AN EXAMINATION OF SOME INDIVIDUAL DIFFERENCES IN INFORMATION PROCESSING, PERSONALITY AND MOTIVATION WITH RESPECT TO SOME DIMENSIONS OF SPATIAL THINKING OR PROBLEM SOLVING IN TAFE COLLEGE STUDENTS

by

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CERTIFICATE

I certify that the substance of this thesis has not already been submitted for any degree and is not being currently submitted for any other degrees.

I certify that to the best of my knowledge any help received in preparing this thesis and all sources used, have been acknowledged in this thesis.

Glenda Hunter

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ABSTRACT

This thesis examines some individual differences in information processing, personality and motivation with respect to restricted and unrestricted spatial thinking or problem solving. The setting for the study is Ithaca TAFE College which has a client population that is representative of emergent client populations of most TAFE Colleges in Queensland. Separate models of individual differences in information processing, personality and motivation are examined with respect to restricted and unrestricted spatial thinking or problem solving.

The Luria theory of information processing provides a perception based model in which cognitive abilities are described in terms that are free from the traditional verbal-spatial dichotomy. Information is processed in two ways - successive (sequential and primarily temporal) and simultaneous (continuous and primarily spatial) in conjunction with the overall planning ability of cognitive control.

The Myers-Briggs theory of personality describes two dichotomies of taking in information, and two dichotomies of making decisions. The Coopersmith theory of self esteem describes facets of motivation; central to the Coopersmith theory is the facet of Locus of Control.

The Raven's Advanced Progressive Matrices Sets I and II, and the Silver Test are used as measures of restricted and unrestricted spatial thinking or problem solving skills.

In a first line analysis components of the models of individual differences in information processing, personality, and motivation and components of restricted and unrestricted spatial thinking or problem solving are examined in relation to the underlying theories. The results generally are consistent with the theories.

In a second line analysis multivariate analysis of variance is used to examine the differences between TAFE program groups, gender and components of information processing, personality and Locus of Control with respect to restricted and unrestricted spatial thinking or problem solving. The findings suggest that TAFE program groups differ on some dimensions of personality. Males and females in the study appear to perform differently with respect to unrestricted spatial thinking or problem solving, and there appear to be differences between males and females in stated preferences for decision making.

Findings also suggest that there are differences between some dimensions of personality and the Locus of Control dimension of motivation, and between some dimensions of information processing and Locus of Control.

Although this study is highly exploratory the findings indicate that further investigation of individual differences in information processing, personality and motivation, particularly the dimension of Locus of Control, with respect to restricted and unrestricted spatial thinking or problem solving is justified. Such differences are worthy of consideration in developing course methodologies that may facilitate more effective learning outcomes for TAFE College students.

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CHAPTER 1 OVERVIEW OF RESEARCH FOCUS

(a) INTRODUCTION

> "The real test is not what knowledge our students can recall at the end of a week, or a term, or a year, but rather what knowledge they can recall and still find useful many years down the track in the problem solving and decision making of adult life." (Langrehr, 1988).

Students of today need to attain proficiency in a wide variety of skills for life. These skills include knowledge of content and processes that will be useful to them not only in their first job but also in subsequent employment, and in enhancing the quality of their life generally. In this age of technology the exponential rate of change means that people need thinking skills that will enable them to adapt to as yet unknown challenges and solve problems in a multifaceted environment.

This chapter provides a background for the study and considers: the importance of problem solving in TAFE Colleges and the need to adopt a process approach to learning; some of the unresolved issues in the literature on thinking or problem solving; and some models of individual differences in thinking or problem solving. Finally, the research focus of the study is described as the examination of some individual differences in information processing,

personality and motivation with respect to some dimensions of restricted and unrestricted spatial thinking or problem solving within a TAFE College setting.

(b) PROBLEM SOLVING IN TAFE COLLEGES

The Department of Employment, Vocational Education and Training and Industrial Relations (DEVETIR) in Queensland offers a wide range of pre-vocational, apprenticeship, and service courses of a traditional nature as well as pre-employment associate diploma, diploma and degree courses through a network of Technical and Further Education Colleges and Senior Colleges (TAFETEQ). The organisational rationale of the Department of Employment, Vocational Education and Training (DEVET) Corporate Plan, Annual Report 1987-88, states that the challenge facing these institutions is to provide services which will enable Queenslanders to maximise their potential throughout life.

During the last few years there has been a concerted move to formulate a policy that will provide a framework for the accreditation of all TAFE level courses. The Victorian State Training Board has prepared such a policy. This policy provides guidelines for the development and implementation of pre-employment programs in the categories of trade based pre-employment, pre-apprenticeship, pre-vocational, bridging, reskilling/retraining, and in the Jobtrain and Traineeship courses. It is proposed that the structure of such pre-employment courses will include core

studies encompassing four broad, transferable skills and knowledge areas of which problem solving is one (The Australian TAFE Teacher 1988).

Traditionally, there has been a convergent and restricting approach to learning and thinking in TAFE colleges whereby content has been presented and assessed in terms of a 'one right answer' to the many questions and problems raised by that content. This approach no longer satisfies the needs of industries which have been restructured to accommodate technological changes and economic practices to maximise profitability. The products of today's TAFE colleges need to be people who can solve every-day problems specific to their vocational area as well as wider life problems. Such people need to employ divergent thinking skills in the most common, daily thinking activities - those of problem solving and decision making.

In some TAFE Colleges there is a shift of focus from a content to a process orientation in courses. Innovative implementation strategies such as fleximode allows for a process rather than a content orientation. An example of a fleximode program is that offered for the training of Veterinary Nurses at Ithaca TAFE College. Laboratory Animal Care/Veterinary Nursing I, TMC276 is offered state-wide from Ithaca TAFE College. The student performs practical work supervised by his/her employing veterinary practitioner in the work environment. Workshops are conducted by visiting lecturers during the year and a phone-in clinic is held for

an hour on three days a week. Students are required to exercise problem solving skills ranging from the selection of appropriate nutrition and housing of animals in care to the application of correct veterinary practices to suit particular environments.

Further examples of how the problem-solving approach is being fostered in various trade areas of TAFE Colleges is the inclusion of 'fee for service' and 'live work' activities. These experiences allow students to participate in problem solving to do with design, materials selection, tool manipulation and the presentation of the final product in line with client needs. Most course content however, is still offered in a teacher-centered, content giving approach in traditionally structured class settings. Life skills components in all courses foster the acquisition of every-day problem solving skills, however, syllabuses in TAFE Colleges generally, place more emphasis on listing content and set objectives rather than on the unobservable cognitive processes used by students in effecting observable performance of achieving mastery of the set objectives.

Boud (1985) suggests that movement towards a problem-based professional education model is characterised in part by:

1 an acknowledgement of the base of experience of learners;
2 an emphasis on students taking responsibility for their own learning;
3 a multidisciplinary or transdisciplinary approach;

4 a situation where theory and practice are inextricably intertwined; and

5 a focus on processes of knowledge acquisition rather than the products of such processes.

The need for such a problem based professional education model is clearly demonstrated at the present time. Australian TAFE Colleges are being called upon to examine closely the relationship between client needs and current industry demands. Industry restructuring within a stringent economic climate has brought many changes in vocational areas. Traditional demarcations between trade areas are disappearing with the introduction of a multi-skilled approach in many work areas. This implies that workers in industry are required to think or solve problems in domains where they may have limited knowledge of specific content. In such instances knowledge of general process becomes of crucial importance to facilitate the solving of problems within restricted parameters.

A high premium is being placed on creative talent in a world of rapid social and technological change according to Deva (1984). Industries are becoming increasingly more complex and the nature of activities that people are required to perform are becoming more diverse. The development, and in some cases the survival of an individual or a community may very well depend on the

ability of that individual or community to respond to new and novel circumstances.

(c) UNRESOLVED ISSUES IN THE LITERATURE ON THINKING OR PROBLEM SOLVING

> "A major difficulty in discussing problem solving seems to be a lack of any clear cut agreement as to what constitutes a 'problem'."
> (Krulik and Rudnick, 1980).

The difficulty described by Krulik and Rudnick is widespread in the in the literature. Within the broad ambit of thinking or problem solving research there does not appear to be a clear consensus on the exact meaning of various descriptors of problem solving, either restricted, or unrestricted (imaginative/creative). This seems to have resulted from the combination of contributions from a wide range of disciplines which are not necessarily closely related, and from non-specific notions about general thinking or problem solving. Duncan (1959) supports the view that tight integration of problem-solving philosophy, data, and theory has not eventuated, giving rise to vagueness and ambiguity with technical definitions.

In recent times, two avenues of mathematical and psychological thought have been identified, and a merging of influence from both areas has given rise to some common ground for pursuing empirical research in problem solving,

especially in mathematics education. The mathematician, Polya, initially promoted the generalization of problem solving through a revitalisation of the notion and study of heurestics or problem solving discovery (Polya, 1962). Mayer (1977), from a psychological perspective, claimed that thinking is problem solving, which implies that thinking, learning, and problem solving rely upon a multitude of interdependent prerequisite skills, experiences and attitudes.

The fact that creativity, like intelligence, represents a highly complex and diffuse construct is attributed by Sternberg (1985) to a lack of integration of understanding of creativity. Mumford and Gustafson (1988), however, regard that the lack of a sound general definition of creative behaviour to be of even greater importance. The lack of a sound general definition can be seen in the differing ideas of Guilford (1950, 1967) and Kris (1952) who define creative behaviour in terms of the production of ideas, and Tyler (1978) who argues that creativity involves the recognition of possibilities.

In contrast to these descriptions, Cattell (1971) advocates that creativity is a form of problem-solving ability. Perkins (1981) has a similar view of creativity and suggests that:

> "The extraordinary, if not specifically creative, abilities involved in extraordinary creating are not different in kind. They can be understood as

> exceptional versions of familiar mental operations such as remembering, understanding, and recognizing. They are more of the same. Creativity has to be understood as the combination of traits which fosters the creative use of that more - the mind's best work."

The view that creative abilities are essentially the same as everyday cognitive operations is supported by Wiesberg (1986) who states that creative thinking becomes extraordinary not because of the way in which the thinker produces it, but rather because of what the thinker produces. This 'product evaluation' approach to defining creative problem solving has emerged from previous attempts to measure rather than to describe it. In contrast, Getzels (1964), regarded creative thinking to be based on "primary-process thought" and problem solving as requiring "secondary-process thought" and thus not to be the same phenomenon. Another aspect of creativity is provided by MacKinnon (1965) who maintained that personality differences contribute to levels of creativity (Hill, 1979).

Although there remain unresolved issues to do with restricted thinking or problem solving and unrestricted (creative) thinking or problem solving, some common ground has been established. A developing thread of inquiry can be traced through the decades of the 20th century since the work of the behaviourists, who were limited to measuring

observable behaviours, to the cognitive science orientation of recent times which recognises that unobservable processes are worthy of study.

Krauskopf and Heppner (1988) believe that there are useful research opportunities in comparing novices and experts as well as routine versus novel problem solving along a continuum that includes daily problems and hassles. Towards one direction of the continuum routine problem solving will include coping with daily hassles and recurring (restricted) problems to which solutions are easily recognisable. Towards the other direction of the continuum non-routine or novel (unrestricted) problem solving will include the invention of new solutions to difficult problems. Such research opportunities may be of considerable theoretical value in broadening the definition of what constitutes a problem, and problem solving from an information processing perspective.

(d) MODELS OF INDIVIDUAL DIFFERENCES IN THINKING OR PROBLEM SOLVING

Much of the work to do with individual differences has been traditionally associated with psychometric models and with developmental theories of intelligence.

The psychometric model is concerned with the identification of latent traits or abilities that characterise stable individual differences in task performance. Spearman (1927), emphasising the variance

shared by all intellectual tasks, argued that a general ability factor "*g*" was the common factor underpinning a wide range of tasks. Differences in task performance between individuals and even within individuals on specific tasks were attributable to other specific factors.

Thurstone (1938), on the other hand, maintained that there were a number of independent primary mental abilities. Somewhere between these two views is that of Vernon (1950) who developed a hierarchical model that incorporated both general and lower-order factors. In Vernon's model the usefulness of specific factors in contributing to prediction of variance over "*g*" was determined.

Guilford (1959, 1967, 1982) pursued a different approach by identifying three aspects of a task: (1) the operations employed, (2) the content operated on, and (3) the product outcome. These aspects intersected to produce 150 ability factors. Guilford (1959) considered that such a multi-factor model meets the needs of modern society which demands an analysis and development of a wide range of intellectual skills. Although Guildford's model does provide task categories, it does not meet the strict requirements of a psychometric model whereby predictive capacity is the prime criterion for evaluation of the model. Hunt (1961) for example, stated that such specific factors do not have predictive value in any situation.

In recent times attention has swung to the information processing models wherein a variety of approaches are taken

to understand the mental processes underlying cognitive task performance, rather than on the prediction of task outcomes. In one approach, Pellegrino and Glaser (1979) consider that the relation of complex abilities to basic cognitive tasks to be a search for cognitive correlates. This approach may be seen also in the work of Hunt and his colleagues (Hunt, Frost and Lunneborg, 1973; Hunt, Lunneborg and Lewis, 1975; Hunt, 1978) where a comparison was made of the performance of individuals of high and low verbal ability on a range of simple tasks including letter matching and retention of order in short-term memory.

Hunt (1978) looked at the relationship between intelligence and short-term memory tasks, such as digit span, by seeking to establish whether short-term memory span was a structural attribute of the task, or if the task itself reflected how much of attentional resources was available for the memory task and for more complex verbal problem solving tasks. Another approach is to be found in the work of Sternberg, Guyote and Turner (1980) whose work focuses on the component stages of performance in individual tasks.

Pellegrino and Kail (1982); Lohman, Pellegrino, Alderton and Regian (1987) claim that types of knowledge representations and processing activities that underlie task performance can be embedded in a general theory of spatial cognition. Although the notion of a general theory will not be examined in this thesis, the process orientation of this

theory holds important implications for the area of instructional design.

Results from studies of skill acquisition and practice show substantial 'ability' changes following practice in various components of spatial processing (see Lohman et al, 1987). These results suggest that the enhancement of specific skill components, or the fostering of the use of compensatory skills in the spatial domain, support a process approach rather than a content approach in future course offerings.

(e) DESCRIPTION OF RESEARCH FOCUS

The focus of this study is the examination of some individual differences in information processing, personality and motivation with respect to some dimensions of restricted and unrestricted spatial thinking or problem solving within a TAFE College setting. A restricted problem is one that requires a correct solution, and an unrestricted problem is one that allows a free response by the test-taker.

The stratified population sample is drawn from full-time enrolments at Ithaca TAFE College. This sample is considered to be representative of the emergent populations in TAFE Colleges in Queensland.

The breadth of this study with respect to the thinking or problem solving tasks considered will be constrained within the spatial domain where the processing of

visuospatial stimuli is required to solve problems both restricted and unrestricted. Spatial ability, or structured visualization, may be measured by tests in which configural information is mentally manipulated. It is suggested that tests of restricted and unrestricted thinking or problem solving that will be used in this study require visuospatial stimuli to be processed in order to obtain restricted solutions that are correct, or unrestricted solutions in which the procedures of selecting, combining and representing vicariously perceived reality interact in a manner that is unique to the individual.

The dimensions of individual differences that will be examined in the research include information processing abilities as described by Luria (1973), together with some attributes of personality described in the theory of Myers-Briggs (Myers, 1962) based on the theory of Jung (1921/1971), and some dimensions of motivation as described by Coopersmith (1987). It is expected that an examination of the constructs of these individual differences will enable a better understanding of the relationship of these complex abilities to a set of performances on restricted cognitive tasks and unrestricted tasks in the spatial domain. The ideas of Raven (Raven J. C., Court, and Raven J. 1983/1986), and Silver (1983) will be examined in this context, specifically in relation to restricted thinking or problem solving tasks (Raven and Silver) and unrestricted thinking or problem solving tasks (Silver).

(f) SUMMARY

This chapter has provided an overview of the focus of research adopted in this study. The pressing demands on individuals to cope and adapt to change in an increasingly complex technological society have placed greater pressure on TAFE Colleges to adopt a process approach to learning. This approach fosters the development of thinking or problem solving abilities and represents a swing from the traditional content approach.

This study examines some individual differences in information processing (Luria model), personality (Myers-Briggs model) and motivation (Coopersmith model) with respect to some dimensions of spatial thinking or problem solving (Raven model and Silver model) in TAFE College students. The breadth of the study is constrained to the spatial domain since research has shown some evidence that 'ability' changes have followed practice in various components of spatial processing. This suggests that an examination of models of individual differences with respect to spatial thinking or problem solving is worthy of further study.

CHAPTER 2 INDIVIDUAL DIFFERENCES IN INFORMATION PROCESSING; SIMULTANEOUS AND SUCCESSIVE PROCESSING AND COGNITIVE CONTROL

(a) INTRODUCTION

Aleksandr Luria (1973:323-340) considers that thinking is problem solving, whereby thinking, learning, and problem solving rely upon a multitude of independent pre-requisite skills, experiences and attitudes. This chapter examines Luria's theory of information processing with respect to individual differences.

Luria adopts a neuropsychological approach of examining the relationships between thinking as a complex form of cognitive activity and the brain. This theory of brain functioning, based as it is on neurological data, facilitates the exploration of the relationships between the areas of the cerebral cortex and specific psychological functions. This is possible because of the concrete and scientific character of this approach rather than a purely philosophical one, and has allowed neuropsychologists to consider that the components of thinking and its stages are the responsibility of a system of cerebral mechanisms.

In the following sections simultaneous and successive information processing, and cognitive control which comprise Luria's model of information processing are described. The model is based on the concept of "quasi-spatial"

synthesis in which links between the visual representation and the process of naming of objects are identified.

(b) SIMULTANEOUS AND SUCCESSIVE INFORMATION PROCESSING ABILITIES

Luria (1966, 1973) in examining the impact of local brain lesions on cognitive functioning, employed the method of "syndrome analysis" (1973:38) to show the relationship between areas of the cerebral cortex and specific psychological functions. Luria observed that damage from lesions in the parietal-occipital regions of the brain manifested itself in such disparate forms of impairment as difficulty in following a map, telling the time from the position of hands on an analog clock, carrying out arithmetical calculations, and understanding various grammatical structures incorporating logical relationships. According to Luria, the common factor in these tasks is a spatial or quasi-spatial factor.

Luria (1973) described three brain units in a theory of cognitive functions, and identified the second functional unit as being concerned primarily with the structuring of information wherein responses to external stimuli are received, analysed and stored. The integration of component elements into "dynamic functional structures" (Luria, 1973:68) occurs according to two basic forms of integrative activity (Luria, 1966); individual stimuli is organised into

either "simultaneous and primarily spatial groups," or into "temporally organised, successive series" (Luria, 1966:74).

Luria's (1966) theory of simultaneous and successive processing diverges from the traditional hierarchical theories of intelligence by swinging the focus away from the identification of specific spatial and verbal factors. Luria considers a more abstract facet of spatial thought in his concept of "quasi-spatial" synthesis. This level of analysis encompasses various forms of arithmetical and verbal structures and allows for a breaking free of a classification whose basis is symbolic content, verbal/non-verbal.

Luria's focus is established on two different principles in the organisation of verbal meaning. Words are organised into linked series to form sentences and as such the syntagmatic relationships between those words have primacy in a developmental sense. When asked to form associations to familiar nouns, young children will respond with verbs (i.e. dog-barks) rather than responding with words of a similar class (e.g. dog-cat). Thus, argued Luria, the predicative function of speech develops out of action.

The classification of words into conceptually similar groupings however, is based on the principles of opposition and substitution and as such is a paradigmatic organisation. Luria (1982) identified the posterior regions of the left hemisphere as the location for the mastery of the

paradigmatic structures of language and in particular described problems to do with the naming of objects in patients who had lesions in the parietal zones. It seemed to Luria that there was a defect in the visual representation of the object which impeded the naming process, thus providing a link between this symptom and a patient's overall spatial difficulties.

The importance of the distinction between Luria's two principles of organisation approach has to do with its application to the multiple levels of cognitive activity which he described; perceptual, mnestic and intellectual. The simultaneous synthesis of information involves the organisation of successively perceived elements into a simultaneously surveyable whole. Simultaneous synthesis is associated with the occipital and parietal lobes of the brain and is related to spatial information, visual imagery and certain high level logical processes.

Luria (1966) considered perception to be an active extraction of information and its synthesis into a unified visual structure. When we perceive things, we generally perceive them as being at some particular place in space. A certain object is either in front of us or behind us, far or near. Furthermore, we not only perceive things in relation to ourselves but also in relation to each other. Failure to form simultaneous structures can be manifested at different levels of cognitive activity. The tasks of finding directions or telling the time depend on the ability

to structure spatial information about surroundings into an adequate system of co-ordinates. The tasks of map reading, drawing of letters, or the reproduction or reversing of geometric figures however, depend upon the organisation of spatial relationships.

The successive synthesis of information involves the synthesis of temporally related information and as such is not surveyable as a whole. Successive synthesis is associated with the frontal and temporal lobes of the brain and is related to sequential organisation such as word sequences. Luria's (1966) examinations of patients with brain lesions showed that disruptions to successive processing did not occur across the whole area of motor, mnestic, linguistic and intellectual activity. In patients with bilateral lesions of the left hemisphere of the brain however, it was observed that successively perceived stimuli could not be converted to simultaneously perceived structures.

The theoretical differentiation between two kinds of organising activity based on spatial or temporally ordered structures is made possible through the development of Luria's two process theory of simultaneous and successive processing. This principle of differentiation is fundamental in the establishment of an individual differences model of information processing and will be examined further in this thesis.

(c) COGNITIVE CONTROL ABILITY

Luria (1973:265) considers that the inhibiting of the impluse to find a direct method of solving a problem is a psychological indicator of higher voluntary attention and concentration. The basis for this stance lies in the neurological evidence to do with the phenomenon of evoked potentials which are electrical responses in corresponding regions of the cortex evoked by the presentation of a special stimulus. For example, a visual stimulus evokes an electrical response (evoked potential) in the occipital region of the brain.

It is the structure of the changes (increases in amplitude) induced by a complex activity, such as a complex problem sited above, that is of particular importance in the study of attention. The study of such changes can provide objective records in the changing amplitude of the reception and analysis of information arising through the mobilization of active attention.

Luria found that under normal conditions the stimulation of a particular modality (visual, acoustic, tactile or nociceptive) produced evidence of evoked potentials in the corresponding cortical zones (occipital, temporal and central). When a preliminary instruction to expect the stimulus or to look out for differences in the stimuli was given, however, not only was there a marked increase in amplitude of evoked potentials, they were also observed to have spread to other zones of the cortex.

While studies of patients with lesions of the posterior zones show that this phenomena of the spread of evoked potentials is intact, studies of patients with lesions of the frontal lobes show that there is no change in the intensity of the evoked potentials, despite instructions which appeared to raise the level of attention or distort the character of the evoked potentials in patients with no frontal lobe lesions.

These findings seem to indicate that when faced with a complex problem solving task, patients with frontal lobe lesions respond on impulse and guess, rather than on concentrating attention on distinctive features (looking out for differences in the stimuli) using past knowledge. Support for this view is found in the work of researchers in the field of metacognition (Flavell, 1978, 1979; Campione and Brown, 1978; Brown, Campione, Cole, Griffin, Mehan and Riel, 1982; Lawson 1984) who stress the importance of self regulation in problem solving. As the complexity of the problem increases, these researchers would expect an increase in the need for the use of abilities to regulate cognitive processes through executive, cognitive control.

Luria considered that the development of voluntary attention from an external, social product of the interactions with adults, to an internal, self-regulating process, occurs during childhood and stablises in adolescence, somewhere between the ages of 12 and 15. This highly developed capacity to direct and select

essential elements for mental activity is "not a point in the processing chain, but is an overarching, regulating and controlling process (Tulloch, 1986:32).

(d) SUMMARY

In summary, it is Luria's proposition that the brain synthesises/analyses information in two fundamental ways - simultaneous synthesis/analysis and successive synthesis/analysis. Luria's research has shown that the psychological function of simultaneous synthesis/analysis is associated with the occipital and parietal lobes of the brain and is related to spatial information, visual imagery and certain high level logical processes. The psychological function of successive synthesis/analysis is associated with the frontal and temporal lobes of the brain and is related to the synthesis/analysis of temporally related information such as word sequences.

These operative conditions are part of the second functional unit of the brain and a number of researchers in recent years have concentrated on applying psychometric methods to test the operational aspects of Luria's model. Notably, these researchers include staff and post graduate students from the University of New England (Fitzgerald, 1973, 1978; Green, 1977; Ransley, 1981; Tullock, 1981, 1986; Walton, 1983; Crawford, 1986; Try, 1990) and researchers originating in North America, Das, Cummins, Jarman and Kirby (See for example Das, Kirby, Jarman and Cummins, 1979).

Findings from these studies have indicated tests that consistently load highly on factors called 'simultaneous' and 'successive' across different age and socio-economic groups.

Although Luria's theory suggests two ways in which people process information, simultaneously and successively, it also presents a third dimension of executive, cognitive control. This dimension is characterised by levels of sustained vigilance which is essential to the orchestration of the direction and selection of mental activity, and exemplifies the intellectual act.

Luria concluded from a neuropsychological analysis that the operative conditions for the performance of intellectual activity are the responsibility of the posterior zones of the hemispheres (forming the second functional unit of the brain). The organisation of intellectual activity as a whole, including the programming of the intellectual act and the checking of its performance is the responsibility of the frontal lobes (forming the third functional unit) of the brain.

Support for the inclusion of this third dimension in Luria's model can be found in the studies of Walton (1983) and Tulloch (1986) in which tests load highly on a factor called "attention" and to a much lesser degree on a factor called "simultaneous". Crawford (1986) identified three factors of "simultaneous" processing, "successive" processing, and "executive control." Crawford (1986:91)

reports that these three distinct factors appear to be closely related to the three brain functions described by Luria as successive synthesis/analysis, simultaneous synthesis/analysis, and the regulatory function of the frontal lobes.

CHAPTER 3 REVIEW OF SOME INDIVIDUAL DIFFERENCES IN PERSONALITY

(a) INTRODUCTION

In this chapter some attributes of personality based upon the Myers-Briggs theory of personality types, and motivation and self-esteem as described by Coopersmith will be discussed. The common thread that thinking is problem solving is evident in both theories, as is the need for individuals to be aware of their thinking or problem solving processes.

The Myers-Briggs theory is based on Jung's theory of psychological types. Jung postulated that an initial choice between the four basic opposite modes of Intuition, Sensing, Thinking, and Feeling determines the line of development of an individual's perception and judgment. The Myers-Briggs theory develops these modes into four dichotomies - Sensing/Intuition, Thinking/Feeling, Judging/Perception, and Extraversion/Introversion. The Sensing/Intuition dichotomy explains differences in how people arrive at perceptions and the Thinking/Feeling dichotomy explains differences in how people arrive at judgments. The Judging/Perception dichotomy explains differences in the ways in which people cope with the world, and the Extraversion/Introversion dichotomy explains differences in attitudes which people adopt in relating to the world. The theory allows a variety of simple human differences, complexities of personality,

and widely different satisfactions and motivations to be explained. Such explanations may be used in the application of type theory in communicating with people, interacting with people, and making decisions that affect another person's life (Briggs Myers with Myers, 1980:25). The role of the Intuitive mode in association with the Perceptive attitude is examined in relation to creativity.

Coopersmith (1987) examines the process of the valuing of self and the link between self-esteem and successful performance or motivation. Coopersmith suggests that since self-esteem expresses an attitude of approval or disapproval towards the self, it may be like other orientations, either conscious or unconscious, and is intertwined with intellectual and motivational processes.

(b) SOME ATTRIBUTES OF PERSONALITY

> "When all is said and done, Jung's theory of personality as developed in his prolific writings and as applied to a wide range of human phenomena stands as one of the most remarkable achievements in modern thought. The originality and audacity of Jung's thinking have few parallels in recent scientific history, and no other man aside from Freud has opened more conceptual windows into what Jung would choose to call 'the soul of man'."
> (Hall and Lindzey, 1970:553).

The Myers-Briggs theory does not embrace all aspects of Jungian theory; it focuses on the conscious aspect of mind and ignores such aspects as the collective unconscious and the components of archetypes.

Jung postulated that the manner in which people perceive the world and how they assess information affects their views of problems. All conscious mental activity can be classified into two perception processes (sensing and intuition), and two judgment processes (thinking and feeling) (Lawrence, 1982:6). These four processes are described as orienting functions that "cannot be related or reduced to one another" (Jung, 1921/1971:437).

Of the perception processes, some people prefer a Sensing mode whereby reality is perceived by way of the five senses. Other people prefer an Intuition mode whereby the subliminal essence of reality is perceived according to a 'sixth sense.' The judging processes are concerned with coming to conclusions about what has been perceived. Jung postulated that the Thinking mode of judging was embraced by people who prefer the ideational and intellectual comprehension of self and world, and who are pragmatic and emphasise ends rather than means. The Feeling mode of judging was preferred by people who stressed value systems and evaluated other people, situations or objects through the emotions.

The two complementary orientations to life of Introversion and Extraversion reflect whether a person is

oriented primarily towards the outer world or primarily toward the inner world. The inner world of concepts and ideas is the orientation of Introversion whereas Extraversion is oriented to the outer world of people and things. These orientations are differentially employed when necessary, however a person has a natural preference for one or the other and operates best in their preferred orientation (Briggs Myers with Myers, 1980:78).

Implicit in Jung's theory are two ways of life or methods of dealing with the world around us - the Perceptive and the Judging attitudes. The Perceptive attitude is said to be preferred by a person when he/she focuses on the modes of Sensing or Intuition. The Judging attitude is said to be preferred by a person when he/she focuses on the modes of Thinking or Feeling. People who prefer the Perceptive attitude like to delay decision making until new developments have been considered; people who prefer the Judging attitude consider that all the evidence is in and the time has come to reach a verdict.

