CHAPTER I
INTRODUCTION

WHAT IS THIS STUDY ABOUT?

This study belongs to the field within psychometry known as 'Psychological Testing'. The foundation of psychological testing lies in the existence of individual differences. It is these differences and consequent differential reactions to stimuli, which form the basis of psychology, the science of behaviour.

Psychological testing is that branch of psychology which attempts at evolving tools, techniques and procedures for the assessment and measurement of individual differences in psychological attributes.

Many of the findings from psychological research are based on information yielded by these tools, techniques and procedures. If one looked at the articles published in journals like, Psychological Review, Psychological Bulletin, Annual Review of Psychology, and other reviews and critiques, one finds that most contradictory findings or lack of replicability and generalizability is attributed to the differences in definitions of the concepts used which are attempted to be "measured". This is true for personality, intelligence, aptitudes and other attributes measured or
assessed extensively in research. Thus, psychological testing suffers from the basic weakness in conceptualization of psychological attributes.

Another difficulty comes when attempts are made at operationalizing the concepts for evolving their measures. Unlike the subject matter of natural sciences, the subject matter of psychology can be studied only indirectly. The psychological attributes can only be inferred through reactions of individuals manifested in particular situations. Finding common and stable behaviour patterns in response to particular stimuli and then to attempt to simulate the natural stimuli in a manner to evoke as natural a response as possible, and from these to infer attributes in quantitative and qualitative manner is the challenge faced by those attempting to capture psychological phenomena.

A third element of difficulty is introduced in testing when the individuals are compared on their test scores or when one interprets the scores. In the absence of additional comparative data, a score on psychological tests is meaningless and difficult to interpret.

Measurement of individual differences and the implication of measurement for educational and vocational guidance, counselling, and for use in personnel selection and placement as well as for basic research are obvious.
From the above three difficulties encountered in the field of psychological testing it can be postulated that performance on ability and aptitude test may be expected to be affected by numerous factors. It would, therefore, be worthwhile to identify those factors which influence test performance.

Past researches in the field have linked performance on tests of various attributes to the process of growth and aging and numerous other environmental and demographic factors. A literature search on studies relating independent variables to performance on psychological tests, distribution of tests scores across population and the effect of factors like practice, exposure, response bias, etc., reveals two basic conclusions: (a) in order to identify "true" scores an understanding of the factors influencing the scores is necessary, and (b) although certain factors might be influencing performance on tests of various attributes and although such effect might be considered generalized, there is need to identify the effect of these factors on each and every test or measure which is used for applied purposes. The literature also reveals that such critical evaluations have been more common with respect to cognitive and personality tests and not much work has been done on performance and manipulative tests of abilities and aptitudes. For example, one such battery of ability/aptitude tests
called the "General Aptitude Test Battery (GATB)" which consists of cognitive as well as manipulative or performance tests, developed by the United States Employment Services (USES) in 1947, and which is being widely used in India and abroad both in research as well as in selection and placement has not yet been critically evaluated in the above perspective. Many Universities in India have the GATB as a part of their Curriculum in Psychological Testing and a few doctoral studies have been devoted to the GATB (Dolke, 1978; Singh, 1965). Also, many textile mills in India for instance, Ambica, Bombay Dyeing, Calico, DCM group mills, and Lalbhai Group mills, are making use of the GATB in the selection of their personnel.

Similarly, there are manipulative tests like the "Pursuit Rotor" and "Reaction Time" which have been used widely in laboratory experiments as well as in selection and placement. Again, the effect of various factors influencing the performance on these sensory and motor tests needs to be studied for their valid use in applied situations.

Since these tests are of performance type it is assumed that the scores on them would be less affected by response bias, response tendency, or by social desirability factors which influence more the performance on cognitive and personality tests. Hence, these variables have not been included in the present study.
JUSTIFICATION OF THE STUDY

This researcher has been on the scientific staff of the Human Resources Division of Ahmedabad Textile Industry's Research Association (ATIRA) since 1973. In this period the nature of continuing professional assignments provided:

(a) a close familiarity with the functioning of the textile industry,
(b) a first hand acquaintance with several aptitude, psychomotor and sensorimotor tests, and
(c) an involvement in standardizing and developing selection norms for assessing the suitability of the applicants to various operative positions in the textile industry.

Accumulated experiences in the above endeavours led the researcher to certain questions in the field of standardization of aptitude tests and development of selection norms. The questions that arose were:

(i) What should be the sample characteristic in a study which aims at evolving selection norms based on job performance criterion where the norms are to be used for the selection of fresh applicants?
(ii) What is the effect of practice and exposure on test performance? and,

(iii) Do people coming from different backgrounds e.g., rural-urban, differ in their test performance?

