THE RELATIONSHIP BETWEEN ABILITIES AND INTERESTS:

A FACTORIAL STUDY

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1. IN TRODUCTION

The Problem

The psychologist engaged in educational and vocational counselling usually makes quite extensive use of two types of psychological tests. These are measures of ability and measures of interest. Instruments of these types usually provide the core of psychometric data about the client upon which the counselling is based. Their use rests on the assumption that the pattern of interests characteristic of an individual and the pattern of abilities found for the same individual are not necessarily related, pattern to pattern, in any particular way.

Experience with the use of such tests in counselling situations suggests, however, that there are certain interest-ability configurations which occur with more than chance frequency. This study was designed to explore relationships between measured interests and abilities in a way that would reveal such interest-ability configurations, if they did exist. The technique of factor analysis seemed the most useful analytic method for this purpose.

Previous Exploration

Historically the question of interest-ability relationships has been examined from both experimental and theoretical viewpoints. Anticipating the problem in its modern form, Woodworth proposed in 1918 that McDougall's theorizing about instinct-emotion relationships might be extended to embrace "native interest as the affective side of a native capacity" (42, p 74). Although Woodworth did not support this suggestion by reference to any experimental evidence, it was not long before relevant

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evidence began to accumulate. The evidence did not seem to support the hypothesis. For example, Hubbard (23) studied mechanical interests and abilities and concluded that these at least were independent variables. It is doubtful that Woodworth had interests as measured by inventory tests in mind, but Carter (10) utilized the first edition of Strong's Vocational Interest Blank (33) to assess potential interestintelligence relationships, with results that were inconclusive.

The study by Carter, and other similar studies such as those of Segel (31) and Alteneder (3) had merit in that they avoided the use of simple verbal expressions of interest. The unreliability of expressed interests may account in part for the conclusion of Berdie (5) who reviewed a number of studies based on such evidence. He concluded that interests and abilities are not significantly related.

The studies referred to above, however, were based on the Strong Vocational Interest Blank, which shows substantial validity and reliability. It also provides for a much more thorough assessment of interest dimensions through the use of several interest scales. Strong apparently found sufficient support in studies such as Carter's to conclude "that there must be some relationship between interests and aptitudes" (33, p 340) and to suggest further that "interests reflect inborn abilities" (33, p 682). He admits, however, that conclusive evidence is lacking.

The inconclusive nature of the evidence which Strong cites may be due to the fact that, although interest dimensions were well differentiated, the sampling of ability dimensions was restricted to the use of measures of general intelligence. It is difficult to understand how substantial relationships could be expected between

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rather well differentiated interest dimensions and general intelligence.

Theoretical Considerations

There have been several attempts to incorporate the concepts of interest and ability into the larger framework of personality theory. Those of Darley (15), Carter (11), and Bordin (6) are representative. Their defects from the point of view of this study are that, given their very broad theoretical framework, they postulate mechanisms which this project was not designed to explore. They tend to make assumptions about abilities and interests and their relationship to environmental and genetic factors which are very difficult to support on the basis of available evidence. This is perhaps a natural consequence of the fact that the above theories were concerned primarily with accounting for the origins of interests and abilities within the developing personality and only incidentally with specific interest-ability relationships as such.

Arguments exist of a theoretical nature which are relevant to this study, and suggest that interests and abilities should show substantial relationships. Although Super has claimed (34) that there is no satisfactory theory of interests, Murphy (29) has advanced the suggestion that interests are overlearned responses. He contends that the concept of overlearning is the only one which makes the consistency of interests over long time periods understandable. Assuming long-term continuity of goals as the basic dynamic, Murphy uses Janet's term 'canalization' to refer to the processes by which more and more means to these goals are incorporated by the personality, while, at the same

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time, the goals become increasingly specific. The strength of the canalization is a function of biologically determined preferences and the frequency of opportunities that the environment provides for specific responses. Canalizations are differentiated from conditioned responses largely by their resistance to extinction, and the role that consummatory responses play in their formation. A parallel line of reasoning has been marshalled by Ferguson (18) to support his contention that abilities, as measured by ability tests, are also overlearned behavior patterns. Drawing attention to the resistance of abilities to extinction, and their stability irrespective of use or disuse, he argues that ability test scores denote limits of learning. These limits are functions, according to Ferguson, of biological and environmental factors which determine which particular abilities will be exercised, and the extent to which they will be developed at any stage in the maturation process.

These attempts to supply theoretical bases for interests and abilities provide for some of their outstanding characteristics stability and resistance to extinction especially - by making learning the central dynamic, and by drawing attention to the role of overlearning. The obvious parallels between these independent formulations of Murphy and Ferguson, and their convergence on the same underlying mechanisms, provides additional support for attempts to demonstrate significant ability-interest relationships.

This study was designed to test the hypothesis that interests and abilities are aspects of more complex overlearned behavior patterns. An attempt was made to include differentiated ability measures as well

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as differentiated interest measures. The resulting interrelationships were analysed by the method of factor analysis. The power of this method to differentiate dimensions of behavior is well established. Its suitability as an exploratory device in this area follows established precedents in the exploration of interests and abilities. Thurstone (37) made the first application of factor analysis to interest test scores, and his study has been followed by others like those of Strong (33) and Lurie (27). Application of the method of intelligence and ability tests is illustrated by the studies of Burt (7), Carroll (9), Cattell (13), Schiller (30) and the Thurstones (38, 40).

The closestapproach to an investigation of the relationships between interests and abilities, of the complexity of the one reported here, was that of Adkins and Kuder (1). A matrix of the correlations between the scores on a battery of ability and interest tests was published by these authors. They concluded, without subjecting the matrix to any further analysis, that the relationships obtained were too small to justify any conclusive decisions regarding interest-ability relationships.

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2. THE PROCEDURE

A battery of tests was selected which provided reasonably comprehensive coverage of various intellectual abilities and interest areas. This battery was administered to a group of college students at the time of their admission to college. The resulting score distributions were T-scored and the intercorrelations between the variables calculated. A centroid factor analysis of the matrix of intercorrelations yielded eight factors which were rotated for simple structure. Interpretation of the rotated factors was validated by reference to other factorial studies in the domains being explored, and by reference to the faculty registration and course achievement of the experimental population.

The Test Battery

This study, essentially exploratory in nature, required the use of instruments which, as measures of interest and ability, were reasonably valid and reliable measures. The selection of instruments which had themselves resulted from the application of factorial or similar methods of analysis, and about which a reasonable body of literature and research had accumulated, was also desirable. The following instruments constituted the test battery.

The Chicago Tests of Primary Mental Abilities. Single Booklet Edition (41). This instrument, a consequence of the factorial investigations of intelligence conducted by Thurstone and his associates (38, 40), yields relatively independent measures of six mental abilities. These are N, the Number factor involving the ability to perform rapid and accurate numerical calculations; V, a measure of verbal comprehension; S, involving the imaginal manipulation of objects in space; a word fluency factor. W:

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a reasoning factor, R, which is a composite of inductive and deductive reasoning ability; and M, a rote memory factor.

Each of these factors, with the exception of M, is appraised by two relatively short tests in the Single Booklet Edition. Testing time for each of these first five factors is either nine or ten minutes. There is no specific time limit for the test of rote memory, but it requires about eight minutes to complete.

<u>The Differential Aptitude Tests</u> (4). The complete set of measures in this battery includes eight tests. Of these only three were used in this study. The Verbal Reasoning test consists of fifty open ended verbal analogies, and has a thirty minute time limit. The test of Numerical Ability includes forty problems of the arithmetic computation type also to be completed in thirty minutes. The Abstract Reasoning test presents the subject with fifty sets of diagrams illustrating the operation of some regular principle in each case. The subject has twenty-five minutes in which to select the most appropriate diagram to continue each set.

These three Differential Aptitude tests (DAT) were included in the battery as supplements to the Primary Mental Ability (PMA) variables.

<u>The Kuder Preference Record - Vocational</u>, Form EB (24). This instrument provides measures of an individual's relative preference for activities in nine largely independent interest areas, named by the publishers as: Mechanical, Scientific, Computational, Persuasive, Artistic, Literary, Musical, Social Service, and Clerical.

The Kuder Preference Record - Personal, Form A (25). This

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instrument measures relative preference for five types of interpersonal relationships labeled Sociable, Practical, Theoretical, Agreeable, and Dominant. (In more recent editions each area has been redesignated by a letter symbol - A, B, C, D, and E.) This instrument was included in the battery because of the potential contribution that its variables could make to the definition and interpretation of the factors produced by the analysis.

