IDENTIFICATION AND IMPLICATIONS OF SOME PSYCHOLOGICAL CHARACTERISTICS OF UNIVERSITY BIOLOGY STUDENTS.

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PART I.

Chapter 1. INTRODUCTION

The Problem and its Setting

The Report of the English Universities Central Council on Admissions reveals that in 1966 there were 1600 student vacancies in science and technological subjects in English Universities. As a contrast to this there were between 4,000 and 7,000 unsuccessful candidates for places in social sciences and arts subjects. The Times Educational Supplement (1967a) focuses attention on the fact that this imbalance inevitably leads to a discrepancy in entrance standards between subject areas; which means that while able candidates are accepted for non scientific subjects, sciences must perforce accept many lower grade entrants.

In further discussion (Times Educational Supplement 1967b) it is made explicit that the drift of students is not to arts subjects but to what are described as

"socio-economic" subjects. Although absolute numbers of students selecting science courses were rising, by approximately 10% per year, the proportions of these students who had "two or more 'A' level passes"[1] had actually fallen. Identification of factors contributing to this decline in quality and rate of expansion of the sciences, notably biology, is one of the main objectives of this study.

A recent New Zealand paper (Matthews and Collins, 1967) discusses what the authors consider to be an irregular distribution of talented university students among the various sciences. Particularly they are concerned about the paucity of the biology intake. Statistics can be selected (1966) to indicate bias in numbers graduating in the various subject areas in New Zealand. e.g. In 1964 213 persons graduated at bachelor level in English; only 52 in botany and 68 in zoology. Also in 1964 13 persons obtained Ph.D. degrees in chemistry, 2 in zoology and 1 in botany.

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1. "A" level is "advanced" level as contrasted with "O" or "ordinary".

From the same source (1966) the following table has been extracted to indicate numbers of students at the 6th form level studying the various subjects offered.

Table 1.

SUBJECT ENROLMENT IN N.Z. 6TH FORMS JULY 1965.

	Form VI b.		Form VI a.		
Subject	Boys	Girls	Boys	Girls	Total
English	6527	4839	2164	903	14433
Languages	1525	3254	627	830	6236
Social Studies	133	100	25	28	286
History	2137	2682	558	423	5800
Geography	2938	3144	552	372	7006
Mathematics	4636	1753	1661	435	8485
Biology	3167	3505	801	491	7964
Chemistry	3559	1157	1465	376	6557
Physics	3366	546	1439	271	5622

Observations from this table can be made as follows.

1. English is a compulsory subject and thus it can be seen that in terms of total numbers in VI a, boys outnumber girls by

nearly three to one.

2. The biology enrolment at the VI b. level is greater than that of other sciences. However at VI a it is smaller than any other science. This change is in part attributable to the sudden decrease in the numbers of female students, but even so the male numbers also have declined sharply. If this trend continues into the first year of university study it would substantiate the claim of Matthews and Collins, although this is difficult to ascertain as it must be remembered that the subject subdivides at this stage into botany, zoology, agriculture, veterinary science, food technology etc.

3. Ratios between sixth form subject enrolments are not necessarily those apparent at the tertiary level.

On the evidence indicated so far, two suggestions might be made. Firstly that an imbalance exists in numbers of students majoring in the various faculty areas and secondly that a similar imbalance in ability levels is also apparent.

Closely akin to this is the evidence amassed by Hudson (1963a), which makes manifest the suggestion that the sciences are not attracting the divergent thinkers. This divergent/convergent dichotomy traces immediately back to Guilford (1950) who revived interest in the field. Getzels and Jackson (1962), McKinnon (1962) and Torrance (1965) to name but a few, have developed their own facets subsequently, adding to the sum total of knowledge of this topic.

Hudson's suggestion then has far reaching implications. Both he and Stenhouse (1965) point out that while science in the initial stages may tend to contain much of the factual knowledge which appears to attract predominantly convergent thinkers, at the research levels the divergent, original and flexible mental outlook is of prime importance. Certainly all science graduates do not engage in research, but this does not alleviate the problem as a majority of those who do not attain this level actually return to science as teachers at the divers stages. As can readily be appreciated a core of predominantly convergent teachers can do untold harm to their students both in repelling the creative thinkers and in fixing negative attitudes of those students who do remain.

The argument now returns to the work of Stenhouse (1965) who takes up this very point of science teaching; specifically biology teaching. In relating much of the previous research he provocatively expands several pertinent issues. To what extent are career structures determined too early and by "factors inimical to science"? Do specific methods of teaching or presentations attract either divergent or convergent thinkers? Are divergent thinkers subtly forced into 'convergent' moulds by social pressures?

It is at this juncture, where with the imbalance and misdirection of intellectual and creative talent, plus the possibility of social pressures towards conformity established, that the studies of student failure carried out by Parkyn (1959 and 1967), Sanders (1961) and others add information to the problem in its generalized form. Unfortunately Parkyn and Sanders did not extend their studies to include convergent/divergent variables, nor did they investigate personality correlates, although to a limited extent Small's (1966) work relates personality factors to the larger field of analysis.

Universal acceptance is accorded the fact that not only New Zealand but also other countries have this

problem of the optimum direction, application and development of adolescent talent. We need to be more cognizant of the factors which guide pupils into the various academic paths and determine success therein. Are these artificial forces or do the abilities and interests of the child provide the major weighting? Matthews and Collins (1967) find that in 6th forms in some schools there are subjects which are mutually exclusive because of timetable and staffing difficulties. The implication in both the Times articles and Stenhouse's writing also is that canalizing factors tend to be circumstantial and to operate at too early an age.

That here is a vast problem area is undeniable. Particularly is this apparent when one envisages both longitudinal and cross sectional perspectives. Longitudinally there is the period of late adolescence and early adulthood encompassing 6th form secondary school years and initial university years of study. In many ways this is the most critical time of life when major decisions affecting vocation selection and levels of aspiration must be made. The cross sectional perspective must explore variables within the student himself, external variables and investigate the multiplicity of resulting inter-relationships.

This then is a brief overview of the precincts of this thesis. It derives from official statistical documents and from research data on divergent thinking, personality and university performance brought into perspective by the hypotheses of differential selection of personality type and differential modification of personality type, put forward by Stenhouse. Most of the data obtained bear upon the "selection" rather than the "modification" hypothesis - but the main objective has been to obtain data which would help to fill the informational hiatus between the work of Parkyn, Small and others (who have worked with a university population but who have not investigated the divergent thinking factors likely to be significant) and Hudson, Getzels and Jackson and others (who have studied the divergent thinking factors but only among school populations).

Assumptions Made

Implicit in the work of Parkyn, Small, Sanders and Hudson, is the assumption that there exist students who, although they do not in fact pass units of a degree, are on a theoretical basis judged capable of doing so. This must remain an assumption only, as in no way can one prove that student 'X' was capable of accomplishing something which under existing conditions he did not do. If he is taken through a course a second time, given specific guidance and wise counselling, and he manages to pass, one has merely proved that he was capable of passing at a second attempt but not that a first attempt pass was possible.

A second and subsidiary assumption which must be made is that it is beneficial for the student, and for the community, that he should realize or actualize his potential academic strengths and that intellectual wastage should be restricted to a minimum. Similarly there can be no absolute certainty that student X would lead a happier or more productive life if he were channelled into an academic or professional vocation by initial examination success.

It is only by making these two assumptions explicit as basic premises that one can justify research into relevant data which may furnish further information. Such knowledge as this however is vitally necessary for vocational guidance personnel, student counsellors and teachers, and, at the economic and organizational level, for education administrators and curriculum advisers.

Significance of the Study Area

The suggestion is that this present research, whether it be judged good research or poor research, at least has the quality that it probes an important and significant sphere. While one cannot prove that one field is more important than any other, the following two quotes are included as reinforcement for this suggestion.

> The progress of science and the growing complexity of our civilization put increasing pressure on the individual to fit himself for an ever more skilled role in his daily work, in his duty as a citizen and in his private life in the community. (Currie G.A. in Parkyn 1959).

> The goals of modern societies are political and social as well as economic. Human resource development is a necessary condition for achieving all of them. A country needs educated political leaders, lawyers, trained engineers, doctors, managers, artists, writers, craftsmen

> and journalists to spur its development. . . . If a country is unable to develop its human resources it cannot develop much else.

Both for reasons of national economic development and the personal fulfilment of the individual it becomes obvious then that a greater knowledge and understanding of the late adolescent, early adult student, and his environment, is to be desired. Once this proposition is accepted, a commencement can be made towards a more detailed analysis of some of the major factors which may be relevant.

To enable these to be selected on an objective basis, a criterion was established; variables were admitted only if previous research had indicated them to be productive themes to pursue. On these grounds five variables central to the problem area were selected to form an operational framework throughout the thesis. They are -

1. Intelligence (AH.5. test)
2. Convergent/divergent thinking (open ended tests)

3. Personality (16PF factors)

4. Subject experience (6th form biology)

5. Social characteristics (age and sex)

Chapter 2. THEORETICAL FRAMEWORK

Definition of Terms.

Nominal Definitions.

Intelligence.

Intelligence has been assessed by means of the A.H.5. test for superior adults. Two important considerations influenced the selection of this instrument.

(1) It was used by Hudson and thus affords a greater degree of comparability between his work and this research.

(2) Practice effects from previous test experience would be minimized as it is not a test commonly used in this country.

It is composed of two sections; I verbal-numerical and II spatial which can be summed to give a total score. This summed score will be employed throughout the research, except for isolated occasions when the two sections will be used separately as a bifurcation of the more global data. These of course will be designated as such.

Divergent/ Convergent Thinking.

The number of definitions of divergent thinking or creativity extends into three figures and emotional associations have proliferated to such a degree that it is felt important to detail both the theoretical underpinning and the practical application of the terms as used in this study.

Psychoanalytic theories of creativity tend either toward a compensatory postulation or to imply that creative acts are the expression of a neurotic personality pattern. The former suggests that persons produce art, literature, music etc. in order to compensate for personality or physical inadequacies, while the latter would indicate that "talent is a disease and creativity a neurosis". (May 1959)

A further theoretical hypothesis is the reductive one which states that creativity is nothing but something else; say motivation. The term is in this manner explained away and what is probably an entity ceases to exist.

At the other extreme is the factor analytic approach such as that of Guilford (1951) who subdivides creativity into factors of spontaneous flexibility, adaptive flexibility, originality, elaboration, redefinition, word

fluency, associational fluency, expressional fluency and ideational fluency.

When the words "creativity" or "divergent thinking" arise in topics of conversation, many people immediately envisage such persons as artists, scientists, architects - well known producers of artistic or creative worth. This is a narrow application of terms which for the purpose of this thesis can apply equally well to the housewife who develops a novel style of cooking venison or the home gardener who constructs an attractive original scoria garden. Convergence-divergence is not a strict dichotomy but rather the concept of the extremes of a continuum, and while a particular person may be divergent in one sphere in which he may have special interests, he could quite likely be most convergent in other pursuits.

Rogers and Maslow are more in accord with this interpretation when they envisage creativity as an advanced form of "self actualization".

> The mainspring of creativity appears to be the same tendency which we discover so deeply as the curative farce in psychotherapy - man's tendency to actualize himself, to become his potential. (Rogers 1957)

While the theory of self actualization is much criticized for its vagueness and lack of precise definition, creativity viewed as a form of self actualization allows for a broad interpretation of the terms, as a contrast to the narrower conceptualizations of some other theorists.

Obviously the testing of such an entity is likely to pose a problem. The solution taken here has been to use one of the Torrance tests, Unusual Uses, plus a test of free association. The questions of validity and reliability of this solution will be discussed in a later chapter. Fluency, flexibility, and an innovation, the ratio or relationship between these two facets of divergent thinking, will also be discussed later. A further point - while a divergent thinker may not necessarily be creative according to some interpretations, for the purposes of this study the terms are used synonymously.

Personality.

Personality differences, where they occur, will be referred to in terms of the 16 P.F. test dimensions. There are two reasons for the selection of this particular test, in preference say to the M.M.P.I. which Small used.

(1) Articles have been published by Cattell and Drevdahl (1955) describing profiles of creative researchers. This contributes a theoretical texture to the research.

(2) Its dimensions are those of normal personality and not personality malfunctions as is emphasized with the M.M.P.I. Hence it is implied that normal personality traits are of more importance in the discovery of failure and interest correlates in the university population than are abnormalities of personality.

Operational Definitions

Intelligence

For several hypotheses a comparison of the top 20% of students on the intelligence test with the lowest 20% is involved. These groups are selected on the basis of total A.H.5 scores and will be referred to henceforth as the 'intelligent' group and the 'non-intelligent' group. Note however that the non intelligent group would be above the mean of the general population but in this highly selected sample they are the lowest 20% (I.Qs of this group would probably range from 100 to 115).

Divergence - convergence

Similarly the top 20% selected from a total score in both divergence tests will be labelled 'divergers', while the lowest 20% will be represented by the term 'convergers'.

All divergence scores will be derived from this total of both tests except for cases where a score is composed of the ratio of fluency to flexibility (fluency $\div$ flexibility). This will be indicated by the term 'ratio score'. (Defined further in Chapter 3).

In hypothesis BII four groups are placed in rank order. For reasons of clarity and simplicity these

groups have been coded by the names, alpha, beta, gamma and delta.

alpha - all students graded in both the top 20% for intelligence and for divergent thinking.

beta - all students in the top 20% for divergent thinking only.

gamma - all students in the top 20% for intelligence only.

delta - students rated in none of these top 20% groups.

Personality

Personality will be referred to in terms of Cattell's 16 P.F. factors.

Subject experience

The top 20% of students in the final biology examination will be indicated as the 'biology' group. These will on occasion be compared with the students who actually sit the examination but fail; the 'biology failers'.

From the university record files has been obtained information concerning each student's proposed majoring

subject. Three main groups emerge; those majoring in biology, in veterinary science and in agriculture. These will be designated as the 'biologists group', the 'veterinary group' and the 'agriculture group' respectively. (A certain amount of confusion between "biology" group and "biologists" group appears likely but any other designations would lack explanatory value so after consideration the names have been retained).

A further contrast considers the 'drop out' group and those who actually sit the examination. (regardless of whether they pass or fail). Terms used here will be 'non completers' and 'completers'.

The criterion for 'previous subject experience' is delineated by whether or not the student actually studied biology as a subject for the University Entrance examination. Experience in nature study or general science must be disregarded for this purpose.

Social Characteristics

Two dimensions only are employed here. The first is 'sex' which needs no further clarification and the second is 'older' and 'young'. 'Older' students are those of age twenty years and above whole 'young' encompasses all of the seventeen and eighteen year olds.

Previous Relevant Research.

It is impossible to assess the numbers of books, articles and research projects which have been undertaken under the appelation of creativity or divergent thinking. They would undoubtedly extend into the four figures category and when one adds to these the assemblage of works on intelligence and personality it becomes evident that some criteria must be employed to systematize the specific research regarded as relevant for this thesis. Consequently the following were established.

(1) Only publications printed during the last one and a half decades will be reviewed.

(2) Topics discussed must relate to the age group involved.

(3) Persons referred to must be students or pupils.

With these characteristics in mind compatible research will be discussed under the usual 'variable' headings.

Intelligence

The correlation between intelligence and attainment in the first year at university is generally not higher than .35. Both Parkyn (1959) and Sanders (1961) report this from separate projects in New Zealand and Western

Australia respectively, and Sanders relates this more specifically to biology by demonstrating that a correlation between I.Q. (A.C.E.R. B40) and scores in first year biology examinations emerged at ·30. This low correlation is to be expected when it is considered that university students constitute a very small percentage of the total population of the age group. Parkyn in particular is quick to qualify his statements on the subject by saying that,

> The low correlation found between university performance and measures of intelligence for example does not mean that intelligence as such is not fundamental to university success; it simply means that the differences in intelligence among students at the university level are not great enough to determine their differences in performance. (Parkyn 1959).

