R E P O R T R E S U M E S

ED 019 877 EM 006 7

STUDIES IN CINE-PSYCHOMETRY II--CONTINUED FACTORING OF AUDIO AND VISUAL COGNITION AND MEMORY. FINAL REPORT.

BY- SEIBERT, WARREN F. REID, J. CHRISTOPHER
PURDUE UNIV., LAFAYETTE, IND., AUDIO VISUAL CENTER

PUB DATE DEC 67

GRANT OEG-7-24-0280-257
EDRS PRICE MF-$0.50 HC-$2.68 65P.

DESCRIPTORS- *FACTOR ANALYSIS, PICTORIAL STIMULI, AURAL STIMULI, VISUAL STIMULI, *PSYCHOMETRICS, *COGNITIVE ABILITY, *COGNITIVE MEASUREMENT, MEMORY, RECALL (PSYCHOLOGICAL), FILMS, TIME FACTORS (LEARNING), KAISER IMAGE ANALYSIS

THREE STUDIES INVESTIGATE AUDITORY AND VISUAL MEMORY ABILITIES AND THEIR POTENTIAL ROLES AS INSTRUCTIONAL AND PERSONNEL PREDICTORS. STUDY I PRESENTS TO 185 COLLEGE FRESHMEN 42 ABILITY TESTS FROM WHICH SEVEN MAJOR ROTATED FACTORS EMERGE--SERIAL MEMORY SPAN, SERIAL INTEGRATION, ASSOCIATIVE MEMORY, ABSTRACTS FROM SOCIAL INTERACTION SITUATIONS, VERBAL INTELLIGENCE, AUDITORY MEMORY FOR VERBAL DETAIL, AND PERCEPTUAL FORESIGHT AND MEMORY FOR TEMPORAL ORDER. STUDY II PRESENTS TO 159 FRESHMEN 25 FILM AND PRINT TESTS, INCLUDING MEASURES OF VIEWING DISTANCE AND ANGLE. THE FIRST FOUR FACTORS RE-EMERGE AND ARE JOINED BY--SHORT TERM MEMORY, FILM SEQUENCE MEMORY, VOCABULARY, AND SHORT TERM VISUAL MEMORY. STUDY III FURTHER ANALYZES SIX SUB-TESTS FROM II COVERING SHORT TERM VISUAL, OBJECT, AND COLOR MEMORY BY SYSTEMATICALLY VARYING EXPOSURE TIME. VARIANCE FROM THE SERIAL INTEGRATION FACTOR (TEMPORAL CLOSURE--"RAPID RECEPTION OF TEMPORALLY SPACED STIMULI AND THEIR ORGANIZATION INTO MEANINGFUL WHOLE COGNITIONS") CONSISTENTLY APPEARS OR IS ABSENT FROM THE SUB-TESTS, SO SERIAL INTEGRATION SEEMS TO SHOW THE MOST PROMOSE FOR FURTHER ANALYSIS, POSSIBLY AS A FIGURAL COGNITION ABILITY. SHORT TERM VISUAL MEMORY ABILITIES CHANGE NOTICEABLY EVEN WHEN CHANGES IN TASKS ARE SLIGHT. OTHER RESULTS ARE INCONCLUSIVE. (LH)

STUDIES IN CINE-PSYCHOMETRY II:
Continued Factoring of Audio and Visual Cognition and Memory

FINAL REPORT

December 1967

Prepared by

Warren F. Seibert and J. Christopher Reid

AUDIO VISUAL CENTER
PURDUE UNIVERSITY - LAFAYETTE, INDIANA

Grant Number 7-24-0280-257
United States Office of Education
Department of Health, Education and Welfare

STUDIES IN CINE-PSYCHOMETRY II:--
CONTINUED FACTORING OF AUDIO AND VISUAL COGNITION AND MEMORY.

FINAL REPORT.

December 1967

Prepared by

Warren F. Seibert and J. Christopher Reid

Audio Visual Center
Purdue University
Lafayette, Indiana

Grant Number 7-24-0280-257
United States Office of Education,
Department of Health, Education and Welfare

TABLE OF CONTENTS

FOREWORD

This report is one of a series concerned with human abilities and ability factors, with special emphasis on those measured with motion picture tests. Work reported here relates to Guilford's extensive work on the varieties and the structure of human intellect. Although the importance of his work is widely acknowledged (e.g., American Psychologist 1964, 19, 947-954), it seems significant also that so few others pursue very similar research interests. Many investigators are concerned with differential psychology and measurement, quite a few make excursions like the one represented in this report, at least a small community of investigators devote themselves to the study and improvement of the required multivariate techniques, but few indeed are devoted to the study of intellectual differences and structure.

Since many of the tests used here are in the form of motion pictures, audio tapes, or slides, this work is also related to prior research on the educational uses of film, television, and other communications technologies. However, that body of research generally uses these media as channels for instruction, not for psychological measurement. Nevertheless, any communications medium may serve psychometric as well as instructional, behavior changing purposes. This much should be clear not only from the pioneering work of James J. Gibson and his associates during the latter part of World War II (film testing report of Gibson), but also from unmistakable statements of Guilford (1959) and L. L. Thurstone (1941). Each has recognized that media other than print are suited to the purposes of psychological testing. Still, it is a rare media specialist who considers non-instructional uses of the media and it is an equally rare test specialist who considers non-print tests.

This work also has elements in common with recent studies by Edwin Fleishman (e.g., 1962) in which the involvement of different ability factors is traced through successive stages in the learning

of a skill. Although Fleishman was concerned with motor skill learning, while the present work focussed neither on learning nor on motor skills, both show a novel and promising methodology. Both simultaneously examine differences among individuals and among intentionally-manipulated treatment conditions.

The lag between the first glimmers of interest and the subsequent, personal involvement in a major research venture is often long, but in motion picture testing, some, including the writers, have made such moves. Among aviation psychologists, a group has now revived interests much like those of Gibson and his colleagues prior to the end of World War II. As an interesting aside, some of Gibson's original film tests are finding new use in this work, but it has seemed prudent to edit new titles onto the tests, both because a rival military service is involved and because the contemporary cadets were born after the revealed production dates of the films. An educational psychologist is also exploring the applications of motion picture tests to the assessment of children's perceptual handicaps. A doctoral student has utilized several film test-derived abilities and factors in a study of aptitude-and-instructional treatment interactions; other students are now considering similar uses.

It is hoped that these signs of interest will grow, even if slowly, and that further work in this novel and promising field of investigation will continue. To bolster these hopes, the authors stand ready to assist qualified investigators, as needed, in initiating related work. At the least, a pool of testing materials has been located, produced, and accumulated and access to these materials should facilitate many later investigations.

Warren F. Seibert
J. Christopher Reid

INTRODUCTION

Studies of the psychometric applications of the motion picture and of abilities associated with those applications are not such that the landscape of the field changes quickly. Since this is true and since two rather thorough examinations of the most relevant literature have recently appeared (Seibert and Snow, 1965a, 1965b), no attempt will be made here to reexamine and resynthesize that literature. Instead, to set the stage for a report of the work just completed, a variety of the more convincing reasons for pursuing the work will be indicated.

After work had begun on psychometric applications of the motion picture and the study of related abilities, it occurred to the writers that a succinct statement of the reasons for interest might be that "Many human decisions are made within contexts which are not static, not principally verbal, and not characterized by the presence of print." (Seibert and Snow, 1965a, p. 140). If this were so, it would also be reasonable to suppose that people possess abilities appropriate to such contexts. A sampling of research tests, and of the existing ability tests, either standardized or specialized, will not only obscure the above notion effectively, but will suggest virtually the opposite. The implication drawn from most such samplings should probably be that when human decisions are made, they are within contexts that are static, principally verbal, and characterized by the presence of print. From this, it virtually follows that the variety of human intellectual talent is effectively, and maybe exhaustively, revealed by tests which adhere to print-on-paper formats.

There are insufficient reasons for believing in the omnipotence of print-on-paper tests. Furthermore, there are other and more positive reasons for considering and studying psychological tests in novel forms. The opportunities to simulate features of complex decision situations are greater with a dynamic, aural

and visual medium than with the static and almost crude medium of print. One need for such simulation was well indicated by an aviation psychologist who in recent conversation likened the sensing and information processing roles of modern pilots to time-sharing, as computer specialists use the term, and to multiplexing, as broadcasters-communication engineers use that term. Pilots and some others who direct sophisticated or swift machines or systems are in no position to dwell on the information coming to them. Their environment is highly dynamic, their continued safety and effectiveness in that environment requires constant monitoring and decision-making, the information available at any one moment far exceeds their processing capabilities, and decisions often require synthesis or integration of information from multiple displays. Considering these requirements, it was thought (or hypothesized, if grander terms are preferred) that if there are unique and relevant abilities to perform in such situations, these abilities might include something called sensitivity to positional information, to change information, and to rate information. All were conceived as abilities demonstrated under conditions of sensory time-sharing or multiplexing. Although correlates of such abilities might be found with conventional tests, more direct measurement and more faithful representations of task complexity should be achievable with motion picture tests.

A more general view of the psychometric potential of film (or, almost equally, of television) identifies eight reasonably distinct and apparently relevant characteristics of film which may be exploited to serve psychological testing purposes. These characteristics are by no means exhaustive, but they include the following: 1) Film provides for the manipulation and control of within-item exposure time and item response-time intervals,[1]

---

[1]Morrison has given extended consideration to the interrelated questions of testing time limits, item complexity, speededness, and factor content of scores, plus some other characteristics of the testing situation. With respect to time limits and speededness, he indicates that Spearman's theory of the interchangeability of response speed and response "goodness" measures is unsupported by accumulated evidence. He recommends that expanded work on timing, time limits, and other manipulable conditions of testing situations be undertaken to fill an apparent void.(Morrison, 1960, pp. 231-250.)

as well as the customary control of total time limits; 2) film permits the sequencing of stimuli within an item, thus providing not only for fixed exposure sequence, but also establishing pace, rhythm, and/or motion; 3) film permits the presentation of complementary or competitive information visually or aurally; 4) through use of kinesic, ideographic, or cinematographic conventions, film can pose problems which minimize or eliminate the use of written or spoken language; 5) film can employ color information either in the posing of questions or in the presentation of response alternatives; 6) with some difficulty, but feasibly, film can approximate the visual third dimension or the stereophonic "second" dimension and can use the added cues either to increase complexity of conventional problems or perhaps to test abilities associated with discrimination of the cues; 7) film can not only encompass the range of item stimulus materials indicated above, but it can also accomplish several functions typically assigned to test administrators, while adding precision and control to the conditions of testing;[2] and 8) since film controls the pace of stimulus presentation, it offers the possibility of synchronized and detailed response recordings, including the indexing of response latencies, galvanic skin responses, electroencephalograms, and other varieties of sometimes relevant but normally infeasible responses.

---

[2]Advice intended for the experimentalist is sometimes equally valuable for the differential-correlational psychologist; the following statement of John Carroll's provides an instance: "If one is truly going to standardize or hold constant the verbal instructions in an experiment, they would have to be acoustically recorded and mechanically reproduced on every occasion on which they are needed. Presenting typed verbal instructions to a subject is not really enough, for it leaves unstandardized the intonation and stress patterns which the subject may impose implicitly, and such variations might be of crucial importance. Psychologists have too often confused the spoken and the written word, or at least they have assumed too freely that spoken and written words are equivalent stimuli." (Carroll, 1959, p.110) The degree of control recommended is a reasonable possibility in the case of motion picture tests, where standardized intonation and stress patterns can be repeated readily. The same cannot be said for the conditions of conventional test administration.

Among the many lesser reasons for interest in motion picture testing is the challenge inherent in a statement of L. L. Thurstone, who, in 1953, referred to Schmidt's test of color-form dominance as "The most ingenious test that I have ever seen." (Thurstone, 1953, p. 5). The test is one later adapted to motion picture form, but originally and in its adapted version it presented a regular series of colored forms arranged around the circumference of a circle. In rapid and successive exposures of the forms, the series of colors would appear to move in one direction, while the series of forms appeared to move opposite. Examinees were to indicate the direction of observed movement. It would seem that Thurstone's statement is as much a commentary on the restricted vision of other investigators and test-makers as it is a compliment to Schmidt. Departures from conventional test formats are rare, even though latitude and potential exists and has been rather well demonstrated by such people as Boring (1916), Conrad (1924), Gibson (1947), Carpenter (1954), McIntyre (1954), Pillsbury (1929), and others. In any event, Gibson's early motion picture tests were certainly ingenious, perhaps as ingenious as Schmidt's, and if modesty permitted, several locally developed tests might also be nominated for the ranks of ingenious tests. What seems important now is that a fair level of ingenuity comes almost automatically in the preparation of motion picture tests.

Another of the interesting but not overriding reasons for continuation of the work stems from a statement of Guilford's. In discussing the "operations" categories of his own proposed structure of intellect, he wrote:

> The area of memory abilities has been explored less than some of the other areas of operation, and only seven of the potential cells of the memory matrix have known factors in them. Considering the blank rows . . . we should expect to find abilities also to remember classes, transformations, and implications, as well as units, relations and systems. (Guilford, 1959b, pp. 472-474.)