For purposes of this investigation a more complete description of the activity preference involved in each area was desirable. Appendix C contains a description of the method that was used to define the Kuder -Vocational (KV) and Kuder - Personal (KP) variables, and the definitions that resulted.

These instruments provided nine measures of ability and fourteen measures of interest in the test battery. The addition of sex yielded a matrix of twenty-four variables in all.

The Experimental Sample

This battery of tests and inventories was administered to a group of Day College Freshmen students of Sir George Williams College as part of the regular program of Orientation Week. The instruments were completed in two group sessions, supervised by experienced psychologists, in complete accordance with the instructions in the appropriate manuals.

The experimental sample consisted of 135 students who attempted every test and inventory during the formal testing program. Thirty-five of these subjects were females. The youngest member of the group was sixteen, the oldest twenty-two, and more were seventeen than

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any other age. An Arts study program claimed the largest registration, 37.7 percent of the total; Commerce accounted for 32.5 percent; and the remaining 29.6 percent were registered in Science.

For the entire group the score distributions on every variable, except sex, were T-scored to a mean of 50.0 and a standard deviation of 10.0.

The Experimental Method

Product-moment correlation coefficients for the twenty-three test variables, and point-biserial correlations relating sex to each of the other variables were computed. The resultant matrix was analysed by the method of centroid factor analysis (39) to yield eight factors. Rotation of axes by the method of two dimensional sections (39) gave an oblique simple structure. The factors were then tentatively defined by reference to the variables with significant loadings.* An attempt was made to verify these tentative definitions by reference to independent factorial investigations of abilities and interests (as discussed in section 3), and also by using data related to the study program of the experimental sample. This latter validation method is discussed in Section h.

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^{*} A significant loading in this study is arbitrarily defined as a loading of absolute value equal to, or greater than 0.27, equivalent to the P = .001 level of significance for zero order correlations where N = 135. Adoption of some such arbitrary criterion is necessitated by the fact that the sampling distributions of factor loadings are unknown.

The correlation matrix for this analysis consisted of the 253 product-moment correlation coefficients between the twenty-three test variables and the twenty-three point-biserial coefficients relating sex to each of the other variables. Tables 3.01 through 3.05 show the significant matrices related to this analysis.

The intercorrelations of the original matrix range from -.15 to .72 for ability test interrelationships and from -.55 to .53 for interest test relationships. The relationships between ability and interest tests are generally smaller, ranging from -.33 to .36. The coefficients involving sex range from -.30 to .22 with ability tests and from -.49 to .43 with interest tests.

Eight factors were extracted using Thurstone's (39) complete centroid method. The residual coefficients were normally distributed, the mean residual being equal to -.004, the modal residual being .01. Two hundred and thirty-one (83.7%) of the residuals were equal to, or smaller than .05. Application of Guilford's criterion of factor significance (20) requires that the product of the two highest loadings should not be much smaller than the standard error of a zero correlation. The product in this case is .078 (.29 x .27), and the standard error of a zero correlation where N equals 135 is .086.

Rotation by the method of two dimensional sections (39) resulted in a factor structure that adequately satisfied the criteria for simple structure. This structure, as Table 3.05 shows, was somewhat oblique.

The following very brief summary of these eight factors is presented at this point to assist the reader in the discussion of the

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analysis to follow. The names suggested for the factors are not meant to serve as anything other than convenient labels with some associative value.

Factor A. Guiding vs Objective. A bipolar interest factor. guiding people for their own presumed good vs being coldly objective.

Factor B. Reasoning Ability. An ability factor. Measures of verbal and abstract reasoning ability have strong loadings on this factor.

Factor C. Nature vs Me. A bipolar interest factor. Thoughtful interest in understanding nature vs being the center of attention.

Factor D. Accounting. A mixed (interest and ability) factor. Orderly - systematic interests and numerical ability.

Factor E. Words vs Things. A bipolar interest factor. Verbal activity vs manipulation of materials.

Factor F. Aesthetic vs Service. A bipolar mixed factor. Musical interests and abstract reasoning ability vs social service interests and word fluency.

Factor G. Female Sex Factor. A bipolar mixed factor. Female sex, abstract reasoning, and sociable interests vs practical and literary interests.

Factor H. Male Sex Factor. A bipolar mixed factor. Numerical and spatial abilities, sociable interests, and male sex vs memory ability.

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The Correlation Matrix Original correlations to the right of the diagonal, residuals to the left.

Variable	Code No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Sex	1		-26	14	-01	-20	-03	-30	04	16	22	-49	-20	-20	-30	26	08	18	39	-03	10	00	23	43	-31
DAT Numerical	2	02		26	42	31	20	34	11	32	-02	20	32	18	00	00	-18	-33	-21	05	20	11	-16	-13	07
DAT Verbal	3	04	04		58	-15	72	33	40	54	26	-07	-19	-04	03	10	20	-18	05	-19	-17	00	12	00	01
DAT Abstract	4	05	08	-03		-04	42	50	16	49	09	10	09	12	-03	05	03	-13	-23	00	-26	-03	-02	_10	-08
PMA Numbers	5	oi	09	01	01		-06	-06	08	-01	-06	00	36	09	-11	-23	-13	-10	-05	25	õĩ	13	-17	-05	-02
PMA Ver. Mean.	6	00	03	03	00	00		27	53	42	21	02	-21	07	11	õi	14	-21	-01	-20	-13	-06	05	-11	06
PMA Space	7	-10	-07	-02	01	09	00		21	42	-08	34	17	17	04	13	-27	-07	-26	-03	-20	01	-19	_13	-06
PMA Word Flu.	8	-03	-06	-07	01	01	04	09		41	32	-19	-16	-17	11	oí	18	-09	13	-06	03	07	12	õi	-01
PMA Reasoning	9	oi	-01	00	-02	01	-02	0Ĺ	05	~	24	-03	10	05	-04	11	-06	-07	$\widetilde{00}$	-01	-05	-13	-05	-03	-05
PMA Memory	10	-01	04	02	02	04	-03	-06	óó	04		-20	-07	-26	20	11	14	08	-03	08	_01	-10	QÍ.	09	-01
KV Mechanical	11	-03	00	04	00	-04	-01	01	01	-01	02	~~	28	53	10	12	-1.8	-30	-56	-13	_21.	03	-55	-38	16
KV Computat.	12	-01	05	-01	-03	02	-06	03	-01	-02	00	03	~•	33	-17	-18	1.2	-19	_29	1.1.	-20	00	-31		17
KV Scientific	13	01	04	-08	00	00	00	-01	-01	02	00	04	01	"	-35	-08	-38	-36	-21	_21	-36	28	-12	_07	_11
KV Persuasive	14	-02	-03	03	01	-08	-01	01	-02	00	05	03	-03	-01	"	-08	17		_20	05	20	-36	-20	_36	1.5
KV Artistic	15	05	06	-01	-03	01	-04	-03	01	-01	oí	_07	-05	_10	-06		-25	-04	_25	-31	_10	6	-21	07	-28
KV Literary	16	oi	02	-01	00	00	-06	-07	04	<u>o</u>	00	-0/	-05	-03	_01	02	~)	13	12	_05	-70	_1/.	1.0	06	18
KV Musical	17	-06	-14	-05	04	04	01	12	05	06	oī	02	-02		-07	_07	-05	-	ñ	-06	11	_10	47	22	-14
KV Soc. Serv.	18	03	-08	05	-01	-04	-01	02	-02	01	00	_0,	-02	_13	0	_07		-08	Ú.	_17	30	30	51	27	-14
KV Clerical	19	03	-04	00	03	-02	01	02	03	-02	-02	-01	01	-06	oī	_10	-06	-0/	03	- -1	$\tilde{0}$	-08	-17	05	08
KP Sociable	20	09	10	02	-07	-03	02	-13	-05	-07	-03	00			03	-10		00	_07	<u>م</u> .	00	-20	-17	09	12
KP Practical	21	04	01	02	-01	-03	-08	-02	02	_03	-02	_01	-03	_0/.	03		-03	-07	0.	00	_06	-20	15	20	-33
KP Theoret.	22	-04	00	-05	-02	-04	-03	05	05		05	_01	03	-04	-02	03	-05	0.	_03			05	1)	27	-01
KP Agreeable	23	01	-02	02	-03	-05	0Ĺ	00	_01	03	02	0.	02	05	01.	-02	02	00	_02	02	-04	0,	02	50	-51
KP Dominant	24	01	04	04	-03	-08	-01	-02	-01	-03	02	06	05	-03	07	01	oi	-04	04	02	02	02	02	02	-)1

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Unrotated Orthogonal Factor Matrix ${\bf F}_{\rm R}$

