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INDIVIDUAL DIFFERENCES AND INSTRUCTIONAL FILM REPETITIONS. I. EXPLORATION OF APTITUDE-LEARNING CORRELATIONS.

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The elusive phenomenon of individual learning differences was probed via the concepts of transfer and practice at different stages of the learning process. Order of presentation of two films covering different subjects provided the transfer task. Practice was introduced by five repetitions of the films, interspersed among six repetitions of an immediate criterion achievement test. The control subjects took only the achievement test on six occasions. Despite methodological obstacles inherent in a repeated measures anlaysis, the following general observations were made. Film repetitions continued to produce significant increments in achievement after three showings, whereas test repetition alone did not produce significant improvement. Although no consistent patterns of test score correlations across trials were evident, the correlations did suggest a positive transfer relation that represented underlying aptitude variables other than content knowledge. These variables were related to general verbal facility, but not to memory span tasks or tests, nor to figural or symbolic cognition. Intrafilm correlations fluctuated very little, however, even though some abilities appeared to be more related to one film than to the other. (LH)

INDIVIDUAL DIFFERENCES AND INSTRUCTIONAL FILM REPETITIONS

I: EXPLORATION OF APTITUDE-LEARNING CORRELATIONS

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INDIVIDUAL DIFFERENCES AND INSTRUCTIONAL FILM REPETITIONS

I: EXPLORATION OF APTITUDE-LEARNING CORRELATIONS

The fact of individual differences in learning has been long acknowledged, but only recently treated to more than passing reference. Growing interest in the analysis of such differences is now evident, however, in the variety of viewpoints and approaches currently being brought to bear on research questions in this area (see, for example, Gagne, 1967). While in theory much of this work is relevant to both laboratory learning and school learning research, it is apparent that the methodology used to study individual differences in learning from meaningful instruction has been severely restricted relative to that available for research with laboratory tasks. Methodology has varied also as a function of the way in which individual difference variables have been conceptualized or operationalized in a given instance. At least three classes of individual-difference measures and three corresponding research approaches can be distinguished in the work accomplished to date. These three kinds of emphases are contrasted together with the laboratory vs. school learning distinction in Table 1.

First, there are antecedent individual differences, represented usually by scores on aptitude tests administered prior to an experimental treatment but including also sex, age, or any other index of a human difference potentially important for learning. These are entered as aptitude inputs and conceptualized as transfer relations from previous situations to the present one. They may be investigated as interactions with learning performance in alternative experimental treatments or as correlations with such performance in single subsequent treatments. The former usage is the course of action originally recommended by Cronbach (1957, 1967); it is illustrated for research on instructional film by some previous work of the present authors (Snow, Tiffin and Seibert, 1965). The latter use is typical of both traditional academic prediction studies and much of the current psychometrically-oriented research on either laboratory or school learning (see, for example, Duncanson, 1966). Radlow's (1955) investigation provides an example for research on film.

Measured differences in learning performance form criteria for aptitude predictors, as indicated above, but are obviously of considerable

TABLE 1

Varieties of Individual Difference Measures in Learning Research

	MEASURED DIFFERENCES IN		
	APTITUDE INPUT	LEARNING PERFORMANCE	APTITUDE OUTPUT
Laboratory Learning Research	Performance in Earlier Learning Situation Aptitude Scores Prior to Treatment	Trial or Stage Scores Curve Parameters Reference Learning Curves	Performance in New Learning Situation (Savings Transfer) Change on Aptitude Measures
School Learning Research		Pre-post Gain Achievement Scores General Achievement Status	Transfer Achievement Test Scores

interest in their own right. In experiments using laboratory learning tasks, learning is typically defined in terms of improvement with practice; individual differences in learning are represented by trial scores, stage scores, or curve parameters and these can then be related to other learning performances or other personal characteristics of learners. In this approach, changes in the structure of performance as a function of practice can be investigated and reference abilities can be used to trace such changes during acquisition or transfer. In research on formal instruction, however, trial data have not normally been obtainable. Pre vs. posttest comparisons or gains scores derived from such tests have had to suffice. Thus, the presence or absence of some degree of learning has been studied, but there have been few attempts to investigate individual differences during intermediate stages of school-related learning.

Finally, in addition to learning criteria, there are measurable differences in aptitude output. That is, individual differences in learning in one situation presumably transfer to new situations and function there again as aptitude inputs. In the experimental laboratory, it is possible to obtain transfer measures from trial performance in new learning tasks and to deal with these phenomena in terms of the concept of savings. Instructional research however has been limited largely to the use of achievement tests measuring skills or knowledge not directly taught by the treatment. These transfer tests probably represent only first trial performance in a new task, not complete performance or savings. Clearly, differences in aptitude arising from previous experience could conceivably be related <u>only</u> to performance at some later stage in new learning.

It is evident then that few, if any, investigations of meaningful instruction have incorporated the concepts of stages of acquisition or savings transfer. This is considered especially limiting for research on individual differences in learning since it is to these concepts that differential psychological considerations seem most relevant. The present study was thus designed to provide exploratory data on differential practice and transfer phenomena in school-related learning. It represents a kind of prototype on which several further stages of investigation could then be planned. This report examines some of the characteristics and correlates of trial scores obtained from repetitions of two instructional films and their associated achievement tests.

BACKGROUND

Individual Differences and Learning

Laboratory learning data are often perplexing because of the marked individual differences to be observed. While learning theorists have addressed themselves to some of the issues raised by such differences (Glaser, 1967), most researchers have traditionally paid little attention in practice, prompting Gullicksen (1961, p. 100) to remark that "For many years, people have analyzed group learning data, plotted group learning curves, and criticized others on the ground that there are individual differences in learning which averages ignore." Research aimed at investigating these differences has suggested a multiplicity of factors of learning. The demonstration of learning factors might in turn suggest the possibility of correlations between learning and cognitive abilities or other personal characteristics of learners. Fleishman (1962, p. 137) has stated that:

> "Investigators interested in learning and training have seldom been interested in individual difference variables in this context. . . interest has traditionally centered on variations in training treatments, with individual differences regarded as troublesome error variance. Yet, one has to be impressed with the large differences in learning due to individual differences when these are compared with the effects usually obtained from difference treatments and methods. Besides, the interaction of treatment effects and individual difference variables (e.g., abilities) would seem to be of major theoretical and practical significance."

DuBois (1962, pp. 66 and 69) has also championed the use of correlational strategies in the study of learning, stating:

> "The impact of individual differences is such that human variation must be taken into account in the study of most of the problems of interest to educators and others concerned with human learning. . . In the case of human learning, it appears that information on individual differences among the trainees may be of great utility in influencing its course. . .If characteristics that vary from individual to individual are ignored, investigations of learning are limited to the study of a relatively narrow range of topics, chiefly the effect of variations of internal drives and of external stimuli, including rewards and reinforcement, on changes in behavior."

The number and kinds of individual differences which have been identified and which might be related to learning are overwhelming. Guilford (1959, 1967) has summarized some of the earlier studies which investigated such relationships. While most of this work has suffered from a reliance upon crude gains scores as measures of learning, it was possible for Guilford (1959, p. 400) to draw some general conclusions from the data presented. With respect to intercorrelations among different learning performances, he stated that "Learning ability, as indicated by rate of learning, is not a unity, but there may be a number of somewhat generalized learning abilities." Attempts to relate general intelligence to learning rates have usually resulted in low correlations. This has been found true for maze learning, learning in perceptual tasks and in space-problem tasks, and for gain in knowledge in beginning psychology. One study reported high positive correlations between gain in school knowledge and IQ, which was taken to indicate the presence of a verbal comprehension factor in both measures. In his summary, Guilford suggested that "The thing to be concluded from all these studies is that we should seek to answer the question of what kinds of gains are related to what intellectual factors."

Gulliksen (1961) also considered the relation between intelligence and learning, discussing two studies (Stake, 1958; Allison, 1960) in which learning curve data on a variety of learning tasks and large batteries of reference aptitude and achievement variables were brought together in factor analyses. His conclusion:

> "First, we can say that, as a result of these two studies, the learning area is definitely a complex area that cannot be represented in terms of one learning ability. There are many different kinds of learning ability--how many we will not know until a good many more studies have been made. Second, it is clear that some of the abilities required for the learning tasks are <u>not</u> represented in any of the intelligence measures. The nature and the importance of these abilities that have been missed by the one-shot aptitude and achievement measures constitutes a very important problem for further investigation." (Gulliksen, 1961, p. 99)

Further work along these lines has been reported by Duncanson (1966).

