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ABSTRACT

The papers in this collection present a description of, and the results of, research in Work Unit REALISTIC. In addition to the first paper which is an overview, the three papers are: "Psychometric Determination of Relationships Among Literacy Skills and Job Proficiency," "Reading Ability, Readability, and Readership: Identifying Job-Related Reading Tasks Performed by Cooks, Clerks, and Mechanics," and "Reducing Discrepancies Between Literacy Skill Levels of Personnel and Literacy Demands of Jobs." (Author)

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Project REALISTIC: Evaluation and Modification of REAding, LIStening, and ArithmeTIC Needs in Military Jobs Having Civilian Counterparts

Thomas G. Sticht, John S. Caylor, and Richard P. Kern

HUMAN RESOURCES RESEARCH ORGANIZATION
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16. Abstracts

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Prefatory Note

These papers were presented in a symposium entitled, "Project REALISTIC: Evaluation and Modification of REAding, LIStening, and ArithmeTIC Requirements in Military Occupations Having Civilian Counterparts," at the Western Psychological Association Annual meeting, April 1970. The papers present findings from Work Unit REALISTIC, Determination of Reading, Listening, and Arithmetic Skills Required for Major Military Occupational Specialties, a program of research being performed by the Human Resources Research Organization, Division No. 3, at Presidio of Monterey, California.

Following the presentation of these papers, they were discussed by Dr. Donald Ross Green of the California Test Bureau and Mr. J. Edmond Phillips of the Department of Human Resources Development, Occupational Analysis Field Center at Los Angeles, California. Chairman of the symposium was Dr. Howard H. McFann, Director, HumRRO Division No. 3.

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OVERVIEW OF PROJECT REALISTIC

Thomas G. Sticht

In 1966, the armed services initiated Project 100,000 in which the armed services joined with other Federal agencies in the war against poverty by admitting men who were previously disqualified for service because of low mental aptitude or, in fewer cases, deficient health standards.

Among the factors leading to the implementation of Project 100,000 was a growing conviction that " . . . the prime reason many men 'fail' the aptitude tests given at the time of induction is simply that these tests are geared to the psychology of traditional, formal, classroom, teacher-paced instruction."[1] And that " . . . these tests inevitably reflect the cultural value-systems and verbal patterns of affluent American Society. That is why so many young men from poverty backgrounds do poorly in the test. It is not because they do not possess basic—and perhaps even brilliant—intelligence; but, simply because their cultural environment is so radically different from that assumed by the test designers."[1] For these reasons, it was felt that many potentially trainable men were being "screened out" of the armed services, and hence being denied the education, job skill, and health benefits of the services, for reasons of past failure, rather than being "screened in" for future development and accomplishment.

A Question of Literacy

With the implementation of Project 100,000 it was anticipated that there would be an influx of many men of marginal literacy into the services. This was confirmed by statistics in 1968 which indicated that 31% of a sample of 46,000 Project 100,000 men read at or below the fourth grade level of ability. Some 68% of these low aptitude men read at or below the sixth grade level of ability.

Because of the low reading skills of many of the Project 100,000 men, there was concern among manpower specialists that many "new standards" men might be assigned to jobs wherein the demands for reading skills might far exceed the ability of the men, and possibly lead to job failure. To reduce this possibility, information about the literacy demands of military jobs was needed. Such information is valuable for decision making regarding classification of men in job areas, for deciding on minimal levels required in adult basic education to render a person qualified for a given job, and for determining whether the literacy requirements of jobs might be altered through the redesign of reading materials, provision of audio materials, and so forth. Such redesign of materials could possibly reduce entrance requirements in literacy skills so that persons deficient in such skills could be effectively utilized, perhaps while receiving training to improve their literacy skills, and thus prepare themselves for higher level job positions.

Project REALISTIC

To obtain information concerning the literacy demands of military jobs, Work Unit REALISTIC was initiated in 1968. REALISTIC is an acronym based upon the three literacy skill areas studied—REAding, LIStening, and ArithmeTIC. The general objectives

[1] Address by Robert S. McNamara, former Secretary of Defense, to the Veterans of Foreign Wars, New York, 22 August 1966.

of Work Unit REALISTIC, which is currently in progress, are to (a) provide information concerning the demands for reading, listening, and arithmetic skills in several major military occupational specialties (MOSs), and (b) provide information and suggestions for reducing discrepancies between personnel literacy skill levels and the literacy skill levels required by the job.

To satisfy the first objective, we are examining relationships between the reading, listening, and arithmetic skills of job incumbents and their performance on four different indices of job proficiency. As Figure 1 indicates, the proficiency indices we are using include proficiency on job-related reading tasks, proficiency on "hands-on" job sample performance tests, proficiency on job knowledge (paper-and-pencil) tests, and proficiency as indexed by supervisor ratings.

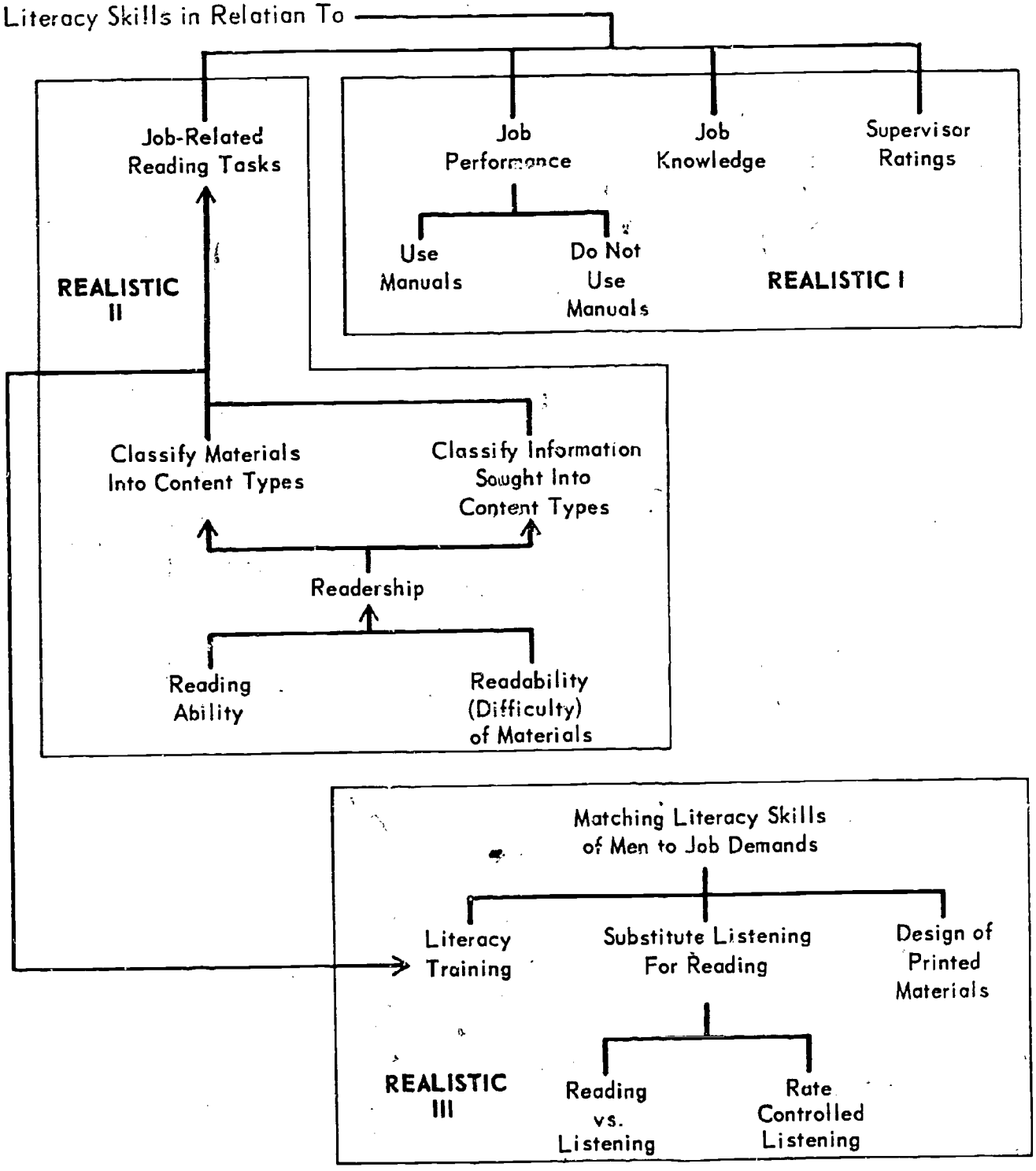
The relationships between literacy skills and proficiency on the job performance test, knowledge test, and supervisor's ratings are being performed under REALISTIC I. Data from this effort follow in the first paper in this series, by Dr. Caylor, Dr. Caylor's "Psychometric Determination of Relationships Between Literacy Skills and Job Performance."

Relationships between literacy skills and performance on job-related reading tasks are being explored under REALISTIC II. Activities under REALISTIC II have been (or are being) accomplished to identify job-related reading tasks. These activities will be discussed in the second paper by Dr. Kern on "Reading Ability, Readability and Readership: Identifying Job-Related Reading Tasks Performed by Cooks, Clerks, and Mechanics."

The third sub-unit of REALISTIC attempts to identify information and to make suggestions useful for reducing gaps that may exist between an individual's literacy skill level and the demands of the job for these skills. This sub-unit has involved some experimental work, primarily in regard to listening, but is otherwise mostly a literature survey type of effort. As indicated in Figure 1, we have considered reducing discrepancies between the skills people have and the skills needed for the job by either modifying the person through literacy training, or by modifying the job demands. In the latter case, we have considered the substitution of listening for reading demands, and the redesign of job and training aids to make them less demanding of literacy skills. These topics are discussed at greater length in the last paper "Reducing Discrepancies Between Literacy Skill Levels of Personnel and Literacy Demands of Jobs."

The emphasis of this research upon identifying genuine educational requirements of jobs, as a step towards redressing the social ills resulting from inflated credential requirements, represents a major shift in the applications of psychometric and behavioral analysis techniques for matching people and jobs.

Organizational Chart for Work Unit REALISTIC



In Sub-unit REALISTIC I, literacy skills are related to performance on job performance, knowledge, and supervisor ratings. In REALISTIC II, literacy skills are related to job-related reading tasks. In REALISTIC III, methods of matching literacy skills of men to literacy demands of jobs are considered.

Figure 1

PSYCHOMETRIC DETERMINATION OF RELATIONSHIPS AMONG LITERACY SKILLS AND JOB PERFORMANCE

John S. Caylor

One of the primary objectives of Work Unit REALISTIC is to indicate to what extent reading, listening, and arithmetic skills may facilitate or, in some manner, enhance job proficiency. To contribute to the accomplishment of this objective, REALISTIC I has followed a model of psychometric research frequently used in designing personnel selection tests, known as a *concurrent validity* study (Dunnette and Kirchner, 1, pp. 35-39). In such a study, a procedure is followed in which men who are working on a job of concern are tested on some skill (or personality trait, set of attitudes, environmental background characteristics, etc.) or area of interest and some measure of the man's proficiency on the job.

The object then, is to determine how well the measures of the man's skill levels predict (are related to) his job proficiency. Knowing this, it is frequently possible to improve the likelihood of selecting men who will perform satisfactorily on the job by administering the skills test before a man is hired. If his score is too low, poor job proficiency would be predicted, and hence the man may be rejected as a candidate for the job.

Defining Literacy

In our application of the model described above in REALISTIC I, we are examining relationships between literacy skill levels of job incumbents and various measures of their job proficiency. Before dealing with this procedure in detail, I want to give some general consideration to the definition of "literacy" skill. Obviously this refers to reading ability, but what is not so obvious is what constitutes "reading ability." Most reading experts today recognize that reading is a complex of skills and abilities. It is also generally recognized that reading involves the ability to translate printed symbols into speech or auditory symbols, and that, in the early stages of reading training, most readers silently speak the words on the printed page to themselves. As we advance in reading skill, there appears to be less need to subvocalize the words, so that there is a more direct decoding of printed symbols into meaning.

Of particular concern to us was the fact that listening ability typically precedes reading ability, and, in fact, the reading process is usually built upon a structure of listening ability. Because of this we have conjectured that some of the lower aptitude men might not be able to learn a job well by reading, but would be able to learn by listening or show-and-tell. Their primary literacy defect might be one of lack of skill in decoding printed symbolism. Thus, we have decided to include listening skill as a subcomponent of "literacy." Thus, the ability to read well presupposes and subsumes the ability to listen well. This idea is discussed further, below. Of secondary interest, we have included arithmetic skill as a measure of a specific literacy skill consisting of the ability to receive and process information in a highly specific, formal, and rigorous language.

Rationale for This Research

The question may be raised as to why we might expect to find relationships between literacy skills and job proficiency. Our research is premised on the notion that

language skills (including reading and listening) are primary means of learning about job tasks, their requirements, and how to accomplish them. Thus, in the formal training programs which precede most jobs, information (vicarious experience) is acquired in large part through reading and/or listening. Then, in day-by-day performance of the job, some tasks are inherently reading tasks, while many others which make no immediate demands on reading skills may have been previously learned by reading, and hence have an indirect requirement for reading. Other jobs, however, may be learned by asking co-workers or supervisors. Such jobs, while not demanding reading skills, make a demand on listening skills.

Thus, we can expect that, to the extent that job tasks make any demands on language skills, their successful performance will be related to some degree to measures of literacy skill. Yet it must be emphasized that being able to exercise literacy skills to obtain information about what to do and how to do it is only one (complex) factor in the set of factors (e.g., personality, attitudes) that determine job proficiency. We do not expect that knowledge of literacy skills will permit us to account for all, or even the greater part of, the differences in job proficiency observed in a broad spectrum of job incumbents.

