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Career Counseling Validity of the ASVAB Job Cluster Scales Used in DISCOVER

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ABSTRACT

This report addresses the career counseling validity of Armed Services Vocational Aptitude Battery Form 14 (ASVAB-14) Composites and ASVAB-14 Job Cluster Scales composed of ASVAB-14 Composites and self-estimates of abilities. The results of four studies (N = 7,548) are described. Only the first included ASVAB-14 scores; the others provide a context for judging the relevance of ASVAB-14 Job Cluster Scales to career counseling. Across the four studies, score profiles and multivariate analyses generally showed that career groups differ substantially on a variety of abilities. Differences on the ASVAB-14 Composites were relatively small, however. Of 21 diverse career groups (e.g., arts, social, science), 18 scored highest on the ASVAB-14 Business and Clerical Composite. In contrast, the ASVAB-14 Job Cluster Scales were among the best differentiators of career groups. Of the 21 career groups, 20 scored highest on the appropriate Job Cluster Scales. General cognitive ability was found to be of secondary importance.

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PURPOSE AND OVERVIEW OF REPORT

Each year the Armed Services Vocational Aptitude Battery Form 14 (ASVAB-14) is administered to over 1,300,000 students in approximately 14,000 high schools (U.S. Department of Defense, 1984). Students are encouraged to use their ASVAB-14 Composite scores (described later) to identify civilian occupations appropriate to their abilities. The purpose of this report is to provide evidence bearing on the career counseling validity of the ASVAB-14 Composites and "ASVAB-14 Job Cluster Scales" composed of ASVAB-14 Composites and self-estimates of abilities. The ASVAB-14 Job Cluster Scales were developed by the American College Testing Program (ACT) for use in DISCOVER, ACT's computer-based career planning system. To enhance its value to career counselors and counselees, DISCOVER accepts and interprets scores from a number of tests and inventories administered off-line.

Overview of ASVAB-14 Job Cluster Scales

There are six ASVAB-14 Job Cluster Scales. Each parallels one of the six ACT Job Clusters (ACT, 1985) which, in turn, parallel Holland's (1985) six occupational groups. Titles for the ASVAB-14 Job Cluster Scales, ACT's Job Clusters, and Holland's groups (in parentheses) are as follows: Business Contact (Enterprising), Business Operations (Conventional), Technical (Realistic), Science (Investigative), Arts (Artistic), and Social Service (Social). In the ACT Occupational Classification System (ACT, 1985), 23 job families (groups of similar occupations) are distributed over the 6 job clusters; 2 to 6 job families are assigned per cluster. Figure 1 lists job cluster titles, job family titles, and examples of occupations in each job family. (See Appendix E for figures.)

When occupations were grouped into job families, similarity of work tasks (as shown by U.S. Department of Labor job analysis data--see Prediger, 1981a) and similarity of work-task-related interests (as shown by by occupational group scores on various interest inventories) were given primary consideration (ACT, 1985). Purpose of work and work setting were also considered. All 12,099 occupations in the Dictionary of Occupational Titles (U.S. Department of Labor, 1977) have been assigned to job families, and hence, job clusters. Because ACT's Job Clusters span the world-of-work, the ASVAB-14 Job Cluster Scales are comprehensive in their occupational coverage.

Models for Test Interpretation

Ability measures traditionally have been used in career (occupational and educational) counseling to identify career groups with ability profiles (patterns) similar to those of the counselee. Groups so identified constitute career options the counselee may wish to consider and explore. Thus, the "profile similarity model" for test interpretation (e.g., see Cooley & Lohnes, 1968; Goldman, 1971; Prediger, 1974; Tiedeman, Rulon, & Bryan, 1951) is followed rather than the "success prediction model" traditional to personnel psychology. Some limitations of the success prediction model are discussed below. (Also see Goldman, 1972.)

Counseling Limitations of the Success Prediction Model

One of the fundamental tasks in personnel selection is to identify the most promising applicants for Occupation X on the basis of test-derived predictions of success or performance, as defined by Organization Y. In contrast, tests are commonly used in

career counseling to help counselees identify appropriate occupations from among all possible occupations, regardless of organization. If predictions of success or performance are to be used to accomplish this task, counselors face the problems of obtaining predictions for a wide variety of occupations and helping counselees compare and evaluate the predictions. These problems suggest some important questions and concerns. For example, are useful measures of success or performance available for the wide variety of occupations considered in career counseling? (See Thorndike, 1982, for a discussion of the many shortcomings of success indicators and their lack of general availability.) What level of performance does a percentile rank of 55, for example, on the ASVAB-14 Academic Ability Composite predict for occupations such as insurance agent, machinist, actuary, commercial artist, elementary school teacher, chef, lawyer, farmer? Are the performance predictions on a common scale? If not, how can counselees compare the predictions for insurance agent, machinist, commercial artist, etc.?

If we cannot predict level of performance on a comparable scale for a wide range of occupations, what about probability of success? What do we mean by success as an insurance agent, machinist, commercial artist, etc.? Can probabilities of success be compared if success is defined differently from occupation to occupation? What about the counselee's own definition of success? (In personnel selection, "success" is defined by the organization.)

Research has shown that test-performance correlations differ across occupations. These differences affect the spread of performance predictions from occupation to occupation. If correlations are low, performance predictions in the average range will be provided to nearly everyone, regardless of test scores. Thus, the highest performance predictions for some counselees will be for occupations for which tests have little validity. How do counselees compare such predictions with predictions for occupations for which tests do well?

The importance of general cognitive ability ("g") in personnel selection has been addressed in a number of recent reports (e.g., see articles by Hunter, Jensen, Thorndike, and others in the December, 1986 issue of the Journal of Vocational Behavior). Much of the emphasis on g has grown out of selection-oriented research using correlation analysis. Despite the many shortcomings of success indicators (Thorndike, 1982), the results of this research are interpreted as showing that g is sufficient for predicting success or performance in nearly all occupations--that more specific abilities (e.g., spatial, clerical, mechanical, sales, leadership, organizational) are of minor importance, at best.

Results of the four studies described in this report indicate that g is of secondary importance in career counseling applications of ability measures. Nevertheless, if g is given primary attention in career counseling--to the exclusion of other abilities--how do counselees evaluate the resulting performance predictions? High levels of performance in "low g" occupations will be predicted for nearly all counselees. Low levels of performance in "high g" occupations will be predicted for nearly all counselees. Sales, leadership, organizational, etc. abilities will largely be ignored. Will counselees be encouraged to enter "low g" occupations by predictions of high levels of performance based on a narrow range of abilities?

DISCOVER's ASVAB-14 Interpretation Procedures

Because of the apparent limitations in the success prediction model noted above, DISCOVER follows the profile similarity model for test interpretation in its use of

ASVAB-14 Job Cluster Scales. A counselee's ability profile (i.e., the three highest ASVAB-14 Job Cluster Scales) is used to identify job families with similar ability profiles. (The procedure for linking a counselee's profile to job families is described by Prediger, 1981b). Counselees are referred to occupations in those job families. The occupations are arranged according to typical level of education/preparation so that a counselee's educational plans and ability pattern level can be taken into account as the occupations are considered. Further exploration of occupations is encouraged in order to determine the possibility of preparation and likelihood of success. Finally, counselees are encouraged to compare occupational attributes (e.g., economic security, task variety, independence) with what they value in a job.

The ASVAB-14 score interpretation procedures described above were developed for several reasons. First, DISCOVER links counselee characteristics to a wide range of occupations. Many of them (e.g., college-level occupations and various occupations in the business contact, social service, scientific, and artistic fields) are not covered by current ASVAB-14 interpretative suggestions (U.S. Department of Defense, 1984, 1985a). On the score report provided to high school students (U.S. Department of Defense, 1984), 38 civilian occupations are grouped according to the four ASVAB-14 Occupational Composites: Mechanical and Crafts (e.g., auto mechanic, carpenter, machinist); Electronics and Electrical (e.g., electrician, line installer/repairer, TV and radio repairer); Business and Clerical (e.g., clerk typist, payroll clerk, stenographer); and Health, Social, and Technology (e.g., cook, dental assistant, exterminator, reporter). In contrast, DISCOVER currently links to 23 job families and 425 occupations spanning the work world. Potentially, DISCOVER can link to all occupations via the ACT Occupational Classification System.

Second, DISCOVER collects self-estimates for career-related abilities that are seldom assessed by paper-and-pencil tests (e.g., sales, leadership, organizational, creative/artistic). Such abilities are relevant to a wide range of occupations. (Issues related to the use of ability self-estimates in career counseling are addressed in the discussion section of the Study 1 report.) In DISCOVER, self-estimates of ability and ability test scores (when available) are linked to occupations through job cluster scales. Thus, DISCOVER systematically collects, integrates, and interprets scores for a wide range of abilities. The ASVAB-14 Job Cluster Scales are an extension of standard DISCOVER procedures for the use of ability measures in career counseling.

Third, ASVAB-14 interpretive procedures appear to be based on the success prediction model--e.g., prediction of success (performance) is the focus of ASVAB-14 validity studies (U.S. Department of Defense, 1985b). Counseling limitations of the success prediction model have been noted. In addition, evidence that the seven ASVAB-14 Composites make unique contributions to the prediction of occupational performance is lacking. (The delimiter "-14" will be dropped from "ASVAB-14" when parallel forms of the ASVAB are discussed.) One ASVAB Composite appears to do about as well as another in predicting performance in a diverse range of military occupational specialties (e.g., see Maier & Truss, 1985; McLaughlin, Rossmeissl, Wise, Brandt, & Wang, 1984). ASVAB-14 reviewers (Jensen, 1985; Murphy, 1984) have concluded that the ability of ASVAB-14 Composites to predict occupational performance derives from common variance closely related to general cognitive ability. This conclusion is supported by an extensive summary of ASVAB validation studies recently reported by Hunter, Crosson, and Friedman (1985).

Hunter et al. note that "according to the specific aptitude theory [which underlies use of the ASVAB-14 Occupational Composites], the validity of each high school occupational composite should be high only for jobs in the corresponding occupational area" (p. 117). To see if this expectation is met, Hunter et al. conducted analyses of performance data (sometimes called "success" data) for 103,791 military trainees in 190 "jobs" grouped into 24 occupational areas. As predictors, they used an ASVAB-based measure of "General Cognitive Ability" (or g) in addition to the usual ASVAB composite scores.

For 15 of the 24 occupational areas (62%), the average correlation between performance and General Cognitive Ability was equal to or greater than the average correlation between performance and the ASVAB Occupational Composite appropriate to (i.e. constructed for) the occupational area. For 16 of the 24 occupational areas (67%), the average performance correlation for an inappropriate ASVAB Occupational Composite was equal to or greater than the average performance correlation for the appropriate composite. Thus, the ASVAB Occupational Composites predicted best in their own occupational areas only about one-third of the time. Such results indicate a "lack of differential validity" (p. 117), as noted by Hunter et al. They conclude that the ASVAB Occupational Composites "are variants of a General Cognitive Ability composite" (p. 142). Thus, it is difficult to understand why they state that the composites "are extremely useful in vocational guidance and counseling with respect to civilian occupations" (p. 144).

We learn from the Hunter et al. research that there is no reason to use four separate ASVAB-14 Occupational Composites if prediction of occupational performance is the goal. What they call General Cognitive Ability does at least as well. However, the ASVAB-14 score report suggests that the four composites are uniquely relevant to four corresponding occupational areas (e.g., see the "occupational groupings" and occupations listed on the back of the score report). The Hunter et al. findings indicate that the ASVAB-14 score report is misleading in this regard. That is, there is no reason to believe that scoring highest on a particular ASVAB-14 Occupational Composite predicts greater success in occupations listed for that composite than for other occupations. Perhaps such an interpretation is not intended. Perhaps the profile similarity model is implied in the interpretation of ASVAB-14 Composites. Perhaps counselees are being told, in effect, "Your ability pattern is most similar to persons in occupations listed for your highest ASVAB-14 Composite." DISCOVER's interpretive procedures for the ASVAB-14 Job Cluster Scales make explicit use of the profile similarity model.

Summary of Related Validity Studies

If DISCOVER's use of the profile similarity model for ASVAB-14 interpretation is justified, persons pursuing diverse occupations must score differently on ability measures--the ASVAB-14 Job Cluster Scales, in particular. That is, ability patterns (mean scores) for diverse occupational groups ("criterion groups") must differ significantly. In addition, the ability patterns must be appropriate to the work tasks characterizing the occupational groups. If, for example, groups composed of insurance agents, machinists, actuaries, and commercial artists have similar ability patterns, the validity and usefulness of the ability measures would be in serious doubt. Although the measures might predict "success" in each of the occupations, one could infer that the success criteria have little relevance to the highly diverse work tasks characterizing the occupations.

This report describes the results of four validity studies bearing on use of the profile similarity model for the interpretation of ASVAB-14 scores. Each study follows the known-group method for assessing the construct validity of measures (e.g., see Cronbach & Meehl, 1955; Hattie & Cooksey, 1984; Thorndike, 1982). The first and second are concurrent validity studies with criterion groups based on occupational choice. The third is a longitudinal with criterion groups based on occupational membership. The fourth is a longitudinal study with criterion groups based on educational program membership at community, vocational, and technical colleges. Three of the studies address the validity of scores based on various combinations of tested and self-estimated abilities.

Only the first study includes ASVAB-14 Composites and ASVAB-14 Job Cluster Scales. However, the other three studies provide a context for judging the relevance of ability measures, in general, and ASVAB-14 Job Cluster Scales, in particular, to career counseling based on the profile similarity model. Stated differently, the four studies replicate counseling-related validity analyses involving a variety of ability measures (tested and self-estimated) and criterion groups. As a by-product, they provide information on the relative importance of general cognitive ability in career counseling applications of ability measures.

An overview of Studies 2-4 is provided below. Study procedures and results are described in Appendix A.

Study 2

Study 2 involved a cross-sectional sample of 1,001 high school seniors who completed ACT's Career Planning Program (CPP; ACT, 1983) during the 1983 national norming. Students who were "very sure" of their occupational choices were assigned to one of ACT's six job clusters. The job clusters served as criterion groups in the validation analyses. (See the discussion of occupational choice as a criterion for test validation in the introduction to Study 1.)

Multivariate statistical analyses showed that the six job clusters differed substantially on (a) the six CPP Ability Tests, (b) a set of nine self-estimates of ability, and (c) six CPP Job Cluster Scales composed of the CPP Ability Tests and self-estimated abilities. (The CPP Job Cluster Scales closely parallel the ASVAB-14 Job Cluster Scales.) Total variance attributable to job cluster differences in ability (as shown by the Wilks index) ranged from 38% for the CPP Ability Tests to 52% for the CPP Job Cluster Scales--values that are statistically significant at far beyond the .01 level.

Four independent ability factors were needed to account for job cluster (occupational choice group) differences on the CPP Job Cluster Scales. Job cluster differences in ability generally were in line with work task differences. General cognitive ability played a minor role in differentiating the job clusters.

Study 3

Study 3 involved a cross-sectional sample of 1,650 high school juniors who completed the CPP during the 1973 national norming. Approximately 6 years later, these students responded to a survey concerning the occupations they were pursuing. On the basis of their survey responses, students were assigned to one of ACT's six job clusters. As before, the job clusters served as criterion groups.

Multivariate statistical analyses showed that the six job clusters differed substantially on the six CPP Ability Tests. Total variance attributable to job cluster differences in ability was 27%, a value that is statistically significant at far beyond the .01 level.

Two independent ability factors were needed to account for job cluster (occupational group) differences. Job cluster differences in ability generally were in line with work task differences for CPP abilities paralleling work tasks. General cognitive ability played a secondary role in differentiating the job clusters.

Study 4

Study 4 involved a cross-sectional sample of 4,607 community/vocational/technical college students who completed the CPP early in their first term. At the end of the first term (approximately 4 months after testing), program of enrollment was obtained from students who were still enrolled, who had obtained a first-term grade-point-average (GPA) of "C" or higher, and who expressed satisfaction with their program choice. Sample sizes sufficient for analysis were available for 22 programs--e.g., auto mechanics, agriculture, business administration (transfer), computer programming, cosmetology.

Multivariate statistical analyses showed that the educational program groups differed substantially on the six CPP Ability Tests, high school GPA, and a set of five self-estimated abilities. Total variance attributable to program differences in ability was 44% for both males and females, a value that is statistically significant at far beyond the .01 level.

Three independent ability factors appeared to account for program differences. A factor similar to general cognitive ability accounted for the largest proportion of among-program variance (46%) in the analysis for males. In the analysis for females, general cognitive ability was of secondary importance. Additional factors identified in the analyses for males and females were labeled "clerical versus technical/scientific" and "artistic." Educational program differences on the three factors generally appeared to make good sense. There were substantial program differences on abilities independent of general cognitive ability.

Relevance of Studies for ASVAB-14

Taken together, results from Studies 2-4 show that career-related criterion groups differ substantially and sensibly on a wide variety of abilities--tested and self-estimated, cognitive and non-cognitive. Thus, interpretation of ability measures via the profile similarity model is supported. Study 2 and 4 results for scores derived from combinations of tested and self-estimated abilities (e.g., the CPP Job Cluster Scales) have special relevance for ASVAB-14 Job Cluster Scales. The combinations of tested and self-estimated abilities were found to be effective in differentiating occupational groups and educational programs. The report for Study 1 that follows focuses on the counseling-related validity of the ASVAB-14 Job Cluster Scales and their components.

STUDY 1: DIFFERENTIATION OF OCCUPATIONAL CHOICE GROUPS BY ASVAB-14 COMPOSITES AND ASVAB-14 JOB CLUSTER SCALES

Study objectives were as follows: (a) to determine whether high school juniors and seniors choosing a diverse range of occupations score differently on the Armed Services Vocational Aptitude Battery Form 14 (ASVAB-14) and on nine self-rated abilities; (b) to determine whether ASVAB-14 Job Cluster Scales combining ASVAB Composite scores and ability self-ratings provide better differentiation than ASVAB-14 Composite scores; (c) to compare ASVAB-14 results with Career Planning Program (CPP) results for the same sample; and (d) to determine whether ability differences among occupational choice groups are appropriate to the work tasks characterizing the occupations.

Occupational Choice as a Criterion for Test Validation

Research has repeatedly shown that the occupational choices of young adults are reasonably predictive of subsequent choices and employment, especially when choices and occupations are categorized into broad groups. McLaughlin and Tiedeman (1974), for example, examined the "career stability" (p. 185) of a nationally representative sample of 9,588 high school senior males who reported occupational plans in 1960 and again in 1965 and 1971. The occupational plans of each sample member, as reported in 1960, 1965, and 1971 were allocated to one of Holland's (1973) six occupational groups. The 5-year and 11-year correspondence (hit) rates for the occupational plans of the high school seniors were 45% and 39%, respectively.

Cairo (1982) obtained the occupational choices of a cross-section of 18-year-old males and compared them with actual occupation at age 36. For purposes of comparison, the occupational choice and subsequent occupation of each of the 83 sample members were assigned to one of Roe's (1956) eight occupational groups. The 18-year hit rate for occupational choice versus occupation was 35% for Roe's eight category system. No data were reported for Holland's six category system. On the assumption that the Roe and Holland occupational classification systems are equally effective (i.e., they differ only in number of classification categories), the Brennan-Prediger (1981) index can be used to estimate a hit rate for the six category Holland system. That estimate, 38%, is nearly identical with the 11-year hit rate in the McLaughlin-Tiedeman (1974) study.

Further evidence that the occupational choices of young adults are reasonably predictive of subsequent employment is provided by Bartling and Hood (1981) in a study that compared the occupational choices of 408 college-bound students (239 males and 169 females) with occupations 11 years later. Occupational choices and occupations were both classified according to Holland's (1973) occupational typology. Three levels of agreement between occupational choice and occupation were determined: "good hit," "poor hit," and "clean miss." Bartling and Hood's definition of a "good hit" was similar (but not identical) to agreement between the Holland group corresponding to occupational choice and the Holland group corresponding to actual occupation. Thus, their "good hit" rate provides an index of career stability similar to the others reported here. The 50% hit rate reported by Bartling and Hood is higher than the hit rates reported in the other studies, possibly because only college graduates were included in their study.

Data for the Study 3 final sample (see Appendix A) also bear on the relevance of occupational choice as a criterion for test validation. Each sample member's occupational preference in Grade 11 was allocated to one of the six ACT Job Clusters and compared with the job cluster containing occupation pursued 6 years later. (As

previously noted, ACT Job Clusters parallel Holland's occupational groups.) The overall hit rate for cluster preferred versus cluster pursued was 42%. The hit rates for 11th graders who said they were "very sure," "fairly sure," or "not sure at all" of their occupational preferences were 46%, 45%, and 33%, respectively. Thus, the predictive value of occupational preference varied by level of certainty, as one would expect.

For five of the six preference clusters, the number of students pursuing an occupation in the same cluster 6 years later constituted a plurality. The exception was the Arts Cluster. Only 10% of the 143 11th graders choosing artistic occupations were pursuing related occupations 6 years later. Of the 1,650 persons in the final sample, only 30 were pursuing artistic occupations. Thus, there appears to have been little opportunity to implement preferences for artistic occupations.

Because of the effects of the labor market on occupation pursued, regardless of job cluster, one might argue that occupational choice is superior to occupation pursued as a criterion for construct validity studies. Many persons, of necessity, find jobs wherever they can--even though their abilities may be better suited to something else. Gottfredson (1979), for example, documents the disparity between the occupational choices ("aspirations") of males in their late teens and the distribution of occupations held by males in their mid to late 20s. She concludes that her study results are "a vivid reminder that the occupational world severely constrains the options of workers and that workers must in some way adjust to this reality" (p. 325). Given the constraints of the labor market, occupational choice and occupation pursued provide different criteria for validating ability measures. Each would appear to have certain advantages.

Taken together, the studies cited above (and others reviewed by Whitney, 1969) indicate that many students establish a general direction for their careers during the high school years. To the extent that they have had an opportunity to develop and explore their abilities through experiences both in and out of school, their occupational choices should reflect personal strengths rather than weaknesses. Thus, occupational choice provides a useful criterion for validating ability measures--especially when accompanied by a screen for certainty, as in this study. If expected differences in the abilities of persons in various occupational choice groups do not occur, serious questions could be raised about the validity of the ability measures.

In this study, criterion groups based on occupational choice provided a common basis for comparing the validity of ability tests used alone and job cluster scales based on tested and self-rated abilities. The results of this study should be considered in the context of the related results of Studies 2, 3, and 4 reported in Appendix A. Study 2 is especially pertinent since it also involves the use of job cluster scales based on tested and self-rated abilities. Study 4 involves statistically derived composites based on tested and self-rated abilities.

Method

Sample

Study objectives required that self-rated abilities and occupational choices be available for students who had taken the ASVAB-14. Since neither is collected during ASVAB-14 administration, the information was obtained from score reports for students who had also taken the CPP. CPP results were available in ACT's archives

for all high school juniors and seniors who had taken the CPP from 1983 to 1986. A sample of 218 high schools that had administered the CPP to at least 100 juniors or seniors in 1984-85 and/or 1985-86 was contacted by mail early in June 1986. (Prior to and subsequent to the mailing, 18 schools were contacted by phone to explore likely response rates.) Schools that had administered the ASVAB-14 to at least 20 students were asked to send ACT a copy of the ASVAB-14 score roster for their students. By July 15, 1986, rosters listing ASVAB-14 Composites for 3,169 students were received from 32 of the 218 schools. Each school also provided information on total enrollment by grade.

When at least 25% of the students in a grade had taken the ASVAB-14, computer records containing the seven ASVAB-14 Composite scores were created for each of the students. (This percentage screen was used to eliminate schools that administered the ASVAB-14 to relatively few students.) ASVAB-14 and CPP student records were then matched by name, and matched records were merged. Thus, student records containing both ASVAB-14 and CPP data were created.

The ASVAB-CPP matched sample consisted of 1,109 students in 7 schools located in the following 5 states: Florida (1), Illinois (1), North Dakota (2), Ohio (2), and Texas (1). One school reported ASVAB-14 Composite scores for both Grades 11 and 12. Hence, there were 8 groups differentiated by school and grade. Table 1 provides an overview of sample sizes and test administration dates by group. (See Appendix D for tables.)

As shown by Table 1, all CPP testing was completed in Grade 11. Time between CPP and ASVAB-14 administrations ranged from 2 to 12 months, with a median of 7.5 months. In six of the eight groups, the CPP was administered first.