Variable	Code No•	I	II	III	IV	V	VI	VII	VIII	h ²
Sex	1	•63	17	•09	13	•29	.04	17	29	. 6495
DAT Numerical	2	30	.23	.41	.14	.11	•13	•34	.17	•5041
DAT Verbal	3	.30	•69	•43	05	10	.12	13	•05	•7973
DAT Abstract	4	08	•52	•47	10	.16	•32	20	•19	.7118
PMA Numbers	5	27	19	.29	•31	-•03	22	.12	.07	.3578
PMA Verb.Mean.	6	.19	.68	.32	.05	23	05	05	05	.6638
PMA Space	7	26	•44	.32	17	. 16	.12	.17	.14	•4810
PMA Word Fl.	8	•33	•45	•29	.29	10	28	.20	07	.6129
PMA Memory	9	.10	.48	•47	.07	•26	.22	.10	25	.6547
PMA Space	10	.28	.27	.06	.18	•20	30	15	-,11	.3519
KV Mechanical	11	69	.23	04	44	13	11	.15	07	.7806
KV Computation	12	61	22	•43	.16	.20	06	-,13	20	.7315
KV Scientific	13	40	-•08	•37	-•44	-•35	•06	.03	18	.6563
KV Persuasive	14	16	•43	47	•34	.07	13	.03	•09	.5778
KV Artistic	15	.11	.23	10	51	•35	14	.11	18	.5217
KV Literary	16	•40	.14	19	•33	25	.11	31	•27	.5682
KV Musical	17	.27	-,18	24	•04	.28	•08	15	.18	.3042
KV Soc.Serv.	18	.61	37	.16	.14	25	.19	.24	09	.7185
KV Clerical	19	26	23	.16	•37	•33	-,18	33	.17	.5621
KP Sociable	20	.14	09	-,22	.38	.16	.18	•45	•04	.4826
KP Practical	21	•08	27	.42	-,26	-,31	18	.19	.26	•5555
KP Theoretical	22	•56	16	.05	.19	29	•35	13	•14	.6209
KP Agreeable	23	•53	41	.27	18	.20	12	•06	.25	.6748
KP Dominant	24	33	.22	29	•46	22	.17	10	17	.5692

Rotated Oblique Factor Matrix ${\tt V}_{\rm R}$ *

No.	Variable	A	в	C	D	E	F	G	Н
	Sex	•29	•23	05	•07	09	•05	•36	46
	DAT Numerical	•06	•35	04	•29	05	•05	.12	•57
	DAT Verbal	.10	•78	.07	04	.18	•04	05	02
	DAT Abstract	•07	•66	•02	.21	•20	•43	•00	•23
	PMA Numbers	•09	01	. 16	•39	03	23	05	.22
	PMA Ver.Mean.	05	•64	.13	09	.10	19	10	06
	PMA Space	02	•44	06	•11	14	•24	•02	•37
	PMA Word Flu.	•04	•56	04	•08	11	46	•01	02
	PMA Reasoning	•03	•72	•00	.28	08	•05	•44	.12
	PMA Memory	-•08	.38	15	.19	19	15	•00	30
	KV Mechanical	32	16	•24	19	29	.10	18	.17
	KV Computation.	-,10	•03	•37	.65	07	•06	.17	.12
	KV Scientific	.13	08	•65	11	•05	0ļ	04	•06
	KV Persuasive	- <u>•58</u>	02	45	-•08	10	07	16	•06
	KV Artistic	05	•19	19	16	54	.19	.13	20
	KV Literary	.02	•05	16	18	•50	04	28	13
	KV Musical	•10	11	35	•03	•03	.25	•01	09
	KV Soc. Serv.	•49	04	1 2	14	.26	34	.28	01
	KV Clerical	01	.01	06	.64	.03	.16	11	.01
	KP Sociable	07	10	43	.02	06	14	•33	.35
	KP Practical	.62	01	•34	07	.04	16	-,26	.16
	KP Theoretical	•36	.02	•04	18	•57	06	.03	04
	KP Agreeable	.73	.11	09	.12	08	.07	•00	05
	KP Dominant	-,62	17	•01	-•03	<u>_28</u>	16	.03	•06
	No.	No. Variable Sex DAT Numerical DAT Verbal DAT Abstract PMA Numbers PMA Ver.Mean. PMA Space PMA Word Flu. PMA Reasoning PMA Memory KV Mechanical KV Computation. KV Scientific KV Persuasive KV Artistic KV Artistic KV Literary KV Musical KV Soc. Serv. KV Clerical KP Sociable KP Practical KP Theoretical KP Agreeable KP Dominant	No. Variable A Sex <u>29</u> DAT Numerical 006 DAT Verbal 100 DAT Abstract 007 PMA Numbers 099 PMA Ver.Mean055 PMA Space -022 PMA Word Flu. 004 PMA Reasoning 03 PMA Memory -088 KV Mechanical - <u>32</u> KV Computation100 KV Scientific 13 KV Persuasive <u>588</u> KV Artistic -055 KV Literary 022 KV Musical 100 KV Soc. Serv. <u>499</u> KV Clerical -011 KP Sociable -077 KP Practical <u>622</u> KP Agreeable <u>735</u> KP Dominant - <u>62</u>	No. Variable A B Sex 229 23 DAT Numerical 006 355 DAT Verbal 10 $.78$ DAT Abstract 07 $.666$ PMA Numbers $.09$ 01 PMA Ver.Mean 05 $.644$ PMA Memory 08 $.38$ KV Mcchanical 322 16 KV Computation 10 $.03$ KV Scientific $.13$ 08 KV Persuasive 58 02 KV Artistic 05 $.19$ KV Literary $.02$ $.05$ KV Musical $.10$ 11 KV Soci	No. Variable A B C Sex 29 .2305 DAT Numerical 06 35 04 DAT Verbal 10 $.78$.07 DAT Abstract 07 $.66$.02 PMA Numbers 09 01 .16 PMA Ver.Mean. 05 $.64$.13 PMA Space 02 $.44$ 06 PMA Word Flu. 04 $.56$ 04 PMA Reasoning 03 $.72$.00 PMA Memory 08 $.38$ 15 KV Mechanical 32 16 .24 KV Computation. 10 .03 $.37$ KV Scientific $.13$ 08 $.65$ KV Persuasive 58 02 45 KV Artistic 05 $.19$ 19 KV Literary $.02$.05 16 KV Musical $.10$ 11 35 KV Soc. Serv. $.49$ 04 $.12$ KV Clerical 01 .01 06 KP Practical $.62$ 01 $.34$ KP Practical $.62$ 01 $.34$ KP Theoretical $.36$.02 $.04$ KP Agreeable $.73$.11 09 KP Dominant 62 17 .01	No.VariableABCDSex $\frac{29}{0.05}$ $\frac{23}{0.05}$ $\frac{0.07}{0.07}$ DAT Numerical 0.06 $\frac{35}{0.55}$ -0.04 $\frac{29}{0.29}$ DAT Verbal 10 $\frac{78}{78}$ 0.07 -0.04 DAT Abstract 0.07 $\frac{66}{0.02}$ 221 PMA Numbers 0.09 -0.01 1.6 $\frac{39}{29}$ PMA Ver.Mean. -0.05 $\frac{64}{0.44}$ -0.06 1.11 PMA Space -0.02 $\frac{64}{0.44}$ -0.06 1.11 PMA Word Flu. 0.04 $\frac{556}{0.56}$ -0.04 0.08 PMA Memory -0.08 $\frac{338}{0.38}$ -1.5 1.9 KV Mechanical $-\frac{32}{0.22}$ -1.6 2.4 19 KV Computation. -100 0.3 $\frac{37}{0.65}$ $\frac{65}{0.511}$ KV Scientific -1.3 -0.08 $\frac{655}{0.511}$ 111 KV Persuasive $-\frac{58}{0.52}$ -0.02 $-\frac{45}{0.5}$ -0.08 KV Artistic -0.05 1.9 -1.9 016 KV Literary 0.22 0.5 -1.6 18 KV Musical 100 -111 $-\frac{325}{0.33}$ 0.02 KV Soc. Serv. $\frac{49}{0.9}$ -0.04 1.22 -1.14 KV Clerical -0.01 0.01 -0.66 $\frac{64}{0.44}$ KP Practical $\frac{62}{0.22}$ -0.11 $-\frac{324}{0.24}$ -0.71 KP Theoretical $\frac{36}{0.02}$ 0.24 -1.8 KP Agreeable <t< td=""><td>No.VariableABCDESex$29$$.23$$05$$.07$$09$DAT Numerical$.06$$35$$04$$.29$$05$DAT Verbal$.10$$.78$$.07$$04$$.18$DAT Abstract$.07$$.66$$.02$$.21$$.20$PMA Numbers$.09$$01$$.16$$.39$$03$PMA Ver.Mean.$05$$.64$$.13$$09$$.10$PMA Space$02$$.44$$06$$.11$$14$PMA Word Flu.$.04$$.56$$04$$.08$$11$PMA Reasoning$.03$$.72$$.00$$.28$$08$PMA Memory$08$$.38$$15$$.19$$19$KV Mechanical$32$$16$$.24$$19$$29$KV Computation.$10$$.03$$.37$$.65$$07$KV Scientific$.13$$08$$.65$$11$$.05$KV Persuasive$58$$02$$45$$08$$10$KV Musical$.10$$11$$35$$.03$$.03$KV Soc. 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* Significant Loadings underlined