In Jungian theory the total personality or psyche is composed of several quite separate yet interacting systems; the ego or largely conscious aspect of mind which helps a person function in daily life and serves to provide him/her with a sense of identity and continuity, and the unconscious processes which are in conflict with the conscious ego. The underlying prime moving force of Jung's theory is the individual's striving for selfhood and ultimate integration

through a balance among the four modes or functions. Such balance, however, can never be completely achieved since the theory is based on psychic energy which operates on the principles of equivalence and entropy. The principle of equivalence is one of conservation of energy whereby increases in one element of personality is balanced by equivalent decreases in another element. The principle of entropy is one of homeostasis or balance whereby a spontaneous shift in psychic energy distribution between the ego, the conscious aspect of mind composed of all the perceptions, thoughts, memories and feelings available to the individual, and the unconscious will take place to achieve approximately equivalent levels (Krech, Crutchfield, Livson, Wilson Jr, and Parducci, 1982:552-553).

The Myers-Briggs theory builds on the aspects of Jungian theory presented above to explain variation in human behaviour in terms of observable differences in mental functioning. These differences are concerned with the way people prefer to use their minds or their cognitive preferences. The Myers-Briggs theory focuses on a description of the consequences of each preference as far as can be observed or inferred, and using the most accessible of these consequences in developing a mechanism of identifying type.

The Myers-Briggs theory is a dynamic one since type development is regarded as a lifelong process in which a person gains greater command over the functions of

Perception and Judgment. Type theory assumes that people are born with a predisposition to prefer certain functions over others and that this generates a natural interest and motivation to exercise their dominant function. As a child grows the constantly practiced preferred function becomes more controlled and trustworthy; the corresponding development of the function at the opposite pole of the same preference will be relatively neglected.

Thus, children will become relatively differentiated in the preferred function and will develop along divergent lines according to the direction of their preferred function. For example, a child with a preference for a Sensing perception spends most time developing the powers of observation of the immediate environment and will spend less time and energy using Intuition. As such development occurs some of the characteristics assumed to be associated with the Sensing function such as realism and practicality will follow. At the same time the second preferred function, (in this case, a Judging function) is developing to some extent. Such development continues through youth (the age of specialisation), however in midlife (the age of generalisation) the less preferred third and fourth (or inferior) functions can be developed to allow a person to gain a greater command of them.

A stage of individuation where each function is used with ease as required by the situation however, is attained by people in only a few rare cases. The role of the

environment in this theory is of extreme importance. Natural preferences can be fostered through a favourable environment. A 'falsification' of type can occur where a person becomes skilled in using an initially less-preferred function in an environment that discourages their natural preference. For example, a person whose first preference is a Perceptive one, either Intuition or Sensing, makes many quick decisions on a daily basis, an attribute of the Judging attitude. Such a person may be less content, have feelings of incompetence, and not be in touch with his/her own best gifts (Briggs Myers and McCaulley, 1985:14-15).

Creativity by definition means the creation of something entirely new for the individual. In type theory the mode of Perception that is oriented to possibilities and to identifying hitherto unknown patterns is Intuition. It is expected in type theory therefore, that creativity is associated primarily with a preference for Intuition, and secondarily with a preference for the Perceptive attitude and its attendant curiosity and receptiveness (Briggs Myers and McCauley, 1985:214). Studies by Hall and McKinnon (1969) tend to show that not only is the Intuitive mode associated with levels of creativity, there is also an association between increased levels of creativity and increased Intuition preference scores.

All Intuition is not creative as Intuition can also include the merest of hunches or unfounded suspicions, however a requirement of creativity is that of a highly

differentiated awareness of observations by the senses from which new patterns are developed by Intuition (Briggs Myers and McCauley, 1985:293).

(c) MOTIVATION AND SELF ESTEEM

One of the feeling states that increase involvement and successful performance or motivation appears to be that of positive feelings about oneself, according to Coopersmith (1987:1). Children form self-images or pictures of themselves based on their treatment by the significant people in their lives. These significant people include parents, teachers and peers and each contributes to the context of a person's perceptions and opinions about himself or herself - the self-image. The way in which a person views the self-image, either positively or negatively, and the evaluations or judgments he/she makes about it form the person's self-esteem.

The mental-set provided by self-esteem includes beliefs about expected success or failure, the gauging of effort to be expended, and the trade-offs and gains of difficult or different experiences. This mental-set prepares the person to respond to situations in accordance with the beliefs and expectations contained in the set. A person's self esteem is conveyed to others by verbal reports and other overt expressive behaviour through the voice, posture, gestures, and performance.

Coopersmith suggests that at a time prior to middle childhood a person develops a general appraisal of his/her worth. This appraisal remains relatively stable and endures for several years. Although drastic changes in a person's life may inflate or deflate self-esteem, these variations are usually short-lived so that a person's appraisal of his/her self-esteem will usually revert to its customary level when conditions are 'normalised' (Coopersmith, 1987:3,5). Coopersmith sites Aronson (1959) who showed that persons will generally resolve any dissonance between the evidence that they are better or worse than they have judged themselves to be in favour of their customary appraisal. These self appraisals are relatively resistant to change because the individual needs to have psychological consistancy, according to Lecky (1945).

Self-esteem may vary across different areas of experience and according to sex, age, and role definitions, however, there does not appear to be any objective evidence to describe how a person's overall self-esteem is determined from such varying levels of appraisal of worth. Further, preadolescent children appear to make little distinction about their worthiness in areas of experience such as school, family, peers, self and general social activities, or if they do make distinctions then these are made within the context of the overall, general appraisal of worth that have been made already by the children.

Indications that self-esteem and performance in school work appear to be related have been shown in many studies (Bledsoe 1964; Brookover, Thomas, and Patterson 1964; and Bodwin, 1962). An associative relationship is shown in these studies where children feel better about their abilities to perform and where they expect to do well, then they actually do perform better in school. Further, a study by Wattenberg and Clifford (1964) appears to indicate that the way a child of kindergarten age feels about him/herself is a better indication of reading readiness than his/her intelligence test scores. Other studies indicate that students who are not sure of themselves or who expect to fail are inclined to stop trying (Quimby, 1967; and Shaw and Alves, 1963). A marked change in beliefs and expectations of success is possible once the person has reason to believe that such success is within reach and that the valued goal is worth the effort.

Coopersmith refers to studies in which people who judge there to be a mis-match between their performance and personal aspirations will evaluate themselves as inferior no matter how high their attainments. Such devaluation of self will persist until the desired levels of performance are reached. Coopersmith sites the studies of Good (1970); Rosenthal and Jacobsen (1968); Brookover, Erickson, and Joiner (1967) as providing clear-cut evidence that marked increases in student performance are produced when teachers expect children to learn and who believe such children are

capable of success. The effects of such 'labeling' by teachers serve to raise their positive expectations for student success and is reflected in more favourable attitudes towards students (Coopersmith, 1987:10). Thus, it appears that there is support from these studies for the conclusion that feelings of confidence and self-respect are as important in school performance as in other areas of life, according to Coopersmith (1987:1). Indeed, Coopersmith (1967:4) states:

> "Motivational research strongly suggests that the striving after social status and social approval stems, in good part, from the desire to maintain a favourable self-evaluation."

Coopersmith (1967:59) claims that the importance of self-esteem for creative expression is almost beyond disproof. Studies of creative persons show that they rank quite high in self-esteem, and are more likely to take an active role in social groups and to express their views frequently and effectively. Such people apparantly move more directly and realistically toward personal goals, unhindered by fears, ambivalence, self-doubt and minor personality disturbances, according to Coopersmith (1967:4). The innovator, working in the frontiers of his field, needs to trust himself to distinguish between the significant and profound innovation and one that is merely different. Coopersmith refers to the creative process as including

analysis, synthesis, and the development of a new perspective or a more comprehensive theory. An essential component in this creative process is the conviction that one's judgment in interpreting the events that occur in the 'real' world is to be trusted. Further, Coopersmith (1967:4) presumes that a basic prerequisite for major creativity includes a belief in one's perceptions together with the conviction that one can force or impose order upon a segment of the universe.

(d) THE ROLE OF MOTIVATION IN THE THINKING OR PROBLEM SOLVING PROCESS

Brown (1985), considers that an information processing approach stresses the necessity of including the training of "executive control systems" in programs (of study) designed to improve thinking skills. An important component of such training is that of metacognition whereby children learn to be aware of their own thought processes, and are thus more likely to transfer learned skills to new situations. The development of metacognition may facilitate enhancement of cognitive functions of processing information through increased opportunities to exercise those functions, or the exercise of cognitive control functions which may serve to compensate for other less developed functions.

Coopersmith refers to the mental-set which prepares a person to respond to situations in accordance with the beliefs and expectations about success or failure.

Where that mental-set contains more positive than negative feelings about self, then the greater the likelihood of successful performance or motivation.

Some of the specific techniques that Coopersmith provides for building self-esteem in children include the fostering of an awareness of alternative strategies in broadening available options for dealing with particular problems, and increasing the range of procedures which will broaden the strengths required in dealing with problems.

(e) SUMMARY

The Myers-Briggs model explains individual differences in personality in terms of four dichotomies. These dichotomies cannot be reduced to each other and explain differences in how people cope with the world (Judging/Perception), relate to the world (Extraversion/Introversion), take in information (Sensing/Intuition), and make decisions (Thinking/Feeling). The Coopersmith model of individual differences in self-esteem explains how motivation dimensions influence perception and decision making processes.

The Myers-Briggs model and the Coopersmith model of individual differences are included in this study so that their utility in accounting for variance in spatial thinking or problem solving may be examined. The importance that Coopersmith (1967:59) attaches to the role of self-esteem in thinking or problem solving and for creative expression in

particular, suggests that there may be a basis for using motivational dimensions to moderate other individual difference variables in examining relationships among information processing dimensions, personality dimensions and thinking or problem solving tasks.

CHAPTER 4 REVIEW OF SELECTED RESEARCH ON SPATIAL THINKING OR PROBLEM SOLVING

(a) INTRODUCTION

In this chapter selected research on spatial thinking or problem solving is reviewed. The historical perspective of spatial ability is examined briefly to provide a framework for further discussion of the theoretical bases of spatial thinking or problem solving measures used in this study. These measures include the Raven's Advanced Progressive Matrices Test and the *Silver Test*.

Raven derived and formalised the matrices tests from the ideas of Spearman (1927) to provide measures of the ability to educe relationships and correlates. The Raven's Advanced Progressive Matrices were developed originally in 1943 for use at War Office Selection Boards. The tests were revised in 1947,

> "for general use as a non-verbal test of the intellectual efficiency with which, at the time of the test, a person is able to form comparisons between figures and develop a logical method of reasoning," (Raven, Court and Raven, 1983:APM2).
>
> The tests were further revised in 1962.

Silver (1983) adopts a visual-spatial approach to cognitive or problem solving skills based on the theories of Bruner (1966), who maintained that pictorial devices are

richly endowed aids that are used to represent reality along with "intellectual prosthetic devices" such as language: "It is still true that a thousand words scarcely exhaust the richness of a single image" (Bruner, 1966:16-19). Silver (1983) states that Witkin (Witkin, Dyk, Faterson, Goodenough and Karp, 1962) found that visual thinking in solving problems and processing information was preferred by some individuals. For some people such as the hearing impaired, the language impaired or the learning disabled, visual thinking becomes more than a matter of preference. For these people it is imperative that provision for assessing visual thinking independent of language is available.

(b) HISTORICAL PERSPECTIVE OF SPATIAL THINKING

Thorndike (1921) and McFarlane (1925) first demonstrated the relative independence of the spatial ability factor from Spearman's General Intelligence factor (*g*). Spatial ability, or structural visualization, is measured by tests in which configural information is mentally manipulated. Spatial measures were included in much of the factor work of the 1920s and 30s (e.g. Kelley, 1928), and in the studies reviewed by Wolfle (1940) the spatial factor was shown to be second only to the Verbal factor in frequency of occurrence.

The growing evidence for a Spatial factor gave rise to examinations of the factorial structure of the spatial

domain (French, 1951; Guildford and Lacey, 1947; Thurstone, 1950) and many of the spatial tests used today were originally developed during this time. Although these tests required the processing of visuospatial stimuli, not all provided a measure of an ability that was relatively distinct from verbal and general reasoning skills.

Distinctions among "spatial" tests and processing modes are drawn from the individual differences literature as well as from the information processing literature. In the individual differences literature, Spearman and Jones (1950) noted that there are two distinct manners of solving items of visuospatial content; one is called analytic (in the sense that attention wanders from one element of the figures to another), and the other mode of operation is comparatively synthetic (in that the figures or their constituents are mentally grasped in much larger units, sometimes called "wholes"). The former procedure, not the latter, tends to load noegenetic [i.e., congeneric] processes with "*g*."

In the information processing literature, distinctions have been made between different modes of processing (e.g. analytic versus holistic [analog] processing of visuospatial information, Cooper, 1976, Metzler and Shepard, 1974; analytic versus nonanalytic spatial ability, Maccoby and Jacklin, 1974; propositional versus spatial/imagery models of visuospatial representation and processing, Kosslyn and

Shwartz, 1977, Paivio, 1977; nonanalog versus analog visuospatial tests, Technical Report 1986-1, Zimowski, 1985).

Studies from an information processing approach have done much to promote the need to distinguish between test items that require verbal reasoning solution strategies and relatively pure measures of spatial (analog) ability. Tests used in studies from the individual differences approach, on the other hand, tend not to make such distinctions and refer to any test that requires the processing of visuospatial information (e.g. Eliot and Smith, 1983; Caplan, MacPherson, and Tobin, 1985). Zimowski and Wothke (1987) point out that many of the tests of so-called 'spatial' ability in the individual differences literature tend to be test-dependent. This may be seen in studies where the focus has been the identification of biological and sociocultural determinants of individual and sex differences in spatial ability.

Barratt (1953), reported in Green (1977), described three spatial factors that appear to encompass the spatial components derived from the work of Guilford and Thurstone. These three factors are incorporated in the two factors found by French, Ekstrom and Price (1963); factor S - spatial orientation, and factor Vz - visualisation. Factor S has to do with the perception of spatial patterns or the maintenance of orientation of objects in space. Factor Vz has to do with the manipulation or transformation of the image of spatial patterns into other visual

arrangements. They suggest that the distinction between these two factors:

> "... is often not clear because of tests having loadings on both and because the factors seem so similar psychologically, ... The tests loading Spatial Orientation seem to involve perception of the position and configuration of objects in space, perhaps best thought of as space with the observer himself as a reference point. With Visualization, on the other hand, the observer seems removed from the stimulus pattern in that he appears to manipulate and alter its image.
> A further distinction is seen in a characteristic of the test administration: Spatial Orientation tests are given under speeded conditions, whereas Visualization tests are relatively unspeeded." (French, Ekstrom and Price, 1963:38).

Luria's research on the disturbance of spatial synthesis suggests a number of facets of task competence that reflect efficiency or inefficiency of simultaneous processing. Factor loadings from studies such as Green (1977); Hunt, Fitzgerald and Randhawa (1978); Das, Kirby and Jarman (1979); and Angus (1984) emphasise the clear relationship betweeen simultaneous processing and the ability to handle geometric shapes and patterns. Further, Guilford's (1972) and Thurstone's (1950) work on spatial

(2) Later, the child can determine the orientation of a figure in relation to objects in the perceptual field.

(3) The child is able to consider the parts of a figure as forming a whole.

(4) Later, the child is able to analyze the whole into its component parts.

(5) Finally, the child is able to compare analogous changes in the figures perceived, and to use this as a method of logical reasoning.

The three series of Standard, Coloured, and Advanced Matrices together provide tests of a person's ability to perceive and think clearly at the time, irrespective of past experiences or present verbal communication ability. Raven, Court and Raven, (1986:G2) describe the scales as "tests of observation and clear thinking". Each problem in a scale is a source of a system of thought, and the progressive nature of the order in which the problems are presented means that all subjects are provided with the standard training in the method of working.

These perceptual tests seek to assess a person's present capacity for intellectual activity, and where they are given free of time constraints, they provide an assessment of a person's capacity for observation and clear thinking. This total capacity for orderly thinking must not be confused with a person's "intellectual efficiency" which

factors indicate that there might be a relationship between simultaneous processing and a number of components of spatial ability.

The measures of spatial ability to be used in this thesis will contain items with both analog and non-analog attributes. This approach is consistent with Luria's theory whereby simultaneous (primarily spatial), and successive (primarily temporal) processes are differentially used at the three levels of perceptual, mnestic, and intellectual processing of information.

(c) RESTRICTED THINKING, OR PROBLEM SOLVING, IN THE SPATIAL DOMAIN (RAVEN)

Raven designed a series of tests within the context of Spearman's concept of '*g*', a general intelligence factor, in which spatial and numerical tests have high loadings. Spearman viewed an undifferentiated concept of intelligence as being less than adequate in describing cognitive abilities, and stressed the importance of eductive and reproductive behaviour. Raven considered Spearman's "Principles of Cognition" in which he described five differentiated levels in the development of intellectual functioning, from a simple level to more complex levels:

(1) The child distinguishes identical figures from different figures, and similar from dissimilar ones.

is described in the sense of a person's present speed of accurate intellectual work.

Knowledge of such "intellectual efficiency" may be useful in assessing a person's suitability for a job in which quick, accurate judgments are required. Although this is generally closely related to total capacity for orderly thinking it is not always the case. Raven et al (1986:G2) stress that the Progressive Matrices are not tests of "general intelligence", rather they are designed to measure, as unambiguously as possible, eductive abilities. Where the tests are used in conjunction with a vocabulary test, they provide an index of reproductive ability.

Raven's Progressive Matrices test has been used as a marker test for simultaneous processing (Das, Kirby, Jarman and Cummins, 1979), and in a shortened form was shown to load strongly on a simultaneous factor in a study by Cowart and McCallum (1984). Kirby and Das (1977) looked at the possibility that simultaneous-successive processing was just another name for reasoning and memory. Through an examination of the relationship between primary abilities and the coding factors, three factors were identified - inductive reasoning, spatial memory, and associative memory. These factor scores then were correlated with factor scores from a coding battery. Relationships between simultaneous processing and all three factors of inductive reasoning, spatial memory, and associative memory were found to exist, as was a relationship between successive processing and

associative memory. These results were interpreted by the authors as confirming the relationship of spatiality with simultaneous processing, but suggested that no unique relationship exists between spatiality and inductive reasoning.

Cowart and McCallum (1988) suggest that although there is abundant correlational and clinical evidence that simultaneous-successive processing and planning exists, the constructs may be narrow as shown by the available nonsupportive evidence. One implication of this view may be that the identification of the Raven's Progressive Matrices test as a marker test for simultaneous processing may be too restrictive; rather than regarding it as a unidimensional test of simultaneous processing it may be better regarded as a test of reasoning and problem solving in the spatial domain. In this study the Raven's Advanced Progressive Matrices test is regarded as a test of restricted perception and reasoning within the spatial domain where correct solutions to problems need to be identified.

(d) RESTRICTED AND UNRESTRICTED THINKING, OR PROBLEM SOLVING, IN THE SPATIAL DOMAIN (SILVER)

Words are the most frequently used elements in thinking, and the most common way of communicating what we think is by using words. Most psychologists will agree that there is a close relationship between thinking and language; Piaget and Bruner for example, use the analysis of language

in children to study the development of thinking and cognitive growth. Although language undoubtedly plays a critical role in human thought, it should not be concluded that language is essential for thinking. With language, as with images, distinction needs to be made between what is necessary for thinking and what may merely be helpful (Krech, et al, 1982:370).

Rawley Silver (1983) postulates that cognitive (thinking) skills can be measured through the use of drawing rather than language. Art can be a language of cognition that parallels the spoken word and cognitive skills that are evident in verbal conventions can be evident also in visual conventions. Cognitive skills are traditionally identified, assessed and developed through language, however, drawing activities can be used in the same way; stimulus drawings prompt response-drawings that solve problems and represent concepts. Silver sites Sless (1981) in stating that vision is not a sensory process separate from the mental activity of thought. Eyes appear first in the developing embryo with the brain as a subsequent outgrowth, and the development of neural tissue to make use of incoming visual information.

Reality is represented vicariously and economically through thought. The barrage of stimuli from the outside world is organised through cognition according to Bruner (1966), and this complexity is reduced by constructing models or imaginary representations. New experiences are matched against a stored model and then a prediction is made

as to what will happen next. Although language is an "intellectual prosthetic device" which aids representation, there are also pictorial devices which aid representation (Bruner, 1966:16-19).

Silver (1983:5) states that accounts of scientific discovery note the importance of vision in cognition; Kekule discovered the benzine ring while visualising the movement of atoms as a snake grabbing its tail; Watson visualised a helix in the discovery of DNA; Einstein reported that physical entities of visual and some muscular type seemed to serve as elements in his thought and that conventional words and signs were sought for seriously only in a second stage of thought. According to Silver (1983:7) "children's drawings are pictorial devices that can represent reality vicariously and economically, and thus reflect their thinking."

Silver posits that children with inadequate language ability lack a major device for representing their experiences, however if children's visual-spatial capacities are intact then reality may be contracted from visual models and drawn images may be used to represent their experiences. Support for this view is found in the work of Bannatyne (1971) who investigated reading disabilities in children and reasoned that spatial, conceptual and sequential categories of subtests would be more useful in describing the various skills of disabled readers on the Wechsler Intelligence Scale for Children than the traditional Verbal and

Performance categories. Rugel (1974) produced findings that supported Bannatyne's categories as did the study by Smith, Coleman, Dokecki and Davis (1977).

Silver explores the relationship between verbal language and thinking by examining writings on this matter. Although verbal language is obviously related to thinking, there is some evidence to suggest that language and thought develop independently, that logical thinking precedes language, and that high-level thinking can and does proceed without verbal language, although language does expand and facilitate thought (Arnheim 1969; Furth 1966; Piaget 1970; Torrance 1962). Silver refers to the recurrent theme in Piaget's writings that logical thought exists before language is acquired. Piaget observed that by the beginning of their second year children were able to repeat and generalise their actions, whereas the acquisition of language occurred around the middle of the second year.

Furth (1966) concluded that intellectual activity is largely independent of language by reviewing over fifty empirical studies comparing the performance of deaf and hearing populations on tasks that included memory and visual perception. Sinclair-de-Zwart (1969) concluded that language is structured by logic. Experiments conducted on children aged five to eight years established a group of conservers who were able to keep in mind more than one object when asked to describe simple objects, and a group of non-conservers who could not accomplish this.

After teaching the non-conservers to use the same verbal descriptions of the objects as were used by the conservers, she tested for any training effect and found that in every case only minimal progress was seen after the linguistic training.

Silver (1983:8) refers to Strauss and Kephart (1955) in stating that in the thinking of normal children language functions primarily to allow perceptions to be pinned down, experiences organised, and environments understood and controlled. Silver states that children's perceptions are made usable again and again by labelling them with words. Further, language opens up vicarious experience for children; words are substituted for unsuccessful activities and by symbolizing it children obtain it imaginatively. Children can collect information about the experiences of other people by hearing and thus language helps them to compare themselves with others and to use their experiences. Art symbols, like lingusistic symbols, can label perceptions and experiences and can represent particular subjects or classes of subjects. Just as the word 'man' can represent one or more ideas depending on the verbal context, so too can a drawing of a man represent one or more ideas, e.g. the artist's father, authority figures in general, humanity in the abstract, or all three (Silver, 1983:9).

The Silver Drawing Test of Cognitive and Creative Skills, referred to as the *Silver Test* was based originally on the three independent structures (i.e. not reducible to

one another) identified by the Bourbaki group of mathematicians as the fundamental structures of mathematics reported by Piaget (1970:3,23). The first structure is based on the idea of a group and applies to numbers and classifications; the second is based on ideas of space and applies to neighbourhoods, borders, points of view, and frames of reference; the third is based on ideas of sequential order and applies to relationships (Silver, 1983:11). Silver states that these concepts of class, space and order can be interpreted visually and although they may seem highly abstract, they are observed, according to Piaget (1970), in primitive form in the thinking of normal children at six or seven years of age.

Silver points out that one of the main ways in which neurological damage impairs thinking is through the impairment of concept formation. According to Rapaport (1972) impairment of verbal expression may escape detection as verbal conventions often survive as "empty shells" even when the ability to form concepts has become disorganised (Silver, 1983:14). Silver implies that drawn representations may provide a medium through which the effects of maladjustment of concept formation may be identified since drawings are representations that are free of verbal conventions. Thus, drawings have the potential to reflect more accurately the level of concept formation than does language.

Silver (1983:10) states that many investigators have found that creative individuals share traits of originality, fluency, playfulness and ability to perceive relationships between apparantly diverse elements. People who use logical and analytical thinking, however, proceed to a correct, conventional solution either inductively or deductively. Moses (1980) explored the effects of instruction in visual thinking on performance in mathematics through a focus on the visual mode of thought rather than on the analytical. Instruction in visual thinking was found to improve both spatial and reasoning abilities with males performing better on spatial tasks and females performing better on reasoning tasks. The difference in performance between males and females however was lessened with further instruction. Problem solving was found to correlate significantly with spatial skills, reasoning skills and degree of visuality; successful problem solvers tended to use visual thinking as one means of solving problems.

Silver (1983:10) refers to various drawing tests to demonstrate that drawing is cognitive and that it can tap creative thinking. *The Torrance Test of Creative Thinking* (Figural Forms) assesses fluency, flexibility, originality, and elaboration. The *Goodenough-Harris Draw-a-Man Test* assesses intellectual maturity. The *Bender Visual-Motor Gestalt Test* assesses visual-motor perception and emotional disturbance. Although these tests are valuable instruments they are not designed to assess ability to solve conceptual

problems graphically. Further, Silver's tests do not purport to assess such an ability, however Silver (1983:11) states that the *Silver Test* does assess cognitive skills not usually tested: the understanding of concepts fundamental in mathematics and possibly reading. In this study the *Silver Test* is regarded as a test of visual-spatial perception where restricted thinking or problem solving is required to identify correct solutions, and unrestricted thinking or problem solving allows for a free response by the test-taker.

(e) SUMMARY OF THE THEORIES IN RELATION TO RESTRICTED AND UNRESTRICTED SPATIAL THINKING OR PROBLEM SOLVING TASKS

Raven drew upon Spearman's view that eductive behaviour was important in describing cognitive abilities. Raven provides a range of tests that provide measures of the ability to educe relationships and correlates in the visual-spatial domain. These tests are suitable for use with children and adults in a culture-free manner. The Advanced Progressive Matrices test, while not a test of pure analog processing ability, does require the use of logical reasoning based upon analogous comparisions of the changes in perceived figures. The use of logical reasoning in this way is characteristic of complex levels of later development found in older children.

Raven maintains that Set II of the Advanced Progressive Matrices provides a means of assessing all the analytical and integral operations involved in the higher thought processes. Further, Raven maintains that it differentiates clearly between people of even superior intellectual ability. Raven points out that although a person's "intellectual efficiency" in the sense of his present speed of accurate intellectual work may be assessed by imposing a time-limit on Set II, a person's total capacity for orderly thinking may not necessarily be indicated, and the two must not be confused one with the other (Raven el al, 1986:G4). In this study, both Set I and Set II of the Raven's Advanced Progressive Matrices test is used under timed conditions to provide a measure of restricted spatial thinking and problem solving.

Silver adopts a process approach in her position on thinking or problem solving. Silver sites evidence that in the developing embryo the sensory organs of the eyes are developed first with the brain as a subsequent outgrowth. Piaget, the stage psychologist, recognised the existence of cognitive structures and described the results of cognitive action, however he did not detail the nature of those structures. Piaget describes structure as a person's representation of knowledge that is available when operating in the world. One's cognitive system would use existing cognitive structures as far as possible to assimilate elements of the new situation, but would alter those

structures as necessary to accommodate the novel features of the situation.

Silver draws on the theories of Piaget to support the notion that logical thought processes precede the development of language, and the age/stage development of cognition as observed by Piaget and Inhelder serve as a paradigm for assessing responses that are drawn rather than written. Silver associates the conceptual abilities to sequence or order subjects and to visualise or conserve both horizontally and vertically with logical thinking. These abilities, together with the ability to perceive and represent spatial relationships, have to do with every-day experiences in the area of restricted problem solving in which a correct, conventional solution is arrived at either inductively or deductively.

Silver suggests that the abilities to select and combine are fundamental to creative thinking and it is the unusual leaps in associating experiences and combining them innovatively that characterise the creative person. The expression of such characteristics may be made through language, visual art, or some other medium, however spatial skills, reasoning skills, and the degree to which visual skills are used are associated with differing levels of thinking or problem solving.

In this study the *Silver Test* is used to provide a measure of restricted spatial thinking or problem solving on tasks where correct solutions are required, and to provide a measure of unrestricted spatial thinking or problem solving on tasks where imagination may be exercised.

CHAPTER 5 DISCUSSION AND RATIONALISATION OF RESEARCH QUESTIONS

(a) INTRODUCTION

In this chapter the research questions are presented and discussed. The study is designed to examine individual differences in information processing, personality, and motivation in respect to restricted and unrestricted thinking or problem solving within the spatial domain. Research themes are identified and various research questions are stated in relation to these themes.

(b) RESEARCH THEME 1

The multidimensionality of certain individual difference models of information processing abilities, personality and motivation.

The expanded Luria model describes two ways in which people process information - successively and simultaneously, together with a third regulatory function - cognitive control. The theoretical differentiation between the two kinds of organising activity, simultaneous (primarily spatial) and successive (primarily temporal) and the executive ability of cognitive control provides the basis for examining these constructs.

The Myers-Briggs theory uses Jung's theories to describe a life-long process whereby a person gains greater command over the attitudes of perception (taking in information) and judgment (making decisions). A person is born with a predisposition to prefer certain dichotomised functions. Eight functions are associated with four dichotomies - Sensing/Intuition, Thinking/Feeling, Judging/Perception, and Extraversion/Introversion. Development of functions continues from childhood through youth in which characteristics associated with the dominant function emerge. In mid-life the less-preferred functions can be developed to allow greater command other them. Although the ideal of individuation will not be reached, an awareness of an individual's strengths and weaknesses as reflected in the dominant and less-preferred functions will allow him/her to arrive at a more informed solution to a problem.

Coopersmith adopts a process approach to self-worth. A person makes a general appraisal of self-worth at a time prior to middle childhood and this appraisal remains relatively stable for several years. Drastic changes in a person's life may lead to inflation or deflation of self-esteem, however, a person's appraisal will revert to the customary level when normal conditions have returned. The notion of Locus of Control is implicit in Coopersmith's theory. A positive self concept is formed through the acceptance of self and the attributing of success to an

internal locus of control (own effort and ability). An increased internal locus of control is associated with an individual's beliefs and expectations of success.

