Statistical Analyses of the Japanese Version of the PGI-Occupations Scale: Proposal of an Alternative Model of Occupational Interest

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Abstract
The purpose of this research is to propose a new model of vocational interest through a series of statistical analyses of Personal Globe Inventory (PGI) Occupational Title scales. Data obtained from Japanese university students (N=1,509) was analyzed from the viewpoints of; 1) Factorial structure of scales, 2) Reliabilities of scales, 3) Spatial configuration of items and scales, and 4) Differential item functioning (DIF) between the genders (male and female). Based on the results, the author proposes a new model of occupational interest, named as the Dual-layer Cylinder Model.

Keyword

Personal Globe Inventory (PGI)	Occupational Interest Model	Validity and Reliability
Differential Item Functioning	Dual-layer Cylinder Model	

Introduction

The Japanese version of PGI was originally derived from the Japanese version of the Inventory of Occupational Preference (IOP), which consisted of various occupational titles for which respondents endorsed their preferences. The structural validity of IOP and the reliabilities of IOP's subscales are already examined with Japanese samples. For instance, Tracey, Watanabe, and Schneider (1997) found support for the octant and the spherical models on a sample of Japanese college students using IOP. They also found that the octant model fit the Japanese sample better than did the RIASEC (Realistic, Investigative, Artistic, Social, Enterprising, Conventional) model. The PGI is an improved and condensed version of the IOP; however, it is not known if these aforementioned results will hold, given the changes to the PGI.

The PGI globe model, which was conceptualized by Tracey (2002), is a more general representation of the structure of interests than the RIASEC model. It includes not only the RIASEC types but also other types and an added dimension. The PGI globe model comprises three dimensions and l8 interest types, which are equally spaced around a sphere. Whereas the RIASEC circular model consists of the circular ordering of six types in two dimensions, often called people/ things and data/ideas (Prediger, 1982; Prediger & Vansickle, 1992), the PGI globe model has three dimensions— the same two dimensions as the RIASEC model and the added dimension of prestige.

Tracey and Rounds (1995) demonstrated that the RIASEC type model is an arbitrary representation of interests in people/things and data/ideas space and that interest types can be validly formed by any equal slicing of the circle. Putting the octant model and the third dimension together, Tracey and Rounds (1996) created scales to represent 18 points equally placed around the sphere and presented their model as a globe. This spherical model was reconceptualized and refined in the PGI (Tracey, 2002). According to the model, eight basic interest types instead of the six RIASEC interest types are on the equator of the globe: Social Facilitating, Managing, Business Detail, Data Processing, Mechanical, Nature/Outdoors, Artistic, and Helping. The PGI globe also has five higher prestige interest types on the top hemisphere —Social Sciences, Influence, Business Systems, Financial Analysis, and Science —and five lower prestige interest types on the bottom hemisphere: Quality Control, Manual Work, Personal Service, Construction/Repair, and Basic Services.

Long, Watanabe, and Tracey (2006) tried to examine the structural validity of the Japanese version of the PGI Occupational Title scales by using 2,492 Japanese college student data. As a result, support was provided

for the RIASEC, octant, and spherical structure. Following the results, this study focused on further examination of the validity of the PGI globe model and the reliability of the scales from the viewpoint of differential item functioning (DIF).

Method

Respondents and Procedure

Respondents consist of 1,509 undergraduate students from a large sized private Japanese university (987 men, 514 women, 8 who did not specify gender) in-Tokyo metropolitan area. A questionnaire including the Japanese version of PGI-Occupations scales was distributed to the respondents two times. The first survey was conducted in the fall semester of the year of 2000 for mainly junior students. The second survey was administered to mainly sophomore students in the Spring semester of the year of 2001. These questionnaires were distributed and retrieved by the student affairs personnel in cooperation with the student counseling center at the university. Only those questionnaires with complete data were included in each analysis. For this reason, there were differing sample sizes for each analysis.

Measure

The Japanese version of PGI-Occupational, which was originally derived from the Japanese version of IOP, is an instrument used to examine the validity of the interest spherical mode. It consists of 108 occupational titles and most of the items of PGI overlap with those of IOP.

The PGI (Tracey, 2002) is an instrument used to evaluate the interest spherical model in which there are (a) eight basic medium prestige interest types (Social Facilitating, Managing, Business Detail, Data Processing, Mechanical, Nature/Outdoors, Artistic, and Helping), (b) five higher prestige interest types (Social Sciences, Influence, Business Systems, Financial Analysis, and Science), and (c) five lower prestige interest types (Quality Control, Manual Work, Personal Service, Construction/Repair, and Basic Services). In addition, Holland's (1997) RIASEC types (i.e., Realistic, Investigative, Artistic, Social, Enterprising, and Conventional), Prediger's (1982) four types (i.e., People, Things, Data, and Ideas), and the three dimensional scores of People/Things, Data/Ideas, and Prestige are also scored from the weighted sums of the other scales. There are, thus, 31 scales to score in the PGI.

