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MONOGRAPH

Occupational Aptitude Patterns Map: Development and Implications for a Theory of Job Aptitude Requirements

LINDA S. GOTTFREDSON

Counseling and Personnel Services, University of Maryland, College Park; and Center for Social Organization of Schools, The Johns Hopkins University

United States Employment Service data on the cognitive and noncognitive aptitude requirements of different occupations were used to create an occupational classification—the Occupational Aptitude Patterns (OAP) Map. The OAP Map consists of 13 job clusters arrayed according to major differences in overall intellectual difficulty level and in functional focus (field) of work activities. The OAP Map was compared with an alternative, aptitude-based classification, with the Holland typology of work environments, and with ratings for complexity of involvement with data, people, and things. Those comparisons provided considerable evidence concerning the construct validity of different aspects of the Map and helped to clarify the uses for which the Map is most appropriate. When combined with previous evidence about patterns of job aptitude demands, the OAP Map provides the basis for a theory of job aptitude requirements. The OAP Map and accompanying analyses support the following hypotheses: (1) general intelligence is the major gradient by which aptitude demands have become organized across jobs in the U.S. economy, (2) within broad levels of work, the aptitude demands of different fields of work differ primarily in the shape of their cognitive profiles, and (3) different aptitude demand patterns arise in large part from broad differences in the tasks workers actually perform on the job.

Job description and classification have been of considerable concern in the effort to design more effective, efficient, and fair counseling and employment practices (Holland, 1985; Pearlman, 1980). In particular, the U.S. Employment Service (USES) has produced a wealth of information

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over the last half century in order to better fulfill its own counseling and placement functions. The USES has designed various products for use outside as well as within the Employment Service, foremost among them being the fourth edition of the *Dictionary of Occupational Titles* (DOT; U.S. Department of Labor, 1977), the *Guide for Occupational Exploration* (GOE; U.S. Deprtment of Labor, 1979a), and the *Occupational Aptitude Pattern Structure* section of the manual for the General Aptitude Test Battery (U.S. Department of Labor, 1979b). The USES has also rated 12,099 job titles on 46 scales—including aptitudes, worker functions, temperaments, working conditions, and physical demands—which have subsequently been widely used in research (cf. Miller, Treiman, Cain, & Roos, 1980). By providing information separately for over 12,000 job titles, the DOT and its associated ratings provide the most detailed level of job description for a comprehensive set of occupations in the United States. In contrast, the GOE and its accompanying Occupational Aptitude Patterns (OAP) manual provide a more general, but for many practical purposes a more useful, level of job description because they classify job titles into 66 groups according to similarity in job attributes.

Although the USES has created useful classificatory systems from its data, the classificatory potential, and thus the practical and theoretical importance, of its data is yet to be fully exploited. Specifically, the USES data currently provide the most promising prospect for developing a comprehensive occupational classification based on the *aptitudes* that different occupations require. The OAP structure created by the USES is a useful way of characterizing aptitude requirements across the wide spectrum of jobs in the United States, but it fails to provide a readily comprehensible overview of aptitude requirements. The present paper shows that an overview of the major dimensions of ability requirements can be created from USES data. First, the development of the USES Occupational Aptitude Patterns is reviewed. The development of an Occupational Aptitude Patterns (OAP) Map based on these data is then described, followed by a description of each of the OAP Map's 13 occupational clusters. Next, several types of analyses are performed to assess the validity of the OAP Map. The paper concludes by showing how the OAP Map and the accompanying validity evidence provide the basis for a theory of how job aptitude requirements are structured among jobs in the United States economy. (See also the forthcoming special issue of the *Journal of Vocational Behavior* (Gottfredson, 1986a) devoted to ability, employment, and job performance.)

DATA

Occupational Aptitude Patterns (OAPs) were developed by the USES to identify the aptitudes that are most predictive of good job performance and to identify the minimum levels of those aptitudes required in different

families of work. In order to describe the derivation and meaning of these OAPs, it is necessary to first briefly review the various types of data used in creating them: the General Aptitude Test Battery (GATB), Specific Aptitude Test Batteries (SATBs), and *Dictionary of Occupational Titles* (DOT) ratings of worker traits and job conditions. It is also necessary to describe the occupational classification in the *Guide for Occupational Exploration* (GOE) for which the OAPs were developed.

General Aptitude Test Battery (GATB)

The GATB is a test battery developed by the USES to measure a variety of cognitive and noncognitive aptitudes. For decades it has been used both within and outside the U.S. Employment Service for counseling and placement. Table 1 lists the nine GATB scales. The aptitudes are scaled so that means are approximately 100 and standard deviations 20. The manual for the GATB (U.S. Department of Labor, 1970) provides extensive information on its derivation, reliability, and validity. That manual also provides data from the validity studies of 444 occupations, including the means, standard deviations, and correlations with job performance measures for each aptitude for workers or trainees in those different occupations. (It should be noted that the OAPs described in that manual have been superseded by those to be described below.)

Specific Aptitude Test Batteries (SATBs)

The U.S. Employment Service has conducted studies of workers and trainees in hundreds of occupations to determine which GATB aptitudes best predict training and on-the-job performance and to determine the minimal aptitude levels required for satisfactory performance. The objective has been to identify from one to four of the total nine GATB aptitudes that are most predictive of good performance and to establish minimum cutting scores on each of those aptitudes. No more than four aptitudes are ever selected when creating SATBs for individual occupations or when creating OAPs for groups of them, even though more may be valid predictors, because a fifth aptitude rarely improves predictive efficiency, and it substantially increases the time required to administer a SATB (U.S. Department of Labor, 1969b, pp. 63–1). To be a viable candidate for an occupation, the applicant must exceed the cutting scores on all the designated SATB aptitudes. For example, the SATB for machine feeder (SATB 089) is motor coordination (K)–80, finger dexterity (F)–85, and manual dexterity (M)–75. In contrast, the SATB for retail store manager (SATB 225) includes a different three aptitudes as well as generally higher cutting scores: general intelligence (G)–105, form perception (P)–95, and clerical perception (Q)–100.

Selecting the aptitudes and cutting scores for a SATB is a complex and somewhat judgmental process, but basically includes the two following

TABLE 1
Aptitudes Measured by the General Aptitude Test Battery (GATB)

Aptitude	GATB tests
G Intelligence General learning ability. The ability to "catch on" or understand instructions and underlying principles; the ability to reason and make judgments. Closely related to doing well in school.	Part 3 Three-dimensional space Part 4 Vocabulary Part 6 Arithmetic reason
V Verbal aptitude The ability to understand meaning of words and to use them effectively. The ability to comprehend language, to understand relationships between words, and to understand meanings of whole sentences and paragraphs.	Part 4 Vocabulary
N Numerical aptitude Ability to perform arithmetic operations quickly and accurately.	Part 2 Computation Part 6 Arithmetic reason
S Spatial aptitude Ability to think visually of geometric forms and to comprehend the two-dimensional representation of three-dimensional objects. The ability to recognize the relationships resulting from the movement of objects in space.	Part 3 Three-dimensional space
P Form perception Ability to perceive pertinent detail in objects or in pictorial or graphic material. Ability to make visual comparisons and discriminations and see slight differences in shapes and shadings of figures and widths and lengths of lines.	Part 5 Tool matching Part 7 Form matching
Q Clerical perception Ability to perceive pertinent detail in verbal or tabular material. Ability to observe differences in copy, to proofread words and numbers, and to avoid perceptual errors in arithmetic computation. A measure of speed of perception which is required in many industrial jobs even when the job does not have verbal or numerical content.	Part 1 Name comparison
K Motor coordination Ability to coordinate eyes and hands or fingers rapidly and accurately in making precise movements with speed. Ability to make a movement response accurately and swiftly.	Part 8 Mark making
F Finger dexterity Ability to move the fingers, and manipulate small objects with the fingers, rapidly or accurately.	Part 11 Assemble Part 12 Disassemble
M Manual dexterity Ability to move the hands easily and skillfully. Ability to work with the hands in placing and turning motions.	Part 9 Place Part 10 Turn

Note. From the U.S. Department of Labor, 1970.

steps. Analysts review several criteria to determine which aptitudes to include in a SATB: the mean and the standard deviation of workers' scores on each aptitude, the correlations of each aptitude with the job performance criteria, and subjective judgments based on job analyses about which aptitudes are essential or irrelevant. Cutting scores are set so that the proportion of workers exceeding the cutting points simultaneously on all the SATB aptitudes equals the proportion of workers who were designated by other criteria as satisfactory. These cutting scores are rounded down to intervals of 5 (e.g., 85, 90, 95). The two volumes of the *Test Development Guide* (U.S. Department of Labor, 1969a, 1969b) describe the development procedures and their rationale in detail; the SATB manual (U.S. Department of Labor, 1980b) lists the SATBs for 460 job titles; and reports that are available from the USES for specific job titles provide data on the derivation of SATBs for those individual titles.

It should be noted that the SATBs have been criticized as providing inefficient use of the GATB data for selection purposes. For example, they provide no way to discriminate among the applicants who pass the minimum cutting scores even though some of those applicants are likely to be much better prospects than others. Largely for these reasons, the USES is pilot testing a new "validity generalization" system to replace the SATBs (McKinney, 1984). Although the single multiple cutoff criterion of the SATBs may be a disadvantage for selection purposes, those cutting points provide valuable information for purposes of this study.

Dictionary of Occupational Titles (DOT) Ratings

The DOT is a periodically revised compendium, the latest edition of which provides descriptions of work activities for 12,099 different job titles (U.S. Department of Labor, 1977). Job analysts within the USES have also rated these job titles according to 46 job attributes: worker functions (3), training times (4), aptitudes (11), temperaments (10), interests (5), physical demands (6), and environmental conditions (7). Nine of the 11 aptitude ratings are parallel to the scales of the GATB.

A description of the 46 rating scales is provided in Miller et al. (1980); *The Handbook for Analyzing Jobs* (U.S. Department of Labor, 1972) provides guidelines and benchmarks for assigning ratings; and one supplement to the DOT (U.S. Department of Labor, 1981) lists the physical demands, working conditions, specific vocational preparation, math development level, and language development level required for the different DOT job titles. Ratings for the worker functions of complexity of dealings with data, people, and things are incorporated as part of the DOT code itself; these three ratings are represented, respectively, by the fourth, fifth, and sixth digits of the nine-digit DOT code. Ratings for the remaining scales, including the aptitudes, interests, and temperaments, were available as of 1985 only on computer tape available from the Occupational Analysis Division of the USES.

