RICE-MARY: A Replicational Study of the Correlation Between a Hullian Constant and Intelligence. (1967) Directed by: Dr. Kendon R. Smith.

Hull suggests an empirical constant which he describes as a measure of individual differences in learning ability. If this constant is indeed a measure of differences in learning ability, then a correlation should exist between this constant and intelligence as measured by standard tests. The purpose of this study was to test the hypothesis that this constant, _a_, is correlated with measured intelligence. Previous research by Eckman suggested that a significant correlation did exist between these two variables.

To further test this relationship, a learning task, which generated curves basically of the form $P=M(1-10^{-aN})$, was administered to 30 10-year-olds at the University laboratory school. Using performance data for each _S_, _a_-factors were extracted and correlated with IQ scores. Correlation coefficients computed between Verbal, Performance, and Full Scale IQ's on the WISC, and _a_-factors, did not reach significance.

Thus the results of the present study did not substantiate Eckman's findings. Several possible explanations were suggested for the different results. These were: (1) methodology of the present research was inadequate, (2) task-specific <u>a</u>'s exist rather than a general learning ability and thus a more specific IQ test was needed, and (3) Eckman's findings occurred because of chance factors, thus indicating that Hull's formulations are not entirely correct. On the basis of the present study and personal communication with Eckman concerning his own recent research, the latter alternative seems to be the most plausible.

A REPLICATIONAL STUDY OF THE CORRELATION

BETWEEN A HULLIAN CONSTANT AND INTELLIGENCE

by

Mary Rice

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INTRODUCTION

Hull's mathematico-deductive theory of learning is composed of 17 postulates and their corollaries, describing the intervening variables presumed to account for observable behavior. These statements were proposed for testing and, after empirical verification, for development into theorems about behavior. Six of the seventeen postulates proposed by Hull are of concern to this study, and they will be discussed below.

Postulate 4 describes the intervening variable for learning. It states that whenever an effector activity occurs in close temporal contiguity with a receptor activity, and this S-R connection is closely associated with a decrease in need, there is an increase in the strength of the potentiality of that afferent impulse to evoke that reaction on later occasions (Hull, 1943, p. 178). Learning, designated by Hull as habit strength ($_SH_R$), is then the summation of such increments. The explicit equation for habit strength is $_SH_R = 1\text{-}10^{-aN}$, where N is the number of reinforced trials and a is an empirical constant. Habit strength is thus described as a simple growth function of the number of reinforced trials, with gains in habit strength being large at the beginning of a learning task but diminishing gradually with each successive trial, to yield a negatively accelerated curve.

According to Hullian theory, then, learning itself is simply a function of number of reinforced trials. It is not affected by other factors such as "drive" (D), "incentive motivation" (K), or "stimulus intensity dynamism" (V). These variables are said to exert their influence on the performance (P) of the individual; they do not affect learning *per se*. It is *Postulates 5, 6, 7*, and *8* that deal with these variables that influence performance rather than learning. The three factors mentioned above are described as multipliers of habit strength in the production of reaction potential ($_SE_R$), the tendency of the organism to respond. Reaction potential is, therefore, described mathematically as $_SE_R = VDK(1-10^{-aN})$. Because overt performance is essentially a function of reaction potential, performance can be expressed as a function of $VDK(1-10^{-aN})$.

Thus, it is evident that, following these postulates, learning is unaffected by drive, incentive motivation, or stimulus intensity dynamism. Learning is influenced by only two variables. These are: N, the number of reinforced trials; and *a*, an empirical parameter. *Postulate 17* describes *a* as being, in fact, a constant that varies from individual to individual. This constant defines the fractional part of the remaining distance to asymptote that is added to level of performance on each trial.

The value of the expression $1\text{-}10^{-aN}$ always approaches unity--that is, full habit strength for the occasion. Thus, in the equation $P=VDK(1-10^{-aN})$, performance approaches the value of VDK. This reinforces the suggestion that V, D, and K determine the performance level but do not affect learning *per se*. In the equation, $P=VDK(1-10^{-aN})$, if the product of V, D, and K is held at a constant value, M, then $P=M(1-10^{-aN})$; and M becomes the asymptote toward which performance tends.

Several studies lend support to this distinction between learning and performance. Using rats in a runway, Crespi (1942, 1944) found that varying the amount of incentive resulted in differing asymptotic levels of performance but did not change the number of trials in which the animals reached a given asymptotic level. Other studies, by Zeaman (1949), Strassburg (1950), and Teal (1952), suggest the same conclusions--namely, that level of performance is affected by drive, incentive motivation, or stimulus intensity dynamism; but that the rate at which the learning curves approach asymptote is unaffected. It is true that Reynolds (1949) presents a study which reaches an opposing conclusion: using resistance to extinction as a measure of habit strength, he found that learning under low drive was superior to learning under high drive. Despite this negative evidence, however, Kimble (1961) indicates that Hull has not yet been convincingly refuted.

Now, if Hull's postulates are correct, each of a group of individuals involved in a learning task should generate a curve described by the equation $P=M(1-10^{-aN})$; and, everything else (V, D, and K) being constant for the individual, each individual's a-factor should determine the shape of his learning curve as it approaches its asymptote. Thus, deriving a from an individual's performance data should yield an estimate of that individual's basic ability to learn. The possibilities for such a measure are, of course, unlimited. They suggest solutions to several of our common problems in testing intelligence. Inasmuch as a is unaffected by V, D, or K, for example, it should be a more stable measure of intelligence than the indices currently in use. Furthermore, no verbal communication would be required for the determination of this constant; therefore, its value for use with the verbally deficient, the mentally retarded, and the infant should be considerable. These are only two of the possible advantages of such a measure. Many more are evident, and even more would undoubtedly emerge with its use.

Despite the advantages of such a measure of basic ability to learn, only one study directly concerned with its potentialities has been completed. Eckman, in an unpublished master's thesis (1966), attempted to isolate _a_-factors for 32 eighth-graders in a Salem, Virginia, school, and to correlate these factors with intelligence. Using nonsense syllables as learning material, and scores on the California Test of Mental Maturity as IQ measures, Eckman hypothesized that rate of real-life learning as measured by IQ, and rate of learning as defined by Hull, would be correlated. A Pearson product-moment correlation coefficient computed between these two variables yielded a coefficient of .363, significant beyond the .05 level. Correlation coefficients comparing teacher ratings and _a_-factors were not significant, however. On the basis of this study, it would seem that there is a relationship between the _a_-factor described by Hull and learning ability as measured by IQ tests.

Several problems arose in connection with Eckman's study, suggesting the need for additional investigation before any firm conclusions could be drawn. One of these problems lay in the IQ measure used in the study. Scores on the California Test of Mental Maturity were obtained from the school, the test having been administered by the school system one year prior to the date of the study. Eckman suggests that a major weakness of his study was the use of these year-old, group intelligence-test scores, and further suggests that additional research should be done with concurrently administered individual intelligence tests.

Eckman also indicates that another problem area was that of drive, which must be held constant if Hullian theory is to be applied. "Reactive inhibition," which Hull considers to have the properties of a drive, was not well controlled in Eckman's study. "Reactive inhibition" is defined by Hull as the tendency of the organism not to respond. Such inhibition builds up on each successive trial and interferes with performance of the task, unless allowed to dissipate. It dissipates only with rest. Eckman's study did not provide rest periods (other than the one-min. recall intervals between learning trials) to control for this drive; thus, performance may have been influenced in some way by this uncontrolled drive.

Analysis of data presented another problem for Eckman. Finding the asymptote of each learning curve was necessary in order to obtain the a-factor, and an adequate method for determining the asymptotes presented a major obstacle. The mathematical procedures for curve fitting require computer programming as well as time, and this method could not be used for Eckman's study because of cost and time limitations. Another possible method for curve fitting was to fit the curves by eye. This also presented problems, however. After obtaining the asymptote in this fashion, it is necessary that the value of M be fitted into the equation, $\log \frac{M-P}{M} = -aN$, where P is performance on each individual trial. If M falls below any of the actual scores, a negative number results. Inasmuch as it is impossible to obtain the logarithm of a negative number, the data for such a trial would be lost. In order to circumvent this problem, Eckman arbitrarily established each subject's asymptote at one point above the highest score obtained by the subject on the learning task. Thus estimating the asymptote, Eckman managed to make all the data on each subject available for the analysis. The procedure was unsatisfactory, however, because isolated high scores sometimes placed asymptotic values considerably above the evident range of scores. Thus, another major weakness of this pioneer study was the lack of an adequate measure of the asymptotes of the learning curves.

Several other problems were also encountered. One was concerned with sample size, which was reduced because of absences during the data collection period. Another was concerned with the learning task employed by Eckman. The learning task of nonsense syllables was inadequate because it placed a ceiling on the amount of possible learning, and such a ceiling could conceivably have exerted an influence on the data. Also the number of trials administered (16) was not sufficient to allow for a clear-cut asymptote to be reached.

The purpose of the present study was to further investigate the postulated relationship, and to do so by refining the procedures employed by Eckman. The hypothesis to be tested was that there is a significant relationship between _a_-factors obtained from an analysis of empirical data and IQ's as measured concurrently by a standard individual intelligence test.

PROCEDURE

Apparatus

The main item of equipment was a commercially manufactured mirror-drawing apparatus. It consisted of a flat wooden base (11 3/4 x 17 in.), a mirror (6 1/8 x 7 in.), and an adjustable plastic shield (6 7/8 x 8 7/8 in.). Because all subjects (*S*s) were right-handed, the shield and mirror were attached to the baseboard in such a way that they were on the *S*'s left.

For each trial of the mirror-drawing task, a six-pointed star design, printed in black ink upon white paper, was taped to the board under the shield. The design itself was 4 3/8 x 3 3/4 in. in outer dimensions. A similar, smaller design was placed within it, in such a way as to leave between the two a working track 1/8 in. wide. A copy of this star design is included in Appendix A, page 31.

The final item of apparatus was a Hunter timer, set for a constant 4-sec. on-interval.

Subjects

Thirty-nine 10-year-olds from the fourth and fifth grades of the University laboratory school were chosen as

Ss in this study. This group included all the 10-year-olds in the school. Of the thirty-nine, nine were not used for the following reasons: (1) the testing week was interrupted for one group of five because of weather conditions which closed the schools; (2) absences from school during testing resulted in a loss of two more Ss; (3) another S was tested but not included statistically because of blindness in one eye; and (4) test data for one S were so erratic that an adequate treatment was not possible. For the above reasons, the present research is based finally on 30 Ss, 16 males and 14 females.