A sex difference in intelligence is reported by Sanders (1961) who states that female students, irrespective of their course, tend to score more highly on verbal sections of intelligence tests than they do on

"quantitative or mathematical questions". Burnham (1955) also reports this trend in both New Zealand and U.S.A. (This is in contrast to males who do not tend to have differential scores).

Convergence - divergence

Getzels and Jackson (1962) selected two groups of pupils which they named "High I.Q." and "High Creative". The former group was composed of pupils who scored highly in intelligence tests but poorly in tests of "creativity" while conversely the "High Creatives" scored relatively poorly in intelligence tests but well in "creativity".

Similar groups were also obtained by Hudson who labelled them "Convergers" and "Divergers" respectively and replaced "creativity" tests by "open ended" tests. He is careful to observe that many pupils score well on both types of tests or poorly on both types of tests, but for purposes of his study consideration is given chiefly to the two contrasting groups.

On further research he discovers that the "diverger" tends to be the arts specialist while the "converger" is predominantly the scientist, with the exception that biology does not fit the science pattern and tends to

attract a wider variety of pupils including 'divergers'. The dangers in this discovery are quickly apparent to Hudson. He says,

> The practical dangers are not only that science may recruit boys who are narrow and inflexible; but having recruited them, may inadvertently reinforce emotional defences which unsuit them for original research (1963).

Personality

Using the M.M.P.I., Small (1966) revealed an association of anxiety and nervousness with success in examinations with low mean scores on the hypomania scale. This he construes as exemplifying the necessity for students to discipline themselves and resist tendencies towards distraction and diffusion of effort. He also reports that failing students tend to be prone to ill health or at least are more conscious of ill health than successful students.

Cattell, who is fundamentally a specialist in the personality field, found creative groups of artists and scientists, relative to the general population, to be

characterized by higher ratings in schizothymia (cool, aloofness with some aggressive tendencies), intelligence, dominance, desurgency, radicalism and self sufficiency, or as Drevdahl (1958) sums it up, "they are both introverted and bold".

Both writers make explicit the theory that creative artists and leading scientific researchers (including a large biology group) do differ significantly from those of equal academic training and ability but who are not creative.

> The difference between the creative and the routine competent individual lies more in the realm of personality than in the realm of special ability tests (Cattell 1963).

Subject Experience

The great majority of full time students who were admitted to university through the normal channels of passing the entrance examination, either by sitting or by accrediting, were adequately prepared by their subject experience at secondary school to cope with university studies at the standard currently being set by the several departments.

Parkyn (1959) also found, at a more particular level, that the correlation between prior school attainment and first year university pass rates of full time students was in the vicinity of ·5. However the correlation between part time or advanced students' prior school attainment and pass rates was negligible.

Theorizing from his experiences as a student and lecturer, and extrapolating from Hudson's data, (and that of others) Stenhouse (1965) suggests that "a diverging tendency is often overborne, . . . by subtle social pressures". At a more concrete level he suggests that differing modes of biology teaching tend to attract or repel these able divergent students. An holistic teleonomic approach, he states, is likely to be more successful than the reductionist view which discusses biological phenomena in terms of their "component physico-chemical phenomena".

> To say: 'an animal has a skeleton in order to keep its body in shape and to provide a firm basis for the muscles to work on', stimulates the interest of the class in proportion as it makes meaningful a number of hitherto discrete and amorphous items of knowledge. (Stenhouse 1965)

Social Characteristics

Information under this heading tends to be of a rather discontinuous nature. There are two particular items however which are appropriate for inclusion among the hypotheses for further verification.

Variables such as, type of lodging, distance to travel to lectures and socioeconomic background have no apparent effect on a students chances of completing a successful first year. Parkyn (1959) finds that this is so and his latter disclosure is substantiated by Wolfle (1961) in America who says,

> The probability of enrolling in college decreases more sharply as one goes down the ability scale for children from economically and socially less favoured homes than it does for children from more favoured homes. After entering college the situation changes. The student who gets into college has already overcome most of whatever handicaps his home environment offered: once there his chances of graduating are

much more dependent upon his family background than were his chances of getting into college in the first place.

(There are indications however that this may not be the case in England. (Jackson and Marsden 1962).)

Following Parkyn, Small (1966) added several pertinent items of information. He states that younger students tended to be more successful than older students. This is interesting as it was also found by Sanders (1961) Philp and Cullen (1955), Fleming (1959) and Moodie (1959) but the phenomenon apparently does not appear in all student samples.

Sanders (1961) also reports that in Western Australia female students have a lower graduation rate than male students. This is not mentioned by other writers however.

In drawing together the fibres which flow through the various researches there are implications, at the theoretical level, for national economics and human resource development, while practical implications are apparent for teaching methods, school organization, student counselling and university admission mechanisms. To an extent this drawing together has been accomplished in Stenhouse's (1965) paper and it is from this point with due regard for the student sample available and the test setting advantages

and disadvantages that the hypotheses to be tested have evolved.

Hypotheses to be Tested

Intelligence

A I(a) Intelligence is not a significant factor in Biology pass rates.

I(b) There will not be a significant correlation between Biology marks and intelligence scores.

II Compared with completers, non-completers will not differ significantly in mean intelligence scores.

III Among the subject groups no significant differences in intelligence scores will be found.

Convergence/Divergence.

B I(a) Compared with convergers, divergers will have a significantly higher mean score in Biology.

I(b) There will be a significant positive correlation between Biology marks and divergent thinking scores.

II Groups alpha, beta, gamma, and delta will be ranked in this specific order for mean performance in Biology. (See definition of groups in Chapter 2).

III The mean divergence score of the completers will be significantly higher than that of the non-completers.

IV Compared with the two other subject groups, the Biologists will be significantly higher in divergent thinking ability.

V When personality profiles of the intelligent, biology and diverger groups are compared, factors will be patterned according to the matrix below.

16 PF factors.

Intelligent	B+				Q_1+
Biology			I-		
Diverger		F+	I+	M+	

VI When contrasted with the convergers' mean personality profile, the divergers' profile will be significantly higher in factors F, H, I, M, Q_1, Q_2.

VII The divergers' mean personality profile will be the functional equivalent of that of Cattell's "creative scientists".

Personality

C I When compared with the Biology failers, the Biology group will reveal higher mean scores in personality factors E, H, L and N.

II The completers' mean personality profile will reveal higher scores than the non completers' profile in factors C, E, G, and Q_4.

Subject Experience.

D I Students with previous subject experience will have a significantly higher mean score in Biology than students with no previous experience.

Social Characteristics.

E I Compared with older students, young students will have a higher mean Biology score.

II Male students will have a higher mean Biology score than female students.

PART II

Chapter 3. METHODOLOGY

Population Sample and Sampling Methods

In 1966 an initial scheme was undertaken in which 198 students enrolled in the Stage I Multicell Biology Course at Massey University were tested with three separate instruments; the A.H.5. Intelligence test, the Unusual Uses test and a test of free association. Of these 198, three cases were rejected because student names were omitted or because parts of the test sequence were missing. Thus there remained a final sample of 193. It should be noted that there is no sampling procedure here - all students taking the course were tested following a short terms test.

This year, 1967, an identical procedure was to have been followed except that an additional test, the 16.P.F., which was not available formerly in sufficient numbers, was to have been administered. Unfortunately the professor

with whom this arrangement was originally made had left the University and the usual short terms test had been replaced by a much longer essay type test. The lecturer in charge of the department would not allow students to sit further tests after this, (and rightly so) both because it was prolonging the situation unnecessarily and because results gathered in this manner would be of suspect validity (in view of fatigue factors). The only solution, and thee one which was adopted, was to request volunteers to come at an arranged time to sit the tests. This resulted, even after two sittings, in a sample of only 60 students instead of the expected 200.

Data Collection

In addition to the test results, final marks from both years were obtained through the Registrar who also supplied data as follows - sex, age, majoring subject, subjects taken for University Entrance and subjects taken for School Certificate.

Design of Research

Hypotheses were detailed in accordance with prior

research (see chapter 2.) but to interrelate areas previously studied in a more isolated manner. Variables chosen were -

(1) Intelligence - at times reduced to two sections: verbal-numerical and spatial.

(2) Divergent thinking - again often in sections: fluency, flexibility and a ratio between the two.

(3) Personality - using the sixteen bipolar factors of the 16 P.F. test.

(4) Previous subject experience - subjects taken for the Entrance Examination and also subject majoring preference.

(5) Social Characteristics - sex and age.

Final biology marks can also be considered a variable, but have not been included in the above list as they are viewed as a dependent variable whereas the five listed variables will be, virtually always, independent variables.

As the main intention is to investigate relationships existing between these variables, the research design essentially consists of the collection of data and the statistical processing of it to reveal this information. While this is not a particularly sophisticated design it is analogous to that of other researches in a field which does not require a high degree of necessary sophistication. Finally this work is to be regarded as a preliminary overview of the subject rather than a deep detailed research on a very specific problem.

Appropriateness of Design

This design, while parallel to those of Parky, Sanders and Small, has the advantage that it considers the divergent thinking variable which they do not. Similarly the use of the M.M.P.I. by Small implies that failure, if caused by personality variables, is attributable to abnormalities of personality. While undoubtedly students do fail because of abnormal personality characteristics, it is considered that normal personality traits have a greater effect over a wider area and thus a more profitable research would be with the use of an instrument which measures normal personality functions rather than abnormal ones.

In his consideration of divergent thinking abilities it is felt that Hudson dichotomizes the subjects in a rigid fashion and rather neglects the able boys who are high scorers on both intelligence and "open ended" tests. This thesis is designed to avoid these limiting aspects. Broadly speaking the inclusion of a wide and pertinent set of variables is the strengthening factor of this research design.

Characteristics of Research Population.

1966 sample — 193 cases

- Test results
  - A.H.5.
  - Unusual Uses
  - Free Association
  - Biology Finals
- Other Information
  - Age
  - Sex
  - U.E. subjects
  - S.C. subjects
  - Majoring subject

1967 sample — 60 cases

- Test results
  - A.H.5.
  - Unusual Uses
  - Free Association
  - Biology Finals
  - 16.P.F.
- Other Information
  - Age
  - Sex
  - U.E. subjects
  - S.C. subjects
  - Majoring subject.

Intelligence

1966

A.H.5.	Part I	Males	Mean = 14.90	Range = 6 - 25
		Females	Mean = 17.23	Range =11 - 23
		Total group	Mean = 15.10	Range = 6 - 25
A.H.5.	Part II	Males	Mean = 18.42	Range = 7 - 32
		Females	Mean = 19.71	Range =14 - 27
		Total group	Mean = 18.54	Range = 7 - 32
A.H.5.	Total	Males	Mean = 33.32	Range =15 - 56
	Score	Females	Mean = 36.94	Range =27 - 50
		Total group	Mean = 33.64	Range =15 - 56

1967

A.H.5.	Part I	Males	Mean = 14.87	Range = 6 - 23
		Females	Mean = 17.50	Range =12 - 22
A.H.5.	Part II	Males	Mean = 19.57	Range = 7 - 29
		Females	Mean = 20.17	Range16 - 27

A.H.5.	Total Score	Males	Mean = 34.44	Range =14 - 49
		Females	Mean = 37.67	Range =28 - 49
		Total group	Mean = 34.67	Range =14 - 49

Divergent Thinking

Flexibility	Males	Mean = 40.38	Range = 12 - 80
	Females	Mean = 38.90	Range = 14 - 60
	Total	Mean = 40.25	Range = 12 - 80
Fluency	Males	Mean = 89.03	Range = 25 - 195
	Females	Mean = 84.40	Range = 20 - 135
	Total	Mean = 88.63	Range = 20 - 195
Total Score	Males	Mean =129.41	Range =43 - 275
	Females	Mean =123.30	Range =34 - 195
	Total	Mean =128.88	Range =34 - 275

Personality

Means for total 1967 group. N = 60

Factor	Mean Sten	Factor	Mean Sten
A	5.00	L	5.82
B	5.45	M	6.70
C	5.20	N	5.25
E	5.82	O	6.00
F	5.52	Q_1	5.70
G	4.53	Q_2	6.17
H	5.18	Q_3	5.50
I	5.30	Q_4	6.23

Subject Experience

1966

93 took biology for U.E.

33 did not take biology for U.E.

67 no subjects given in official records.

1967

35 took biology for U.E.

18 did not take biology for U.E.

7 no subjects given in official records.

Majoring groups 1966

Biologists	=	36
Vets.	=	63
Agriculture	=	84

Majoring groups 1967

Biologists	=	9
Vets.	=	18
Agriculture	=	23

Final Biology marks 1966

'A' passes	4
'B' passes	30
'C' passes	97
Failers	52
Non Completers	10

Final Biology marks 1967

	'A' passes	1
	'B' passes	13
	'C' passes	22
	Failers	12
	Non Completers	12
1966	Male range	56 - 145
	Female range	62 - 157
1967	Male range	51 - 155
	Female range	76 - 128

Social Characteristics

Age 1966	Nos.
17 yrs.	5
18 yrs.	90
19 yrs.	68
20 yrs.	15
21 yrs.	4
22+ yrs.	11

Sex

1966

Males	176
Females	17

1967

Males	54
Females	6

Validity and Reliability of Data.

University records of age, sex and previous study are subject to human error but must be accepted as reliable data. An element of unreliability in the records of majoring subjects is inevitable as some students change their minds during their courses.

The essential problem of validity and reliability exists in the use of results gathered from tests. The final biology marks, according to Parkyn (1967), are likely to have a reliability coefficient of between .80 and .85. Considered in conjunction with terms marks, as these are, he states that a student's final assessment is likely to be a reasonably valid estimate of his ability in biology.

The A.H.5. test manual gives evidence of validity by supplying correlations, between the A.H.5. and other reputable intelligence tests, of from .27 to .54. This instrument is at a disadvantage here as it is especially designed for fine discrimination at an upper adult level but can only be correlated with tests which test the total range of ability and do not discriminate so well at high levels. This would tend to give a spuriously low correlation and thus the test is probably more valid than the coefficients

would lead one to believe. Test-retest reliability (strictly speaking "stability") coefficients are numerously given and range from .80 to .90 over the full test and are only slightly lower for the two sections taken separately. Liggett, reviewing the test for the Sixth Mental Measurements Yearbook states that Heim's main consideration was to develop an instrument which "would effect discrimination between highly intelligent subjects". This aim, he says, "she has achieved with a good deal to spare and there is little doubt that A.H.5. will do much valuable work".

Split half reliabilities (strictly speaking "internal consistencies) of the Sixteen Personality Factors Questionnaire (16.P.F.) range from .71 to .93 (N = 450), ten coefficients being above .80. Adcock, in the Fifth Mental Measurements Yearbook states that, "This is quite good; but even more pleasing is the fact that validities (based on factor loading) range from .73 to .96 with eleven coefficients exceeding .80. For a multidimensional test of this kind one could not hope for much more". Cattell particularly notes in the test manual that his test has good transferability - that is it is reliable and consistent across various different cultures.

