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The Development of Vocational Interests and Abilities in Secondary School Aged Children

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Abstract

This body of work has focussed on the measurement, structure and stability of vocational interests and abilities in mainstream, mixed-ability secondary school aged children. This set of studies investigated how a large group of children's vocational interests developed over a two year period, and how their interests for activities/occupations were related to selected abilities (Mechanical, Spatial Rotation and Logical Reasoning). Published research has consistently demonstrated that for adults, vocational interests are stable over time, and that interests typically fall into six main categories; Realistic, Investigative, Artistic, Social, Enterprising and Conventional (Holland, 1959). Furthermore, there is a wealth of evidence to suggest that the relationships between these six categories broadly approximate a hexagonal framework once individuals reach adulthood (e.g. Holland *et al.*, 1969).

Data analysis revealed that similar to adults, children's interests overall were remarkably stable over time, and that this was particularly the case for Realistic and Social interests. The findings were also suggestive of a pathway of interest development in children aged 11-17. The youngest children who participated in this research had interests that were often gender stereotyped, though the structure of their interests was not consistent with the hexagonal structure commonly seen in adults. However, as children got older, their interests became more aligned to a hexagonal format,

particularly for the female group. Furthermore, there were clear gender differences with females typically having more distinctive and more consistent interest profiles over time. There were a few weak associations between ability and interest, with the clearest link suggesting that early Realistic interests are predictive (in part) of later Mechanical ability. These findings consequently have practical implications for the timing and delivery of careers counselling in school. Theoretical implications and future directions have also been identified and discussed.

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Author's declaration

At no time during the registration for the degree of Doctor of Philosophy has the author been registered for any other University Award without prior agreement of the Graduate Committee.

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A programme of advanced study was undertaken, which included learning how to use advanced data analysis software (M+). Relevant scientific seminars were attended, at which work was presented (for example, the British Psychological Society Developmental Section, 2007, 2011). The ESRC also funded an institutional visit to Arizona State University in 2007 to visit Professor Terence Tracey, who is a key researcher in the field of vocational interests.

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Chapter 1 Introduction

1.1 Outline of thesis

There is a broad consensus that the nature of an individual's interests in vocations is structured in a predictable way once they get to adulthood. However, relatively little is known as to how this structure of interests emerges and develops over time for children younger than the age of 15. There is also limited work that has looked at how objectively measured abilities can relate to and influence the development of vocational interests in children. A structured, quantitative approach was used to measure vocational interest, and recommendations for using this tool in an educational context have been considered. The programme of research to be described addresses some of the gaps in current knowledge about the development of vocational interests in secondary school aged children.

The literature review in this chapter introduces early vocational psychology, describes seminal work in the field (e.g. Strong, 1927, Holland, 1959), highlights key approaches and findings and concludes with a clear statement of the rationale and key aims for this piece of work.

Chapter 2 describes how the PVII (Plymouth Vocational Interest Inventory) was originally developed. This section also details the data collection procedures used at each collection phase and the related descriptive data for the PVII measure.

Chapter 3 describes in detail the Confirmatory Factor Analytic (CFA) approach which was applied to the first round of data collected to result in the second version of the interest measure (PVII2). In addition, factor scores from the PVII2 were validated against children's scores on the Strong Interest Inventory (SII), and against scores on the Personal Globe Inventory (PGI).

Chapter 4 investigates and reports on the structure of interests of children in school years 7, 9, 10 and 12 using various statistical methods including multi-dimensional scaling (MDS), Spearman rank-correlations and the randomisation test of hypothesized order relations.

Chapter 5 explores the stability of interests in Year 7 children over a two year period. This section also investigates Holland's (1973) concepts of consistency and differentiation and how these concepts relate to the stability of interests. Dimension scores have also been calculated and evaluated. Finally, the influence of gender will be investigated with regards to the stability of interests over time.

Chapter 6 briefly covers the development of the ability measures selected for use in this project. This battery of tests measured Mechanical, Spatial Rotation and Logical Reasoning ability. This section also explores the relationship between the measured abilities and vocational interests, and how this relationship changed over time.

The final chapter draws together the conclusions from the previous chapters and discusses the entire research project. The findings are compared to previous research. The limitations of the present research are considered and areas of possible future research direction are suggested.

1.2 Introduction to the chapter

The notion of vocational interest has been around a considerable time. Freyer (1930) defined interest as a 'response of acceptance that guides movement towards an exciting stimulus' (p.551) Whereas Super and Dunlap (1950) considered interest as the things to which an individual responds with a feeling of pleasure. Similarly, Strong (1955) wrote 'interests are activities for which we have liking or disliking and which we go toward or away from, or concerning which we at least continue or discontinue the *status quo*; furthermore, they may or may not be preferred to other interests and they may continue over varying intervals of time.... or an interest may be defined as a liking/disliking state of mind accompanying the

doing of an activity, or the thought of performing the activity.' (p.138). Therefore, in the context of careers, 'interest' can be considered an agreeable state of mind that leads an individual towards a certain set of activities and ultimately, a vocation.

This chapter introduces early vocational psychology and theories of vocational interest, including a discussion of the measures that have been commonly used to measure interests. Existing research that has evaluated the structure and stability of vocational interests is presented, both in Adults (16+ years) and Children (15 years and younger). Literature that has examined the relationship between interests and abilities in both age groups is reviewed, followed by a critique of existing measurement methods. A statement of the rationale and aims of this thesis completes this chapter.

1.3 Current models of vocational interests

1.3.1 Why measure interests?

Campbell (1971) believes that interest plays a large part in job satisfaction and how long an individual may choose to stay in that particular job. Indeed, students' interests have been found to be a major determinant of both occupational choice and selection of university course (Scharf, 1970, Thomas, Morrill & Miller, 1970). Secondary school pupils often need guidance to identify their interests and consequently the kinds of

occupations that are suitable for them. This is particularly important given the rapid development of vocational specialism within the secondary school sector. Crites (1974) claims that psychological testing for vocational preference offers substantial advantages over other possible methods of data collection, and it is important that this is incorporated into an individual's career counselling experience. Similarly, Harmon, Hansen, Borgen and Hammer (1994) the authors of the most recent version of the Strong Interest Inventory (SII) considered that interest inventories have a number of benefits. These are displayed in Table 1.1.

Table 1.1 Benefits of using interest inventories (Harmon *et al.*, 1994)

1	Easier to teach counsellors to use them than other methods (e.g. interview).
2	Tests are more objective than other measures.
3	Tests give career counselling structure and focus.
4	Tests reduce counselling time.
5	Norms provide a method of comparison.
6	Tests may reveal predispositions that might not surface in interviews alone.

Table 1.1 shows that are a number of benefits of using interest inventories as part of the careers counselling process. Harmon *et al.* (1994) also mention the wide spectrum of uses for vocational interest assessment which range from selecting a particular educational pathway (such as A-level

subject choice or degree specialism), to midcareer change, organisational hiring and training and retirement planning. Campbell (1971) also discussed the merits and potential problems of using interest inventories. He considered that such tests give individuals some way of seeing how their interests compare with those of people already employed in a wide variety of professions. However, Campbell (1971) is also keen to make clear that caution should be employed when interpreting the results of interest inventories, and that they should preferably be used only under the guidance of a well-trained counsellor. Campbell goes on further to state that the integration of an individual's other characteristics, intellect, special abilities, and experience should be fed into the results of the interest inventory before any definite recommendations can be made.

1.3.2 Early vocational psychology

Vocational Psychology has had a long history, and the development and usage of careers tests can be traced back to the early 1900s e.g. Parsons ('*Choosing a Vocation',* 1909). Vocational Psychology is primarily concerned with an individual's personal decisions such as whether to apply for employment or continue training and choose future goals. Kitson (1931) spoke of job satisfaction and how it could be achieved. He considered that each individual has a 'peculiar combination of capacities' with respect to their physical and mental capabilities. This combination of skills should

then be matched to an occupation to in which the individual ‘can be happy, and in which they can render their meed of service to their fellow men’ (p.7). Kitson (1929) also proposed a vocational hexagon, showing the points of view from which a vocational choice should be considered. The six points of view assigned to the faces of the vocational hexagon were Physical, Physiological, Mental, Economic, Social and Moral. Kitson (1929) theorised that when considering a vocation, these six aspects should all be taken into account before deciding which career path to take. This vocational hexagon is represented in Figure 1.1.

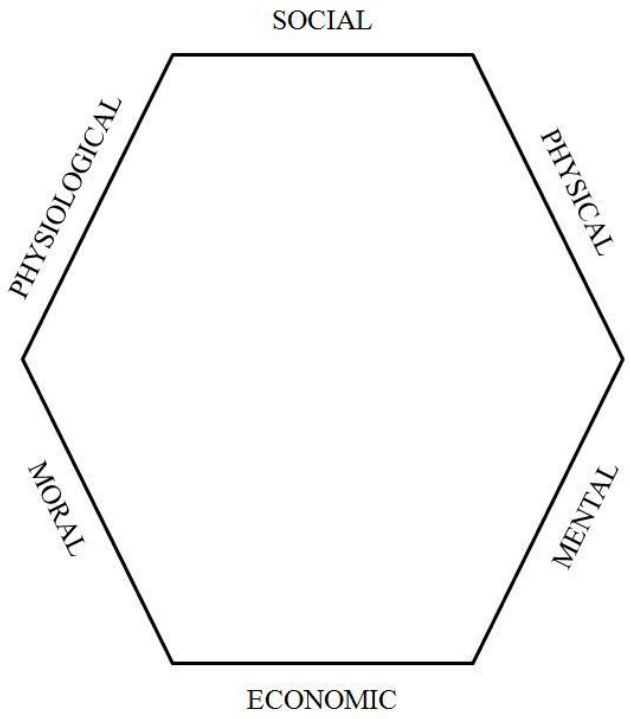


Figure 1.1 Kitson's vocational hexagon (1929)

Table 1.2 further expands on these six perspectives, and shows the kinds of questions an individual must consider when deciding on whether a future vocation is suitable for them. Kitson (1929, 1931) did not provide any empirical support for why he chose to display these six perspectives in a hexagonal structure, and as a consequence this model is infrequently cited in career development literature. However, it was considered important to mention Kitson's model at this stage of the thesis, as later more established models of interest structure are hexagonal or circular in nature and so with regards to structure, show some (surface) parallels to his earlier work.

Table 1.2 What to consider when looking for a vocation (Kitson, 1931)

Physical	Are there any particular physical qualities the worker must possess? (e.g. Any limitations on age, height and weight).
Physiological	What is the condition of the organs of the body? Certain occupations make special demands on various organs of the body.
Mental	How much intelligence is required for the job? How interested is the worker in this particular vocation?
Economic	How much training and education will be needed and how much will this cost?
Social	How much contact with people does the job involve?
Moral	A job should be scrutinised carefully in order to see it is one that will help build up character.

Decisions that are made when choosing a career path should not only involve physical and mental capacity, as Kitson (1931) suggests, but also an individual's interests. Campbell (1971), states that whilst a person's performance in a job or course largely depends on their ability and motivation, whether or not they stay in the job, or complete the course will reflect their level of interest in doing so. A large number of researchers began (under the direction of E.K. Strong) to develop interest measures in

the early 1920's. Moore (1921, as cited in Campbell, 1971) attempted to measure the mechanical and social interests of engineers, and Freyd (1924, as cited in Campbell, 1971) designed a measure that aimed to distinguish between groups of people defined as having primarily either Mechanical or Social interests. There appeared to be a distinction emerging between the individuals who had Mechanical or Social interest, it was seen that people either had a preference for working with 'Things' or a preference for working with 'People'. This distinction will be discussed later in section 1.3.4.

The earliest systematic assessment of interests can however be attributed to Strong (1927) who first published the Strong Vocational Interest Blank (SVIB). Campbell (1966, 1969), who later worked on developing the SVIB, considered that individuals in different jobs do appear to have distinct interests and that the SVIB was a device to identify such differences among those occupations that college students usually enter. The SVIB gives scores of how similar a person's interests are to those of successful men (and women, later in 1933) already in those professions. The SVIB incorporated 420 items in 1927 (and 400 items in 1938 and 399 items in 1966 respectively). Individuals are asked to respond 'like', 'indifferent' or 'dislike' to the majority of these items (some items require a response of 'like me or 'not like me'). An example of the items from the SVIB booklet for men is shown in Table 1.3.

Table 1.3 Sample items from the SVIB (Campbell, 1966, 1969)

Actor	Auto Salesman
Advertising Man	Auto Racer
Architect	Auto Mechanic
Artist	Airplane Pilot
Astronomer	Bank Teller
Athletic Director	Building Contractor
Auctioneer	Buyer of Merchandise
Author of Novel	Carpenter
Author of Technical Book	Cartoonist

Table 1.3 shows a few of the occupations that men had to rate as part of the SVIB. When the SVIB was scored, respondents would get a score for a range of occupational scales (see Table 1.4). The occupational scales were developed by identifying the characteristic SVIB interests of men or women in the specified occupations and contrasting them with a sample from many diverse occupations. Each occupational scale contains items that discriminate between the interests of those two groups. To summarise, a person's score provided an index of the similarity between their interests and the characteristic interests of individuals in a particular vocation. In the SVIB (Campbell, 1966, 1969) these scales were organised in groups (as depicted by the Roman Numerals*) according to their similarity, and states that special attention should be paid to the patterns of scores in these groupings (*SS = Supplementary Scales).

Table 1.4 The SVIB occupational scales (Campbell, 1969)

	Men	Women		Men	Women
I	Dentist Osteopath Veterinarian Physician Psychiatrist Psychologist Biologist	Music Teacher Entertainer Musician Performer Model	**VII**	Accountant owner	Army – Enlisted Navy – Enlisted Army – Officer Navy – Officer
II	Architect Mathematician Physicist Chemist Engineer	Art Teacher Artist Interior Decorator	**VIII**	Senior Accountant Accountant Office worker Purchasing Agent Banker Pharmacist Funeral Director	Lawyer Accountant Bank woman Life Insurance Underwriter Buyer Business Education Teacher
III	Production Army Officer Air Force Officer	Newswoman English Teacher Language	**IX**	Sales Director Real Estate Salesman Life Insurance Salesman	Home Economics Teacher Dietician
IV	Carpenter Forest Service Man Farmer Math-Science Teacher Printer Policeman	YWCA staff member Recreation leader Director, Christian Ed. Nun-Teacher Guidance Counsellor Social Science Teacher Social Worker	**X**	Advertising Man Lawyer Author-Journalist	Physical Ed. Teacher Occupational Therapist Physical Therapist Public Health Nurse Registered Nurse LIC. Practical Nurse Radiologic Technologist
V	Personnel Director Public Administrator Rehabilitation Counsellor YMCA Staff Member Social Worker Social Science Teacher School Superintendant Minister	Speech Pathologist Psychologist Librarian Translator	**XI**	President-Manufacturing	Executive Housekeeper Elementary Teacher Secretary Saleswoman Telephone Operator Instrument Assembler Sewing Machine Operator Beautician Airline Stewardess
VI	Librarian Artist Musician Performer Music Teacher	Physician Dentist Medical Technologist Chemist Mathematician Computer Programmer Math-Science Teacher Engineer	**SS**	Credit Manager Chamber of Com. Exec. Physical Therapist Computer Programmer Business Ed. Teacher. Community Rec. Admin.	

As Table 1.4 shows, the types and groups of occupation scales for men and woman did have some differences as well similarities, and clearly reflect the career opportunities for men and women in the late 1960's. Campbell (1971) notes that using the SVIB in its earlier form (before 1969) provided some difficulties for careers counsellors; for example to say to an individual 'you have similar interests to those of a home economics teacher' was not always useful to the individual receiving counselling. It was therefore decided to add another system of scoring to supplement the occupational scales (Table 1.4). This system was called the 'basic interest scales; a system which would contain fewer scales, but scales which could be generalised beyond a single occupation. Each of the basic interest scale contained items with high inter-correlations and each scale name summarised the item content. Table 1.5 shows the SVIB's basic interest scale categories for both men and women, with common interest scales in bold. Table 1.5 shows that there were common basic interest scales for both males and females, but also there were some clear differences. For example, male interests categorised as or similar to Military practise, Leadership or Business did not appear for the females. Similarly, female interests such as Homemaking or Office Practices did not appear as basic interest scales for the males.

Table 1.5 The basic interest scales for men and women (Campbell, 1969)

Men	Women
1. Public Speaking	**1. Public Speaking**
2. Law/Politics	**2. Law/Politics**
3. Business Management	**3. Merchandising**
4. Sales	4. Office Practices
5. Merchandising	5. Numbers
6. Office Practises	**6. Physical Science**
7. Military Activities	**7. Mechanical**
8. Technical Responsibility	8. Outdoors
9. Mathematics	**9. Biological Science**
10. Science	**10. Medical Service**
11. Mechanical	**11. Teaching**
12. Nature	**12. Social Service**
13. Agriculture	13. Sports
14. Adventure	14. Homemaking
15. Recreational Leadership	**15. Religious Activities**
16. Medical Service	**16. Music**
17. Social Service	**17. Art**
18. Religious Activities	18. Performing Arts
19. Teaching	**19. Writing**
20. Music	
21. Art	
22. Writing	

The work of Strong (1927) has provided a foundation for a great many studies in the psychology and measurement of interests. Furthermore, Super and Crites (1962) considered that Strong made the very important discovery that the interests of men in a given occupation, e.g. engineering, were different from those of ‘men-in-general’. It was only after scales had been developed that factor analysis and item analysis revealed how these interest

scales relate to one another in systematic way. This will be discussed in section 1.3.3.

1.3.3 Theories of career development

There has never been complete agreement as to the origins of vocational interests. Holland (1959) theorised that each individual (at the point of vocational choice) is the' product of the interaction of his genetics and cultural and personal forces…from this experience the person develops a hierarchy of habitual or preferred methods for dealing with environmental tasks' (p35). Holland (1997) still held this view nearly 40 years on, and considered that interests developed out of a combination of biology, child-parent relationships and interactions with the environment. There is still much to learn about the importance of these factors and the relative influence of each however. Osipow (1973) considered that there were four main approaches to career choice development; namely Developmental, Sociological, Trait-Factor and Vocational Personality. Developmental and Sociological theories employed a mix of qualitative and quantitative methods, where as Trait-factor and Vocational Personality theorists used quantitative methods to assess an individual's career aspirations. These theories will be described next.

Developmental/Life Span Approach:

Central to this approach is the belief that individuals develop more clearly defined self-concepts (a sense of self) as they get older, and that people develop images of the occupational world to compare themselves against. Ginzberg, Ginzberg, Axelrad and Herma (1951) interviewed 91 individuals aged between 11 and 24. As a result of these interviews, they theorised that occupational choice is a largely irreversible process and that there are three developmental periods which they labelled Fantasy (aged 6-11 years), Tentative (12-17 years) and Realistic Choices (18+ years). They suggested that there is a clear developmental process that individuals go through when making career choices. Super (1954) presented a much more comprehensive theory of vocational development. He generated a life span vocational choice theory that has six life and career development stages. These six stages are shown in Table 1.6.

Table 1.6 Stages of vocational choice (Super, 1954)

Ages	Stage
14-18	The crystallisation stage
18-21	Specification stage
21-24	Implementation stage
24-35	The stabilisation stage
35-55	Consolidation
55+	Readiness for retirement

As shown in Table 1.6, Super (1954) considered that an individual's self-concept changes and develops over time, and develops throughout people's lives as a result of experience. It is acknowledged that with the ever increasing average age of retirement in today's society, the consolidation period would now apply to individuals aged 35-65 years of age.

In addition to the life-span model, Super (1954) also proposed a model of childhood career development; this is presented in Figure 1.2. Super considered that a very basic drive in children is curiosity, and that curiosity is often satisfied through exploration, an important career development activity. Using information gained from exploring, interests are then considered to develop over time. To make career decisions, children need to

develop some perspective of time, and this alongside with the development of self-concept will eventually lead to the planning of a future career.

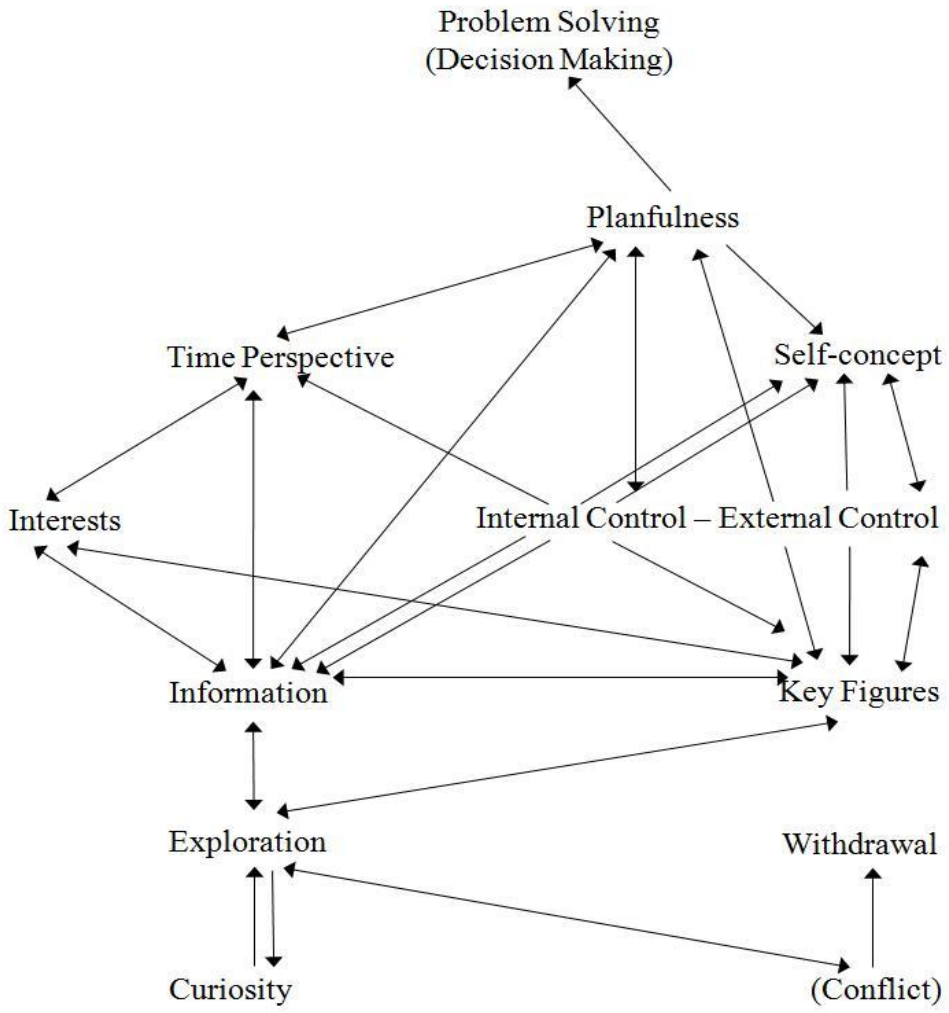


Figure 1.2 A person-environment interactive model of the bases of career maturity (Watts, Super & Kidd, 1981)

Adults are thought to be very important role-models for children when learning about the world of work, and also for the development of their self-

concept. Gottfredson (1981) also proposed a life-stage theory of career development in childhood, with a particular focus on a child's awareness of the different sex roles of men and women. She suggests that schools should not reinforce sex-role stereotypes, so children are free to develop a wide range of interests. Otherwise, she claims this experience will ultimately influence the child's self-concept and their ability to make career decisions.

The Sociological Approach

This theory is also known as the reality or accident theory of vocational choice (Miller & Form, 1951). The central notion of this theory is that circumstances beyond the control of the individual contribute in large part to the career choices they make. Many theories of career development tend not to discuss chance factors as they prefer to emphasise the control an individual has in vocational choice. But some researchers (e.g. Caplow, 1954) have investigated the importance of external chance factors on career choice. How an individual deals with such chance events is suggested to largely depend on their already developed competencies (Bandura, 1982). Bandura goes on to say that individuals react in particular ways to such situations depending on skills they have learnt through modelling and reinforcement. Osterman (1989) found that when looking at jobs for low pay (e.g. for students working part-time) quite often chance had a large part to play. In adults however, advance preparation was found to be very important for those working in professional or skilled areas, but not for un-

skilled opportunities (Hart, Rayner & Christensen, 1971). Scharf (1997) concludes that chance may play a larger role when individuals are not able consider other factors such as abilities and interests.

The Trait-Factor Approach

This is the oldest theoretical approach. This theory states that successful vocational choice is achieved by matching an individual's abilities and interests with a career. Indeed, the vocational testing movement has grown from this viewpoint (e.g. the testing of interests (Strong, 1927) and of abilities (Thurstone, 1935)) as discussed earlier in more detail. A more recent theory that also shares this trait-factor approach is Work Adjustment Theory (Dawis & Lofquist, 1984). This work initially set out to provide improved services for 'vocationally disabled clients', but they consider their theory is now applicable to all adults who are making career choices. Dawis and Lofquist (1984) defined work adjustment as a 'continuous and dynamic process by which a worker seeks to achieve and maintain correspondence with a work environment' (p.237). They see interests as an expression of abilities and values, and so their focus is on ability and value assessment. Dawis & Lofquist measured abilities using the General Aptitude Test Battery (USES, 1967), a widely used ability measure by counselling agencies. This test battery measures nine distinct abilities; General learning ability, Verbal ability, Numerical ability, Spatial ability, Form perception, Clerical ability, Eye-hand coordination, Finger dexterity and Manual

dexterity. Dawis and Lofquist (1984) also measured values using the Minnesota Importance Questionnaire (MIQ; Rounds, Henly, Dawis, Lofquist & Weiss, 1981) which characterised important work concepts such as activity levels, working conditions and moral values. Six different values were found to emerge from a factor analysis of needs, and these were Achievement, Comfort, Status, Altruism, Safety and Autonomy. Combined with information about abilities, scores on the MIQ could be matched with occupational ability patterns when giving careers guidance.

Vocational Choice and Personality Theory:

This viewpoint considers that individuals select their jobs because they see potential for the satisfaction of their needs. Both Holland (1959) and Roe (1957) matched individuals' personality types with their corresponding ideal work environments. Holland's theory will be discussed in detail shortly.

These four distinct approaches to career choice development have perhaps changed and converged over the years since Osipow's (1973) original classifications. Indeed, Campbell (1974) published the Strong-Campbell Interest Inventory which made use of both Trait-Factor theory and Vocational Personality Theory by applying Holland's (1959) theory of vocational choice to the SVIB. There has been considerable debate and discussion as to if and how these theories should be integrated (e.g. in Savikas & Lent, 1994). But to date no definite conclusions have been

drawn. It seems likely that vocational choice is mediated through a number of factors including developmental processes, personality types and external factors such as chance and access to appropriate experiences, opportunity and role models.

Holland's Theory of Vocational Choice

Holland published his 'Theory of Vocational Choice' in 1959. This theory of vocational choice was born from a review of interest literature. Specifically, in particular from factor-analytic studies of personality and vocational interest, and also from his own experiences of being a vocational counsellor and needing to construct his own personality inventory for this purpose. Early factor analytic research by Guilford, Christensen, Bond and Sutton (1954), Strong (1943) and Thurstone (1931) was of particular interest to Holland. For example, Guilford *et al.* (1954) found that there were six major types of vocational interest (Mechanical, Scientific, Aesthetic, Social Welfare, Clerical and Business) following a comprehensive factor analysis of the structural properties of existing interest scales. These six factors are presented in Table 1.7.

Table 1.7 Structural properties of interest scales (Guilford *et al.* 1954)

Interest Scale	**Focus of Interest Items**
Mechanical	Contains items of mechanical manipulation, construction, and design, and items pertaining to working with equipment or tools.
Scientific	Contains items of science theory and investigation, with secondary loadings on thinking activities (mathematical and logical), precision (exactness and detail), and aesthetic appreciation (literature, music, and visual arts).
Aesthetic	Contains primarily items reflecting interest in performance in the fields of musical, literary, dramatic, and visual arts, with secondary loadings on items referring to the appreciations of these arts.
Social Welfare	Involves interest in helping people (Altruism – Welfare of Others, Personal Services, and Health and Healing scales) and controlling others (Control of Others – Coercion, Dominance and Persuasion scales). There are also strong loadings on verbal expression (explanation, clarification, and persuasion), with secondary loadings on business contact and clerical work
Business	Contains items representing business variables of administration, selling, and contact. Verbal expression, pertaining to persuasive writing, also defined this factor.
Clerical	Contains items representing interest in bookkeeping and routine calculation tasks, with secondary loadings on scales of business contact and administration, and mathematical thinking and precision.

Holland (1959) proposed that there were six major classes of occupational environment and that each individual seeks out the environments that best suit their skills and abilities. Holland labelled these environments as; Motoric, Intellectual, Supportive, Conforming, Persuasive, and Aesthetic (see Table 1.8). He considered that each person has a set of adjustive orientations which correspond to these six occupational environments just mentioned. Holland (1959) suggests that for every person, the orientations may be ranked; according to their relative strengths and the life-style heading the hierarchy determines the major direction of choice. The term 'Orientation' has been defined by Holland (1959, p.36) as' a somewhat distinctive life style which is characterised by preferred methods of dealing with daily problems and includes such variables as values, interests and preferences for playing various roles'.

Table 1.8 The six occupational environments with sample occupations and individual characteristics (Holland, 1959, 1966)

1966	1959	Sample Occupations	Individual Characteristics
Realistic	**Motoric**	Labourers, machine operators, aviators, farmers, truck drivers, and carpenters.	Typified by their masculinity, physical strength and skills, and their corresponding lack of social skills and sensitivities.
Investigative	**Intellectual**	Physicists, anthropologists, chemists, mathematicians, and biologists.	Task orientated people who think through rather than act out problems. Enjoy ambiguous work tasks and possess somewhat unconventional values and attitudes
Artistic	**Aesthetic**	Musicians, artists, poets, sculptors, and writers.	Individuals who prefer in-direct relationships with others, have a greater need for self expression, and probably suffer more from emotional disturbance.
Social	**Supportive**	Social workers, teachers, interviewers, vocational counsellors and therapists.	People who enjoy teaching or therapeutic roles and who have good verbal and interpersonal skills. Characterised as responsible, socially orientated and humanistic.
Enterprising	**Persuasive**	Salesmen, politicians, managers, promoters, and business executives.	Individuals who prefer to use their verbal skills in situations which provide opportunities for dominating, selling or leading others. Have a greater concern with power, status and leadership.
Conventional	**Conforming**	Bank tellers, secretaries, bookkeepers, and file clerks.	Prefer structured verbal and numerical activities and subordinate roles. Obtain their goals through conformity, avoiding conflict and anxiety aroused by ambiguous situations or problems.

Holland (1959) also considered that people can be characterised by their resemblance to each of these six categories. Holland (1973) further claimed that the closer a person resembles a particular category the more likely he or she is to exhibit the personal traits and behaviours associated with that category. Holland (1959, 1973) developed these distinctions by reviewing the SVIB scoring keys and those from other studies by Strong (1943), Gough, McKee and Yandell (1955), and Laurent (1951).

According to this approach, vocational harmony is achieved when people are placed in their corresponding work environment. Therefore, people scoring high on the supportive category seek supportive environments and individuals scoring high on conforming seek out conforming environments and so on. This theory of interests was more explicitly defined by Holland later in 1966 alongside the construction of his Vocational Preference Inventory (VPI). The VPI was designed for individuals over the age of 14, and the respondent would reply yes (like), no (dislike) or no response (undecided) to a list of occupational titles. Initially, the first version of the VPI in 1958 had eight scales; Physical activity, Intellectuality, Responsibility, Conformity, Verbal Activity, Emotionality, Reality orientation and Acquiescence. But subsequent work focused on the first six scales as it appeared that individuals were responding to the VPI in a structured way to these first six scales only.

These six categories (or interest scales) were labelled as Motoric, Intellectual, Aesthetic, Supportive, Persuasive, Conforming in 1959, which Holland changed in 1966 to Realistic, Investigative, Artistic, Social, Enterprising and Conventional linking his theory of vocational choice directly with findings from his own research using the VPI measure. These labels are still used today, and are commonly abbreviated to 'RIASEC' in the literature. Table 1.9 shows further characteristics that individuals scoring high on one of the six factors may display (Lowman, 1998).

Table 1.9 Further characteristics of the six Holland categories (Lowman, 1998)

Interest Scale	**Intelligence**	**Predominant Affect**	**Orientation toward people**	**Cognitive style**
Realistic	Low to Av.	Constrained	Avoidant	Concrete
Investigative	High	Suppressed	Rational	Scientific
Artistic	Variable	Labile	Narcissistic	Divergent
Social	Mod. High	Nurturing	Supportive	Inductive
Enterprising	Mod. High	Aggressive	Controlling	Logical
Conventional	Low to Av.	Constrained	Withdrawn	Rigid

Av. = Average; Mod. = Moderately.

In 1971, Strong and Campbell developed the Strong Campbell Interest Inventory (SCII) with later revisions in 1974, and 1981. They applied

Holland's (1959) six factor theory of careers to the original SVIB measure, and they also combined the men's and women's scales to remove gender bias and to reflect societal changes in job selection. This measure is widely used today to assist vocational counselling for adults. To summarise, sections 1.3.2 and 1.3.3 have covered early vocational research and discussed the main theoretical approaches to career choice development. Another hugely influential part of Holland's work is the *structure* of these six interest factors and their interrelationships. This is discussed in the next section.

1.3.4 The structure of interests and the hexagonal model

The structure of vocational interests has generated a huge amount of research interest. Researchers have been keen to identify and display the structure of vocational interests, as analysis of results from career inventories have shown clear relationships between certain pairs of interest categories. The work of Holland, Whitney, Cole & Richards (1969) on the structure of vocational interests is considered by some to be the most widely applied single idea from a career development theory (Spokane, 1996). Holland *et al.* (1969) published the first article that organised the six vocational interest types into a hexagonal structure. From plotting the set of inter-correlations between the six factors, a structure approximating a hexagon arrangement between these factors could be seen. It was found that,

for example that Realistic and Investigative interests were fairly highly correlated (but not high enough to be measuring the same construct), whereas Realistic and Social interests were not correlated at all. Holland's hexagon has been discussed in the literature as a model that meets the assumptions of a circumplex (e.g. Rounds, Tracey & Hubert, 1992). Circumplex models are frequently cited in a wide range of areas in psychology representing the relationships between constructs such as personality (Plutchik & Conte, 1997) and affect (Russell, 1980). Guttman (1954) considers a circumplex as a circular arrangement, where certain patterns of correlations among factors can be modelled geometrically as a circle by their location in relation to two orthogonal factors. Furthermore, all adjacent factors are the most closely related (and have correlations that are equal to that seen between other adjacent factors). All correlations between alternate factors are equal (and less than seen between adjacent factors). Similarly, all correlations between opposite factors are equal, and will be lower than between alternate factors.

The extent to which the data for children's vocational interests are aligned to this kind of structure will be further examined and discussed in Chapter 4.

As Holland *et al.* (1969) explain, their hexagonal model of interests was discovered somewhat by accident when they noticed that the inter-correlational matrix for the six VPI scales could actually be arranged in a

hexagonal structure. Table 1.10 displays the inter-correlations between interest factors Holland *et al.* (1969) found using the VPI scale. Figure 1.3 shows how the interest scales relate to each other on the hexagon.

Table 1.10 Inter-factor correlations using the VPI (Holland *et al.*, 1969)

Interest Scale	R	I	A	S	E	C
Realistic	-					
Investigative	.46	-				
Artistic	.16	.34	-			
Social	.21	.30	.42	-		
Enterprising	.30	.16	.35	.54	-	
Conventional	.36	.16	.11	.38	.68	-

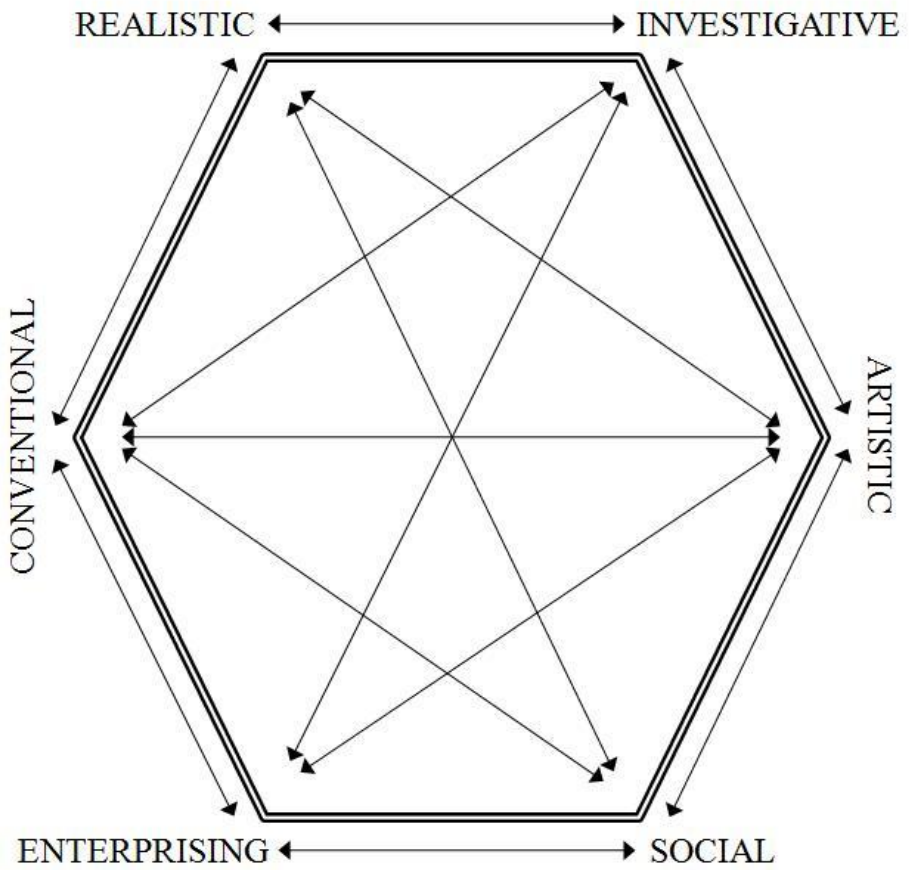


Figure 1.3 The hexagonal structure of interest orientations (Holland *et al.*, 1969)

This hexagonal arrangement represents the degree of relation between interests i.e. interest scales closest on the hexagon are more related. This then means that within a person or environment, some pairs of interest categories are more closely related than others. As Holland (1973) clarifies, the hexagonal model does not imply that there are only six categories of people or environment, but rather that there are 720 possible combinations of interest. This is calculated as (6*5*4*3*2*1) – the total number of

possible RIASEC orders. For example, a person may score higher on the social and artistic factors but less so on the investigative and conventional factors resulting in a profile of SAERIC. In terms of classifying an individual's responses, it was found useful to use the two or three themes that had the highest scores to attribute a code to that person. For example, a person may have a code of RI. It would be suggested for example, that a person with a code of RI would be very interested in and suited to a practical and scientific job such as engineering. There are suggested job types for each two or three letter codes, so the results have direct implications for educational planning and careers guidance.

Holland (1997) spoke of 'consistency' with regards to these resulting codes. Codes were considered to be consistent when the first two code letters that were next to each other on the hexagon e.g. RI or AS. Whereas when the first two letter codes were far apart, the codes were considered to be very inconsistent – implying potential difficulties in placing that individual in a highly suitable work environment. Holland (1997) also spoke of 'Differentiation' - this is calculated by subtracting an individual's lowest score from their highest score. A high score would indicate a differentiated profile, and a low result in an undifferentiated profile. It is suggested that individuals with undifferentiated profiles would enjoy (or dislike) all kinds of activities and do them all well (or badly). It is not known to what extent consistency and differentiation change and develop over time for the same

individuals, and it is an area of vocational psychology that needs further investigation.

Data from Rolfhus and Ackerman (1996) further supports this hexagonal arrangement of interests (see

Figure 1.4). In Figure 1.4 it is possible to see that correlations between interest scales closest on the hexagon are typically larger than the correlations between interest scales that are furthest apart.

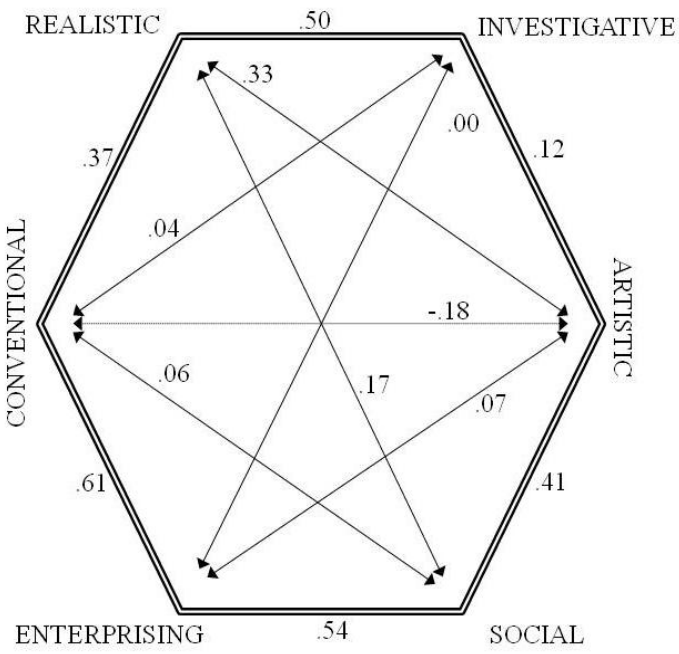


Figure 1.4 Holland *et al.*'s (1969) hexagonal structure of interests, with obtained correlations among interest factors (Rolfhus & Ackerman, 1996)

Holland *et al.* generally found that interests closest on the hexagon were more highly correlated than interests that were further away. However, it is noted that for this data set the correlation between IA is actually less than the correlation between RA. This is a slight deviation from what a hexagonal model would predict for interest data. However, many researchers (such as Borgen, Fouad & Harmon, 1997) view the hexagon as a useful if imperfect way to organise occupational data and is still widely considered and accepted today.

1.3.5 Further developments on the hexagonal model

Myors (1996) considers that the theorised hexagonal relations between the scales provide important constraints on data that can be used to confirm or discount the theory. Indeed, the closer two factors are on the hexagon, the higher the expected correlations between them. Myors (1996) goes on further to state that the 15 correlations in a correlation matrix amongst the six types can fall into one of three categories: Correlations between adjacent factors (e.g. RI), correlations between alternate factors (e.g. RA) and correlations between opposite factors (e.g. RS). It is possible to use this framework as a way of assessing model fit.

Recent analysis techniques that have been used to test interest data against the hexagonal model include multidimensional scaling, Spearman rank

correlations and the RANDALL programme designed by Tracey (1997). There is considerable debate about which methods perform the most rigorous and appropriate test of interest structure and this is considered in more detail in chapter 4.

Prediger (1982a, 1982b; Prediger & Vansickle, 1992) put forward a further perspective on this model of interests. Prediger (1982a, 1982b) used a further two dimensions to characterise the plane on which the hexagon rests. This resulted in having a dimension for 'Things'/'People and for 'Data'/'Ideas'. Indeed, Rounds and Tracey (1993) and Rounds (1995) found support for Prediger's two dimensions and later Tracey and Rounds (1996) also posited the third dimension of PRESTIGE. Prestige has also been called status, occupational level or level of training. Tracey and Rounds (1996) modelled their *Inventory of Occupational Preferences* on this and have found support for the importance of prestige as a third major dimension over several different samples of college and high school students.

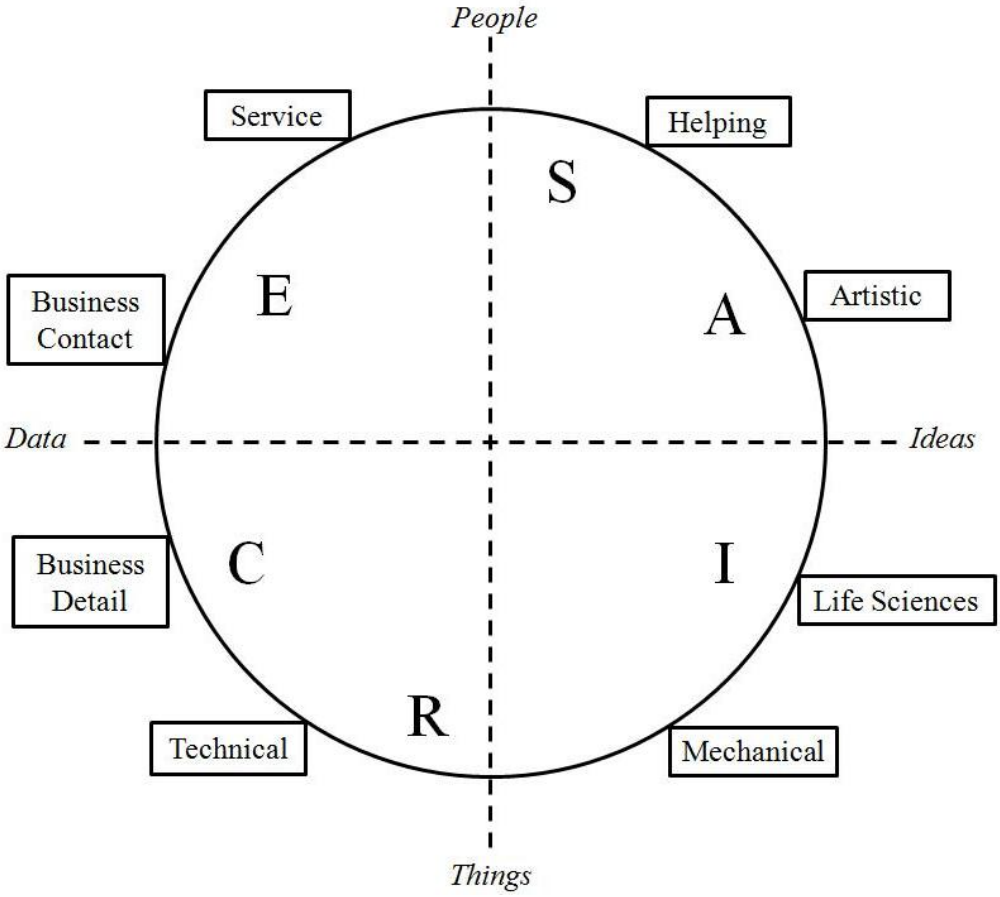


Figure 1.5 Graphical representation of the eight early basic interest level types (shown in boxes), the six RIASEC types (shown inside the circle), and Prediger's two dimensions (marked by dotted lines (Prediger, 1982a, 1982b)

1.4 Measures of vocational interest

The majority of vocational interests measures record preferences for occupations and activities. These tests are typically only suitable for children over the age of 14 as the items refer to activities or occupations the children may not aware of, or use language that is not appropriate for children of this age. In addition, these tests typically have between 200-300 items which may be considered too many items for younger children to complete. One of the best known and commonly used measures is the Strong Interest Inventory (SII: Harmon *et al.* (1994). The SII measure contains preferences for occupations, school subjects, and activities, and also measures preferences between pairs of activities and occupations.

1.5 Vocational interests and abilities in adults (age 16+)

1.5.1 Interest structure and stability in adults

Interest structure in adults has been covered in some detail in section 1.3.4. There is broad agreement that in adults, a hexagonal or circular structure is the most consistent way that interests are structured (Tracey & Rounds, 1993).

In this section, vocational interest stability for older children and adults (16+) will be discussed. The results for children (<16 years) will be covered

in section 1.6.2. The majority of reviews of interest stability (Campbell, 1971; Strong 1943; Swanson, 1999) have relied on qualitative analyses to come to the conclusion that vocational interests are very stable in adulthood, from the age of about 25-30 years old. This is an interesting finding, but as no empirical measures of stability were calculated in these studies it was not possible to conclude the typical age at which interests reach peak stability. The researchers also stopped looking at how interests changed after this age, so it was unclear what happens to interest stability in adults once they reached 25 years of age. To overcome these issues, Low, Yoon, Roberts and Rounds (2005) conducted a comprehensive meta-analysis of 66 studies all of which have investigated the stability of vocational interests over time. The participants in these studies ranged from early adolescence (aged 12) to middle adulthood (age 40). To measure interest stability quantitatively they looked at two indices, *rank order correlations* which measure group-level changes over time, and also *interest profiles* for individuals at different time points. Low *et al.* (2005) were able to calculate indices of stability – (Fischer's Z-transformed correlation coefficients), which were weighted by the inverse of the variance when making population estimates (a technique taken from Hodges & Olkin, 1985). These stability coefficients are presented in aggregated form for each category; CI = 95% confidence interval for estimated population correlation in Table 1.11.

Table 1.11 Population estimates of mean interest stability across age categories (Low *et al.*, 2005)

Age (Years)	**P**	**N**	**95% CI**
12-13.9	.55	1,808	.52, .58
14-15.9	.57	5,477	.55, .59
16-17.9	.58	9,151	.56, .59
18-21.9	.67	5,062	.66, .68
22-24.9	.70	5,136	.66, .72
25-29.9	.83	144	.76, .87
30-34.9	.72	353	.66, .77
35-40	.64	233	.55, .71

This meta-analysis shown in Table 1.11 suggests that late adolescence (ages 16-18) was marked by a substantial increase in the stability of vocational interests. Looking at the findings across all ages it could be seen that vocational interest stability reached a plateau at ages 18-22. This is somewhat earlier than the original qualitatively drawn conclusion of 25-30 years old. Low *et al.* (2005) do mention however, that stability estimates for the 18-22 age groups were not high enough to rule out the possibility that some change also occurred during adulthood.