RESEARCH DESIGN AND PROCEDURES

REALISTIC I is concerned with the relationships between each of the three literacy skill measures (reading, listening, and arithmetic) and each of the three job proficiency measures (job knowledge, job performance, and supervisor ratings) in each of the four Military Occupational Specialties (MOSs).

The subjects were men working on the job in each MOS. These men were being studied under an ongoing HumRRO research program, Work Unit UTILITY (Vineberg and Taylor, 2) and the REALISTIC I literacy measurement requirements were appended to that effort.[1] In keeping with the design for UTILITY, subjects for REALISTIC I were high (AFQT $>$ 30) and low (AFQT $\leq$ 30) aptitude men who were paired with regard to the amount of time they had worked on the job. However, for the purposes of the analyses presented in this paper, the only import of this pairing procedure is that the lower aptitude men are overrepresented in our sample. For this reason the figures we present for literacy skill levels should not be construed as parameters of the general Army population.

The four Military Occupational Specialties (jobs) which we studied (cook, supply-man, vehicle mechanic, and tank crewman) were selected on several criteria:

(1) They represent a range of types of job skills.

(2) They are high density jobs to which a substantial portion of low aptitude men are assigned.

(3) Except for the tank crewman, these Army jobs have close counterparts in the other services as well as in the civilian society.

The nature of these jobs is largely self-apparent: Cooks prepare food in accordance with a master menu and detailed recipes; supply clerks requisition and issue supplies and maintain records, primarily clerical tasks; mechanics diagnose and repair motor vehicles; and the tank crewmen operate the tank and its weapons systems, a substantially procedural set of tasks.

These jobs differ widely in the number of job-related reading tasks involved in job performance, as well as in the literacy and arithmetic requirements for entry. For each,

[1] The cooperation of Dr. Robert Vineberg and Dr. Elaine Taylor and the members of their research team made the REALISTIC I research possible.

the training program contains a large amount of reading material and, for each, extensive manuals are available as part of the job equipment.

Literacy and Other Predictor Measures

Reading—To assess reading skills, the Survey of Reading Achievement, Junior High Level (grades 7-9) developed by the California Test Bureau was used. This test was chosen for the following reasons: (a) It provides a composite index of reading skills expressed in school grade equivalents. (b) Grade placement norms span a wide range of abilities (grades 4.0-14.5), a necessary characteristic when testing men whose AFQT scores range from the 10th to the 99th centile. (c) It has a testing time of 40 minutes, which could be accommodated within the UTILITY testing schedule.

Arithmetic—Arithmetic skills were measured by use of the Survey of Arithmetic Achievement, Junior High Level, California Test Bureau, a companion test to the reading instrument and selection for the same reasons.

Listening—Listening skills were measured by a non-standardized experimental test constructed for this project. It consists of three short descriptive passages presented orally on tape. After each passage, 12 questions, calling for information contained in the passage, are read aloud twice, and after each question the subject is required to give his single word or short phrase answer. (When the passages are regarded as reading material, they fall at the 6th, 7th, and 14th grade level of reading difficulty.)

AFQT—The Armed Forces Qualification Test (AFQT) is a measure of trainability which is used as a "screening" measure for acceptance into all our armed services. It consists of 25 multiple-choice items in each of four areas: *Verbal*, which is vocabulary; *Arithmetic*, which is simple word problems; *Shop Mechanics*, which is matching of line drawing of tools and mechanical equipment according to function; and *Pattern Analysis* or form perception. Corrected for guessing, scores from our four sections are pooled and converted to percentile ranks. The Project 100,000 "New Standards" men mentioned by Dr. Sticht in the "Overview of Project REALISTIC" fall primarily in the next-to-bottom decile.

Maze Test—The Maze Test is an experimental group-administered test devised by Dr. Bernard Rimland of the U.S. Navy Personnel Research Activity at San Diego. It consists of a set of printed Hampton Mazes, each with five numbered entry points and one interior goal area. Provided with a pencil, the subjects are required to determine, for each starting point, whether the goal can be reached from that starting point.

Job Proficiency Measures

The Job Proficiency Measures were developed by the Work Unit UTILITY staff in conjunction with Army content experts (3). There were three different measures of job proficiency as follows:

Job Knowledge — The job knowledge measures were multiple choice tests (ranging from 75 to 96 items in length) for different job areas which sampled job knowledge content deemed by experienced job occupants to be important for competently fulfilling the job. The test items were selected for relevance to job performance, not to school training. Since these were paper-and-pencil tests, the need for reading skills was inherent in the task.

Job Performance — Job performance tests were constructed so as to represent the key tasks, in terms of essentiality, frequency, and urgency, typically performed by men in the jobs. For the most part they do not directly test reading skills; however, they do represent what men *do* in these jobs. Also, the tests were not free of verbal demands since the instructions were presented orally. Hence the listening component of literacy was inherent in the testing situation, though not necessarily involved in the job task per se.

The tests were administered by trained testing crews, at special test sites, using full normal job equipment. Cooks cooked on field ranges, supplymen worked in a fully equipped mock-up supply room, mechanics repaired trucks and tanks, armor crewmen performed in tanks, simulating only the firing of weapons. In short, the job performance tests were hands-on samples of job tasks performed in a given career field.

Supervisor's Questionnaire — Each subject was rated by his immediate supervisor who was directly instructed by the study staff that his ratings would be used for research purposes only and would have no administrative effect on the subject. Ratings were obtained on two rating scales: (a) the standard Army Enlisted Evaluation Report, consisting of five or six point scale ratings on 14 attributes such as conduct, job performance, cooperativeness, reliability, job knowledge, and responsibility; and (b) an experimental scale of 12 items such as, "Does he need more supervision on the job than most?" and "If you could, would you just as soon replace him?" Scores of the two rating scales have been totaled to provide the supervisory rating measure of job proficiency in this study.

RESULTS

Table 1 shows the percentage distribution of our subjects by reading grade, for each MOS separately, and for the pooled samples. A full range of reading ability is represented and the medians cluster around the eighth grade level, which is considered by many today as the defining point of functional literacy. Despite the deliberate, systematic over-sampling of lower aptitude, Category IV men in this study, we find a considerably smaller percentage of men at the lower reading levels than would be expected in light of data currently reported for "New Standards," lower aptitude men. This may be due in part to the requirements for classification in these MOSs and, perhaps, to differential attrition throughout the training and assignment sequence.

Table 2 presents an intercorrelation matrix of a set of our predictor variables (and some additional ones from Work Unit UTILITY) computed from the pooled sample of all

Table 1

Percentage Distribution of Subjects by Reading Grade Level

Reading Grade	Tank Crewman	Mechanic	Supplyman	Cook	Total
4.0 - 4.9	1.5	1.5	0.5	4.2	1.9
5.0 - 5.9	6.0	7.6	2.7	11.6	6.9
6.0 - 6.9	13.5	14.6	12.9	17.4	14.6
7.0 - 7.9	19.8	21.5	19.4	23.4	21.0
8.0 - 8.9	16.7	14.1	15.2	13.7	14.9
9.0 - 9.9	19.3	17.9	21.7	10.8	17.5
10.0 - 10.9	11.7	11.4	11.9	7.9	10.8
11.0 - 11.9	2.9	2.8	4.5	3.9	3.5
12.0 - 12.9	5.2	7.1	5.5	3.2	5.3
13.0 & Over	3.4	1.5	5.7	3.9	3.6
Total Percent	100.0	100.0	100.0	100.0	100.0
N	384	396	402	380	1562

Table 2

Intercorrelation Matrix of Predictors—Pooled Sample

	1	2	3	4	5	6	7	8	9
1 Reading	x	.54	.69	.65	−.04	.30	.54	.59	.29
2 Listening	.54	x	.43	.47	.00	.12	.40	.55	.25
3 Arithmetic	.69	.43	x	.61	−.10	.34	.61	.57	.30
4 AFQT	.65	.47	.61	x	.01	.26	.60	.53	.30
5 Age	−.04	.00	−.10	.01	x	.01	−.14	−.16	−.07
5 Education	.30	.12	.34	.26	.01	x	.22	.22	.06
7 D-48	.54	.40	.61	.60	−.14	.22	x	.56	.41
8 Oral Directions	.59	.55	.57	.53	−.16	.22	.56	x	.35
9 Maze	.29	.25	.30	.30	−.07	.06	.41	.35	x

four MOSs. Omitted from this table are a large number of Army Classification Battery scores which have a pattern of relationships similar to that of the AFQT. The last three tests listed do not rely on reading. The D-48 consists essentially of number series tasks in which the series to be completed is presented, not in conventional numerals, but by means of a series of standard dominoes. The Oral Directions test gives just oral directions, but they are not simple. One of the easier items: "If A comes after B in the alphabet, make an X in the third square, but if B comes after A, make an X in the last circle." The Maze test has been previously described.

Examining Table 2, one pattern of note is that reading, arithmetic, and AFQT, all tests requiring reading ability, are substantially intercorrelated—which is not surprising since one-quarter of the AFQT is vocabulary and one-quarter arithmetic word problems. These three tests show similar profiles over the other predictors. Listening, a verbal but not reading test, presents a somewhat attenuated version of this pattern. Other data in Table 2 will be referred to later.

Before turning to the measures of job proficiency in Table 3, it should be noted that we have found an extremely wide range of job experience in our subjects and substantial relationships between experience and job proficiency. Our samples contain men with from less than one month to more than 15 years job experience. Mean experience is 28 months while the median is only 13. In order to remove the effects of experience from our proficiency measures, as well as to deal with problems of curvilinearity of regression and heteroscedasticity, all job proficiency measures were adjusted. This involved performing a log transformation of the time-on-the-job experience measures,

Table 3

Intercorrelations Among Adjusted Job Proficiency Measures

	Knowledge With Performance	Knowledge With Supervisor Ratings	Performance With Supervisor Ratings
Tank Crewman	.49	.20	.14
Mechanic	.49	.17	.15
Supplyman	.64	.27	.23
Cook	.47	.28	.19

and computing the regression equation for log time-on-the-job and job proficiency. Following this, the regression-based score predicted from job experience alone was computed for each man. This score was then subtracted from the raw proficiency measures. Our adjusted proficiency scores, then, are individual deviations from that value of job proficiency attributable to experience and thus have been freed of the differential effects of job experience.

The interrelationships among the adjusted job proficiency measures for each MOS are shown in Table 3. The relationships among proficiency measures are consistent from one job to another although the commonality of these three aspects of job proficiency is not large. The higher relationships among job knowledge and job performance in the case of the Supply MOS are attributed to the greater similarity of knowledge and performance in this clerical job.

Figure 1 presents the relationships between reading grade level and job proficiency measures for each of the four MOSs. The ordinate shows the percentage of men in a given reading ability category scoring above an arbitrary criterion level which was set as approximately the upper 25% of all subjects in that MOS on that proficiency measure.

The findings on the job knowledge test for tank crewmen show that none of the low readers (grade level 4.0-6.9) reached the upper 25% of the people criterion level, 18% of the middle level readers (grade level 7.0-8.0) reached this level of proficiency, and 38% of the high reading level subjects (reading grade level 9.0 and above) fell in the top quarter of our subjects. Parallel findings are shown for the job performance measure and for supervisor's ratings. As exemplified in Figure 1, our results consistently show that, in all MOSs, reading is most strongly related to job knowledge, less closely related to the job sample measure, and in general, barely, if at all, related to supervisory ratings. With minor fluctuations, this figure provides a representative picture of our findings with the other literacy variables and with AFQT.

Table 4 provides a general summary of our findings. The tabled values are correlation coefficients measuring the relationships between job proficiency measures and literacy variables, with other variables included as bench marks. As indicated previously, relationships of our literacy variables are regularly higher with the written knowledge tests than with the job performance measures—except for the Supply MOS in which the job is clerical and the performance test is written. In all jobs, the relationship with supervisor's ratings is trivial. In our data the substitution of any of 12 other aptitude and achievement variables for these literacy variables would make only minor changes in this general pattern of relationships with the job proficiency measures.

The overall picture of our findings, then, is one of a positive correlational manifold, among a variety of psychometric measures, among measures of different aspects of job proficiency, and between the literacy and psychometric variables and both job knowledge and performance. These relationships obtain, with reassuring consistency in each of the four MOSs despite their different job requirements. Reading and listening, which have been considered as a specific language or literacy skill, show a consistent moderate relationship with job knowledge in a variety of jobs, and a similar but somewhat lower relationship with job performance. So, likewise, does AFQT (and a range of other psychometric measures) which is commonly taken as a measure of trainability, of general aptitude, and of "intelligence."