The occupational titles of the PGI were first translated into Japanese. When some of the occupational titles could not be directly translated, similar but slightly different occupational titles were substituted. Then, the Japanese occupational titles were back-translated into English by bilingual individuals, and the back-translated version of occupational titles was compared with the original English version for the equivalence. Roughly 20% of the items were not perfectly translated, and these items were discussed among three individuals fluent in each language and familiar with each culture until consensus was reached on the more accurate wording for these items.

The respondents were asked to rate the extent to which they like each occupation using a Likert type 7-point scale (1 = very strongly dislike, 7 = very strongly like).

Results

Examination of Factorial Validity

As described above, PGI includes three kinds of interest areas: basic, higher prestige, and lower prestige. The basic interest area includes eight interest dimensions and it is hypothesized that these eight interest dimensions should be arranged as octagonal circumplex configuration, just as Holland’s RIASEC hexagonal circumplex model. Regarding the higher and lower prestige areas, there are five interest dimensions each and it is assumed that these five dimensions should be arranged as hemispherical configuration. Namely, one interest dimension is placed in the Arctic or the Antarctic and the other four dimensions are arranged in latitude 45 degrees north or south in square position.

Firstly, in order to examine the factorial validity of the Japanese PGI-Occupational sale, exploratory factor analysis was conducted on the 108 full items. As the result, eight relatively clear and interpretable factors were elicited by principal axis factoring with orthogonal (varimax) and oblique (equamax) rotations. It became clear that these eight factors reflect the concepts of basic interest area, namely Social Facilitating, Managing, Business Detail, Data Processing, Mechanical, Nature/Outdoors, Artistic, and Helping.

Secondly, in order to examine the three theoretical hypotheses, factor analysis to the items included in each

interest area was separately conducted. As the procedure of factor analysis, principal axis factoring (PAF) with oblique rotation (equamax) was adopted. Concerning the basic area, eight factors were clearly elicited and the result of rotated factor matrix was sufficiently interpretable, although it was not exactly coincident with the previously hypothesized one. Regarding the higher prestige area, hypothesized five factors were obviously elicited and the rotated factor matrix was approximately coincident with the hypothesized factorial structure. In terms of the lower prestige area, five factors were elicited and the factorial structure of the items was interpretable.

Based on these results which were yielded from exploratory factor analyses, we could conclude that the Japanese version of PGI maintains the hypothesized factor structures as long as it is tested in each interest area separately.

Confirmation of Reliabilities and Fundamental Statistics

In order to examine the reliabilities of the basic eighteen scales, the degree of internal consistency of each scale was estimated by using Chronbach's coefficient alpha. As shown in Table 1, the mean of coefficient alpha was .81, with the range from .65 to .90, and all but 2 of the scales above .75.

Table 1 also shows means and standard deviations of the scales. Generally speaking, the scales maintain appropriate characteristics. Table 2-1 and Table 2-2 are the correlation matricies of the 18 scales.

Table 1. Mean, Standard Deviation, and Coefficient alpha of the PGI-Occupations Scales

Scale (abbreviation)	Mean	S.D.	alpha
1 Social Facilitating (sfacili)	20.61	5.94	0.655
2 Managing (managing)	20.64	6.52	0.779
3 Business Detail (bdetail)	23.41	7.27	0.838
4 Data Processing (datapro)	21.39	8.39	0.909
5 Mechanical (mechanic)	20.46	8.66	0.898
6 Nature/Outdoor (natout)	21.91	8.45	0.869
7 Artistic (artistic)	23.61	9.08	0.865
8 Helping (helping)	21.71	7.23	0.814
9 Social Science (sscience)	23.95	7.58	0.802
10 Influence (influen)	23.32	8.56	0.857
11 Business Systems (bsystem)	25.52	7.93	0.873
12Quality Control (qualcont)	17.52	6.86	0.823
13 Manual Work (manuwork)	15.69	6.13	0.772
14 Personal Service (persserv)	19.98	6.92	0.748
15 Financial Analysis (finaana)	23.09	7.43	0.851
16 Science (science)	21.89	7.77	0.844
17 Construction/Repair (conrep)	14.99	7.06	0.883
18 Basic Services (baseserv)	18.63	6.39	0.702

For detecting the relationships between 18 scales, zero-order correlation coefficient was calculated. Table 2-1 shows the correlation matrix between scales. Forty-six pairs out of a total 153 pairs, namely 30 percent of the pairs, the correlation coefficient was less than .02 ($r<.02$). Table 2-2 shows a close look at the correlations of eight basic medium prestige types. It shows the fact that the correlation coefficients in orthogonal elements are relatively low. This means that these fundamental relations provide a good justification for exploring the hypothesized circular circumplex model.