The two preceding tests were administered strictly according to manual instructions. In the area of divergent thinking, many tests have been administered and many dimensions obtained from these. For the purposes of this study, considering time available, numbers to be tested and reliability and validity figures available, the Unusual Uses Test was selected as the main instrument. Torrance (1965), in a section on reliability and validity of creativity tests, mentions fifteen test-retest reliability coefficients ranging from .60 to .85 (two weeks interval between tests) and details nine examples of research which express partial or indicative validity of these tests. (He is undertaking a study at the moment to attempt to prove predictive validity for his tests.) Three objects were chosen for this test, a brick, a hairclip and a newspaper and five minutes each were allotted for written responses. Instructions were as follows - "I want you to try to think of some unusual uses for a brick. List on your paper as many of the cleverest, most interesting and most unusual uses you can think of for a brick".

These responses were then scored for two dimensions, fluency (sheer numbers of responses) and flexibility (number of different categories mentioned). From previous research

(Harper 1965) it was noticed that several apparently uncreative and stereotyped individuals could be very fluent in their replies but lacked any flexibility in their thinking. When both scores are summed up these individuals appear more creative than in practice they actually are; thus to place ratings into what is considered to be a more important perspective a new dimension has been used - a ratio between fluency and flexibility. The inference here is that the crucial factor is not fluency, flexibility or total score, but the number of flexible responses made in relationship to the purely fluent ones.

Originality, based on the frequency with which a certain response occurs within a group of students, is not being employed as a dimension as it is not considered to be a spurious measure e.g. Student X gave as a response to the unusual uses of a newspaper question - "mask car windows prior to spray painting". On checking further it was found that Student X worked in a garage during holidays. This response therefore, while original for the group (it occurred only once from 253 students) was not original for him. This does not mean that true originality is not important, but only that it is a very difficult aspect to measure.

The second test used in the domain of creativity is a "free association" test. Three words were given as cues; "animal", "plant" and "microscope" (note the biological flavour) and two minutes to each word were given for the students to write down every word that came into their heads as trains of thought. This was the type of thing obtained - "Animal, dog, wolf, howl, cry, baby, milk, cow, grass, green, blue, sea, sky, etc". A test of this unstructured type is relatively novel in the field of divergent thinking but has three main advantages. It can be scored on the same dimensions as the Unusual Uses test, it is more open ended or non-directive than other creativity tests and is more likely to give insight into thought processes (see appendices). No knowledge is available on reliability or validity of this measure and the fact must be borne in mind when conclusions are being stated.

Statistical Procedures

The following procedures were employed in analysing the data received during this study.

(1) Correlations

(a) The product-moment correlation is in essence a ratio which indicates to what degree changes in one variable are associated with changes in a second variable. This method of correlation will be used in all cases where both sets of variables have actual scores.

(b) The tetrachoric correlation technique is applicable when both variables are dichotomous. This measure however assumes that each variable has an underlying continuity and would be normally distributed if it were possible to obtain more exact results. The particular formula used is an approximation given by Garrett (1958 p.385).

$$r_t = \cos\left(\frac{180^\circ \times \sqrt{BC}}{\sqrt{AD} \times \sqrt{BC}}\right)$$

(2) Significance of Differences.

(a) The most common problem to be encountered under this heading is that of deciding whether the difference found to exist between two test means is in fact a real difference or one caused by sheer chance factors. The procedure to be employed depends upon whether the groups are uncorrelated and on whether they are large or small samples ($>$ or $<$ 30). Examples in this research are all of the uncorrelated type and formulae used will differ only according to the size of the groups involved. (Garrett 1958 p.213 and p.223).

(b) A similar situation arises in this study when the difference between two percentages is to be tested for significance. For this the following formula is applicable. (Garrett 1958 p.236).

$$\sigma_{0\%} = \sqrt{PQ\left[\frac{1}{N_1} + \frac{1}{N_2}\right]}$$

(c) In other cases it is not so much the difference of the means of two groups which is important but the difference in variability in terms of standard deviations. Garrett (1958 p.303) also supplies the appropriate method through a variation of the F ratio.

(3) Chi square.

The Chi square is a statistical treatment designed to compare frequencies obtained experimentally with frequencies expected. This is particularly applicable where categories only are available rather than scores. A limitation perhaps is that it gives indication of existence of a relationship but does not estimate the magnitude of this relationship. For this purpose the contingency coefficient, calculated directly from the chi square itself gives a good estimate of correlation under certain circumstances (Garrett 1958 p.394).

$$C = \sqrt{\frac{\chi^2}{N + \chi^2}}$$

(4) Profile correlations.

To ascertain the extent to which personality profiles relate to each other, the method outlined in the 16.P.F. Handbook (p.54) must be applied. Briefly, the profile stens are subtracted from the stens of the criterion profile to give sixteen "difference" values. These are then squared, summed and entered in a table supplied to give r_p which indicates the degree of resemblance between the two profiles.

To obtain a mean set of stens the sten scores are averaged directly as they are an equal unit measure (Adams 1965 p.41).

Research Limitations.

One limitation of this study has already been mentioned; the small number of cases collected in the 1967 sample. As explained, this was an unavoidable result of circumstances but is none the less unfortunate as it means that statistical significances will be more difficult to obtain. A more important limitation - again unavoidable - is a volunteer group; a self selected sample of sixty of a population of approximately two hundred. It is likely that

there exists some personality characteristic which is typical of a volunteer group and which would give bias to results. (one actually is mentioned in a later chapter). There appears to be no practical means of overcoming this disadvantage.

The "free association" test involves a possible limitation in that no reliability or 'validity' figures are available for it. However, it is essentially similar to the "Unusual Uses" test and there is consequently no reason why it should lack on this score.

PART III

Chapter 4. RESULTS

Intelligence

Hypothesis A I

(a)

Intelligence is not a significant differentiating factor in biology pass rates at University.

To test this hypothesis the 1966 group was taken (because of the larger numbers) and the means of the 'intelligent' group and 'non-intelligent' group were tested for significance of difference. (N = 38 in each case).

Table 2.

DIFFERENCE MEAN BIOLOGY MARKS - INTELLIGENT and NONINTELLIGENT GROUPS

	Biology Mean	S.D.	Diff Means	t	df	Significance (two tailed)
Intelligent	98.4	20.58				Not
			6.1	1.39	74	significant
Non-intelligent	104.5	17.70				

From the table it will be observed that the hypothesis is upheld.

A I

(b)

<u>There will not be a significant correlation between biology marks and intelligence scores</u>.

Again the 1966 group was taken and, as might have been expected from the preceding table, the correlation between biology marks and intelligence scores was a negative one. It was in fact - .11 , and as this is not significant the hypothesis is again upheld.

In view of the negative result obtained the parallel sets of scores from the 1967 testing were correlated. Further again to this, the part scores of the A.H.5. test were correlated separately with biology marks. The results are tabulated.

Table 3.

CORRELATIONS BETWEEN INTELLIGENCE and BIOLOGY

		r	N	Significance
1966	Intelligence and Biology	- .11	183	Not significant
1967	Intelligence and Biology	.39	48	.01
1967	Pt. 1. Intelligence and Biology	.27	48	.05
1967	Pt. 2. Intelligence and Biology	.35	48	.05

A II

Compared with completers, non completers will not differ significantly in mean intelligence scores.

Table 4.

INTELLIGENCE DIFFERENCES BETWEEN COMPLETERS and NON-COMPLETERS.

	Means	S.D.	Means	df	t	Significance (two tailed)
Completers (N=183)	33.7	7.50				Not
			2.00	191	.8067	significant
Non-completers (N=10)	31.7	9.48				

Hypothesis is upheld.

A III

Among the subject groups no significant differences in intelligence will be found.

To test this hypothesis the 1966 class was divided

accorded to majoring preference - biology majorers (36), veterinary science majorers (63) and agriculture majorers (85). This totalled 184 which with an additional nine students in Arts degrees makes up the original 193. These three groups were then divided into two sections; those who scored above the group median and those who were below.

These six separate cells were then subjected to the chi square procedure to examine differences between these observed frequencies and the frequencies which would normally be expected to occur if there were no factors affecting their distribution.

Table 5.

INTELLIGENCE DIFFERENCES AMONG SUBJECT GROUPS

	Biol.	Vet.	Ag.	
Above median	17	35	39	Frequencies observed.
Below median	19	28	46	
	17.8	31.2	42	Frequencies expected.
	18.2	31.8	43	

Chi square = 1.4116 Not significant.

Hypothesis upheld.

Convergence - Divergence.

Hypothesis B I (a)

Compared with convergers, divergers will have a significantly higher mean score in Biology.

Table 6.

ATTAINMENT DIFFERENCES BETWEEN CONVERGERS and DIVERGERS.

	Biology		Diff.			
	Mean	SD	Means	t	df	Significance (one tailed)
Divergers (38)	104.5	21.02				Not
			2.5	.579	74	significant
Convergers (38)	102.0	16.28				

Hypothesis rejected.

This particular hypothesis was further investigated by selecting convergers and divergers on the bases of flexibility, fluency and ratio scores. This involves three additional tables which will be designated 6.1, 6.2 and 6.3.

Table 6.1.

ATTAINMENT DIFFERENCES BETWEEN

CONVERGERS and DIVERGERS (Flexibility)

	Biology		Diff.			
	Mean	S.D.	Means	t	df	Significance (one tailed)
Divergers	106.7	18.59				Not
			2.6	.652	77	significant
Convergers	104.1	16.82				

Table 6.2

ATTAINMENT DIFFERENCES BETWEEN

CONVERGERS and DIVERGERS (Fluency)

	Biology		Diff.			
	Mean	S.D.	Means	t	d.f.	Significance (one tailed)
Divergers	104.3	20.99				Not
			1.1	.26	75	significant
Convergers	103.2	15.31				

Table 6.3

ATTAINMENT DIFFERENCES BETWEEN

CONVERGERS and DIVERGERS (ratio)

	Biology		Diff.			
	Mean	S.D.	Means	t	d.f.	Significance (one tailed)
Divergers	105.5	15.86				Not
			3.7	.98	74	significant
Convergers	101.8	17.12				

Although it can be observed from these tables that in each case the trend of difference is in the direction indicated, in no case is the difference a significant one.

B I (b)

<u>There will be a significant positive correlation between biology marks and divergent thinking scores</u>.

The particular correlation coefficient found is .04 and although this is positive it is certainly not significant and the hypothesis again must be rejected.

B II

Groups alpha, beta, gamma and delta will be ranked in this specific order for mean performance in biology.

Mean biology scores for the above groups were calculated with the following results.

Group		Mean Score
Alpha	=	97.5
Beta	=	108.58
Gamma	=	98.92
Delta	=	104.76

The hypothesis is thus rejected. To obtain an indication of the possible significance of this rank order of the groups, the highest mean (beta) and the lowest mean (alpha) were tested.

Table 7.

ATTAINMENT DIFFERENCES BETWEEN GROUPS

ALPHA and BETA.

		Biology		Diff.			
		Mean	S.D.	Means	t	d.f.	Significence (two tailed)
Alpha	(14)	97.50	24.47				Not
				11.08	1.577	36	significent
Beta	(24)	108.58	17.45				

To view the same problem on a pass-fail basis the following chi-square cells are established.

Table 7.1.

PASS - FAIL DIFFERENCES AMONG GROUPS

ALPHA, BETA, GAMMA and DELTA.

	Alpha	Beta	Gamma	Delta	
pass	7	20	16	88	Frequencies observed.
fail	7	4	8	32	
pass	10.08	17.27	17.27	86.37	Frequencies expected.
fail	3.92	6.73	6.73	33.63	

chi square = 5.3429

d.f. = 3

Not significant

B III

The mean divergence score of the completers will be significantly higher than that of the non-completers.

Table 8.

DIFFERENCE IN DIVERGENCE SCORES BETWEEN COMPLETERS AND NON-COMPLETERS.

	Divergence		Diff.			
	Mean	S.D.	Means	d.f.	t	Significance (one tailed)
Completers (183)	129.528	37.305				Not
			5.528	191	.4517	significant
Non-completers (10)	124.000	42.080				

Hypothesis rejected.

B IV

Compared with the other two subject groups the biologists will be significantly higher in divergent thinking ability.

This hypothesis was tested using the chi-square procedure, the categories being the majoring subjects and the dichotomy, above and below the divergence median. (1966).

Table 9.

DIVERGENCE DIFFERENCES AMONG MAJORING GROUPS. (1966).

	Biol.	Vet.	Ag.	
Above Median	25	33	33	Observed frequencies
Below Median	11	30	51	
Above Median	17.9	31.3	41.8	Expected frequencies
Below Median	18.1	31.7	42.2	

Chi-square = 9.4724

d.f. = 2

Significant at .01 level of probability.

This result upholds the hypothesis in that it shows that the biologists groups has a significantly greater number of students above the median of the divergent thinking tests.. To obtain an actual estimate of the relationship present the contingency coefficient was calculated from the following formula.

$$C = \sqrt{\frac{\chi^2}{N+\chi^2}}$$

$$= .222$$

To further substantiate this result the procedure was duplicated for the smaller 1967 group with the results tabulated below.

Table 9.1.

DIVERGENCE DIFFERENCES AMONG MAJORING GROUPS (1967).

	Biol.	Vet.	Ag.	
Above Median	7	8	11	Observed frequencies
Below Median	2	10	12	
Above Median	4.68	9.36	11.96	Expected frequencies
Below Median	4.32	8.64	11.04	

Chi square = 2.9669

d.f. = 2

Not significant

B V

When personality profiles of the intelligent biology and diverger groups are compared, factors will be patterned according to the matrix below.

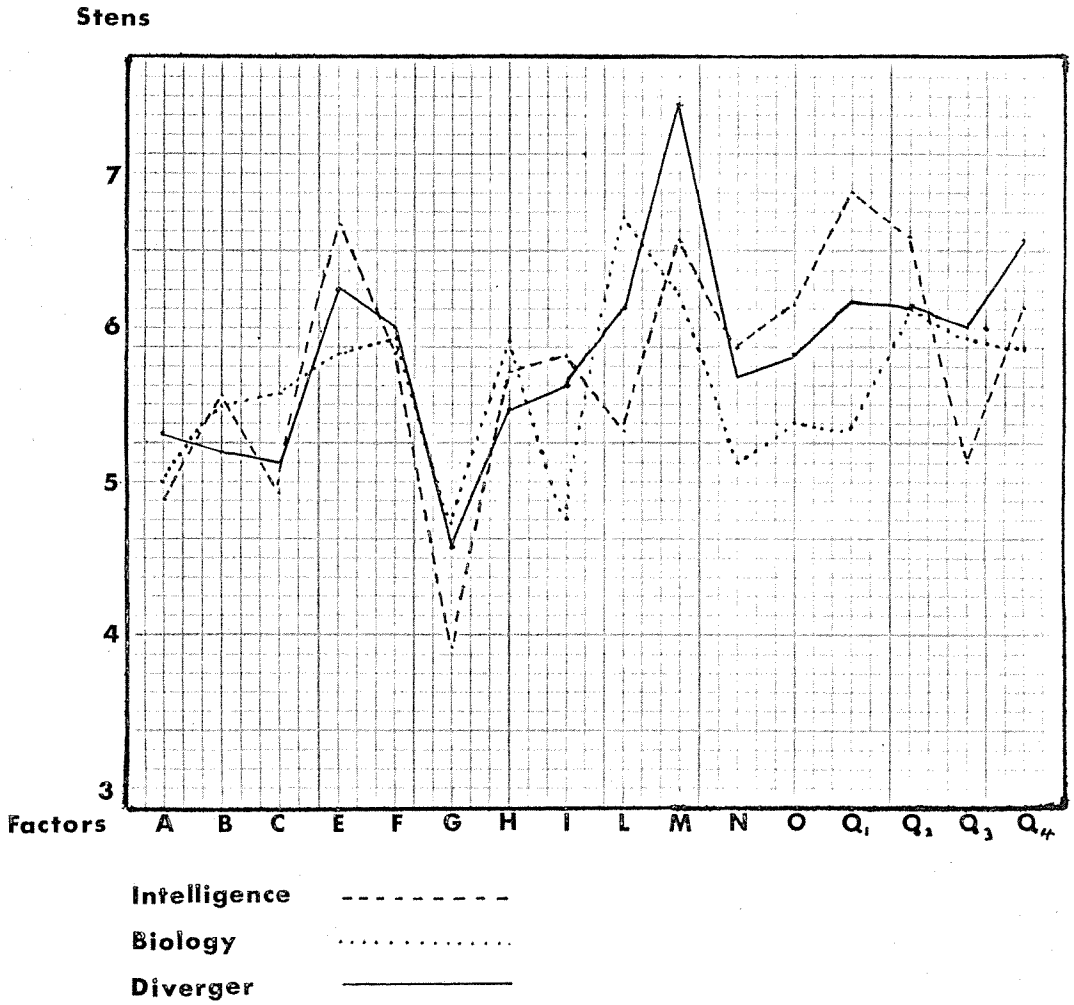
	16 P.F. Factors			
Intelligence	B+			Q_1+
Biology		I-		
Diverger	F+	I+	M+	

This hypothesis can best be tested by reference to the following graph.