Method

On Monday of each week of testing, an S was asked to accompany the experimenter (E) to a small workroom adjoining his regular classroom. The mirror-drawing apparatus and Hunter timer were situated on a table in the middle of the room. S was asked to seat himself directly in front of the mirror-drawing board, and E seated herself on S's right. Before beginning to read the instructions to S, E taped a star design in place. To prevent the design from slipping during the trial, all four corners were taped to the board. Each time a design was placed on the board, the lower edge of the sheet on which it was printed was aligned with two marks which were 4 in. from the lower edge of the board, and 1 3/8 and 7 in. from the left and right sides of the board, respectively. E then read the following instructions:

> For the next few days, we are going to be working together for about 30 minutes each day on this mirror-drawing problem. We are going to use the board that is in front of you. In a few minutes, I am going to ask you to draw a line between the two black lines that make the star. When you are drawing this line, you will be looking at your hand in the mirror. The board that is above the star keeps you from seeing your hand except when you look in the mirror. Put your hand under the board and tell me if you can see your hand in the mirror. [If necessary, the board was adjusted.]
>
> The time it takes you to draw your line is your score, so work as quickly as possible. Drawing this line will be hard at first. It will get easier after you do it several times, so keep on trying even when it gets hard.

When I say "begin," I want you to start at the top of the star and draw the star. Notice the arrow at the top of the star. You will move in the direction in which the arrow is pointing. You must stay within the two black lines at all times. If your pencil touches the lines or goes outside of them, I will take your hand, hold it for a few seconds, and then put it back in the middle of the lines. So each time you touch the lines, you add time to your score. Do you have any questions? [No questions were asked by any of the Ss.]

Put the point of your pencil at the top of the star, and, when I say "begin," start drawing your line, going in the direction in which the arrow points. Remember to stay in the middle of the two black lines, because each time you touch them I will stop you for a few seconds. Begin!

Upon E's direction to begin, S began drawing the star with a red pencil, which was used to enable E to observe errors readily. Throughout the trial, E observed S's performance closely. Each time S touched the lines of the star or went outside them, E pressed a foot pedal which activated a Hunter timer. E took S's hand at the same time that she depressed the pedal. When the 4-sec. cycle was complete, E released S's hand, and S continued work.[1] When S finished drawing the star, E noted the time taken for the task (as measured by a standard stopwatch) and said, for example, "That was two minutes."

The procedure described above was followed for each trial. A 1½-min. interval was observed between trials in order to allow reactive inhibition to dissipate.

On Monday, S was given just three trials. On Tuesday through Friday, he was given five trials per day. On Tuesday, an abbreviated form of the instructions was read before S began work. The new form was as follows:

> Remember what we were doing yesterday. We are going to do the same thing again today. Let's go over the instructions before we begin: Remember to work as quickly as you can and to

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[1]This procedure was followed on each day of testing except for February 21, 1967. On that day, an electrical failure at the school made it necessary to time penalties with a stopwatch.

try to stay in the middle of the two black lines. Each time you touch either of these lines or go outside of them, I will stop you for a few seconds. Put your pencil at the top of the star, and, when I say "begin," start drawing a line between the two black ones. Begin!

For the remainder of the week, no further instructions were given. At the end of the week, S had completed 23 trials. During each week, five Ss were tested. The assignment of Ss to time of testing was based on the teacher's decision.

In addition to the mirror-drawing task, each S was given the Wechsler Intelligence Scale for Children (WISC). The test was administered by E during the week of S's service in the mirror-drawing task, in the same room used for that task. Again, the exact schedule was arranged by the teacher.

RESULTS

In order to extract *a*-factors from the performance data generated by the *S*s, it was necessary to fit curves to those data. Curves were assumed to have the basic form $P=M(1-10^{-aN})$, as postulated by Hull. Several points with regard to Hullian theory needed to be considered, however, before the constants described by this equation could be derived.

Hull's postulates and equations are expressed in terms of speed scores, whereas the data obtained in this study were time scores. It was necessary, therefore, to convert the above formula accordingly before any further analysis could be undertaken. Conversion was accomplished by substituting $\frac{1}{T}$ for P, where T is equal to the time score, and is thus the reciprocal of speed; and by substituting $\frac{1}{A}$ for M, where A is equal to the asymptote of the time curve, and thus the reciprocal of M.

After so transforming the above equation to that of $T = \frac{A}{1-10^{-aN}}$, it became obvious that another transformation was necessary before this equation could be applied to the empirical data. Hull's theory describes N as the number of the reinforced trial. Before n, the number of the reinforced trial in this study, could be considered equal to Hull's N, an additional consideration was necessary. That is, when Hull used N in his formulations, he referred to an ideal situation, in which habit strength before the beginning of the first trial is zero. It was impossible to assume that such a condition existed before the learning task for this study began. Therefore, to correct for any pre-existing habit strength a constant, c, was added to n. Substituting the expression (n+c) for N resulted in the following equation: $T = \frac{A}{1-10^{-a(n+c)}}$.

The latter equation can be transformed to a logarithmic form which represents a linear relationship. Below is an outline of the transformation required:

$$T = \frac{A}{1-10^{-a(n+c)}}$$

$$\frac{T}{A} = \frac{1}{1-10^{-a(n+c)}}$$

$$\frac{A}{T} = 1-10^{-a(n+c)}$$

$$-\frac{A}{T} = 10^{-a(n+c)} - 1$$

$$1 - \frac{A}{T} = 10^{-a(n+c)}$$

$$\frac{T-A}{T} = 10^{-a(n+c)}$$

$$\frac{T}{T-A} = 10^{a(n+c)}$$

$$\text{Log}\,\frac{T}{T-A} = a(n+c)$$

$$\text{Log}\,\frac{T}{T-A} = an + ac.$$

The mathematical derivation of a from this logarithmic form, in any specific instance, demands a knowledge of the value of A. In this study, the latter value was obtained from the empirical data by a process of fitting curves to the data by eye and of making estimates of the asymptote of each curve. The mathematical procedures for fitting such curves and for determining their asymptotes necessitates computer programming. Due to the time and cost limitations of the present study, these procedures were considered impractical, and the method of fitting the curves by eye was employed. Although there has been some disagreement about the validity of this method, a recent article by Murdock and Cook (1960), which reviews several methods for fitting the exponential, suggests that, considering the present status of curve-fitting in psychology, a good fit by eye is acceptable. On this basis, three members of the faculty of the Psychology Department at the University were asked to fit curves to the empirical data, which consisted of scores on 22 learning trials for each S, and to make judgements about the asymptotes of these curves. (The data from the first of the 23 trials were not considered, that trial having been designated as a practice trial before testing began.) A mean asymptote was computed for each S by taking the mean of the judges' three estimates. There was reasonably good agreement among the judges, the overall, within-S, mean deviation of the judgements being 2.17 sec.

After an A was thus obtained for each S, the proper value was substituted into the equation, $\text{Log } \frac{T}{T-A} = an + ac$. The a-factor was then extracted by means of the standard approach for fitting a straight line by means of the method of least squares. In this regression analysis, the a-factor, according to Hull, is the slope of the line; and ac equals the Y-intercept. The constant c is equal, therefore, to the Y-intercept divided by a.

Solving for the value of the expression $\frac{T}{T-A}$, where T is the time score on an individual trial, presented a problem similar to one encountered by Eckman. The problem was that several empirical points fell at or below the value of the ideal asymptote for some of the Ss. When A was subtracted from these values, accordingly, zeroes or negative numbers resulted. Because logarithms cannot be determined for such numbers, the data for those particular trials were lost. To circumvent this problem, only the first 10 trials of the learning task were employed in the computation of a by this regression analysis. Because Hull does not specify how many trials are necessary for computing a, the above decision to use only the first 10 trials, for which the value of $\frac{T}{T-A}$ was positive for all Ss, was made in order to have the same data available for all Ss. Using these trials, a regression analysis of each S's performance data was completed and the a-factors were computed.

After finding the values of a and A for each S, it was possible to substitute them in the equation $T = \frac{A}{1-10^{-aN}}$ and to obtain an expected time score for each of the S's trials. Theoretical values computed for each S in this manner, and the resulting curves, fitted to the empirical data, are displayed in Appendix B, pages 32 through 61.

From the standpoint of the present study, of course, the basic problem was that of the correlation between the a's and the IQ's of the 30 Ss. Table 1 shows the a-factors finally obtained, as well as the requisite IQ scores. The

TABLE 1

SUBJECTS' *a*-FACTORS AND IQ'S

Subject	*a*-Factor	FSIQ	VIQ	PIQ
1	.037	107	111	103
2	.042	123	128	114
3	.039	112	109	112
4	.098	131	125	132
5	.030	123	123	120
6	.104	126	134	113
7	omitted--data were erratic			
8	.054	131	131	124
9	.030	121	121	117
10	.072	120	123	113
11	.059	115	113	115
12	.071	115	111	117
13	.112	100	106	95
14	.067	114	106	120
15	.038	131	129	128
16	.055	111	116	103
17	.032	107	94	120
18	.044	99	101	97
19	.031	119	104	132
20	.057	117	108	124
21	.038	106	104	107
22	.050	92	95	90
23	.034	106	101	110
24	.044	116	109	121
25	.074	104	91	118
26	.072	115	109	118
27	.083	117	106	125
28	.029	132	121	138
29	.059	109	115	100
30	.044	119	124	110
31	.049	116	121	107

Product-moment correlation coefficients:

a vs. FSIQ: −.01

a vs. VIQ: +.09

a vs. PIQ: −.10

a-factors ranged from .029 to .112; the IQ scores fell roughly in the normal through superior ranges. The Pearson product-moment correlation coefficients, between a-factors and Full Scale IQ (FSIQ), Verbal IQ (VIQ), and Performance IQ (PIQ), are -.01, +.09, and -.10, respectively. None of these correlation coefficients is significantly different from zero.

DISCUSSION

The primary purpose of the present study was to investigate the hypothesis, suggested by Eckman, that Hull's a-factor is correlated with rate of real-life learning as measured by IQ. In spite of the previous positive findings concerning the significance of the above relationship, the results obtained here do not lend support to the hypothesis. The discrepancy between the results of the two studies suggests that perhaps methodological inadequacies in this study were responsible for the negative findings. Inasmuch as the research reported here was an attempt to provide more refined procedures for dealing with the proposed problems, its methods will be discussed in order to support the suggestion that they reflect at least as defensible a test of the hypothesis as those employed by Eckman.

Size of sample is a first consideration. The number of Ss used in this study was approximately the same as that employed by Eckman, and, although it is quite small, it is thought to be adequate for a correlational study of this kind. Another factor that might have been influential was that of the procedure used in ascertaining the Ss' IQs. The present study used currently administered, individual intelligence tests of wide acceptance. They were given by E, who had been trained in their administration and scoring. The conclusion that these IQ measures were at least as adequate an estimate of Ss' current levels of functioning as those used by Eckman seems justified.