Three factor analytic studies are associated with this research question. Study 1 examines the Luria model of information processing abilities. Study 2 examines the Myers-Briggs model of personality. Study 3 examines the Coopersmith model of motivation.

(1) RESEARCH QUESTION 1

What is the component structure of information processing, personality, and motivation as specified by the measurement procedures stemming from the research of Luria, Myers-Briggs, and Coopersmith?

(c) RESEARCH THEME 2

The dimensionality of restricted and unrestricted thinking or problem solving in the spatial domain.

According to Zimowski et al (1989:11) Raven's Advanced Progressive Matrices test is often mistakenly used as a measure of spatial aptitude (see Caplan, MacPherson and Tobin, 1985). Zimowski et al consider that the items of the test do not require analog (spatial, holistic) processing for their solution, nor do they contain any of the

properties shown to inhibit nonanalog (verbal, or general reasoning) processing. Rather, some of the items require perceptual accuracy while others require an understanding of the logic of spatial structure. Raven's test was used in this study as a measure of restricted spatial thinking or problem solving, where both analytical and logical reasoning skills are required.

The *Silver Test* was chosen to provide a measure of restricted and unrestricted spatial thinking or problem solving. This is the first time that this test has been used in Australia and consequently no normative Australian data is available. The test is nontheless worthy of inclusion in this study as it provides a measure of cognitive skills performance that partly permits free responses as well as restricted responses. The test is not language based and therefore may reasonably be expected to reflect analog (spatial) processing.

Two factor analytic studies are associated with this research question. The first study, study 4 examines the component structure of the Raven's Advanced Progressive Matrices Sets I and II. The second study, study 5 examines the component structure of the *Silver Test*. These studies examine differences in restricted and unrestricted spatial thinking or problem solving skills.

(1) RESEARCH QUESTION 2

What is the component structure of restricted and unrestricted spatial thinking or problem solving based on the Raven's and Silver tests?

(d) RESEARCH THEME 3

Gender and TAFE program group differences with respect to restricted and unrestricted spatial thinking or problem solving and personality.

The components of the *Silver Test*, and the components of the Myers-Briggs model of personality together with gender and TAFE program group identity variables are considered in this question. The study of differences between these variables may have implications for course selection and instructional design of courses in TAFE Colleges.

Two studies are associated with this research question. Study 6 examines the differences between TAFE program groups with respect to restricted and unrestricted spatial thinking or problem solving (Silver), restricted spatial thinking or problem solving (Raven) and personality (Myers-Briggs). Study 7 examines the gender differences with respect to restricted and unrestricted spatial thinking or problem solving (Silver), restricted spatial thinking or problem solving (Raven) and personality (Myers-Briggs).

(1) RESEARCH QUESTION 3

What are the gender and TAFE program group differences in restricted and unrestricted spatial thinking or problem solving and personality?

(e) RESEARCH THEME 4

The differences between levels of information processing, personality and Locus of Control with respect to restricted and unrestricted spatial thinking or problem solving.

An examination of the differences between information processing, personality and motivation variables and the criterion variables of restricted and unrestricted spatial thinking or problem solving may be helpful in identifying student strengths and weaknesses. Once individual strengths and weaknesses are identified, appropriate intervention strategies designed to improve restricted and unrestricted spatial thinking or problem solving may be developed.

Four studies are associated with this research question. The first study, study 8, examines the differences between levels of personality (Myers-Briggs) and Locus of Control with respect to restricted spatial thinking or problem solving as identified in the *Raven's Advanced Progressive Matrices Test* component structure. The second study, study 9, examines the differences between levels of

personality (Myers-Briggs) and Locus of Control with respect to restricted and unrestricted spatial thinking or problem solving as identified in the *Silver Test*. The third study, study 10, examines the differences between levels of information processing (Luria) and Locus of Control with respect to restricted spatial thinking or problem solving as identified in the Raven's Advanced Progressive Matrices component structure. The fourth study, study 11, examines the differences between levels of information processing (Luria) and Locus of Control with respect to restricted and unrestricted spatial thinking or problem solving as identified in the *Silver Test* component structure. In each of the four studies various contrasts are examined and discussed.

(1) RESEARCH QUESTION 4

What are the differences between levels on information processing, personality and Locus of Control with respect to restricted and unrestricted spatial thinking or problem solving?

CHAPTER 6 RESEARCH METHODOLOGY

(a) INTRODUCTION

This chapter describes the research methodology used to examine the research themes and associated research questions stated in chapter 5. Principal components analysis was used to examine the structures of the various models of individual differences and as a basis for developing component scores. The models included those of information processing, personality, motivation, and restricted and unrestricted spatial thinking or problem solving. Multivariate analysis of variance procedures were used to explore the differences between information processing, personality, motivation, TAFE program group and gender variables, with respect to restricted and unrestricted spatial thinking or problem solving.

The research instruments used to measure individual differences in information processing, personality, motivation and performances on restricted and unrestricted spatial problem solving tasks are described. A brief section on the gathering of the TAFE program group and gender data is included. Finally, the selection of research subjects and research procedures is described.

(b) RESEARCH PROCEDURES

(1) Principal Components

The primary statistical procedure adopted in this research was principal component analysis as described by Tabachnick and Fidell (1983:372-445). Principal components analysis allows an empirical summary of the data set to be made whereby a few orthogonal components may be identified from a large number of variables. Since common, unique and error variance is mixed into the components, maximum variance will be extracted from the data set. This variance, expressed as the sum of the values in the positive diagonal of the correlation matrix (R) is available for analysis. Further, principal components analysis will duplicate exactly the standard scores of the observed variables by a linear combination of components where all components are retained.

Principal components analysis was used in studies 1 - 5. These studies examined the structure of inventories of individual differences in information processing, personality, motivation, and the structure of tests of restricted and unrestricted spatial thinking or problem solving. Factor analysis has been used traditionally as an exploratory technique in studies investigating cognitive abilities. It has also been used to investigate individual differences in ability in some of the cognitive processes described by Luria (ie Angus, 1984; Green, 1977; Tulloch,

1981; Crawford, 1986), and to investigate motivational aspects of self-esteem described by Coopersmith (1987). Since the goal of this research was to collapse a large number of variables into components that may be used to study the interrelationships between spatial thinking or problem solving and several different dimensions of individual differences using component scores, principal components analysis rather than factor analysis was used.

An orthogonal rotation procedure, consistent with the theoretical independence of the underlying dimensions allowed for shared variance to be minimised. The Varimax rotational procedure was used to maximise the simple structure obtained from the various component analyses of the variables included in the studies.

Once the underlying unobservable characteristics or components of individual differences within the variables were identified, multivariate analyses of variance were used to allow specific comparisons to be made among variables in the design, and to examine their relationship to dependent variables.

(2) Multivariate Analysis of Variance (MANOVA) Procedures

The secondary statistical procedure of multivariate analysis of variance (MANOVA) was used to explore the relationships between individual differences and restricted and unrestricted spatial thinking or problem solving. Individual differences included information processing

functions, personality, motivation, TAFE program group identification and gender. Although canonical correlation procedures are the most appropriate to analyse the research data, MANOVA allows for a clearer description of the numerous relationships including interactions being examined. Further, the use of planned contrasts permits contrasts of linear and curvalinear relationships to be explored. MANOVA procedures were used in studies 6 - 11.

(c) RESEARCH INSTRUMENTS

(1) Description of Research Instruments

The test instruments used in this research have been widely used in previous studies. Some tests are better known in Australia than others, however all tests are based on the theories outlined in this thesis. Objective tests were used to measure individual differences of information processing and restricted and unrestricted spatial thinking or problem solving. Self-report inventories were used to measure some individual differences of personality and motivation.

The Luria battery of objective tests was developed in PhD research programs completed at the University of New England and were used in the Queensland TAFE setting for the first time. These tests were used to measure individual differences in information processing abilities based on the

expanded Luria model of simultaneous/successive information processing and cognitive control.

The Myers-Briggs Type Indicator is a self-report inventory of personality/cognitive types. This test has been widely used in many diverse studies in North America and has been used in clinical settings in Australia in recent years. Baker (1985) used the Myers-Briggs Type Indicator to investigate the relationships between attitude towards science, spatial ability, mathematical ability and cognitive preferences that are characteristic of the 'scientific' personality. Kalsbeek (1986) used the Myers-Briggs Type Indicator to assess the cognitive and affective processes that influence the integration of social and academic measures in an investigation into learning style theory and college retention rates. Roach (1986) used the Myers-Briggs Type Indicator to investigate the different types and the different levels of organisational decision-making.

The Coopersmith Self-Esteem Inventory is a self-report inventory that has been used as a measure of general self-concept (Coopersmith, 1967; Dyer, 1964; Smith, 1973; Epstein and Komorita, 1971). Correlations between the Coopersmith Self Esteem Inventory and the California Test of Personality were investigated by Dorr, Rummer and Green, (1976). Marsh and Richards (1986) used the Coopersmith Self Esteem Inventory in a study on academic achievement and self-concepts.

Raven's Progressive Advanced Matrices tests have been used as measures in which higher intellectual functions and superior intellectual efficiency are required. These tests have been used in Australia by Yates and Forbes (1965) to standardise the 1962 edition of Raven's Advanced Progressive Matrices. McLaurin, Jenkins, Farrar and Rumore (1973) used Raven's Advanced Progressive Matrices in a comparision with the intellectual measures of the full Wechsler Adult Intelligence Scale (WAIS) and Otis I.Q. tests.

The Silver Drawing Test of Cognitive and Creative Skills was used in Australia for the first time. The test has been used in North America and Britain in connection with art therapy programs. It has been used to assess the effectiveness of art therapy programs as well as to assess cognitive abilities in the visual-spatial domain to do with normal and creative problem solving.

Each of the abovementioned tests are examined in detail in the following sections. Support material too lengthy to incorporate in the main text is included in appendices as indicated.

(2) Tests for Cognitive Control Ability

Luria (1973) described the capacity to direct and select the essential elements from presented stimuli for mental activity as attention. One aspect of the development of selective attention is shown in the studies of Shepp (1978) which contained tasks involving speeded sorting and

free classification of stimuli that varied on two dimensions. His findings showed that older children and adults demonstrated the capacity to attend independently to dimensions, whereas young children perceived dimensions as integral and responded on the basis of overall similarity. This ability to attend separately to the multiple attributes of a stimulus is crucial to thinking or problem solving performance where the solution relies on the correct identification to the task relevant dimension.

Crawford (1986) described the ability to regulate and maintain intellectual activity that is subordinated to a conscious goal, such as attending selectively to a multiplicity of stimuli as "executive control." Crawford posited that such ability may represent the contribution of the frontal lobes of the cerebral cortex to conscious goal directed activity.

The Cognitive Control ability was measured by the Visual N/L (number/letter) Search Test, and the Auditory Number/Letter Attention Span Test in the Luria battery of tests. The Visual N/L (number/letter) Search Test is a timed test containing two sub-tests in which subjects are required to exercise flexible attention and to choose a correct solution from choices between odd and even numbers, and between vowels and consonants. Before the start of the test the subjects were instructed to regard the letters 'a, e, i, o, u' as vowels, and the number '0' as an even number. The test is presented to subjects as twenty-four

tasks on a printed sheet. An instruction is given in the left-hand column on the printed sheet of paper and subjects are required to place a cross on the letters or numbers as indicated by the instruction (depending on the task relevant dimension of letters or numbers).

Eleven tasks contain twenty-four letters, and require subjects to select either vowels or consonants. Thirteen tasks contain twenty-four numbers and require subjects to select either odd or even numbers. Total time given for the test is 2 minutes 30 seconds. A final score was calculated from the total number of correct responses and the total number of incorrect responses. (See Appendix A). Crawford (1986) found that a similar test, Letter Search Test, loaded .55 on the factor described as "executive control."

In the Auditory Number/Letter Attention Span Test, a shift of focus is required whereby subjects are required to recall the exact order of either numbers or letters as directed by an aural cue given by the researcher at the beginning of each item. In this test a correctness score was assigned to each of the twenty items. This correctness score is derived by rating the correctness of the series recalled. For example, if letters are to be recalled from the item (6 F 2 S 9), and (F S) is the response, then the correctness score is 2 as the entire series is recalled correctly. If (F 2 S) is the response, however, then the correctness score is 1 as the first letter only and not the entire series is recalled correctly. (See Appendix A).

Crawford (1986) found that the Auditory Number/Letter Attention Span Test loaded .38 on the "successive" factor, however in this study the test is regarded as a measure of selective attention.

(3) Tests for Simultaneous Information Processing Ability

The Simultaneous Information Processing Ability was measured by the Form Board Test and the Paper Folding Test in the Luria battery. The Form Board Test and instructions were developed from the test used by Walton (1983) which was chosen from the Ekstrom, French, Harman and Dermen (1976) kit of cognitive tests. The test consists of twenty-four problems each of which contains five geometric shapes. Separate sheets of paper contain six problems which related to each of four geometric shapes: a cross (plus sign), a hexagon, a square, and a triangle. Each item is divided into at least two but no more than five pieces. Subjects are required to indicate which of the five pieces, arranged randomly, make the complete shape when put together by placing a plus sign under the relevant shapes, and a minus sign under those shapes which do not form part of the solution. Each piece may be rotated to any position but none can be turned over as in a reflection.

Three practice problems are provided using a rectangle as the basic shape to be constructed. One possible solution to the first problem is shown on the instruction sheet and subjects are directed to try to solve the other two practice

problems. Possible solutions to these two problems are drawn on a board for all subjects to see before the twenty-four items of the test are attempted. A period of eight minutes is given for completion of the test. Each problem is marked correct (one mark) if all pieces are correctly chosen. Part marks are not assigned if only some of the pieces are selected. Items not attempted are marked as incorrect and all incorrect answers are assigned a mark of zero.

The Paper Folding Test was also used to measure simultaneous processing ability. A Paper Folding Test was used as a measure of simultaneous processing ability in the main study of Cummins (1973), Walton (1983), and Crawford (1986). The test corresponds to Part 1 of the Paper Folding Test Vz-2 of Ekstrom et al (1976), and was based on the Punched Holes test of Thurstone (1938). The test involves the visual manipulation of a spatial configuration and contains 10 items.

In each item two or more drawings are provided in a left-hand column to illustrate how a square sheet of paper is folded. In the final folded sheet, the illustration shows one or two holes are punched through all the thicknesses of paper. Subjects are required to choose from five drawings of unfolded sheets the one that correctly shows all the holes punched in the folded sheet.

The test instructions include a sample item which shows the processes of folding, hole punching, and unfolding the

paper. Subjects were able to match the result to the appropriate drawing. Three minutes is allowed for completion of the test. Each correctly identified item was assigned one mark. (See Appendix B).

(4) Tests for Successive Information Processing Ability

The Successive Information Processing ability was measured by two serial recall tests - The Auditory Word Span Test and the Auditory Number Span Test in the Luria battery. Each test consists of twenty items which are series of words in The Auditory Word Span Test, and series of numbers in the Auditory Number Span Test. Crawford (1986) found that the Auditory Word Span Test, and the Auditory Number Span Test loaded .75 and .93 respectively on a factor called "successive."

The two tests are administered in the same manner. The instructions for a test are given aurally by the researcher to the subjects. The content of the test is then delivered by tape recording to the subjects. The rate of delivery is one symbol (word, number) per second.

In the Auditory Word Span, and the Auditory Number Span Tests, the exact order of all the words or numbers are to be recalled by subjects. In each test a correctness score was assigned to each of the twenty items. This correctness score is derived by rating the correctness of the series recalled. For example, in the Auditory Number Span Test, if the number series (2 4 8 5 1) is to be recalled,

and (2 4 8 5 1) is the response, then the correctness score is 5 as the entire series is recalled correctly.
If (2 4 8 1 5) is the response, however, then the correctness score is 3 as the first three numbers only have been recalled correctly in sequence and not the entire series. (See Appendix C).

(5) Test for Personality Dimensions of Individual Differences

The Myers-Briggs Type Indicator is a self-inventory that, when used with high school students and adults who have at least an 8th grade reading level, will yield a reported personality type that has been frequently used for individual guidance.

Form G is the standard form consisting of 126 forced choice questions. The form contains research items as well as items scored for type. Items that best predict total type scores are arranged at the beginning so that there is an increased likelihood that respondents who do not finish the Myers-Briggs Type Indicator will still receive accurate reports of their type (Briggs Myers and McCaulley, 1985:6-7). Since the Myers-Briggs Type Indicator items are reasonably transparent and answers can be falsified, the environment in which the instrument is administered has to be managed by the researcher to create a situation in which subjects can respond freely, secure in the knowledge that the results will be treated with strict confidentiality.

The construction of the Myers-Briggs Type Indicator is based on three assumptions provided by Jung's theory of psychological types:

(1) 'true preferences' actually exist. Although these preferences can be more confidently identified in persons with good type development than in persons with inadequate type development, the probability must be maximised that correct assignment will occur of persons unsure of their preferences.
(2) A direct or indirect indication of preferences that combine to form type can be given by persons on a self-report inventory.
(3) Preferences are dichotomized; the two poles of a preference being of equal value in its own sphere.

Questions are directed to surface motivation, values, and behaviours, which although seemingly simple, provide evidence about the underlying complex and profound patterns of behaviour. These complex behaviours indicate preferences that may or may not be consciously formulated.

The forced-choice question format is used because type theory postulates dichotomies. All choices are made between the poles of the same preference, e.g. Extraversion or Introversion, Sensing or Intuition, Thinking or Feeling, Judging or Perception. This format has the advantages of:

(a) acceptance of each dichotomy as a choice between equally legitimate alternatives.

(b) avoiding response sets that are biased because of acquiescence and perceived social desirability (Briggs Myers and McCaulley, 1985:140-141).

In this study standardised scores for each of Extraversion, Introversion, Sensing, Intuition, Thinking, Feeling, Judging, and Perception preferences were derived for further analyses. These standardised scores are derived from scoring the first ninety-five items on Form G of the Myers-Briggs Type Indicator. Consistency and reliability data for the Myers-Briggs Indicator are contained in Appendix D.

It is suggested in the Manual that one way to validate the Myers-Briggs Type Indicator is to compare the results with self-assessment of type preferences, and that it is expected that agreement with the Myers' description is the best test of the Myers-Briggs Type Indicator (Briggs Myers and McCaulley, 1985:209). This suggestion was followed in this study. In two studies conducted by Carskadon (1975, 1982) it was found that students were significantly ($p<.001$) less likely to select as most accurate the description differing from the reported type on the functions SN (Sensing and Intuition), and TF (Thinking and Feeling) than they were to choose the type differing from the reported type on the attitudes EI (Extraversion and

Introversion), and JP (Judging and Perception). Validation of the Myers-Briggs Type Indicator was scored 1 for "agree with type" and 2 for "disagree with type" in this study.

According to type theory creativity is expected to be associated primarily with the Intuition preference and secondarily with the Perceptive attitude. The earliest studies were conducted by McKinnon and his colleagues as well as studies by Cropley (1965), Owen (1962), Ruane (1973), Whittemore and Heimann (1965), Burt (1968), Stephens (1975), Erickson, Gantz, and Stephenson (1970), and Gryskiewicz (1982) which are reported in the Manual (Briggs Myers and McCaulley, 1985:214-215). See Appendix D for a detailed description of test administration.

(6) Test for Motivation Dimensions of Individual Differences

The Coopersmith Self Esteem Inventory was developed to be a reliable, valid measure of self-esteem emanating from a study of self-esteem in children (Coopersmith, 1967). The major basis of this study was the widely-held belief that self-esteem is significantly associated with personal satisfactions and effective functioning.

The Adult Form of the Coopersmith Self Esteem Inventory is used with persons aged sixteen and above, and consists of twenty-five items adapted from the School Short Form. A modification of language and situations was made in the

Adult Form to make the items more meaningful to adults. A correlation exceeding .80 for three samples of high school and college students (N=647) is reported for total scores on the School Short Form and the Adult Form in the Manual (Coopersmith, 1981:2). The School Short Form was in turn developed from an item analysis of the School Form. The total score correlation of the School Form with the School Short Form is reported to be .86 (Coopersmith, 1967).

General guidelines only are given in the Manual for the various levels of self-esteem in the absence of exact criteria. The levels will vary according to the characteristics of the sample, the distribution of scores, and theoretical and clinical considerations. High scores correspond with high self-esteem for the SEI, and in most studies there has been a negative skewing of score distributions in the direction of high self-esteem. The means generally range from 70 to 80 with a standard deviation of from 11 to 13.

It is stated in the Manual that the Coopersmith Self Esteem Inventory has been administered to tens of thousands of children and adults who have participated in research studies, and special educational, or clinical programs to enhance self-esteem. A review of these studies was conducted from 1970 through 1979 (Gilberts, 1981), and it is mainly from this source that data on reliability and validity of the School Form of the Coopersmith Self Esteem Inventory is reported. Kimball (1972) administered the test

to 7593 public school children in grades 4 through 8 from two northern Illinois school districts. Students of all socio-economic ranges were included as well as those with Black and Spanish surnames.

Table 1 shows an obtained coefficients range from .87 to .92.

TABLE 1

Grade	r	N
4	.92	1502
5	.87	1407
6	.88	1650
7	.89	1539
8	.90	1495

Table 1: Internal Consistencies for Grades 4 - 8 (Kimball, 1972; Coopersmith, 1981:12).

The sample was purported to be representative of the general population of the United States. Evidence of construct validity of the Coopersmith Self Esteem Inventory may be gleaned from the reported percential equivalents which showed a consistency of score values at a given

percentile (Coopersmith, 1981:13). Fullerton (1972) reported a split-half reliability coefficient of .87 in a study of 104 students in grades 5 and 6.

Coopersmith (1981:12) states that tests of stability should be interpreted with caution since affective traits are subject to sudden and significant changes over short periods of time. Coopersmith claims that temporal stability of the Coopersmith Self Esteem Inventory is confirmed however, in a study by Drummond, McIntire, and Ryan (1977) who used the Coopersmith Self Esteem Inventory in a pretest-posttest comparison with 591 children, grades 2 through 12 (6-month interval). Significant correlations were found for all grade levels and both sexes for the General Self subscale and Total Self scores. Bedeian, Geagud and Zmud (1977) reported coefficients of .80 for males and .82 for females in test-retest reliability estimates for 103 college students using the Short Form.

Evidence of test form reliability is provided in the study by Battle (1977). The Canadian Self Esteem Inventory was constructed to approximate the Coopersmith Self Esteem Inventory, and for N = 198 children in grades 3 through 6, correlations ranged from .71 to .80 (Coopersmith, 1981:13).

There is little available normative data for the Adult Form of the Coopersmith Self Esteem Inventory. The Manual sites one study of N=226 college students drawn from a community college and a state university in Northern California (Coopersmith, 1981:19). The mean age of students

was 21.5 with a standard deviation of 3.5 and a range of 16 to 34 years. There were no significant gender or school effects reported and the reliabilities ranged from .78 to .85. A trend for slightly higher self-esteem for subjects no longer in their teens was reflected by the mean difference in scores between the 16-19 age group and the 20 - 34 age group which approached statistical significance (p=.06). These data may be useful in comparison with the present study where the age ranges of the sample population was similar. As the Coopersmith Self Esteem Inventory has not been used extensively in Australia, it was decided to perform a component analysis on the item data and use appropriate component scores in subsequent analyses.

See Appendix E for a description of the administration of the test.

(7) Tests of Restricted Spatial Thinking or Problem Solving (Raven)

The 1962 edition of the Raven's Advanced Progressive Matrices Set II tests, and the 1958 edition of the Set I tests was used in this study.

The Raven's Advanced Progressive Matrices tests consist of two sets - Set I, containing twelve problems, and Set II containing thirty-six problems. The Set I problems are designed as an introduction to the method of working and cover all the intellectual processes needed for success in Set II. The problems in Set II are identical with respect

to presentation with the problems in Set I; the rate of increase in difficulty is more steady and they become considerably more complex in Set II. The problems are arranged in order according to the frequency with which they are solved which means that the validity of the total score does not depend upon a person's attempting all problems in the scale before stopping. A working period of forty minutes is reported as being the time span which usually gives the most satisfactory distribution of scores (Raven et al, 1983:APM2).

Test items were developed from a conceptual field approach. The most frequently used response in determining the solution to problems is that which shows a *serial change* running through the field of thought. The most frequent mode of this particular response, particularly from an adult, is one in which the field of thought shows a 'productive' change. In the Matrices test the sequence in which the problems are presented provides the appropriate field of thought. The structual 'order' of the field that emerges is determined by the mental activity in progress and the degree of intellectual organisation of which a person is capable. It is the quality of this intellectual organisation revealed by the solution chosen by a person that is of psychological interest, according to Raven et al (1986:G7).

Raven maintains that, keeping in mind the effect which the context or field of thought has upon the order of

solution preferred, it can be seen that an acquired degree of intellectual sophistication is involved in consistent inference by analogy. This method of reasoning is relied upon by the majority of adults but is seldom found in young children. Data were gathered by administering the 1947 version of the Raven's Advanced Progressive Matrices (Sets I and II). The re-test reliability of r = .91 with adult students of more than average intellectual capacity is reported. A probable explanation for the low re-test reliability of r = .76 for children of 11 years was given as an age when the ability to form comparisons and reason by analogy is too recent an intellectual development for it to be exercised with a consistent degree of efficiency (Raven et al, 1983:APM7).

Raven provides some interesting data on test scores obtained by Junior and Senior Technical College and University students. Although not a representative sample of university students in general, attention is drawn to the situation in which mean scores obtained by students in different faculties,

> "fall off more or less in the order in which success in the course they are pursuing might be expected to depend upon the intellectual efficiency with which a person was able to form comparisons and reason by analogy from his

immediate experience rather than upon acquired verbal information,"
(Raven et al, 1983:APM7).

The relationship between speed and efficiency of work is also reported. At the end of forty minutes' work at speed, selected students were asked to continue until they had completed all problems contained in Set II. The output of efficient intellectual activity appears to be almost the same for students who worked at speed and attempted a large number of problems, guessing when a solution is not clear, and for students who attempted fewer problems but made fewer mistakes. It also appears that intellectual efficiency depends to some extent upon the economical utilization of disposable time, however the scale can also be used satisfactority to assess total capacity (Raven et al, 1983:APM10-11).

Further evidence on reliability of the scale is provided by Poortinga (1972) who found that split-half reliability in a cross-cultural study of African and European students to be .83 and .71 respectively. Poole and Stanley (1972) reported that the Raven's Advanced Progressive Matrices was found to have a loading of .64 on a factor identified as figure manipulation or visualisation in a study with examined the validity of the Raven's Advanced Progressive Matrices as one in a battery of instruments for predicting success in university engineering studies.

In comparison with other intellectual measures, McLaurin et al (1973) reported a correlation of .74 with the full WAIS and .75 with the Otis I.Q. tests of APM performance.

Normative data is provided in Table 2 which shows that the scale is designed to differentiate between people around and above the ninety-fifth percentile.

TABLE 2

Percentile	Age in years								
Points	11,½	12	12,½	13	13,½	14	20	30	40
95	16	17	18	19	20	21	24	23	21
90	14	14	15	16	17	18	21	20	17
75	8	10	11	12	13	13	14	12	9
50	-	-	-	8	9	9	9	7	-

Table 2: Estimated norms for the Raven's Advanced Progressive Matrices Set II (1962 revision), (40-minute time limit) (Raven et al, 1983:APM27).

Answer sheets are provided and subjects are asked to fill in the identifying details on the sheets. Set I is introduced as a practice set and the method of working is explained as set out in Section 4 of the Manual. A time limit of five minutes applies for Set I. Set II is

introduced as the 'real test' as suggested in the Manual, and a time limit of forty minutes applies for Set II (Raven et al, 1983:APM4-APM6).

The Raven's Advanced Progressive Matrices was administered to subjects in a group setting. Each of the twelve items in Set I that were correct were given 1 mark, and each incorrect item was given a zero. Each of the thirty-six items in Set II were marked in a likewise manner.

(8) Tests of Restricted and Unrestricted Spatial Thinking or Problem Solving (Silver)

The *Silver Test* has been used in studies designed to assess and develop cognitive skills. The scoring of The *Silver Test* is based on experiments by Bruner and associates (1966) and by Piaget and Inhelder (1967) where the observations about age/stage development of cognition serve as a paradigm for assessing responses that are drawn (Silver, 1983:12). In the present study its use was confined to the assessment of cognitive skills.

There are three sub-tests of The *Silver Test*:

(1) The Predictive Drawing sub-test assesses mastery of sequential order and hypothetical situations involving conservation of horizontal and vertical relationships.

(2) The Drawing from Observation sub-test assesses the spatial relationships of height, width, and depth.

(3) The Drawing from Imagination sub-test assesses ability to form concepts (abstract, concrete), and creativity.

The sub-test of Predictive Drawing focuses on assessing the ability to represent a sequence and to understand the principle of conservation which is basic in logical thinking (Silver, 1983:13). The first natural system of reference a person has involves horizontals and verticals and provides the most stable framework of every-day experience. The ability to visualise or conserve concepts of horizontality and verticality develops throughout childhood, although some adults may never develop the ability to conserve horizontally.

The sub-test of Drawing from Observation is concerned with the ability to perceive and represent spatial relationships. According to Piaget and Inhelder (1967) young children regard single objects in isolation. Eventual development of a co-ordinated system of perception occurs involving three directions - left-right, before-behind, and above-below.

The Drawing from Imagination sub-test assesses the ability to form concepts. The ability to select (content) at the perceptual, functional, or abstract levels is the first stage in concept formation. This ability is developmental in nature as described by Hornsby (in Bruner 1966:79-85) whereby normal children progress from using the basis of attributes (e.g. colour or shape) to

group subjects, through the ability to group on the basis of function (i.e. what the selected subjects do or what can to done to them), to the ability to group conceptually on the basis of class (i.e. the abstract, invisible attributes) (Silver, 1983:14).

The second stage of concept formation is the ability to combine (form). Children gradually develop the ability to consider objects in relation to neighbouring objects in an external frame of reference where account is given for distance and proportion. Increasing complexity in overall co-ordination of the elements provides a scale to assess this ability. Silver (1983:15) associates the ability to represent with creativity and relies on the observations of Piaget and Inhelder (1967) who note that a child's understanding of space is at first imitative and passive on the perceptual level, and continues on to be intellectually active on a representational level where the characteristics of transformation, originality, expressiveness or playfulness are evident in drawn responses to stimulus drawings.