Table 10.

PERSONALITY PROFILES OF INTELLIGENCE,

BIOLOGY and DIVERGER GROUPS.



Considering these factors in turn and comparing the groups on the overlaid graph it is firstly obvious that although the "intelligence" group has the highest mean in factor B (this is an intelligence factor) it is not significantly highest, in fact less than half a sten covers the three groups. (Experience has shown that at least one sten difference is necessary to warrant testing for significance).

Factor F also is highest for the diverger group as predicted, but again not significantly so. (This is the happy-go-lucky, impulsive, enthusiastic surgency factor).

It was hypothesized that factor I (a realistic versus sensitive factor) would be high in the diverger group and relatively low in the biology group. This is true to the extent that the biology group is characterized by a low rating and the diverger group by a high one but the intelligence group is also high; a result which was not predicted. However, the three ratings cover less than one sten and thus do not warrant testing for significance.

The divergers are highest in terms of factor M and as the difference between them and the biology group is 1.26 stens it will be tested for significance.

Table 10.1.

SIGNIFICANCE OF DIFFERENCES IN FACTOR M.

	Mean Sten	S.D.	Diff. Means	t	d.f.	Significance (one tailed)
Divergers (14)	7.47	1.50				
			1.26	2.176	29	.05
Biology (17)	6.21	1.61				

Factor M Cattell (1964) says is Audia (M+) versus Praxernia (M-). Autia typifies the unconventional, artistic, theoretical, imaginative, creative person.

Table 10.2.

SIGNIFICANCE OF DIFFERENCES IN FACTOR Q_1.

	Mean Sten	S.D.	Diff. Means	t	d.f.	Significance (one tailed)
Intelligence (14)	6.86	2.03				
			1.5	1.81	29	.05
Biology (17)	5.36	1.70				

Cattell (1964) designates factor Q_1 Radicalism (Q_1+) versus Conservatism of temperament (Q_1-). The person who scores highly on the Q_1 factor tends to be well informed and more inclined to experiment.

As may be observed from the graph, one factor not included in the hypothesis appears to differentiate the groups sufficiently to warrant testing for significance. This is factor L.

Table 10.3.

SIGNIFICANCE OF DIFFERENCES IN FACTOR L.

	Mean Sten	S.D.	Diff. Means	t	d.f.	Significance (two tailed)
Biology (17)	6.71	1.71				Not
			1.35	1.924	29	significant
Intelligence (14)	5.36	1.86				

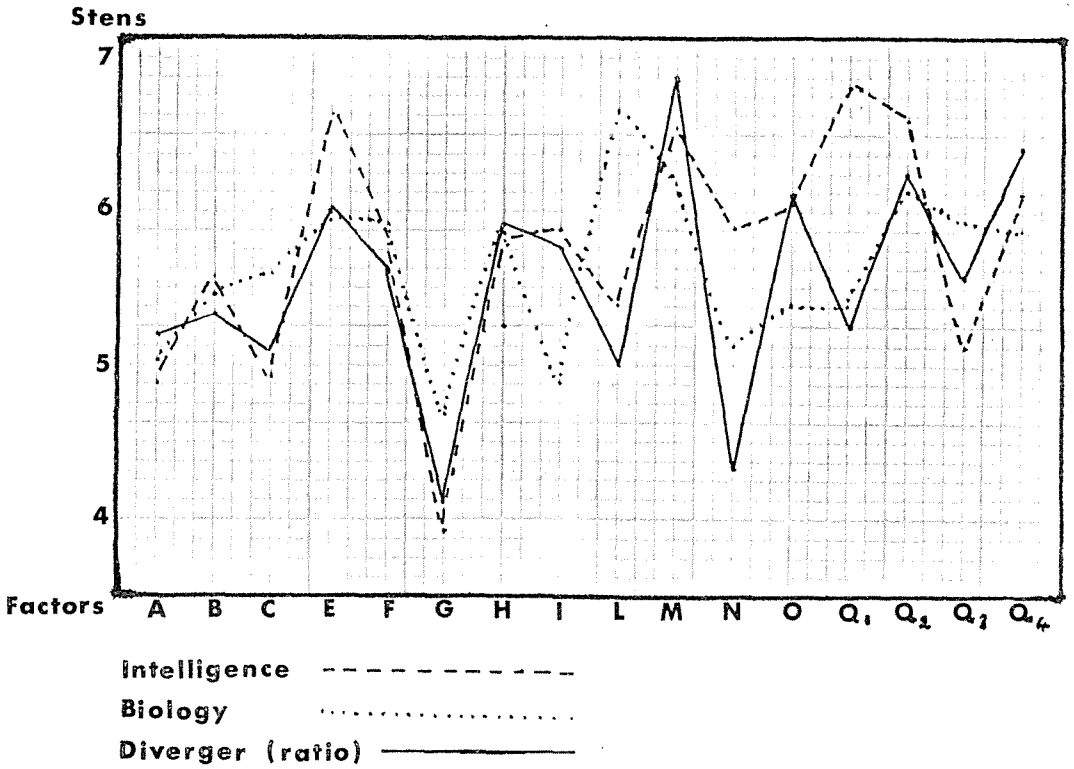
Factor L according to Cattell (1964) is Protension (L+) versus Relaxed Security (L-). Those persons rated highly on this dimension tend to be jealous, self sufficient, suspicious, withdrawn, tyrannical, hard and irritable. Protension signifies projection and inner tension.

To gain further insight into these relationships this comparison was replicated except that the divergence group was selected on the basis of "ratio" scores rather than total scores.

A similar graph demonstrates this comparison pictorially.

Table 11.

PERSONALITY PROFILES OF INTELLIGENCE, BIOLOGY and DIVERGER (RATIO) GROUPS.



The following three differences in the above graph appear large enough to justify testing for significance levels.

(1) Between the biology group and the divergers (ratio) in factor L.

(2) Between the intelligence group and the divergers (ratio) in factor N.

(3) Between the intelligence group and the divergers (ratio) in factor Q_1.

Table 11.1.

SIGNIFICANCE OF DIFFERENCES IN FACTOR L.

	Mean Sten	S.D.	Diff. Means	t	d.f.	Significance (two tailed)
Biology	6.71	1.71				
			1.71	2.72	28	.05
Divergers (ratio)	5.00	1.63				

Table 11.2.

SIGNIFICANCE OF DIFFERENCES IN FACTOR N.

	Mean Sten	S.D.	Diff. Means	t	d.f.	Significance (two tailed)
Intelligence	5.86	1.995				Not
			1.55	2.003	28	significant
Divergers (ratio)	4.31	2.084				

Factor N is a continuum of Shrewdness and Sophistication versus Simple Naivete. The N+ person is polished, socially alert, calculating, aesthetically fastidious and insightful while the N- person is "natural", vague and sentimental, spontaneous and has simple tastes.

Table 11.3.

SIGNIFICANCE OF DIFFERENCES IN FACTOR Q_1.

	Mean Sten	S.D.	Diff. Means	t	d.f.	Significance (two tailed)
Intelligence	6.86	2.03				Not
			1.61	1.73	28	significant
Divergence (ratio)	5.25	2.77				

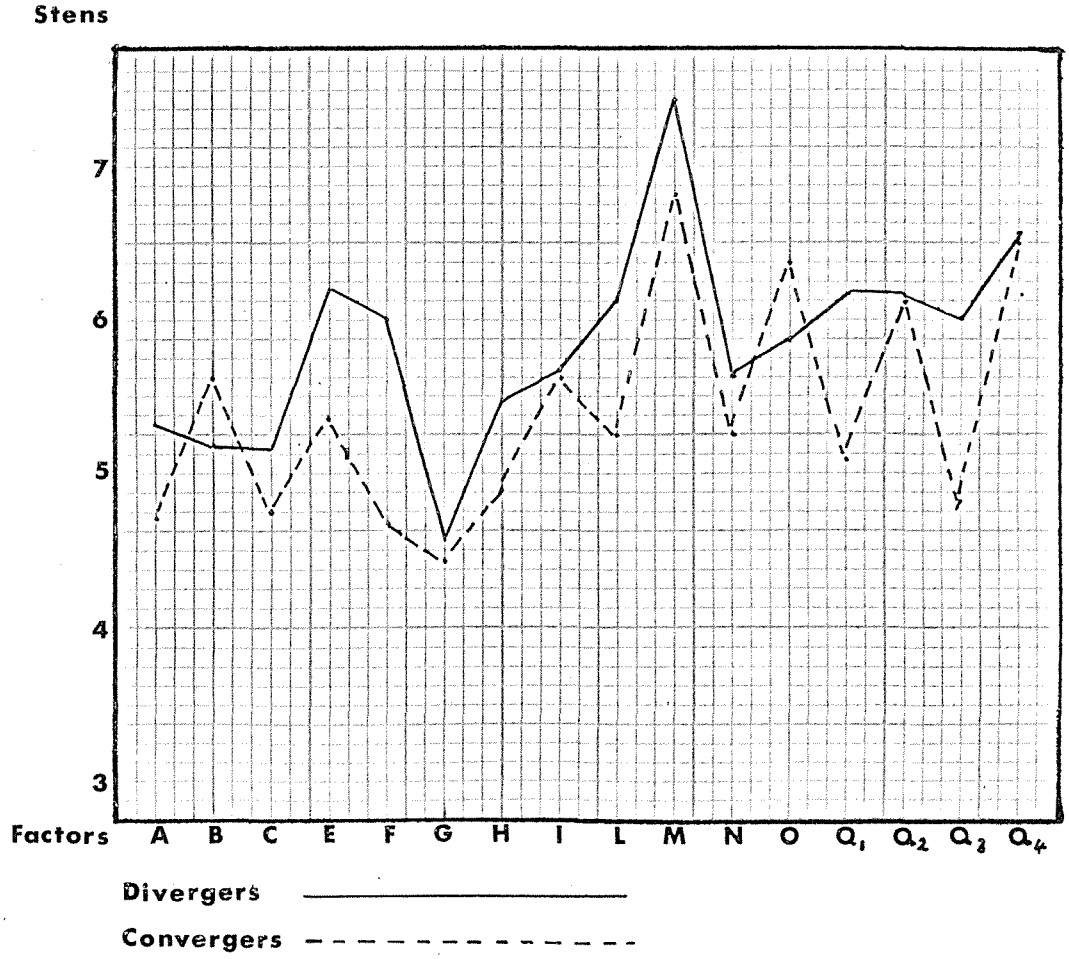
B VI

When contrasted with the convergers' mean personality profile, the divergers' profile will be significantly higher in factors F, H, I, M, Q_1 and Q_2.

Table 12.

PERSONALITY PROFILES OF

CONVERGERS AND DIVERGERS



From a perusal of the graph it can be observed that although in every case the divergers are higher on the factors hypothesized in only two cases, factors F and Q_1. , are the differences sufficient to indicate further testing for significance.

Table 12.1.

SIGNIFICANCE OF DIFFERENCES IN FACTOR F.

	Mean Sten	S.D.	Diff. Means	t	d.f.	Significance (one tailed)
Divergers (14)	6.00	2.12				Not
			1.31	1.659	28	significant
Convergers (16)	4.69	2.28				

The F factor denotes Surgency (+) versus Desurgency (-). The F+ person tends to be talkative, cheerful, serene, happy-go-lucky and expressive while the F- person is rather silent and introspective or may appear to be depressed and brooding.

Table 12.2

SIGNIFICANCE OF DIFFERENCES IN FACTOR Q_1.

	Mean Sten	S.D.	Diff. Means	t	d.f.	Significance (one tailed)
Divergers	6.18	2.53				Not
			1.12	1.28	28	significant
Convergers	5.06	2.33				

Particularly noticeable also from the graph is the difference of 1.19 which occurs between the means in factor Q_3.

Table 12.3

SIGNIFICANCE OF DIFFERENCES IN FACTOR Q_3.

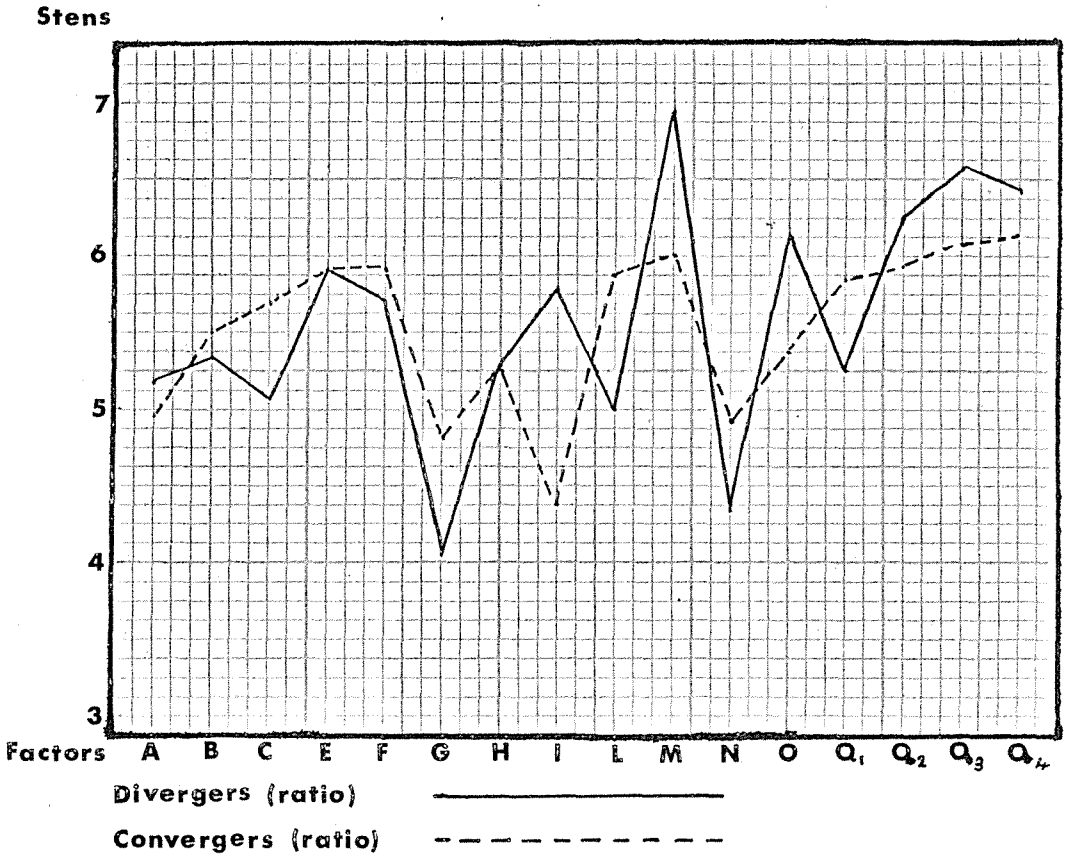
	Mean Sten	S.D.	Diff. Means	t	d.f.	Significance (two tailed)
Divergers	6.00	2.193				Not
			1.19	1.88	28	significant
Convergers	4.81	.357				

Personality factor Q_3 is a High Self Sentiment formation versus a Low Self Sentiment formation measure. This measure, Cattell (1964) says, tends to select good leaders but not necessarily popular leaders. Q_3+ persons tend to make more "problem raising" and "solution offering" remarks than is normal and to show foresight, persistence and consideration of others, while the Q_3- person appears lax and uncontrolled and has not crystallized for himself a clear consistent and admired pattern of socially approved behaviour. (Note the extremely low standard deviation of this characteristic in the convergent group. The difference between these two standard deviations is significant at $< .02$ level.)