Over the years, these questions came to be formulated into a research proposal for this doctoral dissertation. However, it is clear that rather than starting with all the loose ends the researcher would benefit from some minimal anchorage from which he can get a set of tentative bearings to proceed in his-quest.

As a first step in this direction it would be useful to understand the concepts of ability, aptitude and skill as used in psychological literature.

DEFINITIONS OF ABILITY, APTITUDE AND SKILL

Measurement of human attributes such as abilities and aptitudes remains today as the critically important first step in industrial programmes related to all forms of personnel selection and placement. Industrial psychologists have focussed on conducting research that explains the major methodology/strategy of the measurement of abilities and aptitudes because of the kind of pressure that have been applied namely, fulfilling practical demands for personnel selection, placement and training.
Dictionary meanings of abilities, aptitudes and skills are overlapping and at times confusing. They include phrases such as, natural tendency, acquired inclination, propensity, the quality of being apt, competence in any field of action, talents, mental gifts, endowments, so on and so forth.

Counsellors and personnel men think of abilities and aptitudes as predictor of success in avocations, while psychologists think of individual differences in terms of traits and individual attributes and therefore, use them in a narrow scientific sense. However, each of them have attempted to define the term ability and aptitude in their own endeavours.

The most popular definition of such human traits or attributes representing a broad umbrella type approach has been subscribed to and adopted by Walter Van Dyke Bingham. Though Hull published his book on Aptitude Testing in 1928, Bingham was the pioneering authority in measurement of such human attributes as aptitudes and he cites the definition given in Warren's Dictionary of Psychology (1934)-a condition or a set of characteristic regarded as symptomatic of an individual's ability to acquire with training some (usually specified) knowledge, skill, or set of responses such as the ability to speak a language, to produce music, etc., and bases his theory on it (Bingham, 1942).
The use of the term condition in the definition indicates that the "real" nature of aptitude is not very clear. "Set of characteristics" implies that aptitude is not necessarily an entity, but a constellation of entities. Gekoski (1964) has shown that set of characteristics may include, among many things, intelligence, interest, personality, special abilities and attitudes. From this approach one can observe the existence of such a thing as 'aptitude' and one expects that the so called "aptitude tests" should measure all of them.

Freeman's definition of aptitude is very close to the one in Warren's dictionary. He observes that "an aptitude test is one designed to measure a person's potential ability in an activity of a special kind and within a restricted range" (Freeman, 1962, p.431).

Guion (1965) believes that "aptitudes for any type of work can be considered in three major categories: (1) intellectual abilities, (2) physical traits, including psychomotor abilities, and (3) motivational traits, interests, or temperament needed for persistent and attentive effort" (p.213). He further states, "within each of these categories, one may seek highly specific measure of aptitude, or he may consider aptitude within any one of them to be highly generalized" (p.21). Thus Guion may call even a measure of
interest or attitude as a measure of aptitude. This stand is quite similar to that of Wesman (1968) who believes that achievement tests can also be called aptitude tests.

In his Dictionary of Psychology, Harriman (1952) defines aptitudes as "a capacity in any given skill or field of knowledge, on the basis of which a prediction may be made regarding the amount of improvement which further training might affect" (p.31-32). It can be observed that his definition is different from the one given above.

The psychologists and test researchers definition of aptitude is best represented in Super's definition of aptitude. Super (1957) combines in his definition the contentions of many definitions by psychologists when he defines aptitude as "psychological factors, each relatively stable, unitary, and independent, which contribute in varying degrees to success in varying occupations" (p.198). This is a global definition and the differences between this and the definition given in Warren (1934) and English and English (1958) dictionaries are apparent. At another place Super writes "scientific definition of aptitude would provide for specificity, unitary composition and the facilitation of learning of some activity" (Super and Crites, 1962, p.71).

Aptitudes, according to him are potential capacities, which enable one to learn. Thus a person with a high aptitude for science can master any of its branches easily.
This narration of definitions of aptitudes can be concluded by citing one more definition which reconciles the earlier stated definitions. Michael (1960) observes that "aptitude is a person's capacity, or hypothetical potential, for acquisition of certain specific and more or less well defined pattern of behaviours involved in the performance of a task with respect to which the individual has had little or no previous training" (p. 60).