Percentage at Each Reading Grade Level Who Scored in the top 25% of Their Job Group on Each Proficiency Measure

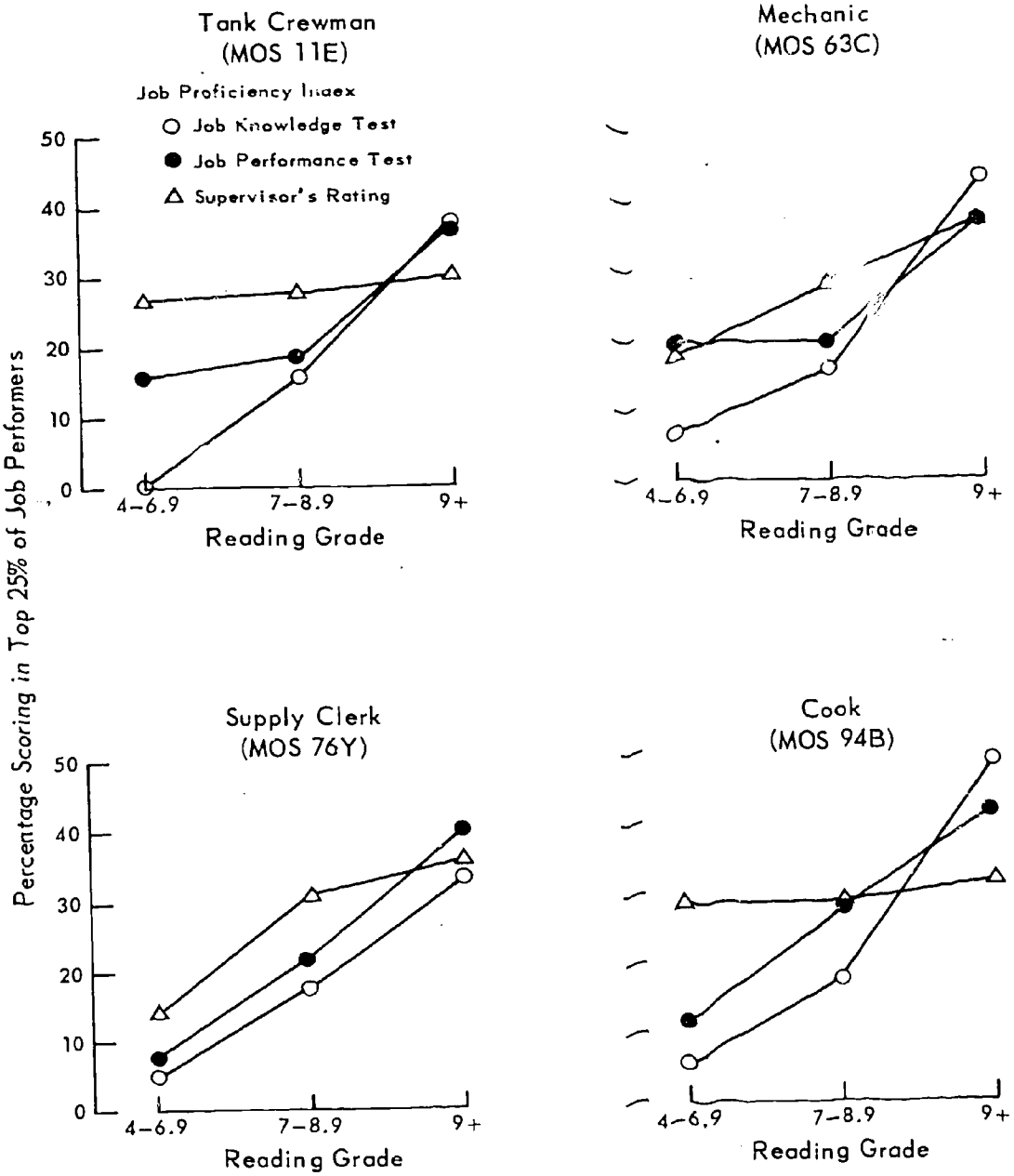


Figure 1

Table 4

Correlation Between Predictors and Job Proficiency Measures

MOS	Predictor	Job Proficiency Index		
		Job Knowledge	Job Performance	Supervisor Ratings
Tank Crewman	AFQT	.55	.37	.07
	Reading	.57	.32	.06
	Listening	.53	.29	.06
	Oral Directions	.47	.35	.04
	Maze	.29	.21	.10
Mechanic	AFQT	.44	.32	.16
	Reading	.47	.26	.17
	Listening	.40	.38	.09
	Oral Directions	.30	.25	.05
	Maze	.13	.10	.00
Supplyman	AFQT	.36	.37	.09
	Reading	.40	.40	.10
	Listening	.35	.42	.11
	Oral Directions	.29	.34	.07
	Maze	.17	.19	.14
Cook	AFQT	.49	.37	.15
	Reading	.56	.34	.11
	Listening	.39	.28	.07
	Oral Directions	.44	.32	.13
	Maze	.20	.21	.05

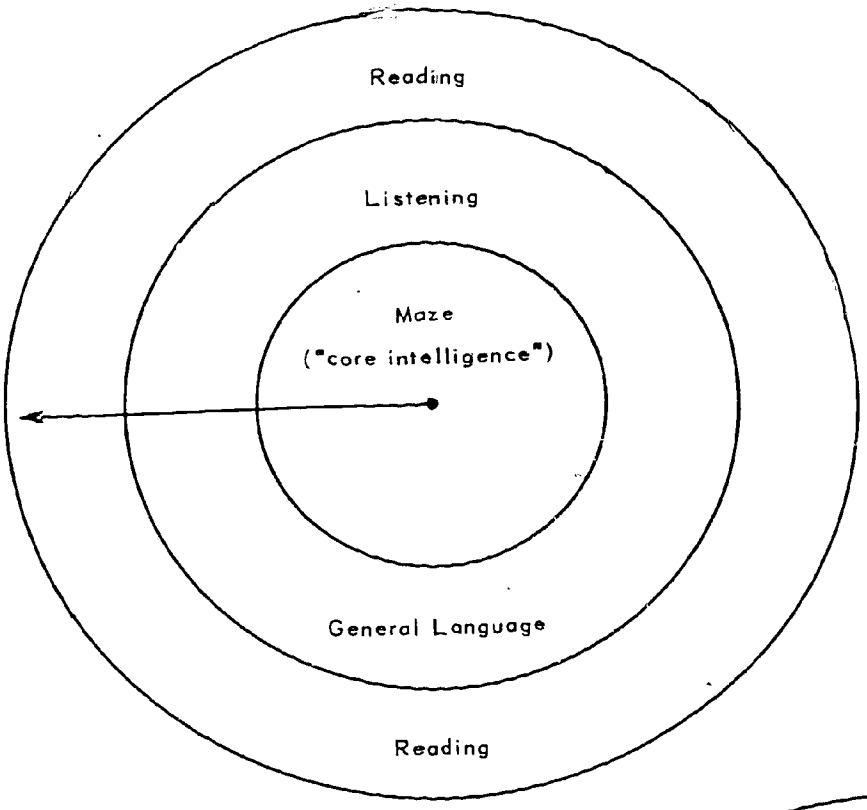
Models to Aid Memory

To help us integrate and hold the information in Table 4 in our cognitive structure, we have found it useful to contemplate a simple developmental model of human ability. This model, schematized in Part A of Figure 2, has as its first stage and core the variable of simple, preliterate basic intelligence or ability to deal with the environment prior to and independent of language development. But man is uniquely a language-using animal and this core rapidly becomes contained in a spoken language ability through which the bulk of his congress with the world is mediated. Circumscribing this spoken language competency is the less uniformly developed skill of ability to deal with the world through written language—in our application, by reading. We see these layers as interacting but, in their developmental order of acquisition, each in turn sets some limits on how fast and to what level the succeeding ability can develop.

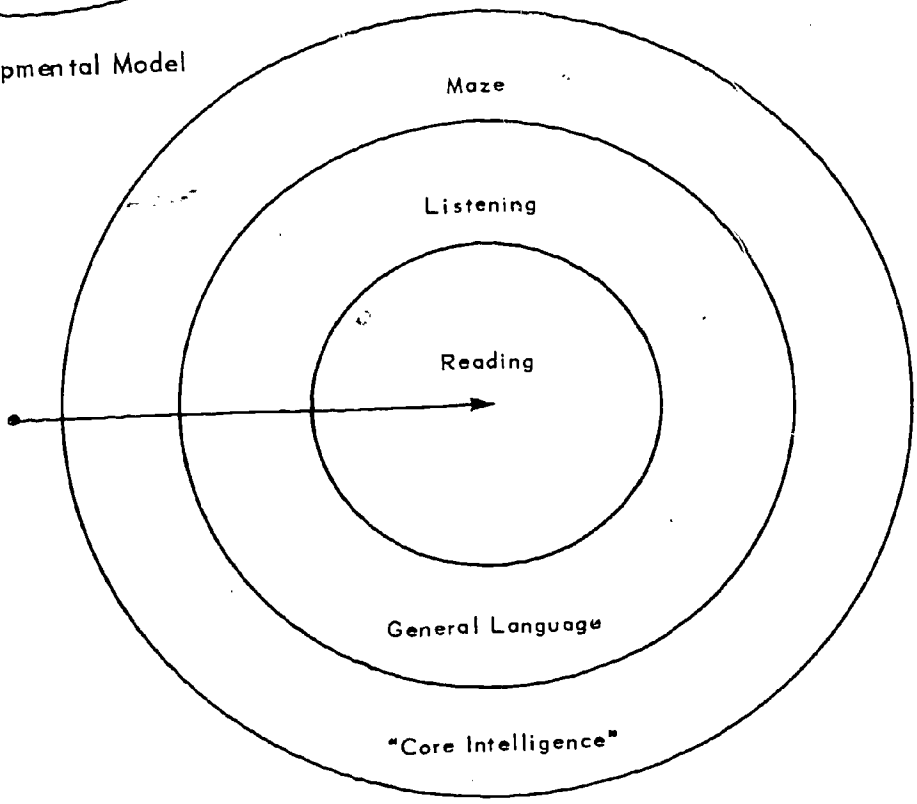
It seems tenable to us that individual differences in the non-language ability to make fundamental discriminations and associations could be or are associated with similar differences in the ability to comprehend subtle and complicated spoken material, and this in turn could be associated with differences in the ability to comprehend and profit by information presented by the printed word.

The major value of this developmental "model" lies in the necessity to turn it inside-out when we use it as a measurement model (Figure 2, Part B). This places reading skill at the center, surrounded by listening (language) which in turn is encompassed by the essentially non-language intelligence factor. In order to measure reading *comprehension* (setting aside fundamental decoding skills involved in the acquisition of

Developmental and Measurement Models of the Development of Reading Skill



A. Developmental Model



B. Measurement Model

Figure 2

reading skill) at the core of the measurement model, we are forced, wish it or not, to do so by observing responses which are mediated not only by reading skill, but, also by the general language skill (indexed by listening in our work) and the "general intelligence," non-language factor (indexed by the Maze in this research). Ascertaining listening comprehension is one step simpler but inevitably is the result of an unknown combination of the language and non-language factors.

Such considerations have led us to regard as futile any attempts to measure pure reading *comprehension*, freed of the effects of intelligence by partialing out aptitude scores which are so generally measured by a test whose material must be read. We have, rather, ordered our variables into three categories:

(1) Variables requiring non-language (or low language) ability *plus* aural/oral language ability *plus* reading language ability, such as our reading measure and AFQT.

(2) Variables requiring non-language ability *plus* aural/oral language ability, such as our listening measure, the Oral Directions Test; and perhaps the D-48 Test.

(3) Variables requiring little or no language ability in the mediation of the response. This goal has long proven elusive to psychometricians and we have settled on the group Maze Test as an approximate exemplar.

Support is given this position by two sets of findings. One set (Table 5) indicates that variables requiring reading (reading test, AFQT, arithmetic test) are more highly related to years of education, than are the listening variables (listening test, Oral Directions Test), with the Maze Test performance being least related to education.

Table 5

Predictor Relationships With Education

	Education			
	Tank Crewman	Mechanic	Supplyman	Cook
Reading	.30	.33	.29	.32
Oral Directions	.18	.26	.27	.23
Listening	.19	.15	.16	.14
Maze	-.01	.09	.07	.12
AFQT	.28	.24	.29	.26
Arithmetic	.37	.26	.33	.32

The second set of findings in support of our "model" is shown in Table 4. These data indicate that the job knowledge tests, which require reading, are indeed most closely related to reading and AFQT, less closely related to the listening tests, and least to the low-language Maze Test. This pattern is found in each MOS. However, few, if any, of the job performance tasks contain specific reading requirements. Here the correlations with the reading tests (and AFQT) shrink appreciably from those found with job knowledge. Similarly, the relationships between the listening variables and job performance are smaller than with job knowledge—but the reduction is less and we find both listening and reading level variables about equally associated with, or predictive of, hands-on job performance not involving reading. The one exception to this pattern is the Supply MOS, a clerical job in which performance tasks make as heavy demands as does its job knowledge test. Finally, the non-language Maze measure maintains its lower relationship essentially unchanged between the knowledge test requiring reading and the hands-on performance measure.

Intelligence, aptitude, ability to learn—however labeled, these seem to contain a significant language factor. Reading comprehension seems usefully viewed as being composed of general, language-free ability plus, or multiplied by, aural/oral language ability, and finally by the specific language and/or perceptual motor skills of reading.

Measures of reading comprehension, or of many otherwise identified skills that are measured through the use of reading, seem necessarily to incorporate general language ability whether wanted or not and thus tend to be measuring a common component. With this in mind, Table 6 presents multiple correlations of progressively inclusive sets of variables with job knowledge and performance. Although the correlations are increased by the use of additional predictors, the increases are not large and would be expected to shrink on cross-validation. Thus, with our data, there seems to be an indication that, when an inclusive measure of reading comprehension is used (e.g., our reading test, AFQT) to predict job proficiency, little additional predictive power is to be expected by adding further literacy measures (e.g.. ODT[1], Listening) or "intelligence" measures (e.g., Maze) to the predictive formula. This appears to apply particularly for predicting proficiency on hands-on, job sample performance tests.

Table 6

Multiple Correlations

	Tank Crewman		Mechanic		Supplyman		Cook	
	Knowledge	Performance	Knowledge	Performance	Knowledge	Performance	Knowledge	Performance
AFQT	.55	.37	.44	.32	.36	.37	.49	.37
Reading	.57	.32	.47	.26	.40	.40	.56	.34
Listening	.53	.29	.40	.38	.35	.42	.39	.28
Reading Listening Arithmetic	.63	.36	.51	.39	.44	.48	.57	.37
Reading Listening Arithmetic AFQT	.65	.39	.52	.42	.45	.48	.59	.40
Reading Listening Arithmetic AFQT D-48 Oral Directions Maze Race	.65	.42	.52	.42	.47	.50	.59	.42

[1] Oral Directions Test (ODT).

