

RELATIONSHIPS BETWEEN CERTAIN  
PERSONALITY FACTORS AND MATHEMATICS  
ATTAINMENT IN SOME SELECTED SCHOOLS  
IN THE RANGE STANDARDS TWO TO SIX

by

JEFFREY ROBERT ILSLEY

Thesis

Submitted to Satisfy the Requirements for

the Degree of

MASTER OF EDUCATION

of

RHODES UNIVERSITY

December 1977

There is of course no logical way leading to the establishment of a theory, but only groping, constructive attempts controlled by careful considerations of factual knowledge.

A. Einstein.

## ACKNOWLEDGEMENTS

My grateful thanks and appreciation go to my supervisor, Prof. A. Noble, whose interest and enthusiasm was invaluable. The permission of the Cape Education Department to carry out the study, and the co-operation of the principals of the schools concerned, are also much appreciated.

## CONTENTS

INTRODUCTION . . . . .	1
Chapter	
1 THE CONCEPT OF PERSONALITY . . . . .	3
1.1 Developmental Perspective	
1.2 The Problem of Definition	
1.3 Primary Personality Factors	
1.4 Some Second-Order Factors	
1.5 Two Personality Types	
2 RELATED RESEARCH . . . . .	26
2.1 Extraversion	
2.2 Neuroticism	
2.3 Extraversion - Neuroticism - a Summary	
2.4 Cattell's First-Order Personality Factors	
3 RESEARCH DESIGN AND EXPERIMENTAL PROCEDURES .	35
3.1 General Aims	
3.2 The Sample	
3.3 Descriptions of Tests	
3.4 Application of Tests	
3.5 Scoring the Tests	
3.6 Standard Five and Six Mathematics Marks	
4 THE STATISTICAL ANALYSIS . . . . .	46
4.1 Calculation of Extraversion and Neuroticism	
4.2 Comparison of Means of Personality Factors	
4.3 Comparison of Means of Mathematical Attainment	
4.4 Correlation of Mathematical Attainment against the First-order and Second-order Personality Factors	
4.5 Zonal Analysis	

Chapter

5	RESULTS . . . . .	62
5.1	Comparisons of the Means of the Personality Factors	
5.1.1	Age trends in the first-order personality factors	
5.1.2	Age trends in the second-order factors	
5.1.3	Sex differences in the first-order factors	
5.1.4	Sex differences in the second-order factors	
5.1.5	Conclusions	
5.2	Comparison of the Mathematics Means	
5.2.1	Sex differences	
5.2.2	Co-educational versus single-sex schools	
5.2.3	South African Norms	
5.3	Correlates between the Personality Factors and Mathematical Attainment	
5.3.1	The first-order factors and mathematical attainment	
5.3.2	Conclusions	
5.3.3	The second-order factors and mathematical attainment	
5.3.4	Conclusions	
5.4	Zonal Analysis	
5.5	Conclusions and Suggestions	
5.6	Implications for Education	
6	SUMMARY . . . . .	91
	APPENDIX . . . . .	94
	BIBLIOGRAPHY . . . . .	107
1	References to which specific reference has been made in the text.	
2	Other References.	

## INTRODUCTION

In the past the emphasis was given to intelligence as the sole major determining factor where academic success was concerned and Warburton (1969) wrote:

The ignorance of educationists in the field of personality makes a striking contrast to their ability to estimate educational and intellectual capacity, imperfect as that may be. ... The understanding of children's personality and the teacher's ability to assess these traits is perhaps the most important topic in the whole field of education.

Where would we be today if we assumed that all children are of equal intelligence? We cannot therefore assume they are equally anxious, introverted and have the same persistence in the performing of a task, just as we cannot assume they have equal intellectual capabilities. "... any attempt to understand the complete causal chain associated with school attainment must include the effect of personality on the child's work in the school." (Eysenck, 1972).

In the past few years there has been a marked increase in the research being conducted in fields other than intelligence, and a wide variety of research reports has subsequently drawn attention to the importance of social factors and early experiences in the home. Environment affects both the development of intelligence and the level of achievement. In the research literature is a series of papers which describes the relationship between personality and academic attainment. The results have been far from clear-cut and consequently have attracted little publicity.

Research has shown that relationships do exist between certain personality factors and scholastic success, but the measurement of personality is not an easy matter. Most research in this area has tended to use the personality tests developed by R.B. Cattell or H.J. Eysenck and this has limited the range of the correlates of personality and attainment and led to the emergence of certain trends.

As a result of a research project undertaken by A. Noble of Rhodes University, Grahamstown, which amongst other aspects concerned itself with personality and mathematical attainment, the writer decided to conduct a research project in certain selected schools in the Cape Town area. The afore-mentioned study which was conducted in almost all the Grahamstown schools had yielded some interesting and surprising results and the writer wished to ascertain if similar results were to be found in a different part of the country with pupils of similar socio-economic, language and cultural backgrounds.

The present study concerns itself with an investigation of the personality factors as measured by the Children's Personality Questionnaire (CPQ), as constructed by R.B. Porter and R.B. Cattell (1968), and mathematical attainment. The CPQ was considered the most suitable personality test as it has been standardised for use in the Republic of South Africa. Mathematics was chosen in preference to general academic ability (as used in most other similar studies), in an attempt to concentrate the focus of the research. It was decided to confine the investigation to the age range nine to thirteen years, because the unexpected findings of Noble (1974) occurred within this age span and because most research has hitherto been conducted with older children and university students.

## CHAPTER 1

## THE CONCEPT OF PERSONALITY

## 1.1 Developmental Perspective

"Personality is influenced by inborn temperament, intelligence, and physical characteristics; but personality growth depends most strongly upon interaction with other people." (Yelon and Weinstein, 1977)

Many years ago, children were simply regarded as small-scale adults and were treated accordingly. However, childhood is a distinct stage of life and we know that children become adults "through a gradual process of physical, social, emotional, moral and mental growth. As they grow they have ways of understanding, of reacting, and of perceiving that are appropriate to their years, to what psychologists call their stage of development." (Yelon and Weinstein, 1977). Therefore, if children are to be taught successfully, teachers should be aware of how they develop, think and respond. The stage that a child has reached plays an extremely important and significant role in his readiness and ability to learn. If a particular developmental stage has not yet been reached, his lack of ability to comprehend a particular concept or task would probably result in wasted effort on the part of both teacher and child.

Developmental psychology is the branch of psychology that studies the human being from conception throughout his whole life.

"Arnold Gessell who established the famous Institute of Child Development at Yale University during the 1930s, was the first to try to convince educators that growth and development occurred in an unvarying sequence." (Sprinthall and Sprinthall, 1977). The developmentalists believe that people pass through stages of personality growth and that any personality develop-

ment follows a sequence, just as intellectual growth does. Every human being is a unique individual and will develop at his own rate, but will pass through all the stages, which do overlap. Definite, clearly defined beginnings and endings of stages are not usually apparent. The ranges in which development could be considered to be 'normal', are of course, wide.

Developmental psychology requires that the child be examined separately in all his different stages of development and his behaviour be classified in various ways. Generally speaking, the stages could be: prenatal; infancy; early childhood; later childhood; (puberty); adolescence; adulthood; middle age and old age. The problem that arises here, is that as soon as any continuous, on-going development is broken up into stages for the purpose of study, it could easily happen that one would lose sight of "the uniqueness, the individuality, and the authenticity of the whole child." (Lugo and Hershey, 1974).

Hurlock (1975) sees developmental psychologists as having six major objectives:

- (i) to find out what the common and characteristic age changes, in appearance, in behaviour, in interests and in goals are from one developmental period to another;
- (ii) to find out when these changes occur;
- (iii) to find out what causes them;
- (iv) to find out how they influence behaviour;
- (v) to find out whether they can be predicted or not; and
- (vi) to find out whether they are individual or universal.

In its early years, developmental psychology was concerned with trying to establish at what ages various stages of development occurred. These attempts quite obviously yielded the well known fact that individuals reach the different stages at different ages. Human beings continue to develop, to change, and to be affected by experience, throughout their lives. The most dramatic changes do, of course, take place in childhood, but adolescence is another period of intense and noticeable change. Despite the age-variations at which

children pass through the various stages, it is believed that physical, emotional and mental growth are related. Yelon and Weinstein (1977) note that "every aspect of human growth influences every other aspect. There is a positive correlation, a direct relationship, among physical, emotional, social and mental development."

There are, of course, many ways in which human behaviour and development can be examined systematically. One particularly interesting framework is the one put forward by Lugo and Hershey (1974) where they propose four distinct domains of human behaviour within which the child psychologist can work. These domains and some examples of the type of behaviour they include are:

- (i) Biological - all biological processes and their psychological implications
- (ii) Social - effect of institutions on human development, effect of society and groups on development
- (iii) Affective - feelings, emotions, motivation
- (iv) Cognitive - thought processes, language development, learning processes

"These domains or systems are in no way independent, separate systems, but are highly interrelated and interactive." They merely provide the basis for the systematic study of human behaviour as it develops according to a definite pattern. There are of course many other developmental domains which could be discussed, but they could all be considered to be subdivisions of those given above, and these four have been chosen as a basis for discussion, but not because they necessarily represent the generally accepted divisions of developmental psychology.

All the above domains represent areas of developmental growth which determine the unique personality of an individual, but two, namely cognitive and affective development are more closely

related to the implications of the present study than the other two. These two will therefore be discussed in greater detail than the biological and social development of the child.

(i) Biological domain

Lugo and Hershey (1974) illustrate four areas in which man's human biological potential may be more fully developed. This would be achieved by promoting:

- (1) Physical health
- (2) Physical competency
- (3) Genetic adequacy
- (4) A biologically maturing self-concept

Biological maturity is not something that is reached at the end of adolescence, but something that continues through adulthood. There are always skills and talents that remain unexplored and failure to recognise this would be a major shortcoming.

(ii) Social domain

It is important to develop to the best possible degree, the social effectiveness of any individual. To predict what qualities will be needed for living a full meaningful life in the years to come is no easy task. This makes the task of determining how to educate and raise children of the present generation, one of the most socially relevant activities. Lugo and Hershey (1974) see socialisation as "the process by which someone learns the ways of a given society or social group so that he can function within it."

(iii) Affective domain

Affective education could be regarded as the emotional well-being of pupils, and according to Yelon and Weinstein (1977) it includes "... the confidence children develop about their

own abilities, their relationships with others, and their willingness and ability to express themselves. And affective education also pertains to values and attitudes." It appears therefore to encompass a wide range of psychological states and according to Lugo and Hershey (1974) "... affect is a constantly changing entity."

Bloom (1976) in dealing with attitudes towards 'subject-related' performance, coins the phrase 'Affective Entry Characteristics' which comes close in meaning to the term 'motivation'. Obviously individuals approach the learning tasks of their choice with enthusiasm and perhaps some confidence. Bloom goes on to observe that "... individuals vary in what they are emotionally prepared to learn as expressed in their interests, attitudes and self views." A child will most often like an activity that he feels he has done, or can do, successfully. Success or failure, approval or disapproval of parents, teachers and peers, are all likely to cause favourable or unfavourable attitudes towards school or school learning. Bloom (1976) sums this up by saying, "while the process evidence is very limited, it is believed that relevant affect is determined by the individual's perceptions about his achievement and that, in turn, affect is a determinant of future achievement."

As mentioned earlier, affective education also pertains to (moral) values. One such theory of moral development is that of Kohlberg, which is based on Piaget's developmental theories. This is described by Yelon and Weinstein (1977), and the theory "... rests on the premise that children develop morality, develop personal value systems, in the process of growing and interacting with the environment." Children reach different stages of moral development, but teachers do influence development as a result of the school environment.

## (iv) Cognitive domain

This domain, which is basically learning and thinking, lies at the heart of Piaget's theory of development, and he has been probably the most influential theorist on the stages of cognitive development. Social competence and moral development are considered to be dependent on cognitive growth, and this seems to be one of the newest and most significant areas in educational psychology.

Piaget proposed that cognitive growth takes place in developmental stages, meaning "that the nature and make-up of intelligence changes significantly over time." (Sprinthall and Sprinthall, 1977). They go on to say, "the stages of growth are distinctly different from one another, and the content of each stage is a major system that determines the way we understand and make sense of our experiences (particularly the experience of learning from someone else)." During these different stages, children use different cognitive systems and each is a major qualitative transformation. Each stage is unique, though it depends on the previous stage for its own development. Lugo and Hershey (1974) note that "the stages appear in a fixed invariant sequence although the time for their appearance varies depending on both biological growth and the extent and timing of experiences." There are four distinct stages of cognitive development, but they lie within broad age ranges.

- |     |               |   |                             |
|-----|---------------|---|-----------------------------|
| (1) | 0 - 2 years   | - | Sensorimotor                |
| (2) | 2 - 7 years   | - | Intuitive or Preoperational |
| (3) | 7 - 11 years  | - | Concrete operations         |
| (4) | 11 - 16 years | - | Formal operations           |

Because of the broadness of the various categories, each stage has sub-categories. It must be remembered though, that the thinking of each stage is different from the preceding one and the change from one to the next is a major leap forward, not a gradual process.

(1) Sensorimotor stage (0 - 2 years)

During this stage, behaviour is dictated by the senses and motor activity. "The child's impression of the world is formed by perceptions of his or her senses or by his or her own increasing manipulations of the environment." (Yelon and Weinstein, 1977). It is during this stage that babies begin to develop the concept of 'object permanence', because babies knowing only themselves, believe that objects only exist if they can see them. Activity is therefore practical, without language to label experiences, or to symbolise and hence remember, events and ideas.

(2) Intuitive or Preoperational thought (2 - 7 years)

Vocabulary development is probably the most significant during this stage and as they are no longer bound to their immediate sensory environment, children increase markedly their ability to form mental images. This major change, in that they are now able to use language and thus communicate, comes at a time when they are maximally ready to learn language. Obviously the richer the verbal environment at the time, the more likely it is that language will develop.

The predominant learning mode is intuitive. "They are not overly concerned with precision, but delight in imitating sounds and trying out different words. They are also unconcerned with the consequences of language." (Sprinthall and Sprinthall, 1977). It is as a result of intuition that a child would choose a tall, narrow glass of water as containing a greater volume than one which is short and broad. The preoperational child cannot comprehend the principle which Piaget calls 'conservation'. Yelon and Weinstein (1977) describe this as "... the ability to recognise that basic attributes of an object, such as number or weight, remain the same even when the appearance of the object is transformed." If the child has not reached this stage of his development, then no amount of explanation will enable him to comprehend

the concept of conservation. Sprinthall and Sprinthall (1977) sum up by saying "... the mental structures at the preoperational stage are largely intuitive, freewheeling, and highly imaginative. Do not assume, however, that because the process seems illogical it is necessarily inferior as a mode of thought."

### (3) Concrete operations or Operational thinking (7 - 11 years)

The children have by now developed the concept of conservation and can concentrate on more than one dimension at a time. They begin to become logical in their thinking and are able to test the answers to problems. Sprinthall and Sprinthall (1977) observe though that "... in their wholehearted abandonment of magical thinking, fantasies, and imaginary 'friends' they become almost too literal-minded. ... they cannot separate hypothesis from fact." Their logical thinking though is only at the beginning and they can only solve problems that are set in concrete terms and cannot extend their logical deductions to imaginary situations. If their teacher desires something to be done in a particular way, then the children can see no other possible way in which something can be done, and this is a concept which teachers and parents so often fail to realise.

Once children are in the stage of concrete operations they are no longer totally egocentric and can communicate and compare other points of view with their own and possibly decide what is right. Yelon and Weinstein (1977) see this as "... a very good stage for co-operation and for competition, for the social interaction in which ideas are used."

### (4) Formal operations (11 - 16 years)

This stage coincides, more or less, with adolescence and here children can think about abstractions, visualise logical solutions internally, and develop formal patterns of thinking.

They can apply a theory to many problems or vice versa and need no longer work with only what they can see. Yelon and Weinstein (1977) say that during this stage children " can organise information, reason scientifically, build hypotheses based on an understanding of causality, and test their hypotheses." Sprinthall and Sprinthall (1977) maintain that the more active the symbolic process is, the better the cognitive growth. Thus writing poems is better than reading them; making films more effective than viewing; taking part in an improvised drama preferable to observing them. They suggest therefore that "probably the most creative and significant task confronting secondary-school teachers, is the challenge that this theory of growth presents, to build new approaches to curriculum materials."

In conclusion then it should be said that a significant educational implication of cognitive development is that growth at any of the stages depends on activity. A logical consequence of Piagetian stages should be an active school and if one accepts these developmental stages, teachers should bear the cognitive level of the pupils in mind and always remember that the thought processes of adults are different to those of children. It can be said that all the lines of human development sketched in this section can be subsumed under the heading of Personality, which should, therefore, be more closely defined.

## 1.2 The Problem of Definition

Different aspects of human personality almost certainly affect learning and academic performance and while there is no definite formula that can be applied to children in order to guide them according to their own personality attributes, "there is every reason why we must recognise that the differences which exist in their scholastic performance may be as much a function of their personality as of their intellect." (Child, 1973).

When one looks at 'personality' and attempts to define it in a way that is acceptable to all, it becomes obvious that this is an impossible task. What one is attempting to do, is to define the total organisation of man. It is a search for an understanding of individual differences, temperamental peculiarities and other deviations from accepted 'normal' behaviour. There doesn't appear to be any generally agreed definition of personality but if one selects a few, it becomes apparent that there is some region of agreement. According to Harsh and Schrickel (1950), 'personality' may be regarded as "that which characterises an individual and determines his unique adaptation to the environment." Allport (1961) sees personality as "the dynamic organisation within the individual of those psychophysical systems that determine his characteristic behaviour and thought." Burt (1965) defines personality as denoting "the distinctive way in which any given individual's non-cognitive or dynamic tendencies are organised, i.e., the various affective, conative and emotional propensities which chiefly determine his interests, motives, preferences and indeed, his whole social and personal behaviour." It is apparent from these definitions that personality will be an important factor in determining the behaviour and academic success of a pupil and its effects should therefore be investigated. Child (1973) goes along with this as he sees personality as "the more or less stable and enduring organisation of a person's character, temperament, intellect and physique which determines his unique adjustment to the environment." He explains his definition by expanding on three key-words: temperament; character and intellect.

He sees temperament as being a quality which describes "the inherent disposition underlying personality. Physiological factors, there from birth, such as variations in endocrine gland secretions in response to different environmental settings, distinguish our excitability, instability or placidity." The effect of environmental factors makes, as for intelligence, the observation of temperament difficult.

"Character, on the other hand, is an evaluative term referring to such traits as honesty, self-control, persistence and justice. ... Environmental constraints accompany the expression of inherited temperamental qualities and lead to character development." This development of character is therefore dependent on the temperamental potentialities possessed at birth and the environment to which the child is exposed. We have thus a situation very similar to that thought to exist in the concept of intelligence, where both heredity and environment play their part.

Intelligence must also play an important part in the determining of personality since Child's definition (and most others) mentions "adjustment to the environment". Child sees bright children as attaining higher levels of abstraction and "in consequence they may face and solve life's problems in ways which contrast with those of the not so bright."

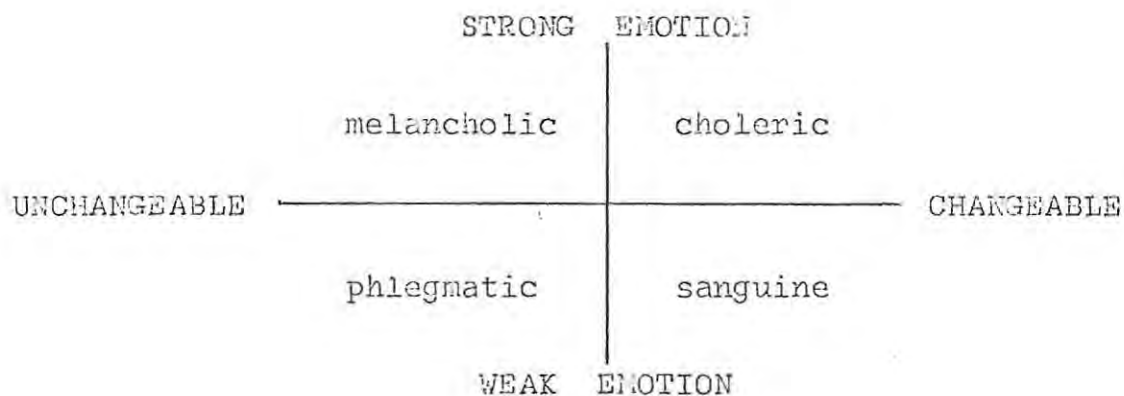
The numerous descriptive terms which are employed by those involved in the field of personality, produce so much overlapping that it would seem imperative to follow a procedure of "reducing them to a small number of relatively independent tendencies, capable of serving as principles of classification." (Burt, 1965)

As long ago as the second century A.D., Galen proposed a typology based on the distribution of the 'body-fluids' or 'humours' as first suggested by Hippocrates. These personality types were termed the 'melancholic', 'sanguine', 'phlegmatic' and 'choleric' and are described as follows:

- |             |   |                                    |
|-------------|---|------------------------------------|
| melancholic | - | pessimistic, suspicious, depressed |
| sanguine    | - | optimistic, sociable, easy-going   |
| phlegmatic  | - | calm, controlled, lethargic        |
| choleric    | - | active, irritable, egocentric.     |

Following on the early ideas of the Greeks, Immanuel Kant produced, in 1798, his famous 'Anthropologie' in which he

dealt with these four temperaments. His idea was that every person would fit into one of these separate and unrelated categories. However, this appears to be a bit rigid and does not make allowance for different degrees of various personality characteristics. Wundt, writing at the beginning of the century, maintained that the fourfold division was justified provided two principles could be incorporated. One was the 'strength' of a person's feelings and the other their 'speed of change'. In other words he had shifted the emphasis from 'a typology conceived as a categorical system' which only allocates people to one of four quadrants, to a quantitative, two-dimensional system in which people can occupy any position and any combination of positions on two major dimensions labelled 'emotionality' and 'changeability'. (Eysenck and Eysenck, 1969)



In other words, two people could both fall into the category which labels them as say phlegmatic but they could differ markedly in their degree of unchangeability and weak emotionality.

These concepts of personality types have found their way in a modified form to some present-day theories. "Essentially however, it may be said that the task which factor analysis sets itself is precisely analogous to that posited by the Wundtian scheme." (Eysenck and Eysenck, 1969)

During the period 1880 to 1930, personality theory based itself on a clinical and general behavioural observation. Freud could be described as the initiator of this approach and "Gross, Jung, Kretschmer and others active around the same time did not add much material to the scientific description of personality; they still relied very much on intuition and argument." (Eysenck and Eysenck, 1969). While it is fairly obvious that their's was a methodologically weak approach there can be no doubt that their contribution was invaluable and Cattell and Warburton (1967) do point out that the initial concepts from which the present questionnaire-method tests were conceived were firstly clinical and derived from Freud, Jung, Kretschmer and others and were also based on "shrewd naturalistic observation and reasoning."