Further results of this meta-analysis by Low *et al.* (2005) produced stability estimates for each of the six Holland (1959) categories, and Kuder's (1939,

1977) 10 activity preferences. These stability estimates are presented in Table 1.12.

Table 1.12 Population estimates of interest stability for Holland (1959) and Kuder (1939, 1977) classifications

Holland (1959)	**P**	**CI**	**Kuder (1939, 1977)**	**P**	**CI**
Realistic	**.67**	.58, .63	Mechanical	**.69**	.67, .70
Investigative	.60	.64, .69	Computational	.63	.61, .70
Artistic	**.65**	.58, .63	Scientific	.67	.65, .69
Social	.62	.63, .68	Persuasive	.62	.60, .65
Enterprising	.54	.60, .64	Artistic	**.71**	.69, .73
Conventional	.57	.51, .57	Literary	.62	.60, .65
			Musical	.68	.66, .70
			Social Service	.63	.61, .66
			Clerical	.65	.62, .67
			Outdoor	.68	.64, .70

Table 1.12 shows that the Realistic and Artistic categories have the highest stability coefficients using both classification systems, suggesting that these scales tend to be more stable over time than the other categories.

One specific study that has examined the stability of vocational interests over a long time period is that by Swanson and Hansen (1988). They

administered the SCII to college freshmen (aged 16-18) in 1974 and again 12 years later in 1986. Results indicated a remarkable degree of stability of interests over time, using five different methods of calculating interest stability. Swanson and Hansen (1988) do not report stability statistics for individual interest scales. Chope (2010) makes the important point there is still the need for more longitudinal follow up studies of interest stability, as relatively short longitudinal studies do not address the interest changes over a person's entire life span.

1.5.2 The relationship between abilities and interests in adults

Although an individual's interests are an important factor in determining career choice and also career satisfaction, ability to succeed in a particular career is also a function of the abilities that they possess in that field. Research has typically found that objective measures of ability are correlated positively with Realistic, Artistic and Investigative interests, whereas Enterprising & Conventional tend to be negatively associated with ability (see Ackerman & Heggestad, 1997, for a detailed review).

In his earlier work, Strong (1943, p683) believed that 'people who have the kind of brain that handles mathematics easily will like such activities and vice versa' and he also believed that interests and abilities were related; although, it is fair to say that this assumption was not strictly based on

empirical evidence at the time. More recently, there have been contrasting findings from studies that investigate the relationship between interests and abilities. Some of these studies use actual measures of intelligence/ability (e.g. Rolfhus & Ackerman 1996; Tracey, Robbins & Hofsess, 2005) whilst some use self-report measures of competence or skill (e.g. Tracey & Ward, 1998, Betz, Harmon & Borgen, 1996). Both types of ability measure will now be discussed in relation to vocational interests.

1.5.3 The relationship between objective measures of ability and interests

Ackerman and Heggestad (1997) considered that some broad personality and interest traits are related to the development of adult intelligence. Furthermore, Ackerman (1996) states that little evidence in the literature exist for determining the direction of the causal arrows (e.g., ability → interests or personality → ability etc.)'. Ackerman (1996) goes on to propose a theory of intellectual development which describes how personality, interests and abilities interact. There are four major components to this theory: Intelligence as process, Personality, Interests, and Intelligence-as knowledge (PPIK). With regards to interests, Ackerman and Heggestad (1997) have identified three domains of interests that are linked to intelligence. These domains are: Realistic, Investigative and Artistic (as mentioned earlier Realistic & Artistic are considered to be the most stable of interest orientations over time). From their review and empirical research,

Ackerman and Heggestad (1997) show that Realistic and Investigative have substantial correlations with intelligence as process factors (e.g. Reasoning, Maths, and Spatial ability). They also find Artistic interest to be more closely aligned with intelligence as knowledge factors (e.g. verbal, crystallised abilities). Data resulting from Ackerman and Heggestad's (1997) review is presented in detail in chapter 6.

In contrast, Tracey *et al.* (2005) measured the relationship between academic skills and interests over time (as part of a larger study). As expected, they found that scores increased over time on all academic skills. Despite hypothesising that higher science and math scores would relate to investigative skill development, the results from their structural equation modelling (SEM) analysis failed to find any evidence of such relationships.

Randahl (1991) considers that previous work in the area of abilities and interests may have not found a link because of the methodology used in those studies. Typically, correlational studies have not shown strong relations between the two domains, but Randahl (1991) argues that the relationship between abilities and interests is too complex to be adequately revealed by correlational methods alone. Indeed, it is possible that the complex interaction of interests and abilities may involve many interests being linked to a particular ability and so on. In Randahl's (1991) study, a profile analysis of measured vocational interests was conducted. Results

showed that relations did exist between abilities and interests, and in fact these relations were in accordance with theoretical predictions of Holland (1973, 1985). Significant positive correlations were found between Realistic interests and Spatial ability, Investigative interests and Spatial ability and Artistic interests with Verbal ability (*r* range .27-.34).

1.5.4 The relationship between subjective measures of ability and interests

A number of researchers have assessed subjective measures of ability using the RIASEC structure, for example Betz *et al.* (1996) who found (in a sample of over 1,000 adults) that both personality and confidence (in their ability to do a particular activity) contributed to the prediction of occupational group membership. Philips and Zimmerman (1990) also found that children's perceptions of their own ability grow more accurate (and modest) from early kindergarten to late childhood. Rolfhus and Ackerman (1996) found significant positive associations between the six Holland (1959) orientations and self-reported knowledge factor scores. Ackerman (1996) points out that although these data do not give evidence for the direction of a causal link, it does suggest that self-report knowledge and interests are very much associated. In the Swanson and Hansen (1988) study it was found that stability coefficients (a correlation between test and re-test SCII profiles) were significantly related to self-ratings of ability (*r* range

from .33 -.50). This means that individuals who had more stable interest profiles were more likely to rate themselves higher for ability.

Todt and Schreiber (1998) suggest that individuals go through a number of stages where they become more aware of their own abilities and talents – which then lead to the progressive organisation of interests that are in line with this knowledge. Bandura (1982) considered that people's beliefs about their own ability to perform well can influence later achievement; this is known as 'self efficacy'. Furthermore, Tracey *et al.* (2005) suggest that self-efficacy beliefs may be important in career choice; indeed current models of interest development (Lent, Brown & Hackett 1994, 1996) support the idea of a self-efficacy as a mediating variable between ability and interests.

1.5.5 The relationship between objective and subjective measures of ability

Studies that have collected data using both objective and subjective measures of ability have reported conflicting findings (e.g. DeNisi & Shaw 1977, Goff, 1994), however the most recent work has found that self-estimates of ability *are* related to objective measures. In a study on college students (Ackerman, Kanfer & Goff, 1995), it was found that self-estimates of math/spatial ability and verbal ability correlated (r = .58 and r = .42) with objective tests of the same respective abilities. They also found that self-

estimates of math/spatial ability correlated (r = -.07) with objective verbal ability and also that verbal ability self estimates correlated (r = -.10) with objective math ability scores. These low correlations suggest that when self-estimating ability, verbal and spatial abilities are quite distinct, and indeed if a person believes they are good at spatial tasks then they may rate themselves lower on verbal ability and vice versa.

1.5.6 The influence of gender on abilities and interests

Gender differences are commonly found when objectively measuring abilities. Tracey *et al.*, (2005) reported that males scored higher than females in Maths and Science and females scored higher than males in English and Reading. Indeed this is similar to the pattern of academic skills development for males and females (ACT, 1997). Su, Rounds and Armstrong (2009) completed a detail meta-analysis of technical manuals for 47 different interest inventories. They found that men preferred to work with 'Things' and women preferred to work with 'People' (d = .93). Rounds and Armstrong also found that males preferred Realistic and Investigative interests, and women clearly preferred Social interests.

Lowman, Williams & Leeman (1985) studied the structural relationships between vocational interests and primary abilities in a sample of college women. They found evidence to support the view that the structure of both

abilities and interests were closely aligned to Holland's hexagonal model for their female participants (which is similar to that seen for males e.g. Holland *et al.*, 1969, Guilford, 1954). It is not known if male and female interests relate to abilities in a similar way, as most empirical work has looked at the interests of mainly males (see Ackerman & Heggestad, 1997 for a review). The relationships between abilities and interests for males and females separately will be examined in the present study as well as for the group.

1.6 Vocational interests in children (aged <16)

Little is known about the nature of interests in children, how they develop and how they relate to abilities. A recent piece of exploratory work by the Department for Children, Schools and Families (DCSF, 2009, now Department for Education) examined the ways in which a group of Year 7 pupils in the U.K. (N = 610) formulate their views about educational and career issues. Their initial findings were particularly relevant to this current study, and indicate that children aged 11 do have clear views regarding their future vocations. In summary, the DCSF report found that:

- Eighty five percent of the children interviewed had a clear idea of what job they wanted to do in the future. Sixty five percent of these children reported that they had held this view for at least two years.

- Pupils from lower socio-economic groups were as likely to want to go to Higher Education (HE) and pursue high status jobs, as their counterparts from higher socio-economic groups.

Also in this report, Year 7 pupils reported that their parents were the most important influence on their views of the future. When this was followed up in focus groups, the discussions revealed that it was the support from their parents that was an influencing factor, rather than being influenced by the actual jobs their mother or father did. Next important influences were

reported to be *interest* in their selected future job, perceptions of how their teachers see them, how they are getting on with school work and how much they enjoy school.

1.6.1 Interest structure in children

The majority of interest measures are either based wholly or in part around a RIASEC framework. Little is known about the structure of interests in children younger than 13 or 14. Tracey and Rounds (1993), demonstrated in a meta-analysis that whilst the structure of the RIASEC scale is a valid representation in participants aged 14 and older, there was a lack of data for younger populations. Tracey (2002a) makes the point that the popular assumption that the hexagonal structure of interests found in older children and adults is *also* applicable to younger children is still somewhat unfounded.

One study that has looked at younger children is that by Tracey (2002a) who measured two groups of student's interests over a one year period (10-11 year olds and 13-14 year olds). Interest (and competence) ratings were assessed using the Inventory of Children's Activities-Revised (ICA-R: Tracey & Ward, 1998). Results showed a good model fit for the older children (aged 13-14) but not for the younger children (aged 10-11). Model fit was assessed by comparing children's responses to the hexagonal

RIASEC structure. They examined the pattern of the RIASEC scale correlations with respect to how well it was fit by a hexagonal order model (i.e. that correlations among closer types would be more than those further away).

Similarly, Tracey and Ward (1998) in an earlier study found that the extent to which children's interests adhered to a hexagonal structure was positively related to age. They report a score called the correspondence index (CI) which is a correlation that represents the magnitude of model-data fit (using a Hexagonal structure as a benchmark). For college students (aged 18+) the CI = .82, middle school students (aged 11-14) CI = .57 and for elementary school children (aged 9-11) CI = .33. This data suggests that the structure of interests develops and changes throughout childhood, towards a hexagonal structure. Tracey and Ward (1998) also suggest that before middle school (earlier than 11 years of age), children perhaps have a very simple interest structure, representing perhaps just the Realistic and Social dimensions.

1.6.2 Interest stability in children

There is a general consensus that vocational interests emerge during childhood and become progressively more stable as individuals develop during adolescence (Tracey, 2002a, Low *et al.*, 2005). As discussed earlier, research has shown that vocational interests are remarkably stable over time

once the individual reaches 18 years old and they reach 'peak stability' between the ages of 25-30 (Campbell, 1971, Low *et al.*, 2005). Roberts and Peterson (1992) claim that the increased competition and cognitive changes of students in middle school help them to evaluate their competencies and interests in a more complex manner (see section 1.5.4 for further discussion of how self-ratings of competency relate to interests). There are a limited number of studies which have investigated interest stability over time in a group of adolescents in mainstream education.

Tracey and Ward (1998) reported on the stability of vocational interests for a group of children aged 11-14. The one year stability estimates are in Table 1.13.

Table 1.13 One year stability estimates (*r)* for RIASEC interests in children aged 11-14 (Tracey, 2002b)

Age	N	Realistic	Investigative	Artistic	Social	Enterprising	Conventional
10-11	126	.54	.62	.46	.50	.35	.44
13-14	221	.76	.77	.72	.81	.74	.79

Table 1.13 clearly shows that for the children aged 10-11, Realistic, and Investigative were the most stable interests over a one year period, whilst interests in the Enterprising and Conventional items were much less stable over time. When compared with the stability of a different group of children aged 13-14, stability estimates were far higher, for all of the six scales. Of

particular interest, is how Enterprising and Conventional interests were significantly more stable for the older group of children. The higher stability estimates for the children aged 13-14 demonstrate the clear value to assessing vocational interests in children of this age group.

Hirschi (2010a) measured vocational interest stability in a group of 292 Swiss children aged 12-16 over a 10 month period using the Revised General Interest Structure Test (a frequently used measure in German speaking countries). He found that Realistic interests were the most stable, whilst Enterprising and Conventional interests were the least stable over time.

Lubinski, Benbow and Ryan (1995) examined the stability of interests in gifted adolescents. Students were given the Strong-Campbell Interest inventory (SCII) at age 13 and again when aged 28. Results showed that their interests remained stable over a 15 year period; however some of the themes appeared to be more stable than others (namely Realistic, Investigative, Artistic & Social). Lubinski *et al.* (1995) go on to conclude that 'both personal attributes…namely abilities and preferences, can be meaningfully assessed in intellectually gifted young adolescents as early as age 13 for use in educational and vocational contexts' (p.200). It is worth noting that the researchers do comment that this was not a random sample of

gifted adolescents, because of their intense interests and ability in mathematics and science.

Mullis, Mullis and Gerwels (1998), gave 14 and 15 year olds the Strong-Campbell Interest inventory (and again three years later). Correlations were highest for Realistic, Artistic and Social interests and lowest for Enterprising, Investigative and Conventional interests. Interestingly, the results also revealed gender differences; it was found that males had higher mean scores on the Realistic theme, whilst females had higher scores on the Social & Conventional themes. In addition to this, gender differences were found to be stable across time for the Realistic, Artistic, Social, & Conventional themes.

1.6.3 The co-development of interests and abilities

There is a distinct lack of research that has explored the longitudinal nature of interests in children aged 11-15, and furthermore there is little published work that has specifically looked at the development of vocational interests in relation to objective measurements of a child's abilities. Tracey and Ward (1998) did however investigate the development of interests in children of this age group with regards to subjective measures of ability (i.e. self-report), as referred to earlier in section 1.6.2. They found a strong link between measures of competence and ability. It appeared that the younger

children were more likely to use sex-typing and locus of activity (in school vs. out) when responding. In each sample however, the interest scores always correlated highly with the competence perception scores. In recent work, Patrick, Care and Ainley (2010) have looked at the relationship between interests, self efficacy and academic achievement on choice of educational pathway in a group of students aged 14-15 years old. When predicting educational pathways for students with clear Realistic interests, self-efficacy and interest were predictors. For students with Investigative interests, both self-efficacy and achievement were the better predictors. For students with Artistic, Social and Conventional interests, achievement was the best predictor. This demonstrates how useful the RIASEC model can be when predicting future academic paths and giving students under the age of 16 careers counselling.

1.7 Rationale

There is a clear gap in the vocational interests' literature when it comes to understanding the development of interests in children. Similarly, there are few suitable method of measuring interest in children younger than 15. In addition, these tests typically have up to 300 items which is considered far too many items for younger children to reliably complete. Tracey (2002a) claims that when measuring children's interests, a focus on familiar activities, rather than unfamiliar occupations is a better means of assessing

interests. In fact ‘in research that measures interests through familiar activities, the structure of interests in children has been found to differ from that of adults’ (Tracey, 2002a p.149). This is the rationale Tracey and Ward (1998) also present for developing their measurement tool the tool ICA-R which is suitable for participants based in the USA. This would indicate that perhaps many of the current measures that solely compare children’s liking of various occupations or activities they have no experience of, are not appropriate when measuring interests in a younger sample. Therefore the current study aims to develop a brief measure of vocational interests that is suitable for children younger than 15.

From their review of research in the field (Low *et al.*, 2005) it can be considered that it may well be possible to forecast some features of a child’s interests profile during early adolescence, however further research is clearly needed in order to examine this issue in a group of children who are younger than 13 over a period of time. By looking at vocational interests and abilities in younger children than the majority of research studies in the area, it will be possible to explore how vocational interests develop over time in adolescence.

1.8 Key aims

1.8.1 Test development

For the purposes of this research study, a measure of vocational interest (previously developed for a related project) has been refined using confirmatory factor analysis techniques. This measure was developed for use with children who are situated in secondary mainstream education the United Kingdom. The development of this new measure will be clearly documented across Chapters 2 and 3. The final developed interest measure will be cross validated against the pre-existing SII (Harmon et al, 1994) and the PGI (Tracey, 2002b) measures. For the purpose of this report, the final version of the measure used in subsequent chapters will be referred to as the Plymouth Vocational Interest Inventory (PVII).

1.8.2 The structure and stability of interests in children

The longitudinal Study

The rationale for the first part of this body of work is *longitudinal* in nature and examines the structure and stability of vocational interests of children approximately aged 11.5 (school Year 7) and the same children again when they are 13.5 years old (school Year 9).

The cross-sectional Study

Interest data will also be collected from separate groups of children who are aged 14.5 (Year 10) and young adults aged 16-17 (Year 12) to enable structural comparisons across the four age groups. The children who are taking part in this study come from three schools local to the Plymouth area, each school specialising in Science, Sports or Art.

1.8.3 The relationship between interests and ability in children

The rationale for the second set of studies is to investigate how the Year 7 cohort's abilities relate to their interests. As with the interest test, abilities measures will also be administered when the children are in Year 9. This enables examination of how interests relate to those abilities and whether abilities predict interests, or vice versa. Many existing studies that have used objective measures of ability have used batteries or measures of *overall* intellectual ability. Lowman *et al.* (1985) noted that such general measures of ability are too broad to enable proper comparisons between interests and abilities. Therefore, a selection of different ability measures will be administered; measures of Mechanical, Spatial Rotation and Logical Reasoning ability. These measures have been developed and influenced by from existing measures of ability to enable the measurement of these skills for use in earlier work (EAP).

1.8.4 Implications of the research findings

A further aim is to consider how the results of this research can be used in a both a theoretical way, to enhance existing knowledge about child development, and also in a practical way to enhance careers guidance in secondary school. The findings from recent work by Tracey (2008) suggest that it is useful to think about careers in a manner similar to the RIASEC structure and that individuals do benefit from using this structure as a basis for making future career decisions.

1.9 Chapter summary

This thesis focuses on the measurement, structure and stability of vocational interests and abilities in secondary school aged children. The research has four key aims:

1. To refine an existing vocational interest measure using confirmatory analysis techniques.

2. To examine the extent to which vocational interests are stable over a two year period, both in terms of structure and in terms of the interests that dominate for particular individuals.

3. To evaluate the relationships between interests and abilities amongst school age children, and the ways in which this relationship might change over time.

4. To consider the implications of this research in both a theoretical and educational context.

Chapter 2 Development of the PVII

2.1 Introduction to the chapter

This chapter begins with a further discussion of the rationale for refining a new measure of vocational interest (PVII) suitable for Year 7 pupils in mainstream education. Next, the development process of this measure has been documented. The ability measures administered in this project are also introduced (with a fuller description of the measures in chapter 6). The data collection methods are described, and summary statistics for each of the data collection phases are presented. Item level responses are presented for the Year 7 children as a group, and also by gender. This chapter concludes with a summary and discussion of the main findings arising from this section.

2.2 Rationale for the development of a new interest measure

Work on the Plymouth Vocational Interest Inventory (PVII) initially began in 2002 as a result of work on a separate but related project entitled 'The Engineering Aptitude Project' (EAP). This project was a collaboration between staff at the School of Psychology (Handley, S. Dennis, I, Bradon,

P, Bennett, S) and Devonport High School for males (DHSB) in Plymouth and was supported by funding from both the school and the Learning and Skills Council (L.S.C). Summary reports of children's scores on interest and ability measures were provided to DHSB directly, the findings from the EAP were not published.

The need for such a partnership arose from the identified skills shortages in the engineering and science sectors, and the lack of students choosing engineering and science subjects at school, college and university. This was considered a result of two things; 1) students often had misconceptions as to what a career in engineering or science entailed 2) students were not given adequate careers counselling opportunities - enabling them to make informed choices (e.g. the selection of G.C.S.E. options) based on their abilities and interests at a young enough age. The EAP's initial aim was to develop and adapt existing measures that were representative and predictive of engineering ability and interest in male students who attended DHSB. It should be noted that DHSB was a grammar school for gifted males. The EAP project's aim was for pupils who scored high on both Engineering interest (Realistic + Investigative) and on the ability measures to be invited by the school to take part in an engineering enriched curriculum between school Years 8 and 11. The vocational interest measure developed for the EAP not only measured interest in Science and Engineering but a wide spectrum of interests (with questions measuring each of Holland's RIASEC

themes). This has enabled this present research project to move into the novel and exciting area of measuring Vocational Interests and Abilities in mainstream students aged younger than 15.

As highlighted in chapter 1, there is only limited research into the usefulness of measuring vocational interests in children under 13 years old. The vast majority of inventories have on average around 250 – 300 items, and typically focus on ratings of occupations. Existing measures have almost exclusively been developed in the US. This does of course raise some issues regarding their suitability for a U.K. based sample with regards to language used and the samples on which the original measures were developed. The key aim of developing the PVII was therefore to develop a simple measure of vocational interest that was age and language appropriate for children aged 11-15 in the U.K.

Work on the EAP enabled work to begin on developing a novel measure of vocational interest. The first version of the PVII was developed with 108 items. This number of items was initially chosen as it is the maximum number of items that can be scored on single sheet of Optical Mark Recognition (OMR) paper. This version was used both for the EAP and for the first phase of the current study.

2.3 The development of items for the PVII

The PVII measure initially comprised of five sections:

- **About you** (questions about the child's personality and their general tendencies e.g. 'I like people to listen when I talk'/ 'I like to do things properly even if it takes a long time'.

- **Hobbies** (questions that ask the child how much they would like to do hobbies such as 'Act in a play or musical'/ 'Play computer games'.

- **School topics/activities** (questions that ask the child how much they like doing topics as school such as 'Music'/'English Literature.

- **Occupations** (questions that ask the child how much they would like to do jobs such as 'Journalist'/ 'Professional sportsperson.

- **Likes/dislikes** (questions that ask the child how much they would like to do activities such as 'Working with cars'/'Learn a musical instrument'.

Questions were generated for each of the five sections. The structure of the items/sections was in part taken from the most recent version of the Strong Interest Inventory (SII) which uses Holland's Hexagonal structure of

interests and a range of response sections. For the PVII, respondents were asked to respond on a five point likert scale to rate the extent to which they 'like' or 'agree' with the various statements. Table 2.1 shows the key requirements of the PVII, and how these requirements were considered and achieved when developing the items for the measure. See Appendix 1.1 to view the PVII as it was administered in collection phase 1.

Table 2.1 Key requirements of PVII and this was achieved

Key Requirements	**How this was achieved**
Appropriate for individuals aged 11	Simplifying items commonly used in existing measures Providing elaboration for items that were ambiguous or unclear
Language understandable and suitable for U.K. based respondents	Re-wording items that used unsuitable spelling/terms
Quick to produce and administer	Pen and paper based questionnaire Can be completed in 15-20 minutes
Easy and quick to score	An average of item responses gives a score of between 1-5 for each scale

2.3.1 Ability measures

The ability measures used in the present study were initially developed for use in the EAP; measures of Mechanical, Spatial Rotation and Logical Reasoning ability. They were originally selected after reviewing relevant literature e.g. Stanley (1990, as cited in Howe, 1990), Wright (1989) and

consulting with senior engineering lecturing staff at the University of Plymouth. Stanley (1990) considered that excellent quantitative reasoning ability has been found to underpin high achievements in the engineering, science and technology fields. Wright (1989) states that good engineers think in analytical and objective terms, and approach problems in a logical and systematic way. Wright (1989) also suggests that a key element of this kind of problem solving is the ability to mentally represent the spatial characteristics of a problem – i.e. good engineers need to have a high level of spatial ability. A further discussion of the relationships between ability and interest in adults is presented in chapter 6. These measures of Mechanical, Spatial Rotation and Logical Reasoning ability were selected for use in the present study as little is known about the co-development of interests and abilities in school-aged children. Furthermore, a review of the literature (Ackerman & Heggestad, 1997) has found consistent relationships between these particular skills and interests in adults, whereas there is limited work that has explored the same relationships in children (see chapter 6 for a detailed discussion on this topic).

2.4 Data collection

Full ethical clearance was granted by the University of Plymouth's Ethical Review Board (Faculty of Science) before collection phase 1. The researcher obtained enhanced CRB disclosure before conducting testing

sessions at schools. This section briefly describes the overall data collection process, including recruitment, data collection and data scoring.

Children's families were all sent a letter to their homes a month before the booked testing data (via school) explaining the project and the testing procedures, and parents were asked to contact the school if they did not want their child to participate. Only one parent requested that their child could not participate as they would be away from school on the testing date. Participants in collection phase 5 were over 16 and therefore were able to give their own consent to take part (and therefore their families were not contacted for this part of the study). During all testing session, participants were asked to read and sign a consent form at the start of the testing session. It was made clear to participants at the outset that they had the right to withdraw themselves or their information at any point during the testing period, and alternate activities were set up by the school should any child wish to not participate. One child withdrew during the testing session at School 1, collection phase 1. No other withdrawals occurred.

2.4.1 Recruitment

The longitudinal Study

At the start of this research project, the broad analysis strategy was developed (which was later refined over the course of the study to take into account new research in the field). It was decided at the outset that confirmatory factor analysis (CFA) would be used to confirm the extent to which items in the PVII were each loading on the six RIASEC factors. This type of analysis plan consequently had implications for the sample size required. There are debates in the literature as to the minimum sample size needed to conduct both exploratory (EFA) and CFA. Early recommendations have either related to the number of observations per measured variable (e.g. Bentler & Chou, 1987), or just blanket suggestions for overall sample size e.g. Hutcheson and Sofroniou (1999) suggested a sample size of between 150 – 300 cases would be adequate. However, more recently, sample size recommendations appear to have moved towards the consideration of measurement quality. Gagné and Hancock (2006) suggest that for a scale reliability of 0.7 (which is the target α), N = 200 is acceptable, as long as there are at least 3 indicators (questions) per interest scale. With these numbers in mind, a sample of at least 300 children was aimed for to allow for attrition over time (with no more than 500 due to time and cost implications).

Head teachers from all local mainstream public schools were contacted via mail with information about the project (which was later followed up with a phone call if no response). Once three different head teachers had consented for their school to take part (each school having at least 130 children in Year 7) it was felt this would be a sufficient numbers of participants.

Each of the three schools that participated in this project had a different subject specialism. Schools can apply for specialist status through the Specialist Schools Programme (SSP), in one of ten curriculum areas. Schools then receive government and private sector sponsorship to help develop centres of excellence for that particular area specialism. In this study, School 1 had specialist status in Art, school 2 had specialist status in Sports and school 3 has specialist status in Science. This therefore meant the participating children came from a diverse set of schools, helping to improve generalisation of the project's findings. A meeting was conducted by the researcher with the head of Year 7 at each school to plan and book a date for each of the testing sessions.

The cross-sectional study

As good links were built up with the schools following the initial Year 7 testing session, one of the schools also allowed their Year 10 students to take part in the cross-sectional study which involved completion of interest inventories only. Schools linked to the EAP allowed for a small group of

Year 8 children to complete both the PVII2 and the SII during school time to enable for test validation of PVII. In addition, the Year 12 data was collected as part of a research open day held at the University of Plymouth, where local A-level students were able to visit the University, attend a number of lectures and take part in staff research studies.

2.4.2 Procedure

The full battery of measures used at collection phase 1 are available in the Appendices 2.1-2.6, and each include full written instructions and example items.

The longitudinal Study

The data collection procedure was slightly varied according to the testing rooms available at each of the three schools. At the first two schools, the testing session took place in a large room that seated the entire year group (which were already set up for school examinations) and at the third school, testing sessions took place within smaller rooms or classrooms (so repeat visits were necessary). All tests were of a pen and paper format, and children were provided with pens if so required. For the PVII at collection phase 1, OMR score sheets were provided alongside the measure to aid the research with data entry. For all other measures and times the children responded directly on the tests booklets.

The test procedure was fully explained to the children by the researcher at the start of each testing session, and full instructions were given for each test, with practice items for each test also clearly explained. These instructions were also available in written form on the front of each test. Children were asked to work independently, and remain quiet during the completion of each test. For each test (apart from Spatial Rotation) the time limit to complete each measure was flexible and typically lasted between 15-20 minutes (and was less if all children had finished). The Spatial Rotation measure is also known as a test of speeded rotation which means that this measure has a fixed time limit. Children were allowed 10 minutes only for this test. Numerous teaching staff were present to assist test administration, and they also helped with the distributing and collecting in of all tests. Teaching staff also assisted the researcher if children had any queries during the sessions. As there were six tests to complete at collection phase 1, a small break (approximately 5 minutes) was held midway through the testing session. Due to time constraints in School 1 at collection phase 1, not all participants were able to complete the PVII measure in the assessment time. In addition, there were some further children in School 1 who did not have English as their first language and therefore needed additional help to understand some of the question items.

The cross-sectional study

Testing for this study took part in teaching rooms provided either at the school (Year 8, Year 10) or Plymouth University (Year 12). Again, the test was of a pen and paper format, and therefore participants were provided with pens if so required. The test procedure was fully explained by the researcher at the start of each testing session, and full instructions were given at the front of the test for the participants to refer to. Participants were requested to work independently, to and remain quiet during the completion of each test. For collection phase 4, OMR score sheets were also used to aid with later data entry, but for collection phases 2, 3 and 5 the participants recorded their answers directly on the tests themselves. For collection phase 2, the SII tests were sent off to the publisher to be scored.

Table 2.2 shows a summary of all data collection phases and the measures that were administered used at each point. In Table 2.2 it is possible to also see the overall testing time for each collection phase. Collection phase 1 was the lengthiest testing session as children had six tests to complete within two hours. As also described in later chapters, children were performing at chance on both the Spatial Relations and Spatial Visualisation measures and for this reason these two measures were removed from the test battery at collection phase 6. Data for the PVII has only been presented and analysed in this chapter and subsequent chapters for children where the measure was

fully completed. Data for the ability measures has been included for all tests, even when the tests were only part completed (e.g. where children could not complete all items in the Spatial Rotation task in the time given). This has resulted in a lower total N for the PVII than for the ability measures.

Gender information was captured at data collection phases 1 & 6 to enable group analyses by gender in later chapters. There were approximately even number of male and females within the group of children in the longitudinal study (53% Male, 47% Female).

Table 2.2 An overview of the measures administered at each phase and sample size

Phase	Year	Ages	Interest	Time (mins)	N	Ability	N
1	7*	10-11	PVII	110	356	Mechanical	453
						Spatial Rotation	453
						Spatial Visualisation	454
						Spatial Relations	415
						Logical Reasoning	468
2	8	11-12	PVII2 SII**	25	77	/	/
3	10	14-15	PVII2	15	148	/	/
4	10	14-15	PVII2 PGI***	25	148	/	/
5	12	16-17	PVII2	15	71	/	/
6	9*	13-14	PVII2	60	296	Mechanical	324
						Spatial Rotation	323
						Logical Reasoning	311

*These are the same children, 2 years on.
** Strong Interest Inventory (Harmon *et al.*, 1994).
*** Personal Globe Inventory (Tracey, 2002b).

2.4.3 Data scoring

As mentioned earlier, some of the interest data was scored using OMR score sheets. This was found to be a quick and efficient way of scoring interest data. All other measures were entered by hand by the researcher and were further checked for accuracy by both the researcher and undergraduate student volunteers before further analysis took place. The next section displays the mean scores for each of the items in the PVII (data from each of the ability measures is displayed and further analysed in chapter 6). Note that some of the items have been shortened in Tables 2.3, 2.4 and 2.5 for ease of presentation.

2.5 PVII item level scores

Table 2.3 Mean item scores for each item on the PVII (N = 356)* note that some items have been abbreviated (see Appendix 1.1 for the full scale).

	Item	**Interest Scale**	**M**	**SD**
1	I like people to listen when I talk	Enterprising	4.33	0.75
2	I enjoy directing people	Enterprising	3.49	1.00
3	I enjoy outdoor activities	Realistic	4.47	0.88
4	I am a very energetic person	Realistic	4.02	1.02
5	I enjoy being physically active	Realistic	4.19	0.94
6	Find out how machines work	Realistic	3.04	1.30
7	I like finding out new information	Investigative	3.61	1.07
8	I find it easy to talk to other people	Social	4.01	0.93
9	I am a popular person at school	Social	3.33	0.97
10	I use talking to resolve arguments	Enterprising	3.34	1.21
11	Easy to work with other people	Social	3.95	0.95
12	I would like to set up own Business	Enterprising	3.63	1.18
13	I like looking after children	Social	3.67	1.25
14	I like to help people who are upset	Social	4.07	0.92
15	I am very organised	Conventional	3.13	1.23

	Item	Interest Scale	M	SD
16	I like to do things properly	Conventional	3.67	1.08
17	I am good at solving problems	Conventional	3.53	1.05
18	I am a perfectionist	Conventional	3.11	1.11
19	I am very efficient	Conventional	3.26	0.94
20	Play computer games	Conventional	4.02	1.13
21	Surfing/windsurfing/kite surfing	Realistic	3.06	1.38
22	Competitive sports	Realistic	4.03	1.16
23	Repairing old or broken things	Realistic	2.88	1.42
24	Building things out of scrap	Realistic	3.19	1.39
25	Studying plants and animals	Investigative	2.74	1.35
26	Entertaining others	Artistic	3.90	1.11
27	Reading really interesting books	Artistic	3.13	1.44
28	Designing and decorating	Artistic	3.26	1.28
29	Help with decorating the house	Artistic	3.79	1.22
30	Direct a movie	Artistic	3.31	1.26
31	Market Research	Enterprising	2.38	1.17
32	Raising money for charity	Enterprising	3.69	1.08
33	Be a volunteer helper	Social	3.10	1.21
34	Writing poetry	Artistic	2.65	1.33
35	Write books or stories	Artistic	2.96	1.40
36	Cooking food for friends	Artistic	3.81	1.22
37	Painting pictures	Artistic	3.56	1.30
38	Drama	Artistic	3.53	1.40
39	Solving number puzzles	Conventional	2.93	1.38
40	Business studies	Enterprising	2.63	1.14
41	Politics	Enterprising	2.37	1.12
42	Economics	Enterprising	2.67	1.13
43	Physical education, sports	Realistic	4.17	1.11
44	Design technology	Artistic	3.92	1.10
45	Building models	Artistic	3.76	1.20
46	Physics	Investigative	2.90	1.25
47	Applied science	Investigative	2.91	1.27
48	Astronomy	Investigative	2.77	1.22
49	Human biology	Investigative	2.98	1.27
50	Debating topics that make you think	Enterprising	3.10	1.27
51	Graphic designer/animator	Artistic	3.62	1.27
52	Photography	Artistic	3.41	1.26
53	Customer service	Conventional	2.97	1.19
54	Music	Artistic	3.85	1.25
55	Dancing	Artistic	3.29	1.57
56	English literature	Artistic	2.81	1.39
57	Statistics	Conventional	2.70	1.35
58	Making charts/graphs from information	Conventional	2.65	1.28
59	Working on the same thing for long time	Conventional	2.92	1.26
60	Chemistry	Investigative	3.51	1.34
61	Mathematics	Investigative	2.90	1.44
62	Lawyer	Enterprising	2.72	1.27
63	Being the manager of a hotel	Enterprising	3.06	1.26
64	Estate agent	Enterprising	2.62	1.16
65	Corporate trainer	Enterprising	2.60	1.18
66	Running company promotes companies	Enterprising	2.88	1.24
67	Police officer	Realistic	3.14	1.38
68	Journalist	Artistic	2.56	1.24
69	Personal trainer (fitness instructor)	Realistic	3.24	1.36
70	Ski/snowboard instructor	Realistic	3.06	1.34
71	Engineer	Realistic	2.81	1.43
72	Artistic news reader on the television	Conventional	2.42	1.27
73	Present your own radio show	Artistic	2.92	1.37

	Item	Interest Scale	M	SD
74	Landscape gardener	Realistic	2.24	1.21
75	Town planner	Realistic	2.47	1.23
76	Architect (design new buildings	Realistic	2.98	1.36
77	Fashion designer	Artistic	3.18	1.53
78	Computer games designer	Conventional	3.24	1.44
79	Office manager	Enterprising	2.78	1.29
80	Accountant	Conventional	2.57	1.30
81	Professional sportsperson	Realistic	3.66	1.42
82	Secretary for director of a big company	Conventional	2.83	1.27
83	Financial consultant	Conventional	2.33	1.14
84	Nanny, looking after children.	Social	2.74	1.43
85	Care assistant	Social	2.49	1.28
86	Nurse	Social	2.40	1.37
87	School teacher	Social	2.78	1.43
88	Hairdresser	Social	2.79	1.57
89	Repairing electronic equipment	Realistic	2.65	1.40
90	Playing team sports with friends	Realistic	4.01	1.24
91	Professional sportsperson	Realistic	3.67	1.46
92	Building a desk	Realistic	2.67	1.30
93	Working with cars	Realistic	2.99	1.51
94	Fixing a clock	Realistic	2.15	1.20
95	Working in a laboratory	Investigative	2.51	1.40
96	Speaking in front of other people in class	Enterprising	2.74	1.36
97	Design web-sites	Artistic	3.40	1.35
98	Work in advertising	Enterprising	2.90	1.30
99	Be the manager of a shop	Enterprising	3.04	1.39
100	Cashier in a bank	Conventional	2.67	1.32
101	Give first aid to someone	Social	3.16	1.34
102	Help others overcome their difficulties	Social	3.13	1.23
103	Learn a musical instrument	Artistic	3.31	1.41
104	Act in a movie/TV. Show	Artistic	3.78	1.33
105	Learn to sing	Artistic	3.08	1.55
106	Work with numbers and statistics	Conventional	2.40	1.27
107	Use computers to record information	Conventional	2.78	1.34
108	Make a speech	Enterprising	2.47	1.34

Mean item response scores are presented in Table 2.3, item scores are presented in order that they were presented on the measure. A higher score reflects greater interest in that activity or occupation. It is possible to see that there is considerable variability, with certain types of occupations and activities being rated more favourably than others. Table 2.4 displays the top 30 rated items for the whole group of Year 7 children.

Table 2.4 The top 30 rated activities, occupations or personal statements (N = 356)

Rank		M
1	I enjoy outdoor activities	4.47
2	I like people to listen when I talk	4.33
3	I enjoy being physically active	4.19
4	Physical education, sports	4.17
5	I like to help people who are upset or worried	4.07
6	Competitive sports	4.03
7	I am a very energetic person	4.02
8	Play computer games	4.02
9	I find it easy to talk to other people	4.01
10	Playing team sports with friends	4.01
11	I find it easy to work and co-operate with other people	3.95
12	Design technology	3.92
13	Entertaining others	3.90
14	Music	3.85
15	Cooking food for friends	3.81
16	Help with decorating the house	3.79
17	Act in a movie/TV. Show	3.78
18	Building models	3.76
19	Raising money for charity	3.69
20	I like to do things properly even if it takes a long time	3.67
21	Professional sportsperson	3.67
22	Looking after children	3.67
23	Athlete	3.66
24	I would like to set up my own business one day	3.63
25	Graphic designer/animator	3.62
26	I like finding out new information	3.61
27	Painting pictures	3.56
28	Drama, acting in a play or musical	3.53
29	I am good at solving problems	3.53
30	Chemistry, doing experiments with chemicals	3.51

Table 2.4 shows the top 30 rated activities, occupations or personal statements out of the set of 108. It is possible to see that six of the top 10 rated activities or occupations involve sport or being physically active. Other themes that emerge from this top 30 list include a tendency to rate higher art and entertainment related items along with social, caring related items. In addition, it is noted that 11 of these top 30 items are personal statements, indicating a higher level of liking for these self-directed statements.

Table 2.5 The lowest 30 rated activities, occupations or personal statements (N = 356)

Rank		M
78	School teacher	2.78
79	Office manager, be in charge of an office	2.78
80	Astronomy	2.77
81	Nanny, looking after children.	2.74
82	Speaking in front of other people in class	2.74
83	Studying plants and animals	2.74
84	Lawyer	2.72
85	Statistics, making charts and graphs from information	2.70
86	Economics	2.67
87	Building a desk	2.67
88	Cashier in a bank	2.67
89	Writing poetry	2.65
90	Repairing electronic equipment	2.65
91	Making charts and graphs from information	2.65
92	Business studies	2.63
93	Estate agent	2.62
94	Corporate trainer	2.60
95	Accountant	2.57
96	Journalist	2.56
97	Working in a laboratory	2.51
98	Care assistant/looking after elderly people	2.49
99	Town planner	2.47
100	Make a speech	2.47
101	A news reader on the television	2.42
102	Work with numbers and statistics	2.40
103	Nurse	2.40
104	Market Research	2.38
105	Politics	2.37
106	Financial consultant	2.33
107	Landscape gardener	2.24
108	Fixing a clock	2.15

Table 2.5 shows the lowest 30 rated activities, occupations or personal statements out of the set of 108. It is possible to see that the mean scores for even the lowest rated items are all above 2. When inspecting Table 2.5, it is possible to see that many of the lower rated items often relate to activities or occupations the child may not yet have had opportunity to experience.

2.6 Chapter summary

This chapter has reported on the methodology adopted throughout the entire research project, and presented the initial descriptive data resulting from the first administration of the PVII. Data presented for the group of Year 7 children showed that children had a strong preference for outdoor and sports related activities. Also highly rated were the questions ‘I like to help people who are upset or worried’ along with ‘I find it easy to talk to other people’ This suggests that the group of Year 7 children as a whole were particularly interested in activities that involved being active, teamwork, working with others and using their communication skills. Many of the lower rated items included items linked to the Enterprising or Conventional interest scales e.g. ‘Working with numbers or statistics’ or ‘Financial consultant’. Factor analysis has been chosen as a technique to select the items from the PVII that best measured each of the Holland (1959) RIASEC factors. The results of this factor analysis are reported next in chapter 3.

Chapter 3 Development of the PVII2

3.1 Introduction to the chapter

Chapter 2 described the data collection methods, and item level responses to the PVII. The aim of this chapter is to further examine the responses of the Year 7 children to the PVII and to generate reliable factor scores for each child from a subset of the original 108 items used. Each of the 108 items in the PVII was designed (or adapted from an existing interest measure) to load on one of the six interest factors; Realistic, Investigative, Artistic, Social, Enterprising and Conventional. As the 108 items were adapted from a number of sources, it was possible that a number of items did not load highly enough on their intended factor. By using the statistical method of Confirmatory Factor Analysis (CFA), it was possible to see which of the 108 interest items loaded well on their intended factor, and the items that did not.

Items that did not load well enough on their intended factor were removed from the analysis (the cut off values for these loadings are specified in section 3.2.4). This method of analysis is an iterative process, as the model is adapted in stages using the results of the CFA to guide item selection.

Before Model 1 was assessed using CFA, three items from the PVII were removed from the model specification. These items were identified as children frequently had difficulties understanding the item content, therefore the CFA analysis as reported analyses 105 of the original 108 items. This chapter describes the process of retaining and removing items based on output from the CFA analysis, and consequently provides the rationale for including each of the 19 items in the final measure (PVII2).

The PVII was fully completed by 356 Year 7 children. PVII scales that were only partially completed were not included in the CFA analysis. Possible responses to each item ranged from 1-5, with higher scores reflecting higher liking of the activity, occupation or school subject. To ensure that the final 19 item questionnaire could be applicable to other groups of children (and not be solely applicable to the dataset it was developed on); the dataset was split into two Groups using an odd-even split. This resulted in 178 children's data in Group 1 and 178 participants in Group 2. The dataset was split in this way to enable the cross-validation of the final model on a different dataset.

Therefore, this means that the CFA analysis was initially conducted using the responses from children who were allocated to Group 1 only. These analyses are reported in detail, including the standardised factor loadings for each item, whether items loaded on more than one scale (cross loadings),

and modification indices (a measure of how much the model fit would improve if that item is added to a specified model).

Following the final CFA analysis, Cronbach's alpha reliability statistics were calculated for each of the six factors, and this indicated that each scale had an acceptable level of internal consistency. Two validation analyses are also reported, one for a separate group of Year 8 children who completed the PVII along with the Strong Interest Inventory (SII); and one for a subgroup of the Year 10 sample who completed the PVII2 along with an abbreviated version of the Personal Globe Inventory (PGI). The influence of school placement on interest factor scores in at baseline is explored separately at the end of this chapter. This chapter concludes with the presentation of the inter-factor correlations for the Year 7 dataset and a discussion of this chapter.

3.2 Report on confirmatory factor analysis (CFA)

This section describes in detail the CFA that was conducted, the resulting output and decisions made to retain or remove each item from the analysis process.

3.2.1 Normality checks

Prior to CFA analysis, data was checked for normality using guidelines specified by West, Finch and Curran (1995). Kurtosis and Skewness scores for each of the 108 items were within an acceptable range (Kurtosis: M -0.64 SD 0.87, Skewness: M -0.20 SD 0.53), and so all data was analysed using a standard CFA procedure that assumes all items are normally distributed.

3.2.2 Model fit indices

The raw data was analysed using Mplus 4.21, and a maximum likelihood minimisation function. For each model, the Chi-Square Test of Model Fit values are reported. Goodness of model fit was evaluated by inspecting the root mean square error of approximation (RMSEA) and its 90% confidence interval (90% CI), standardised root mean square residual (SRMR) comparative fit index (CFI) and the Tucker-Lewis index (TLI). Guided by suggestions provided in Hu and Bentler (1999), acceptable model fit was defined by the following criteria RMSEA ($\leq$.06, upper limit 90% CI $\leq$.06), SRMR ($\leq$.08), CFI ($\geq$.95) and TLI ($\geq$.95). Multiple indices were used because they provide different information about model fit, and used together; these indices provide a more reliable evaluation of the solution.

3.2.3 Group 1 and group 2 datasets

Table 3.1 shows the distribution of children in each of the Group 1 and Group 2 datasets. Table 3.1 confirms that both datasets are equivalent with regards to the number of children at each school and the number of males and females within each Group dataset.

Table 3.1 Distribution of children across group 1 and group 2

	School 1	**School 2**	**School 3**	**Males**	**Females**
Group 1	60	59	59	93	85
Group 2	60	59	59	92	86
Total	120	118	118	185	171

3.2.4 Model 1 – group 1

Based on theory (Holland, 1959), a six-factor model was specified in which 108 interest items from the PVII2 loaded onto the six factors (latent variables): Realistic, Investigative, Artistic, Social, Enterprising and Conventional.

Items 19 (I am very efficient), 24 (Building things out of scrap) and 98 (Work in advertising) were removed due to the number of enquiries from children regarding these items. In particular, item 19 raised a significant number of queries in schools 2 and 3; they did not understand what ‘efficient’ meant. Therefore, responses to these items are likely to be

invalid, and consequently, these items have been removed from the analysis, with 105 items remaining in Model 1.

The measurement model contained no items that loaded on more than one scale. All residual influences were assumed to be uncorrelated. Table 3.2 denotes which latent variable each interest item was designed to load on. The model was over identified, with more than 3 items per latent variable (Brown, 2006). Each of the overall goodness of fit indices suggested that the six-factor model fit the data poorly, χ^2 (5340) = 11724.807, p =.000, RMSEA = 0.082 (90% CI = 0.080-0.084), SRMR = 0.112, CFI = 0.428, TLI = 0.415.

Standardised parameter estimates are presented in Table 3.2. Inspection of Modification Indices (MI) indicated numerous area of ill fit in the model, with MI ranging from 10.17 (10 being the minimum M.I. value Mplus would print by default) to 43.66. M.I is the expected change in Chi-Square Test of Model fit value from making the indicated change to the model, by allowing an item to load on an additional factor. Standardised expected parameter change values (EPC) ranged from -0.96 (Item12 on C) to 0.98 (Item 72 on E). These are the loadings that the item would have on the additional factor, and can also be seen in Table 3.2.

Due to poor model fit, correlations between latent variables are not going to be reliable; however a weak negative correlation between Realistic and Social has been noted (-.006), whereas all other correlations between latent factors are positive and range from 0.23-0.93. Table 3.2 details the results from the CFA on Model 1, including the decision to retain or reject each indicator. When making this decision, the fully standardised parameter estimates, and the modification indices/ expected parameter change statistics were taken into account. Indicators with a fully standardised parameter estimate of approximately 0.6 or more and did not positively cross load on another latent variable (M.I. > 10) were retained in the model at this stage.