	Matr	ix _R o	f the	transf				
	A	В	С	D	E	F	G	H
I II IV V VI	.46 44 .56 28 06 02	.30 .65 .63 .07 .31 01	22 23 .50 19 61 04	24 18 .54 .47 .58 14	.08 10 .11 .30 54 .58	18 .03 05 39 .52 .49	•12 •11 •13 •14 •40 •47	35 .04 .19 .18 .05 .39
VII VIII	-12 -44	04 01	20 41	20 03	- 44 - 24	-•37 •39	•34 -•66	•02 •52

Table 3.05

Cosines of angles between reference vectors.

	A	В	C	D	Е	F	G	Н
A	1.00	•16	. 16	.07	.13	•07	15	.17
В	. 16	1.00	19	•37	11	•07	.17	•03
С	•16	09	1.00	01	•33	32	04	29
D	•07	•37	01	1.00	11	.12	•24	.10
Е	•13	11	•33	11	1.00	.12	17	•09
F	.07	•07	32	.12	•12	1.00	03	.17
G	15	.17	04	•24	17	03	1.00	•07
Н	.17	•03	29	.10	•09	.17	•07	1.00

Factor A. Variables with significant loadings on Factor A are

shown below.

Table 3.06

Factor A

"Guiding vs Objective"

Code No.	Variable	Loading
23	KP Agreeable	•73
21	KP Practical	•62
18	KV Social Service	•49
22	KP Theoretical	• 36
1	Sex	•29
11	KV Mechanical	32
14	KV Persuasive	58
24	KP Dominant	62

It is evident that Factor A is a bipolar factor, and one on which none of the ability variables received significant loadings. The constellations of preferences represented by the positive and negative poles of this factor are reproduced below. They were composed by integrating the composite descriptions for each of the relevant Kuder variables as defined in Appendix C.

Factor A, Positive Pole; Be an art teacher, museum guard, tailor, bank cashier, judge, soldier, sailor, business president, average citizen, social service worker, religious leader, authority on public health, vocational counsellor, college professor, member of a debating society, specialist in the study on the mind;

teaching in high school, broadcasting a prize fight, going fishing, seeing a checker game, avoiding criticizing people, reading about travel, always telling the truth, being kind to people, going on a camping trip, going to a reception, building scenery for a play, teaching retarded children, reading a story about a modern small town, looking after, taking care of, training, teaching, helping, giving personal counselling, reading theories of an ideal world, going to a lecture on world affairs, working mainly with ideas, working with a blind student, slum children, native epidemics, old folks home; studying sociology, immigration, crime causes, social customs, etc. Factor A, Negative Pole: Be a judge, school superintendent, business president, mayor, club president, congressman, authority on advertising, sales manager, radio commentator, publicity director, machinist, aeronautical engineer;

commanding an army, tracking down criminals, reading about politics, writing plays, interviewing the Secretary of State, watching a business executive working, selling, collecting, interviewing, convincing, supervising, designing, inventing; working with insurance, real estate, calculating machines, stocks and bonds, dishwashers, woodworking tools, hand looms, broken toys, broken locks, jig-saw puzzles; studying salesmanship, propaganda, business trends, public speaking, shopwork, metal working, hospital construction, etc.

This factor, contrasting 'taking care of, training, teaching, helping, etc.' with 'selling, interviewing, convincing, etc.', resembles the factor that Strong (33) located which has been called "working with people for their presumed good". This factor opposed the occupations of minister, social science teacher, YMCA secretary and others to those of president, purchasing agent, production manager, etc. In his compilation of the dimensions that have been established in interest and values inventories Cattell (13) combines the above factor of Strong's analysis with clusters produced by Gundlach and Gerum (22) in his suggested factor QI.lb - "Guiding people for their own presumed good v. being coldly objective". Within the limits imposed by the selection of variables for this study it appears that Cattell's factor QI.lb and Factor A of this study are identical.

Factor B. Table 3.07 shows the variables with significant loadings on this factor.

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Factor B

"Reasoning Ability"

Code No.	Variable	Loading
3	DAT Verbal	•78
9	PMA Reason	•72
4	DAT Abstract Reasoning	•66
6	PMA Verbal Meaning	•64
8	PMA Word Fluency	•56
7	PMA Space	•44
10	PMA Memory	•38
2	DAT Numerical Ability	•35

Factor B, extending in a positive plane only, is defined in terms of ability variables. None of the interest variables received significant loadings. PMA Number, with a loading of -.01, is the only ability variable without a significant loading.

This factor can be considered as a factorially collapsed version of the domain explored by L.L. Thurstone (38) and his associates (40) leading to the development of the PMA tests used in this study. Since there is an extensive literature pertaining to this domain and its factorial composition elsewhere (7, 9, 13, 30, 38) it does not require extensive discussion in this study. It may be equated with Cattell's (13) Factor T.1 - General Ability.

<u>Factor C.</u> Examination of the significant variables (Table 3.08) will show that Factor C, like Factor A, is a bipolar preference factor with mone of the ability variables represented by significant loadings.

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Table	э 3	•08
TOUT		•

Factor C

"Nature vs Me"

Code No.	Variable	Loading
13	KV Scientific	•65
12	KV Computational	•37
21	KP Practical	•34
17	KV ^M usical	35
20	KP Sociable	43
14	KV Persuasive	45

Use of the composite descriptions developed for KV

Scientific, KV Computational, and KP Practical produces the following definition of the positive pole of Factor C.

Factor C, Positive Pole: Be a chemist, physician, aeronautical engineer, psychologist, bookkeeper, authority on taxation, professor of mathematics, judge, soldier, sailor, business president, average citizen;

developing, discovering, investigating, exploring, planning, determining costs, always telling the truth, being kind to people;

working with mechanical toys, sewing machines, figures, adding machines, cost of living tables, mental arithmetic, public opinion survey statistics, going on a camping trip, to a reception, building scenery for a play, teaching retarded children, reading a story about a modern small town; studying sociology, disease causes, mathematics of astronomy, science museums, mathematics, cost accounting, etc.

The descriptions of the variables with significant negative

loadings on Factor C combine to yield the following definition of the

negative pole of this factor.

Factor C, Negative Pole: Be an authority on advertising, sales manager, radio commentator, publicity director, clever, sympathetic, socially active, a committee member, teacher of public speaking, organist, radio singer, music teacher;

selling, collecting, interviewing, convincing, supervising, introducing a speaker, giving an impromptu speech, entertaining with tricks of magic, having picture in paper with society leader, playing, composing, arranging, tuning; working with insurance, real estate, calculating machines, stocks and bonds, dishwashers, symphony, musical comedy, music store; studying salesmanship, propaganda, business trends, public

speaking, music arrangement, opera singers, etc.

This factor, opposing preferences for 'developing, discovering, investigating, exploring, etc. ' and occupations popularly supposed to provide such opportunities, with preferences for 'selling, collecting, interviewing, convincing, etc.' resembles Thurstone's (37) Scientific interests factor. Among the occupations with high loadings on this factor were chemist, physician, physicist, etc., opposed to sales manager, life insurance salesman, banker, accountant, etc. Cattell (13) has subsumed the Scientific interests factor of these studies and the 'Science' factor of Strong (33) in his Factor QI.lla - "Thoughtful interest in understanding nature". This label fits the positive pole of Factor C rather well. However it does not convey the nature of the negative pole of Factor C. The central theme of the preferences making up this pole of the factor could be identified as 'being the center of attention'. The activities of selling, interviewing, entertaining with tricks of magic, playing music, etc., all put the 'actor' in the center of the stage. This interpretation makes the loading of KV Musical on this factor more intelligible than it might otherwise be. The implication is that music is a means to an end in the same way that studying public speaking is.

Factor C may then be equated with Cattell's Factor QI.lla and given the label "Thoughtful interest in understanding nature v. being the center of attention".