Personality then shifted from this intuitive approach to one tending to exact measurement and experiment. Cattell and Warburton (1967) point out that "... research proceeded on the normal relation in a healthy science between data and hypothesis, in which each successive factor analysis produced cleaner evidence on the emerging patterns, and each more definite emergence of a pattern led to a cleaner hypothesis."

Before expanding on this factor analytic approach it would be as well to look at a classification compiled by Vernon (1966) in which he sees three broad basic approaches to the interpretation of personality which he terms (a) naive, (b) intuitive and (c) inferential. Personality is discussed under these three headings by Child (1973), because "modern theories of personality structure are many and diverse. To assist in containing these we shall adopt a very useful classification..."

- (a) The naive approach is based on "superficial, face-value observations and interpretations of overt behaviour without the use of standardised norms. What we see in other people is conditioned by our own dispositions,

attitudes, motives, biases and interests and we build up a rule of thumb about human nature on the grounds of previous anecdotal experience." (Child, 1973). He suggests that these interpretations of personality have no chance of succeeding for a variety of reasons: They tend towards an over-simplified view of human nature with rigid stereotypes based on limited and biased experience and people can create 'masks' to disguise or reveal particular qualities. The observer tends to spot the 'irregular' behaviour only, as this is more conspicuous and also to undervalue a person whose ideas clash with his own views. It appears therefore that nothing sound or reliable would emerge from this type of analysis and its virtues are therefore highly questionable.

- (b) Intuitive theories of personality are those that stem from the innovations of Freud and his followers (eg. Adler and Jung) and more recently the neo-Freudians (eg. Horney, Fromm and Sullivan). This theory has had a substantial following and forms a basis for therapy, but seems to have little use to the teacher in the classroom situation. The intuitive approach, according to Child (1973), is the "subjective, and assumed unlearned, understanding of human conduct forming the basis of Freudian psychology." This theory has, as was stated before little practical value to the teacher, but in addition the assumption that man's adaptability plays little or no part, in that his personality is established in his first few years, seems to impose some limitations on its usefulness.
- (c) The first two theories seem to offer little to this investigation, so one looks to the inferential approach for progress in the understanding of the concept of personality. This approach is objective and scientific and "has its origins in the belief that man's behavioural tendencies can be classified as traits or factors measur-

able using tests and evaluated chiefly by the use of factor analysis." Child (1973). The difficulty with this approach is as to whether it is true that behavioural tendencies can be classified or not. Allport (1961) raises this problem: "Are the dimensions or elements we take such pains to analyse out of the total fabric or personality really parts of the life as actually lived, or are they artificial constructs?" Allport goes on to say that he thinks the psychometrists have to be content with "mere approximations to the structure of the individual personality." The personality factors and types will be discussed in the next few sections and it will suffice at this stage to discuss the feasibility of the inferential approach.

The points already made are in favour of the inferential approach and it should be remembered that Galen's and Jung's typologies were the beginnings of this approach. Much progress has been made, with H.J. Eysenck and R.B. Cattell possibly being two of the leading psychometrists at the present time. Eysenck has developed descriptions of three main personality types, namely, extraversion-introversion, neuroticism-stability and psychoticism-normality. Throughout his arguments Eysenck is obviously firmly in favour of the inheritance of personality characteristics.

Cattell differs in approach to Eysenck as he has extracted sixteen personality factors which he terms source traits and from these he derives second-order factors and criteria, some of which are almost identical to Eysenck's character types.

Early attempts at the questionnaire-method approach were not encouraging and even at the present time it is not without its critics. As Vernon (1938) pointed out: "The attempts to classify test items of symptoms logically into distinct groups has not we must admit, been successful." Several

questions can be posed in connection with these so-called pencil-and-paper tests. Are the tests fakeable? Do people give socially desirable responses rather than truthful ones? How stable are the factors across different groups of people or for the same person? Where variations occur, are they due to unreliable test material or are they genuine changes in personality from one test to the next? How total is the profile presented by all the factors together? Satisfactory answers would be needed before these tests could be unequivocally accepted, but while this cannot be achieved at this stage, it is possible to gain a fair level of acceptance for the tests. Saville and Blinkhorn (1976) are of the opinion, and justifiably so, that questionnaire tests are fakeable but that social desirability responses can to some extent be controlled. Eysenck and Eysenck (1969) agree about the fakeability of tests and say "it is impossible to prove that the questionnaires were answered truthfully." This is of course so and thus it is very important that the correct impression about the test be given by the tester before the testing commences. Child (1973) summarises the opinions of various investigators and answers most of the above questions by his comment:

The reliability obtained from testing and retesting the same group with the same or a parallel form of inventory has been encouragingly high. The closer the testing sessions in time, the higher is the reliability. Our reservations about such inventories include the problem of knowing whether changes in the score from one occasion to the next are a measure of unreliability of the test material or an accurate measure of personality change (or both). Moreover, we cannot be certain that all dimensions of personality have been catered for in the selection of items on existing inventories...

What emerged from all of this was that a more detailed approach was required in which homogeneous questionnaires had to be constructed and intercorrelated "in order to study the dimensionality of the whole field, and indeed it became necessary to go even further than that and intercorrelate

individual items in order to achieve greater homogeneity in the measuring instruments." (Eysenck and Eysenck, 1969)

The measurement of personality is far from simple, but Entwistle (1972) makes the observation: "the advent of the pencil-and-paper group tests which have been carefully developed and validated has stimulated interest in this research area." Certainly, the amount of literature available is indicative of this and certain trends are emerging. Most of the British studies have used the personality inventories developed by either Eysenck or Cattell and as stated earlier the present study makes use of the tests developed by the latter. The CPQ has been standardised for use in the Republic of South Africa, and du Toit and Madge (1972) see a need for "an instrument for evaluating children's personality traits at an early age." They give as one of the reasons that "by early recognition of these problems, many behaviour difficulties can be avoided or treated before they harden into complications resistant to treatment." While this is obviously of utmost importance, educationists should not lose sight of the fact that it is not only the problem cases that need specialised attention but that children fall into many different personality groups and these all seem to indicate different needs and hence a varied approach is necessary in order to accommodate them.

### 1.3 Primary Personality Factors

"Psychological common sense, and even a slight acquaintance with existing multivariate statistical analyses, should suffice to convince one that no single test is likely to tap more than a slight fraction of all the dimensions of personality." (Cattell and Warburton, 1967). Charles Spearman can be credited with pioneering the first factor-analytic studies of personality, but there are three workers who have been particularly active in this field over many years. J.P. Guilford, H.J. Eysenck and R.B. Cattell have all produced questionnaires worthy of note and there is a great deal of similarity in the

personality factors which their respective tests yield. These personality tests are based on theories which have emerged from statistical evidence on personality structure. They are constructed to measure, by hypothesis, a demonstrated basic source trait or factor, and not just simply in the hope that something will emerge afterwards. The need for tests that can conveniently be applied to children has long since been recognised. Their use in the clinic setting is obvious, but even in the school in the hands of a psychologist or a teacher with the necessary background, the test results could be of great value.

At the first level of Cattell's model of personality, there are many surface traits of personality. Surface traits are the directly observable aspects of human behaviour, the labels which are frequently used in our everyday experience. It is the first-order factors or primary source traits which are claimed to represent the universal basic variables in the total personality structure.

The CPQ of Cattell produces a general assessment of personality by measuring fourteen distinct dimensions or traits of personality "which have been found by psychologists to approach the total personality" (Porter and Cattell, 1968) and these will be discussed more fully at a later stage.

#### 1.4 Some Second-Order Factors

At times, the identification of a particular first-order factor proves to be difficult and even obscure, but one thing emerges rather clearly from most of the work under review, namely the repeated appearance of two personality dimensions closely resembling stability-neuroticism and extraversion-introversion. "It would appear therefore that Cattell's studies line up with the others reviewed ... to define the same two fundamental dimensions of personality we have encountered so often." (Eysenck and Eysenck, 1969).

It is necessary to examine these two second-order factors a little more closely and separately.

EXTRAVERSION and INTROVERSION are terms commonly acknowledged to have been coined by Jung (1923). Other authors had put forward psychological theories based on a type division, but he was the first to gain widespread acceptance for the type theory. Jung (1923) sees it as follows:

Extraversion means an outward turning of the libido. With this concept I denote a manifest relatedness of subject to object in the sense of a positive movement of subjective interest towards the object. Everyone in the state of extraversion thinks, feels, and acts in relation to the object, and moreover in a direct and clearly observable fashion, so that no doubt can exist about his positive dependence upon the object. In a sense, therefore, extraversion is an outgoing transference of interest from the subject to the object. The state of extraversion means a strong, if not exclusive, determination by the object. One should speak of an active extraversion when deliberately willed, and of a passive extraversion when the object compels it, i.e. attracts the interest of the subject of its own accord, even against the latter's intention. Should the state of extraversion become habitual, the extraverted type appears.

Introversion means an inward turning of the libido whereby a negative relation of subject to object is expressed. Interest does not move towards the object but recedes towards the subject. Everyone whose attitude is introverted thinks, feels and acts in a way that clearly demonstrates that the subject is the chief factor of motivation while the object at most receives only a secondary value. Introversion may possess either a more intellectual or a more emotional character just as it can be characterised by either intuition or sensation. Introversion is active when the subject wills a certain seclusion in the face of the object: it is passive when the subject is unable to restore again to the object the libido which is streaming back from it. When introversion is habitual, one speaks of an introverted type.

Jung does stress that it is a mistake to think of introversion as more or less the same as neurosis. Considered as concepts, there is no connection between the two at all.

All the investigation and testing which followed was generally ineffective and the factors which were produced subsequently, seemed to resemble Jung's I-E, but nothing was conclusive. However, there can be no doubt that the present-day concepts of I-E do not differ markedly from Jung's definitions and this has been borne out by Hildebrand (1958) in an in-depth factorial analysis of Jung's hypotheses.

Many questionnaires have been produced, and as a result trait names have become a source of confusion. What was 'introversion' to one author was not introversion to another. Saville and Blinkhorn (1976) ask, "... is it not possible to find a basic set of constructs by which we can understand human personality? The factor analysts believe it is." The differences found in the results of different tests which claim to measure the same thing are probably a combination of differences: (i) in the meaning of the terms; (ii) in the items included in the tests and (iii) in the methods of scoring.

Like Cattell, Eysenck is more interested in comparing characteristics of an individual with the characteristics of people in general, than with how characteristics are related within the individual. While Cattell is in broad agreement with Eysenck that personality is best described in factored scales, their methods are quite different. Cattell looks for oblique primary factors whose intercorrelations will yield higher order factors, while Eysenck prefers orthogonal factors (i.e. factors which are completely uncorrelated) with, in consequence, no possibility of factoring to a higher order. Cattell thus accuses Eysenck of producing too few factors and hence having lost information, while Eysenck claims that Cattell's primary factors are unreliable. There is a good deal of evidence, however, that Eysenck's two factors, extraversion and neuroticism match rather closely to Cattell's similar factors. "In other words, Cattell's questionnaires may be used to measure these two type factors, and do so probably with the same degree of accuracy as do the Eysenck and Guilford questionnaires." (Eysenck and Eysenck, 1969)

Jung never formally elaborated part of his hypothesis which dealt with a second factor in addition to extraversion - introversion and Eysenck and Eysenck (1969) comment: "This factor we may ... call emotionality or instability or NEUROTICISM. ... The independence of neuroticism and introversion is stressed by Jung." Freud, however, tended to identify introversion with neuroticism and did not see them as being orthogonal at all.

Most of the preceding three paragraphs obviously apply equally to neuroticism as well as extraversion - introversion, but there has been, and still is, some confusion concerning neuroticism and anxiety. Some studies do not differentiate between these two at all and consequently there has been a blurring of distinction between them.

Cattell quite clearly differentiates between anxiety and neuroticism as he has second-order equations which describe these two factors separately. However, five primary factors are common to both equations showing that there is considerable overlap between the two, but that they are distinct personality types. There is however, some tendency, in general, for neurotics to be more anxious, but anxiety is not neuroticism.

In conclusion, we see that while there is some disagreement about the validity of Cattell's primary factors, he and other researchers are convinced that these factors are both reliable and valid. As far as the second-order factors are concerned, although there is still some divergence of opinion, the more established and recognised investigators agree with some confidence about the similarity of their concepts of neuroticism and extraversion and general opinion has tended to accept this development about these two descriptions of personality.

### 1.5 Two Personality Types

Obviously for this study the concepts of neuroticism and extraversion will be those as defined by Cattell's CPQ second-

order equations. However, because it has been proved that there is considerable overlap between the definitions of various investigators, it will be beneficial to look at what 'type' of person we are describing and dealing with.

In Eysenck and Eysenck (1969) a study by Peterson is described, where Peterson extracts his own two factors from Cattell's studies. "Factor 1 is marked by obedience (in children), stability of interests and attitudes, responsibility, conscientiousness, good-natured, easy-going tendencies, patience, trust, good-manners, freedom from jealousy, determination and perseverance, co-operativeness, modesty and emotional stability." This of course very strongly resembles a stability-neuroticism factor. Peterson's second factor has a striking resemblance to extraversion and is "principally marked by boldness, outgoing social tendencies, open expressiveness, gregariousness, energetic alertness, cheerfulness, attentiveness to others, and assertiveness."

Entwhistle (1972) sees neuroticism as characterised by unnecessary worrying, feelings of restlessness, by moodiness and general nervousness, while the stable person would show generally controlled behaviour, tending to be reliable, even-tempered and calm. The typical extravert is "sociable, likes parties, has many friends, needs to have people to talk to and does not like studying by himself. He craves excitement, takes chances, often sticks his neck out, acts on the spur of the moment and is generally an impulsive individual ... The typical introvert on the other hand is a quiet, retiring sort of person, introspective, fond of books rather than people; he is reserved and distant except with intimate friends. He tends to plan ahead, 'looks before he leaps', and distrusts the impulse of the moment."

From the CPQ, Cattell's typical extravert would be outgoing, happy-go-lucky and venturesome while his introvert would be reserved, sober (serious, silent, uncommunicative) and shy.

Neuroticism would be indicated by an excitable but submissive, shy, tender-minded person who would be tense and apprehensive.

A more detailed description of the CPQ factors which it is claimed by Cattell are involved in neuroticism and extraversion, will be given later.

## CHAPTER 2

## RELATED RESEARCH

Research in the area of personality and academic attainment has, for reasons mentioned earlier, been confined mainly to the last twenty years, but while the number of investigations has increased markedly, there is still a lot of conflicting evidence. This being a 'new' region of research has meant that it has covered totally different ground, while falling under the broad spectrum of 'personality compared with scholastic achievement'. Most research has dealt with a very generalised form of academic attainment: passing or failing at school; number of university courses taken successfully each year; aggregate mark for end-of-year school examinations or a specific overall achievement test. Very few have dealt with individual academic subjects and the writer feels that this is a severe limitation of the research that has been undertaken thus far. Another limitation and reason for lack of clarity has been that the age range of the subjects investigated has varied from approximately seven to fifty years old. Very little of the research has been done at either end of this scale and the majority of investigations have been directed at high school pupils and university students.

For the two reasons mentioned above, namely the large age range and extremely 'generalised' measure of achievement used, this study has been confined to subjects in the age range nine to thirteen years (standards two to six) and Cattell's personality factors have been compared with mathematical attainment instead of general academic attainment.

The majority of the questionnaires used in the various investigations to measure personality have been either those of Cattell or Eysenck. Both of these inventories yield Neuroticism and Extraversion as second-order factors and

thus in reviewing the literature it will be simpler to deal with these separately.

## 2.1 Extraversion

Of the studies that have been made, the evidence presented where the sample has been university students, is fairly clear-cut. Lynn (1959), Lynn and Gordon (1961), Furneaux (1962), Savage (1962), Kline (1966), Entwhistle (1972), Saville and Blinkhorn (1976) and others, all come to the conclusion that introversion (i.e. low extraversion) is related to academic success. There isn't any really contrary evidence presented, but a few (Kline and Gale, 1971; Cowell and Entwhistle, 1971) report no conclusive evidence for any relationship at all.

Research involving school children is very conflicting. Child (1964) testing eleven to fifteen year-olds, and Finlayson (1970) using twelve to fourteen year-old boys, report negative correlations between extraversion and general achievement, while the converse is claimed by Entwhistle (1972) for primary school children, and Honess and Kline (1974) and Orpen (1976) for high school children. Entwhistle (1972) presents a table which condenses Warburton's (1968) summaries of studies which have been done using Cattell's inventories. (Table 1). Warburton finds the same age trend noted by Eysenck, namely that of extraversion being related to success in the primary school, and a change at approximately fourteen to introversion being the personality trait necessary for success.

TABLE 1

SUMMARY OF RESULTS FROM STUDIES USING CATTELL'S INVENTORIES: DIRECTION OF CORRELATION COEFFICIENTS WITH SCHOLASTIC ATTAINMENT

		Age Group							
Second-order Factor	Primary Source Trait	Under 12		12-14		15-17		Over 17	
		+	-	+	-	+	-	+	-
Anxiety/ Neuroticism	Instability(C-)	0	3	0	1	3	0	3	2
	Tenseness (Q4+)	0	1	0	1	1	0	5	1
	Insecurity(O+)	0	0	0	2	1	0	1	1
	Bad-temperedness(D+)	0	1	0	2	2	0	0	0
	Unreliability(Q3-)	0	1	0	5	0	2	0	2
	Suspiciousness(L+)	0	0	0	0	0	0	2	2
	Total	0	6	0	11	7	2	11	8
Introversion(1)	Aloofness(A-)	0	0	0	6	3	0	0	1
	Desurgency(F-)	0	3	0	0	8	0	3	1
	Shyness(H-)	0	2	0	2	3	0	1	0
	Total	0	5	0	8	14	0	4	2
Introversion(2)	Submissiveness(E-)	0	1	7	0	4	0	1	2
	Independence(Q2+)	1	0	3	0	3	0	1	0
	Total	1	1	10	0	7	0	2	2
Tendermindedness	Tendermindedness(I+)	0	0	1	0	2	0	3	0
	Unaffectedness(N-)	0	0	0	0	0	0	1	0
	Total	0	0	1	0	2	0	4	0
Radicalism	Bohemianism(M+)	0	0	0	0	0	0	4	0
	Radicalism(Q1+)	0	0	0	0	0	0	1	0
	Total	0	0	0	0	0	0	5	0
Morality	Conscientiousness (G+)	2	0	6	0	4	1	2	3

The signs following the letters in parentheses indicate the direction of scoring on the trait. For example, shyness is inferred from low scores (negative sign) on trait 'H'.

It is worthwhile remembering that while the personality tests probably measured much the same factor (extraversion), all

the scholastic achievement tests had different criteria and perhaps the only definite conclusion that can be drawn here is that there is a relationship between extraversion and academic success which may or may not change with age and the academic level. Noble (1974), dealing specifically with extraversion and mathematical attainment, found a positive relationship for the ages nine and ten (significant at the .05 level for the ten year-olds), highly significant negative correlations for eleven and twelve and thereafter either small negative or negligible correlations.

Several investigators have worked with different ability groups and have found different relationships for the various ability groups. Entwistle and Welsh (1969) found that of high ability pupils, the introverted pupils had higher attainment, whereas for low ability it was found that the extraverts had greater success. This was borne out by Lewis and Ko (1973) who had similar results.

Not many researches have reported any sex differences but those that have, seem to be contradictory. Costello and Brachman (1963) and Kline and Gale (1971) report no significant sex difference, while Eysenck (1965), and Entwistle and Cunningham (1968) report boys as being significantly more extravert than girls, and Ridding (1967) just the opposite. Callard and Goodfellow (1962), as well as Eysenck (1965), found for both sexes, that extraversion scores increased up to the age of thirteen or fourteen and then began to decline.

Entwistle and Cunningham (1968) found a significant departure from linearity when correlating extraversion and attainment for thirteen year-old children and they see this as the reason for the low value of the correlation coefficient obtained in their study. However, other researchers: Ley et al (1966), Kline and Gale (1971) and Noble (1974) find no significant departure from linearity and this seems to be the more common finding.

## 2.2 Neuroticism

For extraversion, the studies for university students yielded clear-cut results, while for high school pupils they did not. However, quite the opposite has been the case for neuroticism.

As far as university students are concerned, both Biggs (1962) and Savage (1962) find that stability (low neuroticism) correlates with achievement and Lynn (1959), Lynn and Gordon (1961) report the opposite. Furneaux (1962) found that the highest proportion of students that enter university are either stable extraverts or neurotic introverts. No definite conclusions can therefore be drawn from this evidence, but perhaps Entwhistle (1972) quoting Warburton's (1968) summaries, tips the scales slightly in favour of neuroticism being the dominant personality factor in higher education. This trend is also in keeping with Eysenck's views, and he sees the change at age fourteen, from extraversion to introversion being related to success, also taking place for a change from stability to neuroticism. Quite obviously the research at university level is still grossly inadequate and inconclusive.

For schoolchildren the research is far more decisive. Child (1964) for eleven to fifteen year-old children, Rushton (1966) for thirteen year-olds, and Entwhistle and Cunningham (1968) studying eleven year-olds, all report significant negative correlations between neuroticism and academic success. Noble (1974) in investigating a school population, found low negative correlations for mathematical attainment and neuroticism, with the exception of the eleven and twelve year-olds (standards four and five) where the relationship was positive and highly significant. Warburton (1962) also finds a negative correlation for school achievement, but for anxiety not neuroticism. Several summaries are in agreement that stability in schoolchildren is a requirement for a good attainment level, namely Rushton (1966), Elliot (1972) and Entwhistle (1972). Biggs (1967) states: "Mathematics and arithmetic

are probably unique amongst school subjects, as currently taught, in the extent to which failure in them is associated with fear and anxiety." This statement on its own seems sufficient reason for undertaking research on the relationship between personality and mathematics and it does seem strange that so little research on better-defined areas of academic courses other than general achievement and success, has been reported. Lewis and Ko (1973) and Finlayson (1970) find that at the school level, stable introverts and neurotic extraverts are the more successful scholars. This is in direct contrast to what Furneaux (1962) found for university students. Entwistle and Cunningham (1968) testing thirteen year-olds found that amongst the boys the stable introverts were the best achievers, while for the girls it was the stable extraverts who performed better.

Those researches that reported sex differences for neuroticism all found that girls had significantly higher neuroticism scores than did the boys. At university level, this was found by Lynn (1959), and at school level by Costello and Brachman (1963) and Eysenck (1965).

As far as curvilinearity is concerned, only Lynn and Gordon (1961) and Savage (1962) found a U-shaped relationship when correlating neuroticism and achievement, while linearity was achieved by, amongst others, Ley et al (1966) and Noble (1974). This would seem to suggest that departure from linearity would be the exception rather than the rule.