Table 3.2 Results of six-factor CFA on model 1 – group 1

Item	S	Std	MI	EPC	CL	R
3	R	0.21				
4	R	0.12				
5	R	0.16				
6	R	0.59				**Y**
21	R	0.34				
22	R	0.28				
23	R	0.68	15.30	-0.24	**S**	**Y**
			16.21	-0.30	E	
			13.18	-0.26	C	
43	R	0.28				
67	R	0.45				
69	R	0.36	10.50	0.29	E	
70	R	0.51	10.23	0.23	A	
71	R	0.77	15.41	-0.30	**I**	**Y**
			17.34	-0.23	A	
			15.88	-0.22	S	
			16.58	-0.27	E	
			15.12	-0.25	C	
74	R	0.48	21.01	0.45	I	
			28.09	0.38	A	
			10.99	0.24	S	
			31.40	0.48	E	
			30.43	0.45	C	
75	R	0.44	13.31	0.37	I	
			29.53	0.40	A	
			16.20	0.29	S	
			32.00	0.49	E	
			26.15	0.43	C	
76	R	0.53	16.98	0.39	I	
			40.20	0.44	A	
			21.32	0.32	S	
			25.91	0.42	E	
			16.85	0.33	C	
81	R	0.42				
89	R	0.72				**Y**
90	R	0.32				
91	R	0.40				
92	R	0.71				**Y**
93	R	0.81	14.09	-0.27	I	**Y**
			22.97	-0.25	A	
			16.57	-0.21	S	
			23.03	-0.30	E	
			22.32	-0.29	C	
94	R	0.64				**Y**
7	I	0.53				
25	I	0.59				**Y**

Item	S	Std	MI	EPC	CL	R
46	I	0.58				**Y**
47	I	0.61				**Y**
48	I	0.72				**Y**
49	I	0.65				**Y**
60	I	0.53				
61	I	0.53	22.14	0.66	C	
95	I	0.66	10.31	0.29	R	
26	A	0.38				
27	A	0.58	14.39	0.34	I	**Y**
28	A	0.44				
29	A	0.61				**Y**
30	A	0.50				
34	A	0.59				**Y**
35	A	0.51				
36	A	0.60				**Y**
37	A	0.52				
38	A	0.61				**Y**
44	A	0.37	16.10	-0.47	S	
45	A	0.34	39.19	0.48	R	
			31.38	0.57	I	
			15.12	-0.46	S	
			11.66	0.43	E	
51	A	0.56	16.72	0.28	R	
			25.66	-0.54	S	
52	A	0.68	10.77	-0.32	S	**Y**
54	A	0.50				
55	A	0.47	43.22	-0.48	R	
			36.76	-0.58	I	
			21.65	0.53	S	
			11.75	-0.41	E	
56	A	0.55	17.12	0.42	C	
68	A	0.50	12.33	0.25	R	
			16.76	0.48	E	
			12.99	0.37	C	
73	A	0.51	18.70	0.31	R	
			24.14	0.58	E	
			12.77	0.37	C	
77	A	0.48				
97	A	0.56				
103	A	0.51				
104	A	0.61				**Y**
105	A	0.58	18.71	-0.29	R	
			22.32	-0.42	I	
			21.88	0.49	S	

Item	S	Std	MI	EPC	CL	R
8	S	0.28				
9	S	0.01				
11	S	0.14				
13	S	0.72				**Y**
14	S	0.52				
33	S	0.63				**Y**
84	S	0.70	13.15	-0.25	I	**Y**
			11.06	-0.33	A	
			12.54	-0.27	E	
			10.48	-0.24	C	
85	S	0.62				**Y**
86	S	0.65				**Y**
87	S	0.63				**Y**
88	S	0.48	15.50	-0.28	R	
			15.64	-0.31	I	
			10.17	-0.27	C	
101	S	0.50	27.31	0.36		
			14.82	0.30		
			17.49	0.37		
			15.77	0.33		
102	S	0.61	21.55	0.30	R	
			21.47	0.34	I	
			12.13	0.36	A	
			22.42	0.39	E	
			19.76	0.35	C	
1	E	0.13				
2	E	0.25				
10	E	0.15				
12	E	0.36	10.25	-0.96	C	
31	E	0.57				**Y**
32	E	0.40	14.56	0.48	A	
			30.08	0.51	S	
40	E	0.63				**Y**
41	E	0.53				
42	E	0.56	10.87	0.42	I	
50	E	0.57	20.51	0.57	E	
62	E	0.48	12.98	-0.48	I	
63	E	0.57				**Y**
64	E	0.59				
65	E	0.61				**Y**
66	E	0.57				
79	E	0.65				**Y**
96	E	0.54				
99	E	0.58				**Y**
108	E	0.62				**Y**

Item	S	Std	MI	EPC	CL	R
15	C	**0.40**	30.91	-0.48	R	
			21.52	-0.69	I	
16	C	**0.36**				
17	C	**0.42**				
18	C	**0.26**	14.12	-0.34	R	
			10.33	-0.50	I	
20	C	**0.13**	10.47	0.30	R	
			18.71	0.69	I	
39	C	**0.65**				**Y**
53	C	**0.55**	24.94	0.42	S	
57	C	**0.72**				**Y**
58	C	**0.66**				**Y**
59	C	**0.31**				
72	C	**0.55**	13.73	0.38	A	
			12.84	0.98	E	
78	C	**0.39**	43.66	0.57	R	
			29.92	0.82	I	
			26.69	-0.47	S	
80	C	**0.57**				
82	C	**0.52**				
83	C	**0.64**				
100	C	**0.59**				
106	C	**0.72**				**Y**
107	C	**0.69**	**10.85**	**0.41**	**I**	**Y**

S	Scale (R = Realistic, I = Investigative, A = Artistic, S = Social, E = Enterprising, C = Conventional).
STD	Fully Standardised Parameter Estimate
MI	Modification Indices
EPC	Expected Parameter Change (Fully Standardised)
CL	Cross Loading on Latent
R	Retain in Model (Yes)

It is possible to see from Table 3.2 that there are a number of areas of poor fit. Specifically, 26 items loaded positively on more than one factor. These items have been removed from subsequent CFA analyses. In addition, a significant amount of items loaded on their intended factor only moderately, with fully standardised parameter estimates lower than 0.57. These items have also been removed from further analyses, to ensure that the best loading items remained. Thirty-seven items remain in the Model 2; seven Realistic items, five Investigative items, seven Artistic items, six Social Items, five Enterprising Items and five Conventional Items. The results from a six-factor analysis on Model 2 are reported next.

3.2.5 Model 2 – group 1

Based on the output from Model 1, a six-factor model was specified in which 37 interest items from the PVII loaded onto the six factors: Realistic, Investigative, Artistic, Social, Enterprising and Conventional. The measurement model contained no items that loaded on more than one scale.

Each of the overall goodness of fit indices suggested that model fit had improved but fit statistics were still not within acceptable ranges χ^2 (579) = 1145.236, p <.001, RMSEA = 0.074 (90% CI = 0.068-0.080), SRMR = 0.084, CFI = 0.808, TLI = 0791.

Standardised parameter estimates are presented in Table 3.3. Inspection of Modification Indices (MI) indicated far fewer areas of ill fit in the model. Four items positively loaded on more than one latent variable (Items 33, 92, 94, 107), with M.I. ranging from 10.56 – 18.471. EPC values ranged from -0.39 (Item 52 on S) to 0.50 (Item 33 on I). These can also be seen Table 3.3.

Table 3.3 details the results from the CFA on Model 2, including the decision to retain or reject each indicator. When making this decision, the fully standardised parameter estimates, and the modification indices/ expected parameter change statistics were taken into account, using guidelines specified earlier.

Table 3.3 Results of six-factor CFA on model 2 – group 1

Item	S	Std	MI	EPC	CL	R	Item	S	Std	MI	EPC	CL	R
6	R	0.62				**Y**	**13**	S	0.74				**Y**
23	R	0.73				**Y**	**33**	S	0.56	12.29	0.26	I	
71	R	0.80				**Y**				18.47	0.50	A	
89	R	0.74				**Y**				12.64	0.29	E	
92	R	0.70	12.83	0.25	E		**84**	S	0.75				**Y**
			10.56	0.21	C		**85**	S	0.64				**Y**
93	R	0.87				**Y**	**86**	S	0.67				**Y**
94	R	0.64	11.58	0.22	A		**87**	S	0.67				**Y**
			13.19	0.24	S								
			11.39	0.25	E		**31**	E	0.56				
							40	E	0.66				**Y**
25	I	0.57					**63**	E	0.54				
46	I	0.59				**Y**	**65**	E	0.59				**Y**
47	I	0.64				**Y**	**79**	E	0.63				**Y**
48	I	0.78				**Y**	**99**	E	0.58				**Y**
49	I	0.67				**Y**	**108**	E	0.60				**Y**
29	A	0.59				**Y**							
34	A	0.57					**39**	C	0.65				**Y**
36	A	0.63				**Y**	**57**	C	0.80				**Y**
38	A	0.68				**Y**	**58**	C	0.76				**Y**
52	A	0.60	11.10	-0.39	A	**Y**	**106**	C	0.71				**Y**
104	A	0.65				**Y**	**107**	C	0.68	10.66	0.22	R	

S Scale (R = Realistic, I = Investigative, A = Artistic, S = Social, E = Enterprising, C = Conventional).
STD Fully Standardised Parameter Estimate
MI Modification Indices
EPC Expected Parameter Change (Fully Standardised)
CL Cross Loading on Latent
R Retain in Model (Yes)

It is possible to see from Table 3.3 that there a few areas of poor fit. Specifically, 4 items loaded positively on more than one factor. These items have been removed from subsequent CFA analyses. In addition, three further items loaded on their intended factor poorly, with fully standardised parameter estimates lower than 0.57, these items have also been removed from further analyses. The M.I. also indicated that two pairs of items (71 & 93) and (57 & 58) correlate highly and so have been allowed to correlate in

the Model specification. Twenty nine items remain in the Model, as indicted by the final column in Table 3.3. Model 3 has five Realistic items, four Investigative items, six Artistic items, five Social Items, five Enterprising Items and four Conventional Items. The results from a six-factor analysis on Model 3 are reported next.

3.2.6 Model 3 – group 1

Based on the output from Model 2, a six-factor model was specified in which 29 interest items from the PVII loaded onto the six factors: Realistic, Investigative, Artistic, Social, Enterprising and Conventional. The measurement model contained no items that loaded on more than one scale.

Each of the overall goodness of fit indices suggested that model fit had improved and were within acceptable range for RMSEA and SRMR but not for the other indices. χ^2 (360) = 561.529, p <.001, RMSEA = **0.056** (90% CI = 0.047-0.065), SRMR = **0.069** CFI = 0.909, TLI = 0898.

Standardised parameter estimates are presented in Table 3.4. Inspection of Modification Indices (MI) indicated one area of ill fit in the Model. One item positively loaded on more than one latent variable with M.I. ranging from 11.01 with an EPC value of 0.43 (49 on E). Table 3.4 details the results from the CFA on Model 3, including the decision to retain or reject each indicator. As the Model fit statistics were still not within acceptable

ranges for all indices consulted, one item with the lowest fully standardised parameter estimates was removed from each factor (apart from item 49, which also loaded on Enterprising and therefore was removed from the Model). In addition, both Items 29 and 34 were removed from Artistic due to their relatively poor parameter estimates.

Table 3.4 Results of six-factor CFA on model 3 – group 1

Item	S	Std	MI	EPC	CL	R	Item	S	Std	MI	EPC	CL	R
6	R	0.65					**13**	S	0.71				**Y**
23	R	0.76				**Y**	**84**	S	0.78				**Y**
71	R	0.78				**Y**	**85**	S	0.64				
89	R	0.72				**Y**	**86**	S	0.67				**Y**
93	R	0.82				**Y**	**87**	S	0.70				**Y**
46	I	0.61				**Y**	**40**	E	0.67				**Y**
47	I	0.63				**Y**	**65**	E	0.60				**Y**
48	I	0.80				**Y**	**79**	E	0.65				**Y**
49	I	0.64	11.01	0.43	E		**99**	E	0.58				
							108	E	0.61				**Y**
29	A	0.59											
34	A	0.57											
36	A	0.63				**Y**	**39**	C	0.65				**Y**
38	A	0.68				**Y**	**57**	C	0.67				**Y**
52	A	0.61	10.65	-0.35	S	**Y**	**58**	C	0.62				
104	A	0.65					**106**	C	0.75				**Y**

S Scale (R = Realistic, I = Investigative, A = Artistic, S = Social, E = Enterprising, C = Conventional).
STD Fully Standardised Parameter Estimate
MI Modification Indices
EPC Expected Parameter Change (Fully Standardised)
CL Cross Loading on Latent
R Retain in Model (Yes)

Twenty two items remain in the Model, as indicted by the final column in Table 3.4. Model 4 had four Realistic items, three Investigative items, four Artistic items, four Social Items, four Enterprising Items and three Conventional Items. The results from a six-factor analysis on Model 4 are reported next.

3.2.7 Model 4 – group 1

Based on the output from Model 3, a six-factor model was specified in which 22 interest items from the PVII loaded onto the six factors: Realistic (R), Investigative (I), Artistic (A), Social (S), Enterprising (E) and Conventional (C). The measurement model contained no items that loaded on more than one scale. Each of the overall goodness of fit indices suggested that model fit had again improved and again were within acceptable ranges for RMSEA and SRMR. χ^2 (193) = 285.889, p =.000, RMSEA = **0.052** (90% CI = 0.039-0.064), SRMR = **0.059** CFI = 0.939, TLI = 0.927.

Standardised parameter estimates are presented in Table 3.5. Inspection of Modification Indices (MI) indicated one area of ill fit in the Model. One item positively loaded on more than one latent variable with M.I. of 10.39 and an EPC value of 0.43 (Item 52 on R). Table 3.5 details the results from the CFA on Model 4, including the decision to retain or reject each indicator.

Table 3.5 Results of six-factor CFA on model 4 – group 1

I	S	Std	MI	EPC	CL	R	I	S	Std	MI	EPC	CL	R
23	R	0.74				**Y**	**13**	S	0.72				**Y**
71	R	0.81				**Y**	**84**	S	0.74				**Y**
89	R	0.70				**Y**	**86**	S	0.67				**Y**
93	R	0.86				**Y**	**87**	S	0.71				**Y**
46	I	0.61				**Y**	**40**	E	0.66				**Y**
47	I	0.62				**Y**	**65**	E	0.60				**Y**
48	I	0.84				**Y**	**79**	E	0.63				**Y**
							108	E	0.62				**Y**
36	A	0.58				**Y**							
38	A	0.76				**Y**	**39**	C	0.64				**Y**
52	A	0.57				**Y**	**57**	C	0.67				**Y**
104	A	0.69	10.39	0.23	R		**106**	C	0.76				**Y**

S Scale (R = Realistic, I = Investigative, A = Artistic, S = Social, E = Enterprising, C = Conventional).
STD Fully Standardised Parameter Estimate
MI Modification Indices
EPC Expected Parameter Change (Fully Standardised)
CL Cross Loading on Latent
R Retain in Model (Yes)

Twenty one items remain in the Model, as indicated by the final column in the Table 3.5. Model 5 had four Realistic items, three Investigative items, three Artistic items, four Social Items, four Enterprising Items and three Conventional Items. The results from a six-factor analysis on Model 5 are reported next.

3.2.8 Model 5 – group 1

Based on the output from Model 4, a six-factor model was specified in which 21 interest items from the PVII loaded onto the six latent variables: Realistic, Investigative, Artistic, Social, Enterprising and Conventional. The measurement model contained no items that loaded on more than one scale.

Each of the overall goodness of fit indices suggested that model fit had again improved and were within acceptable range for RMSEA, SRMR. χ^2 (173) = 250.320, p <.001, RMSEA = **0.050** (90% CI = 0.036-0.063), SRMR = **0.055** CFI = 0.947, TLI = 0.935. Standardised parameter estimates and standard errors are presented in Table 3.6. Inspection of Modification Indices (MI) indicated no areas of ill fit in the Model. Table 3.6 details the results from the CFA on Model 5, including the decision to retain or reject each indicator.

Table 3.6 Results of six-factor CFA on model 5 – group 1

Item	S	Std	R	Item	S	Std	R
23	R	0.73	**Y**	**13**	S	0.71	**Y**
71	R	0.82	**Y**	**84**	S	0.74	**Y**
89	R	0.71	**Y**	**86**	S	0.67	**Y**
93	R	0.86	**Y**	**87**	S	0.71	**Y**
46	I	0.61	**Y**	**40**	E	0.66	**Y**
47	I	0.62	**Y**	**65**	E	0.60	**Y**
48	I	0.84	**Y**	**79**	E	0.63	**Y**
				108	E	0.62	**Y**
36	A	0.54	**Y**	**39**	C	0.64	**Y**
38	A	0.78	**Y**	**57**	C	0.67	**Y**
104	A	0.67	**Y**	**106**	C	0.76	**Y**

S Scale (R = Realistic, I = Investigative, A = Artistic, S = Social, E = Enterprising, C = Conventional).
STD Fully Standardised Parameter Estimate
R Retain in Model (Yes/No)

As Model 5 fits the data well, and the RMSEA and the SRMR fit indices are within acceptable range, and the CFI is also reasonable, it was decided to cross validate this version of the model against the group 2 dataset to see if this six-factor model also applies.

3.2.9 Model 5 – group 2

Based on the output from Model 5, a six-factor model was specified in which 21 interest items from the PVII loaded onto the six latent variables: Realistic, Investigative, Artistic, Social, Enterprising and Conventional. The group 2 dataset comprised 178 cases from the complete Year 7 dataset (total N=356). The measurement model contained no items that loaded on more than one scale.

Each of the overall goodness of fit indices suggested that model fit was fair and was within acceptable range for SRMR. χ^2 (173) = 314.514, p <.001, RMSEA = 0.068 (90% CI = 0.056-0.080), SRMR = **0.073** CFI = 0.902, TLI = 0.881. Standardised parameter estimates and standard errors are presented in Table 3.7. Inspection of Modification Indices (MI) indicated a few areas of ill fit in the Model. Three items loaded positively on more than one factor, namely 36, 89 & 108. Table 3.7 details the results from the CFA on Model 5 (Group 2), including the decision to retain or reject each indicator.

Table 3.7 Results of six-factor CFA on model 5 – group 2

I	S	Std	MI	EPC	CL	R	I	S	Std	MI	EPC	CL	R
23	R	0.70				**Y**	**13**	S	0.71				**Y**
71	R	0.73				**Y**	**84**	S	0.81				**Y**
89	R	0.80	14.65	0.33	I		**86**	S	0.65				**Y**
			15.10	0.29	E		**87**	S	0.76				**Y**
93	R	0.73				**Y**							
							40	E	0.64				**Y**
46	I	0.73				**Y**	**65**	E	0.67				**Y**
47	I	0.80				**Y**	**79**	E	0.71				**Y**
48	I	0.74				**Y**	**108**	E	0.55	11.27	0.36	A	
36	A	0.48	10.69	0.35	E	**Y**	**39**	C	0.59				**Y**
			14.61	0.37	C		**57**	C	0.68				**Y**
38	A	0.74				**Y**	**106**	C	0.71				**Y**
104	A	0.65				**Y**							

S Scale (R = Realistic, I = Investigative, A = Artistic, S = Social, E = Enterprising, C = Conventional).
STD Fully Standardised Parameter Estimate
MI Modification Indices
EPC Expected Parameter Change (Fully Standardised)
CL Cross Loading on Latent
R Retain in Model (Yes/No)

The results of the CFA on Model 5 on the group 2 dataset revealed that three items loaded on more than one factor. From this, it was decided to remove items 89 and 108 from the model. Item 36 could not be removed as

each latent variable needs to have at least three indicator variables (Brown, 2006). The final model (Model 6) included 19 interest items, and was evaluated with the Group 1 and Group 2 datasets and the complete Year 7 dataset. The full results are included for the complete dataset next; the model fit statistics can be seen for all three of these analyses in Table 3.8. Table 3.9 shows the final interest questions left in the questionnaire and their corresponding parameter estimates and factor loadings.

3.2.10 Model 6 – complete dataset

Based on the output from Model 5 on group 2, a six-factor model was specified in which 19 interest items from the PVII loaded onto the six latent variables: Realistic, Investigative, Artistic, Social, Enterprising and Conventional. The measurement model contained no items that loaded on more than one scale.

Each of the overall goodness of fit indices suggested that model fit was good and was within all acceptable range for all indices aside from TLI. χ^2 (136) = 257.902, p =.000, RMSEA = **0.050** (90% CI = **0.041-0.059**), SRMR = **0.045** CFI = **0.950**, TLI = 0.937. Standardised parameter estimates are presented in Table 3.8 Inspection of modification indices (MI) indicated that two items loaded positively on more than one factor, namely 36 & 23. However, as the fit indices are showing the model is a good fit to the data;

these remaining 19 items will be left in the questionnaire. A negative correlation between Realistic and Social has been noted (-0.34), and between Realistic and Artistic (-0.20) whereas all other correlations between latent factors are positive and range from 0.19-0.77. Table 3.8 displays the results from the CFA on Model 6 on all Year 7 data.

Table 3.8 Results of six-factor CFA on model 6 – all Year 7 data

I	S	Std	MI	EPC	CL	R	I	S	Std	MI	EPC	CL	R
23	**R**	0.70	11.05	0.16	A	**Y**	**13**	**S**	0.72				**Y**
71	**R**	0.83				**Y**	**84**	**S**	0.77				**Y**
93	**R**	0.84				**Y**	**86**	**S**	0.66				**Y**
							87	**S**	0.73				**Y**
46	**I**	0.68				**Y**							
47	**I**	0.73				**Y**	**40**	**E**	0.65				**Y**
48	**I**	0.77				**Y**	**65**	**E**	0.66				**Y**
							79	**E**	0.69				**Y**
36	**A**	0.53	11.23	0.23	C	**Y**							
38	**A**	0.75				**Y**	**39**	**C**	0.63				**Y**
104	**A**	0.65				**Y**	**57**	**C**	0.68				**Y**
							106	**C**	0.72				**Y**

3.2.11 Summary of model fit statistics and final questionnaire

Table 3.9 displays a summary of the model fit statistics for each of the versions of the model, and associated model fit statistics.

Table 3.9 Summary of model fit statistics by model (N =356)

Model	**Group**	**χ^2 (DF)**	**Items**	**RMSEA**	**RMSEA C.I.**	**SRMR**	**CFI**	**TLI**
1	1	11724.807 (5340)	105	0.082	0.080 – 0.084	0.112	0.428	0.415
2	1	1145.236 (579)	36	0.074	0.068 – 0.080	0.084	0.808	0.791
3	1	561.529 (360)	29	**0.056**	0.047 – 0.065	**0.069**	0.909	0.898
4	1	285.880 (193)	22	**0.052**	0.039 – 0.064	**0.059**	0.939	0.927
5	1	250.320 (173)	21	**0.050**	**0.036 – 0.063**	**0.056**	**0.947**	0.935
5	2	314.514 (173)	21	0.068	0.056 – 0.080	**0.068**	0.902	0.881
6	All	257.902 (136)	19	**0.050**	**0.041 – 0.059**	**0.045**	**0.950**	0.937
6	1	163.483 (136)	19	**0.034**	**0.000 – 0.051**	**0.046**	**0.978**	**0.972**
6	2	235.795 (136)	19	0.069	0.050 – 0.078	**0.069**	0.920	0.899

The initial 108 item has been reduced to 19 items which all load highly on their intended factor; these items are shown in Table 3.10.

Table 3.10 Final 19 items used to generate factor scores (PVII2)

Item	L	Item	Std
23	**R**	Repairing old or broken things, e.g. cars	**0.70**
71	**R**	Engineer	**0.83**
93	**R**	Working with cars	**0.84**
46	**I**	Physics, study of the physical world	**0.68**
47	**I**	Applied Science	**0.73**
48	**I**	Astronomy	**0.77**
36	**A**	Cooking food for friends	**0.53**
38	**A**	Drama, acting in a play or musical	**0.75**
104	**A**	Act in a movie/TV show	**0.65**
13	**S**	Looking after children	**0.72**
84	**S**	Nanny	**0.77**
86	**S**	Nurse	**0.66**
87	**S**	School teacher	**0.73**
40	**E**	Business studies	**0.65**
65	**E**	Corporate trainer (training people to do their jobs better)	**0.66**
79	**E**	Office manager, be in charge of an office	**0.69**
39	**C**	Solving number puzzles	**0.63**
57	**C**	Statistics, making charts and graphs from information	**0.68**
106	**C**	Work with numbers and statistics	**0.72**

Table 3.10 shows that the 19 items in this final version not only have high factor loadings, but they all have good face validity with respect to the six interest factors they have been designed to measure.

3.3 Scale scores

Scale scores for each of the six interest factors were calculated using the PVII2 which comprises 19 items. Scale scores were created by calculating the average response to items on that scale. Items were given equal weighting.

Table 3.11 Mean scores for each scale using the PVII2 at time 1

	M (SD)			
	All schools	School1	School 2	School 3
	N = 356	N = 120	N = 118	N = 118
Realistic	2.89 (1.26)	2.70 (1.13)	2.97 (1.33)	3.00 (1.27)
Investigative	2.85 (1.03)	2.86 (1.08)	2.84 (.94)	2.89 (1.07)
Artistic	3.70 (1.02)	3.64 (1.02)	3.59 (.90)	3.89 (1.11)
Social	2.89 (1.09)	2.86 (1.06)	3.01 (1.07)	2.81 (1.14)
Enterprising	2.67 (.96)	2.60 (.97)	2.82 (.97)	2.58 (.93)
Conventional	2.89 (.96)	2.98 (1.02)	2.89 (.87)	2.79 (.98)

From Table 3.11 it is possible to see that not all factors means (from children across all schools) are the same. An analysis of variance (ANOVA) was conducted to see if any differences between scale means were statistically significant. The ANOVA was significant F (3.13, 1110.568) = 57.58, p = <.001, partial η = .14. As Mauchley's test of sphericity was significant, Greenhouse-Geisser statistics have been reported. Pairwise

comparisons indicated that the mean response to the Artistic scale items were significantly *higher* (p <.001) than the mean response to all other factors. Pairwise comparisons also confirmed that the mean response to the Enterprising scale items was significantly *lower* (p <.001) than the mean response to all other factors. No other statistically significant differences between mean responses to factors were observed. Therefore it is possible to conclude that the complete group of Year 7 children rated Artistic scale items the highest on average (Cooking food, Drama, Acting), and rated Enterprising scale items the lowest on Average (Business Studies, Corporate Trainer, Office Manager).

3.3.1 Internal consistency of each scale

Cronbach's alpha is a measure of a scale's internal consistency, and it has been calculated for the final set of items for each of the six interest factors. The result of this analysis is reported in Table 3.12.

Table 3.12 Cronbach's alpha reliability coefficients reported for each scale

Interest Scale	*Number of items in Scale*	α
Realistic	3	.84
Investigative	3	.77
Artistic	3	.67
Social	4	.81
Enterprising	3	.70
Conventional	3	.71

George and Mallery (2003) consider that Cronbach's alpha reliability coefficients > .9 are excellent, >.8 are good, >.7 are acceptable and >.6 are questionable. Using this guide, Cronbach's alpha for the Realistic and Social factors are good, for the Investigative, Enterprising and Conventional factors are acceptable, but for the Artistic Scale is questionable, though the alpha statistic is very close to the acceptable level.

3.3.2 Specialist school status

School 1 has specialist status in art, School 2 has specialist status in Sports and School 3 has specialist status in science. The responses of the children were examined separately, to further examine if school specialist status had any impact on the direction and pattern of interests of children at that particular school at collection phase 1. As children would have just been at secondary school for 10 months, it is not expected that interests would differ significantly at this data collection point. Table 3.11 displays the mean vocational interest factor scores for children at each of the three schools.

An independent measures multivariate ANOVA was conducted to see if any differences between scale means were statistically significant between the three different schools at baseline. The only significant analysis was for the Artistic scale: F (2,353) = 2.98, p = .05, η = .02. Pairwise comparisons indicated that the mean response to the Artistic scale was significantly

higher at School 3 (M 3.89, SD 1.12) than at School 2 (M 3.59, SD .90), $p < .05$. No other statistically significant differences between mean responses to factors were observed. Therefore it is possible to conclude that at data collection phase 1 there were overall no systematic differences between the three schools with regards to responses to the interest factors, though the small difference in Artistic factor scores is noted.

3.4 Validation of the PVII2 with the SII (year 8 children).

For a related project, a group of children completed the PVII2 as well as the Strong Interest Inventory (SII: Harmon *et al.*, 1994). The sample consisted of 77 Year 8 gifted children (32 males, 44 females), who were aged between 12 -13.

The SII is a long questionnaire, consisting of 317 items and takes approximately 25-30 minutes to complete. It has been developed for use with children who are 14 years and older (and whom have a reading age of at least 13). The SII was developed to assess patterns of interests for occupational themes, basic interests, and specific occupations. Children indicate interest to items by using one of three options: like, indifferent, and dislike. This is clearly a different method of measuring interest than has been used in the PVII2. Scores for each of the six interest factors from the computer generated SII professional report range from 30-70, with a mean

of approximately 50. Lower scores indicate less interest and higher scores indicate more interest.

Table 3.13 Correlations between PVII2 and SII (N = 77)

Interest Scale	**M (SD) PVII2**	**M (SD) SII**	***r***
Realistic	3.78 (.58)	47.26 (7.50)	.22
Investigative	3.49 (.85)	44.55 (7.25)	.21
Artistic	3.36 (.69)	46.44 (7.01)	.29*
Social	2.74 (.78)	47.35 (8.26)	.35*
Enterprising	3.96 (.65)	50.50 (9.28)	.03
Conventional	3.55 (.70)	49.83 (8.63)	.26*

* Significant at $p < .05$.

Table 3.13 shows the correlations between the six factors for the two interest measures. It is possible to see that there is some degree of relationship between the two factors, with three of the interest factors being significantly related at the .05 level; Artistic, Social and Conventional. However, these correlations are fairly weak, and suggest only a small relationship between the two measures. This may be due to the SII being developed for use with older individuals, and it is likely that a number of items in the SII were above the children's reading age and covered occupations and activities that they had little experience of. This would result in a high frequency of items being coded as indifferent, and would explain why the SII scale means are all in the range of 45-50 and would weaken the correlations with the PVII2. Another reason why the correlation coefficients were weaker may be because some of the six types of interest may not yet exist at this age. As indicated in chapter 1, the rationale for

generating a new appropriate measure of vocational interest was due to existing measures such as the SII being too long and not being suitable for children younger than 14. It would make also make sense to validate the PVII2 measure with an older group of children to see if the relationship with the six factors was strengthened due to their increased age. Therefore, the PVII2 was also validated with the PGI (which is a much quicker measure to complete and score). This is reported next.

3.5 Validation of the PVII2 with the PGI (year 10 children)

A subgroup of the Year 10 children participating in this project completed the PVII2 as well as the first 48 items from the PGI (Tracey, 2002b). The sample consisted of 148 Year 10 children in mainstream education who were aged between 14 – 15 at the time of testing.

The PGI evolved from exploratory work on the spherical structure of interests, and measures activity preferences, activity competence beliefs, and occupational preferences. It is possible to calculate RIASEC factor scores from the first 48 items on this measure. The first 48 items of the PGI were rated for interest only (i.e. not competence) using a five point scale. See Tracey, 2002b for the complete PGI scale. Table 3.14 shows the correlations between the six factors for the two interest measures.

Table 3.14 Scale correlations between the PVII2 and PGI and scale means (N = 148)

Scale	M (SD) PGI	M (SD) PVII2	*r*
Realistic	2.61 (.92)	12.76 (5.58)	.59**
Investigative	2.63 (.95)	13.65 (5.32)	.58**
Artistic	3.18 (1.10)	15.70 (5.74)	.48**
Social	2.86 (1.15)	16.40 (4.54)	.74**
Enterprising	2.04 (.62)	14.00 (4.06)	.50**
Conventional	1.70 (.60)	11.99 (4.36)	.30**

** Significant at $p < .01$

Table 3.14 shows that there is a strong relationship between the scores from the PVII2 and the PGI, for all of the six interest factors. All correlations were significant at the .01 level, indicating a highly significant relationship between all factors in the PVII with the corresponding scale in the PGI. It is also possible to see that for both measures, the Artistic and Social factors were rated the highest, and the Conventional scale was rated the lowest. It is acknowledged that these findings can still only suggest that the PVII2 may be suitable for use with children older than 15.

3.6 Correlations between factor scores

Table 3.15 shows the correlations between the six factors.

Table 3.15 Inter-factor correlations (model 6, all Year 7 dataset)

	R	**I**	**A**	**S**	**E**	**C**
Realistic	/					
Investigative	.35**	/				
Artistic	-.11*	.24**	/			
Social	-.28**	.15**	.51**	/		
Enterprising	.29**	.57**	.37**	.30**	/	
Conventional	.15**	.57**	.41**	.36**	.55**	/

* Significant at $p < .05$; ** significant at $p < .01$.

Table 3.15 displays the inter-factor correlations between each of the six factors, using the 19 item measure (PVII2). All correlations are at least significant at the .05 level. This pattern of correlations implies a negative relationship between the Realistic and Social factors, as would be predicted by Holland (1973), and a positive relationship between all other factors (aside from Realistic and Artistic). The correlations between factor scores are presented and analysed in detail in chapter 4 which focuses on the structure of interests of children at different ages.

3.7 Chapter summary

This chapter has reported on the development and refinement of the initial version of the PVII. The purpose of the set of analyses reported here was to generate reliable factor scores for each of the six Holland (1959) vocational interest factors. As described in the previous chapter, the broad analysis strategy was developed at the outset of this programme of work, as these decisions consequently impacted on the recruited sample size. As Holland's model of the six vocational personality types is grounded in theory, it was considered appropriate to specify the model in advance (as opposed to using an exploratory approach). Previous research has suggested a six factor vocational interest framework is an appropriate way to view vocational interests in children as young as 11 (e.g. Tracey & Ward, 1998). And indeed for the purposes of this project, vocational interests *must* be broadly categorised as Realistic, Investigative, Artistic, Social, Enterprising or Conventional to make the subsequent comparisons between the resulting dataset and published findings (particularly those regarding vocational interest structure).In other words, to evaluate the extent to which our dataset confirms to a hexagonal arrangement we first must measure vocational interests using a six factors approach.

A CFA approach was used (in an iterative fashion) to confirm the extent to which items in the PVII were each loading on each of the six RIASEC

factors. CFA makes it possible to test the hypothesis that a relationship exists between the observed variables (responses to each question on the PVII) and their underlying latent constructs (Holland's six interest factors). The results from the CFA analysis enabled decisions to be made with regards to which items adequately measured their intended interest factor and those that did not, resulting in factor scores which were calculated on a selected subset of questions from the original PVII measure. These resulting factor scores then formed the basis for all the subsequent analyses throughout this entire programme of research. As these scores were so vital to the remainder of the research project, cut off values for item factor loadings were stringent, and recommended overall model fit indices were very closely adhered to (e.g. CFI, RMSEA).

As already discussed in chapter 1, research has been unclear with regards to how vocational interest factors actually interrelate to one another in adolescence over time, which is a key research question in this current study. Each of the original PVII items was originally selected or designed with one of the Holland (1959) RIASEC scales in mind. This CFA analysis was a lengthy process, as many of the items loaded poorly on their intended factors, or cross-loaded on a number of factors. This resulted in a number of model iterations until a good model fit (as determined by inspecting a number of model fit indices) was achieved.

During each stage of the analysis process, interest items were retained that measured their intended vocational interest factor (and only their intended factor) really well. If an item loaded significantly on more than one factor, it was discarded from the analysis. It is acknowledged that this is perhaps different to the approach of some well known vocational interest inventories (e.g. the SII; Harmon *et al.*) which include some vocational interest items that do significantly load on more than one interest factor. However, although this may be appropriate for vocational guidance in practical terms (as individuals often have a wide range of interests), we were keen to have items that clearly measured each vocational interest factor in isolation to enable a more accurate examination of interest structure. Therefore, items that significantly loaded on two or more factors were dropped from the analysis.

This section has described in detail the analysis process that has allowed the selection of interest items from the PVII that best measured each of the six interest factors. This CFA analysis resulted in a 19 item six factor model that fitted the *whole* of Year 7 dataset well, with four out of the five indices of model fit used indicating very good model fit (RMSEA, RMSEA C.I., SRMR, C.F.I). It is acknowledged that a 19 item vocational interest measure is a brief measure, and quite possibly only measures elements of each of the six vocational interest factors. This therefore could suggest that the PVII in its current form may have limited application in a career's counselling

context, but rather should be considered an appropriate tool for measuring and exploring vocational interests in a research context.

The 19 item PVII2 measure was administered against two published, validated measures on two separate occasions, the SII (Harmon *et al.* and the PGI (Tracey, 200b) respectively. These analyses indicated a low-medium concordance (*r* range between .03 - .35) of the six interest factors with the SII (with Year 8 children) and a much higher concordance (*r* range .30 - .74) with the PGI (Year 10 children). The low relationships between the PVII2 and the SII are perhaps not surprising, as the SII is aimed at American language respondents who are aged 15 and above. Whereas, the Year 8 children who completed the PVII2 and SII measures were aged between 12 and 13 years old. Therefore, it is likely that a number of factors e.g. language and terminology used in the SII, the range of response formats used (i.e. some fixed choice questions rather than likert style), and the volume of questions (i.e. more than 300 items) had an impact on the how the Year 8 children's responses on the SII ultimately corresponded with the same children's responses on the PVII2.

What is more encouraging was the stronger relationships between interest factor scores on the PVII2 and factor scores on the PGI for the Year 10 children. These relationships were all highly significant (at least at the .01 level). Indeed, for all interest factors (apart from Conventional) the

correlation coefficient between the PVII2 and the SII were at least 0.48. This outcome from the validation analyses is perhaps due to the fact the PGI measure was appropriate for use children of a year 10 age, and also because the PGI measure is presented and scored in a similar way to the PVII (i.e. a likert format). Of course, it would have been more optimal to validate the Year 7 PVII2 scores against a published measure that is targeted at children of that age (i.e. aged 11 upwards. At the time this element of the research was conducted, a suitable measure was not available, but now Tracey's & Ward's (1998) ICA measure is beginning to receive more research attention (e.g. Rohlfing, Nota, Ferrari, Soresi, & Tracey, 2012) future research could potentially use that measure to further validate the utility of the PVII in a Year 7 sample.

When inspecting the interest factor scores, analysis revealed that the complete group of Year 7 children (N = 356) rated the Artistic scale significantly higher than all other factors. Furthermore, they also rated the Enterprising scale significantly lower than all of the other factors. Overall, school placement in Year 7 was not associated with systematic differences on this measure. The relationship between interest factor scores for the same group of children at this point and again two years later will be explored in chapter 5. Chapter 6 will explore the relationships between interest factor scores and measured Abilities. This final set of 19 items will be used to evaluate the structure of interests in chapter 4 by examining the patterns of

inter-factor correlations for Children in Year 7, 9, 10 and 12 using two distinct methods which are described in detail next.

Chapter 4 The structure of vocational interests in children aged 11-17

4.1 Introduction to the chapter

As discussed earlier, there is wide empirical support for the six factor RIASEC hexagonal model of interests in individuals aged 17 and older (e.g. Day & Rounds, 1997; Darcy & Tracey, 2007). However, it is still not clear at which point in time this hexagonal structure emerges and develops in childhood or adolescence as there are only a few papers published on this topic. Tracey and Ward (1998) found evidence to suggest (in their sample of children in the US) that interests more closely resembled the hexagonal arrangement as they got older. Furthermore, Tracey and Robbins (2005) found evidence to suggest that from approximately aged 14 onwards, the structure of interests did not change significantly. This therefore suggests that there may be structural changes that occur with regards to how vocational interests are inter-related as children develop. This chapter reports on the structure of interests of children of increasing age – from school years 7, 9, 10 and 12. It is the aim of this chapter to explore and document the inter-relationships between vocational interests in adolescence, and furthermore to examine the extent to which these inter-

relationships are consistent with the hexagonal structure initially proposed by Holland *et al.* (1969).

Firstly, this chapter will inspect and reporting on the inter-factor correlations and multi-dimensional scaling plots. Next, in order to examine the fit of the data against the hexagonal model, rank order correlations were calculated using both the procedure originally outlined and utilised by Myors, (1996) and the slightly more recent computerised form of the 'randomisation test of hypothesised order relations' (Tracey, 1997). The relative merits and disadvantages of each of these methods will be considered and discussed. It will then be possible to comment on the emergence of a structure of interests in the *same* group of children over a two year period when they are aged on average 11-12 (Year 7) and then 13-14 years old (Year 9). In addition, the development of interest structure will be explored in *different* groups of school children aged 11-17. This chapter also includes further discussion of how these techniques have been used in previous research to evaluate interest structure.

This unique dataset enables an exploration of interests are structured and how this structure may change over time. There are a number of ways to investigate this. The first way is simply to inspect the pattern of inter-factor correlations for each age group and note how the inter-factor correlations differ by age group. Vocational interest factor scores for all data sets have

been calculated using the 19 item PVII2 and have been presented in Tables 4.1 through 4.6. As discussed in section 1.3.4. It is considered that for the data to form a hexagonal structure there must be particular relationships between the factors. For ease, when discussing relationships between interest factors, the scale names will be abbreviated (e.g. Realistic – Investigative = RI).

It is considered by many vocational psychologists (e.g. Rounds & Tracey, 1993) that Holland *et al.*'s (1969, 1973) hexagonal model is structurally the same type of model as a *circumplex* (Guttman, 1954 - as briefly referred to in Chapter 1). Circumplex structures are not so concerned with the dimensions defining the factors, but rather the relative relationships between the factors. Indeed, 'the circumplex is the structure often most implied when Holland's hexagon is described' (Rounds & Tracey, 1993 p 876.).

The circumplex hypothesis states that the correlations between each of the adjacent factors will be equal, the correlations between each of the alternate factors will be equal, and the correlations between each of the opposite types will be equal. This is equivalent to the relations Holland *et al.* specified in their model of vocational interest by calling it a hexagonal model. So in Holland terms, the associations between RS, IE, AC should be relatively the lowest as they are the furthest apart on the hexagon (Opposite), and subsequently

associations between RI, IA, SA, ES, EC and RC should be the highest (Adjacent) with RA, IS, AE, SC, ER and IC in between (Alternate).

4.2 Inter-factor correlations

This section includes the inter-factor correlations for each of the main participant groups, and where possible split by gender. As it is difficult to interpret differences between correlation matrices visually, an additional type of analysis has been included (Box's M) which can evaluate the extent to which any two correlation matrices can be considered equal or significantly different. Box's M test is typically an additional analysis used when conducting multivariate or discriminant function analyses as it tests whether the covariance matrices of the different groups of data you are exploring are equivalent or not. In this case of this current dataset, any significant Box's M result would indicate that the two selected covariance matrices (and therefore the correlation matrices) are indeed significantly different. This additional analysis can allow further conclusions to be drawn with regards to how vocational interest structure may differ across ages or gender. Table 4.1 displays the inter-factor correlations for the Year 7 dataset, and Table 4.2 shows the inter-factor correlations for the Year 7 males and Year 7 females separately.

Table 4.1 Inter-factor correlations Year 7 dataset (N = 356)

Interest Scale	R	I	A	S	E	C
Realistic	1					
Investigative	.36**	1				
Artistic	-.11*	.24**	1			
Social	-.28**	.15**	.51**	1		
Enterprising	.29**	.57**	.37**	.30**	1	
Conventional	.15**	.57**	.41**	.36**	.55**	1

* Significant at $p < .05$; ** significant at $p < .01$.

Table 4.2 Inter-factor correlations Year 7 dataset (males n = 185, females n = 171)

Interest Scale	R	I	A	S	E	C
Realistic	1	.40**	-.03	-.04	.31**	.23**
Investigative	.31**	1	.21**	.22**	.53**	.52**
Artistic	-.02**	.30*	1	.51**	.28**	.36**
Social	-.14**	.22**	.47**	1	.33**	.39**
Enterprising	.27**	.59**	.49**	.42**	1	.56**
Conventional	.19*	.63**	.44**	.37**	.56**	1

* Significant at $p < .05$; ** significant at $p < .01$.

Note. Correlations based on the men (n = 185) are presented below the diagonal; correlations based on the women (n = 171) are presented above the diagonal.

Table 4.1 and

Table 4.2 show that the lowest observed association between interest factors was between RS for the Year 7 children, both males and females. However, a similar low association was not seen for IE and AC (which is what would be predicted if the data corresponded to a hexagonal structure). In addition,

the high association between IC is not consistent with a hexagonal arrangement.

Box's M test was conducted to compare the equality of the correlation matrices between Year 7 females and Year 7 males; this indicated that there was not a significant difference between correlation matrices at Year 7 for males and females (M = 27.10, F (21, 454953.18) = 1.27, p = .18). This finding would suggest that there was not a significant difference between the inter-factor relationships for males compared to female when aged 11-12.

Table 4.3 Inter-factor correlations Year 9 dataset (N = 300)

Interest Scale	R	I	A	S	E	C
Realistic	1					
Investigative	.28**	1				
Artistic	-.13*	.06	1			
Social	-.46**	-.14*	.40**	1		
Enterprising	.19**	.13*	.10	.04	1	
Conventional	.24**	.44**	.15**	.00	.27**	1

* Significant at $p < .05$; ** significant at $p < .01$.

Table 4.3 displays the inter-factor correlations for the Year 9 dataset, and show that again the lowest association was between RS for the Year 9 children, and this time lower associations were seen for IE and AC than observed in the same group children 2 years previously. Box's M test analysis indicated that there was a significant difference between the correlation matrix at Year 7 when compared to Year 9 (M = 143.84, F (21,

1481303.72) = 6.78, p = <.001). The result of the Box's M analysis show that there is a significant difference in interest structure between the two age groups. The analysis later in this chapter will explore how these changes in structure actually present visually and also the extent to which these changes in structure align to a hexagonal arrangement.

Table 4.4 shows the inter-factor correlations for the Year 9 males and Year 9 females separately.

Table 4.4 Inter-factor correlations Year 9 dataset (males n = 150, females n = 151)

Interest Scale	R	I	A	S	E	C
Realistic	1	.31**	-.06	-.25**	.10	.25**
Investigative	.13	1	.12	-.10	.16*	.39**
Artistic	.02	.11	1	.32**	.18*	.14
Social	-.31**	.05	.33**	1	.31**	.11
Enterprising	.19*	.08	.12	.02	1	.38**
Conventional	.18*	.47**	.24**	.06	.20*	1

* Significant at $p < .05$; ** significant at $p < .01$.

Note. Correlations based on the males (n = 185) are presented below the diagonal; correlations based on the females (n = 171) are presented above the diagonal.

On inspection of Table 4.4 there do appear to be some differences in inter-factor relationships for Year 9 males and females. Furthermore, Box's M test has indicated that there are significant difference between matrices at

Year 9 for males and females (M = 66.66, *F* (21, 326620.96) = 3.11, *p* = <.001). This suggests that the structure of the inter-factor relationships was changing over time.

Table 4.5 Inter-factor correlations Year 10 dataset (N = 296)

Interest Scale	R	I	A	S	E	C
Realistic	1					
Investigative	.34**	1				
Artistic	-.01	.28**	1			
Social	-.17**	.09	.34**	1		
Enterprising	.25**	.23**	.17**	.19**	1	
Conventional	.24**	.32**	.11	.20**	.43**	1

* Significant at *p* < .05; ** significant at *p* < .01.

Table 4.5 shows that the pattern of relationships between the factor scores is similar for the Year 10 children, but the magnitude of some of these relationships is different from the Year 9 dataset. In addition, the association between SE and SC is greater (previously no observed relationship), this suggests there are again developmental changes to the inter-factor relationships. Gender data was not collected for the Year 10 and 12 groups. In addition, Box's M test analysis has shown that there is a significant difference between the correlation coefficient matrix of inter-factor scores at Year 7 when compared to those scores Year 10 (M = 95.23, *F* (21, 1449324.97) = 4.49, *p* = <.001).

Table 4.6 Inter-factor correlations Year 12 dataset (N =71)

Interest Scale	R	I	A	S	E	C
Realistic	1					
Investigative	.46**	1				
Artistic	-.03	.06	1			
Social	-.01	.03	.42**	1		
Enterprising	.39**	.13	.16	.02	1	
Conventional	.44**	.35**	.00	-.05	.32**	1

* Significant at $p < .05$; ** significant at $p < .01$.

Table 4.6 shows that the pattern of relationships between the factor scores is again similar for the Year 12 children, but the magnitude of some of these relationships is different from the Year 10 dataset. In addition, the negative association between RS has almost vanished. This is interesting, whilst all other reported RIASEC matrices for older children and adults (e.g. Holland *et al.*, 1969) show a very low association between RS, this relationship has never been reported to be negative. This suggests there are again possible developmental changes to the inter-factor relationships. Box's M test has not been computed here due to the small sample size of the Year 12 dataset.

This correlational data suggests that perhaps the arrangement of interests firsts manifests as simply a preference for either Realistic or Social activities – resulting in the strong negative correlation between these two factors. It is possible that later in the child's development, when they experience more of the world and learn more about occupations available to them that the structure of interests forms more of a hexagonal arrangement – the next part of this chapter will explore this. The Box's M test analysis revealed that

there were significant structural differences between matrices at Year 7 and Year 9 or Year 10 and also differences between matrices at Year 9 for the males and females. The next three sections take a more detailed look at how children's are interests are structured, using the statistical procedures of multidimensional scaling (MDS), Spearman rank correlation coefficient and the randomized test of hypothesised order relations.

