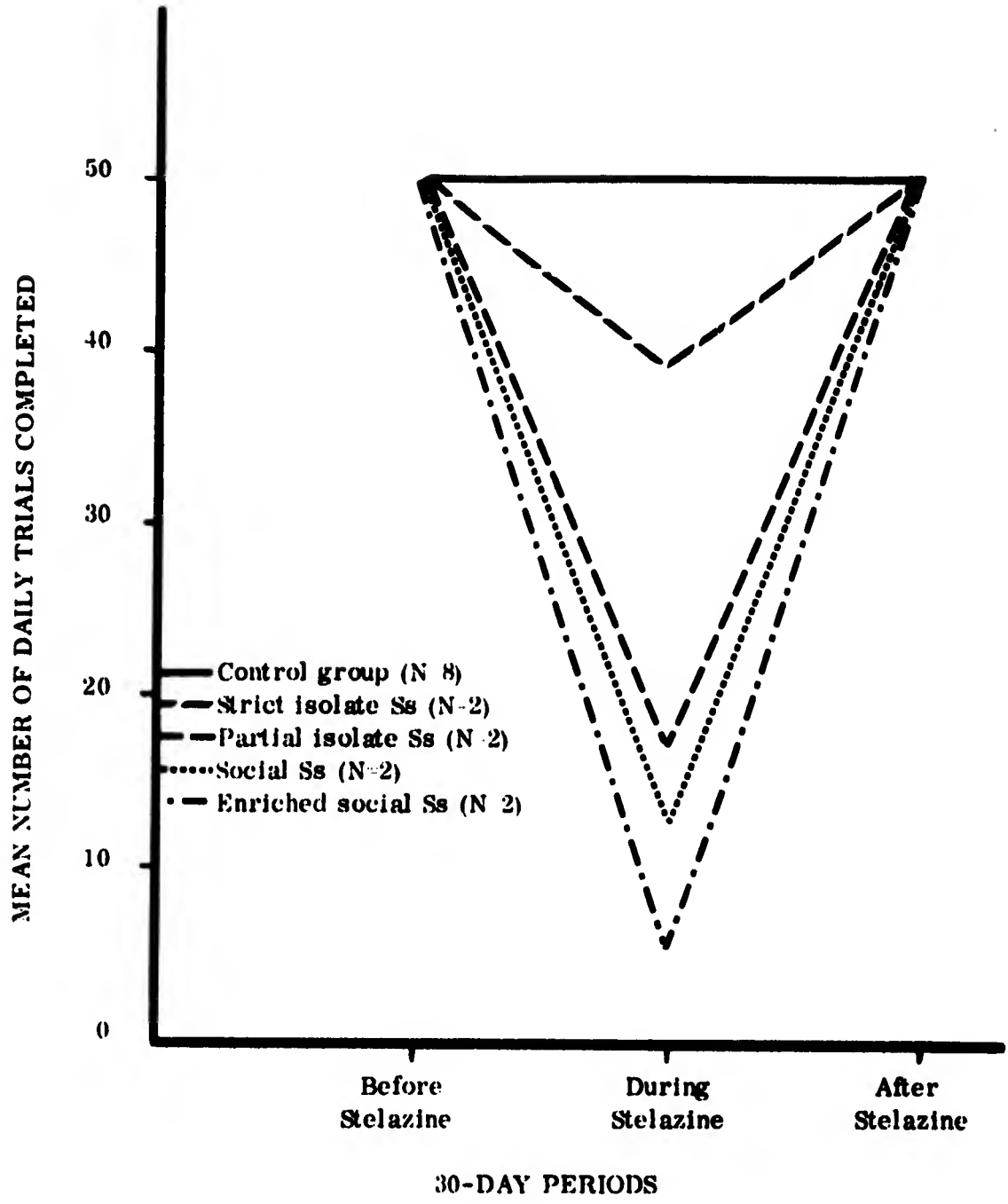


Figure 5. The effects of Stelazine upon performance of a match-to-sample task.

The raw data (number of daily trials completed) for the Stelazine injected animals were subjected to t-tests for differences between correlated means to determine the significance of changes between the pre-drug, drug, and post-drug periods on one hand, and the differences between the four rearing groups on the other. The results of these analyses can be seen in Table V.

TABLE V

Summary of Stelazine Effect on Rearing Groups

Groups	Pre-Drug/Drug	Drug/Post-Drug
Strict Isolation Ss (SI)	.01	.01
Partial Isolation Ss (PI)	.01	.01
Social Ss (S)	.01	.01
Enriched Social Ss (ES)	.01	.01

Groups Compared	Difference between Change: Pre-Drug/Drug	Group with Smaller Change
SI - PI	.01	SI
SI - S	.01	SI
SI - ES	.01	SI
PI - S	N/S	PI
PI - ES	.01	PI
S - ES	.02	S

The data indicate that discriminatory problem solving behavior, as used in this study, was suppressed in accordance with the amount of stimulation to which the animals were exposed during their previous 2-year period of rearing. The more stimulus input had occurred previously, the more suppression was evident.

If these results are viewed from the standpoint of sensory threshold development in differential early rearing procedures, it is evident that the animals subjected to a greater amount of sensory stimulation during rearing have a higher threshold for pain under the influence of Stelazine and vice versa.

Most important, however, is the evidence that Stelazine did affect the four rearing groups differentially. Interesting also is the confirmation of observational evidence that the normal social and the partial isolation Ss are much alike in their cage behavior and problem solving activity.

The findings reported here may have significance for drug administration in general and the use of Stelazine, in particular. The data point out that level of sensory input in the organism to be injected seems to be an important variable to consider when Stelazine is used for therapeutic purposes.

RESULTS AND DISCUSSION: BIOCHEMICAL MEASURES

I. The Effects of Changed Environments

In order to assess the effects of changed environments on blood biochemistry, 3-4 cc of blood was drawn from the great saphenous vein three days before half of the animals were changed from one environment to another, during the 3rd, 13th, and 23rd day of changed environments, and three days after the experimental animals were returned to their original environments. The biochemical values (raw data) for Cholinesterase, Calcium, Tyrosine, Cholesterol, Serum Total Protein, and SGOT were analyzed by a Type III Analysis of Variance Design. The results of these analyses appear in Table VI. The appropriate raw data are presented in Appendix III.

In order to assess the simple effects between the significant C factors apparent in Table VI, appropriate t-tests were applied to the differences between the means of C1 (changed and shock-escape tested), C2 (unchanged and shock-escape tested), and C3 (unchanged and not shock-escape tested), of the Cholinesterase and Calcium data. The results of these tests showed that for Cholinesterase the C1 group had a higher value than the C3 group ($p < .02$), and the C2 group also showed a higher value than the C3 group ($p < .05$). For Calcium $C3 > C1$, and $C3 > C2$, ($p < .05$ and $< .02$, respectively).

TABLE VI

Summary of Analyses of Variance - Changed Environments and Biochemistry

Source of Variance	dfs	Cholinesterase	Calcium	Tyrosine	Cholesterol	S. T. Protein	SGOT
Total (T)	119						
Subjects (S)	23						
Rearing (B)	3						
Changes (C)	2	.05[a]	.05				
(B X C)	6						.05
Error b	12						
Within Subjects (WS)	96						
Blood Samples (A)	4	.001	.001	.001	.025		.001
(A X B)	12						
(A X C)	8						
(A X B X C)	24						
Error w	48						

[a] Refers to significance of respective F-ratio

The differences between the experimental group (C1) and the two control groups (C2 and C3), seems to be important for discussion. The experimental group (C1) consisted - as previously mentioned - of two animals from each of the four rearing conditions. These animals were under considerable stress, deriving from two sources: (1) they were changed to different environments, and (2) they were exposed to rigid shock escape training on the match-to-sample task. The (C2) control group - consisting also of two Ss from each rearing group - was exposed only to the shock escape training procedures. The (C3) group - containing again two Ss from each of the four rearing groups - was neither changed nor tested during this experimental phase and had, in fact, not been exposed to any testing for a period of over 7 months when this phase of experimentation was begun. Both, Cholinesterase and Calcium reflect the background long-range treatment of the three groups. These measures show considerable less stress to be present in the (C3) group, that group which had none of the experimental variables applied to it. In the other measures, except for Cholesterol, this trend is apparent, though not statistically significant. This observation adds to the internal consistency of the data and their interpretation as presented here, and is supported by a number of other investigators (Ref. 14, 26, 27, 28, 29, 30).