Early studies of change in factor structure of tests and/or learning tasks as practice continued were conducted by Woodrow (1938), using verbal learning, and Greene (1943), using both psychomotor and non-motor tasks. Both reported marked changes in factor loadings on the practice variables for various abilities. A further development in this direction succeeded in incorporating data on the course of acquisition in learning tasks into a reference matrix of ability variables. This series of investigations has been summarized by Fleishman (1962). It has been demonstrated, for perceptual-psychomotor learning tasks, that a number of ability factors must be postulated to account for the variance in learning curve data, and that this factorial structure changes as a function of practice. One typical study in this series (Fleishman and Hempel, 1954) serves to exemplify the approach, which is closely related to that used in the present work. Performance measures at eight stages of practice in a complex coordination task were included as separate variables in a battery of reference tests of intellectual, perceptual, and psychomotor abilities. Following factor analysis of the resulting matrix, it was possible to plot the change in factor loadings for each identified factor over the series of practice stage measures. That is, the total variance in performance at each stage of practice could be partitioned into the amounts accounted for by each factor in the ability matrix. The results enabled the investigators to draw conclusions concerning the factorial complexity of the task at each stage of learning and to determine the extent to which each factor played a significant part in performance at each practice level. It was seen, for instance, that the nature of the factors contributing most of the variance shifted from a concentration of non-motor abilities (e.g., Spatial Relations, Visualization) in the early stages of practice to a predominance of motor abilities (e.g., Psychomotor Coordination, Rate of Movement) at the final stages of practice. The author's general conclusion was that:

> "... These changes in factor loadings at different stages of performance on the criterion task indicate that the quantitative pattern of abilities determining differences in goodness of performance changes with practice. In other words, individual differences in performance on the task after certain amounts of practice are likely to depend more on certain abilities and less on others than they did initially (pp. 247-248) ...The rise in the performance curve may be considered to be a resultant of systematic transformations in the particular com-

> bination of abilities contributing variance at different stages of practice " (p. 250).

Guilford (1959, p. 404), in discussing this research, stated that "... The technique ... seems to provide a way in which the roles of aptitudes in learning can be segregated and traced." Cronbach (1957, p. 676) in calling for a general coordination of "correlational" and "experimental" strategies in psychological research, hailed Fleishman's approach:

> "We may expect the test literature of the future to be far less saturated with correlations of tests with psychologically enigmatic criteria, and far richer in studies which define test variables by their responsiveness to practice at different ages, to drugs, to altered instructions, and to other experimentally manipulated variables. A pioneering venture in this direction is Fleishman's revealing work (1954) ... on changes in the factorial content of motor skills as a function of practice. These studies go far beyond a mere exploration of certain tests; as Ferguson has shown (1954, 1956) ..., they force upon us a theory which treats abilities as a product of learning, and a theory of learning in which previously acquired abilities play a major role."

More recently, Bunderson (1967) has pursued and improved further upon this general approach in an investigation of concept learning. He demonstrated that factors representing induction and flexibility were related to early stages of practice on concept tasks, when performance would best be described as a search and differentiation activity, while more general reasoning factors accounted for individual differences in later practice stages where organizing and integrating activities would be more involved. Several other ability factors including a new chunking memory factor were also shown to be involved at some stages of learning.

Individual Differences and Film Learning

Three reviews of the instructional film research literature have dealt specifically with empirical findings on audience characteristics in relation to learning from films (Hoban and Van Ormer, 1950; Allen, 1960; Snow, 1963). Space limitations permit only a brief discussion of some evident general trends and an examination of a few of the more pertinent previous studies.

The kinds of individual differences which have been investigated range broadly across the domains of intelligence, personality and attitude, social-biographical factors, previous knowledge, and past film learning experience. The bulk of previous research has been concerned with one learner characteristic and its relation to film learning. Few studies have brought a collection of different measures to bear in the same learning situation. The variables used have usually been complex, general indices, making an understanding of the underlying structure of the resulting correlations difficult to achieve. Few investigators have attempted to compare film learning conditions with conventional learning, or even no learning, conditions in terms of audience variables and their correlations with criterion test performance. Practice and past experience variables have been related to terminal learning behavior but individual differences at different stages of practice have not been considered. Where learning gains rather than terminal achievement served as the criterion, some form of crude gains index has been used to summarize the change in performance. Separations between stages of learning have not been maintained. In short, the suggestions of Cronbach, Gulliksen, DuBois, Guilford, and Fleishman cited earlier have been followed by few investigations of media learning.

One study of Radlow (1955) obtained information on some individual dimensions of mental ability by correlating part scores from the Guilford-Zimmerman Aptitude Survey with film learning gains scores. Although no single variable consistently offered the best prediction of learning gains for the two films used, the highest single correlation was .53 for the Verbal Comprehension factor. Spatial Visualization also correlated significantly with the measures of learning. For purposes of selecting superior film learners, Radlow suggested that Verbal Comprehension, General Reasoning, and Spatial Orientation would provide a generally satisfactory battery.

Research recently completed by the present authors (Snow, Tiffin, and Seibert, 1965) investigated instructional treatment-by-learner variable interactions using film vs. live demonstrations in college physcis and 14 audience characteristics. Previous knowledge of the subject-matter was included in the ANOV design as a third independent variable and terminal achievement was represented by both immediate and delayed recall criteria. It was concluded that personal characteristics of learners determine, to a significant extent, the amount of learning derived by individual members of the audience in a given learning situation. Seven of the learner variables studied were found to interact significantly with the film vs. live presentation conditions. These were: attitude toward instructional films, ascendancy, responsibility, numerical aptitude, verbal aptitude, past use of Purdue Film Library (one of two measures of past experience with instructional films), and past experience with entertainment films. These and one other variable (emotional stability) also exhibited other relationships which, while not statistically significant, were suggestive of differences worth further consideration. While some of the variables studied were correlated, in only one case were the effects of two variables apparently the result of a common underlying factor. Thus, a number of independent individual differences among learners were found to be differentially related to film learning and conventional learning.

The investigation presented here was considered a necessary prerequisite to a general evaluation of the role played by previously acquired abilities in learning from film. It was designed to provide a basis for more extensive research which could include many films, representing different dimensions of film production[1], and many conventional learning tasks. If the effects of individual differences among learners could be traced over the course of both intra-film and inter-film practice, and if these processes could be compared over systematically varying presentation conditions or media, then our understanding of instructional treatment-by-learner interaction would be considerably enhanced. The development of "film literacy" in learners or of learning sets in general might well be revealed in such research.

Objectives

In brief, the purposes of the present investigation were:

1) To identify factors of human ability and personality which might account for individual differences in learning from film.

[1] For a crude beginning toward identifying the underlying dimensions of film production in terms of physical film characteristics, see Study II in Snow (1963). There may be profit in convergence of this type of research with that proposed here.

2) To examine changes in the correlational structure of learning which might occur with repeated film practice.

3) To compare the correlational structure of learning obtained for different films and for the same film under different conditions of practice in film learning.

METHOD

Subject and Aptitude Measures.

A group of 185 Purdue University undergraduates had participated in a preceding factor analytic study of auditory and visual semantic memory abilities, from which a matrix of aptitude scored was available.[2] Pretest information for the present study was also obtained from the previous work by including in the aptitude matrix two achievement tests, to be described below as "first repetitions" of the criterion measures. Ss were then randomly divided to form two experimental and two control groups. After some random loss of participants, the groups on which all final data were available each consisted of 41 Ss. Descriptive information for the sample has been incorporated into the tables of results.

Treatments and Criterion Measures

Experimental Ss received instruction via two sound color motion pictures, with order of presentation counterbalanced between the two experimental groups. The films used were Baboon Behavior (produced by the University of California Department of Anthropology, 31 minutes in length) and Steam Turbine (produced by Allis-Chalmers Company, 25 minutes in length). These were chosen for their relatively extensive treatment of complex subject matter. They are self-contained instructional presentations differing considerably in both form and content. Five film repetitions, one every 24 hours, interspersed between six repetitions of an immediate criterion achievement test, were administered for each film. Control groups received repetitions of the achievement measures only, with order of presentation similarly counterbalanced. Ss were tested in sub-groups ranging in size from eight to 15. At the same

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[2] For a detailed presentation of the previous work, see Seibert and Reid, 1967.

appointed time each day for two weeks, Ss appeared at one of two experimental classrooms. These rooms were fully equipped for audio-visual presentations, each with an insulated projection booth, and a desk seating capacity of 30. Each group received either a film showing immediately followed by a slide projected achievement test or the test alone. The time needed for each session was approximately 45 minutes and 15 minutes for the experimental and control treatments, respectively. Criterion achievement test items were presented on slides to control exposure time at 20 secs. per item per showing. The same item presentation order was used for each repetition. The Baboon Behavior test contained 38 5-alternative multiple-choice items; the Steam Turbine test contained 36 such items. Earlier work with these tests suggested that KR20 internal consistency was approximately .75 with a 20-second exposure time (see Heckman, Tiffin, and Snow, 1967, also for further details on the slide test presentation procedure).

RESULTS AND DISCUSSION

Learning Data Analyses.