As was the case with the previous hypothesis, the comparison will be replicated using the ratio score as a basis for selecting the divergent and convergent groups.

Table 13.

PERSONALITY PROFILES OF CONVERGENT AND DIVERGENT GROUPS (RATIO SCORES)



The above graph would indicate that one characteristic, factor I, is worth testing for significance of differences.

Table 13.1

SIGNIFICANCE OF DIFFERENCES IN FACTOR I.

	Mean Sten	S.D.	Diff. Means	t	d.f.	Significance (two tailed)
Divergers (ratio)	5.75	1.785				Not
			1.36	1.87	32	significant
Convergers (ratio)	4.39	2.264				

Factor I is a Tender-minded sensitive versus tough-minded realistic dimension. The I+ person tends to be artistic, fastidious, feminine and impractical where as the I- person is independent, realistic, practical and masculine.

While the differences predicted in the hypothesis actually occur, none is significant and to this extent the hypothesis must be rejected.

B VII

<u>The divergers' mean personality profile will be the functional equivalent of that of Cattell's "creative scientists"</u>.

The profile given on page 30 of the "Handbook for the Sixteen Personality Factor Questionnaire" (Cattell 1964

Supplementation) was derived by Cattell and Drevdahl (1955) from a group of 144 professional researchers in biology, physics and psychology. Mean stens are also supplied for a comparable student population. Relationships between these two profiles and two obtained from divergers and divergers (ratio) groups will be extracted by means of the personality correlation coefficient r_p. (See chapter 3).

Table 14.

COMPARISON OF FOUR DIVERGENT PERSONALITY PROFILES.

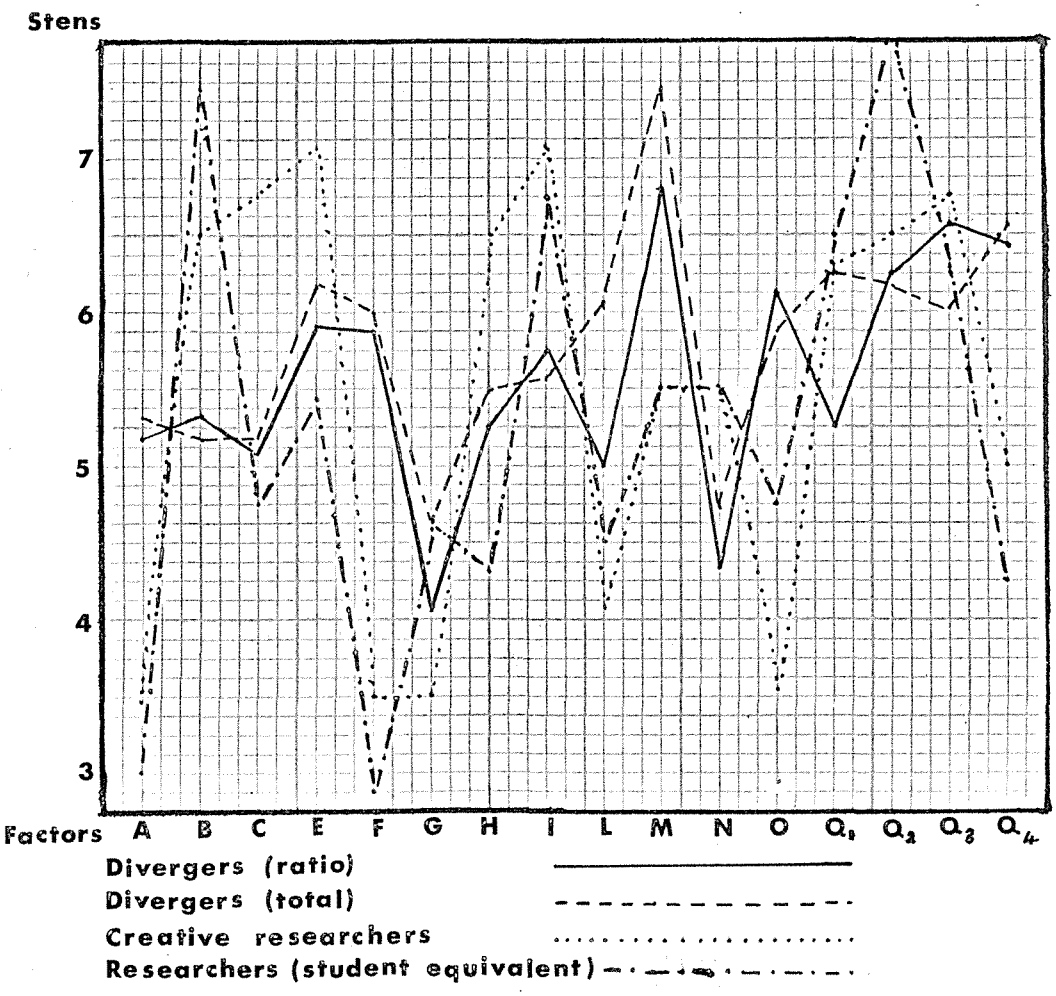


Table 14.1

CORRELATIONS BETWEEN PERSONALITY PROFILES.

	16 P.F. Adult researches	16 P.F. Student Profile
Divergers (ratio)	.58	.52
Divergers	.54	.49

This table indicates that for each of the four calculations the coefficient is positive and, while apparently not high, is considered to be sufficiently high to uphold the hypothesis when one considers complicating variables such as cultural differences, age differences, time differences, group sizes etc.

As a further refinement Cattell (1963) has selected, from several studies of this area, the most important factors for creativity and has weighted them according to their importance. Thus a particular profile can be weighted, the weightings summed, and a sten score given as an indication of "general creativity". These weightings are as follows: -

Personality factor	Weighting of Source Trait Sten.
A(-)	Subtract sten score from eleven and multiply residual by two.
B	multiply sten by two.
E	multiply sten by one.
F(-)	subtract sten score from eleven and multiply residual by two.
H	multiply sten by one.
I	multiply sten by two.
M	multiply sten by one.
N(-)	subtract sten score from eleven and multiply residual by one.
Q_1	multiply sten by one.
Q_2	multiply sten by two.

Disregard all other factors.

When this weighting is applied to both profiles obtained the following sten scores result.

divergers - sten of 6.87

divergers (ratio)- sten of 6.74

Again while these figures are not particularly high, there is a definite trend which supports the hypothesis.

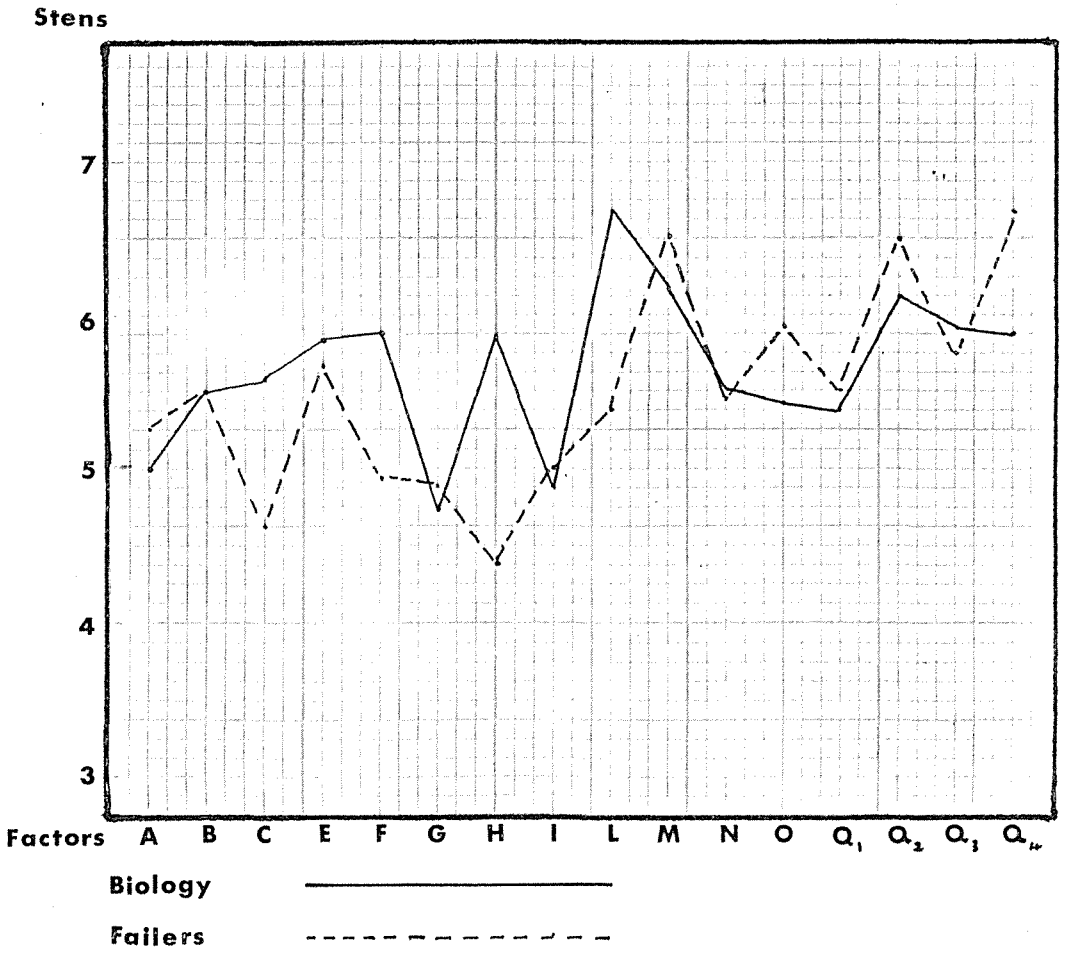
Personality

C I

When compared with biology failers the biology group will reveal higher mean scores in personality factors E, H, L and N.

Table 15

PERSONALITY PROFILES OF BIOLOGY AND FAILERS GROUPS



The relative positions of the two groups in factor N go contrary to the hypothesis, although not significantly so. Of the remaining three dimensions only two, H and L, warrant testing for significance.

Table 15.1

SIGNIFICANCE OF DIFFERENCES IN FACTOR H.

	Mean Sten	S.D.	Diff. Means	t	d.f.	Significance (one tailed)
Biology	5.92	1.791				
			1.59	2.408	24	.05
Failers	4.33	1.374				

Factor H is Parmia versus Threctia; the adventurous, carefree person compared with the shy timid person. The H- person is convinced of his inferiority and shy in personal contacts; is slow and impeded in expressing himself. The "current hypothesis is that H represents some largely constitutional factor of autonomic activity level or resilience. Present evidence indicates it to be one of the most highly inherited of personality factors". (Cattell 16 P.F. Manual).

Table 15.2

SIGNIFICANCE OF DIFFERENCES IN FACTOR L.

	Mean Sten	S.D.	Diff. Means	t	d.f.	Significance (one tailed)
Biology	6.71	1.707				
			1.38	1.816	24	.05
Failers	5.33	2.014				

Factor L it will be remembered is Protension versus Relaxed security.

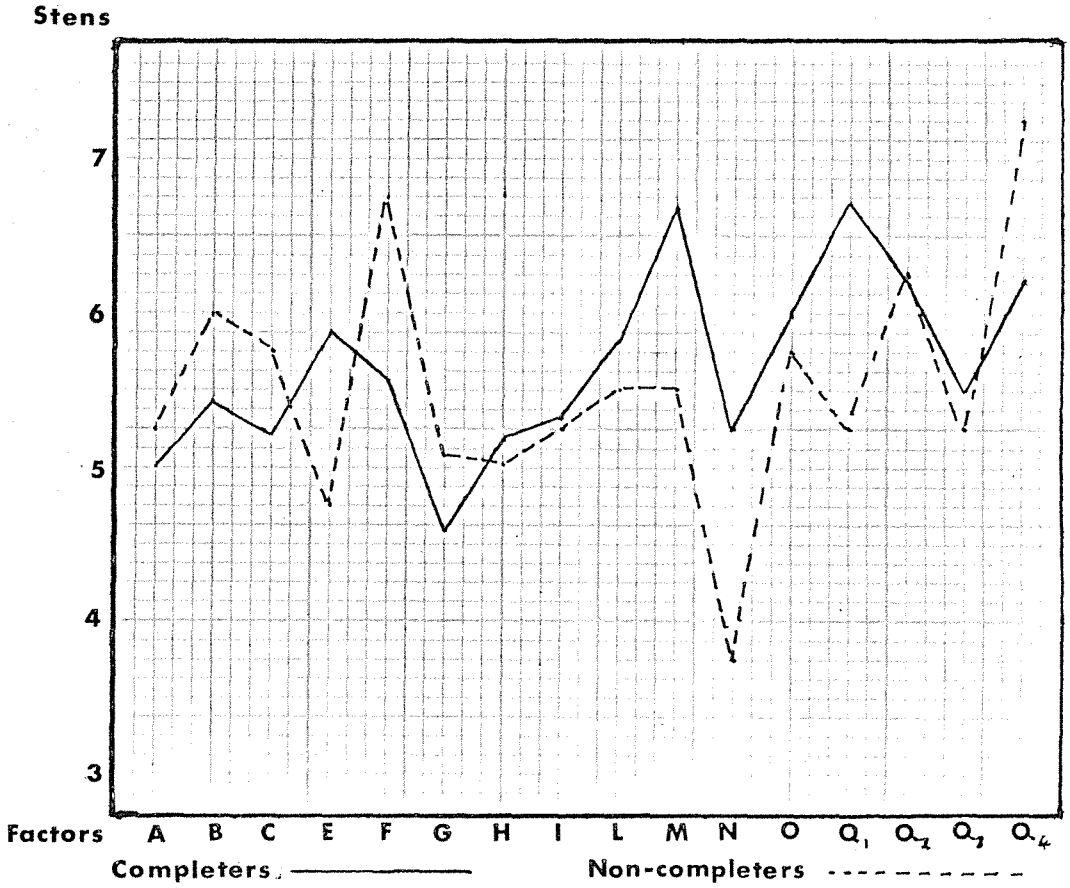
C II

The completers mean personality profile will reveal higher scores than the non-completers profile in factors C, E, G and Q_4.

Table 16.

COMPARISON OF COMPLETERS AND NON-COMPLETERS

PERSONALITY PROFILES



Of the four hypothesized dimensions only one, E, is in the direction predicted. Also, in view of the extremely small number of genuine drop out (4) and the extreme variability of their scores, no differences on any dimension would approach significant levels.

Subject Experience.

D I

Students with previous subject experience will have a significantly higher mean score in biology than students with no experience.