For each of the 11 aptitude requirements, DOT job analysts assigned a rating from 1 (representing the ability level of the highest 10% of the population) to 5 (lowest 10% of the population) according to the level they judged to be required for "average, satisfactory performance" (U.S. Department of Labor, 1972, p. 233). (Level 5 is never assigned when rating job intelligence requirements because, unlike the other aptitudes, a minimal level is assumed necessary to perform any job.) Analysts rated temperaments as present if they were "important in relation to the kinds of adjustments which the worker must make for successful job performance" (p. 313). Interests were likewise rated for their importance for job performance. Thus the implied criterion for the ratings is the level (or in some cases just the presence) of the trait required for satisfactory job performance.

Miller et al. (1980) have reviewed and evaluated the procedures by which DOT ratings were derived. The difficulties that they reported (p. 174) the job analysts have in using some of the scales suggest that ratings are made under conditions that have elsewhere (Cooper, 1981) been identified as creating illusory halo (see Gottfredson, 1983, for a discussion and analysis). Miller et al. also point out that a major problem in evaluating the DOT data is that so little evidence is available about their reliability and validity. Cain and Green (1983) calculated reliabilities for 9 of the 46 DOT scales. With the exception of reliabilities of .44 for "complexity of dealings with things" and .60 for "strength," classical (interrater) reliabilities ranged from .68 to .86. Interrater reliabilities for complexity of involvement with data and people were .82 and .86, respectively. Cain and Green do not provide reliabilities for any of the aptitude ratings. Although the variance of scores on the 11 DOT aptitude scales varies considerably, the distributions of the nine aptitudes parallel to those of the GATB do not depart markedly from normality.

Guide for Occupational Exploration (GOE)

The GOE (U.S. Department of Labor, 1979a) presents the most recent work by the USES to produce a classification of occupations according to their similarities in job attributes. It supersedes all previous Worker Trait Group systems (e.g., U.S. Department of Labor, 1965). The GOE classification organizes the approximately 12,000 DOT titles into 66 "Work Groups." Apparently drawing on DOT job descriptions and ratings, the GOE provides a short description of work in each of the 66 GOE Work Groups, together with a list of the DOT titles within each of those groups. Because OAPs were developed to characterize these Work Groups, rather than being developed independently of any preexisting classification, it is important to describe how those Work Groups were themselves created.

A factor analysis of vocational interest items revealed 11 major dimensions of vocational interest. Job analysts then assigned all DOT occupations to one of 11 Interest Areas (e.g., artistic, scientific, mechanical) on the basis of their knowledge of those occupations. A 12th Interest Area was added because some occupations did not fit well into any of the 11 areas. These 12 Interest Areas were subdivided by the job analysts into more homogeneous groups, also on the basis of their familiarity with the tasks, working conditions, interests, temperaments, and aptitude requirements of jobs. Thus, the classification can be characterized primarily as a rational rather than an empirical one and as a global rather than a specific one. Although the classificatory procedure cannot be well documented or replicated, its rational basis does mean that the resulting classification probably appears sensible and meaningful to users in counseling settings. (See Droege & Hawk, 1977; Droege & Padgett, 1979; Strohmenger & Padgett, 1979; U.S. Department of Labor, 1982, for a description of the GOE and its development.)

Occupational Aptitude Patterns (OAPs)

Occupational aptitude patterns were developed for the GOE Work Groups using the SATBs for 460 occupations in combination with DOT aptitude ratings for all occupations in the DOT. The first step was to classify these 460 occupations into their appropriate GOE Work Groups. (These 460 titles are not precisely the same occupations that are listed in the SATB manual, but the overlap is substantial. Appendix B of the OAP development manual, U.S. Department of Labor, 1980a, lists which specific SATBs were included in the OAP development.) The SATB profiles varied from occupation to occupation within any one group, so a modal SATB was produced for as many of the 66 groups as possible. SATB data were sufficient to create modal patterns for 31 of the work groups. These modal SATBs were used together with the nine analogous DOT aptitude ratings for the same occupations to develop a way of predicting modal SATBs from DOT data. This was done because DOT ratings are available for all 12,064 civilian DOT job titles, and so provide a means to estimate modal SATBs for all the Work Groups. To do so, cutting scores were first developed separately for each aptitude from the DOT ratings. Then the presence or absence of each aptitude was predicted, the aim being to represent each group with from two or four aptitudes.

The resulting modal SATBs for all 66 work groups, together with the predicted SATBs for individual occupations, were reviewed and modifications in the modal SATBs (i.e., the OAPs) were made in some cases. It was found that the predicted SATBs were too heterogeneous for 14 of the Work Groups for them to be well represented by a single OAP. For 7 of the groups, two different OAPs were developed. No OAPs were retained for the other 7. As a result there are 66 OAPs representing 59

of the GOE Work Groups. Homogeneity was further increased by excluding a few occupations with atypical codes on the DOT rating of "complexity of dealings with data" (U.S. Department of Labor, 1979b, Table 1). Droege and Boese (1982) and the OAP development manual (U.S. Department of Labor, 1980a) describe an analysis confirming the internal homogeneity of the resulting 66 OAP groups. The criterion for assessing whether or not a group was sufficiently homogeneous was that the SATBs for *different* occupations within the OAP group not be more variable than the SATBs for the *same* occupation within that OAP group. (More than one SATB had been developed for some occupations.) As is discussed further below, however, many of the OAPs are identical or quite similar to one another, a fact which is exploited here to create a broader occupational aptitude classification.

A total of 10,620 job titles are covered by OAPs, which represents 97% of the 10,993 nonsupervisory DOT titles and 88% of all 12,064 civilian DOT titles. With the exception of some customer service occupations such as waiter (GOE Group 09.04), most of the occupations excluded from OAP coverage are either supervisory (e.g., farm supervisor, foreman) or unusual (e.g., model, psychic reader, athlete, juggler). The USES booklet of OAPs (U.S. Department of Labor, 1979b), presents the 66 OAP groups, their aptitude profiles, and a list of the occupations of most interest in each of the groups (a total of more than 2000 occupations). (See Droege & Boese, 1982; U.S. Department of Labor, 1980a, for descriptions of the development of the OAP groups.)

Strengths and Limitations of the Data

The attributes of the data from which a classification is built restrict the type of classification it can be and the purposes it can serve (Pearlman, 1980). Before presenting the classification, therefore, important attributes of the constituent data are reviewed below.

Occupational coverage. One obvious advantage of the DOT data is that they provide comprehensive coverage of occupations in the United States. No data on the proportion of job titles or of workers in the United States are collected according to DOT codes, but DOT codes have been cross classified by 1970 and 1980 census occupational codes, and employment data are readily available by the latter. Analyses based on this cross classification suggest that the jobs of 93.2% of civilian workers in 1970 were covered by DOT titles, that the jobs of 0.8% of workers are not included in the DOT, and that 6.0% of workers did not report sufficient information for the Census Bureau even to classify their occupations (Gottfredson, 1983). It should be noted, however, that census titles for which no DOT data are available are not distributed randomly—most are varieties of college professors.

Coverage of DOT titles by the OAPs is somewhat less comprehensive, however, for several reasons. As already noted, there were not enough SATB data to create modal SATBs (i.e., OAPs) for seven of the GOE groups, but these omissions may not be too important, because these seven groups include only 1% of DOT job titles. Of more consequence, a fair number of supervisory jobs are not included within the OAP groups because the USES develops SATBs primarily for nonsupervisory jobs. These include all DOT titles with a 3 as the fifth digit of the nine-digit DOT code (i.e., which refers to supervising on the "complexity of involvement with people" DOT scale).

Parallel assessment of people and jobs. One could create a somewhat more comprehensive competency-based occupational classification by using the DOT ratings data (one will be described further below), but the OAPs have the considerable advantage of being directly linked to a way of assessing the aptitudes particular individuals possess (i.e., GATB scores).

Linkage to demographic data. One limitation of the OAP data, and the DOT data as well, is that they cannot by directly linked with demographic data. This is an obstacle for some purposes, for example, comparing the distribution of aptitudes required by jobs to the aptitudes possessed by a population or in assessing what proportion of jobs require given skill levels.

Validity and reliability. The validity of the OAPs as indicators of aptitude requirements is affected by the quality of the component steps used to create them. The GATB manual (U.S. Department of Labor, 1970) provides considerable evidence of the construct and predictive validity of the individual aptitude scales. The most important attribute of the SATBs, upon which the OAPs are directly based, is that they were developed in studies which examined the relation of GATB aptitudes to actual job performance (usually supervisor ratings); that is, they are criterion related. In contrast, less confidence can be placed in the validity of DOT aptitude ratings because they are based on job analysts' *estimates* of what is necessary for satisfactory job performance. It should be noted that many of the modal SATBs (i.e., OAPs) were estimated from DOT ratings and so are not directly criterion related, but that estimation procedure was itself developed using the criterion-related SATBs.

One problem with the SATBs is that, for several reasons, they are not stable. The number of cases in each validity study is sometimes small (i.e., less than 50). The OAP manual (U.S. Department of Labor, 1980a, p. 4) also notes that several different aptitude-cutting score combinations might be equally valid in predicting job performance, and that the particular one selected is largely a matter of chance. Therefore different studies of the same occupation typically produce related but different SATBs

(e.g., see U.S. Department of Labor, 1980b). However, because OAPs are *modal* SATBs, the OAPs should be more reliable than their constituent SATBs (U.S. Department of Labor, 1980a, p. 11).

Aptitude coverage. As Dunnette's (1976) review of aptitude taxonomies makes clear, the term aptitude generally is restricted to general abilities of a cognitive or psychomotor nature. From this vantage point, the GATB probably provides good coverage of general aptitudes, as do the parallel DOT ratings. Although interpersonal competencies are often considered under the rubric of personality, it seems important that they be included in any occupational classification designed to describe the aptitude requirements of jobs. Guion and Gottier (1965) reviewed the relation of various personality traits to job performance. Similarly, Dunnette (1976) reviewed a number of critical incident analyses which reveal the importance of interpersonal capacities such as cooperating with co-workers, motivating workers, and dealing effectively with the public. Many such interpersonal capacities are no doubt correlated with general cognitive ability, but dealing with people is widely recognized as a requirement of some jobs but not others at any given level of work. Factor analyses of worker trait and activity requirements among high-level workers and among job attributes for a representative group of jobs also indicate that interpersonal and self-presentation skills are important dimensions of worker competence (Gottfredson, 1983; Gottfredson, Finucci, & Childs, 1984).