Then, in a related statement, he also wrote:

> There is little scientific knowledge concerning the usefulness of the substance-memory abilities. In a general survey of research on artistic talent, Meier (1939) concluded that visual memory is of considerable importance. Individuals with artistic talent seem to observe better and to remember more of what they observe in a literal sense, which probably means the factor of visual memory, since Meier was dealing with the graphic arts. (Guilford, 1959a, p. 363.)

The indicated shortage of information relating to memory abilities, the special reference to visual memory, and the clear suitability of the motion picture for memory tests, especially short term or intermediate term visual memory, were additional reasons for the present work; several of the experimental tests to be described later and incorporated into the study's two test batteries qualify as tests of visual memory abilities.

A comparable statement from Gibson, one which indicates well the reasons for working further and seriously with motion picture tests is the following:

> The functions which will be exemplified are directly or indirectly related to the characteristics of motion pictures, as distinct from other modes of presentation . . . namely motion, sequence, pacing, and realism. These characteristics presumably have their psychological counterparts. Human behavior, and the capacities latent in it, also involves motion, order, tempo, and the experience of reality. It is reasonable to suppose, therefore, that the motion picture makes available to the test designer not only a special method of measuring known factors of human ability, but also gives him access to new and unnamed functions not accessible to conventional methods of test construction. (Gibson, 1947, p. 20.)

In the earliest of the local studies with motion picture tests, three findings were especially promising and interesting, providing important motivation for further work. The first of these is represented in a factor named "temporal closure" or "serial integration". No similar ability is known to have appeared elsewhere and none is likely, since previous factor analyses have not included tests with the apparently critical characteristics. The ability is described as the rapid reception of

temporally spaced stimuli, their organization into meaningful whole cognition, and possibly their verbal labelling (Seibert and Snow, 1965b, p. 161). The indications are strong that this ability is a time-based analog of spatial closure ability. In both, closure or integration is required in order to perceive a meaningful Gestalt. In the usual case, though, closure operates across a spatial void or gap, while in the present case, it apparently operates across a temporal void.

The second of the promising findings relates to apparent changes in the factor composition of subtests within three short term visual memory tests (Seibert and Snow, 1965b, pp. 75-84). The subtests represent differing intervals over which simple visual memory must operate, but the full range spanned by eight subtests is in each case less than .6 second. Nevertheless, with analysis procedures somewhat like those of Fleishman (1954), evidence of substantial changes in factor composition was found; the processes associated with shorter intervals, for example, appear to be constituted differently from those for longer intervals. These findings, if confirmed and refined, hold the potential for extensive studies of cognitive processes which might be analogous to tracer studies in physiology and pharmacology.

The third finding which was initially intriguing, but which now seems the most suspect of those mentioned here, was derived from the factor loadings of two similar motion picture tests, both of which presented "live action" film footage without prior and direct specification of the examinees' task. The two tests, Film Memory I and Film Memory II, were administered one after the other within a testing session. The principal factor loading of Film Memory I, administered first in order, was on a factor most typically named spatial scanning; ability to process spatial images and perhaps "eidetic imagery" are involved. However, the principal factor loading for Film Memory II was on the verbal

facility factor (Seibert and Snow, 1965b, pp. 62-63). Considering these unanticipated differences in factor loadings, it seemed that the absence of prior specification of the decision making task (in Film Memory I) forced examinees to attempt eidetic processing of the images, in the hope that they could then recall the necessary information from the images when the task was eventually defined. This could account for the results from Film Memory I. For Film Memory II, the task was now known to the examinees, since the similar test that preceded it required examinees to describe things seen in the motion picture. Examinees could reasonably (and accurately) predict that Film Memory II would make the same requirement and, if it did, they could succeed by simply observing the film, assigning verbal labels to things seen, then recording these on the answer sheet. If this were the case, the substantial involvement of verbal facility in the performance would be reasonable. This interpretation might best be regarded as the contrasting of Bruner's iconic and symbolic forms of representation (e.g., Bruner, 1966, p. 11).

PROBLEM

The most general purpose of the present study is to extend earlier work in the psychometric applications of the motion picture and of other non-print media and, principally, to investigate further the abilities associated with these applications. More specifically, the purpose is to develop a number of novel and needed tests and, primarily through factor analysis, to study abilities in the domains of auditory and visual memory, with emphasis on memory for "meaningful" material.

As indicated earlier, memory abilities have received limited attention in prior studies; this emphatically is true of short term memory, since conventional measures and procedures cannot deal readily with intervals shorter than a few minutes. It is important also that abilities from these domains appear potentially significant in some instructional settings. It was intended that their relevance in selected learning situations should be examined. Behind this interest is the recognition that some instruction is no more than indirectly or remotely verbal. Although verbal abilities may have a role in learning from such presentations, their place is not apparent. Examples of indirectly or remotely verbal instruction could include some instructional film materials[3], some physical demonstrations, some science laboratories "experiences", some other "discovery learning" situations, and perhaps the aural presentations which come early in the learning of a new language.

---

[3]Educators seem to regard instructional films as great visual learning experiences, yet it is easier to argue that most are "illustrated lectures", with the bulk of the instructional message presented as verbal material in the audio channel. It seems likely that auditory and verbal abilities often are highly relevant in learning from films. Occasionally, though, films present their principal information visually and non-verbally, as in an un-narrated science demonstration; abilities that contribute to learning in such situations are of interest here.

It is worth noting that although general and verbal ability measures are probably the best predictions of foreign language achievement, an exemplary test in the field, Modern Language Aptitude Test, (Buros, 1965, p. 357) includes subtests to measure "auditory alertness", the learning of symbols for sounds, speeded sound-and-symbol association, and sensitivity to grammatical structure.

Because of the limited prior work in fields directly relevant to the present study, essentially the first problem encountered is one of accumulating and developing the instruments needed for studies such as this. Fortunately a majority of the motion picture tests developed years ago by Gibson (1947) are still available and usable. Also, earlier local work has provided some variety of instruments (Seibert and Snow, 1965b). Reference tests from French, Ekstrom, and Price (1963) or selections from those of Guilford are also useful. Beyond these limited resources, however, the required instruments or devices must be conceived, planned, produced, and refined by the investigator.

The plan adopted for the study represents division of the work and the questions into seven activities or sets of studies, three of which will be fully reported here. For the sake of convenience, we will refer to these three studies as Study A, Study B, and Study C. The four other sets include two dissertations which will be referenced and briefly described, plus two other studies now in progress or not yet fully reported. Study A was a Kaiser image analysis (Kaiser, 1963) of a 42-variable battery of ability measures. It was intended to help clarify a factor solution previously obtained (Seibert and Snow, 1965b), but emphasizing abilities in the domain of auditory memory. The second of the studies to be reported here (Study B) is a similar and subsequent factor analysis of a separately designed 25-variable ability battery which especially emphasizes visual memory. The third and final set of analyses (Study C) constitutes

what we have come to call "Fleishman-like analyses"; they treat data from six distinct visual memory tests, each of which has three or eight systematically varied subtests within. The analysis procedures are somewhat similar to those Fleishman employs (e.g., 1954) in studying the factor composition of performances during successive stages in acquisition of a skill. In the work reported here, the similar analyses are concerned with the factor composition of performances on short term memory tasks, when requirements of the task are varied either by altering the duration of stimulus exposure or by altering the length of the interval over which memory must operate.

The two other sets of studies, both related to the present work, will be considered only briefly in this report. The first is a newly inaugurated, performance prediction factor analysis. Over a period of more than eight months, it will test more than 1000 aviation cadets. Eighteen of the more promising motion picture tests have been selected for the study and constitute the large nucleus of a battery which is supplemented with perhaps a dozen other selected and available reference measures. Results from the study will provide a confirmatory factor analysis of results from earlier, smaller sample studies. In addition, the study will provide the best opportunity to date to assess the contributions these tests and similar tests may make within a demanding and germane selection-prediction situation.

The other set of related studies asks a variety of questions about the contribution or the involvement of motion picture test abilities and ability factors in selected learning situations. One of the studies, a dissertation (Fincke, 1967), contrasts the contributions to prediction derived from motion picture test factors, on the one hand, and biographical inventory factors, on the other. Prediction criteria include several indexes of learning derived either from instruction in which programmed

instructional materials were used or from other sessions in which instructional films were shown repeatedly, with the post-test administered after each (daily) screening. A second dissertation (Heckman, 1967) uses factor scores derived both from motion picture tests and from more conventional test factors in a search for interactions of abilities and of treatment conditions within a learning situation which employs programmed instruction. Finally, a third study not yet reported but sharing some tests, factors, and subjects with studies mentioned above investigates changes in the factor composition of criterion scores from a film learning situation in which two instructional films were screened five times each for the Ss. Preceding the first screening and after each screening, the criterion test appropriate to each film was administered. In addition to these scores, factor scores were derived for each of about nine ability factors. Analysis of the data is "Fleishman-like", which makes it similar to Study C.

In short, the purposes underlying the present work include efforts to clarify and confirm some film test-derived factors identified in earlier work, to investigate the structure of abilities in the domain of auditory memory for meaningful contents, to investigate the structure of abilities in the domain of (short- or intermediate-term) visual memory for meaningful contents, to study further the factor composition of performances at each separable stage of the short term visual memory tests, and to begin studies of the roles these abilities may have within various instructional and personnel prediction settings.

PROCEDURES

Since there are two major and separate data gathering ventures to be reported here, plus an analysis for each set of data, plus additional analyses of selected data from the second set, the immediate need is to sort out for coherent description the several research procedures that are pertinent. To help accomplish this and as indicated earlier, procedures associated with the first set of data and the analysis of those data will be referred to as Study A; procedures associated with the analysis of the second set of data will be referred to as Study B; and the further analyses of the second set of data, analyses we normally call "Fleishman-like", will be referred to as Study C. The principal procedures of Study A, Study B, and Study C are presented in order below. Their results are summarized in the next section of the report.

Study A

The subjects (Ss) who provided data for this study were 185 Purdue undergraduates recruited from the freshman English courses of the University and paid for their participation not only in this study, but either in one or in two other studies planned to follow this one immediately. One of these subsequent studies involved repetitive showings of two instructional films and used all or essentially all of the Ss participating here, plus the test data factor analyzed here. The other was an intricately woven study which involved Ss in learning from programmed instruction and which generated two dissertations (Smith, 1966, Heckman, 1967); it required varying amounts of participation from approximately two-thirds of the study's Ss.

A battery of 42 ability tests was administered to the Ss during three evening sessions, each with a duration of approximately three hours. Sessions were conducted in a lecture hall with a seating capacity of almost 500; assignment of Ss to alternate seats was randomly determined. Seating assignments in the first row, the last few rows, and in extreme angle locations

to the right and left were avoided. The lecture hall has a slanted floor, and is equipped to handle a variety of audio-visual presentations. It includes a closed and elevated projection booth at the rear, a 13 by 30 foot beaded projection screen, a sound amplification system with ceiling-mounted speakers, and room lighting which permits effective adjustment of illumination levels across a wide range. During test administrations, light levels were set to approximate the levels used in prior work (Seibert and Snow, 1965b, p. 41). Although illumination level readings were not taken during the present sessions, it is estimated that the light level on each seat-arm writing surface was between .5 and 1.0 foot-candle.

The tests comprising the battery of 42 ability tests are named and described in Appendix A. The 42 variables include eleven drawn from the ETS Manual for Kit of Reference Tests For Cognitive Factors (French, Ekstrom, and Price, 1963), ten taken from among the tests Guilford and his associates have developed, eleven existing motion picture tests or related tests developed locally, eight new and locally developed tests, and two tests from Christal (1958). Scoring presented only routine problems, even though a majority of both the new and the older local tests allowed free responding. In each case, the rules for scoring permitted reasonably easy and accurate decisions concerning each brief response. The analysis was a Kaiser image analysis (Kaiser, 1963) with orthogonal rotation to a varimax criterion (Kaiser, 1959) of the twenty-four "factors" associated with eigenvalues greater than one.

It should be emphasized that although the terminology "factors" and "loadings" has been used, the analyses performed were not classical factor analyses.

Study B

The Ss of this study, like those of Study A, were recruited from the freshman English classes at the University. The volunteers were either freshman or sophomores and sixty-five

per cent were women. Full participation in the study included attendance at two group testing sessions, plus one individual (vision) testing session; in return each S received a payment of $10.00. Initially, 188 Ss volunteered, but after normal attrition and the elimination of some whose color vision or visual acuity were marginal, an N of 159 Ss remained.

The 25-variable test battery was administered during two evening testing sessions, each lasting about three hours. On each evening, the tests administered included some conventional, paper-pencil tests and some motion picture tests. Physical conditions for the sessions were approximately the same as those reported for Study A; the testing room was the same and its facilities-equipment were unchanged. Motion picture tests were projected on the one of two Eastman Kodak projectors, model 126 TR, with three-inch lens. The projected slide test (Digit Span-Visual) employed a Kodak Carousel projector. Also as in Study A, Ss were assigned to seating locations randomly; Ss' viewing distance (from projection screen center) and viewing angle (from a line perpendicular to projection screen center) have been incorporated into the analyses as "marker" variables.