The 1966 group was split according to this criterion and the usual t test applied. Twenty eight students, for whom previous subject experience was not available, could not be included.

Table 17.

BIOLOGY ATTAINMENT ACCORDING TO PREVIOUS EXPERIENCE.

	Biology		Diff.			
	Mean	S.D.	Means	d.f.	t	Significance (one tailed)
Previous Experience	104.4	19.57				Not
			2.00	130	.5408	significant
No Previous Experience	102.4	17.99				

To view the problem in a different light the same groups were split into pass - fail categories.

Table 17.1

BIOLOGY PASS OR FAIL ACCORDING TO PREVIOUS EXPERIENCE

	Pass	Fail
Previous Experience	72	27
No Previous Experience	23	10

$r_t = .057$

Converted to percentages this table reads: -

	Pass	Fail
Previous Experience	72.7%	27.3%
No Previous Experience	69.7%	30.7%

The difference between these two pass rates (2.0%) is not significant. C R = .332 (Garrett 1958 p.235).

This hypothesis must therefore be rejected. Previous subject experience has no significant bearing on attainment levels in biology.

Social Characteristics

E I

Compared with older students, young students will have a significantly higher mean biology score.

Because of the particular age distribution present the groups (as designated in an earlier chapter) were split unevenly. (92 young - 29 older). When mean scores were calculated it was obvious that the hypothesis could not be upheld as the difference in fact went in the opposite direction to that predicted. This difference was subsequently tested for significance.

Table 18.

BIOLOGY SCORES ACCORDING TO AGE.

	Mean of Final marks	S.D.	Diff. Means	d.f.	t	Significance (two tailed)
Young group	104.7	20.01				Not
			1.7	119	.479	significant
Older group	106.4	15.43				

E II

Male students will have a higher mean biology score than female students.

Table 19.

SEX DIFFERENCES AND BIOLOGY SCORES.

	Mean of Final Marks	S.D.	Diff. Means	d.f.	t	Significance (one tailed)
Male	104.1	17.87				Not
			1.00	181	.2015	significant
Female	103.1	27.08				

Although the male group has a higher mean as hypothesized it is not significantly higher and thus the hypothesis cannot be upheld.

Incidentally the difference between these two standard deviations is not quite significant at the .05 level. (Garrett 1958 p.233).

Chapter 5

CONCLUSIONS

Intelligence

The generalized implication of the hypotheses in this section is that among university students intelligence is not a critical factor determining success or failure.

Results obtained from the testing of the first two hypotheses tend to confirm the conclusions reached by other researchers. There does not appear to be a particularly high correlation between intelligence and academic success at university - in fact the correlation obtained for the 1966 group was a negative but non-significant one. It has been stated by Parkyn 1959 that,

> In the restricted university group the correlation between I.Q. and achievement appears to be in general not more than r = .35.

There is of course a statistical correction which can be applied to counteract the effect of a restriction

in the range of subjects (Borg 1963 p.159) (such as must occur in a selected university group). A more accurate projection of the true relationship between these variables would result from the application of this correction, but this would be misleading in the present study as it is the relationship actually within the restricted group which is important.

From Australia, Sanders (1961) suggests that intelligence discriminates better between passing and failing students in Humanities subjects than it does between passing and failing students in science subjects (.30 correlation between passes in biology and the ACER B 40 intelligence test). This perhaps is a partial indication of the reason for the low correlation found in the 1966 group. Further reasons may be that in this particular subject at this particular university there is more emphasis on factual material and less on complex calculations and depth of understanding; or perhaps the A.H.5 test does not discriminate as well as Heim and Liggett suggest.

The higher correlation in the 1967 subjects may be a function of the fact that this group is composed of volunteers. The conscientious students who feel that they should volunteer are probably also the ones who tend to work industriously and realize their mental potential. The fact also that these persons are volunteers makes them different

from those who did not volunteer and this invalidating variable must constantly condition results taken from any hypothesis involving the 1967 group.

Hypothesis AI(b) involves virtually a partial replication study and as such, conclusions can be stated in much the same vein as Sanders (1961) does when he writes,

> The conclusion . . . is that there is some factor other than intelligence or I.Q. or scholastic aptitude (as normally measured) which is, to a certain extent, deciding success and failure in First Year Science studies.

An interesting comment, which would be worth following up with a New Zealand group, was added by Anderson (1960) who suggests that students with a high I.Q. but low performance on entry are bad risks in science studies.

Parkyn (1967 p.196) found that there were no real differences between the mean intellectual abilities of students majoring in the different subjects. This is confirmed by the results of hypothesis A III; while hypothesis A II attempts to discover similar differences between "drop outs" and students who actually complete the course. Results would suggest that there are none.

Three principal results emerge from this section of the hypotheses. Generalizations can be enumerated as follows.

1. Intelligence is not a significant differentiating factor in university pass rates.

2. Intelligence levels do not vary significantly from subject to subject.

3. Low intelligence is not a causative factor in the "drop out" phenomenon.

Convergence - Divergence

As it had been recorded in previous research (Hudson 1963) that divergers tend to be attracted to biology rather than to physical sciences, it was an interesting speculation to observe whether these more divergent students actually score well in their biology examinations. For these hypotheses (B I (a) and (b)) the divergers were compared with the convergers and the difference of means of final biology marks was tested for significance. This was repeated four times, each with a different selection criterion; total divergence score, flexibility score only, fluency score only and ratio score (flexibility divided by fluency). In each case the mean of the divergers group was a little higher than that of the convergers but in no case did the magnitude of the difference approach levels of significance. The greatest difference between means was noticed in the group selected on the basis of ratio scores,

Results from Getzels' and Jackson's study (1962) indicated that the top divergers were just as superior in achievement as were the high I.Q. students. It is perhaps pertinent to record that the means of the four divergent groups employed in hypothesis B I (a) are all higher than

that obtained from the top intelligence group. It may be that biology is a subject in which the academic abilities of creative students are maximized.

Hypothesis B II follows similar lines to those employed by Getzels and Jackson (1962) in that it compares the biology marks of all students who were placed in top 20% for divergent thinking but not intelligence (beta group), and those in the top 20% for intelligence but not divergent thinking (gamma group). A third group in this comparison, all those in the top 20% for both abilities (alpha group) was not considered by Getzels and Jackson although they state (1958) that they intend to observe this group at a later date. The fourth and final group in this hypothesis was composed of all remaining students (delta group).

Differences were apparent between the various cells of the chi-square table which was employed to test this hypothesis, although results did not reach the customarily accepted level of .05. It is perhaps relevant to interpret the statistics in this case as indicating that differences, as large as these which appeared, would occur by sheer chance alone less than three times in every twenty replications.

The obvious question which the table of results prompts is; why did 50% of the apparently most able 14 students out

of 193 (alpha group) fail their final examinations? Obviously in such a small group chance factors could grossly exaggerate the true position, but one still has a niggling suspicion, in the light of Anderson's (1960) statement on students with high I.Q. and low entrance performance being bad risks, and the negative correlation found earlier between intelligence and attainment, that here might be a course which does not extend sufficient challenge to these exceptionally able students.

Perhaps there is a challenge but not of the right type. As a corollary to one of his major premises, Stenhouse (1965) states that,

> emphatically non-teleonomic teaching, teaching that has been intentionally 'objective', 'factual', 'mechanistic' etc. in the narrowest sense, result(s) in numerically small and academically weak advanced classes.

His theory could have some applicability to this thesis sample although further work with several groups and involving different test instruments would be necessary before conclusions on the matter would have a solid foundation.

Differences perceptible between the completers and non-completers groups were the subject of hypothesis B III. It was hoped that divergent thinking differences would be revealed as a likely causative factor in the "drop out" incidence. The non-completers group was slightly lower than the completers in terms of divergence scores but not significantly so. Similarly no intelligence differences (hypothesis A II) or personality differences (hypothesis C II) reached significant levels. Two possible explanations of these results are that, either the "drop out" groups (1966 and 1967) were too small for trends to be manifest or that a person drops out of a course essentially for exterior, mechanical, circumstantial reasons rather than for some inherent ability or personality weakness.

Hypothesis IV was designed to parallel Hudson's (1962) finding that physical sciences tended to attract convergent thinkers whereas biology, like arts subjects, drew a larger share of divergers. While it is not suggested that veterinary science and agriculture are necessarily "physical" sciences, they are sciences and the opportunity for this comparison was worth accepting. The larger 1966 group was tested, the chi-square formula again applied, and differences

apparent were significant at the .01 level of probability. The biology group has easily the largest proportion above the median divergence score (69.4%). The smaller 1967 group was also tested in the same manner and, although the numbers were too small for accepted levels of significance to appear, the trend was even more marked (77.7% of the 1967 group above the median of the divergent thinking tests).

Chi square has the property of being additive (Garrett 1958 p.266). When tests taken from different populations show the same bias the chi-squares can be summed, along with the degrees of freedom, and a more conclusive result obtained. In this case the summed chi-square shows an overall significance of .02. This then is one case, in consideration of Hudson's similar finding and the summed chi-square, that a reasonably dependable result can be obtained. From the contingency coefficient however it can be noticed that although the difference is a significant one the relationship is not necessarily great (C = .222).

Hypothesis B V is concerned with a comparison of the three groups, divergers, intelligent and biology, in terms of personality characteristics. Again the small sample makes significance of differences difficult to obtain, but from the graph three dimensions were selected for examination.

Of these three factors 'M', 'Q_1' and 'L', both 'M' and 'Q_1' yield differences at the .05 significance level. The difference apparent between the divergence group and the biology group, in factor M, implies that the divergers are more imaginative and creative than the biology top scorers. While this statement is almost tautologous it at least indicates a measure of validity for both tests. The 16 P.F. manual elaborates by saying that the person with a high autia (or M) score is unconventional, self absorbed, interested in art, theory and basic beliefs, imaginative, creative, frivolous, immature in practical judgment, generally cheerful but has occasional hysterical swings of "giving up". This is a subtle pattern which does not conform to the popular introvert concept but nevertheless is a central factor in the second order introversion scale. Persons high in this factor dimension tend to feel unaccepted but unconcerned and in terms of vocations move more towards art, research, planning and editing rather than administration, mechanical occupations or salesmanship. This is a typical pattern of the creative person and one would rather doubt the validity of the research if this agreement did not emerge from the processed data.

A further point which must be stressed at this juncture is that while the divergers are rated more highly in this dimension than the top biology scorers, both groups and

indeed the total sample as a whole are above the average sten for a student population. (Total group sten = 6.7. Average for student population should be between five and six although no New Zealand norms are available). This also adds support to the suggestion that biology students tend to be above average in creativity ratings.

An extension of hypothesis B V considered a similar comparison except that divergence was based upon a different criterion - the ratio score. This revealed a difference between the biology group and the divergers (ratio) on the L factor dimension which was clearly significant at the .05 level and very nearly so at the .01 level. The implications of this result hinge upon the validity of the ratio criterion of creativity. It is suggested that this method of selection for divergence isolates the slower deeper thinker rather than the fluent surgent surface thinker who gives a multitude of possible problem solutions but not necessarily sensible or useful ones. (This matter is reviewed again in chapter six).

A second pertinent difference observed in this replication is that the divergers (ratio) emerge as low in factor N in comparison with the intelligence group. This again is not entirely unexpected as it implies that they are "natural", vague, sentimental, warm, spontaneous and content with their

lot. Cattell suggests in his manual that the N+ person is motivated by "social climbing" and that this dimension accentuates the difference between the courtier or diplomat and the "natural man" of Rousseau.

This result again poses the problem of meeting arbitrarily imposed significance levels and one takes resource to relevant quotation.

> In our opinion, there is no right or wrong level here - the decision must be made in full consideration of the parameters inherent in the problem itself. It is doubtful that setting a priori levels of .05, .01 or what have you, settles this matter. It is suggested that a more rational approach might be to report the actual level of significance, placing the burden of interpretive skill upon the reader. (Skipper, Guenther, Nass 1967).

Following this suggestion, calculations place the level of significance in this case at approximately .0525 which for most purposes is just as significant as .05.

This hypothesis, B VI, seeks to discern personality differences between the divergers and the convergers. Factors F, Q_1 and Q_3 were selected from the graph (table 11) for testing but no differences between stens were found to be significant. Although not significantly characteristic these three attributes are again not unusual in a group selected for divergent thinking ability - expressive, quick and alert, surgent (factor F); radical (factor Q_1); high self sentiment (factor Q_3).

The most remarkable aspect of this hypothesis however was not differences between means but the difference between the standard deviations in scores on factor Q_3. This difference is significant at .02 and is actually caused by the extremely small variability in the convergent group. This means that these students are uniformly low but not extremely low, in self sentiment formation. They tend to resemble each other closely in that they don't appear to have crystallized a clear, consistent, admired pattern of socially approved behaviour to which they strive to conform.

As had been done with a previous hypothesis, this comparison was replicated using divergence ratio scores. Again no differences between mean stens were significant but the largest difference recorded is worthy of a brief mention. This difference (factor I) was indicative of an artistic,

imaginative, fastidious, aesthetic, sensitive and effiminate tendency in the high scoring group. This latter characteristic, femininity, along with aesthetic sensitivity was particularly mentioned by McKinnon (1962) as relating to proven creative architects.

The final hypothesis in this section, B VIII attempts to discover to what extent the mean profile of the divergers in this thesis approaches that of Cattell's group of creative scientists. Two separate divergent groups were used (total score and ratio score) and these were correlated in turn with the creative scientists' mean profile and also with a comparable student profile (given in the 16 P.F. manual). The resulting four coefficients range from r_p = .49 to r_p = .58, again with the ratio group producing the highest correlation (when related to the creative scientists group). The correlation procedures are explained carefully in the 16 P.F. Manual (p.54) but nowhere does Cattell discuss the significance of his correlations. He does state however that, "an r_p of + .50 or more definitely places him with those who are typical of the occupation". (p 31).

Considering the subjectivity involved in scoring procedures, the cultural differences, age differences, time

differences, different group sizes and especially Cattell's sentence just quoted, it is felt that the divergers' profile can be considered the functional equivalent of that of Cattell's "creative scientists". This is an important finding as it implies that creative ability suitable for scientific research could be diagnosed at an early student level.

Secondary to this correlation exercise, the divergent profiles obtained were processed by means of a weighting technique (explained earlier) and condensed into a sten score which indicates a dimension of "general creativity". These resulted in stens of 6.87 (ratio group) and 6.74 (divergent group) which is further indicative of validity for early diagnosis.

Conclusions from this section of the hypotheses (convergence - divergence) may be briefly summarized as follows: -

(1) Convergers and divergers do not differ significantly in attainment; nor do they differ from the most intelligent students in attainment.

(2) A large proportion of the seemingly most able students fail in their final examinations.

(3) Completers and non-completers do not differ significantly in intelligence, divergent thinking or personality.

(4) Students majoring in biology are significantly more divergent in their thinking than those majoring in either agriculture or veterinary science.

(5) Convergers are exceptionally uniform and moderately low on self sentiment formation (factor Q_3).

(6) Students selected as divergent thinkers by means of the "Unusual Uses" and "Free Association" tests also appear to have "creative" personality attributes when 16 P.F. profiles are diagnosed. This appears to reach the point where prediction of research potential may be possible.

(7) The general tenor of the results suggests substantial validation for both the personality questionnaire and the divergent thinking or "open ended" tests.