The derivation of a-factors from the performance data is another area in which variation might have affected results. Although several changes were made in this research concerning the method of deriving these a's, their determination was at least as careful as that of Eckman. In fact, several factors involved in the analysis suggest that the present method for determining a may have been better. One of these factors is that more trials were administered in an attempt to provide more data concerning the asymptotic level reached by the S. Also, Eckman's study did not control for the drive of reactive inhibition, whereas, in this study, 1½-min. intervals were allowed between trials to allow this drive to effectively dissipate before any further learning was attempted. The above method of controlling for the dissipation of reactive inhibition is supported by Osgood's summary (Osgood, 1956) of relevant research; therefore, the drive should not have had any important influence on the data.

A different method of obtaining the asymptotes of the performance curves was also used in the present research. Here, three judges fitted curves to the data by eye; and, from his curves, each made estimates of the asymptotes. Eckman, on the other hand, established an arbitrary value as the asymptote. Thus, the method used here should have been at least as accurate as Eckman's, if not more so. Another difference with regard to analysis of the data was that Eckman did not correct for any pre-existing habit strength by adjusting _n_. This omission would not affect the actual computation of _a_, but it would be concerned with using _a_ to obtain expected values. The adjustment used here should have resulted in curves that were a better fit to the empirical data. (It is of incidental interest that, when this adjustment was made, the value of _c_ was negative for 12 of the 30 _S_s. For them, apparently, some negative habit strength existed before the beginning of the learning task.)

Comparison of the above procedures with those employed by Eckman suggests that _a_-factors were as carefully determined as those obtained in his research. In fact, the procedural changes described here should result in more carefully determined rates of learning ability than had been obtained previously.

If the procedures of the present study were not inadequate, and if they thus do not yield possible explanations for the discrepancy, other alternatives can be considered. Eckman employed a verbal learning task of nonsense syllables in his study, whereas, in this study, a performance task was used. If, instead of a general learning ability as suggested by Hull, there is a specific _a_-factor for each of several kinds of learning ability, it may be that the intelligence test administered in the present research did not yield a measure of intelligence that was related to a perceptual-motor task such as mirror drawing. If such a notion is indeed valid, then a test made up of perceptual-motor tasks might yield a correlation between the _a_-factor and intelligence as thus measured. It would seem unlikely that the explanation for the failure to find a significant relationship lies in that direction. Hull clearly postulates a general learning ability as indicated by the _a_-factor, rather than specific _a_'s for different tasks. The possibility under consideration does exist, however.

Rejecting the two alternatives of methodological inadequacies and task-specific _a_'s leaves yet another consideration. That is that Eckman's results were due to chance factors and that the negative results obtained in the present study are in fact a more accurate reflection of the true relationship involved. Support for this suggestion was gained by the writer through personal communication with Eckman, which indicated that further research under his direction had not resulted in correlation coefficients that were significantly different from zero. (This research was conducted with the same learning and intelligence measures as were employed in the present research.)

If this assumption concerning Eckman's results is accepted, it would imply that Hullian theory concerning the distinction between performance and learning is not entirely correct, and, therefore, that the hypothesis underlying this study was actually not completely correct. Hull's theory describing drive, incentive motivation, and stimulus intensity dynamism as multipliers of habit strength, where habit strength is unaffected by these variables, may require some revision before it can be effectively applied to empirical data. It may be that learning can be described by the Hullian formula for habit strength but that the above factors thought to be influential in performance may also be of importance in the determination of learning. Such a constant as the _a_-factor may indeed be involved in learning and may vary with individuals, but the influences of V, D, and K, might also be of importance in the determination of the value of _a_ for that particular situation. This study, as did Eckman's, found a wide range of _a_-factors, a fact which suggests that such a factor may exist but that it is influenced by the biological conditions of the organism.

Although no definite conclusions can be drawn from this study, it would seem that the latter two possibilities provide a more likely explanation for the failure to find support for Eckman's findings than does the suggestion that methodological inadequacies resulted in a failure to replicate the study. These two possibilities, in recapitulation, are: (1) that a specific _a_ exists for each learning task for each individual, and that the different tasks employed by the two studies were the reason for the opposing results; and (2) that the results obtained by Eckman were due to chance factors and do not represent the actual relationship, or lack thereof, which exists between the two variables.

SUMMARY

Hull suggests an empirical constant which he describes as a measure of individual differences in learning ability. If this constant is indeed a measure of differences in learning ability, then a correlation should exist between this constant and intelligence as measured by standard tests. The purpose of this study was to test the hypothesis that this constant, a, is correlated with measured intelligence. Previous research by Eckman suggested that a significant correlation did exist between these two variables.

To further test this relationship, a learning task, which generated curves basically of the form $P=M(1-10^{-aN})$, was administered to 30 10-year-olds at the University laboratory school. Using performance data for each S, a-factors were extracted and correlated with IQ scores. Correlation coefficients computed between Verbal, Performance, and Full Scale IQ's on the WISC, and a-factors, did not reach significance.

Thus the results of the present study did not substantiate Eckman's findings. Several possible explanations were suggested for the different results. These were: (1) meth-

odology of the present research was inadequate, (2) task-specific *a*'s exist rather than a general learning ability and thus a more specific IQ test was needed, and (3) Eckman's findings occurred because of chance factors, thus indicating that Hull's formulations are not entirely correct. On the basis of the present study and personal communication with Eckman concerning his own recent research, the latter alternative seems to be the most plausible.

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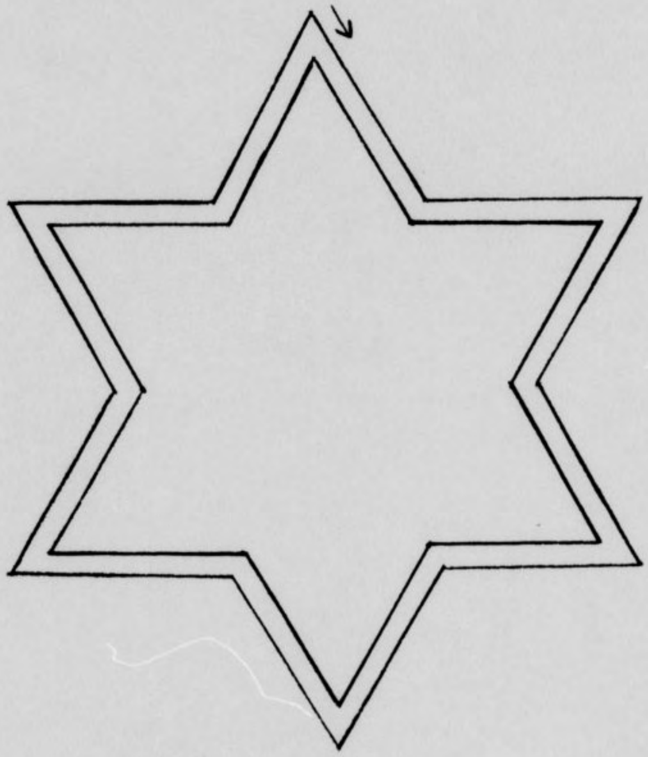
APPENDIX A