Ability is frequently confused with aptitude. Ability refers to a more general trait in an individual which has been raised or inferred from certain response consistencies to certain tasks. Thus, according to some psychologists, ability includes aptitude and achievement (Thurstone and Hagen, 1970). Bingham (1942) uses the term in broadest sense as connoting power to perform designated responsive acts, without implying whether this power is potential or actual, native or acquired. According to Fleishman (1964), abilities are a product of learning and development at different rates mainly during the childhood and adolescence. Some abilities, e.g., colour perception depend more on genetic than learning factors, but most abilities depend on both inherent and acquired factors to some degree. Super and Crites (1962) use ability to include aptitude and proficiency.
In short, ability may be viewed as the current performance of an individual on any task near his maximal level of motivation - a task with respect to which he had a limited amount of more or less loosely structured experience. Ability refers to what a person can do today, at a given time to perform acts or skills. An ability test should reflect the existence of a greater amount of experience of formalized or specific training in that field than the aptitude test.

Skill is the ability to perform an act with ease and precision. Proficiency in flying an aeroplane, typing, weaving, etc., refer to specific skills. According to Fleishman (1964), the skill involved in complex activities can be described in terms of more basic abilities, viz., manual dexterity, finger dexterity, and motor coordination. Skill level is never stable or constant.

Glancing over the various definitions of ability, aptitude and skill, the present study can be viewed to relate with specific aptitudes (e.g., Finger and Manual Dexterity) which are involved in performing complex operations (e.g., Knotting and shuttle change involved in Weaver's job).

In this work Anastasi's (1968) contention that aptitude denotes performance that "reflects the cumulative influence of a multiplicity of experiences" has been accepted. Yet
it is recognised that the terms aptitude and ability are
not mutually exclusive. Thus, the usage of word "aptitude"
in this study would involve ability as well.

APTITUDE TESTING : AN HISTORICAL PERSPECTIVE

Early Efforts

Aptitude, abilities and skills notions have grown out of
mankind's centuries old search for answers about the funda­
mental nature of man. Philosophers' speculations have
yielded all sorts of opinions and conclusions. Charles
Darwin who showed that the "survival of the fittest" maxim
which applied to plants and lower animals could well apply
to human beings. He speculated that if differences in the
survival rate result in slow changes in the species of a
lower animal over many generations, individual differences in
human may slowly lead to changes in the average characteri­
stics of the entire human species. It was soon realized that
there was no end to ways people differed from one another
in physical as well as mental characteristics.

Kant argued against a science of psychology because he
believed that human feelings, sensations, images, and
thoughts could never be accessible to observation and
measurement. Even so, the early Greeks were strongly aware
of human differences in ability to learn. Socrates
developed and refined tests of how much his students learned,
and he used the tests to assess and to enrich their learning. The Greeks also graded boys on an elaborate series of physical tests to keep tab on them as they matured and acquired the skills of manhood. Plato clearly recognized the differing abilities of men and saw the need for accurate assignment of individuals to particular occupation (soldiers, statesman, teachers, etc.), for which they were best suited.

The modern emphasis on the importance of human differences is usually said (Anastasi, 1958; Tuddenham, 1962) to have begun with an incident occurring in 1796 at the Greenwich Observatory. Maskelyne, the astronomer royal, dismissed his assistant, Kinnebrook, because the latter recorded the time of Stellar transits nearly a second later than he (Maskelyne) did. Such "tardiness" in reporting the time at which a star crossed the hairline in the telescope eyepiece was presumed at the time to be merely a matter of careless inattention. In 1816, the curiosity of the astronomer, Bessel, was whetted by reference to the incident in a history of Greenwich Observatory, and he began to measure differences in terms of estimates recorded by various pairs of astronomers. Instead of attributing such discrepancies to carelessness, he suggested that they were stable and interesting qualities of individuals and they became known as "personal equations". Bessel collected and published data on several trained
observers and noted that systematic differences between the pairs of observers were also often accompanied by variation in the sizes of the differences from time to time. These observations and the records of them constitute the first instance of what might be called the true measurement of individual differences.

Sir Francis Galton in his book "Hereditary Genius" published in 1869 presented the elements of a system for classifying men according to their eminence (abilities). He stated that true eminence was extremely rare, characterising only one person out of every 4,000, that all human abilities were distributed according to the normal probability curve, and that persons could, therefore, be classified according to the known frequencies of the normal distribution. Galton's concern with eminence and the relative contribution made by persons to society led him and others to seek ways of measuring human differences in learning ability. As a consequence, the first "mental tests" (used in laboratory investigations, most notably in Wundt's Leipzig laboratory during the late 1800s) consisted of reaction times and measures of factual sensitivity, keenness of vision and hearing, strength of grip, tapping speed, and the like.