### 2.3 Extraversion - Neuroticism - a Summary

In attempting to tie the preceding two sections together, perhaps all that can be said with some degree of certainty is that young schoolchildren will probably achieve better results if they are stable. As to whether they would be better off academically if they are introverts or extraverts, here there is no great clarity. For older schoolchildren

and university students, introversion seems to be an important factor for success, with a fairly high degree of neuroticism possibly being a favourable personality characteristic.

In a very detailed study of both the Cattell and Eysenck Personality Inventories, Saville and Blinkhorn (1976) come to the conclusion that introverted students tend to gain better degrees, but that it is difficult to make generalised statements about the personality of university students. "Although sex differences are to be found which are very much in line with those in general population adults, there appear to be deep-rooted personality differences between the academic disciplines, which must also be taken into account. Moreover, if results are to be replicated, great care should be taken to specify the scales being used."

What seems to be indicated here is a type of analysis termed 'zone analysis', as advocated by Furneaux (1962), Child (1964), Finlayson (1970) and Elliot (1972). Zonal analysis has been used in this study and will be discussed in greater detail later. It will suffice at this stage to explain that zonal analysis enables a researcher in this type of study to look at stable and neurotic introverts as well as stable and neurotic extraverts, i.e. four distinct personality types or zones.

Furneaux (1962) found with university students that the neurotic introverts had the lowest failure rate, while the stable extraverts fared the worst. As far as the school population is concerned, Child (1964) working with eleven to fifteen year-old children, found that neurotic extraverts achieved the worst. Finlayson (1970) with a twelve to fourteen year-old boy-sample found the same lack of success with the neurotic extraverts, and in his study the stable introverts were most successful. Entwistle and Cunningham (1968) claimed that amongst girls the stable extraverts achieved best and agreed with Finlayson with regards the success of the

stable introverted boys.

What is immediately obvious from the above is that any investigation should work with boys and girls separately and then possibly greater clarity might be obtained.

#### 2.4 Cattell's First-Order Personality Factors

The multi-dimensional approach of Cattell is not the same as that of Eysenck who concentrates on the dimensions of neuroticism and extraversion only. Consequently there is not a great deal of research material available which deals with Cattell's fourteen first-order personality factors, but much which deals with his second-order personality factors and criteria. Entwistle (1972) feels that Cattell's detailed factorial approach "... makes it difficult to present a coherent picture of the results of studies using this definition of personality. The use of many more traits might, nevertheless make the possibility of high multiple correlations likely."

Cattell and Cattell (1969) summarise the factors which markedly influence school achievement and quote intelligence (B+) and super ego strength (G+), while submissiveness (E-) and outgoingness (A+) have a slightly less significant effect. (These facts are based on a study by Cattell and Butcher (1968).) Rushton (1966) working with a sample of eleven and twelve year-olds found very small correlations between the CPQ factors and arithmetic, and only surgency (F+) and venturesomeness (H+) were significant at the .05 level. Noble (1974) correlating first-order factors for each age group for the age range nine to twelve years old, found a large number of significant correlations. These will be compared in graphic form with the corresponding results from the present study and are to be found in Figures 6 to 9 in the appendix.

This area of the research seems to be the least investigated,

but it should be mentioned that another of Cattell's inventories, the High School Personality Questionnaire (HSPQ) for the age range twelve to eighteen years, which produces similar first-order factors, has been used in several studies. Here Cattell and Cattell (1969) find the same factors being related to academic success as for the CPQ, but an additional factor  $Q_2$  (self-sufficiency) was associated positively with attainment. This factor ( $Q_2$ ) is not a CPQ factor but it does resemble factor N from the CPQ. Other researchers report small correlations between the first-order factors and attainment, but many find factor C (ego strength) to be positively correlated and some find factor F (surgency) to be correlated negatively. There seems therefore to be some continuity between the factors of the CPQ and the HSPQ.

## CHAPTER 3

## RESEARCH DESIGN AND EXPERIMENTAL PROCEDURES

## 3.1 General Aims

This research was concerned with boys and girls from standard two to standard six, that is from nine to thirteen years of age in average. Their results were analysed separately so that possible sex differences could be detected for all aspects of the investigation. The study had a threefold purpose:

- (i) To investigate changes, with age, in all the fourteen first-order personality factors as well as two second-order factors of extraversion and neuroticism as measured by the Children's Personality Questionnaire (CPQ) constructed by R.B. Porter and R.B. Cattell (1968).
- (ii) To investigate changes, with age, in mathematical attainment as measured for the age range nine to eleven (inclusive), that is from standards two to four.
- (iii) To investigate the correlates, with age, between the above-mentioned sixteen personality factors (fourteen first-order and two second-order factors) and mathematical attainment. This section formed the major portion of the investigation and two different methods of analysis were used: (a) The fourteen first-order and two second-order personality factors were correlated against mathematical attainment and (b) a 'zonal analysis' was used to investigate mathematical attainment within different levels of Neuroticism and Extraversion.

For the nine, ten and eleven year-olds (standards two, three and four), mathematical attainment was determined by standard scores on the achievement tests previously mentioned, but for

the twelve and thirteen year-olds (standards five and six) the mathematics marks from the end-of-year examinations were used. These marks were then corrected so that the scores could be compared between schools. Two different statistical procedures were used for the correction. The first was used to correct the mathematics marks against the fourteen first-order personality factors and the two second-order factors for the purpose of correlation. The second method was to correct them simultaneously against the second-order factors of extraversion and neuroticism for the purpose of zonal analysis.

### 3.2 The Sample

As was mentioned before, one of the reasons for this research being undertaken was the result of a study in the Grahams-town area. In an attempt to replicate the population of the Grahamstown schools, an area in Cape Town with pupils of similar socio-economic, language and cultural backgrounds was chosen. The main difference between the two samples, other than that the two regions are some 900 km apart, was that the present research used pupils from both single-sex and co-educational schools, whereas the previous sample used single-sex schools only, but they were both private and government schools. All of the schools are government schools and all have English as their medium of instruction. Four of the schools were primary schools and the standard six pupils came from high schools. The primary schools serve as feeder schools for the high schools and we can assume some continuity of the sample from this. Methods of instruction at the corresponding levels in the different schools, can be taken as comparable as all follow the same fairly rigid syllabuses. The sample was selected such that for each school standard there were approximately two hundred pupils. Of the approximately one hundred boys in each standard, one half were from single-sex schools and the other half came from co-educational schools. A similar numerical break-down applied to the girls. Where a selection of pupils was required from a particular school,

a random sample was taken using a table of random numbers, according to the method advocated by Butcher (1966). The final numbers of pupils involved in all phases of the testing were as follows:

TABLE 2  
DISTRIBUTION OF SAMPLE

School	Standard									
	2		3		4		5		6	
	B	G	B	G	B	G	B	G	B	G
1	36	32	43	27	37	26	36	29	-	-
2	14	13	9	16	15	11	15	18	-	-
3	-	-	-	-	-	-	-	-	49	47
4	49	-	47	-	50	-	50	-	-	-
5	-	47	-	50	-	48	-	49	-	-
6	-	-	-	-	-	-	-	-	51	-
7	-	-	-	-	-	-	-	-	-	-
TOTAL	99	92	99	93	102	85	101	96	100	98
	191		192		187		197		198	

TOTAL: Boys + Girls = 501 + 464 = 965

### 3.3 Descriptions of Tests.

Two different types of tests were administered, both being Human Sciences Research Council tests, standardised for white South African children. The Personality Test used was the South African version of Cattell and Porter's Children's Personality Questionnaire (CPQ) as adapted and standardised by du Toit and Madge (1972), while the Scholastic Achievement Tests in Arithmetic for Sub Standard A to Standard 4 as constructed by Holtzhausen and Kruger (1974), were used to measure mathematical attainment for Standards 2, 3 and 4.

(a) The CPQ has been developed as a result of extensive research by the Institute for Personality and Ability Testing, Illinois. It was adapted for use in South Africa by the Institute for Psychometric Research of the Human Sciences Research Council and can be used for the age range of eight to thirteen years. The questionnaire consists of two separate booklets, but for the present study, only Form A was used. A form can be given in a class period to a group, the answers for the younger children being marked in the question booklet itself, while for older children, on a separate answer sheet. The test is answered by the pupil merely marking one of two responses set for each question. (Except for factor B where there are three choices for the responses.)

The CPQ has been designed to measure fourteen distinct personality factors or dimensions. Each factor is represented by ten items, giving a total of 140 questions. The factors are presented as a bi-polar continuum (see below) with a high sten score (sten 8, 9 or 10) corresponding to the description on the right and a low sten score (sten 1, 2 or 3) to that on the left. An in-between score would be a combination of the two extreme descriptions. One must not assume that the high scores are 'good' or the low scores 'bad'. Either side could be advantageous depending on the factor. Each factor measures a functionally independent dimension as established by factor-analytic research. The following is a brief description of the first-order factors and the type of person they describe:

#### THE FOURTEEN CPQ FACTORS

Low Sten Score	Factor	High Sten Score
RESERVED (Schizothymia) reserved, critical, cool, aloof, resists adult direction, prone to sulk or cry.	A	OUTGOING (Cyclothymia) easy-going, warmhearted, co-operative, sociable, casual, trustful, adapt- able, attentive to people.
LESS INTELLIGENT low general mental capacity	B	MORE INTELLIGENT high general mental capacity

EASILY AFFECTED BY FEELINGS (ego weakness) emotionally unstable, easily upset, excitable, changeable, worrying, gets emotional when frustrated.

PHLEGMATIC (Placidity of temperament) placid, self-sufficient, not easily jealous, constant, not easily reckless, deliberate.

SUBMISSIVE (Submissiveness) dependent, kindly, soft-hearted, expressive, conventional, self-sufficient.

SOBER (desurgency) serious, silent, introspective, depressed, brooding, concerned, uncommunicative, languid, sticks to inner values.

EXPEDIENT (super ego weakness) frivolous, quitting, fickle, demanding, impatient, undependable, relaxed, indolent, disregards obligations to people

SHY (threctia) withdrawn, aloof, cold, self-contained, careful, considerate, restrained, conscientious, retiring in presence of opposite sex.

TOUGH-MINDED (harria) realistic, expects little, self-reliant, taking responsibility, hard, practical, logical.

C EMOTIONALLY STABLE (ego strength) emotionally mature, calm, placid, realistic, stable in attitudes, does not easily get into difficulties.

D EXCITABLE (excitability) demanding, impatient, attention-getting, prone to jealousy, self-assertive, egotistical, undependable, shows nervous symptoms

E DOMINANT (dominance) assertive, self-assured, independent-minded, hard, stern, solemn, rebellious, attention-getting, unconventional

F HAPPY-GO-LUCKY (urgency) talkative, cheerful, serene, frank, expressive, quick, alert.

G CONSCIENTIOUS (super ego strength) persevering, responsible, determined, emotionally mature, conscientious, consistently ordered, attentive to people and rules.

H VENTURESOME (parmia) likes meeting people, genial, responsive, friendly, carefree, impulsive, and frivolous, overt interest in opposite sex.

I TENDER-MINDED (premsia) demanding, impatient, dependent, seeking help, kindly, gentle, sensitive, intuitive, frivolous, attention-seeking.

VIGOROUS (zeppia) likes to go with the group, likes attention, acts, accepts common standards.	J	DOUBTING (coasthenia) internally restrained, acts individualistically, self- sufficient, unwilling to act, evaluates intellectually.
NAIVE (naiveté) simple, naive, socially inalert, vague and senti- mental, company-seeking, lacking self-insight.	N	SHREWD (shrewdness) shrewd, socially skilful, exact and realistic, cool, aloof, insightful regarding others and self.
PLACID (unperturbed adequacy) complacent, self-confident, cheerful, resilient, tough, expedient, no fears, given to simple action.	O	APPREHENSIVE (guilt proneness) self-reproaching, guilt-prone, worrying, anxious, depressed, cries easily, sensitive, tender, exacting, fussy, moody, lonely, brooding, phobic symptoms, strong sense of duty.
UNDISCIPLINED SELF-CONFLICT (weak self-sentiment) lax, prone to undisciplined self-conflict, lack of integration, careless of protocol.	Q <sub>3</sub>	CONTROLLED (strong self- sentiment) self-controlled, self- disciplined, socially precise.
RELAXED (low ergic tension) composed, relaxed, tranquil, unfrustrated.	Q <sub>4</sub>	TENSE (high ergic tension) over-tense, driven, frustrated, over-wrought.

Various groupings of second-order personality factors have been found, but little research on these factors has been done in this country. Some of the second-order factors and criteria that can be obtained from these fourteen first-order factors are: extraversion; anxiety; neuroticism; academic achievement; possible behavioural problems and creativity. The formulae used in the calculation of the two second-order factors used in this study, are:

$$(i) \text{ Extraversion} = 0,33 (A + F + H) + 0,06$$

$$(ii) \text{ Neuroticism} = 0,13 (I + O + Q_4 - C - E - F - H) \\ + 0,07(D + J) + 5,45.$$

These equations yield approximate sten scores on the second-order factors.

As will have been observed in the description of the personality factors, sten scores have been used. This scale will be explained later, but basically it is a special case of a standard score, the name 'sten' derived from 'standard ten' scale (i.e. a ten-point scale).

(b) The Arithmetic Achievement Tests were updated in 1974 to bring them into line with the amended syllabuses. The tests were compiled "in order to obtain a reliable, objective indication of pupils' achievement in arithmetic from Grade 1 (Sub Standard A) to Standard 4". Each booklet contains three tests, namely:

Test 1 - mainly mechanical calculations

Test 2 - comprehension of subject matter

Test 3 - application of concepts and calculations.

The items in Test 1 of the Standard 2 test are of the completion type : the testee must write down the answer to each question. The items of the other tests are of the multiple-choice type : the testee must choose the answer from a given three or more possible answers. Each test has three practice examples and each test has a further twenty items, giving a total of sixty items which yield the final arithmetic mark.

The specific aspects tested are as follows:

Test 1:

The main purpose is to test the pupils' skill in dealing with the four fundamental arithmetic operations. Mechanical calculations, such as conversions from one unit to another, are included.

Test 2:

The purpose of this test is to find out to what extent the pupils comprehend the arithmetical subject matter and to what extent they can think logically about numbers.

Basically, the content of the items contains the following:

- (i) Calculations on the number line
- (ii) Sets
- (iii) Place values of digits
- (iv) The four fundamental arithmetical operations with natural and concrete numbers
- (v) The use of different number bases
- (vi) Simple graphs
- (vii) Ordinary and decimal fractions.

Test 3:

Here the aim is to test the pupils' ability to solve arithmetic problems set in verbal form. The mechanical calculations here are of an elementary nature. Each item tests whether the testee comprehends the data and what is being asked and whether he can carry out the applicable calculation. The content of the items was chosen from the child's sphere of experience in each standard involved.

### 3.4 Application of Tests

All testing was done during September 1975, which represented the last few weeks of the third term. Where the arithmetic tests were administered (standards two to four) these were given after the personality tests, but not on the same day. All testing was done during the morning sessions and arithmetic tests were given at the beginning of the school day. This was done in order to make allowance for fatigue among pupils and to keep the test conditions as similar as possible for all schools. The writer was responsible for the administering of all the tests, but depending on the numbers in the different groups, and the ages of the pupils being tested, the number of assistants varied from one to four. The instructions given at all the schools were therefore the same for the corresponding standards, and all instructions and necessary assistance was given in accordance with the information in the manuals of both the arithmetic and personality tests.

(a) For the CPQ the pupils were put at their ease before testing commenced and were told the following: "Today we want you to answer some interesting questions. This is not a test. You must simply answer questions about yourself, about what you think and what you do. You must answer for yourself so that I will be able to learn something about you all. Your teachers will not see your answers and you must be truthful as this will be used to help you." The standard two pupils answered the questions in the booklets themselves and all questions were read by the tester, with the assistants sorting out the queries which inevitably arise in a test of this nature. Each pupil, especially those known to be poor readers, was checked to ensure that he or she understood how to answer the questions. For standards three to six, the answers were marked on special answer sheets and after having been given the required information and help, the first three items were read, and when the tester was sure that all the subjects understood what was expected of them, they were allowed to proceed on their own at their own rate (there being no time limit for the test).

(b) The arithmetic tests were given in the pupils' classrooms with the exception of one school where the testing was done in the library. As for the personality tests, the standard two pupils answered in the question booklets, while standards three and four had special answer sheets. The tests consisted of three parts and these were given on different days and always early in the day. As the pupils had completed the personality test the previous day they were fairly familiar with the general test procedure. It was made clear though, that there was a time limit for the tests. However, plenty of time was allowed for the three practice examples and the method of answering was explained clearly. Each pupil was checked and the group was then allowed to proceed with the test proper. It seldom occurred that a pupil failed to complete a test in the allotted time, but the time limits allowed were applied strictly.

### 3.5 Scoring the Tests

(a) For the CPQ, scoring keys were available and this made the ascertaining of the raw scores a simple task. These raw scores then had to be converted to sten scores (standard scores). This was also a relatively straightforward task as tables were available for each age group and for boys and girls separately so that converting the raw score into a sten score merely involved consulting the appropriate table in the manual. The stens are evaluated as follows:

TABLE 3  
CHARACTERISTIC VALUES OF STENS IN RELATION TO THE NORMAL CURVE

Sten	Percentage Areas of Stens	
	Lower Boundary	Upper Boundary
1	0,00	2,28
2	2,28	6,68
3	6,68	15,87
4	15,87	30,85
5	30,85	50,00
6	50,00	69,15
7	69,15	84,13
8	84,13	93,32
9	93,32	97,72
10	97,72	100,00

(b) For the arithmetic tests, scoring keys were available for standards three and four, but for standard two the marking was done directly. These raw scores were then converted, according to age, to standard scores which were on a stanine scale. The stanine score is on a nine-point scale according to which the distribution is divided into nine parts and the divisions were as follows:

TABLE 4  
 CHARACTERISTIC VALUES OF STANINES IN RELATION TO THE NORMAL  
 CURVES

Stanine	Percentage Areas of Stanines	
	Lower Boundary	Upper Boundary
1	0	3
2	4	10
3	11	22
4	23	39
5	40	59
6	60	76
7	77	88
8	89	95
9	96	100

The tables of norms were also available, so that conversion from the total raw score into a stanine score was straightforward.

It must be pointed out that the tables for converting the raw scores into standard scores for both the personality and arithmetic tests are all standardised to South African Norms.

### 3.6 Standard Five and Six Mathematics Marks

As standardised arithmetic tests were not available, the mathematics marks for pupils in standards five and six were used as a criterion for mathematical attainment. The marks used were those obtained in their final school examinations at the end of 1975. These were then converted to percentages and in order to be able to compare these marks between schools they were corrected according to two different statistical procedures. The two analyses were different as they were for different aspects of the study. They will be described in detail in the next chapter.

## CHAPTER 4

## THE STATISTICAL ANALYSIS

## 4.1 Calculation of Extraversion and Neuroticism

The raw scores for the fourteen first-order factors were, as was previously mentioned, converted into stens. These standard scores were entered on computer data sheets and then punched onto cards and processed. In this stage of the study the computer merely printed out the scores of the first-order factors and calculated the second-order factors of extraversion and neuroticism from these sten scores. The equations used, yield scores on the second-order factors which are in approximate stens:

$$\begin{aligned} \text{Extraversion} &= 0,33(A + F + H) + 0,06 \\ \text{Neuroticism} &= 0,13(I + O + Q_4 - C - E - F - H) \\ &\quad + 0,07(D + J) + 5,45 \end{aligned}$$

In addition, the computer printed out the corresponding mathematics scores for each pupil. In the case of standards two, three and four, this was a standard score in the form of a stanine score, and for standards five and six, this was simply the percentage for mathematics as given by the school for the pupil's end-of-year examinations.

## 4.2 Comparison of Means of Personality Factors

For each of the fourteen CPQ first-order factors as well as the second-order factors of extraversion and neuroticism, the means and standard deviations for each of the sexes were calculated. These are recorded in Table 13 in the appendix, and the means were then plotted against age (Figures 1, 2 & 3) in order to establish any trends of changes in personality that might take place as the age of the pupils increases. The means for girls and boys were then compared, to determine whether any of the differences were significant

or not. This was done for each of the sixteen personality factors (the fourteen first-order as well as extraversion and neuroticism). Unfortunately, this part of the analysis was not included as part of the computer programme and consequently was done by desk calculator. The method followed was that as advocated by Smith(1970, p90). A sample calculation for Factor B (Intelligence) follows.

As calculated from the data:

$$\begin{array}{ll} \sum X_b = 3415 & \sum X_b^2 = 25021 \\ N_b = 501 & M_b = 6,816 \\ \sum X_g = 3306 & \sum X_g^2 = 24784 \\ N_g = 464 & M_g = 7,125 \end{array}$$

where X = standard score for factor B  
N = number in group  
M = group mean

$$\sum x^2 = \sum X^2 - \frac{(\sum X)^2}{N}$$

therefore  $\sum x_b^2 = 1743$

and  $\sum x_g^2 = 1229$

$$t = \frac{M_g - M_b}{s(\bar{x}_g - \bar{x}_b)}$$

where  $s(\bar{x}_g - \bar{x}_b)$  is the standard error of the difference

therefore 
$$t = \frac{M_g - M_b}{\sqrt{\frac{\sum x_g^2}{N_g(N_g - 1)} + \frac{\sum x_b^2}{N_b(N_b - 1)}}}$$

$$= \frac{7,125 - 6,816}{\sqrt{\frac{1229}{464 \times 463} + \frac{1743}{501 \times 500}}}$$

$$= 2,74$$

Consulting the t tables for  $N_b + N_g - 2$  d.f. it emerges that these two means are significantly different at the ,01 level.

#### 4.3 Comparison of Means of Mathematical Attainment

Only the means of the standard scores of the arithmetic tests done by standards two to four could be compared, as the standards five and six mathematics marks were unstandardised. Here the achievement of the boys was compared with that of the girls and so the method followed was precisely the same as that for the previous section. The possibility of a sex difference was investigated for each of standards two, three and four. In addition, a comparison was made within the sexes between the single-sex and co-educational schools for each of these standards. For example, the mean for standard two co-educational schools was compared with the mean for standard two single-sex schools.

The means were also compared with the national norms.

#### 4.4 Correlation of Mathematical Attainment against the First-order and Second-order Personality Factors

The problem which arises here, is that for standards five and six the mathematics marks are those marks obtained in end-of-year school examinations and thus they have to be corrected before they can be used. In this portion of the study, these marks were corrected each time against the particular personality factor they were being correlated against. It will be necessary to deal with this correction procedure before dealing with the correlations themselves.