A 2x2x6 factorial design, in which the third factor is a repeated measures variable, was thus available for each of the two achievement tests. Statistical procedures appropriate for repeated measures designs have been outlined by Winer (1962). A summary of our analyses appears in Table 2. Means, standard deviations, and Newman-Keuls results are shown in Table 3. As is frequently the case with learning data, the assumptions involved in the repeated measures analysis were badly violated. The obtained F-ratios are clearly inflated beyond belief and should therefore not be taken seriously. It is obvious without statistical tests that performance continuously improved with practice in the film repetition groups for both films, but did not do so for the test-only control groups. The effects involving presentation order were not judged significant, a finding which is probably reliable.

As a practical matter, it may be useful to note that film repetition continued producing significant improvement through the fourth film showing for both films, although the average gains as a result of the fourth showing were only 1.5 and 1.8 items, for Baboon Behavior and Steam Turbine

TABLE 2

Analysis of Variance Summary for Baboon Behavior and Steam Turbine Achievement Tests

SOURCE		df	Baboon Behavior MS	Baboon Behavior F	Steam Turbine MS	Steam Turbine F
BETWEEN SUBJECTS		163				
Film vs. No Film	(F)	1	37802.63	1113.81**	26682.29	452.40**
Order of Presentation	(O)	1	1.71	----	43.97	----
F x O		1	126.60	3.73	2.33	----
Subj w groups		160	33.94		58.98	
WITHIN SUBJECTS		820				
Repetitions	(R)	5	2496.85	525.65**	2146.75	362.02**
R x F		5	1922.54	404.75**	1564.91	263.90**
R x O		5	6.81	1.43	2.04	----
R x F x O		5	9.57	2.01	4.63	----
R x Subj w groups		800	4.75		5.93	
TOTAL		983				

$*F_{.05}$ (1,160) = 3.90) Conservative tests following Greenhouse and Geisser (1959)
$**F_{.01}$ (1,160) = 6.80) F-ratios are inflated and not to be taken seriously.

Table 3

Means ($\bar{X}$) and Standard Deviations (σ) for Baboon Behavior and Steam Turbine Achievement Tests

			Baboon Behavior						Steam Turbine				
			1	2	3	4	5	6	7	8	9	10	11	12
FILM	Order I n=41	$\bar{X}$	8.32	16.10	22.22	24.44	26.00	27.29	7.98	14.24	19.29	22.22	23.83	25.15
		σ	2.61	3.69	4.02	3.78	3.53	3.84	2.72	4.88	5.55	5.21	4.60	4.89
	Order II n=41	$\bar{X}$	7.83	18.27	22.56	25.24	26.73	27.54	7.61	15.39	19.71	22.61	24.61	25.90
		σ	2.20	4.04	3.67	3.61	3.92	3.00	2.11	5.09	5.15	5.54	4.47	4.45
NO FILM	Order I n=41	$\bar{X}$	7.49	8.12	8.22	8.44	8.51	8.71	8.00	8.34	8.78	9.20	9.07	9.37
		σ	2.13	2.44	2.56	2.57	2.44	2.69	2.29	2.61	2.86	2.99	2.69	2.83
	Order II n=41	$\bar{X}$	8.02	8.95	9.05	9.39	9.32	9.56	7.63	8.24	8.15	8.66	8.76	9.37
		σ	2.51	2.76	3.06	2.60	2.54	2.72	2.91	2.45	2.73	3.03	3.12	1.76

		1	2	3	4	5	6	7	8	9	10	11	12
FILM n=82	$\bar{X}$	8.07	17.18	22.39	24.84	26.37	27.41[a]	7.79	14.82	19.50	22.41	24.22	25.52
NO FILM n=82	$\bar{X}$	7.76	8.54	8.63	8.91	8.91	9.13	7.82	8.29	8.46	8.93	8.91	9.37

[a]Means which do not differ significantly at .01 level using the Newman-Keuls procedure are underlined.

NOTE: Columns #1 through #6 designate the pretest and five repetitive posttests for Baboon Behavior; columns #7 through #12 designate pretest and five repetitive posttests for Steam Turbine.

respectively. The fifth showing did not produce a significant increment for either film using the Newman-Keuls test but this test is also affected by the assumption problems. Using paired t-tests on the increments resulting from the fourth and fifth film repetitions, all gains were significant. These findings relate to earlier work on film repetition reported by McTavish (1949), Kendler, Cook and Kendler (1953), and Ketcham and Heath (1963) and might be interpreted as increasing by at least one a previous recommendation that three showings was maximal.

Matrices of intercorrelation were computed among all learning variables within all four groups and also within the combined experimental and control groups. Results for the combined groups are reported in Table 4. Intrafilm trial intercorrelations may be seen tc display simplex patterns similar to those typically found in practice matrices. Both experimental groups and control groups showed simplexes, though the control group patterns were somewhat less regular. Pecularly, Variable #1, the pretest for Baboon Behavior, seemed to predict later trial performance better than it did the trials closest to it in the time series, but this effect was not large and was not replicated in the Steam Turbine data. The interfilm correlations were significantly different from zero only for the experimental group, showing clearly the effect of film repetitions as opposed to test repetitions only. As shown, these correlations ranged from .39 to .55 but display no consistent patterning across trials. They can be taken to suggest a kind of positive transfer relation between the two learning experiences, representing underlying aptitude variables, other than content knowledge, that are relevant to both. When the correlation matrices were broken down by order subgroups, little change from this pattern was observed. The interfilm correlations were somewhat higher, ranging from .35 to .64, when Baboon Behavior came first in order and lower when Steam Turbine.came first, ranging from .23 to .56. Separate matrices for the subgroups have been included in Appendix A.

Aptitude-Learning Correlations.

Tables 5 and 6 present significant correlations between aptitude variables and trial performance, again for combined experimental and control groups. Complete matrices of intercorrelation for separate subgroups may be found in Appendix A.

TABLE 4

Matrix of Intercorrelations Among Achievement Tests
for Combined Experimental Groups (above main diagonal, n=82)
and Combined Control Groups (below main diagonal, n=82)

	BABOON BEHAVIOR							STEAM TURBINE				
	1	2	3	4	5	6	7	8	9	10	11	12
1		13	20	28	28	34	05	06	17	15	17	18
2	20		55	55	46	41	09	48	41	39	41	43
3	18	56		74	70	64	06	51	53	48	50	55
4	20	61	67		82	75	-02	39	50	44	52	50
5	18	45	53	68		81	03	42	52	43	55	52
6	27	51	56	58	69		00	40	51	41	48	46
7	01	03	-03	15	02	01		23	08	15	11	13
8	-01	14	06	14	01	17	19		77	73	72	67
9	05	-01	08	07	08	02	40	48		87	83	75
10	13	-01	-04	06	05	04	35	48	74		86	81
11	04	06	11	19	16	13	39	50	69	74		87
12	06	04	08	14	06	11	22	46	65	71	71	

TABLE 5

Pearson Correlations Between Aptitude Measures and Achievement Test Repetitions for Combined Experimental Groups (N=82).

VARIABLE	FACTOR	BABOON BEHAVIOR 1	2	3	4	5	6	STEAM TURBINE 7	8	9	10	11	12
17 Advanced Vocabulary	CMU		42	46	47	56	41		52	52	45	54	51
18 Wide Range Vocabulary Part 1	CMU		48	55	53	52	42		50	44	40	45	44
19 Wide Range Vocabulary Part 2	CMU		43	53	48	54	46		55	51	46	55	47
31 Word Classification	CMC		21	27	23	28	31		23	23	21		
32 Verbal Classification Part 1	CMC		40	38	29	36	23		42	45	35	37	35
33 Verbal Classification Part 2	CMC		28	34	26	25			38	29			22
34 Word Matrix	CMR		35	40	42	51	35		34	29		36	31
35 Verbal Analogies Part 1	CMR		35	28	31	27			33	39	32	28	25
36 Verbal Analogies Part 2	CMR		35	29	35	32	26		41	32	26	35	33
20 Math Aptitude	CMS		38	26	23	33	23	23	42	41	35	38	31
21 Necessary Arith Ops Part 1	CMS		31						38	29	31	29	
22 Necessary Arith Ops Part 2	CMS		32	36	33	38	24		50	37	38	46	34
25 Au itory Letter Span	MSU												
26 Auditory Number Span	MSU												
54 Auditory Word Span	(A-MSU)												
53 Memory for Ideas	(A-MMU)		23	30	26	31	22		50	43	38	46	42
84 Sentence Reproduction	(A-MMU)		34	50	41	50	45		42	44	35	39	36
57 Random Word Recognition	(A-MMC)			39	23	26	22						29
62 Class Memory	(A-MMC)		34	26	33	28	27			30			
27 First and Last Names	MMR												
65 Paired Words	(A-MMR)											22	22
70 Phrase Completion	(A-MMR)		34	41	47	42	44		25	30	24		23
75 Sentence Completion	(A-MMR)		37	36	41	38	31		36	38	39	37	38
28 Sequence Memory	MMS			23	30	24	27						
30 Position Recall	MMS		22	27	27								
80 Phrase Sequences	(A-MMS)												
83 Idea Sequences	(A-MMS)		25	23	35	34	26			26		27	
48 Successive Perception III	(F-CFU)											24	
49 Successive Perception IV	(F-CFU)								30				
50 Sequential Words	(F-CSU)												
23 Maze Tracing Speed	(CFS)							30					
24 Map Planning	(CFS)					23			24				