4.3 Multidimensional scaling (MDS)

The ALSCAL algorithm for MDS was used to evaluate the spatial relationships of the six interest factors. MDS output can provide a multidimensional spatial representation of the structure of a set of data and this technique has been commonly used in vocational psychology (Du Toit & De Bruin, 2002). The relationships between the data are expressed spatially, so that variables judged to be psychologically dissimilar are located graphically as distant points and psychologically similar data are represented as points closer in geometric space. As stated earlier, it is considered that for the data to form a hexagonal structure there must be particular relationships between the factors. In particular with regards to MDS plots, the distance between RS, IE, AC should be the greatest as they are the furthest apart on the hexagon, and subsequently the distance between RI, IA, SA, ES, EC and RC should be the smallest (with RA, IS, AE, SC, ER and IC in between). Furthermore as mentioned earlier, the distances for

each of the Opposite, Alternate and Adjacent pairs of factors are considered equal on a hexagonal framework.

The stress value (Kruskal's Stress Formula 1) indicates how well the obtained MDS configuration accounts for the proximity data. It should be noted that the stress value does not reflect the degree to which the data conforms to a hexagonal RIASEC order (Hansen, Scullard, & Haviland, 2000). Furthermore, only two dimensional solutions were considered, so the stress values show whether the correlations can be measured by a 2 Dimensional solution. Stress values range from 0 to 1, with 0 indicating a perfect fit between the obtained spatial configuration and the dataset. Kruskal and Wish (1978) suggested that stress values less than .10 indicate adequate model fit. Table 4.7 displays the Stress and corresponding R^2 values for each of the nine separate MDS analyses.

Table 4.7 Stress scores and R^2 values from MDS analyses

Dataset	**N**	**MDS Stress**	**R^2**
Year 7	356	.024	.997
Year 7 male	185	.050	.989
Year 7 female	171	.009	.999
Year 9	300	.007	.999
Year 9 male	150	.011	.999
Year 9 female	150	.006	.999
Year 10	296	.001	1.00
Year 10 PGI	148	.006	.999
Year 12	71	.018	.999

In Table 4.7 it is possible to see that all of the Stress values fall below the suggested cut off value of .10 indicating that for all nine analyses there was a very good fit between the obtained spatial configurations and the datasets.

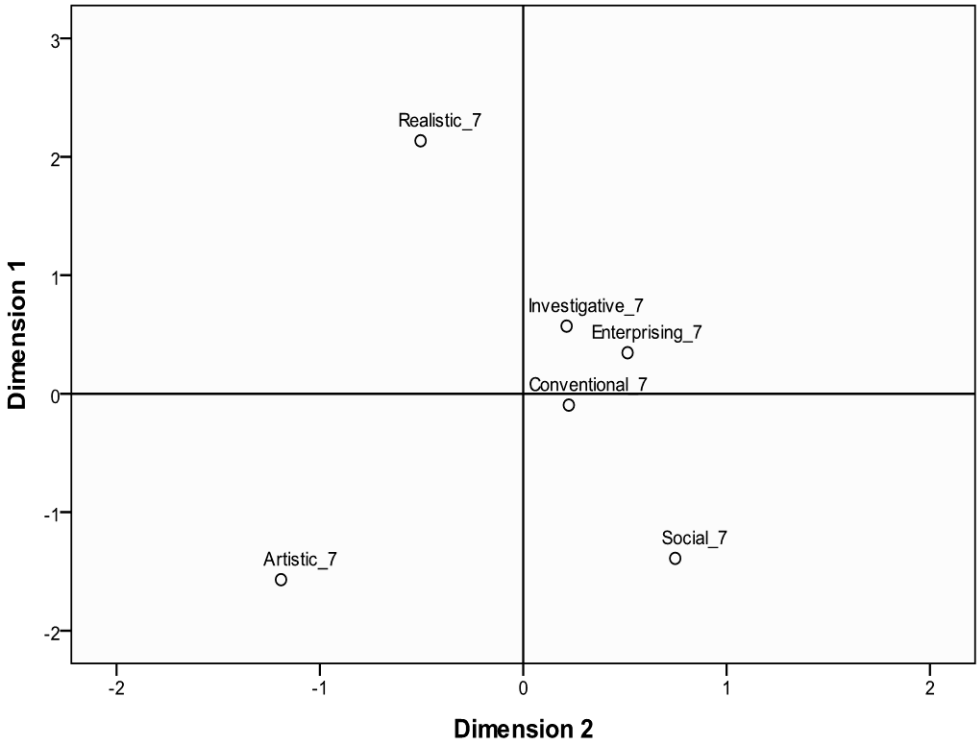


Figure 4.1 Multidimensional scaling plot Year 7

Figure 4.1 displays the relationships between Year 7 children's interest factor scores. This plot shows a clear disassociation between Realistic and Social factor scores and between the Conventional and Artistic factor scores

(which would be predicted by the Hexagon). However, Investigative and Enterprising factor scores are in a similar area on the plot, indicating that the relationship between these two factors and the remaining four factors is quite similar. The Artistic scale appears to not be strongly linked with the Investigative and Social factors – which is again different to that predicted by a hexagonal structure.

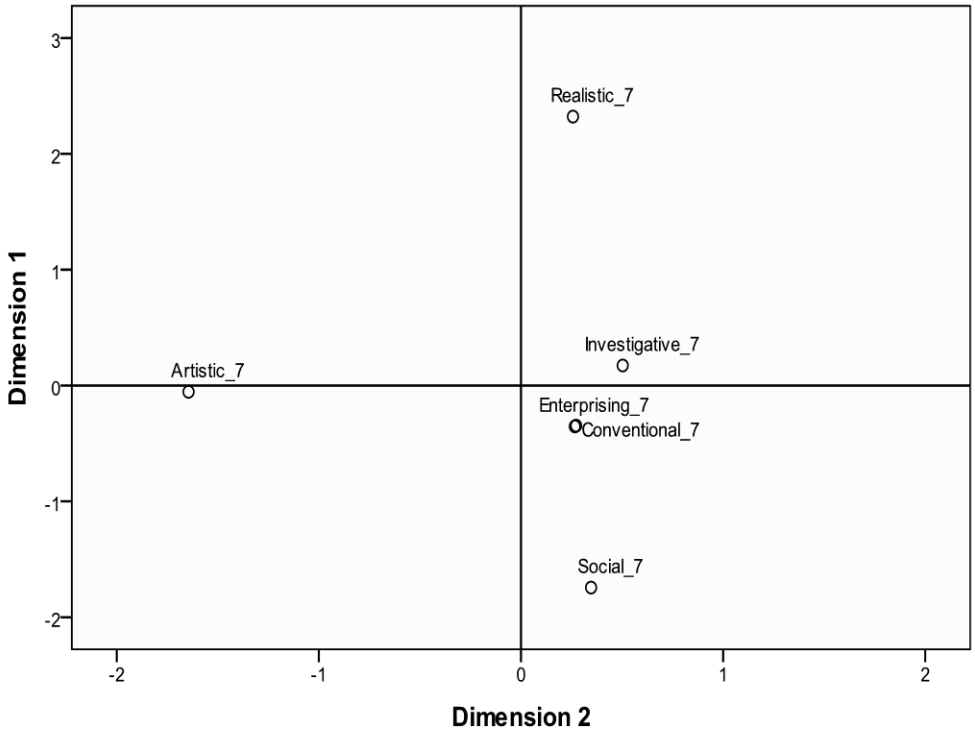


Figure 4.2 Multidimensional scaling plot Year 7 (male)

Figure 4.2 displays the relationships between Year 7 (male) children's interest factor scores. This plot again shows a clear disassociation between

Realistic and Social factor scores and between the Conventional and Artistic factor scores. Investigative and Enterprising factor scores are again in a similar area on the plot. In this plot the Artistic scale is even further away from the other 5 factors, suggesting that Artistic interests are perhaps developing differently in the male participants.

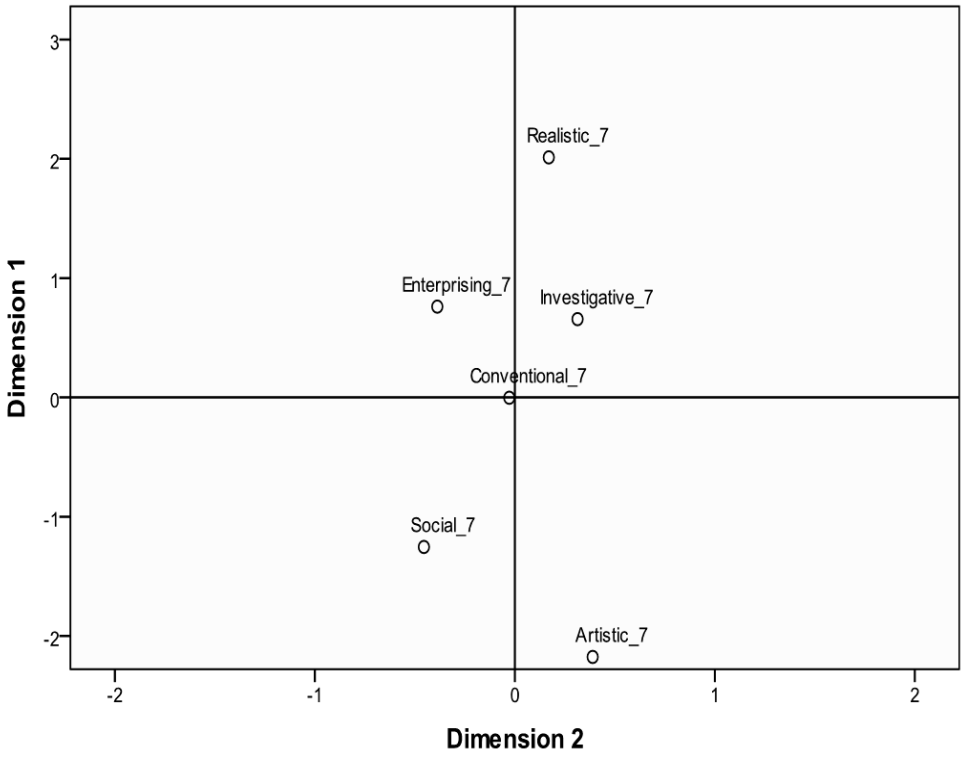


Figure 4.3 Multidimensional scaling plot Year 7 (female)

Figure 4.3 displays the relationships between Year 7 (Female) children's interest factor scores. On this plot it is possible to see that there are more

even spaces between the six factors. Figures 4.3 and 4.4 both show evidence of the emerging Realistic – Social dimension (i.e. ‘Things’/‘People).

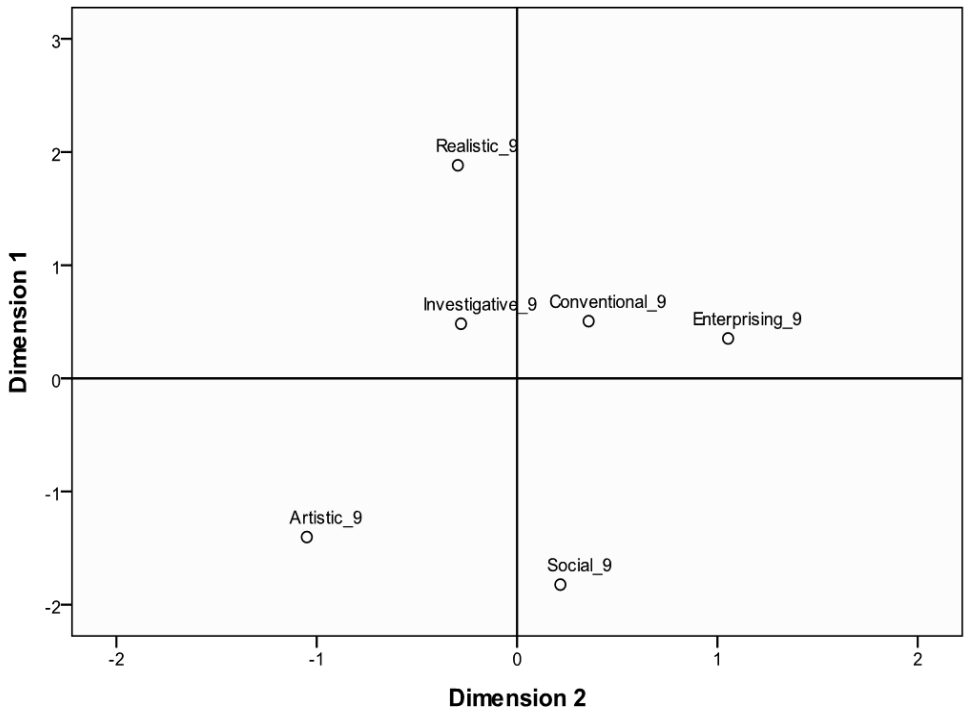


Figure 4.4 Multidimensional scaling plot Year 9

Figure 4.4 displays the relationships between Year 9 children’s interest factor scores. It is possible to see that the spaces between the interest factors are more even, with a closer association between the Artistic and Social scores.

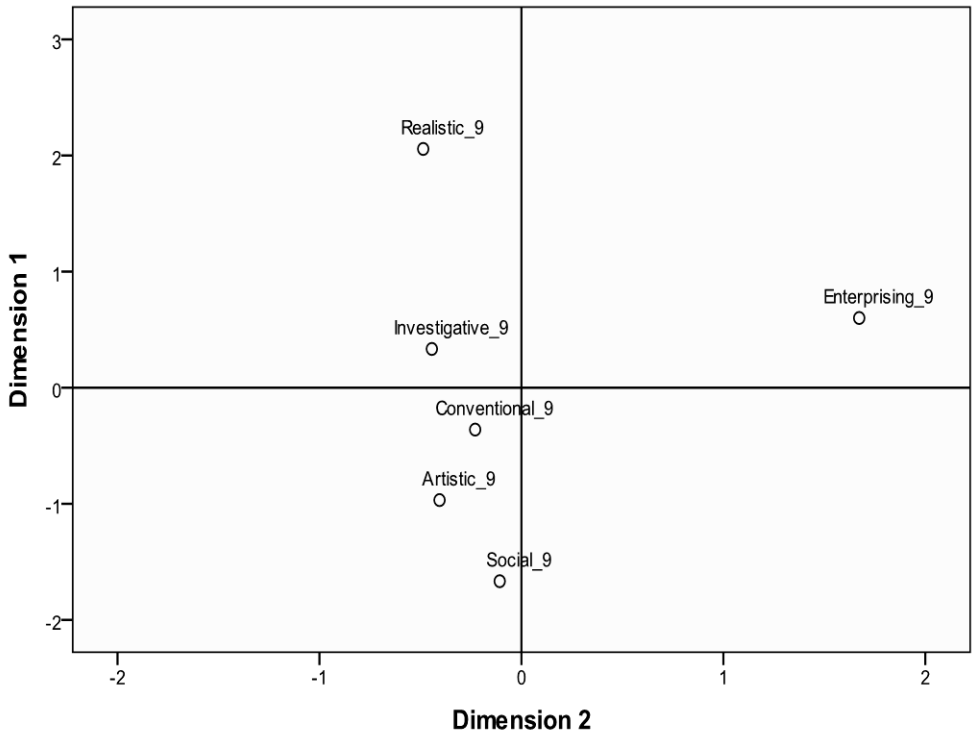


Figure 4.5 Multidimensional scaling plot Year 9 (male)

Figure 4.5 displays the relationships between the group of Year 9 children's interest factor scores. Unlike Figure 4.4, this plot does not show even spacing between factors, with the Enterprising scale appearing to be dissociated from the other five interest factors. This plot does provide evidence to suggest that the structure of interests is developing differently in the males than in the females.

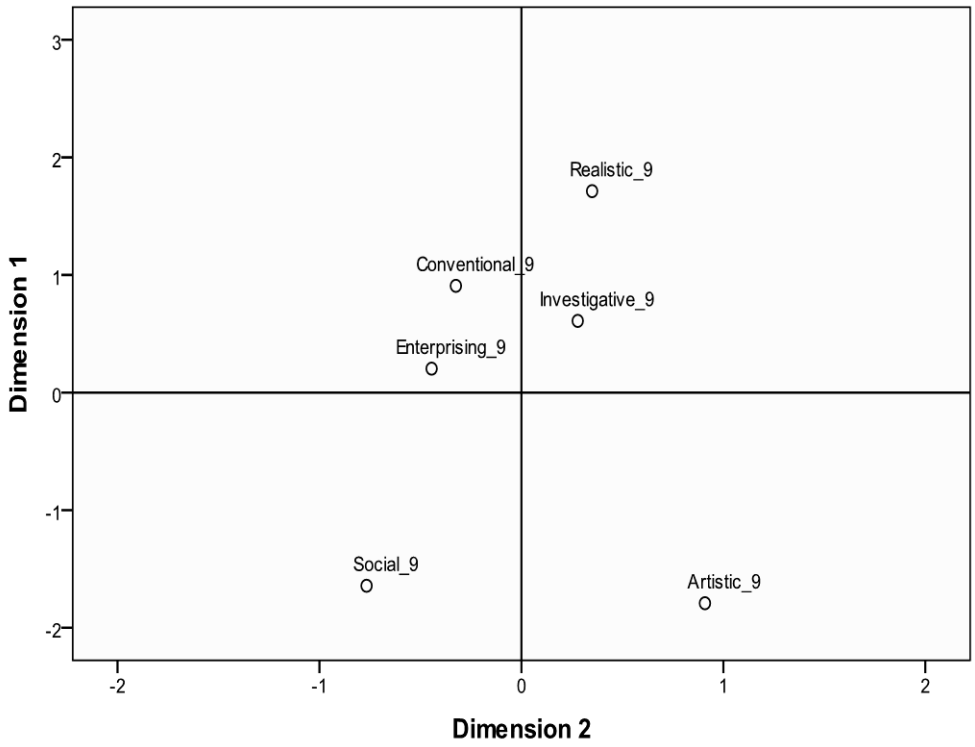


Figure 4.6 Multidimensional scaling plot Year 9 (female)

Figure 4.6 displays the relationships between the female Year 9 children's interest factor scores. It is possible to see that the spaces between the interest factors are more even than seen in the male sample, but the disassociation between the Artistic and Social scores is still quite great. From Figures 4.5 and 4.6 it is possible to see that the Enterprising scale is starting to emerge in the males and the Artistic scale is emerging in the females. As already seen in the Year 7 data, the 'Things'/'People distinction (as evidenced by the large space between Realistic and Social) is becoming stronger.

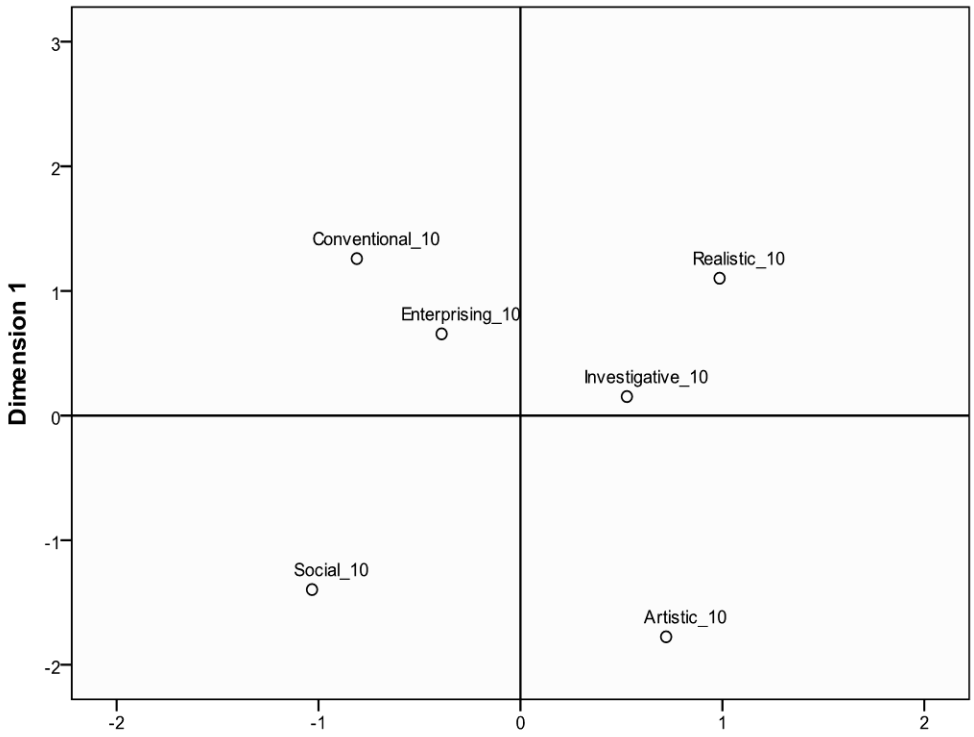


Figure 4.7 Multidimensional scaling plot Year 10

Figure 4.7 displays the relationships between Year 10 children's interest factor scores. It is possible to see that the spaces between the interest factors are more even than seen in the Year 9 samples, but the spacing between the Enterprising and the Investigative factors is less than the hexagonal model would predict.

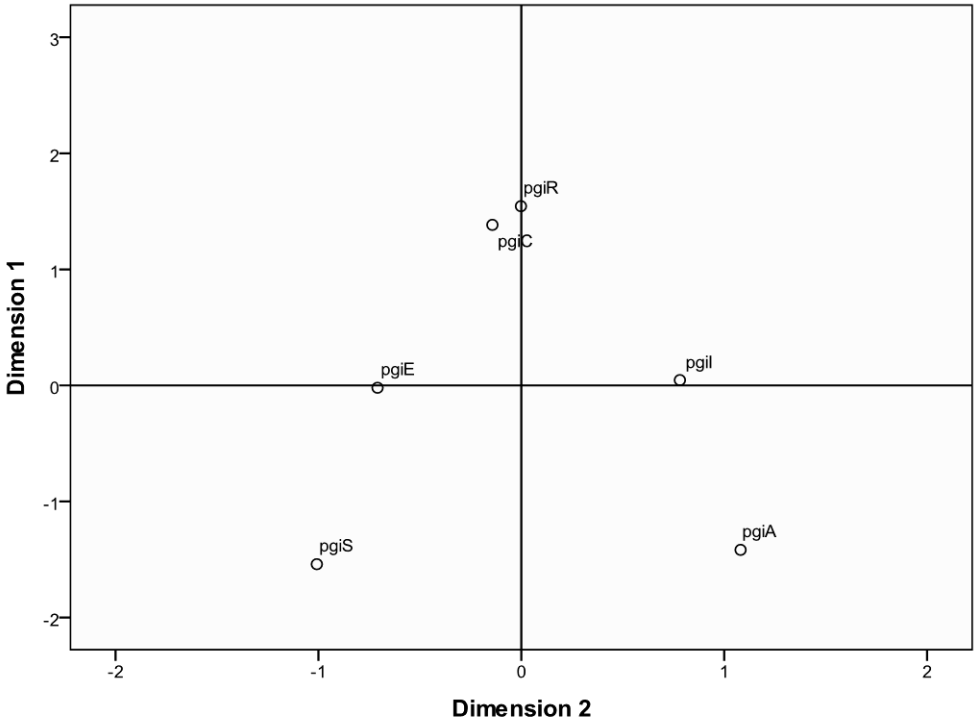


Figure 4.8 Multidimensional scaling plot Year 10 (PGI)

Figure 4.8 shows the relationships between Year 10 children's interest factor scores when using the PGI measure (Tracey, 2002b). It is possible to that the patterns of relationships are very similar to that seen in Figure 4.7 when the PVII2 was used. The key difference between Figures 4.7 and 4.8 is that the Conventional scale is more closely linked to the Realistic scale for the PGI data. This may suggest that the Conventional scale on the PGI is not adequately measuring vocational interests on this scale. Correlational data presented in chapter 3 (Table 3.14) showed when correlating factor scores between the PVII2 and the PGI, the lowest association was on the Conventional scale.

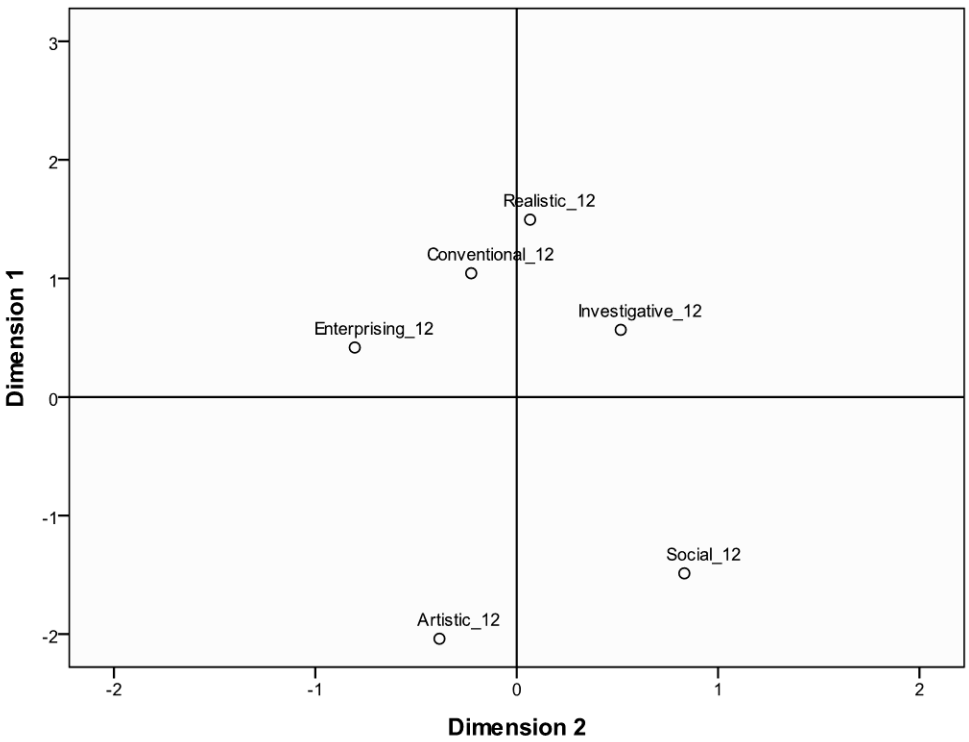


Figure 4.9 Multidimensional scaling plot Year 12

Figure 4.9 displays the relationships between Year 12 children's interest factor scores. This polygon is actually shaped quite similarly to a hexagon, but the Artistic and Social factors are not in the hypothesised RIASEC order. However, as mentioned earlier, the sample size for the Year 12 dataset is relatively small and resulting analysis should be treated with caution. It is suggested that further research should collect additional data from children of a Year 12 age to enable a more accurate and representative structural analysis of children in this age group.

4.4 Spearman rank order correlations

In addition to inspecting the correlation matrices and the MDS plots, it is also possible to apply more stringent statistical tests that measure the extent to which the data are arranged in a hexagonal structure. This section covers the Spearman rank correlation coefficient technique. In order to test patterns of inter-factor correlations against a hexagonal structure, expected rank calculations have been calculated using the method as presented by Myors (1996). Expected rank calculations compare the observed order of correlations and that predicted by the hexagonal model. Myors (1996) chose the Spearman rank order correlation coefficient as a technique because it is in keeping with Holland's (1959) preference for simple measures and techniques. Furthermore, the method is easy and quick to compute and apply.

Table 4.8 shows the hypothetical rankings among the 15 RIASEC correlations as implied by the hexagonal model (Myors, 1996). There are six pairs of variables with a hypothetical ranking of 12.5 (e.g. RI), six pairs of variables with a hypothetical ranking of 6 (e.g. RA) and three pairs of variables with a hypothetical ranking of 2.5 (e.g. RS).

Table 4.8 Hypothetical rankings among the 15 RIASEC correlations implied by the hexagonal model

Type	R	I	A	S	E	C
Realistic						
Investigative	12.5					
Artistic	6.5	12.5				
Social	2	6.5	12.5			
Enterprising	6.5	2	6.5	12.5		
Conventional	12.6	6.5	2	6.5	12.5	-

Note. Midranks are used for ties.

Tables 4.9 displays the correlations between all pairs of variables for each dataset, the expected and actual ranks, and the Spearman rank order correlation coefficient associated with each dataset. Scores reported are for the PVII2 in all cases apart from when the PGI is specified.

Table 4.10 displays the same information, but for the Year 7 and 9 males and females separately, as the MDS plot indicated that the interests of the males were perhaps developing differently to the interests of the females.

Table 4.9 Spearman rank order correlations Year 7, 9, 10, 12 using RIASEC factor scores from the PVII2 and the PGI

	Correlation coefficients					**Ranked coefficients**					
			Year					**Year**			
Pair	**7**	**9**	**10**	**10 PGI**	**12**	**7**	**9**	**10**	**10 PGI**	**12**	**expected ranks**
RI	.36	.28	.34	0.57	.46	8	12	13.5	10	15	**12.5**
IA	.24	.06	.28	0.69	.06	5	6	11	14	7	**12.5**
SA	.51	.40	.34	0.47	.42	12	13	13.5	7	13	**12.5**
ES	.30	.04	.19	0.61	.02	7	5	6	12	5	**12.5**
EC	.55	.27	.43	0.68	.32	13	11	15	13	10	**12.5**
RC	.15	.44	.24	0.77	.44	3.5	14.5	9	15	14	**12.5**
RA	-.11	-.13	-.00	0.33	-.03	2	3	2	5	3	**6.5**
IS	.15	-.14	.09	0.47	.03	3.5	2	3	8	6	**6.5**
AE	.38	.10	.17	0.46	.16	10	7	5	6	9	**6.5**
SC	.36	.00	.20	0.18	-.05	8	4	7	2	2	**6.5**
ER	.29	.19	.25	0.54	.39	6	10	10	9	12	**6.5**
IC	.57	.44	.32	0.30	.35	14.5	14.5	12	3	11	**6.5**
RS	-.28	-.46	-.17	0.17	-.10	1	1	1	1	1	**2**
IE	.57	.13	.23	0.58	.13	14.5	8	8	11	8	**2**
AC	.41	.15	.11	0.30	.00	11	9	4	4	4	**2**
	Spearman rank order correlation					**-.03**	**.41**	**.65****	**.67****	**.56***	

* Significant at $p < .05$; ** significant at $p < .01$.

Table 4.9 displays that there is a relative increase in Spearman rank order correlation coefficients with increased age. The Spearman rank scores for the Year 10 datasets are very similar when using the PGI or the PVII2. Fisher's r to z transformation indicates that the Spearman rank order correlation coefficients for both the Year 10 and Year 10 PGI were indeed significantly different from the Year 7 Spearman rank order correlation coefficients; z = 1.97; -2.06 respectively (p <.05, 2 tailed). The Spearman

rank order correlation coefficients between Year 10 and Year 9 were not significantly different (z = 0.83, *p* = .40, 2 tailed).

Table 4.10 Spearman rank order correlations Year 7, 9 using RIASEC factor scores from the PVII

	Correlation coefficients				**Ranked coefficients**				
	Year				**Year**				
Pair	**7 males**	**7 females**	**9 males**	**9 females**	**7 males**	**7 females**	**9 males**	**9 females**	**expected ranks**
RI	.31	.40	.13	.31	7	11	9	11.5	**12.5**
IA	.30	.21	.11	.12	6	3	7	6	**12.5**
SA	.47	.50	.33	.32	11	12	14	13	**12.5**
ES	.42	.32	.02	.31	9	8	2	11.5	**12.5**
EC	.56	.56	.20	.38	13	15	12	14	**12.5**
RC	.19	.23	.18	.39	3	5	10	15	**12.5**
RA	-.16	-.03	.02	-.06	1	2	2	3	**6.5**
IS	.22	.22	.05	-.10	4	4	4	2	**6.5**
AE	.49	.28	.12	.18	12	6	8	10	**6.5**
SC	.37	.39	.06	.11	8	10	5	5	**6.5**
ER	.27	.31	.19	.10	5	7	11	4	**6.5**
IC	.63	.52	.47	.14	15	13	15	7.5	**6.5**
RS	-.14	-.04	-.31	-25	2	1	1	1	**2**
IE	.59	.53	.08	.16	14	14	6	9	**2**
AC	.44	.36	.24	.14	10	9	13	7.5	**2**
Spearman rank order correlation					**-.01**	**.14**	**.21**	**.64****	

* Significant at *p* < .05; ** significant at *p* < .01.

Table 4.10 shows that the Spearman rank order correlation for the Year 9 females is only marginally smaller than that seen for the complete group of

Year 10 children. However, the correlation for Year 9 males is weak, and is not significant, implying a difference in the structural development of interests in males when compared to females. Using Fisher's r to z transformation, it has been possible to note that there were no significant differences between Spearman rank order correlation coefficients between females and males at either ages. However, the difference between Year 9 females and Year 7 males was marginally significantly ($z = -1.51$, $p = .06$, 2 tailed).

The higher the Spearman rank order correlation coefficient, the better the observed correlation matrix adheres to the theoretical hexagonal model. It has been suggested by Myors (1996) that a coefficient of at least .77 is necessary to conclude that the data conforms to a hexagonal structure. Therefore, the results of the Spearman rank order correlation analysis suggest that none of the interrelationships between interest factors confirm to a hexagonal structure. This could of course also suggest that the PVII2 is not measuring the factors satisfactorily. However, the analysis suggests that the structure of interests in the older children (Year 9 females, Year 10 and Year 12 children) is far more consistent with a hexagonal structure than any of the structures observed in the Year 7 overall group and Year 9 males data. Overall, this set of analyses provides evidence for the view that the structure of interests develops over time, becoming more closely aligned to the hexagonal model with increased age.

4.5 Randomisation test of hypothesised order relations

In addition to the Spearman's rank-order correlation co-efficient technique championed by Myors (1996), there is also another structural analysis technique that has been widely used in evaluating hexagonal structure in the vocational interest literature (e.g. in Hansen, Collins, Swanson & Fouad, 1993; Rounds & Tracey, 1993, 1996). This technique is called the Randomisation Test of Hypothesised Order Relations (Hubert & Arabie, 1987).

This method is a confirmatory examination of the fit of a hypothesised pattern of order relations to a correlational matrix of observed scores. With regards to interest data, there are 72 different predictions between interest types that should hold if the data adhere to a hexagonal structure. After this test has been conducted it reports a significance level of the number of predictions met by the data versus a set of predictions created by random relabeling, and more importantly a correspondence index (CI). The CI indicates the level to which the data fit a hexagonal structure (this is calculated by taking away the proportion of predictions violated from the proportion of predictions met). A significant CI value indicates that there are significantly more correct predictions than would be expected by chance. The correspondence index can take on values between –1 and 1, with 0 indicating chance agreement or disagreement and higher scores

indicating increased correspondence with a hexagonal structure In. a meta-analysis of RIASEC studies, Rounds and Tracey (1996) found a benchmark CI value of .70; with scores equal to or above this value indicating a good correspondence of the data to a hexagonal structure. This value was found by Rounds and Tracey (1996) across a wide range of participants and vocational interest measures.

This randomisation technique has been computerised by Tracey (1997) and the resulting programme (RANDALL) is available free of charge on request. Therefore, interest data collected in this study has also been analysed using this technique in order to further compare the findings with those of the Spearman rank-order coefficient analysis technique, and also to generate CI's for each dataset using a more statistically stringent analysis method. Both of these methods have been used and reported as they have been used in other published research studies and so this will also enable structural comparisons to be made between this data set and that from other research studies. For example, as reported in section 1.6.1, Tracey and Ward (1998) reported CI's for three groups of children aged 9-11, 11-14 and 18+; these were .33, .57 and .82 respectively. Tracey and Ward's findings indicate a developmental progression, with interests demonstrating increased hexagonal structure with increased age. The CI's calculated from the current datasets are presented in Table 4.11.

Table 4.11 CI and *p* values calculated for each set of interest data using the RANDALL programme (significant CI values in bold)

Dataset	**N**	CI	*p*	Predictions met/72
Year 7	356	-.01	.62	34
Year 7 males	185	.03	.40	37
Year 7 females	171	.14	.28	41
Year 9	300	.39	.08	50
Year 9 males	150	.21	.28	43
Year 9 females	**150**	**.53**	**.03**	**55**
Year 10	**296**	**.64**	**.02**	**59**
Year 10 (PGI)	**148**	**.67**	**.02**	**60**
Year 12	71	.50	.06	54

Table 4.11 shows that on the whole, CI increased with increased age, showing similar findings as to that of Tracey and Ward (1998). This is more clearly shown in Figure 4.10.

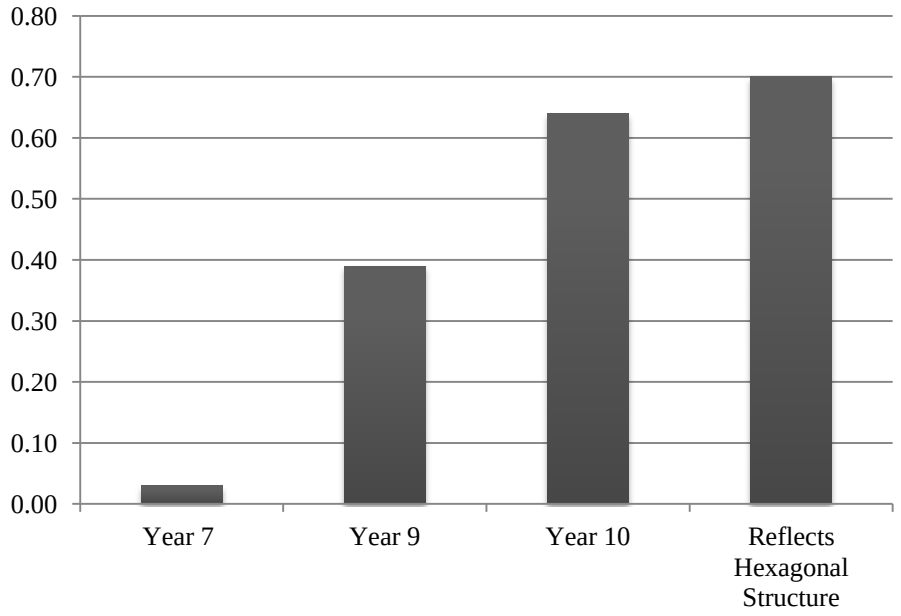


Figure 4.10 Correspondence index (C.I.) scores for the three main datasets

Significant CI scores were found for the Year 9 females, and for the Year 10 group. CI scores were higher for females than for males, which suggest again as in the last section, that the interests of females and males perhaps develop at different rates. CI scores for the Year 7 group were lower than that found in Tracey and Ward's (1998) sample of US school children aged 9-11, but the CI scores for the Year 9 and Year 10 group were in line with that found by Tracey and Ward in a group of US school children aged 11-14. The difference between CI's in the UK and US samples may either be a feature of the instrument used or be indicating some differences in structure as a function of cultural background. Du Toit and De Bruin (2002) found

low CI's for their South African adult samples (<.5), suggesting some cultural differences in structure.

'A pressing question today involves whether vocational interest measures and factors can be applied cross-culturally and multiculturally. If different groups consistently respond in different patterns to the same measures, one explanation is that the groups have differing mental representations of the world of work. This is a matter of structure: If it is not cross-cultural, scores on interest inventories cannot be interpreted the same way for all people. In other word [sic], the construct validity of the measures is in doubt.' (Rounds & Day, 1999, p.104).

In order to evaluate whether the interest measure used makes a difference to the CI score, CI's were calculated for both the Year 10 PVII dataset and for the Year 10 PGI dataset. CI's were almost identical, with .64 found for the PVII dataset and .66 (Spearman rank) or .67 (RANDALL) for the PGI dataset. CI scores as calculated using the more statistically stringent RANDALL programme were equivalent to scores calculated using the Spearman rank correlation coefficient technique suggested either method can be used to assess correspondence to a hexagonal structure.

4.6 Chapter summary

This chapter has taken a close look at how the structure of interests develops in children, and in particular the extent to which the observed structure in children adheres to the hexagonal structure of interests that research commonly finds in adults. This chapter has found strong evidence for the following findings; 1) the structure of vocational interests changes with age in children between the ages of 11 – 15; 2) the structure of vocational interests in children becomes more aligned to a hexagonal framework with increased age, and 3) interest structure develops differently in male and female children between the ages of 11 - 13. These findings regarding structure in adolescence are in line with the other published work in the area that suggests that interest structure changes over time in adolescence becoming more aligned to a hexagonal arrangement (e.g. Tracey & Ward, 1998). There is however, limited work which has explored gender and vocational interest structure in children aged younger than 13; e.g. Darcy & Tracey (2007) found that interest structure did not significantly change between males and females aged between 13- 18. Therefore, the finding that there are vocational interest structural differences due to gender in children younger than 13 could have important implications, both practically and theoretically.

The results as reported in this chapter found that the Year 7 children's interests were not inter-related in a way that would form a hexagonal structure. Furthermore, the observed structure did not significantly differ across the male and female participants. What was interesting however in the Year 7 data was the clear distinction between the Realistic and Social factors (i.e. a negative correlation). This shows that the Year 7 children did respond to those two scales at least in a systematic way – this is a phenomena also observed by Tracey and Ward (1998). In Tracey and Ward's work (1998) they theorised that whilst young children's interests (in their study aged 9-11) were not hexagonal in structure, children were responding to the Realistic and Social scales in a predictable manner – i.e. if a child scored very high on Realistic they would definitely score very low on the Social scale (and vice versa).

Tracey and Ward further considered that perhaps the structure of interests does develop simply as a preference for either Realistic or Social activities, and then as children learn more about world and the kinds of occupations and activities that are available to them then the other parts of the structure emerge. The data presented in this present study does appear to confirm this viewpoint, and further it is considered that as children get older they will also learn more about *themselves* through experience e.g. what they like doing and what they don't like doing and that knowledge then maps on to the kinds of occupations and activities that are available.

The Box's M analysis revealed there was a significant difference between the structure of interests for children in Year 7 when compared to the structure of children in Year 9 – suggesting some degree of change over the two years. The Year 9 children's interests again did not form a hexagonal structure, but when the female scores were inspected alone, there was a much clearer alignment to a hexagonal structure - with a Spearman Rank correlation coefficient of .14 (.14 CI) at Year 7 age, but .64 (.54 CI) at Year 9 age. This is a really key finding, which would suggest that it is really important to consider gender differences in vocational interest research and in careers counselling. The gender differences that have emerged would suggest that the males are perhaps still considering their interests on the Realistic-Social continuum ('Things' – 'People') – where as the females interest structure incorporate a wider range of interests. The interest structure for the Year 10 was closer to a hexagonal model, although Spearman rank coefficients were still under the suggested cut off value of .77 (or .70 CI). This suggests that further development is likely to occur between the ages of 15 – and 18.

In terms of the two different methods used to calculate adherence to the hexagonal model, there were a few small differences between the actual outputs of each method, and so in that respect essentially they complimented each other's findings. The Spearman rank method is easy to compute and apply, and is readily amenable to comparing the fit found in

several matrices and for use in meta-analysis. The randomisation test of hypothesised order relations (RANDALL) is however a more stringent test of structure as it tests 72 assumptions rather than the 15 in the Spearman rank method. Like the Spearman rank method it is also possible to feed in matrices from published vocational interest research into the program. In practical terms, the Spearman rank method is marginally quicker if you haven't used either before (mainly because the RANDALL program is not straight forward to set up), but as the RANDALL program is a far more stringent test of structure (and is very quick, once it is set up the first time), it is suggested that the randomisation test of hypothesised order relations is recommended for use in future research.

Both the Spearman rank analysis and the RANDALL program revealed findings that were very similar for both the PVII2 and the PGI for the Year 10 children, suggesting that the PVII was measuring interests well. However, it was noted, that the relationships between the Conventional scale and other factors were different when using the PVII than when using the PGI. The PVII2 Conventional scale also had the lowest association with the PGI measure (as reported in chapter 3). This suggests that at least one of the two factors may need some further development work, particularly focussed on the Conventional Scale.

The correlation matrices in section 4.2 show that at all time points there is a negative relationship between the Realistic and Social factors, suggesting clear evidence of the dimension called 'Things'/'People as discussed in section 1.2.5 (Prediger, 1982a, 1982b; Prediger & Vansickle, 1992). It is not possible to comment on the second dimension at this time 'Data'/'Ideas' as the two ends of this dimension do not directly link to specific RIASEC factor scores. This change in relationship between the Realistic and Social factors indicates that scores on this dimension do warrant further investigation, in particular how they change and develop over time. As noted in Tracey *et al.* (2005) and Hirschi (2010a) it is possible to calculate scores for the two dimensions called 1) 'Things'/'People' and 2) 'Data'/'Ideas' from RIASEC factor scores. These scores will be calculated and the stability of the scores on these two dimensions will be reported upon in chapter 5.

So to summarise, this type of analysis with the longitudinal and cross-sectional interest datasets does indicate a developmental process, with no observable hexagonal structure in children's interests when they are of Year 7 age, but a much closer alignment with a hexagonal structure for interests in the Year 10 and 12 children. The meta-analysis by Low *et al.* (2005) indicated that interests are remarkable stable once individuals reach the age of 18, and reach peak stability once they are aged 25-30. It is likely that the development of interest structure is strongly related to interest stability in

individuals, i.e. not until the structure of interests has fully developed will the interests of individuals become stable. With this in mind, it is predicted that the interests that have shown consistent structural placement across year groups– i.e. the Realistic and Social interests – will be the most stable over time. The stability of interests in children over a two year period from school Year 7 to school Year 9 will examined in detail next in chapter 5.

Chapter 5 Stability of interests in children

5.1 Introduction to the chapter

If it is known that all or some vocational interests are stable over time from a young age, then this would clearly have important practical implications for the careers guidance children receive. This could further mean that appropriate advice could be offered at an earlier age than it is currently (often children receive careers guidance after they have already made their G.C.S.E. choices). It is the key aim of this chapter to find out more about how vocational interest stability presents in the same group of secondary school children in Year 7 (aged 11-12) and then in Year 9 (aged 13-14). Furthermore, as there are appears to be gender differences emerging with regards to how vocational interests develop over time (chapter 4), this chapter has a sub-section that explores the interest stability within the context of gender. Low *et al.*'s (2005) meta-analysis of published research on interest stability revealed that interests are quite stable in adolescence, increase considerably in stability after age 18, and remain reasonably stable thereafter. Little is still known with regards to how vocational interests develop over time, and exactly at which point interests become stable. A

range of analysis methods have been selected for use in this chapter as there is limited published work available that informs us about interest stability in adolescence to this level of detail. These methods will also be evaluated for ease of use and relevance.

As mentioned, the stability of vocational interests in adolescence within the context of a six factor model has not been extensively researched. However, from the studies that have focussed on interest stability in children and adults, Realistic, Investigative, Artistic and Social interests appear to be consistently more stable over time when compared to the Enterprising or Conventional interest themes (e.g. Tracey & Ward, 1998, Hirschi, 2010b, Lubinski *et al.* (1995) and Mullis *et al.*, 1998). It should be noted however, that the children in these previous published studies were not as young as the children in the present study. This chapter explores in detail the stability of vocational interests in a group of Year 7 children over a two year period using a variety of statistical methods. Vocational interests were measured at two time points, two years apart to a group of children who were initially in Year 7. There were 228 children who fully completed the PVII measure at both time points, and are the group on which the analysis in this chapter is conducted.

In addition to simple correlations between factor scores at each time point, four further detailed measures of stability have been calculated and

presented. This has been done as stability with regards to vocational interests is not simple a test-retest correlation analysis – what is also key are the relationships between interest factors and whether these remain stable. Indeed, if we only look at interest factor stability, a lot of important information would be missed regarding vocational interests and how they inter-relate. Furthermore, it is argued that in order to conduct a rigorous examination of interest development, multiple methods that assess different aspects of interest stability must be conducted.

Profile stability (ranked factor scores) is of significant interest – whilst absolute scale score may change over time, vocational interest could stay broadly the same, so therefore analysis has been conducted looking at absolute factor scores and ranked factor scores and how they changed over the two year time period. Two other measures that have been explored in this chapter with regards to stability are level change and dimension stability. Level change is the sum of scores to the entire measure– it reflects interest in general, independent of interest factor. This statistic was considered important to calculate as it gives further information about what children's interests are like in general, and also whether they become more interested in a range of activities as they get older, or whether their interests become lower, perhaps focussing a selected number of activities. Dimension stability is a statistic that is calculated from many the interest factor scores, and gives individuals scores that relate to each of Prediger's (1982) interest

dimensions – ‘Things’-‘People’ and ‘Data-Ideas’. Dimension scores are considered to have added value as they incorporate many of the interest factor scores rather than just looking at individual interests on their own. As there were clear differences in male and female correlation matrices of interests (reported in chapter 4), it was considered important for Dimension scores to be calculated and examined.

So to summarise, the main stability measures are: 1) Scale score stability, 2) Profile stability (Tracey *et al.*, 2005), 3) Level Change (Low & Rounds, 2007), and 4) Dimension change (Tracey *et al.* 2005). These methods have been documented and used recently by Hirschi (2010a, 2010b) who measured interest stability in a group of Swiss adolescents (age M = 14.09. SD 0.71) over a one year period. Therefore it will be possible to compare many of Hirschi’s findings directly with our sample. These additional measures allow for a more detailed look at vocational interests in adolescence and a further exploration of the extent to which interests remain stable over time. Furthermore, it was considered important to conduct a range of analyses to be able to report on how vocational interest stability presents in adolescence (as there is limited data published in this area).