Because they are based on GATB data and the analogous DOT aptitude ratings, the OAPs are restricted to cognitive, perceptual, and psychomotor aptitudes. DOT ratings provide some information about the extent to which workers in different occupations must deal with people, and these have been incorporated into the aptitude-based occupational classification with which the OAP Map is compared below. Except for the information generated by that comparison, however, the OAP Map provides no direct evidence about interpersonal competence requirements.

Type of job attribute. If one were to set out to construct an occupational classification based on the similarities and differences in *aptitude* requirements, the best procedure would probably be to limit the analysis to job descriptors that reflected aptitudes. However, the GOE classification for which the OAPs were developed is a polythetic rational classification based on the overall nature of the job. It is not clear to what extent the 66 GOE groups (and thus the OAP groups) quantitatively differ on different dimensions of work, but it is clear that aptitudes were only one element in the formation of the groups. For the counseling purposes for which it was intended, this was probably the best approach to take in constructing the GOE classification. Although it might be considered a questionable approach for researching aptitude patterns, its resulting aptitude groups are nevertheless more comprehensive, sensible, and stable than those from the previous more empirically generated OAPs developed by the

USES (U.S. Department of Labor, 1980a, pp. 3–4). Indeed, the USES abandoned its strictly empirical approach of the previous three decades because none of the OAP structures it yielded met criteria for being a useful counseling device.

METHOD

Construction of the OAP Map

Construction of the OAP Map involved two procedures. First, the 66 OAPs were grouped into a smaller number of clusters according to their similarities. Second, additional information about the occupations in those clusters was used to help graphically array the clusters in order to reveal major similarities and differences in the aptitude requirements of work.

Inspection of the 66 OAPs reveals that many are identical or similar and that the variations across different OAPs are systematic. This is important information that apparently has not been pointed out to users of the OAPs. Although there are 66 OAP groups, there are only 42 distinct aptitude patterns, because 14 of the OAPs are repeated in from 2 to 5 of the GOE groups. Many of the remainder differ only slightly, either in cutting scores or in the particular scales represented in the OAPs. Two major considerations guided the grouping of OAPs into clusters: (a) the particular GATB scales included in an OAP and (b) the cutting points on those scales. When the appropriate placement of any OAP was not obvious, judgments about the overall similarity of the OAPs together with the overall similarity of the jobs themselves determined how the OAP was classified. Finally, clusters were created here with four goals in mind: (a) create only as many groups as necessary to show major distinctions in job requirements, (b) reveal the major *qualitative* differences in job demands, (c) reveal the major *quantitative* differences in job demands, and (d) have clusters that appear sensible and consistent with what is known about those occupations.

To highlight the qualitative and quantitative differences among the resulting 13 clusters, the data were further summarized, supplemented with additional information, and then arrayed in a two-dimensional map. The information shown for each cluster includes a summary of the major functional focus of work activities, sample occupations, and the minimal level of the most important aptitudes (i.e., the OAP) the work requires. Work focus or function was inferred from examining lists of the occupations included in each OAP Work Group (U.S. Department of Labor, 1979b), and by examining the descriptions of the parallel GOE Work Groups (U.S. Department of Labor, 1979a). The aptitudes noted in the cluster profiles in that map are those that were most typical of the constituent OAP groups. The minimum aptitude levels required by occupations in the cluster are represented by the mean cutting points for the OAP Work Groups included within each cluster.

Evaluating the Validity of the OAP Map. Three analyses were performed to assess the properties of the OAP Map. First, an alternative occupational classification based on DOT aptitude ratings was created and compared to the OAP Map. Second, the DOT worker functions of involvement with data, people, and things were examined and related to the aptitude requirements of those clusters. Third, the OAP clusters were compared with the Holland (1985) typology of work environments.

Comparison of the OAP Map to an alternative Skills Map classification. The first procedure used to investigate the properties of the OAP Map was to compare it to an alternative classification, which is referred to below as the Skills Map. Although both classificatory schemes were designed to reflect the aptitudes required by different types of work, they differ in significant ways. The OAP map was created from OAP data, but the Skills Map from DOT ratings. Both reflect cognitive and psychomotor aptitudes, but an effort was made to also reflect demands for interpersonal competence in the latter. In addition, quite different methods were used to construct the two classifications. Because of these differences in data and method, it is of interest to see how consistent or complementary the two classifications are in describing occupational aptitude requirements. The comparison provides some indication of the validity and usefulness of the OAP Map. The Skills Map and its strengths and limitations are described in detail elsewhere (Gottfredson, 1981, 1983), so its construction is only briefly reviewed here.

In order to develop the alternative Skills Map, all 46 DOT ratings were classified as aptitude related or not. Because the nine aptitude ratings parallel to those of the GATB are restricted to cognitive and psychomotor demands, DOT traits reflecting dealings with people (e.g., the temperament "dealing with people," the worker function "complexity of dealings with people," the bipolar interest "social welfare vs machines") were considered aptitude-related measures of interpersonal requirements. These aptitude-related traits for all DOT job titles, which had previously been aggregated according to the 440-category 1970 census occupational classification, were factor analyzed to determine the major dimensions of job aptitude. Position Analysis Questionnaire (PAQ: McCormick, Jeanneret, & Mecham, 1972) data were obtained for approximately 1800 titles in the PAQ archives and also aggregated by 1970 census category. The most aptitude-related PAQ elements (e.g., decision making, negotiating), were included in a second factor analysis together with the DOT aptitude-related traits to determine if these additional data would change the factor structure obtained from DOT ratings alone. Because the major factors were quite similar in both cases and because PAQ data were available for only 301 versus 396 titles for the DOT data, construction of the Skills Map classification was based exclusively on the DOT ratings.

Factor analyses, using both orthogonal and oblique rotations, indicated

that general academic aptitude is most useful in distinguishing among occupations, followed in importance by dealing with people and by psychomotor aptitudes, and then by strength. The Skills Map classification was created by (a) averaging scores on the several variables best representing each of the three most important factors (DOT verbal and numerical aptitude ratings for the academic ability factor, the DOT temperament dealing with people for the second factor, and the DOT aptitudes of manual dexterity, finger dexterity, and motor coordination for the psychomotor aptitude factor); (b) dividing occupations into three to four levels on each of those derived scales, and (c) cross classifying occupations according to their placement on each of those three dimensions. The result is a 36-category classification which characterizes occupations according to their rated requirements for general level of academic aptitude (i.e., intelligence), level of psychomotor aptitude, and extent (not complexity) of dealing with people.

The occupational coverage of the Skills Map is quite comprehensive and somewhat more inclusive than the OAP Map, as was suggested earlier. Like the OAP Map, DOT ratings were used in its construction. Beyond those similarities, the two classifications are radically different in several ways. The aptitude descriptors are criterion related in the OAP Map but not in the Skills Map. The aptitude data were appended to a polythetic rational classification in the former case, but were the basis for empirically constructing the classification in the second. The similarities and differences among the categories in the Skills Map are readily apparent, because the factors themselves were used to classify occupations. No such inherent dimensionality is provided by the OAP Map.

In order to determine to what extent the OAP and Skills Maps provide consistent or complementary views of occupational demands, half of the more than 2000 occupations listed in the USES booklet of OAPs (U.S. Department of Labor, 1979b) were cross classified according to both schemes. Because the Skills Map was based on DOT ratings aggregated to 1970 census codes, the occupations in the OAP manual were first classified according to census category using the *Classified Index of Industries and Occupations* (U.S. Bureau of the Census, 1971). The list of occupations in each OAP cluster was examined to see which aptitude groups in the Skills Map were represented in each of those clusters, and a judgment was made about which of the Skills Map groups were significantly represented in the OAP cluster.

The relation of DOT worker functions to aptitude requirements. The three DOT worker function ratings for occupations in the different clusters were examined in order to determine the relation between type of tasks performed on the job and the aptitude profile it requires. Ratings for complexity of involvement with data, people, and things are available as part of the DOT codes which accompany the job titles in all USES publications. These three scales range, respectively, from 0 to 6 (i.e., from synthesizing data to simply comparing data), from 0 to 8 (i.e., from mentoring to taking instructions/helping), and from 0 to 7 (i.e., from setting up machines to handling materials; see Miller et al., 1980, pp. 22–24, or U.S. Department of Labor, 1977, pp. 1369–1371). Means and standard deviations for each worker function were calculated for each of the 13 OAP clusters derived here. The occupations included in the analyses are those listed in the USES booklet of OAPs (U.S. Department of Labor, 1979b).

The relation of Holland vocational interest types to OAP clusters. All job titles in the USES booklet of OAPs (U.S. Department of Labor, 1979b) were classified according to three-letter Holland occupational codes using the *Dictionary of Holland Occupational Codes* (Gottfredson, Holland, & Ogawa, 1982). Frequency distributions of those codes within each of the 13 OAP clusters were then computed. This analysis shows to what extent the *aptitude*-based OAP Map overlaps or complements Holland's widely used typology (1985) which classifies jobs by the vocational *interests* they require and reward.

RESULTS

The OAP Map

Table 2 organizes the 66 OAPs into 13 clusters according to their similarities. Considerable judgment was involved in creating the grouping shown in Table 2, so all data are shown in that table. The cutting points shown are those for adults rather than for students in Grades 9 or 10 (the latter two sets being somewhat lower than the cutting points for adults); all these sets of cutting points are provided in the booklet of OAPs (U.S. Department of Labor, 1979b). Figure 1 arrays the 13 clusters in a way that highlights their similarities and differences. The first feature to notice is that the clusters fall within four general functional work areas: dealing with physical relations, maintaining bureaucratic order, dealing with social and economic relations, and performing. The second feature is that within each functional area of work, the clusters can be ordered vertically according to their general intellectual difficulty and prestige level. These orderings were created using intuition as well as the cutting points for general intelligence requirements where they were available. Data are presented later that confirm the validity of this ordering. More detailed descriptions are provided next for each of the clusters. Then the more extensive analyses relating the clusters to other data are presented.