TABLE 5 (Continued)

VARIABLE	FACTOR	BABOON BEHAVIOR 1	2	3	4	5	6	STEAM TURBINE 7	8	9	10	11	12
41 Film Memory I	(F-MMU)									-23	-22	-20	-28
42 Film Memory II	(F-MMU)												
44 Social Abstracts IA	(F-MMR)				27	28				27	25	27	29
45 Social Abstracts IB	(F-MMR)			27	23								
46 Social Abstracts IIA	(F-MMR)								28	27	29	32	22
47 Social Abstracts IIB	(F-MMR)		25	23					30	25	27	27	
43 Film Memory III	(F-MMS)												
29 Position Recall I	(MFS)												
37 Word Group Naming	NMU					25	23			27	29	31	29
38 Word Grouping	NMC												
39 Vocabulary Completion	NMR		46	42	37	35	26		47	33	26	31	29
40 Sentence Order	NMS			22	28	29				23			
85 Outgoing/Reserved	16PF-A				-22			-26	-32	-27	-23	-25	
86 Intelligent	B		46	41	39	40	32		31	41	42	42	40
87 Emot. Stable/Affect. Feel.	C												
88 Assertive/Humble	E												
89 Happy Go Lucky/Sober	F								-26	-23	-32	-32	-38
90 Conscientious/Expedient	G	46											
91 Venturesome/Shy	H								-22				-28
92 Tender-Minded/Tough-Minded	I								-25			-23	
93 Suspicious/Trusting	L	-25											
94 Imaginative/Practical	M												
95 Shrewd/Forthright	N			24					30	28		25	
96 Apprehensive/Placid	O	-32											
97 Experimenting/Conservative	Q_1								23	34	25		
98 Self-sufficient/Group Dependent	Q_2			23					39	33	29	27	25
99 Controlled/Casual	Q_3	27											
100 Tense/Relaxed	Q_4	-32											
13 Sex (Male = 2, Female = 1)								34	27	26	23	28	
14 Age								23				23	
15 Class				24				29			22	24	23
16 School									30	22	24		

NOTE: Only correlations above $r_{.05}$=.217 (df=80) are reported. Factor abbreviations follow the Guilford Structure of Intellect model; F and A prefix = film and auditory respectively; parentheses indicate purely hypothetical classification according to Guilford model. 16PF indicates Cattell's 16 Personality Factor Inventory; first word of bipolar pair is positive direction.

TABLE 6

Pearson Correlations Between Aptitude Measures and Achievement Test Repetitions for Combined Control Groups (N=82)

VARIABLE	FACTOR	BABOON BEHAVIOR						STEAM TURBINE					
		1	2	3	4	5	6	7	8	9	10	11	12
17 Advanced Vocabulary	CMU												
18 Wide Range Vocabulary Part 1	CMU						23						
19 Wide Range Vocabulary Part 2	CMU								27			25	
31 Word Classification	CMC		42				26						
32 Verbal Classification Part 1	CMC												
33 Verbal Classification Part 2	CMC								24				
34 Word Matrix	CMR								28				
35 Varbal Analogies Part 1	CMR												
36 Verbal Analogies Part 2	CMR												
20 Math Aptitude	CMS									29	36	29	29
21 Necessary Arith. Oper. Part 1	CMS										29	33	30
22 Necessary Arith. Oper. Part 2	CMS								30	33	45	33	38
25 Auditory Letter Span	MSU												
26 Auditory Number Span	MSU						31						
54 Auditory Word Span	(A-MSU)												
53 Memory for Ideas	(A-MMU)			28	28		26						
84 Sentence Reproduction	(A-MMU)						26		28			26	
57 Random Word Recognition	(A-MMC)												
62 Class Memory	(A-MMC)							25					
27 First and Last Names	MMR							-23		-23			
65 Paired Words	(A-MMR)												
70 Phrase Completion	(A-MMR)												
75 Sentence Completion	(A-MMR)											22	22
28 Sequence Memory	MMS												
30 Position Recall	MMS												
80 Phrase Sequences	(A-MMS)			28	29	25							
83 Idea Sequences	(A-MMS)			24	29		23					24	
48 Successive Perception III	(F-CFU)								27		25		
49 Successive Perception IV	(F-CFU)							23	28				
50 Sequential Words	(F-CSU)												
23 Maze Tracing Speed	(CFS)												
24 Map Planning	(CFS)												

TABLE 6 (Continued)

VARIABLE	FACTOR	BABOON BEHAVIOR 1	2	3	4	5	6	STEAM TURBINE 7	8	9	10	11	12
41 Film Memory I	(F-MMU)												
42 Film Memory II	(F-MMU)												
44 Social Abstracts IA	(F-MMR)								24			26	
45 Social Abstracts IB	(F-MMR)								23		23		
46 Social Abstracts IIA	(F-MMR)											27	23
47 Social Abstracts IIB	(F-MMR)							29					
43 Film Memory III	(F-MMS)												
29 Position Recall I	(MFS)												
37 Word Group Naming	NMU												
38 Word Grouping	NMC												
39 Vocabulary Completion	NMR												
40 Sentence Order	NMS					27	27				24		
85 Outgoing/Reserved	16PF-A									-41	-35		-24
86 Intelligent	B						27						
87 Emot. Stable/Affect.Feel.	C												
88 Assertive/Humble	E								24				
89 Happy-Go-Lucky/Sober	F												
90 Conscientious/Expedient	G												
91 Venturesome/Shy	H												
92 Tender-Minded/Tough-Minded	I							-34		-36	-44	-34	-24
93 Suspicious/Trusting	L												
94 Imaginative/Practical	M												
95 Shrewd/Forthright	N	23	28										
96 Apprehensive/Placid	O								-29				
97 Experimenting/Conservative	Q_1								23	28	25	25	
98 Self-sufficient/Group Dependent	Q_2										23	28	26
99 Controlled/Casual	Q_3												
100 Tense/Relaxed	Q_4			-25									
13 Sex (Male = 2, Female = 1)								31	35	29	30	23	
14 Age													
15 Class										-23			
16 School								38	39	37	49	41	27

NOTE: Only correlations above $r_{.05}$=.217 (df=80) are reported. Factor abbreviations follow the Guilford Structure of Intellect model; F and A prefix = film and auditory respectively; parentheses indicate purely hypothetical classification according to Guilford model. 16PF indicates Cattell's 16 Personality Factor Inventory; first word of bipolar pair is positive direction.

In most cases, tests that correlated with learning performance on one film correlated also with performance on the other film, and did not correlate with test-only control behavior. Several reference factors were clearly involved in learning in this situation. Using Guilford's terminology, these were mostly the verbal factors as expected; cognition of semantic units and relations, and convergent production of semantic relations. Others, like memory span and other tests using figural or symbolic content, were clearly not involved. In effect these results suggest only that there is a large meaningful verbal learning factor involved in performance with both films. A factor analysis of the aptitude data, reported elsewhere (Seibert and Reid, 1967), did in fact produce such a factor. More important for our purposes would be the finding of systematic patterning of correlations for one film. With respect to patterning, for most variables there appeared to be little fluctuation across trials beyond what could be expected by chance or by variations in the amount of variance available for correlation. Clearly, one cannot talk of different abilities accounting for variance at different stages of practice on the basis of the correlational data presented here. It had been hypothesized that some of the more conventional verbal abilities like CMU might be correlated with earlier repetitions while tests representing other operations or products in Guilford's model might be related to performance on later trials. This did not occur and its lack of occurrence seems not accounted for by differences in test variance or reliability. It is possible to note however that some aptitude variables related to performance with one film and not the other. Tests of meaningful memory above the units category, particularly those presented using audio tape, seemed more heavily related to performance with the <u>Baboon</u> film. Tests of film memory, on the other hand, seemed more predictive of performance in the <u>Steam Turbine</u> film, suggesting that the films may differ somewhat in their reliance on auditory and visual communication channels. The auditory and film tests of memory skills are newly constructed measures available from other work of the authors. One reason for the production of these tests was the hope that they might be more useful in the analysis of audio-visual communication than traditional paper and pencil measures. While selected measures do appear to serve unique functions, these tests taken as a class do not appear uniquely valuable in this regard.

The available personality information added few notes of interest. Aside from the intelligence scale, the more effective learners for Steam Turbine were characterized as relatively reserved, sober, experimenting, and self-sufficient. Some of these traits seem to correspond to a measure of responsibility which, in earlier work, was also found related to learning from film. These correlations did not appear for the Baboon film, where also the content was definitely not describable as sober, reserved, tough-minded, or experimenting. It must be noted though that most of these scales were also correlated with Steam Turbine performance in the Control Group. These traits also appear to be more characteristic of males from the science and engineering schools. In turn, the science and engineering students displayed more prior knowledge of the Steam Turbine subject-matter. This may also account for the relation of the CMS Factor to Steam Turbine performance in the control group.