The study by Silver, Lavin, Boeve, Hayes, Itzler, O'Brien, Terner and Wohlberg (1980) received the 1980 Award for Research from the American Art Therapy Association. One objective of this study was to determine the relationship of the *Silver Test* to traditional tests of intelligence and achievement. The Otis Lennon School Ability Test and the *Silver Test* were administered to ninety-nine children in

grades 2 and 3 from two schools included in the project and in a third school in New York.

TABLE 3

Subtest	r	p
Predictive Drawing	.30	.01
Drawing from Observation	.05	ns
Drawing from Imagination	.39	.01

Table 3: Product Moment Correlations between the *Silver Test* Scores and Otis Lennon School Ability Test Scores (Silver, 1983:87).

There were significant relationships between two of the sub-tests - Drawing from Imagination, and Predictive Drawing (Table 3). The relationship between these tests is only moderate, however both instruments assess intellectual ability through different assessment techniques, and emphasise language and visuo-spatial cognitive skills to a different extent.

In an investigation involving deaf students the relationship of the *Silver Test* to the WISC Performance IQ scores was examined. Again, there were significant relationships between the Drawing from Imagination and Predictive Drawing at p = .01 of .37, and .33 respectively.

As well, there was a significant relationship between the total score of the *Silver Test* and the WISC of r = .29, p = .05. Thus, the *Silver Test*, which involves the ability to select, combine, and represent, appears to measure aspects of cognition which are also measured to some extent by both the Otis Lennon and WISC Tests. These results support the hypothesis that the use of drawing rather than language can be used to measure cognitive skills in the *Silver Test*, and also explains the cognitive strengths in some children - strengths that are not identified by other instruments (Silver, 1983:21).

In a study by Moser (1980) the reliability and validity of the *Silver Test* was examined. The *Silver Test* was administered twice to twelve learning-disabled students, and separate reliability coefficients for each sub-test were computed. All relationships were significant at p = .05 with a test/retest correlation of .80 for Predictive Drawing, .84 for Drawing from Observation, and .56 for Drawing from Imagination. To assess validity, Moser compared the scores of her learning-disabled subjects on the *Silver Test* with their scores on four other tests. Some of the more significant results include the relationship between the Drawing from Imagination sub-test and the Draw-A-Man test was reported as r = .75 with p = .001. The relationship between the Draw-A-Man test and the total of the *Silver Test* was reported as r = .72 with p = .001. More moderate relationships were reported between the WAIS

(performance) test and the Drawing from Imagination sub-test as r = .59, and between the WAIS (performance) test and the *Silver Test* total as r = .60, all with p = .001 (Silver, 1983:89).

Investigations of scorer reliability have also been carried out on the *Silver Test*. Available data from the Silver et al study (1980) show a high degree of reliability of assessment across examiners with r ranging from .88 to .96 across the sub-tests for seven judges scoring test booklets of six children. In the present study the *Silver Test* was independently scored by the researcher and a second scorer.

Each of the sub-tests consisted of three items. Each item was marked out of a maximum of five marks. Two extra items of Projection and Language were each marked out of a maximum of five marks in conjunction with the third sub-test. In this study the item scores rather than the sub-test total scores will be analysed. See Appendix F for a detailed description of test administration.

(9) Gender and TAFE Program Group

Data on gender and TAFE program group were gathered and included in the study. Gender and TAFE program group membership are of interest in this study with respect to identifying areas for future research and development within the TAFE setting.

(d) SUBJECTS AND RESEARCH PROCEDURES

(1) Permission and Preliminary Data Collection

A permission and preliminary data collection sheet was developed for use in the study. Requirements for last and given names, and student number were necessary as a checking device to ensure that data collected was correctly matched with the research subject. Research subjects were assured that these data would be strictly confidential, and that their data profile would be identified only by an assigned research number.

See Appendix G for a sample of the data collection sheet that was given to all research subjects in Session 1 of the research program.

(2) Selection of Sample

There were 193 subjects in the study. The selection of subjects according to TAFE program group identification was determined by course enrolment and subjects' willingness to participate in the study. This stratified sample was representative of the emergent complex population at Ithaca TAFE College in 1989-1990. A description of the client structure of TAFE Colleges generally, and of Ithaca TAFE College specifically, is provided in Chapter 7.

(3) Assumptions and Limitations of the Study

It was expected that the chosen sample would exhibit a spread in scores with respect to the variables and the factors that are to be measured, as suggested in Tabachnick and Fidell (1983:378). As discussed earlier, there was an imbalance of gender representation across groups and within groups.

Some aspects of instrumentation placed limitations on the study. The *Silver Test* had not been evaluated in Australia before, and the Myers-Briggs Type Inventory had been used in Australia mainly in clinical settings. The use of objective tests to measure individual differences of information processing also placed limitations on the study. Although these objective tests may be considered as adequate for the early stages of research such as contained in this study, their use does limit the extent of investigation. The use of self-report inventories likewise imposed limitations on the study in that students may not have responded honestly to questions and may have provided answers which they perceived to be socially more acceptable.

Testing effects were minimised by providing a balance of objective and inventory tasks and by administering tasks from the same session to all subjects within the span of a few days. Missing data on subjects across the tests did constitute a threat, however allowances were made for this in the statistical procedures for most studies. The study of restricted spatial thinking or problem solving involving

the Raven's Advanced Progressive Matrices was severely affected by missing data.

(4) Description of Test Order and Data Collection

The overall objective for the administration of the testing program was to provide a balance between self-inventory and objective tasks. The secondary objective was to provide a program that would be as free of any cross-effects of the various tests as possible. Data were collected during a six-week period in the first semester, 1989, in seven sessions.

In Session 1 permission, and preliminary data such as name, student number, date of birth, gender, and course identification was gathered. (See Appendix H). In Session 2 subjects completed the Raven's Advanced Progressive Matrices Set I and II which are objective tests of restricted spatial thinking or problem solving.

The inventory/production test balance was established in Session 3 with the Coopersmith Self Esteem Inventory followed by the objective tests: Number/Letter Search Test (Cognitive Control Ability), Form Board Test (Simultaneous Information Processing Ability), and the Auditory Word Span Test (Successive Information Processing Ability) from the Luria battery of tests. The Coopersmith Inventory is short and ample time was provided for the more intensive Luria tests.

In Session 4 the focus of research shifted to the identification of cognitive/personality style preferences through the use of The Myers-Briggs Type Indicator.

Objective tests from the Luria battery were administered in Session 5 to provide a balance to the previous session. These tests included the Number/Letter Attention Span Test (Cognitive Control Ability), Paper Folding Test (Simultaneous Information Processing Ability), and Auditory Number Span Test (Successive Information Processing Ability). As these tests are fairly intensive and there were no remaining inventory tests required at this stage, it was preferable that they were the only tests to be administered in the session.

The *Silver Test* was the only test to be given in Session 6. The focus of the research program to this point had been on the assessment of abilities to process information, personality and motivation and the measurement of restricted spatial thinking or problem solving. The inclusion of The *Silver Test* provided a major shift of focus from the measurement of restricted spatial thinking or problem solving performance to the measurement of unrestricted spatial thinking or problem solving. For this reason it was preferable that it was the only test given in the session.

In Session 7 feedback on the Myers-Briggs Type Indicator was given to subjects. This was the final session.

(5) Description of Sessions

FIG 1

SESSION	NOTES
Session 1:	
Permission/ Preliminary Data	The study was explained to students and preliminary data and permission to include data in the study was obtained.
Session 2:	
Raven's Advanced Progressive Matrices Sets I, and II	The Raven's tests were administered in this session to set the tone of the study as one of serious scientific intent.
Session 3:	
Coopersmith Self Esteem Inventory	The Coopersmith Self Esteem Inventory was administered first to allow subjects to be as unconstrained as possible by any effects of achievement levels of the Luria objective tests.

FIG 1 (continued)

Session 3 (continued)	
Luria Information Processing Ability Tests 1, 2, 3	The first Luria test was The Number/Letter Search Test (Cognitive Control Ability), followed by The Form Board Test (Simultaneous Information Processing Ability), and The Auditory Word Span Test (Successive Information Processing Ability). These are objective tests.
Session 4:	
Myers-Briggs Type Indicator	Subjects were given a brief explanation of the background and the terminology used in the Indicator before it was administered.
Session 5:	
Luria Information Processing Ability Tests 4, 5, 6	The Number/Letter Attention Span Test (Cognitive Control Ability) The Paper Folding Test (Simultaneous Information Processing Ablility),

FIG 1 (continued)

Session 5 (continued)	
	and The Auditory Number Span (Successive Information Processing Ability) are objective tests.
Session 6:	
The *Silver Test*	This objective test consists of three sub-tests of sequential concepts, spatial concepts, and association and formation of concepts.
Session 7:	
Feedback on Myers-Briggs Type Indicator	The feedback on the Myers-Briggs Indicator was administered to allow subjects to verify (or not verify) the personality/cognitive style profiles as being ones that they perceive for themselves.

Fig 1: Description of Sessions.

CHAPTER 7 CLIENT STRUCTURE OF A TAFE COLLEGE

(a) INTRODUCTION

In this chapter the client structure of TAFE Colleges generally, the client structure of Ithaca TAFE College, and the client groups in the study is described. The differences across client groups are examined, and the need to cater for individual differences is highlighted in planning for future course offerings.

(b) DESCRIPTION OF CLIENTS IN TAFE COLLEGES

The populations of TAFE Colleges in Australia are emerging as a complex mix of people who are drawn from an increasingly wide range of socio-economic groups. Some of the major influences on the changing nature of the student structure of TAFE Colleges are: the introduction of the industry training levy whereby businesses contribute to the cost of providing training for their employees, the introduction of Commonwealth Government sponsored training initiatives for the long-term unemployed, the incorporation of TAFE-accredited pre-vocational training courses in secondary schools, the stringent economic conditions in which the demand for broad-banding of skills has increased, and the exponential nature of technological change which has made necessary the frequent updating of vocational skills.

The introduction of the training levy has influenced the makeup of all TAFE Colleges, both metropolitan and country, by placing increased demands on institutions to provide relevant, and current learning outcomes for a wide variety of clients who are currently employed. The needs of long-term unemployed clients are also being targeted through government-sponsored programs that focus on the aquisition of vocational skills that have been identified as being in demand in the employment market.

The general shift of the provision of pre-vocational training away from TAFE Colleges to secondary schools has influenced on-campus TAFE College populations by decreasing the demand for pre-vocational certificate courses especially in the trades and office education areas. Increasing numbers of students are remaining at secondary school to undertake pre-vocational studies and are coming to TAFE Colleges as post-Grade 12 students. Consequently, the demand has increased for Associate Diploma and Diploma courses from which clients expect both higher initial and continuing vocational outcomes.

(c) DESCRIPTION OF CLIENTS AT ITHACA TAFE COLLEGE

Ithaca TAFE College is a metropolitan college, ranked about fourth largest in the State of Queensland. It is situated in a suburb close to the central business district. Its client base is drawn both from the western and northern regions of the greater Brisbane area which it serves, and

from all other areas of Brisbane and the State for those courses that are unique to the College. The wide base from which clients are drawn means that most socio-economic groups are represented.

The broad cultural differences across different courses, eg the various trade apprenticeship courses, and the various certificate and associate diploma courses in the business and computing areas tend to persist largely because clients 'pre-select' themselves by enrolling in courses according to their particular cultural perceptions of course outcomes, job opportunities, and societal expectations. The large numbers of males enrolled in engineering and construction apprenticeship courses, and in associate diploma courses reflects the culturally-accepted view of males being employed in traditional trade areas and in middle management. Likewise the large numbers of females enrolled in certificate level courses, particularly in the office education area reflects the culturally-accepted view of females providing operational support to largely male dominated middle management.

(d) THE CLIENT GROUPS IN THE STUDY

Four different client groups were included in this study. These groups were considered to be broadly representative of the range of clients attending full-time courses at Ithaca TAFE College.

Group one consisted of twenty male students and one female student enrolled in the CN088, Certificate of Pre-Vocational Engineering/Construction Course. Ages ranged from 15 to 18 years. This course is conducted over one year during which time students have the opportunity to acquire basic skills in a range of trades within the engineering/construction areas. On completion of the course students typically apply for an apprenticeship in a trade area in which they are interested. Most of the clients in this course have not completed year 12 secondary education; some have experienced learning difficulties and/or behavioural difficulties during their secondary education.

Group two consisted of one male student and thirteen female students enrolled in CN074, Certificate of Kennel and Cattery Practices, and three male students and twenty female students enrolled in CND29, Certificate of Business Electronic Information Processing. Students ranged in age from 16 to 48 years. The CN074, Certificate of Kennel and Cattery Practices course is conducted over six months, and on completion of the course students may seek employment as Kennel and Cattery assistants. The CND29, Certificate of Business Electronic Information Processing course is conducted over nine months, and on completion of the course students may seek employment as operators in offices using business computer applications such as word processing, spreadsheet, and data base.

Group three consisted of six male students and seventy-seven female students who were sponsored by the Commonwealth Employment Service. These students were enrolled in two Word Processing and Office Skills Courses, and a Stenographic Skills Course which together are identified as CND47, Industry Training courses. Students ranged in age from seventeen to fifty-three years. Only those students who have been registered as unemployed for a period of six months with the CES are eligible for selection for these courses. The CND47 courses are conducted over four months. On completion of these courses students seek employment in specific vocational areas, such as a word processor operator or a stenographer.

Group four consisted of thirty-five male and seventeen female students enrolled in the CNL40, Associate Diploma of Applied Science (Computing) course. Students ranged in age from 17 to 47 years. The course is conducted over two years. On completion of the course students may seek employment as computer software/hardware support personnel.

(e) **SUMMARY**

The emergent complex population of TAFE Colleges generally, and Ithaca TAFE College in particular, is reflected in the diversity of socio-economic groups represented in the sample population of full-time enrolments in this study. Broad cultural differences in the sample are identifiable because of selection criteria

such as corporate sponsorship, and cultural perceptions of job opportunities. An imbalance in gender representation persists in most TAFE College client groups. This imbalance is obvious in the sample in this study where females tend to be selected over males into office practices and computer operator jobtrain courses, while males are predominant in pre-vocational construction and engineering courses.

The need for TAFE Colleges to cater for individual differences in its population is highlighted by the shift in focus of meeting client needs rather than of preparing clients to fill traditionally perceived industry roles. The challenge now is to tailor courses to meet specific needs of clients in the most cost and time efficient manner. Individual differences among clients must be taken into consideration when planning courses to assure quality outcomes of training.

CHAPTER 8 RESULTS AND DISCUSSION OF COMPONENT ANALYSES

(a) INTRODUCTION

This chapter presents five studies associated with research questions 1 and 2. Studies 1-3 were designed to examine the various component structures of the information processing, personality, and motivation assessment tasks used in the study. Studies 4 and 5 were designed to examine the component structures of the Raven's Advanced Progressive Matrices Sets I and II, and the *Silver Test*. The Raven's Advanced Progressive Matrices Sets I and II contains items that reflect restricted spatial thinking or problem solving skills. The *Silver Test* contains items that reflect both restricted and unrestricted spatial thinking or problem solving skills. In each of the studies a principal components solution was applied. The analysis and interpretation of the findings from these solutions is discussed.

(b) ANALYSIS OF INDIVIDUAL DIFFERENCES

(1) Study 1 - Component Structure of Information Processing

This study was designed to examine a model of individual differences based on two information processing dimensions - successive and simultaneous information processing, and a further dimension of cognitive control,

as described by Luria. Six variables were analysed in the study.

FIGURE 2

Variable Name		Test
Visnls	1	Number/Letter Search, and
Audnlm	4	Auditory Number/Letter Attention Span designed to measure Cognitive Control;
Wordm	3	Auditory Word Span, and
Numberm	6	Auditory Number Span, designed to measure Successive Information Processing;
Form	2	Form Board, and
Pfold	5	Paper Folding, designed to measure Simultaneous Information Processing.

Fig 2: Description of Variables in Study 1.

The test data were analysed, and three components were clearly required to account for the major part of the variance. The three components appeared to reflect the separate functional contributions of simultaneous and successive processing abilities and cognitive control. The Varimax rotated solution reflects a clear structure based on three major components. These components accounted for 74.2% of the total variance.

TABLE 4

Variables		Components		
		Succ	Sim	Cogcon
Test 3	Wordm	.81	.04	.10
Test 4	Audnlm	.80	.02	-.12
Test 6	Numberm	.78	.05	.13
Test 5	Pfold	.02	.91	.01
Test 2	Form	.08	.80	.30
Test 1	Visnls	.06	.20	.95

Table 4: The Three Component Solution obtained using Principal Components Analysis and Varimax Rotation in Study 1.

An examination of the component loadings indicates that the Auditory Word Span, Auditory Number/Letter Attention Span, and Auditory Number Span tests loaded substantially on the first component which may be identified as the Successive Information Processing component. The loadings for the Auditory Word Span test (.81), and the Auditory Number Span test (.78) compare very closely with Crawford's (1986) findings of .75 and .93 on a 'successive' factor. The Auditory Number/Letter Attention Span test loaded .78 on the Successive Information Processing component which is similar to the findings shown in Crawford's study where this test loaded .38 on the 'successive' factor.

It was expected that the Auditory Number/Letter Attention span test would load on the component of Cognitive Control. The negligible loading of the Auditory Number/Letter Attention Span test on the Cognitive Control component indicates that shifting focus between tasks is different from selective attention. In the Auditory Number/Letter Attention Span test a shift of focus from one dimension to another (letters and numbers) betweeen tasks is required. Clearly, such a shift of focus is not the same as selecting between two facets of one dimension on the same task (vowels and consonants on the letter dimension, and odd and even on the number dimension).

The substantial loadings on the Successive Information Processing component by the serial recall tests of Auditory Word Span (.81), Auditory Number/Letter Attention Span (.80), and Auditory Number Span (.78) are consistent with the findings from Crawford's study that these tests are associated with successive synthesis/analysis.

The Form Board and Paper Folding tests loaded substantially on the second component which may be identified as the Simultaneous Information Processing component. The Form Board test involves the selection of relevant geometric shapes to make a complete shape. The Paper Folding test involves the visual manipulation of a spatial configuration. These findings are consistent with those of previous researchers such as Fitzgerald and Hattie (1982), Walton (1983), and Crawford (1986) where a

Form Board test loaded on a 'simultaneous' processing factor, and in the studies of Walton (1983), and Crawford (1986) where a Paper Folding test also loaded on a 'simultaneous' factor. The substantial loadings on the Simultaneous Information Processing component by the Form Board (.80) and Paper Folding (.91) tests in this study is consistent with the earlier research sited above that these tests are associated with simultaneous synthesis/analysis.

The Visual Number/Letter Search test loaded substantially on the third component which may be identified as a Cognitive Control component. Although the eigenvalue for this factor was less than 1 at .76, it is included in the interpretation since Crawford (1986) found that a variable similar to the Visual Number/Letter Search test loaded .55 on a factor described as 'executive control'. This component reflects the demands of overall control where sustained judgments under pressure of speed are required to differentiate between two facets of the same dimension (consonant and vowel on the letter dimension) on one task, and to switch focus to differentiate between two facets of another dimension (odd and even on the number dimension) on another task.

Support for this view may be found in the description of the control dimension offered by Luria whereby sustained vigilance is regarded as being essential to the orchestration of the direction and selection of mental activity, and is associated with the frontal lobes of

the brain. The Visual Number/Letter Search test offers opportunities for the observation of this executive control ability where selective attention to task relevent dimensions is required. The test requires that there be overall organisation of the intellectual activity including the programming of the intellectual act involving the selection of differential dimensions (letters or numbers), and the comparison with previous knowledge to do with different facets of those dimensions (consonants and vowels on the letter dimension, and odd and even on the number dimension), and the checking of such performance before a response can be made.

Luria's theory suggests that successive and simultaneous information processing represent two distinct information processing functions and that the cognitive control or overall planning is yet another dimension within the domain of information processing. These abilities reflect the particular series of brain functions associated with the posterior zones of the hemispheres and the frontal lobes of the brain. Luria's theory emphasises the importance of a series of concertedly working brain zones in the complex structure of the processes of practical, constructive thinking. The pattern of loadings reported above is consistent with Luria's suggestion that they are relatively independent mental activities.

(2) Study 2 - Component Structure of Personality

This study was designed to examine a psychometric model of personality based on the standardised scores derived from the Form G version of the Myers-Briggs Type Indicator. Eight variables are analysed in this study. These variables are the standardised scores of Extraversion, Introversion, Sensate, Intuition, Thinking, Feeling, Judging, and Perception obtained from the first ninety-five items of Form G.

The test data were analysed, and four components were clearly required to account for the major part of the variance. The four components seemed to reflect the dichotomised personality dimensions described in the Myers-Briggs theory of Attitudes, Orientation to Life, Perception Processes, and Judgment Processes. The Varimax rotated solution reflects a clear structure based on the four major components. These components account for 95.8% of the total variance.

TABLE 5

Variables	Components			
	Attit	Orien	Percep	Judge
Judging	-.96	.09	-.23	.08
Perception	.95	-.09	.25	-.06
Introversion	-.06	.98	-.10	.06
Extraversion	.11	-.97	.11	-.07
Intuition	.23	-.07	.94	-.07
Sensate	-.25	.15	-.92	.06
Thinking	-.01	.06	-.07	.96
Feeling	.12	-.07	.05	-.95

Table 5: Dimensions of Personality derived from Form G of the Myers-Briggs Type Indicator in Study 2.

On each of the four components there are two variables which loaded in excess of .90, one variable loaded positively and one variable loaded negatively. These variables had very small loadings on each of the remaining components. This pattern of loadings reflects very clearly the four dichotomies described in the Myers-Briggs theory.

Component 1 accounting for 41.6% of the variance (eigenvalue=3.33) is what Myers-Briggs calls an Attitude dimension. This dimension reflects the two ways of life or methods of coping with the world - the Perception and the Judging attitudes.

The Perception attitude is said to be preferred by a person who likes to remain open to new information, insights and experiences and to delay decision making until all developments have been considered. The Judging attitude is said to be preferred by a person who likes to live in a planned and orderly way and to arrive at decisions having considered that all the evidence is in and that the time has come to reach a verdict.

Component 2 accounting for 21.7% of the variance (eigenvalue=1.74) is an Orientation to Life dimension. This dimension reflects whether a person is orientated primarily towards the outer world (Extraversion) or primarily toward the inner world (Introversion). An Orientation to Life of Extraversion is said to be preferred by a person who draws their energy from interacting with the outer world of people or things. An Orientation to Life of Introversion is said to be preferred by a person who draws their energy from making contact with the inner world of concepts and ideas. This does not mean that an extraverted person is a back-slapping party animal or that an introverted person is a hermit in a cave deep in the forest. The two orientations to life can be complementary and differentially employed by a person when necessary.

Component 3 accounting for 20.2% of the variance (eigenvalue=1.61) is a Perception Process dimension. This dimension reflects the two modes of perceiving reality by way of the five senses (Sensing), or according to

a 'sixth sense' (Intuition). A person is said to prefer the Sensing mode when he/she enjoys perceiving the world through the five senses of sight, hearing, touch, taste, and smell. The Intuition mode is said to be preferred when a person enjoys perceiving the world by quickly jumping from sensory impressions into possibilities, associations, and symbols - the 'sixth sense.'

Component 4 accounting for 12.3% of the variance (eigenvalue=.98) is a Judgment Process dimension. This dimension reflects the two modes of making decisions about what has been perceived - Thinking and Feeling. A person who enjoys making decisions on the basis of consistent, logical analysis is said to prefer the Thinking mode. The Feeling mode is said to be preferred by a person who enjoys making decisions on the basis of personal values.

The Myers-Briggs theory of individual differences revolves around the various combinations of choices from the four dichotomies which provide sixteen 'types' or descriptive profiles of how people prefer to process information and to make decisions. A check with the subjects showed that in almost all instances subjects agreed with their 'type' or descriptive profile.

It is suggested that the findings from this study are consistent with the underlying dimensions that are inherent in the Myers-Briggs theory. Support for this suggestion may be found in the discussions of the 'five factor personality model' by Dachowski (1987) and Waller et al (1987).

Dachowski (1987) considers that the four Myers-Briggs Type Indicator dimensions of Extraversion-Introversion, Sensing-Intuition, Thinking-Feeling, and Judging-Perception may be compared to the factors identified by McCrae and Costa (1986) which provide "a universal and comprehensive framework for the description of individual differences in personality" (McCrae and Costa, 1986:1001). The E-I dimension is considered to parallel McCrae and Costa's 'Extraversion' factor, and the Sensing-Intuition dimension to parallel the 'Openness' factor. The Thinking-Feeling dimension is not exactly comparable to McCrae and Costa's 'Agreeableness' factor but it is considered to measure a similar dimension, and the Judging-Perception dimension can be compared loosely with the 'Conscientiousness' factor. Dachowski (1987) points out that the Myers-Briggs Type Indicator dimensions contrast two positive aspects rather than presenting a positive versus negative continuum as in the case of the factors described by McCrae and Costa, and that the Myers-Briggs Type Indicator does not measure anything like neuroticism.

Waller and Ben Porath (1987) comment on the efforts of researchers working with various personality scales such as the Minnesota Multiphasic Personality Inventory where attempts have been made to address the issue of the dimensional overlap of the Minnesota Multiphasic Personality Inventory with the five-factor model. Waller and Ben Porath consider that these works represent an indication of the

reliability rather than the validity of the five-factor model, and that until it can be demonstrated that other systems of personality assessment can be accounted for by the five-factor paradigm, they agree with the conclusion reached by McCrae and Costa that the five-factor solution must be considered tentative.

In this study an attempt was made to identify the underlying dimensions of personality restricted to the Myers-Briggs Type Indicator theory of individual differences. It was not the intention to investigate the dimensional overlap with the five-factor model since the Myers-Briggs Type Indicator theory is not an all-encompassing one, and as pointed out in the discussion above the five-factor model is not a fully researched paradigm. Rather, the discussion of the five-factor model has been included since a significant number of applied psychologists are currently using the Myers-Briggs Type Indicator in North America and to a growing extent in Australia. Since comparisions have been made between the Myers-Briggs Type Indicator theory and the five-factor model it raises the possibility of the convergence of personality theory and the experience of practitioners as pointed out by Dachowski (1987).

Sipps and Di Caudo (1988) suggest that although the Myers-Briggs Type Indicator scales are internally consistent and independent there needs to be further examination of the identity of the measured constructs. According to

Carlyn (1977) and Carlson (1985) there has been a paucity of research at the item level of the Myers-Briggs Type Indicator. In the review of research no parallel studies were found.

(3) Study 3 - Component Structure of Motivation

This study was designed to examine a model of motivation including 'self esteem' as described by Coopersmith.

Twenty-five variables were analysed in the study. These variables are the twenty-five items on the Adult Form of the Coopersmith Self Esteem Inventory.

The analysis yielded ten components with eigenvalues greater than 1 which accounted for 63.9% of the variance. An examination of a scree plot suggested that the six component solution would be the appropriate level of analysis to concisely descibe the dimensions underlying the model. The six component solution accounted for 46.7% of the variance and was subsequently selected for interpretation.

An examination of the six component solution indicated that the variables tended to load clearly on one component, with small loadings on each of the remaining five components.

TABLE 6

Variables	Components					
	Soc	Fam	Per	Chng	F/T	ExSel
18 I am as nice looking as most people	.61	.04	-.01	-.12	.07	-.18
21 Most people are not better liked than I am	.60	.24	.09	.19	.02	-.01
8 I'm popular with persons my own age	.59	-.08	.05	.22	-.13	.15
15 I do not have a low opinion of myself	.55	.06	.30	-.01	.14	-.09
14 People usually follow my ideas	.52	.03	.04	-.09	.11	.13
1 Things usually don't bother me	.23	.10	.21	-.17	-.04	-.38
11 My family does not expect too much of me	.01	.74	-.00	-.01	.11	.04
9 My family usually considers my feelings	.23	.63	-.04	.03	-.17	-.15
22 I do not usually feel as if my family is pushing me	-.09	.63	.19	-.16	.06	.20
20 My family understands me	.05	.56	.31	.04	-.33	-.07
12 It is not pretty tough to be me	.19	.53	.03	.26	.12	-.34

TABLE 6 (continued)

Variables	Components					
	Soc	Fam	Per	Chng	F/T	ExSel
6 I don't get upset easily at home	.04	.37	.27	-.00	.19	.15
17 I do not often feel upset with my work	.04	-.07	.80	.03	-.02	.13
23 I do not often get discouraged with what I am doing	.01	.10	.67	.12	.13	.01
24 I do not often wish I were someone else	.19	.18	.53	-.16	.17	-.14
3 There are not lots of things about myself I'd change if I could	.35	.11	.44	-.07	-.05	-.13
13 Things are not all mixed up in my life	.34	.17	.43	.10	.16	-.40
16 There are not many times when I would like to leave home	.05	.26	.41	.01	-.41	.13
5 I'm a lot of fun to be with	.37	-.08	.04	.64	.02	.20
7 It does not take me a long time to get used to anything new	-.13	.09	.03	.61	.17	.01

TABLE 6 (continued)

Variables	Components					
	Soc	Fam	Per	Chng	F/T	ExSel
10 I do not give in very easily	.04	.18	.15	.05	.65	.11
25 I can be depended on	.08	-.11	.05	.13	.53	-.14
4 I can make up my mind without too much trouble	.20	.20	.18	-.45	.45	.10
2 I don't find it very hard to talk in front of a group	.14	.16	.16	.38	.00	.59
19 If I have something to say, I usually say it	.47	.07	.07	-.16	-.04	.57

Table 6: Rotated Component Analysis of the Coopersmith Self Esteem Inventory in Study 3.

Component 1, accounting for 16.4% of the variance (eigenvalue=4.1) is a Social Relations component and reflects acceptance/rejection of self in a social setting. Item 15, "I do not have a low opinion of myself" loaded .55 on component 1, and also loaded .30 on component 3 which is a dimension of the personal setting. This is consistent with the theory in that feedback (both positive and negative) from significant others (peers, family, friends,

teachers, etc) is the basis for the formation of judgements about self-worth. Although item 1, "Things usually don't bother me" loaded .23 on component 1, it may be more closely related in theory to component 3 on which it loaded .21, however since both loadings are fairly small, they are not considered to be important to the overall interpretation.