Students attending schools that participated in the study may be atypical in that volunteers rather than an entire grade often complete the ASVAB-14. In addition, schools in the study had conducted an unusual amount of vocational testing (i.e., administered both the CPP and ASVAB-14) within the span of 1 year. Nevertheless, the ASVAB-CPP matched sample appears to contain a broad cross-section of high school juniors and seniors. For example, females constituted 51% of the sample. The racial/ethnic distribution was as follows: 71% Caucasian-American/White, 11% Afro-American/Black, 9% other (e.g., Asian-American), and 9% who preferred not to respond. Response percentages for the question "What is the greatest amount of education you plan to complete during your life?" ranged from 3% for high school graduation to 60% for 4 or more years of college. Twenty-six percent planned post-high-school programs of 2-years of less. Five percent choose the category "apprenticeship program; job training program in the military."

The distribution of student occupational preferences across ACT Job Clusters was as follows: Business Contact (11%), Business Operations (16%), Technical (13%), Science (23%) Arts (16%), and Social Service (22%). On the average, these figures differ by only 3 percentage points from national data for 12th graders (ACT, 1985). Mean CPP Ability Test stanines ranged from 5.2 (Numerical Skills) to 5.5 (Language Usage) with a median of 5.3 for the six tests. National means and standard deviations are 5.0 and 2.0, respectively.

Variables

Occupational group membership. When they completed the CPP, students were asked to find, on a list of 140 occupations, the occupation "closest to the one you

are considering." The occupations on the list were grouped by ACT Job Cluster and, within job cluster, by ACT Job Family. For purposes of analysis, occupational choices were categorized into job families and job clusters. Students who preferred not to specify an occupational preference (n = 37) or who had invalid responses (n = 21) could not be included in the validation analyses. After screening, 1,051 cases were assigned to job clusters and job families (95% of the matched sample).

Certainty of occupational choice. Certainty of occupational choice was determined from a student's response to the following question: "How sure are you that the occupational choice you selected . . . will still be your first choice one year from now?" Only the 293 students answering "very sure" were eligible for the analysis group (28% of the classifiable cases) used to address the first three objectives of this study. Additional screening for cases missing any of the ASVAB-14 Composites, CPP Ability Test scores, or self-ratings yielded an analysis group of 290 students who had completed the ASVAB-14 within 2 to 12 months of completing the CPP.

ASVAB-14 Composites. As noted above, ASVAB-14 Composite scores were obtained from student rosters supplied by schools in the study sample. The seven ASVAB-14 Composites (see titles in Table 3) consist of from two to four subtests (U.S. Department of Defense, 1984). Figure B3 in Appendix B describes the subtests in each of the seven ASVAB-14 composites. A report by the U.S. Department of Defense (1985b) provides psychometric data. Grade-by-sex percentile ranks for each ASVAB-14 Composite were recorded from the student rosters. The percentile ranks, which are provided to students on the ASVAB-14 score report, were then transformed to stanines.

CPP Ability Tests. The 1983 edition of six CPP Ability Tests (ACT, 1983) were used in the study. These tests are wide-band measures (Cronbach and Gleser, 1957) of developed abilities intended for use, along with CPP interest and experience measures, in the early stages of career planning. A report by ACT (1985) provides psychometric data. Brief descriptions of the tests are provided below. The stanine scores used in this study were based on combined-sex norms obtained in the 1983 national norming (ACT, 1985; Sawyer and Logan, 1985).

> Reading Skills (40 items, 20 minutes): Assesses the ability to read and understand factual material and to address the more subtle aspects of comprehension (e.g., interpretation). The test is composed of short paragraphs on career-related topics, each followed by multiple-choice questions.
>
> Language Usage (64 items, 11 minutes): Assesses recognition of inappropriate uses of the English language (e.g., errors in punctuation, capitalization, grammar, sentence structure). Examinees judge whether underlined parts of sentences are correct or incorrect.
>
> Numerical Skills (32 items, 18 minutes): Assesses basic arithmetic skills ranging from simple computation to the application of mathematical principles. Word problems are included.
>
> Clerical Skills (35 items, 5 minutes): Assesses perceptual speed and accuracy through a repetitive task involving several steps and a look-up table.

Space Relations (35 items, 9 minutes): Assesses the ability to visualize relations among three-dimensional objects from two-dimensional representations.

Mechanical Reasoning (30 items, 12 minutes): Assesses understanding of the way mechanical devices function and the physical principles governing the movement and interaction of objects.

Ability ratings. (Issues related to the use of self-rated abilities in career counseling are addressed in the discussion section of this report.) When students completed the CPP, they provided self-ratings for the nine abilities listed below. For each ability, students were asked to rate themselves, as compared with persons their own age, on the following 3-point scale: "Low (lower 25%)," "medium (middle 50%)," and "high (upper 25%)."

Scientific: Understanding scientific principles, doing science course work.

Creative/Artistic: Drawing, painting, playing a musical instrument, acting, dancing.

Creative/Literary: Expressing ideas or feelings through writing.

Helping Others: Caring for or teaching others, making others happy.

Meeting People: Talking with people, getting along with others, making a good impression.

Sales: Influencing people to buy a product or take a suggested course of action.

Leadership/Management: Leading/managing people to work cooperatively toward a common goal.

Organization: Keeping track of details, doing things in a systematic way.

Manual Dexterity: Making or repairing things easily and quickly with one's hands.

The stability of the self-ratings over a 5-week interval was studied for a group of 204 12th graders in two high schools. For each ability, the extent to which a student's rating changed from the first to second administrations was tallied. For example, if a student's self-rating changed from low to high or high to low, a change of two categories was tallied. The extent of change over the 5-week interval varied somewhat from ability to ability. Medians across the nine abilities were as follows: No change (64%), change of one category (34%), change of two categories (2%). Specifics are provided in a report by ACT (1985).

ASVAB-14 Job Cluster Scales. The content of six ASVAB-14 Job Cluster Scales paralleling the six ACT Job Clusters is described in Appendix B. Each ASVAB-14 Job

Cluster Scale is based on a combination of one or two ASVAB-14 Composite stanine scores and one or two ability self-ratings transformed to approximate stanine equivalents. A student's three stanines for the abilities assigned to a given ASVAB-14 Job Cluster Scale were added together. The sum was then converted to a standard score through use of the ASVAB-14 Job Cluster Scale means and standard deviations based on all students in the ASVAB-CPP matched sample. Thus, each student in the final sample had scores for six ASVAB-14 Job Cluster Scales paralleling the six ACT Job Clusters.

CPP Job Cluster Scales. The content of six CPP Job Cluster Scales paralleling the six ACT Job Clusters is shown in Table 2 (see Appendix D). Each scale is based on a combination of CPP Ability Tests and self-ratings. The procedures used to obtain scale scores were the same as those used in DISCOVER, ACT's computer-based career planning system. Self-ratings were transformed to approximate stanine equivalents. Then, a student's stanine scores for the four tested and self-rated abilities assigned to a given job cluster scale were added together. Finally, the sum was converted to a standard score through use of CPP Job Cluster Scale means and standard deviations based on all students in the ASVAB-CPP matched sample. Intercorrelations for parallel CPP and ASVAB-14 Job Cluster Scales ranged from .83 to .91 (median of .89) for the matched sample.

Analysis Plan

Three related statistical procedures--multivariate analysis of variance (MANOVA), discriminant analysis (DISANL), and hit rate analysis--were used to address study objectives. The nature and relevance of these procedures are described in Appendix C. For an extended discussion, see Tabachnick and Fidell (1983) and Tatsuoka (1971). Analyses were performed through use of SPSSX DISCRIMINANT routines (SPSS Inc., 1983).

Differentiation of occupational choice groups. The first study objective (to determine whether occupational choice groups score differently on the ASVAB-14 and on self-rated abilities) was addressed through the use of MANOVA and hit rate analyses. As previously noted, each student in the final sample was assigned to one of the six ACT Job Clusters on the basis of his or her occupational choice. The job clusters served as criterion groups in the analyses addressing the first study objective. Final sample sizes for the job clusters were as follows: Business Contact (26), Business Operations (34), Technical (42), Science (56), Arts (52), and Social Service (80).

The dimensionality of job cluster (occupational choice group) differences was determined through the use of DISANL. Cluster hit rates were determined from group similarity indices, as described in Appendix C. The relatively small number of cases per job cluster precluded having both an analysis sample and a cross-validation sample Hence, hit rates were not cross-validated and may be somewhat inflated. Data on the relative performance of the various sets of ability measures are, nevertheless, relevant to study objectives. (Studies 2 and 3 included cross-validation groups.)

Comparison of job cluster scales with ability tests. The second and third study objectives were addressed by comparing validation data for the seven ASVAB-14 Composites, the six CPP Ability Tests, the six ASVAB-14 Job Cluster Scales, and the six CPP Job Cluster Scales. To facilitate comparisons, MANOVA, DISANL, and hit rate results were obtained.

Appropriateness of choice group differences. The fourth study objective (to determine whether ability differences among the occupational choice groups make sense) was addressed by developing mean ability profiles for job families. Job families rather than job clusters were used because ability expectations are clearer for the more specific job families. Also, the ability profile peaks and valleys for a given job cluster may be blurred due to variation in the work tasks characterizing job families in the cluster. Finally, means for a given job cluster are sensitive to the relative sizes of the job families in the cluster. The larger the job family, the more influence it will have on the job cluster mean. Thus, the results for a job cluster may be dominated by the results for one or two job families.

Because only 5 of the 23 job families had 20 or more analysis-group students, the certainty screen was relaxed for the analyses addressing the fourth objective. The 819 students answering either "very sure" or "fairly sure" to the certainty question (78% of the classifiable cases) were included in the analyses. Of the 23 job families, 15 had at least 20 students with a complete set of ASVAB-14 Composite scores.

The effect of relaxing the certainty screen in order to provide a sufficient number of cases for the profile analyses should be conservative. That is, to the extent that students are uncertain of their occupational choices, expected ability differences among occupational choice groups will be less likely to occur. If, for example, students are completely uncertain and choose occupations at random, no ability differences would be expected beyond chance variation.

Readers may wish to use two approaches to checking ability profiles against expectations. Through an intra-occupational analysis, the mean ability profile for a given job family can be examined in light of the work tasks characterizing the job family. Does the Vehicle Operations and Repair Job Family, for example, score higher on the ASVAB-14 Mechanical and Crafts Composite than the other composites? Through an inter-occupational analysis, job family means can be compared, one ability at a time. Expectations regarding which job families will score highest and lowest on the ASVAB-14 Mechanical and Crafts Composite, for example, can be checked against study results.

Results

Differentiation of Occupational Choice Groups

Overall differentiation. Results addressing the first three study objectives are presented in Tables 3-7 (see Appendix D). For each of the five sets of measures, Wilks's lambda is significant at far beyond the .01 level. (See table footnotes.) These results indicate that job cluster (occupational choice group) differences in ability cannot reasonably be attributed to chance.

The proportion of total variance attributable to job cluster differences (as measured by the Wilks index) ranged from 30% for the ASVAB-14 Composites to 58% for the ability self-ratings. Overall hit rates ranged from 34% for the ASVAB-14 Composites to 49% for the ASVAB-14 Job Cluster Scales. Improvement over chance, as determined by the Brennan-Prediger (1981) index (see Appendix C), ranged from 21% to 39%. For the ASVAB-14 Job Cluster Scales, hit rates for the six job clusters were as follows: Business Contact (46%), Business Operations (47%), Technical (69%), Science (39%), Arts (54%), and Social Service (40%).

These results indicate that the ASVAB-14 Job Cluster Scales did the best job of differentiating the job clusters, as determined by the hit rates; whereas, the self-ratings performed the best, as determined by the Wilks index. From a practical standpoint, differences were slight, however. Statistical tests for the significance of differences in results for the various sets of measures are not available.

Univariate F values for the ASVAB-14 Job Cluster Scales were somewhat higher, overall, than the F values for the other four sets of measures. The F values for nearly all of the individual measures were statistically significant at beyond the .01 level. (See table footnotes.) The relative sizes of univariate F values do not necessarily indicate the unique contribution of measures to job cluster differentiation, however. When the measures are analyzed simultaneously, as in MANOVA, some may contribute little due to redundancy.

Table 3, for example, shows that the ASVAB-14 Math Composite ranked sixth in terms of unique contribution, although its univariate F value ranked first. Results for the ASVAB-14 Mechanical and Crafts Composite are reversed; unique contribution ranked first but the F value ranked last. The CPP Mechanical Reasoning Test, on the other hand, ranked first both in terms of unique contribution and univariate F value (Table 4). Other comparisons of data for the ASVAB Composites and CPP Ability Tests are difficult because of differences in what the tests are designed to assess.

Comparisons of data for the ASVAB-14 Job Cluster Scales and CPP Job Cluster Scales (Tables 6 and 7) indicate some differences in the contribution of like-named scales. These differences no doubt reflect differences in the ability tests used in a given scale. Results for the CPP Job Cluster Scales are highly similar to those obtained for the more comprehensive Study 2 sample (see Appendix A, Table 15). In addition, Study 1 and 2 Wilks's lambdas are identical; hit rates are nearly identical; and four discriminant functions are warranted in both studies. These consistencies provide additional evidence that students in the current study represent a reasonable cross-section of students in general. (Students in Study 2 were part of a nationally representative sample.)

Dimensions of differentiation. When judged on the basis of the univariate F values, the ASVAB-14 Composites perform relatively well. However, the MANOVA and hit rate results place the ASVAB-14 Composites last among the five sets of ability measures. A possible explanation for this finding is that the ASVAB-14 Composites contain a substantial amount of overlapping variance. This explanation is supported by the DISANL results which show that only two discriminant functions are warranted for the ASVAB-14 Composites. In contrast, four functions are warranted for the ASVAB-14 Job Cluster Scales and CPP Job Cluster Scales. Thus, the nature of job cluster differences on these latter measures is more complex.

As shown by Table 3, the first discriminant function obtained for the ASVAB-14 Composites accounted for about half of their discriminating power. Correlations (not shown in Table 3) between the discriminant function and the seven ASVAB-14 Composites ranged from .71 to .94, with a median of .90. These results indicate a strong general cognitive ability component, as noted in the Hunter et al. (1985) study. Some evidence for a similar component was found for the second, relatively weak, discriminant function for the CPP Ability Tests. Second function correlations with the six ability tests ranged from .33 to .95, with a median of .65. The first function correlated primarily with Mechanical Reasoning (.90) and Space Relations (.71). The other four correlations ranged from .00 to .24. No evidence of a general cognitive ability component was found for the other three sets of measures.

Given these results, it appears that occupational choice group differentiation achieved by the ASVAB-14 Composites depends primarily on differences in general ability level; whereas, differentiation achieved by the ASVAB-14 Job Cluster Scales depends primarily on ability pattern, since there was no evidence of a general cognitive ability factor. If this is the case, the mean ability profiles for job families should provide supportive evidence.

Appropriateness of Choice Group Differences

Figures 2 through 5 show, for each of the six ACT Job Clusters, mean ability profiles for the job family with the most students. Tables 8-12 provide means for all job families with 20 or more students. (See Appendix D for tables and Appendix E for figures.) Because the ASVAB-14 Job Cluster Scales and CPP Job Cluster Scales are occupationally oriented, the reasonableness of a job family's ability profile for these scales is relatively easy to determine.

Each of the six job families depicted in Figure 4 has a peak score on a different ASVAB-14 Job Cluster Scale. More important, the scales with peak scores appear to correspond to predominant work tasks. For example, the Engineering Job Family scores highest on the Science Job Cluster Scale, with Technical ranking a close second. The Financial Transactions Job Family scores highest on the Business Operations Scale, with Business Contact ranking second. The General Health Care Job Family scores highest on the Social Service Scale, with Science ranking second. (Also see Table 11.)

Results for the CPP Job Cluster Scales (Figure 5) are similar, with one exception. The Engineering Job Family scores highest on the Technical Scale, with Science ranking second. Overall, results for the intra-occupational analyses appear to make good sense.

Overall, results for the inter-occupational analysis also appear to make good sense. For example, Figure 4 shows that the Management and Planning Job Family ranks highest on the ASVAB-14 Business Contact Job Cluster Scale; the Applied Arts Job Family ranks highest on the Arts Scale; and the General Health Care Job Family ranks highest on the Social Service Scale. Results for the Business Operations Scale may seem puzzling in that the Engineering Job Family ranks slightly higher than the Financial Transactions Job Family. (Means for these two job families are essentially tied for highest.) The Engineering Job Family, however, ranks relatively high on all of the ASVAB-14 Job Cluster Scales. Hence, it is surprising that reversals are not more frequent. Further analysis of job family performance on the job cluster scales are left to the reader.

Expectations regarding the results of intra-occupational and inter-occupational analyses of ASVAB-14 Composite scores and CPP Ability Test scores are less clear due to lack of a close correspondence between some of the ability measures and work tasks characterizing the job families. However, one would not expect all six job families to score highest on the ASVAB-14 Business and Clerical Composite, as shown by Figure 2. On the ASVAB-14 score report, only business and clerical occupations are suggested to students who score highest on the Business and Clerical Composite. Other occupations are keyed to high scores on other ASVAB-14 Composites. Hence, one would expect job families (e.g., General Health Care) pertinent to the other ASVAB-14 Composites (e.g., Health, Social, and Technology) to score highest on those composites. The results shown by Figure 2 do not support this expectation; but they

are congruent with the Hunter et al. (1985) conclusion that the composites lack differential validity. (Also see Table 8.)

In general, differentiation (distance between peaks and valleys) is substantial for the ASVAB-14 Job Cluster Scales and CPP Job Cluster Scales. The difference between ASVAB-14 Job Cluster Scale peaks and valleys varies from .9 stanine units for the General Health Care Job Family to 1.9 stanine units for the Vehicle Operation Job Family. (The stanine scale standard deviation for individuals is 2.00 units.) The mean difference between peaks and valleys across all six job families is 1.4 stanine units for both the ASVAB-14 Job Cluster Scales and CPP Job Cluster Scales. In contrast, the mean difference is 0.6 stanine units for the ASVAB-14 Composites (Figure 2). Stated differently, job family profiles for the ASVAB-14 Composites are relatively flat. Such profiles support the supposition, noted previously, that occupational choice group differences on ASVAB-14 Composites primarily reflect differences in general cognitive ability level.

Discussion

ASVAB-14 Results in the Context of Studies 2-4

In accordance with the results of Studies 2-4 (Appendix A), the results of this study indicate that the abilities (tested and self-rated) of high school students differ substantially across broadly defined occupational choice groups. All multivariate analyses and nearly all univariate analyses of differences among the groups were statistically significant at far beyond the .01 level. As in Study 2, job cluster scales combining ability test scores and self-rated abilities provide much better differentiation of the groups than test scores alone--and the differences make good sense.

Had the multivariate analyses been conducted on specific occupations rather than comprehensive clusters of occupations (an option precluded by sample sizes and the work-task-related rationale for the criterion groups), differences may have been even more pronounced. The effect of grouping occupations into a few comprehensive job clusters is to increase within-group (within-cluster) variance relative to total-group variance. Since Wilks's lambda is based on the ratio of within-group to total-group variance, its value is increased and among-group variance (variance explained) is decreased.

As in Studies 2-4, there was no indication that occupational groups differ only in level of general cognitive ability. When a variety of abilities are assessed, occupational differences are patterned and complex. Such results indicate that a counselee's ability profile (ability pattern) can be useful in identifying potentially compatible occupations--occupations pursued by persons with similar ability profiles. More than general cognitive ability needs to be considered.

Self-rated Abilities as Tools for Career Counseling

In general, the results of Studies 1, 2, and 4 support the construct validity of self-rated abilities. (Self-ratings were not included in Study 3.) However, the use of self-ratings in career counseling may be challenged by persons who doubt their objectivity (freedom from deliberate distortion) and accuracy as indicators of "true" abilities. Certainly, self-rating scales are not objective in the sense that ability tests are. Hence, their usefulness in employee selection is limited, at best. In career counseling, however, there is no reason for deliberate distortion

of self-ratings. Thus, the value of self-ratings in career counseling depends on their accuracy.

Unfortunately, it is difficult (if not impossible) to obtain accurate, standardized measures with which to compare many work-relevant self-rated abilities. Hence, the studies reported here examined the construct validity of self-ratings. The following question was addressed: Do the self-ratings of persons pursuing various occupations and educational programs differ in an appropriate manner? In all three studies, the answer was affirmative.

One could argue that the results for ability self-ratings in Studies 1 and 2 are not compelling because occupational choices were collected concurrently with the self-ratings. Hence, the occupational choices could have been influenced by the participants' perceptions of their abilities. If those perceptions were inaccurate, then occupational choices might reflect that inaccuracy. Thus, inaccurate self-ratings and the resulting occupational choices might be congruent simply due to their common basis.

If, however, the occupational choices of young adults are inappropriate to the demands of the work world, why are their choices in substantial agreement with future occupation, as noted in the review of research on this topic? And why do young adults obtain scores on the CPP Ability Tests that are generally congruent with their occupational choices, as shown in Studies 1 and 2?

In summary, research on the congruence between occupational choice and future occupation and research on the tested abilities of occupational choice groups support the use of occupational choice as a criterion against which to validate self-rated abilities. It also seems reasonable that the occupational choices of a substantial proportion of 11th and 12th graders are based on a realistic understanding of their abilities--an understanding gained through more than 10 years of experience drawing on those abilities in and out of school. Finally, it seems reasonable that many 11th and 12th graders have had sufficient experience (direct and vicarious) with the work world to identify broad fields (if not specific occupations) appropriate to their abilities.

Given this logic and the results of the three studies of self-rated abilities reported here, it would appear that the use of self-ratings in career counseling can broaden the scope of abilities (i.e., fill gaps in the abilities) assessed via traditional ability test batteries. Everyone has and is influenced by self-estimates of abilities. Making self-estimates explicit, improving their accuracy, and systematically incorporating them in the career exploration/planning process appear to be worthy goals for measurement specialists and career counselors.

A Two-component Model for Occupational Ability Differences

In a study synthesizing occupational aptitude patterns developed by the U.S. Department of Labor for a variety of occupations, Gottfredson (1986) claims support for the proposition that "general intellectual demands are the major gradient by which aptitude demands are organized. Stated another way, differences in the general intelligence demands among jobs not only constitute the single most important aptitude distinction among jobs, but also influence or constrain all other aptitude demands in some way" (p. 285). Gottfredson acknowledges that "aptitude demand patterns of occupations arise in large part from broad differences in the tasks workers

actually perform on the job" (p.288). However, "general intelligence demands," not work tasks, are ascribed primary importance.

Gottfredson's (1986) emphasis of general intelligence does not appear to be warranted by the data presented here. Instead, results for the four studies suggest different hypotheses:

1. Basic work tasks are the major determiners of the ability (aptitude) demands of occupations. Table B1 in Appendix B defines four basic work tasks (working with data, ideas, people, and things) and shows which work tasks are associated with each of the six ACT Job Clusters and Holland's (1985) occupational groups.

2. When occupations are grouped into broad job clusters (each with a unique work task pattern), they differ mainly in ability pattern. As shown in the studies reported here, general cognitive ability is not the primary factor (discriminant function) differentiating job clusters. Job clusters with divergent work tasks have divergent and sensible ability profiles.

3. Within job clusters, occupations differ mainly in ability profile level. For example, the characteristic ability profile of some occupations in a given job cluster may center around a stanine level of 4; whereas the same general ability profile may center around a stanine level of 6 for other occupations in the cluster.

These hypotheses acknowledge that general intelligence has a role in differentiating occupations without making it "the single most important aptitude distinction among jobs" (Gottfredson, 1986, p. 285). Instead, work tasks receive primary attention. A two-component model of ability demands is proposed. Type of work task comprises the first component. Work task complexity (difficulty) comprises the second component.

The results of the studies reported here support a two-step approach to the use of ability measures in career counseling. First, use the profile similarity model to identify career groups (e.g., ACT Job Families) with ability profiles appropriate to the counselee. Second, within those career groups, search for occupations with profile levels appropriate to the counselee--e.g., occupations attainable by the counselee through further education, training, or experience.

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APPENDIX A

STUDIES PERTINENT TO THE VALIDITY OF ASVAB-14 JOB CLUSTER SCALES

The main body of this report focused on Study 1, which provided validity data for ASVAB-14 Job Cluster Scales and CPP Job Cluster Scales. The three studies reported here provide a context for judging the relevance of ability measures, in general, and ASVAB-14 Job Cluster Scales, in particular, to career counseling based on the profile similarity model. Each study included ability tests similar to those used in Study 1. Studies 2 and 4 also included self-rated abilities and ability composites based on tested and self-rated abilities. Although Study 3 did not include self-rated abilities, it is unique in that it provides counseling-related validity data based on a 6-year longitudinal study using occupational criterion groups.

STUDY 2: DIFFERENTIATION OF OCCUPATIONAL CHOICE GROUPS BY ABILITY TESTS AND JOB CLUSTER SCALES

Study objectives were as follows: (a) to determine whether high school seniors choosing various occupations score differently on an ability test battery and on nine self-rated abilities; (b) to determine whether job cluster scales combining ability test scores and ability self-ratings provide better differentiation than ability test scores; and (c) to determine whether ability differences among occupational choice groups are appropriate to the work tasks characterizing the occupations.