Having surveyed broadly across a quantity of simple correlational data such as that presented here, various forms of higher-order statistical treatment might be suggested for use in further analyses. The plan of analysis for this research did in fact include factor analysis of the ability matrix (see Seibert and Reid, 1967) as well as factor analytic treatment of the learning data using methods proposed by Tucker (1960). These approaches yielded little of value in the present case, however, and were abandoned. Factoring the aptitude data provided a few conglomerate factors the first of which simply combined most of the semantic cognition measures and other variables that had been shown related to learning as simple variables; the overall prediction of learning performance was not improved thereby. Tucker's methods applied to the learning matrices yielded single large factors for each film that could be arbitrarily broken to form any number of simpler factors. The simplicial character of these matrices and the relatively few number of repetitions available thus discourages factor analytic treatment of such data.

In contrast to the more highly processed correlational procedures which are possible, the functioning of individual aptitude variables can be examined within the order-of-presentation subgroups using regression analysis. This approach offers distinct advantages in the study of aptitude-instructional treatment interactions in general. Its application in this situation is aimed at investigating complex relations between part scores on aptitude variables, intrafilm learning performance, and interfilm transfer relations. The order-of-presentation variable is used to provide the transfer task; it was not meant to offer potentially important instructional treatment alternatives. Part scores for a number of aptitude variables were entered into the present matrix to serve these latter purposes. Typically only total scores for ability measures have been included in previous research. Part scores arising from equivalent forms of such tests have served the purposes of reliability estimation only and then have usually been combined for further work. It is possible however to view ability tests as miniature learning situations in which the test parts provide two trials. Many of the tests used by Guilford (1967) and others in factor analytic research on abilities pose quite unusual intellectual tasks to subjects, where it might be expected that the first parts would function as first trials in learning tasks. When interest is centered on ability-learning relations, the two parts of these ability tests might well index significantly different aspects of performance. Thus it might be particularly useful to examine regression analyses of separate part scores.

It is hoped that such analyses will serve to emphasize the complexity of the phenomena under investigation here and help to plan research in which film treatments would actually be compared with other viable treatments (e.g. text reading). This further work was not planned for inclusion in this report since it was conceived as a separately funded, second stage of the ongoing investigation. Also a part of the ongoing work will be detailed item analyses of the achievement test repetitions. It is clear that an understanding of individual differences in learning must be obtained through increasingly specific regression analyses rather than increasingly general and abstract correlational analyses.

CONCLUSIONS

Few firm conclusions regarding individual differences in film learning can be offered at this time since the research reported here was conceived as exploratory in nature, representing only the first stage of more detailed analyses and experimentation. It is possible however to note several general observations and to provide methodological recommendations for further work in this area.

1. It is evident that film repetitions continue to produce significant increments in achievement beyond three showings. Test repetition alone does not result in significant improvement. Learning data displaying characteristics at least superficially similar to those issuing from laboratory learning tasks may be obtained through the use of instructional message and test repetitions.

2. Aptitude variables representing semantic cognition or general verbal facility are highly related to learning performance in the film repetition situation, as they are to most school achievement measures. Abilities represented by memory span tasks and figural and symbolic cognition and memory tests seem relatively unrelated to learning from film as represented here.

3. Little systematic fluctuation in aptitude-learning correlations was apparent across practice trials within a film. However different variables related to performance with different films, to some extent. It is likely that films differ in the patterning of their ability demands.

4. Correlational and factor analytic approaches seem insufficiently sensitive and perhaps prematurely applied to data pertaining to ability-achievement relations. A preference for more detailed treatment of simple regression data was expressed. Further analyses of these data as well as extensions of the present investigation are thus planned.

SUMMARY

The study examined the characteristics and correlates of trial scores obtained from five repetitions of each of two instructional films and their associated achievement tests, as compared with scores from test repetitions only. Using a battery of reference factor tests, a variety of relations among learning, ability, and personality measures were demonstrated. Changes in correlational patterns across repetitions of the same film were not apparent, though some differences in pattern were noted between films. Methodological problems involved in research on individual differences in learning were noted and plans for further analyses were outlined.

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TABLE A1

Matrix of Intercorrelations Among Achievement Tests for the Experimental Group Receiving Baboon Behavior First (above main diagonal, n=41) and the Experimental Group Receiving Steam Turbine First (below main diagonal, n=41)

	BABOON BEHAVIOR								STEAM TURBINE			
	1	2	3	4	5	6	7	8	9	10	11	12
1		20	04	30	31	37	-02	-07	08	10	15	14
2	12		52	58	45	41	10	55	42	47	45	38
3	42	60		78	69	68	05	63	60	54	57	54
4	29	51	70		86	81	-07	54	60	52	61	53
5	28	47	71	79		89	-07	50	64	52	62	56
6	30	45	58	68	76		-08	38	51	35	44	43
7	14	14	09	08	17	14		14	07	15	04	05
8	24	39	38	23	33	44	37		76	78	77	76
9	30	42	45	38	41	51	11	78		86	86	75
10	23	34	40	36	36	48	17	69	88		86	82
11	21	35	42	41	47	54	22	66	80	87		88
12	25	48	56	46	47	50	27	58	75	80	86	

TABLE A2

Matrix of Intercorrelations Among Achievement Tests for the Control Group Receiving Baboon Behavior First (above main diagonal, n=41) and the Control Group Receiving Steam Turbine First (below main diagonal, n=41)

	BABOON BEHAVIOR						STEAM TURBINE					
	1	2	3	4	5	6	7	8	9	10	11	12
1		12	10	06	06	26	07	10	09	14	10	13
2	24		45	63	50	55	-04	17	-04	-08	09	00
3	21	63		69	62	62	-02	07	18	-02	13	10
4	28	56	63		78	70	18	20	25	14	28	16
5	25	38	44	57		69	15	-09	20	05	19	07
6	25	46	50	44	67		08	15	17	10	25	24
7	-01	10	-02	16	-05	-02		12	41	44	40	36
8	-10	13	05	09	11	20	26		47	40	52	47
9	05	06	04	-06	01	-10	39	50		73	71	72
10	14	07	-02	02	09	01	27	56	75		73	79
11	00	06	11	14	16	05	37	49	67	75		74
12	01	08	06	12	06	-02	12	46	57	65	69	

TABLE A3

Pearson Correlations Between Aptitude Measures and Achievement Test Repetitions for Experimental Group Receiving Baboon Behavior First (n=41)

VARIABLE	FACTOR	1	2	3	4	5	6	7	8	9	10	11	12
17 Advanced Vocabulary	CMU	-19	37	40	43	49	33	-05	58	55	48	52	45
18 Wide Range Vocabulary Part 1	CMU	-21	48	56	49	39	32	-08	63	51	55	52	47
19 Wide Range Vocabulary Part 2	CMU	-23	33	53	45	45	35	-11	55	51	45	47	39
31 Word Classification	CMC	04	12	21	19	27	40	15	14	19	12	09	-01
32 Verbal Classification Part 1	CMC	03	42	37	48	45	39	-12	40	49	42	36	28
33 Verbal Classification Part 2	CMC	-19	26	33	27	18	08	-14	45	40	31	28	31
34 Word Matrix	CMR	-18	27	42	35	30	26	10	48	39	28	38	34
35 Verbal Analogies Part 1	CMR	03	24	20	16	03	-05	-03	40	43	33	32	21
36 Verbal Analogies Part 2	CMR	-15	25	30	25	16	11	-19	37	33	22	26	19
20 Math Aptitude	CMS	00	24	27	30	28	20	11	40	40	34	42	28
21 Necessary Arith. Ops Part 1	CMS	-31	33	25	20	08	00	14	32	18	23	19	02
22 Necessary Arith Ops Part 2	CMS	-30	42	47	34	27	15	07	56	40	43	43	34
25 Auditory Letter Span	MSU	15	13	11	04	09	09	-18	-03	-01	17	08	13
26 Auditory Number Span	MSU	03	03	05	07	05	-01	-31	-02	-07	09	12	10
54 Auditory Word Span	(A-MSU)	-05	-08	04	-01	07	07	-10	12	15	16	17	21
53 Memory for Ideas	(A-MMU)	-27	30	28	25	11	07	03	53	43	39	37	31
84 Sentence Reproduction	(A-MMU)	-25	13	48	25	33	33	-13	31	35	29	31	24
57 Random Word Recognition	(A-MMC)	07	-00	41	25	29	26	-12	22	19	14	18	36
62 Class Memory	(A-MMC)	-04	44	33	41	25	25	-02	36	34	20	21	07
27 First and Last Names	MMR	13	05	01	03	-04	01	-22	05	08	-01	00	07
65 Paired Words	(A-MMR)	07	11	06	02	-08	-05	-11	04	18	15	20	23
70 Phrase Completion	(A-MMR)	10	31	39	43	39	42	-24	18	41	29	19	13
75 Sentence Completion	(A-MMR)	-09	29	29	38	32	20	-07	34	39	41	33	28
28 Sequence Memory	MMS	22	08	20	38	20	25	-15	09	03	-07	05	-05
30 Position Recall	MMS	-26	17	25	23	11	-08	-06	15	16	20	21	19
80 Phrase Sequences	(A-MMS)	31	34	-06	06	-02	06	-15	-09	-16	-19	-19	-15
83 Idea Sequences	(A-MMS)	10	48	29	40	29	24	01	24	40	33	29	20
48 Successive Perception III	(F-CFU)	14	33	25	24	21	11	19	38	42	40	45	31
49 Successive Perception IV	(F-CFU)	-11	09	14	19	18	14	17	32	15	21	27	20
50 Sequential Words	(F-CFU)	-07	14	24	83	19	19	-23	24	24	17	31	32
23 Maze Tracing Speed	(CFS)	11	-02	12	08	-02	-05	29	06	-03	05	11	03
24 Map Planning	(CFS)	11	08	29	35	35	21	16	22	33	27	30	21
41 Film Memory I	(F-MMU)	-31	38	26	30	24	13	-21	21	27	08	23	03