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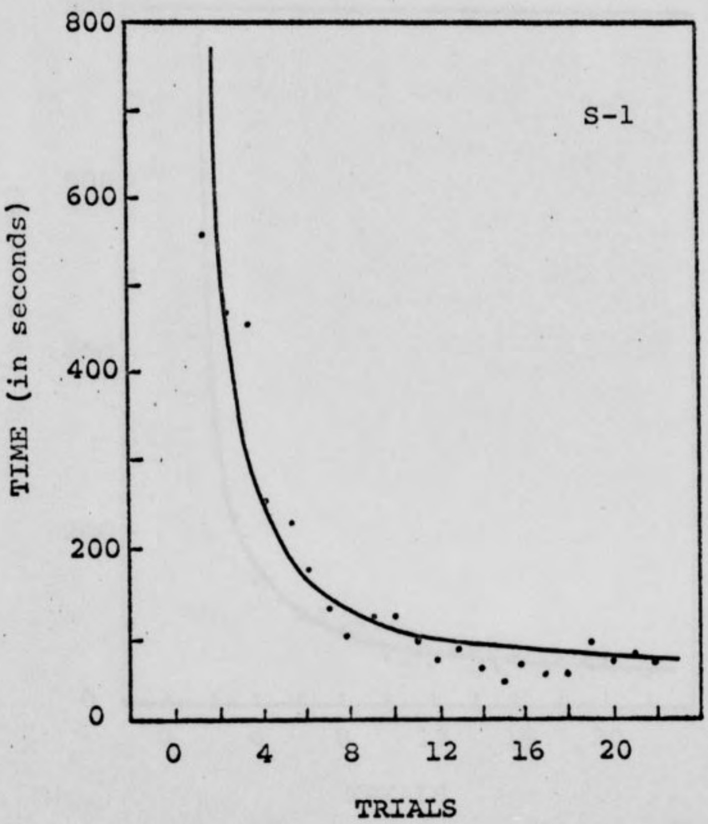
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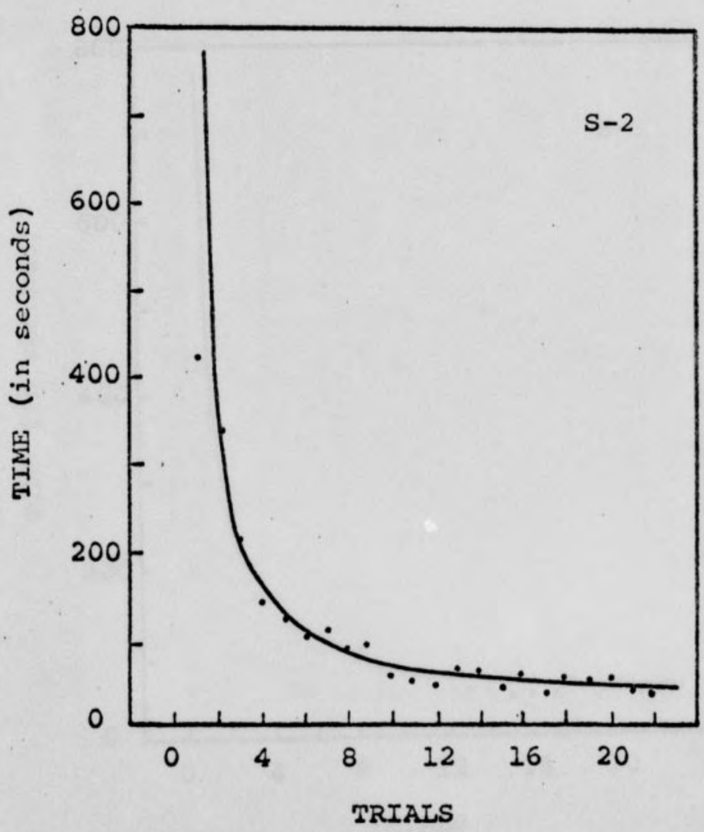
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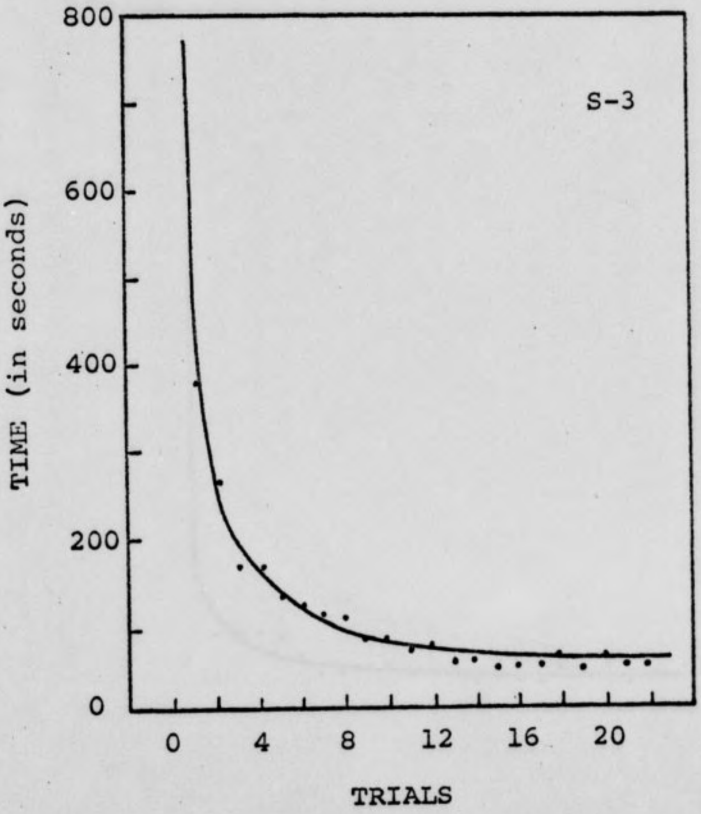
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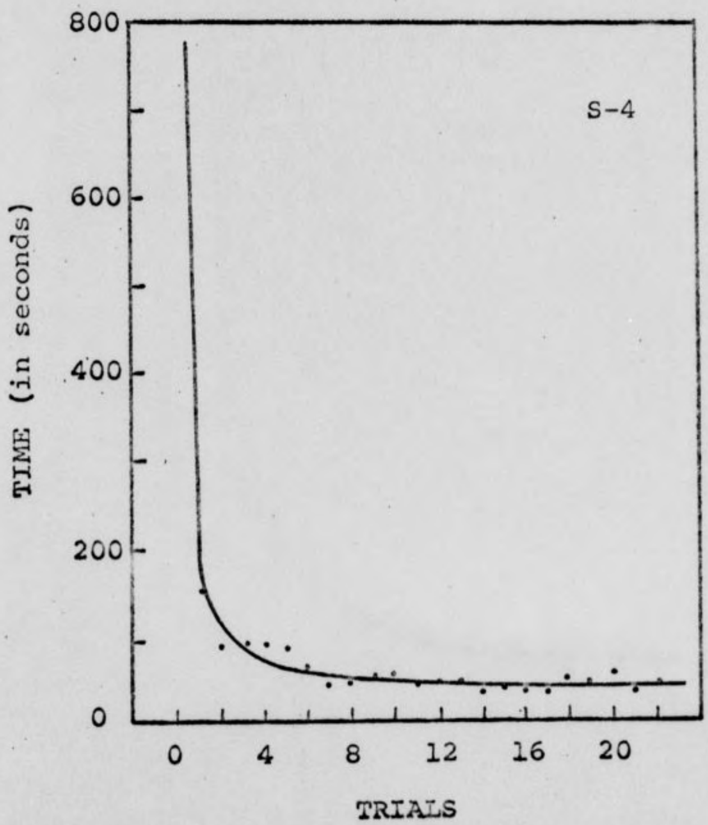
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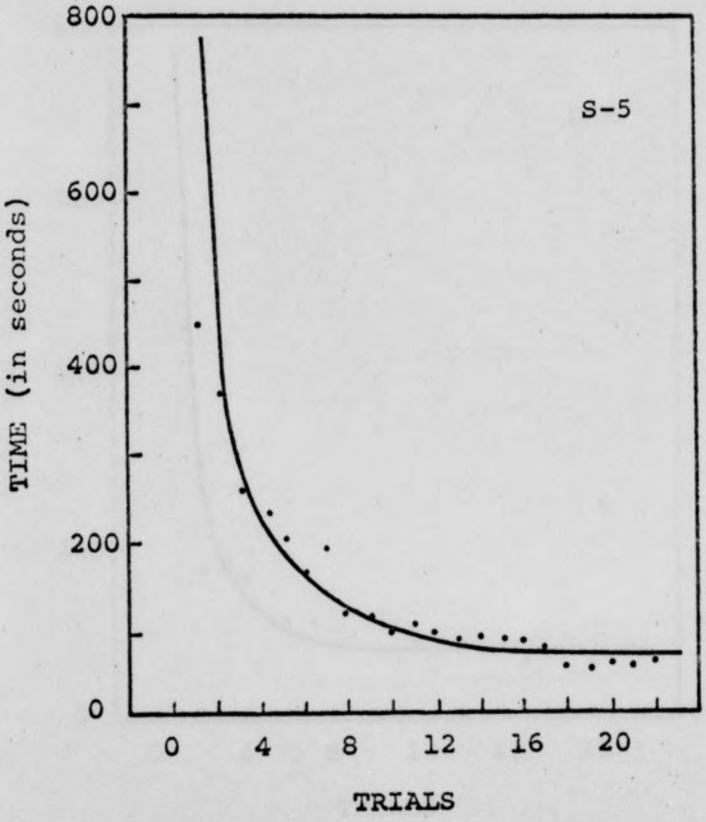
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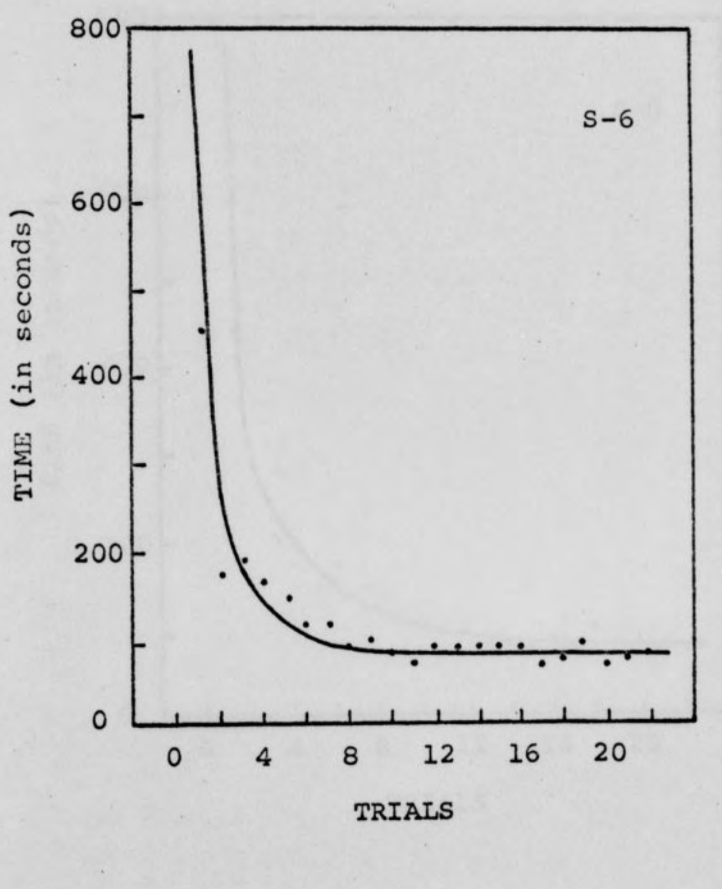