Component 2, accounting for 7.7% of the variance (eigenvalue=1.9) is a Family Relations component and reflects acceptance/rejection of self in a family setting. Item 12, "It is not pretty tough to be me" loaded .53 on this component and .26 on component 4. It seems that in this study the concept of toughness of self is reflected in the family setting and to a lesser extent in the personal setting.

Component 3, accounting for 6.5% of the variance (eigenvalue=1.6) is a Locus of Control component and reflects acceptance/rejection of self in a personal setting. The pattern of loadings on this component suggests a positive self concept formed through the acceptance of self and the attributing of success to an internal locus of control (own effort and ability), and the attributing of failure to an external locus of control (chance, or difficulty of the task). The higher loading items number 17, "I do not often feel upset with my work" .80, and number 23, "I do not often get discouraged with what I am doing" .67, reflect an internal locus of control for success. The lower loading item number 13, "Things are not all mixed

up in my life" .43 tends to reflect an increasingly external locus of control for failure.

According to Gecas and Schwalbe (1983) preferences for occupations with complex skill demands may be mediated by perceived self competence. Positive self evaluations develop from self efficacious action and managing the environment successfully is likely to lead to a positive sense of self. In this study the Locus of Control component will be included in further moderator analyses. These second line analyses will focus on the relationship of this particular dimension of motivation with information processing and personality dimensions, and restricted and unrestricted spatial thinking or problem solving skills.

Component 4, accounting for 5.8% of the variance (eigenvalue=1.5) is an Adaptability component relecting flexibility/rigidity to change. Although item 5, "I'm a lot of fun to be with" loaded .64, the other item loading .61 on this component, item 7 "It does not take me a long time to get used to anything new" seems to indicate that the component is reflecting flexibility/rigidity to change. Item 5 "I'm a lot of fun to be with" loaded .37 on component 1 which is a social setting component. Although theoretically this item may be more closely related to component 1 than to component 4, the size of the loadings shows a strong association with component 4. This may be interpreted in this study as reflecting the underlying dimension of adaptability to change in the personal setting

involving close relationships rather than at a broad social relationship level.

Component 5, accounting for 5.4% of the variance (eigenvalue=1.3) is a Perserverence component and reflects belief/disbelief of own ability to follow through with a task. Component 6, accounting for 4.9% of the variance (eigenvalue=1.2) is a Self-Expression component and reflects ease/difficulty of expression of self.

Ahmed, Valliant and Swindle (1985) used three procedures (factor analysis, correlation of one item with other items, and with total test scores) to assess homogeneity/heterogeneity to show that Coopersmith's Adult form of the Self Esteem Inventory was a heterogeneous scale. Although the concept of self esteem is used in a general sense analysis of the items measuring this trait suggests that it is multidimensional and related to specific situations. The findings of this study provide support for the heterogeneous nature of the Coopersmith Self Esteem Inventory by showing that while the concept of self-esteem, the way in which a person views the self-image either positively or negatively may be general, it is an extremely situation-related trait. Ahmed et al (1985) consider that individuals may consistently show high self-esteem while interacting with family members but not while interacting with a peer group.

It is suggested that the first two components extracted in this study reflect motivation dimensions in the

situational areas of social interaction and family interaction. Components 3, 4, 5 and 6 reflect different motivation dimensions in the personal setting.

(c) ANALYSIS OF SPATIAL THINKING OR PROBLEM SOLVING

(1) Study 4 - Component Structure of the Raven's Advanced Progressive Matrices Sets I and II

This study was designed to examine the structure of spatial thinking or problem solving in the Raven's Advanced Progressive Matrices test, Sets I and II.

Item 1 from Set I was eliminated from the analysis because it was a practice item and was scored correct for all subjects. The analysis yielded sixteen components with eigenvalues greater than 1 which accounted for 76.6% of the variance. An examination of a scree plot suggested that the four component solution would be the appropriate level of analysis to concisely describe the dimensions underlying the model. The four component solution accounted for 35.9% of the variance and was subsequently selected for interpretation. The component structure of the Raven's Advanced Progressive Matrices (I and II) was found to be very complex and difficult to interpret. The following discussion and interpretation of the components is therefore somewhat tentative.

Raven considered Spearman's five differentiated levels of the 'Principles of Cognition' in the development of intellectual functioning when constructing the various forms of the Matrices test. Problems in Sets I and II consist of a matrix of geometrical figures or patterns placed at the top of a page. One of eight graphics placed below the matrix is the correct solution. Set I problems cover all the intellectual processes needed for success in the Set II problems, however Set II problems progressively become considerably more complex than the problems in Set I. Spearman's levels (from simple to complex) are taken into account together with a consideration of the pattern of Set I and Set II variable loadings in the interpretation of the four components. For clarity of presentation, Set I is labelled A and Set II labelled B in Table 7.

TABLE 7

Variables	Components			
	Analytic/ Integral	Concrete Reasoning	Perceptual Field Orien	Abstract Reasoning
B05	.71	.16	.17	-.01
B10	.68	.15	.27	.09
A12	.67	.19	.10	.04
B27	.63	.05	-.05	.17
B18	.49	.27	.02	.17
B04	.47	.26	.20	-.08
B08	.45	-.06	-.14	.17

TABLE 7 (continued)

Variables	Components			
	Analytic/ Integral	Concrete Reasoning	Perceptual Field Orien	Abstract Reasoning
B15	.45	.23	.06	-.01
B14	.44	.14	-.08	.03
B22	.44	.09	-.01	.28
A09	.40	-.30	.36	.11
B13	.22	-.19	.05	.02
B09	.26	.69	.10	-.03
A03	-.12	.66	-.10	.01
B11	.29	.60	.45	-.11
A10	.12	.58	.21	.19
B12	.47	.52	.08	.24
B19	.26	.47	-.20	.21
B20	.23	.44	.13	-.06
B21	.21	.43	.13	.05
B16	.17	.42	.07	.28
A11	.20	.40	.17	.06
B31	.13	.39	.23	.36
B06	-.06	.38	-.07	-.25
B17	.28	.34	.21	.07
B36	.00	.32	-.01	.05
A07	.04	-.06	.68	-.11
B03	.31	.12	.66	-.23
A06	.22	.51	.55	-.06

TABLE 7 (continued)

Variables	Components			
	Analytic/ Integral	Concrete Reasoning	Perceptual Field Orien	Abstract Reasoning
A04	-.15	.19	.54	.13
A05	-.24	.22	.54	.14
B01	.05	-.02	.54	.06
A08	.32	.19	.48	-.06
B07	-.22	.12	.45	-.06
B24	.18	-.05	.41	.39
B35	.12	.04	.24	-.05
B28	.10	.20	-.11	.71
B29	-.06	-.05	-.03	.66
B33	-.03	.20	.12	.63
B25	.33	.20	.21	.56
B32	.18	-.05	.18	.56
B23	.23	-.17	.40	.51
B34	.02	.29	-.28	.47
A02	-.05	-.02	.08	-.42
B30	.09	-.15	.26	.29
B26	.23	.02	.25	.26
B02	.00	-.01	.05	-.10

Table 7: Rotated Component Analysis of the Raven's Advanced Progressive Matrices, Set I (A variables), and Set II (B variables) in Study 4.

Component 1, accounting for 17.2% of the variance (eigenvalue=8.1) could be argued to be an Analytic/Integral component. Raven maintains that Set II of the Advanced Progressive Matrices test provides a means of assessing all the analytic and integral operations involved in the higher thought processes. Spearman describes the levels in the development of intellectual functioning (levels 3, and 4) as being able to consider the parts of a figure as forming a whole, and to analyse (break down) the whole into component parts. Of the eleven variables loading on this component, nine variables are from Set II with a fairly even distribution among the thirty-six variables in that set. The two variables from Set I are from the latter part of that set. Since problems are arranged in order according to the frequency with which they are solved in both Set I and Set II, this pattern of loadings suggests that this component reflects the Analytic/Integral operations that are involved in higher thought processes that Set II of the Advanced Progressive Matrices assesses.

Component 2, accounting for 7% of the variance (eigenvalue=3.3) is labelled a Concrete Reasoning component. Spearman describes the highest developmental level (level 5) as one where a child is able to compare analogous changes in the figures perceived, and to use this as a method of logical reasoning. Such reasoning is described by Raven as 'clear thinking', and is incorporated in the Matrices tests through including problems requiring relatively simple

analogous thought responses in determining a solution, to problems requiring more complex analogous thought responses in determining a solution. Of the eleven variables loading on this component, eight variables are from the mid-range of Set II. This pattern of variable loadings suggests a progression in complexity of problems whereby higher-order skills such as reasoning by analogy are required to solve problems.

Component 3, accounting for 6.3% of the variance (eigenvalue=2.9) is argued to be a Perceptual Field Orientation component. Spearman describes a level of intellectual functioning (level 2) where a child is able to determine the orientation of a figure in relation to objects in the perceptual field. Raven developed the Matrices tests from a conceptual field approach and the sequence in which the problems are presented provides the appropriate field of thought. Set I problems are designed as an introduction to the method of working whereby responses to problems show a serial change running through the field of thought. A degree of intellectual organisation of which a person is capable is indicated in responses in which the field of thought shows a 'productive' change which is the most frequent mode of this response particularly from adults. Of the nine variables loading on this component, five variables are from Set I, and four variables are from Set II. This pattern of variable loadings suggests a progression of complexity of perceptual field orientation.

Component 4, accounting for 5.3% of the variance (eigenvalue=2.5) is labelled an Abstract Reasoning component. Raven maintains that an acquired degree of intellectual sophistication is involved in consistent inference by analogy and that this method of reasoning is relied upon by the majority of adults but is seldom found in young children. Spearman describes the ability to compare analogous changes in figures perceived as the highest developmental level (level 5) and is reflected in the progressive nature of the Matrices where problems requiring simple responses in determining solutions are placed before problems requiring more complex responses in determining solutions. All the seven variables loading on this component are from the latter part of Set II. This pattern of variable loadings suggests that the component reflects performances on problems which require more abstract levels of reasoning by analogy in determining solutions.

The tasks contained in Set I of the Raven's Advanced Progressive Matrices are considered in the theory to provide adequate practice for the method of working and to provide examples of the different levels of intellectual functioning contained in Set II. An inspection of the rotated component analysis shown previously reveals that Set I items loaded on three of the four components. These three components reflect all but the most complex level of intellectual functioning which is associated exclusively with Set II items. Further, it is noted that the majority of Set I

items loaded on component 3 which may be considered as reflecting the most simple level of intellectual functioning. These findings are consistent with the progressive order of the Matrices.

It is suggested that the four components interpreted in this study reflect different mental activities and qualitative differences of intellectual organisation in restricted spatial thinking or problem solving.

(2) Study 5 - Component Structure of the *Silver Test*

This study was designed to examine the structure of spatial thinking or problem solving in the *Silver Test*.

Eleven variables were analysed in this study. Mean ratings of two scorers were used as subject data. The variables are:

1 Predicting a sequence
2 Predicting horizontality
3 Predicting verticality
4 Left-right (horizontal relationships)
5 Above-below (vertical relationships, not necessarily adjacent)
6 Front-back (depth relationships)
7 Select (content)
8 Combine (form)
9 Represent (creativity in form or content, or both)

10 Projection (emotional expression)

11 Language (spelling or grammatic usage is not important here)

Three components were identified which accounted for 62.1% of the variance with the Varimax rotation producing a clear simple structure. The following table identifies the variables loading on the three components.

TABLE 8

	Variables	Components		
		Imag	VisSpat	Adj
9	Represent	.87	.07	.11
7	Select	.86	.17	.15
11	Language	.84	.00	.15
8	Combine	.81	.15	-.11
4	Horizontal Relationships	.17	.85	-.10
6	Depth Relationships	.19	.80	.19
5	Vertical Relationships	.20	.78	.19
1	Predicting Sequence	-.16	.46	.19
2	Predicting Horizontality	-.13	.15	.73
3	Predicting Verticality	.12	.11	.71
10	Projection	.20	.07	.53

Table 8: Rotated Component Analysis of the *Silver Test* in Study 5.

Component 1, accounting for 33.3% of the variance (eigenvalue=3.7) is an Imaginative Association component which is clearly defined by the variables loading .81 or above. This component possibly reflects the vicarious representation of reality by subjects through the formation of concepts and the creative representation of those concepts. Support for this interpretation is provided by the theory proposed by Silver whereby the ability to select and combine, form the stages of concept formation, and that this ability can be assessed through increasing complexity in overall co-ordination of the various elements. Support for the suggestion that the ability to represent is associated with creativity is also provided in Silver's theory whereby the characteristics of creativity such as transformation, originality, expressiveness or playfulness in drawn responses formed the criteria for assessing this ability.

The pattern of loadings are consistent with Silver's theory that cognitive skills evident in verbal conventions can be evident also in visual conventions. The stimulus drawings in the "Drawing from Imagination" sub-test prompt response-drawings that require a title. This title is assessed by the variable 'Language', the highest scores being assigned for the characteristics of transformation, explication of meaning, the use of complex verbal-lingual constructions, and playfulness. Thus the two conventions

(visual and verbal), evident in the cognitive skills of concept formation (abstract and concrete) and representation (creativity) were able to be assessed. In both instances the variables associated with the whole field of vicarious experience were found to load substantially on the same component. This component reflects unrestricted spatial thinking or problem solving which can be associated with creativity. Free responses involving originality are required in determining a solution to a problem that is satisfying to the test-taker, rather than in determining a solution to a problem that is correct.

Component 2, accounting for 17.6% of the variance (eigenvalue=1.9) is a Visual-Spatial Relationships component which is also clearly defined by the very substantial loadings of .78 or higher on three of the four variables, and by the very small loadings of these variables on each of the other two components. This component reflects the visual-spatial relationships of height, width and depth, and to a lesser extent of sequential order. According to Silver's theory the ability to perceive and represent spatial relationships can be assessed through drawn responses requiring a co-ordinated system of perception involving three directions - left-right, before-behind, and above-below. These three directions are assessed by Variable (4) 'Horizontal Relationships', Variable (6) 'Depth Relationships', and Variable (5) 'Vertical Relationships'. The ability to represent a sequence can be assessed through

making predictions about changes in a sequence. This ability is assessed by Variable (1) 'Predicting Sequence' which is based on the idea of sequential order and applies to relationships.

This component reflects restricted spatial thinking or problem solving. Restricted responses to well-defined parameters of direction in spatial relationships, and expected direction of change in predicting a change in a spatial sequence are required in determining a correct solution to a problem.

Component 3, accounting for 11.1% of the variance (eigenvalue=1.2) is an Adjustment component which is fairly well defined with variable (2) 'Predicting Horizontality' loading .73, the variable (3) 'Predicting verticality' loading .71, and the variable (10) 'Projection' loading .53 on this component. This component reflects the visualisation or conservation of concepts of horizontality and verticality. Piaget described the ability to conserve as the hallmark of operational thought whereby a child comes to understand that a certain property of an object does not change despite changes in other perceivable features (Piaget, 1967).

In the instances of variable (2) 'Predicting Horizontality' and variable (3) 'Predicting Verticality' subjects were required to visualise changes horizontally and vertically while the properties of objects remained the same. In the instance of variable (2) 'Predicting

Horizontality' the property of volume remained constant since the amount of water was the same in the bottle when it was upright and when it was in the tilted position. In the instance of variable (3) 'Predicting Verticality' the property of mass remained constant since the size and shape of the house remained constant while subjects were required to visualise changes to its orientation to the hill.

Silver suggests that the ability to understand the principle of conservation is basic in logical thinking along with the ability to represent a sequence; the most stable framework of every-day experience involves horizontals and verticals as it is a person's first natural system of reference. Witkin et al (1962) developed a technique to measure how individuals perceive situations and respond to problems. Their findings indicate that a field-dependent person depends on the visual field (the frame) to make deductions about the position of an object. If the frame is tilted, the field-dependent person will align the object to parallel the orientation of the frame. The field-independent person, however, using body position as a guide, does not depend on visual cues and is better able to disregard the position of the frame in aligning the object. Witkin also found also that although the individual differences of field-dependence/field independence remain quite stable, children tend to become more field-independent as they mature.

Although variable (10) 'Projection' is associated in Silver's theory with aspects of personality such as anxiety, concerns and temperament that are expressed through response drawings, in this study it seems to be associated with emotional adjustment of frames of reference. Assessment of emotional expression involves the projection of happy, well-adjusted feelings being scored highly, and the projection of unhappy feelings or violence being scored very low. In this study it is suggested that the ability to project the feelings of being well adjusted is associated with placing oneself in an external frame of reference, in conjunction with concepts of horizontality or verticality which are related to every-day experience.

(d) SUMMARY

The various component analyses reported in this chapter form the first line analysis of the study. The following summarises the findings from these analyses.

Study one established an individual differences model of information processing. The findings were consistent with those of Crawford (1986) in which simultaneous and successive information processing dimensions and an executive control dimension was identified.

In the second study of personality dimensions four components reflected very clearly the four dichotomies described in the Myers-Briggs theory. The Attitudes dimension describes two ways of coping with the world,

and the Orientation to Life dimension describes two ways for relating to the world. The Perception Processes dimension describes two ways of taking in information, and the Judgment Processes dimension describes two ways of making decisions.

The third study established a model of individual differences of motivation described in the theory of Coopersmith. The dimensions of Social Relations and Family Relations are clearly reflected in the theory associated with self esteem. The Locus of Control, Adaptability, Perserverence, and Self-Expression dimensions are also reflected in the theory, although Coopersmith refers to these dimensions collectively as "Personal" dimensions.

The dimensions of restricted spatial thinking or problem solving skills based on Raven's theory were examined in the fourth study. The Raven's Advanced Progressive Matrices Sets I and II were constructed by Raven from a perceptual field approach. This approach considers that the most frequently used response in determining the correct solution to problems is that which reflects a *serial change* running through the field of thought. The four dimensions of Analytic/Integral, Concrete Reasoning, Perceptual Field Orientation, and Abstract Reasoning are reflected in the theory of Raven which describes the progressive nature of the Matrices tests.

The fifth study examined dimensions of restricted and unrestricted spatial thinking or problem solving skills

as described by Silver. The two dimensions of Visual-Spatial Relationships and Adjustment are reflected in the theory of Silver as describing restricted spatial thinking or problem solving skills. These skills are used in identifying solutions to problems to which there is one correct solution. The third dimension of Imaginative Association is clearly reflected in Silver's theory as describing an unrestricted spatial thinking or problem solving skill. This skill is used in responses involving originality which are required to determine solutions to problems that allow a free response and are satisfying to the test-taker rather than satisfying set paramaters.

The next chapter describes the second line analysis in which differences between TAFE program group, gender and components of information processing, personality and the Locus of Control dimension of motivation with respect to restricted and unrestricted spatial thinking or problem solving are examined.

CHAPTER 9 RESULTS AND DISCUSSION OF MANOVA LINKING INDIVIDUAL DIFFERENCES TO RESTRICTED AND UNRESTRICTED SPATIAL THINKING OR PROBLEM SOLVING

(a) INTRODUCTION

This chapter presents six analyses (studies 6 - 11) associated with research questions 3 and 4 concerning differences between TAFE program groups, gender and components of information processing, personality and Locus of Control with respect to restricted and unrestricted spatial thinking or problem solving. Study 6 was designed to examine the differences between TAFE program groups with respect to restricted and unrestricted spatial thinking or problem solving (Silver), restricted spatial thinking or problem solving (Raven) and personality (Myers-Briggs). Study 7 was designed to examine the gender differences with respect to restricted and unrestricted spatial thinking or problem solving (Silver), restricted spatial thinking or problem solving (Raven) and personality (Myers-Briggs). Studies 8 - 11 were designed to examine the differences between levels of information processing (Luria), personality (Myers-Briggs) and the motivation dimension of Locus of Control (Coopersmith) with respect to restricted and unrestricted spatial thinking or problem solving.

In each of the studies multivariate analysis of variance procedures were used involving a number of contrasts. The dependent and independent variables were the

factor scores derived from the studies in the first line analysis. In studies 8 - 11 the factor scores of the independent variables were assigned to one of three levels (high, medium, low) based on the frequencies. Analysis by levels rather than using original factor scores was carried out to facilitate the examination of interactions. In each of the studies probabilities that are less than .10 will be reported. The significance level adopted will be .05.

Across the studies there were very small numbers of subjects in most cells, and in the two studies associated with the Raven test data there were large numbers of empty cells. In these analyses only main effects and first order interactions were considered. An interpretation of the findings is discussed in relation to each of the studies.

(b) Study 6 - Differences Between TAFE Program Groups with respect to Restricted and Unrestricted Spatial Thinking or Problem Solving (Silver) Restricted Spatial Thinking or Problem Solving (Raven) and Personality (Myers-Briggs).

Two multivariate analyses of variance were carried out. In the first analysis (involving the Silver and Myers-Briggs models) of TAFE program groups the following contrasts were considered.

TABLE 9

	TAFE Program Groups			
Contrast	Group 1 (Pre-Voc Eng./Con.)	Group 2 (Ken.Cats, B.E.I.P.)	Group 3 (Ind.Train.)	Group 4 (Ass.Dip. App.Sc.)
1	0	-1	-1	2
2	0	-1	+1	0
3	-1	0	0	1

Table 9: Contrasts in first analysis of TAFE Program Groups

All three contrasts were significant at the multivariate level. As contrast 2 was shown to be significant, contrast 1 was unable to be interpreted.

In the second analysis (involving the Raven model) none of the three contrasts examined were significant.

In the first analysis there were seven dependent variables: Imaginative Association (Unrestricted Spatial Thinking or Problem Solving), Visual-Spatial Relationships (Restricted Spatial Thinking or Problem Solving), and Adjustment derived from factor scores for restricted and unrestricted spatial thinking or problem solving (Silver), and the personality variables of Attitudes, Orientation to Life, Perception Processes and Judgment Processes derived from the factor scores for personality dimensions (Myers-Briggs). The independent variable was TAFE Program Group of

which there were four levels: Group 1 - Certificate of Pre-Vocational Engineering/Construction; Group 2 - Certificate of Kennel Cattery Practices and Certificate of Business Electronic Information Processing; Group 3 - Industry Training; Group 4 - Associate Diploma of Applied Science (Computing). There were 152 subjects available for the analysis.

TABLE 10

CONTRAST: GROUP 2 WITH GROUP 3

Multivariate Test

Multi.	F = 2.89	p = .007	Eta^2 = .12

Associated Univariate Tests

Imaginative Association	F = 1.48	p -	Eta^2 = .01
Visual-Spatial Relationships	F = 1.66	p -	Eta^2 = .01
Adjustment	F = 2.98	p = .086	Eta^2 = .02
Attitudes	F = 12.01	p = .001	Eta^2 = .08
Orientation to Life	F = 2.20	p -	Eta^2 = .01
Perception Processes	F = .98	p -	Eta^2 = .01
Judgment Processes	F = .68	p -	Eta^2 = .00

TABLE 10 (continued)

CONTRAST: GROUP 1 WITH GROUP 4			
Multivariate Test			
Multi.	F = 2.94	p = .007	Eta^2 = .13
Associated Univariate Tests			
Imaginative Association	F = 2.05	p -	Eta^2 = .01
Visual-Spatial Relationships	F = 11.56	p = .001	Eta^2 = .07
Adjustment	F = .35	p -	Eta^2 = .00
Attitudes	F = .49	p -	Eta^2 = .00
Orientation to Life	F = 1.27	p -	Eta^2 = .01
Perception Processes	F = 1.09	p -	Eta^2 = .01
Judgment Processes	F = 1.85	p -	Eta^2 = .01

Table 10: Multivariate Analysis of Variance Summary of TAFE Program Groups using Restricted and Unrestricted Spatial Thinking or Problem Solving (Silver) variables and Personality (Myers-Briggs) variables as Dependent Variables.

The contrast of Group 2 - Certificate of Kennel Cattery Practices and Certificate of Business Electronic Information Processing with Group 3 - Industry Training, using the multivariate set of DVs was significant, $F(1,148)=2.9$, $p=.007$. The associated univariate F test for Attitudes was significant, $F=12.0$, $p=.001$, $Eta^2=.08$. This indicates that 8% of the variability in Attitudes in this design can be accounted for by the contrast of TAFE Program Group 2 with

TAFE Program Group 3. An inspection of the observed means suggests that the Certificate of Kennel Cattery Practices and the Certificate of Business Electronic Information Processing group, 2 (mean Attitudes=.41) has higher mean factor scores on Attitudes than the Industry Training group, 3 (mean Attitudes=-.34). This suggests that for students in this study there appears to be a difference between these two TAFE program groups with respect to stated preference for ways of coping with the world.

The contrast of Group 1 - Certificate of Pre-Vocational Engineering/Construction with Group 4 - Associate Diploma of Applied Scientc (Computing) using the multivariate set of DVs was significant, $F(1,148)=2.9$, $p=.007$. The associated univariate F test for Visual-Spatial Relationships was significant, $F=11.6$, $p=.001$, $Eta^2=.07$. This indicates that 7% of the variability in Visual-Spatial Relationships in this design can be accounted for by the contrast of TAFE Program Group 1 with TAFE Program Group 4.

An inspection of the observed means suggests that the Associate Diploma of Applied Science (Computing) group, 4 (mean visual-spatial relationships=-.03) has higher mean factor scores on Visual-Spatial Relationships than the Certificate of Pre-Vocational Engineering/Construction group, 1 (mean visual-spatial relationships=-.93). This suggests that for students in this study there appears to be a difference between these two TAFE program groups with respect to performance on restricted spatial thinking

or problem solving tasks where responses require the definition of visual-spatial relationships of objects.

In the second analysis there were four dependent variables: Analytic/Integral, Concrete Reasoning, Perceptual Field Orientation, and Abstract Reasoning. The independent variable was TAFE Program Group as used in the first multivariate analysis of variance. Again, three contrasts were examined.

The contrasts of Group 1 - Certificate of Pre-Vocational Engineering/Construction with Group 4 - Associate Diploma of Applied Science (Computing), and Group 2 - Certificate of Kennel Cattery Practices and Certificate of Business Electronic Information Processes with Group 3 - Industry Training Group using the multivariate set of DVs were not significant at the multivariate level. The contrast of Group 2 and Group 3 with Group 4 was not significant at the multivariate level, however the associated univariate test of Concrete Reasoning approached significance, $F(1,54)=3.78$, $p=.057$, $Eta^2=.07$.

In summary, analysis of differences between the various TAFE program groups indicates significant differences. This suggests significant differences with respect to restricted and unrestricted spatial thinking or problem solving and personality based on the Silver and Myers-Briggs variables, but no differences with respect to restricted spatial thinking or problem solving based on the Raven variables. The findings from the second contrast in the first analysis

suggest that the Certificate of Kennel Cattery Practices and the Certificate of Business Electronic Information Processing may be characterised by an increased level of stated preference for methods of coping with the world than the Industry Training Group. The findings from the third contrast in the first analysis show that the Associate Diploma of Applied Science (Computing) group may be characterised by higher performances on restricted spatial thinking or problem solving involving Visual-Spatial Relationships than the Certificate of Pre-Vocational Engineering/Construction group.

(c) Study 7 - Gender Differences with respect to Restricted and Unrestricted Spatial Thinking or Problem Solving (Silver) Restricted Spatial Thinking or Problem Solving (Raven) and Personality (Myers-Briggs)

Two multivariate analyses of variance of gender differences with respect to restricted and unrestricted spatial thinking or problem solving (Silver), restricted spatial thinking or problem solving (Raven) and personality (Myers-Briggs) were carried out. In the first analysis (involving the Silver and Myers-Briggs models) the contrast examined was significant. In the second analysis (involving the Raven model) the contrast examined was not significant.

In the first analysis there were seven dependent variables: Imaginative Association (Unrestricted Spatial Thinking or Problem Solving), Visual-Spatial Relationships (Restricted Spatial Thinking or Problem Solving), and Adjustment derived from the factor scores for restricted and unrestricted spatial thinking or problem solving (Silver), and the personality variables of Attitudes, Orientation to Life, Perception Processes, and Judgment Processes derived from the factor scores for personality dimensions (Myers-Briggs). There were 152 subjects available for the analysis.

TABLE 11

CONTRAST: GENDER

Multivariate Test

Multi.	F = 5.84	p < .001	Eta^2 = .22

Associated Univariate Tests

Imaginative Association	F = 13.34	p < .001	Eta^2 = .08
Visual-Spatial Relationships	F = 7.70	p = .006	Eta^2 = .05
Adjustment	F = .56	p -	Eta^2 = .00
Attitudes	F = 3.24	p = .074	Eta^2 = .02
Orientation to Life	F = .07	p -	Eta^2 = .00
Perception Processes	F = .46	p -	Eta^2 = .00
Judgment Processes	F = 17.21	p < .001	Eta^2 = .10

Table 11: Multivariate Analysis of Variance Summary of Gender using Restricted and Unrestricted Spatial Thinking or Problem Solving (Silver) variables and Personality (Myers-Briggs) variables as Dependent Variables.

The contrast of gender using the multivariate set of DVs was significant, $F(1,150)=5.8$, $p<.001$. The effect size of .22 indicates that the main effect accounted for 22% of the variance. There were three significant associated univariate tests.

The associated univariate F test for Imaginative Association was significant, $F(1,150)=13.3$, $p<.001$, $Eta^2=.08$. This indicates that 8% of the variability in

Imaginative Association for this design can be accounted for by the contrast of gender.

An inspection of the observed means suggests that females (mean imaginative association=.17) have higher mean factor scores on Imaginative Association than males (mean imaginative association=-.43). This suggests that for TAFE students in this study there appears to be a gender difference with respect to level of performance on the unrestricted spatial thinking or problem solving dimension of Imaginative Association. Female students appear to perform better on unrestricted tasks that require free responses.

The associated univariate F test for Visual-Spatial Relationships was significant, $F(1,150)=7.7$, $p=.006$, $Eta^2=.05$. This indicates that 5% of the variability in Visual-Spatial Relationships for this design can be accounted for by the contrast of gender.

