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Descriptive dimensions of US occupations with data from the O*NET

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Abstract

Several authors have successfully used the Dictionary of Occupational Titles to construct scales measuring occupational work environments. The Dictionary, however, has been replaced by the Occupation Information Network or O*NET, which offers expanded content and higher quality data. This paper reports an exploratory factor analysis of the O*NET (version 4.0). Four factors are identified. Three factors are comparable to the results of earlier analyses: SUBSTANTIVE COMPLEXITY, PEOPLE VERSUS THINGS, and PHYSICAL DEMANDS. A fourth factor, BUREAUCRACY, is discovered that describes work in hierarchical organizations and oriented toward organizational policies and practices. O*NET variables and these factors can be linked to social studies via occupation codes and used as relatively objective and up to date assessments of work environments.
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1. Introduction

In the last three decades the Dictionary of Occupational Titles [DOT (USES, 1991)] has been used to generate measures of the psychosocial characteristics of occupations (Cain and Treiman, 1981; England and Kilbourne, 1988; Parcel and Mueller, 1983; Roos and Treiman, 1980; Shu et al., 1996; Spenner, 1980, 1990). These measures, such as "substantive complexity," "perceptual and motor skills," and

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"physical demands and hazards" (Kohn and Schooler, 1983), have not only been useful in the sociology of work, occupations, and organizations (e.g., Kilbourne et al., 1994; Parcel, 1989; Szafran, 1996), but in the sociology of health and illness (e.g., Amick and Lavis, 1999; Kohn and Schooler, 1983; Muntaner et al., 1993; Oldham and Gordon, 1999) and studies of child development as well (e.g., Parcel and Menaghan, 1994a,b). Moreover, the DOT measures have inspired the design of other direct measures (e.g., job demands and control over work scales; Karasek and Theorell, 1990) that have become standard instruments in social epidemiology (Eaton et al., 2001).

The DOT was created in the 1930s with major revisions in 1949, 1965, 1977, and 1991. It contained, in addition to titles and descriptions, a large number of quantitative variables that described occupations. It is these variables that have been used by social scientists (Miller et al., 1980). The concept of occupation in the DOT was quite specific; the 4th edition contained over 12,000 entries, too many for practical statistical applications. In the late seventies the Bureau of Labor Statistics (BLS), Bureau of the Census and other federal statistical agencies attempted to standardize the production and presentation of occupational statistics with a Standard Occupational Classification [SOC (Office of Federal Statistical Policy and Standards, 1980)]. Standardization, however, was incomplete; different data systems continued to report occupational statistics with incomparable categories, and by the early 1990s government officials and their advisory committees saw changes in work and occupations attributed to de-industrialization, globalization, and advancing technology as justification for an extensive revision of the DOT and the SOC (APDOT, 1993; BLS, 1993, 1999). Initially, these revisions were developed separately.

The revision of the DOT is a database system called the Occupation Information Network, or the O*NET (Mariani, 1999). This system is a major advance in occupational data and in making the content of the system available and relevant to users. The quality of the content is also much improved, or, at least, that is the promise as the current version (4.0) is still incomplete and the BLS estimates it will take some years to refine, collect, and publish new measures (Boese et al., 2001). There are three major innovations in the O*NET. First, the number of occupations is much reduced and they are more broadly defined. Many of the occupational titles in the old DOT describe particular jobs; the occupations in the O*NET are intended to group many jobs according to the type of work and amount of education, skills or training, and were partly defined by grouping titles with similar characteristics in the DOT and the BLS' Occupational Employment Statistics system. Compared to over 12,000 entries in the 1991 revision of the DOT there are 900 occupations described in the current version of the O*NET. Second, the selection and definition of the occupational descriptors has been guided by an extensive review of the progress in occupational analysis since the introduction of the DOT (Boese et al., 2001; Committee on Techniques for the Enhancement of Human Performance, 1999; Mumford and Peterson, 1999; Peterson et al., 2001). The result of the review is a "content model" that classifies variables according to the characteristics of workers, jobs, organizations, and labor markets with variables defined to measure significant aspects of these domains. Third, whereas in the old DOT the data were based upon ratings by expert job

evaluators, in the O*NET expert evaluations are being largely supplanted by variables measured in surveys of workers. In the current version of the O*NET (4.0) the data are still ratings of occupational analysts, but in the future the data on abilities will be updated with new ratings and the data on skills, generalized work activities, work context, and knowledge will be updated with data from a survey of employees (BLS, 2002; ETA, 2002). The survey will cover approximately 300 jobs per year, taking about 3 years to update the entire database (ETA, 2002). In order to make the data representative, probability sampling will be used, but the design for the survey is complex. A sample of business establishments stratified on industry, size, and the number of incumbents in target occupations will be selected. This sample will be augmented with employees drawn from association or other occupational group membership lists to more efficiently find persons in some smaller occupations. It is expected that a minimum of 15 respondents will be found for each questionnaire for each occupation.