Factor D. This factor is the first on which both preferences

and ability variables received significant loadings. As the loadings show, it extends in a positive plane only.

Table 3.09

Factor D

"Accounting Factor"

Code No	• Variable	Loading
12	KP Computational	•65
19	KV Clerical	. 64
5	PMA Numbers	•39
2	DAT Numerical	• 2 9
9	PMA Reasoning	•28

The description of the preferences involved in this factor is

as follows.

Factor D: Be a bookkeeper, authority on taxation, professor of mathematics, private secretary, postal clerk, court stenographer; planning, determining costs, typing, cataloguing, sompiling, sorting, classifying, working with figures, adding machines, cost of living tables, mental arithmetic, public opinion survey statistics, correspondence, bills, tickets, mail, letters of inquiry; studying mathematics, cost accounting, accounting, business English, shorthand, etc.

Involved with these activity preferences is superior computational ability as measured by both the PMA and the DAT.

If attention is restricted to the preference aspect of this factor, it resembles those defined by Thurstone (37) as "Business interest", by Lurie (27) as a "Philistine" factor and by Strong (33) as the "Office Activities" cluster. This is the factor which Cattell calls "Philistine go-getting v. aesthetic interests" - his Factor QI.IVa. Since Factor D of this study did not show bipolarity of the type implied by the above label of Cattell's the alternative title "orderly-systematic" seems more

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appropriate.

The ability variables with significant loadings on this factor define the well established Numerical Ability Factor. The studies of Spearman (32), Thurstone (38), and Goodman (21) among others have confirmed the existence of this arithmetic computation factor. It is classified as Factor T.VI - Numerical Ability by Cattell.

This is the first of four factors in this study which support the hypothesis that interests and abilities are but aspects of more central personality dimensions. Factor D seems to illustrate the convergence of a well defined ability dimension and a well defined preference dimension.

<u>Factor E</u>. This factor, as Table 3.10 shows, is bipolar and the fourth 'simple' factor, in this case a preference factor.

Table 3.10

Factor E

"Words vs Things"

Code No.	Variable	Loading	
22	KP Theoretical	•57	
16	KV Literary	•50	
24	KP Dominant	•28	
11	KV ^M echanical	29	
15	KV Artistic	54	

Integration of the descriptions of KP Theoretical, KV Literary, and KP Dominant defines the positive pole of this factor.

Factor E, Positive Pole: Be a college professor, member of a debating society, specialist in the study of the mind, poet, writer, journalist, literary critic, judge, school superintendent, business president, etc.; giving personal counselling, reading theories of an ideal world, going to a lecture on world affairs, working mainly with ideas, teaching, reading, writing, browsing, working with editorials, English, scripts, articles, reading about politics, tracking down criminals, interviewing the Secretary of State, etc.; studying story writing, history of drama, language, etc.

The negative pole of Factor E is defined by KV Artistic and

KV Mechanical.

Factor E, Negative Pole: Be an artist, architect, sculptor, portrait painter, machinist, aeronautical engineer, etc., drawing, teaching, designing, painting, inventing, etc., working with linoleum block bookplates, art supplies, woodworking tools, hand looms, broken locks, jig-saw puzzles, etc., studying modern painting, fine arts, museums, sketching, shopwork, metal working, hospital construction, etc.

This factor, emphasizing verbal activities at the positive pole and the manipulation of materials at the negative pole resembles Thurstone's (37) interest in language factor, and the factor that Strong (33) called "Things v. People". Cattell in his list of interest factors includes one entitled "Verbal persuasion v. practical control of materials" - Factor QI.lla of his catalogue.

Factor E might more properly be called "Verbal activity v. manipulation of materials" within this study.

<u>Factor F</u>. This factor is the second complex factor to emerge from the analysis but unlike the first complex factor (Factor D) it is bipolar.

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Factor F

"Aesthetic vs Service"

Code No.	Variable	Loading
)4	DAT Abstract	•43
(17	KV Musical	•25)
(7	PMA Space	•24)
18	KV Social Service	34
8	PMA Word Fluency	46

In terms of the level of significance of factor loading established for this study only one variable, DAT Abstract Reasoning, receives a significant positive loading on this factor. However, the two variables KV Musical and PMA Space both received loadings in excess of .22 (equivalent to the P = .01 level of significance) and will be used to establish a more adequate, though tentative, basis for interpretation of the positive pole, Use of these variables produces the following definitions.

Factor F, Positive Pole: Superior DAT Abstract Reasoning. Be an organist, radio singer, music teacher, etc., playing, composing, arranging, tuning, etc., working with a symphony, musical comedy, music store, etc., studying music, arrangement, opera singers, etc. Superior PMA Space.

Factor F, Negative Pole: Superior PMA Word Fluency. Be a social service worker, religious leader, authority on public health, vocational counsellor, etc., looking after, taking care of, training, teaching, helping, etc., working with a blind student, slum children, native epidemics, old folks home, etc., and studying sociology, immigration, crime causes, social customs, etc.

This factor bears a resemblance to Lurie's (27) religious interests factor and a factor involving high religious and social values and low aesthetic values defined by Ferguson, Humphrey, and Strong (19). Its equivalent in Cattell's catalogue is probably QI.V - "Socialized religion v. irreligious aesthetic interests". However these factors do not include any ability measures, and Factor F of this study does.

The spatial cognitive component of the positive pole of Factor F is related to the factor that Cattell labels "Factor T.IV - Spatial-visual ability". This ability is defined by Thurstone (38) as his S Factor, by Schiller (30) as spatial ability, and appears in Estes' (16) analysis of form-board, wiggly block and intelligence tests.

The appearance of PMA Word Fluency with a significant loading on the negative pole of this factor, unsupported however by either DAT Verbal reasoning or PMA Verbal Meaning tends to suggest that the 'Socialized Religion' preference of this factor is associated with the verbal fluency sub-factor (Thurstone's W Factor) that Cattell includes among those verbal factors comprising his Factor T.11 - Verbal ability.

Cattell (13) draws attention to the fact that a measure of ability (a word association test) has a demonstrated relationship to the temperamental trait Surgency v. Agitated melancholic desurgency. He provides a summary description of this temperamental factor which states in part:

"All factorizations stress cheerful joyousness, gregariousness, friendly assertiveness, and talkativeness, adaptability, quick resourcefulness, humor that tends to wit, and (less definite) sympathy, curiosity, and trustfulness". (13, p 484)

This description of the surgency pole of the factor, with which the verbal fluency test has a high positive loading, is not incongruent with the summary description of the negative pole of Factor F of this study, on which a word fluency measure also shows a high loading.

These relationships are cited because they suggest a possible

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convergence of ability, interest and temperamental variables considerably beyond the level of those being explored in this study.

<u>Factor G</u>. This is the third of the complex factors, and the second on which sex shows a significant loading. Although apparently bipolar this factor is not too well defined, since only one variable received a negative loading that may be regarded as significant. However KP Practical received a loading in excess of .22, and will be included in the summary description of the negative pole of this factor.

Table 3.12

Factor G

"Female Sex Factor"

Code No.	Variable	Loading
9	PMA Reasoning	• 1 4
L	Sex	- 30
20	KP Sociable	•33
18	KV Social Service	•28
(21	KP Practical	26)
16	KV Literary	28

Factor &, Positive Pole: Superior PMA Reasoning, female sex, be clever, sympathetic, socially active, social service worker, religious leader, authority on public health, vocational counsellor, a committee member, teacher of public speaking;

introducing a speaker, giving an impromptu speech, entertaining with tricks of magic, having picture in paper with society leader, looking after, taking care of, training teaching, helping, etc.

Factor G, Negative Pole: Be a judge, soldier, sailor, business president, average citizen, poet, writer, journalist, literary critic;

always telling the truth, being kind to people, teaching, reading, writing, browsing;

going on a camping trip, to a reception, building scenery for a play, teaching retarded children, reading a story about a modern small town, working with editorials, English, scripts, articles; studying wtory writing, history of drama, language, etc. Factor G and Factor H share many interesting features in common. For example, although sex has a positive loading with G, it has a significant negative loading with H. KP Sociable, however, shows significant positive loadings on both factors. Factors G and H are also complex factors in that ability and preference variables have significant loadings on both dimensions. Finally it is to be noted that these two factors are orthogonal to one another. A summary description of Factor H will therefore be given before attempting an interpretation of either factor.

Factor H. This factor is clearly bipolar. The positive pole includes both ability and interest variables, with the emphasis on the former. The negative pole is defined by the sex variable and PMA Memory.