An inspection of the observed means suggests that females (mean visual-spatial relationships=.17) have higher mean factor scores on Visual-Spatial Relationships than males (mean visual-spatial relationships=-.30).
This suggests that for students in this study there is a gender difference with respect to level of performance on the restricted spatial thinking or problem solving dimension of Visual-Spatial Relationships. Female students appear to perform better on restricted tasks where responses require

the definition of visual-spatial relationships of objects with respect to height, width, depth and to some extent of sequential order.

The associated univariate F test for Judgment Processes was significant, $F(1,150)=17.2$, $p<.001$, $Eta^2=.10$. This indicates that 10% of the variability in Judgment Processes can be accounted for by the contrast of gender.

An inspection of the observed means suggests that males (mean judgment processes=.46) have higher mean factor scores on Judgment Processes than females (mean judgment processes=-.24). This suggests that for students in this study there appears to be a gender difference with respect to stated preference for Judgment Processes. Male students rather than female students appear to state a preference for ways of making decisions based on logic or according to a personal value system.

In the second analysis there were four dependent variables: Analytic/Integral, Concrete Reasoning, Perceptual Field Orientation, and Abstract Reasoning derived from the factor scores for restricted spatial thinking or problem solving (Raven). The independent variable was gender as used in the first multivariate analysis of variance. The contrast of gender using the multivariate set of DVs was not significant.

In summary, analysis of gender differences among TAFE students in this study indicates significant differences.

The findings of this study suggest that females are characterised by higher performances on the Imaginative Association dimension of unrestricted spatial thinking or problem solving, and the Visual-Spatial Relationships dimension of restricted spatial thinking or problem solving. Males however are characterised by an increased stated preference for decision making processes than females. There were no significant differences in gender for performances on any of the dimensions of restricted spatial thinking or problem solving (Raven).

(d) Study 8 - Differences Between Levels of Personality (Myers-Briggs) and Locus of Control (Coopersmith) with respect to Restricted Spatial Thinking or Problem Solving (Raven)

A multivariate analysis of variance was carried out using four dependent variables: Analytic/Integral, Concrete Reasoning, Perceptual Field Orientation, and Abstract Reasoning derived from the factor scores for restricted spatial thinking or problem solving (Raven).

The independent variables were levels on Locus of Control (Coopersmith), and the personality dimensions of Attitudes, Orientation to Life, Perception Processes, and Judgment processes (Myers-Briggs). There were only 45 subjects available for the analysis. Although none of the contrasts were significant at the multivariate level, two univariate contrasts were significant or approached significance (Table 12).

TABLE 12

CONTRAST: LOCUS OF CONTROL			
Multivariate Test			
Mult.	F = 11.55	p = .081	Eta^2 = .96
Associated Univariate Tests			
Analytic/Integral	F = 1.19	p -	Eta^2 = .19
Concrete Reasoning	F = 3.72	p -	Eta^2 = .43
Perceptual Field Orientation	F = 5.38	p = .068	Eta^2 = .52
Abstract Reasoning	F = 1.11	p -	Eta^2 = .18
CONTRAST: ATTITUDES			
Multivariate Test			
Mult.	F = 7.34	p -	Eta^2 = .94
Associated Univariate Tests			
Analytic/Integral	F = .03	p -	Eta^2 = .01
Concrete Reasoning	F = 1.31	p -	Eta^2 = .21
Perceptual Field Orientation	F = 15.88	p = .010	Eta^2 = .76
Abstract Reasoning	F = .63	p -	Eta^2 = .11

Table 12: Multivariate Analysis of Variance Summary of Locus of Control (Coopersmith) and Personality (Myers-Briggs) variables using Restricted Spatial Thinking or Problem Solving (Raven) variables as Dependent Variables.

The linear contrast of Locus of Control using the multivariate set of DVs approached significance, $F(1,5)=11.55$, $p=.081$. The associated univariate F test for Perceptual Field Orientation approached significance.

The linear contrast of Attitudes using the multivariate set of DVs was not significant, however the associated univariate F test for Perceptual Field Orientation was significant ($p=.010$). An inspection of the observed means suggests that subjects with high levels of Attitudes (mean perceptual field orientation=.31) have higher mean factor scores on Perceptual Field Orientation than subjects with low levels of Attitudes (mean perceptual field orientation=-.63).

In summary, analysis of differences between levels of personality and Locus of Control failed to indicate significant differences. Neither of the two contrasts reported in this study was significant at the multivariate level.

(e) Study 9 - Differences Between Levels of Personality (Myers-Briggs) and Locus of Control (Coopersmith) with respect to Restricted and Unrestricted Spatial Thinking or Problem Solving (Silver)

A multivariate analysis of variance was carried out using three dependent variables: Imaginative Association, Visual-Spatial Relationships, and Adjustment derived from the factor scores for unrestricted and restricted spatial thinking or problem solving (Silver).

The independent variables were levels on Locus of Control (Coopersmith) and the personality dimensions of Attitudes, Orientation to Life, Perception Processes, and Judgment Processes (Myers-Briggs). There were 143 subjects available for the analysis. Table 13 shows that four main effects were significant.

TABLE 13

LINEAR CONTRAST: LOCUS OF CONTROL

<u>Multivariate Test</u>

Mult. F = 2.76 p = .056 Eta^2 = .19

<u>Associated Univariate Tests</u>

Imaginative Association	F = .13	p -	Eta^2 = .00
Visual-Spatial Relationships	F = .12	p -	Eta^2 = .00
Adjustment	F = 7.93	p = .008	Eta^2 = .17

TABLE 13 (continued)

CURVALINEAR CONTRAST: LOCUS OF CONTROL

Multivariate Test

Mult. F = 7.91 p < .001 Eta^2 = .40

Associated Univariate Tests

Imaginative Association	F = .09	p -	Eta^2 = .00
Visual-Spatial Relationships	F = 23.56	p < .001	Eta^2 = .38
Adjustment	F = .38	p -	Eta^2 = .01

LINEAR CONTRAST: ATTITUDES

Multivariate Test

Mult. F = 2.57 p = .069 Eta^2 = .18

Associated Univariate Tests

Imaginative Association	F = 1.29	p -	Eta^2 = .03
Visual-Spatial Relationships	F = 6.61	p = .014	Eta^2 = .15
Adjustment	F = 1.12	p -	Eta^2 = .03

CURVALINEAR CONTRAST: JUDGMENT PROCESSES

Multivariate Test

Mult. F = 3.48 p = .026 Eta^2 = .22

Associated Univariate Tests

Imaginative Association	F = .74	p -	Eta^2 = .02
Visual-Spatial Relationships	F = 7.58	p = .009	Eta^2 = .17
Adjustment	F = .35	p -	Eta^2 = .01

TABLE 13 (continued)

CURVALINEAR CONTRAST: PERCEPTION PROCESSES			
Multivariate Test			
	Mult. F = 4.09	p = .013	Eta^2 = .25
Associated Univariate Tests			
Imaginative Association	F = 4.84	p = .034	Eta^2 = .11
Visual-Spatial Relationships	F = 6.97	p = .012	Eta^2 = .15
Adjustment	F = .00	p -	Eta^2 = .00
LINEAR CONTRAST: LOCUS OF CONTROL BY JUDGMENT PROCESSES			
Multivariate Test			
	Mult. F = 9.56	p < .001	Eta^2 = .44
Associated Univariate Tests			
Imaginative Association	F = 2.46	p -	Eta^2 = .06
Visual-Spatial Relationships	F = 23.73	p < .001	Eta^2 = .38
Adjustment	F = .03	p -	Eta^2 = .00

Table 13: Multivariate Analysis of Variance Summary of Locus of Control (Coopersmith) and Personality (Myers-Briggs) variables using Restricted and Unrestricted Spatial Thinking or Problem Solving (Silver) variables as Dependent Variables.

The linear contrast of Locus of Control using the multivariate set of DVs approached significance F (1,38)=2.8, p=.056. The associated univariate F test for Adjustment was significant (p=.008).

The curvalinear contrast related to Locus of Control using the multivariate set of DVs was significant F(1,38)=7.9, p<.001. The associated univariate F test for Visual-Spatial Relationships was significant (p<.001). An inspection of the observed means suggests that subjects with a medium level of Locus of Control (mean visual-spatial relationships=.41) have higher mean factor scores on Visual-Spatial Relationships than a combined group of subjects with high and low levels of Locus of Control (mean visual-spatial relationships=-.16). This suggests that for TAFE students in this study there appears to be a difference between levels of Locus of Control with respect to performance on the Visual-Spatial Relationships dimension of restricted spatial thinking or problem solving (Silver). Students who are open to both internally and externally attributable sources of control of self appear to perform better on tasks that require the definition of relationships of objects with respect to height, width and depth, and to some extent of sequential order.

The linear contrast of Attitudes using the multivariate set of DVs approached significance F(1,38)=2.57, p=.069. The associated univariate F test for Visual-Spatial Relationships was significant (p=.014).

The curvalinear contrast related to Judgment Processes using the multivariate set of DVs was significant $F(1,38)=3.5$, $p=.026$. The associated univariate F test for Visual-Spatial Relationships was significant ($p=.009$). An inspection of the observed means suggests that subjects with medium levels of Judgment Processes (mean visual-spatial relationships=.18) have higher mean factor scores on Visual-Spatial Relationships than a combined group of subjects with high and low levels (mean visual-spatial relationships=-.12) of Judgment Processes. This suggests that for TAFE students in this study there appears to be a difference between stated strength of preference for ways of arriving at decisions with respect to performance on the Visual-Spatial Relationships dimension of restricted spatial thinking or problem solving (Silver). Students who state that they have a moderate strength of choice for ways of making decisions appear to perform better on tasks where responses require decisions about visual-spatial relationships of objects.

The curvalinear contrast related to Perception Processes using the multivariate set of DVs was significant $F(1,38)=4.1$, $p=.013$. Two associated univariate F tests were significant. The univariate F test for Imaginative Association was significant ($p=.034$), and the univariate F test for Visual-Spatial Relationships was significant ($p=.012$). An inspection of the observed means suggests that a combined group of subjects with high and low levels of

Perception Processes (mean imaginative association=.18) have higher mean factor scores on Imaginative Association than the medium level (mean imaginative association=-.16). This suggests that there appears to be a difference between a combined group of TAFE students in this study who state that they have either a clear or a relatively weak preference for ways of taking in information, with respect to performance on the Imaginative Association dimension of unrestricted spatial thinking or problem solving (Silver). It appears that the performance on unrestricted tasks is affected by the stated strength of student choice for ways of taking in information, either through the five senses or by intuition. An inspection of group means suggests that students who state a clear preference for Perception Processes appear to perform better on tasks requiring free responses. This finding is consistent with Isabel Myers' prediction that creativity would be associated with the open, curious receptivity of the perceptive attitude (Briggs Myers and McCaulley, 1985:214).

Further, a combined group of subjects with high and low levels (mean visual-spatial relationships=.04) of Perception Processes have higher mean factor scores on Visual-Spatial Relationships than the medium level (mean visual-spatial relationships=-.08). This finding suggests that there appears to be a difference between the stated strength of choice by TAFE students in this study for ways of taking in

information with respect to performance on the Visual-Spatial Relationships dimension of restricted spatial thinking or problem solving (Silver). An inspection of group means however, does not suggest clearly which group of students perform better on this dimension.

The linear contrast of the interaction of Locus of Control by Judgment Processes using the multivariate set of DVs was significant $F(1,38)=9.6$, $p<.001$. The associated univariate F test for Visual-Spatial Relationships was significant ($p<.001$).

TABLE 14

Locus of Control	H	.013	-.356
	L	-1.439	.269
		H	L

Judgment Processes

Table 14: Comparison of Observed Means for the Interaction of Locus of Control and Judgment Processes on the Visual-Spatial Relationships variable.

Table 14 suggests that subjects with low levels of Judgment Processes combined with low levels of Locus of Control have higher mean factor scores on Visual-Spatial

Relationships than subjects with any other combined group of means. The findings from the interaction contrast of Locus of Control and Judging Processes suggest that for TAFE students in this study there appears to be a difference between stated strength of preference for ways of making decisions and levels of Locus of Control, with respect to performance on the Visual-Spatial Relationships dimension of restricted spatial thinking or problem solving (Silver). It appears that in this study students who do not state a clear preference for ways of making decisions based on logic or on a personal value system, together with an increasingly externally attributable source of control of self may have lower performances on tasks where decisions about the visual-spatial relationships of objects with respect to height, width and depth, and to some extent of sequential order need to be made.

In summary, analysis of differences between levels of personality and Locus of Control indicates that there are significant differences. The findings suggest that TAFE students in this study who balance control of self between internally attributable and externally attributable sources of control appear to perform better on tasks that require the definition of visual-spatial relationships of objects. These relationships include those of height, width, depth and to some extent of sequential order. Students who state a moderate preference for ways of making decisions either by logic or according to a personal value system also appear to

perform better on tasks requiring the definition of visual-spatial relationships of objects. There also appears to be a difference between the interaction of a stated weak preference for decision making and increasingly externally attributable sources of control of self with respect to performance on visual-spatial relationships tasks. Where students are 'other directed' or control of self is governed by external sources, and they state that they have a relatively weak preference for making decisions either based on logic or on a personal value system, their performance on visual-spatial relationships tasks appears to be adversely affected.

Finally, in this study there appears to be a difference between the stated strength of preference for ways of taking in information, either through the five senses or by intuition with respect to performance by TAFE students on unrestricted spatial thinking or problem solving tasks requiring free responses. Students who state a clear preference for Perception Processes appear to perform better on tasks that require free responses.

(f) Study 10 - Differences Between Levels of Information Processing (Luria) and Locus of Control (Coopersmith) with respect to Restricted Spatial Thinking or Problem Solving (Raven)

A multivariate analysis of variance was carried out using four dependent variables: Analytic/Integral, Concrete Reasoning, Perceptual Field Orientation, and Abstract Reasoning derived from the factor scores for restricted spatial thinking or problem solving (Raven).

The independent variables were levels on Locus of Control (Coopersmith) and the information processing dimensions of Successive Information Processing, Simultaneous Information Processing, and Cognitive Control (Luria). There were 44 subjects available for the analysis. Table 15 shows the summary produced by this analysis.

TABLE 15

LINEAR CONTRAST: LOCUS OF CONTROL

Multivariate Test

Mult. F = 4.45 p = .021 Eta^2 = .62

Associated Univariate Tests

Analytic/Integral	F = .30	p -	Eta^2 = .02
Concrete Reasoning	F = 15.03	p = .002	Eta^2 = .52
Perceptual Field Orientation	F = 4.34	p = .056	Eta^2 = .24
Abstract Reasoning	F = .46	p -	Eta^2 = .03

TABLE 15 (continued)

LINEAR CONTRAST: SUCCESSIVE INFORMATION PROCESSING

Multivariate Test

Mult. F = 6.36 p = .007 Eta^2 = .70

Associated Univariate Tests

Analytic/Integral	F = 6.90	p = .020	Eta^2 = .33
Concrete Reasoning	F = 7.74	p = .015	Eta^2 = .36
Perceptual Field Orientation	F = 1.98	p -	Eta^2 = .12
Abstract Reasoning	F = .08	p -	Eta^2 = .01

LINEAR CONTRAST: SIMULTANEOUS INFORMATION PROCESSING

Multivariate Test

Mult. F = 12.63 p < .001 Eta^2 = .82

Associated Univariate Tests

Analytic/Integral	F = 4.26	p = .058	Eta^2 = .23
Concrete Reasoning	F = 15.26	p = .002	Eta^2 = .52
Perceptual Field Orientation	F = 4.03	p = .064	Eta^2 = .22
Abstract Reasoning	F = 1.03	p -	Eta^2 = .07

CURVALINEAR CONTRAST: COGNITIVE CONTROL

Multivariate Test

Mult. F = 5.77 p = .009 Eta^2 = .68

Associated Univariate Tests

Analytic/Integral	F = .88	p -	Eta^2 = .06

TABLE 15 (continued)

Concrete Reasoning	F = .76	p -	Eta^2 = .05
Perceptual Field Orientation	F = 9.76	p = .007	Eta^2 = .41
Abstract Reasoning	F = .27	p -	Eta^2 = .02

LINEAR CONTRAST: SUCCESSIVE INFORMATION PROCESSING BY COGNITIVE CONTROL

Multivariate Test

Mult. F = 4.35 p = .024 Eta^2 = .61

Associated Univariate Tests

Analytic/Integral	F = .32	p -	Eta^2 = .02
Concrete Reasoning	F = 12.50	p = .003	Eta^2 = .47
Perceptual Field Orientation	F = .05	p -	Eta^2 = .00
Abstract Reasoning	F = .21	p -	Eta^2 = .02

LINEAR CONTRAST: SIMULTANEOUS INFORMATION PROCESSING BY COGNITIVE CONTROL

Multivariate Test

Mult. F = 3.94 p = .032 Eta^2 = .59

Associated Univariate Tests

Analytic/Integral	F = .01	p -	Eta^2 = .00
Concrete Reasoning	F = 5.51	p = .034	Eta^2 = .28
Perceptual Field Orientation	F = 5.44	p = .035	Eta^2 = .28
Abstract Reasoning	F = .19	p -	Eta^2 = .01

TABLE 15 (continued)

LINEAR CONTRAST: LOCUS OF CONTROL BY SUCCESSIVE INFORMATION PROCESSING

Multivariate Test

Mult. F = 3.54 p = .043 Eta^2 = .56

Associated Univariate Tests

Analytic/Integral	F = .93	p -	Eta^2 = .06
Concrete Reasoning	F = 10.06	p = .007	Eta^2 = .42
Perceptual Field Orientation	F = .85	p -	Eta^2 = .06
Abstract Reasoning	F = .17	p -	Eta^2 = .01

LINEAR CONTRAST: LOCUS OF CONTROL BY SIMULTANEOUS INFORMATION PROCESSING

Multivariate Test

Mult. F = 2.92 p = .071 Eta^2 = .52

Associated Univariate Tests

Analytic/Integral	F = 1.60	p -	Eta^2 = .10
Concrete Reasoning	F = 6.26	p = .025	Eta^2 = .31
Perceptual Field Orientation	F = 5.33	p = .037	Eta^2 = .28
Abstract Reasoning	F = .54	p -	Eta^2 = .04

TABLE 15 (continued)

LINEAR CONTRAST: LOCUS OF CONTROL BY COGNITIVE CONTROL			
Multivariate Test			
	Mult. F = 7.82	p = .003	Eta^2 = .74
Associated Univariate Tests			
Analytic/Integral	F = 1.03	p -	Eta^2 = .07
Concrete Reasoning	F = .60	p -	Eta^2 = .04
Perceptual Field Orientation	F = 13.45	p = .003	Eta^2 = .49
Abstract Reasoning	F = 1.97	p -	Eta^2 = .12

Table 15: Multivariate Analysis of Variance Summary of Locus of Control (Coopersmith) and Information Processing (Luria) variables using Restricted Spatial Thinking or Problem Solving (Raven) variables as Dependent Variables.

Four main effects were significant. Each of these effects is discussed in the following paragraphs.

The linear contrast of Locus of Control using the multivariate set of DVs was significant, $F(1,14)=4.5$, $p=.021$. The associated univariate F test for Concrete Reasoning was significant ($p=.002$), and the associated univariate F test for Perceptual Field Orientation approached significance ($p=.056$). An inspection of the observed means suggests that subjects with high levels of

Locus of Control (mean concrete reasoning=.13) have higher mean factor scores on Concrete Reasoning than subjects with low levels of Locus of Control (mean concrete reasoning=-1.36). This suggests that for TAFE students in this study there appears to be a difference between levels of Locus of Control with respect to performance on the Concrete Reasoning dimension of restricted spatial thinking or problem solving. Students who attribute control of self to an increasingly internal source appear to perform better on restricted tasks where reasoning by analogy is required.

The linear contrast of Successive Information Processing using the multivariate set of DVs was significant, $F(1,14)=6.36$, $p=.007$. Two associated univariate F tests were significant. The univariate F test for Analytic/Integral was significant (p=.020), and the univariate F test for Concrete Reasoning was significant (p=.015). An inspection of the observed means suggests that subjects with low levels of Successive Information Processing (mean analytic/integral=.36) have higher mean factor scores on Analytic/Integral than subjects with high levels of Successive Information Processing (mean analytic/integral=-.17). Further, subjects with low levels of Successive Information Processing (mean concrete reasoning=-.11) have higher mean factor scores on Concrete Reasoning than subjects with high levels of Successive Information Processing (mean concrete reasoning=-.76). This suggests that for TAFE students in this study there

appears to be a difference between levels of Successive Information Processing with respect to performance on the restricted spatial thinking or problem solving dimensions of Analytic/Integral and Concrete Reasoning tasks. Students who display low levels of the ability to synthesise temporally related information do not appear to perform well on tasks where responses require the breaking down of the whole into component parts and the integration of those parts to form a whole (Analytic/Integral), or on tasks where responses require reasoning by analogy (Concrete Reasoning).

The linear contrast of Simultaneous Information Processing using the multivariate set of DVs was significant, $F(1,14)=12.63$, $p<.001$. The associated univariate F test for Concrete Reasoning was significant ($p=.002$). An inspection of the observed means suggests that subjects with high levels of Simultaneous Information Processing (mean concrete reasoning=.20) have higher mean factor scores on Concrete Reasoning than subjects with low levels of Simultaneous Information Processing (mean concrete reasoning=-.67). This suggests that for TAFE students in this study there appears to be a difference between levels of Simultaneous Information Processing with respect to performance on the restricted spatial thinking or problem solving dimension of Concrete Reasoning. Students who display high levels of the ability to process information in parallel appear to perform better on tasks where responses

require reasoning by analogy. The associated univariate F test for Analytic/Integral approached significance (p=.058).

The curvalinear contrast related to Cognitive Control using the multivariate set of DVs was significant, $F(1,14)=5.8$, $p=.009$. The associated univariate F test for Perceptual Field Orientation was significant (p=.007). An inspection of the observed means suggests that subjects with medium levels of Cognitive Control (mean perceptual field orientation=.03) have higher mean factor scores on Perceptual Field Orientation than a combined group of subjects with high and low levels of Cognitive Control (mean perceptual field orientation=-.17). This suggests that for TAFE students in this study there appears to be a difference between levels of the Cognitive Control ability with respect to performance on the restricted spatial thinking or problem solving dimension of Perceptual Field Orientation. Students who display a moderate level of the ability to orchestrate essential mental activities appear to perform better on tasks where responses require the identification of a serial change running through the field of thought.

Of five contrasts of interactions using the multivariate set of DVs, four interactions were significant and one approached significance. Because of very low cell numbers however, these interactions will not be interpreted.

In summary, analysis of differences between levels of Information Processing and Locus of Control indicates significant differences.

The findings suggest that TAFE students in this study who display a moderate level of the capacity to concentrate attention on distinctive features through self regulation of mental activity (Cognitive Control) appear to perform better on restricted tasks where responses require the identification of a serial change running through the field of thought (Perceptual Field Orientation). Students who display low levels of the ability to synthesise temporally related information (Successive Information Processing) however, do not appear to perform as well on restricted tasks where responses require the breaking down of the whole into component parts and the integration of those parts to form a whole (Analytic/Integral).

Finally, students who display high levels of the ability to process information in parallel (Simultaneous Information Processing) appear to perform better on restricted tasks where responses require reasoning by analogy (Concrete Reasoning). Students who attribute control of self to an increasingly internal source rather than to external sources also appear to perform better on Concrete Reasoning tasks. Students who display a low level of the ability to synthesise temporally related information (Successive Information Processing) however, do not appear to perform as well on Concrete Reasoning tasks.

(g) Study 11 - Differences Between Levels of Information Processing (Luria) and Locus of Control (Coopersmith) with respect to Restricted and Unrestricted Spatial Thinking or Problem Solving (Silver)

A multivariate analysis of variance was carried out using three dependent variables: Imaginative Association, Visual-Spatial Relationships, and Adjustment derived from the factor scores for restricted and unrestricted spatial thinking or problem solving (Silver).

The independent variables were levels on Locus of Control, and the information processing dimensions of Successive Information Processing, Simultaneous Information Processing, and Cognitive Control. There were 145 subjects available for the analysis. The summary table produced by this analysis is shown in Table 16.

TABLE 16

LINEAR CONTRAST: LOCUS OF CONTROL

Multivariate Test

Mult. F = 5.57 p = .002 Eta^2 = .17

Associated Univariate Tests

Imaginative Association	F = 1.06	p -	Eta^2 = .01
Visual-Spatial Relationships	F = .13	p -	Eta^2 = .00
Adjustment	F = 14.04	p < .001	Eta^2 = .15

CURVALINEAR CONTRAST: LOCUS OF CONTROL

Multivariate Test

Mult. F = 4.68 p = .005 Eta^2 = .15

Associated Univariate Tests

Imaginative Association	F = .07	p -	Eta^2 = .00
Visual-Spatial Relationships	F = 13.96	p < .001	Eta^2 = .15
Adjustment	F = .01	p -	Eta^2 = .00

LINEAR CONTRAST: SUCCESSIVE INFORMATION PROCESSING

Multivariate Test

Mult. F = 2.62 p = .057 Eta^2 = .09

Associated Univariate Tests

Imaginative Association	F = 5.44	p = .022	Eta^2 = .06
Visual-Spatial Relationships	F = 1.51	p -	Eta^2 = .02
Adjustment	F = 2.65	p -	Eta^2 = .03

TABLE 16 (continued)

LINEAR CONTRAST: SIMULTANEOUS INFORMATION PROCESSING

Multivariate Test

Mult. F = 3.88 p = .012 Eta^2 = .13

Associated Univariate Tests

Imaginative Association	F = .30	p -	Eta^2 = .00
Visual-Spatial Relationships	F = .20	p -	Eta^2 = .00
Adjustment	F = 10.90	p = .001	Eta^2 = .19

CURVALINEAR CONTRAST: SIMULTANEOUS INFORMATION PROCESSING

Multivariate Test

Mult. F = 2.51 p = .065 Eta^2 = .09

Associated Univariate Tests

Imaginative Association	F = 1.04	p -	Eta^2 = .01
Visual-Spatial Relationships	F = 6.01	p = .016	Eta^2 = .07
Adjustment	F = .20	p -	Eta^2 = .00

TABLE 16 (continued)

LINEAR CONTRAST: LOCUS OF CONTROL BY SUCCESSIVE INFORMATION PROCESSING			
Multivariate Test			
Mult.	F = 3.14	p = .030	Eta^2 = .11
Associated Univarite Tests			
Imaginative Association	F = 2.49	p -	Eta^2 = .03
Visual-Spatial Relationships	F = 6.45	p = .013	Eta^2 = .07
Adjustment	F = .43	p -	Eta^2 = .01

Table 16: Multivariate Analysis of Variance Summary of Locus of Control (Coopersmith) and Information Processing (Luria) variables using Unrestricted and Restricted Spatial Thinking or Problem Solving (Silver) variables as Dependent Variables.

Table 16 shows that three main effects were significant and two approached significance. Each of these main effects are discussed in the following paragraphs.

The linear contrast of Locus of Control using the multivariate set of DVs was significant, $F(1,81)=5.6$, $p=.002$. The associated univariate F test for Adjustment was significant ($p<.001$). An inspection of the observed means suggests that subjects with high levels of Locus of Control (mean adjustment=.31) have higher mean factor scores on Adjustment than subjects with low levels of Locus of Control (mean adjustment=-.45). This suggests that for TAFE students in this study there appears to be a difference between levels of Locus of Control with respect to performance on the restricted spatial thinking or problem solving dimension of Adjustment. Students who attribute control of self increasingly to themselves appear to perform better on tasks where responses require the visualisation of changes in horizontality and verticality.

The curvalinear contrast related to Locus of Control was significant, $F(1,81)=4.7$, $p=.005$. The associated univariate F test for Visual-Spatial Relationships was significant ($p<.001$). An inspection of the observed means suggests that subjects with medium levels of Locus of Control (mean visual-spatial relationships=.40) have higher mean factor scores on Visual-Spatial Relationships than a group of subjects with combined high and low levels of Locus of Control (mean visual-spatial relationships=-.17).

This suggests that students who are open to both internally and externally attributable sources of control of self in a balanced way appear to perform better on restricted tasks where responses require the definition of visual-spatial relationships of objects.

The linear contrast of Successive Information Processing using the multivariate set of DVs approached significance, $F(1,81)=2.6$, $p=.057$. The associated univariate F test for Imaginative Association was significant ($p=.022$).

The linear contrast of Simultaneous Information Processing using the multivariate set of DVs was significant, $F(1,81)=3.9$, $p=.012$. The associated univariate F test for Adjustment was significant ($p=.001$). An inspection of the observed means suggests that subjects with high levels of Simultaneous Information Processing (mean adjustment=.33) have higher mean factor scores on Adjustment than subjects with low levels of Simultaneous Information Processing (mean adjustment=-.32). This suggests that for TAFE students in this study there appears to be a difference between levels of Simultaneous Information Processing with respect to performance on the restricted spatial thinking or problem solving dimension of Adjustment. Students who display a high level of ability to process information in parallel appear to perform better on tasks where responses require the visualisation of changes to horizontality and verticality of objects.

The curvalinear contrast related to Simultaneous Information Processing approached significance, $F(1,81)=2.5$, $p=.065$. The associated univariate F test for Visual-Spatial Relationships was significant ($p=.016$).

Of the various contrasts of interactions of variables using the multivariate set of DVs, two were significant. Two contrasts of interactions were not significant, however in both instances at least one associated univariate F test was significant.

The linear contrast of Locus of Control by Successive Information Processing using the multivariate set of DVs was significant, $F(1,81)=3.14$, $p=.030$. The associated univariate F test for Visual-Spatial Relationships was significant ($p=.013$).

TABLE 17

Locus of Control	H	-.397	-.005
	L	.149	-.390
		H	L

Successive Information Processing

Table 17: Comparison of Observed Means for the Interaction of Locus of Control and Successive Information Processing on the Visual-Spatial Relationships variable.

Table 17 suggests that subjects with a combined low level of Locus of Control and high level of Successive Information Processing group of means have higher mean factor scores on Visual-Spatial Relationships than subjects with any other combination of groups of means. The findings from the interaction contrast of Locus of Control and Successive Information Processing suggest that for TAFE students in this study there appears to be a difference between levels of Locus of Control in combination with levels of Successive Information Processing with respect to performance on the Visual-Spatial Relationships dimension of restricted statial thinking or problem solving.