The 25 variables of the study include the measures of Ss' viewing distance and viewing angle, plus one new and local test for which two variant scores were derived and included. The remaining 21 variables include five other new and locally developed motion picture tests of visual memory abilities, eight older measures prepared locally and including various visual cognition and memory abilities, four reference tests selected from French, Ekstrom, and Price (1963), and three measures from Christal (1958). The variables in this analysis are named and described in Appendix B. Analysis of the 25 variable matrix is a Kaiser image analysis (Kaiser, 1963) followed by an orthogonal rotation of eight factors to a varimax criterion. Principal components analysis and image covariance analysis (Guttman, 1953) were also undertaken but will not be reported here.

Study C

This study uses the Ss and most of the variables from Study B, above, but for the purpose of studying more closely the performances on a selected set of subtests. Within the battery administered for Study B, six visual memory tests include subtests prepared by systematically varying the duration of a within-item event. In four tests, the exposure duration of the principal stimulus array of an item takes one of three levels. One of these tests, Short Term Color Memory I, presents an array of six colored hexagons in each item and for a duration of four film frames (i.e., about one-sixth second), or eight frames (one-third second), or twelve frames (one-half second). Then after a two-frame delay, an empty or blank hexagon appears and designates one of the six array positions; examinees are then to indicate which color occupied that position. A similar format and the same durations describe the tests entitled Short Term Color Memory II, Short Term Object Memory I, and Short Term Object Memory II.

Another test which systematically varies the duration of a within-item event is Short Term Visual Memory II. Its 64 items encompass eight eight-item subtests, with each item based on a one frame (i.e., about 31 millisecond) exposure of an eight letter, 4 by 2 array. The test employs a circle or "doughnut" to designate and mark one of the eight positions in the array; the "doughnut" may precede the array by 52 milliseconds or may follow by 10, 94, 177, 260, 344, 427, or 510 milliseconds. A similar format and the same durations describe the test entitled Short Term Visual Memory III; it differs from STVM II in that a vertical black bar appears simultaneously with the array to designate one letter and position, then the "doughnut" also appears just before or after the array.

RESULTS

Study A

The means, standard deviations, and variable names for each of the study's 42 variables are presented in Table 1. Also, as already indicated, the descriptions of each test in the battery are presented in Appendix A. (The 42-variable correlation matrix analyzed here appears in Heckman, 1967 and will not be repeated here). The 42-variable matrix was subjected to a Kaiser image analysis and resulted in 24 factors associated with eigenvalues greater than one. These 24 factors were rotated to a varimax criteron. The 24 rotated factors include seven which have at least two loadings of .30 or greater. It is only these seven which merit naming and further discussion. The seven factors, the names assigned to them, and the loadings and names of all variables loading at least .30 are presented below.

FACTOR I - Verbal Intelligence

Variable Number	Variable	Loading
1	Advanced Vocabulary	.76
2	Wide Range Vocabulary Part 1	.80
3	Wide Range Vocabulary Part 2	.78
4	Math Aptitude	.43
5	Necessary Arithmetic Operations Part 1	.39
6	Necessary Arithmetic Operations Part 2	.47
15	Word Classification	.43
16	Verbal Classification Part 1	.46
17	Verbal Classification Part 2	.43
18	Word Matrix	.50
19	Verbal Analogies Part 1	.45
20	Verbal Analogies Part 2	.44
21	Word Group Naming	.33
23	Vocabulary Completion	.59
24	Sentence Order	.49
35	Memory for Ideas Total	.55
38	Phrase Completion Total	.48
39	Sentence Completion Total	.51
41	Idea Sequence Part 2	.40
42	Sentence Reproduction	.57

TABLE 1

Variable Number	Variable	$\bar{X}$	S.D.
1	Advanced Vocabulary	9.91	2.87
2	Wide Range Vocabulary Part I	13.74	4.01
3	Wide Range Vocabulary Part II	12.86	3.78
4	Mathematics Aptitude Test	10.30	2.74
5	Necessary Arithmetic Operations Part 1	10.97	2.22
6	Necessary Arithmetic Operations Part 2	10.99	2.19
7	Maze Tracing Speed	23.16	5.92
8	Map Planning	25.82	6.61
9	Auditory Letter Span	6.66	2.24
10	Auditory Number Span	9.68	3.21
11	First and Last Names	22.05	6.74
12	Sequence Memory	20.05	4.15
13	Position Recall I	30.94	9.79
14	Position Recall II	16.75	7.54
15	Word Classification EL 17A	13.97	2.14
16	Verbal Classification Part 1	27.95	5.41
17	Verbal Classification Part 2	33.14	3.56
18	Word Matrix	9.38	2.08
19	Verbal Analogies I Part 1	10.36	2.06
20	Verbal Analogies I Part 2	8.91	2.16
21	Word Group Naming	11.41	1.68
22	Word Grouping	33.00	6.99
23	Vocabulary Completion	65.04	8.04
24	Sentence Order	12.49	2.58
25	Film Memory I	14.88	3.61
26	Film Memory II	9.61	2.98
27	Film Memory III	21.10	2.58
28	Social Abstracts IA	15.75	4.36
29	Social Abstracts IB	19.84	5.77
30	Social Abstracts IIA	24.95	7.49
31	Social Abstracts IIB	17.70	7.93
32	Successive Perception III	9.90	3.07
33	Successive Perception IV	4.63	3.42
34	Sequential Words	12.48	8.81
35	Memory for Ideas Total	44.96	12.62
36	Auditory Word Span	34.41	10.55
37	Paired Words Total	18.30	7.95
38	Phrase Completion	16.06	5.84
39	Sentence Completion	20.23	5.85
40	Idea Sequence Part 1	29.84	8.59
41	Idea Sequence Part 2	39.61	7.84
42	Sentence Reproduction	24.96	3.22

FACTOR II - Serial Memory Span

Variable Number	Variable	Loading
9	Auditory Letter Span	.70
10	Auditory Number Span	.71
36	Auditory Word Span	.63
42	Sentence Reproduction	.41

FACTOR III - Serial Integration

Variable Number	Variable	Loading
32	Successive Perception III	.64
33	Successive Perception IV	.59
34	Sequential Words	.48

FACTOR IV - Associative Memory

Variable Number	Variable	Loading
11	First and Last Names	.45
13	Position Recall I	.48
14	Position Recall II	.44
37	Paired Words Total	.33

FACTOR V - Auditory Memory for Verbal Detail

Variable Number	Variable	Loading
38	Phrase Completion Total	.46
39	Sentence Completion Total	.45
40	Idea Sequence Part I	.51

FACTOR VI - Perceptual Foresight and Memory for Temporal Order

Variable Number	Variable	Loading
4	Math Aptitude	.34
5	Necessary Arithmetic Operations Part 1	.38
6	Necessary Arithmetic Operations Part 2	.37
7	Maze Tracing Speed	.52
8	Map Planning	.51
22	Word Grouping	.44
29	Social Abstracts IB	.48
31	Social Abstracts IIB	.43

FACTOR VII - Social Abstracts - Figural Memory

Variable Number	Variable	Loading
28	Social Abstracts IA	.54
30	Social Abstracts IIA	.52

Factor I, the large and general verbal ability factor, cannot be more precisely named than it is; "Verbal Intelligence" will have to serve. Its highest loadings are derived from the several vocabulary tests, yet there are high loadings also from virtually all of the verbal tests in the battery. Nevertheless, there are noteworthy exceptions to this and they include the loadings of variable 11, First and Last Names test; variable 34, Sequential Words; variable 36, Auditory Word Span; and variable 37, Paired Words. All of these tests emerge most prominently in other and expected factors, about which more will be said later.

The Serial Memory Span factor or, perhaps more simply, the auditory span factor, Factor II, centers on the two reference tests which commonly represent the factor, Auditory Letter Span and Auditory Number Span. In addition, the new and experimental

test entitled Auditory Word Span has a loading virtually as high as the loadings of the two principal or defining variables; even the Sentence Reproduction test (which requires verbatim recording of a brief sentence after a single exposure) loads substantially here, although this loading of .41 does not rival its .57 loading on Factor I. On examining the factor loadings of the Auditory Word Span and the Sentence Reproduction tests, it appears possible to devise variants of these tests such that they chould "shade" gradually from simple symbol span ability to verbal facility. To accomplish the shading, the principal device would be to employ item contents ranging from zero order approximations to language, which virtually defines letter span item contents, through the intermediate approximations, and on to grammatical and plausible utterances, which approximately represents conditions in the Sentence Reproduction test. At the one end, memory span ability dominates and at the other, span subsides and verbal facility dominates.

Factor III, Serial Integration or Temporal Closure, emerges again and clearly in this analysis, as it did in the only earlier study which included the relevant variables (Seibert and Snow, 1965b, p. 61). The tests entitled Successive Perception III and Successive Perception IV are the dominant variables, well supported by the Sequential Words test; factor loadings are .64, .59, and .48, respectively. From these data, no reason appears for altering importantly the interpretation previously given the factor. It was indicated earlier that tests within the factor "involve rapid reception of temporally spaced stimuli, their organization into meaningful whole cognitions, and possibly their verbal labelling." (Seibert and Snow, 1965b, p. 61) There is some question, though, concerning the location of this factor in Guilford's structure. It might be considered cognition of figural units or perhaps cognition of figural relations, but neither classification does justice to the apparently strong temporal closure characteristics. It <u>is</u> cognition, however, and it is either figural or symbolic in content. More than that is unclear.

Factor IV, Associative Memory, is not a large factor, but it seems thoroughly consistent and clear. Variable 11, First and Last Names test, shows the highest factor loading and its task reflects well the requirements of other variables with substantial loadings here. For the First and Last Names test, examinees study a set of 20 full names for three minutes, then during the two minutes of testing time, they must supply first names for the randomly ordered set of last names. Similarly, variable 13, Position Recall I, allows 1 1/2 minutes to study each of four pages on which there are 12 drawings. After studying each page, examinees must indicate for each drawing (now presented in new locations), the position originally occupied on the "study page". Variable 37, Paired Words, is auditory but analogous to variable 11; it presents 30 pairs of common words, with each pair heard twice but differently ordered in a set of 15 pairs. Then, the first word of each pair is read and examinees must write the paired word. Elsewhere, this ability is described as

> The ability to remember bits of unrelated material. . . . It is possible, although there has been no clear demonstration yet, that this factor represents the ability to form and remember new associations quickly. (French, Ekstrom and Price, p. 22).

Factor V is named Auditory Memory for Verbal Details, but it is unclear how much of the name is crucial. The three dominant and defining variables, Phrase Completion, Sentence Completion, and Idea Sequence (Part I), all suggest that incidental memory may be significantly involved. They place some premium on the recall of normally valueless information. It should also be mentioned that although Idea Sequence (Part I) carries the highest loading, .51, on this factor, the virtually equivalent Part 2 of the same test has a loading of only .22. This probably relates to the fact that Part 1 had a loading of only .15 on Factor I, whereas the loading for Part 2 was .40. For Factor V, less of the variance of Idea Sequence (Part 2) was available. In any event, auditory and verbatim memory for language messages seems to be the essential feature of Factor V.

Factor VI has been named Perceptual Foresight and Speed; it is the most difficult of the factors to interpret and describe. In part, difficulty stems from the relatively large number of variables loading substantially here and this is compounded by the high loadings of Social Abstracts IB and IIB, to both of which could be ascribed many "critical" characteristics. "Perceptual Foresight" seems necessary in the factor name, since the two principal variables here, Maze Tracing Speed and Map Planning, are tests typically used in defining this ability (French, Ekstrom, and Price, pp. 42-44); it is alternatively known as spatial scanning and is classified by Guilford as cognition of figural implications. Perceptual speed must be indicated as the only identifiable ability which can unify variables as diverse as Word Grouping, Necessary Arithmetic Operations, Maze Tracing Speed, and Social Abstracts IB.

The last of the factors, Factor VII, is named Social Abstracts for obvious reasons and, as indicated directly above, the variety encompassed by the items of the Social Abstracts tests make it easy to ascribe performances to any of many abilities and, at the same time, make it difficult to support or bolster any contention. Some form of figural memory and perhaps memory for temporal order are likely to be involved.

Study B

The 25 variables included in this analysis are named and their statistics summarized in Table 2; they are all described in Appendix B. In examining Table 2, however, two unconventional entries should be remembered. First, Table 2 includes summaries from two separate administrations of the test entitled Short Term Color Memory I. This test was administered during both the first and the second testing session (test-retest reliability was .82 for total score and .76, .71, and .59 for the 4-frame, 8-frame, and 12-frame exposure subtests, respectively). Only the data from the first administration are included in the analysis

reported here. Second, the test(s) entitled Film Sequence Memory (A) and (B) are in fact one 20-item test to which two scoring procedures were applied. The scoring methods are described in Appendix B. Both sets of scores were finally included in the following analysis. In short, then, the 26 variables listed in Table 2 include one which represents a retesting and another which comes from application of alternative scoring procedures.