During the same years that the O*NET was being designed to replace the DOT, the SOC was being revised by a committee with members from many federal statistical agencies. Following a period of public discussion and development (BLS, 2001; OMB, 1997) the revision was completed in 1998. The occupations defined in the SOC are not identical to those defined in the O*NET, but the new SOC is being used in the O*NET and for 2000 Census data and will be used in other data systems presenting statistics by occupation (Levine et al., 1999, 2000). The new SOC, like its predecessors, was constructed along pragmatic lines in an effort to meet multiple, conflicting objectives. These included facilitating the compilation of useful data by several statistical agencies that reflect the changes in the American work-force and yet can be compared over time and across nations. The fundamental approach in the new SOC, as in the 1980 SOC, defines occupations by the type of work done, that is by categorizing job titles; however, in the new SOC greater attention has been paid to identifying skill level and to making the system hierarchical. In the new SOC there are 822 detailed occupations at the fourth and lowest level of a hierarchy with these detailed occupations grouped into 452 broad occupations, 98 minor groups, and 23 major groups. There are guidelines for condensing these groups further into 11 or 6 categories (Levine et al., 1999). It is also possible for users to add even more detail for specific applications by subdividing occupations. This is what has been done in the O*NET, which aims to provide data on 974 occupations (Levine et al., 2000).

Previous attempts at creating summary indices have used factor analysis or similar methods of data reduction. Parcel and Mueller (1983) report an exploratory factor analysis (EFA) of data from the 3rd edition DOT aggregate to 1970 Census occupations. Roos and Treiman (1980) aggregated data from the DOT 4th edition to 1970 Census occupations and then did an EFA. Cain and Treiman (1981) did an EFA of a 10% sample of the titles in the 4th edition of the DOT. England and Kilbourne (1988) updated the Roos and Treiman (1980) analysis for 1980 Census occupations. Muntaner et al. (1993) linked the DOT to a probability sample from US metropolitan areas and did an EFA of the DOT data with person as the unit of analysis, comparing the results to Karasek's scales. Shu et al. (1996) developed comparable scales for 1960, 1970, and 1980 Census occupations with a confirmatory factor

analysis. These analyses have produced fairly consistent results, but all authors acknowledge that the data in the DOT are not well documented and are not as reliable, valid, or complete in their content as they might be (Cain and Treiman, 1981).

The main goal of this study is to build on these previous studies and generate a set of summary measures of the psychosocial characteristics of work for occupations using the O*NET. It will be possible to link these measures to datasets with records of individuals whose occupation has been coded. These measures can be used in sociology as well as in population health research to address questions on the consequences of occupation where individual occupational characteristics have not been measured (Muntaner et al., 1993; Schwartz et al., 1988). We report an EFA of the occupational characteristics in the O*NET. EFA is an appropriate statistical tool to summarize O*NET indicators of occupational characteristics because, even though the indicators were collected under the O*NET conceptual model, that model does not clearly define relationships among the dimensions of its various categories and domains.

2. Methods

Data for this analysis are from version 4.0 of the O*NET database (Boese et al., 2001). These data are available from the O*NET Resource Center (2002). The major conceptual categories and domains of the O*NET content model are shown in Table 1 along with the number of variables in each area. Within several of the domains in Table 1 the O*NET content model lists a number of subdomains, which we have not shown here. For instance, the 52 variables that measure abilities are grouped in the O*NET content model into subdomains like cognitive and psychomotor abilities and scales like verbal or quantitative abilities and fine manipulative or control movement abilities (Boese et al., 2001; Fleishman et al., 1999). The variables in the O*NET domains of work activity, ability, knowledge, and skills are measured on more than one dimension. For instance, abilities are measured both for the level of ability and the importance of the ability. These level and importance measures are highly correlated. We rescaled the level and importance measures between zero and one, multiplied them together, and did a natural log transformation so that each concept was measured with just one variable. After these transformations each occupation is described by 227 variables.

There are 900 detailed occupations with data in this version of the O*NET. There are an additional 266 records with no data; some of these are newly defined occupations for which data have not yet been collected, prepared, or entered into the database; others are records for occupations in the SOC that have been subdivided into two or more occupational units in the O*NET.

These 900 detailed occupations with 227 variables were subjected to three sets of exploratory factor analyses. In the first set variables from each of the conceptual subdomains were analyzed separately. In the second set, the estimated values of the latent factors from the first analysis were in turn factor analyzed. In the third set all 227 variables were entered into one overall factor analysis.