It appears that in this study students who display a high level of ability to synthesise temporally related information and who also attribute control of self to increasingly external sources appear not to perform as well on tasks where responses require the definition of visual-spatial relationships of objects.

In summary, analysis of differences between levels of Information Processing and Locus of Control indicates significant differences. The findings suggest that TAFE students in this study who attribute control of self to increasingly internal sources appear to perform better on restricted tasks where responses require the visualisation of horizontal and vertical changes of objects whose properties remain the same (Adjustment).

Students who display a high level of ability to process information in parallel (Simultaneous Information Processing) also appear to perform better on these tasks.

Finally, students who are open to both internally and externally attributable sources of control of self in a balanced way appear to perform better on the restricted spatial thinking or problem solving dimension of Visual-Spatial Relationships. Responses to these tasks require the definition of relationships of height, width and depth of objects, and to some extent of sequential order.

In this study performance on visual-spatial tasks appears to be adversely affected where students display a high level of the ability to process temporally related information (Successive Information Processing) but who also attribute control of self to increasingly external sources.

CHAPTER 10 DISCUSSION, SUMMARY AND RECOMMENDATIONS

(a) DISCUSSION AND SUMMARY

The focus of this study was to examine the relationships amongst models of individual differences in a program of studies encompassing information processing and personality dimensions and restricted and unrestricted spatial thinking or problem solving. The first line analysis was composed of various component analyses while the second line analysis focused on the relationships between the components of the individual differences models and the components of restricted and unrestricted spatial thinking or problem solving. The data base for the study consisted of 193 students of Ithaca College of TAFE in pre-vocational, certificate, associate diploma, and industry training groups.

The research findings of A. R. Luria were used to establish an individual differences model of information processing. In this model two dimensions of successive information processing and simultaneous information processing, and the further dimension of cognitive control were identified. The component analysis of the data in this study was consistent with Luria's theoretical model and the findings of earlier research at the University of New England in recent years.

A model of four dichotomies of personality dimensions based on the Myers-Briggs theory was developed. A component analysis of the data was strongly supported by the theory of psychological preferences for perceiving information and for making decisions about that information.

A model of individual differences in motivation dimensions based on the theory of Coopersmith was developed. A component analysis of the data was supported by the underlying theory. The Locus of Control component from this study and the components from the other studies of individual differences were included in the second line analysis.

The component structures of the Raven's Advanced Progressive Matrices Sets I and II, and the *Silver Test* were examined. In both studies the component analyses of the data was supported by the underlying theories. The Raven's test provided a measure of restricted spatial thinking or problem solving where correct solutions to problems restricted to known parameters are sought. The *Silver Test* provided a measure of restricted spatial thinking or problem solving, as well as a measure of unrestricted spatial thinking or problem solving where solutions allow for free responses by test-takers.

In the second line analysis, multivariate analysis of variance procedures were used. Differences between restricted and unrestricted spatial thinking or problem

solving (Raven), personality (Myers-Briggs) and TAFE student characteristics of group and gender were examined in the first two studies. The next two studies examined the differences between levels of personality (Myers-Briggs) and the motivation dimension of Locus of Control (Coopersmith) with respect to restricted spatial thinking or problem solving (Raven), and unrestricted and restricted spatial thinking or problem solving (Silver). Two further studies examined the differences between levels of information processing (Luria) and Locus of Control (Coopersmith) with respect to restricted spatial thinking or problem solving (Raven) and unrestricted and restricted spatial thinking or problem solving (Silver).

The findings from the first study suggests that there are significant differences between TAFE program groups with respect to personality based on the Myers-Briggs variables and restricted and unrestricted spatial thinking or problem solving based on the Silver variables. The Associate Diploma of Applied Science (Computing) students may be described as performing at higher levels of restricted spatial thinking or problem solving involving visual-spatial relationships than the Certificate of Pre-Vocational Engineering/Construction students. Even higher performances by the Associate Diploma of Applied Science (Computing) students may be encouraged by enhanced presentation of restricted problems involving visual-spatial relationships

of height, width, depth and to some extent of sequential order. Instructional materials that incorporate computer graphics (especially three-dimensional technology) may be useful, particularly if students are required to interact with the programs to arrive at a correct solution. Such enhanced presentation of instructional material to strengthen perception of visual-spatial relationships may be especially useful for students in the Certificate of Pre-Vocational Engineering/Construction group. These students are required to solve problems in a variety of trade foundation study areas where responses require the definition of visual-spatial relationships of height, width and depth.

The Certificate of Kennel Cattery Practices and the Certificate of Business Electronic Information Processing students may be described as exibiting an increased preference for methods of coping with the world, either by arriving at perceptions or by arriving at decisions, than the Industry Training students. These differences have implications for course design and implementation both in the way information is presented to students and the way in which students are encouraged to come to conclusions about what has been perceived.

For the Certificate of Kennel and Cattery Practices and the Certificate of Business Electronic Information Processing students a variety of material may be provided that variously stimulates the five senses or appeals to the

intuition, and provides for decision making based on personal value systems as well as logic. Students may be encouraged to experience material that appeals to their stated preferences for taking in information and for making decisions, as well as alternative presentations that require students to exercise their less developed preferences.

There are clear implications for course design and implementation with regard to the Industry Training students. In this study these students appear to have less clearly stated preferences for forming perceptions and making decisions than the Certificate of Kennel and Cattery Practices and the Certificate of Business Electronic Information Processing students. The role of the environment in the Myers-Briggs theory is of extreme importance; natural preferences can be fostered through a favourable environment. The Industry Training students may benefit from non-threatening learning conditions which allow them to overview a variety of presentations of instructional material that stimulates the senses or appeals to the intuition, and fosters the development of decision making systems. Students may be thus encouraged to achieve some balance among the ways of taking in information and making decisions about that information.

The findings from the second study suggests that females may be described as performing at a higher level than males on the Imaginative Association dimension of unrestricted spatial thinking or problem solving and the

Visual-Spatial Relationships dimension of restricted spatial thinking or problem solving based on the Silver model. In this study it appears that females perform at a higher level on unrestricted spatial thinking or problems that require vicarious representation of reality through the formation of concepts and the creative representation of those concepts, as well as restricted spatial thinking or problem solving involving visual-spatial relationships.

Implementation strategies that foster increased performances by both males and females on unrestricted spatial thinking or problem solving may be included in all course offerings to widen the opportunities for free responses by students. These strategies may include student project work linked to specific industry needs. Such experiental learning through direct involvement with current industry problems may allow students to explore various alternative solutions and to bring fresh perspectives to difficult problems.

Better perceptions of visual-spatial relationships by both males and females may also be developed by allowing students to interact with visual instructional materials in which correct solutions to restricted problems are required. Feedback for incorrect responses could include analyses from different visual-spatial perspectives so that students may be encouraged to select appropriate remedial strategies to address specific visual-spatial relationship deficits.

Further, in this study males may be described as having a clearly stated preference for ways of making decisions. Such a clear preference does not imply excellence in the exercise of the Judging preference by males, rather it reflects the clarity of choice of the Judging preference by males. This suggests that both males and females may benefit from strategies that encourage students to exercise various ways of arriving at decisions about what has been perceived and to develop the traits and habits associated with the exercise of those skills.

Differences in gender and TAFE program group are of particular interest at this time of changing TAFE client populations. As the need for preparation for re-entry into the workforce, particularly for women, and the on-going upgrading of skills and re-skilling for all workers increases, so too will the demands on TAFE College resources increase.

The full effects of such strategies as equal opportunity for male and female workers, and affirmative action for women in the workforce have not yet been felt. It is clear however, that curriculum planners need to consider more divergent approaches to course offerings, both in terms of content and styles of delivery, to appeal to new work images and individual differences of students in a wide variety of TAFE program groups.

In the studies of differences between levels of personality and Locus of Control with respect to restricted and unrestricted spatial thinking or problem solving the importance of the Locus of Control dimension of motivation was highlighted. Miller (1980:80) states that

> "A person who has control over an aversive event ensures having a lower maximum danger than a person without control. This is because a person with control attributes the cause of relief to a stable internal source - his or her own response - whereas a person without control attributes relief to a less stable, more external source."

The findings have clear implications for learners and for instructional design and methodology. Learners need to be encouraged to take responsibility for their own learning. This may be achieved by fostering the notion of the self as an agent in the learning process. Instructional design should incorporate opportunities for student choice and active participation in decision making. Methodology should take into account the provision of materials and activities that will arouse student curiosity, and will challenge students through increasingly ambiguous, uncertain and difficult problems.

According to Hattie (1988) feedback is one of the most powerful single moderators that enhances achievement. Computer aided learning and computer managed learning strategies have the potential to offer ways of fostering self autonomy in the learning process through feedback that such technology can offer. Computer aided learning, especially in the area of graphics, offers the potential for allowing students to explore the projected outcomes of difficult problems. Graphical modelling techniques may be used to allow students to consider a variety of possible solutions that may otherwise not have been apparent to them. In a computer managed learning environment learners are able to direct their learning activities according to feedback on their level of expertise, and to choose the areas for further study according to their special interests.

Findings that suggest differences between information processing abilities and Locus of Control with respect to restricted and unrestricted spatial thinking or problem solving may provide guidelines for the accommodation of these dimensions of individual differences in TAFE College course modules. Students who are empowered through awareness of their individual strengths and weaknesses may be better able to monitor their own performances. Where particular performance deficits are encountered, students may be encouraged to strengthen information processing abilities through problem solving situations.

Such strengthening of abilities may assist student self-efficacy and increase the chances of enhanced performance on tasks which require the exercise of particular abilities.

(b) RECOMMENDATIONS

This study is highly exploratory and the findings should be treated with considerable caution due to the biased nature of the sample, and to the limited sample size which was beyond the control of the experimenter. Further research over wider TAFE population samples is needed to investigate fully the differences between information processing, personality and motivation with respect to restricted and unrestricted spatial thinking or problem solving.

The very small cell numbers in the various studies in this research, and the large numbers of empty cells in the studies involving the Raven data has hampered a full investigation. If the results reported in this study can be replicated in different TAFE Colleges, then the theory developed in this study will be further supported.

The need to accommodate individual differences in developing more effective course methodologies may be highlighted by the generalising of results to other TAFE College settings. TAFE College courses in Queensland are currently being reviewed. It is intended that self-paced modules and competency based learning and testing strategies are to be incorporated across the whole spectrum of TAFE courses.

The wide ranging recommendations made by the Finn Committee on post compulsory education in its Report delivered in August 1991 were reported in The Australian TAFE Teacher, Third Quarter, 1991. Among these recommendations were the following:

> "Australia as a nation should be committed to providing for all of its young people a program of education/training which prepares them for life as individuals, citizens and workers now through the current decade and into the coming century."

> "Curriculum must be appropriate and relevant to the full range of students so that all students can experience success and satisfaction in their learning and the talented should be challenged to extend themselves fully."

> "The curriculums must allow for a range of learning styles and, in particular for experiential learning."

Further, the Australian Education Council and Ministers of Vocational Education, Employment and Training endorse among others the Key Areas of Competency of problem solving (including analysis, critical thinking, decision making, creative thinking), and personal and interpersonal skills (including self esteem) as essential for all young people engaged in post compulsory education and training.

The findings of the present study indicate that there is scope for further investigations of the differences between information processing, personality and motivation with respect to restricted and unrestricted spatial thinking or problem solving. As the nature of these differences become better understood, the clearer the guidelines will become for facilitating effectiveness of various course methodologies for individual learners. For example, course guides and notes that cater for the needs of individual learners will become more important to a self-paced approach of course delivery where students are encouraged to take responsibility for their own learning.

In the information processing environment of today's post-industrial society educational excellence and educational equity are in confluence. Success in learning for some can no longer be described in terms of the failure of others. In the excellent post-industrial society all members have a place in the community, and as such they need to have the skills and knowledge to handle the business of life confidently. The challenge for TAFE Colleges is in meeting the needs of individual learners.

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APPENDIX A - TESTS FOR COGNITIVE CONTROL ABILITY

1 N/L (number/letter) Search Test

INSTRUCTIONS TO PARTICIPANTS:

Please write your name, and course number in the spaces provided at the top of the sheet.

ENSURE THAT ALL PENCILS ARE ON THE DESK

This is a test of your ability to shift your attention from one thing to another.

Place A CROSS on the letters and numbers as indicated in the left hand column. Go as fast as you can but do not be too concerned if you are unable to finish.

USE THE BOARD TO DEMONSTRATE LETTER AND NUMBER SEQUENCES.

For example, after the word 'Vowel' place a <u>cross</u> on each vowel.

B G E R U L O O P G T

After the word 'Odd' place a <u>cross</u> on each odd number in the line.

1 3 8 6 9 5 2 8 4 9 5

STRESS THE IMPORTANCE OF PLACING A CROSS.

When you are asked to stop, please place your pencil on the desk <u>immediately</u>.

Ready? Begin. (TIME WITH STOPWATCH 2 MINUTES 30 SECONDS)

Stop. (ENSURE THAT ALL PENCILS ARE ON THE DESK)

COLLECT SHEETS.

1 N/L (number/letter) Search Test

NAME: ..... COURSE NUMBER: .....

Please place a CROSS on the letters and numbers as indicated by the instruction in the left hand column.

1	Vowel	a	m	x	s	i	e	r	i	y	t	b	b	f	l	o	z	b	c	p	t	c	g	l	r
2	Odd	6	6	0	6	5	7	4	7	1	7	3	4	0	7	2	7	6	8	8	5	0	3	6	2
3	Consonant	c	l	j	k	s	q	l	a	a	p	s	t	b	u	l	o	u	c	d	j	i	m	f	q
4	Odd	1	0	0	9	7	3	2	5	5	3	7	6	5	2	0	1	3	5	8	6	5	4	8	7
5	Even	9	5	5	2	0	1	7	7	6	7	1	4	9	0	5	6	8	6	0	7	2	2	1	0
6	Even	6	5	4	8	1	1	7	6	7	4	1	7	4	6	8	5	0	9	5	0	5	8	4	7
7	Consonant	o	d	a	v	w	c	u	l	w	m	e	e	e	q	m	x	f	h	y	d	k	n	o	t
8	Vowel	f	g	p	s	m	a	n	o	e	g	t	u	i	q	u	s	s	t	b	m	l	g	r	x
9	Consonant	h	g	l	p	h	s	m	u	n	o	q	f	x	m	p	p	x	a	d	l	t	n	v	o
10	Odd	9	1	4	9	9	1	4	5	2	3	6	8	1	7	9	2	7	6	8	6	4	6	1	6
11	Even	6	1	1	9	6	9	0	4	4	6	2	6	4	5	7	4	7	7	4	5	1	9	2	4
12	Odd	0	4	4	9	3	5	2	4	9	4	7	2	4	6	3	3	8	2	4	4	5	8	6	3
13	Even	3	2	1	7	9	0	0	5	9	7	8	7	3	7	9	2	5	2	4	1	0	5	5	2
14	Vowel	a	a	c	e	m	d	p	d	f	x	r	b	z	w	q	b	u	o	m	d	g	l	a	f
15	Odd	9	8	0	8	6	2	4	8	2	6	4	5	2	4	0	2	8	4	0	4	4	4	9	9
16	Vowel	u	t	p	l	l	p	q	e	e	n	f	r	z	i	r	b	j	t	x	d	t	o	n	r
17	Odd	7	4	0	2	9	4	3	9	0	2	7	5	5	7	3	2	2	7	0	9	7	7	3	5
18	Even	5	4	1	7	8	4	5	6	1	1	8	9	9	3	3	7	1	4	3	0	5	3	2	2
19	Consonant	r	q	t	x	o	f	s	s	u	r	n	a	v	r	o	f	l	g	m	k	l	g	r	z
20	Vowel	m	j	k	v	m	s	m	u	o	r	s	e	m	x	s	c	m	o	r	b	d	t	p	u
21	Consonant	a	b	p	t	e	u	m	n	g	e	l	l	x	b	c	r	t	u	m	m	q	x	t	p
22	Consonant	s	n	o	u	b	p	y	d	f	x	b	q	l	f	r	a	s	e	l	i	i	b	n	r
23	Odd	1	1	6	6	4	4	9	8	8	3	5	2	0	7	9	8	4	8	2	7	5	9	3	8
24	Even	4	8	3	2	4	7	7	9	2	8	3	1	2	4	9	6	4	7	1	0	0	2	2	9

PLEASE STOP AND PLACE YOUR PENCIL ON THE DESK WHEN INSTRUCTED

N/L (Number/Letter) Search Test Marking Key

Item	Cue	Solution	Number Correct
1	Vowel	a i e i o	5
2	Odd	5 7 7 1 7 3 7 7 5 3	10
3	Consonant	c l j k s q l p s t b l c d j m f q	18
4	Odd	1 9 7 3 5 5 3 7 5 1 3 5 5 7	14
5	Even	2 0 6 4 0 6 8 6 0 2 2 0	12
6	Even	6 4 8 6 4 4 6 8 0 0 8 4	12
7	Consonant	d v w c l w m q m x f h y d k n t	17
8	Vowel	a o e u i u	6
9	Consonant	h g l p h s m n q f x m p p x d l t n v	20
10	Odd	9 1 9 9 1 5 3 1 7 9 7 1	12
11	Even	6 6 0 4 4 6 2 6 4 4 4 2 4	13
12	Odd	9 3 5 9 7 3 3 5 3	9
13	Even	2 0 0 8 2 2 4 0 2	9
14	Vowel	a a e u o a	6
15	Odd	9 5 9 9	4
16	Vowel	u e e i o	5
17	Odd	7 9 3 9 7 5 5 7 3 7 9 7 7 3 5	15
18	Even	4 8 4 6 8 4 0 2 2	9
19	Consonant	r q t x f s s r n v r f l g m k l g r z	20
20	Vowel	u o e o u	5
21	Consonant	b p t m n g l l x b c r t m m q x t p	19
22	Consonant	s n b p y d f x b q l f r s l b n r	18
23	Odd	1 1 9 3 5 7 9 7 5 9 3	11
24	Even	4 8 2 4 2 8 2 4 6 4 0 0 2 2	14

4 Auditory Number/Letter Attention Span Test

INSTRUCTIONS TO PARTICIPANTS:

Please write your name, and course number in the spaces provided at the top of the sheet.

This is a test of how well you can attend to either numbers or letters in a sequence of numbers and letters mixed together. I will say either the word 'numbers' or the word 'letters' and then call out the sequence. After I have finished, you are to write down either the numbers or the letters in the exact order in which they were called out. Please do not write anything until I have finished calling out the whole series. There will be 20 series.

For example, I might call out, 'Ready. Series One. Numbers. M 2 L 8 T 5. Begin."

When I say 'begin' (showing that the sequence is complete), write the numbers on the answer page opposite the number one in this manner:

USE THE BOARD TO DEMONSTRATE THE NUMBER SEQUENCE

2 8 5

If I had said 'Ready. Series One. Letters. M 2 L 8 T 5. Begin,' you would write the letters on the answer page opposite the number one in this manner:

USE THE BOARD TO DEMONSTRATE THE LETTER SEQUENCE

M L T

It is very important that you do not write numbers or letters while a sequence is being called out. Try to remember all of them if possible, and be sure to write them down in the exact order in which they were called out.

If you do not remember some of the numbers or letters, leave a blank space for them and write down all of those you do remember.

It is very important that you do not write anything while a series is being called out, since this is a test of your memory for a series.

4 **Auditory Number/Letter Attention Span Test**

NAME: ..... COURSE NUMBER: .....

Series 1 .....

Series 2 .....

Series 3 .....

Series 4 .....

Series 5 .....

Series 6 .....

Series 7 .....

Series 8 .....

Series 9 .....

Series 10 .....

Series 11 .....

Series 12 .....

Series 13 .....

Series 14 .....

Series 15 .....

Series 16 .....

Series 17 .....

Series 18 .....

Series 19 .....

Series 20 .....

TIME: 1 second per number/letter.

Series 1	Letters	6 - F - 2 - S - 9
Series 2	Letters	7 - R - 1 - I - A - 4
Series 3	Numbers	L - 3 - H - 2 - T - 6
Series 4	Letters	9 - K - H - 3 - 4
Series 5	Numbers	K - 1 - A - 5 - 8 - 5
Series 6	Letters	2 - S - 5 - F - 6 - 7 - 4
Series 7	Numbers	6 - 9 - V - R - 7 - A - W
Series 8	Numbers	I - 2 - R - 5 - V - 8 - J - I
Series 9	Letters	X - 5 - R - 2 - S - I - V - 7
Series 10	Numbers	7 - F - 2 - W - 9 - J - 6 - R - 4
Series 11	Letters	A - F - 9 - Y - 5 - R - K - 8
Series 12	Numbers	T - 6 - A - 9 - R - 7 - 2 - S - 8 - 3
Series 13	Numbers	A - 1 - Y - V - 6
Series 14	Letters	3 - 2 - W - 4 - F - K - 7 - T - 1 - A
Series 15	Letters	9 - A - H - 8 - A - 2 - K - 5 - 7
Series 16	Numbers	8 - L - 1 - S - 5 - K - 3 - R
Series 17	Numbers	6 - F - 2 - J - 9 - 1 - V
Series 18	Letters	6 - J - 7 - S - K
Series 19	Numbers	4 - R - 7 - W - 3 - A
Series 20	Letters	H - 5 - A - Q - 3 - 1 - S - V

APPENDIX B - TESTS FOR SIMULTANEOUS INFORMATION PROCESSING ABILITY

1 Test 2: Form Board Test Instructions

2 Test 2: Form Board Test Response Sheets

3 Test 2: Form Board Test Marking Key

4 Test 5: Paper Folding Test Instructions

5 Test 5: Paper Folding Test Response Sheet

6 Test 5: Paper Folding Test Marking Key

2 Form Board Test

NAME: ..... COURSE NUMBER: .....

This is a test of your ability to tell what pieces can be put together to make a certain figure.

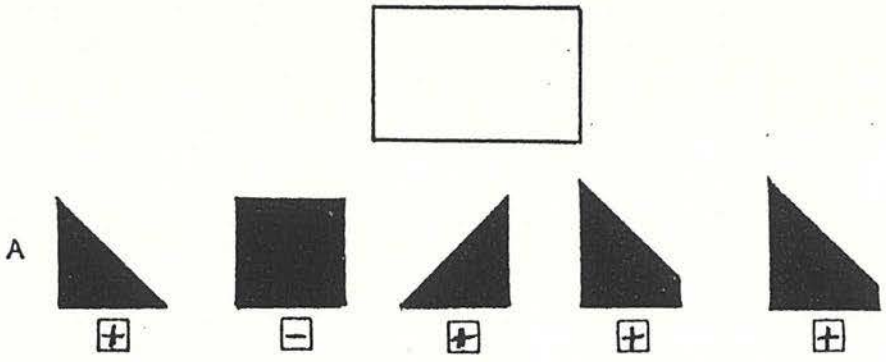
Each test page is divided into two columns. At the top of each column is a geometrical figure. Beneath each figure are several problems. Each problem consists of a row of 5 shaded pieces.

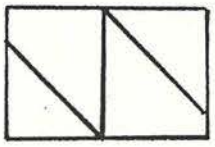
Your task is to decide which of the 5 shaded pieces will make the complete figure when put together.

Any number of shaded pieces, from 2 to 5, may be used to make the complete figure. Each piece may be turned around to any position but it <u>cannot be turned over</u>.

It may help you to sketch the way the pieces fit together. You may use any blank space for doing this. When you know which pieces make the complete figure, mark a <u>plus</u> (+) in the box under ones that are used, and a <u>minus</u> (-) in the box under ones that are not used.

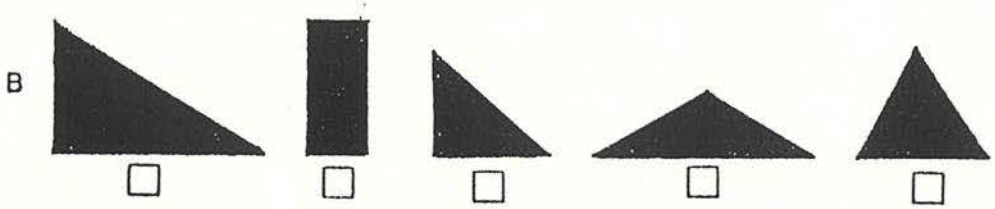
In Example A below, the rectangle can be made from the first, third, fourth and fifth pieces. A <u>plus</u> has been marked in the box under these places. The second piece is not needed to make the rectangle. A <u>minus</u> has been marked in the box under it. The rectangle drawn to the right of the problem shows one way in which the four pieces could be put together.

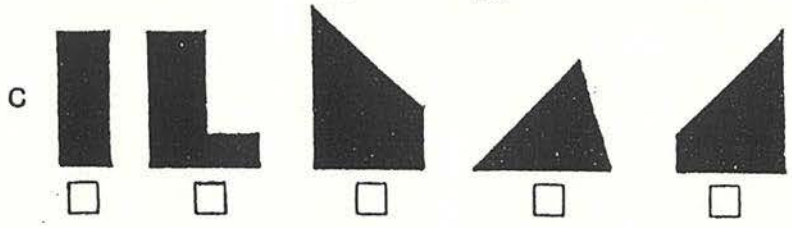




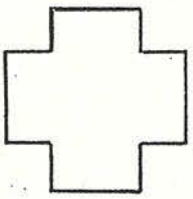
Answer

Now try to decide which pieces in Examples B and C will make the rectangle.