TABLE 2

Number	Variable	No. of Items	$\bar{X}$	S.D.	K-R 20
1	STOM I	54	30.98	6.38	.72
2	STOM II	54	38.77	5.89	.72
3	Successive-Perception III	20	8.98	3.35	.75
4	Successive Perception IV	20	3.95	3.30	.81
5	Picture Identification	20	8.77	2.81	.65
6	STCM I(A)	54	32.52	8.15	.84
	STCM I(B)	54	36.74	7.42	.83
7	STCM II	54	36.63	5.77	.69
8	STVM II	64	27.03	8.03	.81
9	STVM III	64	38.48	10.59	.90
10	Film Sequence Memory (A)	20	8.82	2.64	.49
11	Film Sequence Memory (B)	50	35.04	5.24	-
12	Wide Range Vocabulary	48	27.35	5.50	.73
13	Advanced Vocabulary	36	17.54	4.61	.77
14	Color Form Recognition	28	22.99	4.24	.81
15	Position Recall I	48	31.98	9.68	.91
16	Position Recall II	48	21.40	5.98	.71
17	Picture Memory Span	151	31.92	7.49	.76
18	Digit Span Visual	24	10.31	3.12	-
19	Gestalt Completion	20	17.36	2.55	-
20	First and Last Names	30	22.30	6.08	-
21	Social Abstracts Part 1	28	17.85	4.90	-
22	Social Abstracts Part 2	16	7.70	4.47	-
23	Social Abstracts Part 3	33	18.17	4.53	-
24	Viewing Angle	-	1.58	.95	-
25	Viewing Distance	-	5.35	1.42	-

N = 159 Ss

The correlation matrix for Study B, rounded to two places, is presented in Appendix C. The determination that the 25 variables should constitute the set to be analyzed and reported here includes several decisions. First, data existed from a test entitled Sequence Memory, one similar to a test previously included elsewhere (Seibert and Snow, 1965b, p. 36, and Christal, 1958). It required examinees to recall and indicate which of a pair of tests, by title, was administered earliest in time. There were 24 scored pairs or items in the test, but the standard error of measurement virtually equalled the standard deviation and the K-R 20 estimate was only .24; the test was deleted. Film Sequence Memory posed other problems. Each of its items requires examinees to indicate the sequence or order in which four film actions occurred; after several pilot efforts at scoring, it was decided that the two procedures described in Appendix B would both be retained. Their retention might be questioned, however, since the two scores derived from the test add nothing except the very probable factor which they together generate. The Social Abstracts test were item analyzed and subjected to preliminary factor analyses before the decision was finally made to arrange each of their items into three separately scored subtests, as described in Appendix B.

As in the reporting of Study A, the practice here will be to report in a single table the factor numbers; the names assigned the factors; and the names, numbers, and loadings of variables with loadings of at least .30. This information is presented below.

FACTOR I - Short Term Memory

Variable Number	Variable	Loading
6	Short Term Color Memory I	.66
7	Short Term Color Memory II	.56
1	Short Term Object Memory I	.65
2	Short Term Object Memory II	.70
8	Short Term Visual Memory II	.51
9	Short Term Visual Memory III	.48

FACTOR II - Film Sequence Memory

Variable Number	Variable	Loading
10	Film Sequence Memory A	.70
11	Film Sequence Memory B	.69

FACTOR III - Vocabulary

Variable Number	Variable	Loading
13	Advanced Vocabulary	.63
12	Wide Range Vocabulary	.63

FACTOR IV - Serial Integration

Variable Number	Variable	Loading
5	Picture Identification	.69
3	Successive Perception III	.63
4	Successive Perception IV	.67
8	Short Term Visual Memory II	.37
9	Short Term Visual Memory III	.38
25	Viewing Distance	-.41
19	Gestalt Completion	.38

FACTOR V - Associative Memory

Variable Number	Variable	Loading
15	Position Recall I	.51
16	Position Recall II	.37
20	First and Last Names	.49
14	Color Form Recognition	.44

FACTOR VI - Short Term Visual Memory

Variable Number	Variable	Loading
8	Short Term Visual Memory II	.45
9	Short Term Visual Memory III	.43

FACTOR VII - Memory Span

Variable Number	Variable	Loading
17	Picture Memory Span	.53
18	Digit Span Visual	.49

FACTOR VIII - Social Abstracts

Variable Number	Variable	Loading
21	Social Abstracts Part 1	.44
22	Social Abstracts Part 2	.34
23	Social Abstracts Part 3	.36

The first of the factors, Short Term Memory, is immediately a problem in interpretation, both because the short term memory tests have several features in common, which obscures the critical features, and because two of the tests emerge later and alone to form Factor VI. Although the tests of Factor I share several common features and requirements, they are not more similar than their titles suggest. Differences among them are easy to identify. For example, the item contents of color memory, object memory, and visual memory are distinctive and disparate. Their individual items present either six colored hexagons drawn from a known set of nine, six common object photographs drawn also from a known set of nine, or eight letters of the alphabet. These contents appear to include figural, symbolic, and perhaps semantic information. The exposure durations of these stimulus arrays range from the one frame, 31 millisecond level, throughout both of the visual memory tests to the four, eight, and twelve frame levels (i.e., one-sixth, one third, and one-half second exposures) in the various subtests of the object memory and color memory tests. Furthermore, even though each item requires the remembering of one "element" from the array, this element may be a designated array position, with examinees required to indicate the contents of the position and the designation of the position may precede or follow the array. In other tests (e.g., Short Term Color Memory II), the array appears and disappears, then one of its contents is shown and examinees must indicate the array position occupied by the contents. Finally, the interval over which memory must operate may be as little as ten milliseconds or it may be as great as a half second.

Factor II, Film Sequence Memory, bears little discussion. The two scoring methods applied to the Film Sequence Memory test responses are correlated to the extent of .73 and their correlations with other variables are low. Together, the two scores from Film Sequence Memory form this factor. The format and contents of the test are well removed from all others in the battery, although it would be conceivable that the variables here and some from the

Social Abstracts test might merge in a behavioral memory or a temporal order memory factor..

The Serial Integration factor, Factor IV, is a recurrence of Factor III from Study A, just reported, and of Factor B from an earlier local study (Seibert and Snow, 1965b, p. 61). The critical characteristics of the task appear still and clearly to be the rapid reception of stimuli that are temporally separated and the organization or cognition of these into meaningful wholes. The crucial tests in this factor (i.e., Successive Perception III and IV) control the pace at which figural "fragments" are presented and they enforce the temporal separation, while others of the tests (e.g., Picture Identification and Gestalt Completion) appear to present all requisite information simultaneously; however, it appears possible that eye movements during scanning of the fragments are at the base of the involvement of these seemingly unrelated variables. There are no observable reasons why earlier interpretations of the factor should be modified.

The Associative Memory factor, Factor V, seems essentially the same as Factor IV of Study A, above. Each variable with substantial loadings here required remembering arbitrary pairings of simple contents. Because the test entitled Position Recall II is administered under conditions which make it virtually an afterthought, it may well be "contaminated" with some form of incidental memory; it is at least not inconsistent with this that Position Recall II displays the lowest factor loading. What seems most important is that the First and Last Names test, Position Recall I, and Color Form Recognition are the defining variables of the factor. It seems useful to consider this factor and Factor I (Short Term Memory), since they are rather similar, perhaps only representing different portions of the stimulus exposure range. Whereas the typical task from variables in Factor I requires the association of a simple content (or element) and of a position, all in a few milliseconds to a half second, the typical task from Factor V requires that a similar process occur in a far longer space of time. Associations formed here may involve repeated exposures to

the stimulus over a period of about two minutes. It is almost reasonable to suppose that as the Position Recall I test is altered to imitate Short Term Object Memory I more and more closely, the variants intermediate between the two tests would load decreasingly on Associative Memory and increasingly on the Short(er) Term Memory. The Short Term Visual Memory factor, Factor VI, was briefly mentioned in connection with Factor I, since the two tests present here were present there also. The two tests here, Short Term Visual Memory II and Short Term Visual Memory III, both employ an eight-letter stimulus array for each test item, with the array presented for 31 milliseconds. Thus, item contents and stimulus exposures are the same in each test. These tests also use similar procedures in designating the array element to be recorded. As a guess, it can be suggested that the factor here represents an extremely short term visual memory for symbolic contents.

Factor VII, Memory Span, is this study's analog of Factor II from Study A. It is a version of the memory span factor commonly found and discussed elsewhere (e.g., French, Ekstrom, and Price, p. 26). Since the use of item contents other than letters and numbers has not previously had noticeable effect on the factor composition of such tests and since either visual or auditory tests may be found here, no great importance can be assigned to the appearance here of Picture Memory Span. Also, probably no substantial differences exist between this factor and the span factor of Study A.

The last factor reported, Factor VIII, can only be named Social Abstracts. The three variables with loadings on the factor are the three subtest scores from the test entitled Social Abstracts II. Although the subtests appearing here might reasonably have helped to define factors involved in memory for temporal order, behavioral memory, or perhaps figural cognition, they emerged otherwise. It continues to appear that the techniques of the Social Abstracts tests are interesting and potentially valuable, but they require further work and refinement.

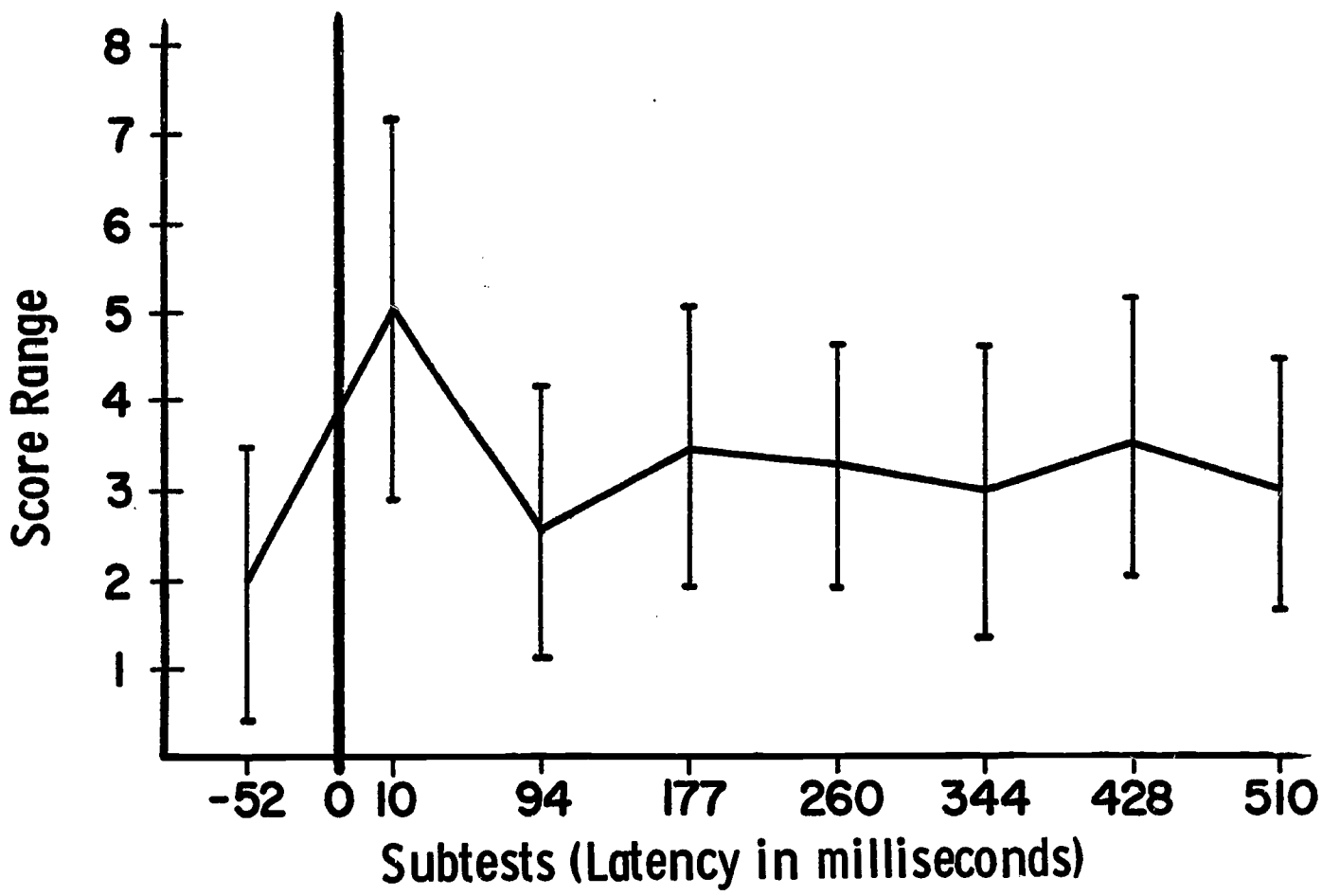
Study C

The detailed analyses of subtest performances on the six visual memory tests are based on data gathered and partially analyzed for Study B. Thus, the study here, Study C, employs the same group of 159 Ss and essentially the same battery of 25 tests and other variables. Here, though, in studying a given memory test,the test is treated as a set of subtest scores, rather than as a single, summed score, as in Study B. The meaning of these statements will be made clear as the results associated with each test are presented.