Table 1
Factor analysis of variables in domains of the O*NET conceptual model

Category/domain/factor	Domain abbreviation	Number of variables	Number of factors	Variance explained	Correlation between factors		
					1	2	3
Worker characteristics							
Abilities	WCAb	52	2	69.0			
Physical ability		28		38.1	1.00	−.08	
Cognitive ability		20		30.8		1.00	
Values and interests	WCIn	27	3	84.7			
Self-realization		12		58.3	1.00	.53	.00
People versus things		6		15.6		1.00	.10
Bureaucracy		5		10.8			1.00
Worker requirements							
Basic skills	WRBS	10	1	89.4			
Cross-functional skill	WRCFS	25	2	80.7			
Organization skills		15		52.5	1.00	−.12	
Physical system skills		9		28.2		1.00	
Knowledge	WRKn	33	3	64.2			
Liberal arts		15		35.4	1.00	−.14	.32
Engineering		5		16.4		1.00	−.16
Bio-medicine		4		12.4			1.00
Occupational requirements							
Generalized work activities	ORGWA	41	3	83.8			
Analyze and decide		15		63.5	1.00	.62	−.28
Interact with others		12		11.9		1.00	−.35
Work with things		5		8.5			1.00
Work context	ORWC	38	2	65.6			
Physically challenging		19		46.2	1.00	−.31	
Socially challenging		10		19.4		1.00	

In each analysis a principle factor structure was estimated and then rotated by a promax method. The principle factor analysis estimates a set of independent latent variables that are assumed to underlie the observed data. The promax rotation aligns the first factor with the dimension with greatest variance and relaxes the assumption of independence among the factors. Decisions on the number of factors to retain were made after looking at scree plots and examining the variables with high loadings on factors with marginal explanatory power to determine whether or not factors were interpretable (Hatcher, 1994). A general rule is to consider all factors in the principle factor analysis with eigenvalues greater than one. With the large number of variables in the O*NET, however, in many of the analyses factors with eigenvalues greater than one explained a very small proportion of the variation, had no clear interpretation, and were for this reason dropped. The analysis was done with SAS (2000).

3. Results

3.1. Analyses of conceptual subdomains

Table 1 presents some results of the first set of factor analyses. The headings in the stub of this table represent the major categories of the O*NET concept model. There are two domains of worker characteristics, abilities and values and interests. In the abilities domain there are two clear factors underlying the 52 variables, one identifying PHYSICAL ABILITY, the other COGNITIVE ABILITY. These dimensions are essentially independent; the correlation between them is only −.08 and they explain 69% of the total variance within the item pool. In a four-factor solution (not shown in table) that explains 85% of the variance the factor PHYSICAL ABILITY is divided into three factors: GROSS MOTOR SKILLS, STRENGTH AND ENDURANCE; AUDITORY AND VISUAL PROCESSING ABILITIES; and FINE MOTOR ABILITIES.

In the values and interests domain there are six items representing occupational interests defined in the Dictionary of Holland Occupational Codes (Gottefredson and Holland, 1996) and 21 items derived from a theory of work adjustment (Dawis and Lofquist, 1984). Each of these items is, in turn, a composite measure based upon multiple items in the data collection instrument. Our factor analysis produced three dominant factors. The first includes measures of ability utilization, achievement, and recognition and can be summarized as SELF-REALIZATION. The second factor, PEOPLE VERSUS THINGS, has two poles contrasting those who work with others and provide personal service against those who work alone and with things. This factor contrasts nurses, training and development specialists and managers, and social and community service managers against certain operators and tenders of machines like grinding machines. The third factor, BUREAUCRACY, measures work in organizations and commitment to rules and organizational controls; sculptors, hunters and trappers, and poets are extremely low on this factor while credit analysts, insurance claims examiners and air traffic controllers are extremely high.

This three-factor solution explains 85% of the variance; the correlation of the first two factors is .53.

We did three-factor analyses of the category of worker requirements. The conceptual model divides required skills into basic and cross-functional skills. One-factor dominates the basic skills items. Two factors dominate the cross-functional skill items; the first represents systems analysis, resource management, and skills relevant to social organizations (ORGANIZATIONAL SKILLS); the second, PHYSICAL SYSTEMS SKILLS. The first of these factors correlates highly with the basic skills factor; the correlation coefficient for scores calculated for these factors is .89.

In the domain of knowledge there are three key factors, but these explain only 64% of the variance. The first factor covers diverse fields that might be described as LIBERAL ARTS; the second factor covers engineering, physics, and construction (ENGINEERING); and the third factor (BIO-MEDICINE) covers biology, medicine, and counseling. There is a moderate correlation of. 32 between the LIBERAL ARTS factor and the BIO-MEDICINE factor. Alternative solutions reproduce the second and third factors while dividing the first factor. These divisions are interpretable, and their intercorrelations are no more than moderate, but scores from the additional factors tend to correlate highly with scores from the first factor of the three-factor solution. For instance, a five-factor solution divides the areas of the first factor into factors for MANAGEMENT/BUSINESS and SOCIAL SCIENCE/LIBERAL ARTS and creates a fifth factor (GOVERNMENT) that includes geography, public safety, law and government, and transportation.