TABLE A3 (Continued)

VARIABLE	FACTOR	1	2	3	4	5	6	7	8	9	10	11	12
42 Film Memory	(F-MMU	-13	38	26	30	24	13	-21	21	27	08	23	03
44 Social Abstracts IA	(F-MMR)	23	09	02	23	19	17	05	15	21	19	26	30
45 Social Abstracts IB	(F-MMR)	-08	17	26	26	07	21	-28	10	03	01	05	-03
46 Social Abstracts IIA	(F-MMR)	06	03	16	24	17	18	08	24	21	19	28	30
47 Social Abstracts IIB	)F-MMR)	02	21	31	28	26	24	07	18	17	17	14	13
43 Film Memory III	(F-MMS)	27	25	-03	04	02	07	-32	13	03	-07	07	02
29 Position Recall I	(MFS)	-07	11	24	23	18	16	-14	-01	15	04	11	15
37 Word Group Naming	NUM	00	20	32	18	19	20	-04	26	40	36	34	38
38 Word Grouping	NMC	-02	23	08	26	17	20	-35	01	14	07	11	02
39 Vocabulary Completion	NMR	-21	32	28	27	26	18	-07	42	27	28	27	13
40 Sentence Order	NMS	-15	05	12	24	26	16	08	16	19	18	10	04
85 Outgoing/Reserved	16PF-A	-13	-01	-16	-24	-13	-11	-24	-22	-35	-25	-27	-12
86 Intelligent	B	-01	48	31	36	38	31	27	47	54	55	56	47
87 Emot.Stable/Affect.Feel.	C	42	17	18	17	09	04	02	25	03	10	19	17
88 Assertive/Humble	E	-15	12	13	07	09	03	27	09	28	12	19	04
89 Happy-Go-Lucky/Sober	F	-15	06	-15	-11	-17	-05	-19	-32	-26	-42	-36	-41
90 Conscientious/Expedient	G	34	42	19	20	10	17	-00	25	-02	06	10	19
91 Venturesome/Shy	H	09	16	-14	-10	-26	-10	-04	-18	-25	-33	-21	-34
92 Tender-Minded/Tough-Minded	I	19	-07	-07	-07	03	12	-26	-20	-14	-13	-21	-13
93 Suspicious/Trusting	L	-27	-17	01	-10	00	-02	13	-03	14	-06	-05	-12
94 Imaginative/Practical	M	-12	-04	-04	-09	-02	03	-15	05	-14	00	-16	-02
95 Shrewd/Forthright	N	-34	18	19	09	02	-07	08	27	26	18	31	24
96 Apprehensive/Placid	O	-28	-10	10	06	03	20	-18	-07	-03	-10	-21	-15
97 Experimenting/Conservative	Q_1	-19	-13	-14	-10	02	-03	-11	19	25	14	14	12
98 Self-sufficient/Group Dependent	Q_2	04	-13	17	14	14	11	11	17	20	25	18	17
99 Controlled/Casual	Q_3	29	17	03	15	11	07	-01	07	-06	12	16	24
100 Tense/Relaxed	Q_4	-27	-09	02	-10	-03	03	-06	-02	10	07	-13	-05
13 Sex (Male = 2, Female = 1)		-09	04	12	01	-04	-09	45	19	28	28	29	20
14 Age		18	-16	18	17	17	18	27	14	27	25	32	18
15 Class		13	-07	28	21	19	19	37	22	25	25	31	28
16 School		-18	13	02	-08	-04	-01	01	14	13	11	-00	02

TABLE A4

Pearson Correlations Between Aptitude Measures and Achievement Test Repetitions for Experimental Group Receiving Steam Turbine First (n = 41)

VARIABLE	FACTOR	1	2	3	4	5	6	7	8	9	10	11	12
17 Advanced Vocabulary	CMU	07	46	53	51	61	52	-00	46	50	43	56	57
18 Wide Range Vocabulary Part 1	CMU	18	48	53	58	63	54	-04	39	37	27	38	40
19 Wide Range Vocabulary Part 2	CMU	13	52	53	50	61	60	-08	54	52	47	62	55
31 Word Classification	CMC	13	27	32	27	29	20	18	30	28	28	25	39
32 Verbal Classification Part 1	CMC	29	36	39	13	29	09	10	42	43	29	38	42
33 Verbal Classification Part 2	CMC	28	30	34	23	33	25	04	30	15	05	12	10
34 Word Matrix	CMR	22	35	37	48	69	46	18	17	18	14	31	26
35 Verbal Analogies Part 1	CMR	10	41	36	44	46	47	00	25	35	30	23	27
36 Verbal Analogies Part 2	CMR	11	40	26	43	44	45	43	43	29	30	42	48
20 Math Aptitude	CMS	17	58	25	18	38	28	39	46	42	37	35	35
21 Necessary Arith Ops Part 1	CMS	16	29	11	13	19	25	16	48	47	45	47	24
22 Necessary Arith Ops Part 2	CMS	19	27	23	32	51	39	29	45	35	32	50	35
25 Auditory Letter Span	MSU	-12	09	17	17	08	01	18	-11	-04	11	23	21
26 Auditory Number Span	MSU	-22	11	08	15	07	-01	11	13	09	15	18	14
54 Auditory Word Span	(A-MSU)	-35	07	04	19	18	10	-16	-05	03	06	11	14
53 Memory for Ideas	(A-MMU)	14	17	33	26	51	42	26	47	43	37	56	57
84 Sentence Reproduction	(A-MMU)	07	49	52	56	64	60	04	50	53	41	45	47
57 Random Word Recognition	(A-MMC)	26	05	38	18	22	15	09	12	05	04	-06	15
62 Class Memory	(A-MMC)	20	17	17	20	28	30	-25	-00	24	16	19	22
27 First and Last Names	MMR	10	06	17	27	33	15	01	-10	01	-06	-05	05
65 Paired Words	(A-MMR)	21	17	14	28	32	24	-06	07	21	09	26	24
70 Phase Completion	(A-MMR)	10	38	43	50	45	49	15	30	21	20	19	31
75 Sentence Completion	(A-MMR)	08	44	44	43	43	44	16	38	38	37	40	50
28 Sequence Memory	(MMS	-11	20	27	23	29	30	05	20	13	07	20	21
30 Position Recall	MMS	10	22	29	30	300	11	23	11	08	10	10	20
80 Phrase Sequences	(A-MMS)	-06	09	01	22	18	25	18	-03	-09	00	10	10
83 Idea Sequences	(A-MMS)	23	15	19	34	39	30	14	12	17	15	28	13
48 Successive Perception III	(F-CFU)	00	-01	04	-11	-02	-12	10	01	-08	-07	01	-06
49 Successive Perception IV	(F-CFU)	35	19	12	04	11	12	13	28	08	02	01	-05
50 Sequential Words	(F-CSU)	25	04	11	-07	08	07	12	07	04	-02	12	07
23 Maze Tracing Speed	(CFS)	19	-08	-01	02	11	03	17	28	22	24	21	09
24 Map Planning	(CFS)	-09	-08	-01	02	11	03	17	28	-00	02	08	-05
41 Film Memory I	(F-MMU)	-01	02	02	03	-00	-12	-29	-28	-21	-21	-16	-27

TABLE A4 (Continued)