The following descriptions of the 13 OAP clusters refer to all the GATB aptitudes listed in the OAP profiles as "requirements." The conclusion to this paper questions whether some of these apparent requirements (e.g., clerical aptitude, verbal aptitude) are in fact important after controlling

TABLE 2

Occupational Aptitude Patterns (OAPs) for the 66 Work Groups in the *Guide for Occupational Exploration* (GOE): Organized into 13 Occupational Clusters According to the Similarity of their OAPs

OAP No.	GOE Code[a]	GOE group	GATB Scale[b] G	V	N	S	P	Q	K	F	M
		Dealing with physical relations									
Cluster P1: Researching, designing, and modifying physical systems											
7	02.01	Physical sciences	115	105	110	110					
8	02.02	Life sciences	115	105	110	110					
9	02.03	Medical sciences	115	105	110	110					
52	11.01	Mathematics & statistics	115	100	110	100					
17	05.01	Engineering	115		105	110					
Cluster P2: Operating and testing physical systems											
18	05.02	Managerial work: mechanical	105	100	100	95					
19	05.03	Engineering technology	105		100	100					
20	05.04	Air & water vehicle operation	105		100	100					
10	02.04	Laboratory technology	105		100						
11	03.01	Managerial work: plants & animals	100		90						
Cluster P3: Crafting or inspecting complex objects; repairing, operating, or setting up equipment or vehicles											
22	05.07	Quality control			90	90	85				
30	06.01 (1–2)	Production technology			85	90	85				
6	01.06	Crafts arts				90	85				85
21	05.05	Craft technology				90	85				85
23	05.08	Land & water vehicle operation				85	80				85
26	05.10 (1–4)	Crafts				85	80				85
28	05.11	Equipment operation				85	80				85
31	06.01 (3–6)	Production technology				85	85				85
46	09.02	Barber & beauty services				85	85		90		85
47	09.03	Passenger services				85					85
Cluster P4: Crafting, finishing, assembling, sorting, or inspecting simple objects											
27	05.10 (5–6)	Crafts					80		85		85
32	06.02	Production work					80		85		85
33	06.03	Quality control					80		85		85
Cluster P5: Tending (machines, buildings, plants, animals) and attending (workers, the public)											
34	06.04	Elemental work: industrial							85	80	80
13	03.03 (3–6)	Animal training & service							85		85
14	03.04	Elemental work: plants & animals							85		80
29	05.12	Elemental work: mechanical							85		80
44	08.03	Vending							85		80
48	09.05	Attendant services							85		80
		Dealing with social and economic relations									
Cluster S1: Researching, planning, and maintaining societal systems											
55	11.03 (0–1)	Social research	110	100	105						
57	11.04 (1)	Law	110	100	105						
60	11.06	Finance	110	95	105			100			
49	10.01	Social services	105	100	100			95			
59	11.05	Business administration	105	95	100			100			
61	11.07	Services administration	105	95	100			100			
63	11.09	Promotion	105	95	100			100			

TABLE 2—*Continued*

OAP No.	GOE Code[a]	GOE group	GATB Scale[b] G	V	N	S	P	Q	K	F	M
Cluster S2: Persuading, informing, and helping individuals											
50	10.02	Nursing, therapy, and specialized teaching services	105	100							
42	08.01	Sales technology	100	100	95			100			
53	11.02 (1–2)	Educational & library services	100	100	95			100			
56	11.03 (2–3)	Social research	100	100	95			100			
58	11.04 (2)	Law	100	100	95			100			
62	11.08	Communications	100	100	95			100			
65	11.11	Business management	100	95	95			100			
66	11.12	Contracts & claims	100	95	95			100			
Cluster S3: Serving and caring for individuals											
45	09.01	Hospitality services	95								
51	10.03	Child & adult care	95								
16	04.02	Security services	95								
12	03.03 (2)	Animal training & service	95					85			
		Maintaining bureaucratic order									
Cluster B1: Maintaining bureaucratic rules, records, and transactions											
64	11.10	Regulations enforcement	105		95			95			
15	04.01	Safety & law enforcement	100					95			
35	07.01	Administrative detail	100		95			100			
36	07.02	Mathematical detail	95		90			100			
37	07.03	Financial detail	95		90			100			
43	08.02	General sales	95		90			90			
24	05.09 (1–4)	Materials control	95		85			90			
Cluster B2: Processing routine information											
38	07.04	Oral communications	95					95			
39	07.05	Records processing	95					95			
54	11.02 (3)	Educational & library services	95					95			
Cluster B3: Manipulating records											
40	07.06	Clerical machine operation	95					100	95		
41	07.07	Clerical handling						90	85		
25	05.09 (5)	Materials control						85	85		
		Performing									
Cluster A1: Verbal arts											
4	01.04	Performing arts: music	100	100				100			
1	01.01	Literary arts	100	100				100			
3	01.03	Performing arts: drama	100	100							
Cluster A2: Spatial arts											
2	01.02	Visual arts	100			100	85				
5	01.05	Performing arts: dance	100			95					
		GOE groups without OAPs									
	01.07	Elemental arts									
	01.08	Modeling									
	03.02	General supervision: Plants and animals									
	05.06	Systems operation									
	09.04	Customer services									
	12.01	Sports									
	12.02	Physical feats									

Note. Source of data: U.S. Department of Labor (1979b).

[a] When GOE group is broken into two OAPs according to "data" code, relevant data codes shown in parentheses under GOE No.

[b] G: Intelligence; V: Verbal aptitude; N: Numerical aptitude; S: Spatial aptitude; P: Form perception; Q: Clerical perception; K: Motor coordination; F: Finger dexterity; M: Manual dexterity.

Dealing with Physical Relations
(Investigative & Realistic)

Maintaining Bureaucratic Order
(Conventional & Enterprising)

Cluster P1

Researching, designing, and modifying physical systems
(chemist, physician, engineer)

intelligence--115
verbal--104
numerical--109
spatial--108

Cluster P2

Operating and testing physical systems
(plant manager, drafter, lab technician)

intelligence--104
numerical--98
spatial--98

Cluster P3

Crafting or inspecting complex objects: repairing, operating, or setting up equipment or vehicles
(carpenter, truck driver, bridge inspector)

spatial--87
form perception--83
manual dexterity--85

Cluster P4

Crafting, finishing, assembling, sorting, or inspecting simple objects
(tire inspector, glass cutter, garment sorter)

form perception--80
motor coordination--85
manual dexterity--85

Cluster P5

Tending (machines, buildings, plants, animals) and attending (workers, the public)
(yarn sorter, general laborer, baker helper)

motor coordination--85
manual dexterity--81

Cluster B1

Maintaining bureaucratic rules, records, and transactions
(bookkeeper, police officer, cashier)

intelligence--98
numerical--91
clerical perception--96

Cluster B2

Processing routine information
(dispatcher, receptionist, mail clerk)

intelligence--95
clerical--95

Cluster B3

Manipulating records
(typist, routing clerk, adding machine operator)

clerical perception--92
motor coordination--88

FIG. 1. Map of job clusters based on similarities among occupational aptitude patterns (OAPs), which shows typical tasks, typical job titles, and minimum levels required of the most important aptitude predictors of job performance. OAP Map includes 88% of DOT job titles; omissions include primarily supervisory or unusual jobs. For all aptitudes, means are approximately 100 and standard deviations 20.

Dealing with Social and Economic Relations
(Enterprising & Social)

Performing
(Artistic)

Cluster S1

Researching, planning, and maintaining societal systems
(urban planner, lawyer, hospital administrator)

intelligence--107
verbal--97
numerical--102
clerical perception--99

Cluster S2

Persuading, informing, and helping individuals
(nurse, sales representative, reporter)

intelligence--101
verbal--99
numerical--95
clerical perception--100

Cluster S3

Serving and caring for individuals
(stewardess, park ranger, nurse aide)

intelligence--95

Cluster A1

Verbal arts
(singer, playwright, announcer)

intelligence--100
verbal--100
clerical perception--100

Cluster A2

Spatial arts
(clothes designer, art teacher, dancer)

intelligence--100
spatial--98

FIG. 1—*Continued.*

for requirements for general intelligence and for general psychomotor ability. Thus, all results concerning requirements for the specific aptitudes discussed below, except for those for general intelligence, should be considered only tentative. It should also be understood that when an aptitude is absent from a profile, this absence does *not* necessarily mean that the aptitude is not related to job performance, but only that it is *less* important than the aptitudes which are in the profile. (The various caveats for interpreting and using the OAP Map are reiterated at the conclusion of this paper.)

Dealing with physical relations: Clusters P1 to P5. Clusters P1 through P5 include jobs where workers deal with physical systems, whether

mechanical or biological. The jobs range from those requiring high intelligence and quantitative abilities to those stressing motor skills.

Cluster P1 includes mathematics, physical sciences, medicine, and engineering. With a mean *lower* boundary of 115 for intelligence, which is 0.75 standard deviation above the population mean, occupations in this cluster clearly require high intelligence. Minimum verbal, numerical, and spatial requirements are also higher than for any other cluster.

Cluster P2 represents technological occupations: managing operating systems (e.g., production superintendent), implementing general design specifications (e.g., drafting), and operating complex vehicles (e.g., aircraft). Although not as demanding as the Cluster P1 occupations, they too stress quantitative and spatial abilities.

Cluster P3 includes craftsworkers and inspectors of complex objects. These include workers who create, assemble, inspect, or repair various types of goods and who set up or operate machines to produce, transform, or transport goods. Most would be considered skilled workers. The jobs require spatial aptitude, form perception, and manual dexterity.

Cluster P4 also includes workers who craft and inspect, but the objects they deal with are simpler than those dealt with by workers in the previous cluster, for example, fuse assembler versus aircraft assembler and meat cutter versus cook. Like Cluster P3 occupations, they require form perception and manual dexterity (at a low level), but motor coordination rather than spatial aptitude appears to be important. This probably reflects a greater need for quick, accurate manipulation in simple assembly and sorting, rather than for the manipulation of objects or their parts in three-dimensional space that is required in the more complex P3 jobs.

Cluster P5 consists of what is often characterized as semiskilled or unskilled manual work. These jobs require only minimal levels of motor coordination and manual dexterity in order to perform manual or farm labor, tend or feed machines, assemble objects, help more skilled workers, or provide elementary services to the public (e.g., shining shoes).