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READING ABILITY, READABILITY, AND READERSHIP: IDENTIFYING JOB-RELATED READING TASKS PERFORMED BY COOKS, CLERKS, AND MECHANICS

Richard P. Kern

Data from REALISTIC II on the relationships between personnel reading skills and their use of printed materials on the job will be given in this paper. As suggested in Dr. Caylor's paper, preceding this one, the low reading skills of many Project 100,000 men have led manpower specialists to become concerned that they might be assigned to jobs where the reading demands are too great, with resulting losses in job and personnel effectiveness.

To suggest a basis for these concerns, in Figure 1, for three job positions, the average reading difficulty level of the job's printed materials is compared with the average reading achievement level of high and low aptitude personnel in that job position. Before I discuss this figure and how we obtained the data, let me emphasize the similarity between the manpower utilization concern addressed by the military's Project 100,000 and current manpower utilization concerns in civilian businesses and industry.

In Figure 1, the reading achievement levels for two groups of personnel are identified for each job position and labeled as "high" and "low" aptitude men. The high aptitude men reflect an estimate of the average reading achievement level of personnel who were being accepted into the job positions under standard personnel selection procedures. The low aptitude personnel represent a subpopulation of men, many of whom would have been screened out—that is, not "hired"—under these standard selection procedures. From this perspective, Figure 1 may reflect a situation similar to that of large civilian employers who are interested in training and employing individuals they have previously turned away on the basis of general aptitude or low educational background.

Now to the origin of the data in Figure 1, and the relationships between readability and reading achievement levels. The three job positions studied were chosen because fairly large numbers of the lower aptitude men are expected to be assigned to them, and they also represent jobs in which the skills, knowledges, and duties involved have a high degree of similarity in civilian counterparts.

To determine the difficulty levels (readability) of printed materials in the three job areas, we had first to identify printed materials actually used on the job. Interviews were conducted with job incumbents in each of the three military occupational specialties (MOSs). For the purpose of estimating the difficulty levels of the reading materials, copies of the publications identified during these interviews were obtained. Copies of Mechanic's and Cook's publications which were cited five or more times were included. For the Supplyman's job, where few publications were cited, a copy of the most frequently cited reference was obtained, along with copies of other publications which supply sergeants reported to be of importance and in general use in the supply field.

The Flesch readability formula as modified by Farr, Jenkins, and Paterson (1) was used to assess the reading difficulty levels of the job publications. The formula was applied to a 10% sample of the pages in each of the publications. For instance, if a publication contained 100 pages, every tenth page was included in the sample. Only those pages were used which contained at least one sample of a 100-word section of connected

Comparison of Readability of Publications in Three Job Fields With Reading Abilities of Men in Those Jobs

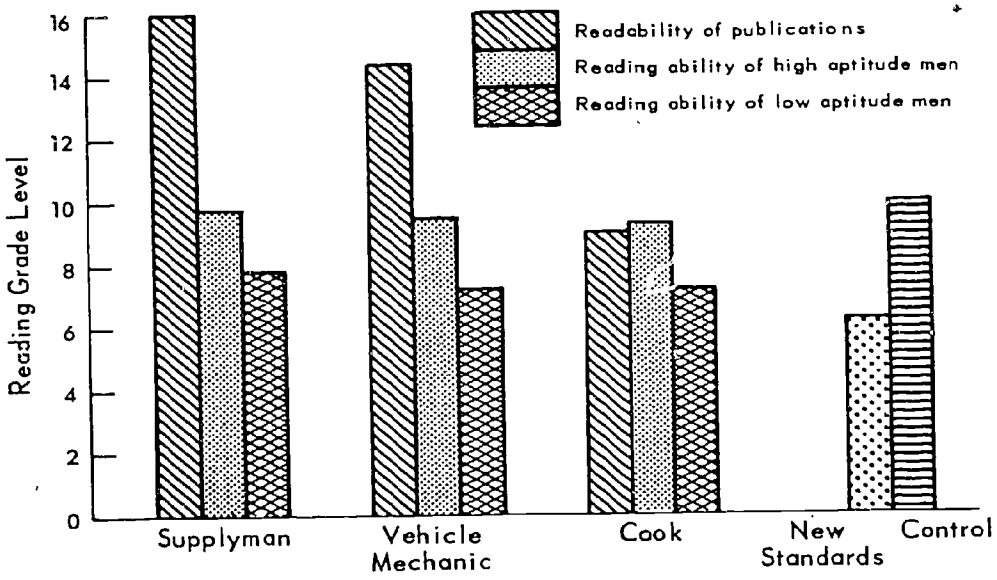

Figure 1

discourse; thus, if the tenth page contained only an illustration, or a recipe, one of the adjacent pages containing a 100-word sample of discourse was evaluated.

The average grade level of difficulty was computed for each publication, and the average of these averages was then computed for each MOS. The readability analyses are summarized in Table 1, showing the total number of publications and pages sampled in each MOS, the range of reading difficulty levels found over all pages, and the average grade level of readability of materials in the MOSs.

Table 1

Readability Scores for Publications in Three Army MOSs

MOS	Number of Publications	Number of Pages Sampled	Range of Flesch Readability Levels (SGE)[a]	Average Readability (SGE)
76Y Supplyman	11	64	8.5–16+	16+
63C Vehicle Mechanic	8	244	7.0–16+	14.5
94B Cook	6	100	6.0–14.5	9.0

[a]SGE = School Grade Equivalent

The data of Table 1 show a wide range of difficulty levels for the materials in each MOS. Additional data indicated that of the 11 publications studied in the Supplyman MOS, eight had average readability scores of 16 +, with the remaining three scoring between grade 13 and grade 16 (14.5 on the average). Next to Supply, the Mechanic (MOS 63C) publications were most uniformly difficult with seven of the eight having an average readability score of 14.5. The Cooks in MOS 94B cited the least difficult material. All of the six publications are recipe books designed, apparently, with the users in mind. As indicated below, it is in the Cooks' MOS that the materials most closely match the skill levels of the personnel.

In Figure 1, we have attempted to portray the problem that reading materials in these job positions may pose for the high and the low aptitude groups studied by plotting average difficulty level of job materials alongside the average reading achievement levels of the personnel. The average reading grade level scores for the high and low aptitude job incumbents were obtained in the course of the work reported in the preceding paper by Dr. Caylor.

At the right of Figure 1, the "New Standards" bar represents the median reading ability of 46,000 new standards men (i.e., assessed under Project 100,000 with AFQT scores in the 10-15 range), and the "Control" bar represents the median reading ability of non-new standards men. These reading ability data are from a Department of Defense report (2) summarizing data concerning Project 100,000, and were obtained using a different test (Metropolitan Achievement Test, Intermediate Level) than used in the present research to assess the skill levels of the men in the three MOSs (Survey of Reading Achievement, Junior High Level, California Test Bureau). The similarity of assessed reading skill levels obtained with the two different tests under widely differing circumstances suggests that the estimates of reading skills for each MOS presented in Figure 1 are accurate.

Making the visual comparisons between readability and reading ability suggested in Figure 1, we note that the difficulty level of printed materials for the supply and mechanic job positions exceeds the average reading achievement levels of the high aptitude job incumbents by about five to six grade-level points. The discrepancy is even greater, of course, for the low aptitude supplymen and mechanics, ranging around eight grade-level points. For the cooks, however, difficulty level of the printed job materials and the reading achievement level of the high aptitude personnel are almost numerically matched. The low aptitude cooks present an average reading achievement level that falls only about two grade level points below the reading difficulty level of their materials.[1]

If the readability formula provides even a rough index of the difficulty of the materials, then Figure 1 suggests that both high and low aptitude personnel would experience considerable difficulty in reading and comprehending the supplymen's and mechanic's job materials.

In general, the greater the gap between readability and reading ability, the less comprehensible the materials are likely to be for the man on the job (6). It is also reasonable to suppose that the gap between the reading ability of the men in an MOS and the readability of materials may influence the extent to which men attempt to use job-related printed materials. Data bearing on the relationships between reading ability, readability of materials, and readership of materials (i.e., the extent of use of printed materials by men on the job) were also obtained by means of the on-the-job interview.

[1] It is recognized that the metric systems underlying the readability and reading ability measures are not the same, and, strictly speaking, the two scales should not be depicted on the same ordinate. Nonetheless, this manner of presentation, when regarded with proper caution, dramatizes the differences between materials and men.

Readability, Reading Ability, and Readership

The questions of concern in the analyses are: Who reads the printed materials and to what extent do they use them?

Before presenting these data it would be well to summarize the interview procedure used in obtaining this information as well as the data concerning the printed materials.

Job-related reading materials were identified by means of a structured interview administered to men in the target MOSs at their job locations. Table 2 summarizes the main items of information obtained with the structured interview. This included personal data, such as name and unit. We also sought information about the kinds of job activities the man usually performed by asking him to describe a "typical work day."

Table 2

Structured On-the-Job Interview to Identify Job-Related Literacy Materials

Personal Data (Name, Unit, etc.)
Describe Typical Work Day
Five Examples of the Use of Information Sources Other Than Printed Materials
Five Examples of Use of Printed Materials
Obtain the Material
Locate the Exact Page Referred to
Five Examples of Duties or Tasks Performed Not Involving Use of Printed Materials
Five Examples of the Use of Arithmetic
Ways to Modify Printed Materials to Make Them Easier to Use

Of primary interest for this report are the two parts of the interview designed to obtain information regarding the man's use of listening and reading sources in obtaining job-relevant information. To identify use of listening sources, the man was asked to give five instances when he had asked somebody for job-related information in the last month. Probing was continued until the man said he couldn't think of any other such instances.

A similar procedure was used to identify use of printed materials or reading sources. The man was asked to give five examples of times during the past month when he had used printed materials in connection with carrying out a job. In each case he was asked to describe the job he had been performing and what information he had been seeking when he went to the printed material. Then he was asked to get the manual and to locate the exact page he had used, then to show the interviewer the specific parts of the material he had used in obtaining the desired information. This process was repeated until either five instances had been described or the individual could give no more; he was not pressed for examples beyond five in number.

The men in this research were selected on the basis of reading grade level scores, with the additional restriction that their total time in the job fall between one and 18 months. Because of entry training and leave time, 18 months tends to be the uppermost limit for individuals serving the standard draftee's two-year tour of duty. This was the group in which we were primarily interested at this time.

In order to select potential interviewees on reading grade level scores, so as to ensure the desired number at each of the three reading level categories, it was first necessary to schedule special testing sessions and administer the reading achievement test. Since it was not feasible to administer reading tests to all men at a given installation who were serving

in the target job positions, available personnel records were prescreened by selecting for reading testing only men who had between one and 18 months of job experience and by selecting equal numbers of men whose AFQT scores fell between 0-20, 30-50, and 51-100. While these exact AFQT category limits were somewhat arbitrary, the general rationale was based on our experience with previous correlations—ranging from .60 to .70—between AFQT and the reading achievement test. Table 3 presents the number of men interviewed at each reading level interval for each of the three job positions, and AFQT scores and reading grade level scores of each reading level subgroup.

Table 3

AFQT Scores and Reading Achievement Test Scores for Men Interviewed in each of Three Job Positions

Subgroup	AFQT			Reading Grade[a]	
	N	Mean	Standard Error	Mean	Standard Error
Supplyman					
High Reading Level (9.0+)	11	73.82	4.97	11.19	0.44
Middle Reading Level (7–8.9)	9	36.00	3.24	7.73	0.13
Low Reading Level (4–6.9)	10	17.41	3.01	6.27	0.19
Mechanic					
High Reading Level (9.0+)	25	45.16	4.42	10.14	0.19
Middle Reading Level (7–8.9)	34	33.26	2.70	7.86	0.10
Low Reading Level (4–6.9)	26	24.73	2.49	6.06	0.13
Cook					
High Reading Level (9.0+)	15	63.60	3.76	11.16	0.37
Middle Reading Level (7–8.9)	16	35.12	3.61	7.99	0.17
Low Reading Level (4–6.9)	17	24.65	4.14	5.44	0.38

[a]Survey of Reading Achievement, Junior High Level, California Test Bureau.

Readership Data—The data in Figure 1 suggested that the reading difficulty level of the job materials in some instances appears to greatly exceed the reading ability of the men. Is there evidence that low reading ability men make less use of these printed materials than do those with higher reading levels? As indicated earlier in describing the interview procedure, each individual was encouraged to recall five different instances during the preceding month when he had used printed material in connection with job duties. When we designed the interview procedure, five instances had not seemed to be a very stringent requirement, even for poor readers who might find it particularly difficult to utilize printed materials. We were surprised to find that with the exception of cooks, very few individuals could recall five different instances of the use of printed materials and most were able to cite only one or two. Many men indicated that they rarely used printed materials and that the one or two instances they had cited were the only times they had used printed materials while on the job.

On the basis of our interview procedure, we assumed that the number of instances cited of use of printed material could be used to reflect the relative extent to which our different reading ability subgroups used printed materials on the job. These data are presented in bar graph form in Figure 2 for each of the three reading achievement subgroups within each of the three jobs.