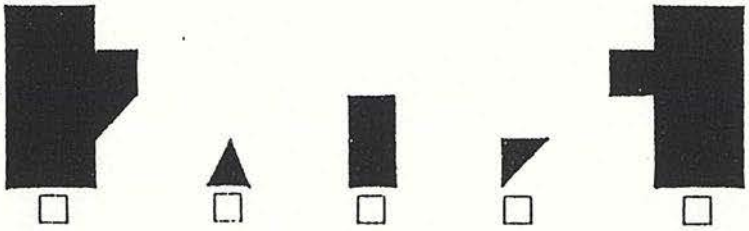


2 Form Board Test

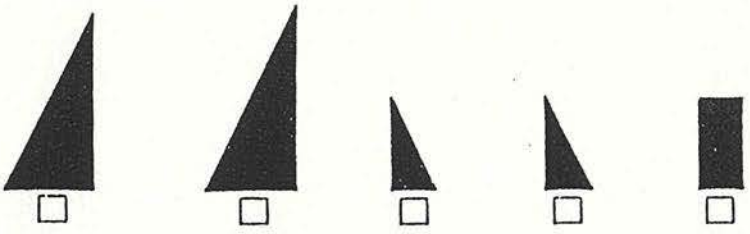


Problem 1

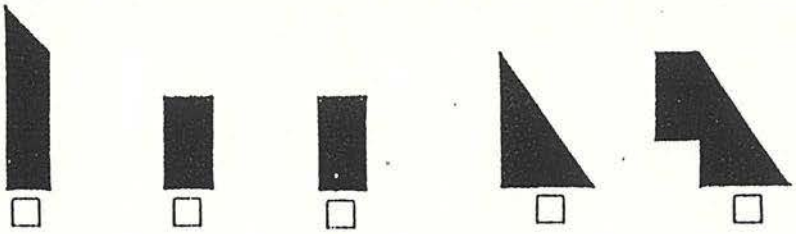
Problem 2



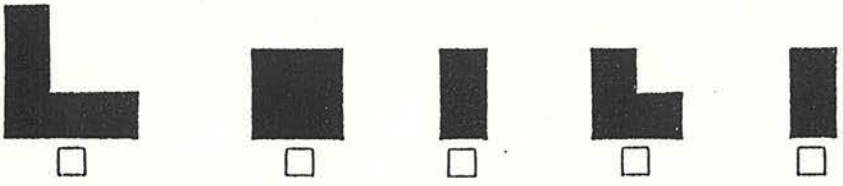
Problem 3



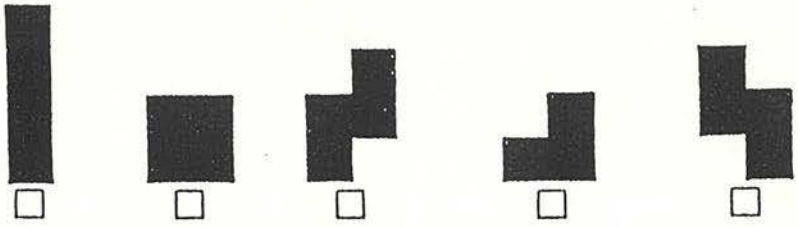
Problem 4

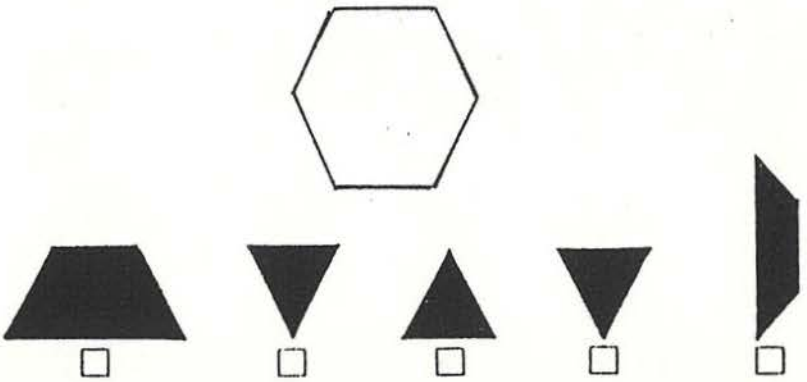


Problem 5

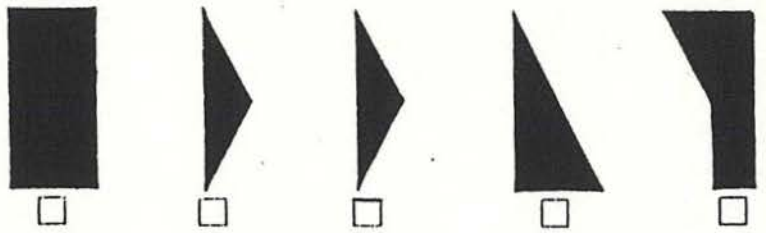


Problem 6

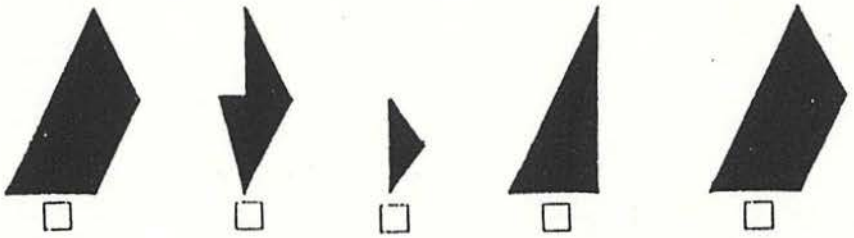




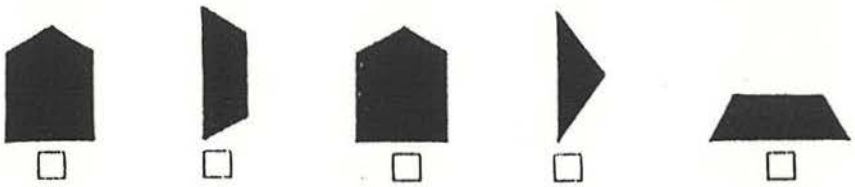
Problem 7



Problem 8

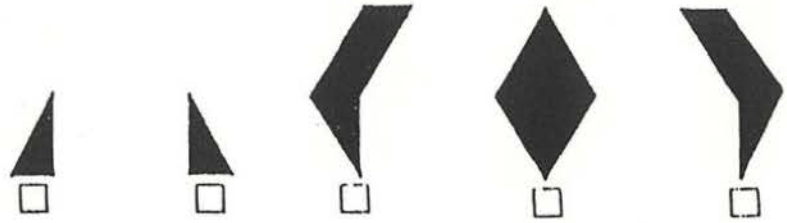


Problem 9

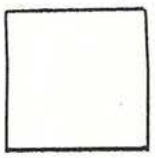


Problem 10

Problem 11



Problem 12



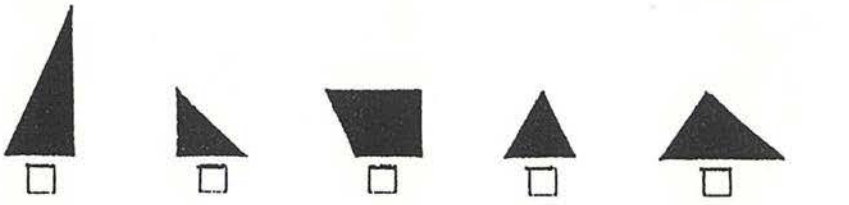
Problem 13

Problem 14

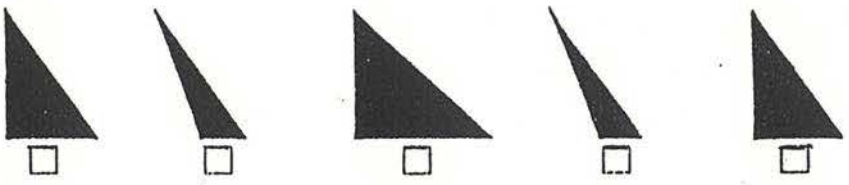
Problem 15

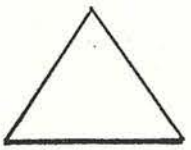
Problem 16

Problem 17



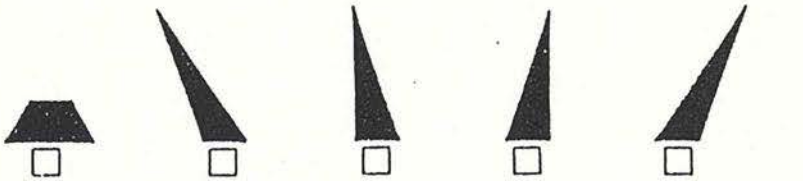
Problem 18



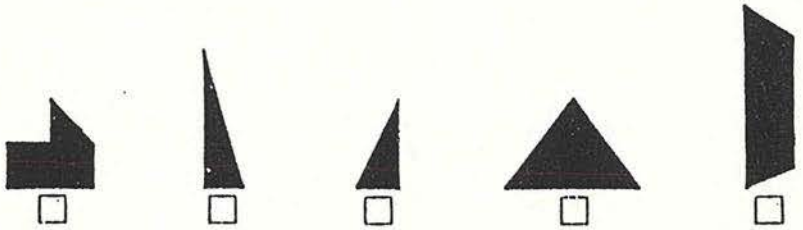


Problem 19

Problem 20

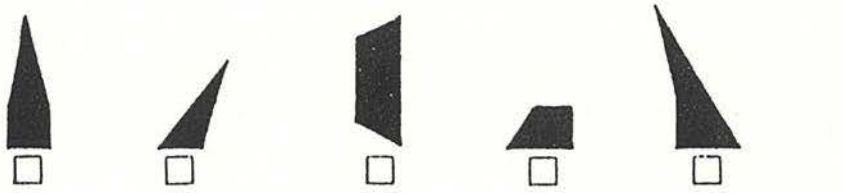


Problem 21



Problem 22

Problem 23



Problem 24

Form Board Test Marking Key

Practice Examples

A +, -, -, +, +

C -, +, +, -, +

Form Board Test:

Problem 1	+, -, +, -, +	Problem 13	+, -, +, -, +
Problem 2	+, -, +, +, -	Problem 14	+, +, -, +, -
Problem 3	+, +, +, +, +	Problem 15	+, +, -, +, -
Problem 4	-, +, +, +, +	Problem 16	+, -, +, +, +
Problem 5	+, -, +, +, +	Problem 17	+, +, +, +, +
Problem 6	-, +, +, -, +	Problem 18	+, +, -, +, +
Problem 7	+, +, +, +, -	Problem 19	+, +, +, -, +
Problem 8	+, +, +, -, -	Problem 20	-, +, +, +, +
Problem 9	+, -, -, -, +	Problem 21	-, -, -, +, +
Problem 10	+, +, +, -, +	Problem 22	+, +, -, +, +
Problem 11	+, +, +, +, +	Problem 23	+, +, -, +, +
Problem 12	+, +, +, +, +	Problem 24	+, +, +, +, +

5 Paper Folding Test

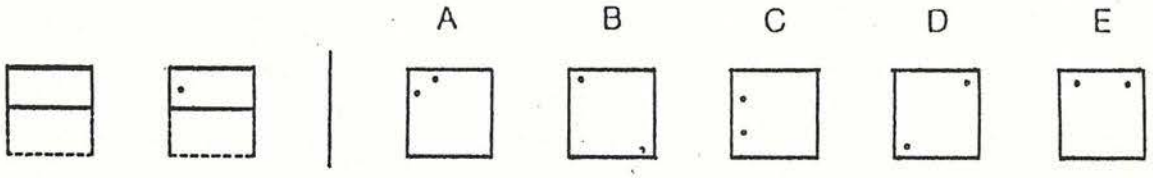
NAME: ..... COURSE NUMBER: .....

In this test you are to imagine the folding and unfolding of pieces of paper.

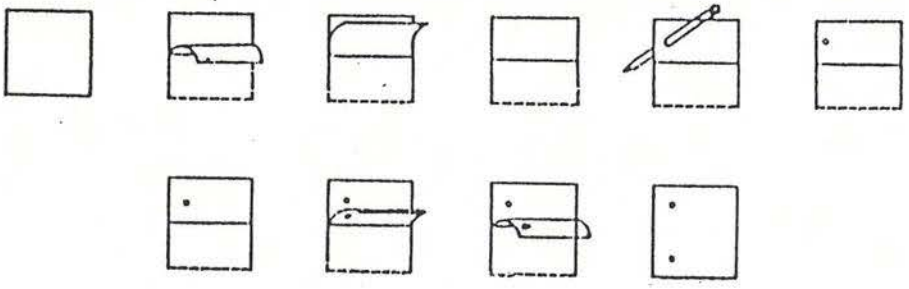
In each problem in the test there are some figures drawn at the left of a vertical line and there are other figures drawn at the right of the line. The figures at the left represent a square piece of paper being folded and the last of these figures has one or two small circles drawn on it to show where the paper has been punched. Each hole is punched through all the thicknesses of paper at that point.

One of the five figures at the right of the vertical line shows where the holes will be when the paper is completely unfolded. You are to decide which one of these figures is correct and draw an X through that figure.

Now try the sample problem below (in this problem only one hole was punched in the folded paper).

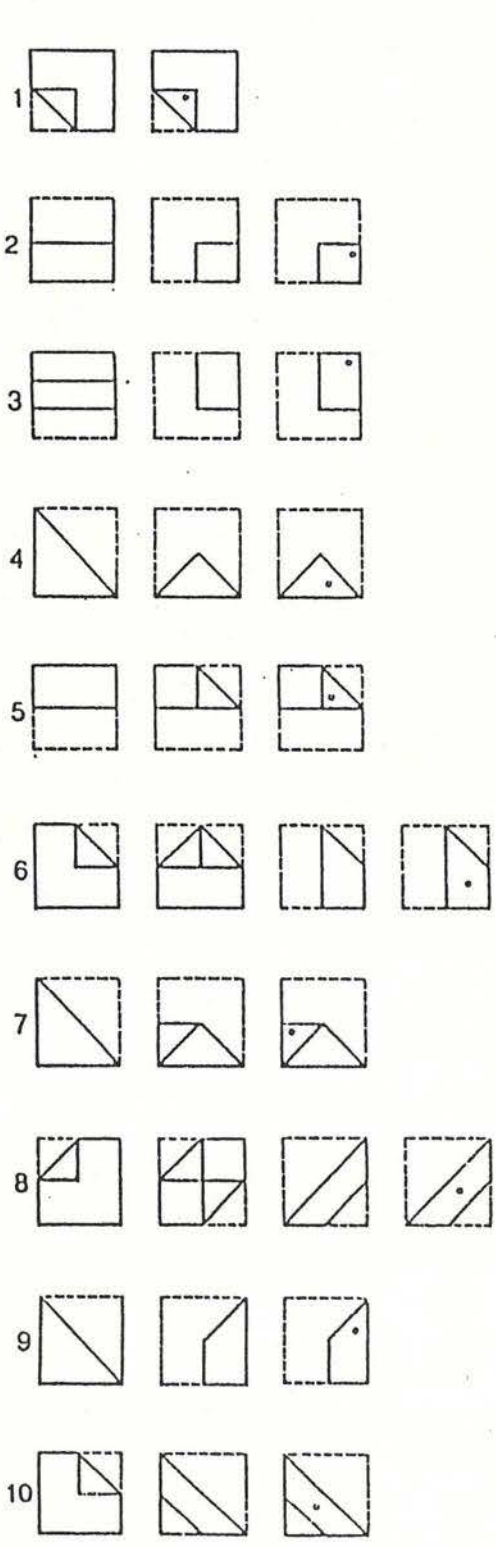


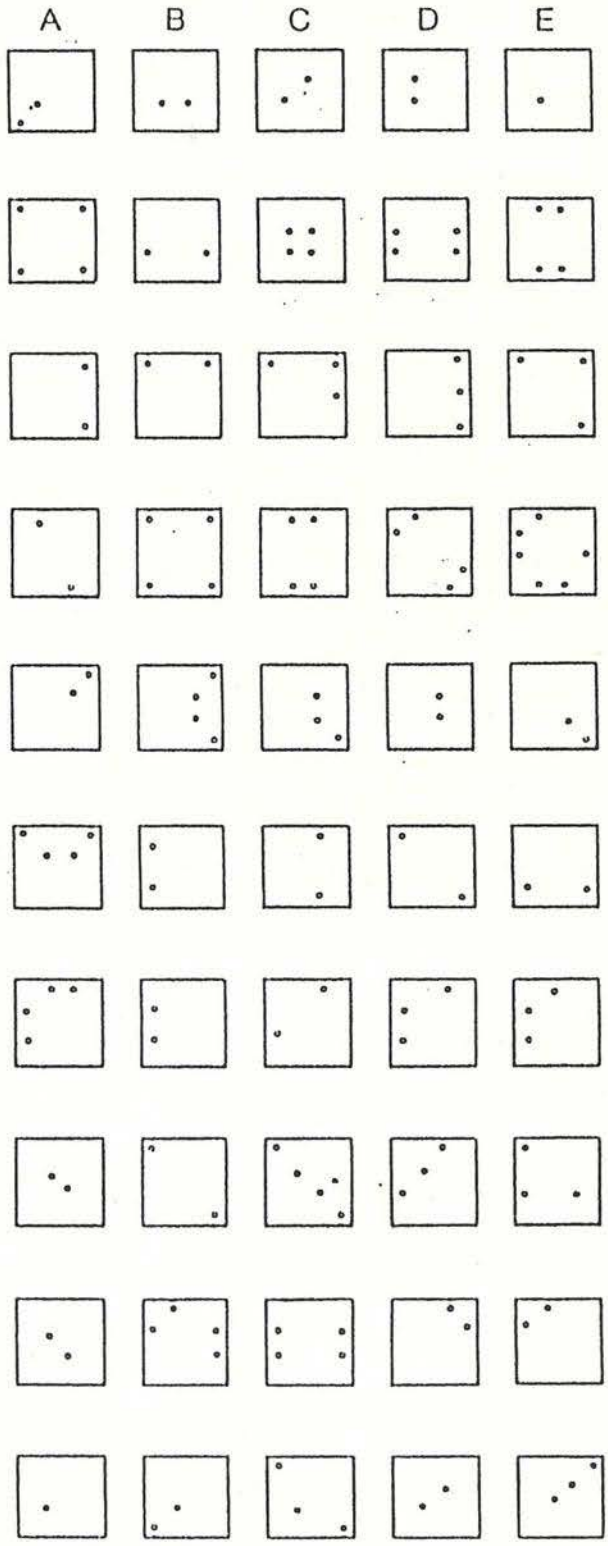
The correct answer to the sample problem above is C and so it should have been marked with an X. The figures below show how the paper was folded and why C is the correct answer.



In these problems all of the folds that are made are shown in the figures at the left of the line, and the paper is not turned or moved in any way except to make the folds shown in the figures. Remember, the answer is the figure that shows the positions of the holes when the paper is completely unfolded.

5 Paper Folding Test





Paper Folding Test Marking Key

1	A	6	E
2	D	7	A
3	B	8	C
4	D	9	E
5	B	10	E

APPENDIX C - TESTS FOR SUCCESSIVE INFORMATION PROCESSING ABILITY

3 Auditory Word Span Test

INSTRUCTION TO PARTICIPANTS:

This is a test of your ability to remember sets of words. I will call out the words. After I have finished each set of words you are to write down the words in the exact order in which they were called out. Please do not write any words of a set until I have finished calling out the whole set. There will be 20 sets.

Some of the sets may be too long for you to remember all of the words. If you do not remember some of them, leave a blank space for them and write down all the words that you do remember. Try to remember all the words if possible, and be sure to write them down in the exact order in which they were called out.

For example, I might call out, 'Set one. Tree - card - bottle - letter - page. Begin.'

When I say 'begin' (showing that the set is complete), write the words on the answer page opposite the number one.

It is very important that you do not write words while a set is being called out, since this is a test of your memory for words.

3 **Auditory Word Span Test**

NAME: ..... COURSE NUMBER: .....

Set 1 .....

Set 2 .....

Set 3 .....

Set 4 .....

Set 5 .....

Set 6 .....

Set 7 .....

Set 8 .....

Set 9 .....

Set 10 .....

Set 11 .....

Set 12 .....

Set 13 .....

Set 14 .....

Set 15 .....

Set 16 .....

Set 17 .....

Set 18 .....

Set 19 .....

Set 20 .....

3 Auditory Word Span Test

TIME: 1 second per word.

Set 1	MAN - LETTER - STRING
Set 2	HORSE - PEN - THORN - BABY
Set 3	TABLE - CAMP - PARTY - LAKE - BODY - ARROW - HALL
Set 4	PAPER - MOSS - RIVER - DREAM - SKIN
Set 5	GRASS - CUP - HOUSE - DOOR
Set 6	AIR - CHIN - INSECT - SNAKE - TICKET - SOCK
Set 7	MOTHER - APPLE - GOLD - BOOK - DRESS - SUGAR - CHAIR
Set 8	PEEPER - CLAW - SLAVE - POLE - ARMY - CAT
Set 9	CLOCK - LIP - ARM - FISH -CARD - BELL - INK
Set 10	TOY - FUR - FORK - ANT - LAND
Set 11	STONE - PEACH - ELBOW - MONEY - IRON - TANK - SKY - FLOOR
Set 12	CHURCH - NAIL - CORN - BIRD - STEP - KING
Set 13	HAIR - QUEEN - HEAD - DOLL
Set 14	KISS - WINE - PAGE
Set 15	ICE - FLAG - SKIRT - FROG - BLOOD - FIRE - SEAT - JAR - PLATE
Set 16	DOG - TREE - FOX - CITY - GIFT
Set 17	JELLY - ROAD - TRAIN - PIN - CAR - FISH - BAR - STEP - TOAST
Set 18	WIFE - CHILD - ROCK - STEAM - WINTER - PENCIL
Set 19	PIPE - SUN - BREAD - CAKE - HAND
Set 20	HOTEL - FOREST - WINDOW - TAP - HILL - JAM - SHIP

6 Auditory Number Span Test

INSTRUCTIONS TO PARTICIPANTS:

This is a test of your ability to remember series of numbers. I will call out the numbers. After I have finished each series of numbers you are to write down the numbers in the exact order in which they were called out. Please do not write any numbers of a series until I have finished calling out the whole series. There will be 20 series.

Some of the series will be too long for you to remember all of the numbers. If you do not remember some of them, leave a blank space for them and write down all the numbers you do remember. Try to remember all the numbers if possible, and be sure to write them down in the exact order in which they were called out.

For example, I might call out, 'Series one. 7 - 2 - 4. Begin."

When I say 'begin' (showing that the series is complete), write the numbers on the answer page opposite the number one.

USE THE BOARD TO DEMONSTRATE

7 2 4

It is very important that you do not write numbers while a series is being called out, since this is a test of your memory for numbers.

6 Auditory Number Span Test

NAME: ..... COURSE NUMBER: .....

Series 1 .....

Series 2 .....

Series 3 .....

Series 4 .....

Series 5 .....

Series 6 .....

Series 7 .....

Series 8 .....

Series 9 .....

Series 10 .....

Series 11 .....

Series 12 .....

Series 13 .....

Series 14 .....

Series 15 .....

Series 16 .....

Series 17 .....

Series 18 .....

Series 19 .....

Series 20 .....

6 Auditory Number Span Test Page 2

TIME: 1 second per number.

Series 1	8 - 1 - 9 - 5 - 7 - 2
Series 2	4 - 6 - 2 - 9
Series 3	3 - 7 - 1 - 4 - 9 - 2 - 5 - 8 - 1 - 6
Series 4	9 - 2 - 6 - 2 - 8 - 6
Series 5	7 - 9 - 5 - 3 - 8
Series 6	5 - 2 - 9 - 4 - 1 - 6 - 8 - 3 - 7
Series 7	2 - 6 - 3 - 1 - 5
Series 8	2 - 4 - 8 - 5 - 1
Series 9	6 - 8 - 2 - 4 - 1 - 3 - 9 - 7 - 2 - 5 - 3
Series 10	9 - 2 - 8 - 5 - 7 - 1
Series 11	7 - 4 - 2 - 9 - 3 - 5 - 8 - 6
Series 12	4 - 3 - 7 - 2 - 3 - 9
Series 13	5 - 7 - 3 - 1 - 6 - 9 - 4 - 8 - 5 - 1 - 7 - 2
Series 14	6 - 2 - 5 - 9 - 7 - 1 - 8 - 3
Series 15	4 - 7 - 9 - 3 - 6 - 1 - 5 - 8 - 4 - 2 - 7
Series 16	5 - 1 - 8 - 7 - 2 - 3 - 1
Series 17	8 - 2 - 6 - 9 - 1 - 7 - 3 - 8 - 5 - 9 - 6 - 4
Series 18	5 - 1 - 9 - 2 - 7 - 4 - 8 - 3 - 6
Series 19	7 - 5 - 2 - 6 - 4 - 9 - 1
Series 20	3 - 2 - 1 - 8 - 1 - 4 - 6 - 5

APPENDIX D - TESTS FOR DIMENSIONS OF PERSONALITY

1 Description of Administration of Myers-Briggs Indicator

2 Description of Myers-Briggs Validation

3 Data on internal consistency and reliabilities of the Myers-Briggs Indicator

Description of Administration of Myers-Briggs Indicator

The Indicator was administered in a group setting by the researcher. Each subject was given the Myers-Briggs Type Indicator Form G Question Booklet, and their attention was drawn to the directions printed on the front of the form. The researcher provided brief background information of the Indicator and the fact that feedback would be provided for each subject. Subjects were directed to supply their name, sex, and course identification on the answer sheet.

The approximate time allowed for the test is one hour, however subjects are allowed extra time to complete the Indicator if required.

Description of Myers-Briggs Validation

The researcher handed to each subject their report form showing how they 'came out' on the Indicator. Subjects were directed not to discuss their profile with other subjects. The researcher provided an overhead projection presentation of the theory on which the Indicator is based. During the presentation the subjects are presented with visual representations and verbal descriptions of characteristics associated with the four preference scales (Page, 1983:31). At the end of the presentation subjects are given the opportunity to examine the long descriptions of each of the sixteen types provided by Briggs Myers (1987:10-25).

The subjects were asked to judge for themselves how accurate the report was for them. Where subjects agreed with their reported type, they were asked to write a short statement to that effect at the top of the report form. Any subjects who did not agree with their reported type were asked to write a short statement to that effect at the top of the report form and to identify the type which they felt more accurately described them. The researcher retained the report forms for the validation of type data input.

Data on Internal Consistency and Reliabilities of the Myers-Briggs Indicator

The internal consistency of the Myers-Briggs Type Indicator continuous scores (split-half correlations with Spearman-Brown formula correction) are reported in Myers Briggs and McCaulley for samples from high schools and colleges. Correlations for Extraversion-Introversion range from .77 to .84, for Sensing-Intuition (N) from .73 to .90, for Thinking-Feeling from .78 to .86, and for Judging-Perception from .84 to .92 as shown in the following extract from Table 10.2 (Briggs Myers and McCaulley, 1985:166) on the next page.

TABLE 18

Description of Sample	Sex	N	EI	SN	TF	JP
Total Form G data bank	M,F	32,671	82	84	83	86
Males	M	15,791	82	84	82	86
Females	F	16,880	82	84	79	86
Traditional:						
junior high school student	M,F	232	79	73	78	86
high school student	M,F	608	84	83	80	87
Adult high school dropout	M,F	378	77	86	84	84
Adult high school graduate, no college	M,F	1,260	82	84	84	85
Traditional college student	M,F	11,908	82	81	82	86
Non-traditional age college student	M,F	1,708	83	84	85	92
Adult college graduate	M,F	5,584	83	89	86	88
Age Groupings:						
9-14	M,F	441	78	73	78	84
15-17	M,F	3,948	82	82	80	86
18-20	M,F	11,052	82	81	81	85
21-24	M,F	2,917	81	83	84	86
25-29	M,F	2,609	80	85	84	85
30-39	M,F	4,807	83	88	85	87
40-49	M,F	2,852	83	89	86	87
50-59	M,F	1,603	82	90	86	88
60+	M,F	520	83	88	85	88

Table 18: Extract from Table 10.2 showing Internal Consistency derived from Product-moment Correlations of X and Y Continuous Scores with Spearman-Brown Prophecy Formula Correction, Form G (Briggs Myers and McCaulley, 1985:166).

Reliabilities are reported to remain stable for up to twenty-five omissions from Form G. Although reliabilities tend to be somewhat lower for respondents in the lower age groups, they do tend to stablise for the age groups ranging from 15-17 through to 60+.

The Manual does not provide any data regarding Test-Retest Reliabilities of Type categories based on form G, however data is provided based on form F which was the standardised form in the early 1970's. These forms are essentially interchangable when scored for type (Briggs Myers and McCaulley, 1985:144). In studies by Myers (1973), Stalcup (1968), Levy, Murphy and Carlson (1972), Howes (1977), McCarley and Carskadon (1983), Weiss (1980), Bruhn, Bunce, and Greaser (1978), Harris, Kelley, and Coleman (1984), Harris (1981), the chance probability of choosing all four preferences resulting in coming out the same type on retest is 6.25%. Persons expected to change one category comprised 25%, to change two categories 37.5%, to change three categories 25%, and to change all four categories 6.25%. Thus, the actual test-retest probabilities are significantly different from chance. Further, the Howes (1977) study involving introductory psychology student volunteers reported separate reliabilities for students originally giving low, moderate, or high preference scores. This study was replicated in the study by Weiss (1980) involving student nurses, and in a study of British medical students. A comparison of the three studies shows that

there is a trend for the most changes to occur in cases where the original preference was low.

Details are provided in the Manual of correlation of the Myers-Briggs Type Indicator continuous scores with other measures including, among others, personality, emotions, self-description and self-report, values, interests, opinions, attitude, and occupation interests. Fig 3 shows some of these measures: [1]Edwards Personality Preference Survey (EPPS) (Edwards, 1959), [2]Sixteen Personality Factor Questionnaire (16PF) (Cattell, Eber and Tatsuoka, 1970), [3]Emotions Profile Index (Plutchik and Kellerman, 1974), [4]Stein Self-Description Questionnaire (Stein, 1966), [5]Study of Values (Allport, Vernon, and Lindzey, 1960), [6]OAIS:Opinion, Attitude, and Interest Scales (Fricke, 1963), [7]Strong-Campbell Interest Inventory (SVIB-SCII), (Campbell and Hansen, 1981), as reported in Briggs Myers and McCaulley (1985:177-203).

In summary, significant correlations at probabilities of .01 or greater were found for each of the four scales of Extraversion-Introversion, Sensing-Intuition, Thinking-Feeling, Judging-Perception in the direction described by the theory. The preference associated most strongly with each scale is underlined. Only correlations of .40 or higher are shown from the above studies.

FIG 3

[1] order	-STJ	[2] venturesome	E---
nurturance	--F-	experimenting	-NT-
		controlled	-S-J
		creativity	-N-P
[3] depressed	I--J	[4] autonomy	-N--
dyscontrol	E--P	dominance	E---
distrust	--T-	order	-S-J
gregarious	E---	defendance	I---
		sentience	-N-P
[5] theoretical	--T-	[6] interests in:	
economic	-STJ	business	ES-J
aesthetic	-N-P	humanities	-N-P
		social sciences	E---
		physical sciences	I-T-
[7] general occupational themes:		opinions and attitudes:	
		social adjustment	E---
artistic	-N-P	emotional adjustment	E---
enterprising	ES-J	masculine orientation	--T-
		creative personality	EN-P

Fig 3: Myers-Briggs Preference Associations with Other Personality Scales.

An independently-derived instrument to determine Jungian types is that of the Gray-Wheelwright Psychological Type Questionnaire (1946). This instrument together with the Myers-Briggs Type Indicator was administed in two studies (Stricker and Ross, 1962; and Grant, 1965) to groups of college students as reported by McCaulley and Natter (1974:115). Both studies found that the Myers-Briggs Type Indicator and the Gray-Wheelwright instruments measured the same dimensions, ie the Jungian opposities, however the Extraversion-Introversion and Sensing-Intuition constructs were more consistently tapped than with the Thinking-Feeling

construct (Briggs Myers and McCaulley, 1985:209). Findings from two recent studies by Thompson and Borrelo (1986) tend to support the Myers-Briggs Type Indicator's construct validity and the item weighting procedures.

APPENDIX E - TEST FOR MOTIVATION

1 Description of Administration of the Coopersmith Self Esteem Inventory

Description of Administration of the Coopersmith Self Esteem Inventory

The test was introduced to subjects as an 'Inventory.' The words 'self-esteem' were not to be used in any descriptions provided during the research session.

The subjects were asked to read the instructions on the front of the Inventory and to complete the details of name, etc. Clarifiication of the 'like me' and 'unlike me' descriptions were provided by the researcher who stated:

> "If you consider the statement to be like you, then place a cross in the box under the 'like me' column. If you consider the statement not to be like you, then place a cross in the box under the 'unlike me' column."

The subjects were asked to work through the twenty-five items. The approximate time allowed for the test is 10 minutes, however subjects are allowed extra time to complete the Inventory if required.

The researcher collected the Inventories as they were completed.

APPENDIX F - TESTS OF RESTRICTED AND UNRESTRICTED SPATIAL THINKING OR PROBLEM SOLVING (SILVER)

1 Description of Administration of the *Silver Test*

2 Example of the *Silver Test*

3 Example of the *Silver Test* Scoring Sheet

4 Photograph of the layout of objects for the "Drawing from Observation" sub-test.

Description of Administration of the *Silver Test*.

Subjects were given a copy of the *Silver Test*. Subjects were asked to use a soft pencil and have an eraser handy throughout the test. Once details such as name, group, etc. had been filled in by subjects, the researcher read through the directions contained in the test booklet for each of the three sub-tests so that subjects had the opportunity to clarify any points.

The subjects were asked to commence the test. The researcher set up a still-life display of items specified in the Manual so that it was possible for research subjects to draw the still-life from positions varying up to 30^0 to the left or right in the Drawing from Observation sub-test. The still-life remained in place until the end of the *Silver Test*.

The *Silver Test* is untimed, however approximately thirty minutes is allowed with extra time being made available if subjects request it. The *Silver Test* was scored according to the guidelines given in the Manual (Silver, 1983:29-33) by the researcher and by an independent scorer.

The author of the test, Dr Rawley Silver, has given permission to include a copy of the *Silver Test* in this appendix. The *Silver Test* used in this study is not the current version of the test. Inquiries regarding the current version should be directed to:

Dr Rawley Silver
3332 Hadfield Greene
SARASOTA, FLORIDA, USA 34235

APPENDIX G - DATA COLLECTION

1 Permission and Preliminary Data Collection Sheet

RESEARCH PROJECT INTO PROBLEM SOLVING

CONDUCTED BY GLENDA HUNTER

I am willing to take part in the research project to be conducted at Ithaca TAFE College in 1989 by Glenda Hunter.

I understand that the results of the research project are strictly confidential and that the identity of participants will not be revealed in the findings of the study.

SIGNED: .....

DATE: .....

PLEASE PRINT THE FOLLOWING PARTICULARS:

LAST NAME: .....

GIVEN NAMES: .....

STUDENT NUMBER: .....

DATE OF BIRTH: .....

GENDER: .....

NAME OF COURSE: .....

COURSE NUMBER: .....