The category occupational requirements has two domains, generalized work activities and work context. There are three factors underlying the items classified as generalized work activities. The first factor, emphasizing analysis of data, interpreting information, and making decisions (ANALYZE AND DECIDE), explains 63% of the variance. Two other factors, dealing with a variety of interpersonal relations in organizations (INTERACT WITH OTHERS) and dealing with material and equipment (WORK WITH THINGS), make additional contributions to bring the total for these three factors to 84%. There are two factors underlying the work context variables, one characterizing workplaces as PHYSICALLY CHALLENGING and one as SOCIALLY CHALLENGING. Some items leading the PHYSICALLY CHALLENGING factor are very hot, extremely bright or inadequate lighting, and keeping or regaining balance. Some items leading the SOCIALLY CHALLENGING factor are frequency in conflict situations, deal with unpleasant/angry people, and coordinate or lead others. These two factors explain only 65% of the variance and they correlate −.31 with each other, but extracting additional factors produces factors that correlate highly with one or both of these two.

In the future the O*NET will contain variables measuring experience and training requirements. In this version there is a single variable, Job Zone.

3.2. Analysis of latent subdomain variables

The next step in the analysis was a factor analysis of the occupational factor scores on the factors described above together with a variable called Job Zone,

Table 2
Second-order factor analysis of O*NET 4.0, explained variance, and factor loadings for a four-factor solution

Abbreviation of concept model subdomain and factor name		Factor			
		1	2	3	4
Explained variance		.61	.21	.09	.06
Substantive complexity					
WRBS	Basic skills	.92	.03	−.14	−.04
WRCFS1	Organization skills	.92	.00	.03	.04
WCIn1	Self-realization	.91	.10	−.15	−.29
WCAb2	Cognitive ability	.89	.10	.13	.18
ORGWA1	Analyze and decide	.87	.22	−.20	.12
Job_zone	Educational requirement	.75	.27	−.19	−.21
ORGWA2	Interact with others	.75	−.17	.14	.13
WRKn1	Liberal arts	.70	−.26	−.10	.21
ORWC2	Socially challenging contexts	.71	−.46	.18	.04
WRKn3	Bio-medicine	.62	−.19	.14	−.49
People versus things					
WCIn2	People versus things	.59	−.61	.06	.00
WRCFS2	Physical system skills	.09	.88	.15	.12
WRKn2	Engineering	.26	.86	.10	.23
ORGWA3	Work with things	−.16	.81	.27	.05
Physical demands					
WCAb1	Physical ability	.00	.22	.80	−.14
ORWC1	Physically challenging contexts	−.04	.32	.75	−.14
Bureaucracy					
WCIn3	Bureaucracy	.09	.27	−.17	.67

which is a rating from 1 to 5 for each occupation of the amount of education and experience required to enter it. This makes 17 variables (see Table 2). In this analysis there are only three factors with eigenvalues greater than one. We choose, however, to present a four-factor solution because even though the eigenvalue of the fourth factor is only .86, it explains 6% of the common variance. The first three factors explain 91% of the common variance; adding the fourth factor brings the total to 98%. The first factor is lead by BASIC SKILLS, ORGANIZATION SKILLS, SELF-REALIZATION, COGNITIVE ABILITIES, and work activities dealing with information and decision making (ANALYZE AND DECIDE). The second factor has three items: PHYSICAL SYSTEMS SKILLS, knowledge of engineering and construction (ENGINEERING), and working activities with things (WORK WITH THINGS). Two items, SOCIALLY CHALLENGING CONTEXTS and work with PEOPLE VERSUS THINGS have moderate loadings on this factor but also have moderate loadings on the first factor. The correlation between the first two factors is −.26. Factor

three is PHYSICAL ABILITIES and PHYSICALLY CHALLENGING CONTEXTS. This factor correlates −.29 with the first factor and .14 with the second. The fourth factor has only a single element, BUREAUCRACY, the third factor from interests and values, which deals with working in a supportive administrative hierarchy on work oriented to policies and rules. It correlates .23, −.21, and .08 with factors one to three, respectively.

Further insight into the factors may be found in considering the occupations that are most extreme on these dimensions. The first factor contrasts executives and managers against refuse collectors, tire builders, hand pressers, and certain machine operators. The second factor contrasts nuclear and aerospace engineers, aircraft engine specialists and machinists with clergy, business agents, bailiffs, receptionists, and waitresses. The third contrasts firemen and structural steel workers with mathematicians, statisticians, and actuaries. The last factor contrasts engineering, sales and several kinds of financial managers with sculptors, oral surgeons, and dentists.