Comparison of Readership Indices for Men of Three Reading Skill Levels in Three Job Fields

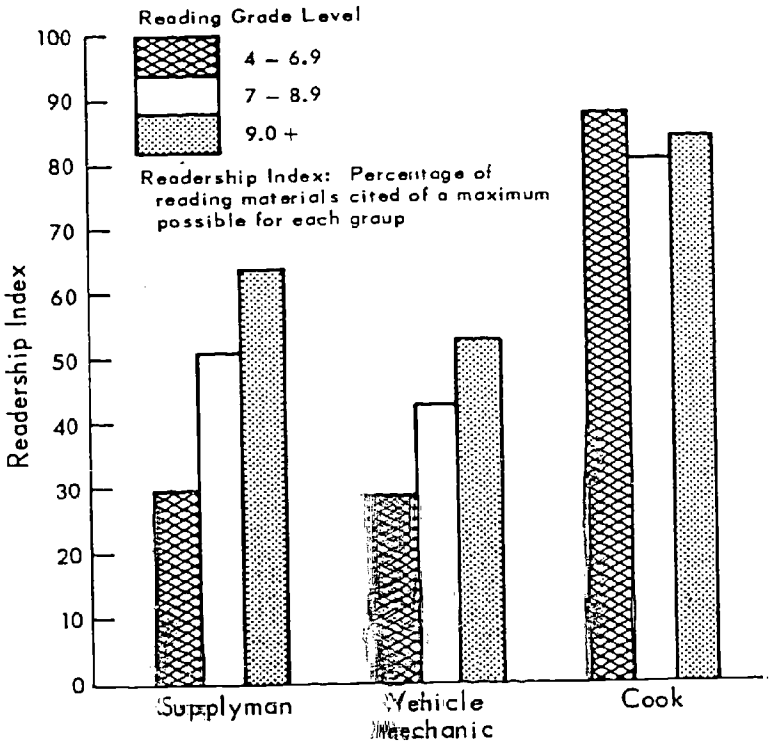

Figure 2

In Figure 2, the total numbers of printed citations given by the men in each reading ability category have been converted into a readership index. This index expresses the number of printed citations given as a percentage of the maximum number possible if each man had given his full limit of five. Thus, a readership index of 20 means that the particular group of men produced on the average, one citation of the use of printed material out of a possible five requested; an index of 40 would mean they produced an average of two printed citations out of the five requested, and so on.

Readership indices for the supplymen and mechanics (Figure 2) suggest that the use of printed materials increases with increases in the reading ability of the personnel. Simple analyses of variance (Table 4) carried out separately for each job indicated that the increase in use of printed material with increase in reading ability level was significant beyond the .025 level for the mechanics, while for the smaller sample of supplymen the *F* fell between the .10 and .05 levels. As visual inspection suggests, reading ability differences among the cooks was not related to use of printed job materials.

For the mechanics and supplymen, whose printed materials range very high in terms of reading difficulty, there is evidence of a relationship between extent of usage of this printed material and reading ability level of the job incumbents. For cooks, whose printed materials range around a tenth grade equivalent for readability, there were no differences in the use of printed materials as a function of reading ability. Of equal importance is the fact that men of all three reading ability levels among the cooks reported high usage of printed materials.

Listening—What role does listening play in the information-seeking activities of these job incumbents? The listening data are presented in Figure 3 in terms of the same type

Table 4

Analysis of Variance Testing Listening vs. Readership as a Function of Reading Ability: Supplymen and Mechanics

Source	*df*	Mean Square	*F*[a]
Supplymen			
Between Subjects			
Reading Level (A)	2	2.385	1.22
Error (Subjects w/Groups)	57	1.956	
Within Subjects			
Listen vs. Read (B)	1	7.94	14.18*
A X B	2	5.56	9.93*
Error (B X Subjects w/Groups)	57	.56	
Mechanics			
Between Subjects			
Reading Level (A)	2	1.945	<1
Error (Subjects w/Groups)	82	2.352	
Within Subjects			
Listen vs. Read (B)	1	21.14	12.81
A X B	2	10.57	6.41*
Error (B X Subjects w/Groups)	82	1.65	

[a]*indicates $p < .005$.

of index as used for the readership data. Simple analysis of variance carried out separately for each of the job positions indicated that there was no systematic change in extent of use of listening sources over the three reading ability levels within any of the job positions.

Listening vs. Reading—Is there any meaningful pattern or relationship between the difficulty level of printed materials and the tendency to ask rather than read? Does this tendency vary with the man's reading achievement level as well as with the reading difficulty level of the materials?

Figure 4 shows the listening and readership data plotted together on the same graph for each job position. As stated, considering each job position separately, the trend for use of listening sources, going from low to high reading ability levels, is essentially a horizontal line. This holds for each of the three job positions. There is some indication that the low reading ability supplymen and mechanics may rely more on listening than reading for their information, but with our fairly small numbers, these data are not statistically significant. There are further indications in Figure 4 that, summing over the three reading ability levels, supplymen may use listening to a greater extent than do mechanics, who in turn may use listening more than do cooks.

The interesting thing about this speculation (and that is all that these data permit) is that if these three jobs are ranked on the basis of the difficulty levels of their printed materials, the supplymen rank as having the most difficult, mechanics next, and cooks the least difficult materials in terms of the readability estimates reported earlier in Table 1 and Figure 1. If these data were to be confirmed, they would suggest that, where the reading materials are too difficult, the men in the job may prefer to ignore the reading material and to get relatively more of their information by asking others (listening).

Comparison of Listening Indices for Men of Three Reading Skill Levels in Three Job Fields

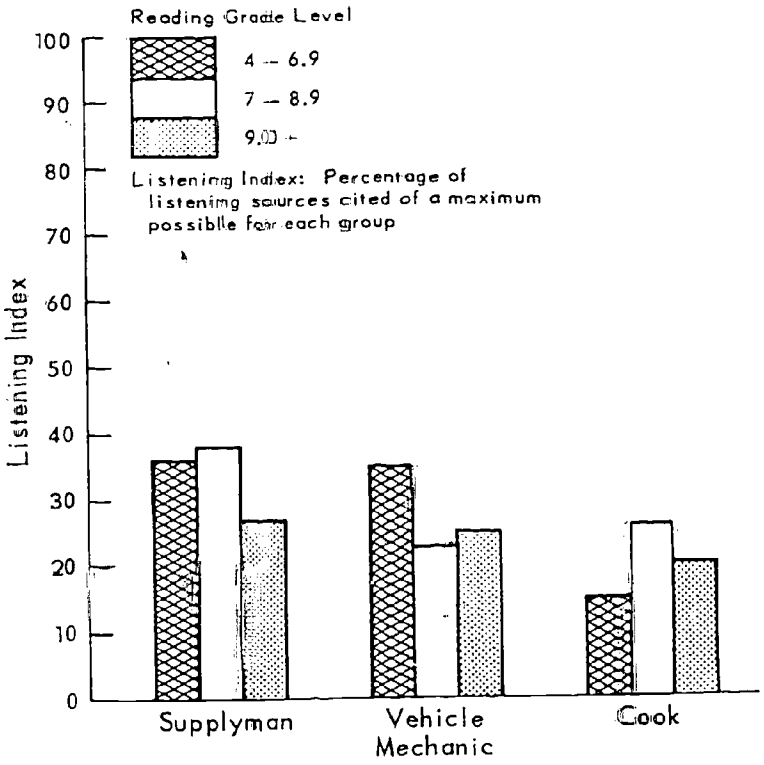

Figure 3

Identification of Job-Reading Tasks

The data reported in this paper were obtained in the pursuit of the primary goal of this part of our research—the identification of job-related reading tasks. We see job reading-tasks, if properly conceived, as providing a means of examining reading requirements of jobs in new and imaginative ways, so that recommendations for redesign of job materials, job restructuring, or remedial training geared at job-related reading skills can be made.

Our usual means of assessing reading achievement or skill levels utilize reading tests developed for use within our school systems, with norms based on student performance at the various, successive grade levels. In using these scores it is generally assumed that the successive grade levels reflect increments in the development or acquisition of some complex skill we call reading.

The specific relevance of reading levels, assessed in this way within the educational system, to reading behaviors of youth or adults outside of the school system is not directly given. It is generally assumed that the better an individual can perform on a grade-norm reading test, the better he or she will be able to handle reading requirements of jobs and other everyday requirements. However, when it comes to identifying some of these specific job or everyday requirements and asking the question, "What is the minimal reading level requirement for successful accomplishment of this reading task?" there seems to be no conversion table handy to provide the answer. It is also possible that the reading behaviors are aligned along such different dimensions that a useful

Comparison of Relative Frequency of Use of Printed and Listening Sources for Men of Three Levels of Reading Skill in Three Job Fields

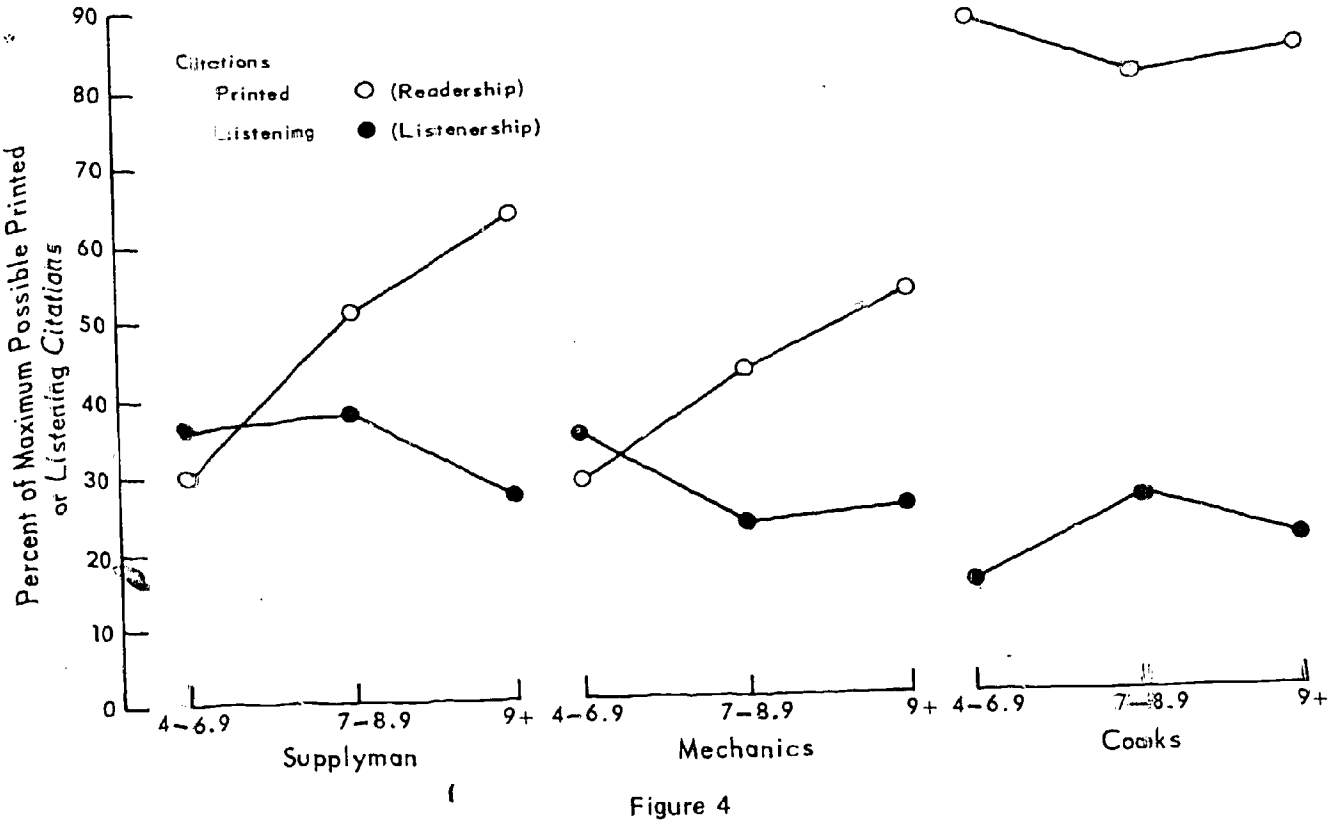

Figure 4

conversion table is not feasible. Because of these types of considerations, one of the objectives of the present research was to identify and describe job reading behaviors so that the relationships between the performance of these reading behaviors and conventional means of assessing reading skill levels could be studied.

The purpose underlying our approach to the study and identification of job reading tasks was to identify aspects of the materials that would tend to increase the requirements placed on the individual to detect, process, and transform information into the form required in order to implement a given job duty or task. Information which is readily identified as relevant to the specific job function, and which is in a directly utilizable form with respect to that job function, places relatively low requirements on the reading or general information processing proficiency of the individual.

We believe that by using this type of identification scheme we will be able to characterize the level of information processing requirements specific job systems place on an individual, and will also be in a position to determine where and how these requirements might be reduced in the given job system.

Using this general premise as an organizing point, we are identifying job reading tasks in terms of a joint classification based on the type of information sought by the incumbent and the type of content objectives of the material he attempted to use to satisfy the information requirement. Both information sought and content objectives are classified on the basis of the same system of categories.

The present system of categories for accomplishing the identification of reading tasks is presented in Figure 5. This can rightfully be called a first draft system. At this point it has been successfully applied in the classification of the examples of information

Definition of Content-Type Categories

1. Standards and Specifications

   Content setting forth specific rules or tolerances to which task procedures or the completed product must conform.

2. Identification and Physical Description

   Content attempting to symbolically represent an object via an identifying code (stock #, nomenclature) and/or by itemizing its distinguishing physical attributes.

3. Procedural Directions

   Content which presents a step-by-step description of *how* to carry out a specific job activity. Essential elements are equipment/materials/ingredients to be used, and how they are to be used, with presentation organized in a sequential step-wise fashion.

4. Procedural Check Points

   Content which presents a key word or highly summarized version of *what* should be done in carrying out a task rather than how it should be done. This content differs from the content classified under Procedural Directions in that it assumes the user knows how to carry out the steps once reminded that the step exists and/or reminded of the decision factors which determine whether the step is required.

5. Functional Description

   Content which presents an operating (cause and effect, dependency relationships) description of some existing physical system or subsystem, or an existing administrative system or subsystem.

6. Thoery

   Content which describes a system of interrelationships among factors in a generalized physical subsystem or system (e.g., internal combustion engines), a generalized version of an administrative system, or in any type of abstract conceptual system.

Figure 5

sought and printed materials used as given by the mechanics. Based on earlier pilot applications, we are reasonably confident this same system can be used in classifying examples of information and printed materials used by cooks and supplymen. There will undoubtedly be ways to improve this system of categories, while still keeping it relatively simple, before the classification of the remainder of the materials is completed.