Table 2-1. Correlation Matrix of the PGI Eighteen Dimensions

	sfacili	managing	bdetail	datapro	mechanic	natout	artistic	helping	sscience	influen	bsystem	qualcont	manuwork	persserv	finaana	science	conrep	baseserv
sfacili	1																	
managing	0.741	1																
bdetail	0.365	0.554	1															
datapro	0.021	0.048	0.212	1														
mechanic	0.014	0.002	0.112	0.899	1													
natout	0.172	−0.003	−0.001	0.555	0.627	1												
artistic	0.252	0.039	−0.101	0.138	0.188	0.431	1											
helping	0.597	0.386	0.089	0.054	0.074	0.391	0.451	1										
sscience	0.411	0.289	0.181	0.215	0.239	0.451	0.414	0.681	1									
influen	0.045	−0.028	0.134	0.681	0.698	0.655	0.342	0.195	0.535	1								
bsystem	0.134	0.191	0.398	0.684	0.593	0.353	0.121	0.122	0.297	0.603	1							
qualcont	0.298	0.211	0.173	0.621	0.656	0.566	0.311	0.339	0.371	0.525	0.486	1						
manuwork	0.481	0.422	0.166	0.305	0.361	0.353	0.229	0.453	0.357	0.241	0.221	0.708	1					
persserv	0.653	0.575	0.234	0.063	0.112	0.204	0.282	0.498	0.381	0.105	0.165	0.418	0.664	1				
finaana	0.396	0.547	0.778	0.156	0.066	0.055	0.013	0.169	0.262	0.139	0.443	0.213	0.211	0.372	1			
science	0.174	0.071	0.154	0.541	0.576	0.741	0.401	0.351	0.553	0.788	0.462	0.557	0.353	0.222	0.228	1		
conrep	0.277	0.172	0.074	0.509	0.582	0.524	0.319	0.268	0.287	0.427	0.306	0.835	0.727	0.407	0.148	0.479	1	
baseserv	0.612	0.576	0.242	0.142	0.174	0.247	0.271	0.528	0.418	0.147	0.182	0.504	0.732	0.729	0.275	0.241	0.501	1

Note: N=1490, : r<.20

Table-2-2. Correlation Matrix of Eight Basic Dimensions

	sfacili	managing	bdetail	datapro	mechanic	natout	artistic	helping
sfacili	1							
managing	0.741	1						
bdetail	0.365	0.554	1					
datapro	0.021	0.048	0.212	1				
mechanic	0.014	0.002	0.112	0.899	1			
natout	0.172	−0.003	−0.001	0.555	0.627	1		
artistic	0.252	0.039	−0.101	0.138	0.188	0.431	1	
helping	0.597	0.386	0.089	0.054	0.074	0.391	0.451	1

Item Characteristics and Differential Item Functioning

Beyond the scale level analysis, item level analyses were conducted. It is widely known that there exist different response patterns to the PGI items between male and female subjects. This phenomenon can be explained by; 1) Occupational titles included in PGI are very simple so that they function as equivalent stimulus to males and females. It is natural that the difference between males simply reflect their interest in the item itself, and 2) Occupational titles included in PGI have different meanings for males and females so that items do not function as equivalent stimulus to males and females. It is reasonable that we suppose there exists differential item functioning (DIF) in the item itself.

Firstly, simple comparisons of the mean of each item were made using t-test procedure. As the results, 26 items out of the total 108 items had no significant difference between the male and female samples. This means items included in the PGI have characteristics heavily reflecting both of the sexes/gender's unique and latent occupational interest. Through the scale level t-test, it became clear that a total 18 scales could be categorized into male preferred, female preferred, and neutral ones. Namely, 8 scales are 'male', 8 scales are 'female', and 2 scales are 'neutral'.

Secondly, differential item functioning (DIF) analyses were conducted to detect the 'item bias' by utilizing Item Response Theory (IRT). This DIF analysis was conducted for each separate scale using BILOG-MG program, which adopts marginal maximal likelihood estimation for estimating the item parameters. After confirming the unidimensionality of each scale based on Rekase's criteria, item parameters, difficulty (b) and discrimination (a), were estimated under the condition of 2 parameter logistic (2PL) model. As shown in Table 3, DIF was found in 22 out of 108 items under the criteria suggested by Thissen, Steinberg, and Wainer (1993), namely the threshold difference (difficulty parameter's difference after equating discrimination parameter) is less than 0.30.