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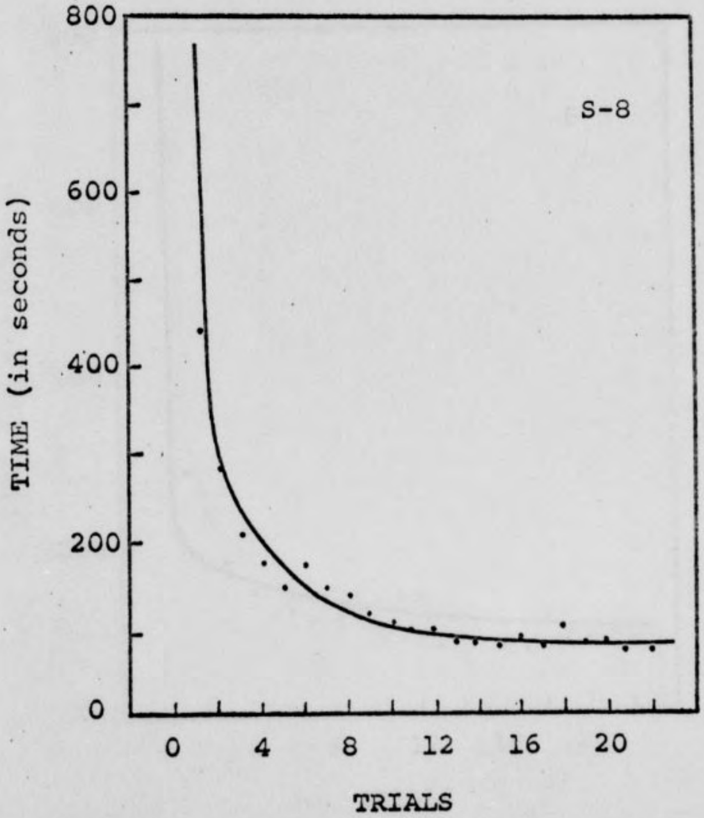
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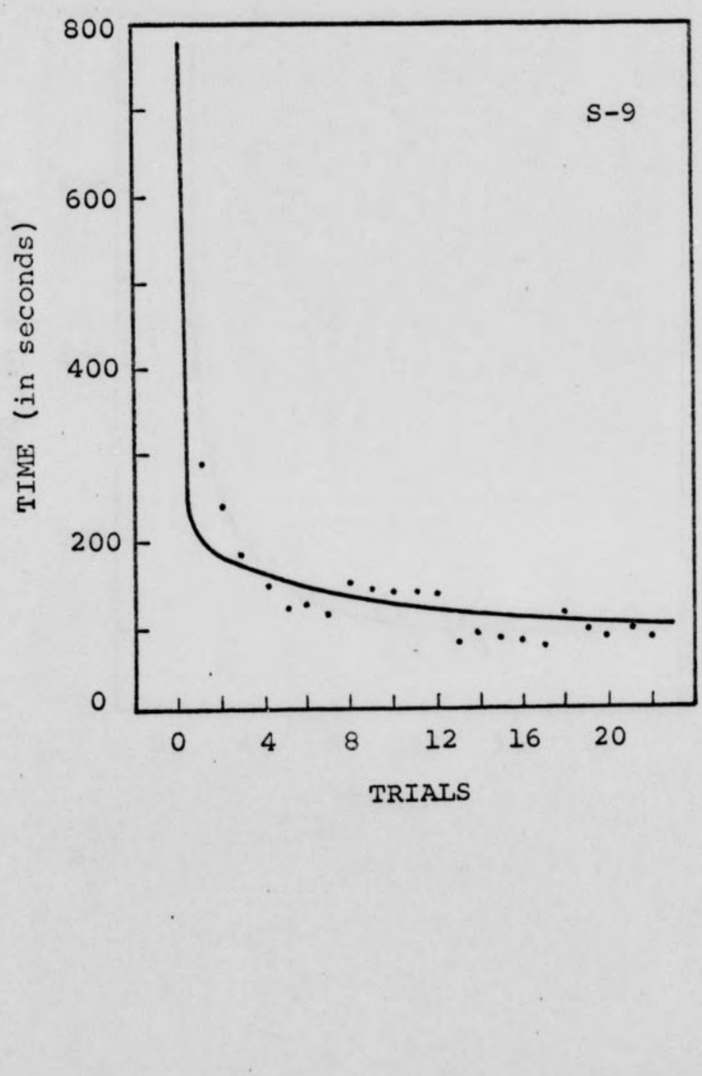
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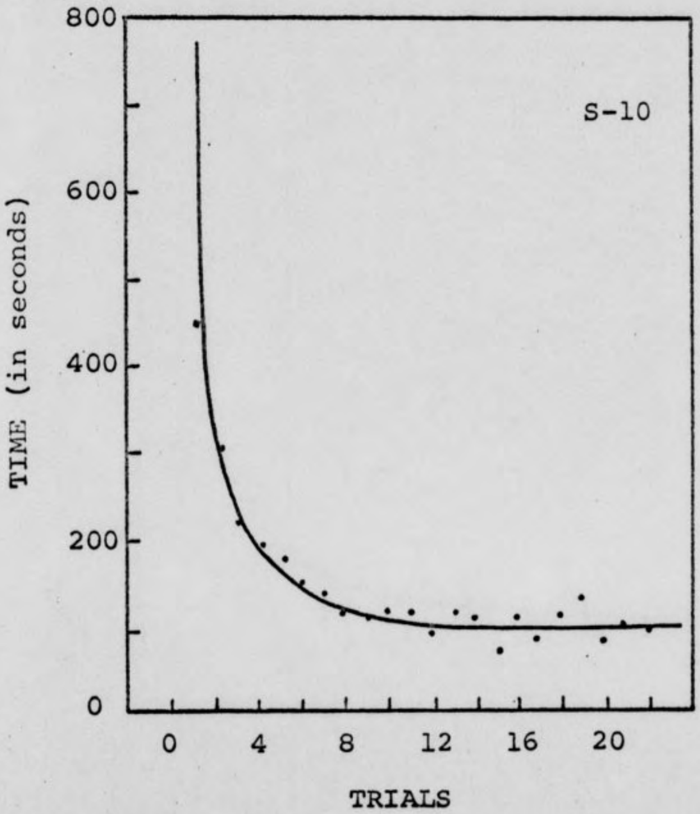
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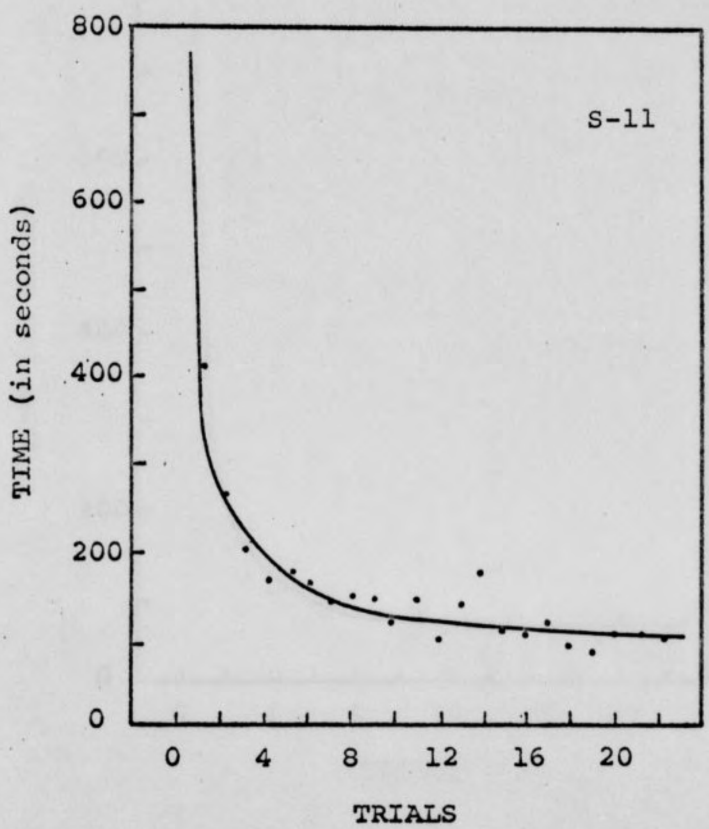
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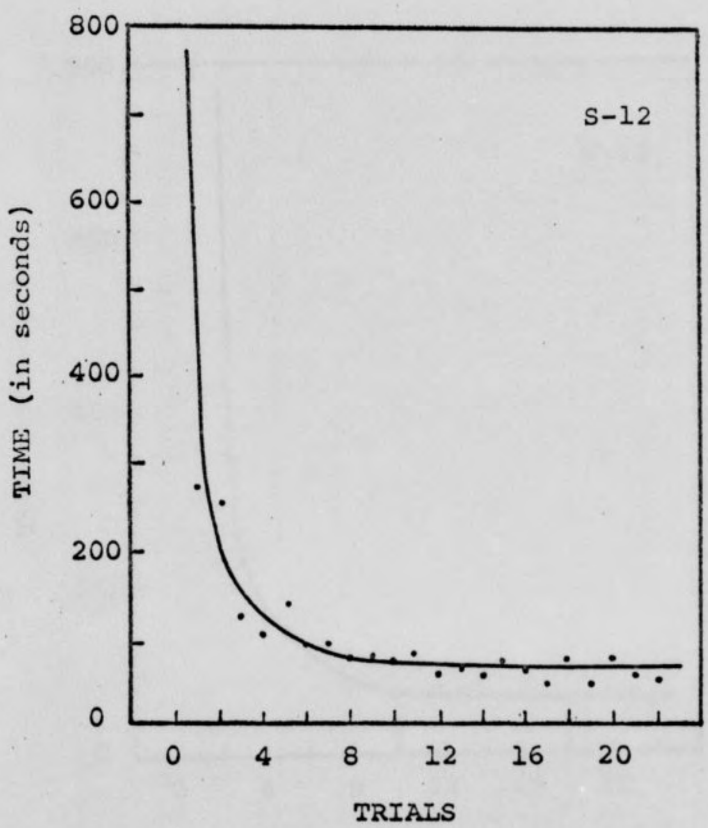
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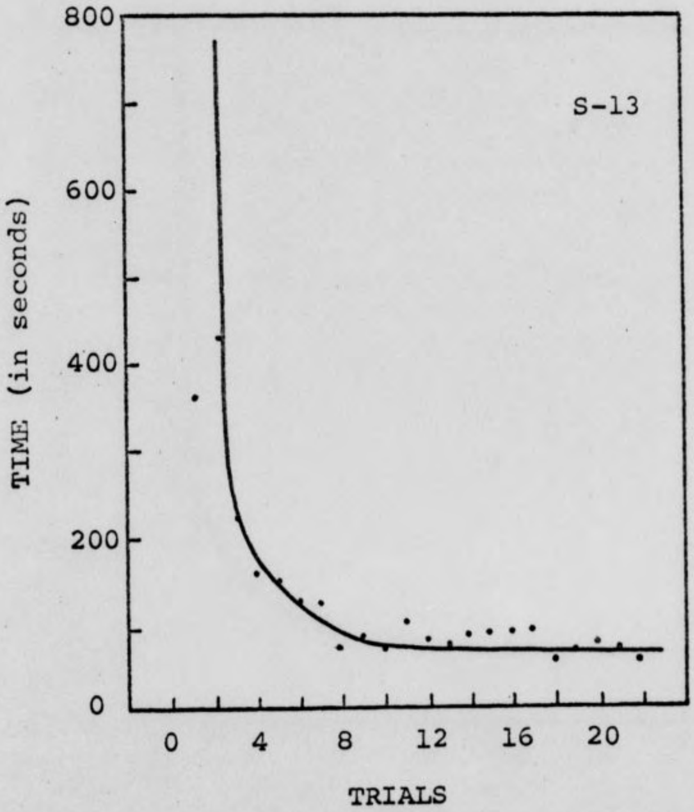