Table 3.13

Factor H

"Male Sex Factor"

Code No.	Variable L	Loading	
2	DAT Numerical Ability	•57	
7	PMA Space	•37	
20	KP Sociable	•35	
10	PMA Memory	30	
1	Sex	46	

Factor H, Positive Pole: Superior DAT Numerical Ability, PMA Space, be clever, sympathetic, socially active, engaged as a committee member, teacher of public speaking, introducing a speaker, giving an impromptu speech, entertaining with tricks of magic, having picture in paper with society leader, etc.

Factor H, Negative Pole: Female sex, superior PMA Memory.

Examination of the variables with significant loadings on these last two factors may suggest that Factor G is a bipolar sex preference factor and Factor H a bipolar sex ability factor. It is true that the majority of variables with significant loadings on Factor G are preference variables and the majority of those on H ability variables. However it is also true that the variable with the highest loading for Factor G is an ability, not a preference variable; and that KP Sociable receives a significant loading on Factor H. The above intepretation would seem to oversimplify these factors.

The variable KP Sociable shows a significant loading on both factors, and in both cases the loading is positive. The emphasis in this variable for socially active self-assertive roles suggests that both of these factors are related to that family of factors labeled by Catell as Factor QP.VI - Confident self assertion. This factor subsumes factors established through the analysis of questionnaire and self-inventory data by ^Layman (26), Mosier (28) and others. Cattell suggests in his discussion of this factor that it may on further analysis turn out to be two or more factors. The results of this analysis suggest that this is the case.

Factor G includes PMA Reasoning among its defining variables. This variable is a measure of what Burt (7) has called Logical Ability, and what Thurstone (38) calls D or deductive ability.

Factor H, in contrast, shows significant loadings for three ability variables. Two of these, DAT Numerical Ability and PMA Space, receive positive loadings, The positive pole of Factor H must thus be interpreted as involving a composite of numerical and spatial-visual ability. The negative pole of the same factor includes a memory component.

Finally it is to be noted that sex is positively loaded with Factor G, negatively with Factor H. This suggests that Factor G defines a personality dimension that differentiates between typical and atypical females, and Factor H a dimension that differentiates between typical and

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atypical males. Typical females would be defined by the constellation of abilities and interests defining the positive pole of Factor G, typical males by the positive pole of Factor H.

Summary

This analysis of test relationships has produced eight factors, one of which, Factor B, is defined solely by ability variables; three of which, Factors A, C, and E are defined solely by interest variables; and four of which, Factors D, F,G, and H are composites of ability and interest variables.

The Procedure

The experimental population was divided into three groups on the basis of faculty registration. After those subjects who had withdrawn from the College during the course of their studies were eliminated there were left 47 subjects in Arts, 35 in Commerce, and 36 in Science. The mean score of each sub-group on each factor was then calculated, and a product-moment correlation was computed for each group between factor score and final grade point average. The resulting statistics, and their significances, were then examined for confirmation of the factor definitions as evolved in section 3. The correlations are summarized in Appendix E.

The Validation Data

The members of the experimental population of this study were all freshmen students entering Sir George Williams College. Through the cooperation of the College the complete academic history for every subject during the first year of studies was made available. This information seemed well suited for use in validating the factors of this study since it provides independent data on both the preferences (faculty registration) and abilities (academic achievement) of the experimental subjects. For each subject two kinds of information were used. First, faculty registration. Since the admission requirements are uniform, faculty registration is largely a matter of preference. Second, average grade on final examinations for the first year of study. By assigning numerical values to the letter grades used to report final course standing a final grade point average was determined for each subject. The values were assigned to the letter

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grades on the basis A = 5, B = 4, C = 3, D = 2, E = 1, F = 0.

The Derived Factor Scores

In order to relate the validation data to the factors it was necessary to assign factor scores to every subject. A variant of Cattell's (14) 'situational index' method was used for this purpose. Cattell states (14, p 79) that addition of the standard scores of those variables with significant loadings on the factor in question will provide sufficiently accurate estimates of the factor scores. The method of computing beta weights is not necessary, he suggests, since the additional labour involved is out of proportion to the possible gain in accuracy.

It was felt in this study, however, that some allowance should be made for the varying contribution of the variables to the factors. Thus the method adopted defined each factor score as the sum of T - score multiplied by factor loading for all variables with significant loadings on the factor. Since the factor scores produced by this method are estimates of the hypothetical true factor scores they will be referred to as derived factor scores. Appendix D contains the formulae and the derived factor score distribution characteristics for the total group and the various sub-groups into which it was divided.

The Evidence of Validity

Factor A. This factor was equated with Cattell's factor QI.lb -"Guiding people for their own presumed good v. being coldly objective". The composite definition of this factor contrasted preferences for activities involving looking after, training, teaching, etc., with

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those emphasizing interviewing, convincing, supervising, etc. A review of the complete description of the factor suggests that a majority of individuals with high Factor A scores would register in Arts, while a majority of those with low scores would select Commerce.

Table 4.01

Factor A		Groups		
	Arts	Commerce	Science	Total
	N = 47	N = 35	N = 36	N = 135
Mean Score	43•4	18.8	38.2	34•1
S.D.	24•5	14.3	18.5	22•9
with G.P.A.	•08	05	.12	

Reference to Table 4.01 shows that the mean Factor A score for Arts students is 43.4, for Commerce students 18.8. This difference yields a t of 5.64.* The difference in mean score between the Commerce and Science students yields a t of -4.89. These differences are significant at the P = .001 level. The difference between the Arts and Science groups does not approach significance (t = 1.09). None of the correlations between factor score and grade point average are significant.

<u>Factor B</u>. This is the general ability factor. Since none of the preference variables show significant loadings there seems little basis for anticipating differences in Factor B score between the groups.

* Where t is defined as t =

$$\sqrt{\frac{s^2 + s^2}{\frac{1}{N_1} + \frac{1}{N_2}}}$$

 $x_1 - x_2$

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Table 4.02

Factor B		Groups		
	Arts	Commerce	Science	Total
	N = 47	N = 35	N = 36	N = 135
Mean Score	23.2	22.3	21.4	22.6
S.D.	2.3	3.6	4.8	3.0
Correlation				
with G.P.A.	•00	•09	•39	

None of the differences between the means shown in Table 4.03 attain significance at the P = .01 level. There might be some expectation of significant correlations between Factor B scores and grade point averages, but the only sizable correlation is that between factor score and grade point average for the Science group (r = .39)which is significant at the P = .05 level.

Factor C. This factor was defined as "thoughtful interest in understanding nature v. being the center of attention". The positive pole carried preferences for discovering, investigating, planning, being a chemist, psychologist, etc. The negative pole was illustrated by preferences for selling, collecting, entertaining, being a sales manager, radio commentator, music teacher, etc.

It is to be expected that individuals with high scores on this factor should show a preference for Science registration, those with low scores a preference for Arts or Commerce. As Table 4.03 shows, the mean score for the science group was 18.0, for Arts 0.3, and for Commerce 1.1. The differences in mean scores between Arts and Science (t = -5.55) and between Commerce and Science (t = -5.19) are both significant at the P = .001 level. The Arts - Commerce difference is not significant.

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Table 4.03

Factor C	Arts N = 47	Group Commerce N = 35	Science N = 36	Total N = 135
Mean Score S.D.	0.3 15.6	1.1 13.8	18.0 13.1	6.4 15.6
with G.P.A.	.16	•28	.18	

None of the correlations is significant at the P = .05 level.

<u>Factor D</u>. This factor, as a 'business interest' or 'accounting' factor, clearly has implications in favor of a Commerce registration for those with high scores. Such scores indicate both superior ability in, and preference for, computational activities. It may be anticipated also that there should be some correlation between scores on this factor and academic achievement within a Commerce program.

Table 4.04

Factor D				
	Arts N = 47	Commerce N = 35	Scien ce N = 36	Total N = 135
Mean Score S.D.	80.0 1/1-0	89.7	81.6	83.9 12.9
Correlation with G.P.A.	02	.45	05	12.07

Reference to Table 4.04 shows that the Commerce group averages significantly higher scores on Factor D. The t scores are, for Arts minus. Commerce -3.b4, for Commerce minus Science 2.96. The Arts minus Science difference is not significant (t = -0.59). Although the correlations for Arts and Science grade point averages are not significant, that for the Commerce group is significant at the P = .01 level.

Factor E. The positive pole of this factor was established as a

"verbal activities" preference. This preference would be associated with registration in Arts. The negative pole, defined as "manipulation of materials" would seem more appropriate for registration in Commerce or Science.