The general notion of identifying job reading tasks using the categories in Figure 5 can be expressed by contrasting two examples of the use of printed information to obtain the same information. In the first example, an individual obtains the gap specifications for a spark plug (Type of Information Sought: Standards and Specifications) from the context of material presented in standard paragraph format and oriented toward describing the functioning of the ignition system (Content Type: Functional description, standard paragraph format). In contrast, consider the example of an individual who obtains the same information (Standards and Specifications) from a tabular display of ignition system specifications (Content Type: Standards and Specifications, tabular

format. These two individuals are performing job-related reading tasks which differ in nature. These two tasks quite likely require different reading skills and behaviors and probably also differ in difficulty if assessed by a performance test.

These studies of the performance of different reading ability groups on the reading tasks identified will, it is hoped, result in knowledge directly relevant to the problem of accurately estimating reading skill requirements for jobs. Reading performance tests are being constructed to represent the job reading tasks. When these job-related reading tests are completed, the relationships will be determined between performance on the job reading tests and standardized reading tests which reflect school grade reading achievement level norms.

By this means, we hope to gain an indication of reading skill levels adequate for performing various job reading tasks. In addition, we will be able to ascertain whether our job reading tasks rank order along a difficulty dimension defined by the assumptions of the complexity of information processing reflected in our classification scheme.

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3. Sticht, Thomas G. *Literacy Demands of Publications in Selected Military Occupational Specialties*, HumRRO Professional Paper 9-69, March 1969.

REDUCING DISCREPANCIES BETWEEN LITERACY SKILL LEVELS OF PERSONNEL AND LITERACY DEMANDS OF JOBS

Thomas G. Sticht

The research described by Dr. Kern in the preceding paper focused on the differences between the reading difficulty levels of the printed materials available for performing a job, and the reading ability levels of the men who are supposed to use these materials. In two of the job areas he described, the reading demands of the materials were considerably above the skill levels of the men in those jobs.

The object of this paper is to discuss two approaches aimed at closing the gap that results when the literacy demands of a job exceed the literacy skills of the men available to perform the job. One approach is to increase the skill levels of personnel by training. The other is to modify the literacy demands of the job by the redesign of literacy materials. These approaches are fairly obvious but their implementation is not simple nor inexpensive, and the two may have entirely different outcomes with respect to a major criterion for the implementation of any such action: the improvement of personnel job proficiency.

Literacy Training and Job Proficiency

One approach for closing the gap between job literacy demands and personnel literacy skills is to upgrade the latter through literacy training. One of the most frequently mentioned programs in this regard was the large scale training of functional illiterates in the Armed Forces during World War II. Figures reported by Goldberg (1) in his extensive review of Army training of illiterates in World War II indicate that, subsequent to June 1, 1943, some 302,838 men received literacy training. Of these, 254,272 were graduated because of successful attainment of required standards, which were designated as literacy skills as possessed by the completion of the fourth grade of school.

This successful performance during World War II is frequently cited by reading experts (Witty, 2; Robinson, 3) as an example of an approach for upgrading the literacy skills of adults to secure better, more competent, job performers. However, the evaluation of the effects of literacy training on job proficiency was almost nonexistent, and such evaluation as was attempted was fraught with methodological difficulties.

In one such attempt, made by Hagen and Thorndike (4), the records of 1,026 illiterates who entered the Navy during 1944 and who received literacy training at Camp Peary were compared with those of 1,021 normal control cases who entered at the same time and from the same parts of the country. The records of 999 marginal aptitude men were also studied to give a comparison with men comparable to illiterates but who did not receive literacy training. Unfortunately, several methodological limitations restrict the conclusions of this study. For one thing, the control group contained no enlistees. For another, the marginal group was superior to the illiterate group in literacy, general intellectual ability, and education level. The marginal group also differed in age and background, and in many cases records were incomplete and inconsistent. Thus, the illiterates who received training were not comparable to the control group of marginal aptitude men.

But at any rate, relative to the normal and marginal control group, the illiterates who received literacy training were subsequently characterized by fewer promotions, lower proficiency ratings, more disciplinary actions, more lost time due to misconduct, fewer honorable discharges, and more VD than the controls. Thus, in this case, literacy training did not result in producing men comparable in job proficiency to marginal aptitude men who did not receive such training, nor to normal aptitude men.

Since World War II, the Armed Services have had additional opportunities to conduct literacy training, and to evaluate its effectiveness in job proficiency. Perhaps the best work is that reported by Goffard (5). In this study, men who scored below the 5.0 grade level of reading on a standardized reading achievement test were given special literacy training. They were graduated from training upon achievement of reading at the 4.9 level. When compared with comparable control groups (i.e., marginally literate men who did not receive special training), the experimental group did slightly better on performance and knowledge tests given at the end of basic training. Differences were not considered of any practical significance, however, being less than 5% in any case.

Additional studies to evaluate the effects of literacy training on job proficiency in the Armed Services are reviewed in the book *Marginal Man and Military Service* (6). These studies show that little benefit to job proficiency has been demonstrated to result from the provision of training in basic literacy skills. It is important to point out, however, that none of the literacy training aimed at providing literacy skills in excess of those represented by a score of 5.0 on standardized reading tests. In this regard, the work reported by Caylor in an earlier section of this report suggests that, if training in reading and arithmetic is to have any notable impact on job proficiency, it should be extended to at least the grade 7.0 level. Caylor's data lead also to the suggestion that literacy training should include training in listening as well as in reading. While these skills are interrelated to a degree ($r \cong .55$), they are apparently not identical (Russell, in Duker, 7, p. 195).

Apart from the somewhat limited data based on military literacy training programs, no additional research could be found which evaluates the effects of remedial literacy training on job proficiency. So the hypothesis that adult level remedial reading training will improve job proficiency remains just an hypothesis. However, it seems clear that, if such training is to have any notable effect on job proficiency, it will have to extend at least to the 7.0 or 8.0 grade level. This is not to say that persons with less than seventh or eighth grade reading skills cannot perform successfully in a variety of jobs. The data from REALISTIC I, presented by Caylor, clearly indicate that a number of less literate men can perform a variety of jobs. But for the most part, those jobs can be, and probably were, learned by men being told or by way of imitation. However, as was noted, even in those jobs the ability to read at or above the seventh grade level was associated with higher job proficiency.

Modifying Job-Related Reading Demands

An alternative to remedial literacy training is to reduce the "literacy gap" by means of changing the literacy demands of the job. We have been doing some research to determine the feasibility of lowering the reading demands of jobs, and job training programs, by substituting listening for reading.

Many studies have indicated that listening may be as effective as, or superior to, reading for some instructional purposes. Duker (8), in his annotated bibliography of over 800 articles on listening, comments on 33 studies that compared reading and listening test performance for children and adults. Of 15 studies using adult subjects (mostly college students), eight reported no differences in reading or listening test scores, six favored listening, and one reported that listening was best with narrative material, while reading was best with descriptive material.

In 18 articles annotated by Duker, children were the subjects. The general finding was that in the early grades (first through fourth or fifth) listening was likely to be more effective than reading, while in the higher grades reading became as effective, or more effective, than listening.

These studies suggest that, in some instances, listening might prove a more effective training technique than reading. To examine the feasibility of this idea, research was initiated to determine the relative effectiveness of reading and listening as means for instructing men of different aptitude levels, as determined by the AFQT. The possibility that listening might prove superior to reading in the case of the lower aptitude men was of particular interest.

Reading vs. Listening[1]

To compare learning by listening with learning by reading, two comprehension tests, A and B, were administered to 96 Army inductees. Forty subjects formed a low mental aptitude group with a mean AFQT score of 18.25; 56 subjects formed an average mental aptitude group, with an average AFQT score of 63.

Both tests A and B served as reading and listening tests. Both had four subtests having a grade difficulty level of either 6.5, 7.5, or 14.5, as determined by a modified Flesch formula.

The low mental aptitude and average mental aptitude groups were split into two equal subgroups. One subgroup listened to test A and read test B, while the other subgroup listened to test B and read test A. In the analysis of results, the scores for the counterbalanced groups were combined. Reading and listening times were equated. The listening test was presented by means of a tape recorder, with gain adjusted to a "comfortable" listening level. Questions for the listening test were read aloud twice. Test questions demanded factual information and were of a "fill-in-the-blank" nature. The results of this comparison indicated that none of the differences between reading and listening within groups were statistically significant (Table 1). There was an overall decrease in performance as the difficulty level of the material was increased, but there was no interaction of mental aptitude with difficulty of material. There were, however,

Table 1

Scores for Low and Average Mental Aptitude Groups on Listening and Reading Subtests

Aptitude Group	Average Grade Level of Material					
	6.5		7.5		14.5	
	Listen	Read	Listen	Read	Listen	Read
Low Mental Aptitude (N = 40)						
Mean	52.87	51.68	52.46	42.98	25.48	26.02
SD	19.96	27.39	16.25	19.48	13.43	17.83
Average Mental Aptitude (N = 56)						
Mean	72.25	72.46	69.54	65.18	44.89	48.72
SD	19.93	21.04	15.88	18.45	19.76	20.63

[1] The assistance of SP 5 Pat Ford in the conduct and analyses of data for these studies is acknowledged. A detailed report of this and related work is found in a HumRRO Technical Report (9).

large differences between the two aptitude groups on both tests. This is not surprising, however, since the groups were based on AFQT scores, and as Dr. Caylor has noted, such scores are derived from tests requiring considerable verbal and reading skills.

These data indicated that a variety of factual information may be communicated equally well through reading or listening to men of average and low aptitudes. Presenting materials via listening does not necessarily mean that the poorer reading man, found in the lower aptitude groups, will learn better by listening than by reading. If the material is too difficult, they do not learn much by either modality, and if it is simple, they learn equally well, as a group, by reading as by listening.

While the modality of presentation of information may not have much of a differential effect upon learning acquisition, there may be differential motivating properties of listening and reading materials. In our work, for instance, 25% of a sample of some 300 men would prefer to learn by listening. Thus, providing listening materials might serve to motivate learning in a significant proportion of men.

Rate-Controlled Recordings (Time-Compression of Speech)

One drawback to listening for instructional purposes is that the listening rate is limited by the speaker's rate of speech, whereas in reading, one may vary his rate of information intake to suit the nature of the reading material. However, recent developments (reviewed in Foulke and Sticht, 10) have provided techniques that permit the speech rate of recorded passages to be speeded up or slowed down without otherwise changing the speech quality. Slowing the speech rate causes the time needed to present the message to increase; such speech is called time-expanded speech. Speeding-up the playback time of a recorded message results in the presentation of the message in less than the original recording time; therefore, accelerated speech is sometimes referred to as time-compressed speech.

To evaluate the possibility of using rate-controlled speech as a teaching medium for men inducted into the Army, studies were performed to compare men of low and high mental aptitudes with respect to their ability to comprehend speech presented at various rates. Previous research (Foulke and Sticht), has indicated that the average oral reading rate for newscasters and professional readers for the blind is around 175 wpm, with a sigma of some 20-25 wpm. In the present research, speech rates ranging from two sigmas below the average (i.e., 125 wpm) to eight sigmas above the average (i.e., 375 wpm) were used. In addition to different speech rates, materials presented varied in difficulty as grades 5.5, 8.5, and 14.5 (modified Flesch formula of Farr, Jenkins, and Paterson, 11).

The results of this evaluation are shown in Figure 1, in terms of the percentage of correct responses on the cloze tests administered after the presentation of a tape-recorded story at various speech rates. The curves connecting the filled points are for lower aptitude men. Each point is the mean for an independent group of 17 men. The dotted lines drawn to the ordinate connect the experimental curves to baseline data obtained by testing control subjects without their listening to the experimental messages. The three levels of difficulty of the messages are represented as: circles = grade 5.5; squares = grade 8.5 and triangles = grade 14.5.

Analyses of variance performed on the data indicated a significant triple interaction of speech rate, message difficulty, and mental aptitude. Additional analyses indicated that the materials X speech rate interaction was significant for the low aptitude men, but not for the high aptitude men. Figure 1 shows that the gain in information across materials was constant for the higher aptitude men at the different speech rates, while the lower aptitude men showed a higher gain from the easier materials at reduced rates of speech.