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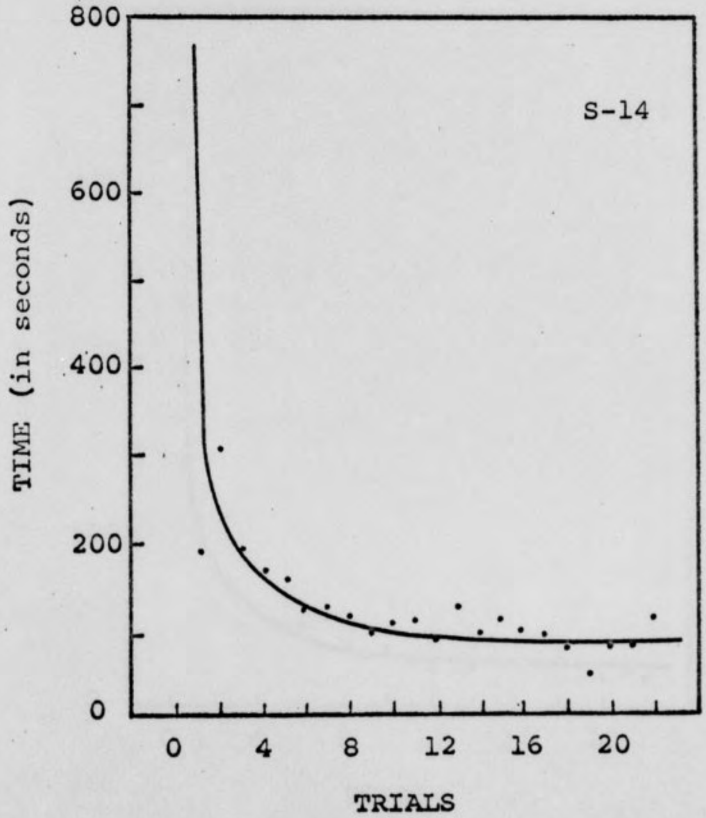
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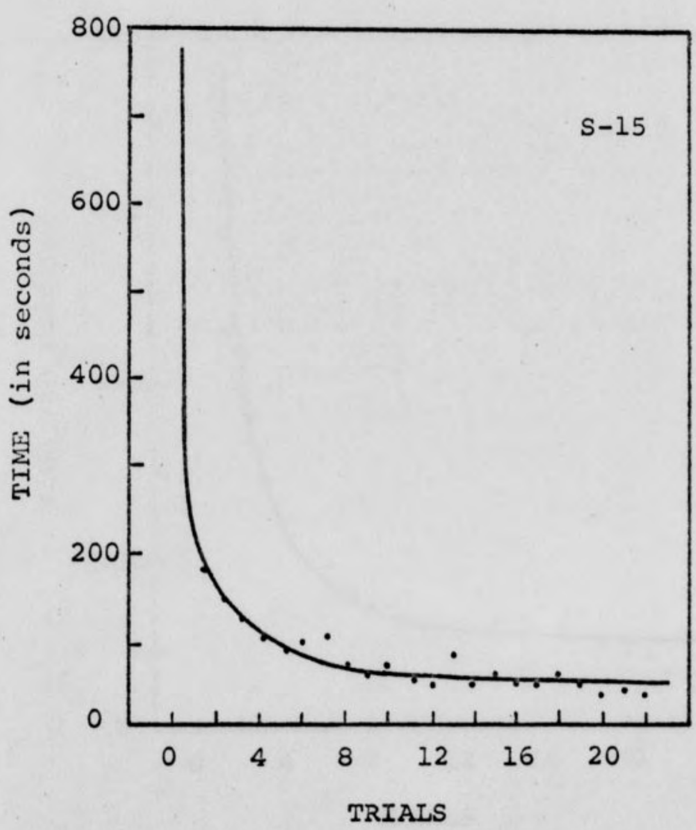
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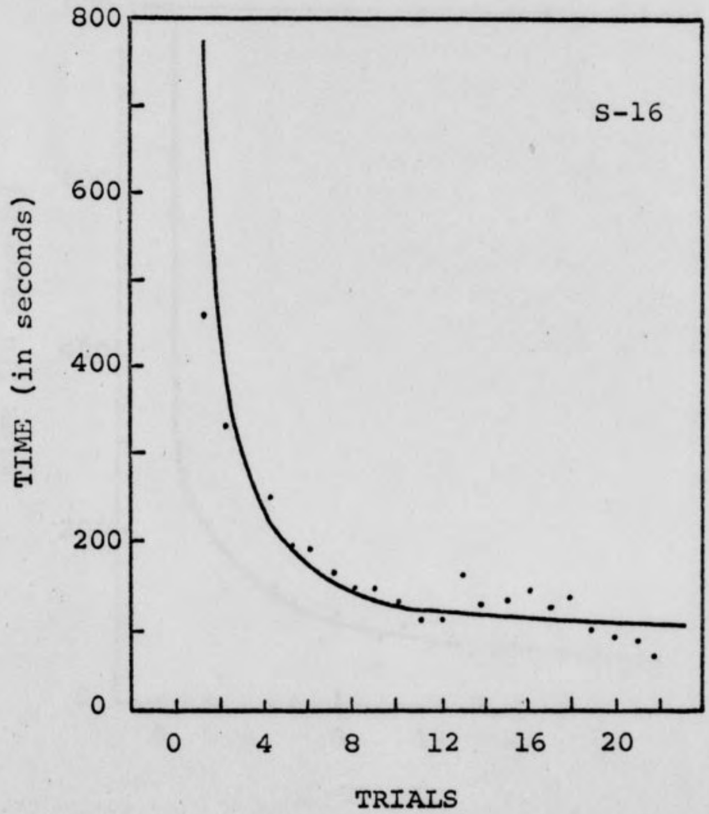
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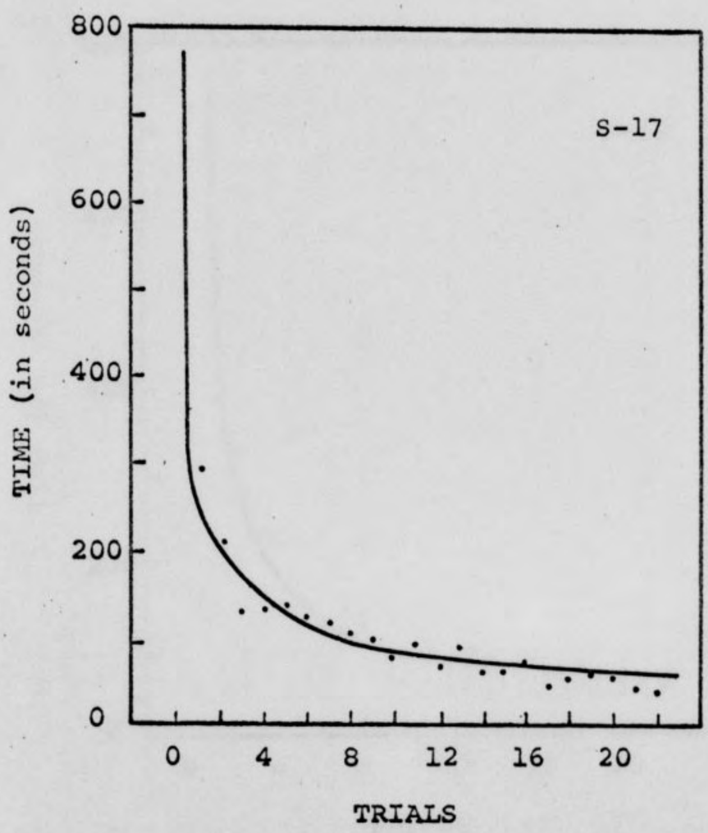
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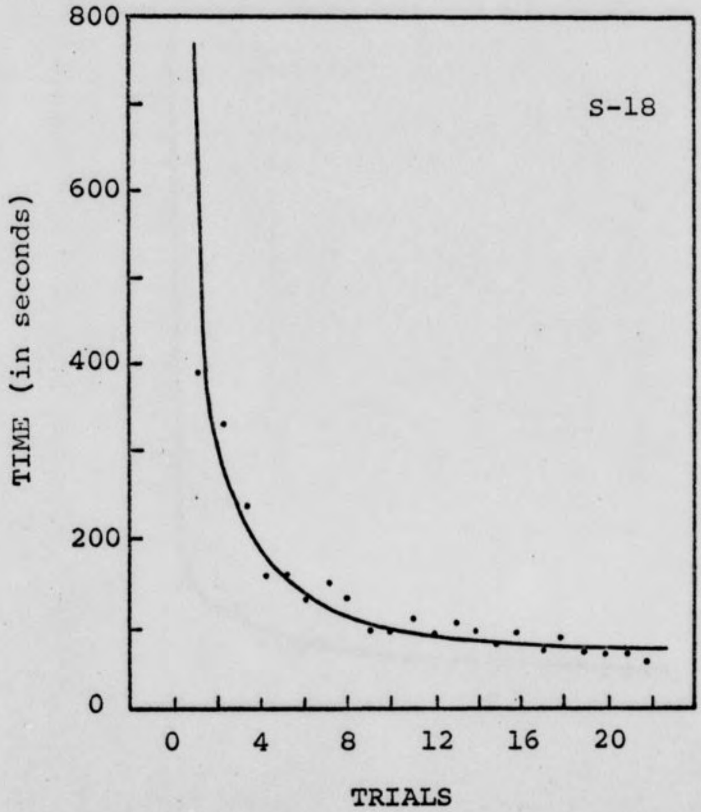