Since the concern in this study was to determine the possible optimum "therapeutic" effects of environmental change on biochemical measures, the assessment of the simple effects of the A-factors (Table VI) was used to compare the pre-change period data with the data from the optimum-improved changed environment period. Again, for each biochemical determination t-tests for the differences between means were performed. The results of this analysis can be seen in Table VII.

TABLE VII

Changed Environments and Optimal Improvement in Biochemistry

Measure	Improvement	p
Cholinesterase	Yes	.01
Calcium	Yes	01
Tyrosine	Yes	N/S
Cholesterol	No	N/S
Serum Total Protein	Yes	.01
SGOT	Yes	N/S

From Table VII it is evident that improvement in the biochemical state was significant in three of six measures, and present in five of the six biochemical determinations.

Finally, it is interesting to note that none of the differences between rearing groups reached statistical significance. In a previous study, conducted 7-8 months prior to this one (Ref. 24) some such differences were apparent. It seems that the longer the animals are exposed to uniform experimental procedures, the less such differences exist. Thus, it appears that testing on complex discrimination tasks furnishes adequate sensory stimulation, usually absent from the partial isolate, and particularly, the strict isolate rearing conditions.

II. The Effects of Stelazine

The effects of Stelazine on blood biochemistry were measured by withdrawing 3-4 cc of blood from the great saphenous vein of all Ss used in this phase 3 days prior to the onset of Stelazine injections, and on the 3rd, 13th, and 23rd day of the Stelazine-injection period. The same biochemical values (Cholinesterase, Calcium, Tyrosine, Cholesterol, Serum Total Protein, and SGOT) that were measured during the changed-environment phase were assessed here also. The raw values were again subjected to a Type III Analysis of Variance, which is summarized in Table VIII.

The raw data, pertaining to the analyses in Table VIII, are shown in Appendix IV.

The simple effects apparent in Table VIII were again analyzed further by the use of appropriate t-tests. These analyses showed significant differences in the C factors of Cholinesterase ($C1 > C3$ and $C2 > C3$, $< .01$ and $< .05$ level respectively). The simple temporal effects were also analyzed by t-tests, in order to determine again any significant differences between the pre-drug and the optimum improved drug period. The results of this analyses are presented in Table IX.

TABLE VIII

Summary of Analysis of Variance - Stelazine and Biochemistry

Source of Variance	dfs	Cholinesterase	Calcium	Tyrosine	Cholesterol	S. T. Protein	SGOT
Total (T)	95						
Subjects (S)	23						
Rearing (B)	3	[a]					
Stelazine (C)	2	.01					
(B X C)	6						
Error b	12						
within Subjects (wS)	72						
Blood Samples (A)	3		.001		.001	.001	.001
(A X B)	9		.01				
(A X C)	6						
(A X B X C)	18		.01				
Error w	36						

[a] Refers to significance of F-ratio

TABLE IX

Stelazine and Optimal Improvement in Biochemistry

Measure	Improvement	p
Cholinesterase	Yes	N/S
Calcium	Yes	N/S
Tyrosine	Yes	.01
Cholesterol	Yes	N/S
Serum Total Protein	Yes	.01
SGOT	Yes	.01

From Table IX it is apparent that all of the biochemical determinations taken from the period of optimum improvement during the drug state showed the "therapeutic" effects of Stelazine. These improvements occurred in biochemical measures different from the ones affected by the environmental change phase (Table VII) (with the exception of Serum Total Protein).

In order to assess differences between the therapeutic value of the changed environment phase and the Stelazine phase, t-tests for differences between differences of optimal biochemical responses were computed. The results of these computations can be seen in Table X.

TABLE X

Comparative Effects of Changed Environments and Stelazine on Biochemistry

Measure	Favored State		
	Changed Environments	Stelazine	p
Cholinesterase			N/S
Calcium	X		.01
Tyrosine			N/S
Cholesterol			N/S
Serum Total Protein			N/S
SGOT		X	.05

The data in Table X seem to indicate that there is little difference between the optimum improved biochemical condition brought about by either changed social environments or prolonged Stelazine injections. The observed significant difference in Calcium could possibly reflect the difference in excitement and reactivity between the respective experimental periods. The difference in SGOT may reflect lowered metabolic processes during the Stelazine phase, which in turn reduced liver and heart activity. A graphic representation of the data from Table X is shown in Appendix V.

CONCLUSIONS

The data of this study seem to warrant the following conclusions:

(1) Performance of complex discrimination improves for social subdominant Ss changed to isolation.

(2) Isolated Ss changed to a state of social companionship, where they become subdominant, show a decrement of discrimination performance.

(3) The performance of unchanged control Ss and animals which are socially dominant changed to isolation or isolates which become dominant in the social conditions did not show any significant increment or decrement.

(4) It appears that social status along the dominance-subdominance scale is more important for prediction of performance than the perceptual conditions of the living environment.

(5) When optimum improved biochemical conditions were considered, both, changed environments and Stelazine (trifluoperazine) showed a definite therapeutic effect.

(6) Statistical analysis showed that there was little or no difference between the relative therapeutic effects of changed social environments and Stelazine.

(7) Stelazine reduced sensitivity to shock in a shock-escape match-to-sample task according to degrees of previous environmental stimulation during early rearing. The least affected Ss were the animals reared in strict isolation; both, partial isolates and normal social Ss were moderately affected. The greatest reduction of reactivity was observed in the enriched social Ss.

(8) The effect described under (7) was interpreted to indicate differential early sensory threshold development in the four rearing groups used in this experiment.

(9) The effects of changed environments and Stelazine were also observed in the animals not directly concerned with these conditions. It appeared that even subtle alterations in the social make-up of the various living conditions seemed to influence performance and biochemical response.

(10) The rearing conditions used in this study had no effect upon performance or biochemical response.

(11) Prolonged exposure to shock-escape training is stressful, as shown by selected biochemical comparisons between experimental and control groups.

(12) The therapeutic value of subtle manipulation of social environment is as great as that of Stelazine chemotherapy. Additionally, social manipulation may increase correct performance, whereas Stelazine seems to reduce reactivity in general. This latter observation may be important in situations where accuracy of performance and continuity of performance are critical variables, such as in certain stages of psycho-therapy, infant rearing, behavior in the industrial process, and the highly complex environment of space flights.

REFERENCES

1. Hymovitch, B. The effects of experimental variations on problem solving in the rat. J. comp. physiol. Psychol., 1952, 45, 313-321.

2. Krech, D., Rosenzweig, M. R., and Bennett, E. I. Relations between brain chemistry and problem-solving among rats raised in enriched and impoverished environments. J. comp. physiol. Psychol., 1962, 55, 801-807.

3. Krech, D., Rosenzweig, M. R., and Bennett, E. I. Environmental impoverishment, social isolation and changes in brain chemistry and anatomy. Physiology and Behavior, 1966, 1, 99-104.

4. Morrison, B. J., and Hill, W. F. Socially facilitated reduction of the fear response in rats raised in groups or in isolation. J. comp. physiol. Psychol., 1967, 63, 71-76.

5. Angermeier, W. F., Philhour, P., and Higgins, J. Early experience and social grouping in fear extinction of rats. Psychol. Rep., 1965, 16, 1005-1010.

6. Angermeier, W. F. Some basic aspects of social reinforcements in albino rats. J. comp. physiol. Psychol., 1960, 53, 364-367.

7. Uyeno, E. T., and White, M. Social isolation and dominance behavior. J. comp. physiol. Psychol., 1967, 63, 157-159.

8. Pratt, C. L., and Sackett, G. P. Selection of social partners as a function of peer contact during rearing. Science, 1967, 155, 1133-1135.

9. Kaufman, I. C., and Rosenblum, L. A. Depression in infant monkeys separated from their mothers. Science, 1967, 155, 1030-1031.

10. Hatch, A., Wiberg, G. S., Balazs, T., and Grice, H. C. Long-term isolation stress in rats. Science, 1963, 142, 507.

11. Stern, J. A., Winokur, G., Eisenstein, A., Taylor, R., and Sly, M. The effect of group vs. individual housing on behavior and physiological responses to stress in the albino rat. J. psychosomatic Res., 1960, 4, 185-190.