Personality

The first hypothesis, C I, compares the biology group of fourteen (all 'A' and 'B' passes) with the twelve failers (all pupils who actually sit the exam but fail). From the graph in table 14 two factors were selected as likely to produce significant differences between the sten means. These are factors H (Parmia versus Threctia) and L (Protension versus Relaxed Security); the former on testing was found to provide differences at the .05 level. This expounded further suggests that the high scoring group is less inhibited by environmental threat, is more adventurous, responsive, genial and friendly than the lower group, although in view of the fact that the upper group sten was in the "normal" band (5.92) a more logical interpretation of the observed difference is that the lower group (failers) tends to be threat reactive (hence the term "threctia"), shy, convinced of their own inferiority, slow and impeded in expression and disliking occupations with personal contacts. Cattell's theory (1957) is that "H" represents some constitutional factor of "autonomic activity level or resilience". The H-person has, at least initially, "an over-responsive sympathetic nervous system which makes him especially 'threat reactive' ".

The difference tested in the second variable, factor L, also proved to be significant; .05. This is the protension factor which is associated with successful examination candidates and will be discussed at the conclusion of this section in conjunction with findings from hypothesis B V.

Hypothesis C II has been discussed, but to briefly recapitulate, it was found that completers and non-completers do not differ significantly in personality characteristics. In view of the extremely small non-completers group however, little importance should be accorded this finding.

In a section of hypothesis B V, two differences between the biology group and the intelligent group were tested for significance. While only one (factor Q_1) was significant (.05 level) they were both differences which it was reasonable and logical to expect. In factor Q_1 the intelligence group tended to be more critical, better informed generally and more inclined to experiment than the biology group.

More interesting was the tendency of the top examination scorers (biology group) to be higher in a measure of factor L which would suggest that they are more

irritable, suspicious and have a higher "inner tension" than the intelligence group. These students are above average in a general tension factor but not excessively so, Small (1966 p. 38) also suggested a similar proposition when he said,

> in the case of successful students such tension might even have promoted rather than inhibited performance.

Hypothesis C I which compared the biology group with the failers group indicated this trend even more strongly (significant at .05). In summarizing the work of Lucas (1952) and Gordon and Berlyne (1954), Cronbach (1963) makes an apposite remark,

> Anxiety therefore tends to facilitate performance on a task where carefulness and reliance on authority pay off.

Interesting as this is, the only conclusion which one can arrive at is that here is a complex field which could richly repay further investigation.

Conclusions from the personality section of the hypotheses can be briefly summarized.

(1) Failing students tend to be "threat reactive" or have inferiority feelings, are slow and impeded in expression and dislike personal contacts. This is symbolized by low sten scores in Factor H.

(2) Highly successful examination candidates tend to score moderately highly in a dimension of "inner tension". (factor L). It appears that they have higher levels of generalized tension than either the intelligent or the divergent group.

Subject Experience

Hypothesis D I compares examination results of students who had taken biology as a sixth form subject for the University Entrance Examination against the results obtained by those who had not taken biology in the sixth form. This problem was attacked along three different dimensions, a 't' test for ascertaining the significance level of the difference of means, consideration of differences in the percentages of passes obtained by each group and a tetrachonic correlation of pass - fail categories. All three results demonstrated that, at least for Massey University, if a student had not taken biology as an Entrance subject he was not at a particular disadvantage when studying biology at the stage I university level. Ramifications of this finding reach far down into secondary school curricula but as these are outside of the original thesis they will be dealt with in a later chapter.

Social Characteristics

Small (1966 p. 9) imparts the knowledge that successful students tend to matriculate at an earlier age than the average student. Hypothesis E I compared two student groups, 29 whose ages ranged from twenty years upwards and 92 who comprised the 17 and 18 year old group. This comparison does not replicate Small's work as some of these students, although sitting a stage I paper may have matriculated several years previously. It is probable that it is for this reason that results are not in agreement with those of Small; in fact the trend is to the contrary - older students average two marks in excess of the younger group (not significant). A point of interest here is that the older students have a lower standard deviation. There is less variability in their scores as one might expect from a more mature group.

The final hypothesis, E II, is somewhat similar in that it compares the biology marks of male and female students. Sanders (1961) observes that women students tend to have a poorer pass rate than men. Whereas this research indicates a similar trend (not significant) the more interesting point is that the female student group has a particularly large

standard deviation in final marks. Women who pass, pass well but those who fail tend to obtain extremely poor marks. e.g. the highest mark in the total group was gained by a female student, but three of the lowest eight marks were obtained by women although there were only 16 female students in this group of 193 (1966). In view of the fact that a lower percentage of women matriculate, one would expect more rigorous selection pressures with consequent high marks and pass rates. That the contrary tendency appears likely may be indicative of a less vocation oriented approach by the fair sex.

As a brief summary of this chapter the following four conclusions are noticeable as significant and major findings of this thesis and will be discussed at greater length in the next chapter.

1. This tendency, for biology majoring groups to contain a higher proportion of the more divergent thinkers than other science groups, could be universal as it was reported by Hudson in England and also found in this work. While the two researches were not parallel the results indicate agreement and pose the question of why this bias occurs, if indeed it does occur universally. Further research is necessary in other universities with other student groups to provide greater evidence of this imbalance of talent distribution.

2. It seems likely that some personality features may differentiate the successful student from the unsuccessful. Further research would be necessary to validate this but from the present study with the 16 P.F. dimensions factor L+ could be associated with success and factor H- with failure.

3. Biology is a university subject which, at least at this university, does not require previous experience at the sixth form level. Obviously it would be advantageous to the student if he had had prior experience but pass percentages suggest that inexperienced students are not seriously disadvantaged.

4. A group of students selected as high divergers on tests of unusual uses and free association has a mean personality profile which correlates at about .5 with the mean profile of a group of proven creative scientists. This finding suggests validity for the creativity tests which compares well with that found by such researchers as Weisberg and Springer (1961), Fleming and Weintraub (1962), Yamamoto (1962, 1963), Sommers (1961), Wodke (1963) and Wallace (1961), all of whom are particularly mentioned by Torrance (1965) who discusses the question in detail.

Chapter 6.

DISCUSSION AND IMPLICATIONS OF SELECTED FINDINGS.

From the direct empirical result of hypothesis B IV, that biology majorers at Massey University in stage I Multicell Biology 1966 and 1967 have a high mean score on tests of divergent thinking, are derived two tenable basic premises. Firstly it could be held that the students were more creative than their fellows on entry to the subject, or secondly it could be that they were not distinguishable from other students on entry but became more divergent in thought during the course. To decide which of these premises is correct, one would need to test students in the sixth form prior to entry and as this cannot be done with the present group the result of such testing can only be left to conjecture. However this is a possible project for future years.

If one follows the supposition that the students were a more divergent group before entry to the subject, the

problem of finding which forces attracted them to biology becomes relevant. This is in fact the matter which is causing Hudson (1963) and Stenhouse (1965) some concern. The proposition of the attraction of an "holistic teleonomic" teaching approach, advanced by Stenhouse (1965) as an attracting force, is very pertinent to the situation which has existed in New Zealand primary schools this century.

Three periods in primary school science education have emerged. The earlier emphasis, till the 1940's, was on agriculture. Education Boards employed Agriculture Instructors to foster interest and organize calf and garden projects in the schools. This gave way in the late 1940's to the introduction of a third year Teachers' College course for what were then termed Nature Study specialists. These specialists were appointed to work with the Agriculture Instructors who were not replaced as they retired and thus gradually phased out. The last few years have seen a further change of emphasis as the Nature Study Specialist is now termed a Science Adviser. His present purpose is to promote a wider more integrated science curriculum rather than a concentration on biological aspects.

It is the middle era of the nature study approach which has most importance for the hypothesis presented by Stenhouse. A nature study lesson was essentially based on

a practical discovery type teaching method. The pupil would be presented with the specimens to be studied and also given a question card. Questions on the card were answered on paper by direct observation and inference. Some typical questions selected from actual cards are -

> The frog has very long strong back legs. Look at them and see if you can tell why this would be?
>
> How would the stick insect's unusual shape help it to survive?
>
> Why has the rabbit got eyes on the side of its head while the cat's eyes are in the front?
>
> Why do you think the gorse has prickles and not leaves?
>
> What use is the parachute on the dandelion's seed?

This is teleonomy of a type and it is the area of experience which our present university students have been subjected to. Thus it is not unlikely that, in view also of Stenhouse's evidence, this method has consciously or unconsciously captured the interest of the able diverger at an early age.

This of course assumes that the students have been attracted and not merely channelled by artificial forces. Discussion with pupils, secondary school principals and science advisers reveals three types of influence on the student to take biology as a sixth form subject. Firstly it is true that in some secondary schools, although apparently very few, enthusiastic biology teachers using modern, practical discovery methods have attracted large talented sixth form classes. (Again it is not known whether the pupils are attracted by the subject presentation or the teacher's personality). A second situation occurs in which principals advise arts orientated pupils to take biology as a fourth subject in order to at least "have a foot in the science camp" without involving themselves in complex mathematics. The third explanation is that the divergent thinker, traditionally regarded as somewhat of a rebel, consciously resists pressures to classify him as either an arts student or a science student and falls between the two into the only area left - biology.

To return to the initial premises, the alternative likelihood is that students not abnormally divergent at the beginning of the year are made more so by biological subject matter and presentation. This assumes that creativity can be developed and improved. Parnes (1962) states the results of four years' research on this matter by saying : -

" 1. Creative imagination can be deliberately developed.

2. Creative problem solving courses can measurably improve the ability of students of average intelligence to produce good ideas, the criterion of quality being uniqueness and usefulness.

3. A systematic course of instruction in applied imagination can also produce significant gains in personality traits such as confidence, initiative and leadership potential".

While Parnes says nothing about the lasting effects of improvement so gained and one wonders whether this is not just a "practice effect", in the light of his statement it is not impossible that biology experience could exert a developing influence on divergent thinking abilities.

One is left after all this in the common position of just not knowing, but on reviewing the ramifications of the problem it is felt that there are definite forces which tend to canalize divergent thinkers in our education system and possibly that the same forces amplify the diverger's creative tendencies.

Highly successful examination candidates appeared to be distinguishable from unsuccessful ones not in levels of intelligence or creativity but in two personality dimensions of the 16 P.F. Questionnaire. Factor L (protension) emerged as higher in the successful group. Three comparisons here demonstrated the same tendency : the comparison between high examination scorers and high creativity scorers (total score), high examination scorers and high creativity scorers (ratio score) and between high examination scorers and low examination scorers. In each case the successful examination group was higher in factor L scores. In the second comparison quoted the difference was significant at .05 and very nearly at .01 while one of the other two differences was significant (.05)

To delve more deeply into this relationship the second order scale of anxiety was calculated for the high and low examination scoring groups. Here the trend was in the opposite direction, the failing group was higher on this second order factor than the very successful group (stens of 6.38 and 5.63 respectively). This is not a contradiction but demonstrates the difference that exists between tension and anxiety. The protension plus person (L+) tends to be suspicious, self opinionated, hard to fool, mistrusting, interested in internal mental life, deliberate in his actions, unconcerned about others and seldom makes a good team member.

This is often the successful examination candidate while the second order factor of anxiety is the over anxious person as we commonly understand the term. The 16 P.F. manual (for forms A and B) says of the person high in this dimension;

> "it is probable that he has some maladjustment i.e. he is dissatisfied with the degree to which he is able to meet the demands of life and to achieve what he desires. Very high anxiety is generally disruptive of performance".

Here is seen the common pattern of the unsuccessful candidate. It is suggested that while significance levels are not as high as one would have wished, the general trend made manifest is reinforced by a background of reasonable and logical explanation.

As also can be noted from the results chapter, failing students tended to be low in the dimension represented by factor H (.05 level). This again is backed by empirical observation as the shy, retiring person who lacks confidence in his own ability is less likely to score well in highly competitive examinations.

An impression of the relative importance of the personality characteristics of university students is thus

built up not only from these results but also by the comments of other writers e.g.

> "the case as a whole is important as an illustration of the extent to which motivation, drive and self discipline can counterbalance inadequate qualification before matriculation". (Small 1966 p.145),

> "tension associated with over achievement, or the attempt to do more than the student is capable of accomplishing, may be real among those with personality and temperamental problems". (Sanders 1961 p.135).

Adequate levels of attainment and intelligence may be assumed once a student has passed the University Entrance Examination in New Zealand but no similar assumptions can be made about personality attributes and it is in this field, it is suggested that greatest progress may be made in future work on success and failure at university. The results of this thesis will be checked against those from different and larger groups and, with the benefit that hindsight brings, a test such as the Edwards Personal Preference Schedule will

be administered to give a measure of motivational characteristics. If present results are corroborated, then by combining this information with that on motivation and taking heed of the several suggestions of both Small (1966) and Parkyn (1967), the present situation, almost totally lacking in predictability of success of the student, will be replaced by one where a relatively sound selection of data is available for student counsellors.

However, lest the wrong impression should be taken, care must be exercised, as Anderson (D.S. 1965 p.137) says, to ensure that

> "the problem should be seen as
> a need to promote achievement
> rather than predict ability".

Personality research such as that of Anderson (A.W. 1960a, 1960b) in Australia could be extended and adapted to New Zealand conditions to perform just this service.

Returning to the topic of creativity or divergent thinking, consideration will be given to the subject of measurement within the field. Torrance (1965 p.28 - 31) mentions seventy eight different tests, all purporting to measure a facet of the area and some, dating back as far as

1900. Thought about the various facets of creativity now appears to have become more crystallized and the following headings are commonly seen - fluency, flexibility, originality, elaboration and redefinition.

The suggestion is that we have now rather exhausted the possibilities for developing new instruments and that a more rewarding line of research would be to develop greater sophistication in the methods used for processing the data obtained from these various tests. A major problem has always been to maintain objectivity in marking procedures, and the more sophistication that is introduced beyond the mere summation of raw scores, the greater the subjectivity involved.

The concept of the ratio score, used in this thesis, is an attempt to evolve a more advanced and useful measurement without reducing the objectivity or interscorer reliability of the test. It was observed while individually testing a large group of seven year old children that some pupils could be exceptionally fluent but in relation to the number of fluent responses there were relatively few flexible ones. Other pupils in contrast gave a smaller total number of flexible responses but these constituted a higher proportion of their total replies. Furthermore the latter group appeared to supply more useful and original answers. Thus something more than a simple addition of responses or

categories was needed to select the truly constructive creative person who would be likely to make a useful contribution to society.

The ratio score, which consequently was evolved, is a measure of the proportion that the flexibility score is of the fluency score (flexibility score ÷ fluency score). This measure obviously does not tap the subject universe but could prove to be a useful addition to the data now available.

Evidence for the usefulness of the ratio score is summarized from the results section of this thesis and detailed below.

1. In hypothesis B I (a) the greatest difference in biology marks between the diverger and converger groups was found when the ratio score was used as a criterion. The next largest difference was between the top and bottom fluency groups and then came the groups selected on a total score basis (fluency plus flexibility).

2. In hypothesis B V the biology group was significantly higher than the divergers (ratio) group on a measure of personality factor L (protension) although the divergent group was normal for a university population.

3. In hypothesis B VII the average personality profile (16 P.F.) of the diverger (ratio) group correlated with the average profile of Cattell's proven creative scientists at

a level of .58. This was higher than the figure found for the total score divergence group but probably not significantly higher.

4. In hypothesis B VII when the average profiles of the total score divergence group and the ratio score divergence group were weighted and processed to give a sten score of "general creativity"; the ratio group sten was the higher (6.87 compared with 6.74).

In each of the four cases cited above the ratio group produced the higher results and in no case was the reverse found. It cannot be shown that differences between the groups were significantly large but the trend of results is obvious and it is hoped that further work will confirm it.