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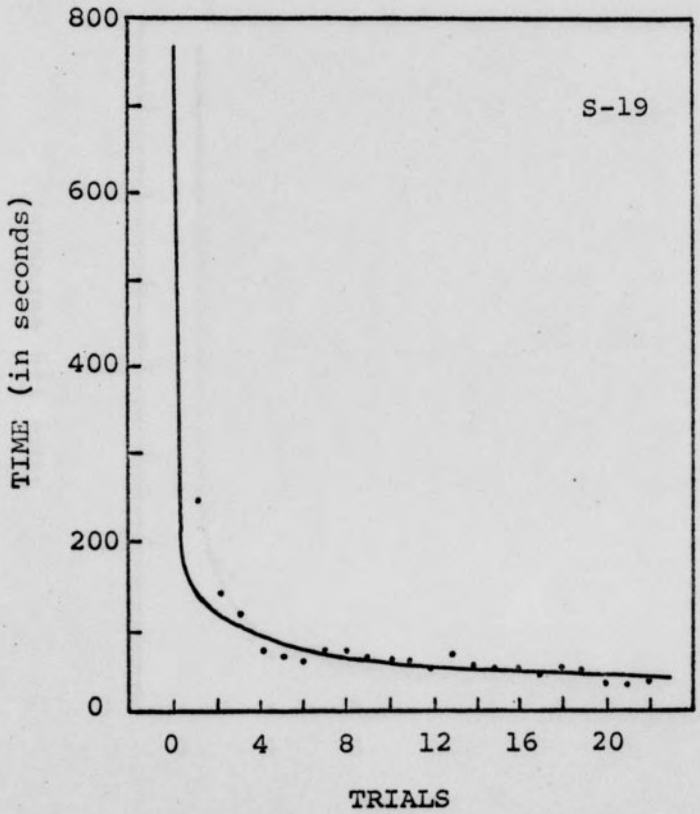
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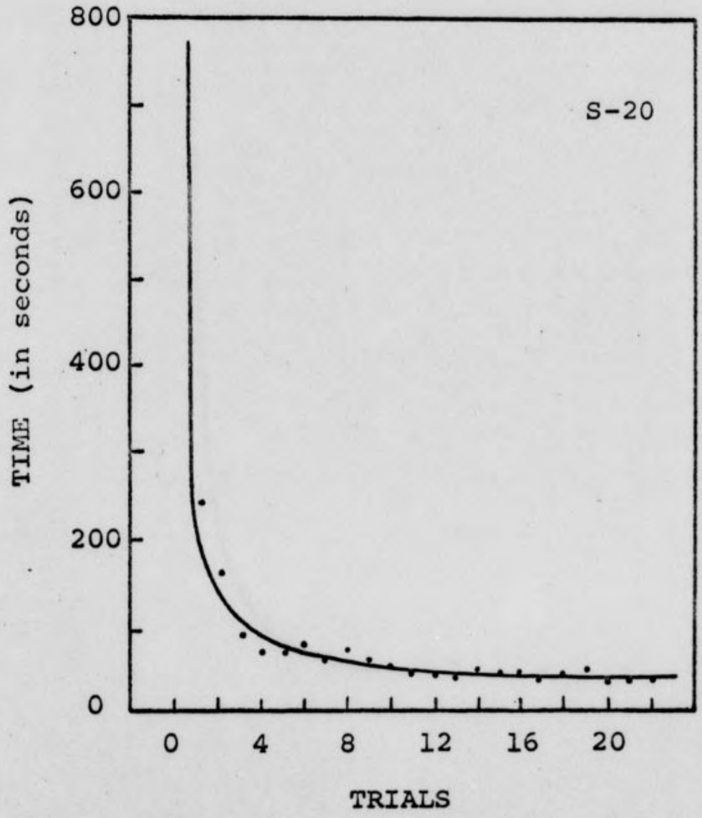
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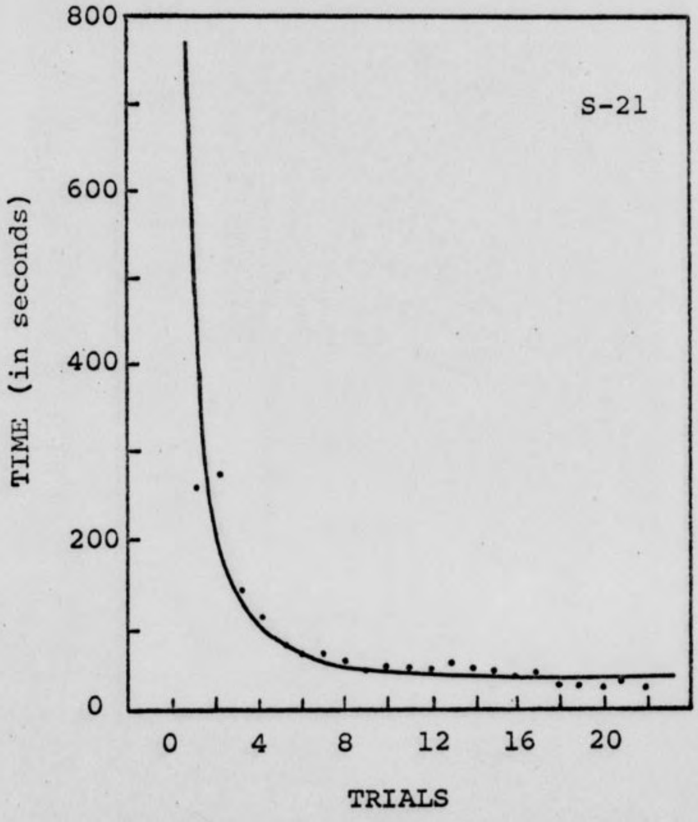
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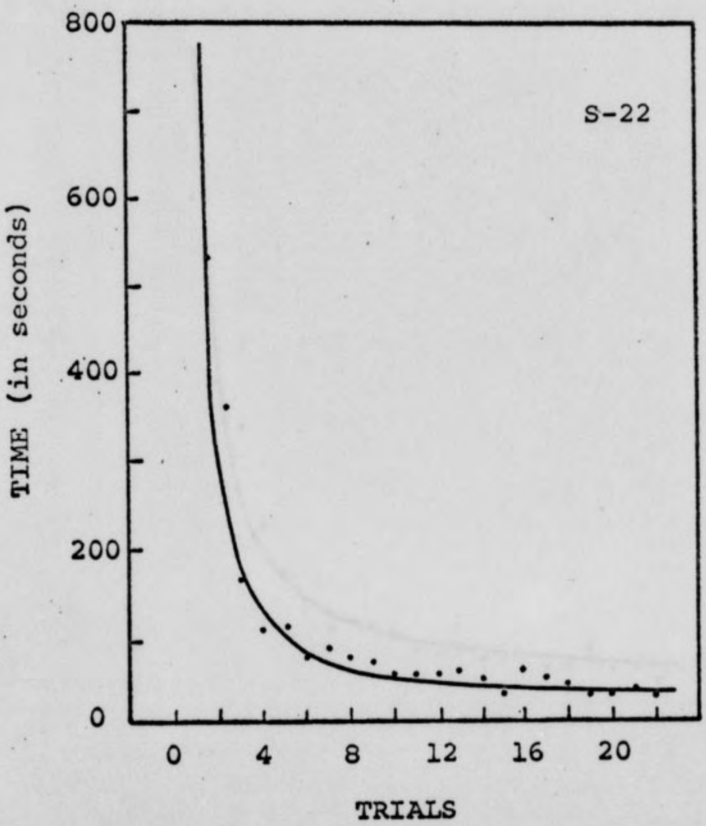
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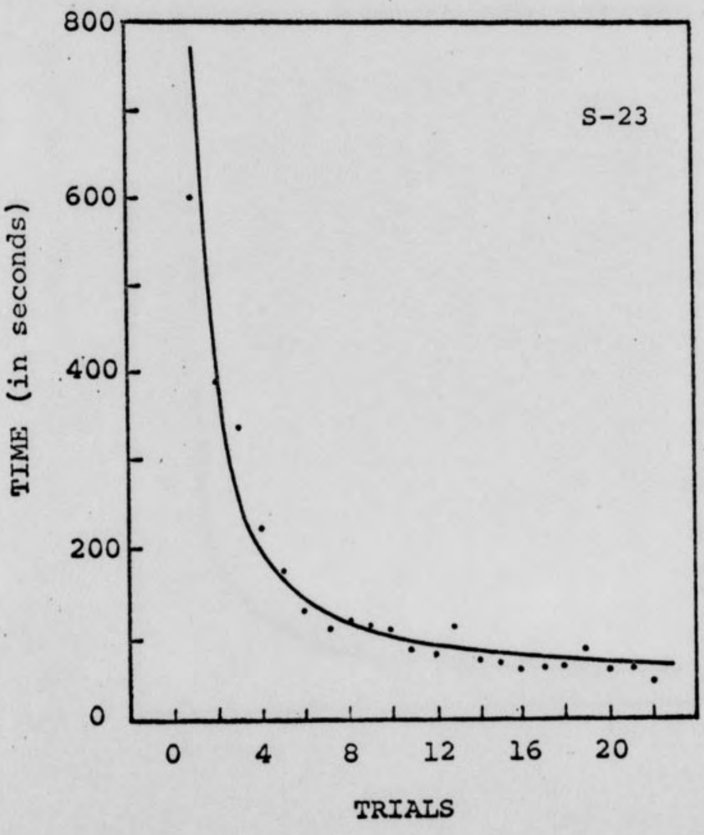
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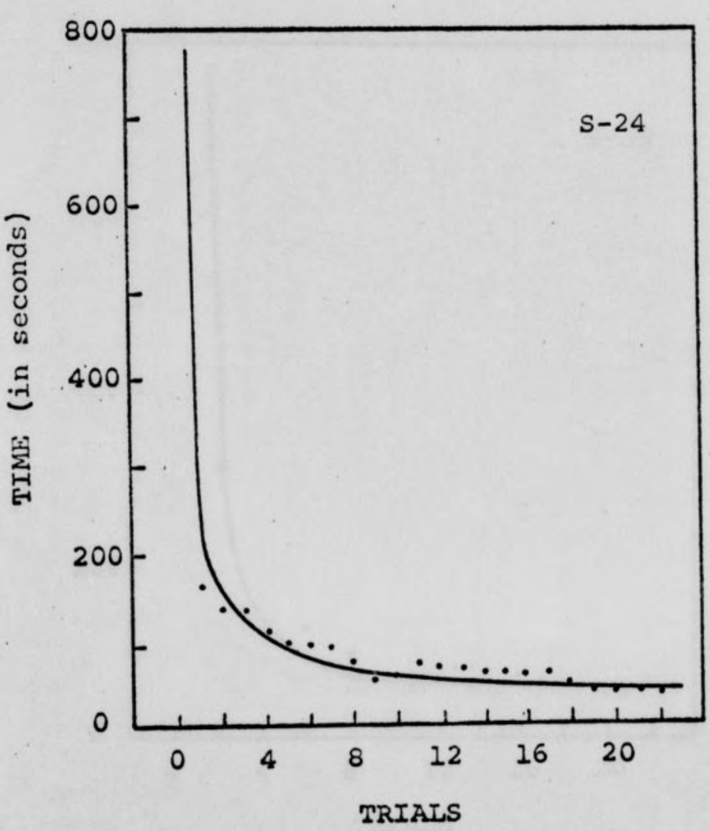