12. Harlow, H. F. The heterosexual affectional system in monkeys. Amer. Psychologist, 1962, 17, 1-9.

13. Rosenzweig, M. R. Environmental complexity, cerebral change, and behavior. Amer. Psychol., 1966, 21, 321-332.

14. Baron, A., Kish, G. B., and Antonitis, J. J. Effects of early and late isolation on aggregative behavior in the domestic chicken. J. genet. Psychol., 1962, 100, 355-360.

15. Reynolds, H. H. Effects of rearing and habitation in social isolation on performance of an escape task. J. comp. physiol. Psychol., 1963, 56, 520-525.

16. Angermeier, W. F., Phelps, J. B., and Reynolds, H. H. The effects of differential early rearing upon discrimination learning in monkeys. Psychon. Sci., 1967, 8, 379-380.

17. Michel, H. O. An electrometric method for the determination of red blood cells and plasma cholinesterase activity. J. lab. clin. Med., 1949, 34, 1564-1568.

18. Reinhold, J. G., Tourigny, L. G., and Yonan, V. L. Measurement of serum cholinesterase activity. Amer. J. clin. Path., 1953, 23, 645-653.

19. Wallach, D. F. H., and Steck, T. L. Fluorescence techniques in micro-determination of metals in biological materials. Anal. Chem., 1963, 35, 1035-1044.

20. Waalkes, T. P., and Udenfriend, S. A fluorometric method for the estimation of tyrosine in plasma and tissues. J. lab. clin. Med., 1957, 50, 733-736.

21. Pearson, S., Stern, S., and McGavack, T. H. Determination of total cholesterol in serum. Anal. Chem., 1953, 25, 813-814.

22. Gornall, A. G., Bardawill, C. J., and David, M. M. Determination of serum proteins by means of biuret reactions. J. biol. Chem., 1949, 177, 751-766.

23. Reitman, S., and Frankel, S. Colorimetric method for the determination of serum transaminase activity. Amer. J. clin. Path., 1957, 28, 57-63.

24. Angermeier, W. F., Phelps, J. B., and Reynolds, H. H. The relationship between performance under stress and blood biochemistry in monkeys. Psychon. Sci., 1967, 8, 389-390.

25. Lindquist, E. F. T. Design and analysis of experiments. Boston: Houghton Mifflin Co., 1953.

26. Betheil, J. J., Feigelson, M., and Feigelson, P. The differential effects of glucocorticoid on tissue and plasma amino acid levels. Biochem. biophys. Acta, 1965, 104, 92-97.

27. Dreyfuss, F., and Czaczkes, J. W. Blood cholesterol and uric acid of healthy medical students under stress of an examination. AMA. arch. int. Med., 1959, 103, 708-711.

28. Naumov, V. A. Activity of cholinesterase in the central nervous system and blood in experimental traumatic shock. Materialy Nauchn. Konf., Ckelyob. Med. Inst., Chylobinsk, 1964, 111-112.

29. Sarai, K. Relation of the blood cholesterol level in emotional stress to the character pattern. Yonoga acta. Med., 1966, 10, 34-37.

30. Wegmann, H. M., Bruener, H., Klein, K. E., and Voigt, E. D. Enzymic and hormonal responses to exercise, lowered pressure, and acceleration in human plasma and their correlation to individual tolerances. Federation Proc., 1966, 25, 1405-1408.

APPENDIX I

Sequence of Match-to-Sample Problem

SEQUENCE	CORRECT SYMBOL
1	△
2	O
3	+
4	□
5	O
6	△
7	□
8	O
9	+
10	□
11	△
12	+
13	O
14	+
15	△
16	□
17	□
18	△
19	+
20	O
21	□
22	△
23	+
24	O
25	△
26	□

APPENDIX II

Performance Related to Environmental Alteration

PER CENT CORRECT PERFORMANCE BEFORE ENVIRONMENTAL ALTERATION

SI	26D[a]	86	80	94	90	96
	30S[a]	72	90	84	68	62
	6	68	80	50	50	68
	5	86	82	84	86	94
PI	10	42	28	62	62	50
	15	78	92	96	68	94
	20D[b]	94	90	64	68	68
	17S[b]	94	88	86	56	98
NS	18D	92	98	82	82	64
	23S	78	72	66	82	54
	16S[c]	64	72	92	72	84
	12D[c]	80	78	72	64	80
ES	31D	52	54	50	40	24
	32S	64	64	78	58	74
	8D[d]	96	94	92	94	94
	1S[d]	92	88	80	76	98

[a] = Changed to strict isolation from social enriched state
[b] = Changed to partial isolation from social state
[c] = Changed to social state from partial isolation
[d] = Changed to enriched social state from strict isolation
D = Dominant
S = Subdominant

PER CENT CORRECT PERFORMANCE DURING ENVIRONMENTAL ALTERATION

SI	26D[a]	94	88	80	74	96	90	90	86	84	90	94	88	76	60	90
	30S[a]	78	80	86	82	92	84	86	84	80	88	84	90	82	76	82
	6	58	50	72	38	24	48	90	72	60	70	56	78	78	82	86
	5	78	88	86	90	84	82	88	82	82	86	88	80	76	92	90
PI	10	70	84	76	84	90	84	84	92	84	98	38	58	64	70	58
	15	76	84	86	72	70	96	88	74	80	70	88	72	58	64	64
	20D[b]	68	94	70	64	70	86	82	80	86	88	94	98	98	100	100
	17S[b]	86	92	86	80	96	98	100	100	98	96	100	96	98	100	100
NS	18D	56	30	86	98	84	94	100	94	98	82	98	100	100	96	100
	23S	64	80	84	80	72	60	78	48	66	82	82	68	80	46	66
	16S[c]	50	62	52	52	74	76	76	58	72	74	88	70	68	60	64
	12D[c]	72	68	78	64	56	70	98	80	90	84	80	86	82	76	86
ES	31D	34	32	24	30	42	52	38	38	52	48	68	48	58	64	58
	32S	68	64	64	84	94	90	78	90	86	90	100	88	100	98	98
	8D[d]	82	88	96	82	84	88	84	84	92	94	98	96	98	80	90
	1S[d]	62	66	78	72	80	94	94	94	96	98	100	92	86	72	66

[a] = Changed to strict isolation from social enriched state
[b] = Changed to partial isolation from social state
[c] = Changed to social state from partial isolation
[d] = Changed to enriched social state from strict isolation
D = Dominant
S = Subdominant

PER CENT CORRECT PERFORMANCE AFTER ENVIRONMENTAL ALTERATION

SI 26D[a]	86	88	88	62	74
30S[a]	76	78	74	76	64
6	76	72	64	34	64
5	90	80	84	96	86
PI 10	90	92	76	78	76
15	64	60	64	58	74
20D[b]	100	96	90	98	100
17S[b]	98	100	100	100	98
NS 18D	98	92	90	90	96
23S	82	88	70	90	84
16S[c]	56	78	86	60	68
12D[c]	82	84	86	72	84
ES 31D	66	58	58	52	54
32S	92	98	96	98	92
8D[d]	98	96	100	100	98
1S[d]	60	84	80	82	98

[a] = Changed to strict isolation from social enriched state
[b] = Changed to partial isolation from social state
[c] = Changed to social state from partial isolation
[d] = Changed to enriched social state from strict isolation
D = Dominant
S = Subdominant

APPENDIX III

Biochemistry Related to Environmental Alteration

CHOLINESTERASE (Michel units)

GROUP C1

		a	b	b	b
SI	1	1.46	1.46	1.23	1.15
	8	0.95	1.20	1.12	0.69
PI	16	1.42	1.46	1.24	1.09
	12	1.29	1.23	1.23	0.94
S	17	1.25	1.35	1.00	0.61
	20	1.34	1.46	1.29	1.11
ES	30	1.05	1.01	1.10	0.84
	26	1.43	1.46	1.23	1.37

a = Before environmental alteration

b = During environmental alteration

CHOLINESTERASE (Michel units)