The first of the visual memory tests to be considered is Short Term Visual Memory II. The format of each item is that it presents a four by two eight-letter array tachistoscopically (i.e., one film frame, 31 milliseconds). Then spaced either 52 milliseconds before the array appearance, or spaced after the array by 10, 94, 177, 260, 344, 428, or 510 milliseconds, a "circle marker" appears briefly to designate one position in the array. Examinees record the letter appearing in the designated position. Each of the eight circle marker intervals represents a subtest and each subtest includes eight items, all ordered randomly throughout the test. The first question concerns the mean performance at each circle marker level. These are presented graphically and numerically in Figure 1, together with their standard deviations and K-R 20 estimates.

The results from Figure 1 may be compared with results previously obtained for the same subtests (Seibert and Snow, 1965b, p. 78). Comparing them, they appear not only similar, but comparable in most details. In both, performance level is initially low, then reaches its highest point when the marker follows the array by 10 milliseconds, it declines again, then rises to a stable and intermediate level until the 10 frame (427 millisecond) delay where it crests before declining again at the longest delay interval.

Figure 1



Data used in Figure 1

SUBTESTS OF STVM II

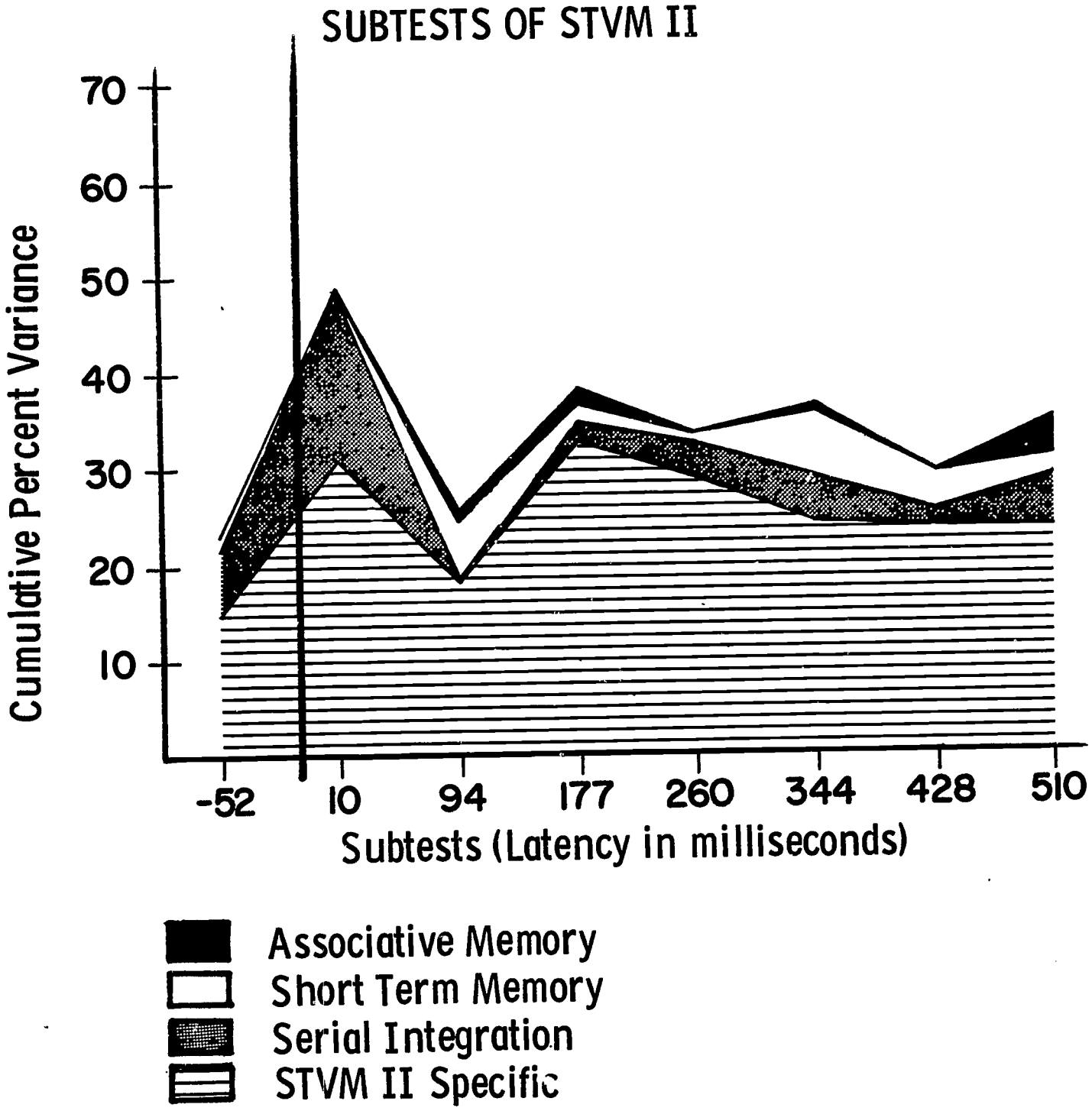
	-52	10	94	177	260	344	428	510
X	2.00	5.03	2.64	3.51	3.33	3.04	3.58	3.09
S.D.	1.56	2.12	1.52	1.53	1.35	1.60	1.54	1.37
K-R 20	.49	.69	.38	.47	.13	.43	.29	.24

The variance composition of subtests within Short Term Visual Memory II is summarized in Figure 2. To obtain these results, the correlation matrix included each of the other 24 variables, plus the eight subtests of Short Term Visual Memory II. Kaiser image analysis was used, with the rotation of eight factors orthogonally to a varimax criterion.

Results in Figure 2 are less fragmented or "cluttered" than those from a similar and earlier analysis of the same test (Seibert and Snow, 1965b, p. 83); however, there is at least one important pattern of results which both share. In both, variance from the serial integration factor appears or is absent from the various subtests similarly. In the current and the earlier analysis, serial integration has little involvement in performances on the "first" subtest (i.e., the eight items in which the marker precedes the array by 52 milliseconds), then involvement is at a maximum in the next subtest and is virtually gone from the third one. At its maximum, it accounts for 18 per cent of the variance. In the earlier analysis, serial integration peaked in the same subtest, but there accounted for 36 per cent of the variance. Proceeding through the other subtests, there is no apparent involvement of serial integration until a weak appearance at the 344 millisecond (marker) delay level, then it constricts and finally it appears weakly again at the 510 millisecond level. In brief, then, tracing the involvement of serial integration ability through successive delay intervals of the test, the ability first is only weakly present, then it peaks in the "second" subtest, subsides in the intermediate subtests, and emerges again weakly in the "sixth" and "eighth" subtests. This one brief description applies equally to the present analysis and to the one similar analysis of earlier data.

Mean performance levels on the eight subtests of Short Term Visual Memory III are presented graphically and numerically in Figure 3. Also included are the standard deviations of scores

Figure 2



Data used in Figure 2

SUBTESTS OF STVM II

	-52	10	94	177	260	344	428	510
STVM II Specific	14.4	30.5	18.1	32.6	28.8	24.0	23.4	23.4
Serial Integration	7.0	17.8	.2	2.1	3.5	4.8	1.7	5.4
Short Term Memory	1.6	.1	6.3	4.0	1.1	6.6	4.1	2.0
Associative Memory	.2	00.0	.7	1.4	.2	.7	00.0	4.1

Figure 3

Data used in Figure 3

SUBTESTS OF STVM III

	-52	10	94	177	260	344	428	510
X	6.12	4.69	3.00	3.60	4.71	4.81	5.70	5.77
S.D.	1.91	2.09	1.43	1.63	1.67	1.58	1.68	1.97
K-R 20	.72	.69	.33	.41	.49	.49	.57	.71

and the K-R 20 estimates for each subtest. The test in question here is similar to the one just discussed, but with the difference that Short Term Visual Memory III not only provides a circle marker, but also a black vertical bar "marker" simultaneously with the eight letter array. The circle marker may precede the array by about 52 milliseconds or may follow it by as much as 510 milliseconds, with six intermediate intervals and thus with six other subtests.

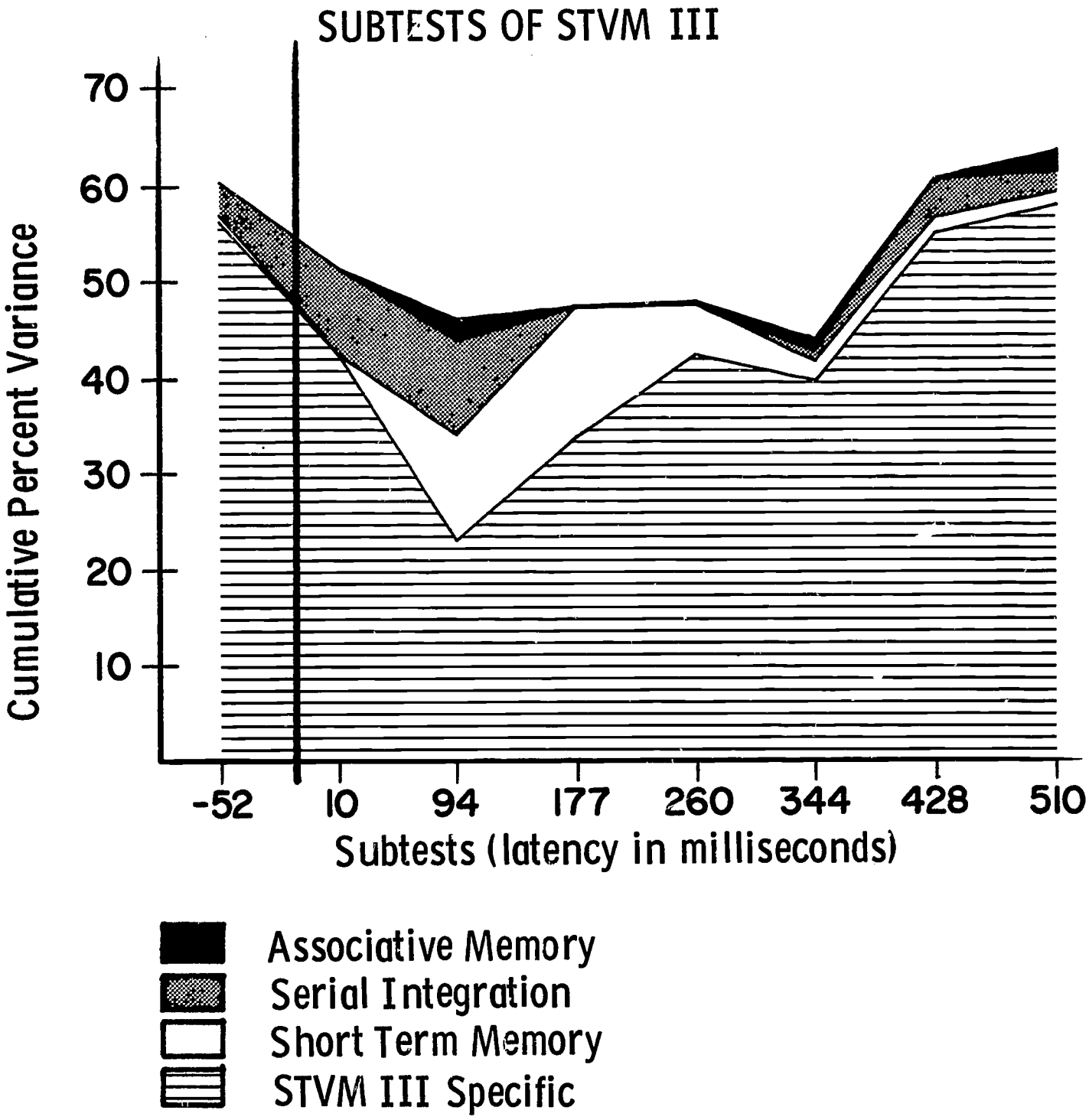
The pattern of subtest means in Figure 3 may also be compared with previous results (Seibert and Snow, 1965b, p. 79). As with Short Term Visual Memory II, the present results are highly similar to those obtained in earlier work. The first of the subtests yields the highest mean, with a sharp decline to the second, and a further sharp decline to the low point at the appropriate number millisecond level. Performance then recovers rather steadily, rising to a level between the levels of the first and second subtests. The results are also reasonably similar to those of Averbach and Coriell (1961) and it may be that the visual erasure phenomenon which they refer to is operating here to depress scores at the 94 millisecond level and then as the erasure period passes, to permit performance recovery.