Toward Complex Processes

Later in the history of mental testing, that early investigators (Ebbinghaus, 1897; Sharp, 1898; Wissler, 1901) argued
and showed empirically that psychomotor and sensory tests of the day showed absolutely no relationship to difference among children or college students in their acquisition of knowledge or their ability to profit from exposure to learning environments.

Soon after the French Psychologist, Alfred Binet, in 1895, criticized the practices of sensory and motor testing. He emphasized the importance of studying and measuring the more complex faculties of memory, imagery, imaginations, attention and comprehension. Through his various studies he concluded that tasks (like identifying familiar objects, name of months in order, name of coins, arrange scrambled words into meaningful sentences, etc.,) obviously were far more complex and closer to the functioning demanded in the real world than the reaction time, sensory, and motor tests being espoused by most of the laboratory psychologists of the time.

In 1905, the first Binet Test was published. He called his series of tasks a "metrical scale of intelligence". Later, Lewis Terman of Stanford University translated, revised, and greatly extended the Binet Test. In 1916, his Stanford-Binet Test was published.
From Intelligence to Aptitudes

The existence of multiple aptitude was yet to be demonstrated during the time that testing, mostly through the impetus of the First World War, experienced its most rapid growth. Binet's conception of intelligence implied the importance of a number of underlying aptitudes which have been "discovered" and studied extensively by theoreticians using factor analytic methodology. According to Anastasi (1968), the publication in 1928 of Kelley's "Crossroads in the Mind of Man" paved the way for studies in quest of groupings of aptitudes or group factors. Kelley proposed five basic human aptitudes: manipulation of spatial relationships, facility with numbers, facility with verbal material, memory and speed. Over many years of test development and factor analyses of them, Turnstone, his student, and other investigators (Turnstone, 1938; French, 1951) have proposed about a dozen relatively independent groupings of aptitudes.

Motor and Physical Skills

So far, we have traced and discussed in brief the development of measure of human cognitive aptitudes - those aptitudes presumed to be important in developing an awareness and understanding of the elements of our environment. The physical manipulation of objects in the environment involves the specification and measurement of motor skills,
many of which would seem to be relevant to the world of work. For example, the job of secretary involves not only a wide range of cognitive abilities, such as verbal comprehension, perceptual speed, memory, and reasoning, but also, possibly, whatever motor skills may be necessary to handle a typewriter adequately. Scores of other jobs could be named (for example weaver, fitter, folder) that require relatively greater or lesser amount of motor proficiency.

Another groupings of skills, similar to motor proficiencies but distinct from them, involves gross physical performances best illustrated probably by differing degrees of competence, proficiency or physical fitness in various athletic endeavors. Fleishman has studied both motor skills (Fleishman, 1962, 1972) and physical fitness (Fleishman, 1964, 1972) more extensively than any other investigator.

A major conclusion from wealth of research on motor skills such as finger dexterity, steadiness, speed of response, and eye-hand coordination show low intercorrelations. Summarizing over a decade of factor-analytic results with motor skills tests, Fleishman (1962) concluded that there are eleven fairly independent groupings of motor skills. These are:

1. Control Precision: Involving tasks requiring finely controlled muscular adjustments, such as moving a lever to a precise setting.
2. Multi-limb Coordination: Involving the ability to coordinate the movements of a number of limbs simultaneously, such as packing a box with both hands.

3. Response Orientation: Involving the ability to make correct and accurate movements in relation to a stimulus under highly speeded conditions, such as reaching out and flicking a switch when a warning horn sounds.

4. Reaction Time: Involving the speed of a person's response when a stimulus appears, such as pressing a key in response to a bell.

5. Speed of Arm Movement: Involving the speed of gross arm movements where accuracy is not required, such as gathering trash or debris and throwing it into a large pile.

6. Rate Control: Involving the ability to make continuous motor adjustments relative to a moving target changing in speed and direction, such as holding a rod on a moving rotor.

7. Manual Dexterity: Involving skillful arm and hand movement in handling rather large objects under speeded conditions, such as placing blocks rapidly into a form board.
8. Finger Dexterity: Involving skillful manipulation of small objects (such as nuts and bolts) with fingers.

9. Arm-hand Steadiness: Involving the ability to make precise arm-hand positioning movements that do not require strength or speed, such as threading a needle.

10. Wrist-finger Speed: Involving rapid tapping movements with the wrist and fingers, such as transmitting a continuous signal with a telegraphic key.

11. Aiming: Involving an extremely narrow ability defined by a test in which the examinee places dots in circles as rapidly as possible.