This chapter also investigates Holland’s (1973) concepts of ‘consistency’ and ‘differentiation’ within the current data set and explores how these concepts present in secondary school aged-children. According to Holland’s

(1997) theory, these constructs of interest differentiation and consistency, are related to more stable career development.

Finally, as explored in the previous chapter, the influence of gender on stability, consistency and differentiation estimates will be explored and discussed further. Based on previous research findings (e.g. Tracey & Ward, 1998, Hirschi, 2010b, Lubinski *et al.* (1995) and Mullis *et al.*, 1998, it is predicted that overall, Realistic, Investigative, Artistic and Social interests (absolute and ranked) will be more stable over the two year period than interest in Enterprising or Conventional activities. As the data in chapter 4 was suggestive of a differing structure of interests for males and females, it is considered that there may be differences in interest stability for males and females. Due to the lack of previous research into interest stability and gender however, it is not possible to anticipate the direction of any potential differences. Similarly, as there is limited work that has looked at the more detailed measures of stability, consistency and differentiation with children as young as 11, it is not possible to formulate any predictions about the data analysis in these sections. Analysis will be presented for the entire group of children initially who fully completed the measure at both timepoints (N = 228), and then the analysis will explore stability, consistency and differentiation as a function of gender.

5.2 Scale score stability

Scale score stability refers to the change in mean interest factor scores across two points. In this section, both correlations and repeated measures t-tests between the mean scores for each scale are presented. The correlational analyses has been conducted to examine how predictable the interest factors scores are over time, and the t-tests have been completed to see if the degree of interest in a particular interest factor increases or decreases with time. In addition, the associated profile difference scores have been calculated (Cronbach & Gleser, 1953 as cited in Tracey *et al.* 2005). Profile difference scores take account of the level, pattern, and dispersion across all six factor scores over time. Tracey *et al.* (2005) argue that profile difference scores can be a preferable and more informative method when looking at changes over time in interest data, and therefore these scores have also been calculated in this section.

5.2.1 Factor score correlations

Mean scores for each interest factor, and factor score correlations across each of the two time points are provided in Table 5.1.

Table 5.1 Mean factor scores and correlations for the same group of children at Year 7 and Year 9

	Year 7 M (SD)	Year 9 M (SD)	***r***	N
Realistic	2.83 (1.23)	2.87 (1.22)	.53**	228
Investigative	2.76 (1.02)	2.86 (.86)	.29**	228
Artistic	3.65 (1.00)	3.10 (1.24)	.35**	228
Social	2.92 (1.06)	2.93 (1.07)	.56**	228
Enterprising	2.59 (.92)	2.74 (.82)	.20**	227
Conventional	2.87 (.92)	2.44 (.97)	.19**	228

** Significant at $p < .01$.

The data in Table 5.1 indicates that across the entire dataset **Social, Realistic**, **Artistic** and **Investigative** factor scores were the most highly correlated, and therefore stable, over time. This finding is consistent with the previous research referred to at the start of this chapter (e.g. Mullis *et al.*., 1998), which has also found these four interests factors to be the most stable in adolescence. In particular, the **Social** and **Realistic** scores were significantly more stable than the four other factors (using Fisher's r to z transformation; all *p's* <.001). Table 5.1 further shows that all of the factor scores correlation coefficients are highly significant, indicating a broad level of stability of responses to the PVII across the two-year period. This finding

alone provides some support for the measure being a potentially useful measure of interests in children of this age. In addition, it gives weight to the view that measuring occupational interests when children are aged 11 may be useful within the appropriate career counselling context, as some aspects of children's interests appear to remain stable over a period of time.

5.2.2 Repeated measures t-tests (factor scores).

A series of repeated measure t-tests were calculated to evaluate the difference between factor scores over time. The results of this analysis can show whether relative interests for a particular scale are becoming stronger or weaker over time. The repeated measures t-test analysis revealed that interest in the Realistic, Investigative and Social factors did not significantly change over time (all p's > .05). However, group interest in the Artistic scale significantly decreased, t (227) = 6.40, p <.01, d .49; interest in Enterprising significantly increased, t (226) = -1.98, p = .05, d .17, and interest in Conventional significantly decreased over the two year period t (227), 5.39, p <.01, d .45. The largest change over the two year period was the decrease in scores on the Artistic scale, as reflected by the large effect size statistic. These scores may in part be a reflection of the school curriculum whilst the children in Year 7, and also the fact that the Artistic scale items may be more familiar to children than items on the other factors.

5.2.3 Profile difference scores

Profile difference scores can be considered an attempt to measure change in the overall pattern of interests for individuals. Profile difference scores were calculated for all participants over the two year time period using formulae provided by Cronbach & Gleser, 1953 (cited by Tracey *et al.*, 2005). Larger scores indicate large profile difference over the two year time period, with a profile difference score of zero indicating an identical profile at each measured time point. Profile difference scores are calculated by squaring any differences between mean factor scores, summing these squared differences and then taking the square root of the sum **(√ ((R1-R2)^2 + (I1-I2) ^{2} + (A1-A2) ^{2} +(S1-S2)2 + (E1-E2) ^{2} +(C1-C2) ^{2}).**

Profile difference scores for the complete sample with valid data at both time points (N = 227) ranged from 0.79 to 5.99 (M 2.75, SD .98). These scores indicate that there were some small differences in profiles over time, and that no participants had an identical profile at both time points. It is not possible to compare these scores with that reported in previous research, as the PVII is a new measure, but it is possible to compare rank profile difference scores in Section 5.3. with that of Hirschi (2010b). The influence of gender on profile difference scores will be investigated further in Section 5.8.

5.3 Profile stability

In this section the analysis has been completed on the ranked factor scores. Conducting the same analysis as in Section 5.1 on the ranked factor scores is of additional benefit as it clearly places participant's interests in order of preferred interest, and therefore allows interest profiles to be more directly compared. Furthermore by ranking, any change in the general level of responses is discounted and this won't appear as profile instability. For both the Year 7 and Year 9 datasets, a rank score from one (lowest scale score) to six (highest scale score) was assigned to each RIASEC type according to the responses given on the PVII. If two or more types received the same score in the inventory they shared their rank

Mean ranked scores for each factor, along with ranked factor score correlations for each of the two time points are provided in Table 5.2.

Table 5.2 Mean ranked factor scores and correlations for the same group of children at Year 7 and Year 9

	Year 7 M (SD)	Year 9 M (SD)	***r***	N
Realistic	2.98 (1.98)	3.31 (1.98)	.54**	227
Investigative	2.89 (1.53)	3.34 (1.53)	.24**	227
Artistic	4.60 (1.48)	3.69 (1.93)	.33**	227
Social	3.42 (1.90)	3.56 (1.86)	.58**	227
Enterprising	2.52 (1.30)	3.15 (1.39)	.14*	227
Conventional	3.17 (1.43)	2.56 (1.43)	.06	227

* Significant at $p < .05$; ** significant at $p < .01$.

The data presented in Table 5.2 shows that (as also seen in Section 5.2), the two most highly correlated factors were Realistic and Social, and the least related were the Enterprising and Conventional factors. In Year 7 and 9, the Artistic factor is most likely to be rated highly, whereas the Enterprising activities were the least popular in Year 7 and the Conventional activities were the least popular in Year 9. As in 5.2.2, the largest change in ranked scores is for the Artistic factor, where the mean assigned rank to that factor dropped from 4.60 to 3.69 which is more in line with the mean assigned ranks for the other five interest factors.

A series of repeated measures t-tests were conducted to evaluate the differences in ranked factor scores over time. The ranked factor scores for the group were all significantly different apart from the Social factor, suggesting that for the group, scores on the Social factor were particularly consistent and stable over time. Rank interest in Realistic activities significantly increased, t (226) = -2.59, p <.01, d .17; rank interest in Investigative activities significantly increased, t (226) = -3.63, p <.01, d .29; rank interest in Artistic activities significantly decreased, t (226) = 6.83, p <.01, d .53; rank interest in Enterprising activities significantly increased, t (226) = -5.42, p <.01, d .47 and rank interest in Conventional activities significantly decreased, t (226) = 4.74, p <.01, d .43 , over the two-year period.

As before, profile difference scores were calculated for all participants over the two-year time period using the ranked factor scores (see section 5.2.3 for formula). Profile difference scores for the complete sample with valid data at both time points (N=227) ranged from 1.00 to 8.83 (M = 4.50, SD = 1.63). These profile difference scores are similar, but slightly larger to that seen in Hirschi, 2010b (range 0.00 - 8.00, M = 3.00, SD = 1.70). This would suggest that interest profiles were more variable in this current sample, when compared to Hirschi's older sample. These scores again are indicative of profile differences over time, and that none of the participating children had an identical profile at both time points.

5.4 Level stability

Level scores (Low & Rounds, 2007) refers to overall interest profile level, whether the sum of all factor scores are broadly high or low (e.g. interested in most things/not interested in anything), and how this changes over time. The total possible score at each time point was 30 (6*5) and the lowest possible score was 6 (6*1). Table 5.3 shows the level change descriptive values for all participants in Year 7 and then in Year 9.

Table 5.3 Sum of RIASEC scores and related descriptive data for participants in Year 7 and 9

	N	Min	Max	M	SD
Year 7	227	7.83	27.84	17.61	3.87
Year 9	227	7.92	27.75	16.91	3.13

Table 5.3 shows that the lowest minimum score was higher than six at both time points demonstrating that none of the participants had an average score of one for any of the six factors; likewise none of the participants gave scores of six for every item. At both time points the average score was between 17 and 18, with a standard deviation of between three and four. Level stability can be calculated at a basic level by correlating the total score of all six interest factors at Year 7 and Year 9. In essence, level

stability is whether the generally interested students in Year 7 are still the more generally interested students in Year 9.

The sum of factor scores at Year 7 and Year 9 was significantly related, r = .24, (225) p <. 01. This is lower than that reported by Hirschi (2010b) (r = .55), but it is worth noting that his participants had a mean age of 14.1 (SD .07) at the start of his one year evaluation study. This is approximately three year older than the participants in this current study, and therefore may explain why the stability coefficients are somewhat higher in his study. Furthermore, as Hirschi's interval was half that in the current study (i.e. 1 year vs. 2 years) this may additionally explain why level stability was lower.

Low and Rounds (2007) have suggested that level change can be further calculated by squaring the difference between the sum of all RIASEC scores at T1 and the sum of all RIASEC scores at T2 and then taking the square root of the sum. This is a good method for looking at level change overall, but it doesn't provide information about the *direction* of the level change. The following change is suggested and will be used in this chapter: **($\sum$(RIASEC scores)$_{T1}$-$\sum$(RIASEC scores)$_{T2}$).** This amended calculation will then give both positive and negative scores, and therefore will show whether interest profile levels overall were increasing or decreasing over time. Level change scores for the complete sample with valid data at both time points (N = 227) ranged from -10.58 to 13.50 (M .69, S.D. 4.37). These

scores show (as does Table 5.3) that on average, total scores on the measure decrease slightly, but there was variation across participants. Section 5.8.3 further looks at gender and level change.

5.5 Dimension stability

Scale scores for each of the six factors can be converted to dimension scores (as reported in Tracey *et al.*, 2005). Hirschi (2010a) argues that this approach has an additional advantage when compared to looking at the factor scores alone as it converts the ordinal data into two continuous factors, which then takes into account the relationships between the factors. Furthermore, this approach enables a closer inspection of the interest factor scores in relation to the two dimensions widely discussed in the vocational psychology literature. This is even more relevant when considering the changing inverse relationship between the Realistic and Social scores (‘Things’/‘People dimension) as noted in chapter 4.

Abbreviated definitions of the four categories and illustrative occupations (Prediger, 1981, as cited in Prediger, 1982b) are shown next:

Things	Nonpersonal tasks involving machines, materials, tools, biological mechanism e.g. bricklayers and laboratory technicians.
People	Interpersonal tasks such as caring for, persuading, entertaining, or directing others. E.g. school teachers, and social workers.
Data	Impersonal tasks involving factors, records, files, numbers, and systematic procedures for assisting goods/services consumption by people e.g. bookkeepers, air traffic controllers.
Ideas	Intrapersonal tasks involving abstractions, theories, knowledge, insights, and new ways of expressing something (for example with words, equations, or music. e.g. scientists and composers.

Scores for the two Dimensions: 'Things'/'People' and 'Data'/'Ideas' can be calculated relatively easily using the following formula (Prediger, 1982b):

'Things'/'People' = (2R + I + C – 2S – E – A).

'Data'/'Ideas' = (1.73 E + 1.73 C – 1.73I – 1.73A).

It is worth noting that a positive 'Things'/'People' dimension score indicates the score is within the 'Things' range area of the dimension and a

negative score indicates the score is within the ‘People’ range. Similarly, a positive ‘Data’/’Ideas’ score indicates the score is within the ‘Data’ range and a negative score indicates ‘Ideas’.

Table 5.4 Mean dimension scores for the same group of children over a two year period (N = 227) and their respective correlation coefficients

	Year 7 M (SD)	Year 9 M (SD)	*r*
‘Things’/‘People’	-0.81 (4.27)	-0.76 (4.93)	.62**
‘Data’/’Ideas’	-1.64 (2.34)	-1.26 (3.26)	.37**

** Significant at $p < .01$.

Using Fisher’s r to z transformation, it is possible to see that the difference between these two correlation coefficients is highly significant ($z = 3.56$, $p < .001$, 2 tailed). This finding confirms that the ‘Things’/’People’ dimension scores were significantly more consistent over time than scores on the ‘Data’/’Ideas dimension.

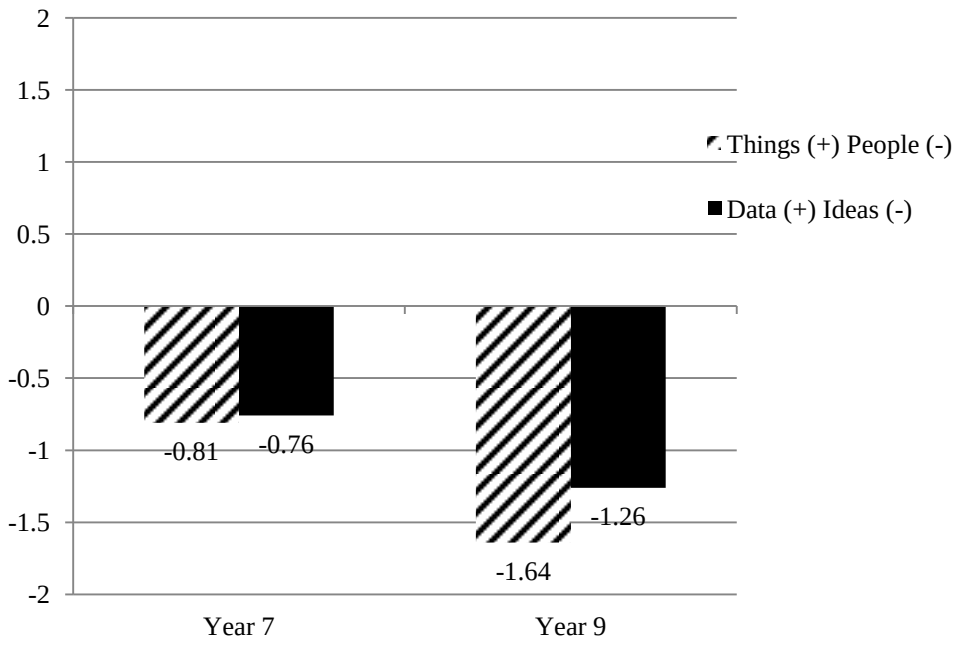


Figure 5.1 Mean dimension scores for the same group of children over a two year period (N = 227)

Table 5.4 shows that the dimension scores were stable over time with 'Things'/'People' dimension scores being significantly more stable over time than 'Data'/'Ideas' dimension scores. What is further noted is that the stability scores for the 'Things'/'People' dimension are higher than for any of the individual orientation factor scores. Hirschi (2010a) also found a similar finding with his older group of Swiss adolescents (N = 292) over a one year period. He found that participant scores on 'Things'/'People' were more stable (r = .83) than 'Data'/'Ideas' (r = .69). This again provides support for the view that the 'Things'/'People' dimension develops earlier,

and leads to increased stability with age. Dimension stability has been calculated for male and females separately in Section 5.8.4.

5.6 Consistency

The next aspect of vocational interest measurement - Consistency - has been calculated as it specifically relates to the ordering of the interest factors in relation to a hexagonal framework. In particular, it is the aim of this section to demonstrate the extent to which children's vocational interests are both consistent over time as this has implications for careers counselling (i.e. how useful is the hexagonal framework when giving advice to children of this age).

Consistency assesses the similarity of the two top scoring factors for each individual in terms of Holland's hexagonal model of vocational interests. The two top scoring factors result in a two letter RIASEC code for each participant, for example if that individual's highest score was given to Realistic, and then Investigative, that person's code would be RI (and it would be IR if the highest score was given to Investigative and then Realistic). In Hirschi (2010b) a value between three and one was assigned to each individual, where higher consistency scores meant the two factors were closer on the hexagon and lower scores meant that the two factors

were further away. In this present study, the values of one, two, or three have been used in the same way.

Table 5.5 Mean and frequency (%) of consistency scores for children whilst in Year 7 (N = 356) and Year 9 (N = 301)

		Year 7	Year 9
		M (SD)	M (SD)
		2.44 (.69)	2.44 (.72)
Consistency score	Definition	% of sample	% of sample
3	Two top factors are adjacent (e.g. RA)	55.30	56.80
2	Two top factors are alternate (e.g. RI)	33.40	29.90
1	Two top factors are opposite (e.g. RS).	11.20	13.30

Table 5.5 shows that there was a range of consistency scores allocated to each individual, but the most dominant score assigned was three (> 55% of children), and a smaller proportion of children were assigned a score of one (< 15% of children). The data in Table 5.5 show that over half of the children in the sample had very consistent profiles at each time point, i.e. that the two factors they gave the highest scores to were very similar, i.e. the factors sit next to each other on Holland's Hexagon e.g. RI or AS. Table 5.5 further shows that the proportion of children with scores of one, two or three remained very similar over the two year period.

In addition to looking at consistency scores, the two letter RIASEC codes given to each individual will be explored next, to identify the most and least common interests in this group of children.

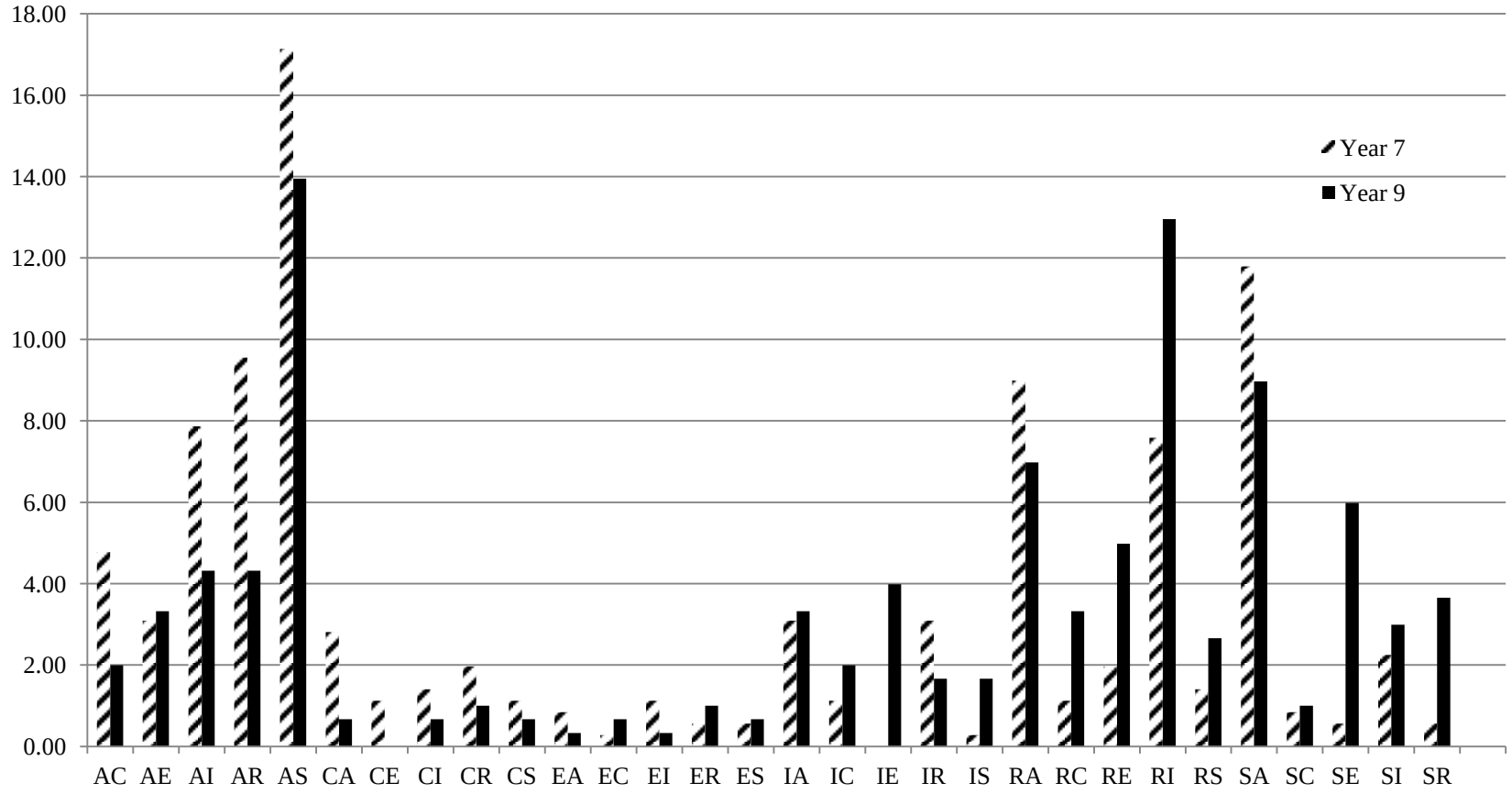


Figure 5.2 RIASEC codes (%) assigned to participants whilst in Year 7 (N = 356), and Year 9 (N = 301).

Figure 5.2 displays the frequency of 2 letter RIASEC codes assigned to each of the children when they were in Year 7 and then in Year 9. There is a clear preference for AS or SA (28% of the group in Year 7 and 23% of the group in Year 9). The next most frequently assigned code was RI, which is the Realistic-Investigative interest orientation (13%). Apart from RA, the top six codes applied either indicated the children most commonly indicated a clear preference for two factors which were adjacent on the hexagon. Figure 5.2 clearly shows that two letter RIASEC codes containing either the Realistic, Social and Artistic factors were more frequently rated highly where as two letter codes containing either Conventional or Enterprising were far less frequently rated highly.

Consistency scores and the frequency of the allocation of the RIASEC codes will also be looked at in males and females separately in Section 5.8. These two letter codes will also be further used in chapter 6 when identifying relationships between interests and ability.

5.7 Differentiation

Interest differentiation is another construct that should be considered in relation to interest profiles, and how they change over time. Differentiation is the extent to which an individual's interest profile is clearly defined – i.e. that a person's interests loosely resemble one or two single types rather than

having similar scores for all types (which would be called an undifferentiated or poorly defined profile). Osipow (1999) considers that an undifferentiated profile makes it difficult to determine the best possible match to the client's interests, leading to a source of difficulty in career decision making. As with the consistency scores, differentiation scores have practical relevance to career's counselling, suggesting that those individuals who have more undifferentiated profiles may need additional support when making decisions that impact on their future career.

Differentiation can be simply calculated as the standard deviation of all six factor scores (Hirschi, 2010b). A high score reflects a clear preference (as indicated in the allocation of high or low) for particular items, and a low score reflects little or no variation in the responses of individuals to each of the interest items. Table 5.6 shows the Differentiation scores for the entire group of children at each of the time points.

Table 5.6 Differentiation scores at Year 7 and Year 9 for the complete sample (N = 227)

Year 7 M (SD)	Year 9 M (SD)
.90 (.31)	.95 (.33)

Differentiation scores for the sample at Year 7 were significantly related to differentiation scores for the sample at Year 9, $r = .18$ (225), $p < .01$, though the association was fairly weak. It can be seen from Table 5.6 that differentiation scores at each time point for the group remained stable, and slightly increased with age. Differentiation scores for males and females will be calculated and discussed further in Section 5.8.7.

5.8 Gender and stability

This following set of analyses takes a more detailed look at Stability (including Consistency and Differentiation) within the context of gender. This further analysis has been completed because as discussed in chapter 4, the structure of interests in the female participants appears to be emerging differently to the male participants. Further to this, previous research has demonstrated that female participants consistently score higher on Social and Artistic factors (and lower on Realistic) when compared to males, and this pattern typically remains stable over time (Harmon *et al.*, 1994, Tracey, 2002a, 2002b). Therefore, it is important to explore stability, differentiation and consistency estimates for the female and male participants separately within the present dataset.

5.8.1 Gender – scale score stability

Mean scores for each scale along with scale score correlations for males and females at each of the two time points are provided in Table 5.7.

Table 5.7 Mean factor scores and correlations between factor scores at Year 7 and Year 9 (males n = 110, females n = 118)

	Year7 males M (SD)	Year 9 males M (SD)	*r*	Year 7 females M (SD)	Year 9 females M (SD)	*r*
Realistic	3.42 (1.17)	3.44 (1.09)	.43**	2.29 (1.03)	2.34 (1.09)	.37**
Investigative	2.85 (1.11)	3.02 (.82)	.19*	2.68 (.93)	2.70 (.87)	.38**
Artistic	3.47 (1.05)	2.76 (1.11)	.26**	3.82 (.94)	3.43 (1.27)	.38**
Social	2.49 (1.00)	2.30 (.86)	.45**	3.33 (.95)	3.56 (.88)	.42**
Enterprising	2.72 (1.03)	2.83 (.83)	.18*	2.48 (.79)	2.65 (.80)	.20*
Conventional	2.82 (.99)	2.56 (1.02)	.13*	2.90 (.86)	2.32 (.89)	.27**

* Significant at $p < .05$; ** significant at $p < .01$.

Table 5.7 shows the stability of interests in the male and female participants separately over a two-year period. For both males and females, responses to the Social scale are the most consistent over time out of all six interest factors. Table 5.7 shows that the stability of factor scores is similar for both Realistic and Social interests, but that there is a different pattern emerging

for Investigative and Artistic interests i.e. that Investigative and Artistic interests appear to be more stable in females than males. However, when sing Fisher's r to z transformation, it was observed that there were no significant differences between the male and female stability coefficients (Z range from -1.55 - .53).

This pattern of findings is potentially related to the findings in the previous chapter. The data reported in chapter 4 suggests that the female participants were developing a hexagonal structure of interests at an earlier age than the male participants. This structural development is likely to be related to the development of stability and it could be argued that interests only become truly 'stable' until the structure of interests in that individual has become more developed. This viewpoint would indicate that the stability of interests in adult individuals would be higher across all factor scores as their interest structure is further developed.

Using the same formulae as documented in Section 5.2, profile difference scores were examined in male and female participants separately. Profile difference scores for the male participants with valid data at both time points (N = 110) ranged from .79 to 5.99 (M = 2.90, S.D. = 1.04). Profile difference scores for the female participants with valid data at both points (N = 117) ranged from .90 to 4.90 (M = 2.61, S.D. = .89). From this data, it is possible to see that that on average, the male participants had higher

profile difference scores than the female participants. This difference was statistically significant, t (225) = 2.22, p <.05, d .30. This result indicates greater variability in profiles as a whole for the male participants when compared to the female participants over the two year time period. This is in contrast to the findings of Tracey *et al.* (2005) who reported almost identical profile difference scores in their older sample of male and female students over a two year period when they were aged approximately 13.5 – 15.5.

5.8.2 Gender – factor scores over time

The differences between mean factor scores for the children whilst they were in Year 7 and then in Year 9 have been analysed using a mixed between-within subjects ANOVA (gender * time). This analysis allow conclusions to be drawn about the change over time for each of the RIASEC factor scores – whether interest in each scale increased or decreased over time, and also whether any changes significantly differed as a function of gender. Figures have been included where interactions between gender and time are significant to illustrate the relationships between the scores. A mixed between-within subjects ANOVA was conducted to assess the change in mean factor scores over the two time periods.

Realistic

There was no significant interaction between gender and time for Realistic scores; F (1,226) = .03, p =.87. There was not a main effect of time; F (1,226) = .16 p = .69. There was a main effect of gender, F (1,226) = 84.15, p <.001, μ .27. This shows that males overall had significantly higher Realistic scores than the females.

Investigative

There was no significant interaction between gender and time for Investigative scores; F (1,226) = 1.11, p = .30. There was not a main effect of time; F (1,226) = 1.72. p = .19. There was a main effect of gender, F (1,226) = 5.84, p <.02, μ .03. This shows that the males overall had significantly higher Investigative scores than the females, however as the effect size was very close to zero, indicating only a small difference between male and female scores on this scale.

Artistic

The interaction between gender and time for Artistic scores was marginally significant; F (1,226) = 3.67, p =.06, There was a main effect of time; F (1,226) = 42.20, p <.001. μ .16. There was a main effect of gender, F (1,226) = 18.40, p < .001, μ .08. Overall, these results show that for all children, scores on the Artistic scale decreased over time, and that female scores were typically higher than the males. It is noted that the interaction

was approaching significance, which reflects the fact that the male Artistic scores decreased more over time than the female scores.

Social

There was a significant interaction between gender and time for Social scores; F (1,226) = 8.62, p <.001, µ .04. There was not a main effect of time; F (1,226) = .00, p = .99. There was a main effect of gender, F (1,226) = 99.52, p < .001, µ .31. Repeated measures t-tests were conducted to follow up the differences for the male and female participants separately. For males, interest in Social activities significantly *decreased* over time, t (109) = 2.03 p <.05, d .20. For females, interest in Social activities significantly *increased* over time, t (117) = -2.12, p <.05, d .25. These results show that whilst group scores didn't change significantly over two years, when gender was taken into account, female Social scores increased with time, and male Social scores decreased with time. This is shown in Figure 5.3.

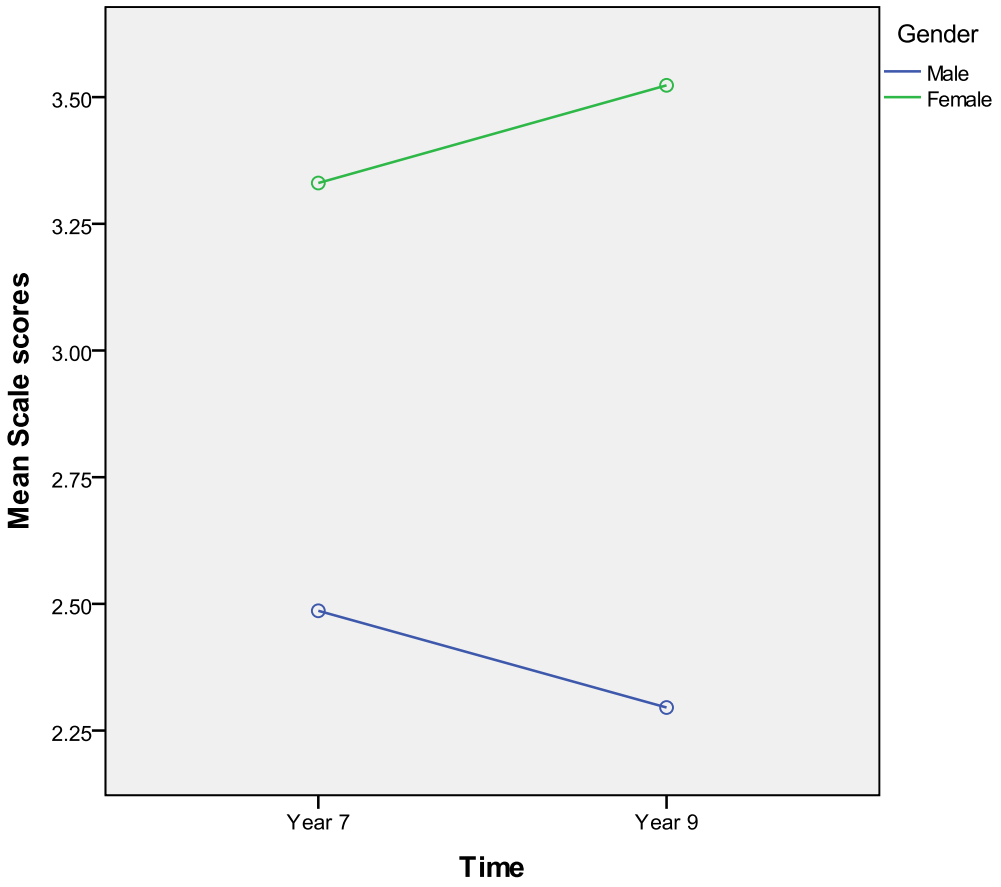


Figure 5.3 Social factor scores for males and females at Year 7 and Year 9

Enterprising

There was no significant interaction between gender and time for Enterprising scores; F (1,225) = 1.50, p = .70. There was a main effect of time; F (1,226) = 3.86, p = .05. µ .02. There was a main effect of gender, F (1,226) = 5.58, p < .02, µ .02. This analysis shows that the male participants overall had significantly higher Enterprising interest, and that scores for both males and females increased over time.

Conventional

There was a significant interaction between gender and time for Conventional scores; F (1,226) = 4.04, p <.05, µ .02. There was a main effect of time; F (1,226) = 28.67, p <.001, µ .11. There was not a main effect of gender, F (1,226) = .63, p = .43. The results of this analysis and Figure 5.4 show that scores for all participating children decreased over time, and that the decrease was more for females than for the males.

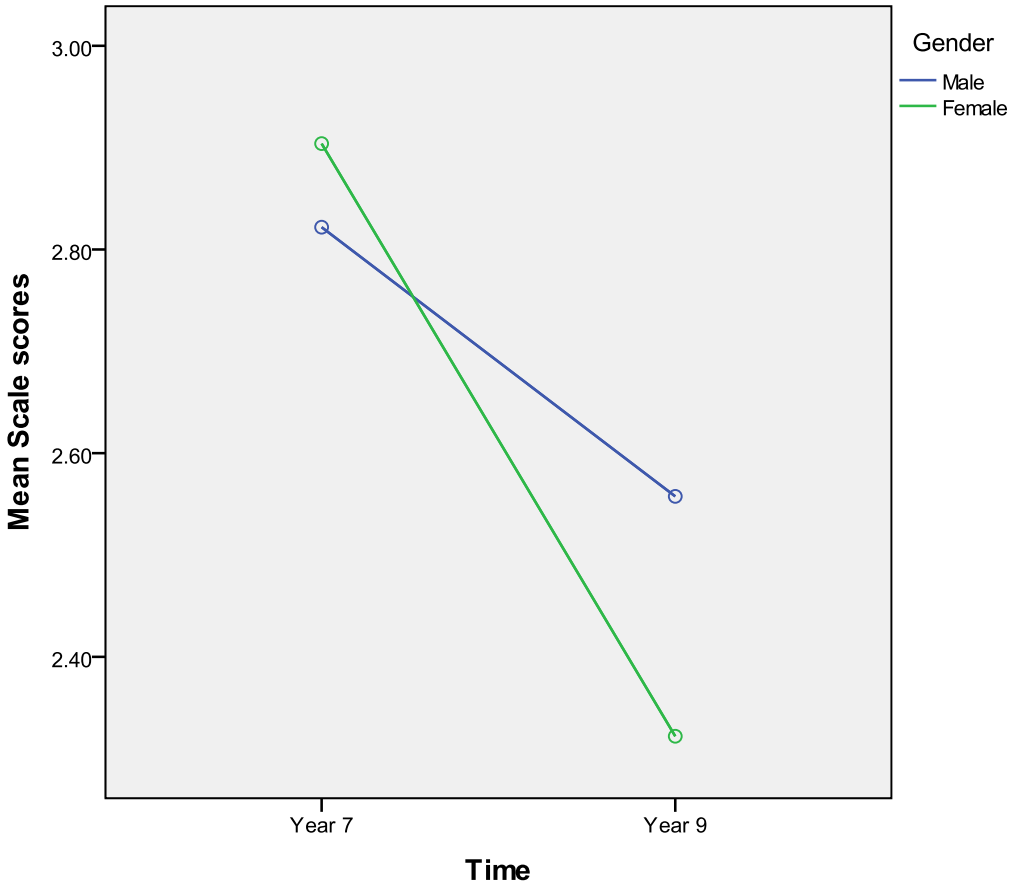


Figure 5.4 Conventional factor scores for males and females at Year 7 and Year 9.

5.8.3 Profile stability

Mean ranked scores for each scale along with ranked scale score correlations for males and females at each of the two time points are provided in Table 5.8.

Table 5.8 Mean ranked factor scores with correlations between ranked factor scores at Year 7 and Year 9 (males n = 110, females n = 117)

	Year 7 males M (SD)	Year 9 males M (SD)	*r*	Year 7 females M (SD)	Year 9 females M (SD)	*r*
Realistic	4.03 (1.90)	4.30 (1.77)	.48**	2.00 (1.49)	2.38 (1.70)	.27**
Investigative	3.00 (1.53)	3.56 (1.52)	.08	2.78 (1.52)	3.14 (1.51)	.38**
Artistic	4.30 (1.52)	3.09 (1.84)	.18	4.89 (1.38)	4.27 (1.84)	.40*
Social	2.40 (1.68)	2.38 (1.58)	.31**	4.38 (1.57)	4.68 (1.35)	.47**
Enterprising	2.65 (1.34)	3.29 (1.44)	.07	2.39 (1.25)	3.02 (1.34)	.20*
Conventional	3.01 (1.52)	2.74 (1.52)	-.02	3.33 (1.32)	2.40 (1.33)	.19*

* Significant at $p < .05$; ** significant at $p < .01$.

Table 5.8 shows that the ranked Realistic scores were the most consistent over time for the males, and that the ranked Social scores were most consistent over time for the female participants.

Using the same formulae as detailed in Section 5.2, profile difference scores were examined in male and female participants separately.

Ranked profile difference scores for the male participants with valid data at both time points (N =110) ranged from 1.00 to 8.83 (M = 4.87, S.D. = 1.67). Whilst cores for the female participants with valid data at both points (N = 117) ranged from 1.00 to 7.62 (M = 4.15, S.D. = 1.52). From this data, it is possible to see that that on average, the male participants had higher profile difference scores than the female participants. This difference was statistically significant, t (225) = 3.40, p <.01, d .45. These results again indicate greater variability in profiles as a whole for the male participants when compared to the female participants over the two year time period.

5.8.4 Gender – ranked factor scores over time

The differences between ranked factor scores for the children whilst they were in Year 7 and then in Year 9 have also been analysed using a mixed between-within ANOVA (gender * time). This analysis again allow conclusions to be drawn about the change over time for each of the RIASEC factor scores – whether rank interest in each scale increased or decreased over time, and also whether any changes significantly differed as a function of gender. Figures have been included where interactions between gender and time are significant to illustrate the relationships between the scores.

Note that N = 226 for this set of analysis as there was a missing data point for Enterprising and therefore the factor scores for this individual were not ranked. A mixed between-within subjects ANOVA was conducted to assess the change in ranked factor scores over the two time periods

Realistic

There was no significant interaction between gender and time for Realistic scores; F (1,225) = .17, p = .68. There was a main effect of time; F (1,225) = .16, p <.05, µ .03. There was a main effect of gender, F (1,225) = 108.26, p <.001, µ .33. These findings show that rank interest for the Realistic scale was higher for males than for females at both timepoints. As also seen in the previous section there was not a significant increase in Realistic though scores did increase marginally over time for both males and females.

Investigative

There was no significant interaction between gender and time for Investigative scores; F (1,225) = .61, p = .44. There was a main effect of time; F (1,225) = 13.34, p <.001. µ .06. There was a main effect of gender, F (1,225) = 25.00, p <.001. µ .10. This analysis shows that ranked Investigative scores were significantly higher for males than for females, and they significantly increased with time for both groups of participants.

Artistic

There was a significant interaction between gender and time for Artistic scores; *F*, (1,226) = 4.92, *p* <.05, µ .02. There was a main effect of time; *F*, (1,226) = 48.29, *p* <.001 µ .18. There was also a main effect of gender, *F* (1,226) = 18.40, *p* <.001, µ .08. These results show that ranked Artistic scores were significantly higher for females than for males, and they significantly decreased with time for both groups of participants, with the decrease being larger for the males; see Figure 5.5.

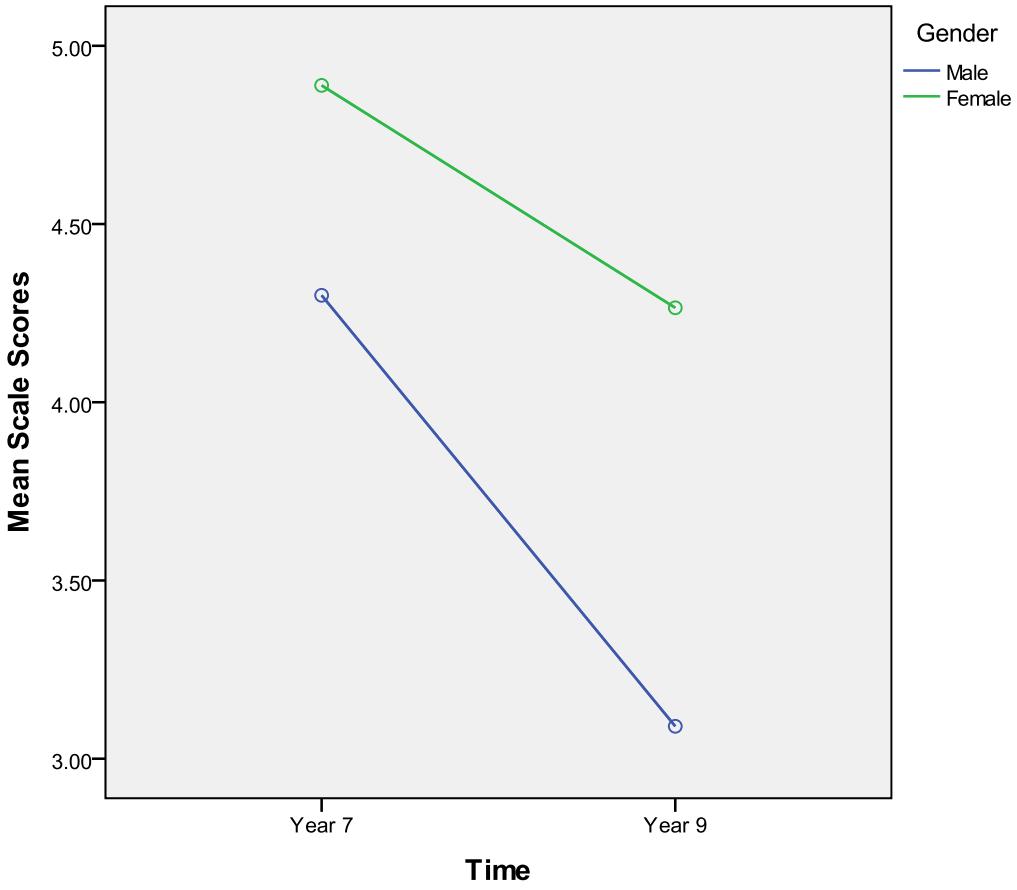


Figure 5.5 Ranked Artistic factor scores for males and females at Year 7 and Year 9

Social

There was no significant interaction between gender and time for Realistic scores; F (1,225) = 2.16, p =.14. There was not a main effect of time; F (1,225) = 1.51, p = .22. There was a main effect of gender, F (1,225) = 157.36, p <.001, µ .41. This analysis shows that ranked Social scores were higher for females than for males – with males having an average rank of 2.4 and females an average rank of around 4.5. These rankings did not

change significantly over time, which is in contrast to the actual factor scores which did significantly increase with time for females and significantly decrease with time for males. This demonstrates that although the ratings did significantly change over time, the rating of Social interests relative to the other five types of interests did not change over time.

Enterprising

There was no significant interaction between gender and time for Realistic scores; F (1,225) = .00, p = .99. There was a main effect of time; F (1,225) = 29.23, p <.001. There was a main effect of gender, F (1,225) = 3.85, p =.05, μ .02. These results show that ranked Enterprising interests increased over time for all participants, and that overall males had higher Enterprising interests.

Conventional

There was a significant interaction between gender and time for Realistic scores; F (1,225) = 6.75, p <.05, μ .03. There was a main effect of time; F (1,225) = 22.28, p <.05, μ .09. There was no main effect of gender, F (1,226) = .01, p = .95. These findings (as also presented in Figure 5.6) show that relative interest in Conventional interest items decreased over time for both males and females, but that interest decreased more for the females than for males.

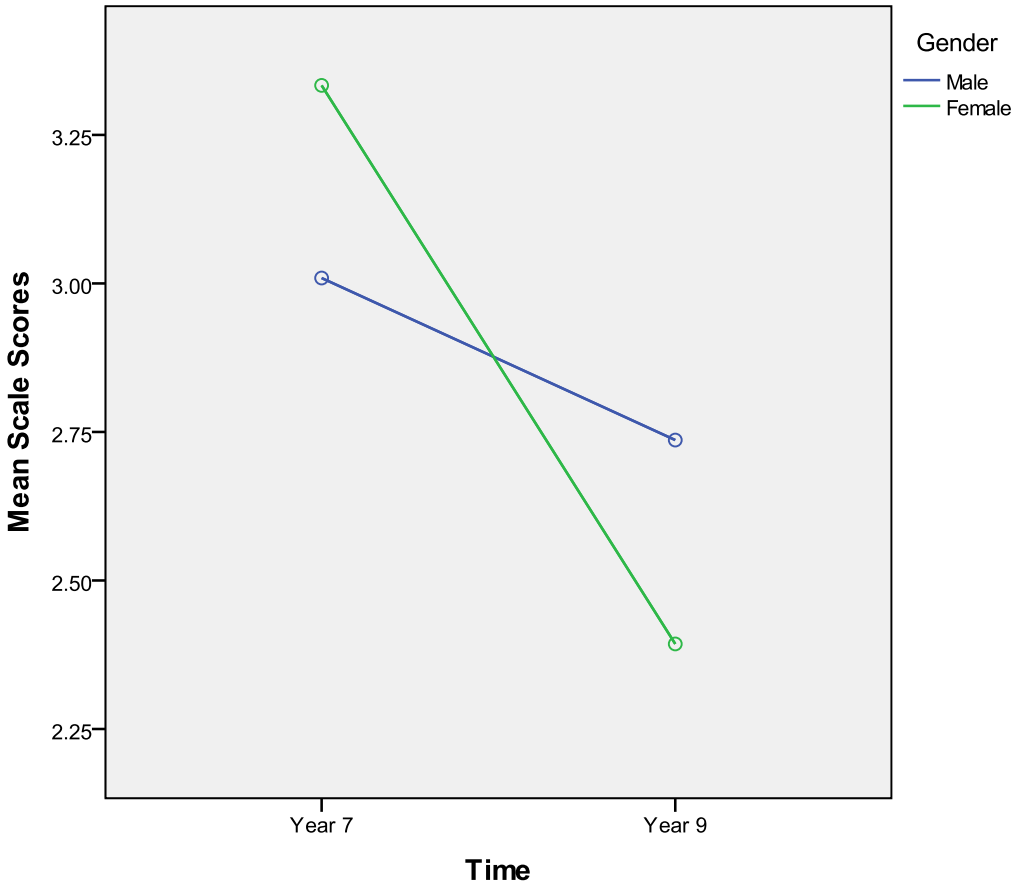


Figure 5.6 Ranked Conventional scale Scores for males and females at Year 7 and Year 9

5.8.5 Level stability

In this section, level change score have been calculated for males and females separately. Level change scores for males are presented in Table 5.9 and level changes scores for females are presented in

Table 5.10.

Table 5.9 Sum of RIASEC scores at each time point for males

	N	Min	Max	M	SD
Year 7	110	8.83	27.34	17.76	4.36
Year 9	110	7.92	24.42	16.90	3.14

Table 5.10 Sum of RIASEC scores at each time point for females

	N	Min	Max	M	SD
Year 7	117	7.83	26.76	17.46	3.36
Year 9	117	9.58	26.08	16.93	3.14

Table 5.9 and

Table 5.10 show that level change scores are similar for both males and females in Year 7. However, in Year 9 level scores decrease for males and

increase for females. Level change scores for both males and females were significantly related; the sum of factor scores at Year 7 and Year 9 was significantly related for males, $r = .23$ (108), $p < .05$ and was significantly related for females, $r = .25$ (115), $p < .05$. This indicates that there is some degree of level stability over the two year time period.

5.8.6 Dimension stability

Dimension scores have been calculated as reported in Section 5.5. Table 5.11 shows the dimension scores for the male and female children separately. To summarise section 5.5; a positive 'Things'/'People' dimension score indicates the score is within the 'Things' range area of the dimension and a negative score indicates the score is within the 'People' range. Similarly, a positive 'Data'/'Ideas' score indicates the score is within the 'Data' range and a negative score indicates 'Ideas'.