As described in the Study 1 report, occupational choice provides a useful criterion for validating ability measures--especially when accompanied by a screen for certainty. In this study, criterion groups based on occupational choice provided a common basis for comparing the validity of ability tests used alone and job cluster scales based on tested and self-rated abilities.

Method

Sample

Initial sample members (N = 3,768) completed Career Planning Program (CPP) tests and inventories (ACT, 1983) as 12th graders during national norming of the CPP early in 1983. The target population for the norming was all full-time 8th, 10th, and 12th grade students enrolled in public and non-public schools. Within each grade level, schools were stratified by type of control (public or private) and by estimated enrollment in the grade. Within each control-enrollment stratum, proportionate stratified sampling was conducted across geographic region and socioeconomic status of community. Schools included in the norming were selected, independently, for Grades 8, 10, and 12. The 12th graders in the initial sample were enrolled in 31 high schools. Sawyer and Logan (1985) provide a detailed description of sampling procedures.

Variables

Occupational group membership. As part of the CPP national norming, students were asked to find, on a list of 276 occupations, the occupation "closest to the one you are considering." To make this task manageable, the occupations were grouped by ACT Job Cluster and, within job cluster, by ACT Job Family. As noted in the report for Study 1, there are 23 job families in the ACT Occupational Classification System; 2 to 6 are assigned per cluster. Figure 1 in the report for Study 1 lists job cluster titles, job family titles, and examples of occupations.

For purposes of analysis, occupational choices were categorized into job families and job clusters. After screening for students who had invalid responses (n = 130), who marked "other" on the list of occupations (n = 325), or who preferred not to specify an occupation (n = 153), there were 3,160 cases assigned to job clusters and job families (84% of the initial sample).

Certainty of occupational choice. Certainty of occupational choice was determined from a student's response to the following question: "How sure are you that the occupational choice you selected . . . will still be your first choice one year from now?" Response options were "very sure," "fairly sure," and "not sure." Only student answering "very sure" were eligible for the analysis group (n = 1,140, 36% of the

classifiable cases). Additional screening for cases missing any of the ability test scores or self-ratings yielded an analysis group 1,001 high school seniors.

Ability tests and ratings. The six CPP Ability Tests used in this study were described in the report for Study 1. Titles are listed in Table 13. A report by ACT (1985) provides psychometric data.

As in Study 1, nine self-ratings were obtained as part of the CPP administration. Titles are listed in Table 14. The Study 1 report provides scale descriptions and reliability data. The discussion section of that report addresses issues related to the use of self-rated abilities in career counseling.

CPP Job Cluster Scales. The content of six CPP Job Cluster Scales paralleling the six ACT Job Clusters is described in Study 1, Table 2. On the CPP, three verbal labels are used to report ability standing so that the basis of scores on the CPP Job Cluster Scales will be readily evident to counselees. The procedures for obtaining scores on the CPP Job Cluster Scales were the same as those used in preparing the CPP score report. First, stanines for each of the ability tests were collapsed to a 3-point scale as follows: 1 = stanines 1-3; 2 = stanines 4-6; and 3 = stanines 7-9. Second, a student's scores for the tests and self-ratings assigned to a given job cluster scale were added together. (The score scale for the self-ratings ran from 1 to 3 for "low" to "high.") Finally, the sum was converted to a standard score through use of CPP high school senior norm group means and standard deviations for the job cluster scale. Thus, each student in the final sample had six CPP Job Cluster Scale scores, one for each of the ACT Job Clusters.

Analysis Plan

Statistical procedures used to address study objectives are described in Appendix C. An overview of the analyses is provided below.

Differentiation of occupational choice groups. As in Study 1, the first objective (to determine whether occupational choice groups score differently on the CPP Ability Tests and self-rated abilities) was addressed through multivariate analyses of variance (MANOVA) and hit rate analyses. Job clusters served as criterion groups. Final sample sizes for the clusters were as follows: Business Contact (44), Business Operations (183), Technical (162), Science (240), Arts (130), and Social Service (242). Approximately two-thirds of the cases in each cluster (total of 668 cases) were randomly assigned to an analysis sample. The remaining cases (333) were assigned to a cross-validation sample. Cluster hit rates were determined from group similarity indices. Discriminant analysis (DISANL) was used to determine the dimensionality of job cluster differences.

Two types of analyses were conducted: weighted and unweighted. In the weighted analyses, cases in each cluster were weighted so that all clusters were of equal size. Hence, in the analysis sample, the weighted sample size of each cluster was, in effect, 668 ÷ 6. Thus, each of the six job clusters would have a similar influence on study results. The Business Contact Cluster, for example, would not be overwhelmed by the Social Service and Science Clusters. Each is nearly six times larger.

All descriptive statistics reported for the study are based on weighted analyses. Alternative weightings (e.g., weighting on the basis of U.S. Census data for workers in various age groups or on the basis of projected job openings) did not appear to

be relevant to the study objectives. The results of statistical significance tests (reported in table footnotes) are based on the unweighted analyses. Thus, they reflect actual sample sizes.

Comparison of job cluster scales with ability tests. The second study objective was to determine whether job cluster scales combining CPP Ability Test scores and self-ratings provide better job cluster (occupational choice group) differentiation than the ability test scores. This objective was addressed by comparing MANOVA, DISANL, and hit rate results for the six ability tests with results for the six CPP Job Cluster Scales.

Nature of occupational differences. CPP Ability Test mean profiles for job families and CPP Job Cluster Scale mean profiles were used to address the third objective. For reasons noted in the report of Study 1, job families rather than job clusters served as criterion groups. Job families with fewer than 20 members were excluded from the analyses.

Results

Differentiation of Occupational Choice Groups

Overall differentiation. Results addressing the first two study objectives are presented in Tables 13-15. (See Appendix E for tables.) For each of the three sets of measures--CPP Ability Tests, self-ratings, and CPP Job Cluster Scales--Wilks's lambda is significant at far beyond the .01 level. Total variance attributable to job cluster (occupational choice group) differences, as shown by the Wilks index, ranged from 38% for the ability tests to 52% for the scales.

Hit rates for the cross-validation sample ranged from 34% for the CPP Ability Tests to 42% for the CPP Job Cluster Scales. Improvement over chance, as determined by the Brennan-Prediger (1981) index, ranged from 21% to 30%. For the CPP Job Cluster Scales, cross-validated hit rates for the six job clusters were as follows: Business Contact (50%), Business Operations (44%), Technical (48%), Science (41%), Arts (41%), and Social Service (25%).

Univariate F values for the CPP Job Cluster Scales were generally higher than the F values for the other two sets of measures. For example, five of the F values for the six scales were approximately 20.0 or higher. Only two of the F values for the six ability tests and two of the F values for the nine self-ratings were as high.

With only one exception, the F values for the 21 variables listed in Tables 13-15 are significant at the .01 level--many at far beyond the .01 level. Taken together, these results indicate that job cluster (occupational choice group) differences in ability cannot reasonably be attributed to chance. Furthermore, group differentiation achieved by the six CPP Job Cluster Scales substantially exceeds that achieved by the other two sets of measures.

Dimensions of differentiation. The DISANL results in Tables 13-15 show that three discriminant functions are warranted for the ability tests whereas four are warranted for the self-ratings and the CPP Job Cluster Scales. The first function obtained for the ability tests was bipolar with Mechanical Reasoning (correlation of .63) and Language Usage (correlation of -.62) anchoring the poles. On the second function, correlations ranged from -.07 (Clerical Skills) to .76 (Reading Skills). The median was .64. Five of the six ability tests had correlations of .60 or higher.

Thus, the second discriminant function, which accounted for less than 20% of the among-group differences, appears to tap general cognitive ability.

Each of the ability tests correlated at least .60 with one of the three functions. Five of the six CPP Job Cluster Scales correlated at least .60 with one of the four functions derived from the scales. The exception, Technical, had correlations above .45 with three of the four functions.

Appropriateness of Choice Group Differences

Figures 6 and 7 show mean ability profiles for the largest job family (in terms of sample size) in each of the six ACT Job Clusters. Tables 16 and 17 provide means for all job families with 20 or more members. (See Appendix D for tables and Appendix E for figures.) Findings regarding the intra-occupational and inter-occupational comparisons of mean scores on the CPP Job Cluster Scales are similar to those for Study 1. Five of the six job families depicted in Figure 7 have peak scores on a different job cluster scale. Scales with peak scores for a given job family generally correspond to predominant work tasks. As before, the Engineering Job Family is an exception. In general, job family differences on the CPP Job Cluster Scales and Ability Tests were more pronounced than in Study 1. This may be due to relaxation of the screen for certainty of occupational choice in Study 1 in order to increase job family sizes.

A comparison of CPP Ability Test Profiles (Figure 6) with the Study 3 profiles (Figure 8) reveals some striking similarities for related occupational groups. The primary difference between profiles for Study 2 and Study 3 (the 6-year longitudinal study) appears to be one of ability level rather than pattern.

In general, job family profiles are better differentiated for the CPP Job Cluster Scales than for the CPP Ability Tests (intra-occupational analysis). The data are especially striking for the Applied Arts (Visual) Job Family. This job family's ability test profile is almost flat; means range from 5.2 to 4.9. However, the CPP Job Cluster Scale profile is well-differentiated; means range from 6.2 to 4.9. The smallest mean range for the CPP Job Cluster Scales is 1.21 (General Health Care). For the CPP Ability Tests, the mean ranges for three job families fall below this level.

Discussion

Study results indicate that the abilities (tested and self-rated) of high school seniors differ substantially across broadly defined occupational choice groups. As in Study 1, CPP Job Cluster Scales combining test scores and self-ratings provide better differentiation than test scores alone. The occupational groups differed significantly on each of the CPP Ability Tests and CPP Job Cluster Scales. As in Studies 1, 3, and 4, there was no indication that a single general cognitive ability score could stand in lieu of scores for the six ability tests. The discriminant function most closely resembling general cognitive ability accounted for less than one-fifth of among-group variance.

Finally, the CPP Job Cluster Scales provide substantially more differentiation than the CPP Ability Tests for three of the Job Families--General Health Care,

Management and Planning, and Applied Arts (Visual). These job families belong to the Social Service, Business Contact, and Arts Job Clusters--each of which involves people-related work tasks to a higher degree than the other three clusters. Including self-ratings for people-related abilities in the CPP Job Cluster Scales no doubt contributes to their effectiveness. Such abilities are not well covered by traditional ability tests.

STUDY 3: DIFFERENTIATION OF OCCUPATIONAL GROUPS BY ABILITY TESTS

Study objectives were as follows: (a) to determine whether persons pursuing various occupations score differently on an ability test battery completed 6 years earlier when they were high school juniors; and (b) to determine whether ability differences among occupational groups are appropriate to the work tasks characterizing the occupations.

Over the 6 years spanned by the study, sample members could be expected to pursue occupations having work tasks compatible with their abilities. That is, within the constraints of the labor market, one would expect them to seek occupations with tasks drawing on their strengths rather than their weaknesses. To the extent that this occurred and to the extent that the abilities of high school juniors are stable, one should find sensible differences in abilities across occupations.

Method

Sample

Initial sample members (N = 9,296) completed Career Planning Program (CPP) tests and inventories (ACT, 1974) as 11th graders during national norming of the CPP, Grades 8-11, early in 1973. The target population for the norming was all 8th, 9th, and 11th graders enrolled in public or Catholic schools. Stratification variables consisted of geographic region, size of community, and socioeconomic status of community. School size was also taken into account in selecting the 72 schools that participated in the Grade 11 phase of the norming. Bayless, Bergsten, Lewis, and Noeth (1974) provide a detailed description of sampling and norming procedures.

In the spring of 1976, the Institute for Demographic and Economic Studies (IDES) conducted a follow-up survey of the experiences of students in the initial sample. Responses were obtained from 5,293 students--66% of those for whom accurate addresses were available. In November of 1978, nearly 6 years after initial testing, IDES conducted a second survey of the experiences and plans of respondents to the first survey. Responses were obtained from 3,615 of the former 11th graders--70% of those for whom accurate addresses were still available and 39% of the initial sample.

Respondents to the 1978 survey were similar to the initial sample of 9,296 11th graders across a broad range of variables. For example, indices of overlap (Tilton, 1937) between the initial sample and the 3,615 respondents were 90% and 91%, respectively, for the CPP Reading Skills and Numerical Skills tests. The two samples did not differ appreciably with respect to geographic region, socioeconomic status, vocational interest inventory scores, and responses to a variety of career planning activity questions. Although second survey respondents did include a slightly higher percentage of Caucasians (79% vs. 72% for the initial sample), females (56% vs. 50% for the initial sample), and persons with longer-term educational goals, the 3,615 former 11th graders, overall, appear to represent a reasonable cross-section of American youth.

Variables

Occupational groups. The 3,615 respondents to the 1978 survey were assigned to the final sample on the basis of responses to educational and employment questions on the survey. Two sets of criteria were used sequentially. Respondents meeting the "in training" criteria reported (a) being currently enrolled in a college, professional school, or work training program; (b) having entered the college, school, or program at least 8 months prior to November of 1978; and (c) being trained for occupations which had been assigned to one of ACT's six job clusters (as described below). These in-training screens were used to identify persons seriously pursuing occupationally related educational programs. The current occupation of such persons was not used for criterion group assignment because it may change upon completion of training.

Respondents not meeting the in-training criteria were screened with "currently employed" criteria. Respondents meeting these latter criteria reported (a) being currently employed and having begun their current job at least 3 months prior to November of 1978; (b) working at least 21 hours a week; (c) having "good" or "fair" opportunities to do interesting work (an indicator of intrinsic job satisfaction), and (d) working in occupations which had been assigned to one of ACT's six job clusters.

Occupation pursued (through training or employment) was determined through responses to a list of 51 "job categories" (e.g., purchasing agent or buyer, retail sales clerk, engineering technician, machine operator or factory worker) included on the 1978 survey. Respondents were asked to indicate the job category that best fit the occupation they were pursuing. The survey's 51 job categories could not be used as criterion groups in the study analyses because over 60% had fewer than 50 members. (Sample sizes ranged from 1 to 157 across the job categories.) Hence, some method of grouping was needed.

For purposes of analysis, IDES job categories were assigned to ACT Job Clusters. (Figure 1 lists job cluster titles and examples of occupations in each cluster.) Five of the 51 job categories were eliminated from further consideration because they were too vague or broadly defined (e.g., "other professional"). Two ACT staff members familiar with the ACT's Occupational Classification System independently assigned each of the remaining job categories to one of the six job clusters. There was agreement for 43 of the 46 job categories. The three disagreements were resolved by the senior staff member.

The final sample consisted of 1,650 of the 3,615 respondents to the 1978 survey. The in-training and currently employed criteria were met by 22% and 78% of the final sample members, respectively. Amount of time in current occupation ranged from 3 to 70 months (average of 20 months) for persons meeting the latter criteria. Gender and racial/ethnic distributions for the final sample paralleled those for all survey respondents. Highest level of education attained, as of November 1978, was reported as follows: High school graduation (22%); post-high-school vocational, technical, or business programs (24%); some college (27%); a 4-year college degree (25%).

Ability tests. The six CPP Ability Tests used in this study are earlier forms of the ability tests used in Study 1. Descriptions of the tests are provided with the Study 1 report. Psychometric data are provided in a report by ACT (1974). Ability test scores were available for all members of the final sample. The stanine

scores used in this study were based on combined-sex norms obtained in the 1973 Grade 11 norming.

Analysis Plan

Statistical procedures used to address study objectives are described in Appendix C. An overview of the analyses is provided below.

Differentiation of occupational groups. As in Studies 1 and 2, the first objective (to determine whether occupational groups score differently on ability tests administered 6 years earlier) was addressed through the use of multivariate analysis of variance (MANOVA) and hit rate analyses. Job clusters served as criterion groups. Final sample sizes for each of the clusters were as follows: Business Contact (240), Business Operations (388), Technical (343), Science (229), Arts (48), and Social Service (402). Approximately two-thirds of the cases in each cluster (total of 1,100 cases) were randomly assigned to an analysis sample. The remaining cases (550) were assigned to a cross-validation sample. Discriminant analysis (DISANL) was used to determine the dimensionality of group differences.

As in Study 2, two types of analyses were conducted: weighted and unweighted. In the weighted analyses, cases in each cluster were weighted so that all clusters were of equal size. Hence, in the analysis sample, the weighted sample size of each cluster was, in effect, 1,100 ÷ 6. Thus, each of the six job clusters would have a similar influence on study results. The Arts Cluster, for example, would not be overwhelmed by the Social Service Cluster, which is more than eight times larger.

All descriptive statistics reported for the study are based on weighted analyses. The results of statistical significance tests (reported in table footnotes) are based on the unweighted analyses. Thus, they reflect actual sample sizes.

Nature of occupational differences. To address the second objective, CPP Ability Test mean profiles were obtained for each IDES job category for which at least 20 persons met the in-training or currently employed screens. For reasons noted in the Study 1 report, job categories rather than job clusters, served as criterion groups.

Results

Differentiation of Occupational Groups

Overall differentiation. Results for analyses addressing the first objective are summarized in Table 18 (see Appendix D). Wilks's lambda is significant at far beyond the .01 level, which indicates that job cluster (occupational group) differences across the six ability tests cannot reasonably be attributed to chance. Total variance attributable to job cluster differences, as estimated by the Wilks index, was 27%.

Each of the CPP Ability Tests differentiated the job clusters, as shown by the univariate *F* values in Table 18. Ranks based on the unique contribution of each test to cluster differentiation were identical to ranks for the *F* values. Mechanical Reasoning was the most effective test, followed by Numerical Skills and Reading Skills.

As one would expect, the hit rate for the analysis sample (34%) was larger than for the cross-validation sample (30%). Improvement over the chance hit rate was

16%, as determined by the Brennan-Prediger (1981) index. Cross-validated hit rates for the six job clusters were as follows: Business Contact (10%); Business Operations (33%); Technical (51%); Science (33%), Arts (25%), and Social Service (28%).

Dimensions of differentiation. DISANL results show that two orthogonal functions based on the six tests were sufficient to account for job cluster differentiation. Each of the ability tests correlated at least .40 with one of the two functions (data not shown here). The first function, which accounted for 62% of the total discriminating power of the tests, was bipolar. Mechanical Reasoning (correlation of .53) and Language Usage (correlation of -.61) anchored the two poles, as in Study 2. On the second function, which accounted for 34% of the among-group variance, correlations ranged from .16 to .89 (median of .59). The correlations for Numerical Skills (.89), Mechanical Reasoning (.74), and Reading Skills (.68) ranked first, second, and third, respectively.

Appropriateness of Occupational Differences

Figure 8 shows mean stanine profiles for one occupational group (job category) in each of the six ACT Job Clusters. Table 19 provides means for all occupational groups with 20 or more members. (See Appendix E for figures and Appendix D for tables.) For five of the six clusters, the largest occupational group is profiled. For the Technical Cluster, the second largest group (Construction, etc.) is profiled. The largest group (N = 92) was described in the following way on the survey: "Machine operator or factory worker (dressmaker, riveter, welder, meat cutter, gas station attendant, etc.)." Because this amorphous group had a rather flat profile (see Table 19), as one would expect, it was not included in Figure 8.

The CPP Ability Tests are most clearly relevant to the following occupational groups (test titles shown in parentheses): Engineer (Numerical Skills, Spatial Relations, Mechanical Reasoning); Construction Crafts (Spatial Relations, Mechanical Reasoning); and Secretary, Typist, Stenographer (Clerical Skills and Language Usage). Figure 8 shows that the three occupational groups generally score highest on the appropriate tests. Conclusions regarding intra-occupational analyses for the other three occupational groups are ambiguous because profiles are relatively flat and none of the abilities are especially appropriate to the occupational groups. In this respect, the job cluster scales used in Studies 1 and 2 have a distinct advantage.

Occupational group means differ by about two to three stanine units for five of the six tests. Thus, inter-occupational differences were substantial. For the Clerical Skills Test, a range of about one stanine was obtained. Although the ordering of occupational groups on the Clerical Skills Test was puzzling, anomalies could be due, to some extent, to differences in general level of ability across the occupational groups. Engineers scored as high as secretaries on Clerical Skills. (Study 2 results were similar.) However, Clerical Skills had the lowest score for engineers and the second highest score (after Language Usage) for secretaries.

Discussion

Study results indicate that broadly defined occupational groups differ with respect to the abilities possessed by their members prior to occupational entry. The variance-explained (Wilks) index obtained for the CPP Ability Tests (27%) was substantially lower than the values obtained in Study 1 (31%) and Study 2 (38%), even though the six ACT Job Clusters served as criterion groups in all three

studies. However, concurrent validity data are generally more favorable than longitudinal data. Also, as noted in the introduction to Study 1, the influence of personal characteristics (e.g., abilities) on occupational choice may be greater than on actual occupation, given the constraints of the labor market.

Of considerable practical significance is the finding that each of the six ability tests differentiated the occupational groups. Furthermore, there was no indication that a single general cognitive ability score could stand in lieu of scores for the six ability tests. Two orthogonal test composites (discriminant functions) were justified. The primary composite differentiating the six clusters was bipolar. The composite most closely resembling general cognitive ability accounted for only one-third of the among-group variance. Taken together and considered in the context of the 6-year time span covered by the study, results appear to show that ability test scores can make a useful contribution to career counseling.

STUDY 4: DIFFERENTIATION OF EDUCATIONAL GROUPS BY ABILITY TESTS AND RATED ABILITIES

Study objectives were as follows: (a) to determine whether successful and satisfied post-secondary students pursuing various programs of study (e.g., accounting, auto mechanics, police science, business administration) score differently on an ability test battery and self-rated abilities completed 4 months earlier; and (b) to determine whether ability differences among educational groups are appropriate to program content and related occupations.

The pursuit of a full-time program of study in post-secondary institutions offering a range of vocational, technical, and 4-year college transfer programs constitutes a real-world implementation of career plans involving a substantial investment of time and money. Within the constraints of program availability, one would expect students to seek programs drawing on their strengths rather than their weaknesses. Thus, one should find substantial and sensible differences in student abilities across programs characterized by different work tasks. Study procedures and results summarized here were drawn from the full report of the study (ACT, 1972).

Method

Sample

Initial sample members (N = 17,564) completed Career Planning Program (CPP) tests and inventories during national norming of the first edition of the CPP (ACT, 1972) in early fall, 1970. At that time, they were first-term, full-time (91%) or part-time (9%) students in 102 community colleges (70%) and post-secondary vocational/technical institutions (30%). Approximately 40% of the sample members were 20 years of age or older.

Variables

Educational group membership. At the end of first term, initial sample members who were still enrolled at the institutions they entered were asked to complete a questionnaire covering, among other things, program of enrollment and satisfaction with that program. Students eligible for the final sample were enrolled throughout the first term and obtained first-term grade-point-averages (GPAs) of 2.0 ("C") or higher in courses directly related to their vocational, technical, or transfer programs. In addition to meeting these "success" criteria, they also expressed satisfaction with their program choice.

Students reported their educational programs via a checklist on the questionnaire administered at the end of the first term. Over 140 programs were listed on the checklist. Programs with enrollments of less than 50 (with one exception) were eliminated or combined with similar programs. The 22 educational programs (17 for men and 14 for women) serving as criterion groups are shown in Table 20 (see Appendix D for tables). The programs typically included students from a number of institutions. The median was 28 institutions per program for men and 20 for women.

In summary, the final sample consisted of 4,607 successful and satisfied students (2,600 men and 2,007 women), as determined by the criteria described above. The programs in which these students were enrolled include a wide variety of community, vocational, and technical college training opportunities. Certainly, one

would expect student abilities to differ in systematic and sensible ways across the programs.

Ability tests and ratings. With two exceptions, the seven CPP Ability Tests used in the study (see Table 21 for titles) were earlier forms of those currently used in the CPP. At the time of the study, there were two tests in the numerical skills area--Numerical Computation (6 minutes) and Math Usage (15 minutes)--rather than one. The current Numerical Skills Test combines computational tasks from the former and word problems from the latter. Also included in the study was a Nonverbal Reasoning Test (10 minutes) intended to assess reasoning ability without reference to verbal material. Later in the development of the CPP, the Nonverbal Reasoning Test was dropped and the Language Usage Test was added. Psychometric data, time limits, etc. are summarized in a report by ACT (1972). The standard scores used in this study were based on combined-sex norms developed from the initial sample described above.

When students completed the CPP, they provided self-ratings for the nine abilities listed below. For each ability, students were asked to rate themselves, as compared with persons their own age, on a 4-point scale ranging from "below average" to "top ten percent."