VARIABLE	FACTOR	1	2	3	4	5	6	7	8	9	10	11	12
42 Film Memory II	(F-MMU)	-02	-08	02	00	-00	01	-14	-14	-09	-08	03	05
44 Social Abstracts IA	(F-MMR)	04	33	41	32	38	27	12	27	34	31	29	28
45 Social Abstracts IB	(F-MMR)	17	20	27	19	13	11	12	08	-03	-06	03	07
46 Social Abstracts IIA	(F-MMR)	14	16	08	13	20	18	12	34	35	39	39	15
47 Social Abstracts IIB	(F-MMR)	18	31	15	-09	13	16	30	43	34	37	40	31
43 Film Memory III	(F-MMS)	-23	17	18	23	24	16	-08	-11	03	-08	00	03
29 Position Recall I	(MFS)	04	-11	-03	-02	05	08	26	10	04	05	18	06
37 Word Group Naming	NMU	14	10	03	19	30	27	21	09	14	24	29	21
38 Word Grouping	NMC	25	06	08	-04	-05	-00	12	08	-05	-07	-07	-08
39 Vocabulary Completion	NMR	11	62	55	47	42	35	11	53	39	26	35	44
40 Sentence Order	NMS	15	25	..33	35	32	23	-15	22	27	01	05	04
85 Outgoing/Reserved	16PF-A	-15	-06	-18	-17	-18	-30	-35	-41	-17	-21	-21	-18
86 Intelligent	B	31	44	56	43	44	35	-02	11	22	26	22	28
87 Emot. Stable/Affect.Feel.	C	30	10	-08	-01	-05	01	01	15	12	06	60	-09
88 Assertive/Humble	E	-15	-14	05	-05	-07	-09	-23	13	13	04	02	-06
89 Happy Go Lucky/Sober	F	-19	-07	-18	-16	-12	-12	14	-20	-18	-19	-26	-33
90 Conscientious/Expedient	G	61	-11	05	01	-04	-07	07	13	07	03	-04	-06
91 Venturesome/Shy	H	06	-07	-06	06	-14	-25	-22	-21	-04	-02	-02	-09
92 Tender-Minded/Tough-Minded	I	05	-00	29	34	13	10	-15	-29	-13	-22	-25	-06
93 Suspicious/Trusting	L	-21	-13	-19	-13	01	00	15	03	05	-05	-04	03
94 Imaginative/Practical	M	08	-07	08	21	18	22	10	-15	-05	-07	02	18
95 Shrewd/Forthright	N	41	17	29	10	17	12	28	34	30	25	20	19
96 Apprehensive/Placid	O	-35	-36	-19	-04	-02	08	-12	-12	-12	05	09	01
97 Experimenting/Conservative	Q_1	-08	13	07	01	11	07	-14	25	42	33	25	21
98 Self-sufficient/Group Dependent	Q_2	23	33	28	13	22	26	07	56	45	31	33	32
99 Controlled/Casual	Q_3	24	16	14	11	12	16	25	39	17	18	11	03
100 Tense/Relaxed	Q_4	-38	-35	-30	-23	-20	-12	03	-20	-20	-07	03	-03
13 Sex (Male = 2, Female = 1)		-14	07	-03	-16	05	03	24	33	24	18	25	09
14 Age		18	-14	11	-04	15	-02	12	19	03	16	12	17
15 Class		22	-02	23	10	23	15	08	14	17	22	17	19
16 School		-09	15	07	-23	05	04	23	48	33	38	38	32

TABLE A5

Pearson Correlations Between Aptitude Measures and Achievement Test Repetitions for Control Group Receiving Baboon Behavior First (n=41)

VARIABLE	FACTOR	1	2	3	4	5	6	7	8	9	10	11	12
17 Advanced Vocabulary	CMU	17	08	-04	06	01	12	-06	16	-10	-03	05	02
18 Wide Range Vocabulary Part 1	CMU	39	-00	03	-04	00	13	07	12	03	11	17	19
19 Wide Range Vocabulary Part 2	CMU	14	-09	-13	02	-04	01	07	20	07	17	25	15
31 Word Classification	CMC	15	36	14	17	14	15	-07	18	-25	-25	05	-20
32 Verbal Classification Part 1	CMC	-10	-02	00	01	-17	-04	-18	-04	-29	-05	-26	-16
33 Verbal Classification Part 2	CMC	30	09	05	-03	-21	-00	-15	26	-01	23	06	05
34 Word Matrix	CMR	-01	-00	19	07	-09	-03	-03	17	-03	07	05	-07
35 Verbal Analogies Part 1	CMR	17	11	01	-09	-05	09	12	03	-03	14	03	-07
36 Verbal Analogies Part 2	CMR	14	01	08	-02	-11	00	11	13	08	01	-16	03
20 Math Aptitude	CMS	23	-04	02	03	-02	20	07	17	21	33	29	33
21 Necessary Arith. Ops Part 1	CMS	04	03	19	10	02	15	03	22	19	32	37	40
22 Necessary Arith. Ops Part 2	CMS	26	-07	05	06	-08	19	36	24	28	47	36	49
25 Auditory Letter Span	MSU	22	10	04	16	-00	19	19	06	09	07	08	03
26 Auditory Number Span	MSU	30	19	17	13	04	36	12	04	03	-04	04	06
54 Auditory Word Span	(A-MSU)	07	01	-03	07	-06	02	20	01	01	15	03	11
53 Memory for Ideas	(A-MMU)	06	05	37	32	22	25	01	17	15	14	23	28
84 Sentence Reproduction	(A-MMU)	23	07	21	21	-03	28	25	32	15	21	21	34
57 Random Word Recognition	(A-MMC)	08	-03	15	23	14	16	17	04	20	34	31	22
62 Class Memory	(A-MMC)	-20	02	-19	-07	-03	-05	28	-06	-03	15	01	-06
27 First and Last Names	MMR	08	-03	05	-13	-05	-04	03	-14	-06	07	15	08
65 Paired Words	(A-MMR)	-01	-12	02	11	16	09	22	-02	02	11	18	05
70 Phrase Completion	(A-MMR)	04	13	-05	01	-15	12	16	13	-04	19	18	21
75 Sentence Completion	(A-MMR)	11	17	09	09	-05	18	15	23	-00	23	29	36
28 Sequence Memory	MMS	-04	01	-13	08	08	10	15	13	-02	-00	-09	04
30 Position Recall	MMS	49	10	15	22	22	19	22	21	-04	13	28	09
80 Phrase Sequences	(A-MMS)	08	-06	23	16	31	23	23	-08	31	14	42	28
83 Idea Sequences	(A-MMS)	09	19	34	38	17	30	19	24	18	14	27	26
48 Successive Perception III	(F-CFU)	18	-37	-28	-34	-36	-13	00	16	04	26	14	26
49 Successive Perception IV	(F-CFU)	03	-43	-03	-29	-32	-21	06	10	08	16	04	17
50 Sequential Words	(F-CSU)	06	-24	-03	-20	-15	-04	19	-01	16	24	26	25
23 Maze Tracing Speed	(CFS)	-08	-15	-19	00	-03	06	09	14	-04	10	-06	06
24 Map Planning	(CFS)	01	05	-03	05	11	25	11	04	-12	05	11	02
41 Film Memory I	(F-MMU)	19	-17	02	-15	-05	-06	29	04	25	24	34	28

TABLE A5 (Continued)

VARIABLE	FACTOR	1	2	3	4	5	6	7	8	9	10	11	12
42 Film Memory II	(F-MMU)	-16	-11	-22	-03	-19	-03	-22	-17	-08	-00	-23	-19
44 Social Abstracts IA	(F-MMR)	01	-14	15	19	-01	16	27	38	36	36	54	38
45 Social Abstracts IB	(F-MMR)	10	-05	-09	-10	-12	04	12	24	05	22	07	23
46 Social Abstracts IIA	(F-MMR)	-01	-13	08	06	-07	10	19	30	33	38	44	45
47 Social Abstracts IIB	(F-MMR)	13	04	-00	13	22	25	43	15	04	12	12	09
43 Film Memory III	(F-MMS)	-05	13	18	26	29	16	-11	-20	-03	-06	-21	-12
29 Position Recall I	(MFS)	16	-00	-02	05	07	11	26	15	06	30	25	22
37 Word Group Naming	NMU	06	09	-07	-03	-20	10	11	24	09	03	13	10
38 Word Grouping	NMC	11	-05	-14	-14	-18	-09	-05	05	-08	14	05	12
39 Vocabulary Completion	NMR	09	-04	08	04	-07	11	23	10	14	20	11	09
40 Sentence Order	NMS	26	04	23	16	30	38	17	12	18	25	19	29
85 Outgoing/Reserved	16PF-A	15	25	06	-00	00	-11	-23	-30	-28	-34	-24	-34
86 Intelligent	B	07	-11	21	04	13	26	-00	02	19	27	04	13
87 Emot. Stable/Affect. Feel.	C	-17	30	16	14	21	24	11	-14	-04	03	-15	07
88 Assertive/Humble	E	-16	-16	-16	-10	-18	-04	-14	23	09	13	12	04
89 Happy-Go-Lucky/Sober	F	-17	06	07	04	07	-10	-00	13	03	-12	03	-19
90 Conscientious/Expedient	G	13	10	-22	-05	08	-05	-05	-14	-15	-08	-31	-05
91 Venturesome/Shy	H	-26	14	09	06	03	07	-12	20	18	06	12	14
92 Tender-Minded/Tough-Minded	I	22	-07	-08	-29	-16	-24	-20	-08	-29	-47	-35	-30
93 Suspicious/Trusting	L	10	-12	-05	-02	-06	20	16	30	20	15	27	21
94 Imaginative/Practical	M	15	-08	08	17	01	00	-29	07	-19	-29	-25	-14
95 Shrewd/Forthright	N	31	18	-19	-07	-09	09	-16	23	-19	-09	-17	-04
96 Apprehensive/Placid	O	19	-03	-05	-05	20	-01	-10	-38	-04	-18	-15	-05
97 Experimenting/Conservative	Q_1	20	04	12	18	13	03	23	36	21	19	25	21
98 Self-sufficient/Group Dependent	Q_2	40	11	-05	11	01	32	20	16	10	27	16	39
99 Controlled/Casual	Q_3	-22	14	10	03	05	-07	-22	-17	03	12	-08	13
100 Tense/Relaxed	Q_4	-05	-12	-26	-30	-15	-17	-02	-18	-19	-12	-15	-18
13 Sex (Male = 2, Female = 1)		04	-00	-01	18	02	25	29	47	24	38	23	30
14 Age		-06	11	01	15	17	16	21	18	21	18	30	32
15 Class		07	17	-11	04	-17	01	21	07	-17	00	-13	02
16 School		10	-10	-02	11	01	13	39	48	29	48	41	32