Dealing with social and economic relations: Clusters S1 to S3. These clusters range from those requiring high intelligence (S1) to those requiring at least average intelligence (S3). None is as demanding as the highest level cluster in the Physical Relations functional area of work, and they require clerical aptitude (the ability to perceive pertinent detail in verbal or tabular material) rather than spatial aptitude. Another difference is that motor aptitudes are not important, on the average, in any of these clusters.

Cluster S1 includes social scientists, administrators, and professionals who help clients deal with the social system (e.g., lawyers, lobbyists). These occupations require above average to high intelligence (mean cutting

point of 107) and above average verbal (97 minimum) and numerical (102 minimum) abilities. Like Cluster P1 occupations (which include math, medicine, and the physical sciences), requirements are higher for numerical than for verbal in Cluster S1 (see Table 2). However, Cluster S1 occupations are less demanding of all the cognitive abilities than are the P1 occupations.

Cluster S2 occupations include a variety of types of work activities—teaching and nursing, disseminating news and information, selling, and business management—but the aptitudes required are much the same. They require above average intelligence (101 minimum), verbal aptitude (99), and clerical perception (100), and they require average numerical aptitude (95). Thus they are somewhat less demanding cognitively than are the Cluster S1 occupations.

Cluster S3 workers serve or care for people in a variety of ways: hospitality (e.g., flight attendant), child and adult care (e.g., practical nurse), and security (e.g., some police officers). They also include animal trainers. All require at least average intelligence (95 minimum), but apparently no other GATB aptitude is an important contributor to predicting job performance.

Maintaining bureaucratic order: Clusters B1 to B3. These clusters constitute the records keepers and rules keepers of all other activities, and their workers carry out many of the minor transactions for the organization. The required aptitudes in this functional area of work differ across the three clusters, ranging from purely cognitive to primarily noncognitive.

Cluster B1 includes occupations whose workers inspect work processes and products for conformity to government rules and regulations, as well as clerks, secretaries, tellers, cashiers, and salespeople. These jobs require at least average intelligence (98 minimum), numerical ability (91), and clerical perception (96). The requirements are much the same, although slightly lower, as those for Cluster S2 (which involve persuading, informing, and helping individuals), except that Cluster B1 has no particular demand for verbal aptitude. Various police and fire officers (other than those in Cluster S3) are included in this cluster even though their aptitude pattern resembles that of the next cluster (which also requires intelligence and clerical aptitude but not numerical aptitude), because it seemed to be a more sensible assignment.

Whereas Cluster B1 occupations maintain bureaucratic rules, records, and transactions, Cluster B2 occupations primarily process (e.g., claims clerk) or orally transmit (e.g., dispatcher) bureaucratic detail. These occupations require at least average intelligence (95) and clerical perception (95).

Cluster B3 occupations are distinctive from those in Cluster B2 by requiring less cognitive and more *physical* processing of records. They

include, for example, clerical machine operators. Cluster B3 occupations require average clerical perception (92) and minimal or average motor coordination (88).

Performing: Clusters A1 to A2. These occupations require above average intelligence (100), but the other aptitude requirements create two distinct clusters. Cluster A1 includes music, literary arts, and drama, and tends to require average or above verbal aptitude (100) and clerical perception (100). Cluster A2 includes dance and visual arts; it requires average or above spatial aptitude (98), as well as intelligence (100), as was noted above.

Comparison of the OAP Map with the Skills Map

Table 3 shows the predominant OAP clusters appearing within each of the Skills Map aptitude groups. To aid interpretation, results are listed separately by major functional area of work—physical relations, social relations, and bureaucratic relations. Clusters A1 and A2, the performing occupations, include relatively few jobs and so are not included in the figure.

Looking first at the results for the physical relations clusters (P1–P5), it is apparent that these clusters differ systematically according to DOT ratings of the general level of academic aptitude or intelligence required. The very high academic aptitude level in the Skills Map is represented primarily by Cluster P1, high academic aptitude by Cluster P2, moderate academic aptitude by Cluster P3, and the lowest academic aptitude level by Clusters P3, P4, and P5, although primarily the latter two. Neither the motor nor the dealing with people dimensions of the Skills Map seems to distinguish well among the five clusters, although it is the case that Clusters P2 to P4 are *not* found among the "low motor" aptitude groups in the Skills Map.

Turning to the social and economic relations clusters (S1 to S3), the general intelligence or academic aptitude dimension of the Skills Map once again distinguishes among the OAP clusters, but the motor skills and people dimensions do so weakly at best. Consistent with the results for the physical relations clusters, the two highest level social relations clusters are found to require high or very high academic aptitudes according to the Skills Map. Although the three social relations clusters are found at all Skills Map levels of motor skill and involvement with people, and so are not distinguished well by those dimensions, they do tend to fall toward the lower end of the motor skills dimension in the Skills Map.

The three bureaucratic relations clusters (B1 to B3) are found only at the moderate and high academic aptitude levels of the Skills Map, the high level being represented primarily by Cluster B1. They tend not to be high on the Skills Map motor aptitudes dimension. Cluster B3 (manipulating records) does not have high involvement with people whereas

TABLE 3
The Predominant OAP Clusters within Each of the Skills Map Aptitude Combinations: Shown Separately by Three OAP Functional Areas of Work

Academic aptitude	Motor aptitude	Percentage of 1970 jobs[a]	Physical relations			Social/economic relations			Bureaucratic relations		
			Extensiveness (not complexity) of dealings with people								
			Lo	Mod	Hi	Lo	Mod	Hi	Lo	Mod	Hi
Lo	Lo	5.0	P5	P5	P5						
	Mod	21.0	P3,P4,P5	P4,P5	P5			S3			
	Hi	1.9	P4,P5	--	--		--	--		--	--
Mod	Lo	4.6							B2	B1,B2	B1,B2
	Mod	21.8	P3	P3	P3		S3	S3	B1,B3	B1,B3	B1,B2
	Hi	5.0	P3	P3	P3				B3	B2	
Hi	Lo	7.7	P1			S1	S2	S2,S3		B1,B2	B1
	Mod	4.5	P2	P2	P2			S2	B2	B1	B1
	Hi	5.4	P2,P3					S2	B3		B1
Very hi	Lo	10.4	P1	P1		S1	S1	S1,S2			
	Mod	4.4	P1	P1	P1		S1	S2			
	Hi	1.6	P1,P2	P2	P1			S2			

Note. See Gottfredson (1983, Fig. 1) for the Skills Map aptitude group numbers and sample occupations for each combination of academic aptitude, motor aptitude, and people involvement levels. Dashes (–) represent the two aptitude combinations in the Skills Map aptitude group matrix which are not found among jobs.

[a] Source: Gottfredson (1983, p. 85). Total adds to only 93.3% because some workers did not report codable job titles.

Cluster B1 tends to. Overall, however, the three bureaucratic OAP clusters are not well distinguished from each other by either the motor aptitude or people dimensions of the Skills Map.

Table 4 lists the summary aptitude requirements for the OAP clusters predominating at each of the four Skills Map academic aptitude levels and three of the major OAP functional areas of work. This table highlights the relation between demands for cognitive and noncognitive (i.e., *less* cognitive) aptitude requirements.

It appears that the cutting point on *any* aptitude, whether cognitive or not, is related to level of academic aptitude on the Skills Map. For example, Clusters P3, P4, and P5 are moderate to low on the academic aptitude dimension and require only minimal motor skills, even though differences in workers' motor skills are important relative to other aptitudes

TABLE 4
Predominant Pattern(s) of Aptitudes Required in Three OAP Functional Areas by Four Skills Map Academic Aptitude Levels

Skills Map academic aptitude level	OAP functional area of work[a]		
	Physical relations	Social/economic relations	Bureaucratic relations
Low	Clusters P3 P4 P5 S-87 P-80 K-85 P-83 K-85 M-81 M-85 M-85	Cluster S3 G-95	
Moderate	Cluster P3 S-87 P-83 M-85	Cluster S3 G-95	Clusters B1 B2 B3 G-98 G-95 Q-92 N-91 Q-95 K-88 Q-96
High	Cluster P2 G-104 N- 98 S- 98	Cluster S2 G-101 V- 99 N- 95 Q-100	Cluster B1 G-98 N-91 Q-96
Very High	Cluster P1 G-115 V-104 N-109 S-108	Clusters S1 S2 G-107 G-101 V- 97 V- 99 N-102 N- 95 Q- 99 Q-100	

Note. G = intelligence, V = verbal aptitude, N = numerical aptitude, S = spatial aptitude, P = form perception, Q = clerical perception, K = motor coordination, F = finger dexterity, M = manual dexterity. The average cutting points are shown for each aptitude and refer to the *minimum* aptitude level required for satisfactory job performance.

[a] Data shown for clusters taken from Fig. 1.

according to the OAPs in predicting differences in job performance. This pattern of cutting points that decrease in tandem with intelligence requirements, despite the type of aptitude in question, does not appear to be an artifact of the procedure used to develop modal OAPs. Both the OAP development manual (U.S. Department of Labor, 1980a, Table 9) and the list of several hundred individual SATBs (U.S. Department of Labor, 1980b) reveal that few occupations require more than minimal motor aptitude, even when motor aptitudes are the most important ones for predicting job performance. They also show that this is *not* the case for the cognitive skills, because the cutting scores for the latter range all the way from minimal to high. In addition, if intelligence does appear in a SATB together with a motor aptitude, the cutting score for intelligence also tends to be low.

Relation of OAP Cluster Profiles to Three DOT Worker Functions

Figure 1 suggests that the aptitudes jobs require are systematically related to the tasks workers perform. For example, high-level jobs judged to deal primarily with physical relations require spatial aptitude, whereas high-level jobs judged to deal mostly with social and economic relations require clerical perception, although both require high intelligence, verbal, and numerical aptitude. Table 5 reveals these relations between aptitude demands and work functions more explicitly by presenting data on worker functions that were not used in constructing the OAP Map (although they may have played a small role in the development of the GOE Work Groups for which the original 66 OAPs were developed). This table shows means and standard deviations for the DOT ratings of complexity of dealings with data, people, and things for each of the 13 OAP clusters. Grand totals for the three ratings for all (unweighted) occupational titles in the 1970 census are also shown in order to provide a sense of what the average level of complexity is among all occupations.