If we adopt less strict criteria for DIF detection, for example, the threshold difference is less than 0.4, by

considering that the PGI is not an ability test but an attitude test, whose response pattern tends to be more fluctuating than ability test, only one item out of 48 basic interest area has DIF. Under the same criteria, 9 out of 60 items from prestige area have significant DIF.

Table 3. Results of Differential Item Functioning (DIF) Detection

Scale (abbreviation)	Item #	Male endorsement proportion	Female endorsement proportion	DIF index: threshold difference
1 Social Facilitating	1	0.44	0.46	0.31
	9	0.55	0.56	0.5
	17	0.63	0.77	-0.14
	25	0.39	0.59	-0.2
	33	0.48	0.68	-0.14
	41	0.24	0.43	-0.32
(-2loglikelihood)				7511.69
2 Managing (managing)	2	0.3	0.43	-0.35
	10	0.63	0.65	0.29
	18	0.51	0.67	-0.17
	26	0.33	0.43	-0.02
	34	0.45	0.53	0.12
	42	0.62	0.69	0.14
(-2loglikelihood)				7148.71
3 Business Detail (bdetail)	3	0.72	0.61	0.36
	11	0.63	0.6	0
	19	0.67	0.65	-0.06
	27	0.39	0.4	-0.17
	35	0.74	0.69	0.04
	43	0.57	0.58	-0.18
(-2loglikelihood)				6767.83
4 Data Processing (datapro)	4	0.46	0.28	0.38
	12	0.73	0.54	-0.13
	20	0.71	0.54	-0.16
	28	0.54	0.33	-0.02
	36	0.61	0.39	-0.01
	44	0.44	0.28	-0.05
(-2loglikelihood)				5714.23
5 Mechanical (mechanic)	5	0.51	0.36	-0.03
	13	0.49	0.24	0.34
	21	0.71	0.53	-0.07
	29	0.54	0.37	-0.1
	37	0.51	0.37	-0.15
	45	0.51	0.33	0.02
(-2loglikelihood)				6276.21
6 Nature/Outdoor (natout)	6	0.55	0.48	0.15
	14	0.48	0.45	0
	22	0.63	0.53	0.25
	30	0.57	0.56	-0.03
	38	0.57	0.56	-0.03
	46	0.53	0.59	-0.34
(-2loglikelihood)				6673.38
7 Artistic (artistic)	7	0.49	0.53	-0.08
	15	0.66	0.68	0.02
	23	0.66	0.64	0.12

Table3 (continued).

Scale (abbreviation)	Item #	Male endorsement proportion	Female endorsement proportion	DIF index: threshold difference
	31	0.49	0.47	0.07
	39	0.62	0.67	-0.05
	47	0.62	0.68	-0.08
(-2loglikelihood)				6404.01
8 Helping (helping)	8	0.48	0.65	0.1
	16	0.46	0.68	-0.23
	24	0.55	0.65	0.24
	32	0.43	0.62	-0.03
	40	0.31	0.5	-0.16
	48	0.64	0.79	0.09
(-2loglikelihood)				7124.95
9 Social Science (sscience)	49	0.69	0.82	-0.02
	59	0.6	0.76	-0.17
	69	0.55	0.71	-0.25
	79	0.67	0.7	0.26
	89	0.54	0.59	0.16
	99	0.51	0.61	0.02
(-2loglikelihood)				6711.91
10 Influence (influen)	50	0.67	0.49	0.24
	60	0.69	0.54	0.15
	70	0.6	0.62	-0.35
	80	0.68	0.64	-0.14
	90	0.54	0.35	0.25
	100	0.6	0.56	-0.14
(-2loglikelihood)				6407.85
11 Business Systems (bsystem)	51	0.78	0.58	0.2
	61	0.73	0.62	-0.05
	71	0.78	0.73	-0.04
	81	0.68	0.56	0.04
	91	0.64	0.54	-0.09
	101	0.68	0.57	-0.06
(-2loglikelihood)				5778.5
12Quality Control (qualcont)	52	0.35	0.33	-0.16
	62	0.43	0.34	0.01
	72	0.59	0.48	0.1
	82	0.27	0.15	0.27
	92	0.39	0.37	-0.2
	102	0.38	0.32	-0.03
(-2loglikelihood)				6629.97
13 Manual Work (manuwork)	53	0.28	0.36	-0.16
	63	0.22	0.19	0.26
	73	0.2	0.18	0.2
	83	0.32	0.4	-0.12
	93	0.41	0.61	-0.77
	103	0.28	0.17	0.59
(-2loglikelihood)				6249.94
14 Personal Service (persserv)	54	0.39	0.7	-0.8
	64	0.39	0.56	0.03
	74	0.28	0.42	-0.39

Table3 (continued).