Table 5.11 Mean dimension scores for the same group of children over a two year period (males n = 110, females n = 117) and their respective correlation coefficients

Dimension	Year 7 Males	Year 9 Males	*r*	Year 7 Females	Year 9 Females	*r*
T/P	1.33 (3.97)	2.14 (3.85)	.45**	-2.83 (3.51)	-3.49 (4.24)	.52**
D/I	-1.35 (2.14)	-0.45 (3.41)	.28**	-1.90 (2.50)	-2.02 (2.94)	.44**

** significant at $p < .01$.

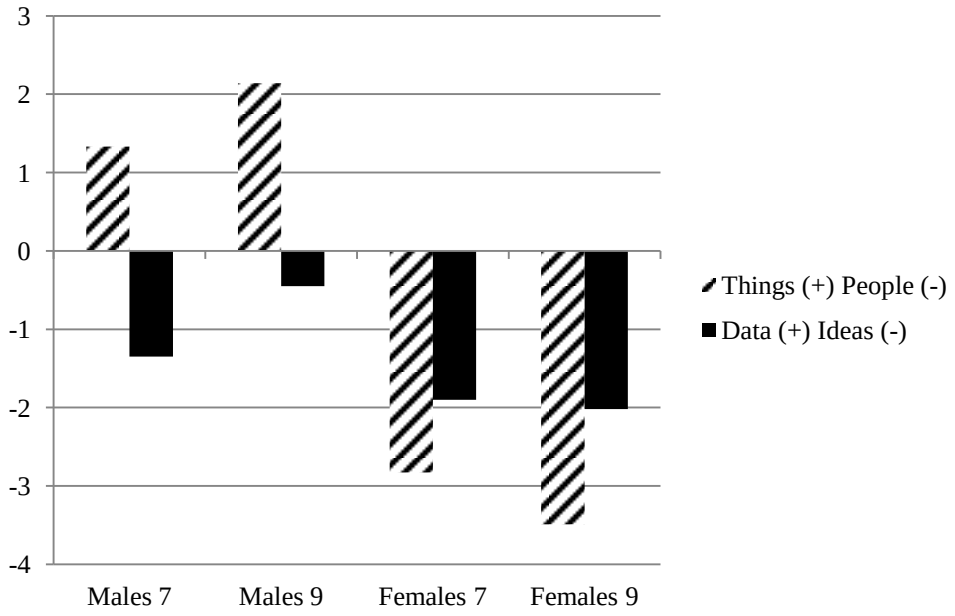


Figure 5.7 Mean dimension scores for the same group of children over a two year period (males n = 110, females n = 117)

Table 5.11 and Figure 5.7 suggest differences between dimension scores for the male and female participant. Overall, male participants scored high on 'Things' and 'Ideas', whereas females scored high on 'People' and 'Ideas'. Neither group of participants had scores showing a preference for 'Data'.

With regards to 'Things'/'People', the male participants had a clear preferences for 'Things' as indicated by a positive score, where as the female participants had a clear preference for 'People' as indicated by a negative score. For both groups of males and female participants, their respective 'Things'/'People' dimension scores both increase and become

more polarised with age, with male participants scoring higher on the ‘Things’ end of dimension and females scoring higher on the ‘People’ end of the dimension after a two year time period. The correlation coefficients (Table 5.11) suggest that ‘Things’/‘People’ dimension scores for both males and females are consistent over the two year time period.

With regards to ’Data’/’Ideas’, all participants scored on average within the ‘Ideas’ end of the dimension, though the female participants had higher (as evidenced by the negative score) scores on the ‘Ideas’ end of the dimension. In addition, male ‘Ideas’ scores decreased over the two year period. As with ‘Things’/‘People’, the correlation coefficients indicate that ’Data’/’Ideas’ scores for both males and females are consistent over the two year time period. Fishers r to z transformation analysis of the correlation coefficients indicated that there were no significant differences between the ‘Things’/’People’ coefficients when compared those for males and females, and likewise for ‘Data’/’Ideas’.

5.8.7 Consistency

Consistency scores for the male participants have been calculated as in Section 5.5 and are presented in Table 5.12. Consistency scores for the female participants are presented in Table 5.13. Table 5.12 and Table 5.13 show the proportions of scores in each male and female sample that have

very consistent (score of 3) somewhat consistent (score of 2) and inconsistent profiles (score of 1).

Table 5.12 Mean and frequency (%) of consistency scores for males whilst in Year 7 (N = 185) and Year 9 (N = 150)

		Year 7	Year 9
		M (SD)	M (SD)
		2.39 (.66)	2.34 (.71)
Consistency score	Definition	%	%
3	Two top factors are adjacent (e.g. RA)	48.60	48.00
2	Two top factors are alternate (e.g. RI)	41.60	38.00
1	Two top factors are opposite (e.g. RS).	9.70	14.00

Table 5.12 shows that the majority of assigned RIASEC codes are adjacent, with 48% of males having two top adjacent factors, indicating a consistent profile. Approximately 10% of male participants had an inconsistent profile at Year 7 and this increased to 14.00% in Year 9.

Table 5.13 Mean and frequency (%) of consistency scores for females whilst in Year 7 (N = 171) and Year 9 (N = 151)

		Year 7	Year 9
		M (SD)	M (SD)
		2.50 (.71)	2.53 (.71)
Consistency score	Definition	%	%
3	Two top factors are adjacent (e.g. RA)	62.60	65.60
2	Two top factors are alternate (e.g. RI)	24.60	21.90
1	Two top factors are opposite (e.g. RS).	12.90	12.60

Table 5.13 shows that the majority of RIASEC codes are adjacent for the female participants, with > 62% of females having two top adjacent factors (compared to the 48% seen in the male sample). This is an interesting finding, suggesting that the female participants typically had a more coherent pattern of interests than the males.

Figure 5.8 and Figure 5.9 display the frequency of RIASEC two letter codes assigned to participants whilst they were in Year 7 (Figure 5.8) and in Year 9 (Figure 5.9). Figure 5.8 clearly shows that AS and SA were the most common two letter codes assigned to the female participants, with between 50% of all female participants having either a two letter code of AS or SA in Year 7. The most common two letter codes for Year 7 males was RA or AR with 30% of males having one of these codes. For both males and females,

two letter codes containing Conventional or Enterprising were far less common. Figure 5.9 shows that in Year 9, AS and SA were again the most commonly assigned two letter to the female participants though the proportion of females having either one of these codes had reduced from 50% to approximately 40% of the female sample. For males, the most common code has moved from RA to RI. Males with a RI code has almost doubled (12% in Year 7) to account for 21% of the sample in Year 9. As in Year 7, two letter codes containing Conventional or Enterprising were less common for both males and females, but RC and RE two letter codes tripled in frequency between Year 7 and Year 9 for the males.

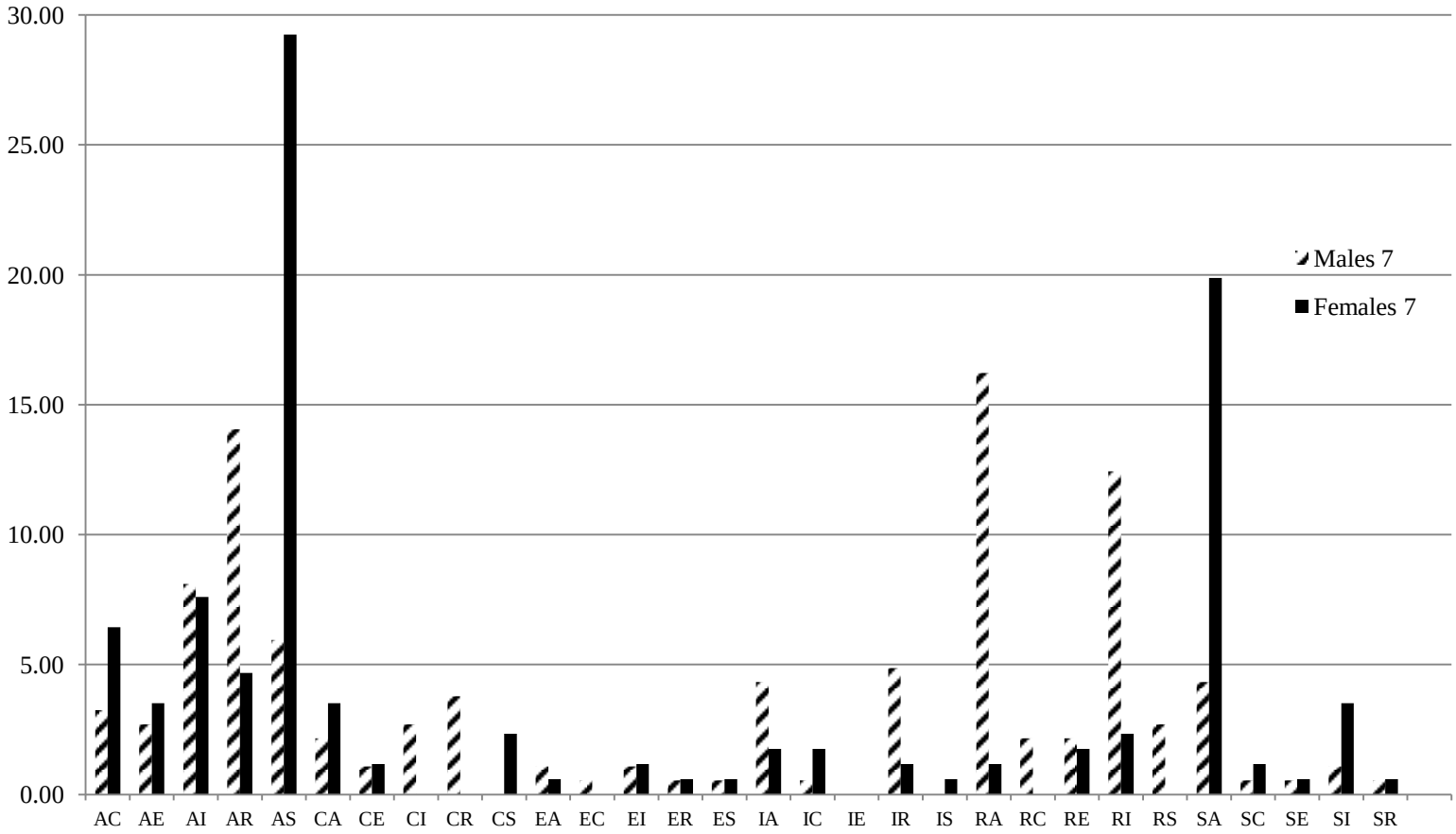


Figure 5.8 RIASEC codes (%) assigned to participants whilst in Year 7 (males, n = 185, females, n = 171)

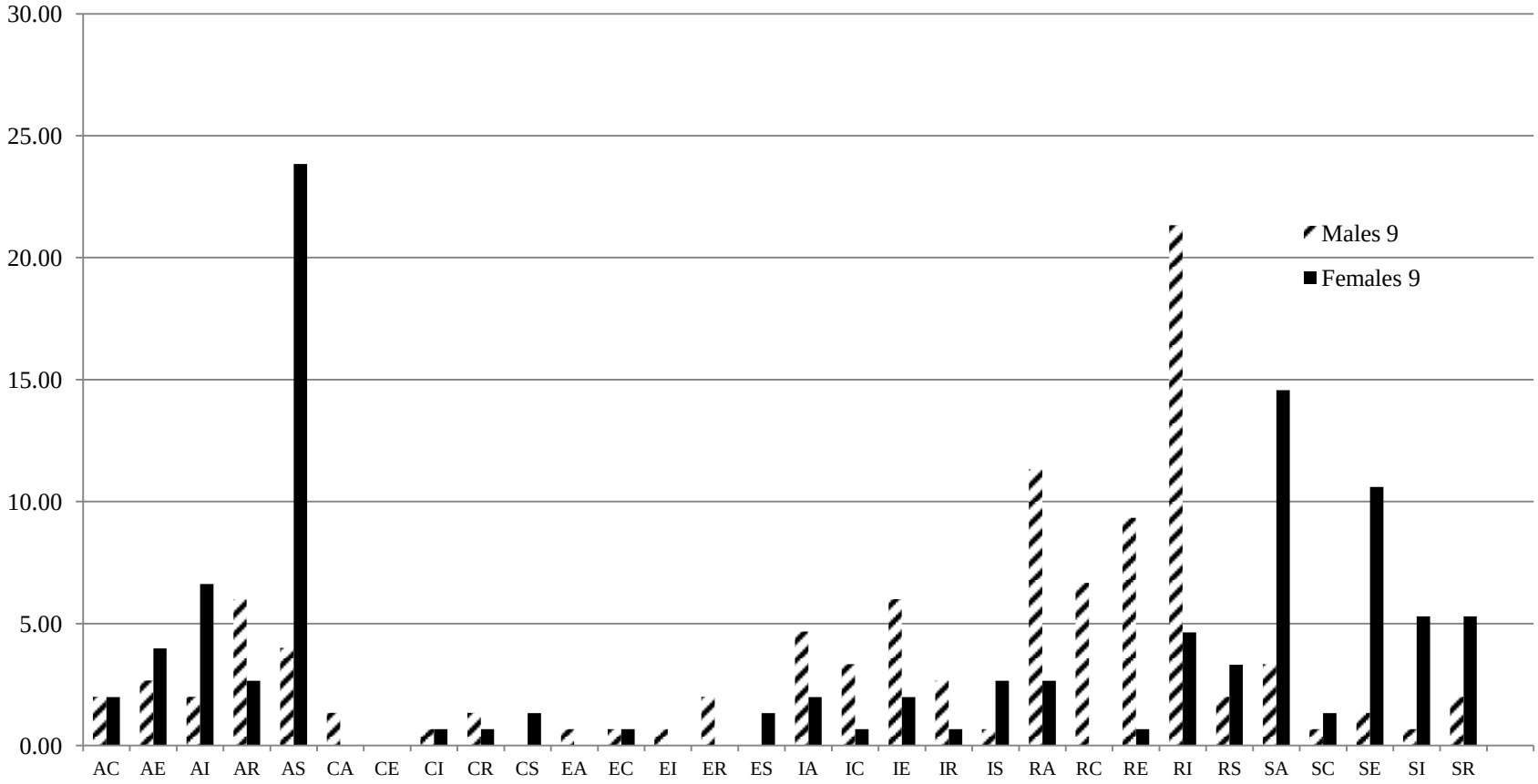


Figure 5.9 RIASEC codes (%) assigned to participants whilst in Year 9 (males, n = 150, females, n = 151)

5.8.8 Profile codes

In addition to calculating two letter RIASEC codes for the purpose of creating consistency estimates, three letter RIASEC codes have also been calculated for each participant (Profile Codes). This analysis has been conducted to enable the suggestion of suitable occupations for each participant using tables in Holland (1985). These three letter codes reflect (in order) the top three rated factors for each individual. On occasion, there were more than three top rated factors (for example, where the third and fourth factors were rated equally). When this occurred, the first three have been reported only.

Table 5.14 shows the most common three letter codes for male and female participants in Year 7. These top five rated factors account for approximately 20% of all Year 7 male and female participants (total N = 227).

Table 5.14 The most common RIASEC three letter codes for males and females in Year 7

Rank	Year 7 Males	Frequency	Year 7 Females	Frequency
1	RIA	15	ASC	17
2	RAE	12	SAC	14
3	ARI	11	ASE	11
4	RAI	11	ASI	11
5	ARC	8	ASR	11

In Table 5.14, it is possible to see that for the males, the most common RIASEC three letter codes always contained Realistic and Artistic, whilst the most common RIASEC three letter codes for the females always contained both Social and Artistic. In Holland (1985), not all of these three letter codes are assigned to occupations, but as an example, RIA = Landscape Architect, RAI = Bookbinder, SAC = Hair stylist and ASE = Actor or Actress. It should be noted that in Holland (1985) these three letter codes can refer to a number of jobs e.g. ASE also can refer to an English Teacher. These types of suitable occupation give an idea of the differences between the common interests of the Year 7 males and females. Of course it

should be further noted that these occupation titles refer to available occupations nearly two decades ago, and some e.g. Bookbinder may no longer be valid occupations due to advances in technology. Artistic was most often the dominant theme for females (the first code in the list of three). Table 5.15 show the most commonly assigned three letter codes for male and female participants in Year 9. These top five rated factors account for over 20% of all Year 9 male and female participants (total N = 227).

Table 5.15 The most common RIASEC three letter codes for males and females in Year 9

Rank	Year 9 males	Frequency	Year 9 females	Frequency
1	RIE	13	ASE	17
2	REI	8	ASI	15
3	RAE	7	SAE	8
4	RIA	7	SEI	8
5	RIC	7	SAI	7

From Table 5.15, it is possible to see that for the males in Year 9, the most common RIASEC three letter codes always contained Realistic as the first code in the list of three, whilst the most common RIASEC three letter codes for the females always contained Social as the first or second code.

Furthermore, Realistic is not present in any of the top five sets of codes for females, and Social is not present in any of the top five sets of codes for males.

Further to this a score of 0, 1, 2 or 3 was assigned to each individual to reflect the number of letters within their assigned profile code which were the same (but not necessarily in the same order) at both Year 7 and in Year 9. For example, if a participant had a code of REI at Year 7 and then a code of IER at Year 9 they were given a score of three. If they had a code of REI at Year 7 and SIA at Year 9 then this would result in a score of one, as only one letter was present at both time points. Table 5.16 shows the number of consistent RIASEC letters at Year 7 and Year 9.

Table 5.16 Consistent RIASEC letters (%) at Year 7 and Year 9

Letters present at both Years 7 & 9	Males	Females
3	10.00	15.40
2	61.80	67.50
1	28.20	17.10
0	0.00	0.00

The data presented in Table 5.16 suggests that the female participants were more likely to have two or three RIASEC letters the present at both time points than the males. No participants had a score of 0, meaning that all

participants had at least once letter the same at each time point. An independent measures t-test revealed that this difference in scores between males (M = 1.82, SD = .59) and females (M = 1.98, SD = .57) was statistically significant, t (222.85) = -2.13, p <.05, d .28.

The findings presented this section clearly show that the female participants had a more consistent profile of interests over time when compared to the male participants.

5.8.9 Differentiation

Differentiation scores for the males and female participants at Year 7 and Year 9 have been calculated and presented in Table 5.17.

Table 5.17 Differentiation scores at Year 7 and Year 9 for males (n = 110) and females (n = 117)

	Year 7 M (SD)	Year 9 M (SD)
Males	.87 (.32)	.90 (.33)
Females	.92 (.31)	1.00 (.33)

These findings presented in Table 5.17 suggest that the females had marginally more differentiated interests than the males overall (as indicated by the higher score). A mixed between-within subjects ANOVA was

conducted to assess the change in mean differentiation scores over the two time periods. There was no significant interaction between gender and time for differentiation scores; F (1,225) = .63, p = .43. The main effect of time was marginally significant; F (1,225) = 3.47 p = .06. There was a main effect of gender, F (1,226) = 5.18, p <.05, µ .02. These findings suggest that the females had higher differentiation scores overall. Furthermore, the differentiation scores for females were significantly related, r = .29 (115), p < .01, however the differentiation scores for males at Year 7 and Year 9 were not significantly related, r = .06 (108), p = .56. This pattern of results would suggest that there were more changes that occurred with regards to interest profiles for the male participants than the females.

These findings show that females had more clearly differentiated interest profiles than the males, and for the females differentiation score at Year 7 were predictive of differentiation scores at Year 9 For the male participants, differentiation scores did not significantly change with increased age, and differentiation scores in Year 7 were not predictive of differentiation scores at Year 9.

5.9 Chapter summary

This chapter has taken a very detailed look at how stable vocational interests in a group of mixed secondary school aged children are over a two year time period. A wide range of statistical methods have been employed to explore different forms of vocational interest stability. These different methods have allowed conclusions to be drawn about the nature of vocational interest in adolescence, particularly with regards to the interest factors that are most stable over time and whether gender interacts with stability. Clearly, knowledge about the stability of vocational interests in adolescence is vital to successful career counselling – if it is known what features of vocational interests are typically stable – and from which age – then guidance can be given to those individuals at the appropriate time. Overall, the results of this set of analysis demonstrate that some aspects of vocational interests are stable and some are changing, for example; interest score elevation may significantly change over time but these scores still will be closely correlated to the original interest scores measured at the first time point.

The key message here is there is strong evidence to suggest that children's vocational interests (both actual and ranked) are indeed broadly stable over time, and are partially mediated by gender. Evidence to support this is provided primarily by the factor score correlations and Dimension scores correlations between the Year 7 and Year 9 datasets. Although all six factor

score stability coefficients were highly significant (all *p's* < .01), the data analysis revealed specifically that both actual and ranked factor scores for Realistic, Investigative, Artistic and Social interests were the most stable over time when compared to interest in Enterprising or Conventional activities. This finding is in line with previous research into vocational interest stability (e.g. Tracey & Ward, 1998, Hirschi, 2010b, Lubinski *et al.*, 1995, and Mullis *et al.* 1998) who also found that these four interest factors in particular to be more stable over time than Enterprising or Conventional interests in other adolescent populations.

The main themes in this set of findings as reported in this chapter consistently relate to both Realistic and Social interest factor scores. Realistic factor scores were significantly higher for males and females and Social factor scores the reverse was observed (which is consistent with Harmon *et al.*, Tracey, 2002a). The overall magnitude of interest in Realistic activities didn't change over time for the sample overall, or for males and females individually. In contrast, the magnitude of interest in Social activities significantly increased for the females and significantly decreased for the males over the two year time period. This knowledge about the differing trajectories for Realistic and Social interests is quite remarkable, particularly as we now know that interests for these two factors to be very stable over time (evidence as presented in section 5.2.1). Simply, the data suggests that if we know a Year 7 child's gender and their factor scores for

Realistic and Social interests we will have a good idea what their interests may look like (just for those two factors) two years on.

Overall, interest in Investigative activities were significantly more stable over time for the female participants than for the males. (Fisher's z = 2.2, p <.05, 2 tailed). Any other differences noted between factor scores stability as a function were not significant. This is an interesting finding as it provides evidence to support the view that many females who show an interest in Science and Scientific activities at a young age will maintain that viewpoint two years later on. The analysis completed on the ranked factor scores (section 5.3) revealed similar patterns of finding as reported in section 5.2. However, there were a few key differences (and therefore reflects why this set of analysis has been included); namely with regards to the Social and Conventional factor scores. Whilst the *actual* Social factor scores significantly increased for females and decreased for males over time, the *ranked* Social factor scores did not change. This would suggest that relative Social interests (whilst polarised by gender) are stable over time for both males and females. Furthermore, the ranked Conventional ranked factor scores were not consistent over time, suggesting that relative interest to the Conventional factor items were not stable. This, of course may be due to problems with the Conventional set of items as discussed previously (and later, in chapter 7).

Profile difference scores suggested that profiles were more variable than that seen in Hirschi (2010b), but as already noted; the current sample is younger than that evaluated in Hirschi's study. It is considered that profile difference codes were difficult to interpret, and whilst provided a point of reference with which to compare Hirschi's (2010a) findings; they ultimately are of limited practical application. Level scores refer to the range of interests an individual has, with higher Level scores showing a higher degree of interest in many activities. In this study, level scores were moderately correlated over time for the entire sample and for the groups of male and female participants separately. This shows that children who had a wide range of interests aged 11, were also likely to have a broader range of interests aged 13. As was considered with the profile difference scores, this set of analysis is unlikely to have practical relevance – but it was included to allow future comparisons.

What is of more interest, and potentially of practical application is the findings related to the calculation of vocational interest Dimension scores. Dimension scores are created from factor scores for at least four of the interest factors. Dimension scores were found to be very stable over time, particularly for the 'Things'/'People' dimension scores. Indeed dimension scores on 'Things'/'People' were significantly more stable over time for than 'Data'/'Ideas'. This would suggest (as the data was indicating in chapter 4 when looking at the MDS plots) that consistent relationships can

be seen between the Realistic and Social factors over time. Furthermore, Dimension scores for 'Things'/'People' (r = .62) were higher than for Realistic scores alone (r = .53). Although the stability coefficient for 'Things'/'People' was not significantly higher than the Realistic stability coefficient (using Fisher's r to z transformation), it does suggest that relative interests as well as absolute interest factor scores should be considered both in vocational interest's research in career's counselling.

Dimension scores for males and females were strongly polarised, with males having a clear interest in 'Things' and females having a clear interest for 'People'. These scores became more polarised over time which is consistent with the findings of Su *et al.* (2009). On average, group scores didn't fall into the 'Data' area, instead both males and females scored within the 'Ideas' area. With regards to consistency, over 50% of the sample had consistent profiles (i.e. the top rated factors were adjacent on the Hexagon). In addition, male participants were typically less likely to have a consistent profile when compared to the female participants. Furthermore, the most common three letter RIASEC codes contained both Realistic and Artistic for the male participants and both Social and Artistic for the female participants. Female interest profiles were more differentiated (i.e. more distinct), which increased significantly with time when compared to the males whose differentiation estimates did not significantly increase with time.

To summarise, the analysis as reported in this chapter has demonstrated that there is a degree of stability to the reported interests of children aged 11-14 over a two year period. Furthermore, there was evidence to suggest that there is value in incorporating Holland's hexagonal approach to career's guidance (i.e. by applying 2 or 3 RIASEC factor codes to PVII2 item scores). Responses to some interest factors were more stable than others, and there was a clear pattern of differences in stability, consistency and differentiation estimates between the male and female participants. These findings have important theoretical and practical implications for the vocational guidance secondary school age children receive, and this will be discussed further in chapter 7. Chapter 6 next investigates the relationship between interests as measured on the PVII with Mechanical, Spatial Rotation, and Logical Reasoning ability and explores how this relationship changes over time.

Chapter 6 Abilities and interests

6.1 Introduction to the chapter

This chapter explores how abilities relate to vocational interest development in adolescence. Specifically, ability in three key areas; Mechanical, Spatial Rotation and Logical Reasoning. Pen and paper multiple choice self-completed factors were adapted from existing ability measures and were administered to secondary school aged children. These measures were given at two time-points, two years apart, when the children were in Year 7 and then later in Year 9 alongside the PVII measure of vocational interests.

There is limited published work that has explored the relationship between objective measures of ability with vocational interests. The studies that have looked at the relationship between interests and objectively measured abilities have had adult participants, and have typically found little common variance between interests and ability. However, as also discussed in chapter 1 this lack of association may be due in part to the measures and sampling methods used. Often, as pointed out by Lowman (1991), gifted or male only samples were assessed, along with the usage of rather broad measures of intelligence rather than measurements of specific abilities.

The majority of research in this area has focussed on the relationships between ability and subjective measures of vocational interests in adults. These studies have consistently found relationships between self reported abilities and interests in line with the hexagonal structure (e.g. Rolfhus & Ackerman, 1996; Betz *et al.*, 1996) e.g. if someone reports that they strongly like Realistic occupations or activities, then they are then much more likely to also rate themselves as good at those occupations or activities.

Although research, (e.g. Ackerman *et al.*, 1995) has demonstrated that subjective interests are positively related to objective measures of the same ability in adults, it is not known whether this is also the case for children's interests. Ackerman and Heggestad (1997) conducted a thorough review of studies that explored the links between vocational abilities and objectively measured interests up until that point. The participants in all of the studies they reviewed were at least of junior college age (approximately 16+), with the majority of participants being university students and therefore 18+. There is very clearly a gap in the literature that takes a longitudinal look at how vocational interests and objectively measured abilities co-develop and influence each other in adolescence. Clearly, if there is more understanding as to how these factors develop over time, then suitable educational interventions and opportunities can be administered with more impact.

As found in chapter 5, the structure of interests develops over time, towards a hexagonal arrangement with differing structural profiles and rates of development for male and female participants. It is expected that any observed relationships between abilities and interests will also emerge and develop over time, but the expected nature and strength of these relationships is as yet unknown.

Findings relevant to this current body of work from Ackerman and Heggestad's (1997) review will be presented and discussed in this chapter. Ackerman and Heggestad concluded from their review that Realistic and Investigative interests tended to be positively associated with Mechanical and Spatial abilities, and that Realistic interests were more closely related to Mechanical ability than were Investigative interests. Furthermore, the data suggested that Social interests were commonly negatively associated with Spatial ability.

The aim of this chapter is therefore to report on the ability measures, firstly, how stable scores on these measures were over a two year time period, and how they relate to one another. Next, the relationship between ability and interest scores is evaluated, specifically the associations between ability and interest factor scores, level scores and dimension scores. As data has been collected for abilities and vocational interests at two different time points, it may be possible to identify a causal pathway, i.e. does ability lead to

subsequent interest, or do interests guide an individual to engage with an activity resulting in improved skill.

In line with Ackerman and Heggestad's (1997) summary of existing research in the area, it is tentatively predicated that there will be a degree of positive association of Realistic interests with both Engineering and Spatial abilities. The expected magnitude of these associations is unknown due to the lack of previous research in this area with adolescent participants. Analysis will be evaluated for the group, but also for males and females separately as the previous two chapters have indicated gender differences in the way that interests change and develop over time. Higher scores on Mechanical and Spatial measures are commonly associated with males (Lowman, 1991), and indeed it seems that there are consistent gender differences on a wide variety of spatial tasks, particular on tests of mental rotation (e.g. Linn & Petersen, 1985; Voyer, Voyer & Bryden, 1995). It is therefore possible that gender may be an influencing factor when exploring the stability of abilities and the link between abilities and interests, and will be considered here.

6.2 Ability measurement and relationships with vocational interest

This section will briefly discuss ability measurement, and how ability measurement has developed over time. Furthermore, this section will present existing research that has evaluated the relationships between abilities and interests. The three main types of ability measure used in this body of work were selected and developed for use in the EAP.

ABET (Previously, the Accreditation Board for Engineering and Technology) has defined engineering as "the profession in which a knowledge of the mathematical and natural sciences gained by study, experience, and practice is applied with judgement to develop ways to utilise, economically, the materials and forces of nature for the benefit of mankind" (Wright, 1989, p48.). Engineers are considered to need have advanced science and mathematics skills. Furthermore excellent quantitative reasoning ability is considered to underpin high achievements in the technology fields (Stanley, 1990, as cited in Howe, 1990). Measures of Mechanical, Spatial Rotation and Logical Reasoning ability were chosen specifically because these are all skills that are suggestive of later success in an Engineering career (further detail on measure selection also provided in chapter 2).

6.2.1 Ability measurement

Ability has been defined as ‘what one is able to do or potentially able to do’ (Lowman, 1991, p11). The measurement of ability has had longer research history, with early work starting in the late 1800’s (e.g. Galton, 1883; Cattell & Farrand, 1896) Over the last century, a wide range of self-completed measures have been developed to assess ability for spatial ability, mechanical reasoning, verbal and numerical skills, logical reasoning and manual dexterity amongst many others. These types of ability measures were commonly used (and still are today) by many employers to aid with personnel selection.

Historically, there has been a debate in the literature as to whether these kinds of abilities can be seen as distinct measures in their own right, or whether they all also correspond to an overall general ability factor. Research findings were mixed, with early work (Spearman, 1904) reporting evidence for a general or intelligence factor known as ‘g’. A few decades later using factor analysis techniques and a variety of aptitude measures, Kelly (1928) found data to suggest that aptitudes could indeed be classified as verbal, numerical, spatial, motor, musical, and social. Similarly, Thurstone (1938) also found evidence for distinct aptitudes namely ‘the Primary Mental Abilities’; number, visualisation, memory, word fluency, verbal relations, perceptual speed, and induction. More recently however,

there appears to be a consensus in the field that the relationships between abilities can be represented in a hierarchical manner. For example, Vernon (1950) proposed that the general intelligence factor ‘g’ could be divided into main two group factors, a spatial-mechanical factor and a verbal-educational factor, both of which were further divided into sub-factors. There are a number of hierarchical theories of intelligence e.g., Cattell, (1971), Gustafsson (1984), and most of them specify general ability at the highest level, followed by group factors at the next level and so on. More recently, Carroll (1993) conducted an extensive review of existing data and identified one third order factor, seven second order factors and two third order factors (See Figure 6.1).

Figure 6.1 A list and structure of ability constructs (Derived from information in Carroll, 1993). Third order construct = General Intelligence; second order constructs shown with solid lines; first order constructs with dotted lines (Ackerman & Heggestad, 1997)

It is possible to see from Figure 6.1 that the three ability measures used in this set of studies fall within three second order factors: 'Fluid intelligence', 'Visual Perception' and 'Knowledge and Achievement'. As only three distinct abilities have been measured in the current body of work, it is not possible to conduct a similar type of factor analysis as other researchers have done. Instead, the relations between these three abilities; Mechanical, Spatial Rotation and Logical Reasoning will be investigated and their corresponding links to Vocational interests over time will be explored. These measures were selected as the literature (e.g. Ackerman & Heggestad, 1997) has identified a number of consistent relationships between these specific abilities and interests, and furthermore suitable tests to measure these skills had been developed for the EAP. The rationale for identifying these abilities in particular has been presented in further detail in chapter 2.

6.2.2 Abilities and interests

As mentioned earlier, Ackerman and Heggestad (1997) conducted a very detailed review of research studies that have looked at the relationship between vocational interests and intellectual abilities. This review contained a summary of the key studies published between 1931-1997. Early work (Moore, 1941) found engineering interest scores to correlate with measures of general ability, mechanical knowledge, mathematics and science. Triggs

(1943) also found that scientific interest scores were related to achievement in general science and mathematics. Similarly, Long (1945) found a strong positive relationship between scientific ability and interest in technical/maths occupations.

Up until 1997 (and there has not been much published since on this topic), Ackerman and Heggestad (1997) were able to identify five empirical studies that reported correlational data. This data is summarised in Table 6.1.

Table 6.1 Correlations between Holland themes and intellectual abilities (Ackerman & Heggestad, 1997)

Study & Ability	**N**	**R**	**I**	**A**	**S**	**E**	**C**
Randall (1991)	846[a]						
Spatial		.34*	.27*	.01	–.13*	–.06	–.06
Verbal		–.03	.27*	.28*	–.01	–.17*	–.08*
Numerical (computation)		.09*	.27*	–.02	.01	–.04	.15*
Lowman *et al* (1985)	149[b]						
Reasoning/Mechanical Knowledge		.28*					
Music				.43*			
Ackerman *et al.* (1995)	93[c]						
Spatial		.24*	.13	.01	–.04	–.15	.00
Math		.38*	.34*	–.20	–.14	–.15	.18
Verbal		.14	.33*	.37*	–.08	–.32*	–.32*
Perceptual Speed		.08	.12	–.04	.06	–.05	–.07
Rolfhus & Ackerman (1996)	180[c]						
Spatial		.28	.16*	.06	–.08	–.16*	.01
Mechanical		.35	.21*	.11	–.21*	–.15*	.04
Math		.27	.14	.11	–.20*	.01	.19*
Verbal		.23	.20*	.24*	.03	–.03	–.05
Perceptual Speed		.10	.02	.05	.14	.02	.15*
Kanfer *et al.* (1996)	150[c]						
Spatial		.26	.17*	.16*	.00	–.17*	–.12
Math		–.04	.02	–.03	–.09	–.21*	–.09
Verbal		–.12	–.05	.21*	–.09	–.31*	–.22*
Perceptual Speed		.03	.02	–.03	–.10	–.02	.16*

[a]Vocational assessment clients who completed the SVIB . [b]Female college students who completed the Self-Directed Search booklet. [c]College students who completed the Unisex Edition of the American College Testing Interest Inventory. *$p < .0.5$ (no distinction is made for higher levels of significance, for example, $p < .01$).

Table 6.1 clearly shows that there are relationships between certain abilities and interests. There is a clear pattern of positive correlations between Spatial ability and Realistic interests across the five reported studies, and also a positive association between Spatial ability and Investigative interests. Social interests appear to typically have negative or weak association with the six vocational interest factors. Interestingly, Enterprising and Conventional interests also appear to be negatively related to many of the objectively measured abilities, in particular with Verbal

ability. These numerical relationships have been conceptualised by Ackerman and Heggestad (1997) which gives a clearer pictures of the more consistent relations, see Figure 6.2.

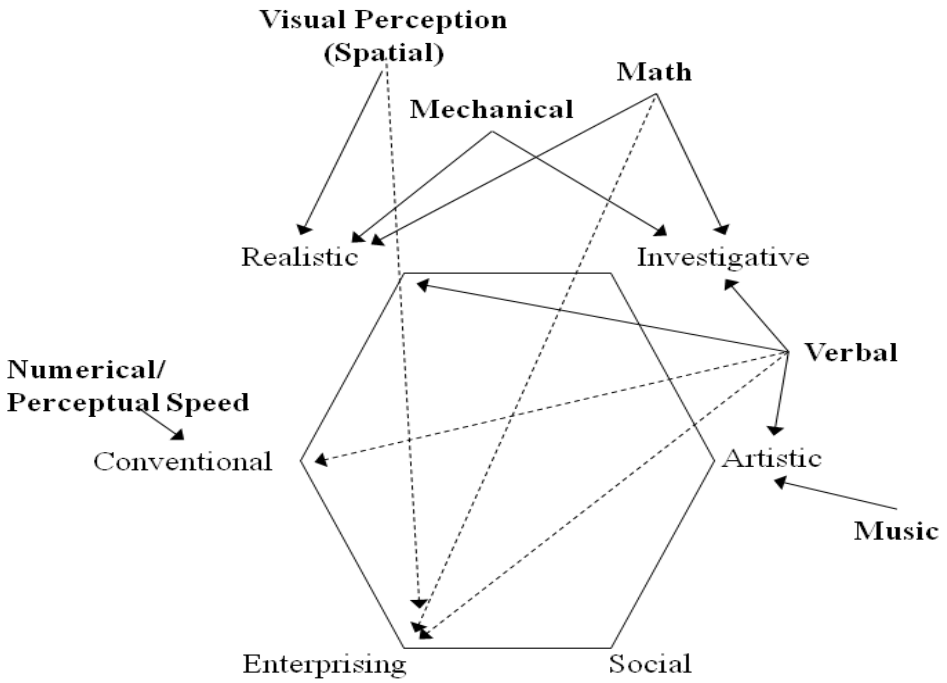


Figure 6.2 Associations between Holland's interest themes and intellectual abilities (bold). Solid lines = positive correlations; dotted lines = negative correlations (Ackerman & Heggestad, 1997)

Figure 6.2 clearly shows that across the five summarised studies, Spatial ability has the closest links with Realistic interest and Mechanical ability is linked to Realistic and Investigative interests. As measures of Logical Reasoning have not been commonly reported in the literature in relation to

vocational interests the nature of this relationship is not clear. In addition, there appears to be an association between intellectual ability and level scores (Terman, 1954, as cited in Ackerman & Heggestad, 1997), suggesting that individuals with high levels of intelligence tend to have a wider range of interests – i.e. are interested in numerous activities rather than just specific ones. The relationship between level scores and the three ability measures will therefore be evaluated in Section 6.6.

6.3 Measuring ability

This Section gives a descriptive account of the five ability measures used in this study, and example items. Detailed test administration is detailed in chapter 2, and is therefore summarised here. Descriptive data for each of the ability measures is displayed in Table 6.2.

6.3.1 Mechanical ability

Mechanical ability has been defined as 'the ability to understand principles about the physical world and how machines work and operate' (Lowman, 1991, *p*. 58). Mechanical abilities have been found to closely relate to Spatial abilities, and tend to increase with age and experience (Super & Crites, 1962). Mechanical ability has typically been measured by pen and paper tests, which require the participant to utilise mechanical or physical principles to order to answer a question. The measure of mechanical ability

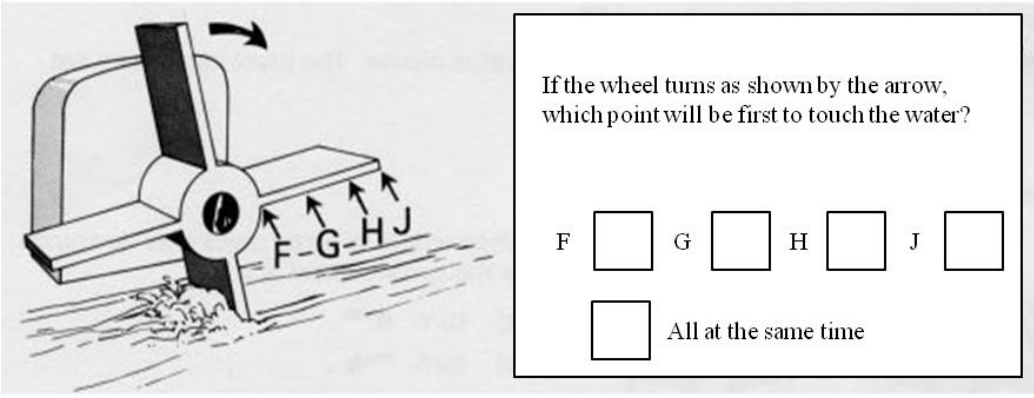
used in this set of studies was influenced by three existing measures of mechanical ability for the EAP, 2002:

1) Bennett Mechanical Comprehension Test, form T (Bennett, 1969);

2) American Council for Educational Research (ACER) - Mechanical Reasoning Test (ACER, 1977);

3) Differential Aptitudes Test (DAT) - Mechanical Reasoning Test (Bennett, Seashore & Wesman, 1974).

It was found that many of the existing measures that measure Mechanical ability were either too long to form part of a test battery (ACER and DAT comprise of over 60 items) or were targeted at students who were at least 15 years old. The Mechanical ability measure used in the EAP had 24 items, with each item having one correct answer to select from between three-five possible answers. Participants were not strictly timed, and were allowed approximately 15-20 minutes to complete all items. The 24 items used were cross-referenced with the UK Key stage 3 Science curriculum to confirm that the concepts the items referred to in the measure had been already covered in Science classes in Year 7. Concepts included: Energy resources and Energy transfer, Physical processes, Forces and Linear motion, Materials and Properties & Electricity and Magnetism. Figure 6.2 shows two example items from the Mechanical ability measure.



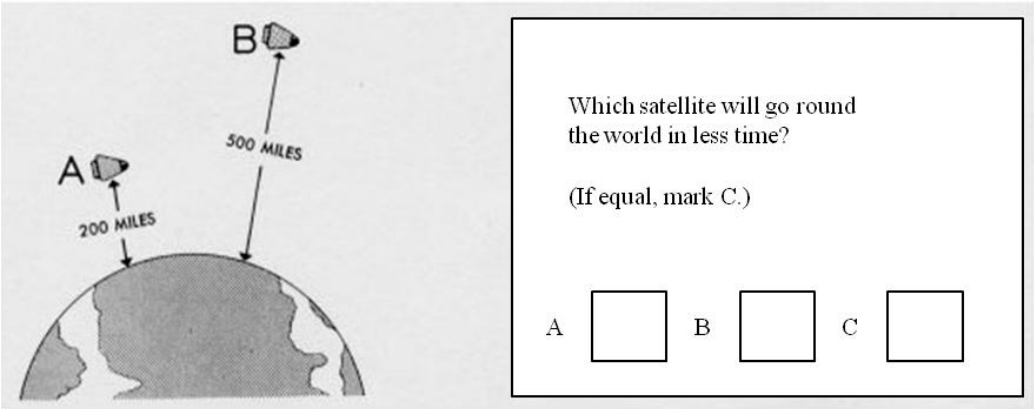


Figure 6.3 Sample items from the Mechanical ability measure

6.3.2 Spatial ability

Closely related to Mechanical ability, is Spatial ability. Spatial ability has been defined as 'the ability to visualise or mentally manipulate two or three dimensional objects' (Lowman, 1991, *p*.64). Research would suggest that Spatial and Mechanical Abilities are strongly associated and indeed some researchers have found evidence of a Spatial-Mechanical factor (Bennett & Cruikshank, 1942; Vernon, 1950). The literature also suggests that Spatial abilities are influenced by practice and experience, and are expected to be important for many Realistic or Investigative occupations (Lowman, 1991).

Spatial ability has been constructed and measured in a number of different ways, for example McGee (1979) found in a review of the literature that there was convincing evidence for two main types of Spatial ability; Spatial visualisation and Spatial Orientation. More recently however researchers (e.g. Carroll, 1993 – see Figure 6.2) have found evidence for seven major spatial factors: Spatial Relations, Spatial Visualisation, Closure Speed, Closure Flexibility, Perceptual Speed, Spatial Scanning and Imagery. For the EAP measures of both Spatial Relations (specifically; Spatial Rotation) and Spatial Visualisation were developed and administered. These two measures being the most feasible to administer in a pen and paper group testing situation, and also because researchers (e.g. Mast & Jancke, 2007) consider that the other factors e.g. Closure Speed, Closure Flexibility and Perceptual Speed to load on other factors not directly linked to Spatial ability. Further to this, Dennis and Tapsfield (1996), considered a further type of spatial test - verbal tests of spatial ability. These types of measures are considered to have more ecological validity, as performance on this type of measure is more representative of the way spatial abilities are used in everyday life. Therefore, the three different measures of spatial ability initially administered in this current study were 1) Spatial Rotation, 2) Spatial Visualisation and a 3) Verbal test of Spatial ability.

6.3.2.1 Spatial Rotation

The Mental Rotations Task (MRT: Shepard & Metzler, 1971; Vandenberg & Kuse, 1978, and recently redrawn: Peters *et al*., 1995) is a spatial measure that involves the ability to imagine how objects will appear when they are rotated in three-dimensional (3-D) space. The MRT used in this study had 24 items, with each item having two correct answers. Each item consists of a 'criterion' figure (comprised of 10 cubes) presented to the left and four alternatives to match on the right (two of which are correct matches). Participants were timed and a maximum of 48 points was obtainable, where a point was only given for each correct answer. For this measure, the time limit was strict (10 minutes), and is therefore speed weighted. Participants were given both verbal and written instruction, and were able to practise two items. It should be noted that for adult participants, the scoring technique is more stringent, where a point is only given for each pair of correct answers. This less strict method of scoring was used as it gave children credit for each correct answer – and enables participants who misunderstood the instructions and only selected one answer for each item (this occasionally happened) to still gain a score on this measure.

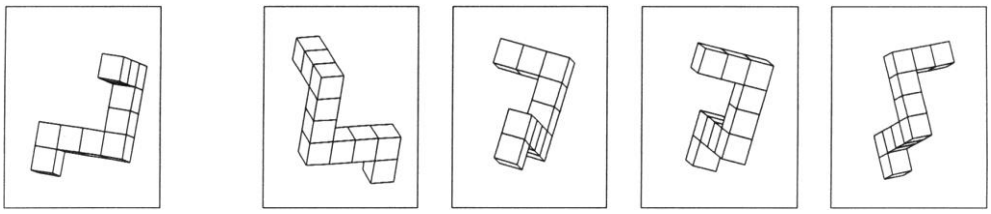
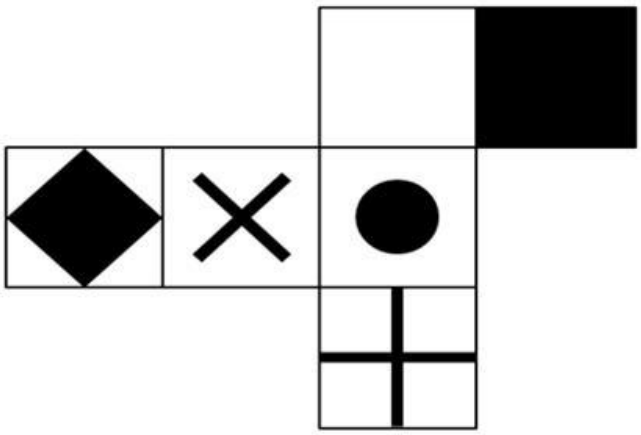


Figure 6.4 Sample item from the Spatial Rotation measure

6.3.2.2 Spatial Visualisation

The first measure used to measure Spatial Visualisation in this study was originally developed by Wright and Dennis (1992) for the Ministry of Defence for use in officer selection. This measure was adapted and simplified for use in the EAP as described in chapter 2. This is a measure of spatial visualisation in which item difficulty can be predicted from the form of the item. Participants were given both verbal and written instruction, and were able to practise one item. There are 18 items, and one point was awarded for each correct answer. There is a much more generous time limit for this test (20 minutes, or until they have all finished – whichever is earlier). Therefore, this measure is much less speed dependant than the MRT. Figure 6.5 shows an example item from the Spatial Visualisation measure.

Imagine that the figure below was printed on paper or card. The symbols are printed on the top of the card only and cannot be seen through the card. Which of the cubes below the figure could be made by folding it?



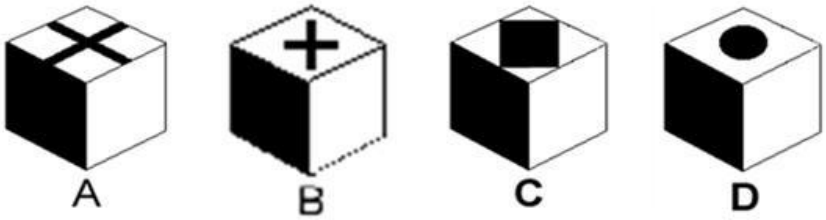


Figure 6.5 Sample item from the Spatial Visualisation measure

Out of the four choices, D is the only one of the four cubes where the faces appear as they would when the figure is folded. So D is the correct answer. The full version of this measure is in Appendix 2.1.