GROUP C2		a	b	b	b
SI	5	1.33	1.46	1.26	1.33
	6	1.31	1.34	1.26	0.94
PI	15	1.43	1.46	1.21	1.19
	10	1.12	1.46	1.24	0.94
S	18	0.83	0.83	0.94	0.62
	23	1.41	1.44	1.22	1.24
ES	31	1.27	1.43	1.21	0.86
	32	0.39	0.46	0.55	0.27

a = Before environmental alteration

b = During environmental alteration

CHOLINESTERASE (Michel units)

GROUP C3

		a	b	b	b
SI	2	1.17	1.05	1.11	0.96
	3	1.46	1.50	1.26	1.16
PI	11	0.64	0.61	0.70	0.39
	14	0.36	0.52	0.64	0.38
S	19	0.77	0.83	0.78	0.59
	24	0.63	0.68	0.77	0.64
ES	27	1.27	1.26	1.18	0.63
	28	0.51	0.42	0.57	0.38

a = Before environmental alteration

b = During environmental alteration

BLOOD CALCIUM (mg/percent)

GROUP C1		a	b	b	b
SI	1	9.7	10.2	9.6	10.0
	8	10.8	10.9	10.2	10.9
PI	16	10.6	10.5	9.6	10.2
	12	10.7	9.8	11.4	12.0
S	17	10.2	10.2	10.7	10.6
	20	10.0	9.9	10.2	10.9
ES	30	10.2	9.8	10.5	10.9
	26	10.7	9.8	10.0	11.7

a = Before environmental alteration

b = During environmental alteration

BLOOD CALCIUM (mg/percent)

GROUP C2

		a	b	b	b
SI	5	10.0	10.8	10.0	10.2
	6	9.3	10.3	10.2	10.6
PI	15	9.7	9.9	10.3	10.0
	10	10.2	10.2	10.5	10.9
S	18	10.0	10.5	10.3	12.5
	23	10.7	10.2	10.7	10.1
ES	31	10.1	10.7	10.3	10.9
	32	10.7	10.9	10.7	10.1

a - Before environmental alteration

b - During environmental alteration

BLOOD CALCIUM (mg/percent)

GROUP C3		a	b	b	b
SI	2	10.8	10.3	10.7	12.2
	3	10.7	10.9	9.3	10.9
PI	11	11.0	10.9	11.2	12.0
	14	10.7	10.9	10.8	11.5
S	19	10.0	12.5	10.0	10.9
	24	10.0	10.7	10.5	10.9
ES	27	10.5	10.5	9.7	11.5
	28	9.7	10.3	10.8	11.1

a = Before environmental alteration

b = During environmental alteration

TYROSINE (µg/ ml)

GROUP C1

		a	b	b	b
SI	1	17.0	18.0	14.5	15.5
	8	22.9	16.2	15.8	16.0
PI	16	13.9	9.7	13.5	12.3
	12	15.4	12.5	14.0	17.0
S	17	19.0	12.4	15.2	13.6
	20	17.0	14.0	14.3	19.0
ES	30	16.0	15.0	22.2	20.7
	26	11.3	13.5	17.5	17.5

a = Before environmental alteration

b = During environmental alteration

TYROSINE (µg/ ml)

GROUP C2

		a	b	b	b
SI	5	19.6	21.8	26.1	16.5
	6	14.9	13.0	16.5	14.0
PI	15	16.8	11.2	19.0	16.5
	10	17.7	10.5	18.5	17.5
S	18	16.0	12.5	14.8	20.7
	23	13.5	11.6	14.0	11.0
ES	31	14.9	14.3	13.5	13.9
	32	14.9	11.6	14.0	15.5

a = Before environmental alteration

b = During environmental alteration

TYROSINE (µg/ ml)

GROUP C3

		a	b	b	b
SI	2	26.7	21.5	23.5	28.5
	3	15.4	13.6	13.0	15.5
PI	11	17.3	18.8	21.0	22.8
	14	13.5	15.0	18.5	15.0
S	19	13.0	15.0	13.0	15.0
	24	13.9	12.0	12.3	14.0
ES	27	14.9	13.0	15.2	20.0
	28	13.0	11.2	14.0	13.0

a = Before environmental alteration

b = During environmental alteration

CHOLESTEROL (mg / 100 ml)

GROUP C1

		a	b	b	b
SI	1	187	190	195	195
	8	202	212	227	230
PI	16	163	160	155	150
	12	145	150	162	175
S	17	147	157	127	162
	20	152	165	160	177
ES	30	142	160	110	117
	26	225	260	245	260

a = Before environmental alteration

b = During environmental alteration

CHOLESTEROL (mg / 100 ml)

GROUP C2

		a	b	b	b
SI	5	147	170	147	150
	6	150	165	172	140
PI	15	112	115	110	102
	10	142	157	137	157
S	18	122	120	125	140
	23	118	157	147	157
ES	31	185	182	190	182
	32	180	172	192	180

a = Before environmental alteration

b During environmental alteration

CHOLESTEROL (mg / 100 ml)

GROUP C3

		a	b	b	b
SI	2	147	155	152	160
	3	190	225	215	205
PI	11	140	160	152	145
	14	165	187	178	177
S	19	265	250	265	240
	24	112	120	115	122
ES	27	175	175	190	185
	28	147	165	165	170

a = Before environmental alteration

b = During environmental alteration

SERUM TOTAL PROTEIN (gm / 100 ml)

GROUP C1

		a	b	b	b
SI	1	7.0	7.7	7.0	7.3
	8	6.9	6.8	7.1	7.1
PI	16	7.3	7.7	7.1	6.9
	12	7.3	6.8	7.6	7.7
S	17	7.3	8.0	6.5	7.1
	20	7.2	7.0	7.0	7.6
ES	30	7.4	7.2	7.0	6.6
	26	7.9	7.5	7.7	8.1

a = Before environmental alteration

b = During environmental alteration

SERUM TOTAL PROTEIN (gm / 100 ml)

GROUP C2

		a	b	b	b
SI	5	7.7	7.6	7.7	7.5
	6	6.7	7.1	7.3	6.9
PI	15	6.9	7.1	6.8	6.7
	10	7.4	7.5	7.1	6.8
S	18	6.7	6.9	6.4	7.6
	23	7.9	7.6	8.1	7.8
ES	31	7.1	7.2	7.1	6.8
	32	7.5	7.5	7.8	7.2

a = Before environmental alteration

b = During environmental alteration

SERUM TOTAL PROTEIN (gm / 100 ml)

GROUP C3		a	b	b	b
SI	2	8.0	7.5	7.5	7.9
	3	7.6	7.1	7.5	7.5
PI	11	7.0	7.0	7.1	7.0
	14	7.6	7.6	6.8	7.5
S	19	7.1	7.4	6.9	6.9
	24	7.2	7.5	7.1	7.8
ES	27	8.0	8.4	7.8	7.8
	28	7.8	8.1	7.7	8.2

a = Before environmental alteration

b = During environmental alteration

SGOT (units)

GROUP C1

		a	b	b	b
SI	1	55	92	58	73
	8	48	45	36	41
PI	16	31	31	25	23
	12	45	35	46	53
S	17	59	87	58	110
	20	44	49	53	52
ES	30	32	27	33	32
	26	36	37	28	25

a = Before environmental alteration

b = During environmental alteration

SGOT (units)

GROUP C2

		a	b	b	b
SI	5	36	44	32	33
	6	92	53	41	37
PI	15	27	37	26	27
	10	47	34	37	32
S	18	55	55	46	55
	23	36	36	27	55
ES	31	59	66	52	48
	32	53	57	44	43

a = Before environmental alteration

b = During environmental alteration

SGOT (units)

GROUP C3

		a	b	b	b
SI	2	43	38	38	46
	3	45	38	37	35
PI	11	34	40	34	37
	14	52	46	34	43
S	19	42	46	30	38
	24	36	33	28	20
ES	27	42	37	33	35
	28	44	43	41	41

a = Before environmental alteration

b = During environmental alteration

APPENDIX IV

Biochemistry Related to Stelazine Injections

CHOLINESTERASE (Michel units)

GROUP C1

		a	b	b	b
SI	1	0.93	1.33	1.13	1.29
	8	0.96	0.75	0.81	0.92
PI	16	1.14	1.01	1.13	1.28
	12	0.94	0.22	0.99	1.30
S	17	0.72	0.61	0.84	0.89
	20	1.18	1.32	1.20	1.46
ES	30	1.01	0.77	0.72	0.89
	26	1.18	1.49	1.25	1.46

a = Before drug injection

b = During drug injection

CHOLINESTERASE (Michel units)