Table 4.05

Factor E		Groups		
	$\begin{array}{l} \mathbf{Arts} \\ \mathbf{N} = 47 \end{array}$	Commerce N = 35	Science N = 36	Total N = 135
Mean Score S.D.	18.2 14.1	8.5 13.0	9.2 10.1	12.0 13.6
with G.P.A.	•41	.21	01	

The differences between the means shown in Table 4.05 are significant at the P = .001 level for both the Arts - Commerce difference (t = 3.18) and the Arts - Science difference (t = 3.35). The Commerce -Science difference is not significant (t = -0.24). Examination of the correlations of grade point averages with factor scores shows that the coefficient for the Arts group is significant at the P = .01 level, although neither of the other coefficients approach significance.

Factor E is a preference factor, since none of the ability variables achieved significant loadings on it. This makes the correlation between Factor E scores and grade point averages for the Arts group even more suggestive, since in this case measures of interest are functioning as predictors of achievement.

Factor F. This factor was defined as a composite of socialized religion and verbal fluency v. irreligious aesthetic interests and spatial visual ability. The negative pole - socialized religion and verbal fluency - clearly implies an Arts registration. The opposing

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preference-ability constellation does not have such clear implications. None of the programs of study available to this group seem particularly appropriate to it.

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Table 4.06
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Factor F

Group

	Arts	Comme rce	Science	Total
	N = 47	N = 35	N = 36	N = 135
Mean Score	-21.6	-17.2	-15.7	-18.4
S.D.	7.3	6.4	6.0	7.5
with G.P.A.	02	•30	07	

The differences in group means for the Arts - Commerce (t = -2.82) and Arts - Science (t = -3.97) comparisons on Factor F are significant at the P = .01 and P = .001 level respectively. The Commerce - Science difference (t = -1.05) is not significant, and neither are any of the grade point average coefficients.

<u>Factor G</u>. The positive pole of this factor was identified as a composite of confident self-assertion, abstract or logical reasoning ability, and female sex. Individuals characterized by this constellation may be expected to show some preference for registration in Arts or Commerce. Those with low scores on the factor would probably be inclined more to register in Science study programs. These expectations are based partially on the implications of the factor definition alone, and in part on the known fact that Arts study programs typically attract a higher proportion of female registrants than do either Commerce or Science. (Of the 35 females in this experimental sample 27 registered in Arts.) It may also be anticipated

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that females would average higher scores on Factor G than males. (It should be noted that sex was not included among the variables used in the calculation of the derived factor scores for either Factor G or

Factor H.)

Table 4.07

Factor G

Group

	Arts	Comme rce	Science	To tal	Male	Female
	N = 47	N = 35	N = 36	N = 135	N = 100	N = 35
Mean Score	40.8	38.9	35•9	38.5	37•4	41.7
S.D.	7.9	4.9	7•0	7.0	6•4	7.6
with G.P.A.	29	41	05			

The mean Factor G scores shown in Table 4.07 are significantly different for Arts - Science at the P = .01 level (t = 2.96), for Commerce - Science at the P = .05 level (t = 2.08), and for sex difference at the P = .01 level (t = 2.89). The Arts - Commerce difference is not significant. Of the three correlations with grade point averages those for the Arts and Commerce groups are both significant at the P = .05 level.

<u>Factor H</u>. As with Factor G, 'confident self-assertion' is associated with the positive pole of this factor. However in this case it is part of a constellation including superior numerical and spatialvisual abilities. Since sex has a negative loading on this factor the positive pole was defined as representing a typically masculine group of abilities and preferences. The negative pole was identified by superior memory ability and the sex variable.

In the absence of any preference variable which would be suggestive for faculty registration such predictions must be based on the implications of the ability variables. Since both Science and Commerce programs allow scope for superior numerical ability it is to be expected that these faculties will show higher average factor scores than will the Arts group. The mean Factor H score for males can also be expected to be higher than that for females.

Table 4.08

Factor H

Group

	Arts	Commerce	Science	Total	Male	Female
	N = 47	N = 35	N = 36	N = 135	N = 100	N = 35
Mean Score S.D. Correlation with G.P.A.	47.1 8.4 54	51.3 9.2 .30	50.5 7.2 .24	49.6 8.3	51.3 7.8	44•8 7•9

The sex difference (t = 4.09) is significant at the P = .001 level. The Arts - Commerce difference (t = -2.08) is significant at the P = .05 level, and the Arts - Science difference falls just short of this (t = -1.92). It is interesting to note that the coefficients of correlation for derived factor score v. grade point average for Arts students is negative, and significant at the P = .01 level, whereas those for Commerce and Science are positive, although neither of the latter who are significant at the same level.

Summary and Conclusion

The validity of the definitions of each of the eight factors produced in this study have been tested by relating derived factor scores to faculty registration and academic achievement. Faculty registration, as a largely voluntary matter, was considered to be an acceptable criterion for testing the preference aspect of each factor.

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Academic achievement was used to assess the ability implications of the factors. The significance tests which were applied supported the definitions in each case, with the possible exception of Factor B the general ability factor. The lack of substantial discriminations or correlations in this latter case cannot be interpreted as invalidating the factor interpretation, however.

The results of the validity study are interpreted as supporting the interpretation of the factors as meaningful and dynamic dimensions of personality.

5. SUMMARY AND CONCLUSIONS

This study was designed as an essentially exploratory investigation of potential relationships between abilities and interests. Although available research suggested that substantial relationships should exist, results were not conclusive. Theoretical considerations implied, however, that such relationships could be expected.

The centroid factor analysis of the battery of ability and interest measures produced eight factors. Upon rotation to simple structure one of these factors was defined as an ability factor, three as preference factors, and four as composite factors including both ability and interest variables. Validation studies demonstrated that the factors allowed prediction of behavior in both free choice situations and in terms of achievement.

The results confirm the hypothesis. They demonstrate that abilities and interests are related. Not, perhaps, in precisely the way that previous investigators have presumed, since some were concerned with assumptions of causality, others with one-to-one relationships between abilities and interests. This research suggests that abilities and interests converge, in various constellations, on relatively independent behavior dimensions. For certain theoretical reasons these behavioral dimensions may best be defined as overlearned behavior patterns; 'traits' in the language of Allport (2) and Eysenck (17).

Eysenck (17, p 28) defines traits as "observed constellations of individual action-tendencies" and illustrates them as being composites of habitual responses. His use of this concept is congruent with that of Allport, who has advanced a set of criteria which such attributes of

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behavior should meet in order properly to be called traits. A review of these qualifications will demonstrate that the composite factors of this study clearly qualify for designation as traits.

The first of these specifies that a trait must have more than nominal existence. This requires that traits be defined operationally. The second requirement is that traits be more generalized than habits, that they be systems of integrated and organized habits. Third, traits are required to be dynamic, capable of directing responses. The fourth and fifth criteria specify that traits be capable of identification through statistical or empirical methods and that they need show only relative independence. The very critical use of conventional moral and ethical concepts as guides in the search for traits, and the avoidance of unrealistic demands for consistency in human behavior are also included in the list. Finally, Allport specifies that traits may be studied clinically, for the role that they play in a single personality, or through techniques of population sampling and individual difference.

The composite factors of this study seem to satisfy all of Allport's criteria rather elegantly, and may properly be considered as personality traits with integrative and dynamic characteristics. The theoretical considerations of Ferguson and Murphy cited in the introduction to this paper converge on overlearned behavior patterns as the most acceptable definition of what ability and interest measures measure. The results of this study support the hypothesis that abilities and interests are but aspects of overlearned behavior patterns properly called personality traits.

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APPENDIX A

The Code

Code No.		Code			
l	Sex				
2	Differe	ential Ap	titude 7	lests -	Numerical
3	Ħ		11	# <u>-</u>	Verbal
4	11		††	" -	Abstract
5	Primary	v ^M ental	Abilitie	es –	Numbers
6	11	11	11	-	Verbal Meaning
7	11	tt	11	-	Space
8	ŧf	ti	8 3	-	Word Fluency
9	11	n	99	-	Reasoning
10	11	#	Ħ	-	Memory
11	Kuder]	Preferenc	e Record	-Vocat	ional - Mechanical
12	13	11	11	11	- Computational
13	11	11	11	11	- Scientific
14	**	88	11	11	- Persuasive
15	11	11	"	11	- Artistic
16	19	ŧŧ	11	11	- Literary
17	17	11	11	11	- Musical
18	tt	11	11	11	- Social Service
19	Ħ	11	11	tt	- Clerical
20	Kuder]	Preferenc	e Record	-Person	nal - Sociable
21.	11	11	11	11	- Practical
22	**	11	n	**	- Theoretical
23	17	11	11	Ħ	- Agreeable
24	17	tt	łt	tt	- Dominant

APPENDIX B

THE KUDER VARIABLES

The Kuder - Vocational and Kuder - Personal inventories are constructed so that the subject is presented with a long series of named or described activities. These activities are grouped in sets of three. For each set the subject is required to indicate the most liked activity and the least liked activity. Selection of the most liked activity scores one for the interest area to which it is appropriate. With very few exceptions selection of the least liked activity scores one additional point for the interest area appropriate to the most liked activity in each set of three which is neither most liked nor least liked. The result is that the three activities of every set are ranked in order of their appeal to the subject. The most liked receives two points, the least liked receives no points, and the third, presumably intermediate activity, receives one point.