Fleishman (1964) found that nine factors account for much of the common variance in performance over 100 different physical fitness measures, and he has also developed a manual describing the specific physical tests and their mode of administration for maximizing the accuracy of determining each of the nine factors.
FACTORS INFLUENCING PERFORMANCE ON
APTITUDE TESTS

Many studies have been conducted with some of the above mentioned and some other tests of abilities and aptitudes to find out the factors that influence the test scores. For the better understanding of the factors it would be appropriate to have a look at the findings available in the literature. This would help in stating the objectives of the study and in evolving a few working hypothesis.

The Age Factor

The psychological study of motor performance in relation to age stands at the meeting point of two lines of research that have been vigourously pursued during the last 30 years. One has yielded what is now a substantial body of physiological, behavioural and social knowledge about the nature and processes of the effect of age on various human abilities. The other approach known as "skill research" which has greatly enhanced the understanding of human behaviour both in laboratory and in certain applied fields such as industrial work and, more recently sports and athletics.
Experimental investigations of age differences in motor and skill performance were conducted in Germany during the latter part of the nineteenth century by Weber, Fechner, Helmholtz and Wundt, and in Holland by Donders.

Prior to Galton, Quetelet (1835) had proposed the concept of "average man" and presented data from various age groups on sensory functioning, height, weight, hand strength and productivity. The latter topic was greatly extended more than a century later by Lehman (1953). Quetelet was a statistician, astronomer and sociologist and is often regarded as the founder of the study of aging (Birren, 1961). In a manner advocated by his contemporary, Comte (1798-1857), and later expanded by Durkheim (1858-1917), Quetelet caused upon both biological and social determination of man.

Galton's main contribution to the psychology of age effects relies on data collected at the International Health Exhibition in London, 1884. Seventeen different anthropometric, sensory and psychomotor measures were obtained from 9,337 persons ranging in age from 5 to 80 years. Galton's data (Ruger and Stoessiger, 1927; Elderton, Moul and Page, 1928) are still considered to be the most reliable material, for example, on age differences in simple visual and auditory reaction time across the life span.
During and shortly after World War I, age differences in psychomotor skills were occasionally tested for selection purposes but the work remained rather unsystematic until W.R. Miles began to direct his attention to the topic.

At that time a good amount of research had been completed on age differences in sensory capacities. Miles (1931) directed most of his researches to psychomotor functions and was led to distinguish motility, i.e., the speed of motor movements, from the speed of simple reaction. The distinction was retained in most of the subsequent smaller studies. Major new investigation were not initiated and new interpretation were not provided until about 1950.

Alan Welford's focus was on the measurement of skilled behaviour and its application to industry (Welford, 1951, 1958).

James Birren who joined the gerontological unit of the National Institute of Health (United States) in 1946, concluded researches aiming to identify a general speed factor that would explain the decrease in various psychomotor performances with age (1965). For this purpose, age differences in speed of nerve conductivity were investigated (Norris, Shock, and Wagman, 1953; Birren and Wall, 1956), in reflex time (Hugin, Norris and Shock, 1960), in reaction time varying in the length of path for nerve transmission
(Birren and Botwinick, 1955a) or the difficulty of task
(Birren and Botwinick, 1951a), in choice reaction time
(Birren, Riegel, and Morrison, 1962) and in writing speed
(Birren and Botwinick, 1951b). From this and other evidence
Birren (1965) sought to explain the age decrement in speed
of performance by cerebral rather than sensorimotor factors.

The work of Jack Botwinick, one of the Birren's associates
in those years, was concerned with reaction time and pre-
paratory set. (Botwinick, 1965; Botwinick and Brinley, 1962;
Botwinick and Thompson, 1966), as well as with perceptual
discrimination (Birren and Botwinick, 1955b; Szafran, 1951).
Besides these attempts the study of age differences in
complex perception and perceptual integration has not been
pursued much. A few studies have been made on perceptual
illusions (Comalli, 1970), and ambiguous figures (Botwinick,
Robbin, and Brinley, 1959; Korchin and Basowitz, 1957;

Birren's work and, in particular, that of Welford and his
associates was influenced by the development of information
theory. Information theory led to refined analysis of
choice reaction (Singleton, 1954), the effect of task
difficulty (Clay, 1954; Birren, Allen and Landau, 1954), and
the sequential order of movements upon psychomotor performances
(Kay, 1951). Furthermore, practical application in work
training situations were explored at the cambridge laboratory (Brown, 1957; Shooler, Schonfield, King and Welford, 1965). Previously a few similar studies had been made in Russia (Plantanoff, 1911), Germany (Weiss, 1927), France (Ehinger, 1927), Japan (Kubo, 1938), and in USA (Miles and Shriver, 1953). None of them led, however, to a comprehensive interpretation of changes in skill and performance as those proposed by Welford.