> Artistic Ability: Drawing, dancing, playing a musical instrument, writing, painting.
>
> Clerical Ability: Keeping neat and accurate records, filing, typing, bookkeeping.
>
> English Ability: Writing, understanding literature, using correct grammar.
>
> Math Ability: Working math problems, understanding math reasoning.
>
> Mechanical Ability: Working with tools, fixing things, understanding how things work.
>
> Scientific Ability: Doing laboratory experiments, understanding scientific principles.
>
> Social Self-Confidence: Being at ease in a social setting, being able to talk easily with people.
>
> Working with People: Getting along with others, having an agreeable personality.
>
> Academic Motivation: Having the desire and determination to succeed in school.

For purpose of analysis, several of the self-ratings were combined (through the addition of ratings) into three composites: Science (Science, Math, and Academic Motivation); Trades (Mechanical and Math); and Interpersonal (Social Self-Confidence and Working with People). The Artistic and Clerical self-ratings were included, separately, in the analyses.

High school GPA. High school GPA was used in the study in conjunction with the ability measures. Student GPA was obtained by averaging self-reported grades for the last course taken in each of the following subject areas: English, math, social studies, natural science, business education, and vocational.

Analysis Plan

Statistical procedure used to address study objectives are described in Appendix C. An overview of the analyses is provided below.

Differentiation of educational groups. As in Study 1, this study objective was addressed through use of multivariate analysis of variance (MANOVA). Hit rate analyses were not conducted (ACT, 1972). Educational programs served as criterion groups; and analyses were conducted separately for males and females. Discriminant analysis (DISANL) was used to determine the dimensionality of group differences.

Nature of educational group differences. At the time of the study, ACT emphasized use of discriminant functions rather than original scores for identifying educational groups in line with a counselee's abilities. Hence, means for the ability measures were not reported (ACT, 1972). Group means on the discriminant functions were reported, instead. These means are used to address the second study objective.

Results

Differentiation of Educational Groups

Overall differentiation. Results addressing the first objective are presented in Table 21 (see Appendix D for Tables). For both males and females, Wilks's lambda is significant at far beyond the .01 level. These results indicate that differences in the abilities of the educational groups cannot reasonably be attributed to chance. Total variance attributable to educational group differences, as estimated by the Wilks index, was 44% for both males and females.

With one exception (the Interpersonal Composite for females), each of the ability measures differentiated the educational groups at far beyond the .01 level of significance. The univariate F values for three of the measures based on self-ratings rank among the top six for males; two of the measures based on self-ratings rank among the top six for females. Of the five measures based on self-ratings, only the Interpersonal Composite failed to rank among the upper half of all measures.

Dimensions of differentiation. Statistical significance tests bearing on the number of discriminant functions sufficient to account for group differentiation were not reported (ACT, 1972). However, the among-group variance percentages in Table 21 suggest that three discriminant functions are sufficient for both males and females. For males, all measures except Clerical Skills, Space Relations, and the Interpersonal Composite correlated at least .40 with one of the three functions. For females, all but the Trades Composite and the Interpersonal Composite correlated at least .40 with one of the three functions.

Appropriateness of Educational Group Differences

Correlations between the ability measures and the discriminant functions (ACT, 1972) were used to assign labels to each of the functions. These function labels and the three educational programs scoring highest and lowest on each function are

reported in Table 22 (see Appendix D for tables). Differences in the results for males and females should be considered in the context of the differing sets of programs for which sufficient data were available. Program means are reported on a standard score scale with a mean of 50 and a standard deviation of 10.

Conclusions regarding the second objective (whether educational group differences are in accord with what one would expect) will be left to the reader. For both males and females, the highest and lowest programs for a given function differed by at least one standard deviation. It should be noted that apparent anomalies in the program rankings (e.g., Other Trades ranking highest on Artistic for females) appear to make sense when the mix of programs in the "other" categories is considered (see Table 22 footnotes).

Discussion

Study results indicate that students enrolled in post-secondary educational programs differ substantially with respect to tested and self-rated abilities. Only one of the measures (the Interpersonal Composite) failed to correlate at least .40 with one of the discriminant functions differentiating the educational groups.

The variance-explained (Wilks) index obtained for males and females was considerably higher than the index obtained in the longitudinal study of occupational groups (Study 3). There are several possible reasons. First, short-term longitudinal validity data are generally more favorable than long-term longitudinal data. Second, self-ratings addressing additional types of ability were included in the current study. Third, criterion groups in the current study were more specific. Finally, educational program choice might be less a function of the labor market or economic necessity and more a function of personal characteristics (e.g., abilities) than occupation 5 years out of high school.

As before, criterion group differences extended beyond general cognitive ability to include various specialized abilities--whether assessed by tests or self-estimates. The first three discriminant functions accounted for 83% and 80% of among-group variance for males and females, respectively. The discriminant function most closely resembling general cognitive ability (labeled "academic" in Table 22) accounted for less than half (46%) and one-third (28%) of the among-group variance for males and females, respectively. Since the study included a wide range of educational programs (e.g., auto mechanics, accounting, computer programming, cosmetology) and since the programs were not grouped by job cluster, a general cognitive ability factor ("g") had ample opportunity to dominate study results. Nevertheless, there were substantial ability differences on dimensions other than g. Thus, study results show that a wide variety of abilities (cognitive and non-cognitive) can be helpful to persons seeking to identify post-secondary educational programs compatible with their personal characteristics.

APPENDIX B

CONTENT OF ASVAB-14 JOB CLUSTER SCALES

The six ASVAB-14 Job Cluster Scales consist of abilities appropriate to basic work tasks characterizing occupations in each of the six ACT Job Clusters. Since the ACT Job Clusters parallel Holland's occupational types (groups), Holland's descriptions of six occupational environments and their demands (Holland, 1985, pp. 36-40) were considered along with basic work tasks in allocating abilities to the ASVAB-14 Job Cluster Scales.

Definitions of four basic work tasks--working with data, ideas, people, and things--are provided in Table B1 together with their job cluster assignments. The work tasks were identified and confirmed in a series of studies reported by Prediger (1976, 1981a, 1981b, 1982). Figure B1 shows, through ACT's World-of-Work Map, interrelationships among work tasks (center of map), Holland's occupational groups, job families, and job clusters (periphery of map). Development of the current (2nd) edition of the World-of-Work Map is summarized in a report by ACT (1985). The results of a recent ACT study titled "Abilities Corresponding to Basic Work Tasks and Job Clusters" (Prediger, report in preparation) support, with few exceptions, the abilities assigned to each job cluster. The job cluster ability profiles developed in the study were based on job analysis data covering cognitive and non-cognitive abilities (National Technical Information Service, undated) for occupations in the 4th edition Dictionary of Occupational Titles (U.S. Department of Labor, 1977).

Table B2 shows the abilities assigned to each of the six ASVAB-14 Job Cluster Composites in Study 1. The assignments differ somewhat from those used in DISCOVER (Table B3) due to the availability of two additional self-ratings in DISCOVER. Ratings for those abilities--Language Usage and Space Relations--are not collected as part of ACT's Career Planning Program (CPP) since they are covered by the CPP Ability Tests. Hence, the ratings were not available for use in Study 1.

Figure B2 defines each of the ASVAB-14 Job Cluster Scales (as implemented in DISCOVER) in terms of occupations covered, primary work tasks, and the related Holland occupational group. The four abilities assigned to each job cluster are also defined. Thus, Figure B2 provides information useful for determining the content validity of each of the ASVAB-14 Job Cluster Scales. Study 1 results, of course, bear on their construct validity. Figure B3, which is arranged by ASVAB-14 Composite, provides an alternative perspective on the allocation of ASVAB-14 Composites to the ASVAB-14 Job Cluster Scales.

TABLE B1

Work Task Definitions and Job Cluster Assignments

Work task definitions[b]	ACT Job Clusters (and Holland's related groups)[a]					
	Business Contact (E)	Business Operations (C)	Technical (R)	Science (I)	Arts (A)	Social Service (S)
People Tasks: Interpersonal tasks such as caring for, educating, entertaining, serving, persuading, or directing others	X				X	X
Things Tasks: Nonpersonal tasks involving machines, tools, living things, and materials such as food, wood, or metal		X	X	X		
Data Tasks: Impersonal tasks involving procedures and transactions that expedite goods/services consumption by people (for example, by organizing, verifying, or transmitting facts, numbers, instructions, etc.)	X	X				
Ideas Tasks: Intrapersonal tasks involving insights, theories, abstractions, knowledge, and new ways of expressing something (for example, with words, paint, equations, or music)		X	X	X	X	

[a]The abbreviations for Holland's (1985) occupational groups are defined as follows: E--Enterprising; C--Conventional; R--Realistic; I--Investigative; A--Artistic; and S--Social.

[b]Although any occupation will involve some work with data, ideas, people, and things, only one or two of the work tasks typically predominate.

TABLE B2

Content of ASVAB-14 Job Cluster Scales Used in Study 1

	ASVAB-14 Job Cluster Scales[a]					
Abilities	Business Contact	Business Operations	Technical	Science	Arts	Social Service
ASVAB-14 Composites						
Academic Ability				1	1	1
Verbal[b]						
Math	1					
Mechanical and Crafts			2			
Business and Clerical		2				
Electronics and Electrical				1		
Health, Social, and Technology[b]						
Self-rated abilities						
Scientific				1		
Creative/Artistic					1	
Creative/Literary					1	
Helping Others						1
Meeting People						1
Sales	1					
Leadership/Management	1					
Organization		1				
Manual Dexterity			1			

[a]The weight an ability receives in an ASVAB-14 Job Cluster Scale is shown by a "1" or a "2". The weights, which are applied to scores expressed as stanines, total to three for each ASVAB-14 Job Cluster Scale.

[b]These ASVAB-14 Composites are not assigned to job cluster scales because other ASVAB-14 Composites cover similar abilities.

TABLE B3

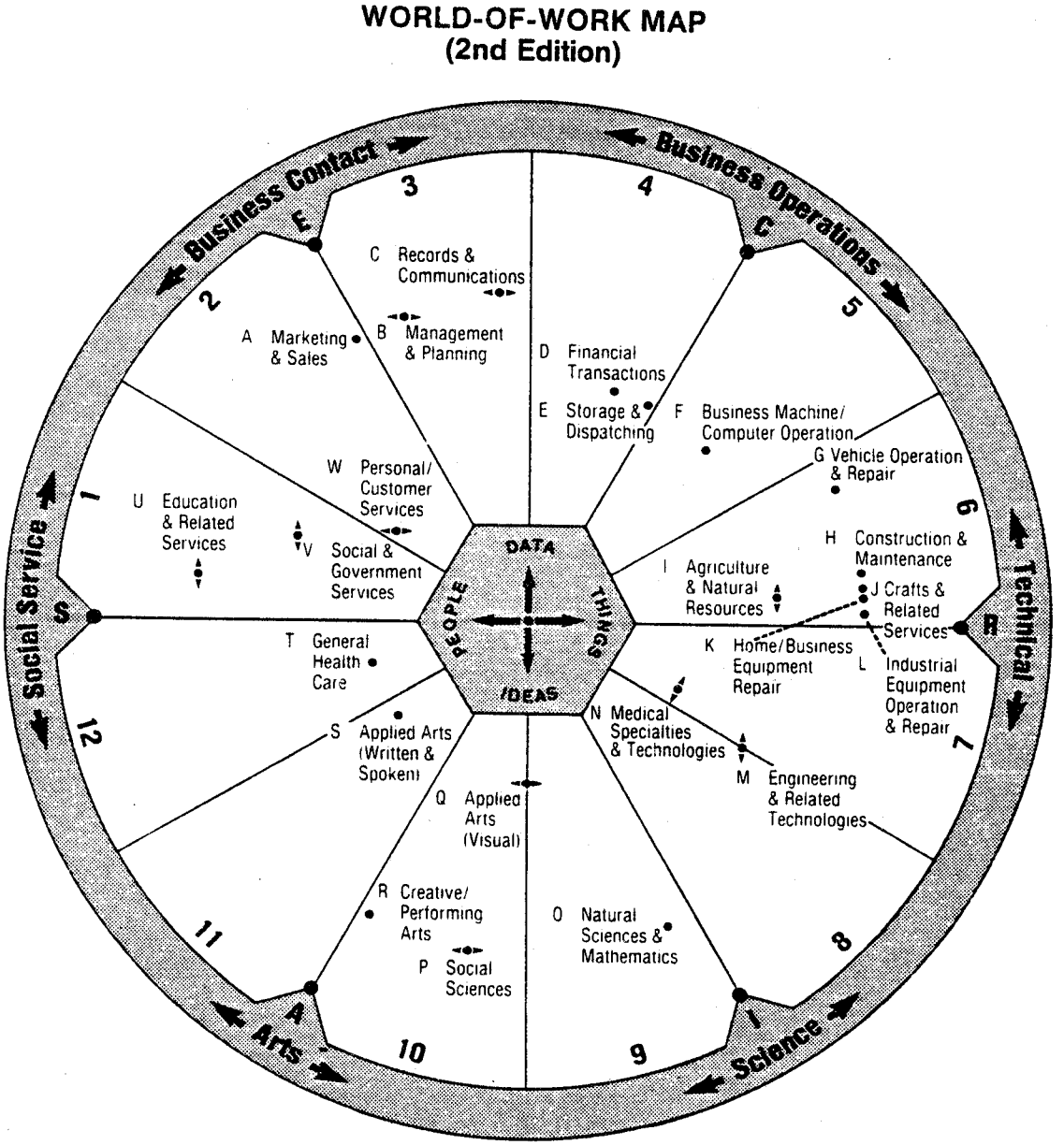
Content of ASVAB-14 Job Cluster Scales Used in DISCOVER

Abilities	ASVAB-14 Job Cluster Scales[a]					
	Business Contact	Business Operations	Technical	Science	Arts	Social Service
ASVAB-14 Composites						
Academic Ability				1	1	1
Math	1					
Mechanical and Crafts			2			
Business and Clerical		2				
Electronics and Electrical				2		
ASVAB-14 Subtests[b]						
General Science				X		
Word Knowledge		X		X	X	X
Paragraph Comprehension		X		X	X	X
Arithmetic Reasoning	X		X	X	X	X
Math Knowledge	X	X		X		
Auto and Shop Information			X			
Mechanical Comprehension			X			
Electronics Information			X	X		
Coding Speed		X				
Self-rated abilities						
Language Usage	1	1				1
Space Relations			1		1	
Scientific				1		
Creative/Artistic					1	
Creative/Literary					1	
Helping Others						1
Meeting People						1
Sales	1					
Leadership/Management	1					
Organization		1				
Manual Dexterity			1			

[a]The weight an ability receives in each ASVAB-14 Job Cluster Scale is shown by a "1" or a "2". The weights, which are applied to scores expressed as stanines, total to four for each ASVAB-14 Job Cluster Scale.

[b]ASVAB-14 subtests included in the ASVAB-14 Composites are shown by an X. Word Knowledge and Paragraph Comprehension, combined, are treated as one subtest in the ASVAB-14 Composites for which they are flagged.

Figure B1. *World-of-Work Map*



About the Map

- The World-of-Work Map arranges job families (groups of similar jobs) into 12 regions. Together, the job families cover all U.S. jobs. Although the jobs in a family differ in their locations, most are located near the point shown.
- A job family's location is based on its primary work tasks—working with DATA, IDEAS, PEOPLE, and THINGS. Arrows show that work tasks often heavily involve both PEOPLE and THINGS (⟷) or DATA and IDEAS (↕).
- Six general areas of the work world and related Holland types are indicated around the edge of the map. Job Family Charts (available from ACT) list over 500 occupations by general area, job family, and preparation level. They cover more than 95% of the labor force.

Figure B2. *Content of ASVAB-14 Job Cluster Scales*

I. BUSINESS CONTACT JOB CLUSTER

A. JOB FAMILIES IN CLUSTER (with examples of occupations)

1. Marketing and Sales: Sales workers in stores; route drivers (milk, etc.); buyers; travel agents; sales workers who visit customers (real estate and insurance agents; stock brokers; farm products, office, and medical-supplies sales workers)

2. Management and Planning: Store, motel, restaurant, and agribusiness managers; office supervisors; purchasing agents; managers in large businesses; recreation/parks managers; medical records administrators; urban planners

3. Personal/Customer Services: Bellhops; flight attendants (stewards, stewardesses); waitresses and waiters; cosmetologists (beauticians); barbers; butlers and maids

B. PRIMARY WORK TASKS: Working with data and people

C. RELATED OCCUPATIONAL TYPE: Enterprising (Holland, 1985)

D. ABILITIES IN ASVAB JOB CLUSTER SCALE

1. ASVAB Mathematics Composite[a]

a. Arithmetic Reasoning: Ability to solve arithmetic word problems (CM) through application of basic math operations (addition, division, etc.) and processes (TSCM).

b. Math Knowledge: Knowledge of high school math principles (CM). Use of formulas; finding perimeter, area, volume of figures; roots and powers; etc. (TSCM).

2. Sales (rated): Influencing people to buy a product or take a suggested course of action.

3. Leadership/Management (rated): Leading/managing people to work cooperatively toward a common goal.

4. Language Usage (rated): Recognizing correct and incorrect uses of the English language (grammar, punctuation, etc.).

II. BUSINESS OPERATIONS JOB CLUSTER

A. JOB FAMILIES IN CLUSTER (with examples of occupations)

1. Records and Communications: Office, library, hotel, and postal clerks; receptionists; computer tape librarians; office, medical, and legal secretaries; court reporters.

2. Financial Transactions: Bookkeepers; accountants; grocery check-out clerks; bank tellers; ticket agents; insurance underwriters; financial analysts.

3. Storage and Dispatching: Shipping clerks; mail carriers; truck and cab dispatchers; air traffic controllers.

4. Business Machine/Computer Operation: Computer console, printer, etc. operators/office machine operators; typists; word-processing equipment operators; statistical clerks.

B. PRIMARY WORK TASKS: Working with data and things

C. RELATED OCCUPATIONAL TYPE: Conventional (Holland, 1985)

D. ABILITIES IN ASVAB JOB CLUSTER SCALE

1. ASVAB Business and Clerical Composite[a]

   a. Word Knowledge: Ability to select the correct meaning of words presented in context and to identify the best synonym for a given word; and Paragraph Comprehension: Ability to obtain information from written passages (CM).

   b. Math Knowledge: Knowledge of high school math principles (CM). Use of formulas; finding perimeter, area, volume of figures; roots and powers; etc. (TSCM).

   c. Coding Speed: Ability to use a key in assigning code numbers to words in a speeded context (CM).

2. ASVAB Business and Clerical Composite: Note. This composite is weighted twice in the ASVAB-14 Job Cluster Composite.

3. Organization (rated): Keeping track of details; doing things in a systematic way.

4. Language Usage (rated): Recognizing correct and incorrect uses of the English language (grammar, punctuation, etc.).

III. TECHNICAL JOB CLUSTER

A. JOB FAMILIES IN CLUSTER (with examples of occupations)

1. Vehicle Operation and Repair: Bus, truck, and cab drivers; mechanics; forklift operators; airplane pilots; ship officers

2. Construction and Maintenance: Carpenters; electricians; painters; bulldozer operators; building inspectors; custodians

3. Agriculture and Natural Resources: Farmers; foresters; ranchers; landscape gardeners; tree surgeons; plant nursery workers

4. Crafts and Related Services: Cooks; meatcutters; bakers; shoe repairers; piano/organ tuners; tailors; jewelers

5. Home/Business Equipment Repair: Repairers of TV sets, appliances, typewriters, telephones, heating systems, etc.

6. Industrial Equipment Operation and Repair: Machinists; printers; welders; production painters; firefighters; machine operators

B. PRIMARY WORK TASKS: Working with things

C. RELATED OCCUPATIONAL TYPE: Realistic (Holland, 1985)

D. ABILITIES IN ASVAB JOB CLUSTER SCALE

1. ASVAB Mechanical and Crafts Composite[a]

   a. Mechanical Comprehension: Knowledge of mechanical and physical principles and ability to visualize how illustrated objects work (CM).

   b. Electronics Information: Knowledge of electricity and electronics (CM)--both theory and practice (TSCM).

   c. Auto and Shop Information: Knowledge of mechanical/electrical systems in cars; knowledge of shop tools, terminology, and practices (CM, TSCM).

   d. Arithmetic Reasoning: Ability to solve arithmetic word problems (CM) through application of basic math operations (addition, division, etc.) and processes (TSCM).

2. ASVAB Mechanical and Crafts Composite: Note. This composite is weighted twice in the ASVAB-14 Job Cluster Composite.

3. Space Relations (rated): Looking at a drawing of something (for example--a house, a coat, a tool) and imagining how it would look from different sides; thinking in three dimensions.

4. Manual Dexterity (rated): Making or repairing things easily and quickly with one's hands.

IV. SCIENCE JOB CLUSTER

A. JOB FAMILIES IN CLUSTER (with examples of occupations)

1. Engineering/Other Technologies: Engineers and engineering technicians; lab technicians; computer progammers and technicians; drafters; food technologists

2. Medical Specialties/Technologies: Dental hygienists; EEG and EKG technicians; opticians; prosthetics technicians; X-ray technologists; dentists; pharmacists; veterinarians

3. Natural Sciences and Mathematics: Agronomists; biologists; chemists; mathematicians; physicists; soil scientists

4. Social Sciences: Marketing research analysts; anthropologists; economists; political scientists; psychologists

B. PRIMARY WORK TASKS: Working with ideas and things

C. RELATED OCCUPATIONAL TYPE: Investigative (Holland, 1985)

D. ABILITIES IN ASVAB JOB CLUSTER SCALE

1. ASVAB Academic Ability Composite[a]

   a. Word Knowledge: Ability to select the correct meaning of words presented in context and to identify the best synonym for a given word; and Paragraph Comprehension: Ability to obtain information from written passages (CM).

   b. Arithmetic Reasoning: Ability to solve arithmetic word problems (CM) through application of basic math operations (addition, division, etc.) and processes (TSCM).

2. ASVAB Electronics and Electrical Composite[a]

   a. General Science: Knowledge of the physical sciences (physics, chemistry, earth science) and biological sciences (CM, TSCM).

   b. Arithmetic Reasoning: See D1b.

   c. Math Knowledge: Knowledge of high school math principles (CM). Use of formulas; finding perimeter, area, volume of figures; roots and powers; etc. (TSCM).

   d. Electronics Information: Knowledge of electricity and electronics (CM)--both theory and practice (TSCM).

3. ASVAB Electronics and Electrical Composite: Note. This composite is weighted twice in the ASVAB-14 Job Cluster Composite.

4. Scientific (rated): Understanding scientific principles; doing science course work

V. ARTS JOB CLUSTER

A. JOB FAMILIES IN CLUSTER (with examples of occupations)

1. Applied Arts (Visual): Floral designers; merchandise displayers; commercial artists; fashion designers; photographers; interior designers; architects; landscape architects

2. Creative/Performing Arts: Entertainers (comedians, etc.) actors/actresses; dancers; musicians; singers; composers; writers; art, music, etc. teachers

3. Applied Arts (Written and Spoken): Advertising copywriters; disk jockeys; legal assistants; advertising account executives; interpreters; reporters; public relations workers; lawyers; librarians; technical writers

B. PRIMARY WORK TASKS: Working with ideas and people

C. RELATED OCCUPATIONAL TYPE: Artistic (Holland, 1985)

D. ABILITIES IN ASVAB JOB CLUSTER SCALE

1. ASVAB Academic Ability Composite[a]

   a. Word Knowledge: Ability to select the correct meaning of words presented in context and to identify the best synonym for a given word; and Paragraph Comprehension: Ability to obtain information from written passages (CM).

   b. Arithmetic Reasoning: Ability to solve arithmetic word problems (CM) through application of basic math operations (addition, division, etc.) and processes (TSCM).

2. Creative/Artistic (rated): Drawing, painting, playing a musical instrument, acting, dancing.

3. Space Relations (rated): Looking at a drawing of something (for example--a house, a coat, a tool) and imagining how it would look from different sides; thinking in three dimensions.

4. Creative/Literary (rated): Expressing ideas or feelings through writing.

VI. SOCIAL SERVICE JOB CLUSTER

A. JOB FAMILIES IN CLUSTER (with examples of occupations)

1. General Health Care: Nursing aides; dental assistants; licensed practical nurses; physical therapy assistants, registered nurses; dieticians; occupational therapists; physicians; speech pathologists

2. Education and Related Services: Teacher aides; preschool teachers; athletic coaches; college teachers; guidance/career/etc. counselors; elementary and secondary school teachers; special education teachers

3. Social and Government Services: Security guards; recreation leaders; police officers; health/safety/food/etc. inspectors; child welfare workers; home economists; rehabilitation counselors; sanitarians; social workers

B. PRIMARY WORK TASKS: Working with people

C. RELATED OCCUPATIONAL TYPE: Social (Holland, 1985)

D. ABILITIES IN ASVAB JOB CLUSTER SCALE

1. ASVAB Academic Ability Composite[a]

a. Word Knowledge: Ability to select the correct meaning of words presented in context and to identify the best synonym for a given word; and Paragraph Comprehension: Ability to obtain information from written passages (CM).

b. Arithmetic Reasoning: Ability to solve arithmetic word problems (CM) through application of basic math operations (addition, division, etc.) and processes (TSCM).