GROUP C2

		a	b	b	b
SI	5	1.18	1.19	1.13	1.40
	6	0.96	0.69	0.84	0.97
PI	15	1.17	0.30	1.19	1.42
	10	1.07	0.99	0.85	1.09
S	18	0.77	0.38	0.53	0.73
	23	1.15	1.06	1.17	1.31
ES	31	0.96	1.06	1.00	1.13
	32	0.40	0.31	0.39	0.40

a = Before drug injection

b = During drug injection

CHOLINESTERASE (Michel units)

GROUP C3

		a	b	b	b
SI	2	1. 19	0. 82	0. 74	0. 96
	3	1. 22	1. 13	1. 01	1. 33
PI	11	0. 43	0. 68	0. 34	0. 43
	14	0. 45	0. 87	0. 32	0. 36
S	19	0. 71	0. 46	0. 56	0. 71
	24	0. 66	0. 50	0. 49	0. 62
ES	27	0. 98	0. 96	0. 94	1. 13
	28	0. 40	0. 41	0. 50	0. 57

a = Before drug injection

b = During drug injection

BLOOD CALCIUM (mg/percent)

GROUP C1

		a	b	b	b
SI	1	10.2	10.5	10.3	10.0
	8	11.2	11.0	10.9	9.8
PI	16	11.0	10.1	10.7	10.0
	12	10.7	11.4	10.7	10.7
S	17	10.2	10.1	10.7	10.0
	20	9.6	10.1	10.4	9.7
ES	30	10.0	10.3	10.0	9.8
	26	10.5	10.6	10.9	10.7

a = Before drug injection

b = During drug injection

BLOOD CALCIUM (mg/percent)

GROUP C2		a	b	b	b
SI	5	11.1	10.0	11.1	10.0
	6	10.4	10.0	10.6	9.8
PI	15	10.5	10.6	9.8	9.6
	10	10.7	9.5	10.7	9.8
S	18	10.2	10.1	11.2	10.9
	23	10.2	9.9	10.0	10.2
ES	31	10.4	11.8	11.1	10.3
	32	10.5	11.2	11.1	10.0

a = Before drug injection

b = During drug injection

BLOOD CALCIUM (mg/percent)

GROUP C3

		a	b	b	b
SI	2	10.5	9.5	10.7	10.8
	3	10.2	9.5	10.9	10.0
PI	11	10.4	11.0	10.6	10.4
	14	10.4	10.7	10.4	9.8
S	19	9.6	11.2	11.1	10.0
	24	9.8	10.6	10.4	9.7
ES	27	10.2	10.5	11.4	10.7
	28	10.2	10.5	11.1	10.7

a = Before drug injection

b = During drug injection

TYROSINE (µg/ ml)

GROUP C1

		a	b	b	b
SI	1	16.8	14.9	10.9	15.3
	8	18.2	24.0	12.0	17.4
PI	16	13.7	10.5	9.9	10.0
	12	12.4	13.4	12.9	13.0
S	17	15.4	8.8	17.5	16.0
	20	11.0	13.0	10.0	14.0
ES	30	15.7	13.4	13.8	13.4
	26	13.0	9.5	12.8	14.5

a = Before drug injection

b = During drug injection

TYROSINE (µg/ ml)

GROUP C2

		a	b	b	b
SI	5	17.4	14.0	16.0	20.3
	6	15.5	14.2	13.8	14.5
PI	15	16.0	15.3	16.0	11.5
	10	16.0	11.1	15.1	9.0
S	18	15.0	14.9	21.0	20.3
	23	14.8	9.2	11.8	15.3
ES	31	12.6	17.2	14.9	13.0
	32	10.4	15.5	15.5	13.4

a = Before drug injection

b = During drug injection

TYROSINE (µg/ ml)

GROUP C3

		a	b	b	b
SI	2	24.0	20.0	20.0	26.2
	3	15.3	14.2	13.8	14.0
PI	11	13.9	9.5	14.5	14.9
	14	12.4	10.9	13.8	14.0
S	19	11.4	16.0	15.4	13.6
	24	14.8	16.4	11.1	14.5
ES	27	14.5	13.0	11.8	12.5
	28	12.4	14.0	12.8	14.0

a = Before drug injection

b = During drug injection

CHOLESTEROL (mg / 100 ml)

GROUP C1

		a	b	b	b
SI	1	187	225	172	192
	8	212	225	202	200
PI	16	172	192	190	176
	12	177	162	148	152
S	17	175	176	186	152
	20	148	200	165	152
ES	30	140	186	151	165
	26	240	314	210	265

a = Before drug injection

b = During drug injection

CHOLESTEROL (mg / 100 ml)

GROUP C2		a	b	b	b
SI	5	155	162	145	142
	6	170	177	165	152
PI	15	112	186	102	110
	10	162	115	151	142
S	18	127	158	140	140
	23	140	137	150	145
ES	31	185	202	175	176
	32	181	186	167	165

a = Before drug injection

b = During drug injection

CHOLESTEROL (mg / 100 ml)

GROUP C3

		a	b	b	b
SI	2	140	155	130	127
	3	230	255	200	197
PI	11	140	152	137	125
	14	192	186	142	167
S	19	247	262	277	252
	24	102	108	110	120
ES	27	186	180	185	176
	28	155	155	147	147

a = Before drug injection

b = During drug injection

SERUM TOTAL PROTEIN (gm / 100 ml)

GROUP C1

		a	b	b	b
SI	1	7.8	8.1	8.3	8.0
	8	7.7	7.6	7.6	7.5
PI	16	7.7	7.4	8.1	7.6
	12	7.7	7.7	8.1	7.9
S	17	7.7	7.8	8.3	7.9
	20	7.3	8.3	8.1	7.8
ES	30	7.4	8.0	7.5	8.2
	26	8.0	7.8	8.0	8.2

a = Before drug injection

b = During drug injection

SERUM TOTAL PROTEIN (gm / 100 ml)

GROUP C2

		a	b	b	b
SI	5	8.2	8.2	8.4	8.3
	6	6.6	7.4	7.6	7.7
PI	15	6.8	8.0	7.0	7.4
	10	6.8	7.1	7.6	7.5
S	18	7.5	7.6	7.8	7.3
	23	8.3	8.0	8.2	8.1
ES	31	7.5	7.9	8.1	7.6
	32	7.5	8.0	8.5	8.3

a = Before drug injection

b = During drug injection

SERUM TOTAL PROTEIN (gm / 100 ml)

GROUP C3

		a	b	b	b
SI	2	7.7	8.0	7.9	7.8
	3	7.9	7.9	7.9	8.2
PI	11	7.2	7.6	7.8	7.7
	14	7.6	8.2	8.1	7.1
S	19	7.6	7.5	8.0	7.5
	24	7.3	7.6	7.8	8.3
ES	27	7.5	8.0	8.4	8.3
	28	7.9	7.6	8.2	8.4

a = Before drug injection

b = During drug injection

SGOT (units)

GROUP C1

		a	b	b	b
SI	1	45	44	44	37
	8	40	40	*27	19
PI	16	33	28	19	18
	12	52	31	24	30
S	17	68	68	*31	42
	20	46	45	*37	34
ES	30	34	35	44	33
	26	40	33	20	33

a = Before drug injection

b = During drug injection

SGOT (units)

GROUP C2

		a	b	b	b
SI	5	30	18	30	20
	6	32	33	20	37
PI	15	28	33	30	28
	10	35	31	30	18
S	18	62	45	55	50
	23	36	22	20	26
ES	31	57	47	44	42
	32	46	42	40	41

a = Before drug injection

b = During drug injection

SGOT (units)