Scale (abbreviation)	Item #	Male endorsement proportion	Female endorsement proportion	DIF index: threshold difference
	84	0.56	0.58	0.29
	94	0.4	0.61	-0.08
	104	0.53	0.46	0.96
(-2loglikelihood)				7241.08
15 Finamcial Analysis (finaana)	55	0.74	0.67	0.14
	65	0.7	0.65	0.02
	75	0.56	0.55	-0.07
	85	0.59	0.52	0.06
	95	0.47	0.54	-0.39
	105	0.62	0.52	0.23
(-2loglikelihood)				6634.5
16 Science (science)	56	0.67	0.63	0.07
	66	0.56	0.52	0
	76	0.51	0.61	-0.46
	86	0.67	0.64	0.04
	96	0.47	0.41	0
	106	0.54	0.38	0.34
(-2loglikelihood)				6658.63
17 Construction/Repair (conrep)	57	0.26	0.16	0.1
	67	0.28	0.16	0.14
	77	0.35	0.35	-0.27
	87	0.28	0.18	0.14
	97	0.27	0.24	-0.14
	107	0.32	0.24	0.02
(-2loglikelihood)				5509.01
18 Basic Services (baseserv)	58	0.18	0.48	-0.55
	68	0.35	0.42	0.33
	78	0.49	0.69	-0.69
	88	0.35	0.43	0.22
	98	0.38	0.26	1.45
	108	0.49	0.78	-0.77
(-2loglikelihood)				7148.03

Note: Item with DIF index >|0.30| is highlighted.

These results suggest; 1) PGI's individual item, particularly, belonging to basic interest area has almost no DIF as long as we deal with each scale independently. and 2) When we compare the response of males and females to each scale, it is more appropriate to use individuals' estimated latent trait value (theta) rather than the simple summation of the item scores. That is why each item has various degrees of difficulty.

Validities of Circular and Hemispherical Models

In order to examine the hypothesized circular and hemispherical models, a series of multidimensional scaling procedures were conducted. The geometrical configuration was explored both at item level and scale level. Regarding item level of analyses, as shown in Figure 1, circular configuration was generally observed in two dimensional space. On the other hand, hemispherical configuration was not observed (Figure 2).

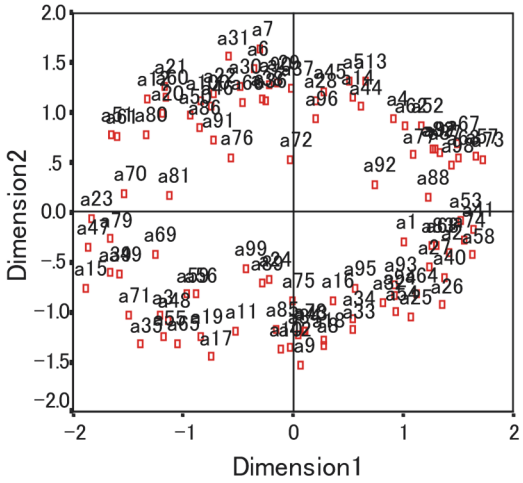


Figure 1. Item Level Configuration of Two Dimensional Space

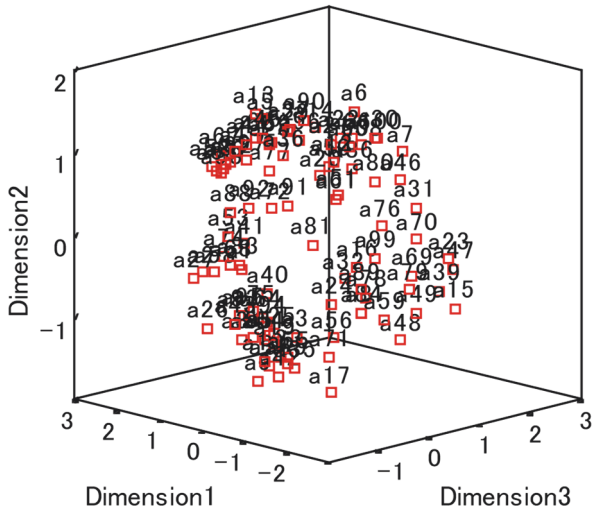


Figure 2. Item Level Configuration of Three Dimensional Space

As to the scale level of analysis, a relatively clear octagonal circumplex configuration was observed in basic area of interest (Figure 3). On the other hand, the hypothesized hemispherical configuration was not observed (Figure 4).