With regard to the main effects of speech rate, these data indicate that speech rates of 350 wpm and above are distressingly fast, with comprehension returning to baseline or near baseline levels of performance for both aptitude groups. It is also of interest to note

Listening Comprehension Test Scores for Messages on Three Levels of Difficulty Given at Different Rates of Speech

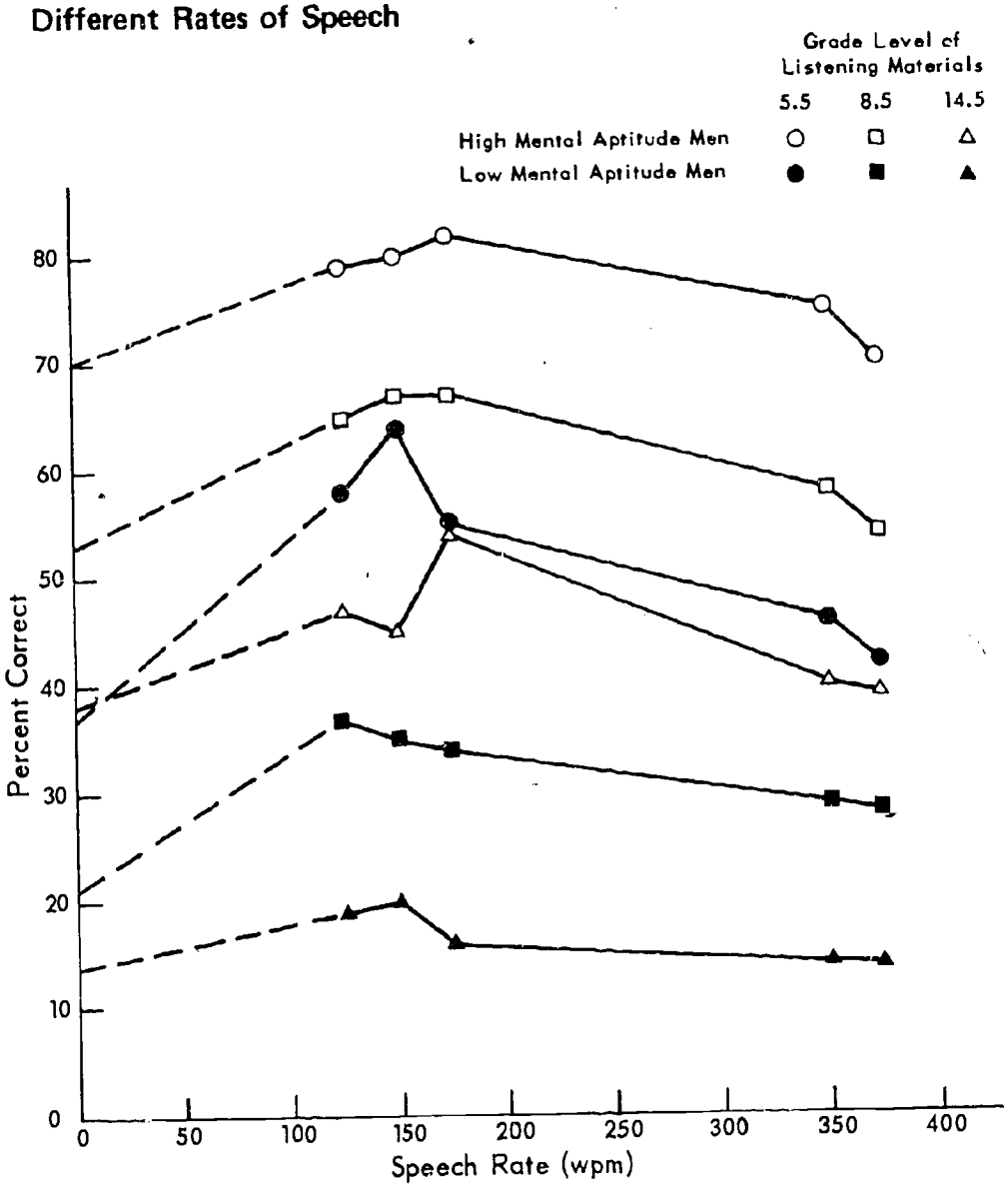


Figure 1

that the optimal speech rate for learning appears to be slower for the lower aptitude men than for the higher aptitude men. However, before such a conclusion is generally acceptable, replication is needed.

A further evaluation has been made of the comprehensibility of speech accelerated above 175 wpm. In Figure 2 curves are shown that indicate how well men of high, medium, and low mental aptitude comprehended listening materials presented at 175, 275, or 425 wpm. These data show that, for speech rates of 275 wpm, comprehension declined only slightly from that at the normal 175 wpm rate for all three groups. Since the message presented at 275 wpm can be presented in 64% of the time required to present the message at the rate of 175 wpm, there is a 36% saving in time.

The fact that there was such a small loss in comprehension with a 36% saving in time suggested that the total amount learned could be increased by presenting the message twice in compressed form in the same amount of time required to present the message once in uncompressed form.

Comprehension Scores for the Three Aptitude Groups as a Function of Message Presentation Rate

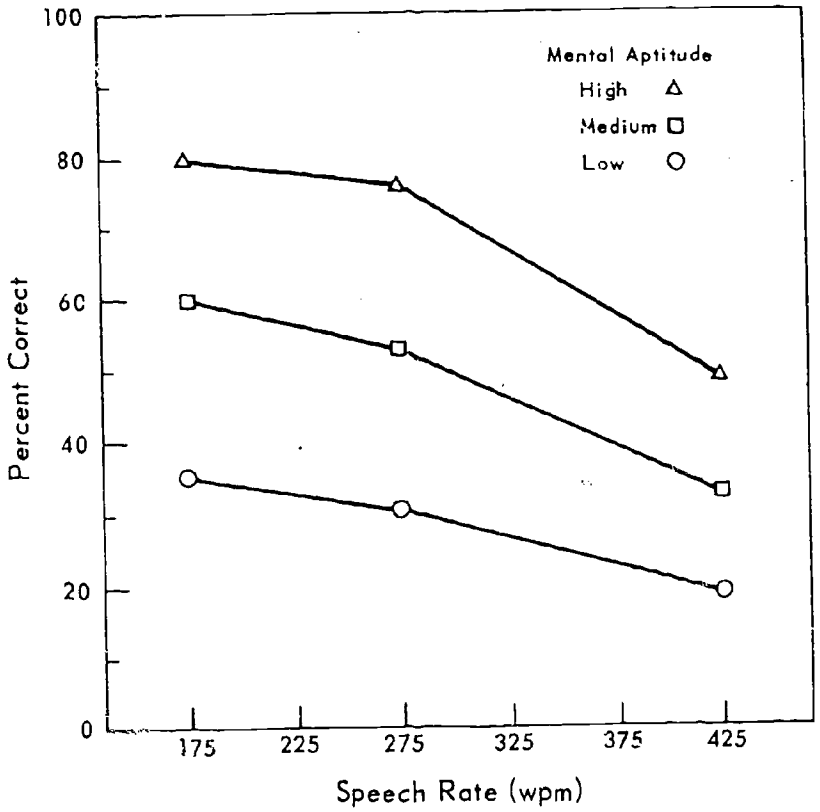


Figure 2

Figure 3 gives the results of research in which a time-compressed recorded message was given two times in the same amount of time needed to give the uncompressed message once. The ordinate shows the percentage correct on a listening comprehension test. The lower abscissa shows the time-compression ratios used, while the upper abscissa shows the resultant speech rates in words per minute. In each instance, the upper numerals in the paired values on the scales indicated the compressed version presented first.

The open symbols show the results on listening comprehension of presenting the message twice. The filled symbols give results of listening one time to the message presented at the speech rate (compression ratio) indicated by the upper numeral on the abscissa at that point.

As indicated, while presenting the message twice in compressed form did improve comprehension over that obtained with a single presentation in compressed form, in no case was the double presentation more effective than a single presentation of the message in uncompressed form. Similar results have been reported by others (12, 13, 14, 15, 16, 17).

In a second attempt to improve peak learning in a given unit of time, additional, *new* information was presented in the time saved by the compression process. In this case five different conditions were presented to high and low aptitude men (Figure 4). In one condition, a message was presented at 178 wpm. In two conditions the message was given in compressed speech form at rates of 278 and 378 wpm. These speech rates resulted in reduction in the time required for listening to the message. In two additional conditions,

Comprehension Scores for High and Low Aptitude Men for One and Two Compressed Presentations of a Listening Selection

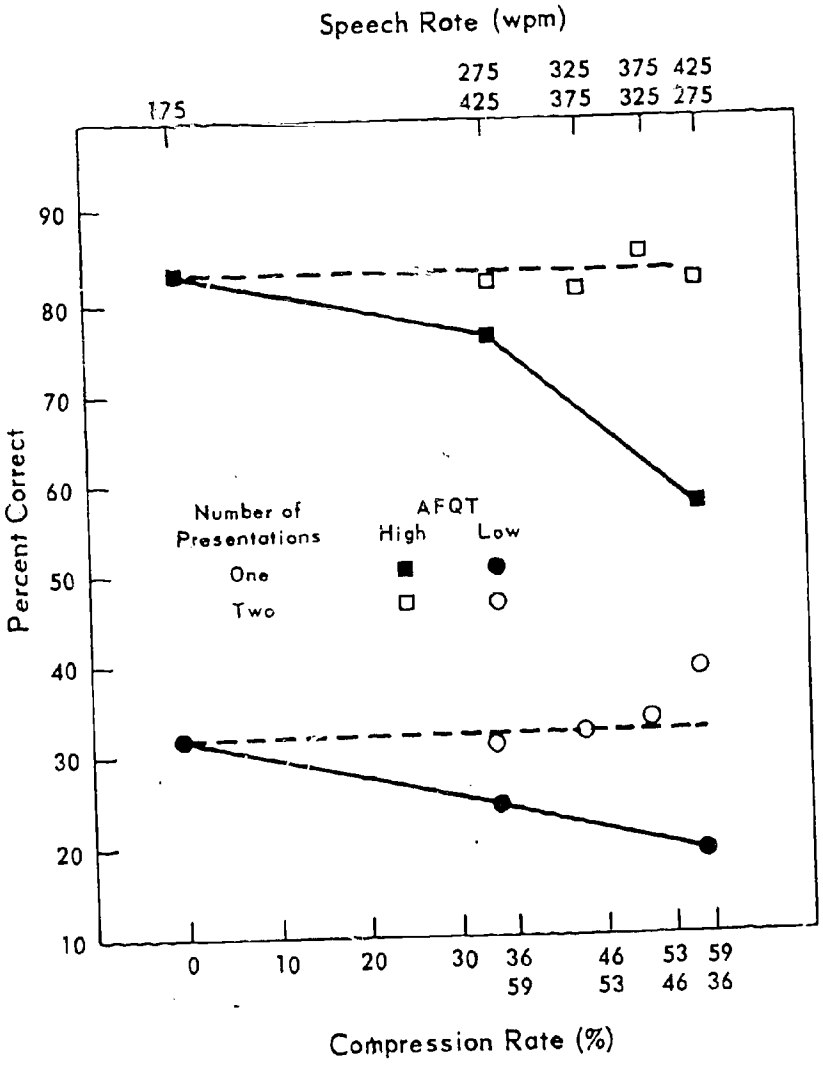


Figure 3

the original message was compressed. But in these conditions, additional, *new* compressed material was added to maintain the total listening time equal to that for the uncompressed message. These conditions are represented in Figure 4.

In all conditions, subjects were administered a comprehension test over all the information presented at the rate of 378 wpm when the listening time was held constant to equal that of the uncompressed message. As indicated in Figure 4, presenting the new information relevant to the comprehension test in the time saved by the time compression of speech, did not improve peak learning over that obtained by listening to less information relevant to the test, but presented in uncompressed form. This was so for both high and low aptitude subjects, and for material presented at 278 and 378 wpm.

Summary on Substituting Listening for Reading

The work done on the feasibility of substituting listening for reading as a means of reducing the literacy demands of jobs has been exploratory and quite basic in regard to rate-controlled recordings. So far, this research indicates that men all along the

Listening Comprehension Scores for High and Low Aptitude Men Listening to Time Compressed–Time Limited, or Time Compressed-Time Extended Selections

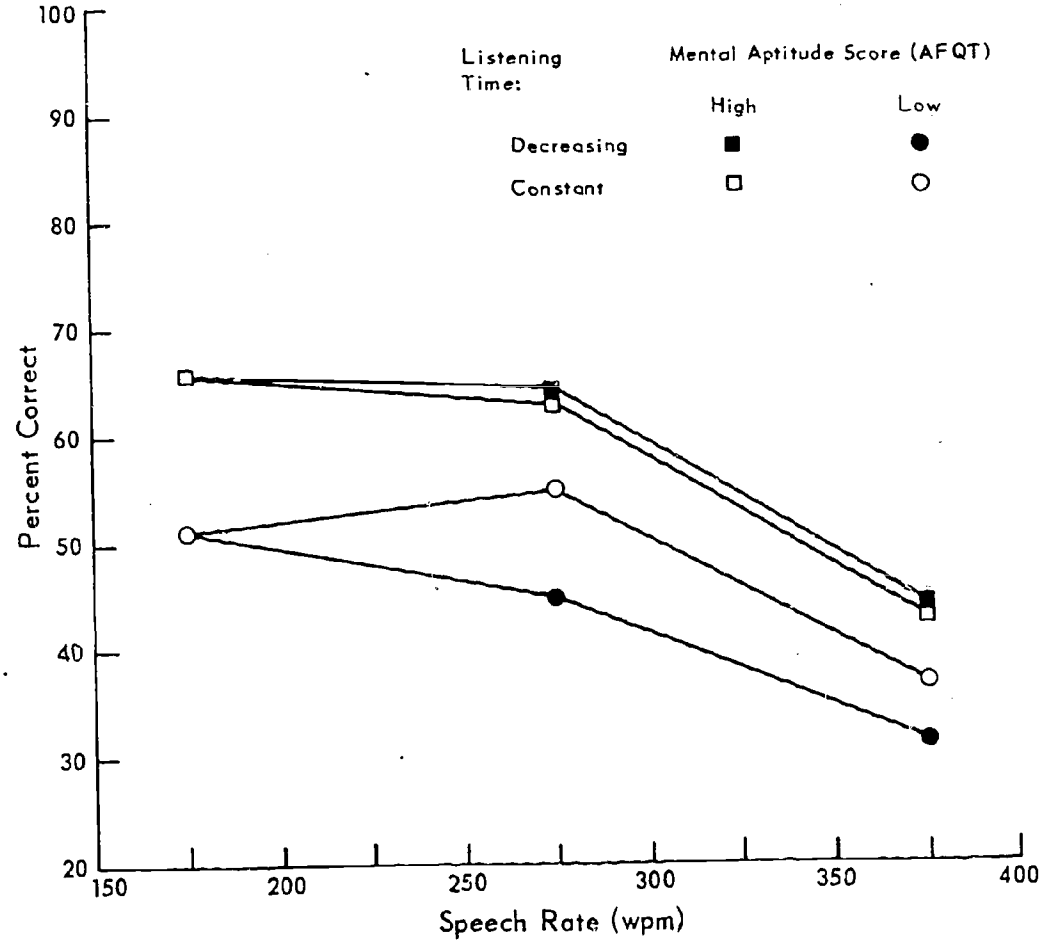


Figure 4

continuum of aptitude can learn certain verbal prose equally well by listening and by reading. The work using rate-controlled recordings suggests that, in some cases, both high and low aptitude men can learn less difficult materials at rates of speech more than four sigmas above the mean rate of 175 wpm with only moderate losses in comprehension. While this may result in as much as 36% savings in listening time, how the time saved can be used to increase the general level of learning has yet to be demonstrated. Our projected work includes further examination of this problem, as well as research to study the effects of speech rate upon particular information processing procedures, such as "chunking" of input for subsequent recall. A major research activity to attempt to improve listening skills by training via audio-visual film loops is also planned. Such loops might also be used as job performance aids.