*3.3. Analysis of all O*NET variables*

The final analysis included all 227 variables derived from the O*NET. An extract of the results is presented in Table 3. The solution presented has four factors that explained, before rotation, 37, 13, 8, and 4% of the common variance, respectively, for a total of 62%. There were a total of 23 factors with eigenvalues greater than one, but we choose to present a four-factor solution based on the scree plot and the interpretability of the factors. The first factor is dominated by variables measuring reasoning ability, thinking skills, learning, and information processing work activities. This factor contrasts chemical, nuclear, and aerospace engineers, and private sector executives with refuse collectors, stevedores, pile-driver operators, and housekeeping cleaners. The second factor contrasts interpersonal work contexts and activities and social skills with work contexts and skills with electrical or mechanical equipment. This factor contrasts government service executives, post-secondary education administrators, clergy, and marketing managers against production workers like machinists. These first two factors correlate .38 with each other. The third factor represents the physical demands of work and has negative correlations, −.16 and −.25, respectively, with the first and second factors. Jobs at the extremes of this factor are mathematicians, insurance underwriters, and cost estimators at the low end and fire fighters, highway patrol pilots, and athletes at the high end. The fourth factor is dominated by values and interest variables that contrast work embedded in a supportive administrative structure and guided by policies and practices with artistic interests. Airline pilots, bookkeepers, and air traffic controllers are high on this factor while sculptors, dancers, oral surgeons, and chiropractors are low. This factor is nearly independent of the others; the correlations are .11, .04, and .01 with factors 1–3, respectively.

The correlations of factor scores on the four factors from the second-order factor analysis with the four factors of the last analysis of all the variables are .97, −.92, .96, and .84, respectively.

Table 3
Factor analysis of all O*NET 4.0 variables, explained variance (62.4% total), and variables with highest loadings for a four-factor solution

Factor and items	Domain	Loading
Substantive complexity (36.6%)		
Deductive reasoning	WCAb	.93
Updating and using relevant knowledge	ORGWA	.92
Inductive reasoning	WCAb	.89
Complex problem solving	WRCFS	.89
Active learning	WRBS	.88
Making decisions and solving problems	ORGWA	.88
Ability utilization	WCIn	.88
Critical thinking	WRBS	.87
Getting information	ORGWA	.87
Importance of repeating same tasks	ORWC	−.41
People versus things (13.2%)		
Social interest	WCIn	.80
Contact with others	ORWC	.78
Deal with unpleasant or angry people	ORWC	.78
Performing for or working directly with the public	ORGWA	.74
Deal with external customers	ORWC	.74
Installation	WRCFS	−.63
Operation monitoring	WRCFS	−.64
Troubleshooting	WRCFS	−.64
Spend time using your hands to handle, control, or feel objects	ORWC	−.68
Realistic	WCIn	−.69
Physical demands (8.3%)		
Peripheral vision	WCAb	.85
Spatial orientation	WCAb	.81
Response orientation	WCAb	.78
Gross body equilibrium	WCAb	.77
Far vision	WCAb	.77
Reaction time	WCAb	.76
Stamina	WCAb	.76
Speed of limb movement	WCAb	.75
Spend time sitting	ORWC	−.43
Indoors, environmentally controlled	ORWC	−.56
Bureaucracy (4.3%)		
Supervision, human relations	WCIn	.65
Conventional interest	WCIn	.61
Company policies and practices	WCIn	.57
Perceptual speed	WCAb	.43
Artistic interest	WCIn	−.50

4. Discussion

Factor analysis of the data in the O*NET reveals that despite the complex conceptual structure of the O*NET the variance structure of the data displays much lower dimensionality than suggested by the number of concepts and variables in the system.

Separate analyses within domains of conceptual categories sometimes group the variables into factors similar to the concepts of the conceptual model, but often mix and match variables from different conceptual domains into overarching structures. Factor analyses of the variables scored from the factors of the conceptual domains and of all the variables taken at once both produce similar models with four important factors—cognitive abilities and work activities involving analysis and decision making, interpersonal skills and social work settings contrasted with skills and work settings involving physical systems, physical demands and physically challenging work settings, and individual, creative work contrasted with work embedded in organizations and oriented to systems of rules. As discussed below, the first three of these factors are similar to factors identified by previous analysts working with data from the various editions of the DOT. To emphasize this continuity we label these factors as early analysts have labeled them—SUBSTANTIVE COMPLEXITY, PEOPLE VERSUS THINGS, and PHYSICAL DEMANDS. The fourth factor we label BUREAUCRACY.

Because the O*NET is intended to be a replacement for the DOT (Mariani, 1999) it is reasonable to compare our results with the previous analyses of the DOT. Broadly the comparison supports the approach taken by previous analysts in that the basic factor structure we found in the O*NET is similar to what has been reported for the DOT. However, the results also justify the efforts of the team producing the O*NET; the O*NET provides more detail and thus greater confidence and understanding. Even if one wishes to measure the old concepts the O*NET has better quality data than the DOT and with more variables the concepts should be measured with greater validity and reliability, thus improving the power of any analysis.