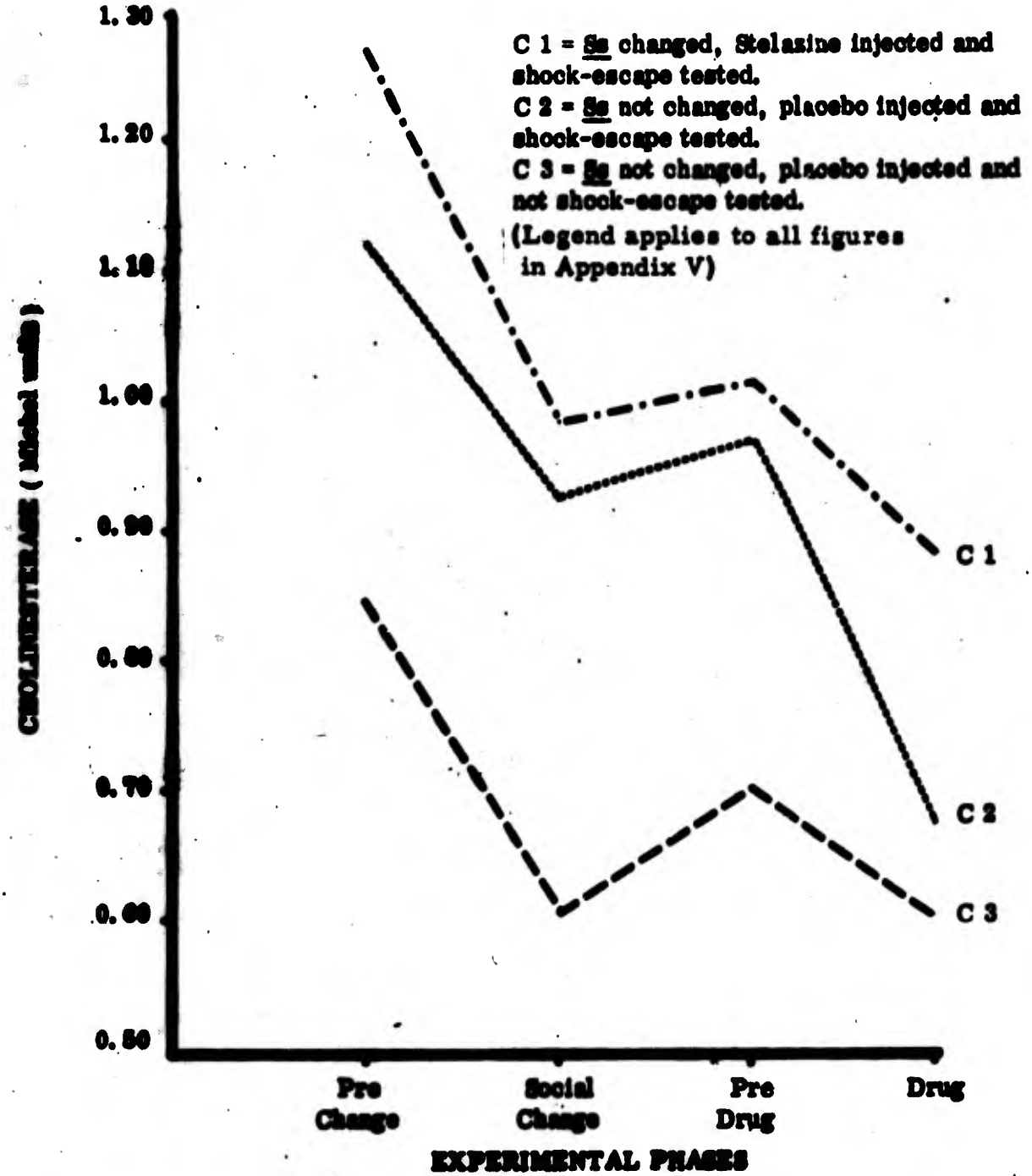
GROUP C3		a	b	b	b
SI	2	31	25	22	30
	3	25	25	24	22
PI	11	28	31	19	30
	14	41	35	30	30
S	19	33	40	30	33
	24	29	35	20	37
ES	27	38	42	24	33
	28	38	29	33	26