The end-of-year mathematics marks were used in percentage form and had to be corrected in order that marks could be compared between schools. Two regression equations had to be calculated in order to correct any mark against any one personality factor. A 'best' fitting prediction line was

calculated in order to correct the mark for that particular standard within the school and a second prediction line was necessary to adjust the mark for the whole standard for all schools. This method is termed by Blommers and Lindquist (1965), "fitting a prediction line by the method of least squares." For this aspect of the analysis the computer was used as it involved correcting approximately four hundred scores, each sixteen times against the standard personality scores.

The method of correction is as follows:

$X$  = standard score on personality factor A

$Y$  = end-of-year school mathematics mark

let  $Y_1 = b_1X + c_1$  be the regression equation for this standard for this school, and

$Y_2 = b_2X + c_2$  be the regression equation for all the schools together (for the same standard).

The corrected score ( $Z$ ) would then be obtained from

$$Z = Y - Y_1 + Y_2$$

The constants in the regression equations above are found by applying the following formulae within their respective groups.

$$b = \frac{\sum xy}{\sum x^2}$$

$$\text{and } c = \bar{Y} - b\bar{X}$$

where  $\bar{X}$  and  $\bar{Y}$  are the means of the personality and mathematics scores.

$$\sum xy = \sum XY - \frac{\sum X \sum Y}{N}$$

$$\text{and } \sum x^2 = \sum X^2 - \frac{(\sum X)^2}{N}$$

Pupil 1 in standard 5 in school 1 had a factor A score of 4 and a school mathematics mark of 61. The regression equation for standard 5, school 1 is:

$$Y_1 = 9,884X + 6,3611$$

and that for standard 5 (all schools) is:

$$Y_2 = 0,95X + 70,4951$$

This pupil's mark would thus be corrected to:

$$\begin{aligned} Z &= 61 - (9,884 \times 4) - 6,3611 + (0,95 \times 4) \\ &\quad + 70,4951 \\ &= 89,40 \end{aligned}$$

Using corrected marks:

Once the mathematics marks for standards five and six had been adjusted, all the marks (standards two to six) were then correlated against each of the sixteen factors. Boys and girls correlations were analysed separately so that at a later stage these could be examined for possible significant differences.

If the Pearson product-moment correlation coefficients are to have any significant meaning, then it is essential that a linear relationship between the two variables be tested and not simply assumed. As mentioned previously most research has simply assumed linearity and of those that have investigated the possibility of curvilinearity, very few have found any evidence of departure from linearity. It should be remembered though that these investigations dealt with correlations between second-order factors and academic attainment. Noble (1974) investigating relationships of the first-order factors with mathematics also found very little evidence for departure from linearity. The Analysis of Variance technique was used in the present study to test the significance of linear correlation and linear regression in order to establish the significance and usability of the Product-Moment Correlation Coefficients. This aspect of the study was processed by the computer and the following calculations

were made:

- (i) The product-moment correlation coefficient - 'r'
- (ii) The correlation ratio - 'η' (eta)
- (iii) The significance of the correlation ratio -  $F_1$
- (iv) The significance of linear correlation -  $F_2$
- (v) Linearity of regression -  $F_3$

The method followed was that as described by McNemar (1962, pp270 - 281) and a brief outline follows:

- (i) The product-moment correlation coefficient (r).

Scatter diagrams varying in size from 11 by 11 (for standards two to four) to 11 by 30 (for standards five and six) were drawn. The sizes of the scatter diagrams were different because the standard two to four mathematics marks had a small range while those for standards five and six had a very much larger spread. The product-moment correlation coefficient can now be calculated according to:

$$r = \frac{N \sum d_x d_y - \sum d_x \sum d_y}{\sqrt{N \sum d_x^2 - (\sum d_x)^2} \sqrt{N \sum d_y^2 - (\sum d_y)^2}}$$

where  $d_x$  is defined as the individual's score deviation, in step intervals, from an arbitrary origin on the X scale and  $d_y$  is defined similarly for the Y scale.

- (ii) The correlation ratio (η) - eta)

In order to check on linearity in the following stage, it is necessary that the same grouping intervals be used for eta as for r, so that no corrections for grouping error are needed. At this stage, the within-arrays, between-arrays, and total sums of squares are needed.



Eta is calculated from:

$$\eta^2 = \frac{\sum_g m_g (\bar{Y}_g - \bar{Y})^2}{\sum \sum (Y - \bar{Y})^2}$$

where the numerator is the sum of squares of deviations between arrays and the denominator is the sum of squares of deviations.

(iii) The significance of the correlation ratio ( $F_1$ )

The value of eta having been obtained, it is now necessary to check its significance and this is established relatively simply by means of the following equation:

$$F_1 = \frac{s_b^2}{s_w^2}$$

where  $s_b^2$  = variance estimate for between-array means and  $s_w^2$  = variance estimate for within-array means. From this it follows that the between-array variance must be significantly larger than expected on the basis of sampling errors in the array means, otherwise a correlation ratio cannot be deemed significant.

(iv) The significance of linear correlation ( $F_2$ )

On the basis of the null hypothesis, that the degree of linear correlation is zero for the population being sampled, the regression line for the population would pass through the mean score with zero gradient. The F (or the t) test can be used for judging whether the correlation is significant or not and this quantity is obtained from:

$$F_2 = \frac{s_p^2}{s_r^2}$$

where  $s_p^2$  = variance estimate of linear regression  
 and  $s_r^2$  = variance estimate of residual from line.  
 If  $F$  is significantly sufficiently large, then  
 confidence is expressed in the value of the  
 correlation coefficient.

(v) Linearity of regression

We have seen that the correlation ratio is a general measure of the degree of correlation and that  $r$  measures the degree of linear relationship. "Even though the regression of  $Y$  on  $X$  for a population be exactly linear, it will be found for a sample that the means of the arrays will show some deviation from a straight line; hence the correlation ratio will tend to be larger than  $r$ ." (McNemar, 1962). In testing the significance of the variation of the array means from linear regression, we are testing the significance of the difference between  $\eta$  and  $r$ . If  $F_3$  falls beyond the .01 level of significance, the hypothesis of linear regression for the population being sampled is rejected. When this happens, the correlation coefficient is not an appropriate measure to use to describe the relationship. The relevant  $F$ -score is given by:

$$F_3 = \frac{s_d^2}{s_v^2}$$

where  $s_d^2$  = variance estimate of deviation of the means from the regression line.

An example

The above variance technique is now applied to the situation where the mathematics marks for standard

two boys were correlated against Factor B.

Scattergram                    11 columns by 11 rows  
 Lowest X value            0,00        X Increment            1,00  
 Lowest Y value            0,00        Y Increment            1,00  
 Total entries                99

Row											
11	0	0	0	0	0	0	0	0	1	0	0
10	0	0	0	0	0	2	1	1	1	4	0
9	0	0	1	3	3	5	2	4	2	0	0
8	0	0	2	3	3	10	4	2	1	2	0
7	0	0	0	3	2	8	3	2	0	1	0
6	0	0	1	4	1	3	1	0	0	0	0
5	0	1	2	0	2	2	2	0	2	0	0
4	0	0	1	1	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	0
Column	1	2	3	4	5	6	7	8	9	10	11

Source	Sum of Squares	d.f.	Variance Estimate
Linear Regression	35,56	1	35,560
Deviations of means from line	6,83	7	0,975
Between-array means	42,39	8	5,298
Within-array means	197,25	90	2,192
Residual from Line	204,08	97	2,100
Total	239,64	98	

	F	N <sub>1</sub>	N <sub>2</sub>
Significance of Correlation ratio (F <sub>1</sub> )	2,417	8	90
Significance of Linear Correlation (F <sub>2</sub> )	16,902	1	97
Linearity of Regression (F <sub>3</sub> )	0,445	7	90

Correlation Ratio Y on X (eta) = 0,421

Correlation coefficient (r) = 0,385

We first look at F<sub>3</sub> and if the F tables are consulted it can be seen that there is no significance departure from linearity

(F for ,05 level = 2,11) as  $F_3 = 0,445$  which is much less than 2,11.

The next step is to consult  $F_2$ . Here the calculated  $F_2$  value is 16,90 which exceeds the F -score of 11,60 required for a ,001 level of significance and we conclude therefore that the correlation coefficient of 0,385 is significant at beyond the ,001 level.

#### 4.5 Zonal Analysis

As mentioned in chapter two, Furneaux (1962), Child (1964), Finalyson (1970) and Elliot (1972) are some of the comparatively few researchers who have used zone (zonal) analysis in an attempt to investigate the relationship between personality and academic attainment. In the present study each of the pupils from the same standard was placed in one of four zones (boys and girls were treated separately). Each pupil had an extraversion and a neuroticism score and the mean of each of these factors was calculated. The two scales were then organised at right angles to each other with the origin being the means of the two variables. Four quadrants (zones) were thus generated giving four distinct personality types as follows:

	N	
Neurotic Introvert	Neurotic Extravert	
Stable Introvert	Stable Extravert	E

Once the pupils had been allocated to their respective zones, the mean of the mathematics scores was calculated for each zone in order to determine any significant difference in mathematical attainment between the personality types. This procedure was relatively straightforward for standards two to four but it meant that, as before, the standard five and six mathematics marks had to be adjusted. The situation was,

however, not the same as that dealt with in the previous section, because here the marks had to be corrected against two variables (extraversion and neuroticism) simultaneously and not simply one factor at a time. The method used is that as described by Theil (1971), where, as for the previous section, a "fit line" had to be calculated for each school (for a particular standard) and then one for the whole group (a particular standard for all schools). The "fit line" for a particular school (j) would be of the form:

$$\hat{z}_i^{(j)} = \beta_0^{(j)} + \beta_1 x_i^{(j)} + \beta_2 y_i^{(j)}$$

and for the whole group:

$$\bar{z}_i = \bar{\beta}_0 + \bar{\beta}_1 x_i + \bar{\beta}_2 y_i$$

All the betas are constants while

$x_i$  = extraversion score

$y_i$  = neuroticism score

The corrected mark for pupil (i) in school (j) would therefore be:

$$\text{Corrected Mark} = \text{Original mark} - \hat{z}_i^{(j)} + \bar{z}_i$$

The constants would be obtained each time by solving the following three equations simultaneously:

$$\begin{aligned} n\beta_0 + \beta_1 \sum x_i + \beta_2 \sum y_i &= \sum z_i \\ \beta_0 \sum x_i + \beta_1 \sum x_i^2 + \beta_2 \sum x_i y_i &= \sum x_i z_i \\ \beta_0 \sum y_i + \beta_1 \sum x_i y_i + \beta_2 \sum y_i^2 &= \sum y_i z_i \end{aligned}$$

where n = number in a particular group

$z_i$  = uncorrected mathematics mark

and the other symbols have their previous meanings.

This part of the research was done by pocket calculator and an example is given for pupil 1 in standard 5 of school 1. The data for school 1 in standard 5 is:

$$\begin{array}{rcl}
 n & = & 65 \\
 \sum x_i & = & 390 \qquad \sum y_i = 353 \\
 \sum z_i & = & 3812 \qquad \sum x_i^2 = 2391 \\
 \sum y_i^2 & = & 1986 \qquad \sum x_i y_i = 2062 \\
 \sum x_i z_i & = & 23093 \qquad \sum y_i z_i = 20531
 \end{array}$$

Substituting in the equations we get:

$$\begin{array}{rcl}
 65 \beta_0 & + & 390 \beta_1 & + & 353 \beta_2 & = & 3812 \\
 390 \beta_0 & + & 2391 \beta_1 & + & 2062 \beta_2 & = & 23093 \\
 353 \beta_0 & + & 2062 \beta_1 & + & 1986 \beta_2 & = & 20531
 \end{array}$$

Solving these equations simultaneously yields:

$$\begin{array}{rcl}
 \beta_0 & = & 162 \\
 \beta_1 & = & -8,44 \\
 \beta_2 & = & -9,69
 \end{array}$$

Thus the "fit line" for all the standard five pupils of this school is:

$$\hat{z} = 162 - 8,44 x_i - 9,69 y_i$$

Now the information is obtained for all the standard five classes and substituted into the above equations and solved. Doing this yields the values of the constants which apply to the whole standard five group.

$$\bar{\beta}_0 = -10,90$$

$$\bar{\beta}_1 = 6,68$$

$$\bar{\beta}_2 = 5,80$$

and the "fit line" is

$$\bar{z} = -10,90 + 6,68 x_i + 5,80 y_i$$

Now taking pupil 1 in school 5, who has the following scores:

$$\text{Mathematics} = 61$$

$$\text{Extraversion} = 5,22$$

$$\text{Neuroticism} = 6,94$$

we can find his adjusted mathematics mark ( $Z$ )

$$\begin{aligned} Z &= \text{original mark} - \hat{z} + \bar{z} \\ &= 61 - 162 + (8,44 \times 5,22) + (9,69 \times 6,94) - 10,90 \\ &\quad + (6,68 \times 5,22) + (5,80 \times 6,94) \\ &= 74 \end{aligned}$$

This process was then repeated and all the standard five and six corrected mathematics marks were obtained.

The procedure for the zonal analysis will be explained using the standard five girls as an example.

All the extraversion and neuroticism scores were summed and the respective means were found:

$$\bar{E} = 6,35$$

$$\bar{N} = 4,97$$

The four zones were therefore defined and the subjects were allocated to these on the basis of their own scores. Those pupils whose scores were either on, or very close to the means, were not placed in zones in order to give better clarity to the personality types.

The zones were numbered as follows:

- 1 = neurotic extraverts
- 2 = neurotic introverts
- 3 = stable introverts
- 4 = stable extraverts

and the data for this group is:

$\sum X_1$	=	96,1	$\sum X_1^2$	=	676
$\sum X_2$	=	198,3	$\sum X_2^2$	=	1192
$\sum X_3$	=	57,8	$\sum X_3^2$	=	362
$\sum X_4$	=	248,1	$\sum X_4^2$	=	1857
$N_1$	=	14	$\bar{X}_1$	=	6,86
$N_2$	=	36	$\bar{X}_2$	=	5,51
$N_3$	=	10	$\bar{X}_3$	=	5,78
$N_4$	=	35	$\bar{X}_4$	=	7,09
$N$	=	95	$\bar{X}$	=	6,32

The next stage is to find if there is a significant difference between any of the means of the four zones. Analysis of variance was used. The first stage is the F-test and this will tell us if there are any significant differences between the means. In order to establish where the actual differences are, it is necessary to apply the S method of Scheffé (1959). In other words, if the test based on  $\frac{V_b}{V_w}$  does not reject the null hypothesis, the population means are considered as being equal, but if the null hypothesis is rejected then the S test enables us to pin-point the significant differences.

We continue our example with the standard five girls and first we establish the value of the F ratio:

$$\frac{V_b}{V_w} = \frac{\left( \sum_{i=1}^k n_i - k \right) \sum_{i=1}^k n_i (\bar{X}_i - \bar{X})^2}{(k-1) \sum_{i=1}^k \sum_{j=1}^{n_i} (x_{ij} - \bar{X}_i)^2}$$

where  $k$  = number of groups (zones)

$i$  = group number

$j$  = the pupil in the group

$V_b$  = variance estimate between groups

$V_w$  = variance estimate within groups

and there are  $k - 1$  and  $\sum_{i=1}^k n_i - k$  degrees of freedom.

This equation can of course be applied to this situation where the number in each group differs.

In calculating  $F$  above it is clearer if we calculate the three parts separately.

$$\sum_{i=1}^k n_i - k = 95 - 4 = 91$$

$$\begin{aligned} \sum_{i=1}^k n_i (\bar{X}_i - \bar{X})^2 &= 14(6,86 - 6,32)^2 + \\ & 36(5,51 - 6,32)^2 + \\ & 10(5,78 - 6,32)^2 + \\ & 35(7,09 - 6,32)^2 = 51,37 \end{aligned}$$

$$\begin{aligned} \text{and } \sum_{i=1}^k \sum_{j=1}^{n_i} (x_{ij} - \bar{X}_i)^2 &= \sum_{i=1}^k \left( \sum_{j=1}^{n_i} x_{ij}^2 - n_i \bar{X}_i^2 \right) \\ &= 4087 - (14 \times 6,86^2 + 36 \times 5,51^2 + 10 \times 5,78^2 + 35 \times 7,09^2) \\ &= 242 \end{aligned}$$

$$\text{Therefore } F = \frac{91 \times 51,37}{3 \times 242}$$

$$= 6,44$$

For 3 and 91 d.f. on a normal distribution the F score at the ,001 level = 5,98. We conclude therefore, that we reject the null hypothesis of equal means at the ,001 level of significance and we must now use the S test to find which means differ significantly.

The formula  $s^2 = (k - 1) F_{0,95} (k - 1, \sum_{i=1}^k n_i - k)$  will give us the value of S for an F-score at the ,05 level of significance. In our example this will be:

$$s^2 = 3 \times 2,71$$

$$s = 2,85$$

This value is now fixed while we compare all of the possible six pair-combinations of our four groups. We continue our example with groups 2 and 4 which have means:

$$\bar{X}_2 = 5,51$$

$$\bar{X}_4 = 7,09$$

We now establish the quantity  $a(2;4) = s \sqrt{v_w \left( \frac{1}{n_2} + \frac{1}{n_4} \right)}$

and compare it with the difference between the two means.

$$a = 2,85 \sqrt{\frac{242}{91} \left( \frac{1}{36} + \frac{1}{35} \right)}$$

$$= 1,10$$

$$\bar{X}_4 - \bar{X}_2 = 1,58$$

$$\text{and } 1,58 > 1,10$$

therefore  $\bar{X}_2$  and  $\bar{X}_4$  differ significantly at the ,05 level.

If S and a are recalculated for the ,01 level instead of the ,05 level it is found that  $a = 1,34$ . Noting that the difference between the two means (1,58) is greater than this, we can in fact say that the means differ at the ,01 level of significance.

## CHAPTER 5

## RESULTS

## 5.1 Comparison of the Means of the Personality Factors

## 5.1.1 Age trends in the first-order personality factors.

In order to establish any age trends that might exist for the fourteen personality factors, graphs were drawn. For each factor, the means for each age-group (boys and girls separately) were plotted against age and these graphs are presented in Figures 1 to 3 in the appendix.

As was mentioned before, the CPQ has been standardised for use in this country and as tables were available for converting raw test scores to standard (sten) scores for each age group, it was possible to establish from the norms in which factors age corrections had been made. It was apparent that noticeable corrections were made in exactly the same factors that had required correction according to data in the I.P.A.T. (1968) supplement of Norms. These factors were B, D, E, F, I, Q<sub>3</sub> and Q<sub>4</sub>. This agreement would seem to indicate confidence in the South African Norms.

Consulting Figures 1 to 3 for each of these seven factors it appears that the gradients of these fourteen curves (boys and girls are plotted separately) are, within reason, approximately zero. This implies that the age trends as reported for the I.P.A.T. and South African Norms are replicated in the present study as the corrections produce consistent means. There were two exceptions: (i) for boys on factor I a slight increase was found where there had been a correction for slightly decreasing means, which implies that the means of the raw scores for the boys had been constant; and (ii) for girls on factor Q<sub>3</sub> where a very slightly inverted-U relationship was apparent instead of a very slight increase.

The age trends for the above seven factors are presented in Table 5 below, but it should be remembered that they represent the trends before correction and that the present study revealed the same trends.

TABLE 5

AGE TRENDS AS EVIDENT FROM NORMS OF FACTORS WHICH REQUIRE CORRECTION

Factor	Description	Trend	
		Boys	Girls
B	Intelligence	increase	increase
D	Excitability	slight increase	slight increase
E	Dominance	increase	increase
F	Surgency	increase	increase
I	Tender-Mindedness	slight increase	slight increase
Q <sub>3</sub>	Self-Control	slight decrease	slight decrease
Q <sub>4</sub>	Tenseness	slight increase	slight increase

The graphs of the means of the remaining seven factors are now examined. According to the I.P.A.T. and South African Norms, these should reveal no age trends at all. Here it is found that for the boys no trends are evident for factors A, H, J, N or O and that factor C shows a definite increasing trend, while factor G shows fluctuations but no definite trend. For the girls, factors A and J show no trend at all, while C and H show increases. Factors O and G show fluctuations with no particular trend and factor N a slight inverted-U relationship. These are presented in Table 6 below.

Examination of these two tables shows that the means and trends of all fourteen first-order personality factors from the present study are very much in line with the I.P.A.T. Norms, the only major differences being in factor C where boys and girls both show increases in emotional stability, and factor H

where the girls of this sample become more venturesome mainly due to a very low mean for the nine year-olds (standard two).

TABLE 6

## AGE TRENDS OF FACTORS NOT REQUIRING CORRECTION

Factor	Description	Trend	
		Boys	Girls
A	Outgoing	-	-
C	Emotionally Stable	increase	increase
G	Conscientious	fluctuating but level	fluctuating but level
H	Venturesome	-	increase
J	Doubting	-	-
N	Shrewd	-	slightly inverted-U
O	Apprehensive	-	fluctuating but level

## 5.1.2 Age trends in the second-order factors

As for the previous section, the graphs of the means were plotted against age, this time for extraversion and neuroticism. With the exception of the mean of the standard two girls on extraversion, which is significantly lower than the others, the respective means are remarkably constant and no age trends are apparent at all.

These findings are in agreement with those of Noble (1974) also using the CPQ, but contrary to those of S.B.G. Eysenck (1965), using the Junior Eysenck Personality Inventory, who found a steady increase in extraversion for both boys and girls over the same age range. Eysenck found a very small drop in neuroticism for boys and fluctuating scores with no real trend, for the girls.

## 5.1.3 Sex differences in the first-order factors

The means for all boys and girls in the sample were calculated for each of the fourteen first-order factors, and then compared to establish if any differences were significant.

Table 7 below shows the means and the levels of significance of the differences between the respective means. Also shown are the I.P.A.T. results and those of Noble (1974).

TABLE 7

## DIFFERENCE BETWEEN THE FACTOR MEANS

Factor	Means		level of significance of difference	I.P.A.T.: significant difference-Higher Sex	Noble: significant difference-Higher Sex
	Boys	Girls			
A Outgoing	5,22	4,91	,05 boys	girls	girls
B Intelligence	6,82	7,13	,01 girls	girls	-
C Emotionally Stable	5,21	4,79	,01 boys	-	-
D Excitable	6,84	6,72	-	-	-
E Dominant	6,61	6,51	-	boys	boys
F Surgency	6,72	7,02	,05 girls	boys	boys
G Conscientious	3,80	3,82	-	girls	girls
H Venturesome	5,47	5,17	,01 boys	-	-
I Tender-Minded	4,59	3,92	,001 boys	girls	girls
J Doubting	5,79	5,52	,05 boys	-	-
N Shrewd	6,48	6,81	,01 girls	-	boys
O Apprehensive	5,31	5,54	-	girls	girls
Q <sub>3</sub> Self Control	3,98	3,80	-	girls	girls
Q <sub>4</sub> Tense	6,66	6,85	-	-	-

As can be seen from the table, the findings in this aspect of the present study appear to be in considerable disagreement with those of Noble (1974) and the I.P.A.T. CPQ handbook data. The only agreement with the I.P.A.T. data is for factors B, D

and  $Q_4$ , while for factors E and O the differences are not significant but are in the correct direction. The most serious disagreement is for factor I where it appears that the boys of the present study are far more tender-minded than the girls. Some of the discrepancies are due to a large difference in means at one or two age-levels and not throughout the whole age-range and it is advisable therefore to interpret Table 7 while consulting the graphs in Figures 1 to 3.