Table 5 shows that complexity of involvement with data, people, and things varies systematically both (a) across different levels of work within any particular functional area of work and (b) across different functional areas of work at a given level of work. Specifically, within any particular functional area, if one cluster is lower than another according to the OAP Map, it also requires less complex work with data or people. There is no such relation with general cognitive level for complexity of involvement with things. These results are consistent with occupational-level correlations of the three DOT ratings with the academic aptitude factor reflected in the Skills Map: −.88 for data, −.59 for people, and .05 for things (Gottfredson, 1981, Appendices C, D, and E). (Correlations are generally negative because high complexity receives a low score.) The following pattern of results summarizes the systematic differences across functional areas in the profiles of their scores for the three DOT ratings.

TABLE 5
Mean and Standard Deviation of Three DOT Worker Functions (Data, People, Things) for Job Titles in Each OAP Cluster

	DOT rating of complexity of involvement with						
	Data		People		Things		
OAP cluster	$\bar{X}$	*SD*	$\bar{X}$	*SD*	$\bar{X}$	*SD*	*N* of job titles
Physical relations							
P1	0.4	0.5	4.9	2.4	2.4	2.5	162
P2	1.6	0.7	6.2	1.4	3.8	2.8	136
P3	3.1	1.3	7.3	1.0	1.5	1.3	442
P4	5.1	1.3	7.6	0.8	3.6	2.0	276
P5	5.9	0.5	7.8	0.6	5.4	1.3	543
Social/economic relations							
S1	0.9	0.4	3.4	2.6	6.7	1.2	176
S2	1.6	0.8	4.6	2.0	6.4	1.6	172
S3	3.7	1.6	6.0	1.6	5.6	1.8	41
Bureaucratic relations							
B1	2.7	0.9	5.8	1.3	5.6	2.2	221
B2	3.1	1.0	6.2	0.9	5.5	2.3	106
B3	4.6	1.1	7.6	0.8	4.2	3.0	43
Performing							
A1	1.4	0.4	4.5	1.6	6.5	1.8	22
A2	2.1	1.1	5.8	1.6	2.2	2.3	28
1970 census occupational categories[a]	3.1	1.7	6.2	1.6	4.2	2.1	396

Note. Data range from 0 (high) to 6 (low); people range from 0 (high) to 7 (low); things range from 0 (high) to 8 (low). Data for clusters obtained from DOT codes for occupations listed in U.S. Department of Labor (1979b).

[a] Source: Gottfredson (1983, p. 86). The 396 census titles for which there are DOT data represent 93% of all employed persons in 1970.

First, except for the performing clusters, if above average complexity of dealings with *data* (i.e., a mean score below 3.0) is required, then *numerical* aptitude is critical (i.e., is in the aptitude profile). This means that numerical aptitude is an important predictor of job performance in jobs requiring synthesizing, coordinating, or analyzing versus only compiling, computing, copying, or comparing data. It should be noted that complexity of dealings with data may essentially reflect the *intelligence* requirements of jobs, as is suggested by their correlation of about .8 (Miller et al., 1980) and by the systematic relation of complexity of data with job level in the OAP Map. All four of the nonperforming clusters which have above average requirements for intelligence also have numerical aptitude in their OAP profiles.

Second, if relatively high complexity of dealings with *people* (i.e., a mean score below 5.0) is required, then *verbal* aptitude is in the OAP profile. This means that in jobs requiring mentoring, negotiating, instructing, supervising, diverting, or persuading versus only speaking/signaling/serving or taking instructions/helping, verbal aptitude is an important predictor of job performance.

Third, with the exception of Cluster P4, if above average complexity of dealings with *things* is required (i.e., a mean below 4.0), then *spatial* aptitude is in the aptitude profile. This means that in jobs requiring setting up, precision working, operating/controlling, or driving/operating versus only manipulating, tending, feeding/offbearing, or handling, spatial aptitude is an important predictor of job performance. It might also be noted that above average complexity of dealings with either things or people tends to occur only if dealings with data are also above average.

Fourth, if low complexity of dealings with data is required (i.e., about 1 *SD* above the grand mean), motor aptitudes appear in the OAP profile. (Cluster P3, which is average in dealings with data, is an exception because motor aptitude appears in its OAP profile). And, finally, if average or above average dealings with data are required *and* dealings with things are only average or below, clerical aptitude is in the OAP profile. In general, then, if the job requires at least average intelligence, it will usually require either spatial or clerical perception, the former if dealings with things are complex and the latter if they are not.

Relation of OAP Clusters to Holland Typology

Table 6 shows the percentage of occupations from each OAP cluster that falls within each of the six major Holland types. That table also shows the three-letter codes that are particularly common within each of the clusters. The physical relations clusters are predominantly investigative (I) or realistic (R), with the I job titles found predominantly in the higher OAP clusters (P1 and P2). The bureaucratic relations clusters are composed primarily of conventional (C) occupations, except for the highest level cluster (B1), half of which is enterprising (E) job titles. The social and economic relations clusters are a mix of social (S) and enterprising (E) Holland types with E job titles dominating the two higher level clusters. The two performing clusters contain primarily artistic (A) occupations.

DISCUSSION

This paper presented an aptitude-based, occupational classification. It was constructed by organizing the U.S. Employment Service's Occupational Aptitude Pattern (OAP) Work Groups (U.S. Department of Labor, 1979b) into a smaller number of clusters. Those 13 clusters were created according to similarities in the particular General Aptitude Test Battery

TABLE 6
Distribution of Holland Occupational Types within Each OAP Cluster

OAP cluster	Most common 3-letter codes[a]	Percentage in each Holland type[b]						*N* of job titles[c]
		R	I	A	S	E	C	
P1	I(RE), I(RS)	14	**77**	1	1	5	2	163
P2	R(IE), I(RE)	**39**	32	0	4	24	2	133
P3	R(IE), R(ES)	**94**	1	1	2	1	2	439
P4	R(ES), R(EI), R(CE), R(CS)	**82**	0	0	0	0	17	276
P5	R(CE), R(ES), R(EI)	**85**	0	0	0	2	12	543
B1	E(SA), C(SE), E(SR), C(SR)	10	1	1	8	**50**	30	225
B2	C(SE), C(SR)	5	0	0	12	19	**64**	105
B3	C(SE), C(SR)	26	0	0	0	2	**72**	42
S1	E(SA), E(SR), E(SC)	2	8	5	29	**55**	1	172
S2	E(SR), E(SA), S(EC)	2	6	2	32	**57**	1	170
S3	S(ER), S(EC)	11	0	2	**50**	34	2	44
A1	A(ES)	0	0	**77**	23	0	0	22
A2	A(ES)	7	0	**93**	0	0	0	28

Note. Percentages less than 0.5 are shown here as zero.

[a] Each set of three letters represents two 3-letter codes; when reversed, the two letters in parentheses create the second code (and the less common code of the two). Each set of two 3-letter codes constitutes at least 10% of the job titles in the OAP cluster in question.

[b] Percentages may not add to 100% because of rounding error.

[c] The number of job titles listed here does not agree completely with the number of job titles listed in the USES booklet of OAPs (Department of Labor, 1979b) because of adjustments made here to those data to reconcile coding inconsistencies for a few occupations across USES publications. It should also be noted that, although the introduction to the USES booklet of OAPs states that the booklet lists 2556 job titles, it actually lists only 2371 titles.

(GATB) aptitudes that job analysts determined to be most critical for performance in those groups and also according to the groups' similarities in OAP cutting points, which represent the minimum levels of the most essential aptitudes necessary for minimally satisfactory job performance.

Strengths of the OAPs and the resulting classification are that they provide comprehensive and comprehensible coverage of occupations and that they are based on empirical research concerning the relation between aptitudes and actual job performance. Weaknesses are that coverage of major aptitude dimensions (e.g., interpersonal skills) may be incomplete and that some of the procedures used to produce the original OAP Work Groups cannot be well documented or replicated. Nevertheless, the resulting classification—the OAP Map—seems sensible and consistent with common perceptions of occupations and their requirements.

Validity of the OAP Map

Evidence regarding the validity, or proper interpretation, of the OAP Map was obtained by comparing that map with another aptitude-based classificatory scheme (the "Skills Map") developed in a very different way, by analyzing data on the kinds of tasks performed on jobs in the different OAP clusters, and by looking at the relation between the OAP clusters and Holland's typology of work personalities and environments. Those analyses showed that the OAP and Skills Maps are consistent in how they classify occupations by intellectual difficulty level. This common ordering is further validated by the results regarding complexity of involvement with data, because the means for "data" reflected successively more complex work in the higher level OAP clusters (Table 5) and because that variable is highly correlated with the DOT rating of intelligence requirements (the latter *not* having been directly used in this study to create either the OAP or Skills Maps). The people and motor skills dimensions of the Skills Map did little to differentiate the clusters.

There was a strong relation, however, between the OAP Map and the Holland (1985) typology of vocational interests and work environments. The clusters in each functional area of work were dominated by one or two Holland types: physical relations by I and R; bureaucratic relations by C and E; social and economic relations by E and S; and performing by A. It might also be noted that the four OAP functional areas are arrayed across the OAP Map (Fig. 1) as a mirror image of Holland's hexagonal ordering of the six types (that is, in reverse RIASEC order)—IRCESA. Holland type was also associated with job level *within* each functional area of work: I clusters were higher level than R clusters, and predominantly E clusters were higher than either S or C clusters. There were also systematic differences across OAP clusters in the profiles of requirements for working with data, people, and things. This variation in Holland types by cluster level, as well as by functional work area, seems consistent with previous research (Gottfredson, 1980) which showed that the six Holland types differ in the occupational levels they span, for example, with investigative work usually being high level and realistic being low level.

Theory about Job Aptitude Requirements

When juxtaposed to past evidence concerning job aptitude demands (to be reviewed below), the OAP Map and the new evidence presented above provide the basis for a theory about the patterning and evolution of occupational aptitude demands across different kinds of work. (See Gottfredson, 1986a, for further papers on job aptitude demands and their implications.) The implications of the research reported here are best reviewed by sketching the theoretical definitions and propositions for which the research provides support. The paper concludes by highlighting

some practical applications of the OAP Map and its accompanying theory. The research suggested first of all that two definitions are necessary for interpreting the OAP Map and for clarifying theoretical issues: *aptitudes* and aptitude *requirements*.

Definition: Aptitude. The term *aptitude* refers to a relatively stable capacity for performing well some broad class of tasks. Aptitudes are distinct from skills in that the latter are more task-specific, they are molecular rather than molar, and they are more trainable. Because aptitudes are less trainable, they constitute more of a constraint for both workers and employers in matching people to jobs. The OAP Map refers to general aptitudes and not to specific skill patterns, and so is most useful when one is particularly concerned for either practical or theoretical reasons with the constraints imposed by relatively stable traits.