Besides the above studies in which the age effects on the performance on the various psychomotor and sensory tasks were investigated, there have been number of attempts by child and developmental psychologists who have tried to study pattern of development of abilities and aptitudes at various stages in life span. It has been shown that in early childhood the development of motor skills proceeds according to the laws which govern the physiological maturation of the child, with the developments of movement patterns progressing from simple arm or leg actions to highly integrated total body coordinations. This increase in complexity of patterns of performance is defined by most investigators as sequential motor patterning in terms of stages of development and seems to be more interrelated with physiological maturation than with chronological age.

The relatively slow and constant growth trend of later childhood extending approximately from 6 to 10 or 12 years of
age, is terminated by the pubescent growth spurt. Although these changes are ones of slow development, it is a time of rapid learning (Goodenough, 1945).

Metheny (1941) found that there was a rapid growth or gain in grip strength of approximately 65% for both boys and girls between the ages of 3 and 6 years. Meredith (1935) noted that boys tend to double their grip strength between ages of 6 and 11 while an increase of 59% is shown between 6 and 18 years of age. It can, therefore, be said that changes in strength are associated with general growth (Gates, 1924, and Baldwin, 1926).

With the steady increment that has been noted in strength, a few studies of flexibility have usually been conducted in conjunction with other aspects of motor performance. One such study was undertaken by Hupprich and Sigerseth (1950) where twelve measures of flexibility were taken on 300 girls ranging in age from 6 to 18 years. There was a general increase in flexibility until the girls approached the age of 12 years, with a general decline thereafter.

This period of late childhood may be thought of as a growth consolidation, characterized more by the perfection and stabilization of previously acquired skill and abilities rather than emergence of new ones.
The marked physiological and structural changes of adolescent growth spurt are reflected in large increment in strength development. Jones (1949) found a great improvement in performance in all motor activities during adolescence. This is primarily because of the increased leverage, strength and endurance at this stage. Cultural influences also play a role in the more marked differentiation of performance levels at puberty.

The analysis of adult development by Arikson (1951); Levinson, et.al., (1974); Lowenthal, et.al., (1975), Nen-garten (1977), and Riley (1971) reveal a richness and orderliness in psychological transitions of the adult life between the ages of 20 and 65 years.

Following the period of rapid adolescent development there is a period of gradual increase in size and capacity and finally a levelling off or plateau in adulthood when few growth changes occur. Increments in physical performance and motor skills are however due to practice, training and experience.

Findings of some of the reviewed studies will be stated in a later chapter and the findings of the present study will be discussed with reference to them.
Other Demographic Factors

The present investigation also attempts to study the effect of other demographic variables (like, education and experience) on psychomotor performances. Although, not much research literature is available on the above topic it would not be wrong to record findings of studies which throw light on the relationship of other variables with the performance on cognitive and psychomotor measures.

Studies relating to changes of sensorimotor performances to variables of sex, education and socio-economic status appear to have yielded somewhat equivocal results. As regards sex, Bellis (1933) in his investigations of reaction time although found women's times to be a little longer than men's, there was no real evidence of a differential rate of change with age between the sexes. Noble and his associates (1964) found women to be slower than men between the ages of 18 and 60s, but to be slightly faster in a group aged 71 to 87. On the other hand, Engel, Thorne and Quilter (1972) found differences in reaction time for men and women between groups aged 20 to 30 and 55 to 65. Botwinick and Storandt (1974) found no difference between the reaction time of men and women in their twenties. However, they found shorter reaction time among older people with more years of education.
Pacaud (1953, 1955a and 1955b) in her extensive studies of French railway personnel found substantial differences in test of intellectual, memory, and learning functions associated with different levels of educational attainment or achievement. However, no differences were found between the different educational grades in sensorimotor tasks, although, the differences between age groups in these were substantial.

Similar findings to Pacaud's were obtained by Cle'ment (1969) for a group of factory workers. Higher education correlated with higher score on a coding test and somewhat higher on a test of memory. As regards reaction time or strength of grip very little difference was observed.

Nuttall and Fozard (1971) have shown that age and socio-economic status are not equally associated with the 12 tests which make up the General Aptitude Test Battery of the U.S. Department of Labour. Scores on the tests concerned with dexterity were associated with age but virtually not at all with socio-economic status.