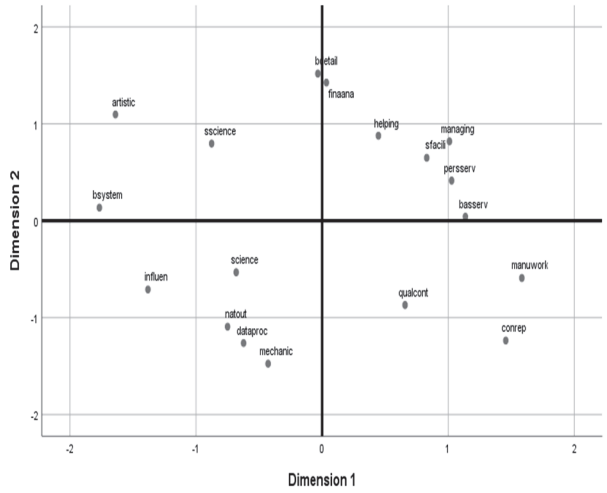


Figure 3. Scale Level Configuration of Two Dimensional Space

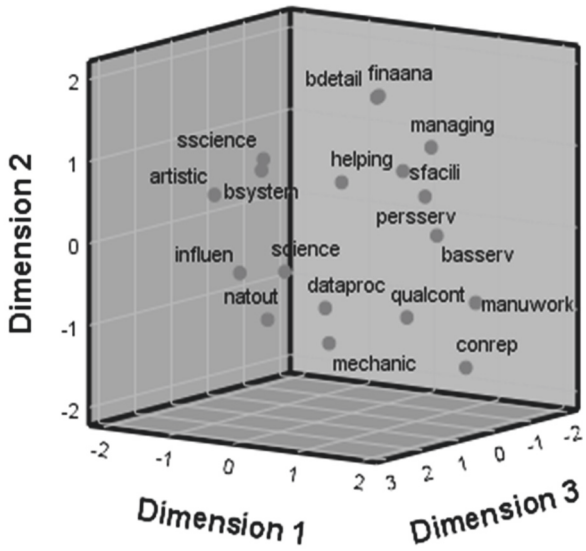


Figure 4. Scale Level Configuration of Three Dimensional Space

As to the prestige area level of analysis, a relatively clear circular circumplex configuration was observed in each area, particularly basic area of interest (Figure 5-1). Hypothesized hemispherical configuration was not observed in higher and lower prestige area (Figure 5-2, Figure 5-3). Although the prestige area scales were plotted in circular order, Influence and Manual Work, both of which should be located in the center of rectangular configuration, were plotted on the edge of rectangular, which means pentagonal configuration was yielded,

From these results, it could be concluded that items and scales included in each interest area are arranged in two dimensional circular circumplex, which is defined by People-Things and Data-Ideas latent axis.