a = Before drug injection

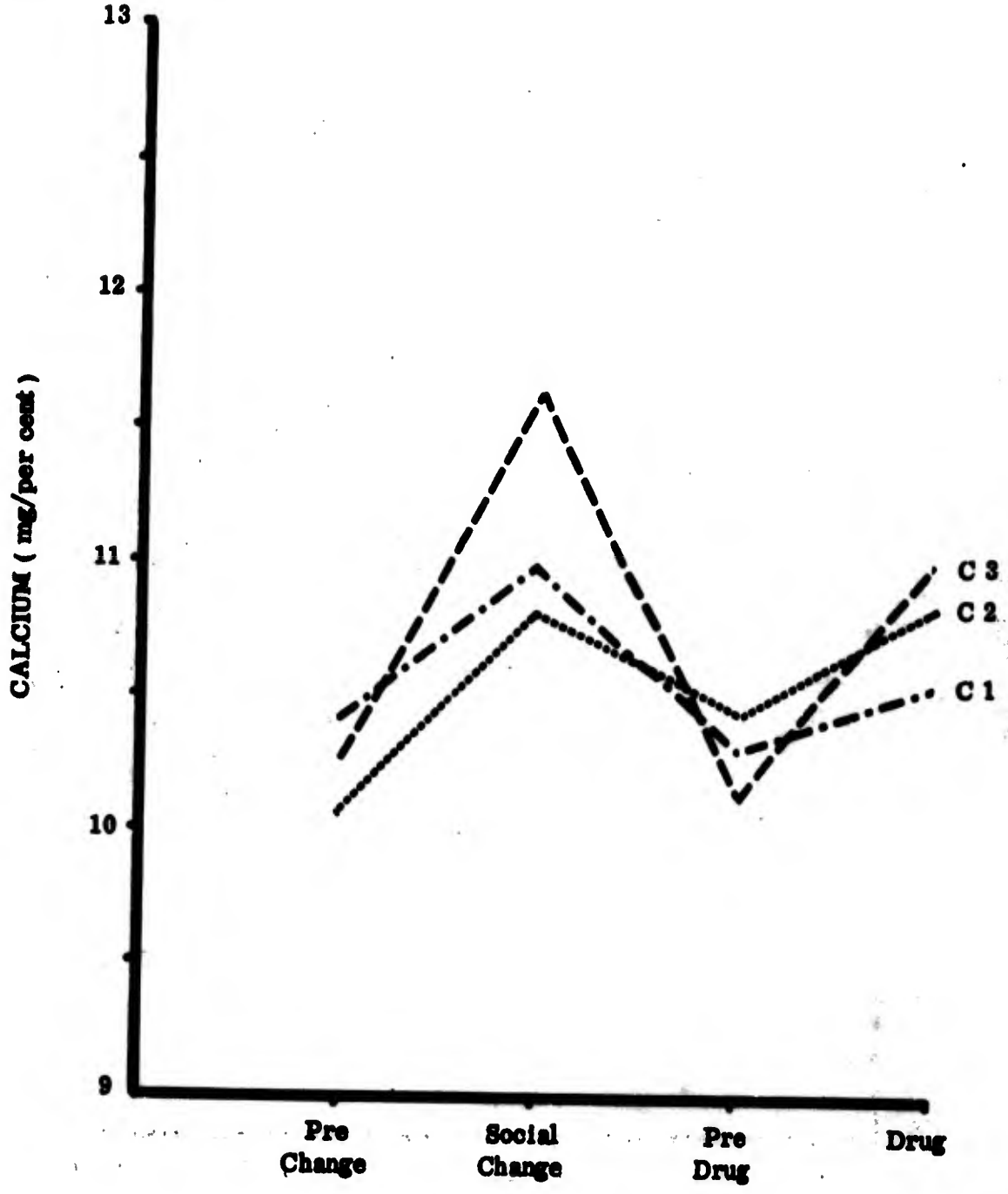
b = During drug injection

APPENDIX V

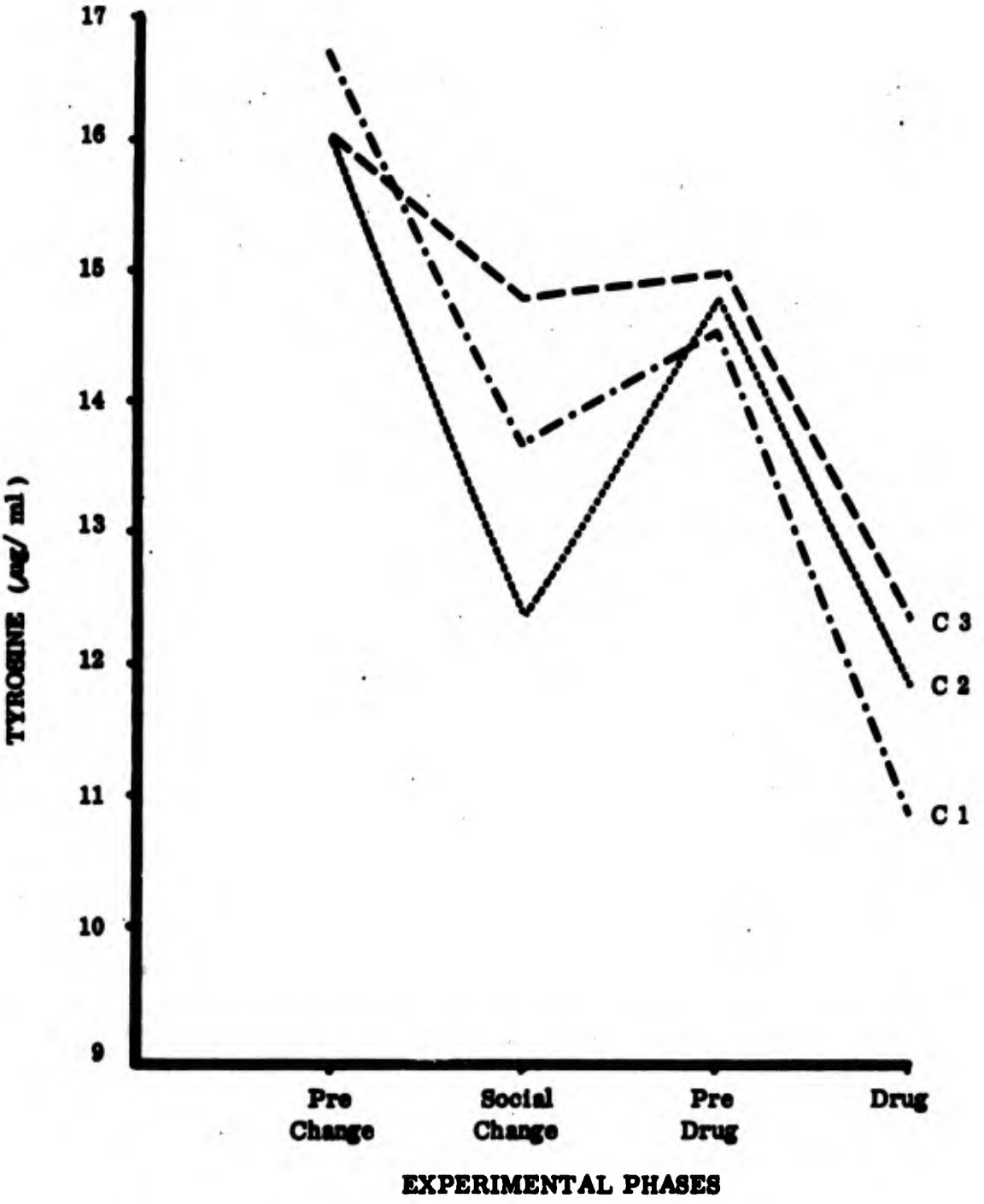
Biochemistry of Environmental Alterations and Stelazine Injections Compared



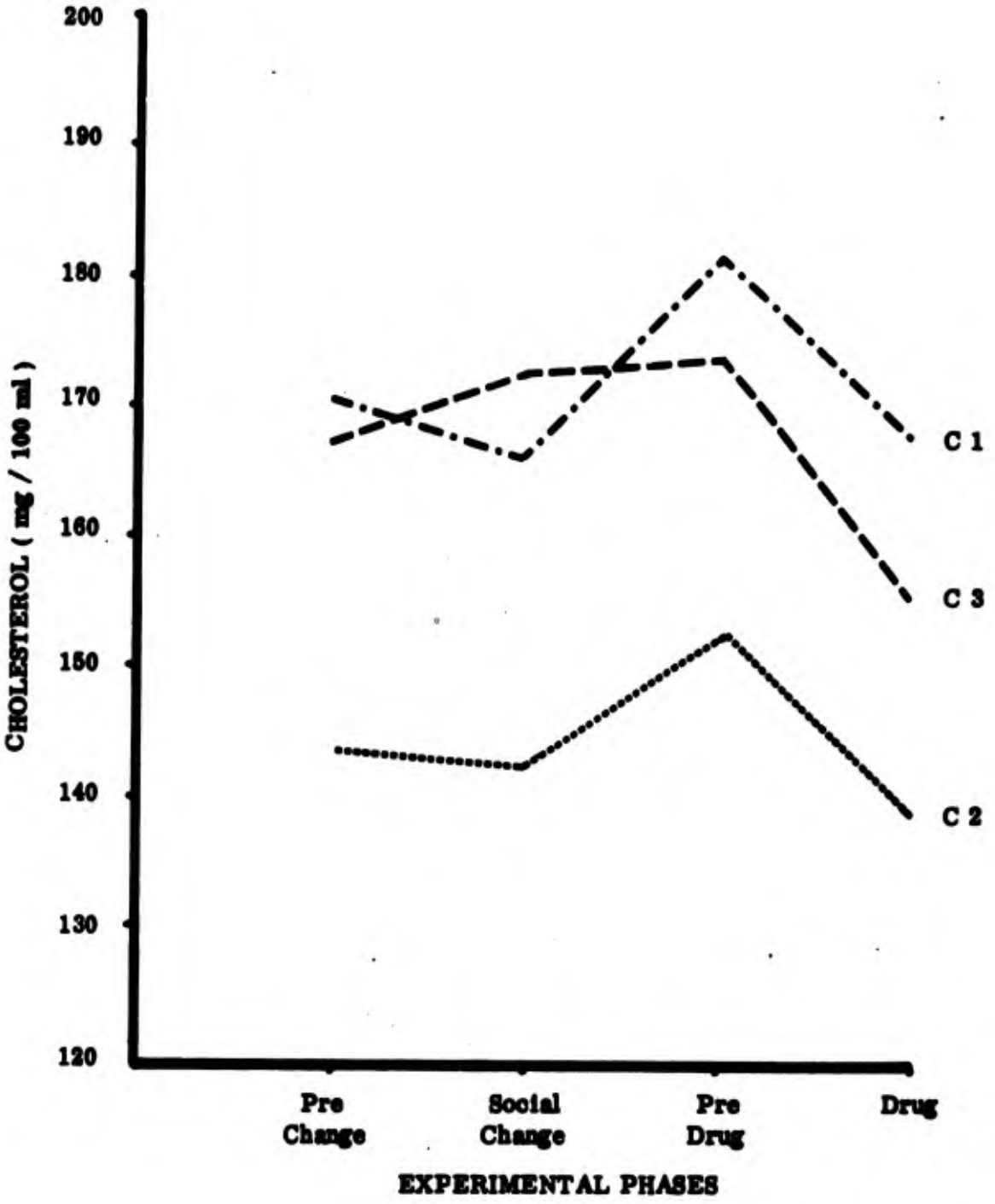
Optimum Improvement of Cholinesterase Response in Rhesus Monkeys Exposed to Changed Social Environment and Stelazine.



Optimum Improvement of Calcium Response in Rhesus Monkeys Exposed to Changed Social Environment and Stelazine.



Optimum Improvement of Tyrosine Response in Rhesus Monkeys Exposed to Changed Social Environment and Stelazine.