6.3.2.3 Verbal test of Spatial relations

The final measure used to measure spatial ability in this study was also developed for the purposes of the EAP (again, as described in chapter 2). This measure is a verbal test of Spatial ability and is similar to the 'Directions and Distance test (Dennis, Handley, Bradon, Evans & Newstead, 2002), but with the appropriate adaptations to suit a younger participant group. This type of test requires the participant to construct a mental image from a set of verbal information, and then answer a question relating to that mental image. Participants were given both verbal and written instruction, and were able to practise one item. Following the practice item, children were instructed not to write anything on the paper apart from their response to each question, and were closely monitored to check that they did not do so. Each item in this measure takes the following form:

B is in the square to the left of A. C is in the square below B. D is in the square to the left of C. Which of these pairs is furthest apart? (i) A and C (ii) B and D (iii) B and C (iv) A and D

There were 13 items, and one point was awarded for each correct answer, the full version of this measure is in Appendix 2.2.

6.3.3 Logical Reasoning ability

The Logical Reasoning measure used in this study was used in Handley, Capon, Beveridge, Dennis, and Evans (2004), which was developed following the work of Evans and Perry (1995), and Moshman and Franks (1986). This measure is strongly related to other measures of academic skill; reading, writing, numeracy and maths, and also cognitive skill; verbal working memory (Handley *et al.*, 2004).

The Logical Reasoning measure has a total of 24 items, 12 of which are based on transitive relations and 12 on conditional relations. Each logical form was paired with a believable, neutral or unbelievable conclusion, and a point was awarded for each correct answer given, giving a total possible score of 24 (See Handley *et al.* (2004) for detailed scoring instructions). As well being able to calculate an overall Logical Reasoning ability score, it is also possible to calculate three additional indices from these 24 items. These are Belief Index – which reflects the number of responses that were consistent with how believable the conclusion was (irrespective of the logical structure of the item); Logic Thematic Index – which is a measure of logical performance on all items apart from the one with a neutral (arbitrary) conclusions; and Logic Neutral Index which indicates performance on items that had a neutral conclusion. Based on work on reasoning development (e.g. Markovits, Scheifler & Fortier, 1989, and Moshman 1990) , it is

expected that scores on the Belief Index will decrease over time, and scores on the Logic Thematic and Neutral indexes will increase with time.

Participants were given both verbal and written instruction, and were able to practise one item. The full set of instructions and 24 items are available in Handley *et al*., (2004) but example items have been given below, one transitive and one conditional. Participants respond to each item by circling either yes, no, or it is not possible to say.

Transitive Reasoning item

Babies are older than children
Children are older than adults
So, are adults older than babies?

Conditional Reasoning item

Elephants have long noses
Animals with long noses are not heavy
So, are elephants heavy?

6.4 Ability stability

This section will explore how stable the ability scores were over the two year time period, for both the group as a whole and for the males and female participants separately. In addition, the differences between raw scores for the children whilst they were in Year 7 and Year 9 have been analysed using

a mixed between-subjects analysis of variance (gender * time) for each of the ability measures used. This combination of analyses will enable conclusion to be drawn about the stability of the ability measures used in this project, but also the extent to which the children improved on the various ability measures over time, and whether this improvement differed by gender.

Participants completed the pen and paper based assessments in group testing sessions as per the methods described in chapter 2. Mean raw scores for each measure, plus standard deviations, and stability coefficients are presented in Table 6.2. Scores are given for the group and for males and females separately at each time point.

Table 6.2 Mean raw scores for each of the ability measures and their associated test-retest coefficients

	Year 7	**Year 9**			**Year 7 males**	**Year 9 males**			**Year 7 females**	**Year 9 females**		
	M(SD)	**M (SD)**	**N**	***r***	**M(SD)**	**M (SD)**	**N**	***r***	**M(SD)**	**M (SD)**	**N**	***r***
Measure (Total possible)												
Mechanical (24)	12.53 (2.99)	14.01 (3.21)	312	.46**	12.68 (3.37)	14.47 (3.36)	158	.56**	12.37 (2.54)	13.54 (2.99)	154	.31**
Spatial Rotation (48)	20.90 (7.47)	23.25 (8.59)	311	.16**	21.47 (8.01)	24.79 (9.07)	154	.12	20.33 (6.88)	21.74 (7.83)	157	.19*
Spatial Relations (18)	4.84 (2.52)	n/a	454		4.75 (2.62)	n/a	238		4.94 (2.14)	n/a	216	
Spatial Visualisation (13)	4.06 (2.08)	n/a	415		3.99 (2.09)	n/a	219		4.15 (2.06)	n/a	196	
Logical Reasoning (24)	11.05 (4.58)	12.05 (4.29)	308	.40**	11.49 (4.84)	12.04 (4.32)	147	.41**	10.65 (4.31)	12.06 (4.27)	161	.39**
Logic Belief (16)	9.67 (3.50)	8.95 (3.03)	310	.22**	9.24 (3.61)	9.05 (3.14)	149	.20*	10.06 (3.35)	8.86 (2.94)	161	.24**
Logic Thematic (16)	7.12 (3.34)	7.59 (2.80)	309	.38**	7.38 (3.55)	7.53 (2.79)	147	.40**	6.88 (3.14)	7.65 (2.81)	162	.37**
Logic Neutral (8)	3.87 (1.58)	4.02 (1.52)	310	.29**	4.00 (1.69)	4.03 (1.57)	149	.29**	3.75 (1.46)	4.01 (1.47)	161	.29**

* significant at $p < .05$; ** significant at $p < .01$. (Note that mean scores are only reported for participants who completed measures at both time points (resulting in larger N for measures for the two spatial visualisation measures which were only administered in Year 7).

Table 6.2 shows a clear picture; participant performance on all of the ability measures increased over time, as would be expected with increased age and educational experience. Percentage correct increases for the Engineering measure were marginally higher than that seen in the Spatial and Logical Reasoning measure. As already detailed in chapter 2, the two Spatial Visualisation measures were removed from the battery of tests administered at Year 9. The main reason for this was that children were performing at chance on these two measures (see Table 6.2 for child performance data). Reliability statistics have been presented for each of the ability measures in Table 6.3; where possible, published reliability statistics have been given. Cronbach alpha statistics have not been computed for the Spatial Rotation measure on the current dataset as it is a timed test, and therefore not considered appropriate. It possible to see that overall reliability was good, though the low score for the Mechanical measure is noted.

Table 6.3 Reliability statistics for the ability measures

Ability Measure	Source	Type	Score
Mechanical	Year 7 data collection, present study.	Cronbach α	.47
Spatial Rotation	Vandenberg and Kuse (1978).	Test-retest Kuder-Richardson	.83 .88
Logic	Year 7 data collection, present study.	Cronbach α	.83
Logic Belief	Handley *et al*. (1994). Year 7 data collection, present study	Cronbach α Cronbach α	.81 .78
Logic Thematic	Handley *et al*. (1994). Year 7 data collection, present study	Cronbach α Cronbach α	.85 .68
Logic Neutral	Handley *et al*. (1994). Year 7 data collection, present study	Cronbach α Cronbach α	.57 .75

6.4.1 Ability stability – Mechanical

Table 6.2 shows that the Mechanical measure was the most stable ability measure over time out of the three ability measures used. The raw scores for the Mechanical measure in Table 6.2 show that the male participants had higher scores Year 9 than the females. A mixed between-within subjects analysis of variance was conducted to assess the change in scores over the two time periods. There was no significant interaction between gender and time for Mechanical scores; F (1,310) = 2.92, p = .09. There was a main effect of time, F (1,310) =66.03, p <.01, μ .18. There was a main effect of gender, F (1,310) = 4.28, p <.05, μ .01. This analysis indicates that group scores on the Mechanical measure significantly increased with time, and

that this increase was similar for males and females. Males did score higher on the Mechanical measure overall. Scores on the Mechanical measure were reasonably stable over time for both genders, and interestingly the correlational data suggests that the Mechanical scores were more stable for the male participants than for the females. The stability coefficients for this measure have potential practical implications for careers guidance for young people aged 11-12 and will be discussed later in chapter 7.

6.4.2 Ability stability – Spatial Rotation

As can be seen in Table 6.2, scores on the Spatial Rotation measure were far less consistent over time. So, although the group overall were doing better in Year 9 on the Spatial Rotation measure, these children as not necessarily the same children who were doing well on this measure in Year 7. A mixed between-within subjects ANOVA was conducted to assess the change in scores over the two time periods. The analysis revealed that there was no significant interaction between gender and time for Spatial Rotation scores; F (1,309) = 2.64, p = .11. There was a main effect of time, F (1,309) = 16.10, p <.01, µ .05. There was a significant effect of gender, F (1,309) = 9.36, p <.05, µ = .03.

So, the group as a whole improved in their Spatial Rotation ability over time, and this increase over time was not significantly different for males

and females within that group, males overall had significantly higher Spatial Rotation scores in general however. It is noted that the effect size of time is only .05 and therefore indicates that the increase in Spatial Rotation scores was relatively very small.

6.4.3 Ability stability – Logical Reasoning

Scores for three of the Logic measures; Logical Reasoning (complete), Logic Thematic and Logic Neutral all increased over time. Three mixed between-within subjects analysis of variance analyses were conducted to assess the change in scores over the two time periods.

There was no significant interaction between gender and time for Logical Reasoning scores; F (1,306) = 2.44, p = .12. There was a main effect of time, F (1,306) = 12.41, p <.01, µ .04. There was not a significant main effect of gender, F (1,306) = .97, p = .32. There was no significant interaction between gender and time for Logic Thematic scores; F (1,307) = 2.53, p = .11. There was a main effect of time, F (1,307), p <.01, µ .02. There was not a significant main effect of gender F (1,307) = .44, p = 50. There was no significant interaction between gender and time for Logic Neutral scores; F (1,308) = 1.38, p = .24. There was not a main effect of time, F (1,308) = 1.87, p = .17. There was not a significant main effect of gender, F (1,308) = .95, p = .33.

These results show that scores on the Logical Reasoning and the Logic Thematic indices significantly increased over time; and that the rate of any change was not significantly different for the males and females in the group. Scores on the Logic Neutral measure did not significantly improve over the two year time period.

Scores on the Logic Belief Index decreased over time, which again was as expected as previous research has shown that there is a significant negative correlation (r = -.38) between age and the ability to reason independently from personal beliefs and experiences (Handley *et al.*, 2004). When inspecting the raw scores for the male and female participants, it can be seen that this change occurs in the female participants, whilst raw scores for the males only change marginally. A mixed between-within subjects ANOVA was conducted to assess the change in Belief Index scores over the two time periods. There was a significant interaction between gender and time for Logic Belief scores; F (1,308) = 4.81, p < .05 µ .02. There was a main effect of time, F (1,308) = 9.01, p <.01, µ .03. There was not a significant main effect of gender, F (1,308) = 1.21, p = .27. These results suggest that as the females got older they were less likely to be influenced by their prior beliefs when the logically correct solution to an item was inconsistent with those beliefs. This was not necessarily the case for the males as their mean scores remained largely the same over the two year time period.

6.5 Relationships between the ability factors

In this section the ability inter-factor correlations have been calculated. It is predicted that all measures will be related, but that the relationship between the Mechanical and Spatial measures will be the strongest as research (e.g. Vernon, 1950, and more recently, Harvey, 1985) has consistently found that these two ability areas are closely related).

Table 6.4 Relationships between the ability measures at Year 7 and Year 9 (N range 299-468)

	Year 7					**Year 9**					
	Spatial	**Logical**	**Logic Belief**	**Logic Thematic**	**Logic Neutral**	**Mechanical**	**Spatial**	**Logical**	**Logic Belief**	**Logic Thematic**	**Logic Neutral**
Year 7											
Mechanical	.14**	.16**	-.01	.17**	.12**	.46**	.15**	.20**	-.05	.23**	.08
Spatial	/	.21**	-.06	.20**	.17**	.15**	.16**	.12**	-.05	.15**	.10
Logical	/	/	-.50	.96**	.84**	.19**	.14**	.40**	-27**	.40**	.29**
Year 9											
Mechanical	/	/	-.05	.23**	.08	/	.09	.32**	-.17**	.33**	.25**
Spatial	/	/	-.06	.15**	.10	/	/	.20**	-.11	.22**	.11
Logical	/	/	-.27**	.40**	.29**	/	/	/	-55**	.96**	.83**

** Significant at $p < .01$.

Table 6.3 displays the correlational data between the key ability measures at both time points. From Table 6.3 is it possible to see that there is a weak (but significant) positive association between the Mechanical and Spatial Rotation measures in Year 7, as predicted. However, this association disappears when looking at the relationship between both measures at Year 9. Furthermore there is a weak (but again significant) association between the Spatial and Logical Reasoning Scores, which continues in Year 9. Mechanical scores are significantly related to the Logical Reasoning scores, and this relationship increases over time. Logical Reasoning scores are negatively related to the Logic Belief Index scores which is as would be expected, as individuals become more able to reason independently of their own beliefs their score on the Logic Belief index will decrease, and increase on the overall Logical Reasoning measure.

6.6 Relationships between ability and interest factor scores

As discussed in Section 6.2.2., previous research has identified that there are relationships between objectively measured Abilities and Vocational interests (as summarised in Ackerman & Heggestad, 1997). Specifically, the data is suggestive of a positive association between Realistic interests and Mechanical and Spatial abilities. In this section, correlational analysis has been completed between the various ability measures and the mean interest

factor scores at each of the two time points. This analysis has been conducted to identify if there are relationships between ability and vocational Interest whilst the children are in Year 7 and Year 9.

6.6.1 Relationships between interests at Year 7 & 9 with abilities at Year 7

In this section, the relationships between all interest factors (both time points) and ability scores at Year 7, are presented. This data has been presented to further explore the extent to which Mechanical, Spatial Rotation and Logical Reasoning ability at Year 7 is related to interests. Significant correlations are in bold typeface. It should be noted that the correlational analysis has just been presented for the entire group at each time point as no clear pattern of difference in relations was found between the males and female participants.

Table 6.5 Relationships between interest factors at Year 7 & 9 and ability scores at Year 7 (N = 227 – 356)

	Ability Year 7					
	Mechanical	**Spatial**	**Logical**	**Logic Belief**	**Logic Thematic**	**Logic Neutral**
Interests						
Year 7						
Realistic	.14	.10	.04	-.09	.03	.04
Investigative	.09	.07	.03	-.08	.03	.03
Artistic	-.01	.10	.10	.10	.11	.08
Social	-.10	.07	-.06	.02	-.04	-.07
Enterprising	.04	.01	-.06	.06	-.05	-.07
Conventional	.09	.07	.01	-.01	.01	.01
Year 9						
Realistic	.05	.05	.08	-.02	.09	.04
Investigative	.09	.06	.07	-.04	.07	.02
Artistic	.03	-.01	.12	-.01	.10	.13
Social	-.01	-.03	.00	.06	.01	.00
Enterprising	-.03	-.04	.04	.00	.04	.01
Conventional	.10	.03	.10	-.02	.12	.05

Table 6.4 shows that there are no highly significant associations between ability scores in Year 7 and interests at either year (conservative significance levels have been used here). There is a week relationship between Mechanical ability and Realistic interests in Year 7 (as predicted), which later disappears when looking at the association between Mechanical ability in Year 7 and Realistic interest in Year 9. This would perhaps suggest that early Mechanical ability is not predictive of later interest.

6.6.2 Relationships between interests at Year 7 & 9 with abilities at Year 9

In this section, the relationships between all interest measures (both time points) and ability scores at Year 9 are now presented.

Table 6.6 Relationships between interest factors at Year 7 & 9 and ability scores at Year 9 7 (N = 227 – 356)

	Ability Year 9					
	Mechanical	**Spatial**	**Logical**	**Logic Belief**	**Logic Thematic**	**Logic Neutral**
Interests						
Year 7						
Realistic	**.23****	.15	.09	-.04	.09	.10
Investigative	.08	.02	.02	.04	.03	.04
Artistic	.04	-.02	.08	.04	.07	.15
Social	.12	-.06	.02	.02	.00	.06
Enterprising	.04	.05	-.04	.13	-.05	.00
Conventional	.00	.01	.00	.16	.04	.09
Year 9						
Realistic	.15	.10	-.04	.10	-.10	.00
Investigative	**.21****	.03	.05	.00	.08	.02
Artistic	-.05	-.03	.02	.03	.02	.06
Social	.10	-.03	-.03	.06	.00	-.05
Enterprising	.00	.00	.01	.03	.00	.05
Conventional	.05	.06	.02	.08	.00	.08

* Significant at $p < .01$.

Table 6.5 shows that again that there are only two significant relationships between ability and interest. Indeed the only clear associations are between Mechanical ability at Year 9 and Realistic interests at both Year 7, and between Mechanical ability and Investigative interests in Year 9. The pattern of relations between Mechanical and Realistic is encouraging; and it does provide some evidence for there being a stronger relationship between Realistic Year 7 and Mechanical ability Year 9 (r = .23**) than between Realistic Year 9 and Mechanical ability Year 7 (r =.05). Using Fisher's r to z transformation analysis, it was possible to see that the difference between these two correlation coefficients is significant (z = 2.11, p <.05, 2 tailed).

Furthermore, the data presented in Table 6.5 suggests that potentially any association between Mechanical ability and Investigative interest doesn't emerge until the children are in Year 9.

6.6.3 The relationship between Realistic interests and Mechanical ability

In light of the data presented in Section 6.6.1 and 6.6.2, it was decided that the relationship between Realistic interests and Mechanical ability warranted further exploration. A regression analysis was completed on the data, to evaluate predictors of both Realistic interest at Year 9 and Mechanical ability at Year 9 separately.

Model 1

Multiple regression was used to assess if Mechanical ability scores at Year 7 and at Year 9 could predict Realistic interest scores at Year 9. Preliminary analyses were conducted to ensure no violations of the assumptions of normality, linearity, multicollinearity and homoscedasticy. The total variance explained by the model as a whole was 2.2 %. F (2,272) = 3.12, $p < .05$. Mechanical ability scores at Year 9 were a significant predictor of Realistic interests at Year 9 (beta = .06, $p < .05$).

Model 2

Multiple regression was used to assess if Realistic interest scores (Year 7 and Year 9) could predict Mechanical ability scores at Year 9. Preliminary

analyses were conducted to ensure no violations of the assumptions of normality, linearity, multicollinearity and homoscedasticy. The total variance explained by the model as a whole was 5.2%. F (2,225) = 6.13, p <.01. Only Realistic interest scores at Year 7 were statistically significant predictor (beta = .52, p < .05).

The results of this regression analysis demonstrate that Realistic interest at Year 7 significantly predicts Mechanical ability at Year 9 (but Mechanical ability at Year 7 does not reliably predict Realistic interests at Year 9). The total variance explained by Model 2 was very low, and therefore means that there are a number of other unmeasured influencing factors that also explain the variability in Mechanical ability Year 9 scores. However, these results do suggest that for Mechanical ability at least, increased Realistic interests at aged 11-12, can lead to increased Mechanical ability when aged 13-14. But for the other interest factors, the picture is far less clear.

6.7 Ability and interest dimension scores

In this section correlational analysis has been completed between the ability measures and the mean Dimension scores calculated for each of the two time points. Dimension scores incorporate scores on all of the six RIASEC factors for the 'Things/People' dimension, and incorporate scores on four of the factors for the 'Data/Ideas' dimension. Therefore, dimension scores can

be a lot more informative, as they take into account the wide range of interests and scores on the majority of the PVII measure. As already stated in chapter 5, positive ‘Things’/‘People’ Dimension score reflects ‘Things’ and a negative ‘Things’/‘People’ Dimension score reflects ‘People’. A positive ‘Data’/’Ideas’ score indicates ‘Data’ and a negative ‘Data’/’Ideas’ score indicates ‘Ideas’.

It is predicted that there will be a positive association between Mechanical ability and a positive score on the ‘Things’/‘People’ Dimension. As the data presented in Tables 6.4 and 6.5 suggests a stronger relationship between Realistic interest at Year 7 and Mechanical ability in Year 9 than between Mechanical ability in Year 7 and Realistic interest in Year 9, the same pattern is expected to be displayed in Table 6.7.

Table 6.7 The relationship between dimension scores and ability (N = 227- 468)

	Ability Year 7					
	Mechanical	**Spatial**	**Logical**	**Logic Belief**	**Logic Thematic**	**Logic Neutral**
Dimensions						
'Things'/'People' 7	**.16****	.03	.05	-.07	.03	.06
'Things/'People' 9	.03	.05	-.04	.05	.05	.00
'Data'/'Ideas' 7	.04	-.08	**-.15****	**.18****	**-.14****	**-.12***
'Data'/'Ideas' 9	-.05	-.06	-.01	.05	-.04	-.08
	Ability Year 9					
	Mechanical	**Spatial**	**Logical**	**Logic Belief**	**Logic Thematic**	**Logic Neutral**
Dimensions						
'Things'/'People' 7	**.21****	.12	.04	.00	.05	.02
'Things'/'People' 9	**.17****	.10	-.02	.01	-.04	.03
'Data'/'Ideas' 7	**-.13***	.04	-.10	**.20***	**-.13***	-.07
'Data'/'Ideas'9	-.02	.02	-.05	-.08	.07	.00

* Significant at $p < .05$; ** significant at $p < .01$.

Table 6.6 shows associations between 'Things' and Mechanical ability as expected, with the strongest association seen between 'Things' in Year 7 and Mechanical ability in Year 9. There is also a significant relationship between 'Ideas' and Mechanical ability in Year 9, which is interesting as 'Ideas' does include 'Interpersonal tasks involving abstractions, theories, knowledge, insights; and relates to occupations such as 'Scientists'. 'Ideas' is essentially a combination of scores on the Investigative and Artistic interest factors (minus any score on the Enterprising and Conventional factors). This suggests that not only do Realistic interests relate to later Mechanical ability, but also scores on Investigative and Artistic (and relative interest in these factors relative to the other three factors).

Multiple regression was used to assess the extent to which ‘Things’ scores in Year 7 and Year 9 could predict Mechanical ability scores at Year 9. Preliminary analyses were conducted to ensure no violations of the assumptions of normality, linearity, multicollinearity and homoscedasticy. The total variance explained by the model as a whole was 4.7%. F (2,224) = 5.55, $p < .01$. The results showed that Year 7 ‘Things’ scores at Year 7 were a statistically significant predictor of Mechanical ability in Year 9 (beta = .12, $p <.05$), but ‘Things’ scores at Year 9 was not.

Furthermore, Multiple regression was used to assess to extent to which Realistic scores in Year 7 and ‘Ideas’ scores in Year 7 together could predict Mechanical ability scores at Year 9. Preliminary analyses were conducted to ensure no violations of the assumptions of normality, linearity, multicollinearity and homoscedasticy. The total variance explained by the model as a whole was 7.8%. F (2,243) = 10.27, $p < .001$. Realistic interest scores at Year 7 were a statistically significant predictor of Mechanical ability in Year 9 (beta = .63, $p <.001$), as was ‘Ideas’ (beta = -.24, $p < .01$). The results of the regression analysis show that both Realistic interests at Year 7 and ‘Ideas’ at Year 7 significantly predict Mechanical ability in Year 9. The amount of variance explained is still low, at only 7.8%, but is more than that predicted by Realistic scores at Year 7 alone, suggesting that interest in Investigative and or Artistic activities (and a lesser interest in Enterprising or Social activities) is also linked to Mechanical ability.

Table 6.6 also shows a link between scores on the Logic thematic index and interest in 'Ideas', and an association between Logic belief index scores and interest in 'Data'. Interestingly these associations were only seen between interests and Logic ability in Year 7 or between interests in Year 7 and Logic ability in Year 9; the associations disappeared when looking at both measures in Year 9. This suggests early interest in 'Data' (Impersonal tasks involving facts, records, numbers etc.) leads to the child still be being biased by their previous beliefs in Year 9. Whereas early interest in 'Ideas' (definition stated earlier) leads to increased scores on the Logic Thematic Index which is a measure of how well the child is able to inhibit their past beliefs and identify the logically correct answer. It is acknowledged though that the degree of association between these sets of measures is very weak, but it does provide evidence for a small link between scores on the 'Data/Ideas' dimension and Logical Reasoning ability. There are no significant associations between Spatial ability and dimension scores, though the correlation between 'Things' Year 7 and Spatial ability in Year 9 was approaching significance (p = .07). This section has demonstrated that there are a number of weak associations between dimension scores and ability, with the overall pattern of results suggesting earlier interests are more predictive of later ability than earlier ability predicting later interests.

6.8 Ability and interest level scores

As mentioned earlier, Ackerman and Heggestad (1997) describe previous research (Terman, 1954; Holland, 1959) that is indicative of a positive relationship between level of intellectual ability and interest level overall (i.e. the Sum of all RIASEC factor scores at either Year 7 or Year 9). Terman (1954) found an association between objectively measured levels of intellectual ability and the amount of interest items participants reported they were interested in.

The relationship between level scores for both Year 7 and Year 9 and the ability measures is presented in Table 6.7.

Table 6.8 The relationship between level scores and ability

	Ability Year 7					
	Mechanical	**Spatial**	**Logical**	**Logic Belief**	**Logic Thematic**	**Logic Neutral**
Level score Year 7	.07	**.11***	.02	-.05	.03	.01
Level score Year 9	.04	.00	**.14***	.08	**.15***	.09
	Ability Year 9					
	Mechanical	**Spatial**	**Logical**	**Logic Belief**	**Logic Thematic**	**Logic Neutral**
Level score Year 7	.05	.05	.05	.06	.03	.12
Level score Year 9	.07	.04	-.02	.08	-.02	.05

* Significant at $p < .05$.

Table 6.7 shows that there are a few weak significant correlations between Level scores and ability scores. In particular there is a weak correlation between Year 7 Level scores and Year 7 Spatial Rotation ability, and a further weak association between Year 9 Level scores and Logical ability in

Year 7. These results suggest that there is a small link between Logical Reasoning ability and later breadth of interests.

There are a few significant correlations between the ability measures in Year 9 and Level scores, between Spatial ability and interest level scores at Year 7, and between Logical ability at Year 7 with interest level scores at Year 9. On the whole, the associations are weak however, and do not strongly support the findings by Terman, (1954) where a positive association was found between intellectual ability and Level scores. It is considered that the general lack of association in this current study may be due, in part, to the fact that Terman's participants were a gifted sample, and that different measures of objectively measured ability were used – i.e. that any association between Level scores and ability may only be present for a select group of participants.

6.9 Ability, interests and gender

As previously noted, there is limited published work on the relationships between abilities and interests, but there is work that has looked at abilities and gender which give some insight into this area. In this chapter, the data analysis revealed that males did perform significantly better on the Mechanical and Spatial measures (though only marginally). Interestingly, some researchers have suggested that experience with spatial activities may

account for this difference, (e.g. Voyer, Nolan & Voyer, 2000). However, a more recent paper (Terlecki, Newcombe & Little, 2008) found that increased experience (or practice) ultimately resulted in similar levels of improvement overall, but that the rates of growth were different for males and females. Males showed higher levels of improvement at the start, whereas females also improved a number of months later on. With this in mind, future research should record the children's levels of prior engagement with spatial activities to rule out this potential confound. However, with regards to Reasoning, research has been mixed, with some studies (e.g. Morgan, 1956) showing males outperforming females, but other work (with adolescents) showing more inconsistent findings (e.g. Ennis & Paulus, 1965; Roberge & Paulus, 1971).

The results presented in this chapter have shown no significant differences with regards to Logical Reasoning ability scores and gender – but rather a significant interaction between gender * time for the Logic Belief Index scores. These results suggest that females were more able to inhibit their prior beliefs and more able reason logically with increased age, whereas the males had the same Logic Belief scores in both Years 7 and in Year 9.

6.10 Chapter summary

This chapter has taken a close look at the relationship between vocational interests and selected abilities in secondary school aged children. Furthermore the relationship between interests, abilities and gender has been considered. At the outset of this chapter the scores on the ability measures were presented and discussed, which clearly showed that performance on the ability measures was increasing with time. This is to be expected, and is consistent with research that has shown that scores on Mechanical ability measures do tend to increase with increased age and experience (e.g. Super & Crites, 1962).

There was differential performance on the Mechanical and Spatial Rotation measures for males and females, with males performing significantly better on both of these two measures overall (although improvement over time did not significantly interact with gender).

Scores on the Logical Reasoning measure increased with time in a similar manner for both males and females overall, though a significant reduction for the Logic Belief Index scores was seen for the female participants over time. This suggests that the females in particular were improving on their ability to decontextualise their thinking from their prior beliefs with increased age. However, as mentioned earlier, further research is clearly

needed to explore the link between Logical Reasoning, gender and how this develops over time in adolescence. Success on the Logical Reasoning measure is related to success on a whole range of other academic skills. Handley *et al.* (2004) found that a number of academic skills, namely Maths, Reading, Writing and Numeracy were strongly correlated to the Logic Thematic Index scores ($r = .47\text{-}.65$ $p < .01$). These results reinforce the view that the ability to reason and problem solve is strongly related to the ability to do well in school, and in later study. Recent work has found evidence to suggest that reasoning skills can be strengthened by practise and instruction in adult participants (e.g. Neilens, Handley & Newstead, 2009). It would be interesting to see if the reasoning skills of younger participants would also benefit from a similar type of intervention.

Closely related to this idea of intervention is Terlicki *et al.*'s (2008) findings; that Spatial Rotation skills can be improved with the appropriate kind of practice. This finding is undoubtedly very promising. Indeed, the potential for school children who have poorer spatial skills to be able to improve these skills by utility of a computer programme certainly does warrant further investigation. Furthermore, the idea that Mechanical, Spatial Rotation and Logical Reasoning skill have the ability to be strengthened by intervention or experience may be of interest to employers in the Engineering and Technology sectors. Particularly as these specific skills are

key to jobs where recruitment levels are reported to be low and significantly under target (IET, 2011).

The ability inter-factor correlational analysis revealed a small significant positive association between Mechanical and Spatial Rotation ability in Year 7, which was as predicted, but this relationship disappeared in Year 9. This is perhaps suggestive of these skills becoming more divergent as the children got older. Interesting, the Mechanical ability scores were more linked to the Logical Reasoning ability scores, which increased over time. On the whole the associations between the ability measures were small, indicating that all three measures were measuring quite different constructs. In Section 6.6 the relationships between the ability and interest measures at each timepoint are presented. In this section it was revealed that there were a few significant associations between Abilities and interests, but most of the associations were weak. The main finding from this section is the pattern of association between Realistic interests and Mechanical ability. The pattern of correlations in Tables 6.4 and 6.5 were suggestive of a stronger link between Realistic interest at Year 7 and Mechanical ability at Year 9 than between Mechanical ability at Year 7 and Realistic interest in Year 9. Indeed, a regression analysis confirmed that Realistic interests at Year 7 were indeed a significant predictor of Mechanical ability at Year 9, but Realistic interests at Year 9 were not so. Similarly, Mechanical ability at Year 7 or 9 was not a significant predictor of Realistic interests at Year 9.

These findings provide some evidence for a causal pathway for the development of Mechanical ability, suggesting that earlier interest in this area may well contribute to the later development of objectively measured skill in this area. It is of course acknowledged that the amount of variance explained in Mechanical ability at Year 9 was only 5.2%, indicating that there clearly are additional factors that also contribute to the development of Mechanical ability at Year 9. A regression analysis was also completed (not reported) looking at the contribution of both gender and Realistic interests at Year 7, and it was found that gender was not a significant predictor of Mechanical skill at Year 9.

The next section looked at the relationships between interest Dimension scores and Abilities. Dimension scores can be more informative than just looking at factor scores alone, as they are calculated from a number of factor scores and take in account relative differences between factor scores. The analysis completed in this section showed that 'Ideas' Year 7 significantly predicted later Mechanical skill, and indeed added to the amount of variance explained by Realistic interests in Year 7 alone. Again it is noted however, that the amount of variance explained by Realistic Year 7 and 'Ideas' Year 7 was still low (7.8%). Research suggests (Super & Crites, 1962) that increased experience of mechanical activities in everyday life contributes to increased mechanical skill, and as such it likely that mechanical experience could be a further important predictor of later

mechanical skill. In addition to the significant relationships between Dimension scores and Mechanical skill, there were also some weak significant associations between Year 7 Dimension scores for ‘Data’ and ‘Ideas’ and Logical ability at both years 7 and 9. The findings suggest that the children who scored higher on ‘Data’ were more likely to be influenced by their prior beliefs (Logic Belief Index), and children who scored higher on ‘Ideas’ were more able to inhibit their prior beliefs and answer with the logically correct answer (Logic Thematic Index). This could be seen to be consistent with the descriptions Prediger (1982b) gives; ‘Data’ relates to facts, records and files; and ‘Ideas’ relate to ‘abstractions, theories, and insights’ – i.e. individuals who prefer facts and data may find it more difficult to reason outside of their existing knowledge base, whereas individuals who prefer abstract thought and theorising may find it easier to do. There was a small relationship between Spatial ability and interest level scores in Year 7, but this disappeared in Year 9. In addition, there was a weak relationship between Logical ability in Year 7 and later Level scores in Year 9, this suggests that earlier Logical ability is in part related to later breadth of interests. The patterns of relations between Abilities and interests are on the whole weak, and as such it has not been possible to make any definite conclusions about the causal pathway between Vocational interests and ability in general. The battery of measures used was of course limited to those relevant to engineering disciplines and as such the data is suggestive

of a small link between earlier engineering interest and later engineering skill. But it is impossible to conclude much further beyond this at this point. It is further acknowledged that the PVII interest measure has its own limitations and this may have also in part contributed to the small degree of relation between ability and Vocational interest seen in this chapter.

It is further considered that a number of research studies have also evaluated the relationship between Verbal ability and interests, whereas the present study did not have the capacity to also measure Verbal ability. As previous research has revealed a number of interesting findings (see Table 6.1) regarding the relationship between Verbal ability and Artistic interests, it is suggested that further longitudinal work is also needed to assess the relationship between Vocational interests and Verbal ability in adolescence. Whilst out of the remit of this project, it is suggested that future work is focussed on following up children during the course of their secondary school years and beyond to further understand how abilities and vocational interests co-develop over time. The next and final chapter will now summarise and discuss the main findings from this thesis and identify both theoretical and practical implications arising from this body of work. Limitations and future directions will also be presented.

Chapter 7 General discussion

7.1 Introduction to the chapter

This programme of work has focussed on the measurement, structure and stability of vocational interests and selected abilities in mainstream, mixed-ability secondary school aged children aged 11-17. A novel measure of vocational interests was adapted from a measure developed in a related project for gifted children. This new interest measure (PVII2) used Holland's (1959) widely used and accepted framework of six interest types; Realistic, Investigative, Artistic, Social, Conventional and Enterprising.

The PVII2 was administered alongside ability measures to cohorts of Year 7 children at three separate schools in the South West of England. These ability tests measured Mechanical, Spatial Rotation and Logical Reasoning ability and were chosen as they were specifically related to the skills required for success in Engineering, Technology and Science roles. The children at the three schools were followed up two years later (when they were in Year 9) to examine 1) how their vocational interests had developed and changed over time, with regards to both vocational interest structure and stability; and 2) how the three abilities were related to vocational interests, and to what extent ability mediates the development of vocational interests

in school aged children. In addition to following up these cohorts of Year 7 children, the structure of interests in two groups of older children (Year 10 and Year 12) was also analysed to see how the structure of interests develops over time in adolescence from age 11 to age 17. There is a broad consensus amongst researchers that responses to interest factors are stable over time once individuals reach adulthood. Furthermore, it is also considered that the relationships between factors are structured in a hexagonal format in adults but published research at the start of the project was far less conclusive with regards to how the interests of children aged 17 and younger develop.

One of the issues for previous research has been that many interest inventories are not suitable for individuals younger than 16 years of age. Despite this, a few studies have concluded that vocational interests in children aged 12 to 16 have moderate levels of stability (e.g. Tracey, 2002a, Tracey & Ward, 1998). Similarly, research has found evidence (e.g. Tracey & Ward, 1998) to support the view that the structure of interests can be more and more accurately described by the hexagonal RIASEC structure as children get older. Indeed, there is also some evidence to suggest that the structure of interests does not significantly change after the age of 14 (e.g. Tracey & Robbins, 2005). Therefore of particular interest in the present study has been to further inspect the development of interests in children younger than 14. The influence of gender has also been noted in previous

research when exploring the nature of vocational interests (e.g. Tracey & Ward, 1998). Tracey and Ward (1998) consider that gender does have an impact on scores on the six RIASEC factors for students aged between 16-18; specifically that Realistic scores increase over time for males significantly more than any increase seen in females. In addition it was found that for the Investigative, Artistic, Social and Enterprising factors, male scores increased, but female scores decreased over time. The present study has explored the nature of interests in the entire group of Year 7 children, but analysis has also been presented for the male and female participants separately to explore any additional influences of gender.

As already noted for vocational interests, there is also limited published work which has explored the links between vocational interests and abilities in adolescence. Ackerman and Heggestad's (1997) review reported on numerous relationships between vocational interest and objectively measured ability in adults (see Table 6.1). It was noted that a number of research studies found significant positive relationships between Realistic interest and both Mechanical and Spatial ability, and negative relationships were seen between Social interests and Mechanical and Spatial ability. Significant positive relationships were also shown to exist between Artistic interests and Verbal ability, though Verbal ability was not measured within the scope of this present study. What is still unclear from the literature is the nature of the relationship between vocational interest and ability, i.e. do they

develop in tandem, or does one influence the other. Within the current study, as both vocational interests and abilities were measured at two time points two years apart, it has been possible to explore the resulting data to see if measured abilities in Year 7 predict later interests at Year 9 or if indeed interests at Year 7 predict later abilities at Year 9 using regression analyses. It is acknowledged that there are numerous likely factors influencing the development of children's abilities and interests at this age (which include opportunity, education, experience, access to appropriate role models, school environment, and their relationships with their family and peers to name but a few). However, if the data analysis can start to explain why children may develop certain types of interest or abilities at Year 9 before they make their G.C.S.E subject selections, this can only add to a child's careers counselling experience, and could potentially help assist vocational counsellors identify appropriate advice and interventions for those children. It is the overall aim of this body of work to add to existing literature which has explored the nature of interests in adolescence, to see findings are consistent with that carried out in other countries (mostly the U.S.), and to fill in gap in the literature; specifically 1) how interests present and develop over time in children younger than 14, 2) how children's interest and abilities co-develop over time, and how interests and abilities might influence and interact with each other.

This final chapter will summarise the main findings from chapters 2-6, within a context of the existing literature as introduced and discussed in chapter 1. Limitations and further directions will be discussed, with a statement of concluding comments.

7.2 Summary of chapters

Chapter 2 reported on the methodology adopted throughout the entire research project, and presented the initial descriptive data resulting from the first administration of the PVII. Data for children in Years 7-10 was all collected at children's schools in group testing sessions during usual school hours. The Year 12 students completed the interest measure at the University of Plymouth during a group visit. Data presented for the group of Year 7 children showed that children had a strong preference for outdoor and sports related activities (items ranked 1, 3, 4, 5, 7, 10). Also highly rated (ranked 5th) was the question 'I like to help people who are upset or worried' along with 'I find it easy to talk to other people' (ranked 9). This suggests that the group of Year 7 children as a whole were particularly interested in activities that involved being active, teamwork, working with others and using their communication skills. Many of the lower rated items included items linked to the Enterprising or Conventional interest factors e.g. 'Working with numbers or statistics' (ranked 102) or 'Financial consultant (ranked 106). When looking at the top rated questions for the

males and females separately, there was a very similar pattern of responses, with the males and females overall reporting they were interested in similar activities or occupations on the PVII measure. It is noted however, that this version of the PVII was developed for use with gifted children, and questions had not been further analysed using factor analysis at this point to check which items best represented each of Holland's six interest factors; Realistic, Investigative, Artistic, Social, Enterprising and Conventional (1959). As discussed in chapter 2, it was decided at the outset that factor analysis would be used to select the items from the PVII that best measured each of the Holland (1959) factors. The results of the factor analysis have been reported in chapter 3.

Chapter 3 reported on the development and refinement of the PVII. The aim was to further examine question level responses of the Year 7 children to the PVII to be able to generate reliable factor scores for each child from a subset of the original set of 108 items. Each of the 108 items in the PVII was originally designed to load on one of the six RIASEC interest factors. By using the statistical method of Confirmatory Factor Analysis (CFA), it was possible to see which of the questions loaded well on their intended scale, and therefore should be retained in the analysis procedure. CFA was used iteratively six times, each time systematically removing questions from the analysis that either loaded on more than one interest scale or did not load well at all on their intended scale, with the aim of improving the model fit

indices so that they fell within acceptable ranges. The final set of 19 interest questions retained all loaded highly on their intended interest factors, and when the 19 question model was tested on the entire Year 7 dataset, all model fit indices (i.e. RMSEA, RMSEA C.I., SRMR and CFI) were within normal ranges; TLI was 0.937 which was just under the acceptable value of 0.950. On the basis of the CFA analysis process, it was decided to use the retained 19 items to calculate factor scores, and to measure subsequent vocational interests in this programme of work. Initial inspection of scale score for the group of children in Year 7 revealed that overall; children rated questions on the Artistic scale significantly higher than their ratings of any of the other factors. Furthermore, initial analysis revealed that there were no significant differences between interest scores at Year 7 as a function of school specialism, confirming that the data from three cohorts could be collapsed and analysed as a complete group in later analyses. Two validation analyses were reported in this chapter, one with the SII (Harmon, *et al.*, 1994), and one with the PGI (Tracey, 2002b). The PVII2 measure showed mild associations with the SII and moderate-strong associations with the PGI. This was to be expected as the SII is not intended for use for children younger than 15 (children were 12-13). There was some evidence to suggest that there were some issues with the Conventional scale in the PVII2, as there was a low association between the PGI (r = .30) compared to the correlations for the other five factors (r range = .48-.74). These

findings suggest some caution should be exercised when interpreting the findings from the Conventional scale on the PVII2.

Chapter 4 reported on the structure of interests of children in Year 7, Year 9, Year 10 and Year 12 by inspecting and interpreting inter-factor correlations and two-dimensional scaling plots and by calculating rank order correlations and using the computerised version of the 'randomisation test of hypothesised order relations' (Tracey, 1997). Using these methods, it was possible to look at how the structure of interests developed over time and comment on the extent to which the observed structure in children adhered to the hexagonal structure of interests commonly found in adults. The findings demonstrated that the Year 7 children's interests did not form a RIASEC hexagonal structure; however the structure was far more consistent with RIASEC for the Year 7 females than for the Year 7 males, indicating some movement towards a hexagonal structure for the youngest female group. As a group, the Year 9 children's interests also did not closely approximate a hexagonal structure, but when the female scores were inspected alone, there was a much clearer alignment to a hexagonal structure, both when looking at the structure of interests on the MDS plot, but also when inspecting the Spearman rank order correlation scores and the correspondence index scores calculated by the RANDALL programme. Overall, the data presented in chapter 4 showed that the structure of interests became more closely aligned with the hexagonal structure over time, with

scores approaching the required value of .70 for the group of Year 10 children (.64 using the PVII2 measure and .67 using the PGI measure). Furthermore, from the first data collection phase there was a clear distinction between the Realistic and Social factors (evidenced by the negative correlation between these factors). This was true for both the males and females aged 11-12 and remained over time (though the strength of the negative relationship somewhat declined with increased age). The pattern of development between the other interest factors was less clear, but the relationships between the factors developed over time becoming more aligned to the RIASEC framework. As noted earlier, there was low concordance between the PVII2 Conventional scale and the PGI scale for the Year 10 sample suggesting that scores on at least one of these scale should be treated with caution (and may explain why the Conventional scale was often not placed in between the Realistic and Enterprising factors on the MDS plots). A further possible explanation for the low association between Conventional factor scores may be that interest for this particular area has not yet fully developed. Indeed previous work (e.g. Low & Yoon, 2005) has suggested that both Conventional and Enterprising are the least stable interest over time, implying that interest in these areas develops and stabilise at a later age.

The close link between scores from the PVII2 and the PGI is reassuring and suggests that the PVII2 is an adequate brief measure of vocational interests using Holland's (1959) RIASEC framework in Year 10 children.

In chapter 5, the stability of interests in children over a two year period from school Year 7 to school Year 9 was examined in detail. When looking at test-re-test correlations in previous work (e.g. Hansen, 1984; Swanson, 1999), interests in adults have been found to be highly stable over time, increasing with age and are thought to reach peak stability once an individual reaches the age of 25. Research has typically found that Realistic, Investigative, Artistic and Social interests tend to be the most stable over time (in adults and in children aged 14+; see review by Low *et al.*, 2005). There have been a few studies that have looked at interest stability using test-retest methods in children younger than 14 (e.g. Tracey, 2002a) and moderate levels of stability were found which again increased with time. The analysis reported in chapter 5 found a clear pattern; both actual and ranked Realistic and Social interest scores were far more stable over time and Enterprising and Conventional the least stable over time. When looking at the mean factor scores (unranked), group interests increased a little (though not significantly) for all factors apart from Artistic and Conventional (which significantly decreased over time). In chapter 5, as well as test-retest scale score correlations, a number of additional stability indices were calculated to enable a deeper understanding of how children's

interests for each scale change and relate to each other over time. This is important in a career's counselling context; as looking at an individual's factor scores in the context of their scores on all of the factors will always be far more informative than looking at each factor scores in isolation; i.e. looking at what children are not interested in can be just as informative as what children are interested in. For example, this can be particularly useful when an individual may score an average of above 4.0 for all of the six RIASEC factors (indicating high interest for all factors), but score an average of 4.6 for Social, and therefore indicating a stronger preference for Social interests than all other factors. Profile difference scores indicate change in a person's score on all of the RIASEC scores over time; Tracey *et al.* (2005) found that profile difference scores typically decrease with increased age in adolescence and adulthood. Profile difference scores showed, as expected, there were differences in profiles over time, with males showing greater differences (though only marginally) than the females. When compared with those reported by Hirschi (2010a) for a group of children two-three years older, it appears that profile difference scores do seem to decrease over time in children aged 11-16. However, it is considered that whilst profile difference scores are worth calculating and reporting here (if only for other researchers to use as a benchmark), profile difference scores perhaps have limited use when collecting data at only two separate time points. Consistency scores are perhaps more informative with

regards to individual and group profiles over a period of time, as Consistency takes into account the two factors that individuals rated the highest and the placement of those scores on the RIASEC hexagonal framework. Over the half of the sample at both timepoints had high levels of consistency, which does provide evidence that the RIASEC framework can be of use when implementing vocational guidance. Dimension scores were stable over time, with 'Things'/'People' being more stable than 'Data/Ideas' (this may also tie in with the potential issues with the PVII2 Conventional scale), it seems that the group overall favoured both 'Things' and 'Data' over 'People' or 'Ideas'.

Some interesting gender differences emerged; Realistic interests were more stable over time for the males, where as Social interests were more stable for the females. In addition, Investigative and Artistic interests were stable over time for the females, but were not at all so for the males ($r < .02$). Social interests were rated significantly higher overall for the females than for the males, furthermore there was a significant interaction between gender and time for Social interests – i.e. male Social interests decreased over time, and female Social interests increased over time. Linked to this, when looking at Dimension scores, there are large gender effects; males clearly have interests in 'Things' which increased with time, and females had a strong interest in 'People' which also increased with time. These findings are consistent with that found by Su *et al* (2009). This suggests that male and

female interests do appear to be broadly gender stereotyped at this age and become more polarised over the two year time period. Profile Codes look at the three factors that individuals rated the highest at Year 7 and then again for Year 9. These are presented for just males and females separately as it would not be practical to present for the group (given the clear differences in male and female interests at this age). The profile codes again show a marked difference in the profiles of the males and females, with the females having significantly more consistent profiles over time than the males. This overall pattern of findings clearly show that male and female interests do not emerge and develop in the same way, and consequently has important implications for the careers guidance children receive. This will be discussed further in section 7.4.

Chapter 6 explored the potential relationships between measured abilities and vocational interest. Mechanical, Spatial Rotation and Logical Reasoning abilities were objectively measured in this study alongside the collection of vocational interest data. Research (as summarised in Ackerman & Heggestad, 1997) has found evidence to suggest a correspondence between ability and vocational interests in adults, particularly between Realistic interests and both Mechanical and Spatial ability, and further a negative association between Social interests and Mechanical ability. As measures of reasoning ability typically have not been administered alongside measures of vocational interests, the nature of this relationship is perhaps less

apparent. There is a clear gap in literature in two main areas related to abilities and vocational interests, firstly; interest and objectively measured abilities are not often researched with adolescent participants, often due to the lack of appropriate measures; and secondly, longitudinal research that looks at how interests and abilities develop over time is limited.