An attempt was made to list every activity which would, if scored most liked by a subject, contribute to the score for each of the several interest areas in turn. The least liked items were not included in the list because they score only by indirection. That a least liked item should score for any particular interest area is a matter of the specific context rather than the manifest content of that item. The activities appropriate to each interest area of the two Kuder inventories were then examined. An attempt was made to abstract a sufficient number of the items to construct an adequate description of the activity preferences involved in each area.

The advantage believed to accrue from this analysis of the

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Kuder scales is that the composite descriptions provide a more adequate basis for subsequent interpretation of the factors than do the publisher's area titles. The composites reproduce a sampling of the actual preferences contributing to each scale without drawing any specific conclusions about the nature of the preference dimension being sampled. The composite descriptions for each interest area of the Kuder inventories, as they were used in the interpretation and definition of the factors, are reproduced below.

<u>KV Mechanical</u>. Be a machinist, aeronautical engineer, etc., designing, inventing, etc., working with woodworking tools, hand looms, broken locks, jig-saw puzzles, etc., and studying shopwork, metal working, hospital construction, etc.

<u>KV Computational</u>. Be a bookkeeper, authority on taxation, professor of mathematics, etc., planning, determining costs, etc., working with figures, adding machines, cost of living tables, mental arithmetic, public opinion survey statistics, etc., studying mathematics, cost accounting, etc.

<u>KV Scientific</u>. Be a chemist, physician, aeronautical engineer, psychologist, etc., developing, discovering, investigating, exploring, etc., working with mechanical toys, sewing machines, etc., studying sociology, disease causes, mathematics of astronomy, science museums, etc.

<u>KV Persuasive</u>. Be an authority on advertising, sales manager, radio commentator, publicity director, etc., selling, collecting, interviewing, convincing, supervising, etc., working with insurance, real estate, calculating machines, stocks and bonds, dishwashers, etc., studying salesmanship, propaganda, business trends, public speaking, etc. <u>KV Artistic</u>. Be an artist, architect, sculptor, portrait painter, etc., drawing, teaching, writing, designing, painting, etc., working with linoleum block bookplates, art supplies, etc., studying modern painting, fine arts, museums, sketching, etc.

<u>KV Literary</u>. Be a poet, writer, journalist, literary critic, etc., teaching, reading, writing, browsing, etc., working with editorials, English, scripts, articles, etc., and studying story writing, history of drama, language, etc.

<u>KV Musical</u>. Be an organist, radio singer, music teacher, etc., playing, composing, arranging, tuning, etc., working with a symphony, musical comedy, music store, etc., studying music, arrangement, opera singers, etc.

<u>KV Social Service</u>. Be a social service worker, religious leader, authority on public health, vocational counsellor, etc., looking after, taking care of, training, teaching, helping, etc., working with a blind student, slum children, native epidemics, old folks home, etc., studying sociology, immigration, crime causes, social customs, etc.

<u>KV Clerical</u>. Be a private secretary, postal clerk, court stenographer, etc., typing, cataloguing, compiling, sorting, classifying, etc., working with correspondence, bills, tickets, mail, letters of inquiry, etc., studying accounting, business English shorthand, etc.

<u>KP Sociable</u>. Be clever, sympathetic, socially active, engaged as a committee member, teacher of public speaking; introducing a speaker, giving an impromptu speech, entertaining with tricks of magic, having picture in paper with society leader, etc.

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<u>KP Practical</u>. Be a judge, soldier, sailor, business president, average citizen, always telling the truth, being kind to people, going on a camping trip, to a reception, building scenery for a play, teaching retarded children, reading a story about a modern small town, etc.

<u>KP Theoretical</u>. Be a college professor, member of a debating society, a specialist in the study of the mind, giving personal counselling, reading theories of an ideal world, going to a lecture on world affairs, working mainly with ideas, etc.

KP Agreeable. Be an art teacher, museum guard, tailor, bank cashier, teaching in high school, broadcasting a prize fight, going fishing, seeing a checker game, reading about travel, avoiding criticizing people, seeing movies of beautiful scenes, etc.

<u>KP Dominant</u>. Be a judge, school superintendent, business president, mayor, club president, congressman, commanding an army, tracking down criminals, reading about politics, writing plays, interviewing the Secretary of State, watching an executive working, etc.

APPENDIX C

THE DERIVED FACTOR SCORES

Preliminary Considerations

The formulae used to obtain the derived factor scores used in this study were obtained by summing the products of the loadings of each variable with a significant loading multiplied by the T-score for each individual for each factor. The calculation of multiple regression coefficients and the use of the resulting Beta weights may have provided more exact estimates of factor scores. However since all the variables (excepting sex, which was not used in the determination of any derived factor score) were T-scored, the problem of differing variances does not have to be contended with. As a factor loading may be thought of as a quantification of the contribution of any given variable to the composition of a factor, the product of factor loading and T-score can serve as a measure of the contribution of any given score to the total factor score of an individual. A certain error is introduced by this method since it neglects to allow for the intercorrelations of the variables involved. This error can be tolerated, however, without doing undue violence to the resultant analysis.

The Derived Factor Formulae

The following formulae identify the variables in each equation by the code numbers they were assigned in the initial coding (see Appendix A).

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Factor A Score =	(.73)(23) + (.62)(21) + (.49)(18) + (.36)(22)
	+ $(32)(11)$ + $(58)(14)$ + $(62)(24)$.
Factor B Score -	(.78)(3) + (.72)(9) + (.66)(4) + (.64)(6) +
	(.56)(8) + (.44)(7) + (.38)(10) + (.35)(2).
Factor C Score =	(.65)(13) + (.37)(12) + (.34)(21) + (35)(17)
	+ (43)(20) + (45)(14).
Factor D Score =	(.65)(12) + (.64)(19) + (.39)(5) + (.29)(2)
	+ (.28)(9).
Factor E Score =	(.57)(22) + (.50)(16) + (29)(11) + (54)(15).
Factor F Score =	(.43)(4) + (34)(18) + (46)(8).
Factor G Score =	(.44)(9) + (.33)(20) + (.28)(18) + (28)(16).
Factor H Score =	(.57)(2) + (.37)(7) + (.35)(20) + (30)(10).

Derived Factor Scores : Distribution Characteristics.

Fac	ctor	Group					
		Arts N - 47	Commerce N - 35	Science N - 36	Male N - 1 00	Female N - 35	Total N - 135
<u>A.</u>	Mean S.D.	43•4 24•5	18.8 14.3	38.2 18.5			34 .1 22 . 9
<u>B</u> •	Mean S.D.	23.2 2.3	22 . 3 3.6	21.4 4.8			22.6 3.0
<u>C</u> .	Mean S.D.	0 .3 15 . 6	1.1 13.8	18.0 13.1			6.4 15.9
D.	Mean S.D.	80.0 14.0	89 .7 11 . 4	81.6 11.4			83.9 12.9
<u>E</u> .	Mean S.D.	18.2 14.0	8.5 13.0	9.2 10.1			12.0 13.6
<u>F</u> •	Mean S.D.	21.6 7.3	17.2 6.4	15 .7 6 . 0			18.4 7.5
<u>G</u> .	Mean S.D.	40.8 8.0	38.9 4.9	35•9 7•0	37.4 6.4	41.7 7.7	38•5 7•0
<u>H</u> .	Mean S.D.	47 .1 8.4	51.3 9.2	50.5 7.2	51.3 7.8	44.8 7.9	49.6 8.3

APPENDIX D

Correlations between derived factor scores and grade point averages,

Factor	Arts N = 47	Comme rce N = 35	Science N = 36
A	•08	05	.12
В	•00	•09	<u>•39</u>
С	.16	•28	•18
D	02	•45	- .05
E	<u>.41</u>	.21	01
F	02	•30	07
G	 22	41	05
Н	54	• 30	.24

by t	facu	lty	¥
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* Note: Broken underlining (___) indicates significance at the P = .05
level, solid underling (___) indicates significance at the
P = .01 level.

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