The first factor identified in these analyses is similar in content to the first factor in previous analyses of the DOT. Parcel and Mueller (1983) called this factor COMPLEXITY OF WORK. Others have followed Cain and Treiman (1981) in calling this factor SUBSTANTIVE COMPLEXITY after a concept developed by Kohn (1969). Kilbourne et al. (1994) called it COGNITIVE SKILL. The specific items in the O*NET, of course, are different than those in the DOT, but the factors are clearly the same. Whereas in Cain and Treiman's (1981, Table 8) analyses the items with the highest loading on this factor were "general educational development," "specific vocational preparation," "intelligence," and "complexity of functioning with data," the items in Table 3 that load highly on this factor measure cognitive abilities (deductive and inductive reasoning), generalized work activities updating and using knowledge and active learning, and the cross-functional skill complex problem solving. The ability items in the latter must be conceptually similar to the intelligence item in the former, but the other items are different. The item in the O*NET that most closely corresponds to the education and vocational preparation items in the DOT is Job Zone; it has a high loading on the first factor, .78, but not high enough that there is room to list it in Table 3. There are also several items in the O*NET that are comparable to the DOT item on functioning with data and these also load on the first factor; one of these, for instance, is work activity analyzing data or information and has a loading of .87.

The second factor in our analysis we label PEOPLE VERSUS THINGS. Parcel and Mueller (1983) also found a factor they labeled PEOPLE VERSUS THINGS in their

analysis of version 3 of the DOT. The DOT, however, had relatively few items that loaded on this factor; the items with the highest unambiguous loadings were involvement with things, dealing with people, and talking/hearing as a physical demand. The O*NET has many more items and both the people and the thing ends of this continuum are well defined. Other analysts have found somewhat different second factors. Kilbourne et al. (1994) first linked DOT data to survey data and did separate analyses for men and women. In their analysis of women they found a factor comparable to Parcel and Mueller's, except that the people end of it was more clearly defined and they called it NURTURANT SOCIAL SKILL. When Cain and Treiman (1981) did their analysis the fourth and fifth factors that they found had elements in common with this PEOPLE VERSUS THINGS dimension; they named their factors MANAGEMENT and INTERPERSONAL SKILLS. Shu et al. (1996) tried a model making a similar distinction, having factors for LEADERSHIP and SOCIAL SKILLS, but found that these two were so highly correlated as to be a single SOCIAL SKILLS factor.

The content of our third factor, which we have named PHYSICAL DEMANDS, is comparable to content which other analysts have identified but divided into three or four factors. Our factor includes items that measure perceptual ability, fine and gross motor skills, strength, activity on the job, and environmental exposure. Our analyses of the subdomains of the O*NET concept model showed that a model with separate factors for gross motor skills and capacity, fine motor skills, and perceptual ability was an alternative to the model with a single PHYSICAL ABILITIES factor. The items in the DOT that describe physical demands and exposures are much more superficial and are coded in less detail, most of them in binary yes/no categories, than the items in the O*NET. In naming the three or four factors that they have identified other analysts have emphasized physical demands, motor skills, undesirable working conditions, and perceptual requirements, but the precise meaning and content of these factors varies with the data and method of analysis used.

The final factor in our analysis, BUREAUCRACY, is new; no comparable factor has emerged from analyses of the DOT. The five items in Table 3 are the only items to load highly and unambiguously on this factor. This factor reflects the new content of the O*NET. Items like these were introduced to try to make the O*NET reflect more accurately the conditions in changing work places and labor markets (APDOT, 1993; Committee on Techniques for the Enhancement of Human Performance, 1999). This factor appears to be related to a concept that Kohn et al. measured in their studies of relationships between work and personality, which they also called bureaucracy, but their measures of this concept were organizational size and number of formal levels of supervision (Kohn, 1971; Kohn and Schooler, 1982). Kohn found that the effects of bureaucracy were attributable to the presence of jobs with greater job protection and substantive complexity and higher pay in bureaucracies. Substantive complexity is our first factor; this factor, however, is related to the job protections—contractual tenure protection, formal grievance procedures, and sick pay—that Kohn considered (Kohn, 1971).

Our analyses of the underlying structure of the O*NET measures of the US workplace reveal that the new database expands and builds upon previous descriptions of work environments in applied sociology and social psychology. Our results confirm

the continuity of factors SUBSTANTIVE COMPLEXITY and PHYSICAL DEMANDS. But our factors PEOPLE VERSUS THINGS and BUREAUCRACY highlight the increasing relevance of interpersonal relations and organizational culture and structure (bureaucratic, flexible) as one may have expected in a post-industrial service economy (DOL, 1994; Mishel et al., 2001). The O*NET is still incomplete; there are still no data for some elements of the content model, particularly in occupation specific requirements and work, and organizational contexts. When these data are available, and when analyst ratings are replaced by incumbent ratings, it may be necessary to reevaluate this factor structure. Although the sampling of incumbents in the new survey will make the O*NET data far more representative than the old DOT data, there are still questions of the representation of the self-employed and employees with temporary work contracts (Committee on Techniques for the Enhancement of Human Performance, 1999).