Initial results from this section indicated that overall children improved on all three ability measures. Mechanical and Logical Reasoning ability scores were moderately stable over time, but this was not the case for Spatial ability. As with the scores for Realistic interests, Mechanical ability was more stable for males than it was for females, and overall males had significantly higher Mechanical ability scores than the females. Spatial ability scores were also significantly higher for the males than for the females (though this was only a small difference). Logical Reasoning ability scores improved over time overall, specifically children were more able to reason outside of their prior beliefs with increased age. The female participants were less influenced by their prior beliefs (they had significantly lower Logic Belief Index scores) as they got older, whereas the male Logic Belief Index scores remained relatively static. In terms of the relationships between abilities and interests, the pattern of findings was far less conclusive. Group scores have been presented only, as there was no evidence of gender mediating any relationship between abilities and interests. There was a weak, but significant association between Mechanical

ability at Year 7 and Realistic interest at Year 7. This relationship however disappeared when looking Mechanical ability in Year 7 and Realistic interest in Year 9. What was interesting was the significant and stronger association between Realistic interest in Year 7 and Mechanical ability in Year 9 (which remained when looking at Realistic interest in Year 9. This pattern of results was confirmed by using regression analysis to examine predictors of interest and ability at both years. The only significant predictor of Mechanical ability at Year 9 was Realistic interests at Year 7

Although the relationships are relatively weak, this pattern of findings does suggest that perhaps Realistic interests when the children are aged 11-12 can (in part) be predictive of later Mechanical ability. There were no other clear patterns of influence between interests and abilities, though there appeared to be some evidence of an association between Artistic interests and Reasoning ability, and also a weak link between Conventional interests and Logic Belief Index scores. The analysis using interest Dimension scores and abilities confirmed the analysis completed using the factor scores – Mechanical ability at Year 9 was best predicted by 'Things' scores at Year 7. So once again, earlier interests are predictive of later ability.

Interestingly, an association was also seen between 'Ideas' and Logical Reasoning skills. As an interest dimension, 'Ideas' relates to performing tasks related to abstract ideas and theories, and so it does make theoretical

sense that 'Ideas' interest scores relate to some extent to their Logical Reasoning skill. As mentioned throughout, the outputs of this research study have important theoretical and practical implications; these will be considered next.

7.3 Theoretical implications

This programme of work has been strongly influenced by Holland *et al.*'s (1969) early work on the structure and inter-relationships between the six major areas of vocational interest. The key rationale for conducting this set of studies was to explore the nature of vocational interests in adolescence (from an earlier age than most of the published work in area); how they develop and change (or remain stable) over time. As discussed in chapter 1, Osipow (1973) initially considered there were broadly four different theories of career development; Developmental, Sociological, Trait-Factor and Vocational Personality. It can be fair to say however, that more recent approaches to understanding career development have taken a more integrative approach. Vocational interest theories can now be categorised as one of two general approaches; Person-environment models (e.g. Holland, 1959) or developmental models (e.g. Super, 1954, Savikas, 1999). Person-environment models (or trait models) are concerned with matching individual's interests and traits to the environment; whereas developmental models are concerned with how interests change over time in terms of

maturation and by interacting with the environment. In terms of vocational interest develop in adolescence; it is likely these two approaches have relevance here, developmental theories go some way to explain how (and when) interests develop in younger children, and trait theories consider how to map those interests onto the environment once they have emerged and stabilised. Super's (1954) life-span approach presented a clear developmental pathway of career development, namely his 'Stages of Vocational Choice', which specifies that vocational interests stabilise around the ages of 24-35. Super considered that an individual's self concept develops and changes over time mainly as a result of their experiences of interacting with the environment.

What is interesting is that the extensive meta-analysis as conducted by Low *et al.* (2005) did indeed find that vocational interests did not stabilise until adulthood, with interests becoming more stable with increased age. In this current dataset, interests were measured with adolescents only and so it is not possible to conclude what happened beyond age 17 – but what was particularly interesting, and perhaps very relevant here was that children's interest profiles did become more consistent and differentiated (distinct) as they got older. Furthermore, there was strong evidence in this set of studies to support the view that children's interests are strongly sex typed (also found by Tracey & Ward, 1998; Mullis, 1998) – as evidenced by numerous sets of analyses in the present study; e.g. males were significantly more

likely to prefer Realistic or 'Things' interests and females were significantly more likely to have a preference for Social or 'People' interests. These gender differences also provide support for Gottfredson's (1981) developmental (life-stage theory) of career development in childhood that focussed particularly on children's awareness of sex roles. Holland's (1959) trait-factor approach considered that there are six major classes of occupational environment, and that people try to find the best environment that suits their interests and abilities – resulting in vocational harmony. In this study, in order to assess how children's interests developed over time, the extent to which their interests mapped onto each of Holland's six vocational interests factors was assessed.

As discussed in chapter 3, it is acknowledged that more exploratory strategies to assess the interests of children could have been adopted; however it was not the intention to take this approach here. The plan from the outset for this work was to take a more confirmatory approach. Indeed, it was necessary for the vocational interest measure applied to use a six factor structure in order to be assessed for structural alignment to the hexagonal model (see chapter 5). Although full correspondence with Holland's hexagonal model was not present for even the older group of participants, the data strong evidence to support the view that interests become more closely related to a hexagonal framework with increased age.

This pattern of findings does support the view that there is substantial value to measuring vocational interests in children using a six factor approach, even when it is considered that their interests are still emerging and stabilising. (Holland *et al.*, 1969). The evidence would also suggest gender impacts on the age at which interests start to become inter-related in a hexagonal way. Whilst gender did not impact on the structure of vocational interests in children when they were in Year 7, the structure of female interests at Year 9 was significantly different to male interests (Box's M analysis). Furthermore, the two statistical methods of model fit (Spearman Rank correlation and the Randomisation test of hypothesised order relations) demonstrated that the only datasets that significantly fitted the hexagonal model were that of the Year 9 females and the Year 10 group. It is acknowledged that gender information should have been captured for the Year 10 sample, as this would have enabled further exploration of gender differences with regards to interest structure.

Whilst these gender differences are undoubtedly very interesting, it is still of course unknown at this stage whether these gender differences persist beyond Year 9, and at which point male interests also become inter-related as the hexagonal model would predict. Career development research that has focussed on the structure of interests in adults hasn't found gender effects (e.g. Tracey & Rounds, 1993) so there must be a critical age at which interest inter-relationships become more equivalent. The work carried out

by Tracey *et al*.(2005) which explored interests in children aged 13-18 found that there were gender differences – male interests were less stable particularly for ages 16-18 - suggesting that the male participants were still considering their different career options at this point when compared to the female participants. Rounds and Tracey (2005) also found that males were had less consistent vocational interest profiles at these ages when compared to a female sample of the same age. Clearly, future longitudinal research is needed to examine these findings in more detail; to explore gender differences in interest structure from age 11 over a more extended period of time.

The findings emerging from this set of research studies compliment and significantly add to the published work in the area; and confirm that there is a measureable structure to children's vocational interests. Furthermore, there is evidence to suggest that both Person-Environment and Developmental theories are relevant to understanding the development of vocational interests in adolescence. Overall, the pattern of findings suggest that there is significant value in measuring children's vocational interests from age 11.

With regards to the relationships between vocational interest and abilities, the pattern of findings is rather less conclusive. All relationships between vocational interest and ability are very low, and mostly not significant,

which is not in line with the relationships commonly found in adults by Ackerman and Heggestad (1997). This either implies that the relationships between ability and interest are not well defined in adolescence or that the measures administered here were not appropriate (or both). Interestingly, Tracey *et al.*'s (2005) work that explored the stability of vocational interests and scores on selected academic skills when aged 13-18 also found no relationships at all between academic skill and vocational interests. Like Tracey *et al* we were also surprised to see little relation between ability and interest in children of this age. But as discussed in chapter 1, there is evidence to suggest that a child's perception of their own skills or abilities is more strongly related to their interests, than their *actual* skills (e.g. Rolfus & Ackerman, 1996; Swanson & Hansen, 1998). This then suggests that vocational interest are linked to concepts such as self-efficacy beliefs, and indeed as mentioned in chapter 1, some of the more recent Developmental models of interest development (e.g. Lent *at* al. 1994, 1996) do consider that self-efficacy performs an important mediating role between ability and interest. This very clearly is yet another for future research, as the evidence would suggest that research that focuses on objective measures of ability alone, limited associations will be found with vocational interests in an adolescent population.

Notwithstanding, the relatively weak relationships, the data suggests that early (Year 7) interest for Realistic/'Things' is associated with later (Year 9)

Mechanical ability. Perhaps what is of greater theoretical interest is that in this study, earlier Realistic/'Things' interests are more predictive of later Mechanical ability when compared to the relationship between earlier Mechanical ability and later vocational Realistic/'Things' interests. Therefore the data is indicative of earlier interests influencing later ability to some extent, though the variance explained in the regression model was very low (indicating a range of other unmeasured influencing factors). It is therefore strongly recommended that further work is required to explore this pattern of findings in more detail. Further investigations should use a broader range of ability measures that have been selected for established reliability in the relevant age group.

7.4 Practical implications

One of the most interesting findings arising from this set of studies and from recent published work in the area is that despite the ever changing nature of the work landscape, the hexagonal arrangement of interests first identified by Holland *et al*. (1969) over 40 years ago still has relevance today.

This suggests that whilst environmental factors clearly play a part in how children formulate their views about their future career goal, there are also internal measurable processes at work. Holland *et al*.'s (1969) structural arrangement of interests is currently used by the Department of Education

(DCSF, 2009) as a framework for assessing interests in Year 9 pupils. In their recent publication 'Which way now' children are asked to tick statements across six categories if they are interested in the activity (all six categories equate with Holland's RIASEC interest themes). Individual responses are then tallied, to identify which category or categories of interests the children are most interested in. This information is then used by the children themselves, their parents and by school staff to help children make decisions about G.C.S.E. subject choice, work placements and when planning their future career pathways.

The current research project has identified that interests are broadly stable between Year 7 and Year 9, particularly for Realistic and Social interests. With this in mind, it is considered that careers guidance for children in Year 7 could include particular measurement and discussion around their interest for Realistic and Social themes, as interests in these two main areas does appear to remain largely stable over time. It is further considered that the PVII2 measure itself was rather a narrow inventory, having three or four questions per interest scale, and whilst it has been successful in measuring interests in a research context it perhaps has limited practical application in its current form. It is acknowledged that for interest inventories to have practical relevance there should be sufficient items to fully represent each scale. Furthermore, there are some concerns about the validity of the Conventional scale – this scale had the lowest concordance with the PGI

measure compared to the other five factors. It could be argued that the Conventional scale contains items that are too similar, and so this scale could benefit from further development before it is used again either in a research or practical context.

However, it is considered that with further development, the PVII2 could be used in a careers counselling context as a preliminary diagnostic tool to ascertain general information about a student's activity preferences to stimulate initial discussion. Following this, a more detailed assessment of the individual's interests, ability and aspirations should be conducted, and in particular including a self assessment of their own skill. Previous research has identified that there are often stronger relationships between self-report of ability and interest than for objective measures of ability and interest in adults (e.g. Ackerman, 1996, Swanson & Hansen, 1988). And as discussed in section 7.3, the lack of association seen here between objectively measured abilities and vocational interest has also been found by other researchers (Tracey *et al*., 2005) may well be due to the fact that children's ratings of their own skill are more related to their interests for activities.

This finding regarding a limited relationship between objectively measured ability and vocational interests would suggest that it should not be taken for granted that children necessarily have interests in academic areas they are good at (and vice versa), and perhaps what may be of more value is the

child's self rating of skill in an area and their interest for it. Indeed, it is possible that a child's early interest in an area, coupled with a high self-belief that they perform well in that area is what then leads to increased performance in that field later in life; i.e. the initial interest and self-belief lead to increased mastery in that area – and that is why there are significant relationships between ability and interest in adults (as reported in Ackerman & Heggestad, 1997).

As also mentioned in Section 7.3, there was strong evidence that children's interests were strongly sex-typed with regards to scores on the Realistic-Social 'dimension'. In particular for Social interests, male interest significantly decreased, and female interest significantly increased over the two years. Gottfredson (1981) was keen to point out that schools should try to avoid reinforcing common sex-role stereotypes, so that children are able to experience and develop a broad range of interests. It is further considered that careers counselling may benefit female pupils in particular at a younger age, as their vocational interest profiles appear to stabilise earlier than that seen in males.

There were also gender differences with regards to interest factor stability – the Investigative interest scores of males were not at all stable over time, whereas female Investigative interest was very stable over time (and significantly more so at $p < .05$). Additional findings suggested that male

interest profiles were less consistent and less differentiated than the female profiles between the ages of 11-13. Knowledge about these features of vocational interests, and the clear differences than are emerging for male and female children, should be communicated to individuals (e.g. secondary school teachers, parents) who deliver and support a child's careers development at school and at home.

Incorporating these discussions earlier may help children identify appropriate opportunities for work experience or engagement with relevant activities that are linked to certain occupations, and also identify areas where ability needs to be strengthened. For example, a child may show a strong interest for Realistic at age 11 (and also subjectively rate their skills in that area as high), but their academic skills in that area need to be built upon e.g. skills in Science and Mathematics. Past research as summarised in chapter 6 clearly shows that some abilities can be improved with the appropriate intervention (e.g. Neilens *et al.*, 2008; Terlicki *et al.*, 2008), which is a promising finding. Therefore, it may be appropriate to suggest that interest measurement is linked to identification of appropriate interventions related to those interests, particularly where a child has a stable and clearly differentiated vocational interest profile.

Overall, in practical terms, the evidence as presented here provides support for the view that there is significant value to delivering career's guidance to

children as young as 11. Children's interests in two key areas were particularly stable over time; Realistic and Social and discussions regarding interests for these two key areas is suggested as a starting point for career intervention; whereas interest for others areas were more variable over time. It is further suggested that children who have more variable interest profiles over time are likely to require more support and career intervention than those children who have more consistent profiles. This all points to the value of measuring children's interests at a range of timepoints (starting at 11 years old) to enable any variability to be ascertained, and the appropriate support and advice to be delivered where needed.

7.5 Further directions and evaluation of methodologies

As is often the case with longitudinal research studies, it would have been beneficial to have had the capacity and resources to collect additional data both quantitative and qualitative, across extended periods of time. Although collecting data from the same group of children when they were in adulthood wasn't possible within this particular project timeframe, the value of doing so in future projects is acknowledged. Instead of collecting additional longitudinal data in this project, a cross-sectional approach was utilised which enabled comparisons to be drawn about the vocational interest structure of different groups of children at different stages of their development. Bearing in mind the project time constraints, this overall

approach was successful, and has enabled conclusions to be made about how the *structure* of interests in particular develop over time in for children aged 11 onwards. Furthermore, the data collected from the longitudinal component has enabled a detailed exploration of interest stability in the same group of children aged 11-14. The longitudinal data also revealed numerous interesting patterns with regards to how interests develop for males and females separately. Gender information was not recorded for the Year 10 and 12 datasets, but on reflection it is considered that this data would have added to chapter 5, to see if the clear gender differences seen at Years 7 and 9 persisted both one and three years later in the Year 10 and 12 groups.

As mentioned earlier, the relationships between the ability and vocational interest were weak, with only Realistic/'Things' interest having consistent associations with the Mechanical ability scale. This may due in part to both the interest and ability measures requiring a certain level of reading comprehension. It is further considered that adaptations to improve the instructions given for the ability measures during administration would have improved performance and reduced any potential for confusion. It is also possible that despite the numerous members of staff available to assist the children in completing the battery of measures, some children may have benefited from additional support. It was at times challenging to manage and coordinate the large testing sessions at Schools 1 & 2, whereas the

smaller sessions at School 3 were easier to deliver. Despite this, the children at School 3 did not consistently perform better than the children at Schools 1 & 2, but rather that children at both School 2 & 3 typically performed better than children at School 1 when inspecting total scores. As already highlighted in earlier discussions in chapter 6, the measures of ability administered in this research were measuring only a very narrow area of ability, specific to those skills required for success in an engineering, technology or science career pathway. In order to make broader conclusions about the relationships between vocational interests and ability, it would be necessary to measure a wider set of abilities. For example, previous work has highlighted significant relationships between Verbal ability and Artistic interest (e.g. Randall, 1991, Ackerman *et al.*, 1995 as summarised in Ackerman & Heggestad, 1997), and so this would be a very interesting direction for future research.

7.6 Concluding comments

> 'The hexagon is a useful if imperfect way to organise personal and occupational data and is still widely accepted and considered today.' (Borgen *et al.*, 1997, p339).

The evidence provided in this body of work provides support for the view that there is a developmental pathway for vocational interests in adolescence. Children's interests develop both in terms of their structure and stability over a period of time; i.e. the inter-factor structure of interests changes over time whilst actual and relative interests (for Realistic and Social in particular) remain largely stable over time. The evidence put forward confirms the view that the structure of vocational interests develops over time, beginning with a simple structure that is broadly gender stereotyped. This structure then develops over time into a framework that more closely approximates the widely accepted hexagonal arrangement of interests seen in adults. The data also suggested that whilst the structure of interest in children of Year 10 age was closest to a hexagonal arrangement; it was still different from the structure of interests commonly seen in adults. This therefore indicates that further development is likely to occur during the ages of 15-18.

The evidence also confirms, as other researchers have also found (Low *et al.*, 2005) that some vocational interests are more stable than others. Realistic and Social interests were highly stable over time for the participating children (both *r*'s >.5) where as Enterprising and Conventional interests were far less stable over the two year time period. There were clear gender differences both in terms of the structure and stability of interests. Female interests appeared to develop more in line with the hexagonal framework at an earlier age, and also female interest profiles were more stable over time when compared to the group of males in the study. Females were more likely to have interests in the Social or 'People' domains, whereas males were more likely to have interests in the Realistic or 'Things' domain. These findings have clear implications for the delivery of careers counselling as discussed earlier, and suggest that the utility of a brief vocational interest measure can make an important contribution to the overall package of vocational guidance children currently receive. It is acknowledged that the PVII2 needs further development work, and that subsequent work in this area would benefit from following up children over an extended period of time using a wider battery of ability measures.

There was some evidence to suggest that the development of some academic skills is mediated, in part, by earlier vocational interest. Realistic interests at Year 7 were more strongly associated with Mechanical ability at Year 9 than any of the other measured variables. This is an area that clearly needs

further investigation. In conclusion, the benefits are two-fold; the knowledge gained has both important potential practical implications for young people's career counselling in the U.K. Furthermore, the research that has been carried out and reported in this thesis has significantly added to the emerging body of knowledge concerning the development of vocational interests and abilities in adolescence, highlighted directions for future research and has made an important contribution to the field.

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Appendix 1.1 Plymouth Vocational Interest Inventory (PVII)

NAME :
ID number:

Instructions

You will shortly see a list of statements.

You must rate each statement with a A, B, C, D or E on the sheet provided :

Example:

A = Strongly Agree
B = Agree
C= Unsure/Don't Know
D= Disagree
E = Strongly Disagree

'I am a friendly person ' ☐

If you strongly agree then you would mark A
If you strongly disagree then you would mark E
If you are unsure or *don't know* what the statement means then mark C

1. About you

How much do you agree the following statements describe you?

A = Strongly Agree

B = Agree

C= Unsure/Don't Know

D= Disagree

E = Strongly Disagree

1. I like people to listen when I talk
2. I enjoy directing people in their activities
3. I enjoy outdoor activities
4. I am a very energetic person
5. I enjoy being physically active
6. I am interested in how machines work
7. I like finding out new information
8. I find it easy to talk to other people
9. I am a popular person at school
10. I use talking to resolve arguments
11. I find it easy to work and co-operate with other people
12. I would like to set up my own Business one day
13. I like looking after children
14. I like to help people who are upset or worried
15. I am very organised
16. I like to do things properly even if it takes a long time
17. I am good at solving problems
18. I am a perfectionist; I like to get things just right
19. I am very efficient

2. Hobbies

How much would you like to do the following hobbies?

A = Strongly Like

B = Like

C= Unsure/Don't Know

D= Dislike

E = Strongly Dislike

20. Play computer games
21. Surfing/windsurfing/kite surfing
22. Competitive sports
23. Repairing old or broken things, e.g. cars
24. Building things out of scrap
25. Studying plants and animals
26. Entertaining others
27. Reading really interesting books
28. Designing and decorating the interior of buildings
29. Help with decorating the house
30. Direct a movie
31. Market research -finding out what customers think about products
32. Raising money for charity
33. Be a volunteer helper for a hospital or youth group
34. Writing poetry
35. Write books or stories
36. Cooking food for friends
37. Painting pictures
38. Drama
39. Solving number puzzles

3. School Topics/Activities

How much do you like the following topics/activities at school?

A = Strongly Like
B = Like
C= Unsure/Don't Know
D= Dislike
E = Strongly Dislike

40. Business studies
41. Politics
42. Economics
43. Physical education, sports
44. Design technology
45. Building models
46. Physics, study of the physical world
47. Applied science
48. Astronomy
49. Human biology, study of the human body
50. Debating topics that make you think
51. Graphic designer/animator
52. Photography
53. Customer service, helping customers with their problems
54. Music
55. Dancing
56. English literature, study of books and writing
57. Statistics, making charts and graphs from information
58. Making charts and graphs from information
59. Working at the same thing for a long time
60. Chemistry, doing experiments with chemicals
61. Mathematics

4. Occupations

How much do would you like to do the following jobs?

A = Strongly Like

B = Like

C= Unsure/Don't Know

D= Dislike

E = Strongly Dislike

62. Lawyer
63. Being the manager of a hotel
64. Estate agent (helping people to buy and sell their houses)
65. Corporate trainer (training people to do their jobs better)
66. Running a company that promotes companies/products using T.V. or radio
67. Police officer
68. Journalist
69. Personal trainer (fitness instructor)
70. Ski/snowboard instructor
71. Engineer
72. A news reader on the television
73. Present your own radio show
74. Landscape gardener
75. Town planner
76. Architect (design new buildings)
77. Fashion designer
78. Computer games designer
79. Office manager, be in charge of an office
80. Accountant, helping people manage their money
81. Professional sportsperson
82. Being a secretary or a personal assistant to the director of a big company
83. Financial consultant (advising people what to do with their money; savings, investments etc.).
84. Nanny, looking after children.
85. Care assistant/looking after elderly people
86. Nurse
87. Primary school teacher
88. Hairdresser

5. Likes/Dislikes

How much would you like to do the following activities?

A = Strongly Like
B = Like
C= Unsure/Don't Know
D= Dislike
E = Strongly Dislike

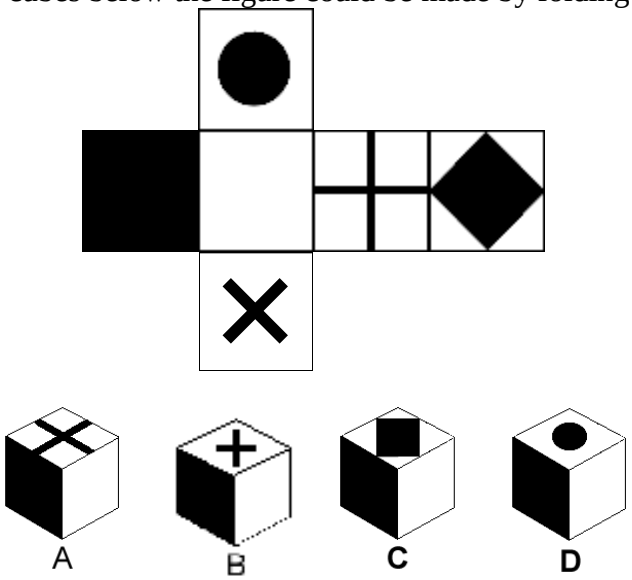
89. Repairing electronic equipment
90. Playing team sports with friends
91. Professional sportsperson
92. Building a desk
93. Working with cars
94. Fixing a clock
95. Working in a laboratory
96. Speaking in front of other people in class
97. Design web-sites
98. Work in advertising
99. Be the manger of a shop
100. Cashier in a bank
101. Give first aid to someone
102. Help others overcome their difficulties
103. Learn a musical instrument
104. Act in a movie/tv. Show
105. Learn to sing
106. Work with numbers and statistics
107. Use computers to record information
108. Make a speech

Appendix 2.1 Spatial Visualisation ability

NAME
ID number :

Mental Cube Folding Test

Imagine that the figure below was printed on paper or card. The symbols are printed on the top of the card only and cannot be seen through the card. Which of the cubes below the figure could be made by folding it?

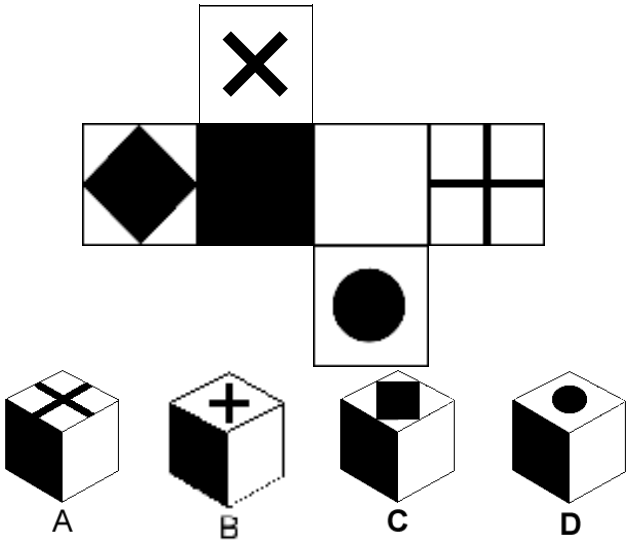


D is the only one of the four cubes where the faces appear as they would when the figure is folded. So D is the correct answer.

All you need to do is decide which one of the four cubes could be made by folding the figure, and circle the correct answer as above.
In every case **only one** of the four is possible. You must decide which one. If you find it helpful, you can rotate the question paper.

Work as quickly as you can without making mistakes. If you find a question too difficult leave it and go on to the next one. If you have time left over at the end go back and try to answer any questions you left out.

3.



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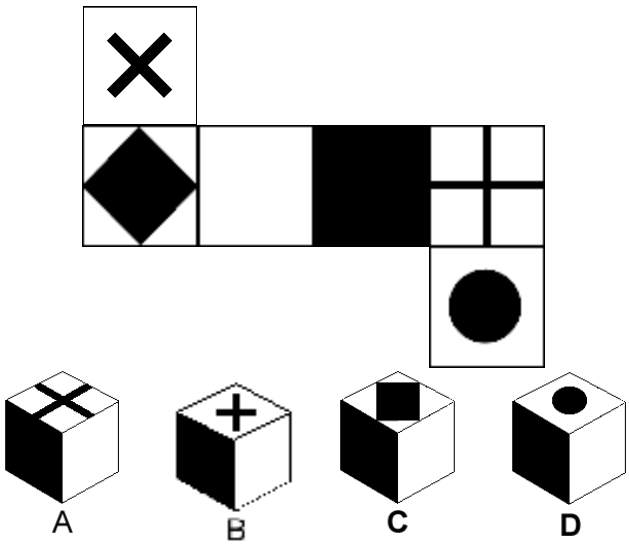

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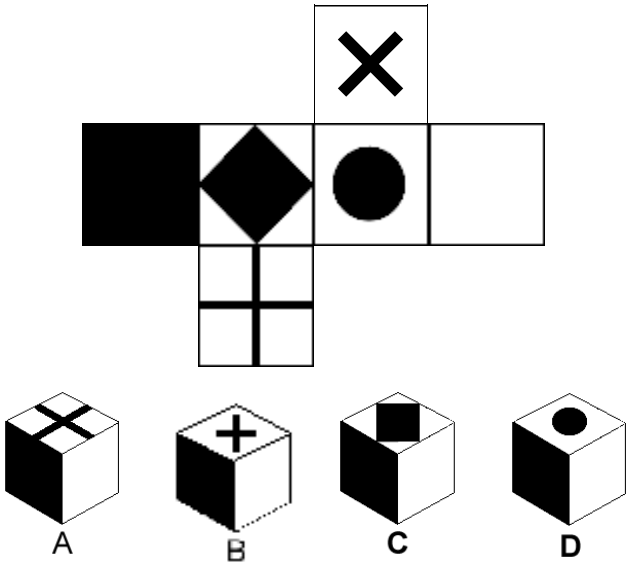

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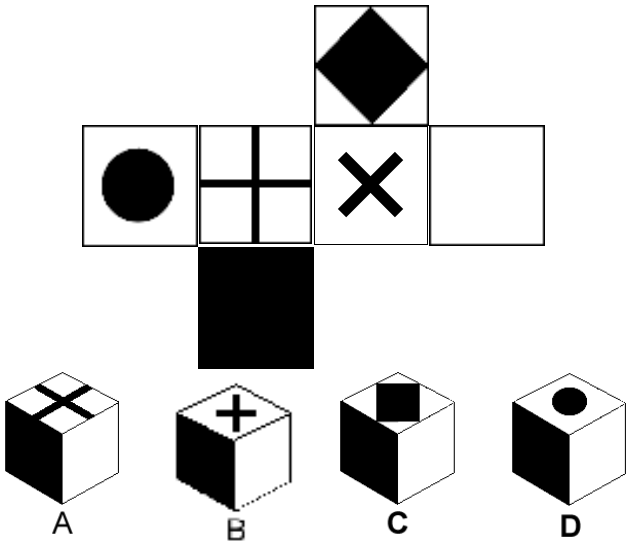

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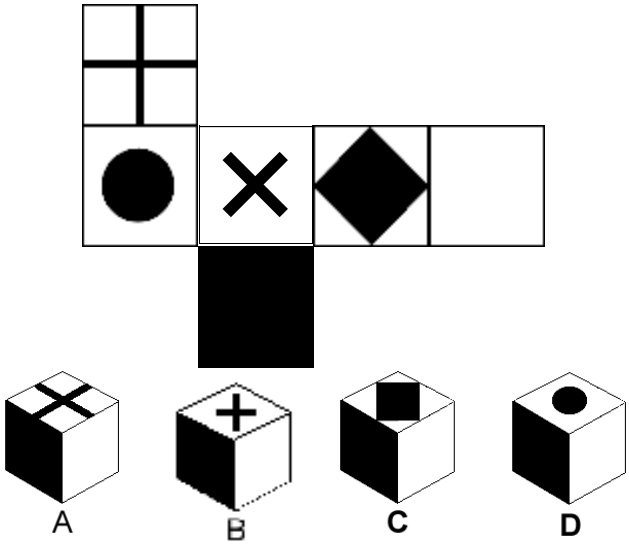

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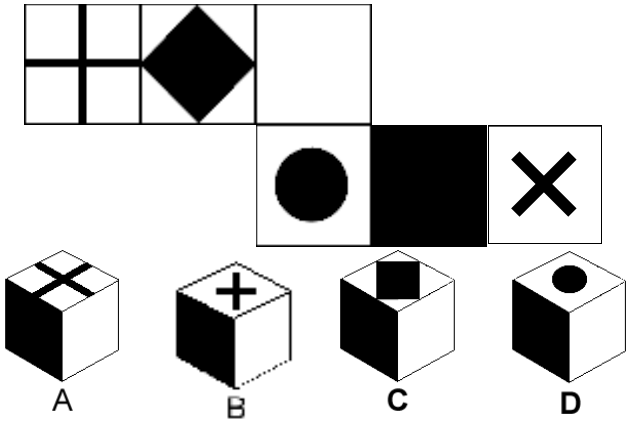

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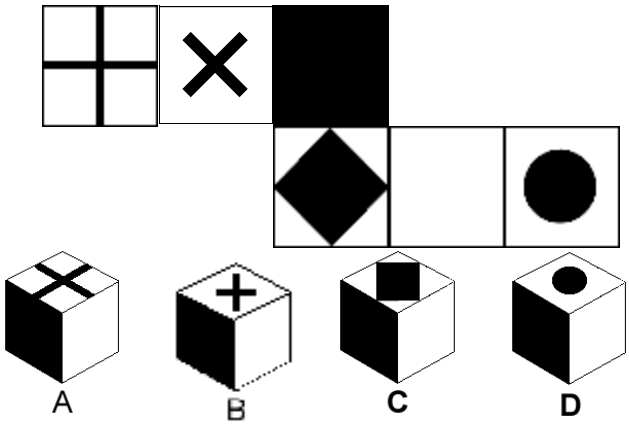

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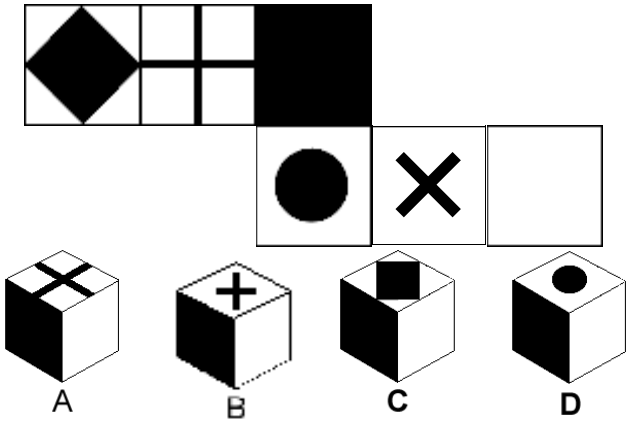

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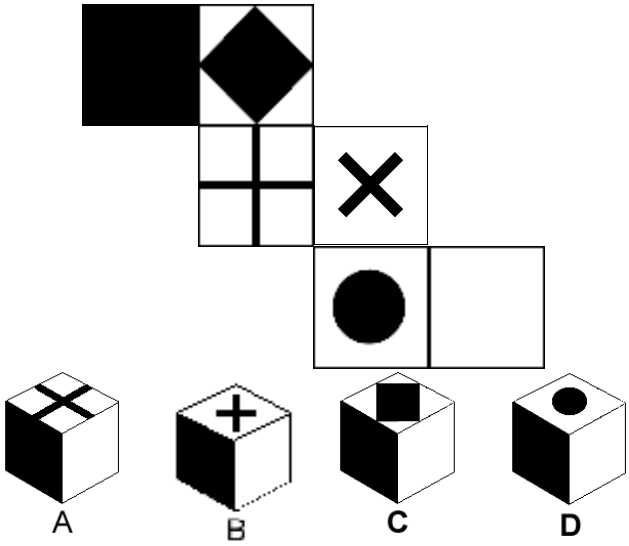

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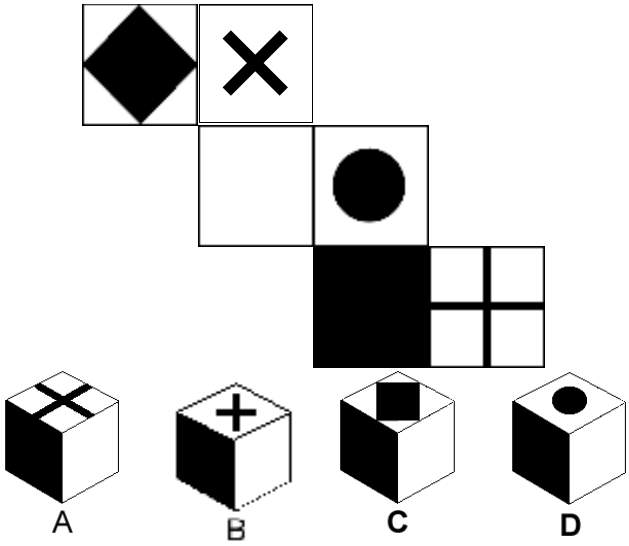

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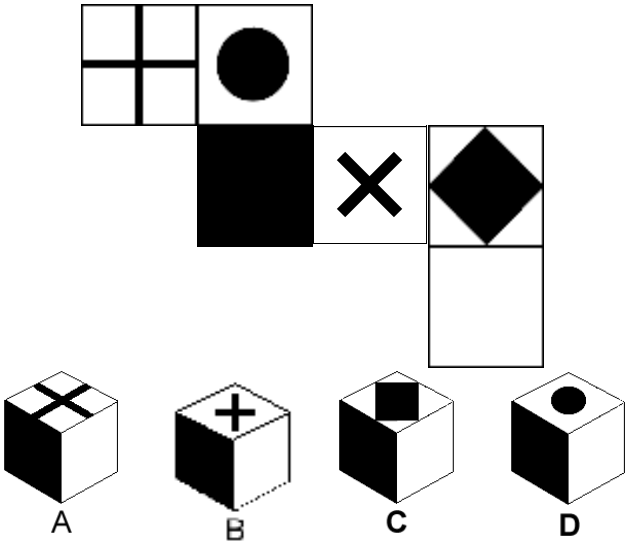

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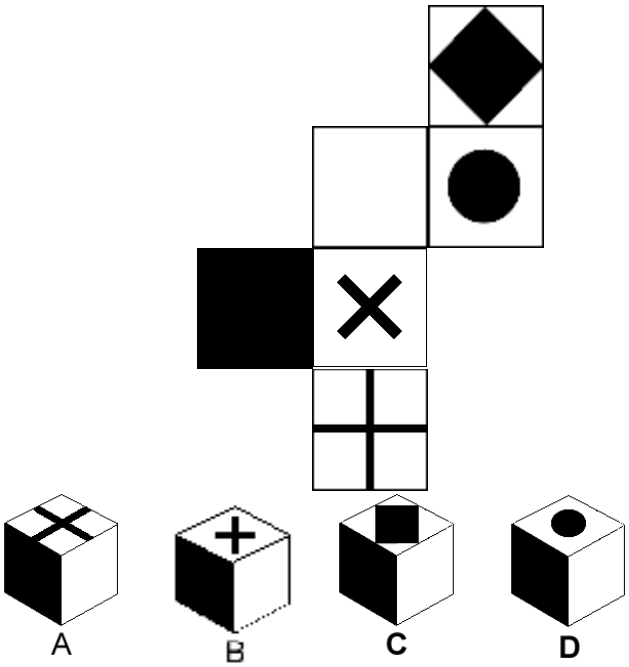

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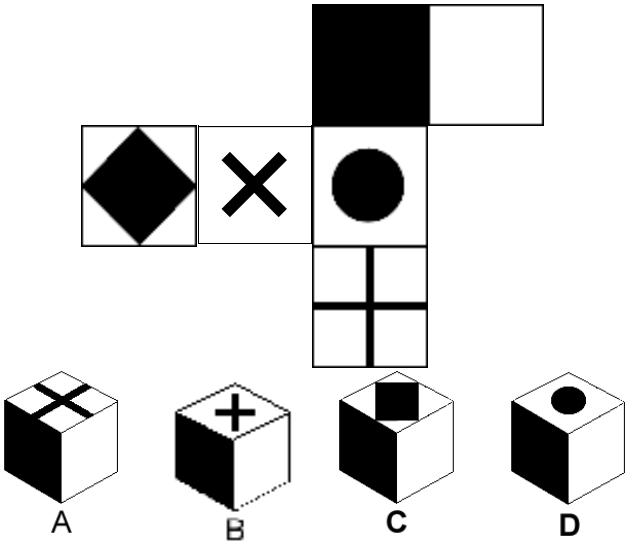

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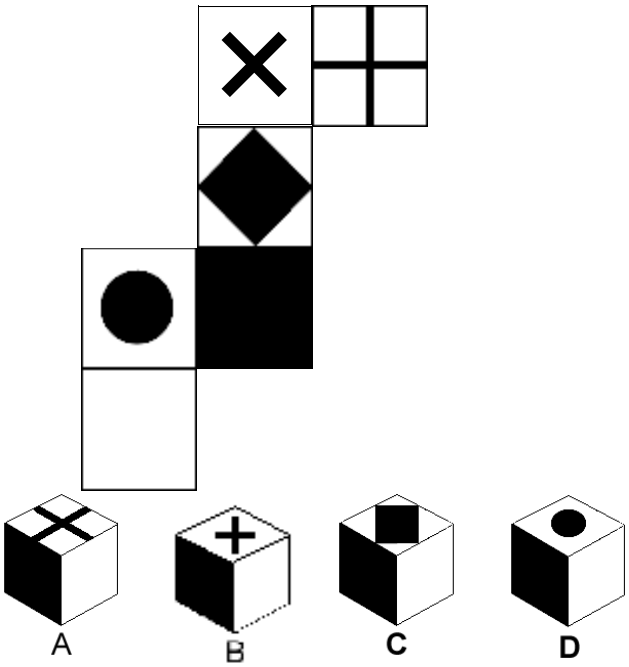

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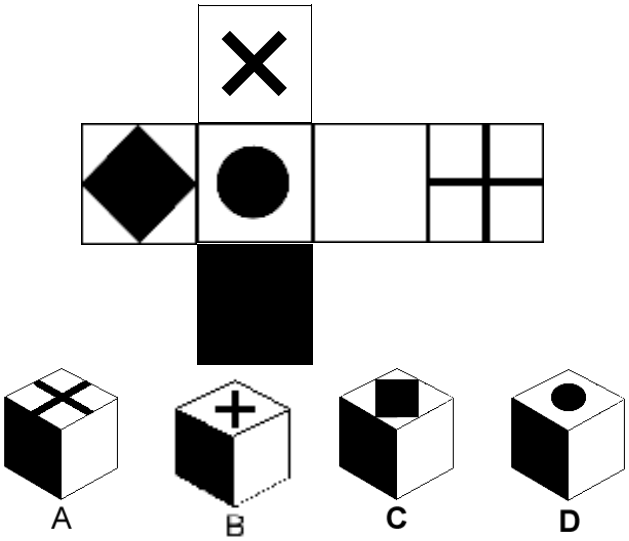

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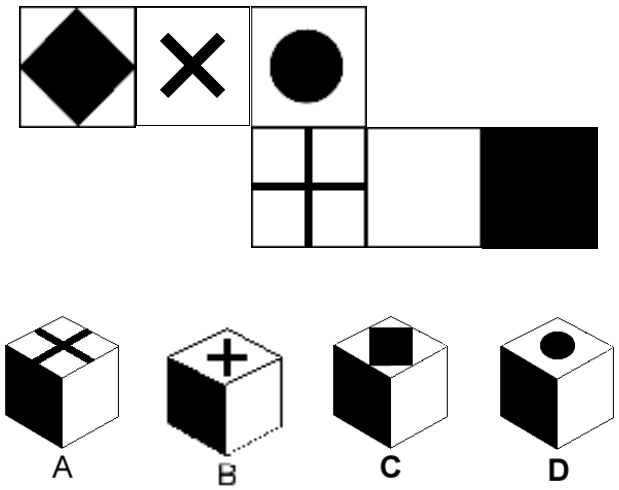

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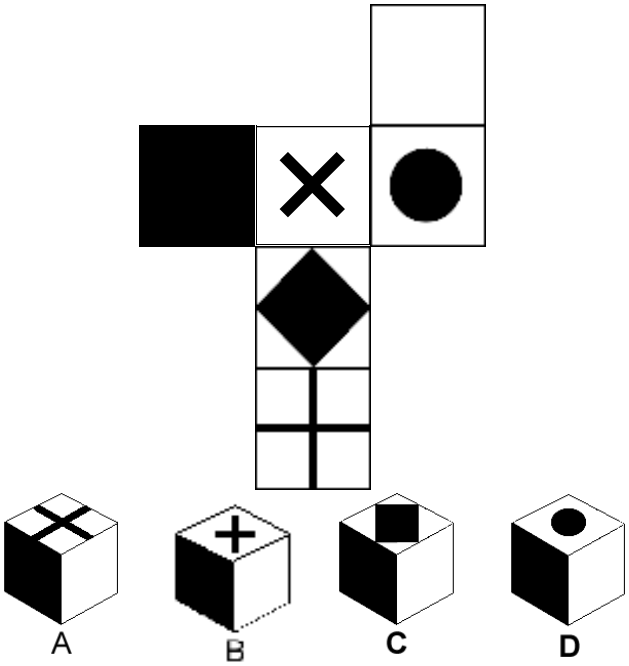

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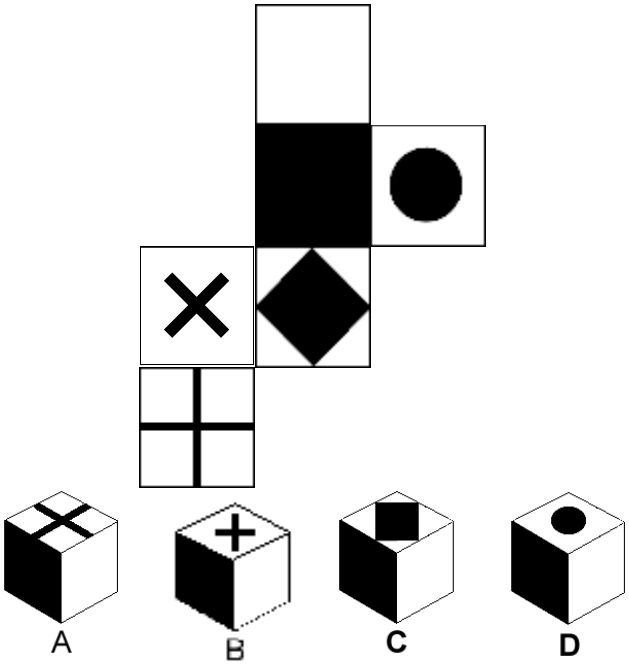

Appendix 2.2 Verbal test of Spatial Relations

NAME
ID number :

Instructions

The questions in this test all relate to the positions of letters in a grid.

Each question starts by describing the positions of some letters. For example, suppose the question said -

A is in the square to the left of B
C is in the square below A.
D is directly to the right of C with one empty square between them.

Then the grid would look something like this-

A	**B**		
C		**D**	

After the positions of the letters have been described, you will be asked something about them. A complete question would be something like -

A is in the square to the left of B
C is in the square below A.
D is directly to the right of C with one empty square between them.

Which of the following pairs of letters is furthest apart-

(i) A and C(ii) B and C (iii) A and D (iv) B and D

Look at the diagram of the grid. You can see that the correct answer to this question is ***(iii) A and D.***

- For the real questions you will not be given a diagram of the grid
- **You are not allowed to draw any diagrams when doing the test.**
- Instead you have to try to create a picture of the layout of the letters inside your head.

Here is an example question to try-

B is in the square to the left of A
C is in the square below A.

Which of the following routes would get you from C to B?

(i) move one square left and one square up
(ii) move one square right and one square up
(iii) move one square left and one square down
(iv) move one square right and one square down

The correct answer is (i). You could get from C to B by moving one square left and one square up.

DO NOT TURN OVER TO START THE TEST UNTIL INSTRUCTED TO DO SO.

Question 6.

B is in the square to the right of A.
C is in the square below B.
D is in the square to the left of C.

Which of the following routes would get you from A to D?

(i) Move one square down.
(ii) Move one square down and one square to the right.
(iii) Move one square down and one square to the left.
(iv) Move one square to the left.

Question 1.

B is in the square to the right of A.
C is in the square to the right of B.
D is in the square above C.

Which of the following routes would get you from D to A?

(i) Move two squares left and one square down.
(ii) Move one square left and two squares down.
(iii) Move two squares right and one square down.
(iv) Move one square right and two squares down.

Q uestion 2.

B is in the square to the left of A.
C is in the square below B.
D is in the square to the left of C.

Which of these pairs is furthest apart?

(i) A and C (ii) B and D (iii) B and C (iv) A and D

Question 3.

B is in the square to the left of A
C is above B with one empty square between them.

Which of these routes would get you from A to C?

(i) Move one square up, one square right, and another square up.
(ii) Move one square up, one square left, and another square up.
(iii) Move one square right, one square up, and another square right.
(iv) Move one square left, one square up, and another square left.

Question 4.

B is in the square to the right of A.
C is in the square to the right of B.
D is in the square below B.

Which of these pairs is furthest apart?

(i) A and C
(ii) A and D
(iii) C and D
(iv) A and B

Question 7.

A is in the square to the left of B.
D is in the square to the right of C.
B is above C with one square between them.

Which of these pairs is furthest apart?

(i) A and D
(ii) A and C
(iii) B and D
(iv) B and C

Question 9.

B is to the right of A with one empty square between.
C is in the square below B.
D is in the square to the left of C.

If only horizontal and vertical moves are allowed which of these letters would be in squares on the shortest route from A to D?

(i) Neither B nor C
(ii) B but not C
(iii) C but not B
(iv) Both B and C

Question 13.

B is below A with one empty square between them.
A is to the left of C with one empty square between.
D is to the right of B with one empty square between.

If only horizontal and vertical moves are allowed how many empty squares lie on the shortest route from C to D?

(i) 0
(ii) 1
(iii) 2
(iv) 3

Question 10.

B is below A with two empty squares between.
C is in the square to the right of B.
D is above C with one empty square between.

Which of these pairs is closest together?

(i) A and B
(ii) A and C
(iii) A and D
(iv) B and D

Question 8.

B is in the square to the left of A.
C is in the square below B.
D is in the square to the left of C.
E is in the square below D.

Which of these pairs is closest?

(i) A and D
(ii) A and E
(iii) B and D
(iv) B and E

Question 5.

B is in the square above A.
C is in the square to the right of B.
D is in the square below C.
E is in the square to the right of D.

Which of these routes would take you from E to A?

(i) One square left.
(ii) Two squares left.
(iii) One square left and one square up.
(iv) Two squares left and one square up.

Question 11.

B is to the left of A with one empty square between.
C is in the square below B.
D is in the square to the right of C.
E is in the square to the right of D.

If you take the shortest route from E to A how many squares with letters in do you pass through?

(i) 0
(ii) 1
(iii) 2
(iv) 3

Question 12.

B is below A with one empty square between.
C is to the right of B with one empty square between.
D is in the square above C.
E is in the square to the left of D.

Which of these routes would take you from E to A?

(i) One square up and one square left.
(ii) One square up and one square right.
(iii) One square down and one square left.
(iv) One square down and one square right.