Aptitudes can be conceptualized and measured at several different levels (Hunter, 1983, in press; Jensen, in press, a; b), the two most common being group or *primary* aptitude factors (such as verbal aptitude, numerical aptitude, or finger dexterity) and *general* factors (such as general intelligence and general psychomotor aptitude). The general factors (such as intelligence) underlie or account in large part for the moderate to high correlations among clusters of primary aptitude factors (such as verbal and numerical aptitude). Correlations among the GATB aptitudes, in particular, can be accounted for by two general aptitude factors—general intelligence and general psychomotor aptitude. The general intelligence (G) scale of the GATB is a good approximation of the general factor *g*, and the other eight GATB aptitude scales are measures of group aptitude factors falling primarily into two clusters of correlated scales—cognitive and motor. (The perceptual aptitudes—spatial, form, and clerical perception—load primarily on the cognitive general factor, but less so than do the exclusively "cognitive" group factors, such as verbal aptitude.)

Definition: Requirements. To say that a particular aptitude is "important" or "required" in a job can mean several specific things: (a) differences in that aptitude are highly correlated with level of job performance (i.e., the predictive validity of the aptitude is high), (b) the aptitude is more useful than other aptitudes for predicting later job performance (i.e., its predictive validities are higher than those of other aptitudes), (c) a high *level* of that aptitude is necessary for some specified level of job performance (say, "satisfactory" performance), and (d) employers demand a high level of that aptitude among the workers they hire (whether or not it is truly necessary for satisfactory performance).

The OAP Map does not deal at all with existing employer hiring standards (d above), nor was it intended to. Although aptitude "requirements" have usually been treated as a unitary concept in the vocational literature, the comparison of the OAP and Skills Maps makes it clear that aspects (a) to (c) above do not necessarily move in tandem. Thus, it is very important to distinguish just what facets of aptitude demand we wish to measure or have actually captured with different classificatory schemes.

Such distinctions help to clarify, further below, some of the apparent inconsistencies between the OAP and Skills Maps. The Skills Map registers only (c) above, specifically, the levels of the aptitude that are presumably necessary for achieving the level of performance that was considered to be "satisfactory" or "average" at the time of the USES job analyses. It is an indication of whether differences in any particular aptitude have any appreciable effect on overall job performance (a above), or whether one aptitude is a better predictor of performance than another (b above). In contrast, the OAP Map captures all the first three facets of importance to some (unclear) extent because aptitudes are included in an OAP profile only after a joint consideration of (a) to (c). Regardless of whether they are high or low, however, GATB minimum cutting points—which represent the typical aptitude level of minimally satisfactory performers (c above)—are actually listed in an occupational family's aptitude profile only for aptitudes judged to be important by some combination of the three criteria.

Proposition 1: 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. Specifically, this hypothesis is supported by the following four empirical generalizations (A–D below).

A. Intelligence is more useful than any other aptitude factor, whether group or general, for predicting job performance across the full spectrum of jobs and job families. Cognitive tests predict performance in *all* jobs (Schmidt & Hunter, 1981), and cognitive group factors (specific aptitudes) seldom have much predictive validity after partialing out the general cognitive factor (Hunter, 1985, in press; Thorndike, 1985, in press). Also, it is only in low-level jobs that predictive validities are higher for "non"-cognitive aptitudes (Hunter, 1983). Consistent with this, the GATB Intelligence scale (G) appears in the aptitude profiles of all but one of the moderate to high-level OAP clusters, which includes 9 out of the 13 OAP clusters. The next most frequently occurring aptitudes are numerical and clerical aptitude which are found in 5 clusters each.

B. The higher the job level, the more important intelligence is, both in terms of predictive validity and in terms of minimum levels required. There are various ways of operationalizing overall occupational level, common ones being complexity of the work performed, prestige, educational levels required, educational levels typical of incumbents, and level of responsibility or criticality of work. However, all these measures are highly correlated with each other and with the level of intelligence estimated to be required by different occupations (Gottfredson, 1984,

1985). Likewise, the more complex (the higher the level) the work is, the higher is the correlation between cognitive ability and job performance (Hunter, 1983). Predictive validities for cognitive abilities, whether they are group or general factors, are themselves moderately correlated with minimum cutting points as well as with average aptitude levels of incumbents in those jobs (Gottfredson, 1984). The OAP Map is consistent with the foregoing results because it shows that minimum cognitive aptitude requirement levels are successively lower among the OAP clusters that are widely perceived to be lower in level, and because cognitive aptitudes do not even appear in the profiles for the lowest level clusters.

C. The lower the job level, the more useful motor aptitudes are relative to cognitive ones in predicting job performance. Hunter (1983) found that predictive validities for general cognitive ability decrease with lower job level whereas validities for the general psychomotor factor increase, with the result that the multiple correlation for the two general factors together is about the same across all job levels. This pattern is reflected by the OAP Map in the sense that cognitive aptitudes dominate the OAP profiles in high-level jobs and motor aptitudes dominate in the low-level jobs.

D. Although different facets of aptitude importance (e.g., predictive validities vs levels of aptitudes required) are correlated for cognitive abilities, they are not correlated for psychomotor aptitudes. Instead, aptitude level requirements for *all* aptitudes appear to be tied to the importance of intelligence in a job. Lower boundary (or mean) scores among occupational incumbents on the GATB psychomotor scales are uncorrelated with the predictive validities of those aptitude scales (Gottfredson, 1984). Instead, the estimated cutting points for motor coordination are somewhat *positively* correlated with the validities for *intelligence* and for the more specific cognitive group factors.

The OAP Map is consistent with this finding in that the OAP minimum psychomotor requirements decrease rather than increase in the lower level OAP clusters, and they are never high. Psychomotor requirements are overshadowed by cognitive requirements in high-level OAP clusters, partly because relatively few high-level jobs have high psychomotor requirements and so do not affect the modal SATB profiles, and also because motor requirements tend not to be as important as cognitive abilities in predicting job performance in such clusters. In fact, use of the alternative Skills Map (Table 4) shows that jobs with the highest levels of psychomotor requirements tend to be found among moderately to highly intellectually demanding jobs (e.g., crafts workers, dentists, surgeons). This is consistent with the fact that the SATBs for individual occupations (which were used in developing the OAP profiles) show that some occupations do indeed have high requirements for level of psychomotor aptitude, but that these tend to be moderate to high-level occupations (e.g., dentist).

The fact that higher levels of intelligence tend to be required in jobs where differences in intelligence have a bigger impact on job performance makes sense. If intelligence has a bigger impact on job performance, employers can be expected to seek more of it in their employees. Why, then, do we not find the same pattern for psychomotor ability? The answer may lie partly in the fact that cognitive and psychomotor abilities are positively correlated within the human population, so that selecting employees for intelligence also has the effect of selecting them for psychomotor ability to some extent, thus tending to pull persons with psychomotor aptitude into cognitively demanding jobs even when motor skills are not required in them. The criticality of good job performance to the organization is more highly correlated with the general intellectual difficulty of jobs than with their psychomotor demands (Gottfredson, 1984), so employers can also be expected to place highest priority on getting good workers for the more intellectually demanding jobs. This means in turn that it is unrealistic for employers to create intellectually easy jobs with high psychomotor requirements because the pool of workers with high levels of psychomotor aptitude will be significantly depleted by the selection of workers for more attractive, more intellectually demanding jobs. It is also possible that high performance levels, even on putatively noncognitive tasks, usually requires some minimum level of intelligence. This possibility is suggested by the Skills Map, because it shows that jobs dealing extensively with people are relatively rare among cognitively undemanding jobs and that high levels of psychomotor skill are displayed most often in jobs with moderate to high cognitive demands (see also Gottfredson, 1983). Whatever the explanation, however, it is apparent that cognitive and noncognitive job demands are interdependent to some extent, and that the former tend to structure the latter rather than the reverse.

Proposition 2: Within levels of work, the aptitude demands of different functional areas (broad fields) differ primarily in the shape of their cognitive profiles (where perceptual aptitudes are classified as predominantly cognitive aptitudes). Beyond this sweeping statement, it is still not possible to specify just what those profile differences are or how important they might be. It was long believed in personnel selection research that each job requires its own unique aptitude profile which might differ from one location or time to another, even for the same job title within the same organization. This perspective has since been characterized as the "specificity hypothesis" (Schmidt & Hunter, 1981; see also Jensen, 1984). However, recent research on validity generalization has provided evidence that tailored selection batteries (which would correspond to different

cognitive profiles) seldom predict performance in training or on the job better than does a single general cognitive (intelligence) factor when restriction in range on intelligence is taken into account (Hunter, 1985, in press; Thorndike, 1985, in press). So far, that research has shown only that spatial or mechanical aptitudes add to the prediction of performance in some technical and artistic jobs, and that speeded clerical tests are marginally useful in some clerical jobs (Schmidt, Hunter, & Pearlman, 1981; Hunter, in press). It is entirely possible, then, that many of the aptitudes listed in the OAP profiles are redundant and that the most accurate OAP profiles would be ones that include only general factors (e.g., intelligence, general psychomotor ability) and perhaps one perceptual aptitude. For example, it seems highly likely that performance in the physical relations clusters truly is marginally influenced at least by differences in spatial or related perceptual aptitudes, net of intelligence. Being less highly correlated with the general intelligence factor than are the most highly cognitive primary aptitudes, perceptual aptitudes are the most likely to make an independent contribution to the prediction of job performance net of the general intelligence factor.

Only further research can settle this question. It is interesting to note, however, that job analysts' estimates of the presence or absence of the group factors of verbal, numerical, clerical, and spatial aptitude in the OAPs were in fact found to be systematically related to the work functions that the analysts judged workers to perform on those jobs (Table 5).

It is entirely possible that the major differences in requirements across functional areas or fields of work, at least as captured by the OAP Map, are in interests and temperaments rather than in aptitude profiles. Table 6 showed that there are large and systematic differences among the OAP clusters in the Holland codes of their constituent occupations. Those differences also seem consistent with Holland's (1985) description of his typology.