#### Factor A "Outgoing"

The boys' means are all higher than those of the girls' except for standard four. The difference therefore seems quite definite, but contrasts with the I.P.A.T. data.

#### Factor B "Intelligence"

All the girls' means are significantly greater than those of the boys'. This is in agreement with the I.P.A.T. data.

#### Factor C "Emotionally Stable"

The girls' means are only higher for standard five, but the cause of the significant difference is the relatively large differences of the means of standards two and three. This is not in agreement with I.P.A.T. data.

#### Factor D "Excitable"

With the exception of standard four, all the means are close. This is in agreement with I.P.A.T. data.

#### Factor E "Dominant"

If it were not for the low mean of the standard three boys, the difference between the means would have proved significant and thus been in line with I.P.A.T. data.

#### Factor F "Surgency"

With the exception of standard two, the higher scores of the girls are very marked, but this is contrary to I.P.A.T. data.

## Factor G "Conscientiousness"

There is nothing apparent here, except that the scores are very low, which is possibly the reason for the lack of clarity.

## Factor H "Venturesome"

Only the very low score of the standard two girls has caused the resultant significant difference. Apart from this, the results are in agreement with I.P.A.T. data.

## Factor I "Tender-Minded"

The differences here are very decisive and this is the most significant difference between the means (.001 level) if all the factors are considered. This result is most unexpected and contrary to any previous findings.

## Factor J "Doubting"

The standard three and four pupils are responsible for the significant differences, the other ages agree with I.P.A.T. data.

## Factor N "Shrewd"

Here the standard three and four girls cause the significant differences. The closeness of the other means is in keeping with I.P.A.T. data.

## Factor O "Apprehensive"

The standard three, four and six girls do have significantly larger means than the boys for this factor, in agreement with I.P.A.T. data, but the low score of the standard five girls causes the lack of an all-round significant difference. The significance is very near to the .05 level however, and it thus comes close to agreement with the I.P.A.T. norms.

Factor Q<sub>3</sub> "Self Control"

As for factor G, the unusually low scores seem to indicate a lack of 'normalcy' for this factor and no pattern emerges therefore.

Factor Q<sub>4</sub> "Tense"

The girls' means being greater than that of the boys' is in agreement with I.P.A.T. data.

Disagreement with the I.P.A.T. Norms is therefore not quite as marked as it first appears. Only factors A, F and I are conclusively opposite to these norms. The other disagreements are all caused by much higher or lower means of a particular age-group which then alter the group means considerably. The means of factors G and Q<sub>3</sub> are unusually low and this could be the reason for the lack of any significant differences for these factors.

#### 5.1.4 Sex differences in the second-order factors.

If Table 8 below is consulted, it is immediately obvious that there is very little difference between the boys' and girls' means, for both extraversion and neuroticism. The differences between the means for each age-group were checked to establish whether any were significant or not.

TABLE 8  
THE SECOND-ORDER FACTOR MEANS.

Factor	Standard	Means		Significance of difference between means
		Boys	Girls	
Extraversion	2	6,48	5,57	,001
	3	6,40	6,34	-
	4	6,33	6,51	-
	5	6,31	6,35	-
	6	6,37	6,45	-
Neuroticism	2	5,40	5,56	-
	3	5,35	5,29	-
	4	5,30	5,13	-
	5	5,39	4,97	,05
	6	5,08	5,24	-

As can be seen from the above results, the only significant difference in the extraversion means was for standard two where the girls were lower at the ,001 level, while for neuroticism it was the standard five girls who were significantly lower, but only the the ,05 level. These results conflict with those of both S.B.G. Eysenck (1965) and Noble (1974), who found, for the same age-range, that for extraversion the boys were significantly higher at the ,001 level. For neuroticism, Eysenck found the girls' means higher and Noble the girls' lower, both at the ,001 level. For high school students, Costello and Brachman (1963) found no sex difference for extraversion, while Ridding (1967) found girls were more extraverted and Entwistle and Cunningham (1968) just the opposite. Considering neuroticism, only Costello and Brachman (1963) found a sex difference and this was that girls were significantly higher than boys.

The reports seem to yield very little conclusive evidence and it is probably fairly safe to conclude that the results of the present study, namely that there are no sex differences for neuroticism or extraversion, are not too unreasonable.

#### 5.1.5 Conclusions

Applying the CPQ obviously enables the educationist to learn something about the personality traits of a particular person or group, but the information does not end there. By having conclusive evidence of personality trends and sex differences for the various first-order and second-order factors, the changes in personality that obviously take place as the children move through the educational system will be to a certain extent, predictable. This would enable educationists to alter and adapt their planning so that they could offer the best possible 'education' for all pupils, always bearing in mind that each individual has a unique personality.

If of course correlations can be established between any personality factors and any form of scholastic attainment, be it a specific subject or all-round success, then the trends of the changes in personality with age would be invaluable.

## 5.2 Comparison of the Mathematics Means

### 5.2.1 Sex differences

The means of the boys' and girls' marks for each age-group were compared for possible significant differences. As was explained before, this was only done for the nine to eleven year-olds (standards two to four) where standard mathematics scores were available, and not for the other two age-groups. The means for these groups are shown below in Table 9.

TABLE 9  
MATHEMATICS MEANS FOR DIFFERENT AGE-GROUPS

Standard	Means		Standard Deviations		Significance of difference between means
	Boys	Girls	Boys	Girls	
2	5,16	5,12	1,94	1,75	-
3	5,00	5,40	2,22	1,50	-
4	5,57	5,71	1,92	1,75	-

As can be seen, there are no significant differences between the means and we conclude therefore that the boys and girls as separate groups do not have any significant difference in mathematical attainment between the ages of nine and eleven.

### 5.2.2 Co-educational versus single-sex schools

Here the mathematics marks for the boys in co-educational schools were compared with those from single-sex schools. This was done for girls as well. Once again, the investigation

was confined to standards two, three and four and the means are shown in Table 10 below.

TABLE 10

## CO-EDUCATIONAL AND SINGLE-SEX SCHOOLS

Std	Sex	Means		Standard Deviations		Significance of difference between means
		C	S	C	S	
2	Boys	5,02	5,31	2,15	1,70	-
	Girls	4,93	5,30	1,95	1,55	-
3	Boys	5,06	4,94	2,42	1,55	-
	Girls	5,12	5,52	1,70	1,73	-
4	Boys	5,60	5,54	2,02	1,82	-
	Girls	5,68	6,35	1,72	1,38	-

C = Co-educational School      S = Single-Sex School

As can be seen from the above table, no significant differences were obtained, but for the standard four girls the significance of the difference was close to the ,05 level. From this we can conclude that there is no significant difference between the mathematical attainments of girls and boys at co-educational and single-sex schools in standards two, three and four.

### 5.2.3 South African Norms

The six means recorded in Table 9 above all lie in the fifth stanine and it can be seen from Table 4 on page 45 that this represents the 40 to 59 percentage range. We conclude therefore that the mathematics means of the six groups are all in agreement with the South African Norms.

### 5.3 Correlates between the Personality Factors and Mathematical Attainment

As was described in section 4.4 the analysis of variance technique was used to examine the relationships between

mathematical attainment and the first- and second-order personality factors. This meant that Pearson product-moment correlation coefficients, correlation ratios and their significances were calculated for each age-group, for boys and girls separately. Linearity of regression was tested in order to ascertain the usability of the correlation coefficients as a measure of the relationship. Departure from linearity at the ,05 level or better was not found for any of the 160 sets of data used and it is therefore with some confidence that the correlation coefficients were examined for possible trends and age differences.

### 5.3.1 The first-order factors and mathematical attainment.

The correlation coefficients for the above factors are to be found in Table 14. These are also plotted against age and are shown in Figures 4 and 5. This makes the interpretation of age trends much simpler.

While variations of correlation coefficients with age are not unexpected, probably the most unusual feature of Table 14 is the break in pattern, in that there are a large number of high correlations for the standard five and six boys. Two of these correlations are significant at the ,01 level and the remaining twelve at the ,001 level. The standard four and five girls show a similar break in pattern but for far fewer factors. Each factor will be examined for age trends and sex differences. Table 14 and Table 15 and Figures 4 and 5 will be consulted for this purpose.

#### Factor A "Outgoing"

No correlations are significant until standard five where highly significant negative correlations appear for both boys and girls. The boys retain this high negative correlation, but that for the girls disappears. As can be seen from Table 15, there are significant sex differences for the standard five and six pupils.

#### Factor B "Intelligence"

Here, highly significant positive correlations prevailed for all age-groups except that for the girls these disappeared for standards five and six. This obviously led to a sex difference for these two groups for these two standards.

#### Factor C "Emotional Stability"

Once again there is a dramatic change in the boys' correlations at the standard five stage. Likewise the girls change at the same stage, but once more the boys' correlation is significantly more negative. The boys maintain this high negative correlation, but the girls do not and there is a sex difference for standards five and six.

#### Factor D "Excitability"

The coefficients for this factor are generally smaller than the previous ones, but there is a break in the pattern at the standard four level for girls and the standard five level for boys. Although both of these correlations are significant, neither shows a significant boy-girl difference.

#### Factor E "Dominance"

For the boys, low negative correlations are found, except at the standard five and six stage where they are large, significant and negative. The girls' correlations on the other hand are low and positive except for standard four, where they are significantly positive at the .05 level. Sex differences are consequently found in all standards except standard two.

#### Factor F "Surgency"

Once again the boys show low correlations for standards two to four, and then large, significant and negative correlations for the remaining two age-groups. The girls show a peculiar pattern which is that of low correlations, but for standard four they are significantly positive, and for standard five, significantly negative. Significant sex differences are found for standards four, five and six.

#### Factor G "Conscientiousness"

Low correlations occur for both boys and girls, with breaks in the pattern for the boys in standards five and six and girls in standard five, where the correlations were significantly negative. Accordingly, sex differences were found for standards five and six. These unexpected correlations are almost certainly caused by the very low scores obtained for factor G.

#### Factor H "Venturesomeness"

The same pattern is found for boys with significantly low negative correlations occurring at the standard five and six stage. For the girls the correlations are positive, being significant at the standard four level and then changing dramatically to a high negative correlation for the standard five pupils. Sex differences are found for standards five and six.

#### Factor I "Tender-Mindedness"

Once again a break in pattern for standard five and six boys is found, but this time it is from low to significant positive correlations. For girls the correlations are low except for standard four where it is significantly negative. Sex differences are found therefore at the standards four, five and six levels.

#### Factor J "Doubting"

The now familiar pattern is found once again for the boys, with low correlations becoming significantly negative for standards five and six. The girls show steady negative correlations (except for standard six), which only just fails to achieve significance. Sex differences are found at the standard five and six levels.

#### Factor N "Shrewdness"

Boys show low correlations, significant positively for standard five only. The girls' coefficients are low, but positive, and only just fail to achieve significance for standard four where they are significantly higher than the boys'.

#### Factor O "Guilt Proneness"

The girls show small negative correlations throughout, while the boys show a steady negative increase from zero correlation. The coefficients are significantly negative for standards four, five and six and in this region the boys show significantly larger correlations than the girls.

#### Factor Q<sub>3</sub> "Self-Control"

Once again the boys show low correlations for standards two, three and four, followed by a dramatic drop to a large, highly significant, negative correlation coefficient for both standards five and six. The girls show the same drop at standard five which is not quite as significant (.01 level), but this falls away for standard six. Highly significant sex differences are evident for standards five and six.

#### Factor Q<sub>4</sub> "Tenseness"

Boys show the same pattern of low correlations followed by highly significant negative correlations for standards five and six. The girls appear to have low negative correlations, but for standard five it is highly significant. Significant sex differences are evident for standards five and six.

#### 5.3.2. Conclusions

As can be seen from the foregoing, with the exception of factors B and O, a remarkable change to a significant negative value in the correlation coefficients for boys takes place at the standard five level. In factor B this exception is because the coefficients are highly significant and positive for the entire age-range, and for factor D this change takes place one year earlier. For the girls this change to significant negative correlation coefficients is not as pronounced, because although it takes place in ten of the factors, the coefficients generally are not as large as for the boys and the break in pattern occurs for some factors at standard four and for others at the standard five level.

A trend worth noting is the extremely strong positive relationship between intelligence (factor B) and mathematical attainment. This is not unexpected, but the standard five and six girls show zero correlations. This is somewhat surprising.

Achievement in mathematics does, on the basis of this study, have very strong correlations with personality, but it is perhaps the sudden breaks in the trends which require some comment.

Noble (1974) in a similar investigation, reported breaks in the pattern of the correlation coefficients. Very much the same as found in the present study. The main difference though was that in his study the breaks in pattern occurred for both boys and girls at the standard four and five level. For ease of comparison, the sets of correlation coefficients for the two studies are plotted on the same axes and are shown in Figures 6 to 9. Looking at these 28 comparisons (boys and girls are separate) it will be noticed that:

- (i) 5 sets are identical;
- (ii) 2 sets are similar, but the break in pattern for the present study is more marked;
- (iii) 11 sets are similar, but the break in pattern takes place 1 year later in the present study;
- (iv) 10 sets are either opposite or no trend is noticeable at all.

The factors which fall into the above categories are:

Boys	Girls
(i) D, N	D, N, Q <sub>3</sub>
(ii) G, Q <sub>3</sub>	-
(iii) A, C, E, F, H	A, B, C, F, G, H
(iv) B, I, J, O, Q <sub>4</sub>	E, I, J, O, Q <sub>4</sub>

The fact that 18 of the 28 comparisons show similar trends (although those in category (iii) are out of phase) is

evidence of some considerable agreement between these two independent studies and would seem to indicate that further research is required in this area. Cattell and Cattell (1969) also feel the need for more extensive research especially in trying to determine mathematical equations capable of predicting school achievement. They feel that it is necessary, in order "... to show how the weights change with different school subjects, with age, and with changing school instruction styles and circumstances."

Some possible explanations (not in order of importance) of the breaks in the patterns are:

- (i) A change from the class-teacher to a subject specialist usually occurs at the standard four or five stage and with the exception of all-girls' schools this very often means a change from a female to a male teacher.
- (ii) The mere fact that they are the top class and the seniors in the school, must work itself out in their attitude to school and schoolwork in one way or another.
- (iii) Possibly they have simply reached a stage where they question for the first time the value of what they are doing, and perhaps the 'glamour' of school is receding and thus leads to this marked alteration in attainment for the various personality types.
- (iv) Standard five is the last year in primary school and most pupils must feel somewhat uncertain about the unknown senior school career that lies ahead and this could have some effect on their attitude towards schoolwork, and mathematics in particular. Herbert (1974) comments as follows: "At eleven, children exhibit an increase in fear. Among eleven and twelve-year-olds, worries connected with school are nearly half as many again as worries about home matters. In Britain, eleven is that awkward

phase in a child's life when change from junior to senior school is being made. It may not be coincidental that it is also the age at which school phobias are at a high peak."

- (v) At the standard four or five level it is common for the class averages for mathematics and other subjects to be reduced by the schools in an attempt to bring the primary school allocation and awarding of marks 'into line' with those of the high school. This could of course have a disturbing effect as the pupils might tend to feel thwarted in their scholastic attempts.
- (vi) Noble (1974) feels that possibly parental attitude changes at about this age level and that "Parental interest in schoolwork can decrease in standard four as changing syllabus content and teaching methods make it increasingly difficult for parents to coach their children at home. At the same time parents are granting more independence and freedom to their children, while demanding a greater sense of responsibility from them."
- (vii) The imminence or onset of puberty is a factor which is fairly likely to have an effect on scholastic attainment. If this is so, then it would be expected that girls would exhibit this tendency earlier. With the present study this is exactly what was found, as the breaks in the pattern of the correlation coefficients occurred earlier for girls than for boys in six of the factors (see Table 14).
- (viii) One of the drawbacks of the present study was that standardised arithmetic tests were not available for standards five and six and the mathematics marks were corrected end-of-year marks. There is the possibility that this could be responsible for the trends that were found but arguments against this are as follows:

- (a) breaks in the patterns were found at the standard four level as well;
  - (b) the breaks did not always occur for boys at the same age as for girls;
  - (c) factor B for boys attained a significant positive correlation throughout;
  - (d) the trends found in the next section dealing with extraversion and neuroticism are continuous through the entire age-range, and
  - (e) confidence is felt in the methods used for the statistical adjustments.
- (ix) Noble (1974) quoting Skemp, feels that as far as the content of the primary Mathematics syllabus is concerned, "... the order of presentation of material can present psychological difficulties in learning mathematics."

Bruner expresses the same opinion as Skemp above and Lawton (1973) referring to Bruner writes: "A theory of instruction must specify the ways in which knowledge should be structured for the learner. This is different from the philosophical problem about the structure and organisation of knowledge: Bruner is here referring to the relationship between the nature of knowledge to be learned and the nature of the learner as an individual." (Underlining not in the original.) Bruner advances three factors which he feels any theory of instruction must be concerned with:

- (a) the nature of the knowledge to be learned;
- (b) the nature of the learning process;
- (c) the individual children.

One of Bruner's major contributions is that he has shown that the interaction of these three factors is likely to be so complex that "every learning situation for every child must be regarded as unique."

- (x) Last, but by no means least, is the possibility that the general development of the child might follow the patterns as described above. The breaks in pattern that were found, occurred for eleven and twelve year-old children, and this is precisely the stage at which, according to Piaget's theory of cognitive development, they change from the concrete operations to the formal operations stage. This means that they can now think about abstractions and visualise logical solutions internally and do not have to rely on concrete objects to solve problems. They can, in the formal operations stage, apply a theory to many problems or reason from a hypothesis. They are capable of organising information, reasoning scientifically and building and testing hypotheses.

Possible links between attitudes towards School Mathematics and the observed break in pattern of correlations between Personality Factors and Mathematical Attainment.

Noble (1974a) in an article dealing with attitudes towards school mathematics, quotes various writers: "Land (1970) lists the need to explore more fully the attitudes to mathematics... Attitude scales are liable to error if not validated and cannot be treated as interval scales. (Nisbet and Entwistle, 1970). Biggs (1962) reports little consistency in patterns of attitude towards arithmetic at the primary level with, generally, no difference between the sexes, but at about the age of twelve to thirteen years, girls begin to dislike arithmetic consistently, while after the age of fourteen years, boys manifest an increased liking for arithmetic and mathematics." Noble in this study investigated attitudes to, and abilities in mathematics throughout the age range nine to seventeen years and the writer feels that the results have a direct bearing on the present study and consequently a portion of a table of correlation coefficients is reproduced as Table 16 in the appendix. The

conclusions drawn from the table indicate that prior to standard seven there is no discernible pattern. From standard seven upwards, all correlation coefficients are significant and all are positive. Also indicated was that for standards seven and eight, girls show a stronger relationship between attitude and ability than do the boys. "It would seem therefore that the attitude of girls towards mathematics, even more than that of boys is a factor that should be taken into account when teaching mathematics to standards seven and eight." (Noble, 1974a).

It is realised that mathematics content does change in standards seven and eight, but in addition it may be that the significant correlations between attitude and mathematics attainment observed in these standards (Noble, 1974a) are partly linked to disturbing effects between personality factors and mathematics attainment indicated by the break in correlation pattern observed for standards four and five in both the present study and those of Noble (1974).

Attitudes can be expected to form some time after the break in pattern of correlation coefficients has been observed, and the findings reported by Noble could well tie up with the breaks in pattern found at the standard four and five level in the present study. For example, if we consider factor G, (conscientiousness) we see that for both boys and girls the break in pattern (a sudden large negative increase in the correlation coefficient) occurs at the standard five stage. This means that those that are conscientious tend not to achieve, despite their efforts, and there is every possibility that eventually (possibly as much as two years later) their whole approach and attitude towards the subject will change. This could result in a resistance towards mathematics and produce the result found by Noble in his study where attainment is highly correlated with attitude.

### 5.3.3 The second-order factors and mathematical attainment.

The correlation coefficients for the above are to be found in Table 14. These are plotted against age and are shown in Figure 5. As was previously mentioned, linearity of regression was tested and there was no departure from linearity in any of the extraversion or neuroticism correlations. The correlation coefficients obtained may therefore be used to describe the above-mentioned relationship.

What is most striking about these correlation coefficients is that eighteen of the twenty show a significant negative correlation at the ,001 level (lowest is  $-0,375$  and the highest  $-0,796$ ), one is significant negatively at the ,05 level and only one fails to reach significance (that of the standard six girls for extraversion).

#### EXTRAVERSION

It is obvious from Table 14 and Figure 5 that the boys show a very definite negative relationship between extraversion and mathematical attainment and that the correlations remain fairly constant, but show a very slight decrease in relationship. The girls, however, are more fluctuating and while their's is also a significant negative correlation, there is a sudden change for standard six: A sex difference was found for standard six only and here the boys had a negative correlation which was significantly greater at the ,001 level than that of the girls.

Generally speaking it appears that with the present sample the introvert is the pupil most likely to be successful at mathematics. As was noted earlier, there is no great clarity from previous reports as to the academic success of extraverts or introverts in the age-range of the present study (see section 2.1). On the basis of Entwistle's (1972) condensation of Warburton's summaries (see Table 1 on page 28) the scale was, however, tipped slightly in favour of

extraversion favouring academic success, but this was of course general success and not specifically mathematics. Noble (1974), as previously stated, working with mathematics and extraversion, found positive correlations for standards two and three (significant for the latter), highly significant negative correlations for standards four and five, and thereafter either small negative or negligible correlations. There is therefore some agreement between the two studies for both standards four and five boys, and standards four, five and six girls. It must be remembered that these are the regions where Noble (1974) found his correlations which were highly significant and this lends weight to the argument that there is some agreement.

With most studies pointing to the introvert being successful at high school and university level, the present results are not all that surprising and do seem to indicate the necessity for further research in order to gain greater clarity. Possibly Entwistle and Welsh (1969), and Lewis and Ko (1973) who found high ability introverted pupils achieving better, and low ability extraverts having greater success, have pointed out the direction for further investigation, namely that of working within different ability groups.

#### NEUROTICISM

Previous findings are fairly conclusively in favour of a negative correlation between neuroticism and school achievement for the age-range covered by the present study. The findings of this study are therefore in accord with this and are extremely decisive as every one of the ten correlation coefficients is negative and significant at better than the ,001 level. The boys, as is evident from Figure 5, do show a very slight U-shaped trend as do the girls and a similarity is the fairly marked upward trend of the standard six pupils.