2. Helping others (rated): Caring for or teaching others; making others happy.

3. Meeting People (rated): Talking with people; getting along with others; making a good impression.

4. Language Usage (rated): Recognizing correct and incorrect uses of the English language (grammar, punctuation, etc.).

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[a]The sources of descriptions are as follows: CM = Counselor's Manual for the ASVAB-14, (U.S. Department of Defense, 1984, page 3); TSCM = Technical Supplement to the Counselor's Manual, (U.S. Department of Defense, 1985b, pages 59-63).

Figure B3. *Allocation of ASVAB-14 Composites to ASVAB-14 Job Cluster Scales*

A. ASVAB-14 COMPOSITE: ACADEMIC ABILITY

1. ASVAB-14 Subtests[a]

a. Word Knowledge: Ability to select the correct meaning of words presented in context and to identify the best synonym for a given word; and Paragraph Comprehension: Ability to obtain information from written passages (CM).

b. Arithmetic Reasoning: Ability to solve arithmetic word problems (CM) through application of basic math operations (addition, division, etc.) and processes (TSCM).

2. ASVAB-14 Job Cluster Scale Allocations: Social Service; Science; Arts

B. ASVAB-14 COMPOSITE: VERBAL

1. ASVAB-14 Subtests[a]

a. General Science: Knowledge of the physical sciences (physics, chemistry, earth science) and biological sciences (CM, TSCM).

a. Word Knowledge: See Ala.

b. Paragraph Comprehension: See Ala.

2. ASVAB-14 Job Cluster Scale Allocation: None

C. ASVAB-14 COMPOSITE: MATH

1. ASVAB-14 Subtests[a]

a. Arithmetic Reasoning: See Alb.

b. Math Knowledge: Knowledge of high school math principles (CM). Use of formulas; finding perimeter, area, volume of figures; roots and powers; etc. (TSCM).

2. ASVAB-14 Job Cluster Scale Allocation: Business Contact

D. ASVAB-14 COMPOSITE: MECHANICAL AND CRAFTS

1. ASVAB-14 Subtests[a]

a. Arithmetic Reasoning: See Alb.

b. Auto and Shop Information: Knowledge of mechanical/electrical systems in cars; knowledge of shop tools, terminology, and practices (CM, TSCM).

c. Mechanical Comprehension: Knowledge of mechanical and physical principles and ability to visualize how illustrated objects work (CM).

d. Electronics Information: Knowledge of electricity and electronics (CM)--both theory and practice (TSCM).

2. ASVAB-14 Job Cluster Scale Allocation: Technical

E. ASVAB-14 COMPOSITE: BUSINESS AND CLERICAL

1. ASVAB-14 Subtests[a]

a. Word Knowledge and Paragraph Comprehension: See Ala.

b. Math Knowledge: See C1b.

c. Coding Speed: Ability to use a key in assigning code numbers to words in a speeded context (CM).

2. ASVAB-14 Job Cluster Scale Allocation: Business Operations

F. ASVAB-14 COMPOSITE: ELECTRONICS AND ELECTRICAL

1. ASVAB-14 Subtests[a]

a. General Science: See B1a.

b. Arithmetic Reasoning: See A1b.

c. Math Knowledge: See C1b.

d. Electronics Information: See D1d.

2. ASVAB-14 Job Cluster Scale Allocation: Science

G. ASVAB-14 COMPOSITE: HEALTH, SOCIAL, AND TECHNOLOGY

1. ASVAB-14 Subtests[a]

a. Word Knowledge and Paragraph Comprehension: See Ala.

b. Arithmetic Reasoning: See A1b.

c. Mechanical Comprehension: See D1c.

2. ASVAB-14 Job Cluster Scale Allocation: None.

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[a]The sources of descriptions are as follows: CM = Counselor's Manual for the ASVAB-14 (U.S. Department of Defense, 1984, page 3); TSCM = Technical Supplement to the Counselor's Manual (U.S. Department of Defense, 1985b, pages 59-63).

APPENDIX C

DESCRIPTION OF STATISTICAL ANALYSIS PROCEDURES

Multivariate Analysis of Variance (MANOVA)

MANOVA, a multivariate generalization of analysis of variance, can be used to determine the extent to which two or more groups, considered simultaneously, differ on a set of two or more measures, considered simultaneously. When there are only two groups (e.g., criterion groups), MANOVA procedures (and the discriminant analysis procedures described below) have a number of similarities with point-biserial multiple regression analysis. When there are more than two groups, however, MANOVA procedures and results are unique.

The Wilks's lambda statistic is typically used as an index of group differentiation in MANOVA. This statistic reflects the ratio of within-group variance to total-group variance, as determined from multivariate estimates of variance. The value of lambda can range from zero to one. When there are no group differences on a set of measures (i.e., when among-group variance is zero), lambda will equal one. Lambda approaches zero as group differences increase.

Although lambda ranges from zero to one, it does not directly provide an index of explained variance analogous to R^2 in regression analysis. In MANOVA, one would prefer to have an index that provides the proportion of total variance in a set of measures (among-group plus within-group variance, across all measures) that is attributable to criterion group differences. Huberty (1983) cites seven indices proposed for this task. Four of the seven provide similar results when sample sizes are "large" (p. 710) relative to the number of measures. One of these, the "Wilks index," is simply one minus Wilks's lambda.

Since there does not appear to be a single, best index of explained variance in MANOVA (Huberty, 1983, p. 712), the Wilks index is used here. The index estimates the proportion of total variance in individual differences across a set of measures that is attributable to inter-group differences. More briefly, the Wilks index "is a variance-explained index" (Huberty & Smith, 1982, p. 419). Because lambda is commonly available in MANOVA, the Wilks index can be easily obtained and compared across studies with comparable criterion groups.

An F value based on Wilks's lambda is used for tests of statistical significance in MANOVA. If Wilks's lambda is significant at the chosen significance level, it is common to examine univariate Fs to determine the extent to which each measure in the analysis differentiates the groups. If the measures have overlapping variance, a different approach is needed to determine the unique contribution of each measure to group differentiation. One possibility, suggested by Huberty (1984), is to note the change in lambda when a measure is removed from the set. Thus, if there are six measures in a set, the overall lambda is compared with lambdas obtained for six sets of five measures, a different measure being omitted from each set. Degree of change in lambda can then be used to rank the measures with respect to their unique contribution to group differentiation.

Discriminant Analysis (DISANL)

If MANOVA indicates that criterion groups differ significantly on a set of variables, the dimensionality of the differences can be examined through DISANL. Although

a number of statistical procedures are sometimes grouped under the term, DISANL might best be thought of as a statistical technique for finding uncorrelated combinations of measures (discriminant functions) which best differentiate among a set of criterion groups. A discriminant function is defined as a linear combination of measures which maximizes the ratio of among-group variance to within-group variance, with variances represented by multivariate estimates. After each discriminant function is obtained, variance associated with it is removed and successive uncorrelated functions are obtained until residual among-group variance is exhausted.

The eigenvalue associated with a discriminant function can be used to estimate the proportion of overall group differentiation (among-group variance) that is accounted for by the function. Successive functions will account for successively smaller proportions of variance.

Although there is no generally accepted test of statistical significance for a specific discriminant function, it is possible to determine, through a chi-square transformation, whether significant group differences remain after the function is extracted. Thus, one may find that criterion group differences remaining after the first (or second, etc.) function is extracted can be reasonably attributable to chance. (The .001 level of statistical significance was required to reject the null hypothesis of no group differences in the studies reported here.) Together, the chi-square test and the "variance-explained" estimate for each function provide a basis for deciding whether criterion group differences can be adequately represented by a given number of dimensions.

Two types of data are typically used to determine the nature of the dimensions (discriminant functions) on which groups differ. First, correlations of the measures with the functions can be examined, much as in factor analysis. Second, group means and standard deviations can be obtained for the functions.

not provided in this report

Hit Rate Analysis

Another indicator of group differentiation is the extent to which group members can be assigned into their own groups through use of a set of measures. If the measures fail to differentiate criterion groups, the proportion of correct assignments (the "hit rate") will approximate chance. On the other hand, if there is no overlap among the criterion groups, all group members will be assigned to their own group and a hit rate of 100% will be obtained. Thus, hit rate and discrimination power co-vary. (Sampling anomalies result in less than a perfect correlation, however.)

Although frequently associated with DISANL, hit rate analyses can be conducted for any set of scores--e.g., original test scores, factor scores, discriminant function scores. In the studies reported here, hit rates are based on scores for all available discriminant functions. Hit rates determined from all discriminant functions generally approximate those obtained directly from the original variables.

In order to determine hit rates, indices of group similarity are needed for each member of a sample. Thus, if there are six criterion groups in a study, six indices of group similarity are needed. Each person in the study can then be assigned to the group for which he or she has the highest index. In the studies reported here, similarity indices were based on Bayes's rule, as described by Norusis (1985). The pooled within-group covariance matrix was used, and group sizes were considered to be equal.

SPSS "automatically" provides cross-validated hit rates

Hit rates can generally be improved by taking relative group size into account. However, information on group size was not used in the studies reported here. Instead, criterion group assignments were based solely on similarity indices derived from the ability scores. This approach to validation is compatible with the use of test scores in career counseling. Few counselors, for example, would reason as follows: "Mary scores like persons in Occupation A. But there are few persons in Occupation A. So I will suggest something else." Most counselors would not hesitate to tell a counselee that he or she has scores similar to persons in Occupation A, even though its size might be quite small in comparison to other occupations. Job opportunities could then be considered, separately, as part of counseling.

Although hit rates have concrete meaning, their evaluation (are the hit rates "high" or "low"?) is not straightforward. Among the factors to be considered are the following.

1. What is the chance hit rate and to what extent does the observed hit rate improve upon chance? Brennan and Prediger (1981) discuss various indices of agreement beyond chance. They show that when there are no restrictions on the number of persons assigned to a given criterion group in a classification study, chance should be defined as $1/n$, where n is the number of criterion groups. Proportional improvement over chance is then defined by the following variation of Cohen's (1960) kappa: $(\Sigma P_{ii} - 1/n)/(1-1/n)$, where i varies from 1 to n and ΣP_{ii} is the hit rate expressed as a proportion. The Brennan-Prediger index is used here to describe results of hit rate analyses.

2. How many groups are in the analysis? This question is important because the number of groups directly influences the chance hit rate ($1/n$). Thus, if there are two groups, a hit rate of 51% would not be impressive.

3. What is the nature of the criterion groups in the analysis? They may differ, for example, from comprehensive categories covering all recognized occupations (e.g., ACT Job Clusters) to highly diverse, specific occupations (e.g., mechanical engineer, social worker, accountant, commercial artist). Greater criterion group differentiation (hence, higher hit rates) can be expected for specific occupations because comprehensive groups, by their very nature, shade into each other. If only a few specific occupations are included in an analysis, however, the relevance of results to comprehensive career counseling would be in doubt.

4. Are the hit rates statistically significant? This question is addressed by providing confidence limits for hit rates and comparing the limits with the chance hit rate. Also, it is related to the question of group differentiation. The latter question, as noted above, is addressed by an F test based on the Wilks's lambda statistic.

Re: DISAVL

Two types of analyses can be conducted: weighted and unweighted. In the former analyses, the job clusters were weighted to have equal size and influence. Thus, the Arts Job Cluster (for example) would not be overwhelmed by the Technical Job Cluster, which is more than 12 times larger. All descriptive statistics are based on weighted analyses. Statistical significance tests, however, are based on unweighted analyses. Thus, they reflect actual sample sizes.

APPENDIX D

TABLES CITED IN STUDIES 1-4

Table Page

TABLE 1

Overview of the ASVAB-CPP Matched Sample

School	Sample size	Percent tested[a]	CPP testing		ASVAB-14 testing	
			Grade	Date	Grade	Date
1	97	58	11	12/84	11	4/85
2	151	35	11	12/84	12	12/85
3	83	25	11	2/84	12	9/84
4	232	83	11	10/83	12	10/84
5	229	80	11	10/84	12	10/85
6	58	37	11	3/85	12	11/85
	74	40	11	1/86	11	11/85
7	185	76	11	2/85	11	12/84

[a]Based on enrollment for grade in which ASVAB was administered.

TABLE 2

Content of CPP Job Cluster Scales

Abilities	CPP Job Cluster Scales[a]					
	Business Contact	Business Operations	Technical	Science	Arts	Social Service
CPP Ability Tests						
Reading Skills				X		X
Language Usage	X	X		X	X	X
Numerical Skills	X	X	X	X		
Clerical Skills		X				
Space Relations			X		X	
Mechanical Reasoning			X			
Self-rated abilities						
Scientific				X		
Creative/Artistic					X	
Creative/Literary					X	
Helping Others						X
Meeting People						X
Sales	X					
Leadership/Management	X					
Organization		X				
Manual Dexterity			X			

[a]An "X" indicates that the ability is used in the CPP Job Cluster Scale. Each of the four abilities used in a scale receives equal weight.

TABLE 3

Differentiation of Occupational Choice Groups by ASVAB-14 Composites

Statistics	Results
MANOVA	
Wilks's lambda[a]	0.70
Wilks's variance-explained index	30%
Univariate F (and rank for unique contribution)[b] for ASVAB-14 Composites	
Academic Ability	8.7 (5th)
Verbal	7.2 (7th)
Math	9.3 (6th)
Mechanical and Crafts	6.4 (1st)
Business and Clerical	9.1 (2nd)
Electronics and Electrical	9.0 (3rd)
Health, Social, and Technology	8.5 (4th)
DISANL	
No. of functions warranted by significance tests[c]	2
Among-group variance for 1st 3 functions	49%, 24%, 15%
Hit rate (average)	34%

[a] F (35, 1,172) = 2.99, $p < .0001$.

[b] $p < .0001$ for each F (5, 284). See discussion of MANOVA in Appendix C for procedure used to determine the unique contribution of an ASVAB-14 Composite.

[c] Chi-square (24, N = 290) = 53.6, $p < .001$ for Functions 2-5. For Functions 3-5, chi-square (15, N = 290) = 28.9, $p > .01$.

TABLE 4

Differentiation of Occupational Choice Groups by CPP Ability Tests

Statistics	Results
MANOVA	
Wilks's lambda[a]	0.69
Wilks's variance-explained index	31%
Univariate F (and rank for unique contribution)[b] for CPP Ability Tests	
Reading Skills	3.8 (6th)
Language Usage	4.1 (3rd)
Numerical Skills	6.2 (2nd)
Clerical Skills	1.9 (5th)
Space Relations	6.9 (4th)
Mechanical Reasoning	10.8 (1st)
DISANL	
No. of functions warranted by significance tests[c]	2
Among-group variance for 1st 3 functions	56%, 28%, 11%
Hit rate (average)	36%

[a] F (30, 1,118) = 3.59; $p < .0001$.

[b] For three of the tests, $p < .0001$, F (5, 284); for two, $p < .01$; for Clerical Skills, $p > .05$.

[c] Chi-square (20, $N = 290$) = 47.4, $p < .001$ for Functions 2-5. For Functions 3-5, chi-square (12, $N = 290$) = 17.3, $p > .13$.

TABLE 5

Differentiation of Occupational Choice Groups by Ability Self-ratings

Statistics	Results
MANOVA	
Wilks's lambda[a]	0.42
Wilks's variance-explained index	58%
Univariate F (and rank for unique contribution)[b] for ability self-ratings	
Scientific	8.6 (1st)
Creative/Artistic	10.7 (2nd)
Creative/Literary	8.9 (4th)
Helping Others	3.9 (6th)
Meeting People	5.4 (8th)
Sales	2.5 (9th)
Leadership/Management	2.2 (7th)
Organization	4.3 (5th)
Manual Dexterity	7.2 (3rd)
DISANL	
No. of functions warranted by significance tests[c]	4
Among-group variance for all 5 functions	44%, 27%, 16%, 9%, 4%
Hit rate (average)	46%

[a] F (45, 1,238) = 5.81, $p < .0001$.

[b] For five of the self-ratings, $p < .0001$, F (5, 284); for two, $p < .01$; for Sales and Leadership/Management, $p < .05$ and $p > .05$, respectively.

[c] Chi-square (32, $N = 290$) = 139.8, $p < .0001$ for Functions 2-5. For Functions 3-5 and 4-5, $p < .0001$ and $p < .001$, respectively. For Function 5, chi-square (5, $N = 290$) = 11.3, $p > .04$.

TABLE 6

Differentiation of Occupational Choice Groups by ASVAB-14 Job Cluster Scales

Statistics	Results
MANOVA	
Wilks's lambda[a]	0.43
Wilks's variance-explained index	57%
Univariate F (and rank for unique contribution)[b]	
Business Contact Scale	3.4 (6th)
Business Operations Scale	10.0 (4th)
Technical Scale	7.9 (3rd)
Science Scale	11.3 (2nd)
Arts Scale	17.2 (1st)
Social Service Scale	5.8 (5th)
DISANL	
No. of functions warranted by significance tests[c]	4
Among-group variance for all 5 functions	43%, 23%, 20%, 12%, 3%
Hit rate (average)	49%

[a] F (30, 1,118) = 8.72; $p < .0001$.

[b] For five of the scales, $p < .0001$, F (5, 284); for the Business Contact Scale, $p < .01$.

[c] Chi-square (20, $N = 290$) = 140.9, $p < .0001$ for Functions 2-5. For Functions 3-5 and 4-5, $p < .0001$. For Function 5, chi-square (2, $N = 290$)= 7.2, $p > .02$.

TABLE 7

Differentiation of Occupational Choice Groups by CPP Job Cluster Scales

Statistics	Results
MANOVA	
Wilks's lambda[a]	0.48
Wilks's variance-explained index	52%
Univariate F (and rank for unique contribution)[b]	
Business Contact Scale	2.6 (3rd)
Business Operations Scale	6.6 (4th)
Technical Scale	10.4 (2nd)
Science Scale	8.4 (5th)
Arts Scale	12.0 (1st)
Social Service Scale	5.8 (6th)
DISANL	
No. of functions warranted by significance tests[c]	4
Among-group variance for all 5 functions	41%, 25%, 19%, 12%, 3%
Hit rate (average)	45%

[a] F (30, 1,118) = 7.49, $p < .0001$.

[b] For five of the scales, $p < .0001$, F (5, 284); for the Business Contact Scale, $p < .05$.

[c] Chi-square (20, N = 290) = 125.2, $p < .0001$ for Functions 2-5. For Functions 3-5 and 4-5, $p < .0001$. For Function 5, chi-square (2, N = 290) = 6.4, $p > .04$.

TABLE 8

Mean ASVAB-14 Composite Stanines for Job Cluster and Job Family Criterion Groups

Criterion group	N	ASVAB-14 Composites[a] AA	V	M	MC	BC	EE	HST
Business Contact Cluster	84	5.2	5.1	5.4	5.1	5.7	5.2	5.2
Marketing & Sales	41	4.9	4.8	5.1	4.8	5.4	4.9	4.9
Management & Planning	43	5.4	5.4	5.7	5.4	5.9	5.5	5.4
Business Operations Cluster	138	5.7	5.3	6.0	5.6	6.2	5.7	5.6
Records & Communications	34	4.9	4.4	5.4	5.0	5.2	4.9	4.9
Financial Transactions	71	6.1	5.5	6.4	5.8	6.7	6.0	6.0
Storage & Dispatching	3							
Business Machine/Computer Operation	30	5.9	5.7	5.9	6.0	6.4	5.8	5.9
Technical Cluster	101	5.4	5.3	5.3	5.6	5.6	5.3	5.4
Vehicle Operation & Repair	59	5.8	5.7	5.7	6.0	6.0	5.7	5.9
Construction & Maintenance	16							
Agriculture & Natural Resources	10							
Crafts & Related Services	5							
Home/Business Equipment Repair	2							
Industrial Equipment Operation & Repair	9							
Science Cluster	177	6.7	6.5	6.7	6.5	6.9	6.7	6.7
Engineering & Other Applied Technologies	83	6.8	6.7	7.0	6.7	7.2	7.0	6.9
Medical Specialties & Technologies	59	6.3	5.8	6.1	6.2	6.2	6.1	6.4
Natural Sciences & Mathematics	19							
Social Sciences	16							

TABLE 8 (Continued)

Criterion group	N	ASVAB-14 Composites[a] AA	V	M	MC	BC	EE	HST
Arts Cluster	123	6.1	6.0	6.0	5.5	6.3	5.8	6.0
Applied Arts (Visual)	47	6.0	6.0	5.9	5.8	6.2	5.8	6.1
Creative/Performing Arts	30	6.0	5.9	5.7	5.2	6.1	5.5	5.9
Applied Arts (Written & Spoken)	46	6.4	6.2	6.4	5.4	6.7	5.9	5.9
Social Service Cluster	196	5.8	5.8	5.8	5.7	6.1	5.8	5.8
General Health Care	93	6.0	6.0	6.0	5.9	6.4	6.1	6.0
Education & Related Services	21	6.1	6.2	6.2	5.9	6.1	6.2	6.1
Social & Government Services	50	5.9	5.8	5.7	5.7	6.1	5.7	5.9
Personal/Customer Services	32	5.1	4.9	5.0	5.1	5.0	4.8	5.1

[a]Abbreviations are as follows: Academic ability (AA), Verbal (V), Math (M), Mechanical and Crafts (MC), Business and Clerical (BC), Electronics and Electrical (EE), and Health, Social and Technology (HST).

TABLE 9

Mean CPP Ability Test Stanines for Job Cluster and Job Family Criterion Groups

Criterion group	N[b]	CPP Ability Tests[a] RS	LU	NS	CS	SR	MR
Business Contact Cluster	84	4.8	5.0	4.8	5.6	4.8	4.8
Marketing & Sales	41	4.7	4.7	4.4	5.4	4.6	4.5
Management & Planning	43	5.0	5.2	5.1	5.7	4.9	5.0
Business Operations Cluster	137	5.0	5.3	5.2	6.0	5.2	4.8
Records & Communications	33	4.6	5.7	4.7	5.6	4.6	4.2
Financial Transactions	70	5.3	5.3	5.6	6.4	5.5	5.1
Storage & Dispatching	3						
Business Machine/Computer Operation	30	5.0	5.1	4.9	5.9	5.3	4.7
Technical Cluster	99	4.5	4.6	4.6	5.1	5.5	6.0
Vehicle Operation & Repair	59	5.0	4.7	5.0	5.4	5.8	6.2
Construction & Maintenance	15						
Agriculture & Natural Resources	9						
Crafts & Related Services	5						
Home/Business Equipment Repair	2						
Industrial Equipment Operation & Repair	9						
Science Cluster	177	5.9	5.9	5.9	5.5	6.1	6.1
Engineering & Other Applied Technologies	83	5.8	5.8	6.2	5.3	6.4.	6.6
Medical Specialties & Technologies	59	5.6	5.7	5.3	5.5	5.6	5.5
Natural Sciences & Mathematics	19						
Social Sciences	16						

TABLE 9 (Continued)

Criterion group	N[b]	CPP Ability Tests[a] RS	LU	NS	CS	SR	MR
Arts Cluster	122	5.5	5.8	5.2	5.4	5.3	5.2
Applied Arts (Visual)	46	5.2	5.5	5.1	5.1	5.6	5.7
Creative/Performing Arts	29	5.0	5.7	4.8	4.8	4.8	4.9
Applied Arts (Written & Spoken)	46	6.0	6.2	5.6	5.9	5.2	5.0
Social Service Cluster	196	5.3	5.8	5.1	5.4	5.1	4.8
General Health Care	93	5.7	6.0	5.5	5.6	5.4	5.1
Education & Related Services	21	5.4	6.1	5.4	4.8	4.9	4.5
Social & Government Services	50	5.1	5.5	4.9	5.3	5.0	4.8
Personal/Customer Services	32	4.3	5.2	4.1	5.4	4.7	4.2

[a]Abbreviations are as follows: Reading Skills (RS), Language Usage (LU), Numerical Skills (NS), Clerical Skills (CS), Space Relations (SR), and Mechanical Reasoning (MR).

[b]Most of the sample sizes vary slightly from test to test. Each sample size shown is the smallest number of scores for the set of tests.