Results from the analysis of subtest's factor composition in Short Term Visual Memory III are summarized in Figure 4. Its results may also be compared with those from a similar and earlier analysis of the same test (Seibert and Snow, 1965b, p. 84). Similarities in the two sets of results are weaker than those compared for Short Term Visual Memory II, yet two apparent consistencies should be mentioned. In both sets of results, the serial integration ability appears faintly in the first subtest, more strongly in the second, then virtually disappears from the third; it reappears weakly in the last two subtests. This description fits both the present and the earlier analysis of Short Term Visual Memory III. In addition, it approximately described both analyses of Short Term Visual Memory II. The pattern appears

with enough consistency to warrant the suggestion that serial integration (or temporal closure) ability is importantly involved in processing the test's arrays and later, their nearly simultaneous circle markers (where "nearly simultaneous" means that only about ten milliseconds separates the stimuli); serial integration is involved further when the time separation between stimuli is one-third second, one-half second, or perhaps greater. It may be worth mentioning also that serial integration plays no observable part in any subtest of Short Term Visual Memory I (Seibert and Snow, 1965b, p. 82), which is like its successor tests, except that it employs only a black bar marker to designate array elements, rather than including the circle marker.

As with the tests entitled Short Term Visual Memory II and III, four other visual memory tests were specially analyzed to trace changes in the factorial composition of subtest scores. Although the analyses were productive in the case of the two earlier visual memory tests, similar analyses of the four other tests yield nothing of apparent value. In support of this, results from analysis of Short Term Color Memory II are presented in Figure 5. These results show that the largest portion of the variance accounted for in each subtest is attributable to the Short Term Memory factor. Small and additional fractions are accounted for by other factors, but these are reasonably stable across subtests. The comparable results from the tests entitled Short Term Object Memory I, Short Term Object Memory II, and Short Term Color Memory I seem no more valuable than those in Figure 5. None of the results support the suspicion held earlier, that an extension of the stimulus exposure interval, especially in the color memory tests, would be accompanied by the increased involvement of verbal abilities. The suspicion derives both from Bruner's views of intellectual development, cited earlier, and from the compatible views of his colleague, George Miller, when Miller writes:

Figure 4



Data used in Figure 4

SUBTESTS OF STVM III

	-52	10	94	177	260	344	428	510
STVM III Specific	56.2	42.2	23.0	33.6	42.2	39.7	54.8	57.8
Short Term Memory	.6	00.0	10.9	13.7	5.3	1.7	1.7	1.2
Serial Integration	3.6	9.0	00.0	.1	.2	1.2	4.0	2.2
Associative Memory	.5	.2	2.2	00.0	.1	1.2	00.0	2.2

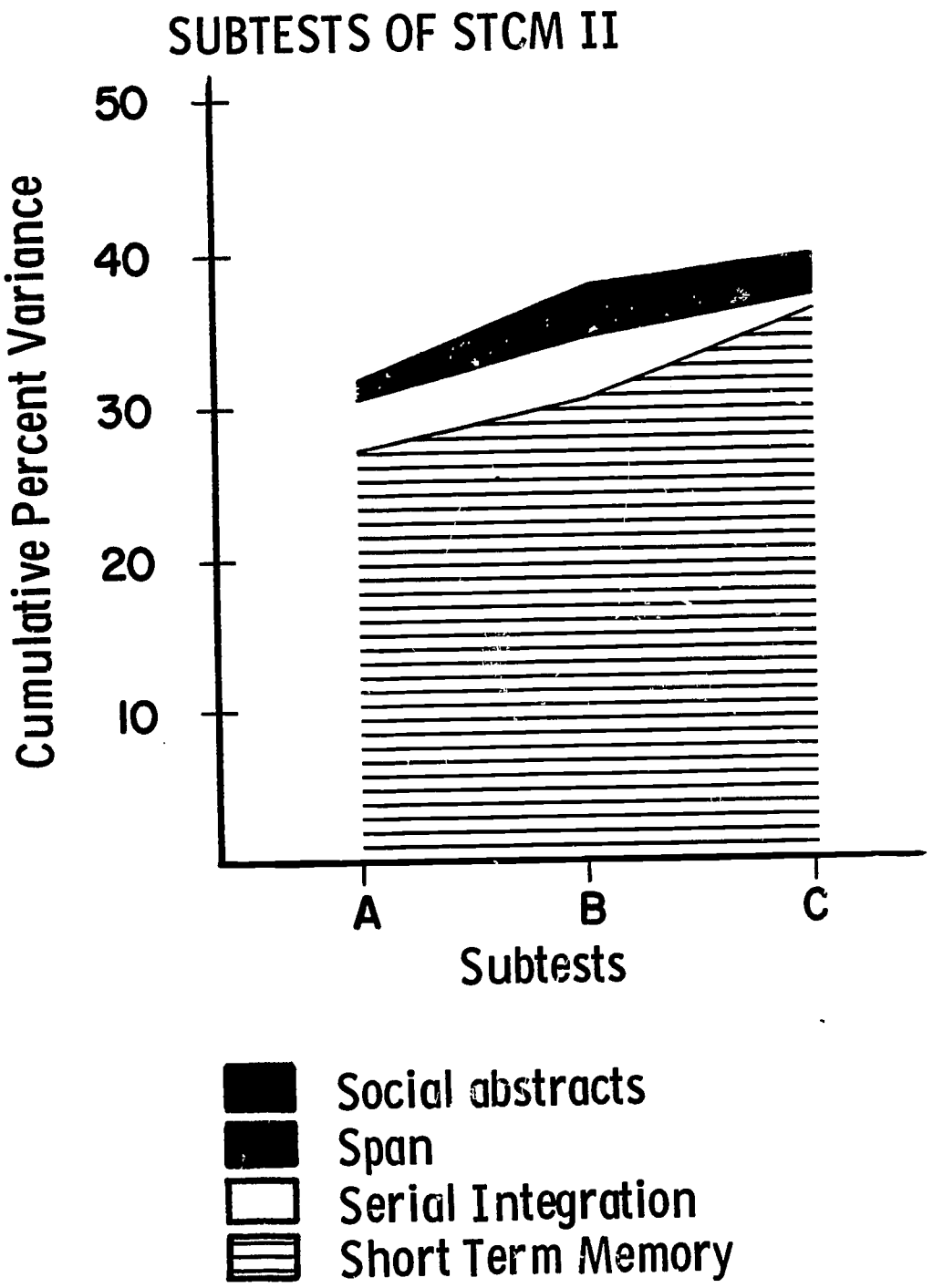
> In my opinion the most customary kind of recoding that we do all the time is to translate into a verbal code . . . When we witness some event we want to remember, we make a verbal description of the event and then remember our verbalization. . . . Our language is tremendously useful for repackaging material into a few chunks rich in information. (Miller, 1956, p. 95).

Following Bruner and Miller, it was just possible that brief exposure intervals would allow no opportunity for recoding of the stimulus, but that longer exposures would. If this were true, then it was also just possible that recoding would bring verbal abilities into play and that an increased fraction of the variance would be attributable to one or more verbal ability factors. It was a more interesting possibility initially than now, but it at least will bear further development and study.

Although the color and object memory subtests show no important changes in factorial composition, they reveal one interesting inversion in the subtest means. The means, standard deviations, and K-R 20 estimates for each subtest of Short Term Object Memory I, II, and Short Term Color Memory I, and II are presented in Table 5. For one of the tests, Short Term Color Memory I, two sets of data are shown, one from the first and one from the last testing session.

Each of the tests considered in Table 3 shows performance increases associated with lengthening of the stimulus exposure interval, except for Short Term Color Memory I. For each test, items in the first or "brief exposure" subtest present six "element" displays for four film frames, items in another subtest present their displays for eight film frames, and the third subtest's items present their displays for twelve frames. It is reasonable that lengthening of the exposure interval should facilitate performance; however, in Short Term Color Memory I, facilitation occurred as display duration was lengthened from four frames to eight, but with further lengthening, performance declined. Not

Figure 5



Data used in Figure 5

SUBTESTS OF STCM II

	A	B	C
Short Term Memory	27.0	30.3	36.0
Serial Integration	3.6	4.0	1.0
Span	1.2	3.2	.6
Social Abstracts	00.0	.2	2.0

TABLE 3

Variable	Subtest	$\bar{X}$	S.D.	K-R 20
Short Term Object Memory I	A (4 frames)	9.13	2.56	.412
	B (8 frames)	10.34	2.85	.525
	C (12 frames)	11.51	2.40	.374
Short Term Object Memory II	A (4 frames)	11.99	2.62	.496
	B (8 frames)	13.25	2.43	.486
	C (12 frames)	13.53	2.23	.407
Short Term Color Memory Ia	A (4 frames)	10.73	3.27	.678
	B (8 frames)	10.70	3.01	.625
	C (12 frames)	10.14	2.95	.591
Short Term Color Memory Ib (retest)	A (4 frames)	11.98	2.94	.633
	B (8 frames)	13.15	2.89	.647
	C (12 frames)	11.71	2.68	.532
Short Term Color Memory II	A (4 frames)	11.30	2.62	.499
	B (8 frames)	12.20	2.29	.341
	C (12 frames)	13.19	2.29	.392

only did this happen once, but on retest, the same pattern appeared. Considering this, it was thought that any of several mistakes or extraneous factors might have produced it: Errors in item production, subtle factors involving the selection of the correct response or the distracter context of the item, or perhaps the chance occurrence that many of the subtest's items appeared early in the test and before stable and practiced responding had evolved. No evidence was found to support any of these possibilities. Currently, there is only the fact that lengthened exposure durations regularly increased the average performance levels, except in the case of Short Term Color Memory I, where the one-third second exposure of the item stimulus led to mean scores substantially lower than those for either of the other exposure durations.

DISCUSSION

The result with the greatest apparent significance and promise is the continuing emergence of the serial integration factor. This factor appeared first in the earliest of local studies and it has now emerged in each of the subsequent factor analyses. It appears as Factor III of the current Study A and as Factor IV of Study B. Serial integration would seem to be a figural cognition ability, but it does not fit clearly into Guilford's proposed structure of intellect. Perhaps it could be classed as cognition of figural units or as cognition of figural relations, but both of those cells seem independent of the temporal "bridging" ability which best typifies performances on the defining variables of this factor. The involvement of this ability in external situations (other than those summarized in Figures 2 and 4) has not been established, but it deserves to be investigated as a potential predictor of performance on a variety of complex tasks.

A second result with fair promise and significance is that reflected in Figures 2 and 4. Outwardly, the tasks represented in tests like Short Term Visual Memory II and Short Term Visual Memory III are homogeneous. Most investigators would be comfortable in the assumption that the abilities or processes underlying performance on items within the tests are hardly distinguishable. Nevertheless, as in Fleishman's work, some evidence emerges here to question such assumptions. In the test entitled Short Term Visual Memory II, for example, the constituent abilities of the different subtests appear not to be stable. Especially, the present results (Study C) and earlier results (Seibert and Snow, 1965b) show a substantial involvement of serial integration ability during one of the "earlier" subtests then some increased involvement again when memory intervals of one-third to perhaps one-half second are employed. The further accumulation of results like these could or should be disturbing to experimentalists

and differentialists alike, since the results cast doubt on some convenient assumptions. These results seem especially disturbing because they suggest that the constituent abilities have changed noticeably even while the task conditions have changed very slightly (e.g., in Short Term Visual Memory II when the memory interval is changed from about 1/100th to about 1/10th second, the involvement of serial integration ability declines sharply). At this point, such results certainly cannot be adequately interpreted, but they can at least serve to encourage the further investigations advocated by Morrison (1960).

The results from the test entitled Short Term Color Memory I contain some of the ingredients of a mystery. If there is a simple reason why its mean subtest scores should behave as they do, that reason has escaped the writers. Initially, it seemed possible that the constituent abilities of the Color Memory subtests would differ, much as they have in Short Term Visual Memory II and III, but no clear evidence for that was found. It was also expected initially that the mean performance levels on subtests of the Color Memory and Object Memory tests would increase as the exposure intervals of the stimulus arrays were increased. For all relevant tests ex e t Short Term Color Memory I the expectation was borne out, but for both administrations of that test, there is an unexpected reversal of the mean scores. As already mentioned, several possible explanations were considered and the test or its data were examined for evidence that one of these explanations might be supportable, but none is sufficient. We might interpret the present outcome as the result of some fleeting phenomenon, perhaps even the erasure phenomenon discussed by Averbach and Coriell (1961), but before such possibilities are seriously considered, further data should be gathered.

Much could be done in the further development of tests that are now experimental instruments but that show promise in defining

novel ability factors or in applications to prediction-selection-classification. Several applications involving perceptually handicapped or culturally deprived examinees are conceivable and an initial study with each group is now under development. If current plans mature, both studies will begin in the immediate future. In addition, selected motion picture tests are now included in a study of potential and new predictors of success in military aviation. This is the measurement role which prompted the first serious work with motion picture tests a quarter of a century ago, but the necessary validation studies have hardly begun. This new study seems important because its conditions represent many similar situations in which individuals must adapt to highly complex and dynamic environments. Improved identification and selection of such individuals is possible and perhaps some measures of "time sharing" or "multiplexing" abilities can be usefully added to those currently used in selection.