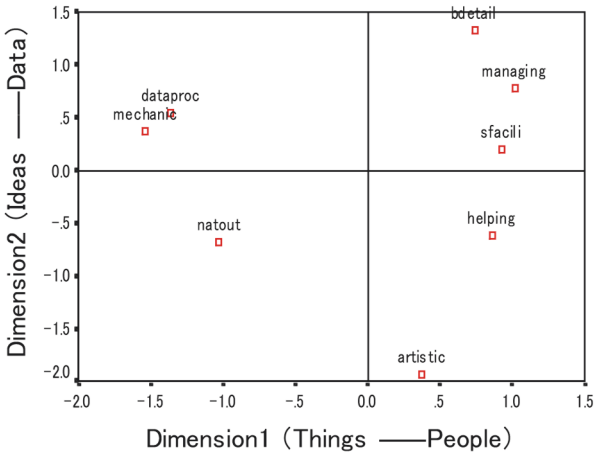


Figure 5-1. Scale Configuration of Eight Basic Medium Prestige Area

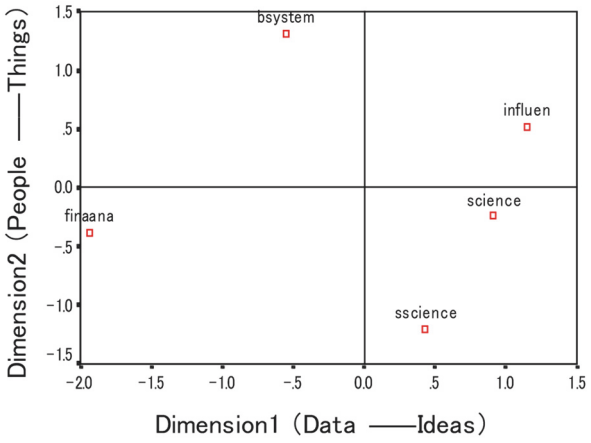


Figure 5-2. Scale Configuration of Five Higher Prestige Interest Area

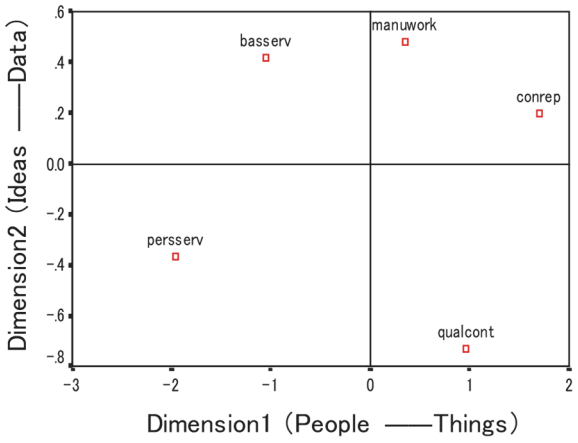


Figure 5-3. Scale Configuration of Five Lower Prestige Interest Area

Discussion

Toward a New Model of Occupational Interest

Through a series of statistical analyses, it became clear that the Japanese version of the PGI-Occupational scale robustly maintains the hypothesized octagonal circumplex structure in basic interest area. On the other hand, we could not find clear evidence supporting PGI's hemispherical structure as long as observing the three dimensional configuration yielded from multi-dimensional scaling (MDS). This result, however, is coincident with the findings obtained from previous research (Long, Watanabe, & Tracey, 2006), which explored the validity of hypothesized order relations for the RIASEC, octant, and PGI's hemispherical configuration by using correspondence indices (CIs) of the randomization tests. In the research, PGI's model fit index (CI) was relatively low compared with RIASEC and octant scales. It could be assumed that the three dimensional model is much more sophisticated than two dimensional model so that it is difficult to prove the hypothesized structure.

Feasibility of Dual-layer Cylinder Model

As long as Japanese data and statistical procedures used in this study are concerned, preference for evidence supporting PGI's hemispherical structure is relatively weak. However, some portion of higher and lower prestige items were highly correlated with the items belonging to the basic interest area. This might suggest that we could challenge the development of a new occupational interest model which reflects Japan-specific labor and employment context.

Under Japan's work circumstances, life-long employment and seniority systems are still dominant. It is difficult to assume the prestigious axis representing the highest to lowest occupation continuum. That is why, even though an employee who work for a company as a low-skilled worker, he/she has a lot of chance to get high prestigious position in the future within the company. This means Japanese workers' realistic career goals seem not to get a highest prestige occupation in the world but to become a highest professional or a highest generalist within the company. In addition, considering Japanese social context and lingual connotations, the items belonging to higher and lower prestige dimensions are appropriate to be categorized and called as 'mental labor' and 'physical labor' respectively.

Based on the above-described interpretations and logic, the author proposes an alternative model of occupational interest, which is named as the Dual-layer Cylinder Model. Figure 6-1 shows the graphical presentation of the model, where octagonal basic area, rectangular high and low prestige areas of PGI are located in horizontal space and mental-physical orientation is presented by the vertical position (height) of octagonal basic area plate. Figure 6-2, figure 6-3 and Figure 6-4 are graphical presentations focusing on the degree of mental-physical labor orientation. It is expected to examine the usability as well as reliability and validity of a dual-layer cylinder model by using PGI-Occupational scales data in the future.