TABLE 10

Mean Self-rating Stanine Equivalents for Job Cluster and Job Family Criterion Groups

Criterion group	N[b]	Self-ratings[a] 1	2	3	4	5	6	7	8	9
Business Contact Cluster	83	4.5	5.0	5.2	5.0	5.6	6.1	5.8	5.1	4.8
Marketing & Sales	40	4.2	5.1	4.9	4.8	5.5	5.7	5.3	4.9	4.6
Management & Planning	43	4.8	4.9	5.4	5.3	5.8	6.5	6.3	5.2	4.9
Business Operations Cluster	138	4.3	4.7	4.8	5.1	4.9	5.1	5.1	5.5	4.5
Records & Communications	34	3.4	4.7	5.1	5.6	5.1	4.6	4.5	4.7	3.7
Financial Transactions	71	4.4	4.7	4.8	4.8	4.7	5.2	5.2	5.8	4.7
Storage & Dispatching	3									
Business Machine/Computer Oper.	30	4.9	4.6	4.3	5.1	5.3	5.3	5.5	5.6	4.7
Technical Cluster	101	4.6	4.3	4.1	4.3	4.1	5.1	5.1	4.5	6.2
Vehicle Operation & Repair	59	4.8	4.4	4.1	4.3	4.1	5.0	5.3	4.7	6.2
Construction & Maintenance	16									
Agriculture & Natural Resources	10									
Crafts & Related Services	5									
Home/Business Equipment Repair	2									
Industrial Equipment Operation & Repair	9									
Science Cluster	175	6.2	5.2	5.1	4.8	5.1	5.0	5.2	5.3	5.4
Engineering & Other Applied Technologies	81	6.3	5.0	4.9	4.3	4.9	5.0	5.6	5.5	5.8
Medical Specialties & Tech.	59	5.8	5.0	5.0	5.4	5.2	4.7	4.5	5.1	4.9
Natural Sciences & Mathematics	19									
Social Sciences	16									

TABLE 10 (Continued)

Criterion group	N[b]	Self-ratings[a] 1	2	3	4	5	6	7	8	9
Arts Cluster	122	4.9	6.2	5.7	5.0	5.2	5.0	5.0	4.8	5.0
Applied Arts (Visual)	47	5.1	6.7	5.3	4.9	5.1	4.9	4.6	5.0	5.6
Creative/Performing Arts	29	4.6	6.9	6.1	4.7	4.6	4.6	4.3	4.2	4.6
Applied Arts (Written & Spoken)	46	5.0	5.4	5.8	5.2	5.6	5.3	5.7	4.9	4.6
Social Service Cluster	196	5.0	4.9	5.3	5.7	5.5	4.9	4.9	5.0	4.5
General Health Care	93	5.6	5.0	5.0	5.8	5.5	4.9	4.9	5.1	4.5
Education & Related Services	21	5.2	5.3	5.9	6.0	5.7	4.8	5.1	5.8	3.8
Social & Government Services	50	4.8	4.6	5.4	5.5	5.5	5.0	5.2	5.0	5.0
Personal/Customer Services	32	3.6	4.8	5.6	5.5	5.4	4.7	4.0	4.2	4.1

[a]Codes are as follows: Scientific (1), Creative/Artistic (2), Creative/Literary (3), Helping Others (4), Meeting People (5), Sales (6), Leadership/Management (7), Organization (8), and Manual Dexterity (9).

[b]Most of the sample sizes vary slightly from scale to scale. Each sample size shown is smallest number of scores for the set of scales.

TABLE 11

Mean ASVAB-14 Job Cluster Scale Stanines for Job Cluster and Job Family Criterion Groups

Criterion group (and Holland code)	N	ASVAB-14 Job Cluster Scale[a]						Three-letter code[b]
		E	C	R	I	A	S	
Business Contact Cluster (E)	83	5.7	4.5	4.3	4.2	4.7	4.9	ESA
Marketing & Sales	40	5.1	4.2	3.9	3.8	4.4	4.5	$E\overline{SA}$
Management & Planning	43	6.3	4.8	4.7	4.6	4.9	5.3	$ES\overline{AC}$
Business Operations Cluster (C)	138	5.1	5.2	4.6	4.5	4.6	4.9	$\overline{CE}S$
Records & Communications	34	4.3	4.0	3.6	3.5	4.4	4.8	$S\overline{AE}$
Financial Transactions	71	5.4	5.8	4.9	4.9	4.8	4.8	$CE\overline{RIAS}$
Storage & Dispatching	3							
Business Machine/Computer Operation	30	5.4	5.5	5.1	5.0	4.4	5.2	$\overline{CE}\ \overline{SR}$
Technical Cluster (R)	101	4.8	4.2	5.5	4.4	3.8	3.8	REI
Vehicle Operation & Repair	59	5.1	4.6	5.9	4.8	4.1	4.0	REI
Construction & Maintenance	16							
Agriculture & Natural Resources	10							
Crafts & Related Services	5							
Home/Business Equipment Repair	2							
Industrial Equipment Operation & Repair	9							
Science Cluster (I)	175	5.4	5.7	5.9	6.2	5.5	5.4	IRC
Engineering & Other Applied Technologies	81	5.8	6.1	6.3	6.4	5.4	5.1	IRC

TABLE 11 (Continued)

Criterion group (and Holland code)	N	ASVAB-14 Job Cluster Scale[a] E	C	R	I	A	S	Three-letter code[b]
Medical Specialties & Technologies	59	4.7	5.0	5.3	5.6	5.2	5.5	ISRA
Natural Sciences & Mathematics	19							
Social Sciences	16							
Arts Cluster (A)	122	5.0	5.0	4.8	5.1	6.2	5.2	ASI
Applied Arts (Visual)	47	4.7	5.0	5.4	5.1	6.2	5.0	ARICS
Creative/Performing Arts	29	4.4	4.5	4.4	4.8	6.7	4.7	AIS
Applied Arts (Written & Spoken)	46	5.7	5.4	4.5	5.2	5.9	5.7	AES
Social Service Cluster (S)	196	4.8	4.9	4.7	5.0	5.1	5.6	SAI
General Health Care	93	4.9	5.2	4.8	5.4	5.0	5.7	SIC
Education & Related Services	21	5.1	5.3	4.5	5.3	5.8	6.0	SACI
Social & Government Service	50	4.9	4.9	4.9	4.8	5.0	5.5	SAECR
Personal/Customer Services	32	3.8	3.6	4.0	3.6	4.8	5.0	SAR

[a]To conserve space, scales are designated by codes for Holland's (1985) occupational groups. Holland's groups (and corresponding job cluster scales) represented by the codes are: E--Enterprising (Business Contact); C--Conventional (Business Operations); R--Realistic (Technical); I--Investigative (Science); A--Artistic (Arts); S--Social (Social Service).

[b]A dash over two or more codes indicates that the corresponding means differed by less than one-tenth of a standard deviation, and thus were considered tied for practical purposes. Codes considered tied are reported in descending order, with the exception that the order for exact ties is arbitrary and follows the sequence ECRIAS.

TABLE 12

Mean CPP Job Cluster Scale Stanines for Job Cluster and Job Family Criterion Groups

Criterion group (and Holland code)	N	CPP Job Cluster Scale[a]						Three-letter code[b]
		E	C	R	I	A	S	
Business Contact Cluster (E)	83	5.4	4.7	4.3	4.3	4.6	4.9	ESCA
Marketing & Sales	40	4.8	4.3	4.0	3.9	4.3	4.5	ESCA
Management & Planning	43	6.0	5.0	4.6	4.7	4.8	5.2	ESC
Business Operations Cluster (C)	134	5.0	5.4	4.6	4.6	4.6	4.9	CES
Records & Communications	32	4.5	4.9	3.7	4.2	4.7	5.1	SCA
Financial Transactions	69	5.3	5.7	5.0	4.9	4.7	4.8	CERI
Storage & Dispatching	3							
Business Machine/Computer Operation	30	5.1	5.1	4.6	4.7	4.3	4.9	ECS
Technical Cluster (R)	99	4.5	4.1	5.6	4.1	3.9	3.7	RECI
Vehicle Operation & Repair	59	4.8	4.5	5.9	4.5	4.2	3.9	RECI
Construction & Maintenance	15							
Agriculture & Natural Resources	9							
Crafts & Related Services	5							
Home/Business Equipment Repair	2							
Industrial Equipment Operation & Repair	9							
Science Cluster (I)	175	5.5	5.6	5.9	6.0	5.6	5.5	IR CAES
Engineering & Other Applied Technologies	81	5.7	5.6	6.5	6.1	5.5	5.1	RIEC
Medical Specialties & Technologies	59	4.8	5.2	5.1	5.5	5.1	5.5	IS CRA
Natural Sciences & Mathematics	19							
Social Sciences	16							

TABLE 12 (Continued)

Criterion group (and Holland code)	N	CPP Job Cluster Scale[a]						Three-letter code[b]
		E	C	R	I	A	S	
Arts Cluster (A)	120	5.1	5.0	5.0	5.2	6.0	5.3	$\overline{\text{ASI}}$
Applied Arts (Visual)	46	4.8	4.8	5.4	5.0	6.0	5.0	AR$\overline{\text{IS}}$
Creative/Performing Arts	28	4.5	4.4	4.5	4.8	6.3	4.8	A$\overline{\text{IS}}$
Applied Arts (Written & Spoken)	46	5.8	5.5	4.8	5.6	5.8	5.9	$\overline{\text{SEA}}$
Social Service Cluster (S)	196	4.9	5.0	4.5	5.1	5.1	5.6	S$\overline{\text{IAC}}$
General Health Care	93	5.2	5.4	4.8	5.6	5.2	6.0	SIC
Education & Related Services	21	5.3	5.3	4.1	5.4	5.6	6.0	SA$\overline{\text{IEC}}$
Social & Government Service	50	4.9	4.8	4.6	4.8	4.8	5.3	S$\overline{\text{ECIA}}$
Personal/Customer Services	32	3.9	4.1	3.6	3.7	4.7	4.8	$\overline{\text{SAC}}$

[a]To conserve space, scales are designated by codes for Holland's (1985) occupational groups. Holland's groups (and corresponding job cluster scales) represented by the codes are: E--Enterprising (Business Contact); C--Conventional (Business Operations); R--Realistic (Technical); I--Investigative (Science); A--Artistic (Arts); S--Social (Social Service).

[b]A dash over two or more codes indicates that the corresponding means differed by less than one-tenth of a standard deviation, and thus were considered tied for practical purposes. Codes considered tied are reported in descending order, with the exception that the order for exact ties is arbitrary and follows the sequence ECRIAS.

TABLE 13

Differentiation of Occupational Choice Groups by CPP Ability Tests

Statistics	Weighted-sample results
MANOVA	
Wilks's lambda[a]	0.62
Wilks's variance-explained index	38%
Univariate F (and rank for unique contribution)[b] for CPP Ability Tests	
Reading Skills	14.0 (5th)
Language Usage	21.0 (2nd)
Numerical Skills	13.2 (4th)
Clerical Skills	8.4 (3rd)
Space Relations	8.5 (6th)
Mechanical Reasoning	21.3 (1st)
DISANL	
No. of functions warranted by significance tests[c]	3
Among-group variance for 1st 4 functions	65%, 18%, 15%, 2%
Hit rate (average)	
Analysis sample	39%
Cross-validation sample	34%

[a]For the unweighted analysis, lambda equaled .62; F (30, 2,630) = 11.14, $p < .0001$.

[b]For the unweighted analyses, Fs (5, 662; $p < .0001$ for each F) were as follows: 13.5, 19.7, 16.0, 8.6, 9.6, and 22.8. See discussion of MANOVA in Appendix C for procedure used to determine the unique contribution of a test.

[c]For the unweighted analysis, chi-square (20, $N = 668$) = 112.9, $p < .0001$ for Functions 2-5. For Functions 3-5, $p < .0001$. For Functions 4-5, chi-square (6, $N = 668$) = 3.1, $p > .80$.

TABLE 14

Differentiation of Occupational Choice Groups by Ability Self-ratings

Statistics	Weighted-sample results
MANOVA	
Wilks's lambda[a]	0.52
Wilks's variance-explained index	48%
Univariate F (and rank for unique contribution)[b] for ability self-ratings	
Scientific	25.6 (1st)
Creative/Artistic	14.5 (4th)
Creative/Literary	16.3 (5th)
Helping Others	9.1 (6th)
Meeting People	5.2 (9th)
Sales	13.8 (3rd)
Leadership/Management	4.1 (8th)
Organization	3.3 (7th)
Manual Dexterity	19.9 (2nd)
DISANL	
No. of functions warranted by significance tests[c]	4
Among-group variance for all 5 functions	40%, 30%, 17%, 10%, 2%
Hit rate (average)	
Analysis sample	44%
Cross-validation sample	38%

[a]For the unweighted analysis, lambda equaled .54; F (45, 2,929) = 9.52, $p < .0001$.

[b]For the unweighted analyses, Fs (5, 662) were as follows: 27.2, 11.4, 14.7, 11.21, 4.3, 5.0, 2.5, 3.7, and 23.0. For five of the variables, $p < .0001$; for two, $p < .001$; for Leadership/Management and Organization, $p < .05$ and .01, respectively.

[c]For the unweighted analysis, chi-square (32, N = 668) = 233.8, $p < .0001$ for Functions 2-5. For Functions 3-5 and 4-5, $p < .0001$ and $p < .001$, respectively. For Function 5, chi-square (5, N = 668) = 9.8, $p > .08$.

TABLE 15

Differentiation of Occupational Choice Groups by CPP Job Cluster Scales

Statistics	Weighted-sample results
MANOVA	
Wilks's lambda[a]	0.48
Wilks's variance-explained index	52%
Univariate *F* (and rank for unique contribution)[b]	
Business Contact Scale	12.6 (3rd)
Business Operations Scale	19.5 (4th)
Technical Scale	21.6 (1st)
Science Scale	23.7 (5th)
Arts Scale	28.3 (2nd)
Social Service Scale	21.8 (6th)
DISANL	
No. of functions warranted by significance tests[c]	4
Among-group variance for all 5 functions	43%, 32%, 15%, 7%, 3%
Hit rate	
Analysis sample	44%
Cross-validation sample	42%

[a]For the unweighted analysis, lambda equaled .49; F (30, 2,630) = 16.85, $p < .0001$.

[b]For the unweighted analyses, Fs (5, 662; $p < .0001$ for each F) were as follows: 12.4, 20.6, 24.6, 23.9, 23.5, and 23.0.

[c]For the unweighted analysis, chi-square (20, $N = 668$) = 243.3, $p < .0001$ for Functions 2-5. For Functions 3-5 and 4-5, $p < .0001$. For Function 5, chi-square (2, $N = 668$) = 9.5, $p > .008$.

TABLE 16

Mean CPP Ability Test Stanine Scores for Job Cluster and Job Family Criterion Groups

Criterion group	N[b]	CPP Ability Test[a] RS	LU	NS	CS	SR	MR
Business Contact Cluster	50	4.8	4.7	4.7	5.5	4.8	4.5
Marketing & Sales	18						
Management & Planning	32	5.0	4.7	5.0	5.8	4.9	4.4
Business Operations Cluster	199	4.8	5.3	4.8	6.0	4.4	4.2
Records & Communications	83	4.2	5.2	4.2	5.7	4.0	3.8
Financial Transactions	61	5.4	5.6	5.6	6.2	4.8	4.7
Storage & Dispatching	4						
Business Machine/Computer Operation	52	4.7	4.9	4.9	6.0	4.6	4.4
Technical Cluster	190	3.9	3.5	4.2	4.4	5.2	6.0
Vehicle Operation & Repair	74	4.2	3.9	4.1	4.8	5.6	6.1
Construction & Maintenance	28	3.2	2.8	3.8	4.0	5.2	6.0
Agriculture & Natural Resources	32	4.1	3.2	4.2	4.3	5.1	5.7
Crafts & Related Services	11						
Home/Business Equipment Repair	12						
Industrial Equipment Operation & Repair	33	3.8	3.2	4.2	4.1	5.0	6.0
Science Cluster	259	5.5	5.4	5.9	5.7	5.8	6.1
Engineering & Other Applied Technologies	162	6.6	5.4	6.3	5.7	6.2	6.6
Medical Specialties & Technologies	57	5.5	5.5	5.4	5.7	5.3	5.3
Natural Sciences & Mathematics	21	5.6	5.1	5.8	5.9	4.7	5.7
Social Sciences	18						

TABLE 16 (Continued)

Criterion group	N[b]	CPP Ability Tes					
		RS	LU	NS	CS	SR	MR
Arts Cluster	142	5.5	5.5	5.0	5.1	5.1	5.2
Applied Arts (Visual)	51	5.0	5.2	4.9	5.2	5.0	4.9
Creative/Performing Arts	45	5.4	5.1	4.6	4.6	5.0	5.2
Applied Arts (Written & Spoken)	46	6.2	6.2	5.4	5.4	5.2	5.4
Social Service Cluster	261	5.2	5.2	4.9	5.4	4.7	4.7
General Health Care	132	5.7	5.6	5.4	5.5	5.0	4.9
Education & Related Services	48	5.5	5.4	5.1	5.6	4.9	4.6
Social & Government Services	39	4.4	4.4	4.0	5.1	4.2	4.7
Personal/Customer Services	41	4.0	4.4	4.0	5.1	4.2	4.1

[a]Abbreviations are as follows: Reading Skills (RS), Language Usage (LU), Numerical Skills (NS), Clerical Skills (CS), Space Relations (SR), and Mechanical Reasoning (MR).

[b]Most of the group sample sizes vary slightly from scale to scale. Each sample size shown is the mean of the number of valid scores for the six scales, rounded to the nearest whole number.

TABLE 17

Mean CPP Job Cluster Scale Stanines for Job Cluster and Job Family Criterion Groups

Criterion group (and Holland code)	N	CPP Job Cluster Scale[a]						Three-letter code[b]
		E	C	R	I	A	S	
Business Contact Cluster (E)	47	5.8	5.0	4.4	4.6	4.8	5.2	ESC
Marketing & Sales	16							
Management & Planning	31	5.9	5.2	4.4	4.7	4.7	5.3	$E\overline{SC}$
Business Operations Cluster (C)	191	5.1	5.5	4.2	4.8	4.6	5.2	$C\overline{SE}$
Records & Communications	80	4.5	5.1	3.6	4.2	4.6	5.0	$\overline{CS}\ \overline{AE}$
Financial Transactions	60	5.7	6.2	4.9	5.5	4.9	5.9	CSE
Storage & Dispatching	2							
Business Machine/Computer Operation	49	5.0	5.3	4.4	4.8	4.4	4.8	$CE\overline{IS}$
Technical Cluster (R)	176	4.1	3.8	5.7	4.0	4.1	3.7	$RA\overline{EI}$
Vehicle Operation & Repair	71	4.5	4.1	5.9	4.3	4.5	4.0	$RA\overline{E}$
Construction & Maintenance	22	3.7	3.2	5.6	3.4	3.5	3.3	$RE\overline{AI}$
Agriculture & Natural Resources	32	3.7	3.8	5.6	3.9	4.1	3.6	$RA\overline{IC}$
Crafts & Related Services	10							
Home/Business Equipment Repair	11							
Industrial Equipment Operation & Repair	30	3.7	3.6	5.7	3.6	3.5	3.3	$RE\overline{CI}$
Science Cluster (I)	250	5.7	5.9	6.2	6.2	5.7	5.4	$\overline{RI}C$
Engineering & Other Applied Technologies	156	5.9	6.0	6.9	6.3	5.8	5.2	$RI\overline{CE}$
Medical Specialties & Technologies	56	5.2	5.7	5.4	6.0	5.6	5.6	ICAS
Natural Sciences & Mathematics	20	5.2	5.8	5.3	6.3	5.4	4.6	$IC\overline{AR}$
Social Sciences	18							

TABLE 17 (Continued)

Criterion group (and Holland code)	N	CPP Job Cluster Scale[a]						Three-letter code[b]
		E	C	R	I	A	S	
Arts Cluster (A)	134	5.4	5.2	4.9	5.5	6.3	5.6	$\overline{\text{ASI}}$
Applied Arts	49	4.9	5.2	5.0	5.3	6.2	5.0	A$\overline{\text{IC}}$
Creative/Performing Arts	39	4.9	4.5	4.8	5.2	6.5	5.2	A$\overline{\text{IS}}$
Applied Arts (Written & Spoken)	46	6.4	5.9	5.0	5.9	6.3	6.4	$\overline{\text{ESA}}$
Social Service Cluster (S)	248	5.1	5.2	4.6	5.3	5.1	5.8	S$\overline{\text{ICEA}}$
General Health Care	125	5.4	5.8	5.0	6.2	5.2	6.2	$\overline{\text{SIC}}$
Education & Related Services	47	5.3	5.3	4.6	5.2	5.7	5.8	$\overline{\text{SA}}$ $\overline{\text{ECI}}$
Social & Government Service	37	4.6	4.4	4.2	4.2	4.4	5.1	SE$\overline{\text{CA}}$
Personal/Customer Services	39	4.1	4.4	3.9	4.0	4.7	4.9	SAC

[a]To conserve space, scales are designated by codes for Holland's (1985) occupational groups. Holland's groups (and corresponding job cluster scales) represented by the codes are: E--Enterprising (Business Contact); C--Conventional (Business Operations); R--Realistic (Technical); I--Investigative (Science); A--Artistic (Arts); S--Social (Social Service).

[b]A dash over two or more codes indicates that the corresponding means differed by less than one-tenth of a standard deviation, and thus were considered tied for practical purposes. Codes considered tied are reported in descending order, with the exception that the order for exact ties is arbitrary and follows the sequence ECRIAS.

TABLE 18

Differentiation of Occupational Groups by CPP Ability Tests

Statistics	Weighted-sample results
MANOVA	
Wilks's lambda[a]	0.73
Wilks's variance-explained index	27%
Univariate F (and rank for unique contribution)[b] for CPP Ability Tests	
Reading Skills	22.2 (3rd)
Language Usage	20.1 (4th)
Numerical Skills	25.1 (2nd)
Clerical Skills	7.7 (5th)
Space Relations	7.5 (6th)
Mechanical Reasoning	26.8 (1st)
DISANL	
No. of functions warranted by significance tests[c]	2
Among-group variance for 1st 3 functions	62%, 34%, 3%
Hit rate (average)	
Analysis sample	34%
Cross-validation sample	30%

[a]For the unweighted analysis, lambda equaled .715; F (30, 4,353) = 12.71, $p < .0001$.

[b]For the unweighted analyses, Fs (5, 1,094; $p < .0001$ for each F) were as follows: 19.8, 19.7, 16.3, 8.7, 8.5, and 31.4. See discussion of MANOVA in Appendix C for procedure used to determine the unique contribution of a test.

[c]For the unweighted analysis, chi-square (20, N = 1,100) = 103.4, $p < .0001$ for Functions 2-5. For Functions 3-5, chi-square (12, N = 1,100) = 11.2, $p > .50$.

TABLE 19

Mean CPP Ability Test Stanines for Job Cluster and IDES Job Category Criterion Groups

Criterion group	N	CPP Ability Test[a] RS	LU	NS	CS	SR	MR
Business Contact Cluster	234	5.8	5.7	5.6	5.4	5.5	5.3
Buyer/Bank Officer	21	6.1	6.0	5.4	5.3	5.5	5.8
Administrator, Other	102	5.9	5.7	5.7	5.4	5.6	5.5
Clerk, Retail Sales	58	5.4	5.5	5.1	5.3	5.0	4.4
Sales Person, Other	53	5.8	5.9	6.1	5.6	5.9	5.7
Business Operations Cluster	364	5.6	5.9	5.5	5.7	5.1	4.6
Bank Clerk/Bookkeeper	68	5.4	5.7	5.5	5.5	5.2	4.3
Secretary/Typist	157	5.4	6.1	5.0	5.7	4.7	4.2
Clerk, Other	73	5.5	5.7	5.6	5.8	5.1	4.7
Accountant	66	6.3	6.0	6.6	5.9	5.8	5.6
Technical Cluster	311	4.8	4.6	5.0	4.9	5.6	5.8
Mechanic/Repairing	43	4.3	4.3	5.0	4.8	6.0	6.7
Construction, Crafts	78	4.9	4.5	5.2	5.0	5.9	6.0
Machine Operator	92	4.8	4.8	4.7	4.7	5.3	5.3
Transport Equipment Operator	24	4.7	4.2	5.1	4.2	5.5	6.0
Laborer, Non-Farm	35	4.5	4.5	4.7	4.9	5.4	5.4
Technician, Other[b]	39	5.4	5.0	5.8	5.4	5.7	5.9
Science Cluster	174	6.2	5.9	6.5	5.6	6.1	6.3
Computer Programmer	28	6.5	6.4	6.6	5.7	5.9	6.4
Engineer	68	6.8	6.2	7.3	5.7	6.7	7.2

TABLE 19 (Continued)

Criterion group	N	CPP Ability Test[a] RS	LU	NS	CS	SR	MR
Engineering Technician	27	4.8	4.8	5.4	5.0	6.3	6.0
Health Technologist	51	5.9	5.8	5.8	5.7	5.4	5.1
Arts Cluster	20	6.4	6.0	6.2	5.5	5.2	5.4
Writer/Artist/Entertainer	20	6.4	6.0	6.2	5.5	5.2	5.4
Social Service Cluster	384	5.9	5.9	5.6	5.5	5.2	4.6
Registered Nurse/Dietician	97	6.1	6.0	5.9	6.0	5.1	4.4
Religious, Social Work/Counselor	27	5.5	5.9	5.3	4.9	5.1	4.8
Teacher, Secondary School	45	6.4	6.4	6.0	6.0	5.5	4.8
Teacher, Elementary School	70	5.8	6.1	5.5	5.2	5.0	4.3
Teacher, Other[b]	39	6.2	5.9	5.6	5.7	5.2	4.2
Cleaning or Food Service[b]	37	5.0	5.0	4.8	4.9	5.2	4.8
Health Service	34	5.6	5.4	5.1	5.6	5.2	4.3
Protective Service	35	5.7	5.5	5.4	5.4	5.8	5.6

[a]Abbreviations are as follows: Reading Skills (RS), Language Usage (LU), Numerical Skills (NS), Clerical Skills (CS), Space Relations (SR), and Mechanical Reasoning (MR).