TABLE A6

Pearson Correlations Between Aptitude Measures and Achievement Test Repetitions for Control Group Receiving Steam Turbine First (n=41)

VARIABLE	FACTOR	1	2	3	4	5	6	7	8	9	10	11	12
17 Advanced Vocabulary	CMU	-32	36	20	10	11	25	23	23	09	24	33	23
18 Wide Range Vocabulary Part 1	CMU	-16	28	34	14	21	42	11	10	-04	-00	16	04
19 Wide Range Vocabulary Part 2	CMU	-20	16	30	22	12	24	11	35	14	13	25	15
31 Word Classification	CMC	09	47	16	06	17	36	15	22	01	12	09	-07
32 Verbal Classification Part 1	CMC	11	-02	05	07	14	06	-15	07	23	18	06	18
33 Verbal Classification Part 2	CMC	-07	32	15	31	19	29	15	22	14	00	14	07
34 Word Matrix	CMR	-05	17	-02	16	20	21	-05	40	25	29	14	27
35 Verbal Analogies Part 1	CMR	-11	14	25	31	38	34	24	28	01	11	22	15
36 Verbal Analogies Part 2	CMR	-33	11	-08	-05	-03	06	-04	03	-21	-11	-11	-00
20 Math Aptitude	CMS	-13	14	16	23	13	23	-04	27	37	37	29	24
21 Necessary Arith Ops Part 1	CMS	07	-21	03	04	-10	-01	-08	12	13	25	29	18
22 Necessary Arith Ops Part 2	CMS	-03	02	04	21	08	-08	06	37	37	41	30	25
25 Auditory Letter Span	MSU	-08	-06	01	06	21	25	-10	01	-06	-03	10	12
26 Auditory Number Span	MSU	-12	05	31	19	25	34	-13	-03	-25	-27	-14	-06
54 Auditory Word Span	(A-MSU)	-08	13	29	33	23	12	-11	-05	-13	-20	-06	04
53 Memory for Ideas	(A-MMU)	-32	11	22	24	20	29	29	16	-19	-10	07	-11
84 Sentence Reproduction	(A-MMU)	-14	26	25	24	29	31	09	22	09	03	12	16
57 Random Word Recognition	(A-MMC)	-10	-19	-17	-03	21	-22	-19	-31	-36	-34	-37	-19
62 Class Memory	(A-MMC)	-04	31	13	28	17	13	23	23	15	17	16	-03
27 First and Last Names	MMR	-13	-14	-11	-03	-01	03	-50	-24	-43	-34	-40	-26
65 Paired Words	(A-MMR)	-01	13	13	29	04	-03	-17	-37	-41	-33	-35	-24
70 Phrase Completion	(A-MMR)	-09	00	09	23	10	01	14	07	-11	06	12	14
75 Sentence Completion	(A-MMR)	-25	09	-01	-04	04	03	09	-01	13	05	15	05
28 Sequence Memory	MMS	22	30	30	35	16	32	04	01	-00	02	-00	-02
30 Position Recall	MMS	-29	-20	-05	-03	-19	-28	-11	-15	-09	-14	-18	-04
80 Phrase Sequences	(A-MMS)	02	16	31	40	18	14	-25	-14	-34	-36	-38	-32
83 Idea Sequences	(A-MMS)	-05	19	17	20	22	16	04	01	-11	17	22	09
48 Successive Perception III	(F-CFU)	-04	32	10	23	23	10	16	36	16	22	22	13
49 Successive Perception IV	(F-CFU)	-11	35	19	31	19	13	36	45	19	14	14	01
50 Sequential Words	(F-CSU)	-04	38	33	31	26	18	05	14	-14	-01	-05	-10
23 Maze Tracing Speed	(CFS)	10	08	06	02	-00	25	18	08	13	18	22	-03
24 Map Planning	(CFS)	-37	07	17	11	04	-09	-18	08	07	05	12	03
41 Film Memory I	(F-MMU)	-03	-08	02	-00	-01	04	06	-12	-04	03	-16	-31

TABLE A6 (Continued)

VARIABLE	FACTOR	1	2	3	4	5	6	7	8	9	10	11	12
42 Film Memory II	(F-MMU)	01	21	14	30	09	13	-09	25	07	35	31	44
44 Social Abstracts IA	(F-MMR)	-18	29	19	05	12	15	-03	09	01	-03	02	-07
45 Social Abstracts IB	(F-MMR)	-30	14	23	00	-12	00	-04	21	24	24	26	18
46 Social Abstracts IIA	(F-MMR)	-19	24	10	20	25	05	10	06	-12	-04	15	-00
47 Social Abstracts IIB	(F-MMR)	-01	05	13	08	-05	-27	18	-01	16	07	13	17
43 Film Memory III	(F-MMS)	-13	19	12	-05	-15	-03	11	03	12	11	-09	-10
29 Position Recall I	(MFS)	-28	-03	-12	03	02	06	-11	04	-08	-25	-16	-20
37 Word Group Naming	NMU	07	-18	-17	09	08	18	10	04	-06	07	-08	-07
38 Word Grouping	NMC	-23	-15	11	10	-06	-04	-05	-13	-11	-07	-17	-14
39 Vocabulary Completion	NMR	-13	05	31	20	32	35	-14	10	05	11	17	-01
40 Sentence Order	NMS	-11	16	09	14	22	15	-02	25	11	25	10	11
85 Outgoing/Reserved	16PF-A	-18	07	10	12	-06	19	-04	-01	-57	-36	-19	-12
86 Intelligent	B	-02	-05	-09	01	-08	24	09	06	-16	08	01	14
87 Emot.Stable/Affect. Feel.	C	07	13	15	12	05	-02	-02	03	04	15	02	-05
88 Assertive/Humble	E	15	06	12	16	16	14	40	26	16	24	32	11
89 Happy-Go-Lucky/Sober	F	11	-20	-13	-00	-15	-06	07	06	-21	-14	-27	-16
90 Conscientious/Expedient	G	-38	15	16	10	28	14	-09	00	-07	-01	03	05
91 Venturesome/Shy	H	01	-02	-01	06	14	23	13	15	-18	04	-10	-13
92 Tender-Minded/Tough-Minded	I	-21	03	13	03	26	25	-44	-28	-41	-41	-33	-19
93 Suspicious/Trusting	L	-04	-12	-09	-03	-09	-06	-13	02	-00	11	-10	07
94 Imaginative/Practical	M	-11	19	10	10	20	17	13	-22	02	-04	11	14
95 Shrewd/Forthright	N	16	36	32	11	08	27	40	05	22	03	18	-08
96 Apprehensive/Placid	O	01	-23	-09	-02	-06	-11	-24	-22	-27	-22	-13	-10
97 Experimenting/Conservative	Q_1	11	15	21	11	03	11	49	11	38	32	26	07
98 Self-sufficient/Group Dependent	Q_2	-13	-05	-04	06	18	-14	04	-18	30	17	37	15
99 Controlled/Casual	Q_3	07	27	24	21	04	05	-18	-16	-28	-13	-19	01
100 Tense/Relaxed	Q_4	-16	-24	-23	-13	-04	-08	-06	15	08	13	15	20
13 Sex (Male = 2, Female = 1		07	-14	-00	-06	-25	-21	32	23	34	23	24	06
14 Age		25	21	17	09	11	-04	18	16	-09	-05	-01	-23
15 Class		25	19	10	05	-01	-02	15	05	-27	-19	-14	-36
16 School		05	06	-03	07	21	12	37	30	45	50	40	21