A possible interpretation of the differences between the two measures is that the ratio measure tends to select the slower but deeper thinking less tense person who makes the most useful contribution in practice, whereas the total score is biassed towards the surgent, effervescent type whom everyone regards as creative but who often never really achieves anything worthwhile.

The finding that experience of sixth form biology is not essential for success in Stage I biology is not a

surprising one, as discussion with the lecturer in charge of the zoology department at Massey University discloses that the course is designed to enable students to begin without prior knowledge of the subject. Obviously some background experience is an advantage but biology is not a cumulative type of subject as maths, physics or chemistry where past knowledge is essential for the understanding of future material.

This situation in itself is a factor tending to channel interested students into other subjects and probably rightly so as it could be argued that knowledge of say sixth form chemistry would be of more use to a biologically inclined student at university. While this argument cannot be proved with the data available it is more likely that the advantage could accrue at an advanced stage of study of say soil science or biotechnology.

Returning to an earlier point in a child's education in New Zealand, it is found that the science emphasis in contributing school (5 - 11 years) is wholly biological in the form of nature study. At intermediate school the physical sciences share limelight with the biological in almost equal proportions while at secondary school physical sciences are given progressively more stress and biology is the "poor relation", taken often as a last choice if nothing more important is available. In a country like ours with its

strong pastoral background, subjects such as food technology, veterinary science, horticulture, silvioulture, biochemistry, agronomy, soil science, marine biology, plus the various specialist agricultural fields are of prime economic importance. It is thus just as foolish to relegate the biological fields to the background at secondary school as it is to neglect entirely physical sciences at the younger levels.

What is required in terms of curriculum development is twofold - firstly, more emphasis placed on science subjects in general from the time a child begins school in primer one (this is relating back to the quote from the Times Educational Supplement (6-1-67) in the thesis introduction) and secondly, a better balance of the two aspects, biological and physical, at all levels. This would necessitate the official introduction (and it has been done already unofficially in isolated instances by enlightened teachers and headmasters) of simple physical science experiences in the contributing school, plus the strengthening of the secondary school biology scope and a better linkage with the university curricula in this subject. At the moment the country is not getting an economic return from moneys spent on biology laboratories and teachers at the secondary level; especially in these days of a post primary teacher shortage.

Appendices.

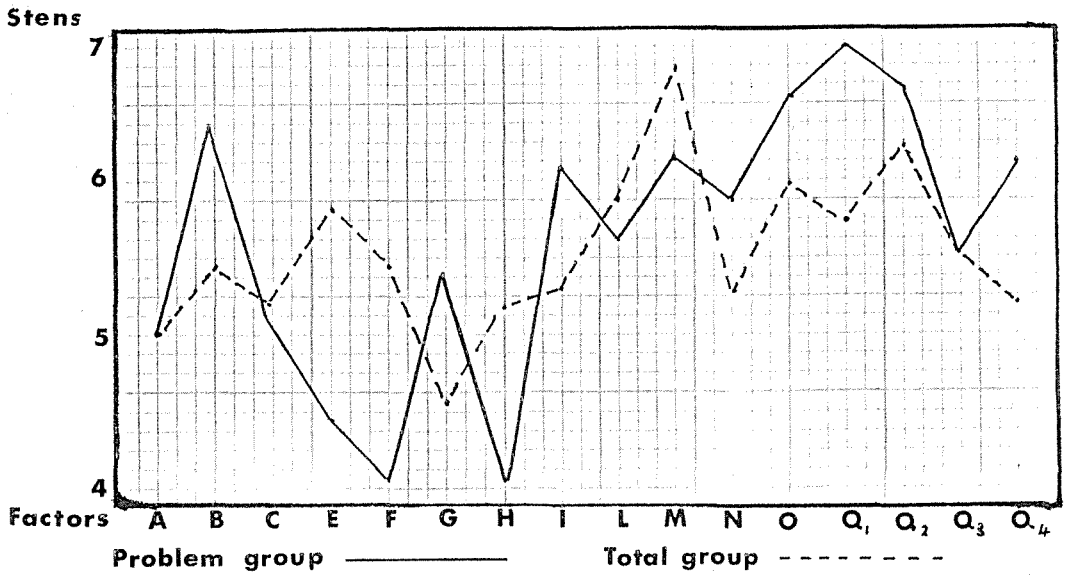
I. Comparison of total 1967 biology group with Mr. M. Hancock's group in terms of personality.

An interesting extension of one of the main themes of this thesis comes from a comparison of 16 P.F. profiles obtained during this work with a mean profile obtained from eighteen students who had approached the Massey University Student Counsellor, Mr. M. Hancock, for help and guidance with their personality problems. This group was comprised of ten male students and eight female students with ages ranging from eighteen years to twenty two years, all at different stages in their respective courses of study and each selected for this comparison because his or her problem was essentially one of personality rather than one of intellect or circumstance. (No names were made available as this would obviously involve an unethical breach of confidence).

Table 20.

TOTAL GROUP PROFILE AND

PROBLEM GROUP PROFILE.



The above graph compares the mean profile of the 1967 biology group (60 students) with that of the eighteen students who sought guidance with their problems. From this, four dimensions were selected as having sufficient difference to warrant testing for significance levels - factors E, F, H and Q_1. The results of this testing are tabulated below.

Table 20.1.

PERSONALITY FACTOR E TESTED FOR

SIGNIFICANCE OF DIFFERENCES

	Mean Sten	S.D.	Diff. Means	t	d.f.	Significance (two tailed)
Total 1967 biology group	5.82	1.76				Not
			1.26	.773	76	significant
Personality problem group	4.56	2.24				

Factor E represents the submissiveness - dominance dimension.

Table 20.2.

PERSONALITY FACTOR F TESTED FOR

SIGNIFICANCE OF DIFFERENCES

	Mean Sten	S.D.	Diff. Means	t	d.f.	Significance (two tailed)
Total 1967 biology group	5.52	2.20				Not
			1.41	.793	76	significant
Personality problem group	4.11	1.53				

Factor F is the desurgency - surgency continuum.

Table 20.3.

PERSONALITY FACTOR H TESTED FOR

SIGNIFICANCE OF DIFFERENCES.

	Mean Sten	S.D.	Diff. Means	t	d.f.	Significance (two tailed)
Total 1967 biology group	5.18	2.03				Not
			1.07	.654	76	significant
Personality problem group	4.11	1.37				

Factor H represents the dimension of shyness - boldness.

Table 20.4

PERSONALITY FACTOR Q_1 TESTED FOR

SIGNIFICANCE OF DIFFERENCES

	Mean Sten	S.D.	Diff. Means	t	d.f.	Significance (two tailed)
Total 1967 biology group	5.70	2.29				Not
			1.19	.613	76	significant
Personality problem group	6.89	2.10				

Factor Q_1 is established as a conservative - experimenting dimension.

As can be observed from the tables, in none of these factors is the problem group significantly different from the total group. Both factors F and H however, are notable for their small standard deviations which indicates that these characteristics of desurgency and shyness may ultimately prove to be uniformly low in a group of this type. Overall, the trend from this profile appears to depict a person who is humble, submissive, taciturn, pessimistic, shy, timid with feelings of inferiority. Particularly cogent for a group of people experiencing personality problems, is the comment attached to the description of factor E-, "This passivity is part of many neurotic syndromes". (Cattell, 16 P.F. Manual for Forms A and B). Once again the situation appears that although significance levels are not of an acceptable magnitude the underlying model revealed is in concord with empirical observation and logical reasoning.

To probe further beneath the surface of this complex, second order factors were calculated as follows: -

Table 20.5.

SECOND ORDER PERSONALITY FACTORS.

	Mean Sten
Low Anxiety v. High Anxiety	6.43
Introversion v. Extraversion	3.65
Emotionality v. Alert Poise	4.68
Subduedness v. Independence	6.54

Of these results it is interesting to note that this group is even higher than the failing subgroup of the 1967 total group in the second order factor of anxiety (6.43 and 6.38 respectively). The most important finding of this appendix study is the unusually low second order sten score which appears for the introversion scale. In all of the thesis work this is the only mean sten score to emerge as lower than four. For further emphasis the introversion - extraversion sten for the total 1967 group was calculated. This, a sten of 5.21 is within the normal range. Unfortunately no method is available for ascertaining the significance of differences between second order group factors calculated from a mean profile but it appears from previous comparisons that this difference would almost certainly be a significant one. It is likely therefore that persons who experience personality problems in their student life are most often of an introvert type.

Within this group studied are several categories of personality problems (these internal differences, plus the small numbers, have to a large extent made significance levels difficult to obtain) and as more and more profiles become available it is confidently expected that highly significant results will accrue from studies of these subdivisions. Even with this small number processed, subpatterns can be discerned but numbers as yet are too small to warrant a subpattern study.

II Analysis of results of the A.H.5 test.

While the A.H.5. test manual does not convert raw figures to I.Q's it does give norms based on a five point scale, A to E. These were derived from the scores of 946 university students and are graded as follows -

Grade A - Top 10%
Grade B - Next 20%
Grade C - Middle 40%
Grade D - Next 20%
Grade E - Lowest 10%

By combining the 1966 and 1967 groups into a total group of 253 students and applying this scale to their marks the following tables are obtained

Table 21.

INTELLIGENCE SCORES PART 1.

Grade raw scores	Student Nos	%
A (25 - 36)	1	.4 %
B (22 - 24)	14	5.5 %
C (17 - 21)	82	32.4 %
D (14 - 16)	62	24.5 %
E (0 - 13)	94	37.2 %
	253	

Table 21.1

INTELLIGENCE SCORES PART 2.

Grade	raw scores	Student Nos.	%
A	(27 - 36)	14	5.5 %
B	(23 - 26)	40	15.8 %
C	(18 - 22)	101	39.9 %
D	(14 - 17)	64	25.3 %
E	(0 - 13)	34	13.5 %
		253	

Table 21.2

INTELLIGENCE SCORES TOTAL (PART 1 and PART 2).

Grade	raw scores	Student Nos.	%
A	(50 - 72)	4	1.6 %
B	(44 - 49)	19	7.5 %
C	(36 - 43)	94	37.1 %
D	(29 - 35)	75	29.7 %
E	(0 - 28)	61	24.1 %

Because this distribution does not compare favourably with the British norms and because of the apparent imbalance between the two halves of the test, a second set of figures

was obtained, this time from 100 Palmerston North Teachers' College students. This test was administered by a different person. The three sets of figures now available (1966, 1967 and Teachers' College groups) will be considered in more detail.

Table 21.3

INTELLIGENCE - 1966 BIOLOGY GROUP

Group	Part	Mean	Range
Males	Pt.1.	14.90	6 - 25
(176)	Pt.2.	18.42	7 - 32
	Total	33.32	15 - 56
Females	Pt.1.	17.23	11 - 23
(17)	Pt.2.	19.71	14 - 27
	Total	36.94	27 - 50
Total	Pt.1.	15.10	6 - 25
Group	Pt.2.	18.54	7 - 32
(193)	Total	33.64	15 - 56

Table 21.4.

INTELLIGENCE 1967 BIOLOGY GROUP

Group	Part	Mean	Range
Males	Pt.1.	14.87	6 - 23
(54)	Pt.2.	19.57	7 - 29
	Total	34.44	14 - 49
Females	Pt.1.	17.50	12 - 22
(6)	Pt.2.	20.17	16 - 27
	Total	37.67	28 - 49
Total	Pt.1.	15.13	6 - 23
Group	Pt.2.	19.63	7 - 29
(60)	Total	34.67	14 - 49

Table 21.5.

INTELLIGENCE - TEACHERS' COLLEGE GROUP.

Group	Part	Mean	Range
Males	Pt.1.	12.80	6 - 23
(25)	Pt.2.	16.64	8 - 26
	Total	29.44	16 - 49
Females	Pt.1.	13.04	4 - 24
(75)	Pt.2.	16.23	7 - 27
	Total	29.27	12 - 45
Total	Pt.1.	12.98	4 - 24
Group	Pt.2.	16.33	7 - 27
(100)	Total	29.31	12 - 49

From the norming group Heim gives a mean of 39.06 although she mentions that a group of 866 medical students obtained a lower mean of 37.49. While it must be kept in mind that this thesis group of New Zealand students is not likely to be such a select group as its British counterparts, it appears probable, from these figures and from verbal reports of testing in other countries, that the norms given are not obtained from a typical student population and should

be used with some reservations.

Heim also mentions that students tend to score more highly in the spatial subtest than in the verbal numerical section and her norms reflect this. The greatest discrepancies in the thesis figures are in the male section and as this is noticeable in the Teachers' College group, but to a lesser extent, it is likely that this is partly a male linked characteristic and also in part a function of the fact that the main thesis group is a science biassed one. Heim does not give male and female figures separately.

When one compares the thesis group's marks with the norms given it also appears that the group as a whole is relatively stronger on part 2 (spatial) of the test (the slight difference that Heim finds being accounted for within the norms). It is interesting to speculate as to why this should be so. It could be that the predominance of males in the group produces this effect or there may be cultural, social or educational factors in the New Zealand situation which favour this mental bias (if indeed it is a true bias).

III Sex drive as a factor tending to disrupt study patterns.

The subsidiary test given to assess levels of divergent thinking, a free association test, was revealing in many ways but most striking was the tendency of many male students to eventually revert to a word having overt sexual associations. In numerous cases words such as 'sex', 'intercourse', 'girlfriend', 'bed', 'marriage' etc. were found either singly or most often in association with each other. Several students seemed to be unable to depart from this line of thought no matter what clue word was suggested.

While this may not be entirely surprising, as university students are renowned for their rather earthy humour, it did suggest the possibility that at least for some students the sex drive may be a significant factor leading to the unaccountable failures which regularly occur. After all the male sex drive is reputed to be at its peak in the late teens and early twenties and in our society normal gratification of this drive is not socially acceptable prior to marriage. Thus the university student in most cases is denied fulfilment of a primary drive when this drive is at its peak strength.

To follow this hypothesis a little further, the males

in the 1966 group were divided into three sections; firstly those who had made no mention of any words having sexual overtones, secondly those who had given such replies once or only occasionally and thirdly those who had given these responses for each of the clue words or had pursued the subject to some depth. A table was then constructed to show means for each of these groups, failure figures, drop out figures and higher passes.

Table 22.

SEX DRIVE LEVELS AND DIFFERENTIAL SCORES.

Group	Mean Intell.	Mean Creativ.	Mean Biol. Mark.	Numbers passing	% passing
No mention (92)	32.3	120.1	104.1	63	68.5 %
Little Mention (67)	34.3	143.0	104.8	46	69.3 %
Excessive mention (11)	38.5	144.5	100.0	6	54.5 %

	Numbers failing	% failing	B passes	A passes	Drop-outs.	Dropout %
No mention (92)	25	27.1%	12	3	4	4.3 %
Little mention (67)	19	28.3%	13	-	2	3.0 %
Excessive mention (11)	2	18.1%	-	-	3	27.2 %

The original thesis design was not intended to test hypotheses in this field and the results at best only indicate avenues for future exploration but it is relevant to note that the difference between the intelligence mean of the "no mention" group and that of the "excessive mention" group is significant at less than .02 while the difference in divergence scores (total score) is significant at less than .05. No differences in biology final marks means are significant.

Therefore the situation occurs where the "excessive mention" group is significantly better than the other two in terms of intelligence and creativity yet three members of the group do not complete the course, two fail, and of the six who pass, none get A or B grade passes. It is an easy step to suggest that perhaps this group is one in which excessively high unrelieved sex drive does interfere with regular study patterns. Conversely it may be argued that more creative people tend to have higher sex drive levels. McKinnon (1962) has found that creative architects are higher than a normal sample of people in a femininity dimension, but these two factors are not mutually exclusive.

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