Two recent dissertations, both prompted by the work reported here, have used ability tests or ability factors from this work either in the prediction of outcomes from fairly conventional instruction-training (Fincke, 1967) or as individual difference variables which may interact with instructional treatment variables (Heckman, 1967). The first of the studies selected nine of the ability tests from Study B and employed their data and/or factor scores from biographical information to predict five learning criteria, one from a programmed instruction task and four from instructional film posttests. Although the film test scores exhibited some significant correlations with the criteria, their contributions were generally modest (Fincke, 1967, pp. 44-49). In the other of the two dissertations, no strong evidence of aptitude-treatment interactions was found, although this outcome is confounded with the methodological difficulties which are virtually inevitable here. (Heckman, 1967). The nature of these interactions in instruction and training is still

largely a matter of speculation, as is the special involvement of abilities associated with motion picture and other non-print tests. Nevertheless, the investigation of these interactions is all that has been claimed by its principal advocates. In essence, they indicate that the really interesting psychological questions in the field are to be found in the study of treatments in interaction with individual difference variables (e.g., Cronbach, 1967; Carroll, 1967) and that the work will be difficult and frustrating (Carroll, 1967, p. 41).

Perhaps the most general purpose of the present work is to make trouble or to agitate. The work was begun and has been continued largely because it made no sense to allow Gibson's earlier efforts to be wasted, because it made no sense to regard the motion picture and other non-print media in education only as instructional media, because it made no sense to regard intellect as if it expired at the (right) edge of a printed page, and because it made no sense to separate always the interests of correlationists and experimentalists in education and psychology. It is impossible to tell now whether this most general purpose has been served, but perhaps eventually we shall know.

BIBLIOGRAPHY

Averbach, E., and Coriell, A.S. Short-Term Memory in Vision. Bell System Technical Journal, 1961, 40, 309-328.

Boring, E.G. Capacity to Report upon Moving Pictures as Conditioned by Sex and Age. Journal of Criminal Law and Criminology, 1916, 6, 820-834.

Bruner, J.S. Toward a Theory of Instruction. Cambridge, Massachusetts: The Belknap Press of Harvard University Press, 1966.

Buros, O.K. (Ed.), The Sixth Mental Measurements Year Book. Highland Park, New York: The Gryphon Press, 1965.

Carpenter, C.R., et al. The development of a Sound Motion Picture Proficiency Test. Personnel Psychology, 1954, 7, 509-523.

Carroll, J.B. Study of Language. Cambridge, Massachusetts: Harvard University Press, 1959.

Carroll, J.B. Instructional Methods and Individual Differences. In Gagne (Ed.), Learning and Individual Differences. Columbus, Ohio: Merrill Inc., 1967.

Christal, R.E. Factor Analytic Study of Visual Memory. Psychologica Monographs, 1958, 72, No. 13 (Whole No. 466).

Conrad, H.S. Psychological Studies of Motion Pictures. Berkeley: University of California Press, Publications in Psychology, 1929.

Cronbach, L.J. How Can Instruction be Adapted to Individual Differences? In Gagne, R.M. (Ed.), Learning and Individual Differences. Columbus, Ohio: Merrill Inc., 1967.

Fincke, G.E. A Factorial Approach to the Autobiographical Correlates of Training Task Performance. Unpublished Ph.D. Thesis, Purdue University, 1967.

Fleishman, E.A., and Hempel, W.E., Jr. Changes in Factor Structure of a Complex Psychomotor Test as a Function of Practice. Psychometrika, 1954, 18, 239-252.

Fleishman, E.A., The Description and Prediction of Perceptual-Motor Skill Learning. Training Research and Education. In Glaser (Ed.), Pittsburgh: University of Pittsburgh Press, 1962. pp. 137-175.

French, J.W., Ekstrom, R.B., and Price, L.A. Manual for Kit of Reference Tests for Cognitive Factors. (Revised 1963). Princeton: Educational Testing Service, 1963.

Gibson, J.J., (Ed.), Army Air Forces Aviation Psychology Program, Report No. 7; Motion Picture Testing and Research. Washington, D. C.: U.S. Government Printing Office, 1947.

Guilford, J.P. Personality, New York: McGraw-Hill, 1959.

Guilford, J.P. Three Faces of Intellect. American Psychologist, 1959, 14, 469-479.

Guilford, J.P. Distinguished Scientific Contribution Awards. American Psychologist, 1964, 12, 947-954.

Guilford, J.P. and Hoepfner, R. Current Summary of Structure-of-Intellect Factors and Suggested Tests. Reports from the Psychological Laboratory, University of Southern California, No. 30, December 1963.

Guttman, L. Image Theory for The Structure of Quantitative Variates. Psychometrika, 1953, 18, 277-296.

Heckman, R.W. Aptitude-Treatment Interactions in Learning from Printed Instruction: A Correlational Study. Unpublished Ph.D. Thesis, Purdue University, 1967.

Heider, F., and Simmel, Marianne. An Experimental Study of Apparent Behavior. American Journal of Psychology, 1944, 57, 243-259.

Kaiser, H.F. Computer Program for Varimax Rotation in Factor Analysis. Educational & Psychological Measurement, 1959, 19, 413-420.

Kaiser, H.F. Image Analysis. In C.W. Harris (Ed.) Problems in Measuring Change. Madison: University of Wisconsin Press, 1963.

McIntyre, C.J. Sex, Age, and Iconicity as Factors in Projective Film Tests. Journal of Consulting Psychology, 1954, 18, 337-343.

Miller, G.A. The Magical Number Seven, Plus or Minus Two: Some Limits on Our Capacity for Processing Information. The Psychological Review, 1956, 2, 81-97.

Morrison, E.J. On Test Variance and the Dimensions of the Measurement Situation. Educational and Psychological Measurement, 1960, 2, 231-250.

Pillsbury, W.B. The Cinematoscope as a Memory Apparatus. American Journal of Psychology, 1929, 41, 123.

Seibert, W.F., and Snow, R.E. Cine-Psychometry, AV Communication Review, 1965, 1, 140-158. (a)

Seibert, W.F., and Snow, R.E. Studies in Cine-Psychometry I: Preliminary Factor Analysis of Visual Cognition and Memory. Lafayette, Indiana: Purdue University Audio Visual Center, 1965. (USOE Grant No. 7-12-0280-184.) (b)

Smith, M.E. Prediction of Effects with Selected Characteristics of Linear Programmed Instruction. Unpublished Ph.D. Thesis, Purdue University, 1967.

Thurstone, L.L. A Micro-Film Projector Method for Psychological Tests. Psychometrika, 1941, 6, 235-248.

Thurstone, L.L. The Development of Objective Measures of Temperament. Psychometric Laboratory Report No. 1. Chapel Hill: University of North Carolina, 1953.

APPENDIX A

Variable Names, Descriptions and Numbers for Study A

1. Advanced Vocabulary: A printed test in which a word is presented and S must choose a synonym from among five alternatives. Each of the two parts includes 18 rather difficult items. Four minutes are allowed for each part. Only part one was used for the present study (French, Ekstrom, and Price, 1963, p. 46).
2. Wide Range Vocabulary (Part I): A printed test of knowledge of word meanings. It is a five-choice synonym test having items ranging from very easy to very difficult. Each part consists of 24 items. Six minutes are allotted for each of the two parts (French, Ekstrom, and Price, 1963, p. 46).
3. Wide Range Vocabulary (Part 2): See #2 above.
4. Mathematics Aptitude Test: A printed test of ability to solve problems in mathematics. Each part consists of 15 five-choice word problems requiring arithmetic only. Ten minutes are allowed for each of the two parts. Only part one was used for the present study (French, Ekstrom, and Price, 1963, p. 34).
5. Necessary Arithmetic Operations (Part 1): A printed, four-choice test requiring S to indicate what numerical operations are required to solve arithmetic problems. Computations are not necessary. In each of the two parts, S is given five minutes for 15 items (French, Ekstrom, and Price, 1963, p. 35).
6. Necessary Arithmetic Operations (Part 2): See #5 above.
7. Maze Tracing Speed: A printed test requiring S to find and mark an open path through a moderately complex series of paper mazes (French, Ekstrom, and Price, 1963, p. 43).
8. Map Planning: A printed test which presents to S diagrammatic sections representing city maps. The "streets" have barriers at certain points which cannot be crossed. The task is to plan routes between given points in such a way that the barriers are not crossed. The Ss are required to find the shortest possible route as quickly as possible. (French, Ekstrom, and Price, 1963, p. 44).

9. Auditory Letter Span: In each item of this test, the examiner reads aloud a series of letters. After he finishes a series, S is required to record the letters in the exact order in which they were read. Ten minutes are allotted for the 24 items in this test. (French, Ekstrom, and Price, 1963, p. 27).

10. Auditory Number Span: In each item of this test, the examiner reads aloud a series of numbers. After he completes a series, S is required to record the series in the exact order in which they were presented. Ten minutes are allotted for the 24 items in this test (French, Ekstrom, and Price, 1963, p. 26).

11. First and Last Names: A printed test of ability to learn first and last names. In each of the two parts of the test, S studies a page of 15 full names, first and last. He then turns the page to find a list of the last names only. He must record the first names associated with each last name (French, Ekstrom, and Price, 1963, p. 23).

12. Sequence Memory: Each item in this printed test consists of a pair of test titles from the battery. The Ss are to decide which test in each pair was administered earlier. The test has 35 items (Seibert and Snow, 1965b, p. 36).

13. Position Recall I: In this printed test, S studies four pages that each contain 12 drawings. The drawings are arranged on each page in four rows and three columns. The S is given one and one-half minutes to study each page. Later, S is shown the same pictures, but in different page positions, and must recall where each was located on the original study pages (Christal, 1958).

14. Position Recall II: The same stimulus material used for variable 13 was also used for this variable. However, this test, requires S to indicate the page on which each picture appeared. (Christal, 1958).

15. Word Classification EL 17A: In this printed test, S is given four words in each item. He is required to select the word that does not belong in the same class with the others. Each of the two parts has 20 items. The Ss are given seven minutes for each part. Only part one was used for this study (Guilford and Hoepfner, 1963, p. 5).

16. Verbal Classification (Part 1): In this printed test, S is given items containing three columns of words. Words in the left column belong to one class, and words in the right column belong to another class. The Ss are required to decide which class the words in the middle column belong to. Each part consists of five items and there are two parts (Guilford and Hoepfner, 1963, p. 5).

17. Verbal Classification (Part 2): See # 16 above.

18. Word Matrix: A matrix of words is presented in each item. One of the rows has a word missing. The task is to determine how the words in each row are related, then decide what word in a set of five alternatives belongs in the blank space. The examinee is given eight and one-half minutes to answer 14 items (Guilford and Hoepfner, 1963, p. 6).

19. Verbal Analogies I (Part 1): A printed test of ability to find relations between words. In each item, S is given a pair of related words. He must complete a second pair by choosing one of four given words. The second pair should have a relation similar to that of the first pair. Each of the three parts has ten items and three minutes are allowed for each part (Guilford and Hoepfner, 1963, p. 6).

20. Verbal Analogies I (Part 2): See #19 above.

21. Word Group Naming: A printed, two-part test, with 15 items in each part. The Ss are allowed five minutes for each part. Each item consists of five words which are alike in some way. The Ss must write a name to describe each group of words (Guilford and Hoepfner, 1963, p. 11).

22. Word Grouping: This test consists of two parts, each part with two items. Each item includes a list of 12 words and the task is to arrange these into four meaningful groups. The score is based on the number of terms assigned to meaningful groups. The Ss are given three minutes to complete the test (Guilford and Hoepfner, 1963, p. 11).

23. Vocabulary Completion: In this printed test, the Ss are presented with a definition and the first letter of a word which fits the definition. The Ss must write the word that fits the given difinition. Each of the two parts has forty items and three minutes are allowed

for each part. This is a speed test developed by the Aptitudes Project at the University of Southern California.

24. Sentence Order: In this printed test each item consists of three sentences. The task is to place a "one" before the sentence that should come first, a "two" before the one which should come second, and a "three" before the one which should come last. Each of the two ten-item parts has a ten minute time limit (Guilford and Hoepfner, 1963, p. 11).

25. Film Memory I; The Ss view a short motion picture filmed at a super market check-out counter. They are then asked to record the names of as many as possible of the objects appearing in the film (Seibert and Snow, 1965b, p. 32).

26. Film Memory II: The examinee views a short motion picture filmed in the parking lot of a shopping center and is then required to write descriptions of the individuals appearing in the film. Any descriptive remarks which distinguish the individual are judged correct. Score is based on the number of correctly identified individuals (Seibert and Snow, 1965b, p. 33).