[b]This IDES occupational category consists of disparate occupations, one or more of which are not classified in the ACT job cluster shown.

TABLE 20

Number of Students Involved in Discriminant Analyses Across Educational Groups

Educational programs	Males		Females	
	Cases available[a]	Final sample	Cases available[a]	Final sample
Auto Mechanics	1,036	328	--	--
Drafting	663	210	--	--
Machine Work	227	97	--	--
Other Trades	1,959	471	142	36[b]
Agriculture	319	137	--	--
Computer Programming	277	84	175	61[b]
Elect. Engineering Tech.	1,322	410	--	--
Other Technical	564	172	--	--
Other Health--Technical	234	76[b]	711	262
Natural Science (Transfer)	697	109	--	--
Arts & Humanities (Tr.)	415	48[b]	291	67[b]
Cosmetology	--	--	172	54
Dental Assisting	--	--	361	125
Nursing--Practical	--	--	648	289
Nursing--Registered	--	--	757	290
Police Science	283	69	--	--
Social Service/Science (Tr.)	369	54[b]	532	103
Business & Marketing	420	80[b]	173	48[b]
Bus. Administration (Tr.)	414	82	148	44[b]
Accounting	342	71	250	84
Secretarial Science	--	--	1,332	471
Data Processing	327	102	243	73[b]
Total	9,918	2,600	5,935	2,007

[a]Indicates program enrollment after removal of unusual institutions identified by within-program analyses conducted across institutions. About 10% of the students in the original sample were excluded for this reason. Original sample sizes were 10,870 for males and 6,694 for females.

[b]Students expressing no opinion on the satisfaction survey were combined with satisfied students to increase sample size.

TABLE 21

Differentiation of Educational Groups by CPP Ability Tests and Self-ratings

Statistics	Results by gender group: Male	Female
MANOVA		
Wilks's lambda[a]	.56	.56
Wilks's variance explained index	44%	44%
Univariate F (and rank)[b]		
Ability tests		
Reading Skills	17.7 (3)	15.4 (4)
Numerical Computation	17.3 (4)	17.9 (3)
Math Usage	27.1 (1)	20.2 (1)
Clerical Skills	5.1 (12)	9.2 (8)
Space Relations	6.7 (11)	5.5 (12)
Mechanical Reasoning	11.1 (7)	8.9 (9)
Nonverbal Reasoning	9.2 (8.5)	11.0 (7)
High school GPA	7.1 (10)	11.9 (5)
Self-ratings		
Artistic Ability	12.1 (6)	6.9 (11)
Clerical Ability	9.2 (8.5)	20.1 (2)
Science Composite	21.8 (2)	11.8 (6)
Trades Composite	13.2 (5)	8.3 (10)
Interpersonal Composite	3.6 (13)	1.9 (13)
DISANL		
No. of functions warranted by significance tests	c	c
Among-group variance for 1st 4 functions	46%, 24% 13%, 6%	39%, 28% 13%, 9%
Hit rate	c	c

[a]The associated F values ($p < .0005$) are as follows for males and females, respectively: F (208, 26,121) = 7.3; F (169, 18,368) = 6.9.

[b]For males, $p < .0005$ for F (16, 2,583) > 2.6. For females, $p < .0005$ for F (13, 1,993) > 2.9. The F of 1.9 for Interpersonal Composite for females was significant at the .05 level. Rank for unique contribution was not provided in the study report. Hence, the ranks for F values are shown.

[c]Not provided in the study report.

TABLE 22

Educational Groups Scoring Highest and Lowest on First Three Discriminant Functions

Discriminant function (and % variance)	Educational program (and function mean)	
	Highest	Lowest
	Males	
1. Academic (46%)	Data Processing (56) Elect. Engr. Tech. (55) Computer Programming (55)	Auto Mechanics (42) Machine Work (45) Other Trades (45)[a]
2. Clerical vs. Tech. (24%)	Social Science--Tr. (58) Police Science (58) Business Admin.--Tr. (57)	Natural Science--Tr. (46) Elect. Eng. Tech. (46) Other Technical (46)[b]
3. Artistic (13%)	Arts & Humanities--Tr. (61) Drafting (57) Social Service/Sci.--Tr. (51)	Data Processing (47) Business Admin.--Tr. (47) Computer Programming (48)
	Females	
1. Clerical vs. Sci. (39%)	Business Admin.--Tr. (58) Secretarial Science (56) Accounting (55)	Nursing--Registered (45) Nursing--Practical (46) Other Health (46)[c]
2. Academic (28%)	Computer Programming (59) Data Processing (54) Other Health (53)[c]	Cosmetology (42) Other Trades (42)[d] Nursing--Practical (44)
3. Artistic (13%)	Other Trades (60)[d] Arts & Humanities--Tr. (57) Cosmetology (54)	Business Admin.--Tr. (47) Nursing--Practical (47) Nursing--Registered (48)

Note. Mean scores for discriminant functions are reported on a standard score scale with a mean of 50 and a standard deviation of 10.

[a]Primarily Refrigeration/Heating, Construction, and Auto Body Repair

[b]Primarily engineering technologies (e.g., civil, mechanical)

[c]Primarily Dental Hygiene, Medical Technology, and Medical Assisting

[d]Primarily Commercial Art and Graphic Arts.

APPENDIX E

FIGURES CITED IN STUDIES 1-4

BUSINESS CONTACT JOB CLUSTER

A. MARKETING AND SALES JOB FAMILY
Sales workers in stores; route drivers (milk, etc.); buyers; travel agents; sales workers who visit customers (real estate and insurance agents; stock brokers; farm products, office, and medical supplies sales workers)

B. MANAGEMENT AND PLANNING JOB FAMILY
Store, motel, restaurant, and agribusiness managers; office supervisors; purchasing agents; managers in large businesses; recreation/parks managers; medical records administrators; urban planners

BUSINESS OPERATIONS JOB CLUSTER

C. RECORDS AND COMMUNICATIONS
Office, library, hotel, and postal clerks; receptionists; computer tape librarians; office, medical, and legal secretaries; court reporters; medical record technicians

D. FINANCIAL TRANSACTIONS
Bookkeepers; accountants; grocery check-out clerks; bank tellers; ticket agents; insurance underwriters; financial analysts

E. STORAGE AND DISPATCHING
Shipping and receiving clerks; mail carriers; truck, cab, and airline dispatchers; cargo agents; air traffic controllers

F. BUSINESS MACHINE/COMPUTER OPERATION
Computer console, printer, etc., operators; office machine operators; typists; word-processing equipment operators; statistical clerks

TECHNICAL JOB CLUSTER

G. VEHICLE OPERATION AND REPAIR
Bus, truck, and cab drivers; auto, bus, and airplane mechanics; forklift operators; merchant marine officers; airplane pilots

H. CONSTRUCTION AND MAINTENANCE
Carpenters; electricians; painters; custodians (janitors); bricklayers; sheet metal workers; buildozer and crane operators; building inspectors

I. AGRICULTURE AND NATURAL RESOURCES
Farmers; foresters; ranchers; landscape gardeners; tree surgeons; plant nursery workers; pet shop attendants

J. CRAFTS AND RELATED SERVICES
Cooks; meatcutters; bakers; shoe repairers; piano/organ tuners; tailors; jewelers

K. HOME/BUSINESS EQUIPMENT REPAIR
Repairers of TV sets, appliances, typewriters, telephones, heating systems, photocopiers, etc.

L. INDUSTRIAL EQUIPMENT OPERATION AND REPAIR
Machinists; printers; sewing machine operators; welders; industrial machinery repairers; production painters; laborers and machine operators in factories, mines, etc.; firefighters

SCIENCE JOB CLUSTER

M. ENGINEERING AND OTHER APPLIED TECHNOLOGIES
Engineers and engineering technicians in various fields; biological and chemical lab technicians; computer programmers; computer service technicians; drafters; surveyors; technical illustrators; food technologists

N. MEDICAL SPECIALTIES AND TECHNOLOGIES
Dental hygienists; EEG and EKG technicians; opticians; prosthetics technicians; X-ray technologists; medical technologists; dentists; optometrists; pharmacists; veterinarians

O. NATURAL SCIENCES AND MATHEMATICS
Agronomists; biologists; chemists; ecologists; geographers; geologists; horticulturists; mathematicians; physicists; soil scientists

P. SOCIAL SCIENCES
Marketing research analysts; anthropologists; economists; political scientists; psychologists; sociologists

ARTS JOB CLUSTER

Q. APPLIED ARTS (VISUAL)
Floral designers; mechandise displayers; commercial artists; fashion designers; photographers; interior designers; architects; landscape architects

R. CREATIVE/PERFORMING ARTS
Entertainers (comedians, etc.); actors/actresses; dancers; musicians, singers; composers; writers; art, music, etc. teachers

S. APPLIED ARTS (WRITTEN AND SPOKEN)
Advertising copywriters; disk jockeys; legal assistants; advertising account executives; interpreters; reporters; public relations workers; lawyers; librarians; technical writers

SOCIAL SERVICE JOB CLUSTER

T. GENERAL HEALTH CARE
Nursing aides; orderlies; dental assistants; licensed practical nurses; physical therapy assistants; registered nurses; dieticians; occupational therapists; physicians; speech pathologists

U. EDUCATION AND RELATED SERVICES
Teacher aides; preschool teachers; athletic coaches; college teachers;* guidance/career/etc., counselors; elementary and secondary school teachers; special education teachers

V. SOCIAL AND GOVERNMENT SERVICES
Security guards; recreation leaders; police officers; health/safety/food/etc. inspectors; child welfare workers; home economists; rehabilitation counselors; sanitarians; social workers

W. PERSONAL/CUSTOMER SERVICES
Grocery baggers; bellhops; flight attendants (stewards, stewardesses); waitresses and waiters; cosmetologists (beauticians); barbers; butlers and maids

Figure 1. *Job Clusters, Job Families, and Examples of Occupations in the ACT Occupational Classification System, 2nd Edition.*

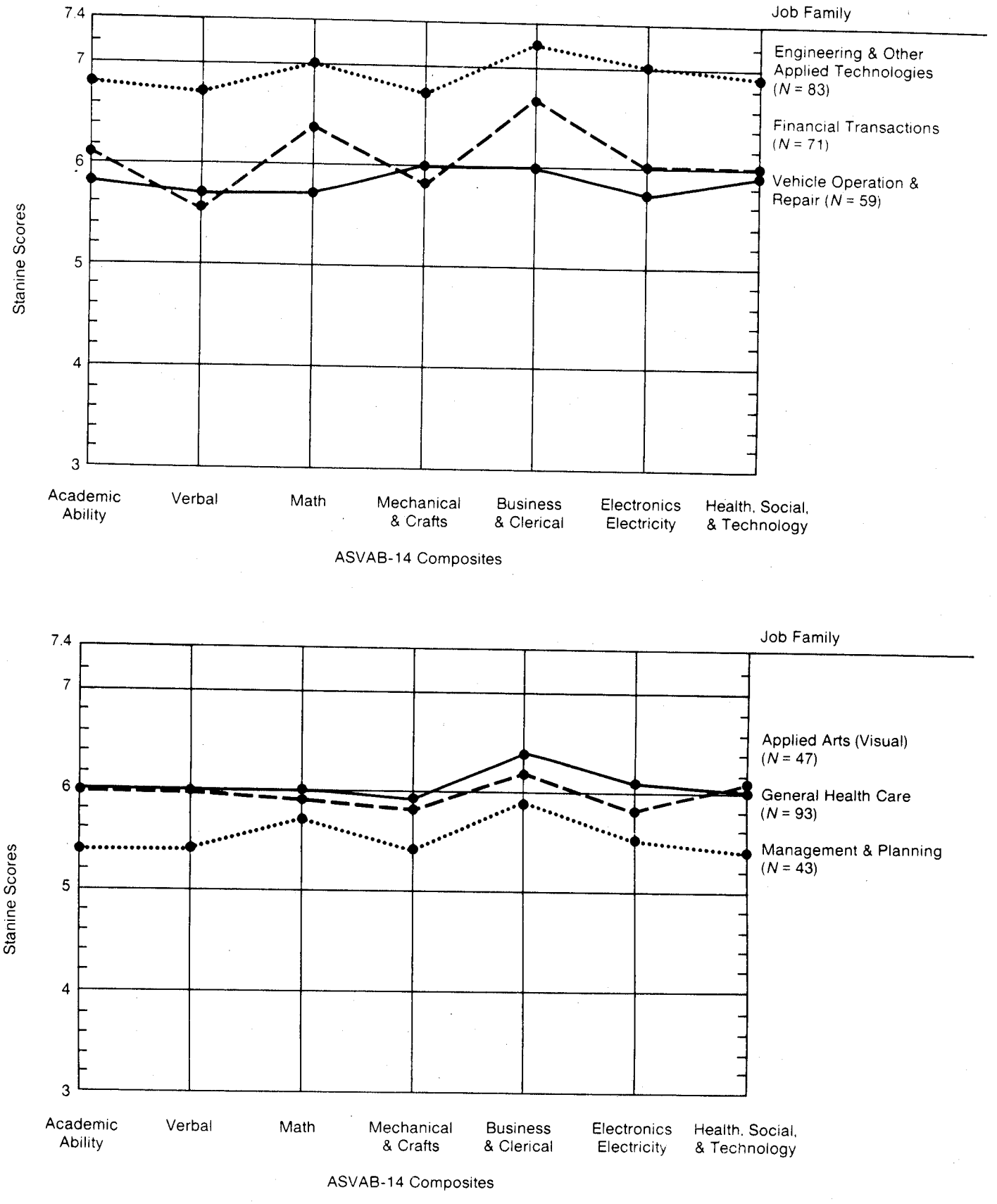
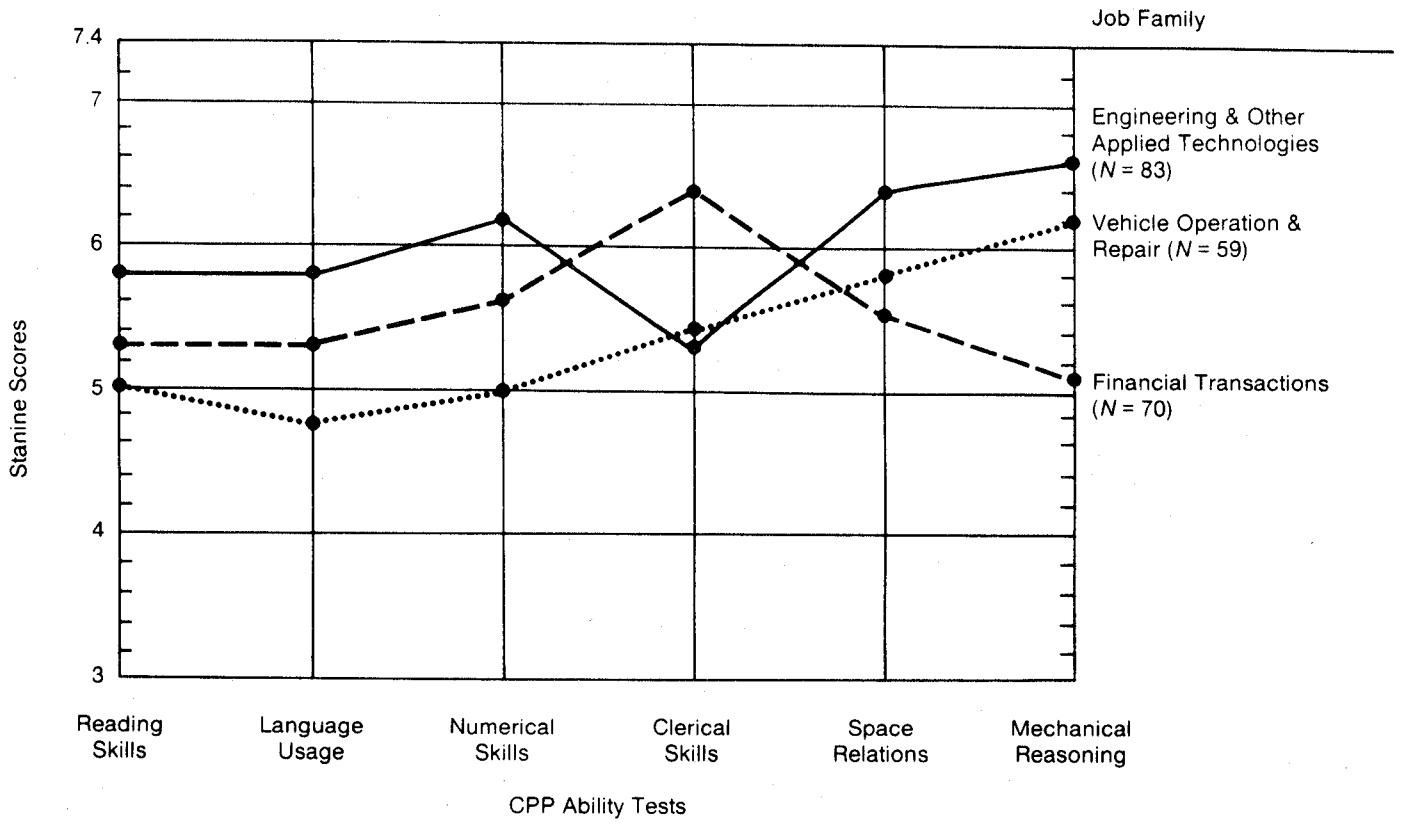


Figure 2. *How Study 1 Occupational Choice Groups Scored on ASVAB-14 Composites.* (Mean scores for the largest job family in each ACT Job Cluster are profiled.)



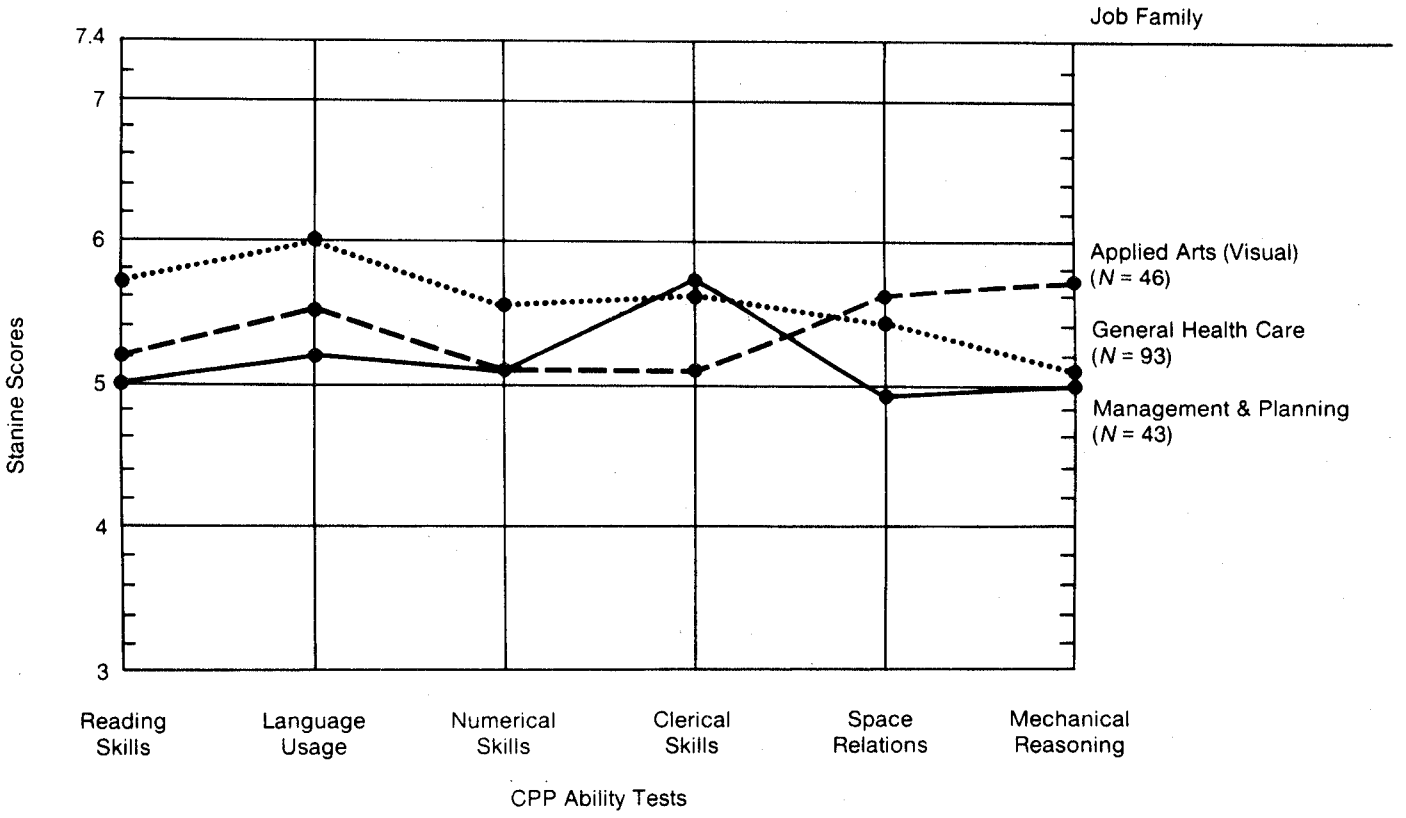


Figure 3. *How Study 1 Occupational Choice Groups Scored on CPP Ability Tests.* (Mean scores for the largest job family in each ACT Job Cluster are profiled.)

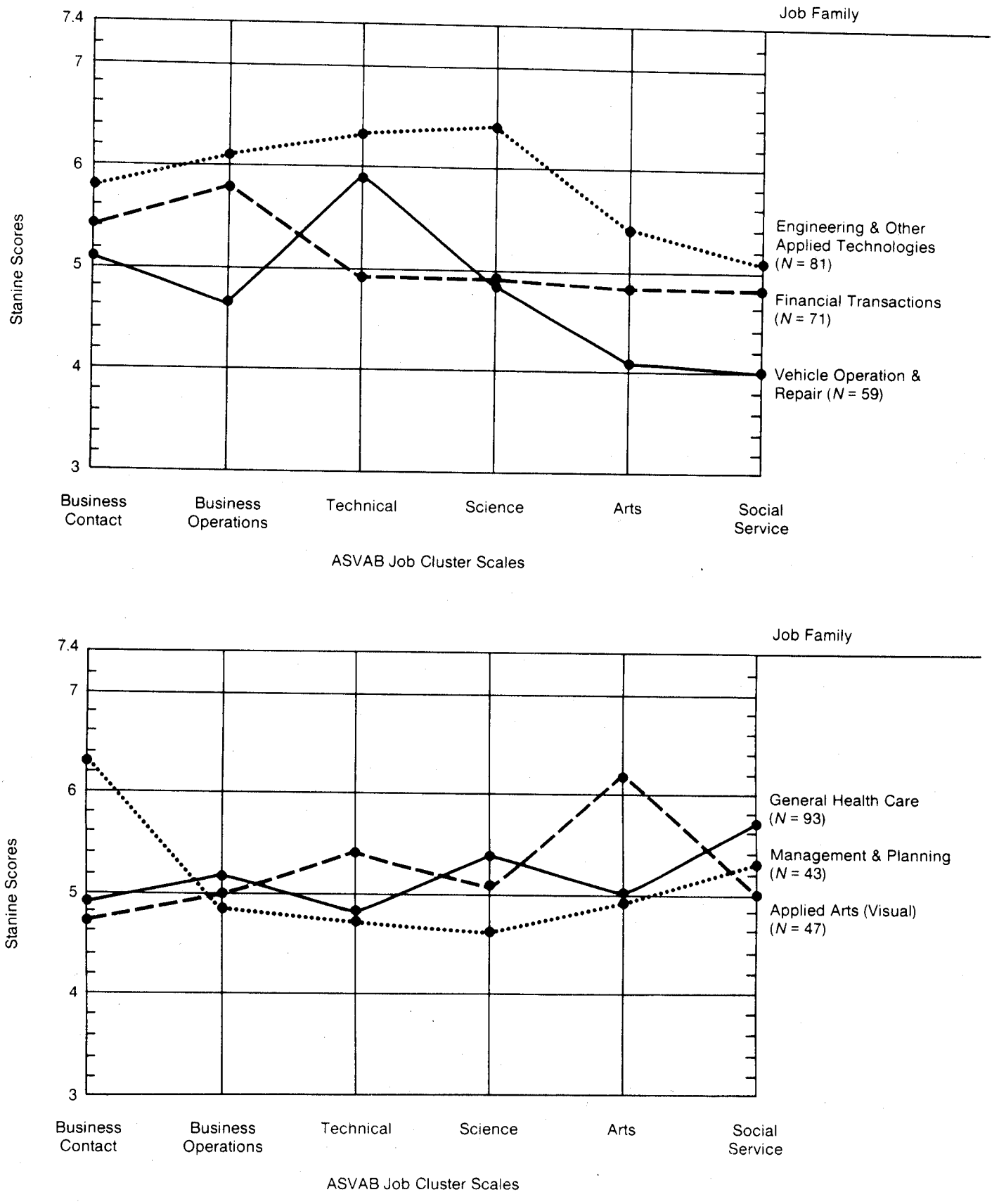


Figure 4. *How Study 1 Occupational Choice Groups Scored on the ASVAB Job Cluster Scales.* (Mean scores for the largest job family in each ACT Job Cluster are profiled.)