Design of Job Performance Aids to Reduce Literacy Demands of Jobs[1]

A job performance aid is any information storage device, such as a manual, checklist, or diagram, which is available to assist a man in doing his job. The present

[1] The assistance of PFC Donald Enderby in the work on Job Performance Aids is acknowledged.

discussion will deal primarily with technical manuals as job aids, and will focus on the design of such manuals to make them more effective. There is considerable evidence (18, 19, 20), to indicate that properly designed job manuals can enable the less experienced and less literate man to achieve acceptable job performance, with fewer errors and little or no loss in time, and with much less training than has been thought necessary. This has been demonstrated for highly technical jobs in which complex machines and electronics systems are involved.

The major principle underlying the success of well designed aids is that job-related information, which is usually stored in a man's head, is stored in the aid *in such a way as to maximize the retrievability of the information.* Thus, the long training or on-the-job experiences that are usually needed for a man to acquire the necessary job information are reduced to the time spent in learning to use the job aids.

It must be underscored, however, that it is not the mere storage of information in the job performance aid rather than in the man's head which accounts for the effectiveness of the aid. Rather, it is the nature and manner of storage that is of crucial importance. For instance, a technical manual may contain needed information, but this information may be stored in such a way that the user is not able to work with it. Relevant data reported in the preceding paper by Dr. Kern showed that most of the technical manuals in the mechanic and supply clerk jobs were written at a level well above the reading ability of the men in the job, and that there was a correspondingly low level of usage of the materials. In addition to the reading difficulty level, other factors such as format, and nature and sequencing of information, may reduce the effectiveness of a job manual.

The key to the success or failure of a job manual or other aid is its design, which includes the nature and manner of presentation of the information in the aid. The foundation for the effective design of such materials is stimulus-response learning theory as applied to jobs by human factors scientists. In applying the stimulus-response theory to job aid design, the job is viewed as being composed of a set of tasks in which the worker makes some appropriate responses to a stimulus which cues (calls for) that response. By performing a task analysis, the various cuing stimuli and their associated responses are identified. Decisions can then focus on determining which cuing stimuli are to be placed in the job aid, and how they will be displayed.

The procedures for the production of job performance aids have been reviewed in detail (21), including analysis of man-machine systems, task description and analysis, allocation of functions to the job aid, determination of design features of aids, and production of the aids. I will describe one project for which technical manuals were redesigned to improve performance. Included in the description will be a comparison of the standard and redesigned manuals, and a summary of some of the production principles that HumRRO personnel and others have developed for producing pictorial job manuals.

Manuals From Work Unit SHOCKACTION

In the late fifties, HumRRO initiated Work Unit SHOCKACTION to develop training procedures for improving the performance of the tank crew in combat. Three job manuals were produced in the form of picture guides for tank drivers, loaders, and gunners. The procedure used in developing these guides involved the determination of what each member of a tank crew needs to know in order to do his job. To this end, training literature and crew activities were studied, and experienced officers were consulted. Lists of job requirements, covering the duties and skills of the three crew positions were established (22).

From the job task lists, job manuals, in the form of picture guides, were developed to cover the skills required of a given crew member. In developing the guides, an attempt

was made to make most statements in behavioral terms (e.g., "unscrew the turret lock"), and to use simple terms. Then most of the tasks covered in the guides were given field tryouts and revised until it was found that even low aptitude trainees could profitably use the guides.

Figure 5 shows a page from the HumRRO picture guide developed for tank gunners. It has small task steps, clearly identified by numbers in large type. Each step contains action verbs indicating the type of behavior the crewman is to perform. In the manual, the articulated pictures and verbal context provide a step-by-step procedure on the same page.

The HumRRO manual can be contrasted with a standard technical manual (excerpts shown also in Figure 5) which provides instructions for the same task—giving the quadrant the end-for-end test. The standard manual also presents step-by-step procedures for the end-for-end test; however, these procedures are provided in the context of other procedures on the same page, and there are no helpful illustrations. The only relevant information in picture form occurs more than 200 pages before the instructions for the end-for-end test. It provides only an orienting full-view of the gunner's quadrant; there are no pictures for guiding the behavior of the user.

The SHOCKACTION endeavor, and additional HumRRO research and development under RECON have led to several guidelines[1] for designing training or job performance manuals in the form of pictorial aids. The most important guideline is to *test the job or training aid on the prospective user.* Revisions should be made until a novice can use the aid to guide his performance without error or assistance, and with little hesitation. Additional guidelines for design of manuals, resulting also from HumRRO research (24, 25, 26, and 27, and a memorandum[2]) are:

(1) Conciseness: The information provided in the job manual should require a minimum of coding, decoding, and manipulation of information. Hence the simplest possible vocabularies and sentence constructions should be used. Irrelevant information, background material, and "nice to know" information should not be interspersed with directions designed to guide the actions required in the task performance.

(2) Standardization: The presentation and organization of information should be standardized across and within each class of tasks. In this respect, specific guidelines may be developed to control syntax (sentence structure), use of classes of verbs and nouns, and so on. This reduces the need for creative writing on the part of the aid designer, and insures high redundancy levels for the user.

(3) Analysis of Complex Tasks Into Sub-Tasks: At times, to keep a performance sequence simple, small portions of a complex task will have to be presented as a sub-task.

(4) Sequencing of Information: The organization of content within any type of task should be based on analysis of the nature and sequence of task elements involved. For instance, procedural instructions should be presented in the sequence in which they are performed. This applies to pictures, paragraphs, sentences, and phrases within the sentences.

(5) Completeness: Each significant point in a task action sequence should be presented. This requires careful task analysis and thorough development by user testing. Content of the job aid manual should be accurate and kept up-to-date, and provisions should be made for modifying the manual as new requirements arise.

[1] A Consulting Report on pictorial methods of instruction for the M-73 machinegun and the .45 cal. automatic pistol, by J. Roger Ware, Elmo E. Miller, and James L. Constantinides, December 1968.

[2] A memorandum by HumRRO Division No. 2, Fort Knox, Kentucky, August 1967, giving guidelines for the design of technical manuals to be used in training.

3-37A) and rotate knob until micrometer and azimuth pointers are at zero.

c. Traverse the turret manually through a complete circle until periscope M31 or M32 reticle aiming cross is laid on the original aiming point.

d. Assure azimuth indicator micrometer and azimuth pointers are at zero. If both pointers are not at zero, notify organizational maintenance personnel.

3-267. Azimuth Indicator M28A4 or M28E2 Slippage Test. To check for slippage of the azimuth indicator, proceed as follows:

a. Perform steps a and b of paragraph 3-266.

b. Traverse the turret rapidly in power and stop suddenly; repeat this operation two or more times in the same direction. Turn off turret power.

c. Manually traverse the turret in the opposite direction until the periscope M31 or M32 reticle aiming cross is laid on the original aiming point.

d. Assure azimuth indicator micrometer and azimuth pointers are at zero. If both pointers are not at zero, notify organizational maintenance personnel.

e. If both pointers indicate zero, repeat steps b through d, in opposite direction.

3-268. Ballistic Computer M13A1D or M13A2 Test. To test the ballistic computer, proceed as follows:

a. With the range correction knob of the ballistic computer (figure 2-35) at zero, rotate the range knob on range finder (figure 2-27) and determine whether the inner (range) pointer indicates the same range on the computer range dial that is indexed on the range scale of the range finder. Make this check for various ranges.

b. Index a range of 1,000, 1,200, or 2,000 meters on the range scale of the range finder.

c. Index a type of ammunition in the computer as shown in procedure 7 of figure 2-55.

d. Turn the computer on as shown in figure 2-55 and determine whether the superelevation output shaft and superelevation actuator shaft rotate.

e. Determine whether the outer (superelevation) pointer moves to match the inner (range) pointer.

f. Determine whether the correct superelevation range and ammunition selected is indicated on the superelevation mil counter. (Use firing table.

3-269. Fire Control (Elevation) Quadrant M13A2 (M60) or M13A3 (M60A1) Adjustment. To adjust the fire control (elevation) quadrant, proceed as follows:

a. Level the 105-mm gun using a corrected gunner's quadrant M1A1 (figure 2-41).

b. Without disturbing the lay of the 105-mm gun, center the bubble in the level vial of the fire control quadrant (figure 2-39) by rotating the elevation knob.

c. Check the elevation scale. If zero is not indexed on this scale, loosen the screw at each end of the scale and slip it until zero is opposite the elevation scale index. Tighten the screws.

d. Check the micrometer scale. If zero is not indexed, loosen the three screws on the elevation knob, then slip the micrometer scale. Check the bubble to be sure it is still centered in the level vial; if it is, tighten the three screws on the elevation knob, and the instrument is ready for use. If the bubble is not centered, repeat the adjustment procedure.

3-270. Gunner's Quadrant M1A1. To test the zero setting (end-for-end test) of the gunner's quadrant, proceed as follows:

a. Set both the index arm and the micrometer scale at zero.

b. Place the quadrant on the quadrant seats of the breech ring with the black "Line of Fire" arrow pointed toward the muzzle. Center the bubble by elevating or depressing the gun.

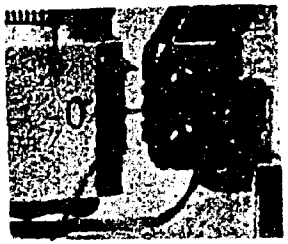
c. Turn the quadrant end-for-end. If the bubble recenters itself, the quadrant is in perfect adjustment. If the bubble does not recenter itself, try to center the bubble by turning the micrometer knob.

d. If the bubble recenters, the correction is plus (positive) and equal to one-half the micrometer reading. Set this adjusted reading on the micrometer scale; center bubble by elevating the gun; verify correction by turning

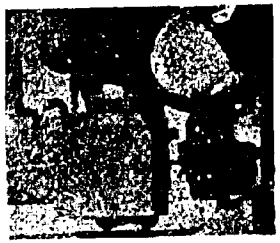
CHECKING THE GUNNER'S QUADRANT FOR ACCURACY

Giving the quadrant the end-for-end test.

1 Looking at the quadrant from the side which reads LINE OF FIRE, turn the micrometer knob to line up the mark on the index arm with the mark on the index plunger.



2 Set the micrometer scale at zero by lining up the mark below the micrometer knob with 0.



3 Push the index plunger toward the index arm to free the plunger from the teeth of the elevation scale; then move the index arm until the top of the plunger is lined up with the zero mark on the elevation scale.

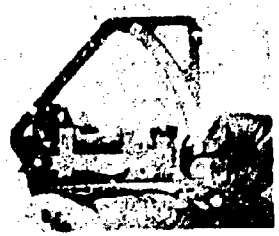


Figure 5

These are general design considerations that may enter into the production of any job-aid manual. Where extensive use of photographs or other pictures is to occur, there are several additional recommendations:

(1) Page layout: Ideally, a sequence of photographs, or drawings, illustrating one step, or element, in a task (such as setting the micrometer scale in Figure 5) should be presented on one page or opposing pages so the user can see all of that step without turning pages.

(2) Relating pictures to words: Figures, photographs, and drawings should be closely correlated, in proximity and relevance, to the text material.

(3) Subjective viewpoint: Photographs and figures should be taken from the user's point of regard.

(4) Consistency of camera angle: Do not change the camera angle (user's point of view) unless critical cues can be seen only from another angle. In such cases, indicate graphically the changes of view.

(5) View "before" the action: Photographs or drawings should show the present state of the system rather than its state after a response is made. The system status "after" the action should be represented by animation devices, such as arrows or dotted lines, corresponding to the operator's mental image of the desired change.

(6) Avoid two pictures for one movement: In presenting a single movement, do not use two separate photographs or drawings to represent the system "before" and "after." This requires the user (especially the novice) to make an extremely difficult discrimination between pictures, even when the difference seems apparent to an experienced person.

(7) Critical cues: Direct attention to critical cues by relevant animation such as arrows, color coding, outlining, and so forth.

As these guidelines indicate, the development of an effective job-aid is not a simple, "quickie" process. However, in the interim between the decision to develop adequate job aids and their actual delivery, a supervisor or manager may take several steps to make existing aids more usable. Some suggested measures are: (a) provide indexes to existing manuals in terms of local jargon; (b) excerpt (photocopy, etc.) certain frequently-used segments of manuals; (c) rewrite parts of present aids in local jargon and in simple language suitable to even the poorest readers; and (d) encourage and provide on-the-job training in the location and use of existing manuals and other job aids where available.

Summary

I believe that most of the evidence available today indicates that the provision of more useable job materials may be the most rapid, least expensive method of assuring that job proficiency is attained by men across a wide spectrum of literacy or verbal aptitude skill levels. There is even some evidence (23) to suggest that the use of printed materials may be facilitated more by the design characteristics of the materials than by increasing the reading skills of men, and this may be true for able as well as for poor readers.

The fact that it is possible to design materials to permit marginally literate men to perform jobs satisfactorily indicates that it is feasible to hire the less literate man and to utilize him effectively, while providing literacy training to up-grade these skills. By this means, it should be possible to employ the marginally literate in responsible, growth-oriented jobs, while maintaining the efficiency and effectiveness of the job sub-system.

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