These scales may be used in several applied fields such as sociology of health and illness, stress psychology, public health, and social epidemiology that usually rely on self-reports of stress by workers or a restricted number of broad occupational groups to capture the health effects of working conditions. As the new SOC is adopted for classifying occupation of survey respondents linking the O*NET data to survey data will become easier. In the meantime it is necessary to develop crosswalks to translate among occupational coding systems. Existing crosswalks have been collected by the National Crosswalk Service Center (NCSC, 2003). These crosswalks, however, generally create many-to-many relationships in matching older classification systems with the new SOC and the O*NET. Nevertheless, the O*NET scales potentially may be used to explain the proximal socio-psychological determinants of health associated with structural characteristics of the US workforce such as race/ethnicity, social class, immigration status, and gender.

References

Amick, B.C., Lavis, J.N., 1999. Labor markets and health. In: Tarlov, A.R., St Peter, R.F. (Eds.), Society and Population Health Reader: volume II. The New Press, New York.

APDOT (Advisory Panel for the Dictionary of Occupational Titles). 1993. "The New DOT: A Database of Occupational Titles for the Twenty-First Century (Final Report)." US Department of Labor, US Employment Service, Employment and Training Administration, Washington, DC.

BLS (Bureau of Labor Statistics), 1993. "Proceedings of the International Occupations Classification Conference." US Department of Labor, Washington, DC.

BLS, 1999. "Revising the Standard Occupational Classification System." US Department of Labor, Washington, DC.

BLS, 2001. "Standard Occupational Classification (SOC) System", Bureau of Labor Statistics accessed on March 18, 2002 at http://www.bls.gov/soc/home.htm.

BLS, 2002. "Appendix D: the development of the Occupational Information (O*NET) Analyst Database," Bureau of Labor Statistics accessed on February 7, 2003 at http://www.onetcenter.org/dl_files/appendix_d.pdf.

Boese, R., Lewis, P., Frugoli, P., Litwin, K., 2001. "Summary of O*NET. 4.0 Content Model and Database." National Center for O*NET Development, Raleigh, NC.

Cain, P.S., Treiman, D.J., 1981. The dictionary of occupational titles as a source of occupational data. Am. Sociol. Rev. 46, 253–278.

Committee on Techniques for the Enhancement of Human Performance, 1999. The Changing Nature of Work: Implications for Occupational Analysis, Edited by Commission on Behavioral and Social Sciences and Education and N.R. Council. National Academy Press, Washington, DC.

Dawis, R.V., Lofquist, L.L.H., 1984. A Psychological Theory of Work Adjustment. University of Minnesota Press, Minneapolis, MN.

DOL (Department of Labor), 1994. Report on the American Workforce. US Government Printing Office, Washington, DC.

Eaton, W.W., Muntaner, C., Bovasso, G., Smith, C., 2001. Socioeconomic status and depressive syndrome: the role of inter- and intra-generational mobility, government assistance, and work environment. J. Health Social Behav. 42, 277–294.

England, P., Kilbourne, B., 1988. Occupational Measures from the Dictionary of Occupational Titles for 1980 Census Detailed Occupations. Inter-university Consortium for Political and Social Research, Ann Arbor, MI.

ETA (Employment and Training Administration) 2002. "O*NET data collection program: Office of Management and Budget clearance package supporting statement and data collection instruments," US Department of Labor, Employment and Training Administration accessed on February 7, 2003 at http://www.onetcenter.org/dl_files/PDF/Supporting_Statement.pdf.

Fleishman, E.A., Costanza, D.P., Marshall-Mies, J., 1999. Abilities. In: Peterson, N.G., Mumford, M.D., Borman, W.C., Jeanneret, P.R., Fleishman, E.A. (Eds.), An Occupational Information System for the 21st Century: The Development of O*NET. American Psychological Association, Washington, DC, pp. 175–195.

Gottefredson, G.D., Holland, J.L., 1996. Dictionary of Holland Occupational Codes. Psychological Assessment Resources, Odessa, FL.

Hatcher, L., 1994. A Step-by-Step Approach to Using the SAS System for Factor Analysis and Structural Equality Modeling. SAS Institute, Cary, NC.

Karasek, R., Theorell, T., 1990. Healthy Work: Stress, Productivity, and the Reconstruction of Working Life. Basic Books, New York.

Kilbourne, B.S., England, P., Beron, K., 1994. Effects of individual, occupational, and industrial characteristics on earnings: intersections of race and gender. Soc. Forces 72, 1149–1176.

Kilbourne, B.S., England, P., Farkas, G., Beron, K., Weir, D., 1994. Returns to skill, compensating differentials, and gender bias: effects of occupational characteristics on the wages of white men and women. AJS 100, 689–719.

Kohn, M.L., 1969. Class and Conformity: A Study in Values. Dorsey Press, Homewood, IL.

Kohn, M.L., 1971. Bureaucratic man: a portrait and an interpretation. Am. Sociol. Rev. 38, 461–474.

Kohn, M.L., Schooler, C., 1982. Job conditions and personality: a longitudinal assessment of their reciprocal effects. AJS 87, 1257–1286.

Kohn, M.L., Schooler, C., 1983. Work and Personality: an inquiry into the impact of social stratification. Ablex Pub. Corp, Norwood, NJ.