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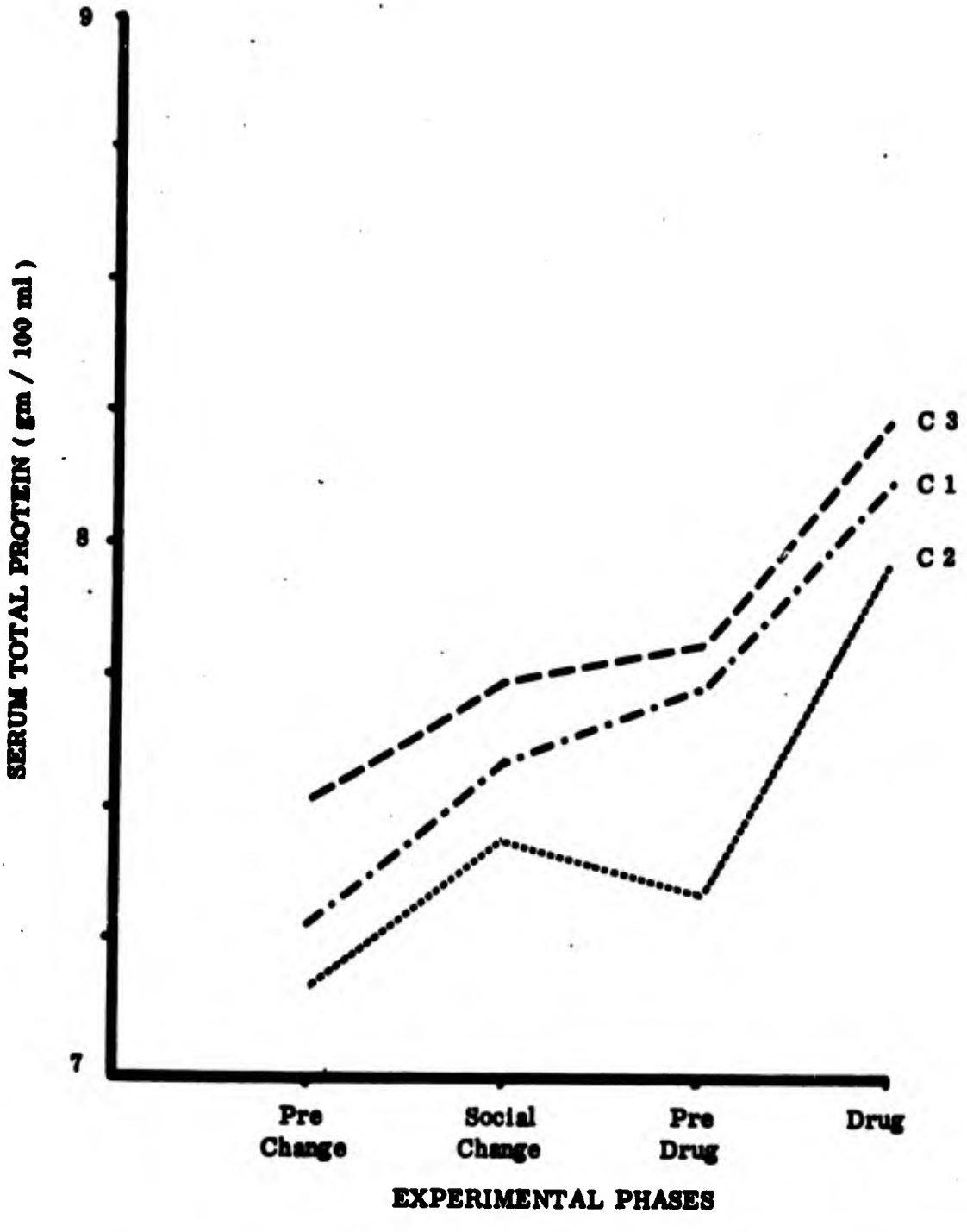
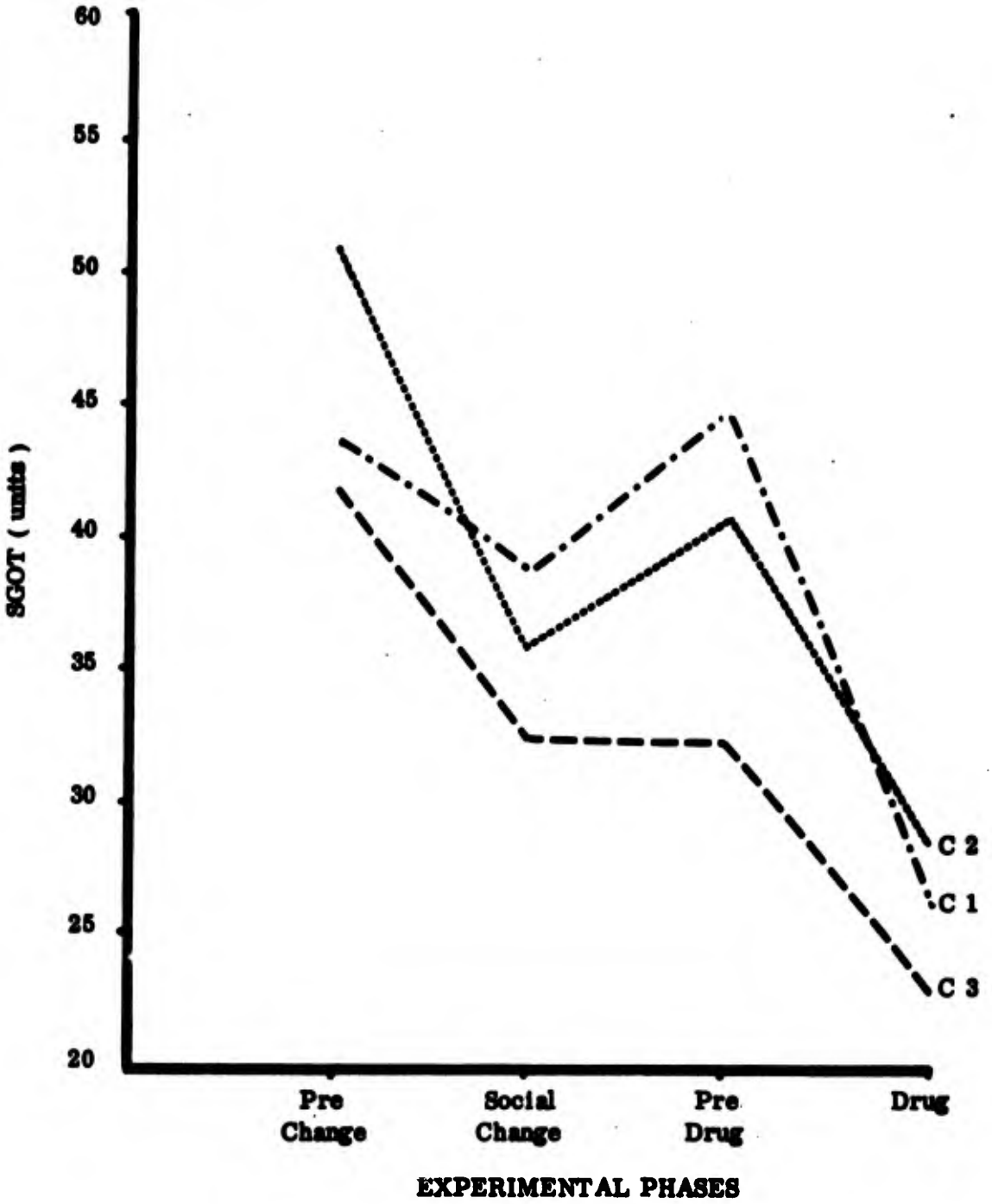


Optimum Improvement of Serum Total Protein Response in Rhesus Monkeys Exposed to Changed Social Environment and Stelazine.



Optimum Improvement of SGOT Response in Rhesus Monkeys Exposed to Changed Social Environment and Stelazine.

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13. ABSTRACT

A study was made to determine the effects of social change versus chemotherapy upon performance and biochemical response in nonhuman primates (rhesus monkeys). Twenty-four male rhesus monkeys from 26-30 months of age were used for this research. The results indicated the following: (1) performance of complex discrimination improves for social subdominant animals changed to isolation; (2) performance of complex discrimination shows a decrement for isolated animals which become subdominant after the change to a state of social companionship; (3) social status along the dominant-sub-dominant scale seems to be more important for prediction of performance than the perceptual conditions of the living environment; (4) both changed environments and injections of Stelazine (trifluoperazine) improved the biochemical condition of subjects so treated; (5) there was little or no difference between the relative therapeutic effects of changed social environments and Stelazine injections; (6) Stelazine reduced sensitivity to shock in a shock-escape match-to-sample task according to degrees of previous environmental stimulation during early rearing. The least affected Ss were the animals reared in strict isolation. Both partial isolates and normal social Ss were moderately affected. The greatest reduction of reactivity was observed in the enriched social Ss. The noted effects were interpreted as indicating differential early sensory threshold development in the four rearing groups used in this experiment; (7) differential rearing conditions, as used in this study, had no effect upon any of the factors mentioned above.

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Complex discrimination						