Sex differences are evident for all but the latter standard. These are caused by the very large negative correlations of the girls and occur in spite of the boys having highly significant negative correlations. The results do, however, contrast with those of Noble (1974) who found significant positive correlations for standards four and five while the remainder of his coefficients were negative.

#### 5.3.4 Conclusions

In trying to find a reason for the success of introverts in examinations, Lynn and Gordon (1961), dealing with university students say: "The extravert is handicapped in academic work, as in other tasks requiring sustained concentration, because of his tendency to fatigue and to give up more quickly." Similarly, Child (1973) feels that the extravert is at a disadvantage because his concentration in studious tasks "will be marred by involuntary rest periods." However, researchers are understandably not really prepared to offer reasons for the various relationships and likewise for neuroticism there have not been many attempts at explanation, but Lynn (1959) writes: "It seems that neuroticism has two different effects on attainment, a disorganising one on learning and performance in stress situations, but a facilitating one in so far as it motivates sustained work." Biggs (1962) suggests that "the intelligent child may be more able to deal adaptively with his anxiety...", and Child (1973) feels "that the intellectual demands perceived by children are relatively more complex because of the children's inexperience, with the consequence that higher levels of anxiety, disadvantageous to performance, are generated."

As the state of this field of research stands at the moment, not too much can be made of the present evidence, especially at the primary school level. Until far more conclusive evidence is compiled it will be difficult to be more specific as to what exact relationships exist and what the cause might be.

## 5.4 Zonal Analysis

On the basis of the previous section's results that mathematical attainment was negatively correlated with both extraversion and neuroticism it would be expected that the stable introvert would be the best achiever in mathematics in the primary school. For this reason the zonal analysis procedure as described in section 4.6 was undertaken. The means for neuroticism, extraversion, and the mathematics scores for each of the four zones are given below in Table 11.

TABLE 11  
MEANS FOR ZONAL ANALYSIS

Std	Sex	Neuroticism	Extraversion	N.E.	N.I.	S.I.	S.E.
2	Boys	5,40	6,48	5,63	4,86	5,60	5,13
	Girls	5,50	5,57	4,75	4,95	5,85	5,72
3	Boys	5,35	6,40	4,17	5,51	5,26	5,14
	Girls	5,29	6,34	5,43	5,12	5,55	5,45
4	Boys	5,30	6,33	4,89	5,55	5,73	5,60
	Girls	5,13	6,51	5,33	5,29	6,16	6,08
5	Boys	5,39	6,31	6,28	6,03	6,45	6,30
	Girls	4,97	6,35	5,66	5,51	5,78	7,09
6	Boys	5,09	6,34	4,74	6,69	5,78	4,68
	Girls	5,24	6,45	5,11	6,04	6,20	5,27

N.E. - Neurotic Extravert  
N.I. - Neurotic Introvert

S.I. - Stable Introvert  
S.E. - Stable Extravert

An analysis of variance technique was used and F scores used to establish if there were any significant differences between the means. Where differences were indicated, the Scheffé test was applied to establish exactly where the differences were. The F-scores and their significances are recorded in Table 12 below.

TABLE 12

## F SCORES

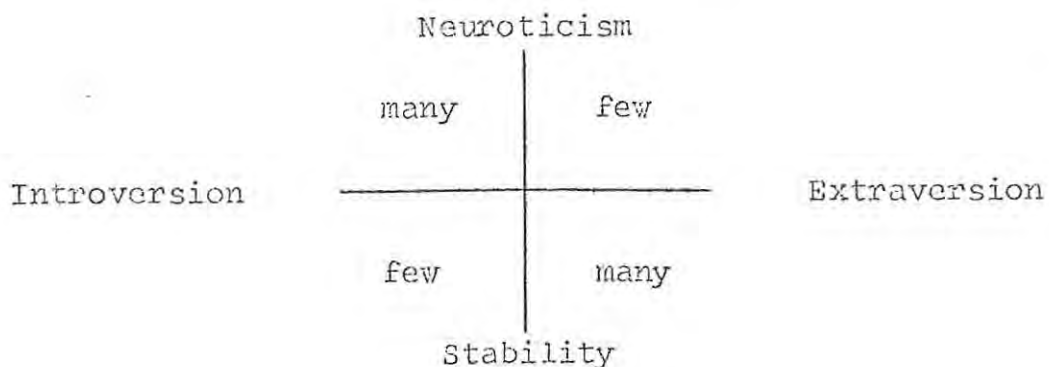
Standard	Sex	F	level of significance
2	Boys	0,16	-
	Girls	2,64	-
3	Boys	2,27	-
	Girls	0,75	-
4	Boys	0,47	-
	Girls	1,05	-
5	Boys	1,45	-
	Girls	8,63	,001
6	Boys	2,53	-
	Girls	2,73	,05

The means of the standard five and six girls were then examined to find which the significant differences were. It transpired that none of the differences of means for the standard six girls quite reached the ,05 level of significance, but that for the standard five girls the neurotic introverts had a lower mean than the stable extraverts, at the ,01 level of significance.

This lack of significant differences between the means of the various groups implies that there is no difference in mathematical attainment between these four personality types. However, before these results are dismissed as contrary to the findings of the previous section it would be as well to examine the means of the four zones in Table 11. It will be seen that the stable introverts have the highest mean in six of the ten comparisons and on the other four occasions they have the second highest score. As far as the neurotic extraverts are concerned, they have the lowest mean on four occasions and the second lowest on five of the comparisons. Thus, while almost no statistically significant differences can be found in the present sample there certainly are some pointers that

imply the need for further investigation. The breakdown of the means given above is evidence supporting the findings of the previous section which would suggest that the stable introverts should score best in mathematics tests, while the neurotic extraverts should fare the worst. This statement is in agreement with the findings of Child (1964) as reported in section 2.3 of the present study. He reported the lack of achievement of neurotic extraverts, which agreed with Finlayson's (1970) findings with twelve to fourteen year-old boys. Finlayson also found that the stable introverted boys fared best, and Entwistle and Cunningham (1968) agreed with this result, but amongst the girls in their study, the stable extraverted girls were the most successful.

A possible explanation for the lack of significant statistical evidence was the comparative sizes of the four zones in each group. The neurotic introverts and the stable extraverts were always small groups, and the other two were, without exception, larger. In an attempt to equalise the sizes of the zones, instead of using the means of the extraversion and introversion scores to establish the origins on the extraversion-neuroticism axes, the medians were found and these were used to find the dividing lines along the two axes. The medians hardly differed from the means at all and so brought about no change in the distribution. The zonal analysis was therefore completed using means, as was described by Child (1964). The distribution described above produced a diagram as follows:



A typical distribution, using the standard five girls as an example, is:

	Neuroticism	
	36	14
Introversion		Extraversion
	10	35
	Stability	

This distribution implies a negative correlation between neuroticism and extraversion and this in fact concurs with the findings of Lynn and Gordon (1961).

### 5.5 Conclusions and Suggestions.

This study has covered several areas, some of which have been subjected to a fair amount of previous research and others very little. Obviously the question of personality and scholastic attainment is an area of education where the surface has only been scratched. Child (1973) maintains that it is surely important to realise that

personality characteristics play a significant role in both the act of learning and in attitudes towards the act of learning. Variations in performance are not entirely a question of intellect, motivation or thinking skills, but may depend on the personal attributes which can enhance or inhibit the quality of that performance. This fact alone is sufficient to justify continued research in this field.

It does however, still require some imagination to see where the results will lead, but Entwistle (1972) writes:

"The lack of generality in relationships and the probable link between teaching methods and personality correlates of success, both reinforce the growing realisation of the importance of variety in the presentation of material to be learned."

The present study made little of the possibility of difference between members of the same sex studying in co-educational schools and those in single-sex schools. The one area where it was developed, namely that of mathematical attainment,

showed no difference at all, but there is still the possibility that significant differences would be found with the correlates between personality and scholastic achievement. For various reasons, only limited access to the computer was available and it was decided at the outset not to pursue this line of research in the present study. However, with the breaks in pattern that were found in the correlations of the first-order personality factors and mathematical attainment and in view of the fact that these were in fair agreement with the findings of Noble (1974), further research in this direction would appear to be necessary.

The correlations of extraversion and neuroticism with scholastic attainment have received a fair amount of attention in the past twenty years, but definite patterns have been slow in emerging. Child (1964) notes: "No evidence has yet been provided to show whether the extraversion score of an individual varies greatly over a period of years ..." With research noting age-trends in extraversion and neuroticism, and correlations of these with attainment, quite obviously a longitudinal study is required if more conclusive evidence is to emerge.

#### 5.6 Implications for Education

While further research in the same areas as touched on by the present study is indicated, the results seem to point out that particular care and attention needs to be paid to the standard four and five primary school pupils.

Teachers should also be aware of the implications of Developmental Psychology. The Cognitive growth of pupils, and very marked changes between stages are possible reasons for the breaks in pattern found by Noble (1974) and in the present study. However, these results excepted, the implications of developmental psychology still give more

than sufficient reason to demand attention from teachers. The Affective development which has a bearing on the attitudes and changes in attitude of pupils should also be noted, particularly in view of the results obtained by Noble (1974a) where he found that the attitudes of boys and girls towards mathematics at the standard seven and eight level were different. It seems that mathematics needs to be 'sold' to children, especially the girls, prior to standard seven and this ties in with the observations above.

## CHAPTER 6

## SUMMARY

"The task of describing and defining the total organisation of man is very complex." (Child, 1973). Personality is therefore a concept which is extremely difficult to define. The development of group questionnaire methods of testing has stimulated interest in the field of personality and scholastic achievement.

R.B. Cattell and H.J. Eysenck are two of the foremost developers of personality inventories and their different methods have yielded similar personality descriptions of extraversion and neuroticism. In addition, Cattell's personality test, the CPQ, yields fourteen first-order factors from which he derives his second-order factors of extraversion - introversion and neuroticism - stability. The South African standardised version of the CPQ was used in the present study which encompassed the ages nine to thirteen years. In addition, standardised arithmetic tests for the age-range nine to eleven years were administered and the end-of-year examinations marks for the twelve and thirteen year-olds were obtained and adjusted to allow for differences between schools. The sample consisted of 965 English speaking children (501 boys and 464 girls) from six schools in Cape Town. The pupils were drawn from similar socio-economic and cultural backgrounds as those of a similar study done in Grahamstown schools. This was done in order to make comparisons between the results of the two pieces of research.

The aims of the present study were: (i) to investigate possible age trends and sex differences for the fourteen first-order factors as yielded by the CPQ, as well as the second-order factors of extraversion and neuroticism which

derive from them; (ii) to investigate possible age trends and sex differences in mathematical attainment for the age-range nine to eleven years; and (iii) to investigate the correlates, with age, between the above-mentioned sixteen personality factors (fourteen first order and two second-order) and mathematical attainment.

Briefly the findings were:

- (i) Age trends in the first-order factors were, in general, similar to those as indicated by the I.P.A.T. Norms. Sex differences were found, but these contrasted with previous findings. No trends were evident for extraversion and neuroticism and sex differences for these two factors were negligible.
- (ii) No age trends or sex differences were observed for the mathematics' means. Within the sexes, no difference was found between the means obtained in co-educational schools and those from single-sex schools. In addition, the means were in agreement with the South African Norms.
- (iii) Pearson product-moment correlation coefficients were calculated and the data from the different groups was tested to determine the possibility of a departure from linearity. No departure was found in any of the 160 groups analysed. Breaks in the patterns of the correlation coefficients were found for standard five (twelve year-old) boys for twelve of the fourteen first-order factors and for the girls similar breaks showed at the standard four and five level (eleven and twelve year-olds) in ten of the factors. There was considerable agreement regarding the breaks in the patterns, between the findings of this study and those of the similar study undertaken in Grahamstown and possible explanations have been put forward. The correlations of extraversion and neuroticism against mathematical attainment were both strongly negative and highly significant.

- (iv) Zonal analysis was used to investigate mathematical attainment within different levels of extraversion and neuroticism. Here nothing statistically significant emerged, but the pattern of the means suggests that the stable introverts were possibly the best achievers (in mathematics) and the neurotic extraverts seemed to fare the worst.

The entire study appeared to indicate the need for further research of a longitudinal nature, particularly in the field of scholastic achievements within the contexts of extraversion and neuroticism. In addition, it seems necessary to establish the change (or constancy) of an individual's degree of extraversion or neuroticism as he or she moves through the school system, and a study of this type is the best possible way of establishing this.

TABLE 13

MEANS AND STANDARD DEVIATIONS OF PERSONALITY FACTORS BY SCHOOL STANDARD

Standard		2		3		4		5		6	
Factor		B	G	B	G	B	G	B	G	B	G
A	M	5,41	4,90	5,31	4,99	4,79	4,98	5,29	4,57	5,32	5,11
	S	1,70	2,12	1,95	1,95	2,17	2,15	1,89	2,34	1,75	2,26
B	M	6,61	6,84	6,25	6,92	7,12	7,28	7,14	7,35	6,95	7,22
	S	1,56	1,58	1,61	1,18	2,03	1,74	1,88	1,92	1,97	1,43
C	M	4,49	3,49	4,98	3,97	5,50	5,32	5,28	5,69	5,78	5,46
	S	1,54	3,36	2,09	2,94	2,21	1,95	2,01	2,47	1,96	1,86
D	M	6,69	6,73	6,91	7,09	7,32	6,62	6,68	6,51	6,61	6,64
	S	1,48	2,18	1,95	2,30	1,90	1,85	1,89	2,26	2,15	2,03
E	M	6,63	6,83	6,63	6,35	7,01	7,47	6,48	7,32	6,29	6,51
	S	2,05	2,01	1,88	1,96	2,06	1,96	1,69	2,06	1,68	1,64
F	M	7,28	6,43	6,86	7,03	6,57	7,47	6,39	7,38	6,51	6,81
	S	2,13	2,61	1,95	2,14	2,55	2,05	2,38	2,04	2,02	1,80
G	M	3,80	4,49	3,69	3,35	3,49	3,61	4,36	3,44	3,67	4,20
	S	1,99	2,18	2,20	3,18	1,65	2,78	1,12	1,96	1,70	1,75
H	M	5,19	3,87	5,40	5,19	5,56	5,51	5,55	5,47	5,64	5,81
	S	2,25	1,97	1,63	1,33	1,83	2,23	1,71	1,99	1,85	1,64
I	M	4,25	3,73	4,52	3,52	4,24	3,73	4,91	3,99	4,99	4,59
	S	1,74	1,81	1,60	2,00	1,81	2,11	1,84	2,12	1,87	1,46
J	M	5,58	5,84	6,20	5,76	5,78	5,15	5,69	5,48	5,40	5,37
	S	1,92	1,77	2,00	2,06	2,06	2,32	1,68	2,06	2,07	1,91
N	M	6,41	6,32	6,37	6,59	6,61	7,48	6,47	7,26	6,51	6,46
	S	1,93	2,34	1,93	2,02	1,95	1,81	1,97	2,09	1,96	1,86
O	M	5,73	5,53	5,23	5,67	5,50	6,00	5,40	5,23	4,72	5,34
	S	1,98	2,73	2,23	2,30	2,13	2,27	1,94	2,16	1,75	1,65
Q <sub>3</sub>	M	3,98	4,17	3,73	3,40	3,82	3,45	4,03	4,13	4,35	3,81
	S	1,72	1,83	1,59	1,05	1,60	1,82	1,33	1,84	1,71	1,90
Q <sub>4</sub>	M	6,51	6,42	6,65	7,20	6,87	7,15	6,34	6,98	6,81	6,54
	S	2,03	2,00	1,95	1,90	1,81	1,79	1,83	1,98	1,76	1,69
Extra-version		6,43	5,57	6,40	6,34	6,33	6,51	6,31	6,35	6,37	6,45
		1,55	1,41	1,46	1,15	0,85	1,53	1,02	1,52	1,30	1,13
Neuroticism		5,40	5,55	5,35	5,29	5,30	5,13	5,39	4,97	5,08	5,24
		1,12	1,06	1,23	1,69	1,19	1,16	1,00	1,29	1,82	2,12

M - Means

S - Standard Deviations

TABLE 14

CORRELATION COEFFICIENTS FOR CATTELL'S PRIMARY PERSONALITY FACTORS  
AND MATHEMATICAL ATTAINMENT

Standard	2		3		4		5		6	
Ave. Age	9		10		11		12		13	
Numbers	99	92	99	93	99	85	99	96	99	98
Factor	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
A	-,039	,133	,074	,090	,169	,106	+,646	+,350	+,583	,124
B	+++ ,385	+++ ,371	+++ ,332	+++ ,433	+++ ,410	+++ ,452	+++ ,359	-,016	+++ ,470	,031
C	-,118	+ ,220	+ ,221	,150	+ ,246	+ ,247	+++ ,591	-,192	+++ ,391	,017
D	,192	,023	,046	,028	,086	+ ,245	++ ,275	,049	,097	,059
E	-,046	-,025	-,175	,180	-,023	++ ,340	+++ ,762	-,116	+++ ,539	-,108
F	,088	,154	-,117	,111	-,065	+++ ,308	+++ ,767	++ ,270	+++ ,661	,033
G	,064	-,024	-,018	,016	-,073	-,039	+++ ,594	+++ ,365	+++ ,490	,023
H	,120	,087	-,087	,129	,024	+ ,239	+++ ,646	+++ ,350	+++ ,583	,124
I	,001	-,083	,009	-,086	,049	++ ,295	+++ ,359	-,016	+++ ,470	,031
J	,074	-,188	-,072	-,187	-,024	-,150	+++ ,591	-,192	+++ ,391	,017
N	,089	-,004	-,076	,133	-,104	,192	++ ,275	,049	,097	,059
O	,006	-,074	-,152	-,155	+,357	-,078	+++ ,762	-,116	+++ ,539	-,108
Q <sub>3</sub>	-,045	,082	,169	,191	,055	-,011	+++ ,767	++ ,270	+++ ,661	,033
Q <sub>4</sub>	,168	-,033	,107	-,143	,112	-,050	+++ ,594	+++ ,365	+++ ,490	,023
Extra- version	+++ ,413	+++ ,375	+++ ,513	+++ ,444	+++ ,400	+ ,217	+++ ,570	+++ ,414	+++ ,569	-,053
Neuro- ticism	+++ ,431	+++ ,662	+++ ,513	+++ ,713	+++ ,597	+++ ,796	+++ ,577	+++ ,762	+++ ,397	+,411

+ Significant at the ,05 level  
 ++ Significant at the ,01 level  
 +++ Significant at the ,001 level

TABLE 15

PERSONALITY FACTORS AND MATHEMATICAL ATTAINMENT.  
SIGNIFICANCE OF DIFFERENCES BETWEEN MEANS.

Factor	Average Age in Years				
	9	10	11	12	13
A	-	-	-	,01 b-	,001 b-
B	-	-	-	,01 b+	,001 b+
C	,05 g+ b-	-	-	,001 b-	,01 b-
D	-	-	-	-	-
E	-	,05 g+ b-	,05 g-	,001 b-	,001 b-
F	-	-	,01 g+	,001 b-	,001 b-
G	-	-	-	,05 b-	,001 b-
H	-	-	-	,01 b-	,001 b-
I	-	-	,05 g-	,01 b+	,001 b+
J	-	-	-	,001 b-	,01 b-
N	-	-	,05 g+	-	-
O	-	-	,05 b-	,001 b-	,001 b-
Q <sub>3</sub>	-	-	-	,001 b-	,001 b-
Q <sub>4</sub>	-	-	-	,05 b-	,001 b-
E	-	-	-	-	,001 b-
N	,05 g-	,05 g-	,01 g-	,05 g-	-

Note: The information next to each level of significance indicates the direction and sex of the group with the larger correlation coefficient.