Levine, C., Salmon, L., Weinberg, D.H., 1999. Revising the standard occupational classification system. Mon. Labor Rev., 36–45.

Levine, J., Nottingham, J., Paige, B., Lewis, P., 2000. Transitioning O*NET to the Standard Occupational Classification. National Center for O*NET Development, Raleigh, NC.

Mariani, M., 1999. Replace with a database: O*NET replaces the dictionary of occupational titles. Occup. Outlook Quarterly, 3–9.

Miller, A.R., Treiman, D.J., Cain, P.S., Roos, P.A., 1980. In: N.R.C. Committee on Occupational Classification and Analysis (Ed.), Work, Jobs, and Occupations: A Critical Review of the Dictionary of Occupational Titles. National Academy Press, Washington, DC.

Mishel, L., Bernstein, J., Schmitt, J., 2001. The State of Working America 2000/2001. Cornell University Press, Ithaca, NY.

Mumford, M.D., Peterson, N.G., 1999. The O*NET content model: structural considerations in describing jobs. In: Peterson, N.G., Mumford, M.D., Borman, W.C., Jeanneret, P.R., Fleishman, E.A. (Eds.), An Occupational Information System for the 21st Century: The Development of O*NET. American Psychological Association, Washington, DC, pp. 21–30.

Muntaner, C., Eaton, W.W., Garrison, R., 1993. Dimensions of the psychosocial work-environment in a sample of the United States metropolitan population. Work Stress 7, 351–363.

NCSC (National Crosswalk Service Center), 2003. "Home page" accessed on February 7, 2003 at http://www.xwalkcenter.org/index.html.

O*NET Resource Center, 2002. "O*NET Database," National O*NET Consortium accessed on February 7, 2003 at http://www.onetcenter.org/database.html.

Office of Federal Statistical Policy and Standards, 1980. Standard Occupational Classification Manual. US Department of Commerce, Washington, DC. Office of Federal Statistical Policy and Standards: Supt. of Docs. US G.P.O. Distributor.

Oldham, G.R., Gordon, B.I., 1999. Job complexity and employee substance use: the moderating effects of cognitive ability. J. Health Social Behav. 40, 290–306.

OMB (Office of Management and Budget), 1997. "1997 Standard occupational classification revision." Federal Register 62, 36338–36409.

Parcel, T.L., 1989. Comparable worth, occupational labor markets, and occupational earnings: results from the1980 Census. In: Michael, R.T., Hartmann, H.I., O'Farrell, B. (Eds.), Pay Equity: Empirical Inquiries. National Research Council (US) Committee on Women's Employment and Related Social Issues. Panel on Pay Equity Research. National Academy Press, Washington, DC.

Parcel, T.L., Menaghan, E.G., 1994a. Early parental work, family social capital, and early childhood outcomes. AJS 99, 972–1009.

Parcel, T.L., Menaghan, E.G., 1994b. Parents' Jobs and Children's Lives. Aldine de Gruyter, New York.

Parcel, T.L., Mueller, C.W., 1983. Ascription and Labor Markets: Race and Sex Differences in Earnings. Academic Press, New York.

Peterson, N.G., Mumford, M.D., Borman, W.C., Jeanneret, P.R., Fleishman, E.A., Levin, K.Y., Campion, M.A., Mayfield, M.S., Morgeson, F.P., Pearlman, K., Gowing, M.K., Lancaster, A.R., Silver, M.B., Dye, D.M., 2001. Understanding work using the occupational information network (O*NET): implications for practice and research. Personnel Psychol. 54, 451–492.

Roos, P.A., Treiman, D.J., 1980. DOT scales for the 1970 Census classification. In: Miller, A.R., Treiman, D.J., Cain, P.S., Roos, P.A. (Eds.), Work, Jobs, and Occupations: A Critical Review of the Dictionary of Occupational Titles (pp. Appendix F 336-89). N.R.C. Committee on Occupational Classification and Analysis. National Academy Press, Washington, DC.

SAS, 2000. SAS OnlineDoc, Version 8. SAS Institute Inc, Cary, NC.

Schwartz, J.E., Pieper, C.F., Karasek, R.A., 1988. A procedure for linking psychosocial job characteristics data to health surveys. Am. J. Public Health 78, 904–909.

Shu, X., Fan, P.-L., Li, X., Marini, M.M., 1996. Characterizing occupations with data from the dictionary of occupational titles. Soc. Sci. Res. 25, 49–73.

Spenner, K.I., 1980. Occupational characteristics and classification systems: new uses of the dictionary of occupational titles. Sociol. Methods Res. 9, 239–264.

Spenner, K.I., 1990. Skill: meanings, methods, and measures. Work Occupations 17, 399–421.

Szafran, R.F., 1996. The effect of occupational growth on labor force task characteristics. Work Occupations 23, 54–86.

USES (United States Employment Service), 1991. In: US Department of Labor and Employment and Training Administration (Ed.), Dictionary of Occupational Titles. Government Printing Office, Washington, DC.