27. Film Memory III: In this film test a sidewalk encounter between two people is shown. A printed test is then administered in which true-false statements require recall of the series of actions that took place (Seibert and Snow, 1965b, p. 33).

28. Social Abstracts IA: "The film depicts the silent actions of five 'actors' in a simple social encounter. The actors, represented on the screen by different geometric figures, and the plot are adapted from a similar film constructed and used in studies of social perception by Heider and Simmel (1944). Following the film presentation, Ss complete a printed test consisting of two parts." (Seibert and Snow, 1965, p.p. 31, 32). In part A of this test questions are asked which require the recall and identification of the characters and other objects and also the order in which the actors came on and left the screen (Seibert and Snow, 1965b, p.p. 31, 32).

29. Social Abstracts IB: In this part of the test above true-false questions are asked about the so-called human actions and interactions that took place (Seibert and Snow, 1965b, p. 32).

30. Social Abstracts IIA: Another, film, similar to that of Social Abstracts I was constructed but with a different plot. A test similar to the one described in variable 28 was administered (Seibert and Snow, 1965b, p. 32).

31. Social Abstracts IIB: In this test true-false questions are asked about the human interactions that took place in Social Abstracts II (Seibert and Snow, 1965b, p. 32).

32. Successive Perception III: For each item in this film test the examinee must identify and name the picture of some common object. A series of eight overlay mats are used to block certain portions of the photograph. Thirty-two cells (1/8 of the total cells) were randomly removed from each mat which represents a 16 x 16 grid. Since there is a mat change every 42 msecs, the examinee never sees the complete photograph. However, over one second, all details of the photo appear three times (Seibert and Snow, 1965b, p. 29).

33. Successive Perception IV: The difference between this test and test 32 is that the mat changes every 625 msecs. The examinee is required to identify the common object by writing its name (Seibert and Snow, 1965b, p p. 29, 30).

34. Sequential Words: Each item in this film test presents a six letter adjective, the letters being presented one after another in rapid succession. These letters appear in the middle of the screen. The letters are separated by 62 msecs. of blank screen. Each letter appears for 31 msecs. (Seibert and Snow, 1965b, p. 28).

35. Memory for Ideas-Total: In each of the two parts of this auditory test the examinee hears an actual reading edited from a magazine article. The reading is done by an examiner and lasts approximately two minutes. After the reading the examinee is given five minutes in which to record on paper as many of the ideas expressed in the reading as he can (locally produced).

36. Auditory Word Span: In each item of this auditory test the examinee hears a list of common words, three to six letters in length. The length of the list varies from six to thirteen words in length. After each list is read the examinee is required to write the entire list on the answer sheet, in proper order. The test consists of sixteen items (locally produced).

37. Paired Words Total: In each of the two parts of this auditory test a list of 15 pairs of common words is read by the examiner twice, with the order of the pairs changed the second time they are read. After hearing the list of pairs, the examinee hears a third, test list of the first word in each of the previously read pairs. He must complete the pair by writing the second word that belongs with each first word or test word (locally produced)..

38. Phrase Completion: In each of the four parts of this auditory test the examinee hears a list of ten unrelated phrases. After the ten phrases are read the examinees are required to look at these phrases on their answer sheets and fill in the word that is missing in each phrase (locally produced).

39. Sentence Completion: In each of the four parts of this auditory test a list of five, unrelated sentences is read, These same sentences appear on the examinee's answer sheet, but with two words missing from each one. The examinee is required to fill in the missing words (locally produced).

40. Idea Sequence (Part I): In each of the two parts of this auditory test the examinee hears a brief reading. After the reading is completed, he turns to his answer sheet and is presented with ten statements or ideas which have been taken from the reading. He is required to indicate the order in which the ten ideas appeared (locally produced).

41. Idea Sequence (Part 2): See #40 above.

42. Sentence Reproduction: Each of the sixteen items of this auditory test consists of a sentence. After each sentence is read, the examinee is required to write it on his answer sheet (locally produced).

APPENDIX B

Variable Names, Descriptions, and Numbers for Study B

1. Short Term Object Memory I: A film test in which Ss are first shown a stimulus pool of nine common object photographs (camera, binoculars, boat, car, shoe, pistol, drill, chair, and pipe). In each item, six of the photographs are presented in a 2 by 3 array, appearing either for 4, 8, or 12 film frames. The 54 items, total, include 18 items at each of the three exposure durations and thus, three subtests. After the array disappears, there are two blank frames and then an empty rectangular marker appears in one of the six array positions and remains on the screen for ten frames. The Ss are to mark on their answer sheet the name of the object which appeared in the marked position. Twelve seconds are allotted for responding to each item.

2. Short Term Object Memory II: A film test very similar to variable, 1, above. It includes 54 items, the same stimulus pool of nine common object photographs, and three subtests distinguished as are subtests in variable 1. However, in each item of this test, after the array disappears, there are two blank frames, then one of the photographs appears again, centered on the screen. The Ss mark on their answer sheet the position occupied by the pictured object.

3. Successive Perception III: See variable 32 in Appendix A.

4. Successive Perception IV: See variable 33 in Appendix A.

5. Picture Identification: A film test of 20 items, with each item presenting a still photograph of some common object partially obscured behind overlaying white strips. The photograph are halftone black and white and each appears on the screen for twenty seconds. The task is similar to that of the Street Gestalt Completion test and it requires Ss to identify the object and to record its name.

6. (87) Short Term Color Memory I: A film test with format highly similar to that of variable 1, above. The Ss are first shown a stimulus pool of nine hexagonal color chips (a red, green, purple, yellow, orange, brown, gray, pink, and blue.) After these are presented and named, the 54 items of the test then present the color chips in a 2 by 3 array, holding the array on the screen either for the duration of 4, 8, or 12 frames. There are, thus, three 18 item subtests, each with a different stimulus exposure duration. In each item, after the array disappears, there are two blank film frames, then an empty hexagonal marker appears in one of the array positions. The Ss are to indicate the color which occupied the marked array position.

8. Short Term Color Memory II: This film test is similar to variable 6, above. It differs in that it marks the color to be remembered and identified by following the array with a horizontal colored bar in screen center. The Ss are then to indicate the position occupied by the color, rather than the color occupying a designated position, as in variable 6.

9. Short Term Visual Memory II: A film test of 64 items which includes eight eight-item subtests. In each item an eight letter, 4 by 2 array is presented tachistoscopically (i.e., for about 31 milliseconds) in screen center. A black circle marker appears to mark on one of the eight array positions and Ss are to record the letter occupying the designated position. The vertical bar marker may precede the array by 52 milliseconds or may follow it by 10, 94, 177, 260, 344, 428, or 510 milliseconds.

10. Short Term Visual Memory III: This film test is highly similar to variable 9, above, except that it employs two markers to designate the same array position in each test item. Simultaneously with each 4 by 2 array, a black vertical bar marker appears. Then, at intervals identical with those for variable 9, a circle marker also appears.

11. Film Sequence Memory (A): This film test presents a brief live action "story" in which a single actor executes a sequence of activities in which several of his actions are at least approximately repeated. After the "story", each of the five items presents four still pictures taken from the film. The Ss must then indicate the order in which these appeared within the story. One point is given for each picture placed in the correct position in the story sequence.

12. Film Sequence Memory (B): This is identical with variable 11, above, except that the scoring procedures have been altered. The scoring here consisted of assigning points that correspond to the magnitude of the rank order correlation between the correct sequence or order of still pictures and that given by the S.

13. Wide Range Vocabulary: See variable 2 in Appendix A.

14. Advanced Vocabulary: See variable 1 in Appendix A.

15. Color Form Recognition: This is also an adaptation of a test by Christal, entitled Color Form-Word Association. It presents a list of colored geometric forms for memorization. Afterward, S is given a larger list of colored forms from which he must recognize and select those presented previously.

16. Position Recall I: This printed test presents twelve drawings in a 3 by 4 array on each of four pages. The Ss are allowed 1 1/2 minutes to study each page. Later, the same drawings are shown randomly ordered on each page and the Ss must indicate the position each drawing occupied on the original study page.

17. Position Recall II: This printed test is a continuation based on variable 16, above. Here, though, the Ss must indicate for each drawing whether it first appeared on the first, second, third, or fourth study page.

18. (& 19) Picture Memory Span: This film test employs a pool of 22 common object photographs and in each item it presents four to ten of these pictures, as in a customary memory span test. Each photograph is on the screen for one-half second,

with one-sixth second between adjacent photographs. Response time is adjusted in accordance with the number of photographs in the series. The Ss are to record in correct order the names of the objects in each series.

20. Digit Span-Visual: Each of the 24 items in this projected slide test presents a series of digits; the series may range from four to thirteen digits. Each slide (i.e., each digit) appears for one second, with one-half second separating adjacent digits. At the close of each series, a slide says "Begin". The Ss are given 12 seconds to respond to each item and they must record the digits in the same order as presented. The test is a minor adaptation of the digit span test described by French, Ekstrom, and Price (1963, p. 27).

21. Gestalt Completion: This printed test presents ten items in each of its two parts. Each item presents a partial drawing of an object. Sections of each drawing have been deleted to make recognition of the object difficult. The Ss are to record the name of each object. The test is described in French, Ekstrom, and Price (1963, p. 11).

22. First and Last Names: See variable 11 in Appendix A.

23. Social Abstracts II (Part 1): The film depicts the silent actions of six "actors" in a simple social encounter. The actors, represented on the screen by different geometric figures, go through a short, meaningful sequence of action. Following the film presentation, Ss complete a printed test of 3 parts. In Part 1 of this test they are asked to describe the geometric figures that were actors in the film, using "shape, shading and relative size". They are then required to complete a two sentence paragraph from which key words have been deleted and which describes the "story" of the film, in effect, asking the Ss for their interpretation of the film's action.

24. Social Abstracts II (Part 2): See part 1, above. In this section of the printed test, Ss are asked to indicate (a) the order in which the actors appeared on the screen, (b) the order in which they left the screen, (c) the edge of the screen used by each actor

to enter the film; and (d) the edge of the screen used by each actor to leave the screen.

25. Social Abstracts II (Part 3): See part one, above. In the third part of the printed test the subjects are asked to answer 33 true/false questions on the film covering the content of the film including the film characters, actors and details of the scene of action.

26. Viewing Angle: The angle in degrees between a perpendicular to the projection screen center and each S's randomly assigned seating position was determined.

27. Viewing Distance: The distance in feet between the projection screen center and each S's randomly assigned seating position was determined.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
2	.16																							
3	-.05	.12																						
4	-.01	-.02	-.05																					
5	.03	.12	-.06	-.25																				
6	.18	.13	.19	.02	.04																			
7	.02	-.05	.19	.01	-.11	.10																		
8	.14	.06	.31	.06	.03	.53	.07																	
9	.06	.12	.17	.11	-.18	.56	.01	.47																
10	.10	.11	.33	-.02	.00	.53	.09	.64	.38															
11	-.01	-.08	.43	-.05	-.30	.17	.22	.27	.28	.27														
12	.03	.01	.38	-.03	-.34	.06	.07	.20	.19	.16	.55													
13	.03	-.05	.40	-.05	-.34	.19	.25	.27	.33	.20	.63	.61												
14	-.02	.00	.19	-.02	-.11	.09	.73	.14	.10	.16	.19	.13	.26											
15	.24	.53	.07	-.02	.08	.17	.05	.03	.06	.03	-.05	-.01	-.05	.15										
16	.12	.00	.18	.16	-.22	.38	.09	.56	.35	.44	.36	.50	.34	.17	.09									
17	.12	-.01	.14	.05	-.22	.33	.10	.52	.34	.39	.35	.44	.40	.17	-.02	.76								
18	.41	.10	.00	-.03	.06	.10	.09	.14	.03	.20	.06	.09	.12	.07	.08	.14	.19							
19	.25	.04	.03	.12	-.05	-.06	.11	.04	.06	.04	.20	.19	.06	.11	.08	.14	.04	.33						
20	.05	.14	.23	.08	-.08	-.00	.19	.18	.01	.13	.20	.17	.14	.09	.05	.13	.11	.06	.15					
21	.06	.08	.20	.05	-.09	.12	.11	.23	.22	.17	.18	.18	.21	.10	.00	.14	.15	.10	.03	.39				
22	-.09	.05	.05	-.00	-.06	.05	.01	.01	.11	.02	.03	.07	-.04	-.04	.11	.09	.04	-.11	.14	.29	.20			
23	.04	.24	.13	-.01	.07	.03	-.01	.08	-.00	-.03	-.08	.01	.02	.00	.10	-.07	.00	-.05	.06	.11	.10	.03		
24	.07	.23	.19	-.02	.05	.05	-.02	.18	.01	.07	-.04	.06	-.00	.01	.08	.05	.11	.03	.00	.16	.12	-.01	.66	
25	.38	.07	.02	-.08	.01	.15	.10	.11	.13	.09	.12	-.04	.13	.04	.11	-.02	.07	.35	.21	.16	.11	.01	.00	-.01

APPENDIX C

Correlation Matrix of 25 Variables Used in Study B
Rounded to Two Places