TABLE 16

## CORRELATIONS BETWEEN MATHEMATICAL ABILITY AND ATTITUDES

	Std.	Boys		Girls	
		n	Correlation Coefficient	n	Correlation Coefficient
Correlations between National Bureau Arithmetic tests and Attitude towards Arithmetic	2	72	,029	59	,037
	3	68	,309++	69	,234
	4	121	,258++	69	,351++
	5	152	,179+	108	,304++
Correlations between National Bureau Arithmetic tests and Attitude towards Mathematics	6	241	,002	118	,044
	7	262	,415+++	129	,519+++
	8	201	,483	114	,658+++
Correlations between National Bureau Mathematics tests and Attitude towards Mathematics	7	262		129	
	Algebra		,502+++		,626+++
	Geom. & Graphs		,405+++		,608+++
	8	201		114	
	Algebra		,471+++		,738+++
	Geom. & Graphs		,442+++		,732+++

+ ,05 level of significance

++ ,01 level of significance

+++ ,001 level of significance

FIGURE 1  
 MEANS OF PERSONALITY FACTORS AGAINST SCHOOL STANDARD

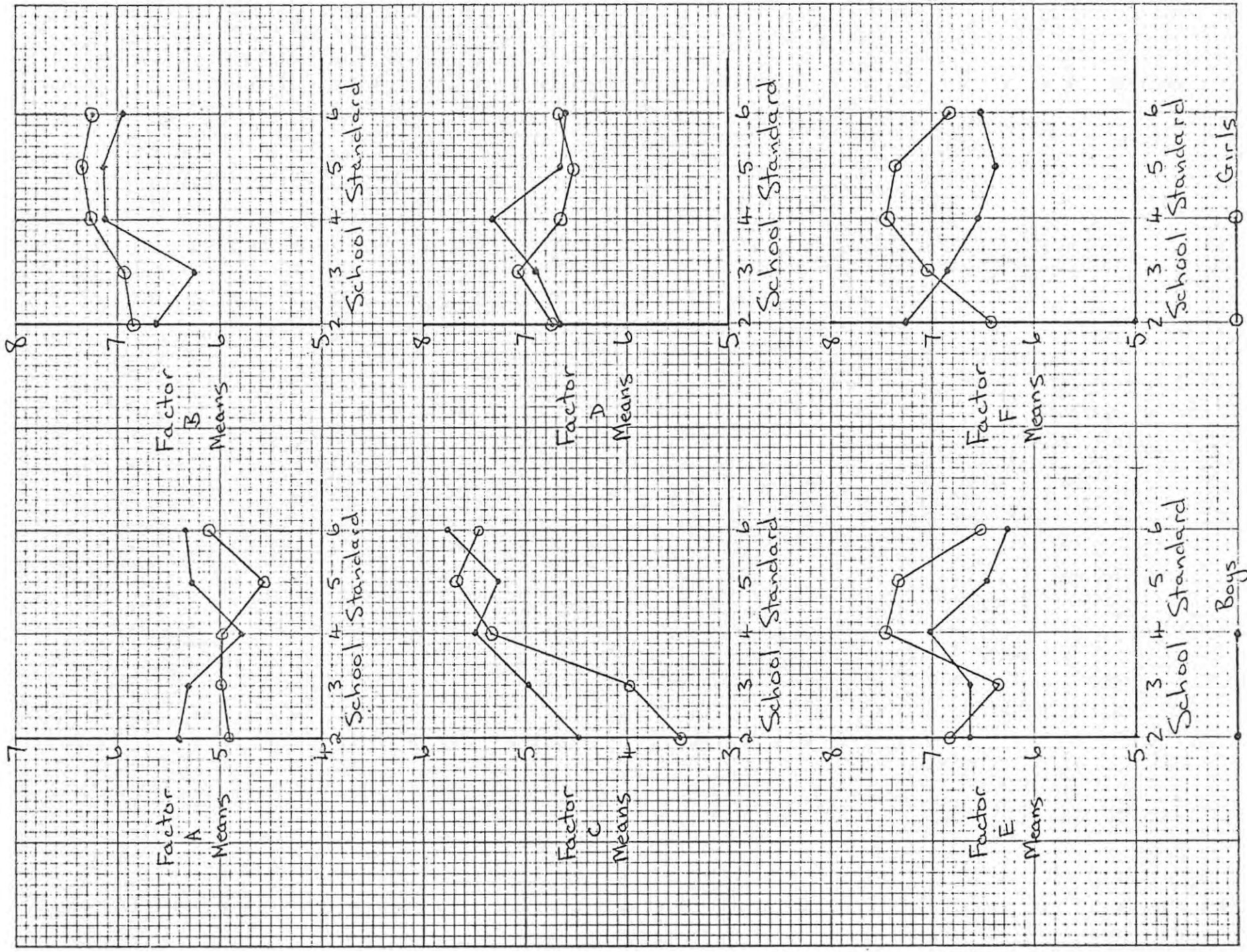


FIGURE 2

MEANS OF PERSONALITY FACTORS AGAINST SCHOOL STANDARD

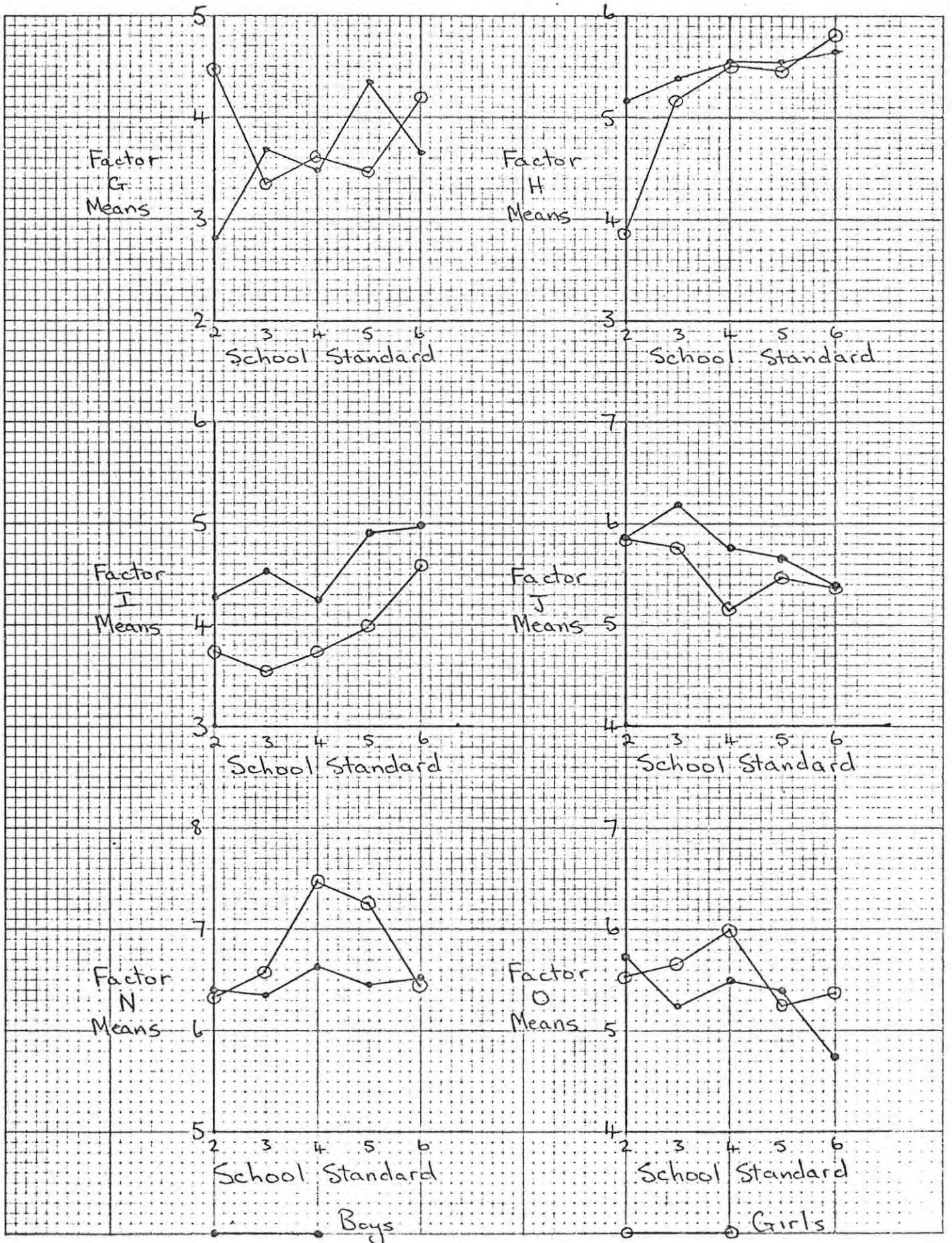


FIGURE 3  
 MEANS OF PERSONALITY FACTORS AGAINST SCHOOL STANDARD

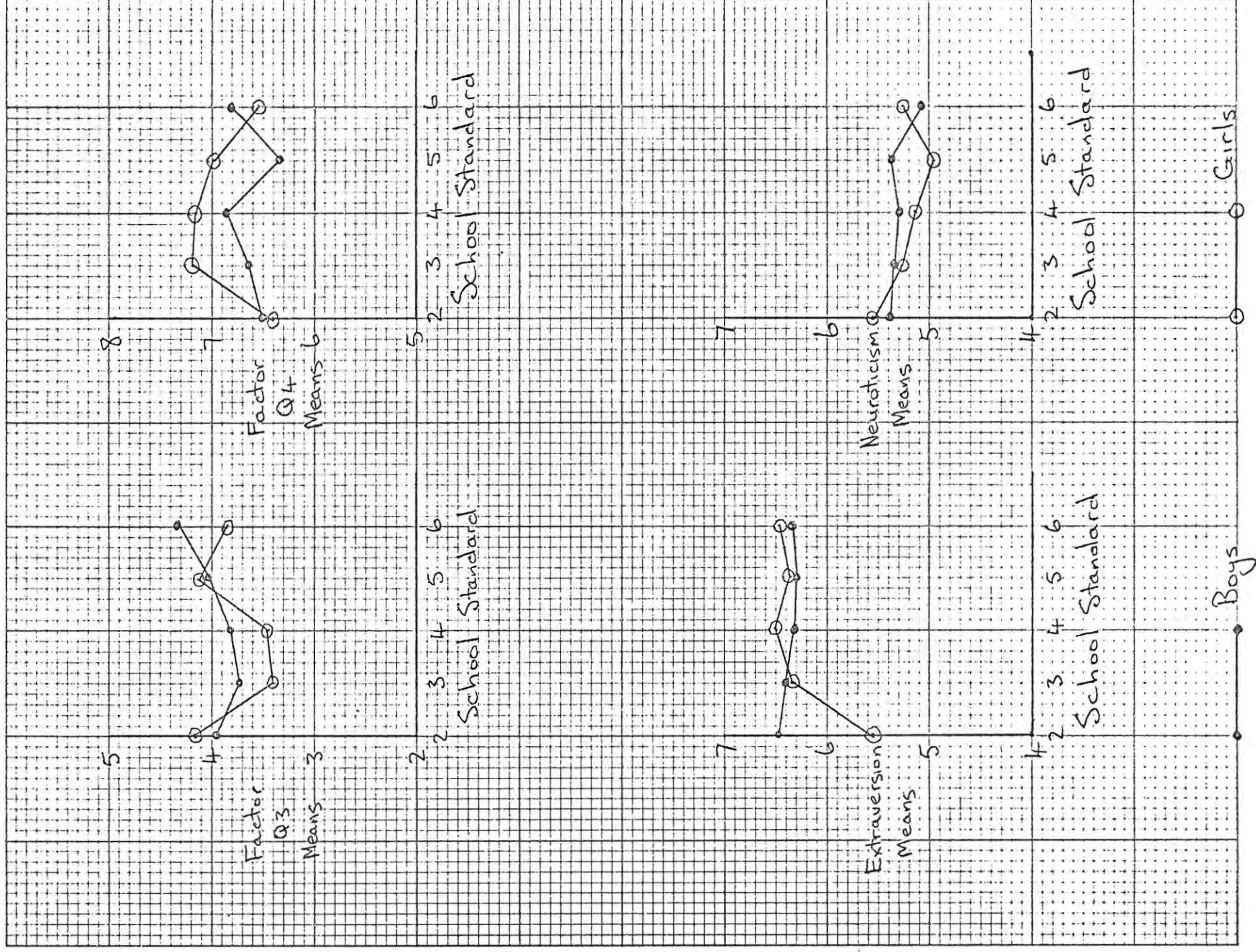


FIGURE 4

CORRELATION COEFFICIENTS BETWEEN PERSONALITY FACTORS AND MATHEMATICAL ATTAINMENT VERSUS SCHOOL STANDARD

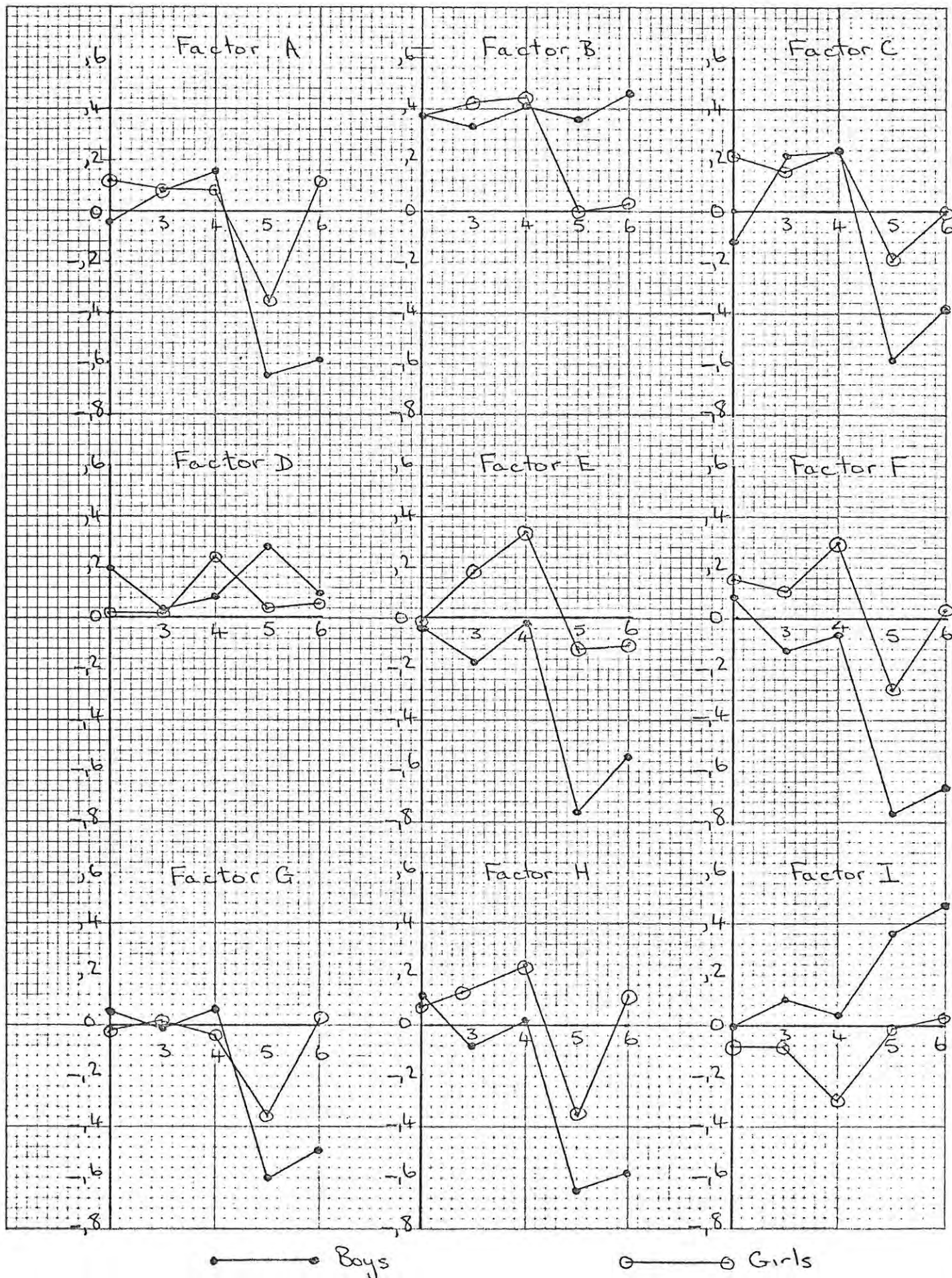


FIGURE 5

CORRELATION COEFFICIENTS BETWEEN PERSONALITY FACTORS AND  
MATHEMATICAL ATTAINMENT VERSUS SCHOOL STANDARD

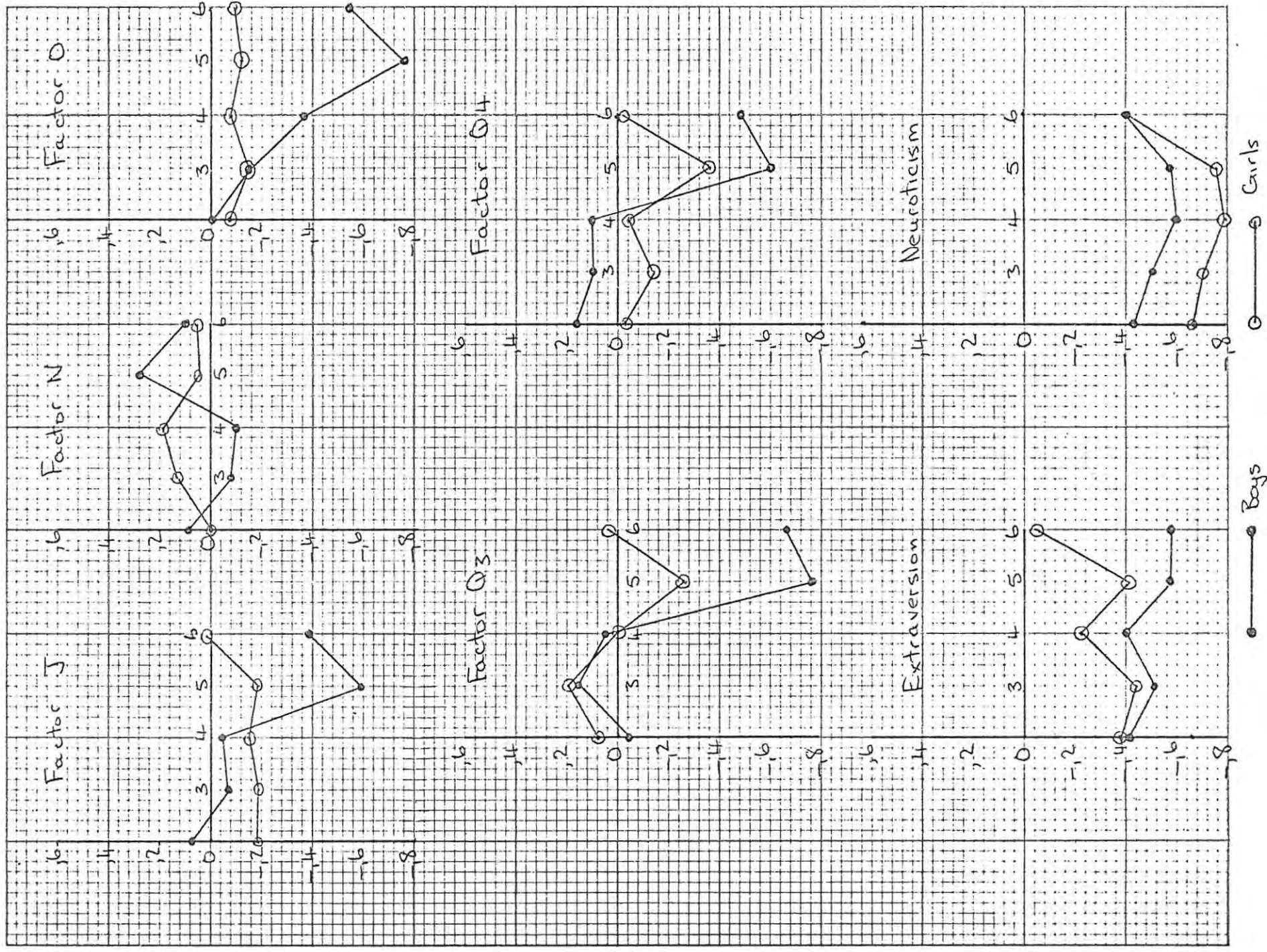


FIGURE 6

CORRELATION COEFFICIENTS BETWEEN PERSONALITY FACTORS AND MATHEMATICAL ATTAINMENT VERSUS SCHOOL STANDARD

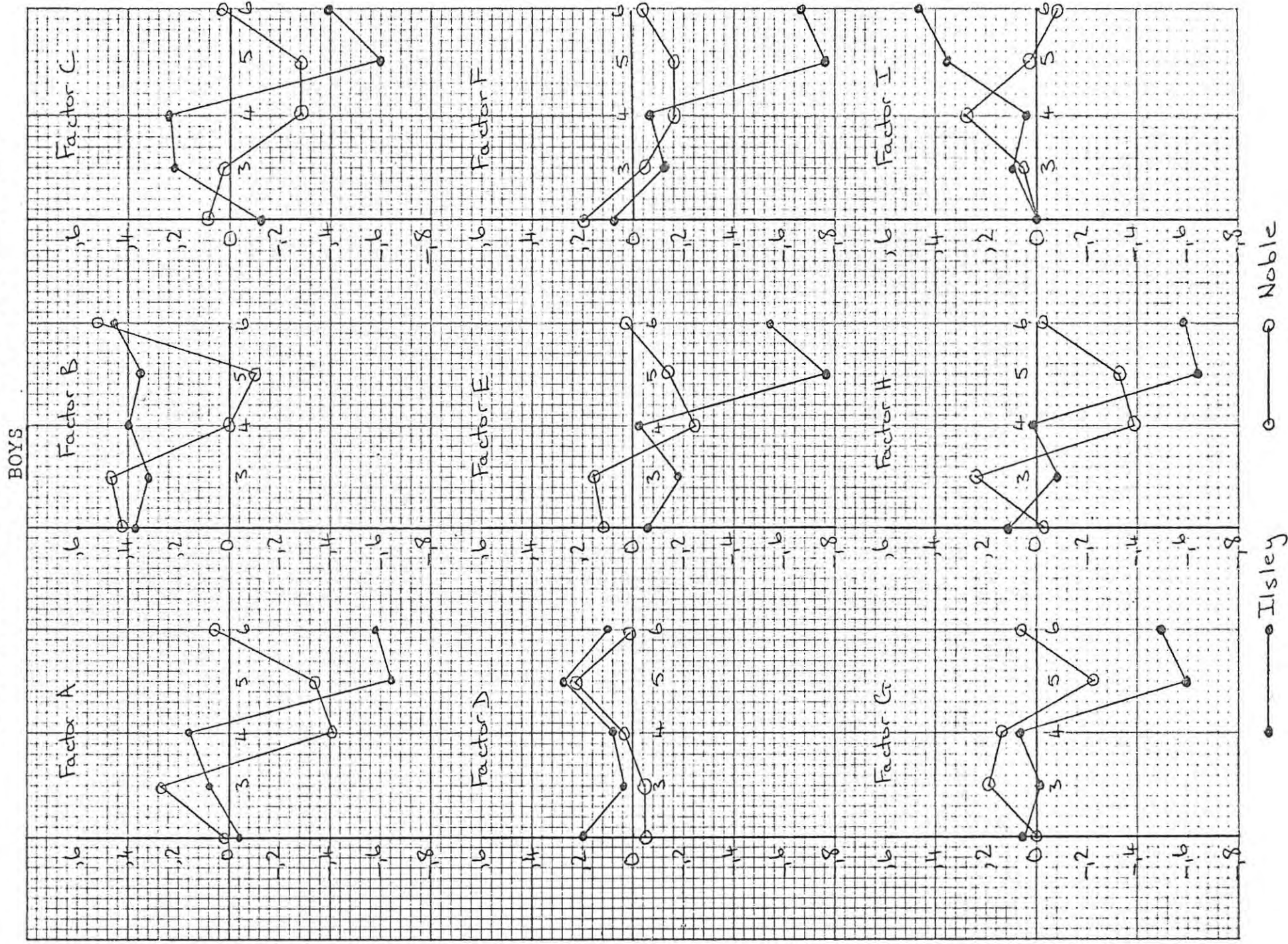


FIGURE 7

CORRELATION COEFFICIENTS BETWEEN PERSONALITY FACTORS AND MATHEMATICAL ATTAINMENT VERSUS SCHOOL STANDARD

BOYS

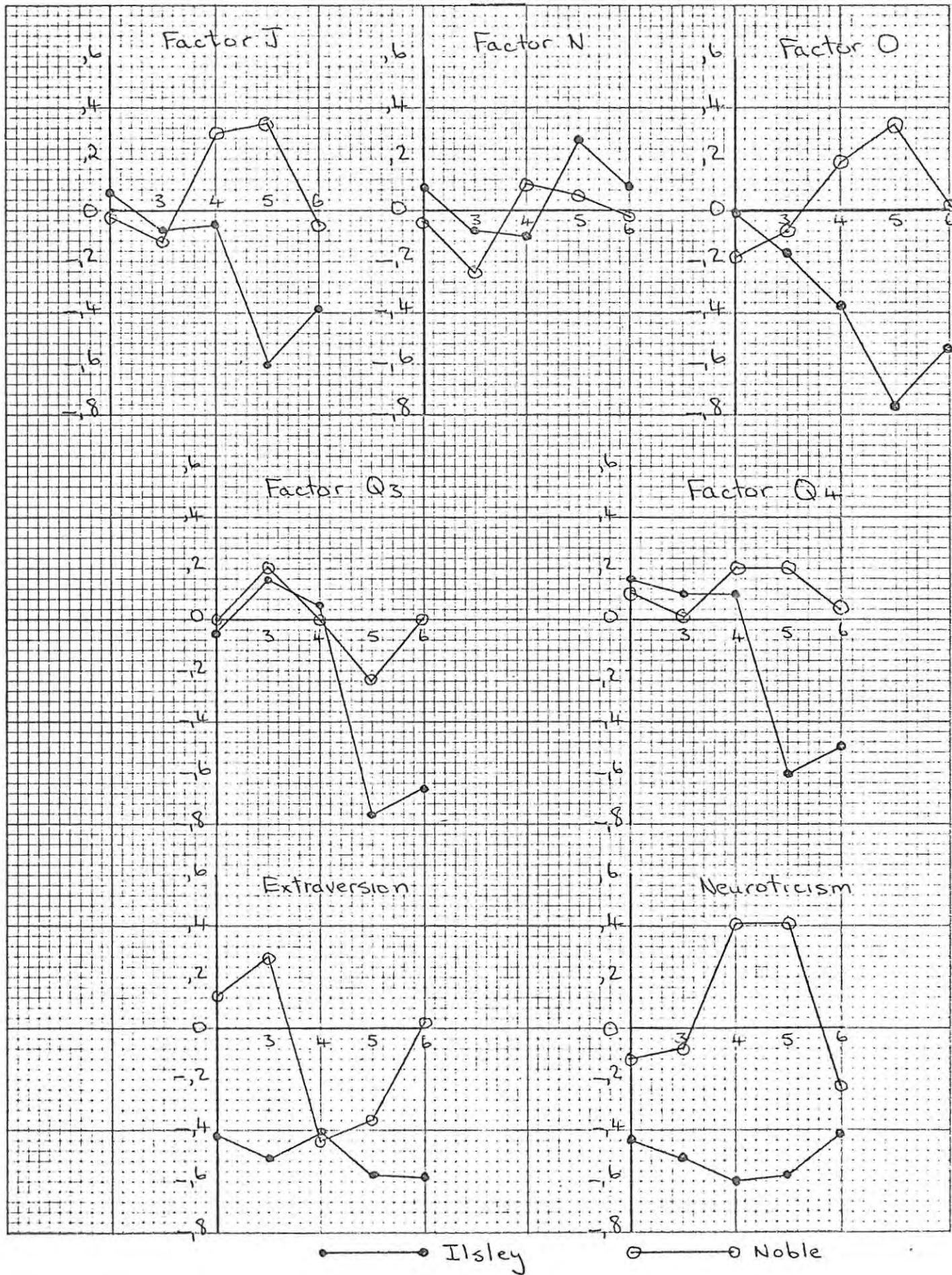


FIGURE 8

CORRELATION COEFFICIENTS BETWEEN PERSONALITY FACTORS AND MATHEMATICAL ATTAINMENT VERSUS SCHOOL STANDARD

GIRLS

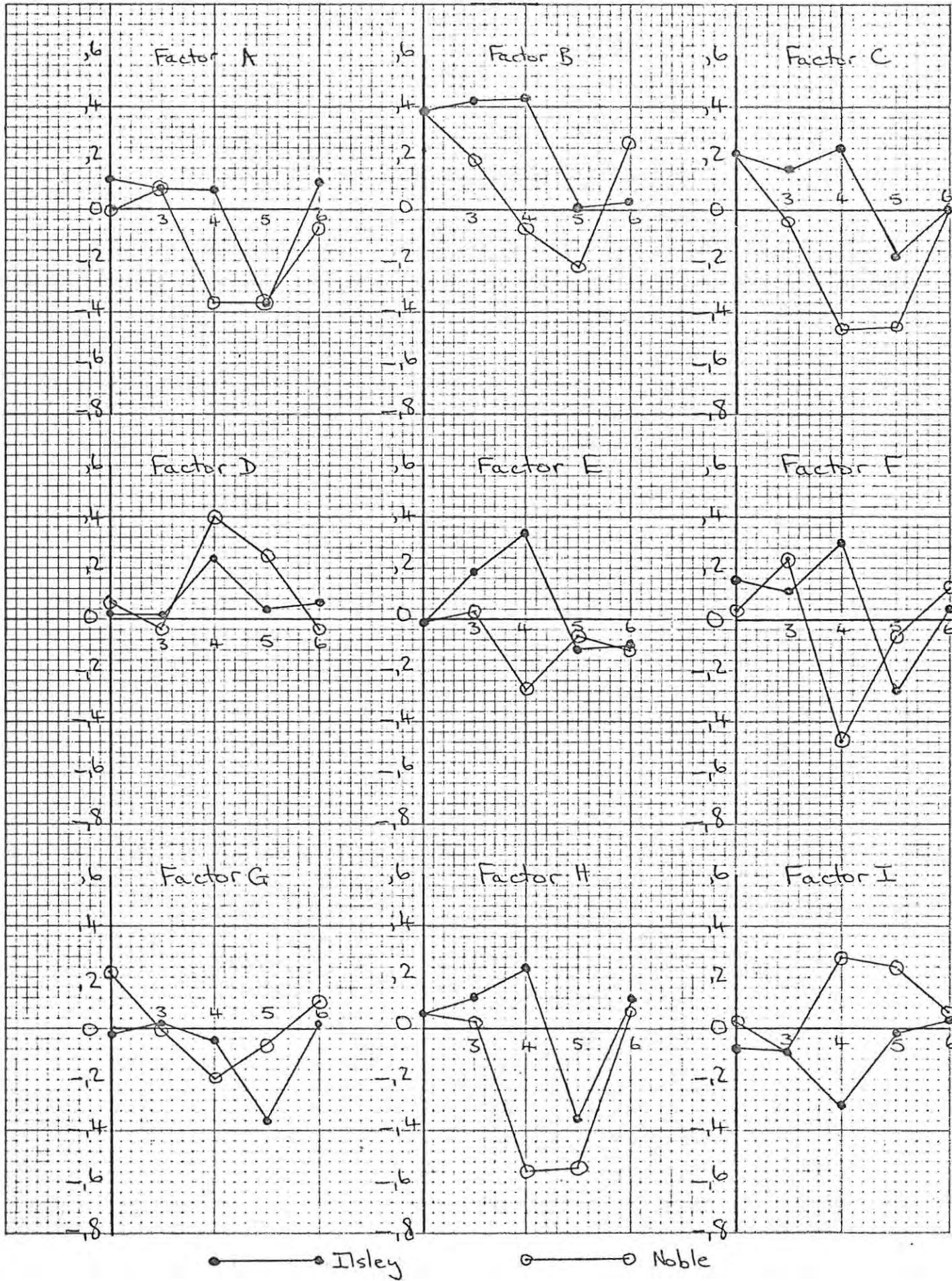
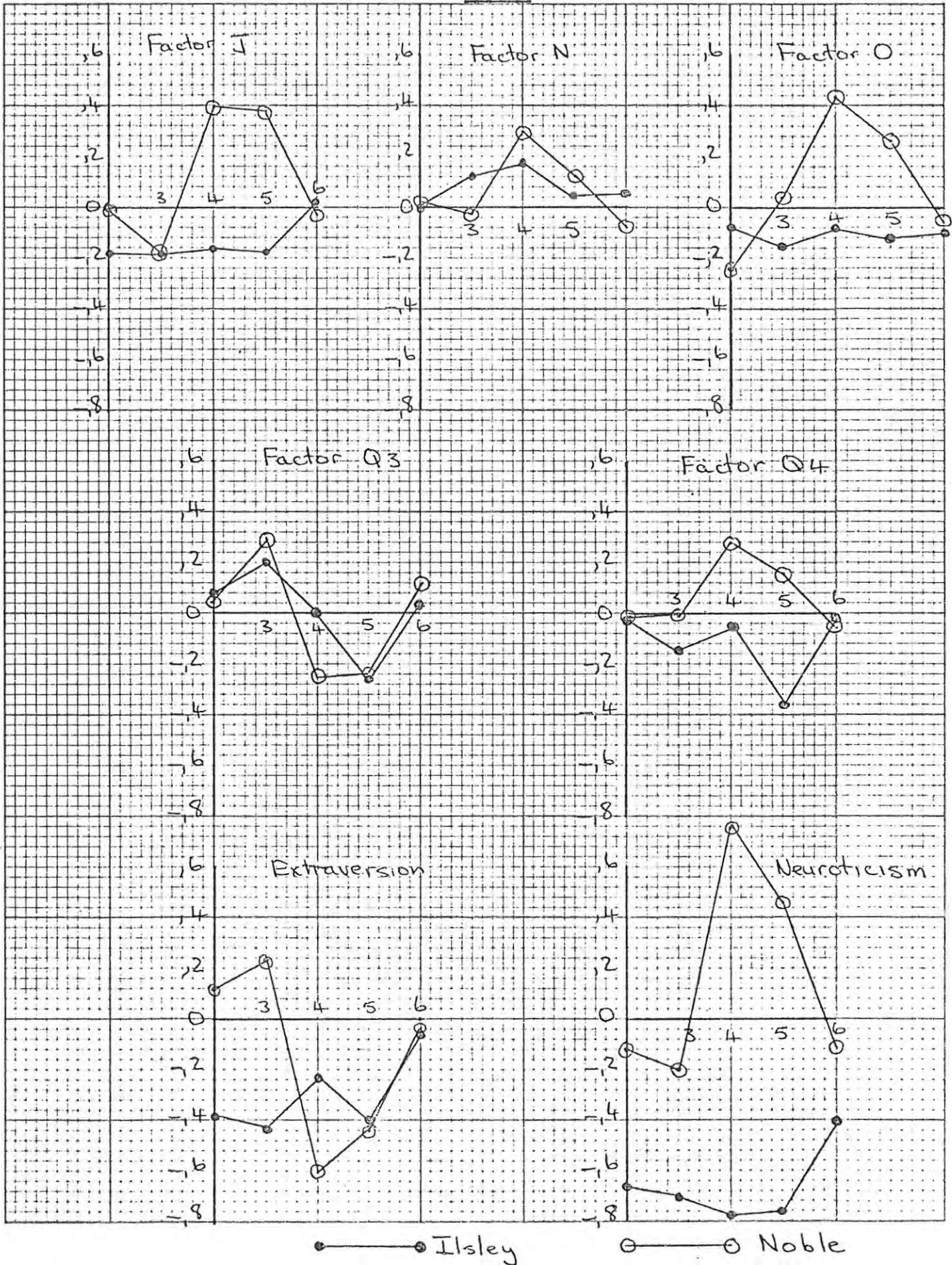


FIGURE 9

CORRELATION COEFFICIENTS BETWEEN PERSONALITY FACTORS AND MATHEMATICAL ATTAINMENT VERSUS SCHOOL STANDARD

GIRLS



## BIBLIOGRAPHY

1. References to which specific reference has been made in the text.

- Allport, G.W. Pattern and Growth in Personality. New York: Holt, Rinehart and Winston, 1961.
- Biggs, J.B. Anxiety Motivation and Primary School Mathematics. National Foundation for Educational Research in England and Wales, 1962.
- Biggs, J.B. Mathematics and the Conditions of Learning. National Foundation for Educational Research in England and Wales, 1967.
- Blommers, P. and Lindquist, E.F. Elementary Statistical Methods in Psychology and Education. London: University Press, 1965.
- Bloom, B.S. Human Characteristics and School Learning. New York: McGraw-Hill, 1976.
- Burt, C. "Factorial Studies of Personality and Their Bearings on the Work of the Teacher." British Journal of Educational Psychology, 35(1965), 368 - 378.
- Butcher, H.J. "Sampling in Educational Research." Statistical Guides in Educational Research III. Manchester: University Press, 1966.
- Callard, P. and Goodfellow, C.L. "Neuroticism and Extraversion in Schoolboys as measured by the Junior Maudsley Personality Inventory." British Journal of Educational Psychology, 32(1962), 241 - 250.
- Cattell, R.B. and Butcher, H.J. The Prediction of Achievement and Creativity. U.S.A.: Bobbs-Merrill, 1968.
- Cattell, R.B. and Cattell, M.D.L. Handbook for the Jr - Sr School Personality Questionnaire. Champaign, Illinois: Institute for Personality and Ability Testing, 1969.
- Cattell, R.B. and Warburton, F.W. Objective Personality and Motivation Tests. Chicago: University of Illinois Press, 1967.

- Child, Dennis. "The Relationships between Introversion-Extraversion, Neuroticism and Performance in School Examinations." British Journal of Educational Psychology, 34(1964), 187 - 196.
- Child, D. Psychology and the Teacher. New York: Holt, Rinehart and Winston, 1973.
- Costello, C.G. and Brachman, H.M. "Cultural and Sex Differences in Extraversion and Neuroticism Reflected in Responses to a Children's Personality Inventory." British Journal of Educational Psychology, 33(1963), 254 - 257.
- Cowell, M.D. and Entwistle, N.J. "The Relationships between Personality, Study Attitudes and Academic Performance in a Technical College." British Journal of Educational Psychology, 41(1971), 85 - 90.
- du Toit, L. and Madge, E.M. Manual for the Children's Personality Questionnaire. (South African Adaptation.) Pretoria: Human Sciences Research Council, 1972.
- Elliott, C.D. "Personality Factors and Scholastic Attainment". British Journal of Educational Psychology, 42(1972), 23 - 32.
- Entwistle, N.J. "Personality and Academic Attainment." British Journal of Educational Psychology, 42(1972), 137 - 151.
- Entwistle, N.J. and Cunningham, S. "Neuroticism and School Attainment - A Linear Relationship?" British Journal of Educational Psychology, 38(1968), 123 - 132.
- Entwistle, N.J. and Welsh, J. "Correlates of School Attainment at Different Ability Levels." British Journal of Educational Psychology, 39(1969), 57 - 63.
- Eysenck, H.J., ed. Readings in Extraversion-Introversion, Vol. 3: Bearings on Basic Psychological Processes. London: Staples Press, 1972.
- Eysenck, H.J. and Eysenck, S.B.G., ed. Personality Structure and Measurement. California: Knapp, 1969.
- Eysenck, S.B.G. "A New Scale for Personality Measurements in Children." British Journal of Educational Psychology, 35(1965), 362 - 367.

- Finlayson, D.S. "A Follow-Up Study of School Achievement in Relation to Personality." British Journal of Educational Psychology, 40(1970), 344 - 348.
- Furneau, W.D. "The Psychologist and the University." Universities Quarterly, 17(1962), 33 - 47.
- Harsh, C.M. and Schrickel, H.G. Personality Development and Assessment. New York: Ronald Press, 1950.
- Herbert, Martin. Emotional Problems of Development in Children. New York: Academic Press, 1974.
- Hildebrand, H.P. "A Factorial Study of Introversive-Extraversion." British Journal of Psychology, 49(1958), 1 - 11.
- Holtzhausen, J.A. and Kruger, S.J.P. Manual for the Scholastic Achievement Tests in Arithmetic for Sub Standard A to Standard 4. Pretoria: Human Sciences Research Council, 1974.
- Honess, T. and Kline, P. "Extraversion, Neuroticism and Academic Attainment in Uganda." British Journal of Educational Psychology, 44(1974), 74 - 75.
- Hurlock, E.B. Developmental Psychology. 4th ed. New York: McGraw-Hill, 1975.
- Institute for Personality and Ability Testing. Tabular Supplement with Norms for the Children's Personality Questionnaire. Champaign, Illinois, U.S.A.: I.P.A.T., 1968.
- Jung, C.J. Psychological Types. Translated by H. Godwin Baynes. New York: Pantheon Books, 1923.
- Kline, P. "Extraversion, Neuroticism and Academic Performance among Ghanaian University Students." British Journal of Educational Psychology, 36(1966), 92 - 94.