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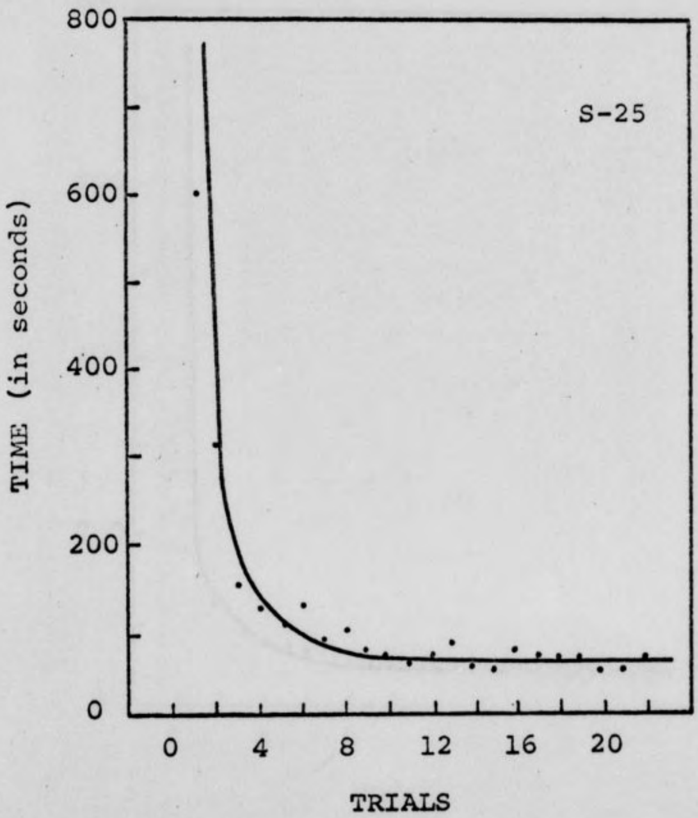
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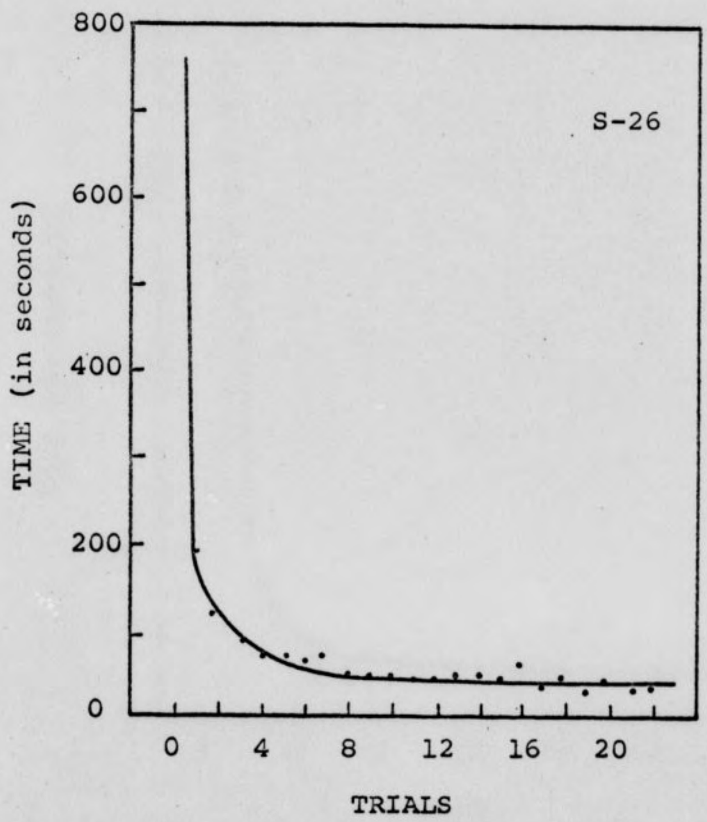
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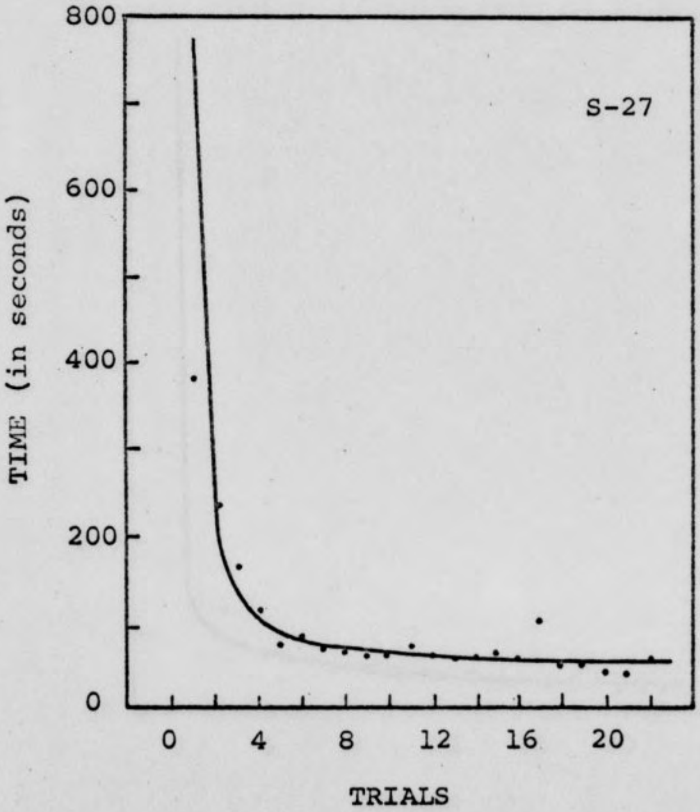
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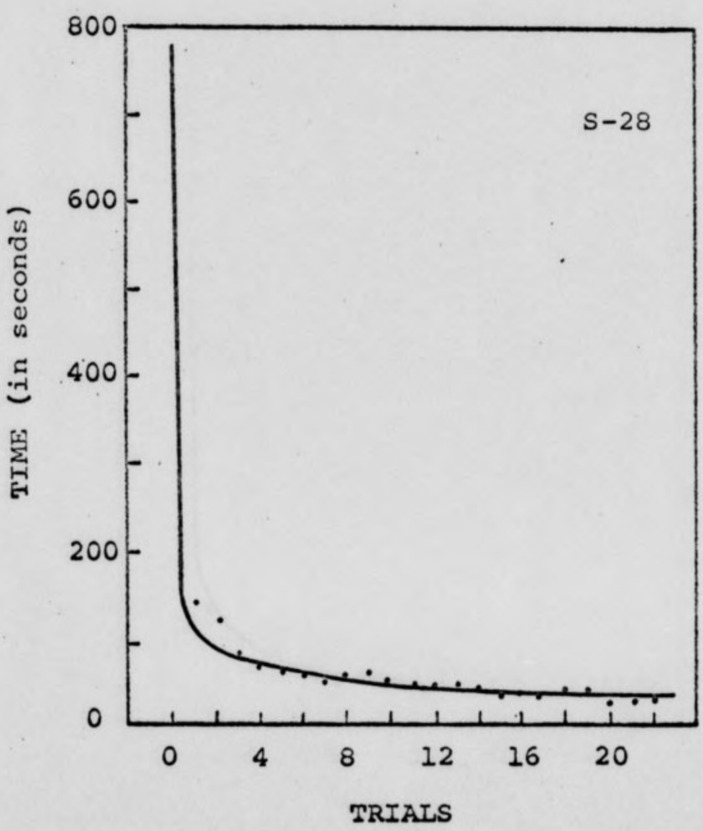
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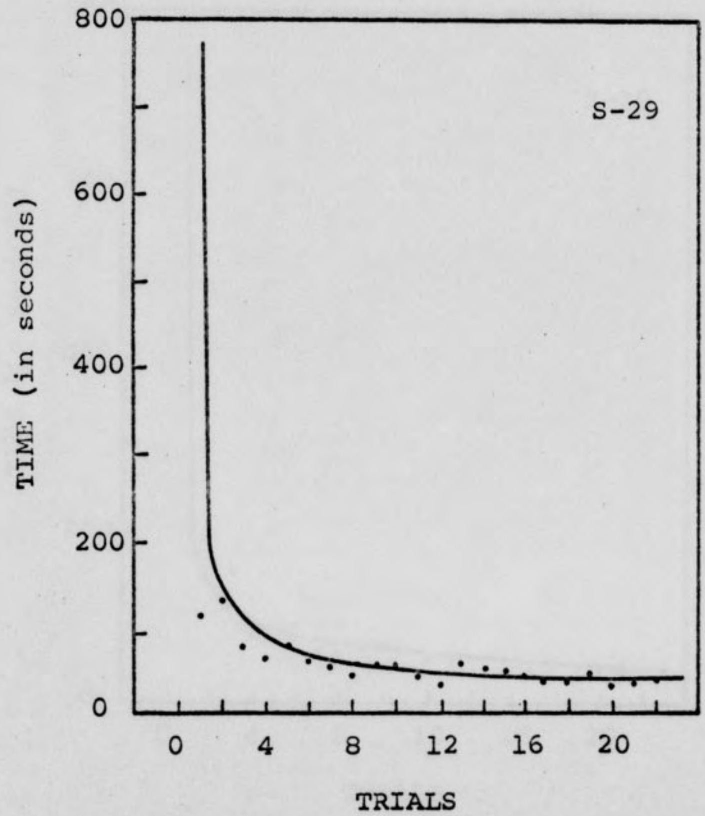
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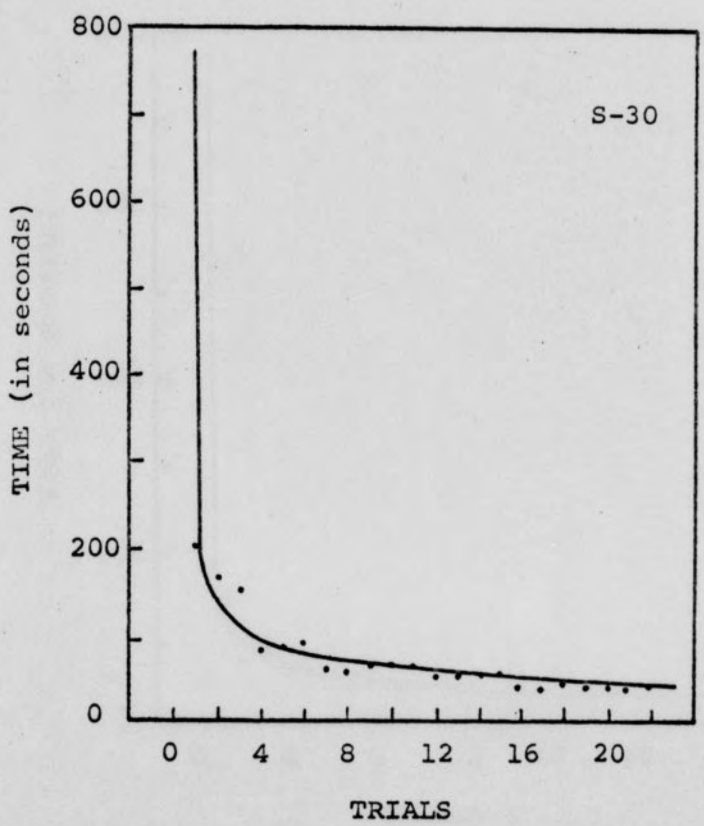
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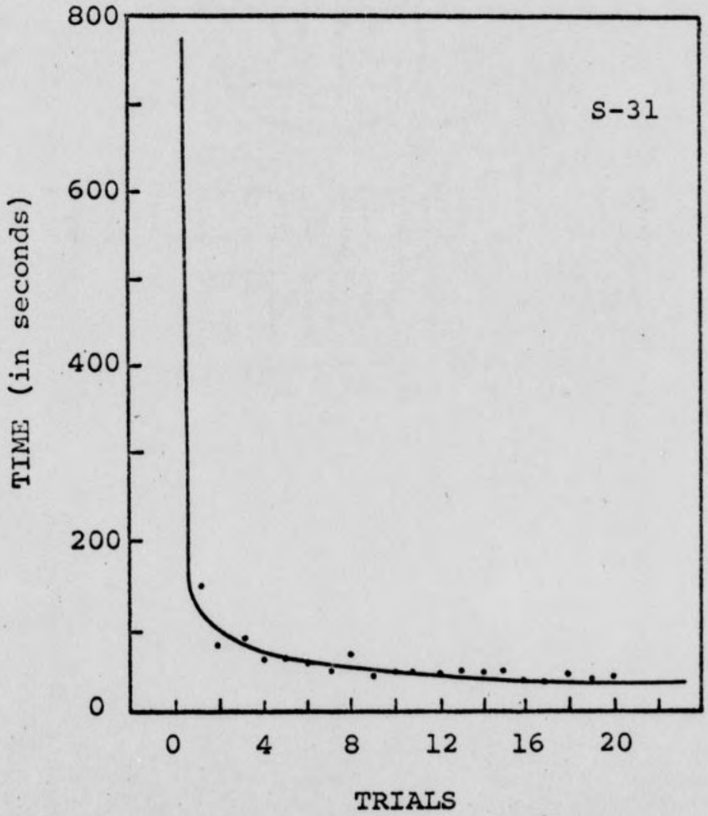
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