Besides the age, education and other variable differences in the psychomotor performances, the social class and cultural group differences have also been studied, and found to be a determinant variable in development of mental abilities. Some studies have developed profiles and patterns of mental
abilities for different racial/ethnic groups. (Fifer, 1966; Backman, 1972; Boehm, 1972; Campbell et al., 1973; Schmidt, Berner and Hunter, 1973; Schmidt and Hunter, 1974; Hennessey and Merrifield, 1976, 1978; Smith, 1976; and Hilda, 1980).

There is a long tradition of differentiating rural and urban populations. In times of nomadic life, rural-urban differences were few, but they increased as Renaissance cities came to be the abode of artisans and craftsman rather than of land owners and cultivators. Development from the Renaissance city to the modern metropolis further increased rural-urban differences.

Some major rural-urban differences that have been enumerated include occupations, environment, size of community, density of population, social differentiation, mobility and social interaction. Rural-urban differences have also been observed in other encounters like spoken speech (Mystkowska, 1975), mental development and personality traits (Kostrzewski, 1972; Gill, 1976), cognitive development and acquisition of language (Reyes, et al., 1971; Anastasiow, et al., 1974; Wessner, 1976), vocational maturity, educational aspirations (Davis, 1973; Smith, 1975), cooperation and competition (Madsen and Sunin, 1975), creativity (Sharma, 1974), and intelligence (Vance and Gaynor, 1976).
Practice/Exposure Effect

The effects of coaching on test scores have been widely investigated. Many of these studies were conducted by British Psychologists with special reference to the effects of practice and coaching on tests formally used in assigning 11-year-old children to different types of secondary schools (Yates, et al., 1953-1954). As might be expected, the extent of improvement depends upon the ability and earlier educational experiences of the examinees, the nature of tests and the amount and type of coaching provided. Individuals with deficient educational background are more likely to benefit from special coaching than are those who have superior education opportunities and are already prepared to do well on the tests (Anastasi, 1976). It is obvious, too, that the closer the resemblance between the test content and coaching material the greater will be the improvement in test scores.

In USA, the College Entrance Examination Board has been concerned about the spread of ill-advised commercial coaching courses for college applicants. To clarify the issues, the college Board conducted several well-controlled experiments to determine the effect of coaching on its Scholastic Aptitude Test (SAT) and surveyed the results of similar studies by other independent investigators (Angoff, 1971; College Entrance Examination Board, 1968). These studies concluded
that intensive drill on items similar to those on the SAT is unlikely to produce appreciably greater gains than occur when students are retested with SAT after a year. The effect of sheer repetition or practice on test performance are similar to the effects of coaching. A number of studies have been concerned with the effect of the identical repetition of intelligence tests over periods ranging from a few days to several years (Querceshi, 1968). All by and large show significant mean gains on retest. This improvement however is not necessarily limited to initial repetition whether the gain persists or levels off in successive administration depends on the difficulty of the test and ability level of the subject. The implications of such findings are illustrated by the results obtained in retest of 3,500 school children with a variety of intelligence scales (Dearborn and Rothney, 1941). When the same test was readministered in successive years, the median IQ of the group rose from 102 to 113, but it drop to 104 when another test was substituted. Because of the retest gains, the meaning of IQ obtained on the initial and later trial proved to be quite different.

Gains in scores are also found on retesting with parallel forms of the same test, although such gains tend in general to be smaller. Significant mean gains have been reported when alternate form of a test were administered in immediate
succession or after intervals ranging from one day to
three days (Peel, 1951, 1952; Droege, 1966; Angoff, 1971).

Such researches have also been carried out on reaction time.
Murrell (1970) for example thought that older adults might
improve their reaction time with practice and his results
do indicate that the long-term practice appears to speed up
reaction time.

A more recent study of reaction time in active sports
enthusiasts was carried out with an examination of the
inevitability of age change towards slowness in reaction
time with age (Spirduso, 1975). Apparently, older active
individuals show less slowness of response time than do
inactive persons.

The general problem of "test-wiseness" or exposure needs also
to be considered in this connection. The individuals who
had extensive prior experience in taking psychological test
enjoy a certain advantage in test performance over one who
is taking his first test (Rodger, 1936; Heim and Wallace,
1949, 1950; Millman, Bishop and Ebel, 1965). Part of
this advantage stems from having developed more self-
confidence and better test taking attitudes. Partly this
is due to the amount of overlap in the type of content and
functions covered by many tests. Specific familiarity with
common item type and practice in the use of objective answer-
sheets may also improve performance slightly.
Relationship of Demographic Variables to Aptitudes: How Has the Research Influenced the Thinking on Psychological Testing

Two broad streams of work can easily be identified in Psychological Testing literature: (a) test construction and standardization work, and (b) researches that have attempted to explore the relationship or influence of variables like age, education, experience, sex, rural-urban and ethnic background, practice, exposure, etc., on test scores. There are also attempts at evaluation or "testing of tests".