- Kline, P. and Gale, A. "Extraversion, Neuroticism and Performance in a Psychology Examination." British Journal of Educational Psychology, 41(1971), 90 - 94.
- Land, F. "The Teaching of Mathematics." Research in Britain 2, ed. H.J. Butcher and H.B. Pont. London: University of London Press, 1970.
- Lawton, D. Social Change, Educational Theory and Curriculum Planning. London: University of London Press, 1973.

- Lewis, D.G. and Ko, P. "Personality and Performance in Elementary Mathematics with special reference to Item Type." British Journal of Educational Psychology, 43(1973), 24 - 34.
- Ley, P.; Spelman, M.S.; Davies, A.D.M. and Riley, S. "The Relationship between Intelligence, Anxiety, Neuroticism and Extraversion." British Journal of Educational Psychology, 36(1966), 185 - 191.
- Lugo, J.O. and Hershey, G.L. Human Development. New York: MacMillan, 1974.
- Lynn, R. "Two Personality Characteristics Related to Academic Achievement," British Journal of Educational Psychology, 29(1959), 213 - 216.
- Lynn, R. and Gordon, I. "The Relation of Neuroticism and Extraversion to Intelligence and Educational Attainment." British Journal of Educational Psychology, 31(1961), 194 - 203.
- McNemar, Q. Psychological Statistics. 3rd ed. New York: Wiley, 1962.
- Nisbet, J.D. and Entwistle, N.J. Educational Research Methods. London: University of London Press, 1970.
- Noble, A. "Towards Individualised Teaching in School Mathematics." Bulletin, Department of Education, Rhodes University, 3 No. 1 (1974), 32 - 58.
- Noble, A. "The Attitudes and Abilities of Boys and Girls in School Mathematics." Humanitas, 2 No.3 (1974a), 267 - 274.
- Orpen, C. "Personality and Academic Attainment : A Cross-Cultural Study." British Journal of Educational Psychology, 46(1976), 220 - 222.
- Porter, R.B. and Cattell, R.B. Handbook for the Children's Personality Questionnaire. Illinois: Institute for Personality and Ability Testing, 1968.
- Ridding, L.W. "An Investigation of Personality Measures with Over and Under Achievement in English and Arithmetic." British Journal of Educational Psychology, 37(1967), 397 - 398.
- Rushton, J. "The Relationship between Personality Characteristics and Scholastic Success in Eleven-Year-Old Children." British Journal of Educational Psychology, 36(1966), 178 - 184.

- Savage, R.D. "Personality Factors and Academic Performance." British Journal of Educational Psychology. 32(1962), 251 - 253.
- Saville, P. and Blinkhorn, S. Undergraduate Personality by Factored Scales. Slough, Berkshire: NFER, 1976.
- Scheffé, H. The Analysis of Variance. New York: John Wiley, 1959.
- Smith, G. Milton. A Simplified Guide to Statistics. 4th ed. New York: Holt, Rinehart and Winston, 1970.
- Sprinthall, R.C. and Sprinthall, N.A. Educational Psychology - A Developmental Approach. 2nd ed. Massachusetts: Addison-Wesley, 1977.
- Theil, H. Principles of Econometrics. New York: John Wiley, 1971.
- Vernon, P.E. The assessment of Psychological Qualities by Verbal Methods. London: H.M.S.O., 1938
- Vernon, P.E. Personality Assessment : A Critical Survey. London: Methuen, 1966.
- Warburton, F.W. "The Measurement of Personality III." Educational Research, 4(1962), 193 - 206.
- Warburton, F.W. "The Relationship between Personality Factors and Scholastic Attainment." Unpublished report, Department of Education, University of Manchester, 1968.
- Warburton, F.W. "The Assessment of Personality Traits." Contexts of Education, Vol. 3: Development in Learning. Edited by J.F. Morris and E.A. Lunzer. London: Staples Press, 1969.
- Yelon, S.L. and Weinstein, G.W. A teacher's World-Psychology in the Classroom. New York: McGraw-Hill, 1977.

## 2. Other references.

- Anthony, W.S. "The Development of Extraversion, of Ability and of the Relation Between Them." British Journal of Educational Psychology, 43(1973), 223 - 227.
- Biggs, J.B. "The Relation of Neuroticism and Extraversion to Intelligence and Educational Attainment." British Journal of Educational Psychology, 32(1962), 188 - 195.

- Bruner, J.S. Toward a Theory of Instruction.  
Massachusetts: Harvard University Press, 1966.
- Butcher, H.J. "Human Intelligence. Its Nature and Assessment." Methuen's Manuals of Modern Psychology, (1968), 284 - 288.
- Butcher, H.J. "The Structure of Abilities, Interests and Personality in 1000 Scottish School Children." British Journal of Educational Psychology, 39(1969), 154 - 165.
- Butcher, H.J.; Ainsworth, M. and Nesbitt, J.E. "Personality Factors and School Achievement." British Journal of Educational Psychology, 33(1963), 276 - 285.
- Cattell, R.B. "Teachers' Personality Description of Six-Year-Olds: A Check on Structure." British Journal of Educational Psychology, 32(1962), 219 - 235.
- Craig, J.K. "The Intelligent Use of Intelligence Tests." Education Bulletin, Vol 21 No. 2 of Transvaal Education Department, 1977.
- Entwhistle, N.J. "Academic Motivation and School Attainment." British Journal of Educational Psychology, 38(1968), 181 - 187.
- Entwhistle, N.J. and Brennan, T. "The Academic Performance of Students." British Journal of Educational Psychology, 41(1971), 268 - 276.
- Entwhistle, N.J. and Entwhistle, D. "The Relationships between Personality, Study Methods and Academic Performance." British Journal of Educational Psychology, 40(1970), 132 - 141.
- Eysenck, H.J. The Biological Basis of Personality.  
Springfield: C.C. Thomas, 1967.
- Eysenck, H.J., ed. Readings in Extraversion - Introversion, Vol.1: Theoretical and Methodological Issues.  
London: Staples Press, 1970.
- Eysenck, H.J., ed. Readings in Extraversion - Introversion, Vol.2: Fields of Application. London: Staples Press, 1971.
- Eysenck, H.J. and Cookson, D. "Personality in Primary School Children." British Journal of Educational Psychology, 39(1969), 109 - 122.
- Eysenck, H.J. and Cookson, D. "Personality in Primary School Children." British Journal of Educational Psychology, 40(1970), 117 - 129.

- Frost, B.P. "Anxiety and Educational Achievement." British Journal of Educational Psychology, 38(1968), 293 - 308.
- Gilliland, A.R. "What do Introversion - Extraversion Tests Measure?" Journal of Abnormal and Social Psychology, 28(1934), 407 - 412.
- Jackson, D.N. and Messick, S. Problems in Human Assessment. New York: McGraw-Hill, 1967.
- King, W.H. Statistics in Education, London: Macmillan, 1969.
- Levitt, Eugene E. The Psychology of Anxiety. London: Paladin, 1971.
- Rowell, J.A. and Renner, V.J. "Personality, Mode of Assessment and Student Achievement." British Journal of Educational Psychology, 45(1975), 232 - 236.
- Sarason, I.G. Personality; An Objective Approach. New York: John Wiley, 1966.
- Sarason, S.B.; Davidson, E.S.; Lightall, F.F.; Waite, R.R. and Ruebush, B.K. Anxiety in Elementary School Children. New York: Wiley, 1960.
- Savage, R.D. "Personality Factors and Academic Attainment in Junior School Children." British Journal of Educational Psychology, 36(1966), 91 - 92.
- Spielberger, C.D. and Sarason, I.G. ed. Stress and Anxiety. New York: Wiley, 1975.