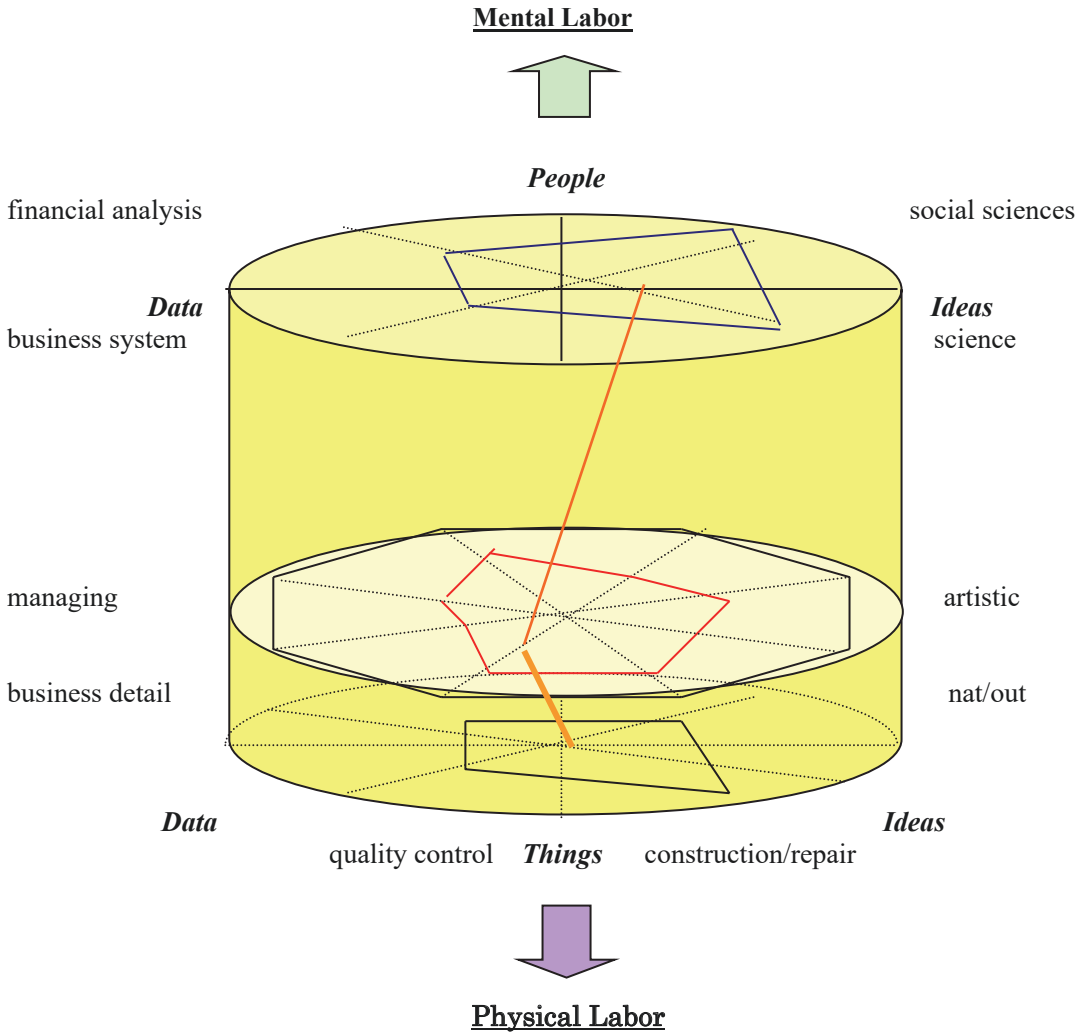
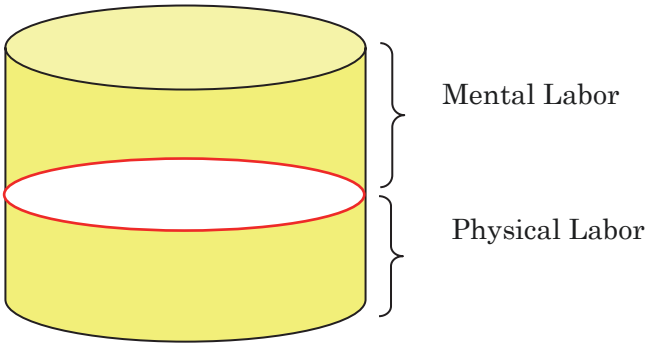


Figure 6-1. Graphical presentation of the Dual-layer Cylinder Model



Neutral Type

Figure 6-2. Neutral Type

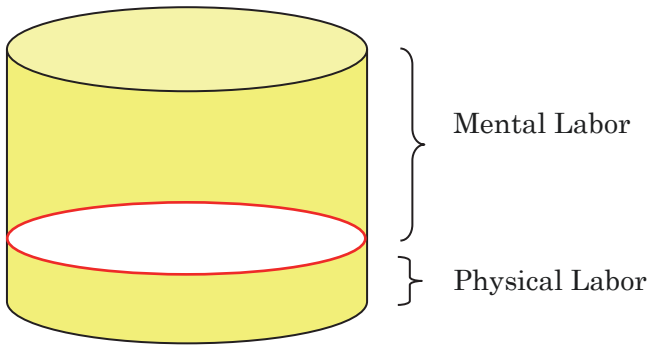


Figure 6-3. Physical Labor Oriented Type

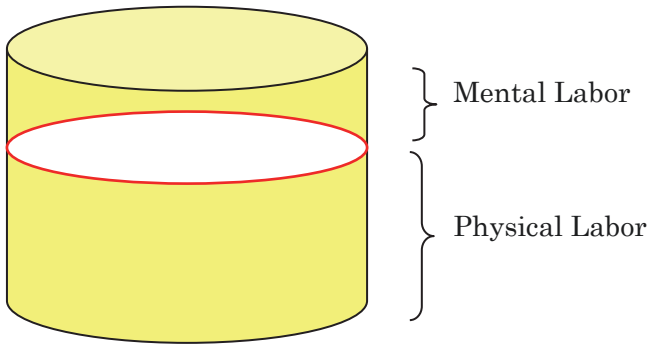


Figure 6-4. Mental Labor Oriented Type

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