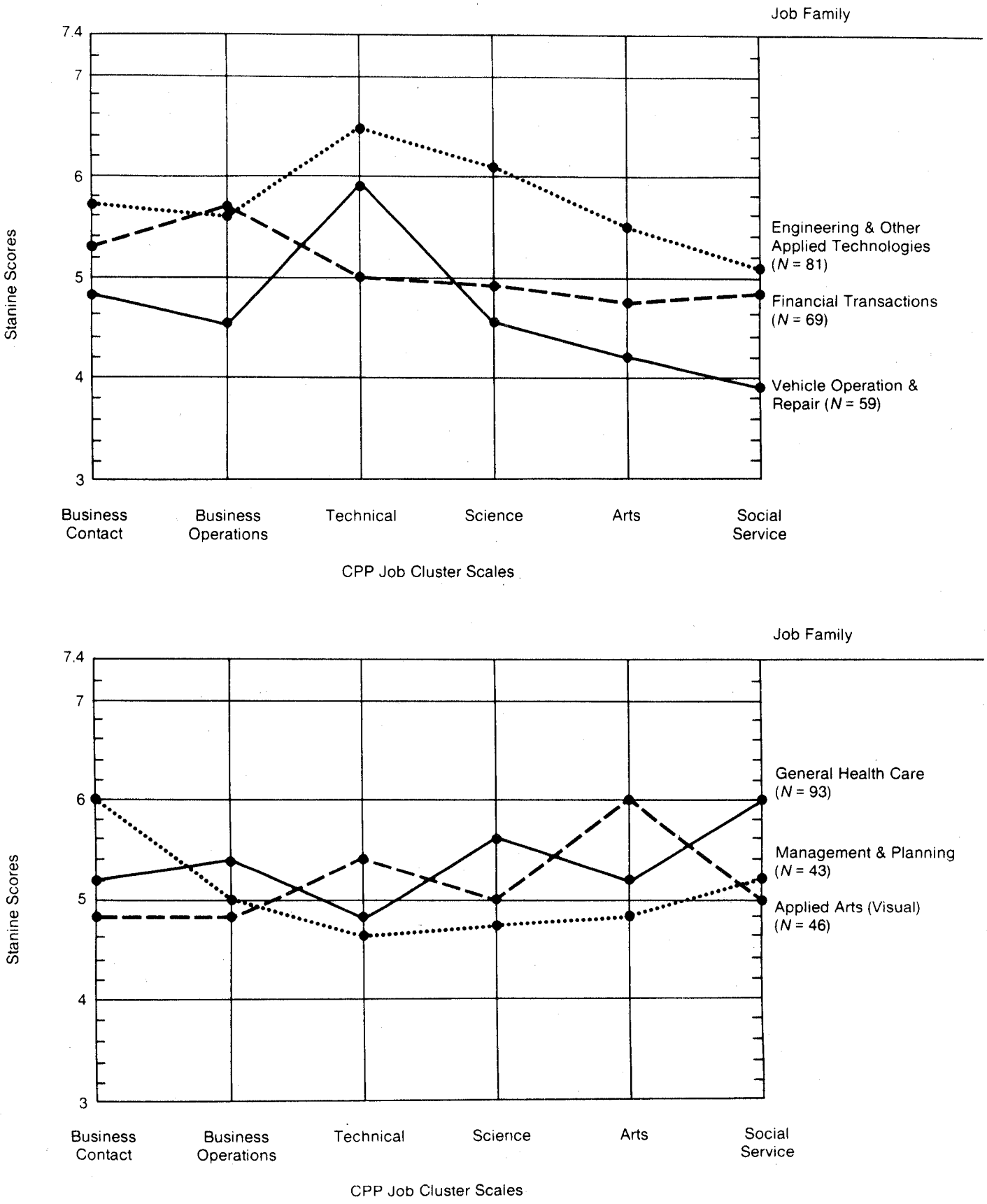
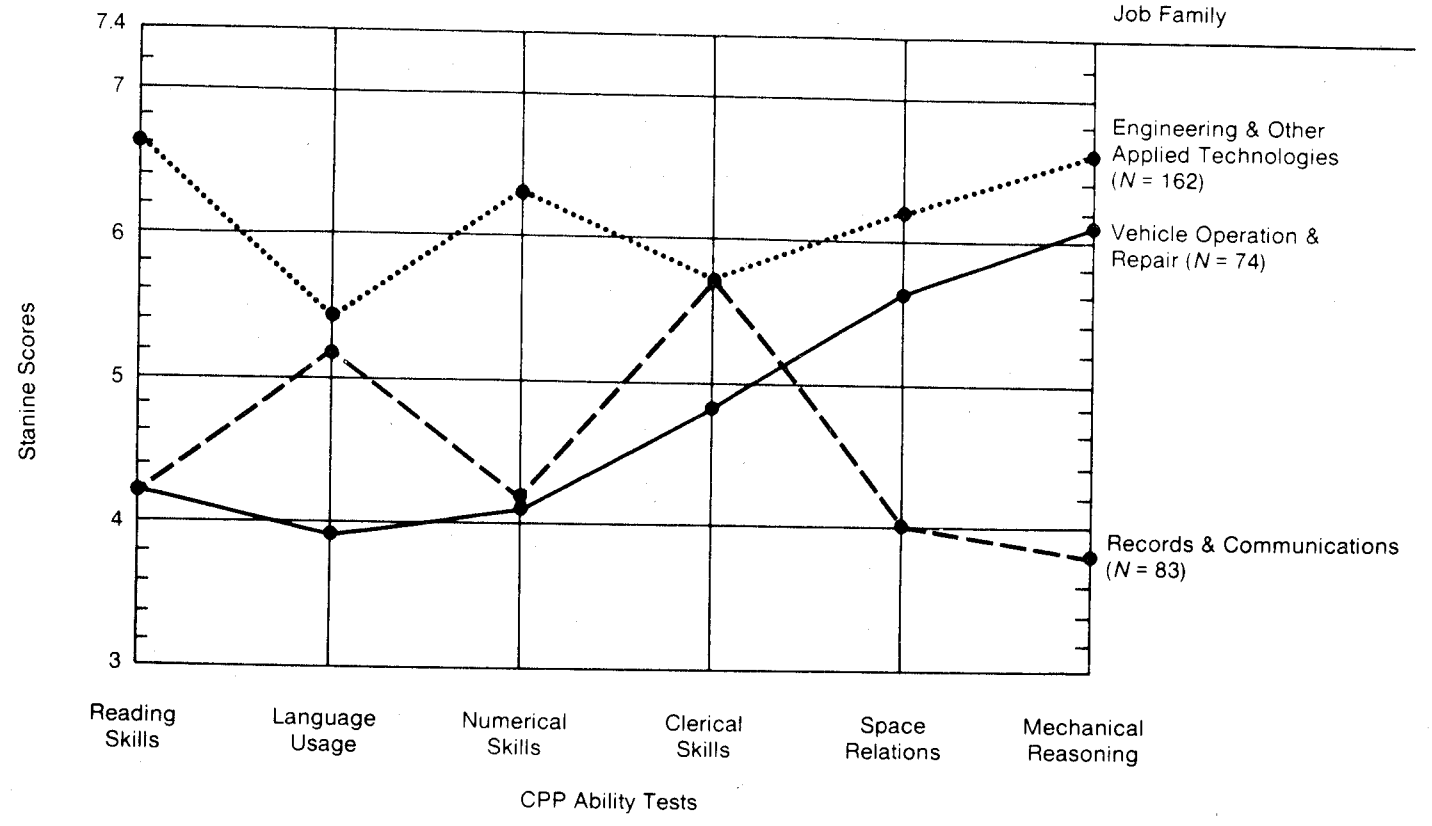


Figure 5. *How Study 1 Occupational Choice Groups Scored on the CPP Job Cluster Scales.* (Mean scores for the largest job family in each ACT Job Cluster are profiled.)



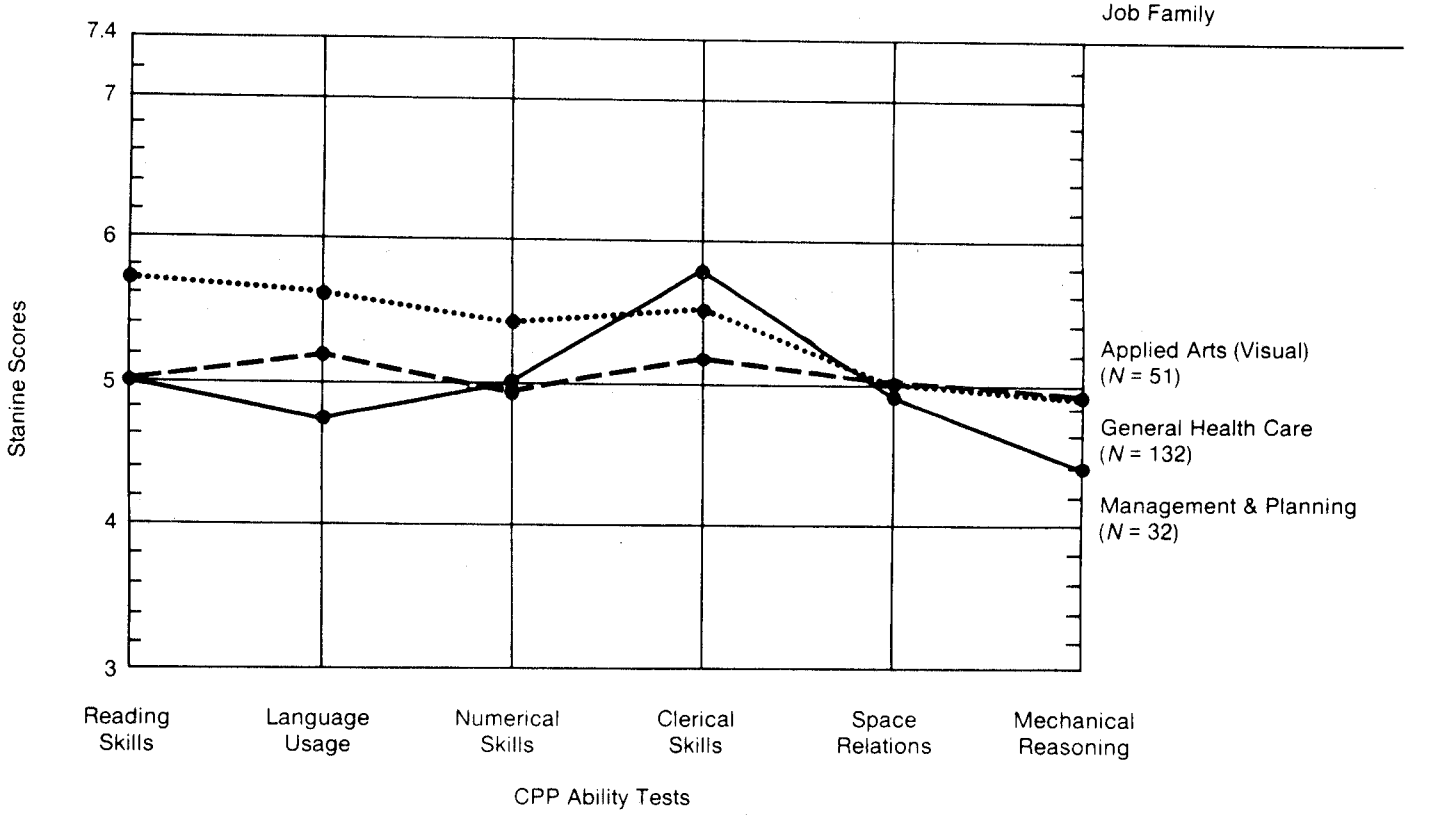


Figure 6. *How Study 2 Occupational Choice Groups Scored on CPP Ability Tests.*
(Mean scores for the largest job family in each ACT Job Cluster are profiled.)

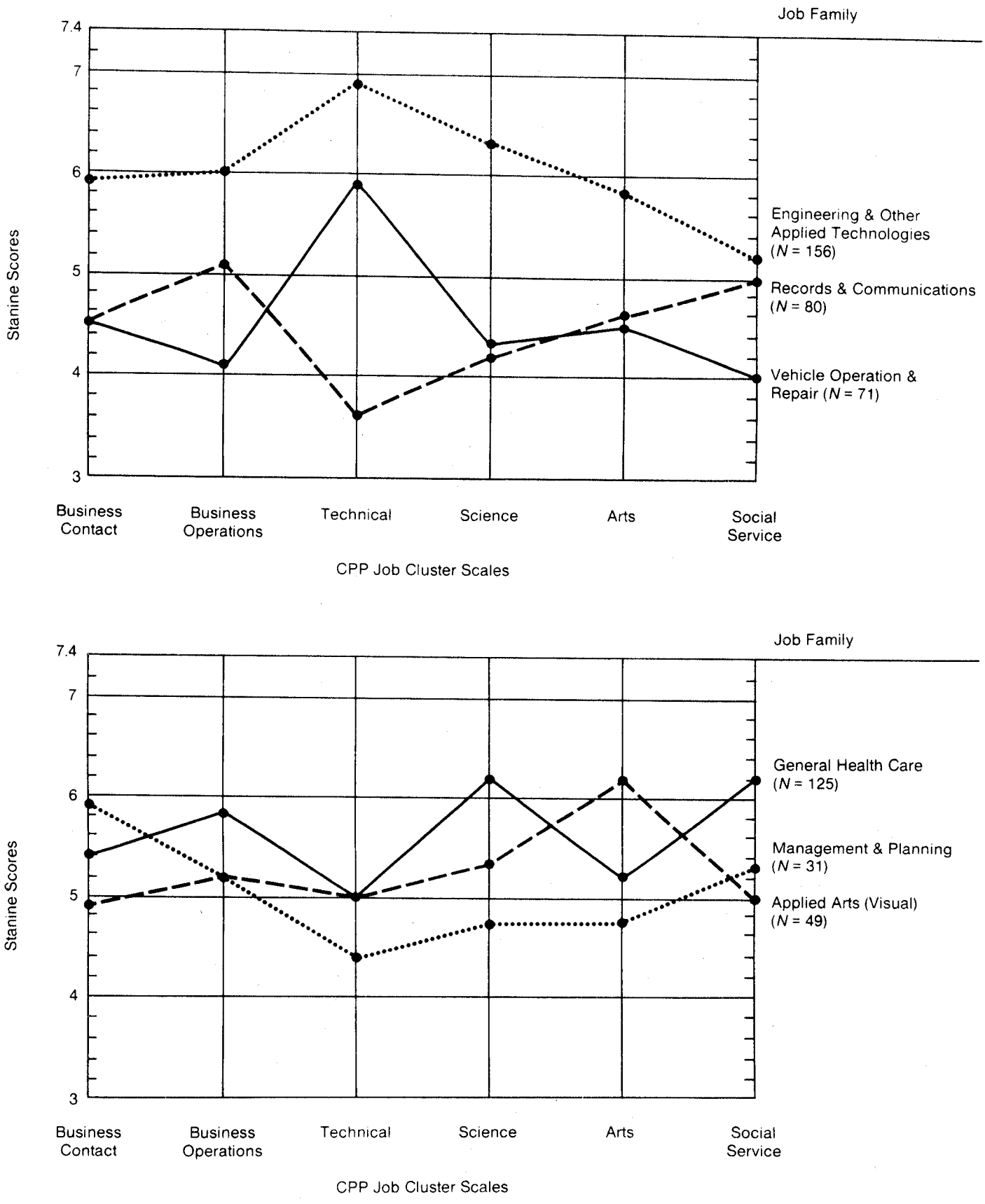
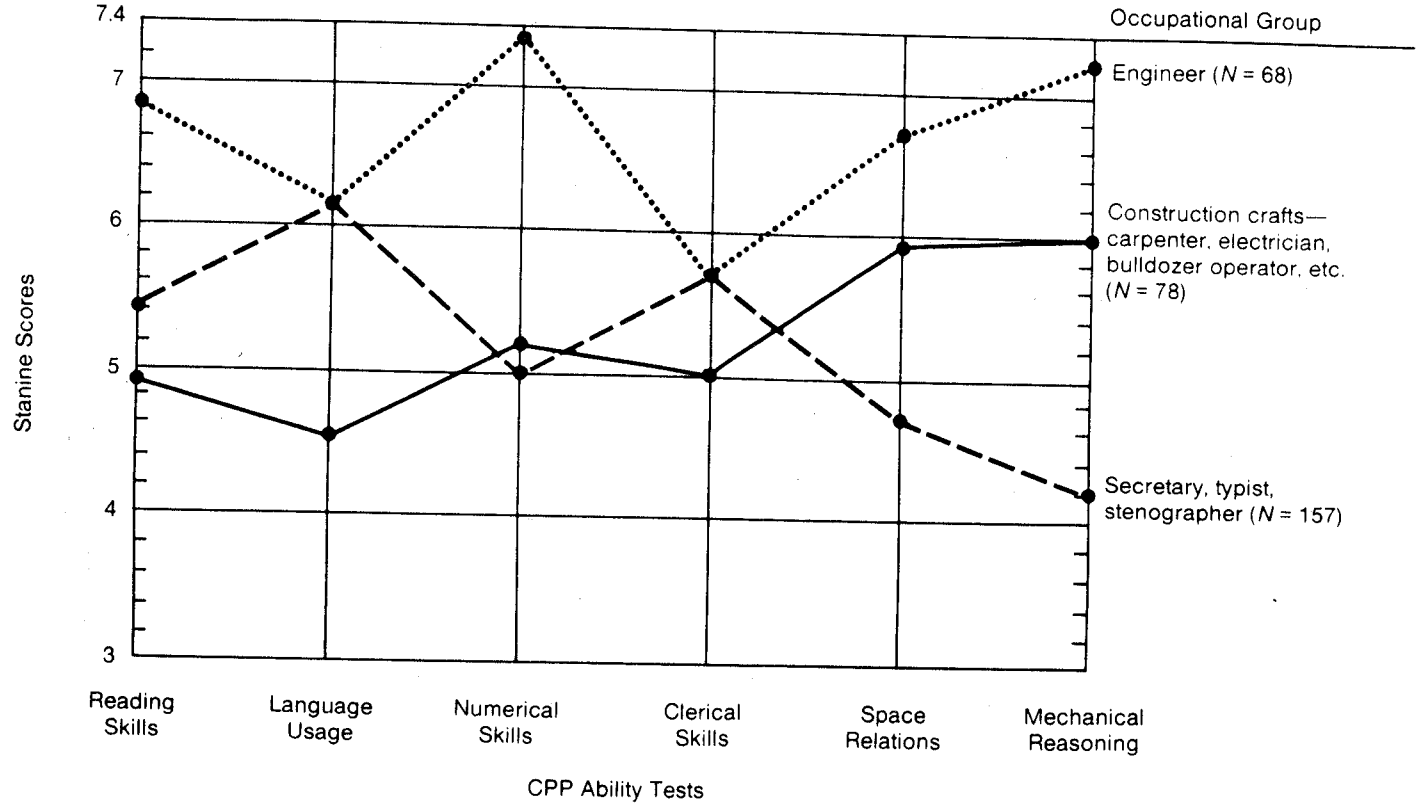


Figure 7. *How Study 2 Occupational Choice Groups Scored on the CPP Job Cluster Scales.* (Mean scores for the largest job family in each ACT Job Cluster are profiled.)



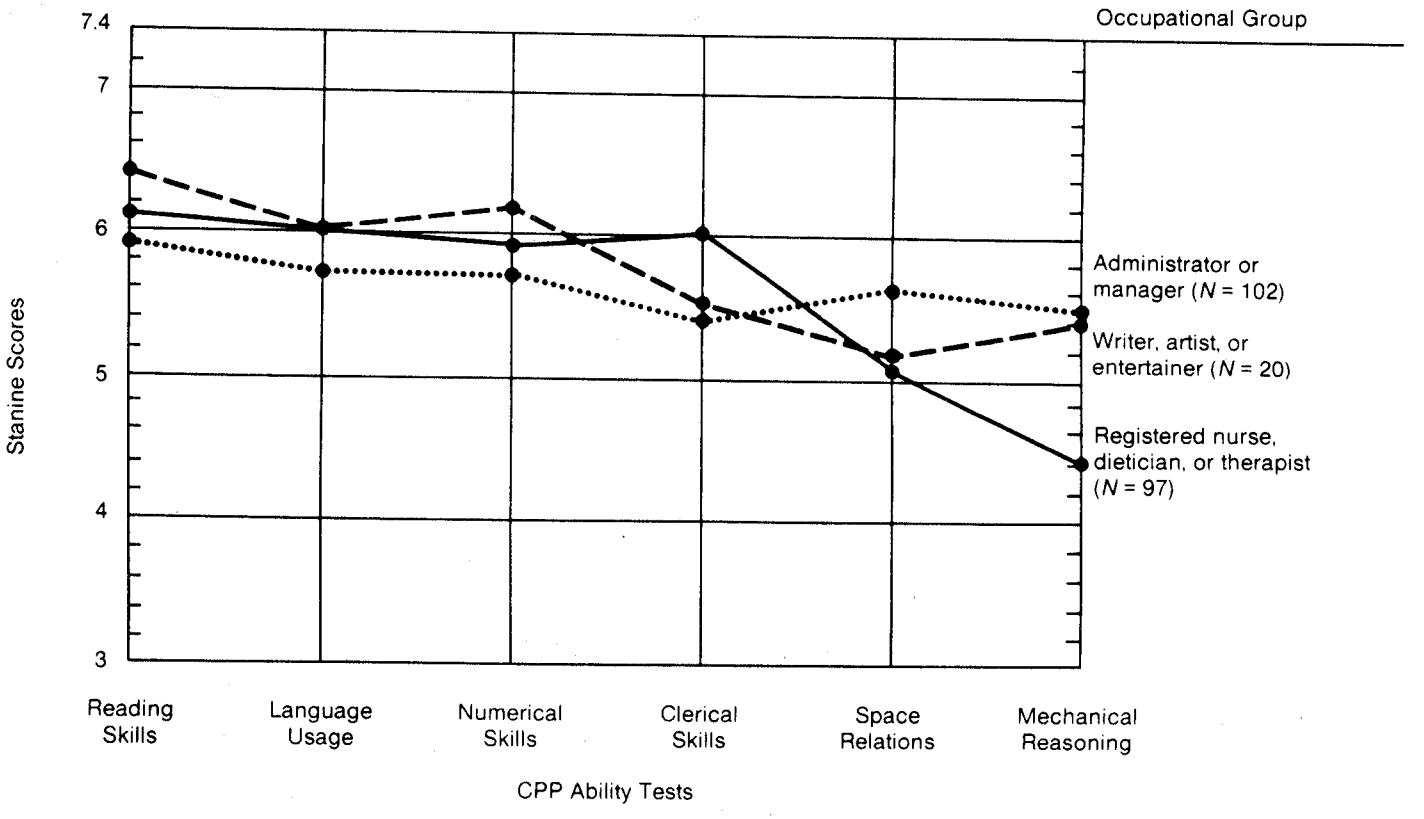


Figure 8. *How Study 3 Occupational Groups Scored on CPP Ability Tests 6 Years Earlier.*
(Mean scores for the largest job family in each ACT Job Cluster are profiled—see text.)