It is quite logical to believe that there has been much intermingling of the two stream of work. Many a test constructors or testing attempts have incorporated both the aspects in their work. Yet there are innumerable test construction attempts which seem to have neglected the existence of findings which have direct bearing on the utility of the test.

As far back as 1923 Freyd had prescribed a number of steps to be followed in test construction. Among other steps he indicated that the sample for standardization of the test should exclude those whose standing on the criterion derived from chance or "special advantages", or who had previous knowledge of the test, or sensory or motor defects, or literacy problems. Sex or age differences should be studied. Freyd also believed that "...if maximum value is to be
attached to test scores the conditions under which the applicants are employed with the use of test should reproduce in general the conditions under which they were employed when the tests were evaluated" (p. 381). He goes on to say "... if men and women are both employed in the occupation, it will be necessary to examine the results for sex differences, and if need be, to evaluate the test separately for two sexes... if proper sampling does not permit a limited range of ages then some correction should be made for age differences" (p. 225). These and other steps prescribed by Fryd are as valid today as these were sixty years ago.

Guion (1976) has said that "... in fact, much that was expected as good practice in the text books of the 1920s... has dropped from contemporary typical practice more from atrophy than from obsolescence" (p. 782). The 1964 Civil Rights Act (Bureau of National Affairs; 1964) and the Equal Employment Opportunity Commission (EEOC) and the Office of Federal Contract Compliance (OFCC) in the United States of America have reiterated the tenets of orthodoxy as well as added some considerations to be kept in mind in employee selection testing (EEOC, 1966, 1970; OFCC, 1968, 1971). For example these documents insists that tests be validated not only for the total applicant population as a whole, but independently for minority and non-minorities subgroups. Yet, even some of the longest programmes of test battery develop-
ment, including the GATB*, are open to serious criticism. Bechtoldt (1965) in his review of the General Aptitude Test Battery notes that "... the relationships of the GATB test scores to scores of a variety of other tests, to educational level, to sex, and to age are treated briefly in the Guide, but with incomplete data reporting... changes in means and variances are noted with respect to practice effects, but the discussion of the effect of heterogeneity on "reliability" coefficients is inadequate... A brief, but inadequate, discussion deals with the possible influence both of experience on the job and of specific academic courses on GATB scores... The positive relationship of educational level to GATB scores is noted at several points but this point is not pursued" (p.1023).

Most reviews and evaluations of psychological tests have emphasized the need of studying the influence of demographic variables, group differences and the effect of coaching, practice and exposure on test scores and use of such information in the norm development work. It has been suggested that such studies are needed to be conducted for all those tests which are used in employee selection.

* Since the review of Bechtoldt (1965) the originators of GATB i.e., USES have started giving the descriptive statistics of validation sample as well as the use of minority and non-minority groups in validity of the test battery e.g., Development of USES Specific Aptitude Test Battery 5-471R81, USES (1981).
It is in this context that the present study has been undertaken and it is expected that the findings would be of use to both practitioners and researchers in the field of psychological testing.

OBJECTIVES OF THE STUDY

The objectives of the study are:

1. to examine the relationship of the demographic variables (independent variables) with the performance on ability/aptitude tests (dependent variables);

2. to study the extent of variance in the dependent variables explained by the independent variables;

3. to study the ability/aptitude tests performance of subjects differing on demographic variables;

4. to examine the effect of practice/exposure on the performance on the selected ability/aptitude scores; and

5. to examine the factor structure of the selected tests of ability/aptitudes.

In the light of the above issues and keeping in mind the findings in the literature, the following hypotheses were raised for testing in this study.
(a) Demographic variables of age, education and experience will show a significant relationship with the performance on the tests of strength of grip, motor coordination, manual dexterity, finger dexterity, perceptual motor coordination, and simple and choice reaction time.

(b) Each of the above demographic variables will have significant contribution and account variance in the performance on the selected ability/aptitude tests.

(c) Groups differing in age, education, experience, state ethnicity and rural-urban background will differ significantly in the performance on the selected ability/aptitude tests.

(d) Practice/exposure will show significant improvement in the performance on the selected ability/aptitude tests.