Proposition 3: Aptitude demand patterns arise in large part from broad differences in the tasks workers actually perform on the job. Differences in level of general intellectual demands can be traced largely to differences in the overall complexity of the work performed, for example, as indicated by the complexity of involvement with data (Table 5; Hunter, 1983). Also, the apparent differences in profile *shape* for various cognitive and perceptual demands were found to be related to the relative complexity of dealings with people versus things (Table 5). More extensive evidence for the link between aptitude and task demands is presented and discussed elsewhere (Gottfredson, 1984, 1985). In short, then, occupational aptitude demands are not sensitive to minor variations in tasks performed or the settings in which they are performed (Schmidt et al., 1981), but they do vary systematically and significantly according to *major* differences across jobs in the classes of tasks or functions they require workers to perform.

Practical Applications

Several caveats must be kept in mind when using the OAP Map (see also Gottfredson, 1986b):

a. The research showed that differences in intelligence play a larger role in determining job performance than many people might have expected, because it appears to be the most important of all aptitudes and, indeed, it is very important overall. Nonetheless, it should be clear that intelligence is not the only aptitude that makes a difference, and that interests and temperaments may also play a significant role in vocational choice and adjustment, particularly by field of work.

b. Little or no reliance should be placed on differences in the shape of cognitive profiles for the different OAP clusters until additional evidence becomes available concerning their validity and importance. For practical applications, then, it would be best to use only the general intellectual factor in the OAP Map until more evidence becomes available concerning the role of the primary or group factors (e.g., verbal or clerical perception).

c. The placement of individual occupations into GOE Work Groups and of GOE Work Groups into OAP clusters is far from an exact process, and some occupations could just as correctly be placed into two different OAP clusters. Thus, the OAP clusters should be viewed as only rough and overlapping job families.

d. The OAP clusters reveal only the major differences and similarities among occupations. Other sources of information must be used to determine the particular task, skill, and training requirements of specific jobs.

Provided that these caveats are observed, the OAP Map is a useful supplement to the counseling aids published by the USES, including the *Dictionary of Occupational Titles* (U.S. Department of Labor, 1977), the *Guide for Occupational Exploration* (U.S. Department of Labor, 1979a), and the booklet of OAP Work Groups and related occupations (U.S. Department of Labor, 1979b). More broadly, the OAP Map could be used in a variety of settings to promote realistic occupational exploration. Despite the need for one, there has been no comprehensive occupational classification that students or job seekers could use to gain an overview of the types and levels of abilities different occupations require and with which they might assess the wisdom of their vocational choices. Broader vocational exploration and greater realism in vocational choice can both be promoted using the OAP Map, and one system that uses the OAP Map to do so is presented elsewhere (Gottfredson, 1986b).

REFERENCES

Cain, P. S., & Green, B. F. (1983). Reliabilities of selected ratings available from the *Dictionary of Occupational Titles*. *Journal of Applied Psychology*, **68**, 155–165.

Cooper, W. H. (1981). Ubiquitous halo. *Psychological Bulletin*, **90**, 218–244.

Droege, R. C., & Boese, R. (1982). Development of a new occupational aptitude pattern

structure with comprehensive occupational coverage. *The Vocational Guidance Quarterly*, **30**, 219–229.

Droege, R. C., & Hawk, J. (1977). Development of a U.S. Employment Service interest inventory. *Journal of Employment Counseling*, **14**, 65–71.

Droege, R. C., & Padgett, A. (1979). Development of an interest-oriented occupational classification system. *Vocational Guidance Quarterly*, **27**, 302–310.

Dunnette, M. D. (1976). Aptitudes, abilities, and skills. In M. D. Dunnette (Ed.), *Handbook of industrial and organizational psychology*. Chicago: Rand McNally.

Gottfredson, G. D., Holland, J. L., & Ogawa, D. K. (1982). *Dictionary of Holland occupational codes*. Palo Alto, CA: Consulting Psychologists Press.

Gottfredson, L. S. (1980). The construct validity of Holland's occupational typology in terms of prestige, census, Department of Labor, and other classification systems. *Journal of Applied Psychology*, **65**, 697–714.

Gottfredson, L. S. (1981). *A skills map: The general and specific competencies required in different occupations*. (CSOS tech. rep.). Baltimore, MD: Johns Hopkins University, Center for Social Organization of Schools.

Gottfredson, L. S. (1983). *The validity of an occupational classification based on job competencies for assessing employability* (CSOS tech. rep.). Baltimore, MD: Johns Hopkins University, Center for Social Organization of Schools.

Gottfredson, L. S. (1984). *The role of intelligence and education in the division of labor* (Rep. No. 355). Baltimore, MD: Johns Hopkins University, Center for Social Organization of Schools.

Gottfredson, L. S. (1985). Education as a valid but fallible signal of worker quality: Reorienting an old debate about the functional basis of the occupational hierarchy. In A. C. Kerckhoff (Ed.), *Research in Sociology of Education and Socialization*, Vol. 5, pp. 123–169. Greenwich, CT: JAI Press.

Gottfredson, L. S. (Ed.). (1986a). The *g* factor in employment (special issue). *Journal of Vocational Behavior*, **29**(3).

Gottfredson, L. S. (1986b). *Using an Occupational Aptitude Patterns (OAP) Map to promote reality-based career exploration*. Unpublished paper, Center for Social Organization of Schools, Johns Hopkins University, Baltimore, MD.

Gottfredson, L. S., Finucci, J. M., & Childs, B. (1984). Explaining the adult careers of dyslexic boys: Variations in critical skills for high-level jobs. *Journal of Vocational Behavior*, **24**, 355–373.

Guion, R., & Gottier, R. (1965). Validity of personality measures in personnel selection. *Personnel Psychology*, **18**, 135–164.

Holland, J. L. (1985). *Making vocational choices: A theory of vocational personalities and work environments*. Englewood Cliffs, NJ: Prentice–Hall.

Hunter, J. E. (1983). *Test validation for 12,000 jobs: An application of job classification and validity generalization analysis to the General Aptitude Test Battery*. Washington, DC: U.S. Department of Labor, Employment and Training Administration, Division of Counseling and Test Development.

Hunter, J. E. (1985). *Differential validity across jobs in the military*. Unpublished paper, Department of Psychology, Michigan State University.

Hunter, J. E. in press. Cognitive ability, cognitive aptitude, job knowledge, and job performance. *Journal of Vocational Behavior*, **29**.

Jensen, A. R. (1984). Test validity: *g* versus the specificity doctrine. *Journal of Social and Biological Structures*, **7**, 93–118.

Jensen, A. R. (in press, a). The *g* beyond factor analysis. In J. C. Conoley, J. A. Glover, & R. R. Ronning (Eds.), *The influence of cognitive psychology on testing and measurement*. Hillsdale, NJ: Erlbaum.

Jensen, A. R. (in press, b). *g*: Artifact or reality? *Journal of Vocational Behavior*, **29**.

McCormick, E. J., Jeanneret, P. R., & Mecham, R. C. (1972). A study of job characteristics and job dimensions as based on the Position Analysis Questionnaire (PAQ). *Journal of Applied Psychology*, **56**, 347–368.

McKinney, M. W. (1984). *Final report: Validity generalization pilot study*. Southern Test Development Field Center, Employment Security Commission of North Carolina, P.O. Box 27625, Raleigh, NC 27611.

Miller, A. R., Treiman, D. J., Cain, P. S., & Roos, P. A. (Eds.) (1980). *Work, jobs, and occupations: A critical review of the Dictionary of Occupational Titles*. Washington, DC: National Academy Press.

Pearlman, K. (1980). Job families: A review and discussion of their implications for personnel selection. *Psychological Bulletin*, **8**(1), 1–28.

Schmidt, F. L., & Hunter, J. E. (1981). Employment testing: Old theories and new research findings. *American Psychologist*, **36**, 1128–1137.

Schmidt, F. L., Hunter, J. E., & Pearlman, K. (1981). Task differences as moderators of aptitude test validity in selection: A red herring. *Journal of Applied Psychology*, **66**, 166–185.

Strohmenger, C. T., & Padgett, A. (1979). Guide for occupational exploration: A new approach in career planning. *Journal of Employment Counseling*, **16**, 16–20.

Thorndike, R. L. (1985). The central role of general ability in prediction. *Multivariate Behavioral Research*, **20**, 241–254.

Thorndike, R. L. in press. The role of general ability in prediction. *Journal of Vocational Behavior*, **29**.

U.S. Bureau of the Census (1971). *Classified index of industries and occupations*. Washington, DC: U.S. Gov. Printing Office.

U.S. Department of Labor (1965). *Dictionary of occupational titles* (3rd ed.) Washington, DC: U.S. Gov. Printing Office.

U.S. Department of Labor (1969a). *Test development guide. Vol. 1: Methodology*. Washington, DC: U.S. Gov. Printing Office.

U.S. Department of Labor (1969b). *Test development guide. Vol. 2: Derivation of norms and illustrative experimental designs*. Washington, DC: U.S. Gov. Printing Office.

U.S. Department of Labor (1970). *Manual for the USTES General Aptitude Test Battery, Section III: Development*. Washington, DC: U.S. Gov. Printing Office.

U.S. Department of Labor (1972). *Handbook for analyzing jobs*. Washington, DC: U.S. Gov. Printing Office.

U.S. Department of Labor (1977). *Dictionary of occupational titles (4th ed.)*. Washington, DC: U.S. Gov. Printing Office.

U.S. Department of Labor (1979a). *Guide for occupational exploration*. Washington, DC: U.S. Gov. Printing Office.

U.S. Department of Labor (1979b). *Manual for the USES General Aptitude Test Battery. Section II: Occupational Aptitude Pattern Structure*. Washington, DC: U.S. Gov. Printing Office.

U.S. Department of Labor (1980a). *Manual for the USES General Aptitude Test Battery. Section II-A: Development of the Occupational Aptitude Pattern Structure*. Washington, DC: U.S. Gov. Printing Office.

U.S. Department of Labor (1980b). *Manual for the USES General Aptitude Test Battery. Section IV: Specific Aptitude Test Batteries*. Washington, DC: U.S. Gov. Printing Office.

U.S. Department of Labor (1981). *Selected characteristics of occupations defined in the Dictionary of Occupational Titles*. Washington, DC: U.S. Gov. Printing Office.

U.S. Department of Labor (1982). *Development of 1979 revision of the Interest Check List*. USES Test Research Report No. 36. Washington, DC: U.S. Gov. Printing Office.

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